CRUISE REPORT

R/V Aranda

Cruise 06/2022

COMBINE 2/2022

30.5.2022 – 11.6.2022

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

Objectives of the cruise

The objectives of the cruise were:

1) The COMBINE 2 cruise contributes 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 contributes to the long-term monitoring of zooplankton communities as well as monitoring of microlitter in sediment and water. Water and sediment samples were taken for the monitoring of radioactive substances (HELCOM MORS programme).
2) Hydrophones were installed for monitoring the underwater soundscape, including noise. In addition a wave buoy and drifting ARGO floats were deployed, and an ADCP mooring recovered.

Table 1

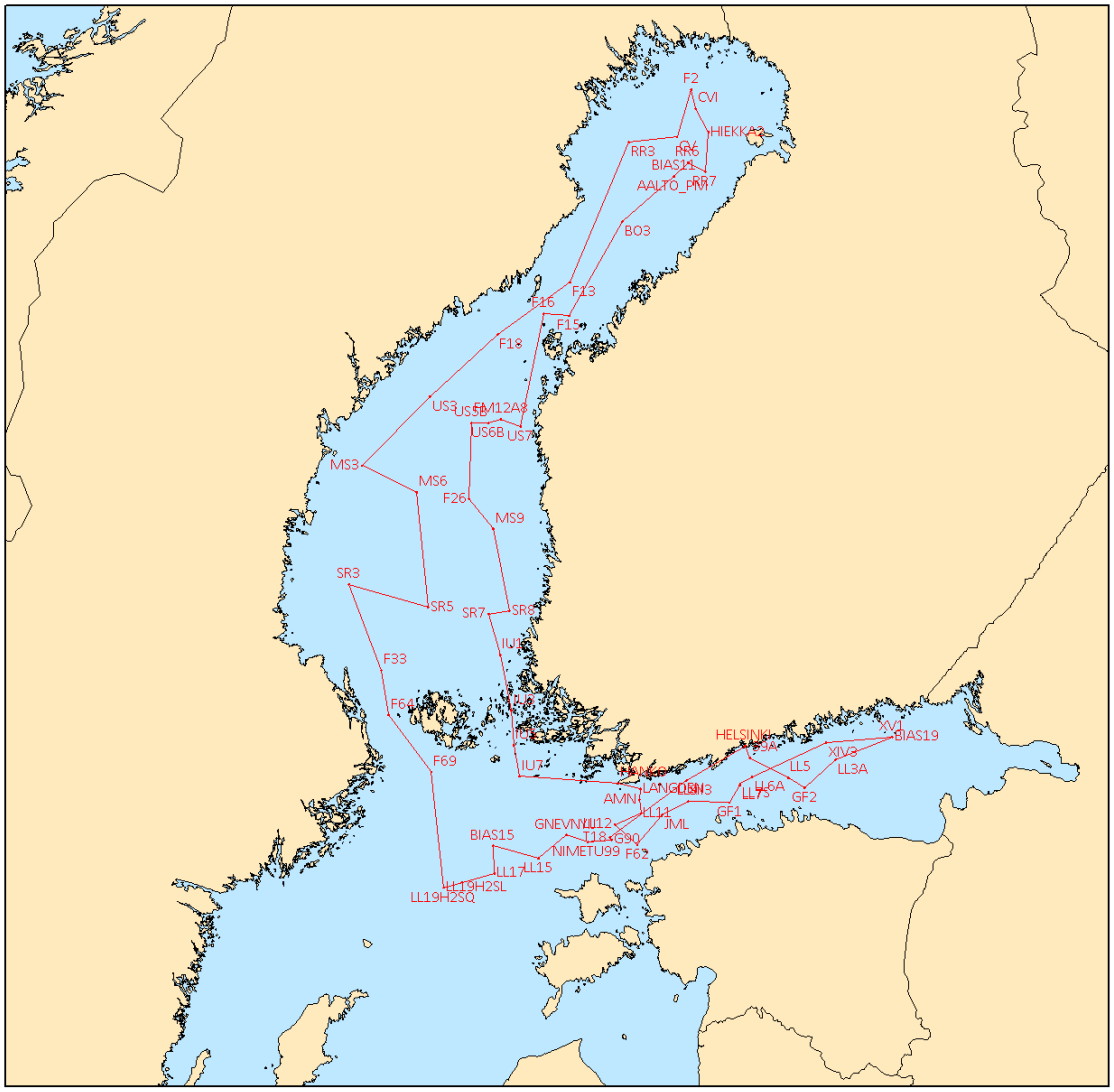
Scientific crew:	Time onboard	Institution
Juha Flinkman	30.5.2022 – 11.6.2022	SYKE
Hänninen Panu	30.5.2022 – 11.6.2022	SYKE
Varmanen Pia	30.5.2022 – 11.6.2022	SYKE
Mira Granlund	30.5.2022 – 11.6.2022	SYKE
Heini Jalli	30.5.2022 – 11.6.2022	FMI
Jonna Kangas	30.5.2022 – 11.6.2022	SYKE
Harri Kankaanpää	30.5.2022 – 11.6.2022	SYKE
Tarja Katajisto	30.5.2022 – 11.6.2022	SYKE
Tanja Kinnunen	30.5.2022 – 11.6.2022	SYKE
Ilkka Lastumäki	30.5.2022 – 11.6.2022	SYKE
Maiju Lehtiniemi	30.5.2022 – 02.6.2022	SYKE
Siru Tasala	30.5.2022 – 11.6.2022	SYKE
Riikka Mattson	30.5.2022 – 11.6.2022	SYKE
Anna-Riina Mustonen	30.5.2022 – 02.6.2022	SYKE
Okko Outinen	30.5.2022 – 11.6.2022	SYKE
Sami Rantapusa	30.5.2022 – 11.6.2022	FMI
Outi Setälä	30.5.2022 – 11.6.2022	SYKE
Katharina Heinrich	02.6.2022 – 12.6.2022	ULAPLAND

Cruise Route

The cruise started 30th May in Helsinki, covered Gulf of Finland, Archipelago Sea, Bothnian Sea, Quarken, Bothnian Bay, Åland Sea, NW Baltic Proper and finished in Helsinki on 11th June 2022. Cruise covered all stations in HELCOM Combine monitoring scheme for zoobenthos-, zpl-, chemical and physical monitoring.

Finnish Environment Institute
Agnes Sjöbergin katu 2
FI-00790 Helsinki
Finland
http://www.syke.fi/en

Finnish Meteorological Institute
Erik Palménin aukio 1
P.O. Box 503
FI-00101 Helsinki
Finland
http://en.ilmatieteenlaitos.fi/



Cruise route

Observations

Please cf. to graphs in appendix 1. Averages, standard deviations and variability mentioned in text are calculated from year 2000 to present.

1. Gulf of Finland and NW Baltic Proper:

   Deep water oxygen situation In GoF remains poor, as all stations that have depths greater than average halocline depth (±70m) have anoxic or very low oxygen content in near-bottom water. In most cases H_2S was present in abundance, resulting in omitting zoobenthos sampling. Surface water temperatures were at higher end of standard deviation. Salinity was towards lower end of the inter-annual variability at surface, but towards higher or average at deeper, sub-thermocline water. This links with low oxygen content. Nutrients, measured as nitrate-nitrite and phosphate, were? towards higher end of deviation range, especially in deeper water layers, indicating perhaps increased internal loading of phosphorus from sediments due to anoxic conditions.

Finnish Environment Institute
Agnes Sjöbergin katu 2
FI-00790 Helsinki
Finland
http://www.syke.fi/en

Finnish Meteorological Institute
Erik Palménin aukio 1
P.O. Box 503
FI-00101 Helsinki
Finland
http://en.ilmatieteenlaitos.fi/

2. Aland Sea, Bothnian Sea and Bay of Bothnia:

   At Åland Sea deep station F64 the temperature and oxygen content were quite close to average. However, the salinity is beyond the standard deviation, perhaps indicating a “spill” of more saline water over the Åland sill. Nutrients are mostly close to averages, except phosphate in intermediate layers below thermocline to 150m, where they are close to higher end of deviation. This may coincide with increased salinity.

   At Bothnian Sea stations temperature is somewhat high at surface, but through the water column well within deviation. Oxygen content displays similar trend at stations SR5 and US5b: lower at surface, but higher at depth, even exceeding daviation limits in near bottom water. As for nutrients, nitrite-nitrate is ae?? quite near the averages, as well as phosphate at US5b. However, at SR5 the phosphate well exceeds, or is at higher end of deviation.

   At Bay of Bothnia the situation is different between southern (BO3) and northern (F2) ends of the basin. Temperature at south is higher at surface,but towards th?? lower end of deviation at deeper layers, whereas at northern end is higher at the surface and lower at depth so that both ends exceed the deviation limits. Salinity at southern end sits quite well at higher end of deviation limit, but at north it’s below the deviation limit at surface, and shifts towards higher end of deviation at depth. Nutrients display differences between southern and northewrn ends of the basin as well: Nitrite-nitrate is towards lower end of deviation scale in the south, but over the higher end of deviation in the north. Phosphate is way over the high limit of deviation scale, and also high at north, however within the deviation limits.

3. General remarks

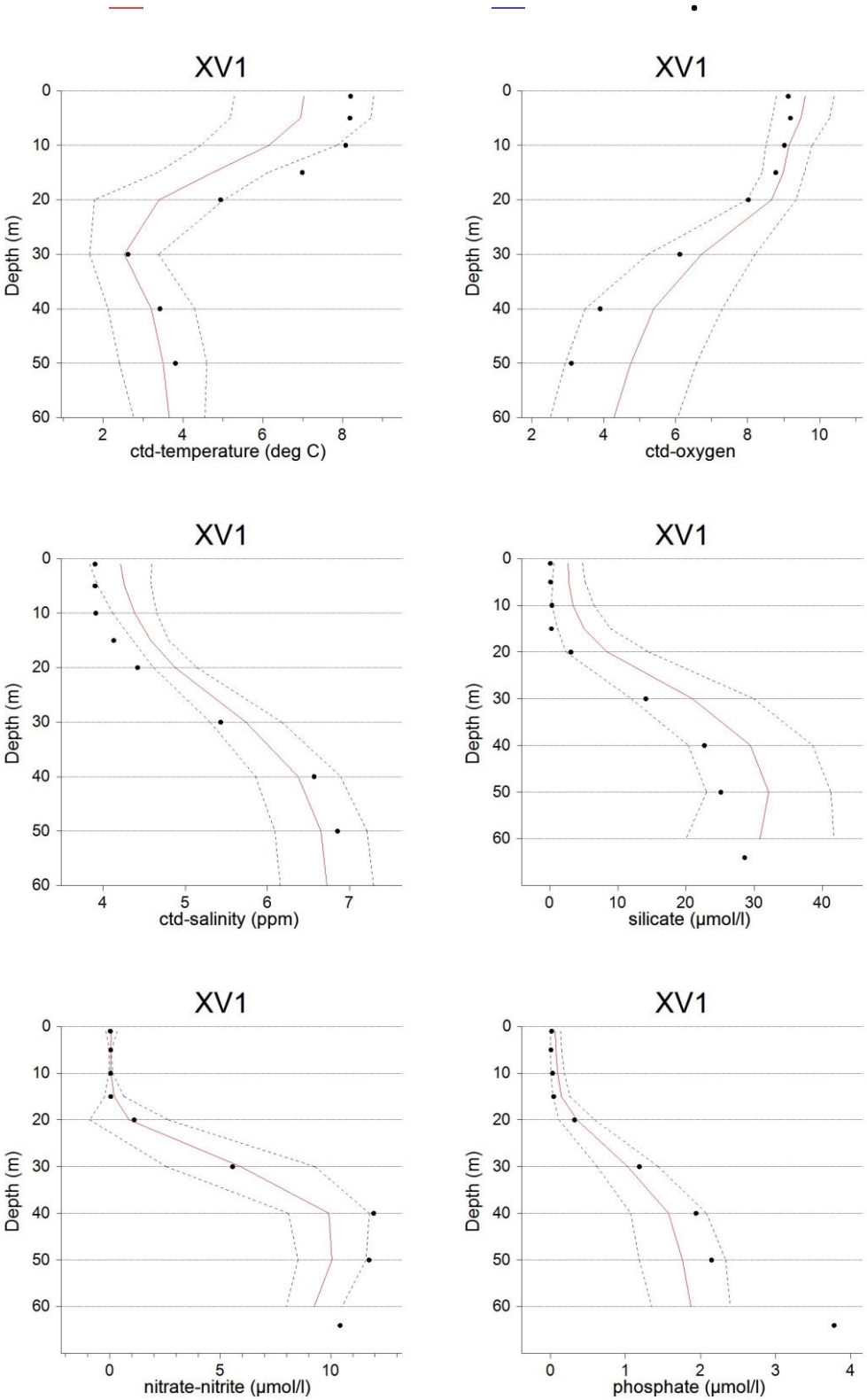
   The cruise was successful in obtaining all the goals set for it. This was facilitated by exceptionally good weather allowing fast cruising between stations and efficient station work. All deployments and retrievals of moored equipment were succesful and proceeded according to plans. Due to time saved by good conditions, we were able to survey som potentially environmentally hazardous wrecks by hydroacoustic methods at GoF on the return leg.

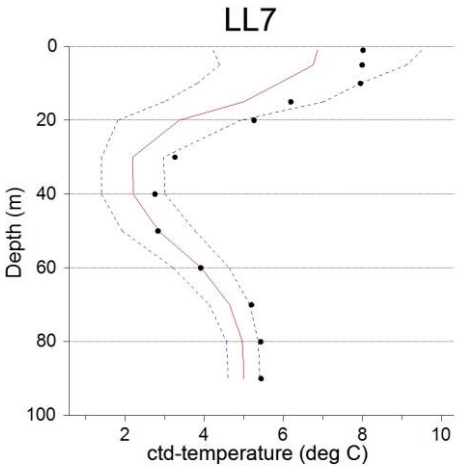
Conclusions

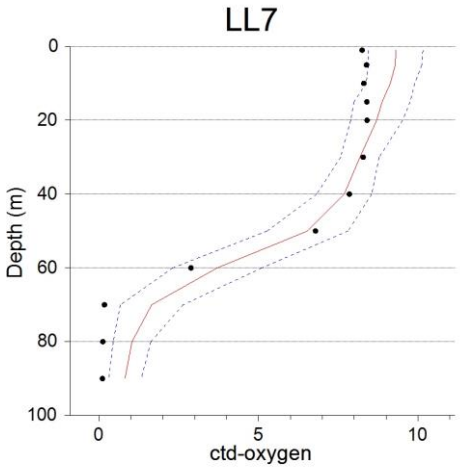
Based on preliminary observations on the data, it seems that unfavorable stratification at Gulf of Finland continues, resulting in anoxic bottoms at practically all stations where the deth exceed that of halocline. Situation is of course similar or even worse at the Baltic Proper, where lack of saline water inflows since 2015 has resulted in practically all water below halocline to become anoxic. This of course results in release of phosphorus from sediments due to anoxic condition, leading to increased internal loading, which in turn facilitates blue-green blooms.

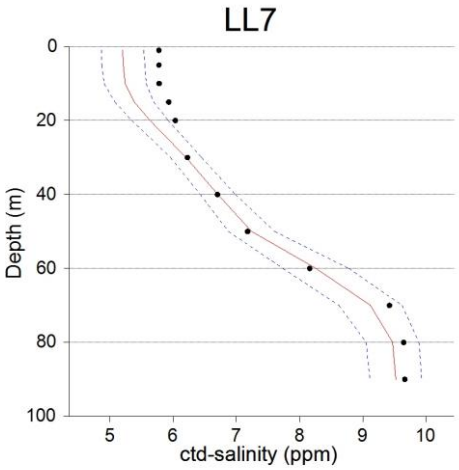
North of Åland sill the deep water still has oxygen, but the increase in salinity, decrease in deep water oxygen levels at some stations are worrying. Even more so is the general rise of temperetures observed at several stations. This is also detectable in deep water layers, making it more significant.

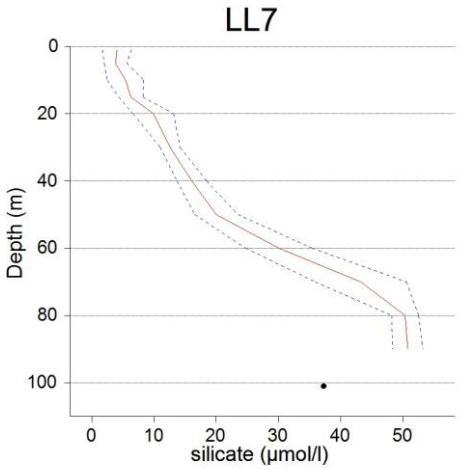
Annex 1. Selected variables at the stations XV1, LL7, LL12, LL17, F64, SR5, US5B, BO3 and F2. Mean (red solid line) and standard deviation (blue dotted lines) represent the data collected at the same time of season since the year 2000.

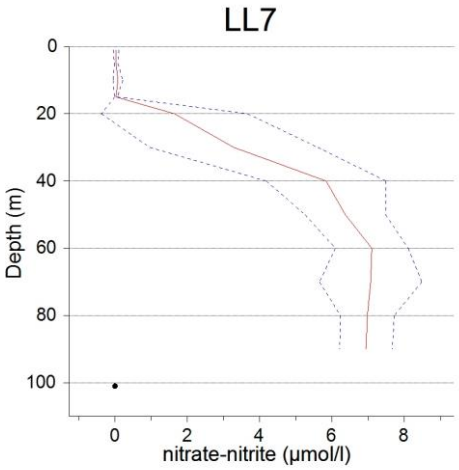


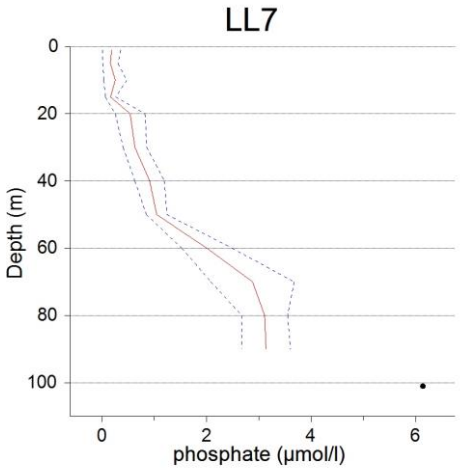

LL7
Depth (m)
0
20
40
60
80
100
2
4
6
8
10
ctd-temperature (deg C)

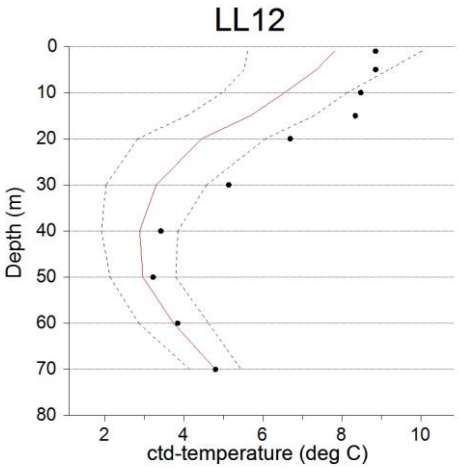

LL7
Depth (m)
0
20
40
60
80
100
0
5
10
ctd-oxygen

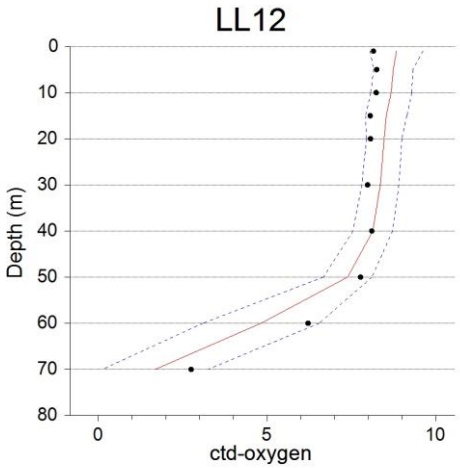

LL7
Depth (m)
0
20
40
60
80
100
5
6
7
8
9
10
ctd-salinity (ppm)

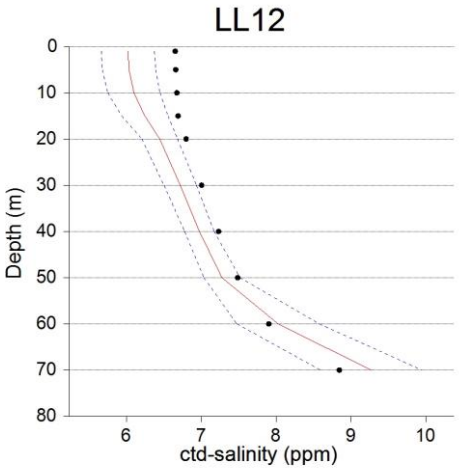

LL7
Depth (m)
0
20
40
60
80
100
0
10
20
30
40
50
silicate (µmol/l)

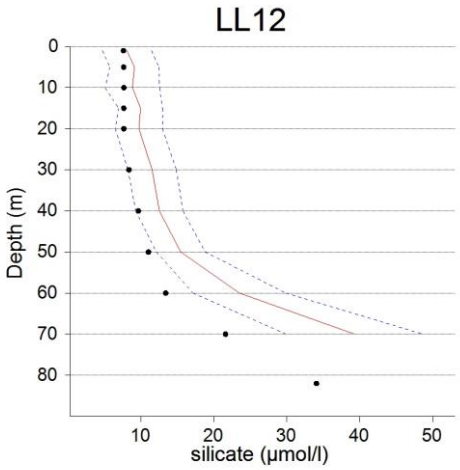

LL7
Depth (m)
0
20
40
60
80
100
0
2
4
6
8
nitrate-nitrite (µmol/l)

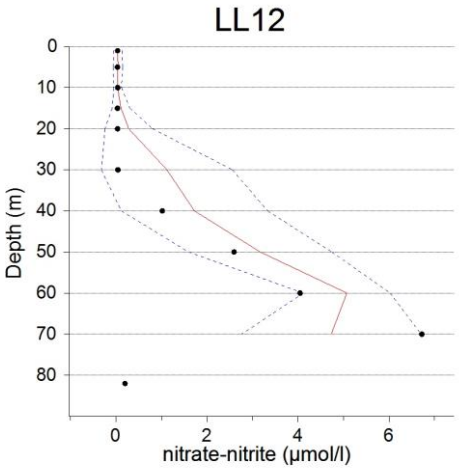

LL7
Depth (m)
0
20
40
60
80
100
0
2
4
6
phosphate (µmol/l)

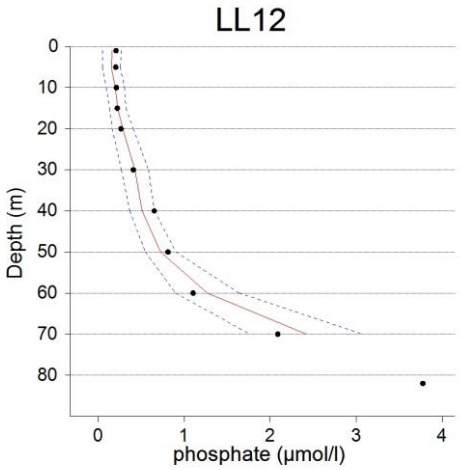

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
2
4
6
8
10
ctd-temperature (deg C)

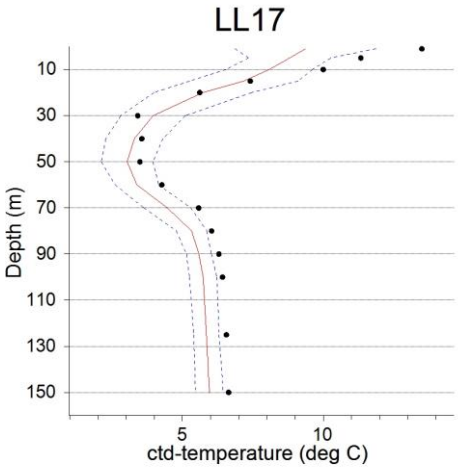

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
0
5
10
ctd-oxygen

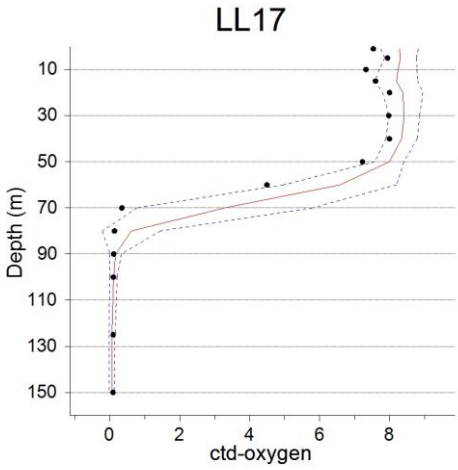

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
6
7
8
9
10
ctd-salinity (ppm)

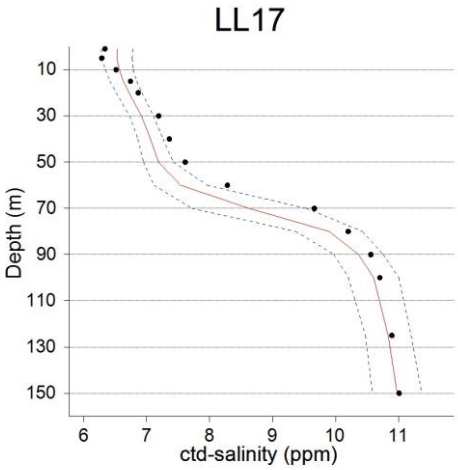

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
10
20
30
40
50
silicate (µmol/l)

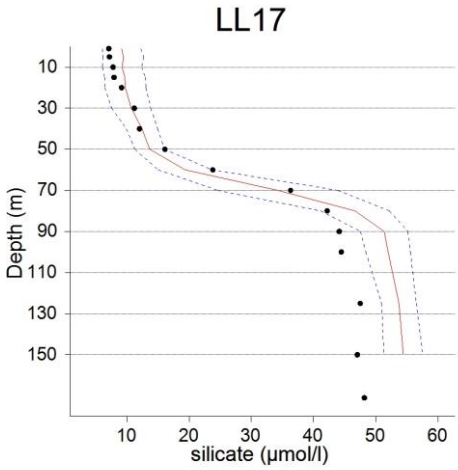

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
nitrate-nitrite (µmol/l)

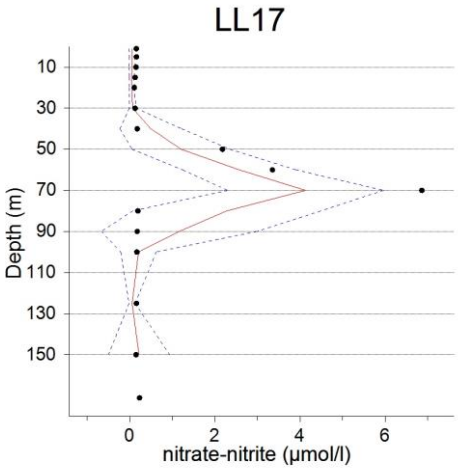

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
phosphate (µmol/l)

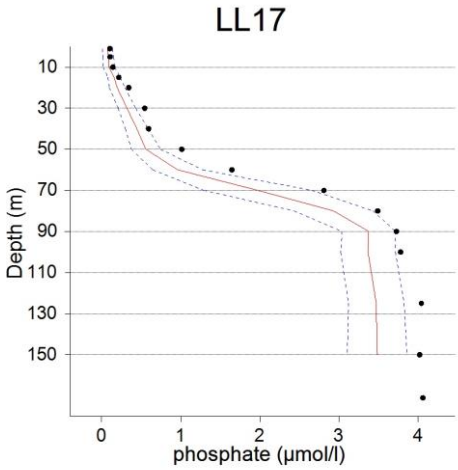

LL17
Depth (m)
10
30
50
70
90
110
130
150
5
10
ctd-temperature (deg C)

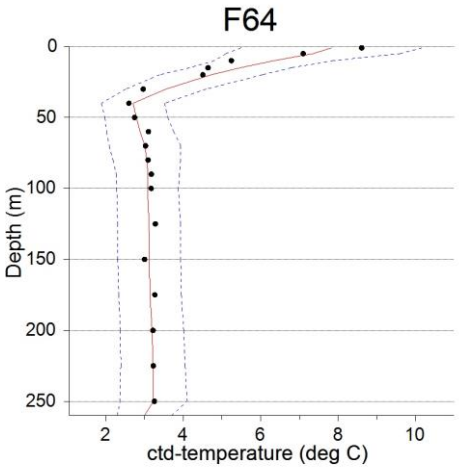

LL17
Depth (m)
10
30
50
70
90
110
130
150
0
2
4
6
8
ctd-oxygen

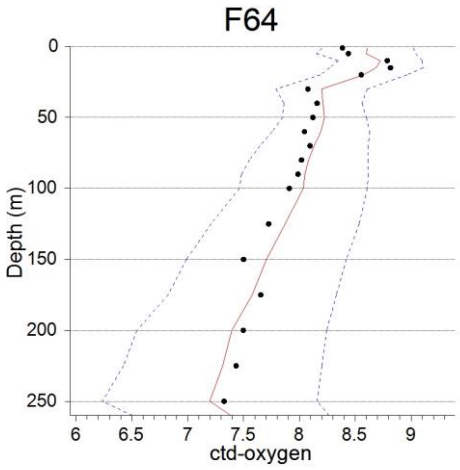

LL17
Depth (m)
10
30
50
70
90
110
130
150
6
7
8
9
10
11
ctd-salinity (ppm)

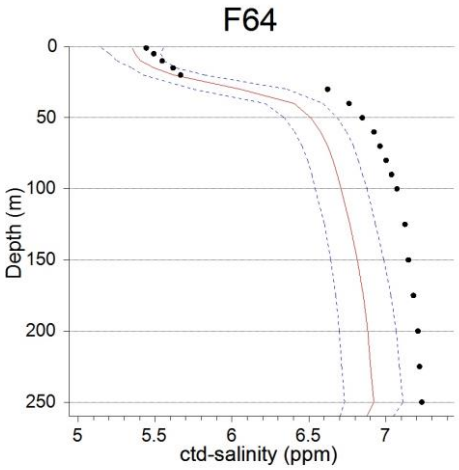

LL17
Depth (m)
10
30
50
70
90
110
130
150
10
20
30
40
50
60
silicate (µmol/l)

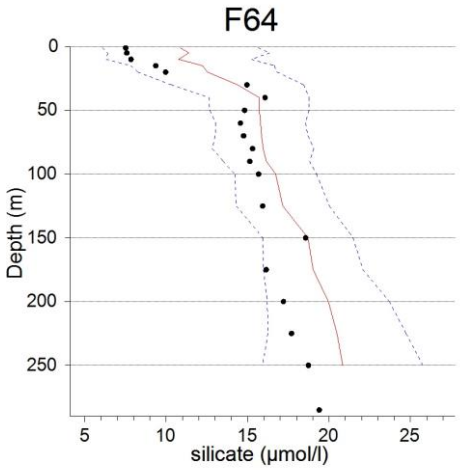

LL17
Depth (m)
10
30
50
70
90
110
130
150
0
2
4
6
nitrate-nitrite (µmol/l)

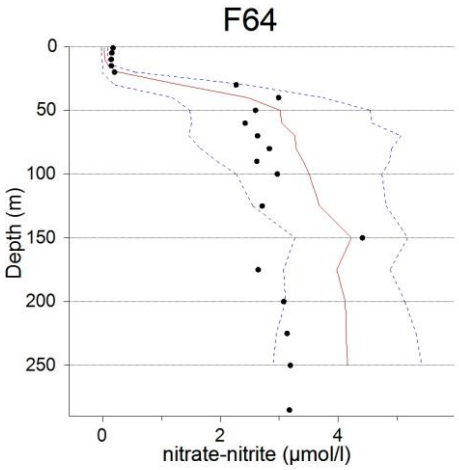

LL17
Depth (m)
10
30
50
70
90
110
130
150
0
1
2
3
4
phosphate (µmol/l)

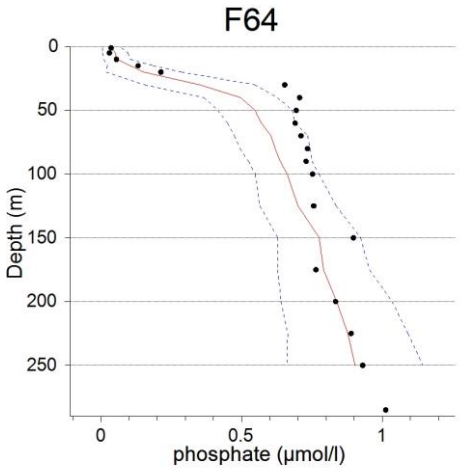

F64
Depth (m)
0
50
100
150
200
250
2
4
6
8
10
ctd-temperature (deg C)

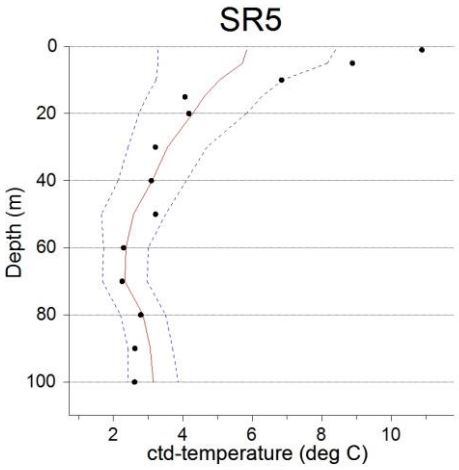

F64
Depth (m)
0
50
100
150
200
250
6
6.5
7
7.5
8
8.5
9
ctd-oxygen

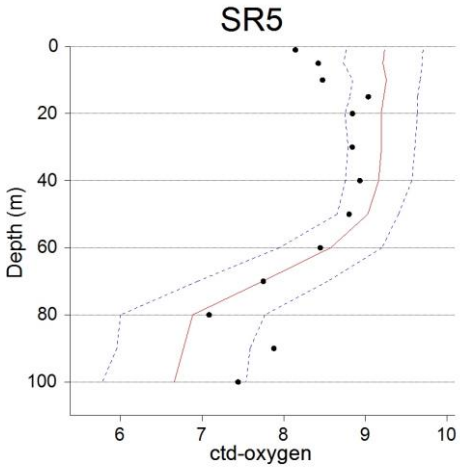

F64
Depth (m)
0
50
100
150
200
250
5
5.5
6
6.5
7
ctd-salinity (ppm)

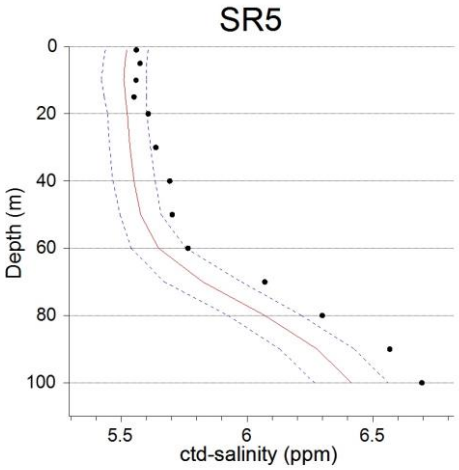

F64
Depth (m)
0
50
100
150
200
250
5
10
15
20
25
silicate (µmol/l)

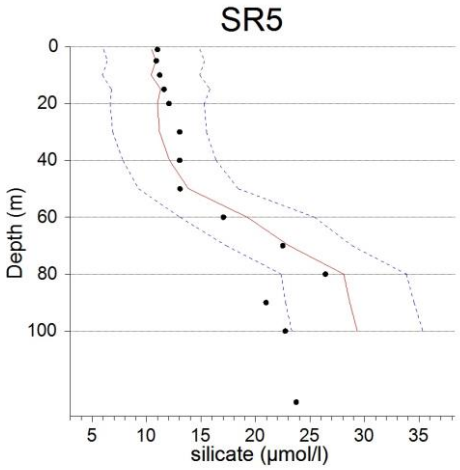

F64
Depth (m)
0
50
100
150
200
250
0
2
4
nitrate-nitrite (µmol/l)

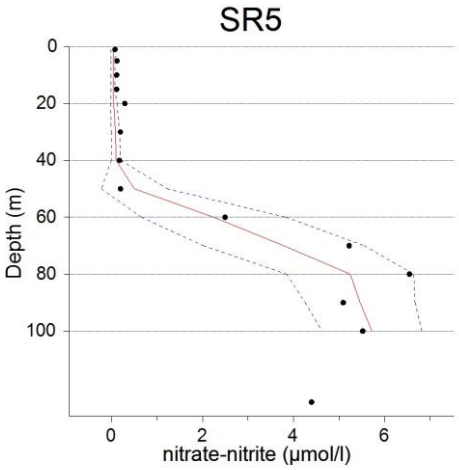

F64
Depth (m)
0
50
100
150
200
250
0
0.5
1
phosphate (µmol/l)

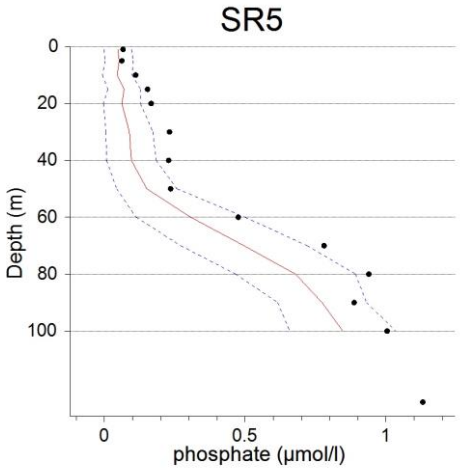

SR5
Depth (m)
0
20
40
60
80
100
2
4
6
8
10
ctd-temperature (deg C)

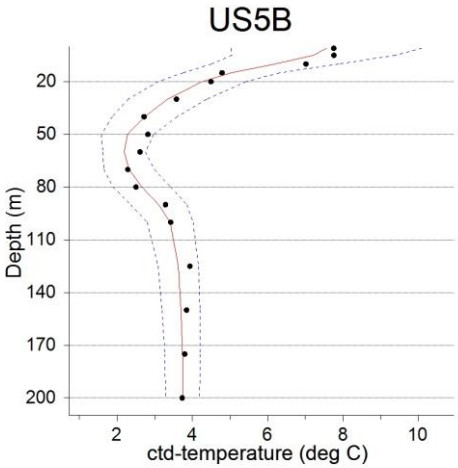

SR5
Depth (m)
0
20
40
60
80
100
6
7
8
9
10
ctd-oxygen

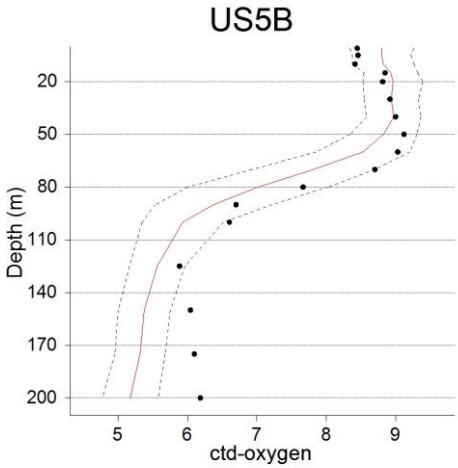

SR5
Depth (m)
0
20
40
60
80
100
5.5
6
6.5
ctd-salinity (ppm)

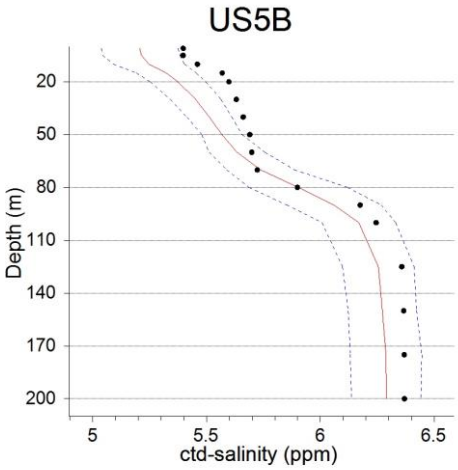

SR5
Depth (m)
0
20
40
60
80
100
5
10
15
20
25
30
35
silicate (µmol/l)

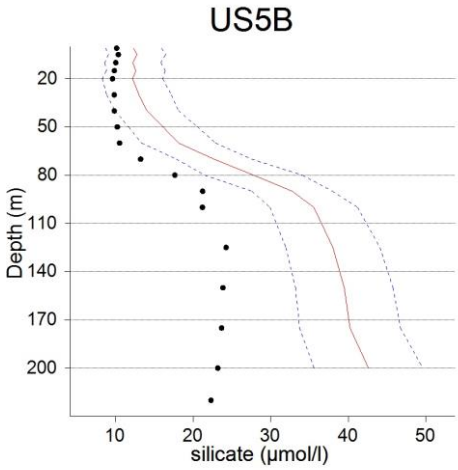

SR5
Depth (m)
0
20
40
60
80
100
0
2
4
6
nitrate-nitrite (µmol/l)

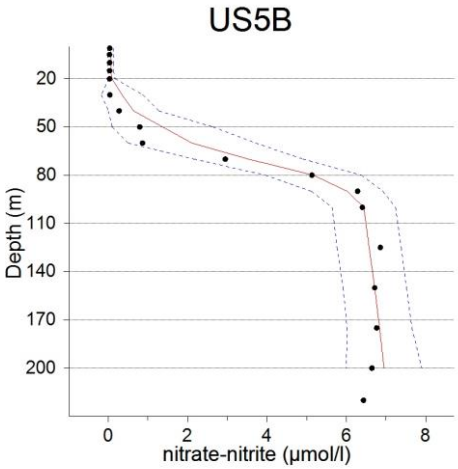

SR5
Depth (m)
0
20
40
60
80
100
0
0.5
1
phosphate (µmol/l)

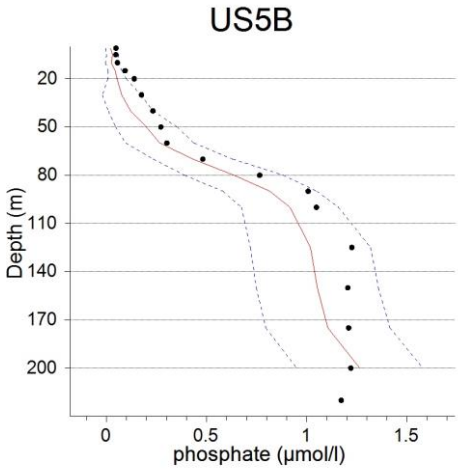

US5B
Depth (m)
20
50
80
110
140
170
200
2
4
6
8
10
ctd-temperature (deg C)

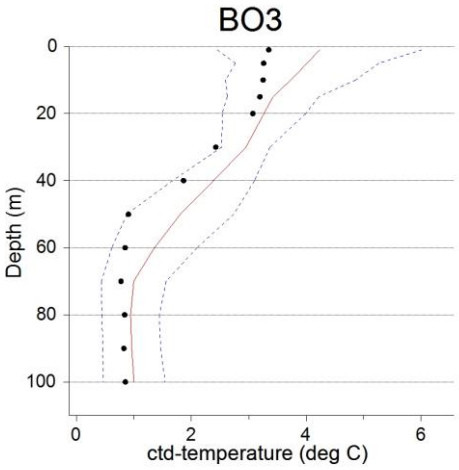

US5B
Depth (m)
20
50
80
110
140
170
200
5
6
7
8
9
ctd-oxygen

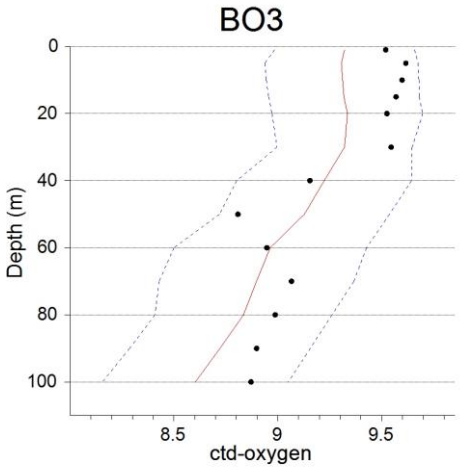

US5B
Depth (m)
20
50
80
110
140
170
200
5
5.5
6
6.5
ctd-salinity (ppm)

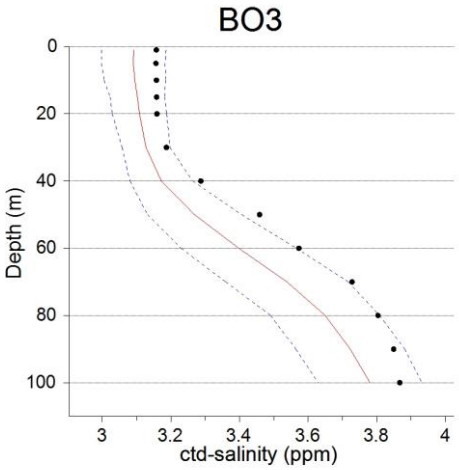

US5B
Depth (m)
20
50
80
110
140
170
200
10
20
30
40
50
silicate (µmol/l)

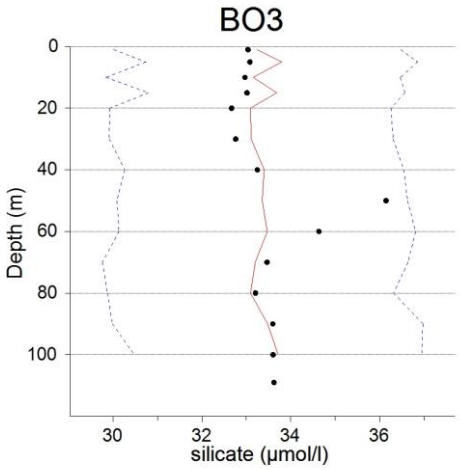

US5B
Depth (m)
20
50
80
110
140
170
200
0
2
4
6
8
nitrate-nitrite (µmol/l)

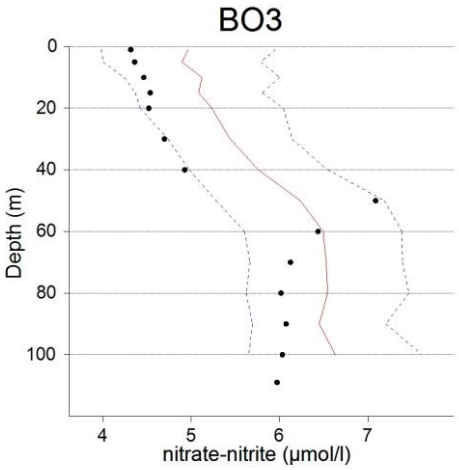

US5B
Depth (m)
20
50
80
110
140
170
200
0
0.5
1
1.5
phosphate (µmol/l)

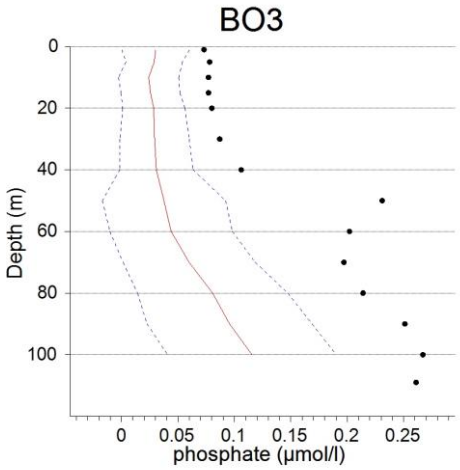

BO3
Depth (m)
0
20
40
60
80
100
0
2
4
6
ctd-temperature (deg C)

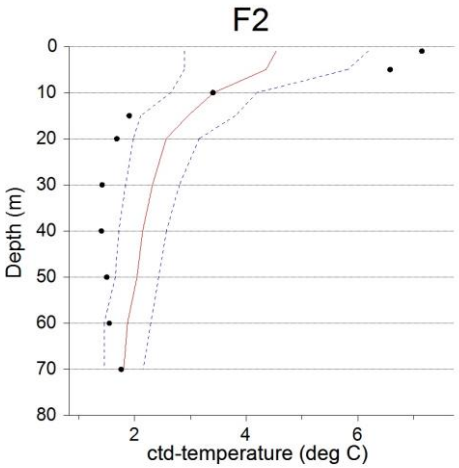

BO3
Depth (m)
0
20
40
60
80
100
8.5
9
9.5
ctd-oxygen

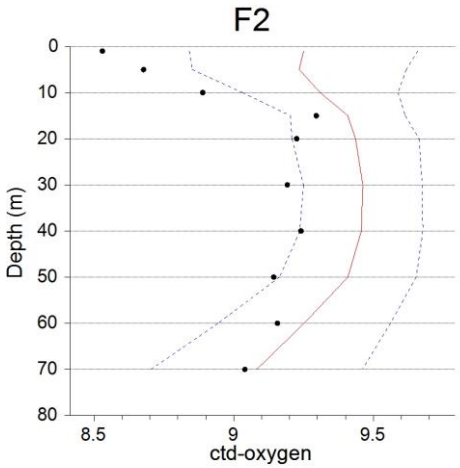

BO3
Depth (m)
0
20
40
60
80
100
3
3.2
3.4
3.6
3.8
4
ctd-salinity (ppm)

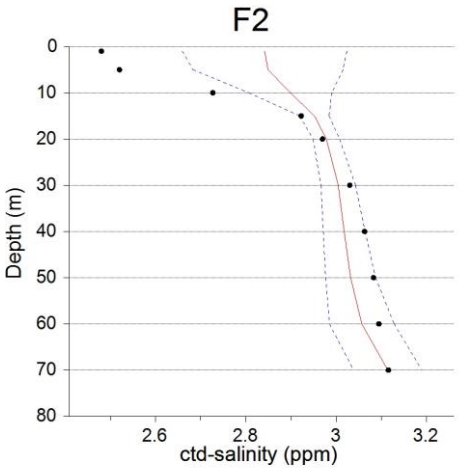

BO3
Depth (m)
0
20
40
60
80
100
30
32
34
36
silicate (µmol/l)

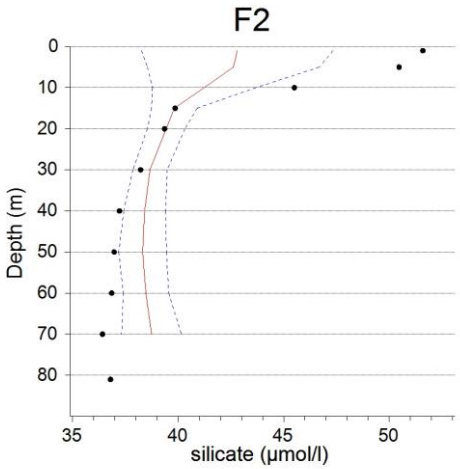

BO3
Depth (m)
0
20
40
60
80
100
4
5
6
7
nitrate-nitrite (µmol/l)

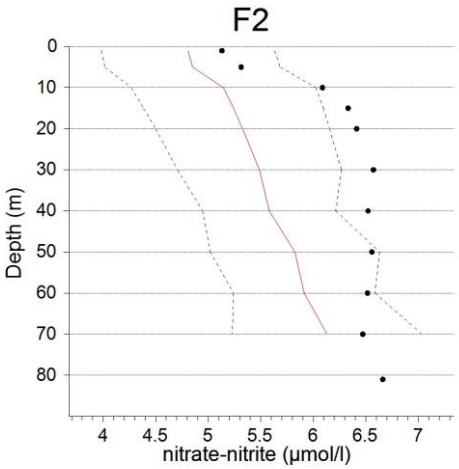

BO3
Depth (m)
0
20
40
60
80
100
0
0.05
0.1
0.15
0.2
0.25
phosphate (µmol/l)

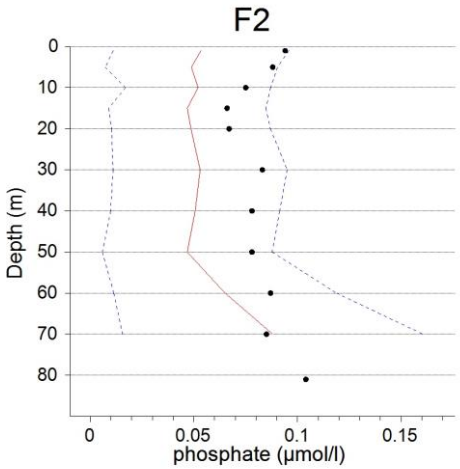

F2
Depth (m)
0
10
20
30
40
50
60
70
80
2
4
6
ctd-temperature (deg C)


F2
Depth (m)
0
10
20
30
40
50
60
70
80
8.5
9
9.5
ctd-oxygen


F2
Depth (m)
0
10
20
30
40
50
60
70
80
2.6
2.8
3
3.2
ctd-salinity (ppm)


F2
Depth (m)
0
10
20
30
40
50
60
70
80
35
40
45
50
silicate (µmol/l)


F2
Depth (m)
0
10
20
30
40
50
60
70
80
4
4.5
5
5.5
6
6.5
7
nitrate-nitrite (µmol/l)


F2
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.05
0.1
0.15
phosphate (µmol/l)

Annex 2. List of sampled stations of the cruise

INDEX	STATION	latitude	longitude	depth	DATE	time	ctd	pH	ox	nu	ph	zo	be	chl	oil	tox	secchi
HELSINKI	HELSINKI	60.16182	24.90158		2022-05-30	06:23											
2022010159	39A	60.06685	24.98032	42	2022-05-30	10:05	x	x	x	x				x			x
2022010160	LL5	59.91678	25.59718	69	2022-05-30	13:31	x	x	x	x			x	x			x
2022010161	GF2	59.83855	25.85697	85	2022-05-30	16:40	x	x	x	x			x	x			x
2022010162	LL3A	60.06718	26.34675	68	2022-05-30	21:11	x	x	x	x		x	x	x			
2022010163	BIAS19	60.25002	27.24798	64	2022-05-31	04:25											
2022010164	XV1	60.25003	27.24705	65	2022-05-31	09:36	x	x	x	x		x	x	x			x
2022010165	XIV3	60.20318	26.19272	80	2022-05-31	16:19	x	x	x	x				x			
2022010166	LL6A	59.91680	25.03018	72	2022-05-31	22:09	x	x	x	x			x	x			
2022010167	LL7S	59.85858	24.83765	76	2022-06-01	00:27	x	x	x	x		x	x	x			
2022010168	LL7	59.84645	24.83785	102	2022-06-01	03:20	x		x	x							
2022010169	GF1	59.70500	24.68222	84	2022-06-01	05:10	x	x	x	x		x	x	x			x
2022010170	LL9	59.70015	24.03013	66	2022-06-01	08:46	x	x	x	x		x	x	x			x
2022010171	JML	59.58177	23.62683	80	2022-06-01	12:04	x	x	x	x			x	x			x
2022010172	F62	59.33360	23.26342	97	2022-06-01	16:23	x	x	x	x				x			x
2022010173	LL12	59.48358	22.89705	83	2022-06-01	18:57	x	x	x	x		x	x				
2022010174	LL11	59.58352	23.29677	67	2022-06-01	22:59	x	x	x	x			x	x			
2022010175	AMN	59.69048	23.25718	55	2022-06-02	01:02	x	x	x	x			x	x			
2022010176	LANGDEN	59.77687	23.26292	57	2022-06-02	02:43	x	x	x	x		x	x	x			
HANKO	HANKO	59.80983	22.90323		2022-06-02	07:08											
2022010177	IU7	59.81517	21.33667	92	2022-06-02	14:08	x	x	x	x		x		x			x
2022010178	IU5	60.05813	21.19827	90	2022-06-02	17:51	x	x	x	x			x	x			
2022010179	IU3	60.33327	21.11320	51	2022-06-03	00:16	x	x	x	x			x	x			
2022010180	IU1	60.76685	20.84683	33	2022-06-03	04:35	x	x	x	x				x			
2022010181	SR7	61.08340	20.59643	78	2022-06-03	08:02	x	x	x	x			x	x			x
2022010182	SR8	61.12645	20.92990	47	2022-06-03	11:06	x	x	x	x				x			x
2022010183	MS9	61.76683	20.53052	101	2022-06-03	16:03	x	x	x	x			x	x			x
2022010184	F26	61.98347	20.06302	138	2022-06-03	19:41	x	x	x	x			x	x			
2022010185	US5B	62.58618	19.96885	221	2022-06-04	01:18	x	x	x	x		x	x	x			
2022010186	US6B	62.60018	20.26305	82	2022-06-04	05:44	x	x	x	x			x	x			x
2022010187	FM12A8	62.64317	20.47248	39	2022-06-04	09:08	x	x	x	x				x			x
2022010188	US7	62.60015	20.82962	27	2022-06-04	12:40	x	x	x	x				x			x
2022010189	F16	63.51683	21.06285	50	2022-06-04	20:25	x	x	x	x		x	x	x			
2022010190	F15	63.51685	21.51297	48	2022-06-04	23:34	x	x	x	x			x	x			
2022010191	BO3	64.30202	22.34317	110	2022-06-05	05:48	x	x	x	x		x	x	x			x
2022010192	BIAS11	64.68515	23.23898	78	2022-06-05	12:26											x
2022010193	AALTO_PM	64.68392	23.23498	81	2022-06-05	17:24	x										
2022010194	RR6	64.80028	23.47952	87	2022-06-05	19:00	x	x	x	x			x				
2022010195	RR7	64.73367	23.81280	39	2022-06-05	21:47	x	x	x	x				x			
2022010196	HIEKKA2	65.05000	23.83333	21	2022-06-06	00:34	x	x	x	x			x	x			
2022010197	CVI	65.23368	23.56292	68	2022-06-06	02:40	x	x	x	x			x	x			x
2022010198	F2	65.38368	23.46263	82	2022-06-06	06:23	x	x	x	x		x		x			x
2022010199	CV	65.00033	23.24615	87	2022-06-06	10:25	x	x	x	x			x	x			x
2022010200	RR3	64.93375	22.34618	94	2022-06-06	14:13	x	x	x	x			x	x			x
2022010201	F13	63.78352	21.47950	64	2022-06-06	23:07	x	x	x	x				x			
2022010202	F18	63.31438	20.27278	104	2022-06-07	05:13	x	x	x	x			x	x			x
2022010203	US3	62.75883	19.19568	176	2022-06-07	12:12	x	x	x	x			x	x			x
2022010204	MS3	62.13448	18.16292	84	2022-06-07	18:48	x	x	x	x			x	x			
2022010205	MS6	61.98367	19.16350	73	2022-06-07	23:21	x	x	x	x			x	x			
2022010206	SR5	61.08330	19.57960	126	2022-06-08	06:01	x	x	x	x		x	x	x			x
2022010207	SR3	61.18340	18.23012	73	2022-06-08	16:50	x	x	x	x			x	x			x
2022010208	F33	60.53317	18.93763	135	2022-06-08	22:58	x	x	x	x				x			
2022010209	F64	60.18902	19.14250	286	2022-06-09	02:37	x	x	x	x		x	x	x			x
2022010210	F69	59.78333	19.92997	193	2022-06-09	12:12	x	x	x	x			x	x			x
2022010211	LL19	58.88067	20.31083	166	2022-06-09	19:55	x	x	x	x			x				
2022010212	LL19H2SL	58.88067	20.31083	166	2022-06-09	21:27	x										
2022010213	LL19H2SQ	58.88067	20.31083	166	2022-06-09	22:05	x										
2022010214	LL17	59.03323	21.07910	172	2022-06-10	01:45	x	x	x	x		x	x	x			
2022010215	BIAS15	59.24970	21.01623	90	2022-06-10	05:41											
2022010216	LL15	59.18333	21.74687	131	2022-06-10	12:54	x	x	x	x			x	x			x
2022010217	GNEVNYIJ	59.38155	22.15000	82	2022-06-10	16:06											
2022010218	NIMETU99	59.33587	22.49060	103	2022-06-10	19:12											
2022010219	G90	59.36338	22.86392	91	2022-06-10	20:27											
2022010220	T18	59.38205	22.83392	95	2022-06-10	22:00											
2022010221	XII3	59.86420	23.98588	36	2022-06-11	04:14	x	x	x	x				x			x
HELSINKI	HELSINKI	60.16157	24.90158		2022-06-11	10:32											

Parameters: ox = oxygen, nu = nutrients, ph = phytoplankton, zo = zooplankton, be = benthos, chl = chlorophyll a, oil = dissolved oil, tox = phytotoxins.

Group photo of scientific crew Combine 2, 2022.