CRUISE REPORT

R/V Aranda

Cruise 01/2021

Combine 1 leg 2 GOF

22.1.2021 – 31.1.2021

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

Objectives of the cruise

The objectives of the cruise were:

1) to monitor water chemistry and nutrients in the Archipelago Sea, the Gulf of Bothnia and the Northern Baltic Proper. Monitored parameters were temperature, salinity, conductivity, density, fluorescence, dissolved oxygen/hydrogen sulphide, pH and nutrients (Ntot, Ptot, NH4, NO2,3, PO4) and silicate;
2) to analyze concentrations of oils and harmful substances;
3) to maintain automated wave buoys in the Bothnian Sea and the Northern Baltic Proper;
4) to install hydrophones in the Bothnian Bay and in the Northern Baltic Proper;
5) to study coverage, thickness and quality of ice in the Bothnian Bay and spatial coverage of ice during the cruise;
6) Reference samples of sediments for WARTOX -project (A study of the toxic substances of chemical munition)

Table 1 The scientific crew

Name	On board	Organization
Pekka Kotilainen	**22.-.31.1.2021**	**SYKE**
Ilkka Lastumäki	**22.-.31.1.2021**	**SYKE**
Tanja Kinnunen	**22.-.31.1.2021**	**SYKE**
Jere Riikonen	**22.-.31.1.2021**	**SYKE**
Panu Hänninen	**22.-.31.1.2021**	**SYKE**
Olga Kovru	**22.-.31.1.2021**	**SYKE**
Okko Outinen	**22.-.31.1.2021**	**SYKE**
Antti Räike	**22.-.31.1.2021**	**SYKE**
Heini Jalli	**22.-.31.1.2021**	**IL**
Pekka Kosloff	**22.-.31.1.2021**	**IL**
Eero Rinne	**22.-.31.1.2021**	**IL**
Mikko Lensu	**22.-.31.1.2021**	**IL**

Cruise Route

The 2nd leg of the COMBINE 1 winter cruise started from the port of Hanko on the 22nd of January 2021. Due to increasing wind Aranda headed straight to the Archipelago Sea and started at the station IU7 and then sailing the Archipelago Sea towards the north (stations IU5, IU3 and IU1).

After that, the route followed the Finnish coast of the Bothnian Sea SR8, SR7, SR5, and then headed to the station MS9. The cruise continued with a maintenance of the wave buoy in the Bothnian Sea, and then followed the stations F26 and MS6. In the evening on the 24th of January, the stations US7, US6b, US5b were monitored.
The first station in Kvarken sampled was F15 and then the cruise headed to the Bothnian Bay at BO3. A hydrophone at the station BIAS11 was released on the 26th of January, Tuesday night.
In the Bothnian Bay the stations RR7, RR6, CV, CVI, F2, RR3 were monitored. Then followed three stations in Kvarken F13, F16 and F18. Back to the south, in the Bothnian Sea US3, MS3, SR3 and F33 were sampled and then, station F64 between the Åland Islands and Sweden.
South of Åland station F69 was monitored before moving for the CT chain installation in the Southern Archipelago Sea. The installation was obliged to be carried out in day light and in favourable weather conditions. After the installation maintenance of the wave buoy and hydrophone installation were carried out, and finally, LL transect of 4 stations (LL19, LL17, LL15, LL12) were monitored and an amendment to LL7, before the arrival and to Helsinki.

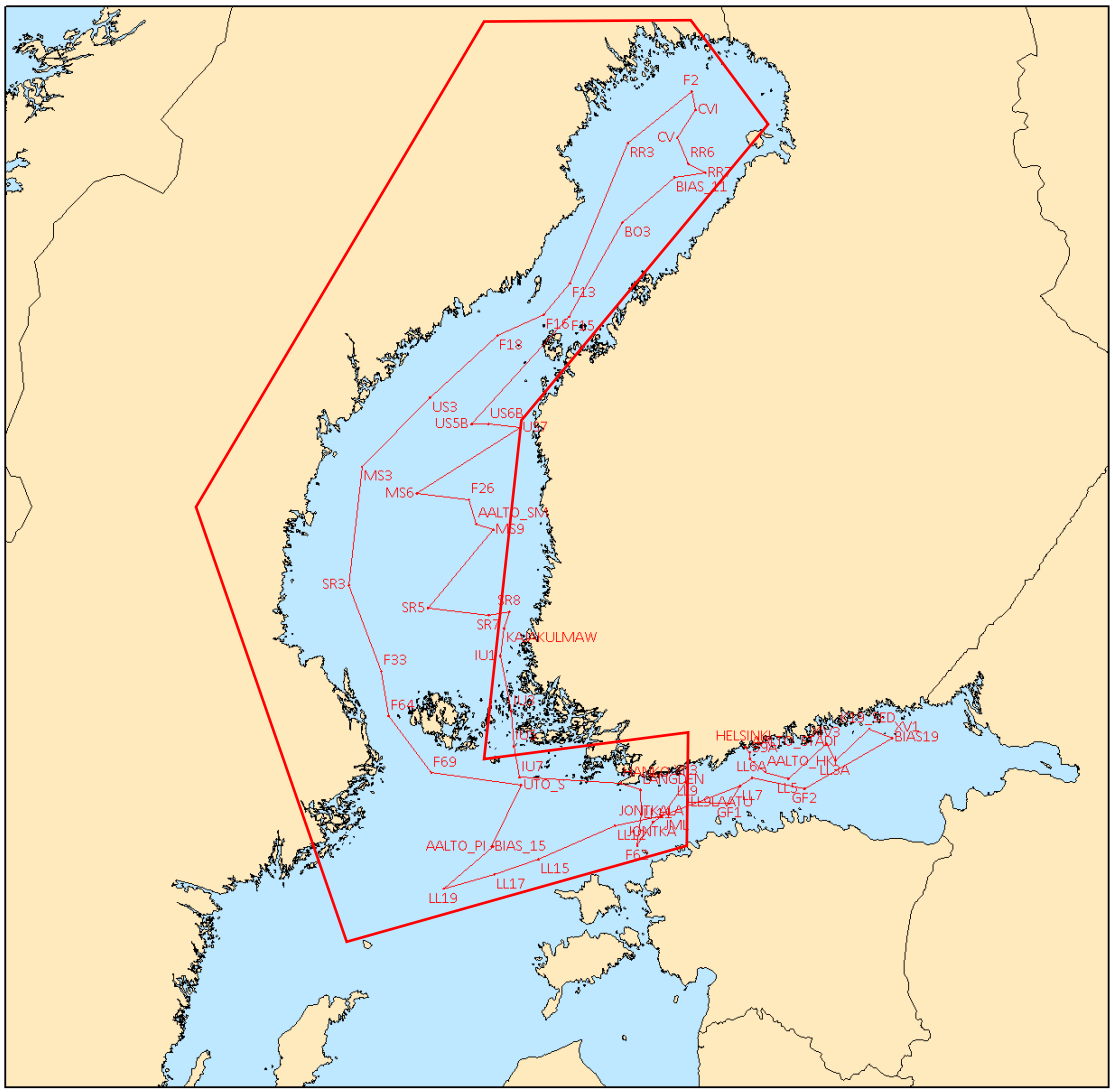


Figure 1. Cruise route of the 2nd leg of the COMBINE 1 / 2021.

Conclusions

Hydrography

Archipelago Sea
Entire water column was completely mixed from surface to bottom.

Bothnian Sea
Clear stratification was observed below 60-80m at deep stations. Thermocline and halocline were typical, but well-defined oxycline was also observed. Oxycline indicates a clear decline in oxygen concentration at deep waters. Furthermore, exceptionally high deep-water temperatures were observed, too.

Kvarken
No stratification was observed in Kvarken. Oxygen concentration at all stations was > 8ml/l.

Bothnian Bay
Ice formation was detected and surface temperatures at some stations were very close to zero.

Åland Sea
Deep water temperatures were exceptionally high ~+7°C, below 120-130m depth.

Northern Baltic Proper
Well defined stratification was observed at 70-80m depth, thermocline, halocline and oxycline. Fairly high-water temperatures were observed in deep waters, below 80m. The water column below 80m depth was practically anoxic.

Hydrogen sulphide

Anoxic waters were observed only in the Northern Baltic Proper. H2S concentrations were higher than on average (2010-2020) in winter.

Nutrients

Exceptionally high PO_4 winter concentrations were observed especially in the Bothnian Sea and Kvarken, but in all, the concentrations were higher than on average (2000-2020) in wintertime.

NH4 concentrations were low, higher than on average at some stations.
Highest concentrations were observed in the Northern Baltic Proper at deep waters.

$NO_{2,3}$ concentrations
High concentrations were observed in the Archipelago Sea and on the Finnish coast of the Bothnian Sea and in deep waters. In the Northern Baltic Proper the concentrations were average winter concentrations. Low concentrations in the Bothnian Bay were observed. NO_2 concentrations were low and typically near LOQ.

P_{tot}
High P_{tot} concentrations were observed almost in all areas compared with winter averages (2000-2020). Exceptionally high concentrations were detected in the Archipelago Sea and in deep waters of the Bothnian Sea. The highest concentrations were observed in the anoxic layers of the Northern Baltic Proper.

N_{tot}
High concentrations were observed in the Archipelago Sea and in the Northern Baltic Proper, but average or low concentrations in the Gulf of Bothnia.

Silicate
Silicate concentrations were higher than on average (2000-2020) in winter.
Typically, ~5 µmol/l higher concentrations were observed. In the deep waters of the main basin highest concentrations were > 50µmol/l.

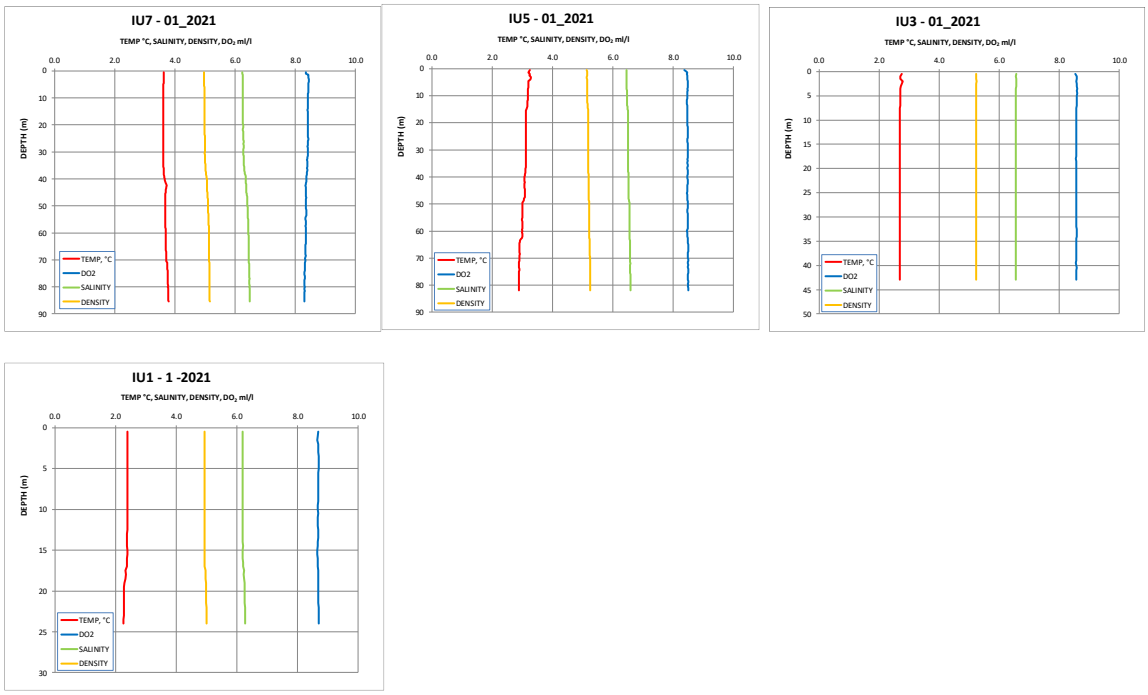
Observations

Hydrography

CTD profiles were taken at the following monitoring stations: IU7, IU5, IU3, IU1 (Archipelago Sea), KAJAKULMAW, SR8, SR7, SR5, SR3, MS3, MS6, F26, F33, MS9, US3, US5b, US6b, US7 (Bothnian Sea), F13, F15, F16, F18 (Kvarken), BO3, RR3, RR6, RR7, CV, CVI, F2 (Bothnian Bay), F64 (Åland Sea), F69, LL19, LL17, LL15, LL12 (Northern Baltic Proper) and LL7 (Gulf of Finland) and in addition at the maintenance of wave buoys (AALTO_PI and AALTO_SM,), separately at the station UTO_S.

Archipelago Sea

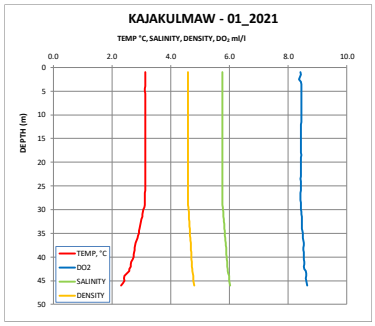
The following stations were monitored: IU7, IU5, IU3 and IU1. Salinity, temperature, oxygen and water density winter profiles were typical for the region. Water temperature declined towards the north, oxygen concentrations were high, and salinity declined slightly towards the north.

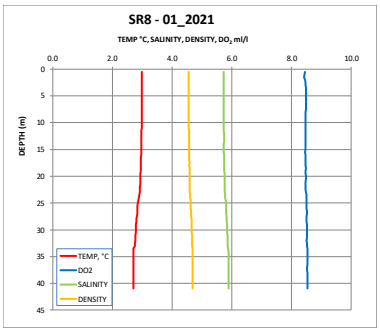


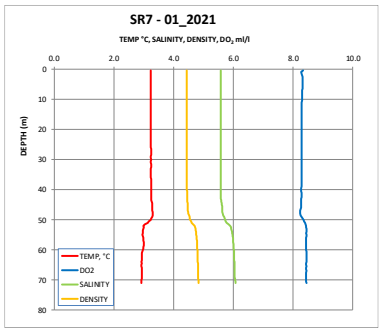
Figures 2-5. CTD profiles at the stations IU7, IU5, IU3 and IU1.

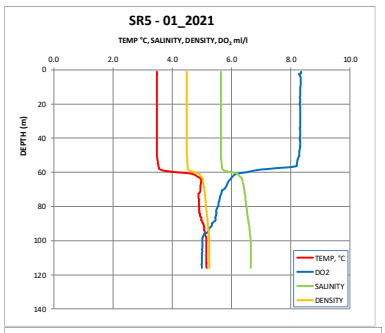
Bothnian Sea

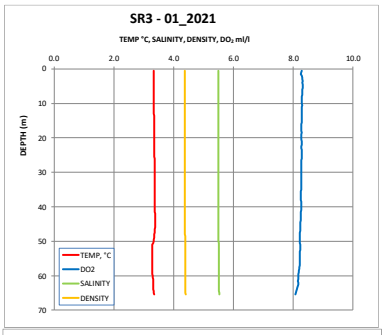
CTD profiles were taken at the following stations:
KAJAKULMAW, SR8, SR7, SR5, SR3, MS3, MS6, MS9, F26, F33, US3, US5, US6b and US7. At depths below 70m some stratification was observed. At deep stations, SR5 and US5b, a clear oxycline was observed at 60m and at around 80m, respectively.
Water temperature below 100m was above 5°C, which was exceptionally high in winter.

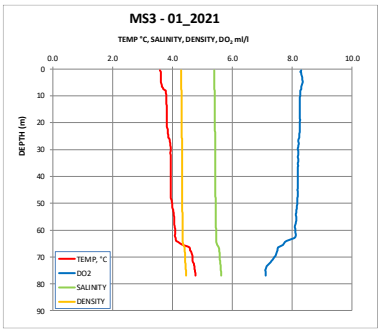


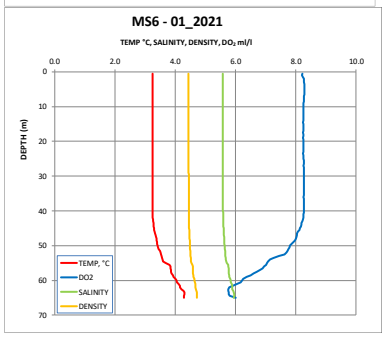


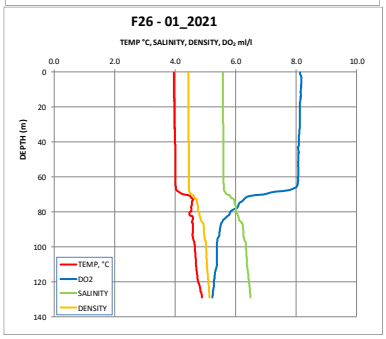


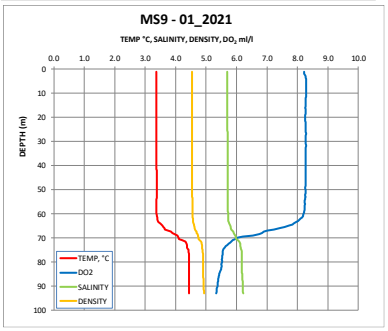


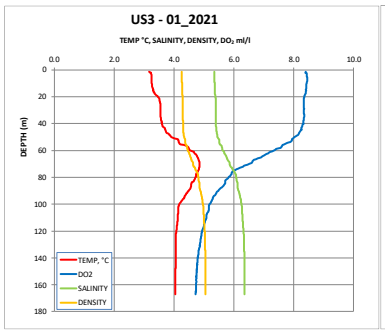


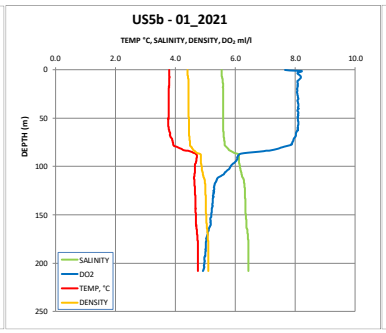


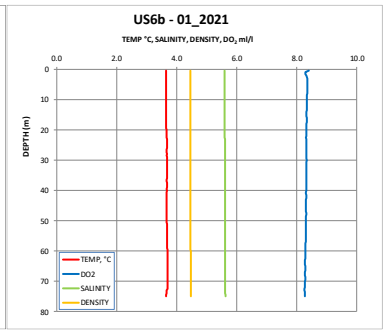












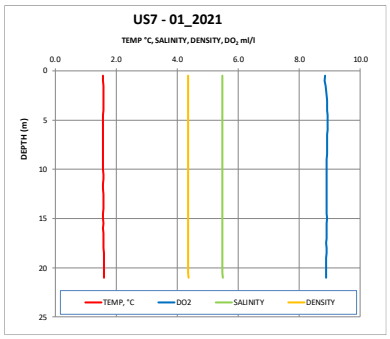
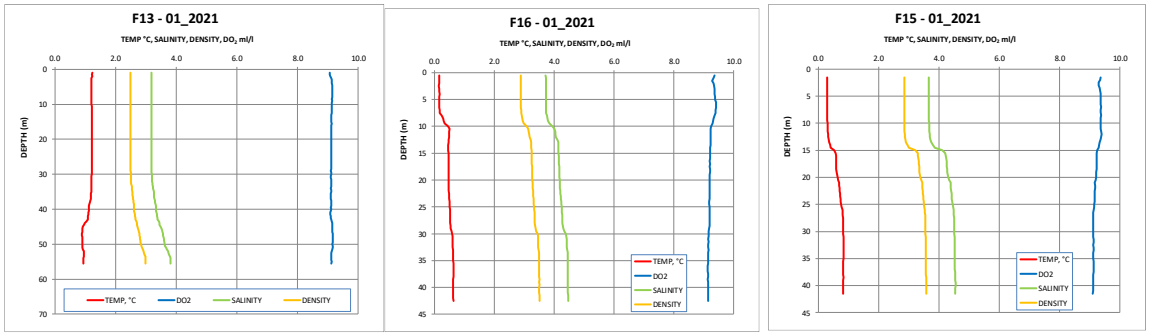
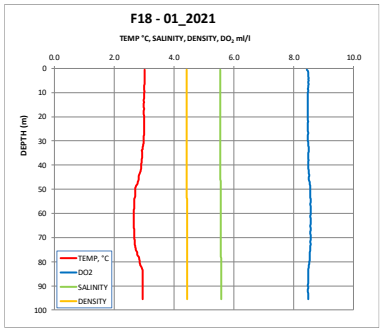


Figure 6-18. CTD profiles in the Bothnian Sea.

Kvarken

CTD was launched at the stations F13, F15, F16 and F18.
Observed temperatures were close to zero at F15 and F16, which are the shallower stations than F13 and F18. Oxygen concentrations were > 8ml/l at all stations in Kvarken. Only minor or no stratification was observed.

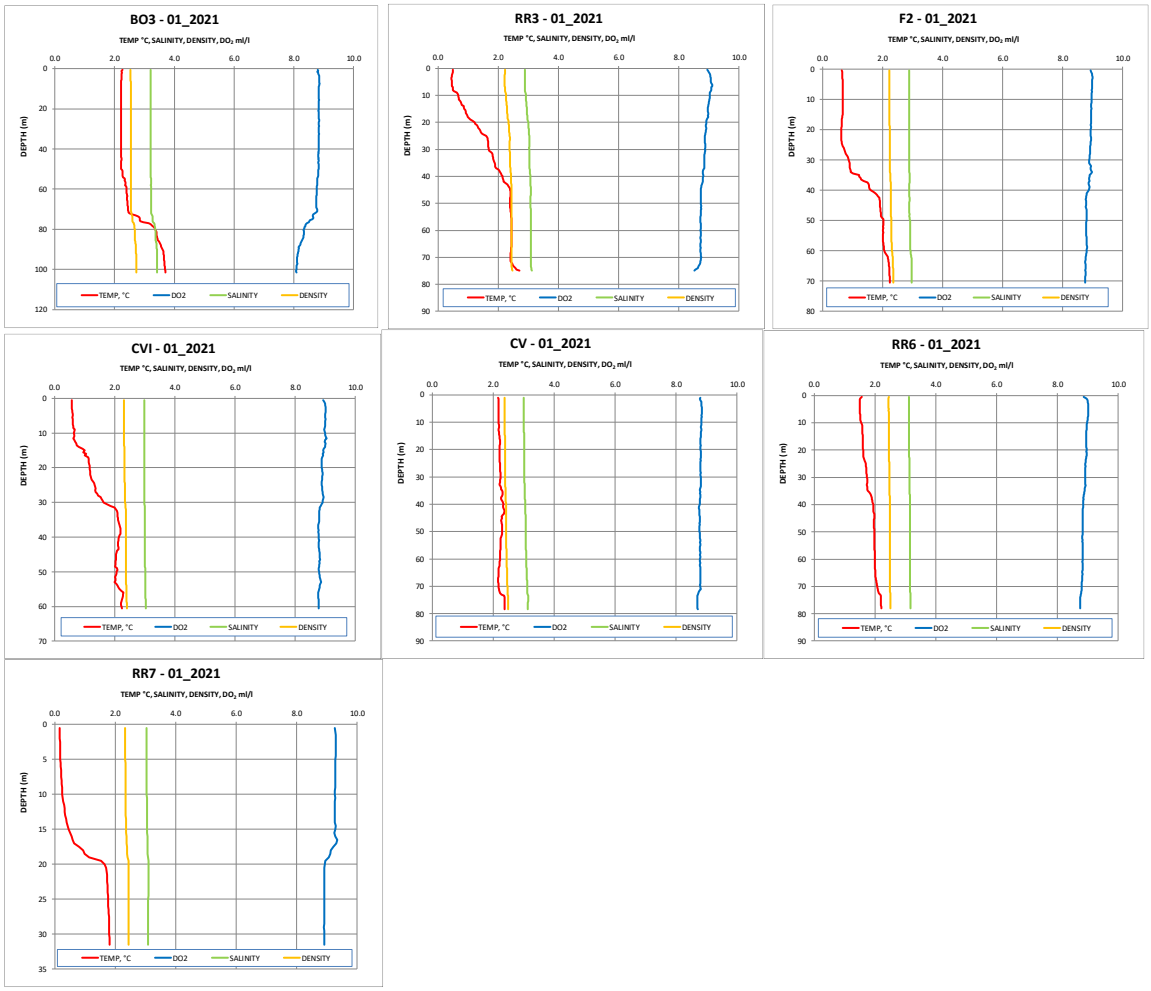




Figures 19-22. CTD profiles in Kvarken.

Bothnian Bay

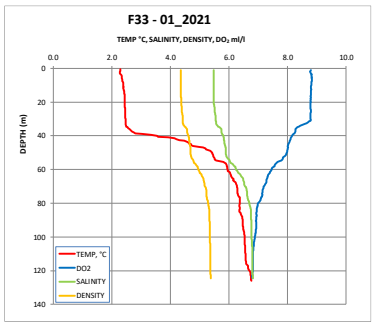
The following stations in the Bothnian Bay were sampled: BO3, RR7, RR6, CVI, CV, F2 and RR3.
Ice formation was detected in the Bothnian Bay, and therefore, also the surface temperatures at some of the stations (RR3, RR7) were mainly close to +0°C.

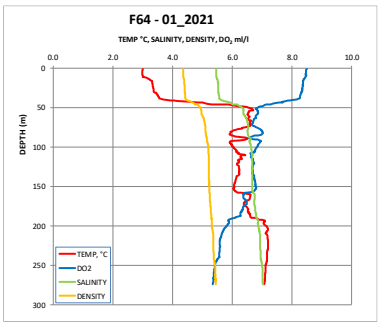


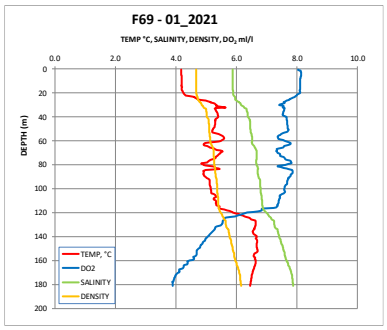
Figures 23-29. CTD profiles in the Bothnian Bay.

Åland Sea

Water temperatures near bottom were exceptionally high, 6.5 - +7.2°C, in the southwestern part of the Bothnian Sea (F33), in the Åland Sea (F64) and in the south of Åland Islands (F69). Oxygen concentrations were even in deep waters > 4ml/l.

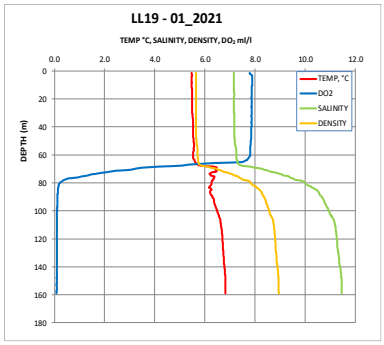


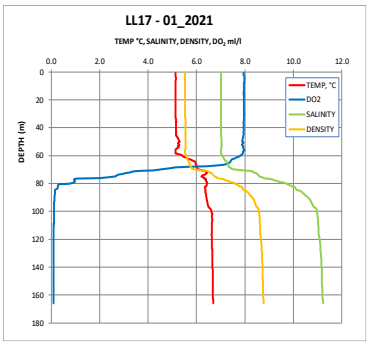


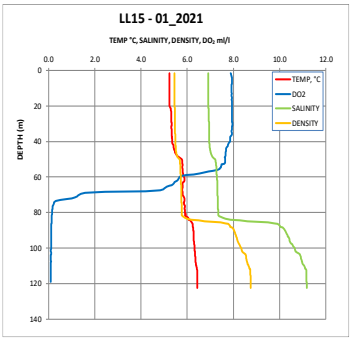


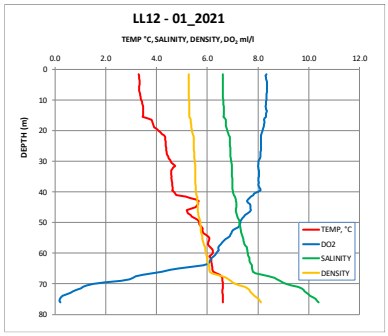
Northern Baltic Proper and Gulf of Finland
LL19, LL17, LL15, LL12 (NBP) and LL7 (GOF)

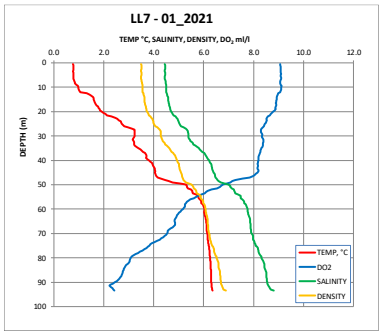
Stratification was well defined in 70-80m in a form of thermocline, halocline and oxycline. Fairly high-water temperatures were observed in deep waters and below 80m the water column was practically anoxic.









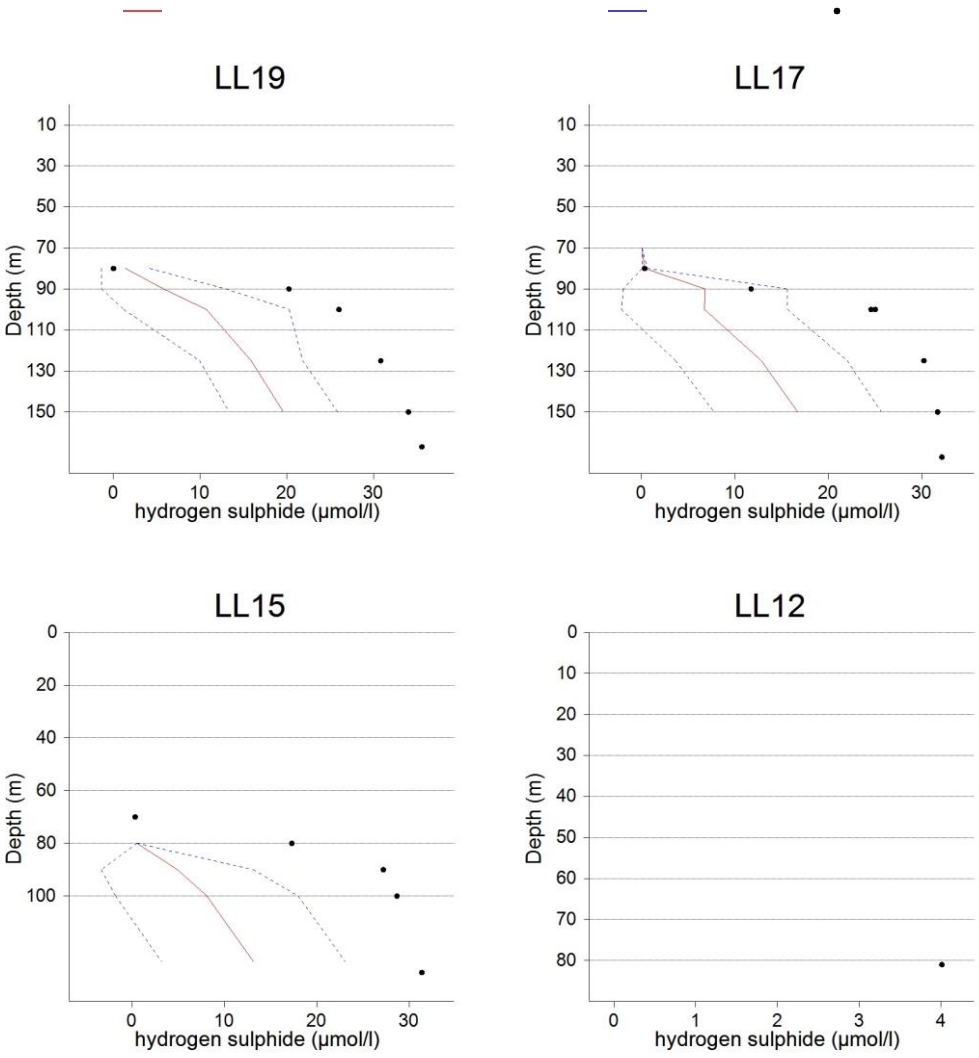


Figures 30-34. CTD profiles in the Northern Baltic Proper and in the Gulf of Finland.

Annex 1. Selected variables at the stations IU7, IU5, IU3, IU1, KAJAKULMAW, SR8, SR7, SR5, SR3, MS9, MS6, MS3, US7, US6B, US5B, US3, F33, F15, F13, F16, F18, BO3, RR3, RR6, RR7, CVI, CV, F2, F64, F69 LL19, LL17, LL15, LL12 and LL7. Mean (red solid line) and standard deviation (blue dotted lines) represent the data collected at the same time of season since the year 2000.

Hydrogen sulphide H_2S concentrations in the Northern Baltic Proper

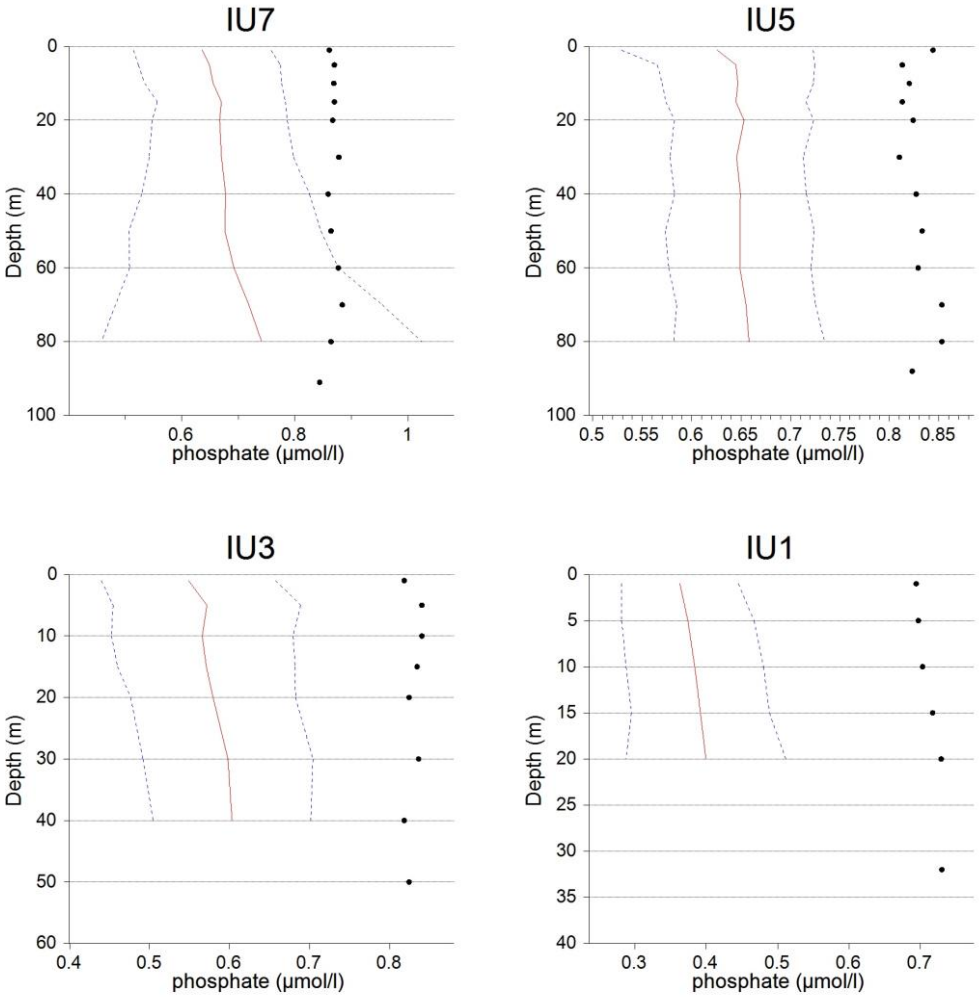
Hypoxia was observed only in the Northern Baltic Proper below 80m depth, and H_2S concentrations were higher than on average (2000-2020) in winter. Hypoxic conditions were observed only in the region.



Phosphate

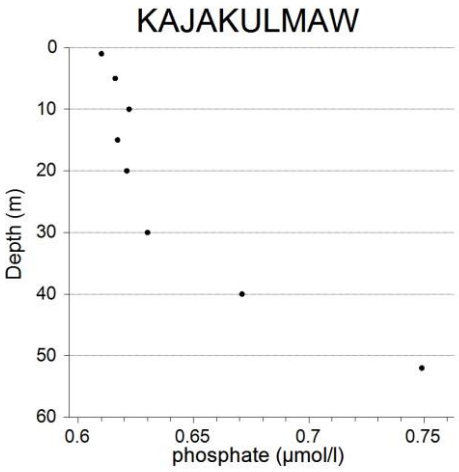
Archipelago Sea

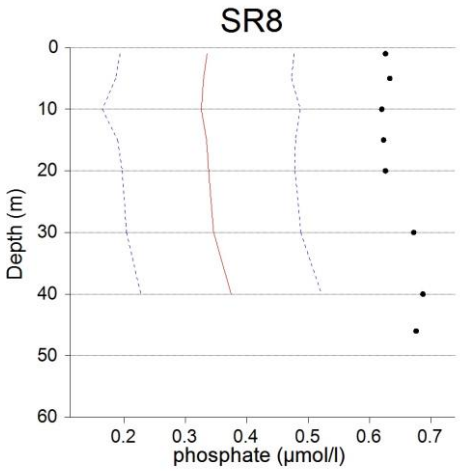
High PO_4 concentrations were observed, compared with average concentrations (in 2000-2020) in winter. The highest in the southern part of the transect (stations IU7 ad IU5). Concentrations were between 0.8 and 0.9 µmol/l.

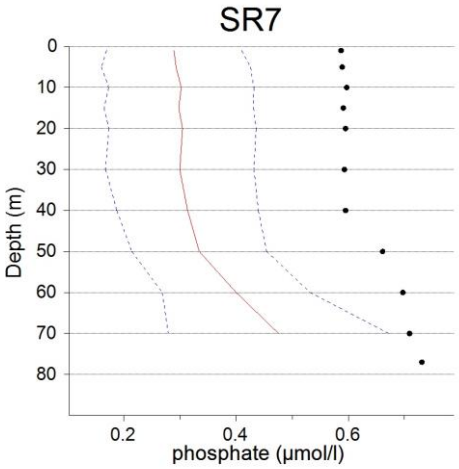


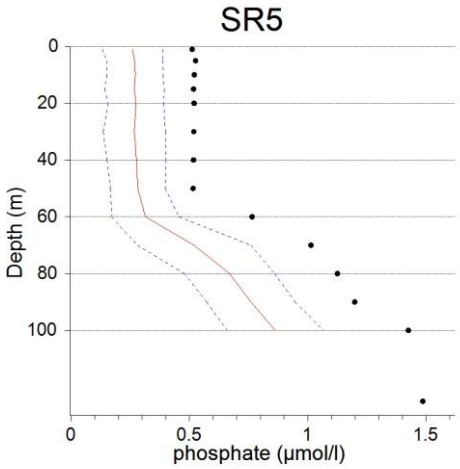
Bothnian Sea

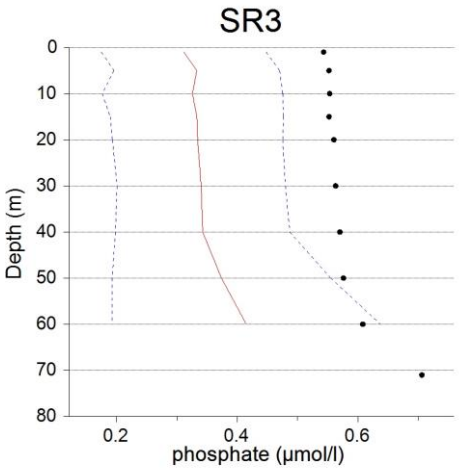
PO_4 concentrations were exceptionally high, even 2 times higher than on average (2000-2020) in winter.

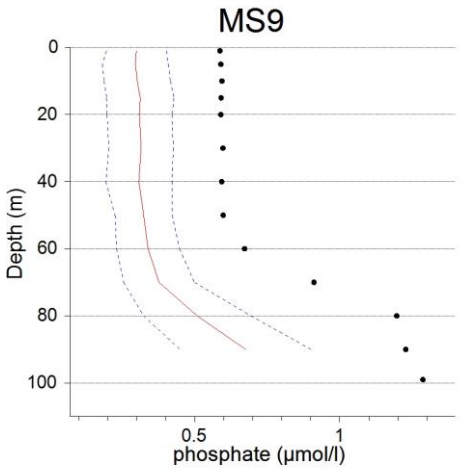


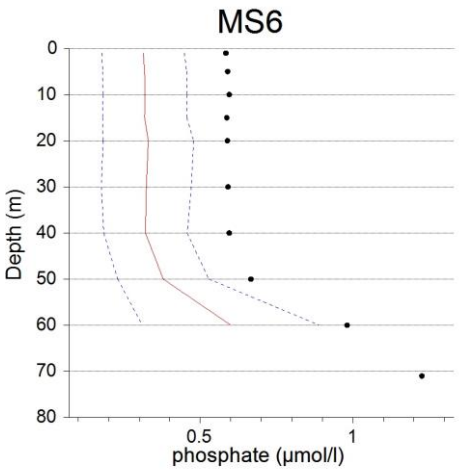


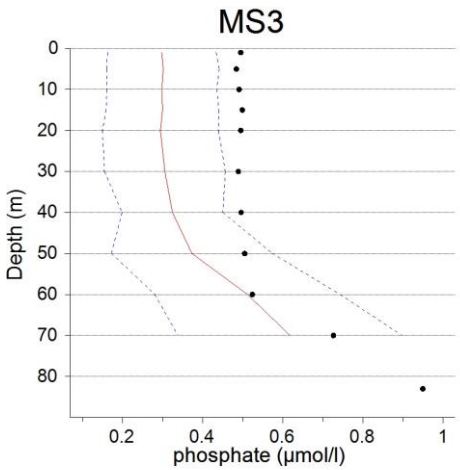


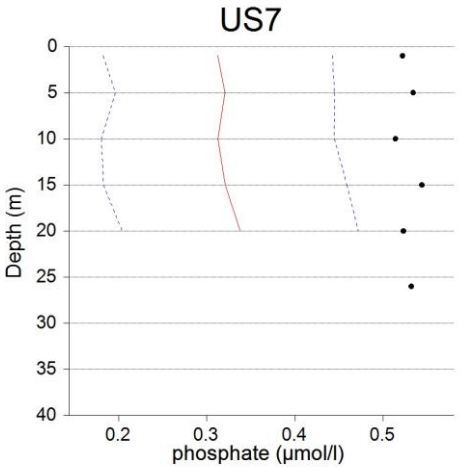


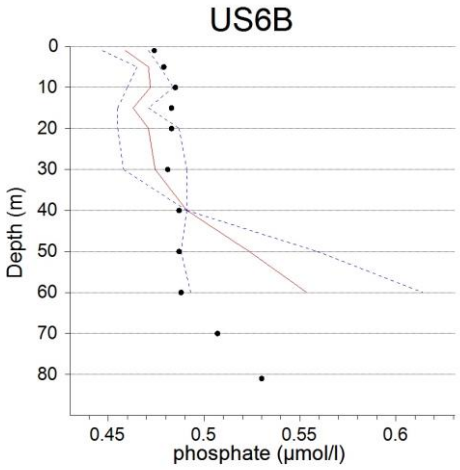


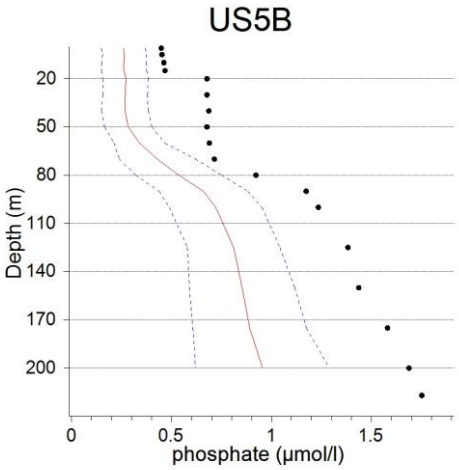


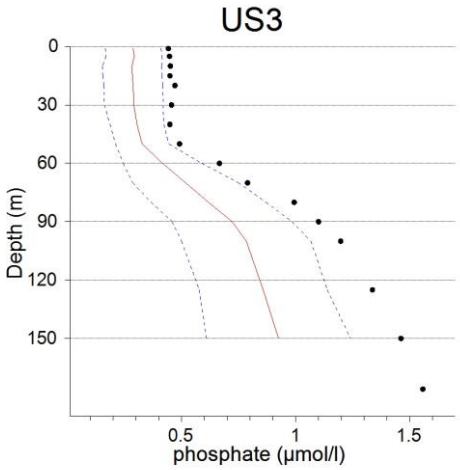

MS6
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
phosphate (µmol/l)

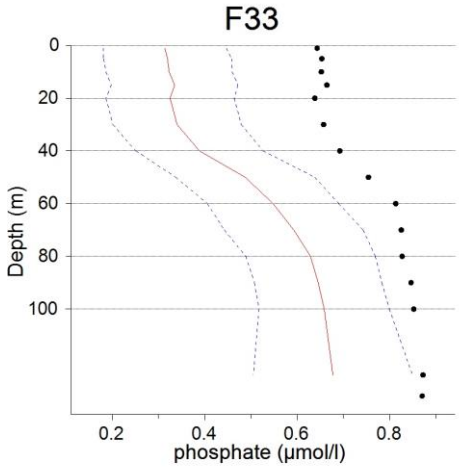

MS3
Depth (m)
0
10
20
30
40
50
60
70
80
0.2
0.4
0.6
0.8
1
phosphate (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
0.2
0.3
0.4
0.5
phosphate (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
0.45
0.5
0.55
0.6
phosphate (µmol/l)

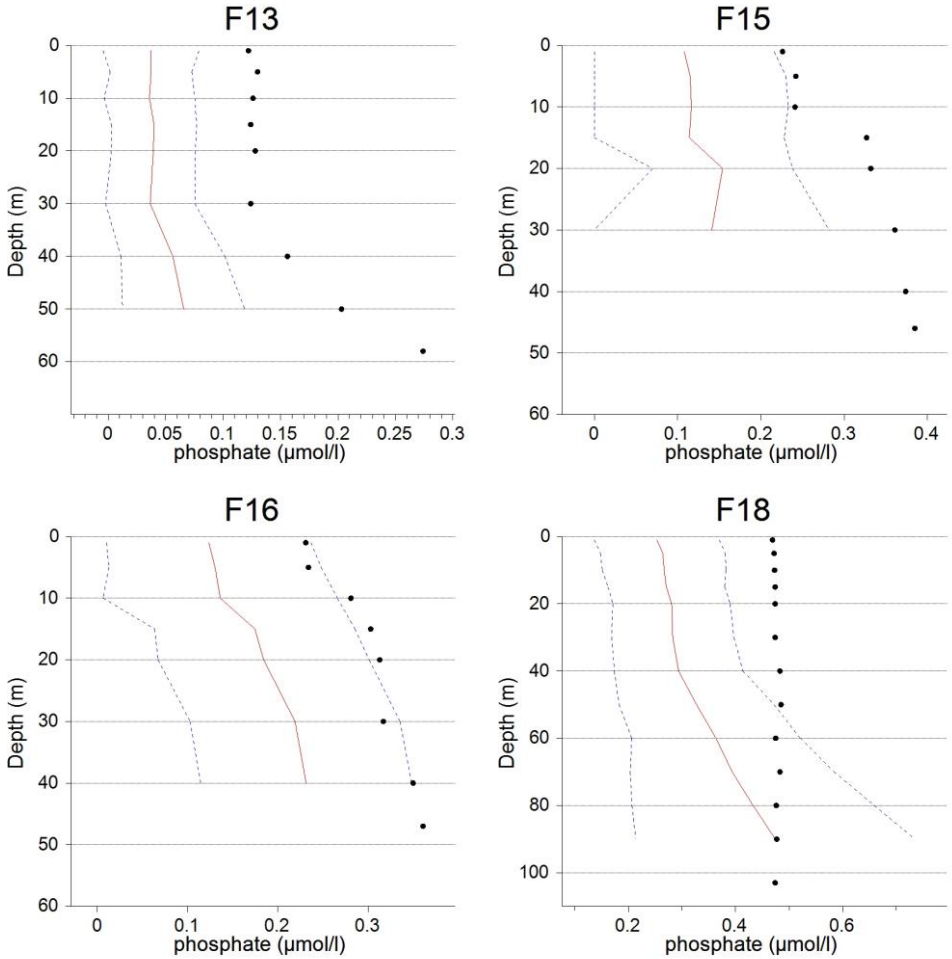

US5B
Depth (m)
20
50
80
110
140
170
200
0
0.5
1
1.5
phosphate (µmol/l)


US3
Depth (m)
0
30
60
90
120
150
0.5
1
1.5
phosphate (µmol/l)



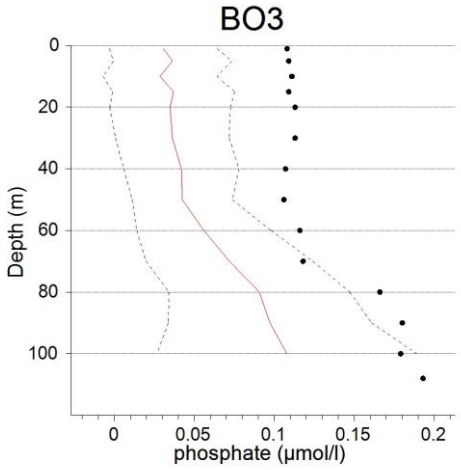
Kvarken

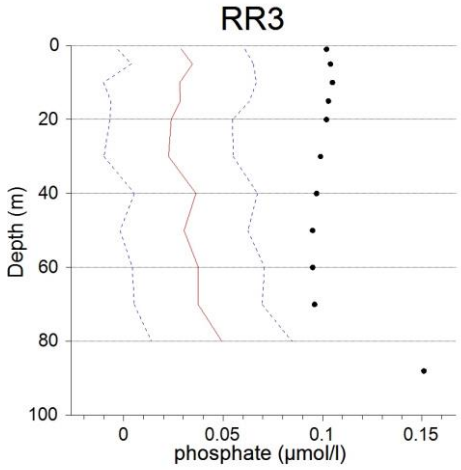
High PO_4 concentrations were observed, lowest at F13, the northernmost station in Kvarken and highest at the edge of the Bothnian Sea, station F18.

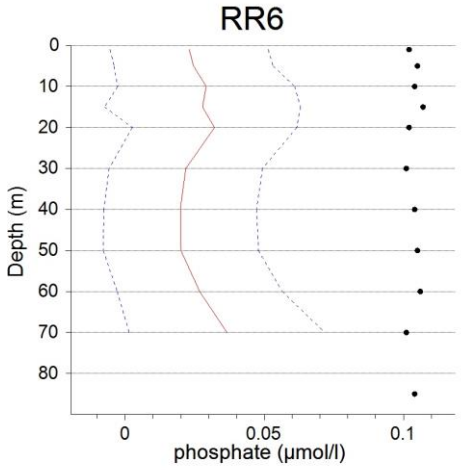


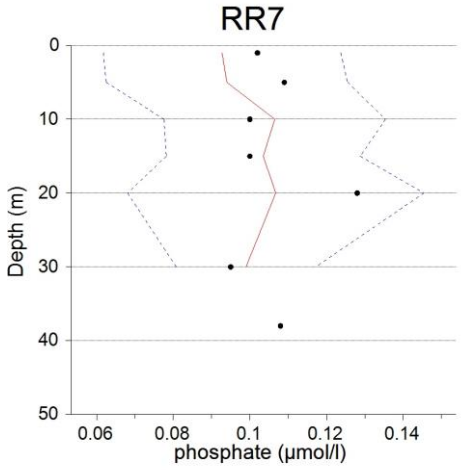
Bothnian Bay

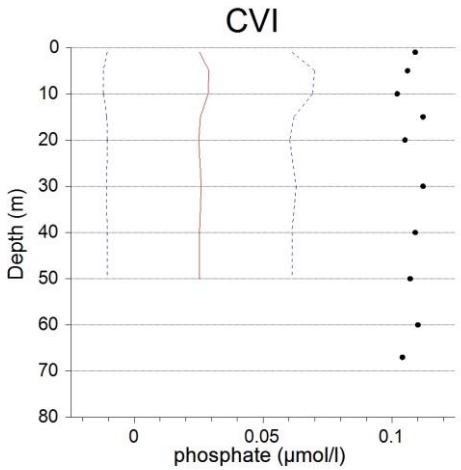
Low concentrations, as common in the region, were detected, ~0.1µmol/l, compared with the other monitored sea areas (Bothnian Sea, Archipelago, Northern Baltic Proper, Gulf of Finland). However, PO_4 concentrations have increased compared with the observations of the previous years.

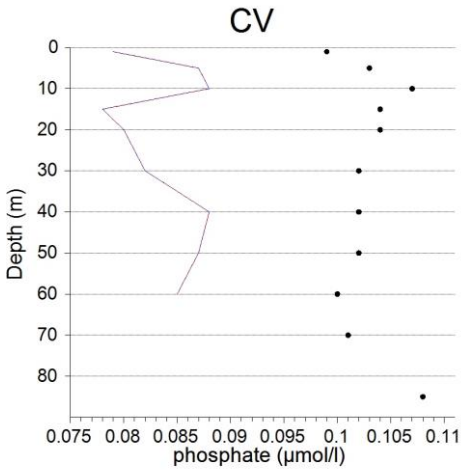


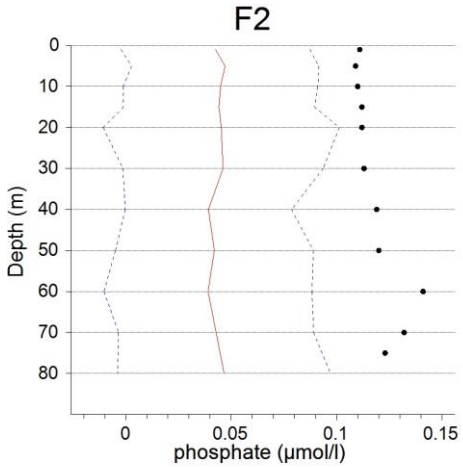






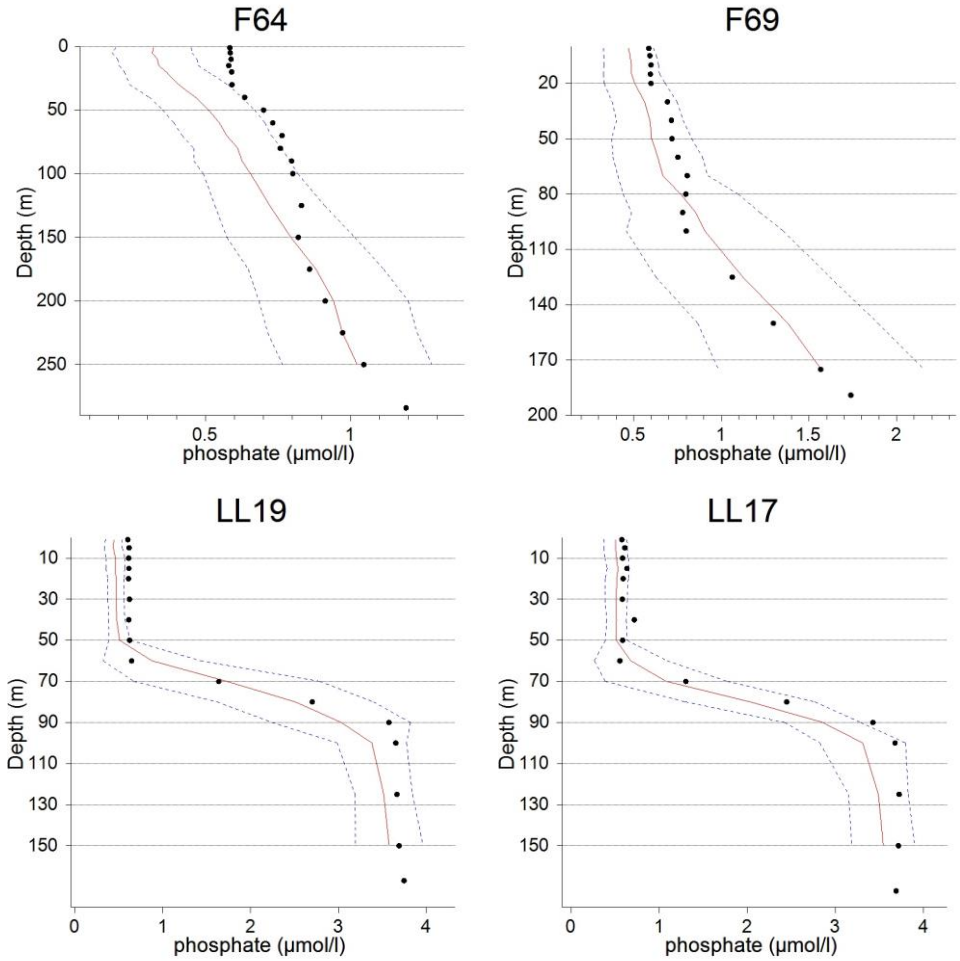


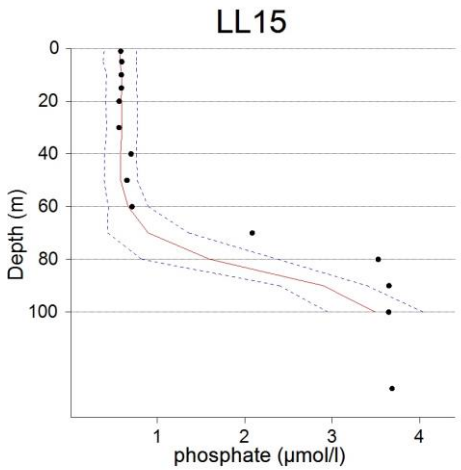


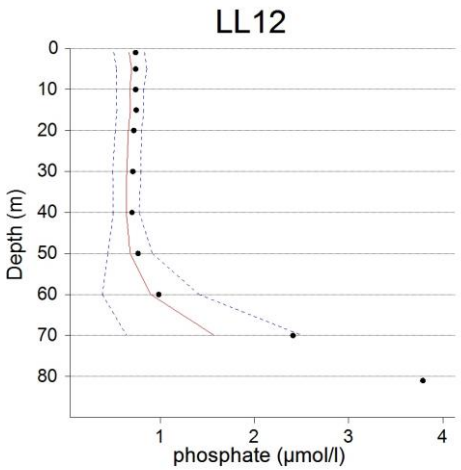


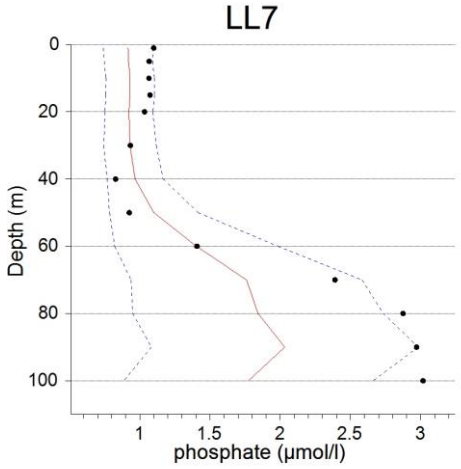
Åland Sea and the Northern Baltic Proper

Observed concentrations were slightly higher both in the Åland Sea and in the Northern Baltic Proper than on average, and in all, high concentrations (>3µmol/l) were measured in anoxic/hypoxic layers (below 80m depth) in the Northern Baltic Proper.





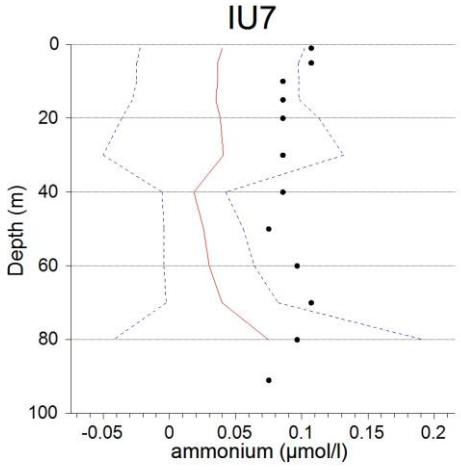


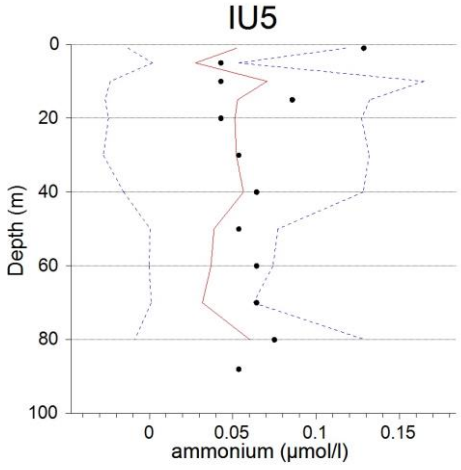


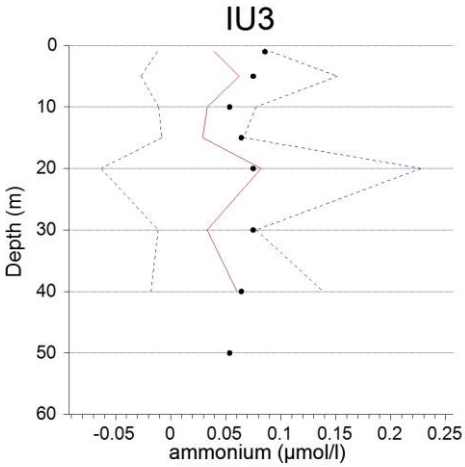
Ammonium

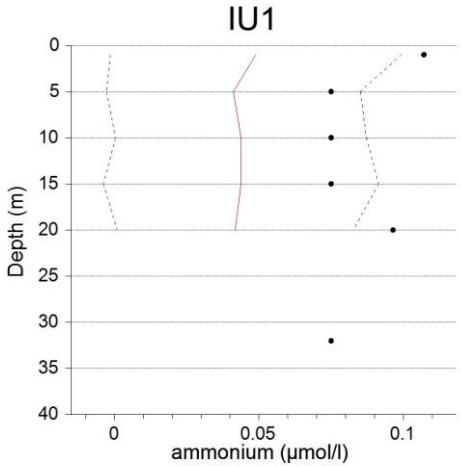
Archipelago Sea

NH_4 winter concentrations were close to average or at higher level than on average (2000-2020), but in all, at low level.



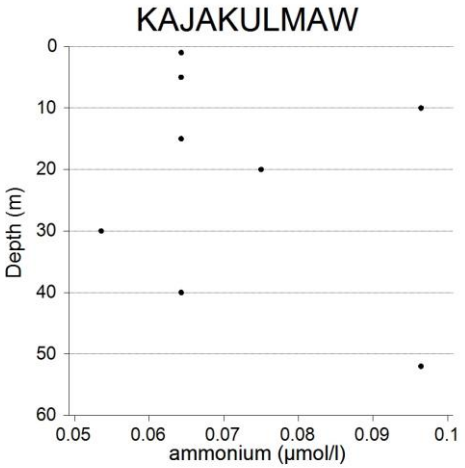


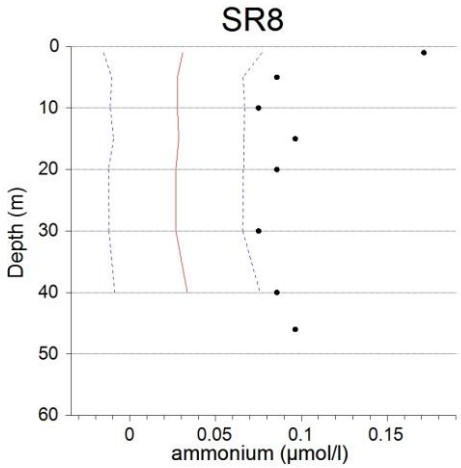


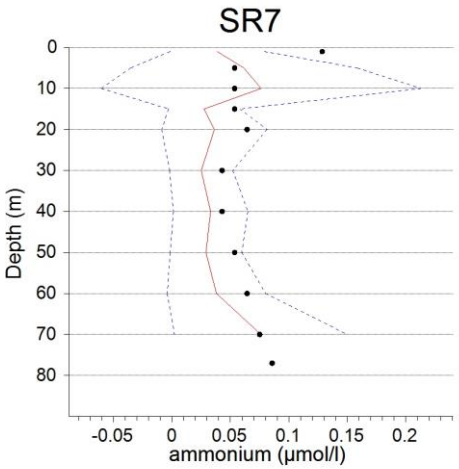


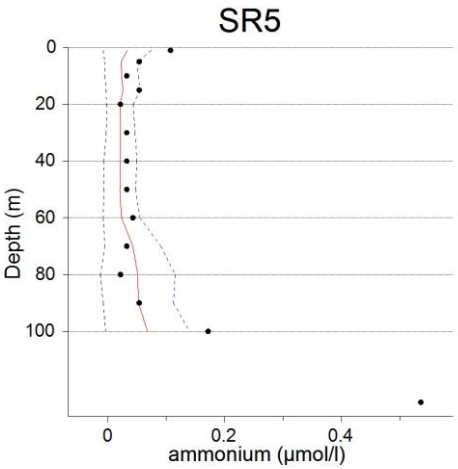
Bothnian Sea

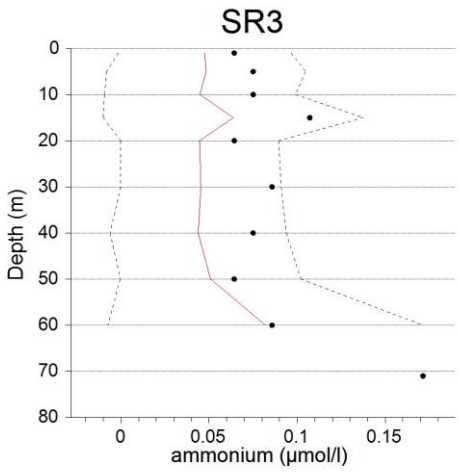
KAJAKULMA W was monitored for the first time. Concentrations at the regular stations were also low and as highest at deep waters 0.6µmol/l at US5b. Typically the measured concentrations were ~0.1-0.2µmol/l.

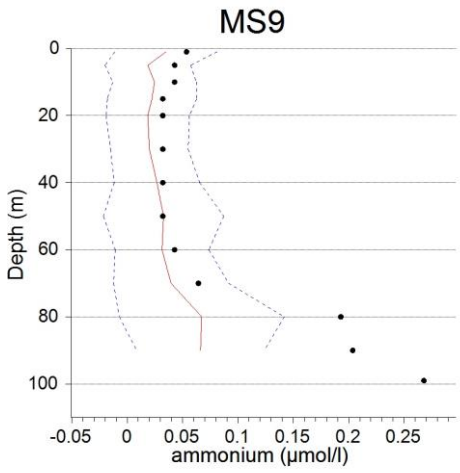


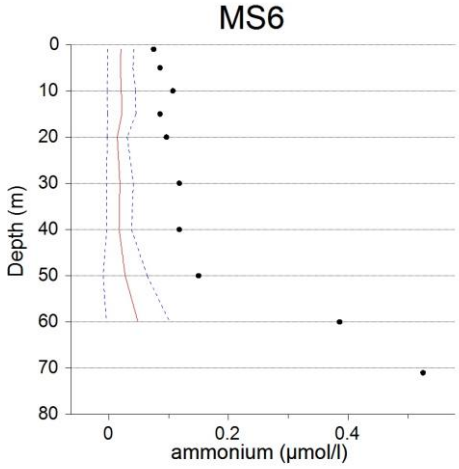


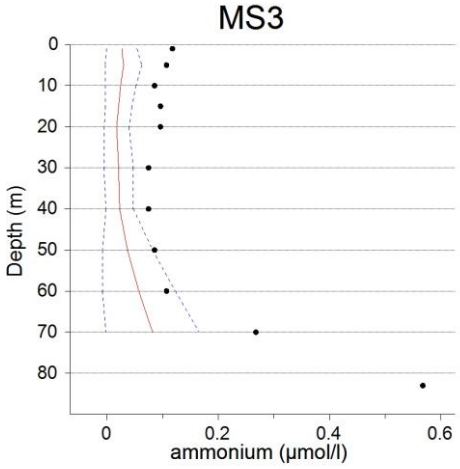


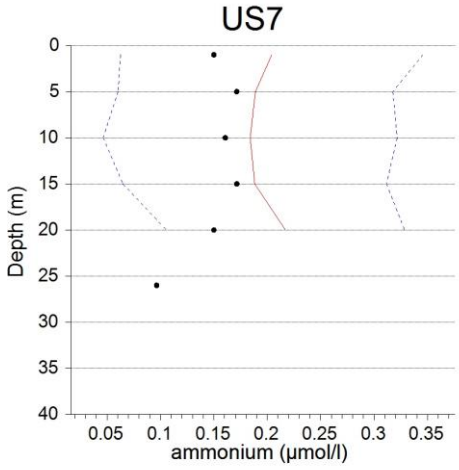


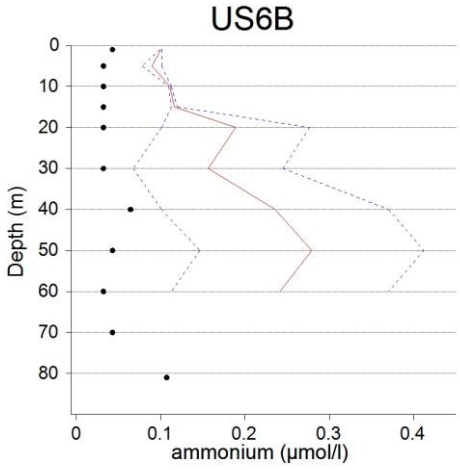

SR3
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.05
0.1
0.15
ammonium (µmol/l)

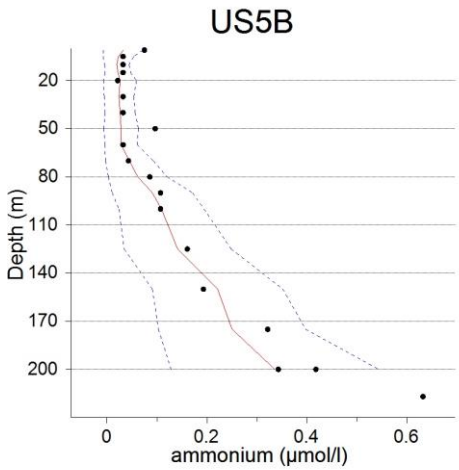

MS9
Depth (m)
0
20
40
60
80
100
-0.05
0
0.05
0.1
0.15
0.2
0.25
ammonium (µmol/l)

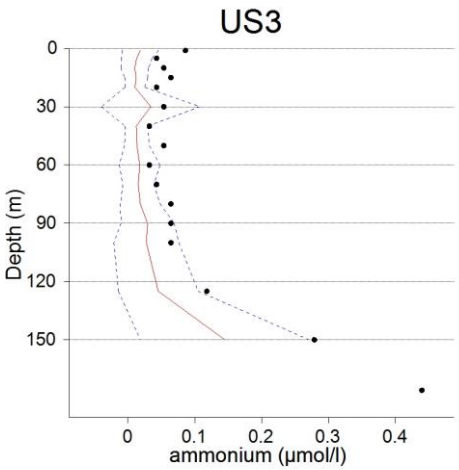

MS6
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.2
0.4
ammonium (µmol/l)

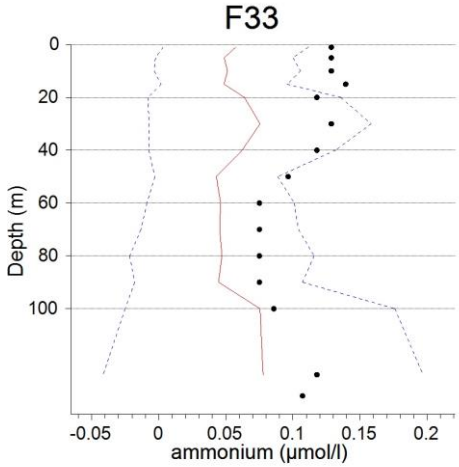

MS3
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.2
0.4
0.6
ammonium (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
0.05
0.1
0.15
0.2
0.25
0.3
0.35
ammonium (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.1
0.2
0.3
0.4
ammonium (µmol/l)

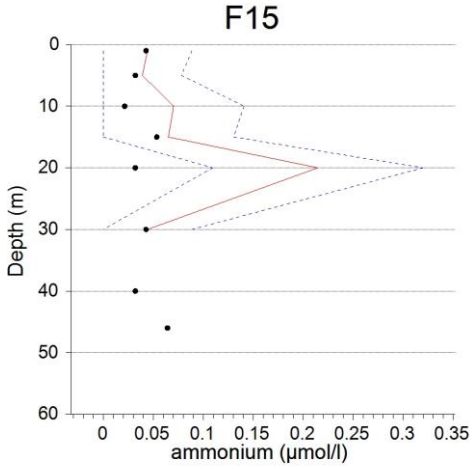


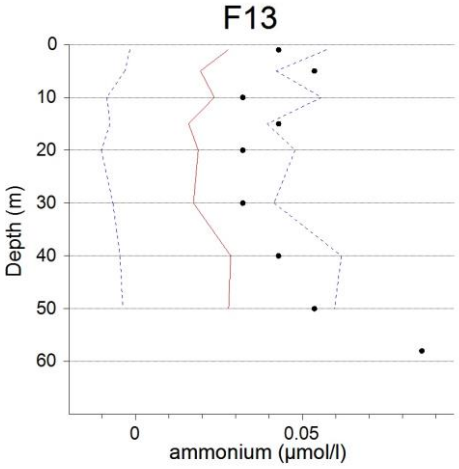


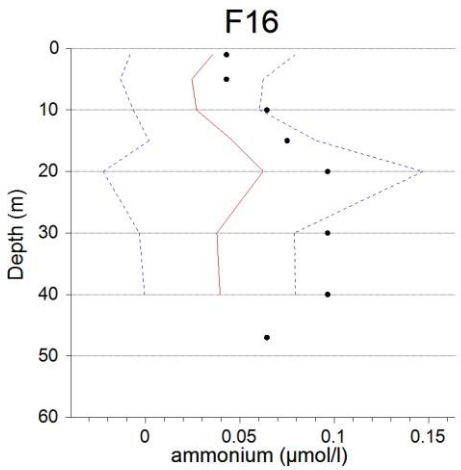


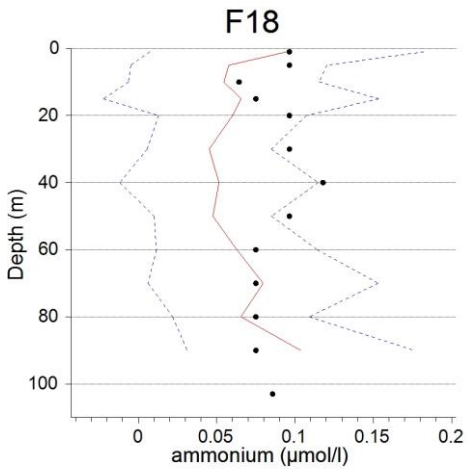
Kvarken

NH4 concentrations in Kvarken were low and close to average (in 2000-2020) for winter concentrations.



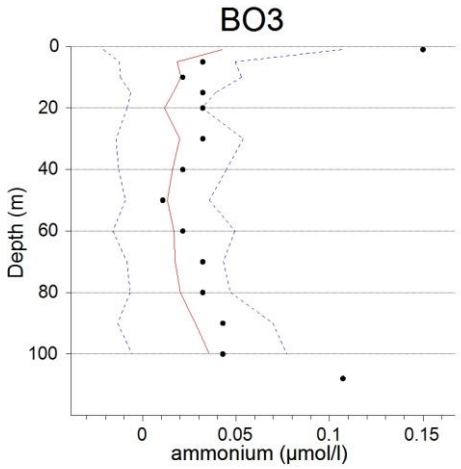


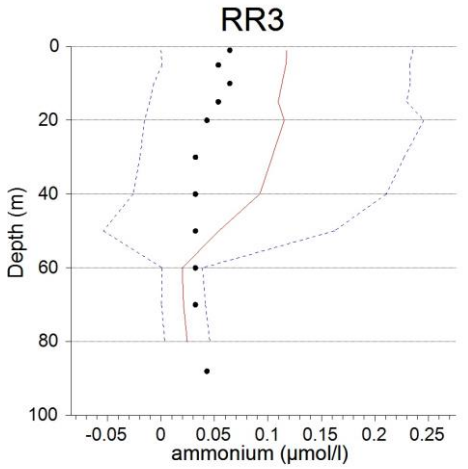


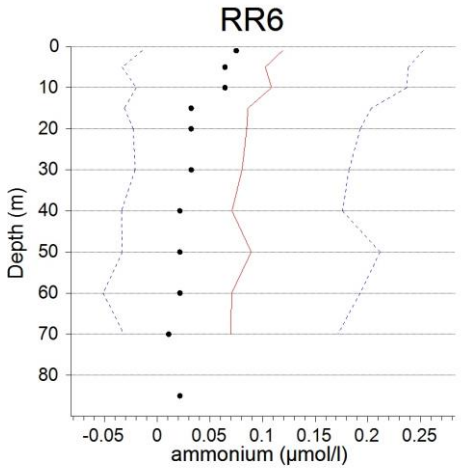


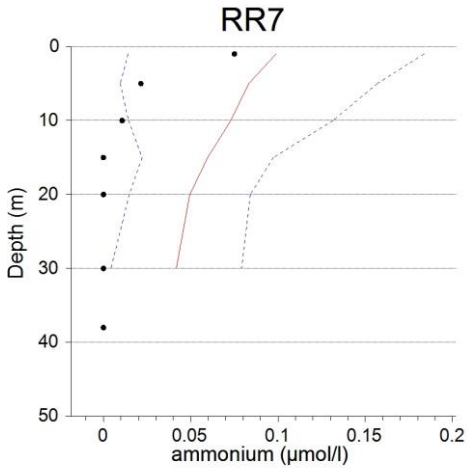
Bothnian Bay

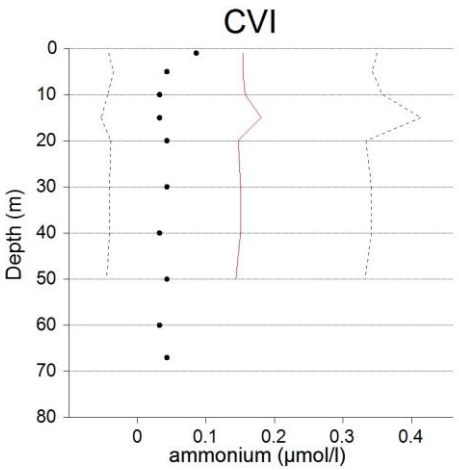
Average or below average winter concentrations were detected in the Bothnian Bay.

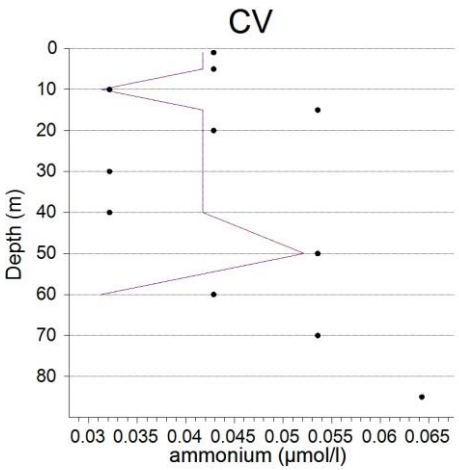


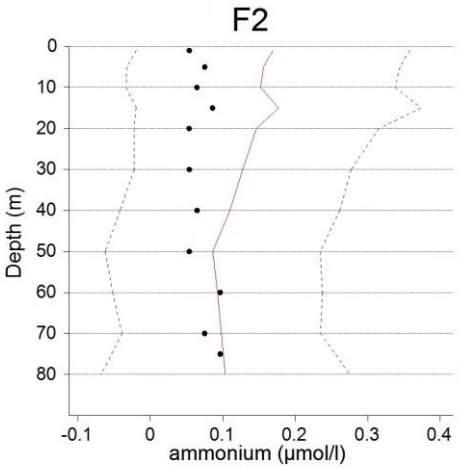






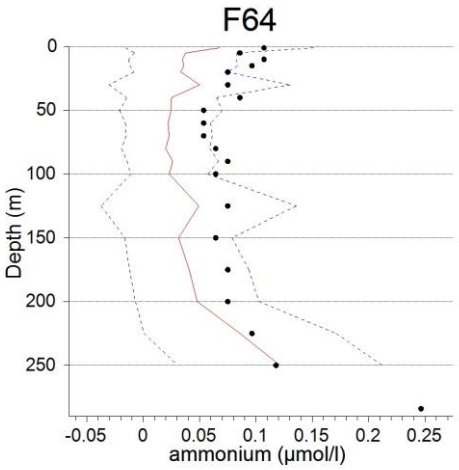


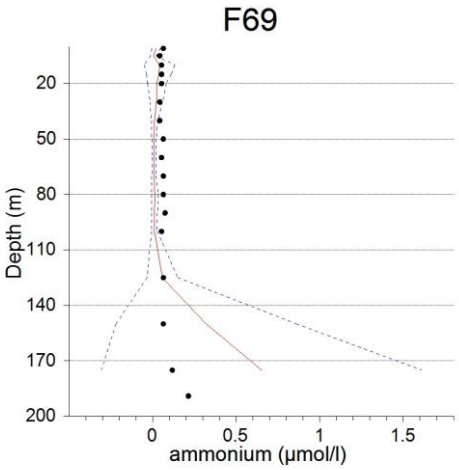


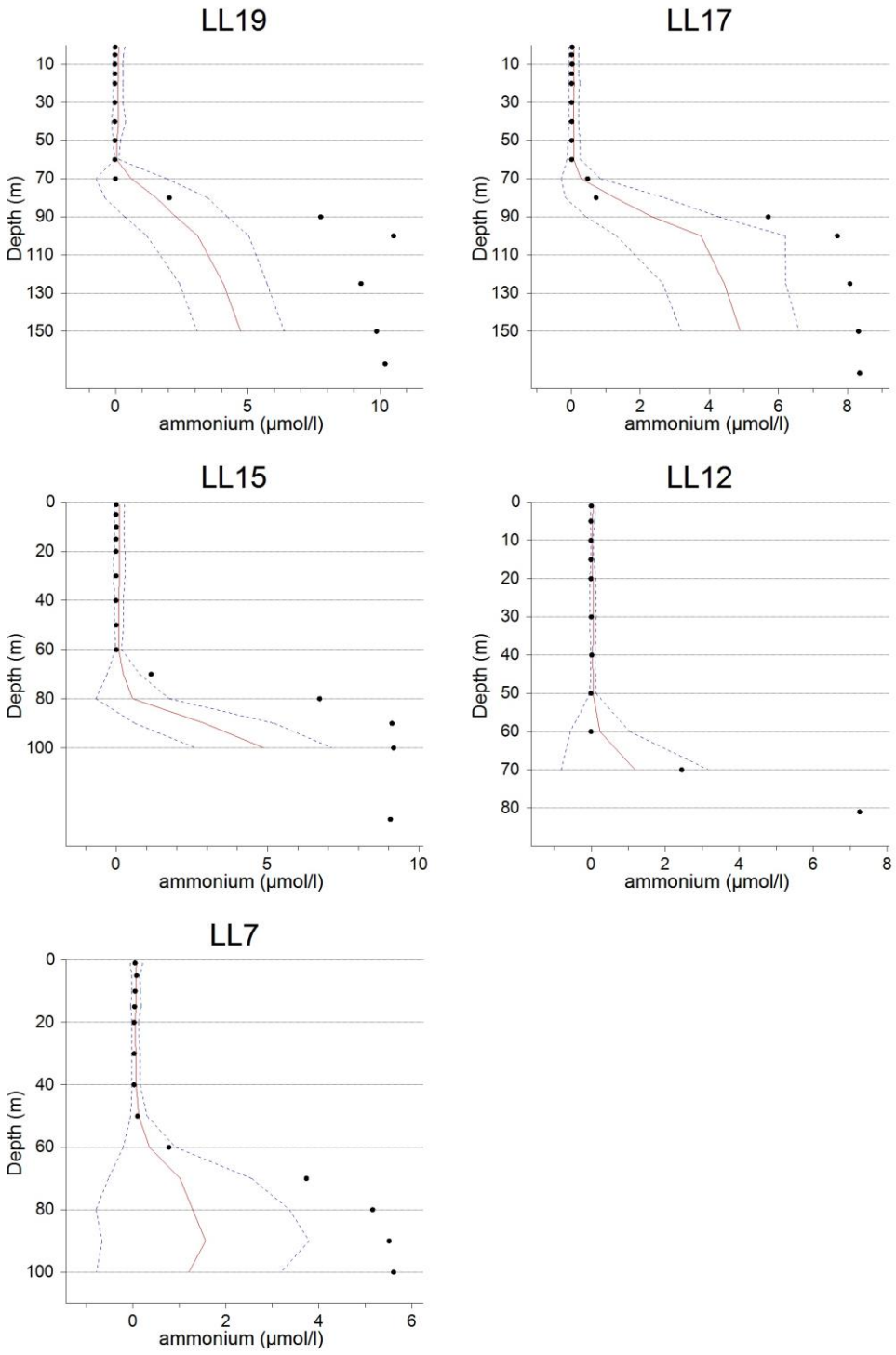


Åland Sea and the Northern Baltic Proper

Highest NH_4 concentrations were observed in deep waters and the concentrations were the highest of all areas, even > 10µmol/l at LL19 below 100m.



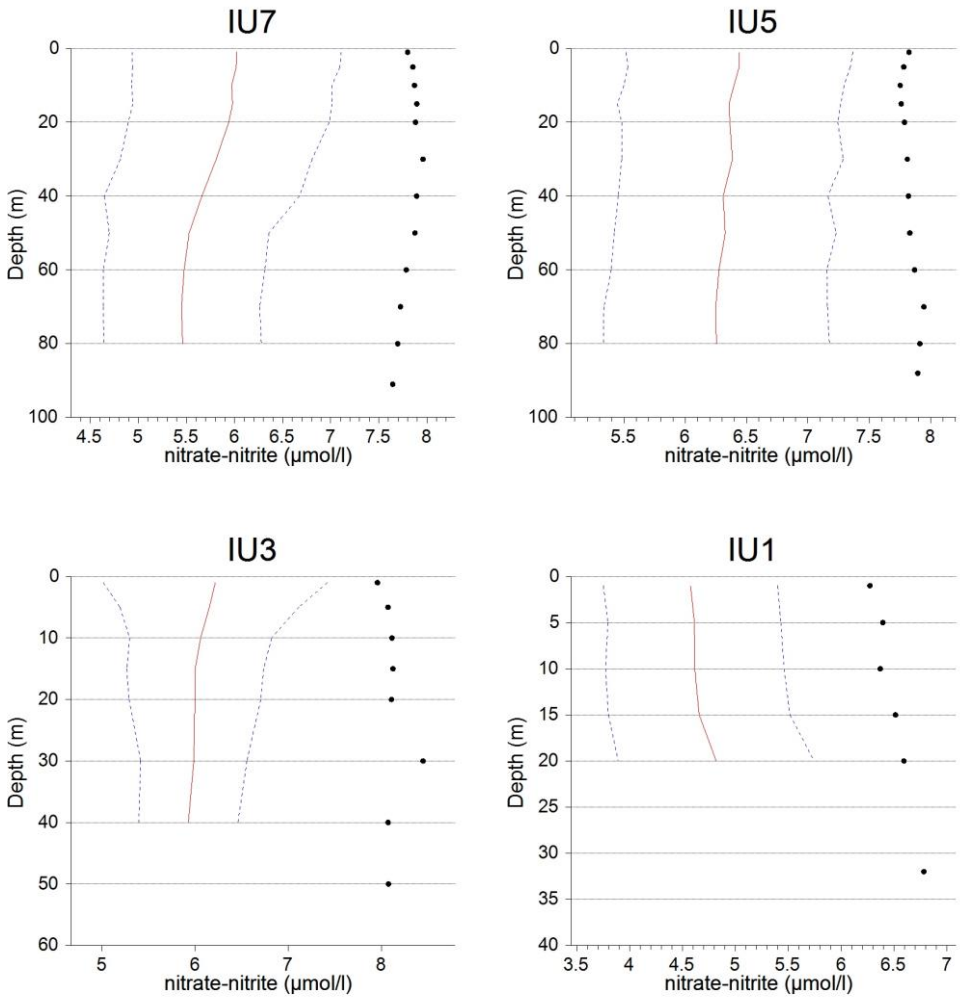




Nitrate - nitrite ($NO_{2,3}$)

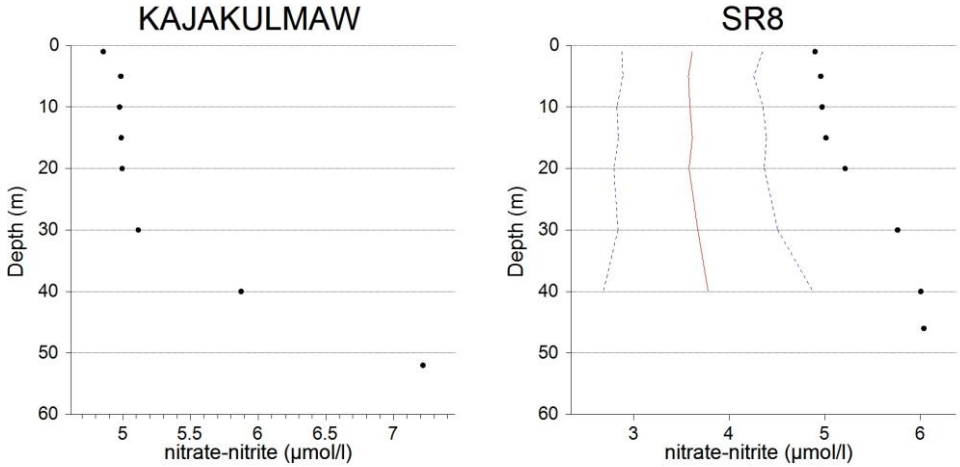
Archipelago Sea

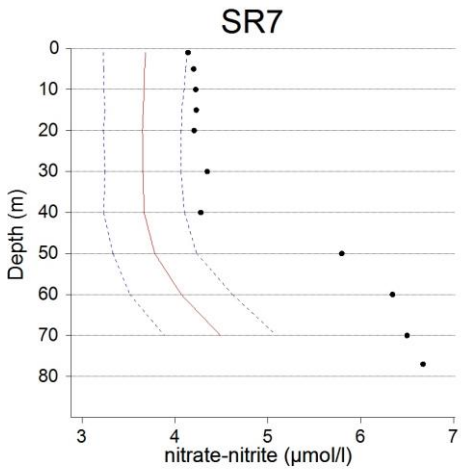
Exceptionally high $NO_{2,3}$ concentrations were observed.
On average (2000-2020) in winter $NO_{2,3}$ concentrations have been 4.5-6.5 µmol/l. In January 2021 the highest values observed were > 8µmol/l at IU3.

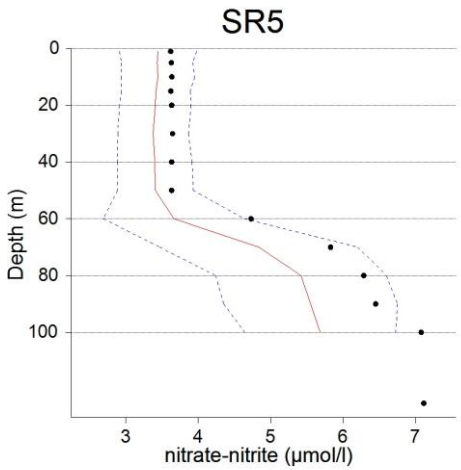


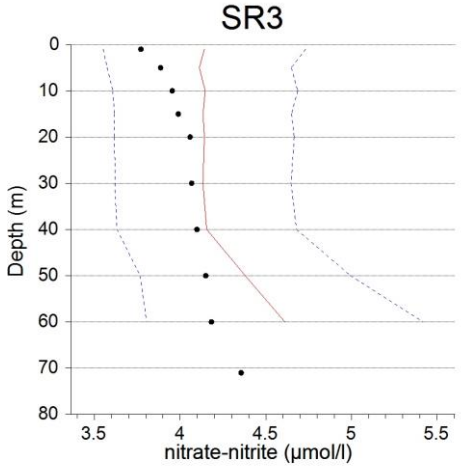
Bothnian Sea

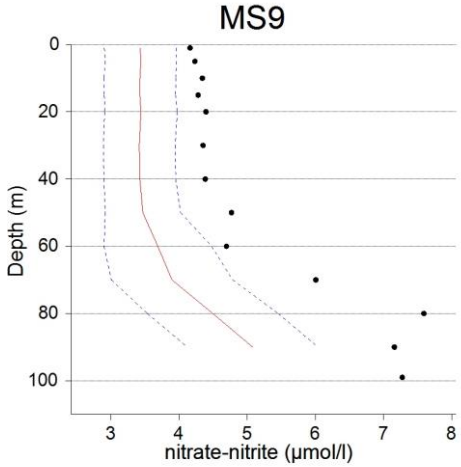
Variable concentrations were observed and the highest found at deep layers, at 100m depth. At the stations close to the Finnish coast were typically higher than on average (2000-2020) in wintertime. Exceptional concentrations were detected also at F 33, which is in the southern part of the Bothnian Sea on the Swedish coast.

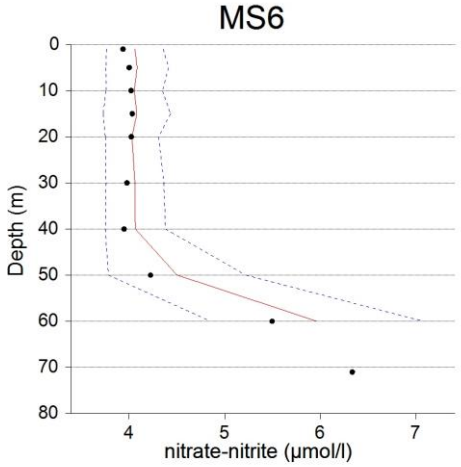


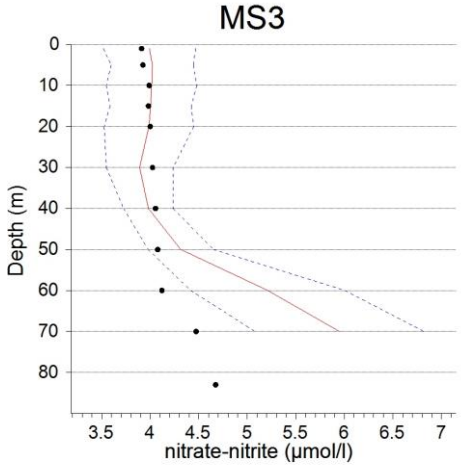

SR7
Depth (m)
nitrate-nitrite (µmol/l)

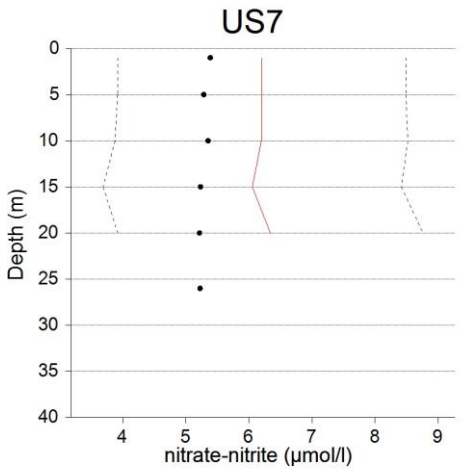

SR5
Depth (m)
nitrate-nitrite (µmol/l)

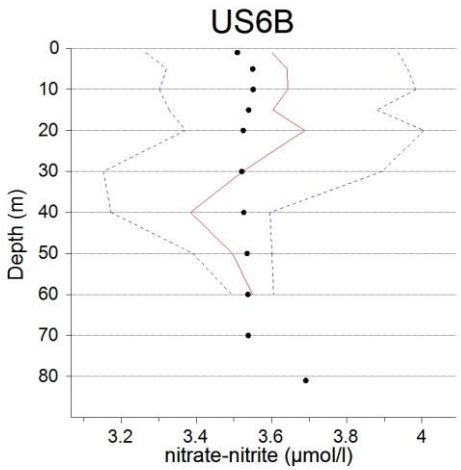

SR3
Depth (m)
nitrate-nitrite (µmol/l)

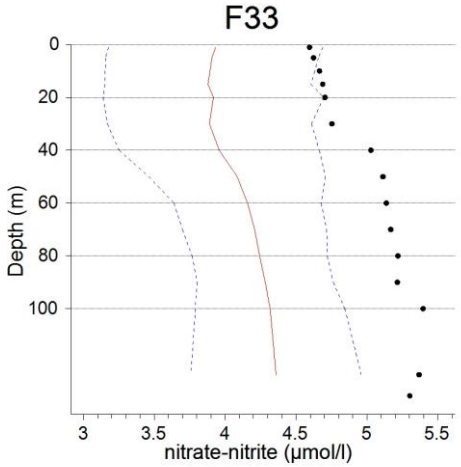

MS9
Depth (m)
nitrate-nitrite (µmol/l)

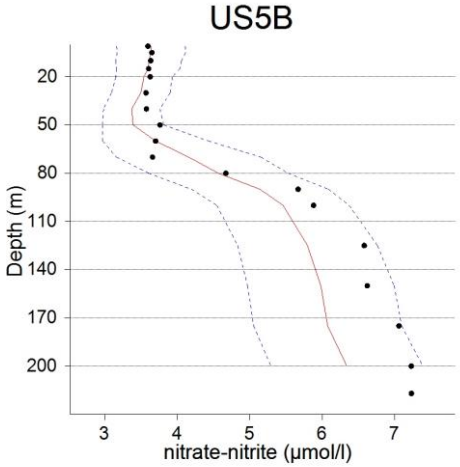

MS6
Depth (m)
nitrate-nitrite (µmol/l)

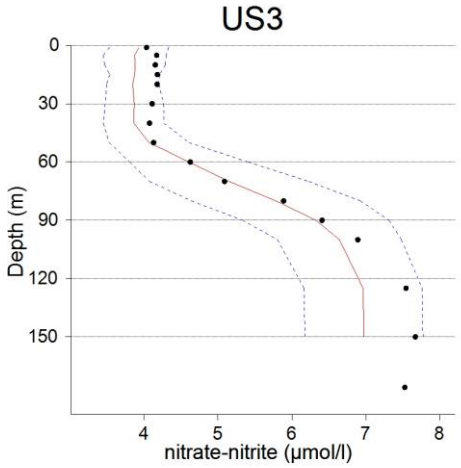

MS3
Depth (m)
nitrate-nitrite (µmol/l)





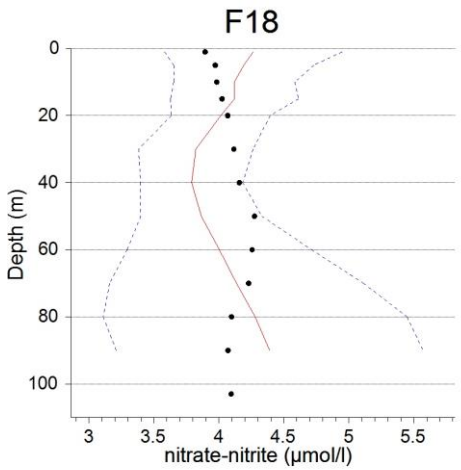


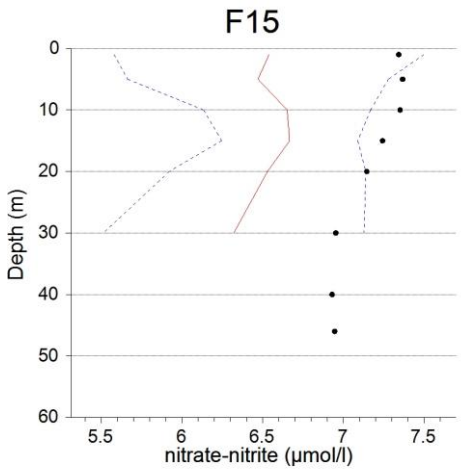


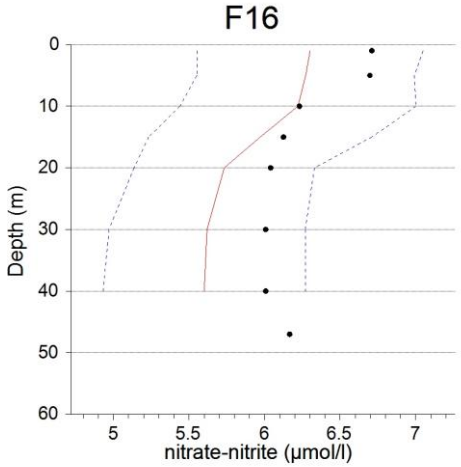


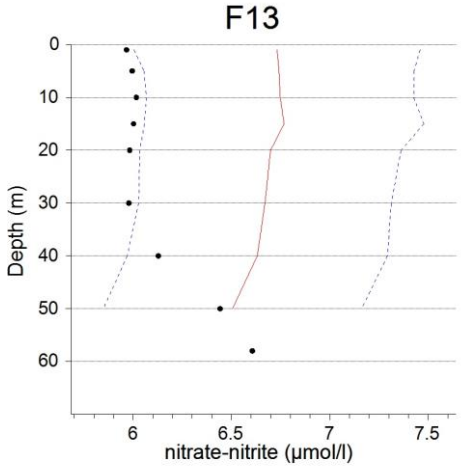
Kvarken

Variable concentrations were detected. Concentrations were between 4-7.5 µmol/l.



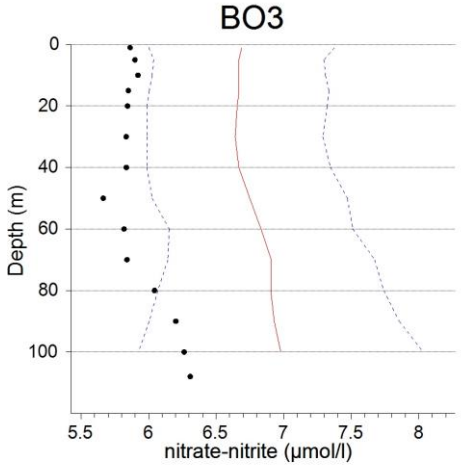


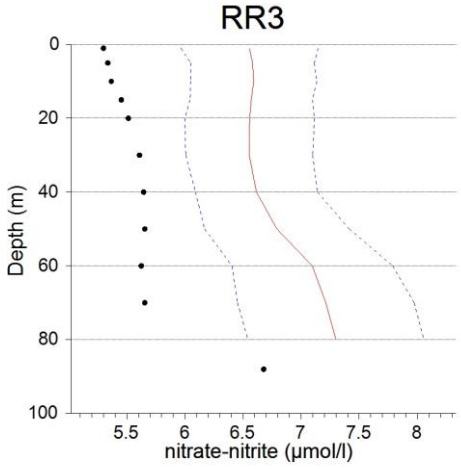


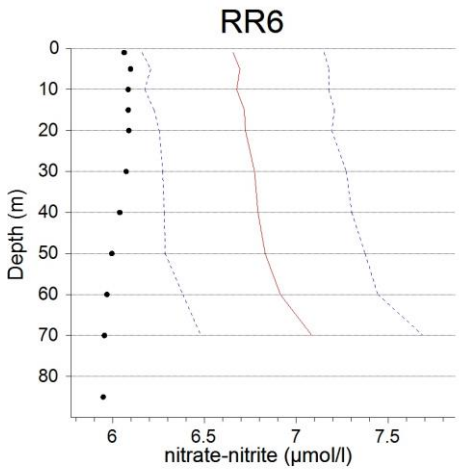


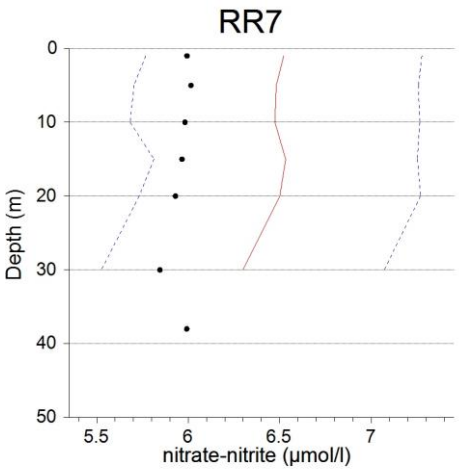
Bothnian Bay

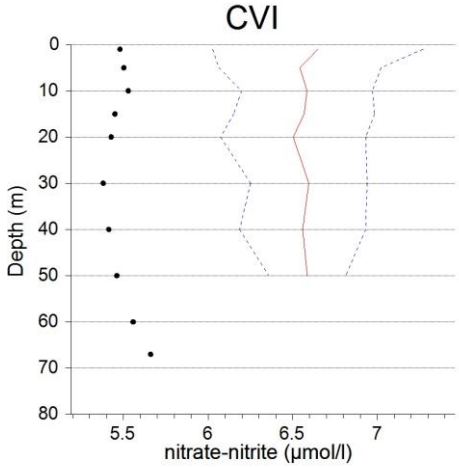
Lower concentrations than on average (2000-2020) in winter time were detected.

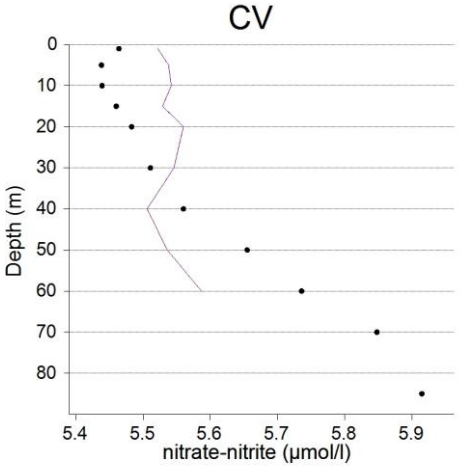


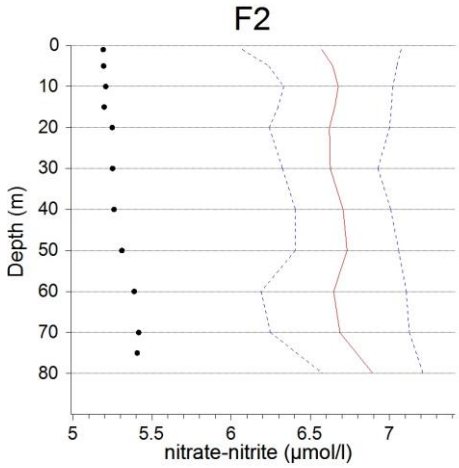



RR6
Depth (m)
0
10
20
30
40
50
60
70
80
6
6.5
7
7.5
nitrate-nitrite (µmol/l)


RR7
Depth (m)
0
10
20
30
40
50
5.5
6
6.5
7
nitrate-nitrite (µmol/l)

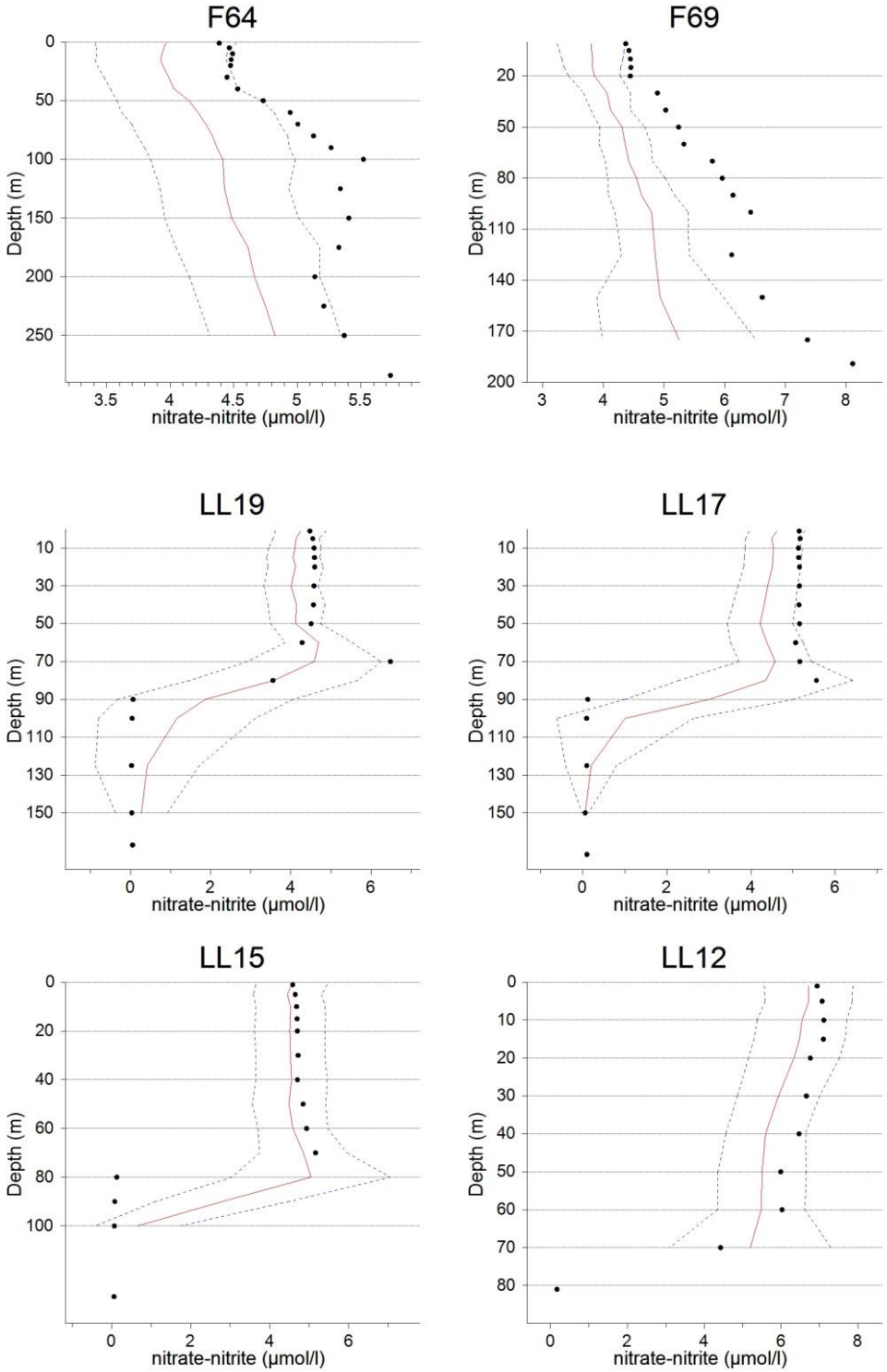

CVI
Depth (m)
0
10
20
30
40
50
60
70
80
5.5
6
6.5
7
nitrate-nitrite (µmol/l)

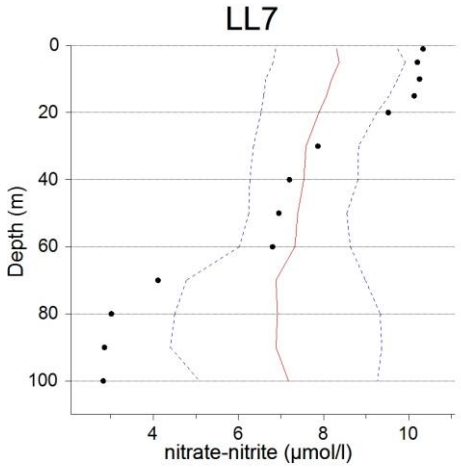

CV
Depth (m)
0
10
20
30
40
50
60
70
80
5.4
5.5
5.6
5.7
5.8
5.9
nitrate-nitrite (µmol/l)


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

Åland Sea and the Northern Baltic Proper

$NO_{2,3}$ concentrations were higher than on average in the Åland Sea, but average level in the Northern Baltic Proper.

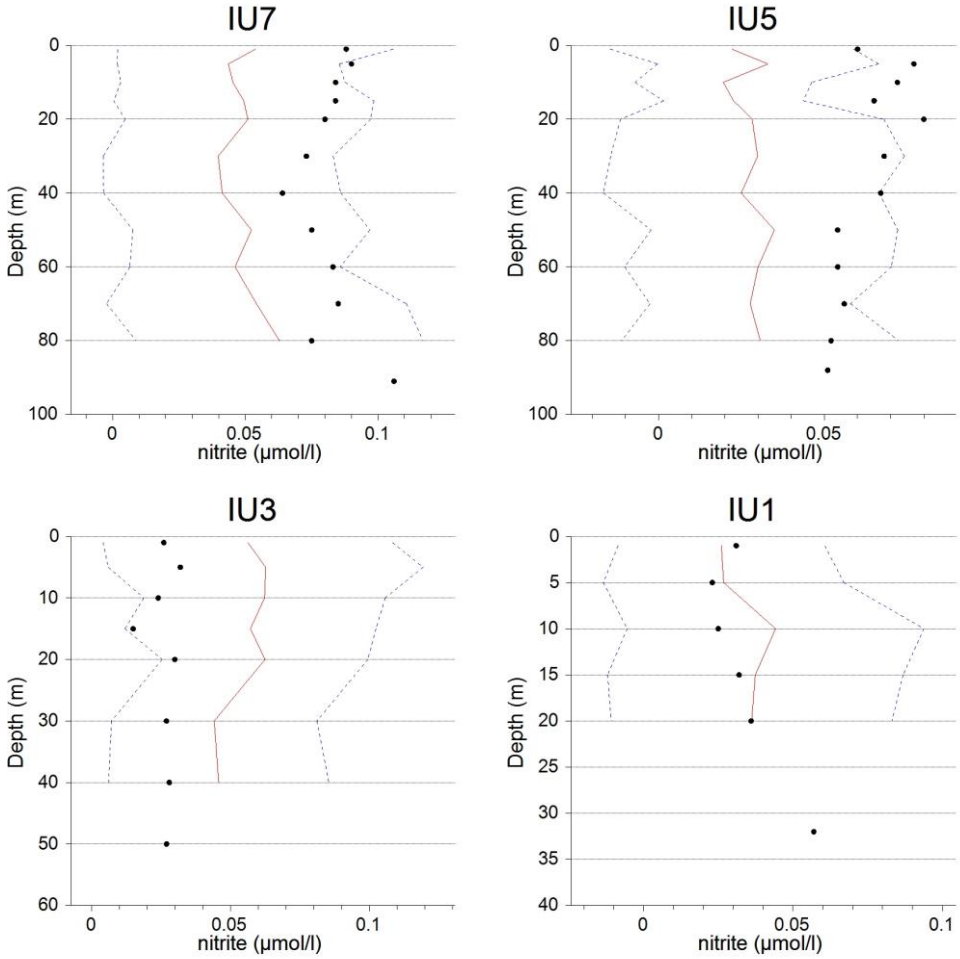




Nitrite

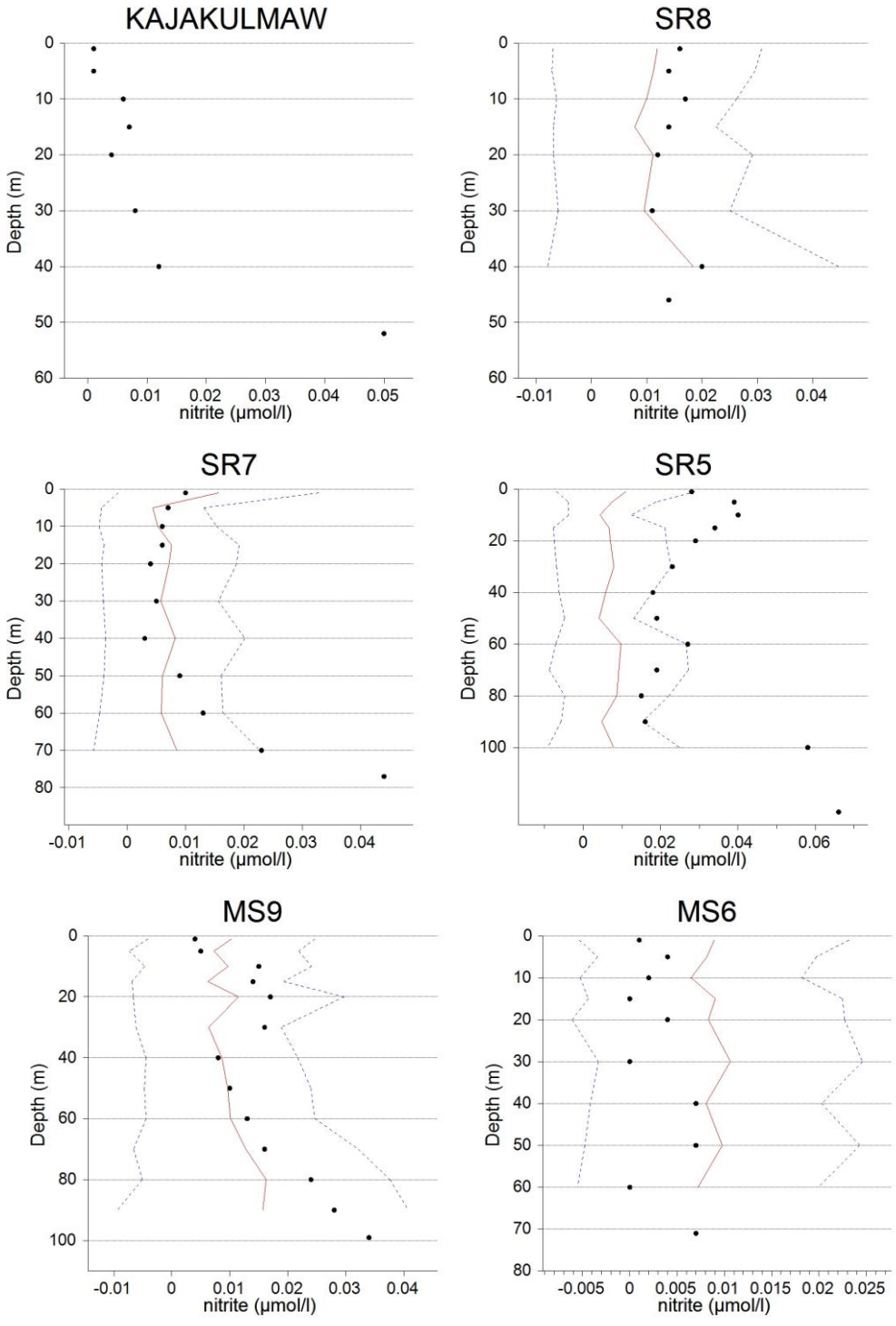
Archipelago Sea

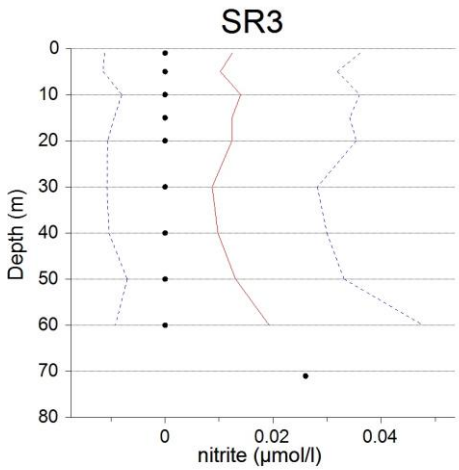
Observed NO_2 concentrations we higher than on average in the southern part of the Archipelago Sea.

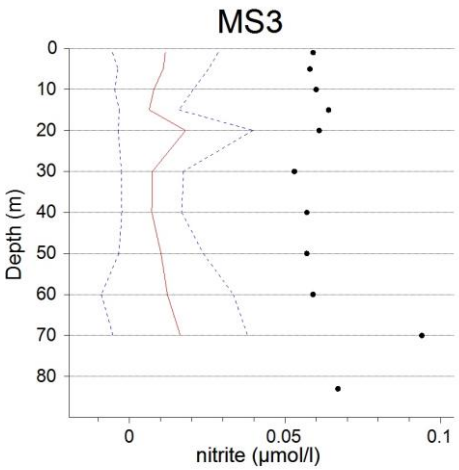


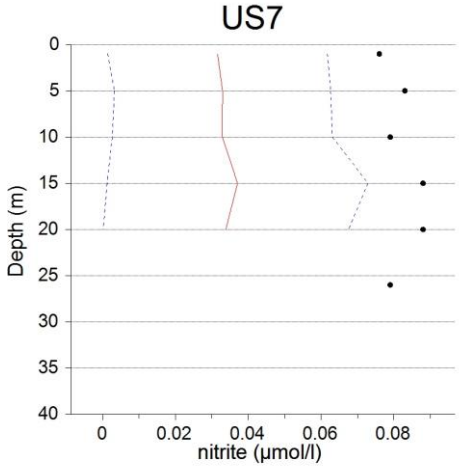
Bothinan Sea

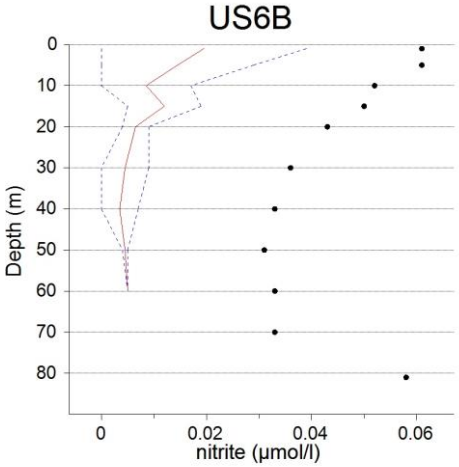
NO_2 concentrations were near average in the Southern part of the Bothnian Sea and slightly above an average in the Notrhern part of the region.

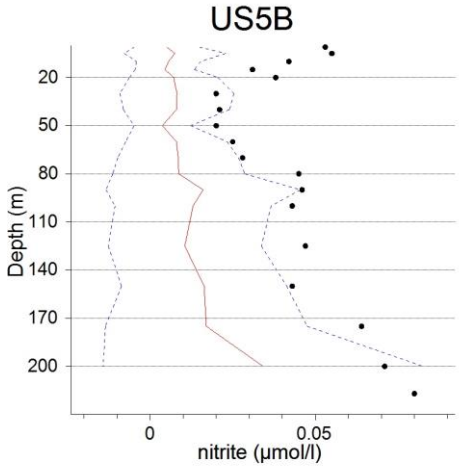


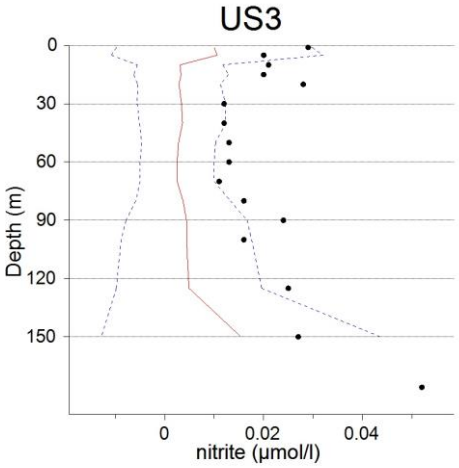

SR3
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.02
0.04
nitrite (µmol/l)

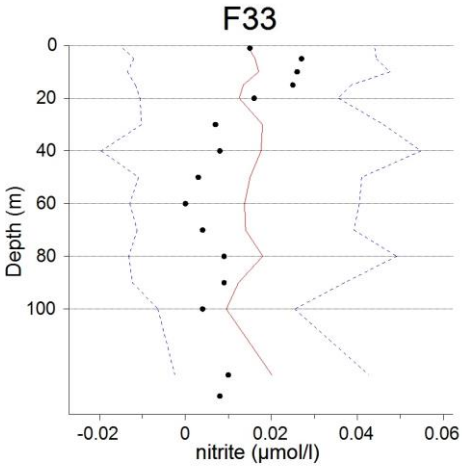

MS3
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.05
0.1
nitrite (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
0
0.02
0.04
0.06
0.08
nitrite (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.02
0.04
0.06
nitrite (µmol/l)

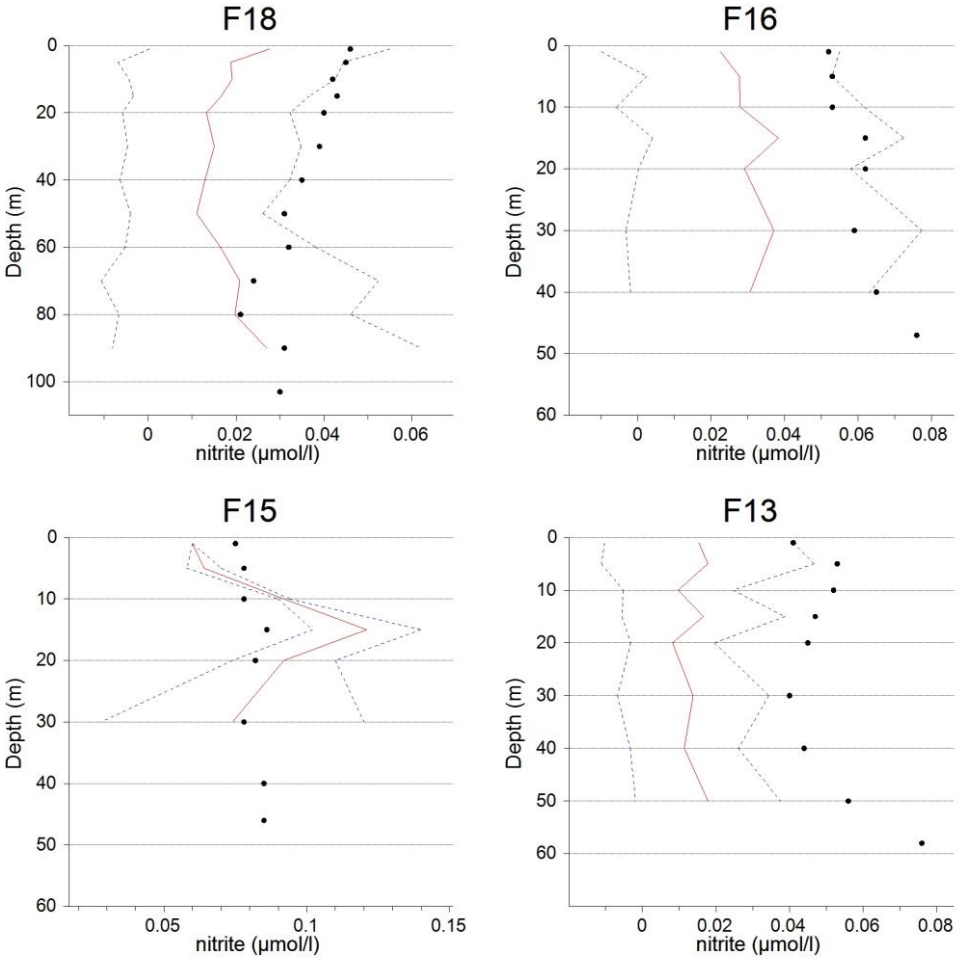

US5B
Depth (m)
20
50
80
110
140
170
200
0
0.05
nitrite (µmol/l)


US3
Depth (m)
0
30
60
90
120
150
0
0.02
0.04
nitrite (µmol/l)



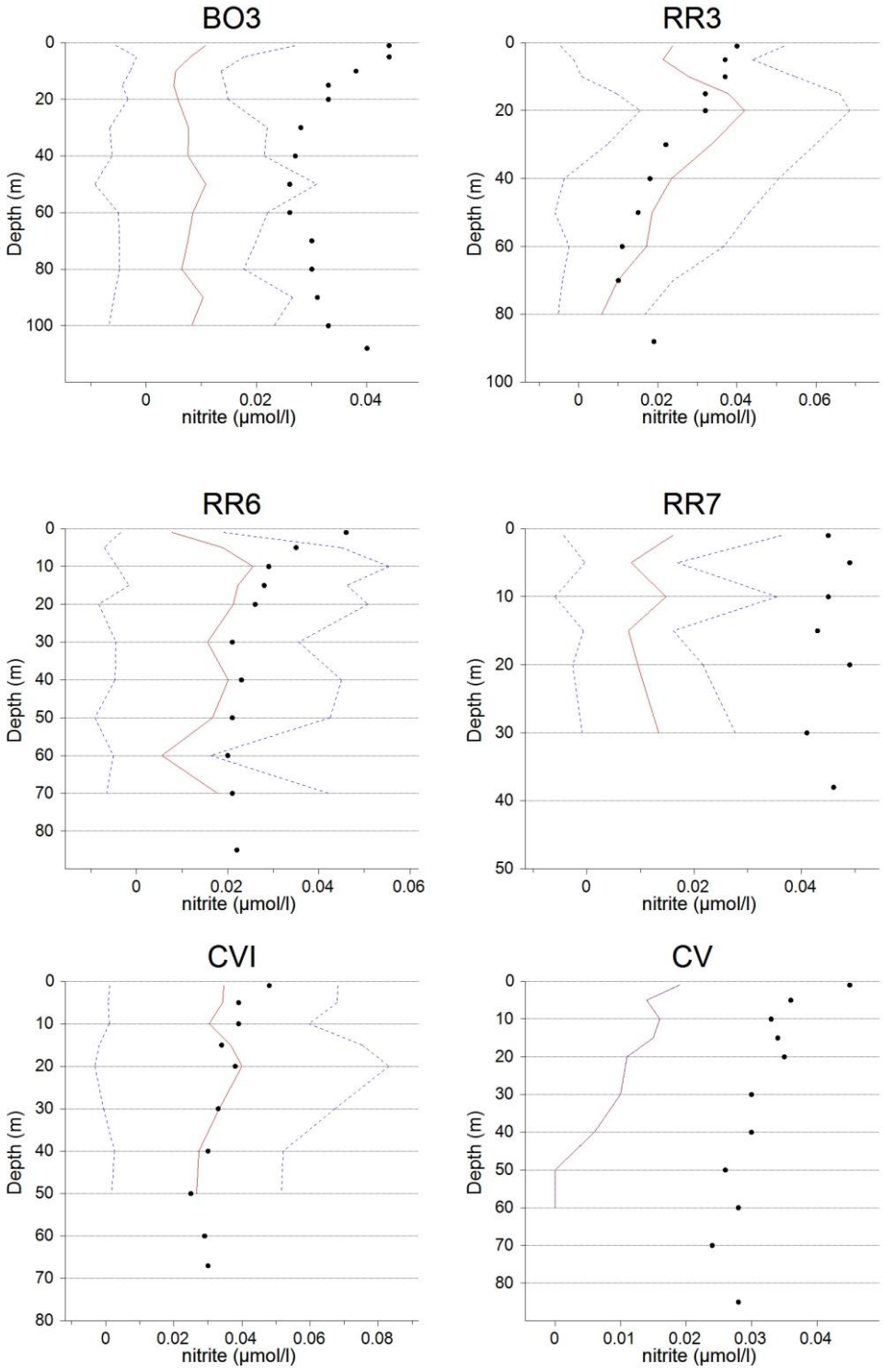
Kvarken

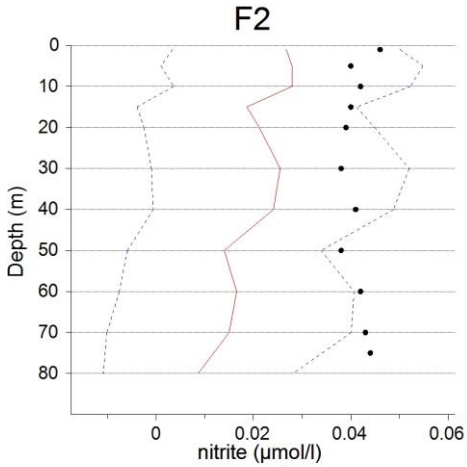
Observed NO_2 concentrations were higher than on average in winter (2000-2020).



Bothnian Bay

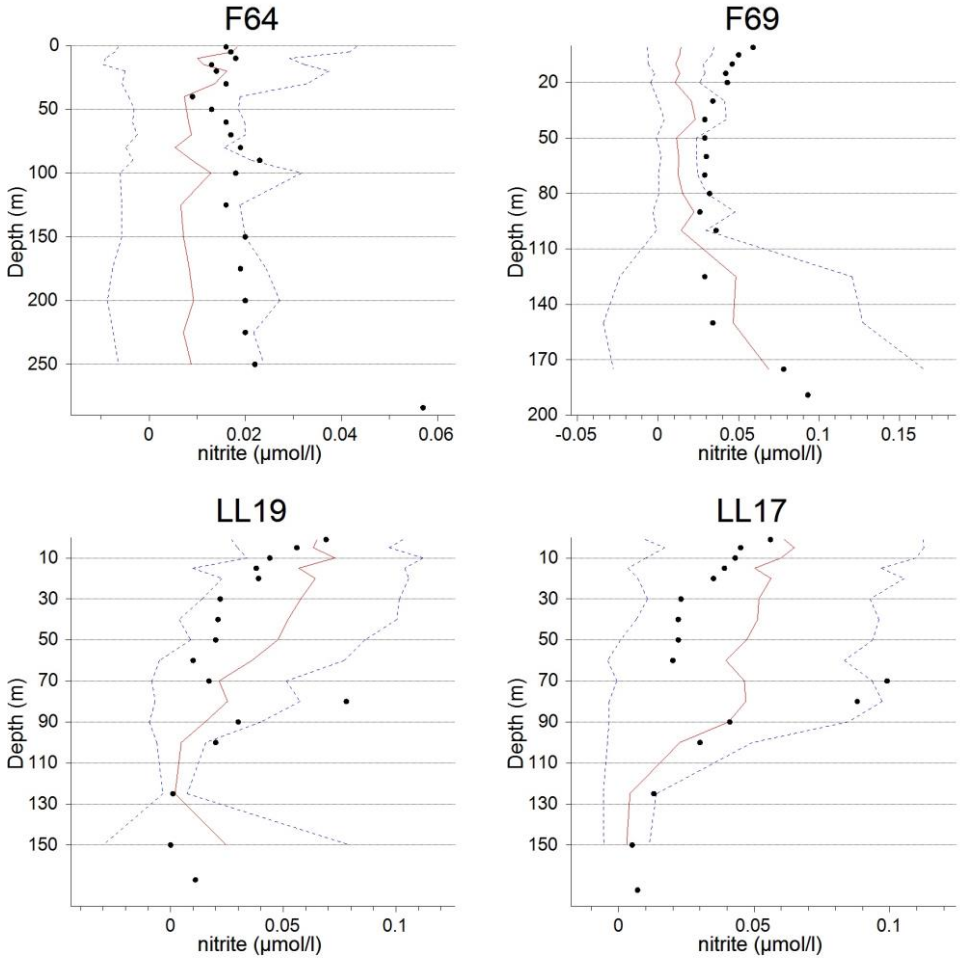
Observed NO2 concentrations were above the winter average (2000-2020).

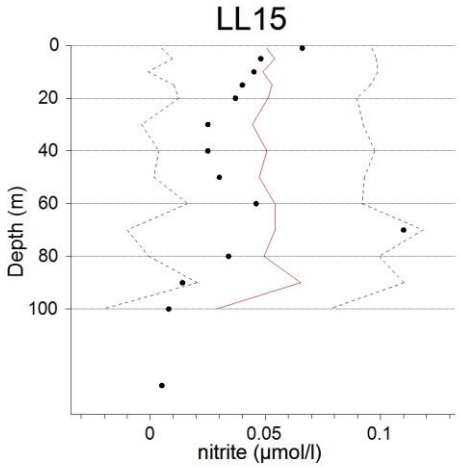


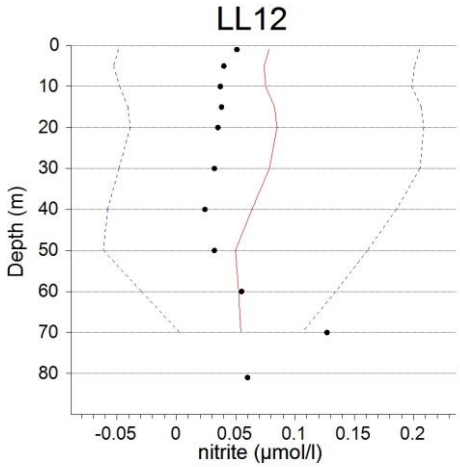


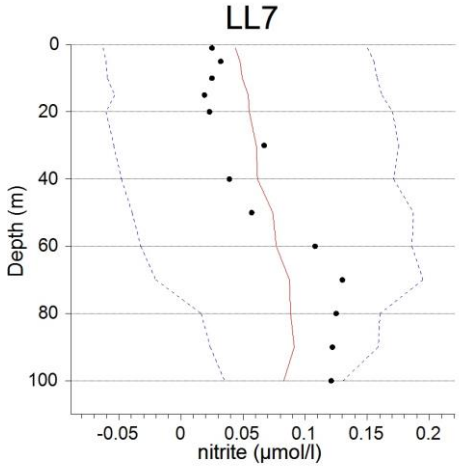
Åland Sea and the Northern Baltic Proper

Observed NO2 concentrations were on an average level in January 2021.





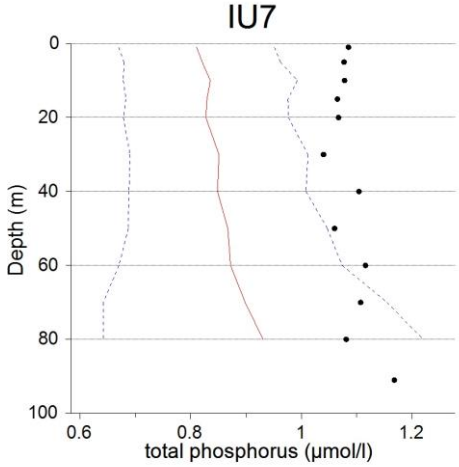


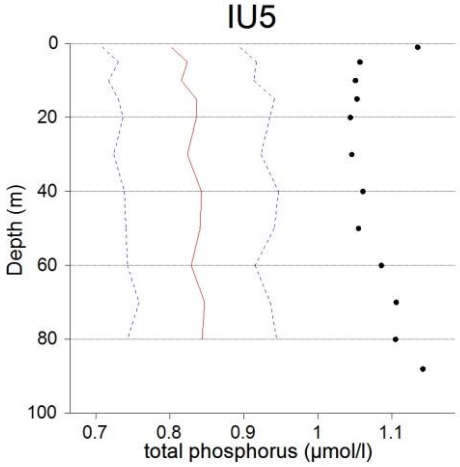


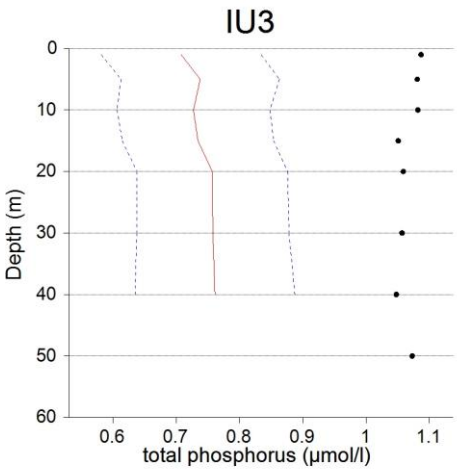
Total phosphorus

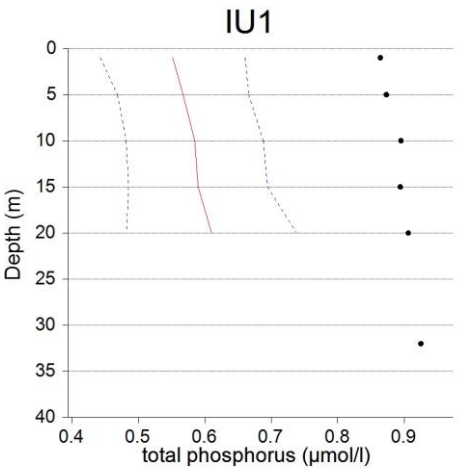
Archipelago Sea

Exceptionally high concentrations, 50% higher than on average, of Ptot were observed in January 2021.



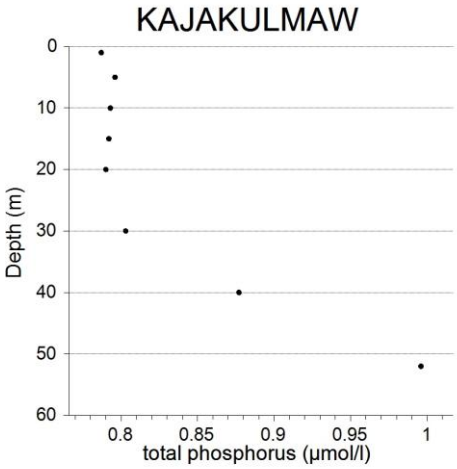


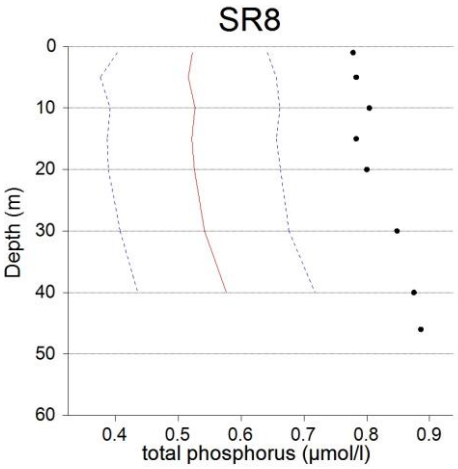


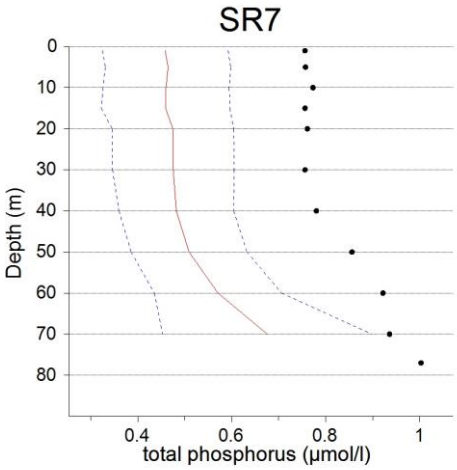


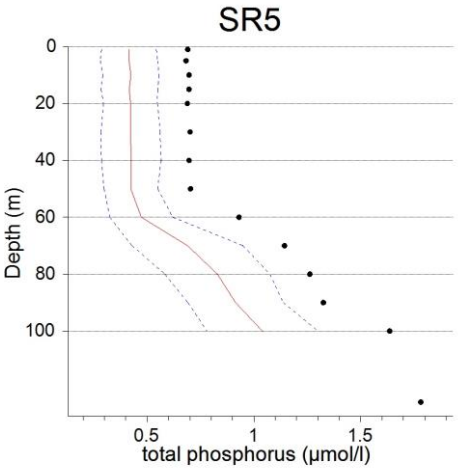
Bothnian Sea

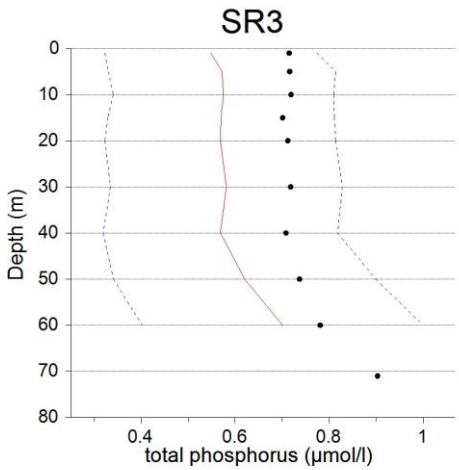
High Ptot concentrations were detected in the Bothnian Sea compared with average winter concentrations of 2000-2020. Highest concentrations were observed in deep waters.

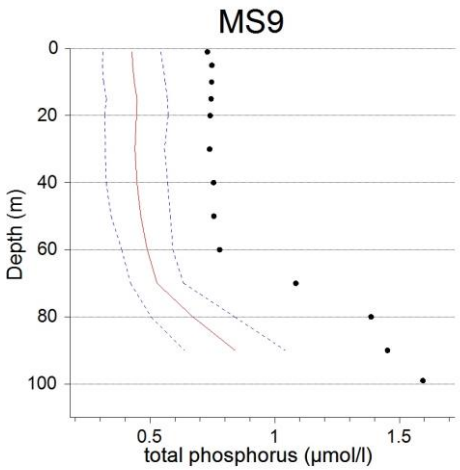


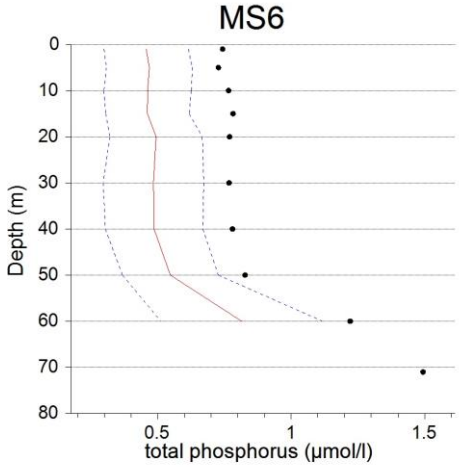


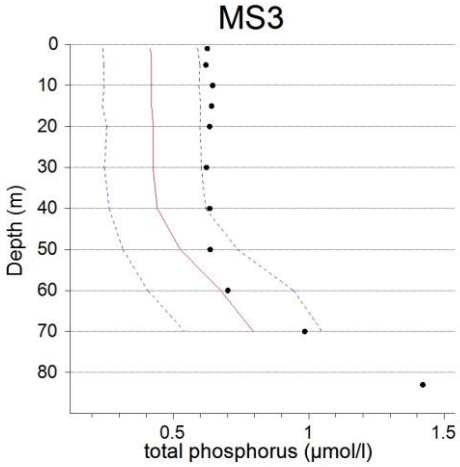


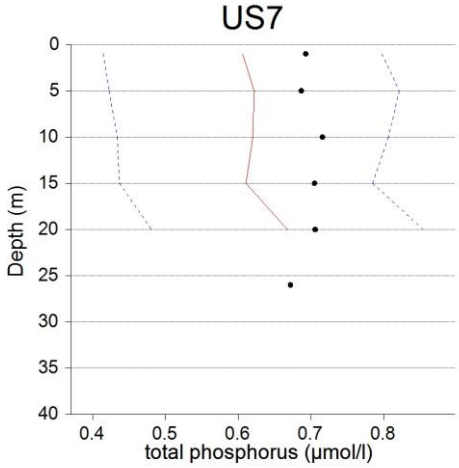


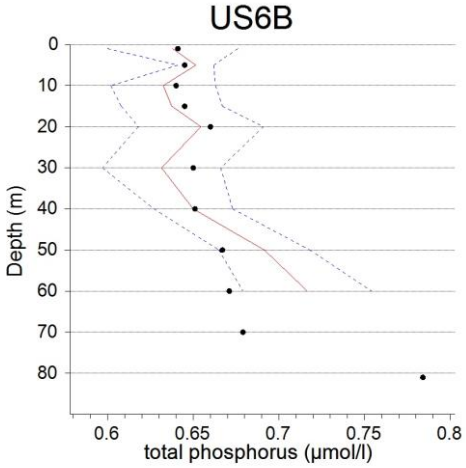

SR3
Depth (m)
0
10
20
30
40
50
60
70
80
0.4
0.6
0.8
1
total phosphorus (µmol/l)

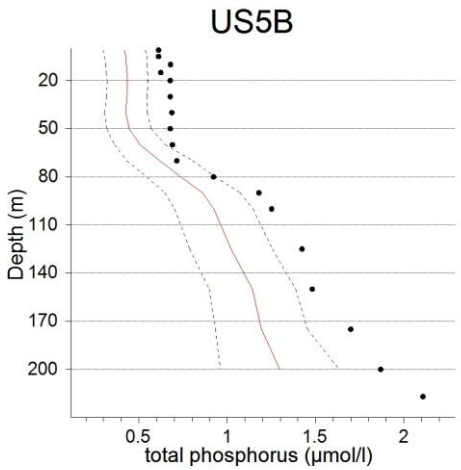

MS9
Depth (m)
0
20
40
60
80
100
0.5
1
1.5
total phosphorus (µmol/l)

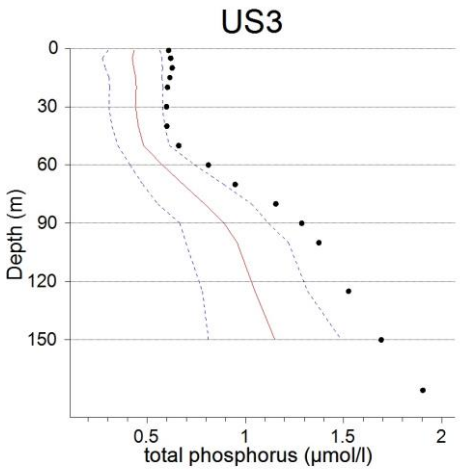

MS6
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
1.5
total phosphorus (µmol/l)

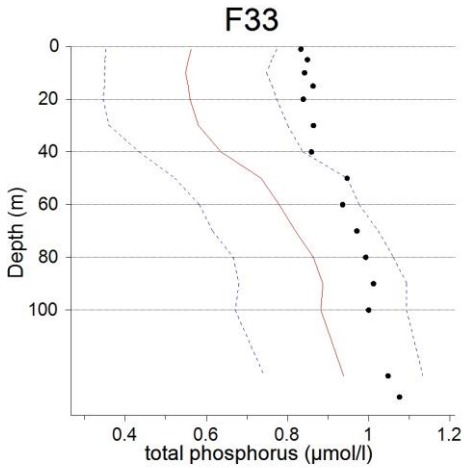

MS3
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
1.5
total phosphorus (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
0.4
0.5
0.6
0.7
0.8
total phosphorus (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
0.6
0.65
0.7
0.75
0.8
total phosphorus (µmol/l)

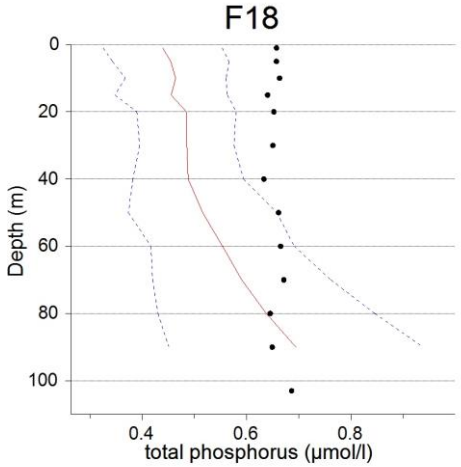


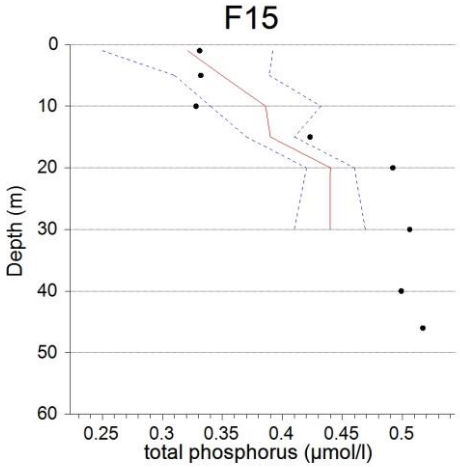


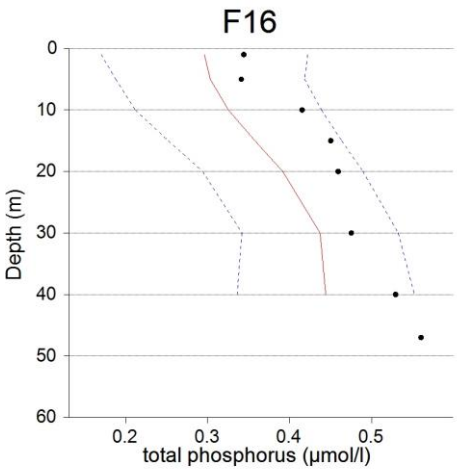


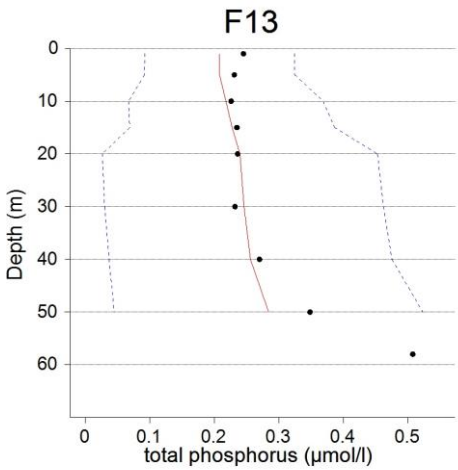
Kvarken

Slightly higher concentrations than on average (2000-2020) in winter were observed in Kvarken.



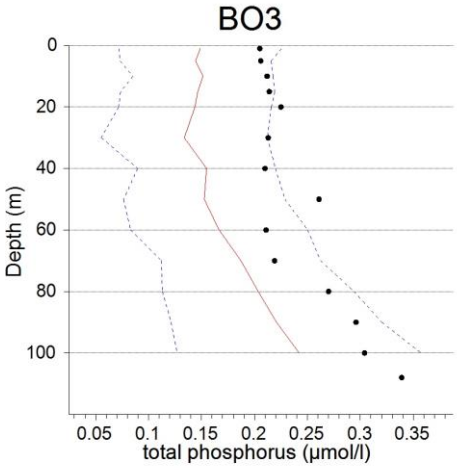


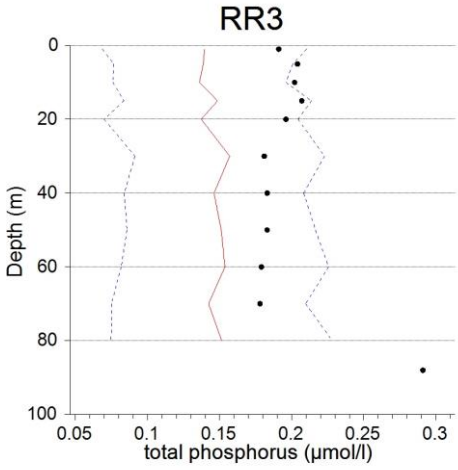


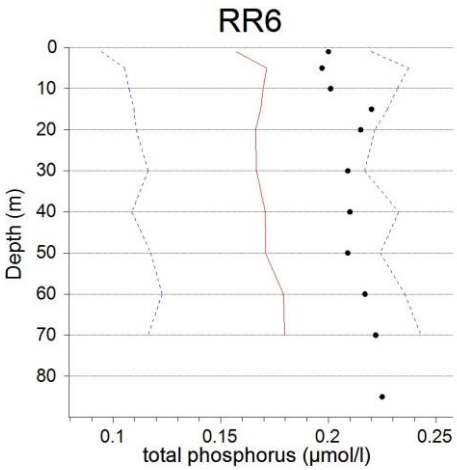


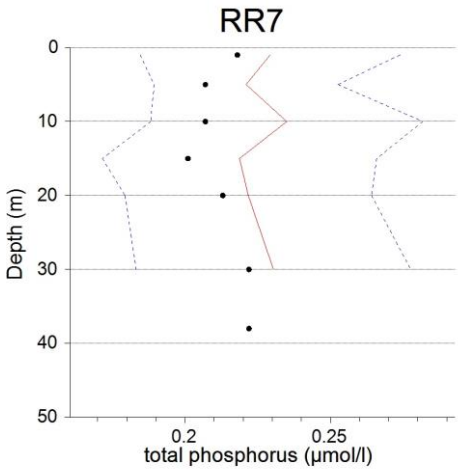
Bothnian Bay

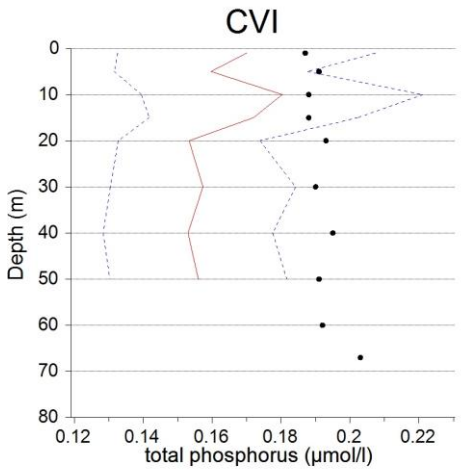
The observed concentrations were higher than on average (2000-2020) in winter. Still the concentrations were at a level of 0.35µmol/l.

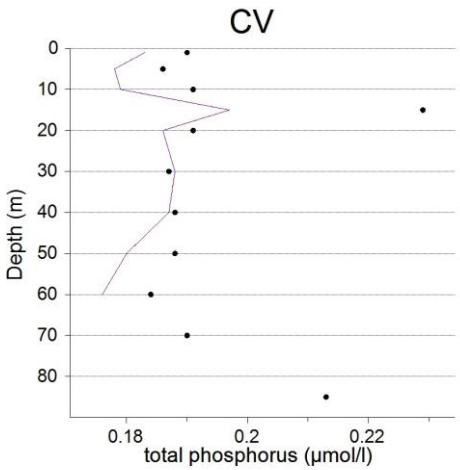


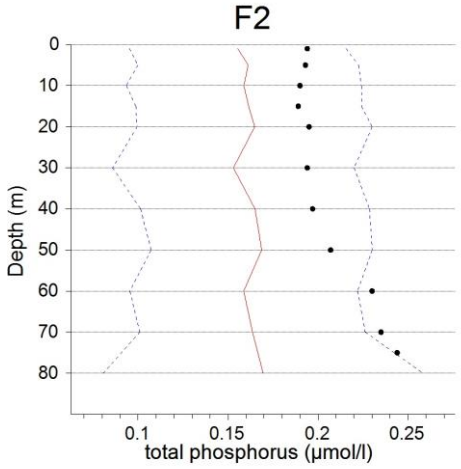






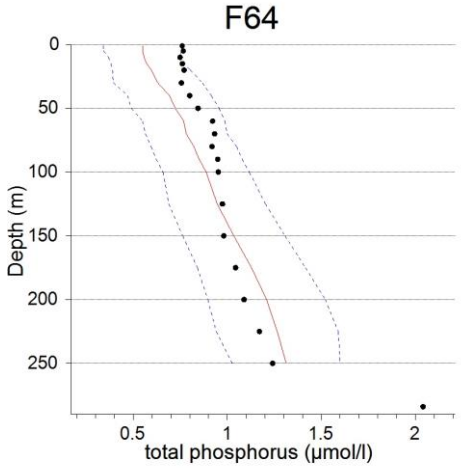


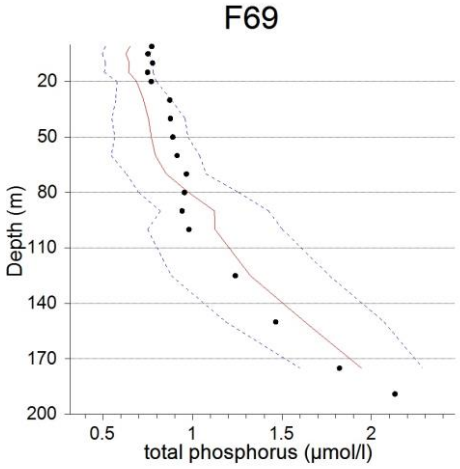


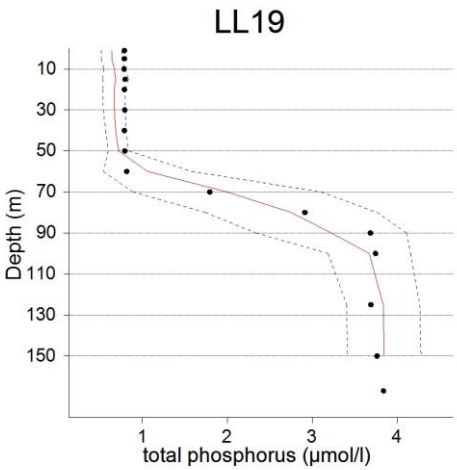


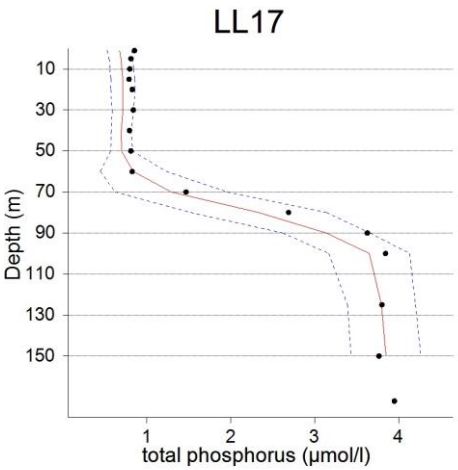
Åland Sea and the Northern Baltic Proper

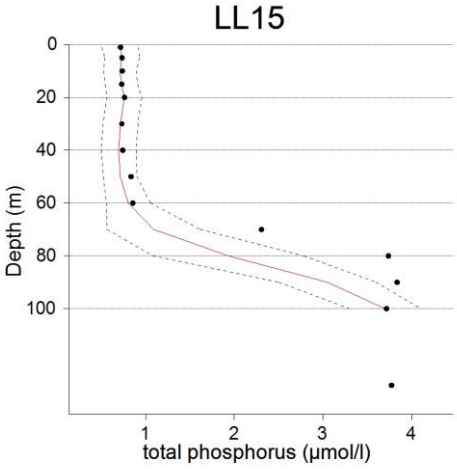
Highest P_{tot} concentrations were detected in deep waters in the Northern Baltic Proper were. In the anoxic layer, below 80-90m concentrations as high as 4µmol/l were observed.

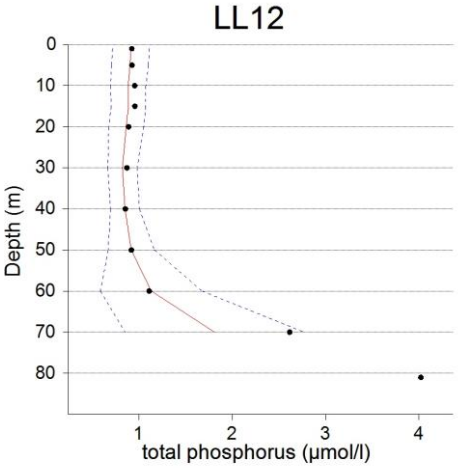


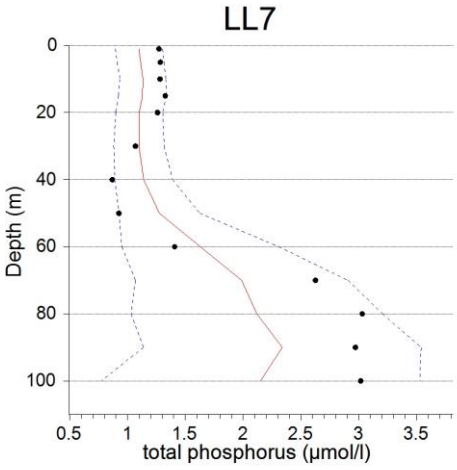



LL19
Depth (m)
10
30
50
70
90
110
130
150
1
2
3
4
total phosphorus (µmol/l)


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


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

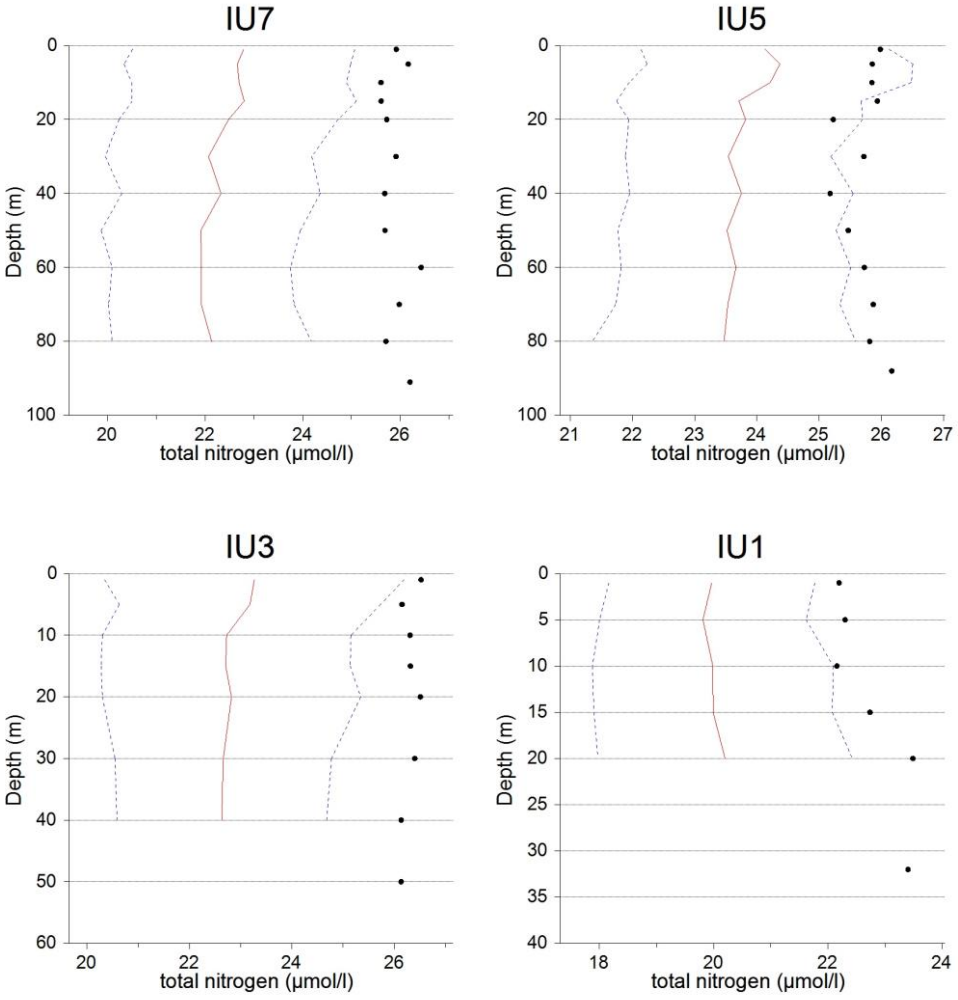

LL12
Depth (m)
0
10
20
30
40
50
60
70
80
1
2
3
4
total phosphorus (µmol/l)


LL7
Depth (m)
0
20
40
60
80
100
0.5
1
1.5
2
2.5
3
3.5
total phosphorus (µmol/l)

Total nitrogen

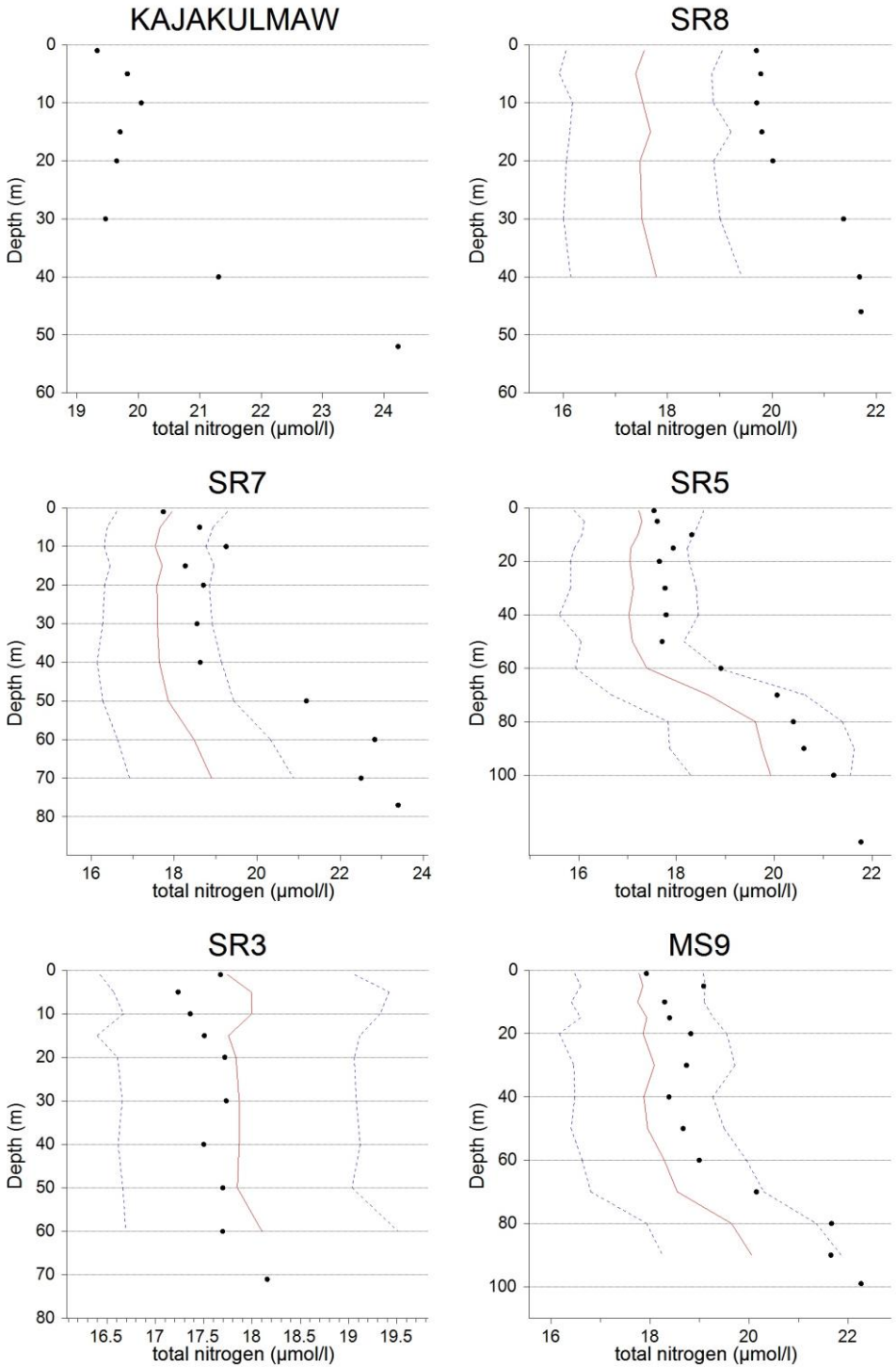
Archipelago Sea

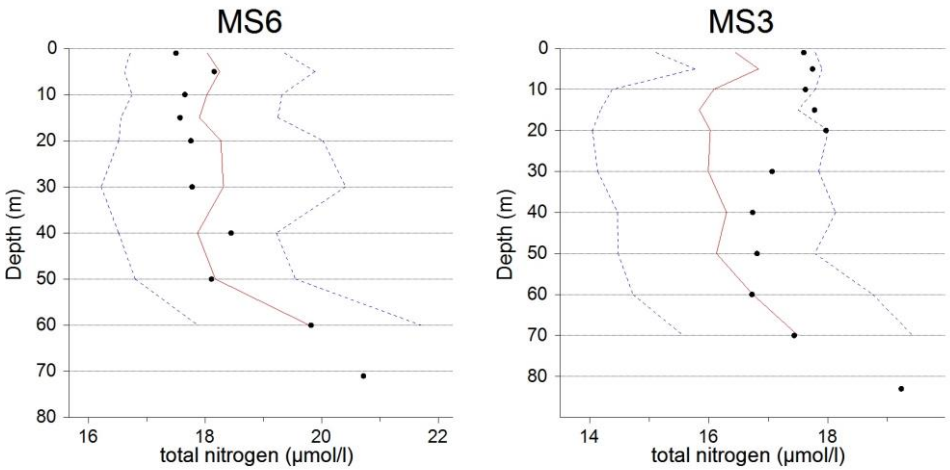
Observed N_{tot} concentrations were > 24µmol/l, which is well above an average (2000-2020) in winter.

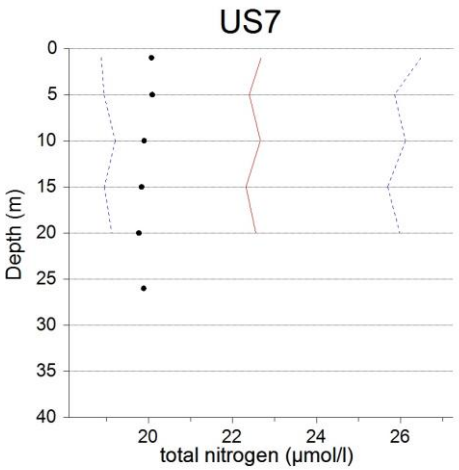


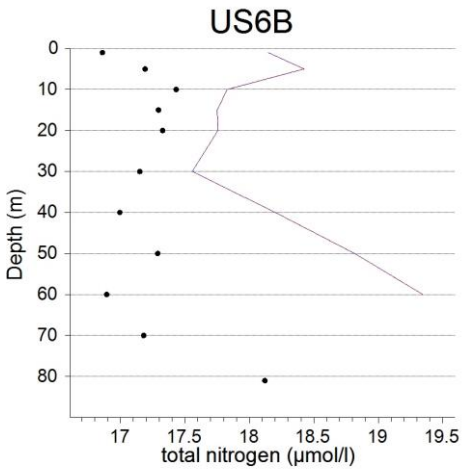
Bothnian Sea

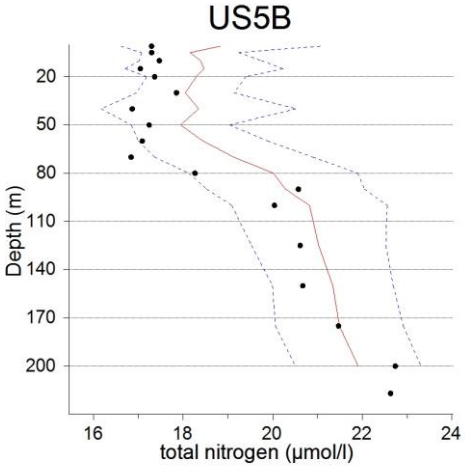
Observed Ntot concentrations were between 16 µmol/l to 23 µmol/l and followed at some stations the average winter concentrations.

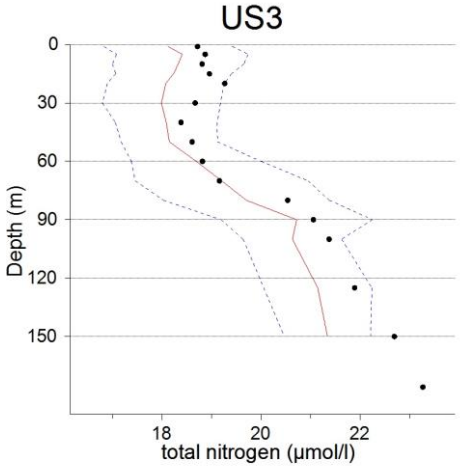


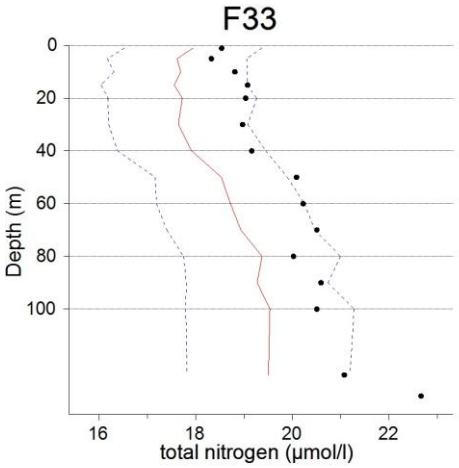

MS6
Depth (m)
0
10
20
30
40
50
60
70
80
16
18
20
22
total nitrogen (µmol/l)
MS3
Depth (m)
0
10
20
30
40
50
60
70
80
14
16
18
total nitrogen (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
20
22
24
26
total nitrogen (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
17
17.5
18
18.5
19
19.5
total nitrogen (µmol/l)

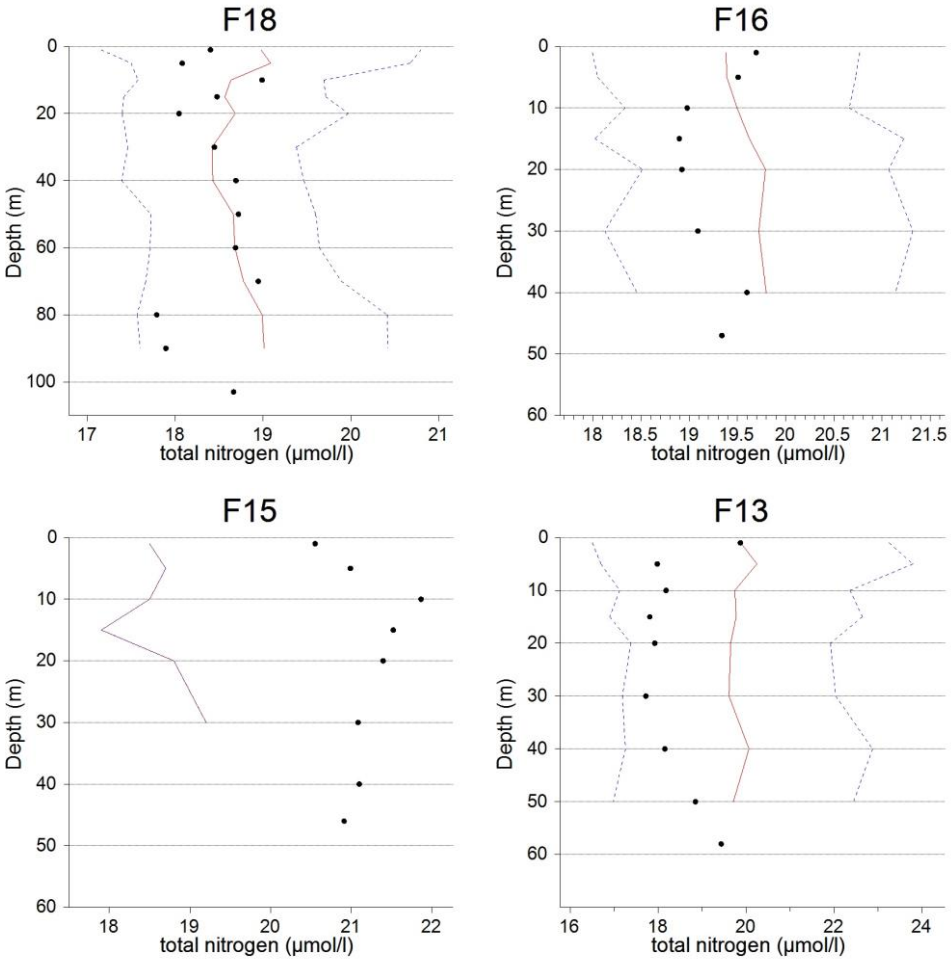

US5B
Depth (m)
20
50
80
110
140
170
200
16
18
20
22
24
total nitrogen (µmol/l)


US3
Depth (m)
0
30
60
90
120
150
18
20
22
total nitrogen (µmol/l)


F33
Depth (m)
0
20
40
60
80
100
16
18
20
22
total nitrogen (µmol/l)

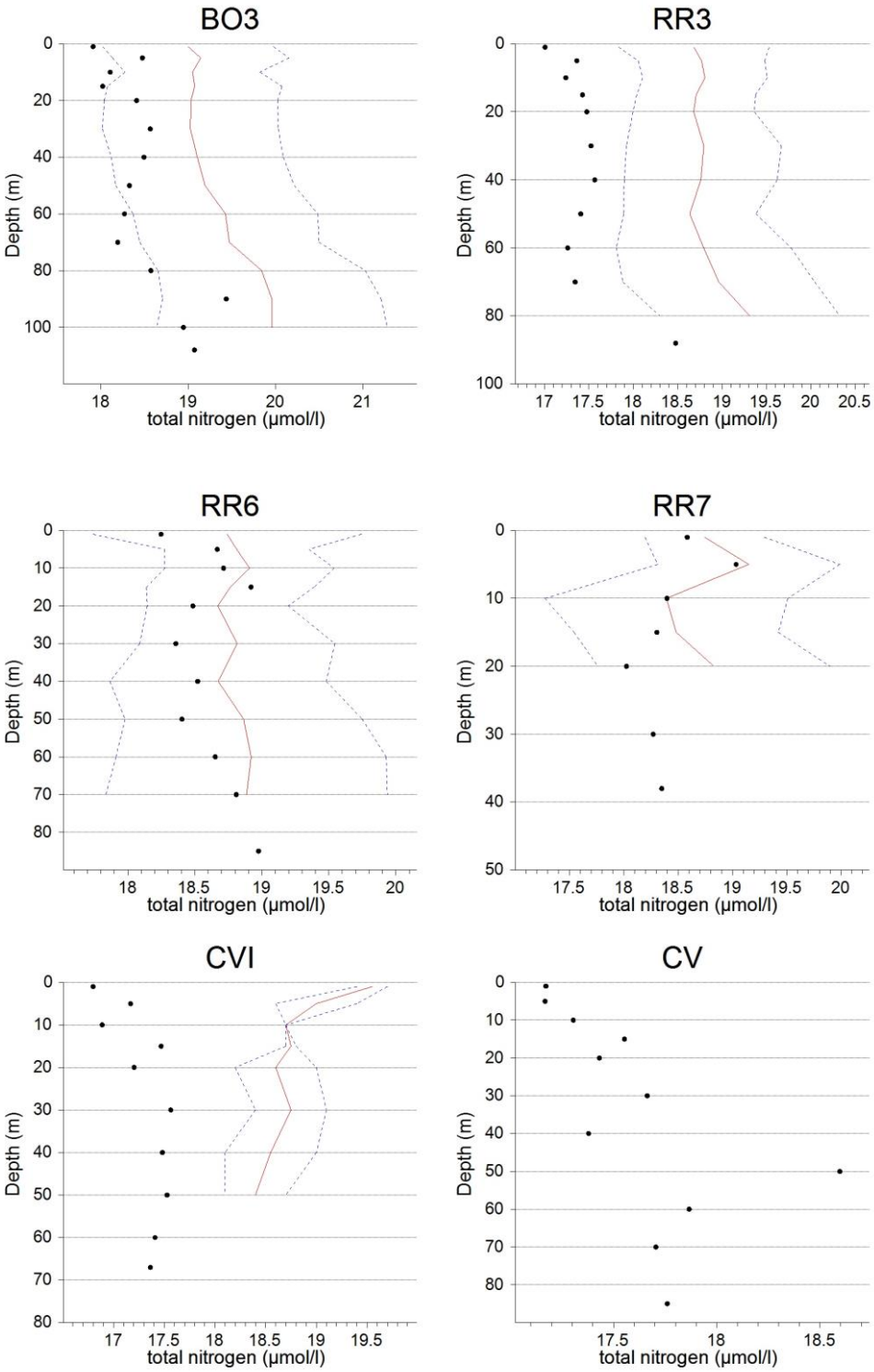
Kvarken

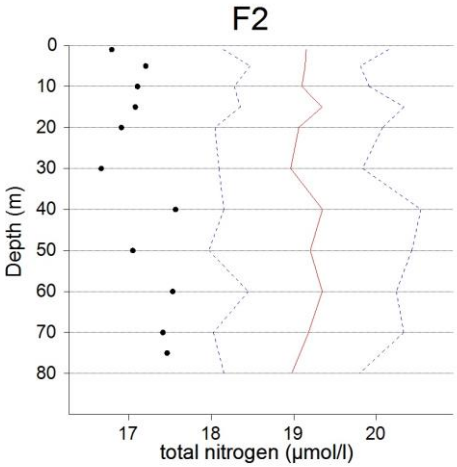
Average N_{tot} concentrations in winter were observed. The concentrations were approximately 20µmol/l.



Bothnian Bay

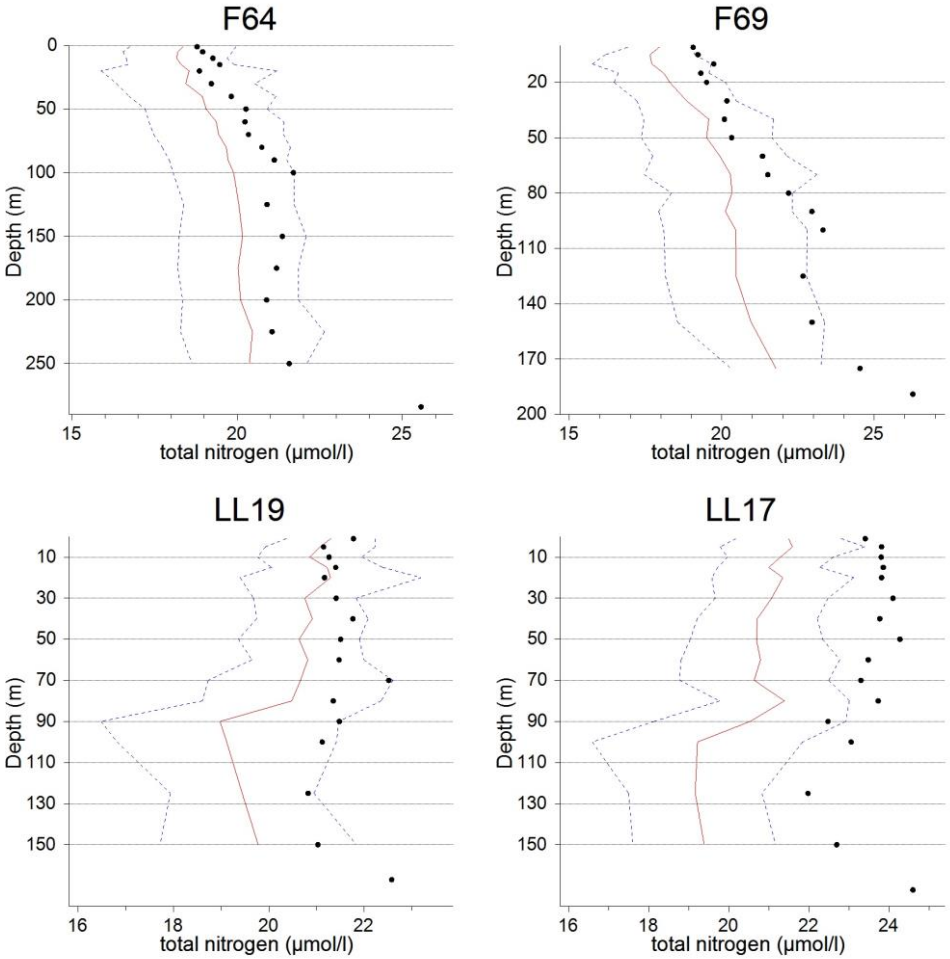
Lower concentrations than on average (2000-2020) in winter were observed in the Bothnian Bay.

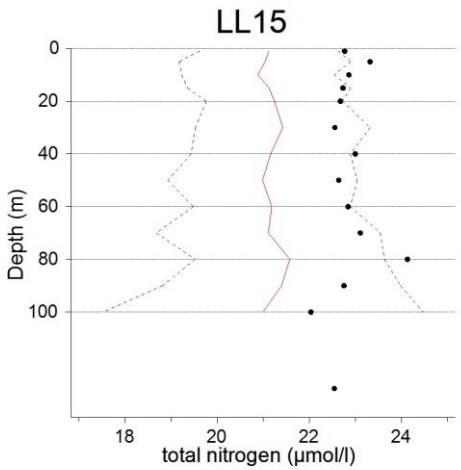


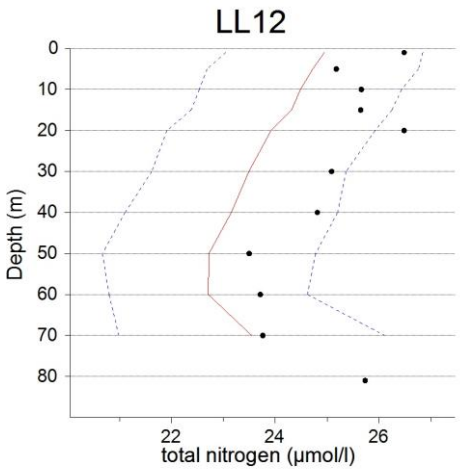


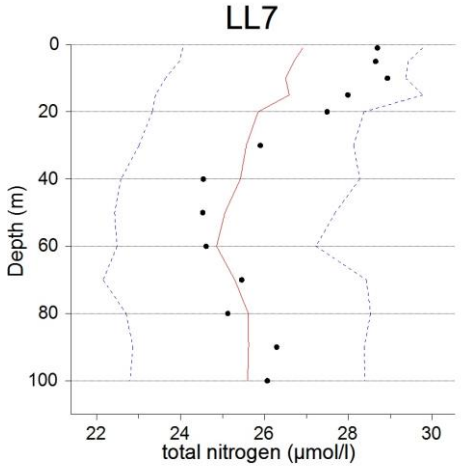
Åland Sea and the Northern Baltic Proper

Increased N_{tot} concentrations were detected. They were > 20µmol/l and concentrations > 25µmol/l towards the east (station LL12).





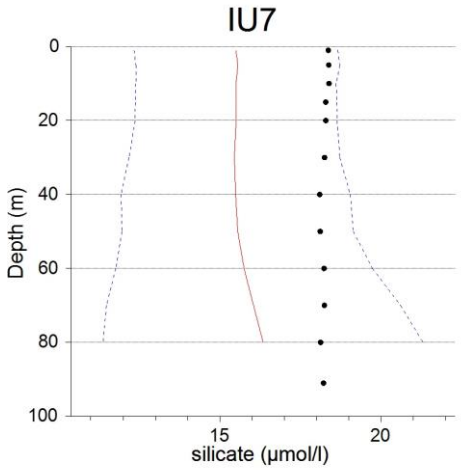


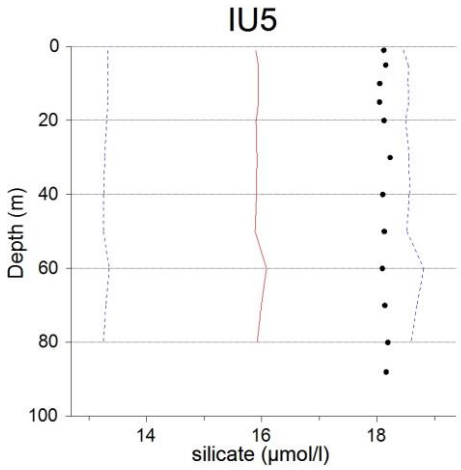


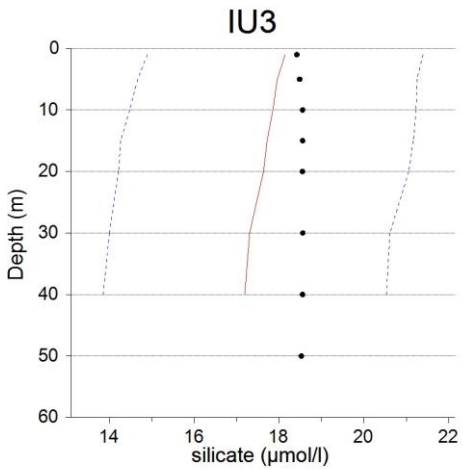
Silicate

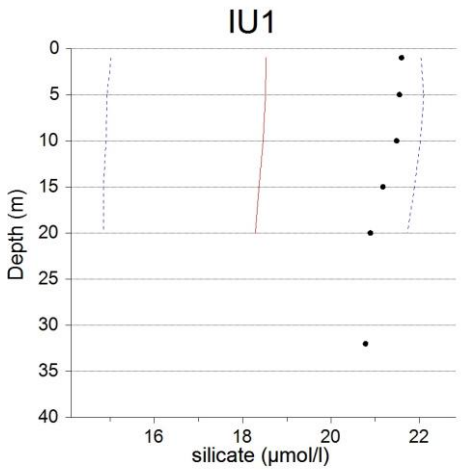
Archipelago Sea

Higher silicate concentrations were observed than on average (2000-2020) in winter.



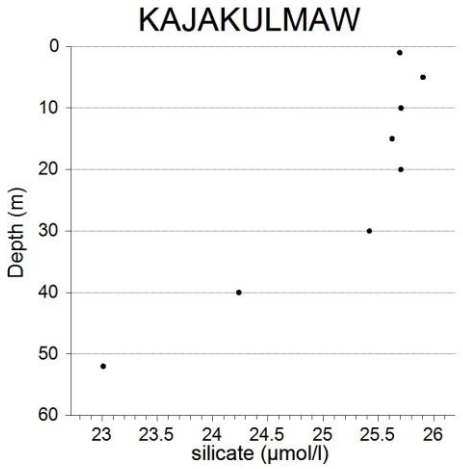


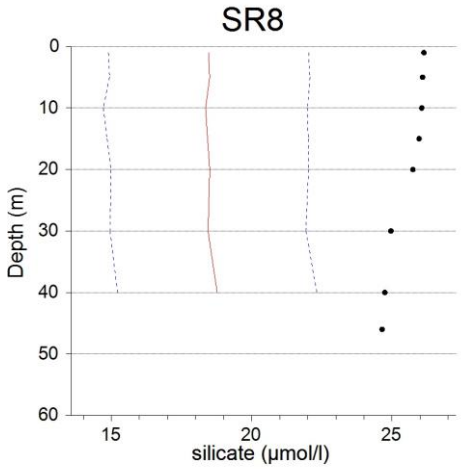


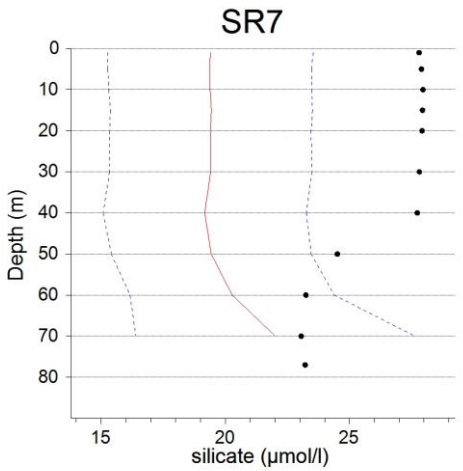


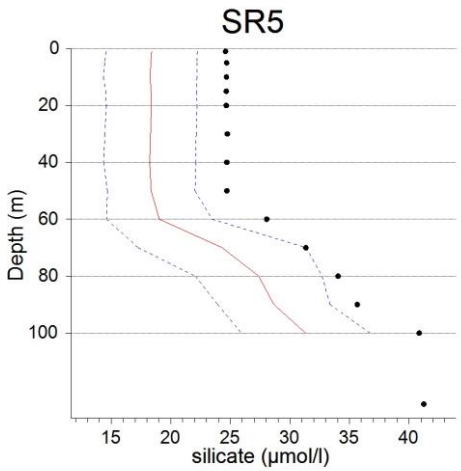
Bothnian Sea

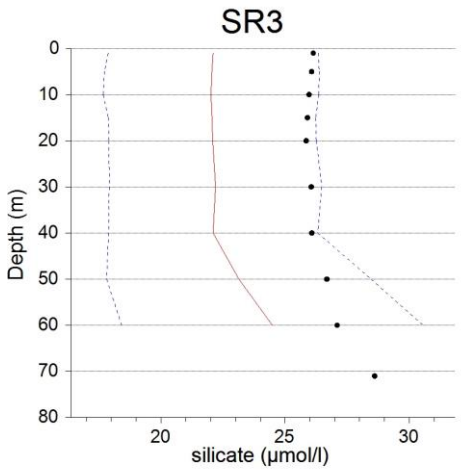
Higher concentrations were detected compared with the average winter concentrations in 2000-2020. Typically, the concentrations were ~5 µmol/l higher than on average.

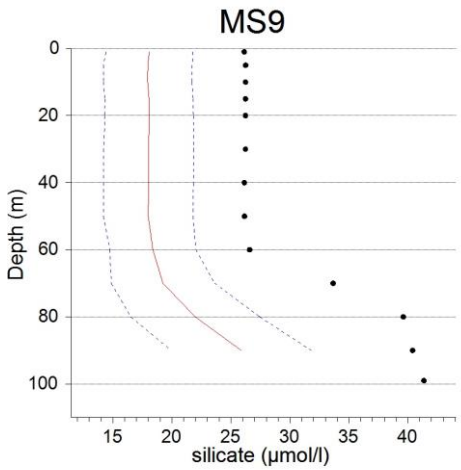


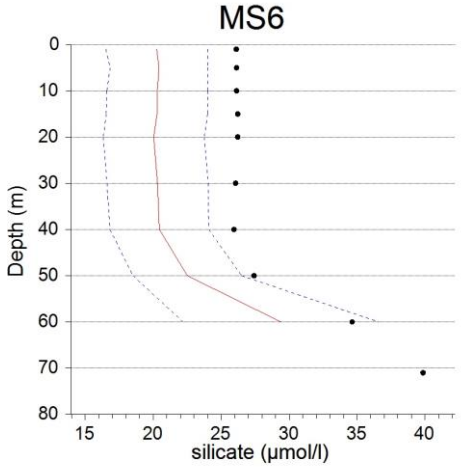


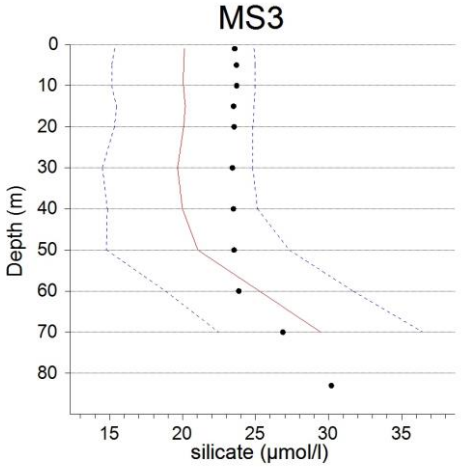


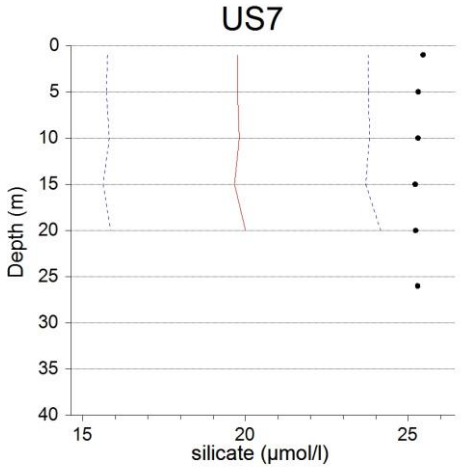


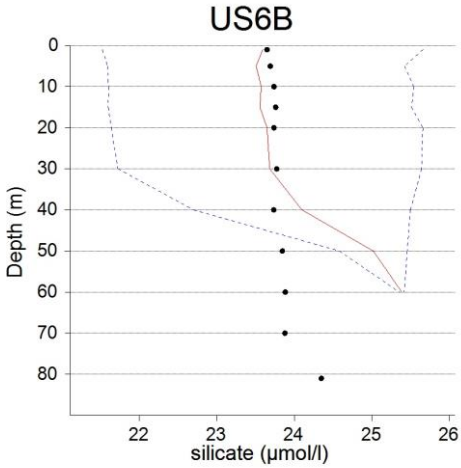

SR3
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
silicate (µmol/l)

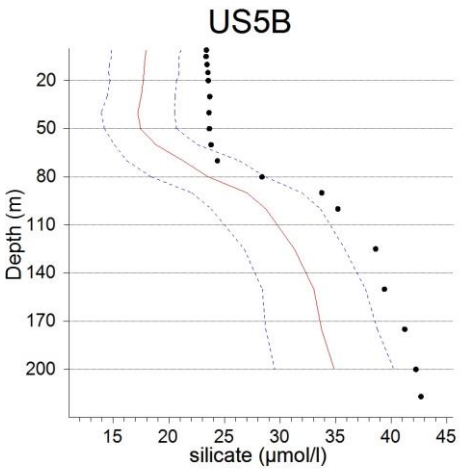

MS9
Depth (m)
0
20
40
60
80
100
15
20
25
30
35
40
silicate (µmol/l)

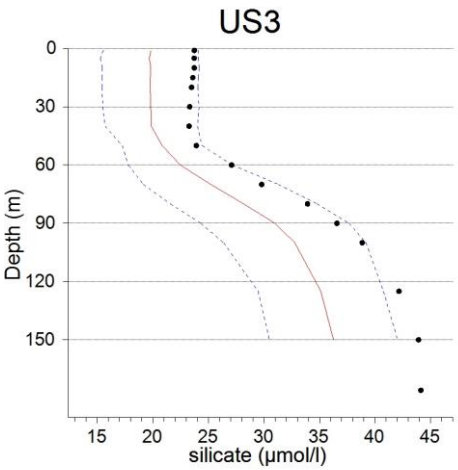

MS6
Depth (m)
0
10
20
30
40
50
60
70
80
15
20
25
30
35
40
silicate (µmol/l)

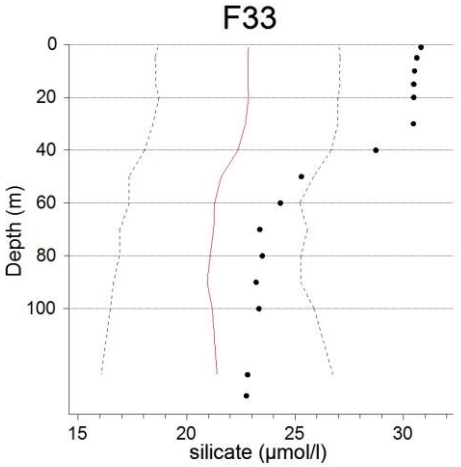

MS3
Depth (m)
0
10
20
30
40
50
60
70
80
15
20
25
30
35
silicate (µmol/l)


US7
Depth (m)
0
5
10
15
20
25
30
35
40
15
20
25
silicate (µmol/l)


US6B
Depth (m)
0
10
20
30
40
50
60
70
80
22
23
24
25
26
silicate (µmol/l)

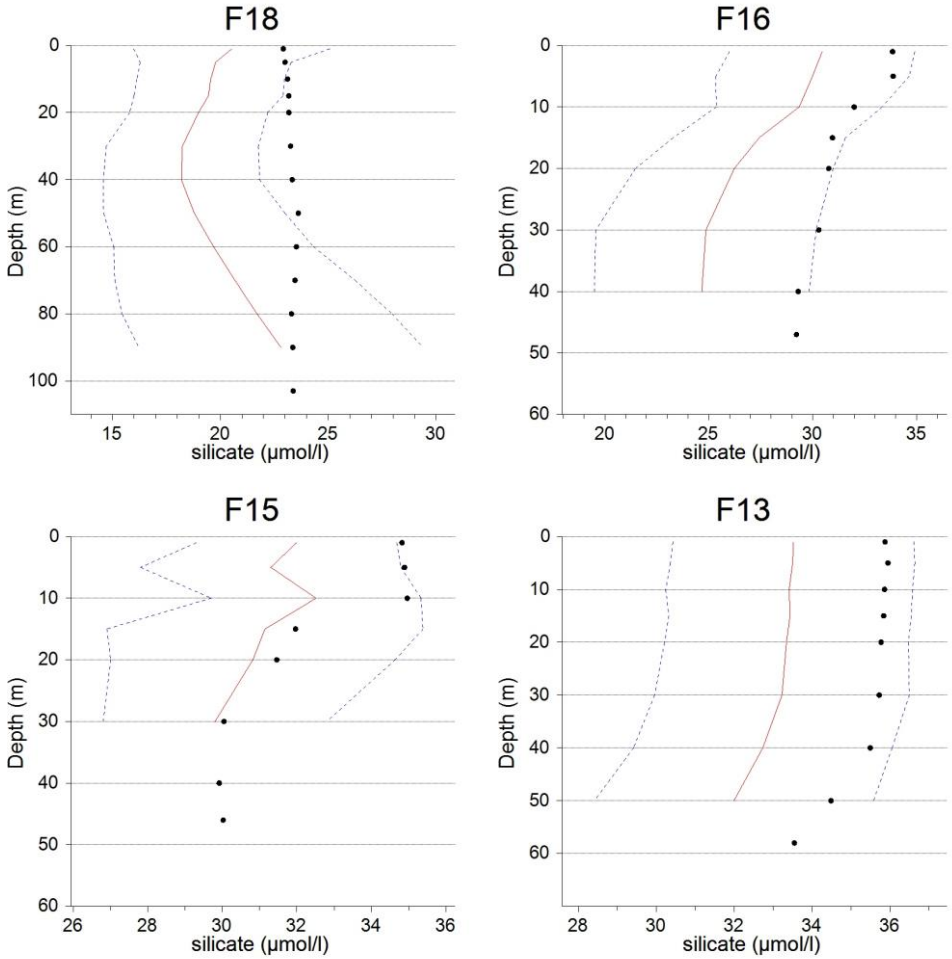

US5B
Depth (m)
20
50
80
110
140
170
200
15
20
25
30
35
40
45
silicate (µmol/l)


US3
Depth (m)
0
30
60
90
120
150
15
20
25
30
35
40
45
silicate (µmol/l)


F33
Depth (m)
0
20
40
60
80
100
15
20
25
30
silicate (µmol/l)

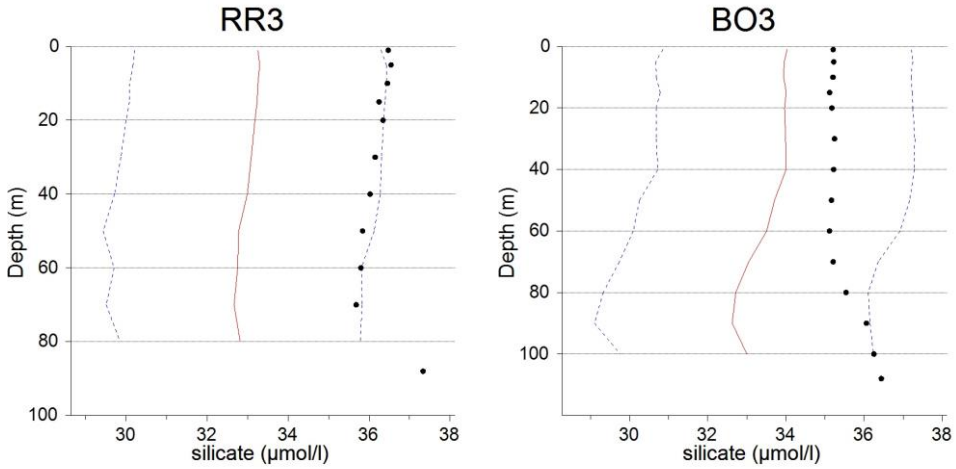
Kvarken

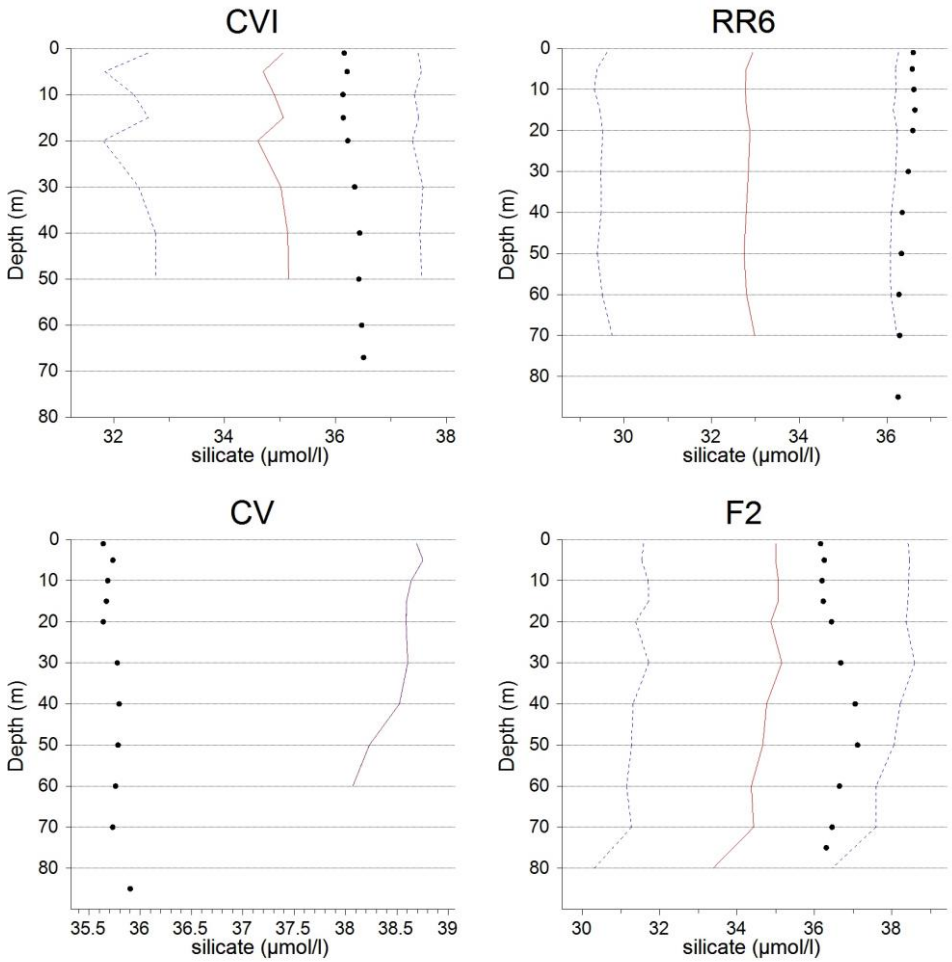
Higher concentrations were observed than on average (2000-2020) in winter.



Bothnian Bay

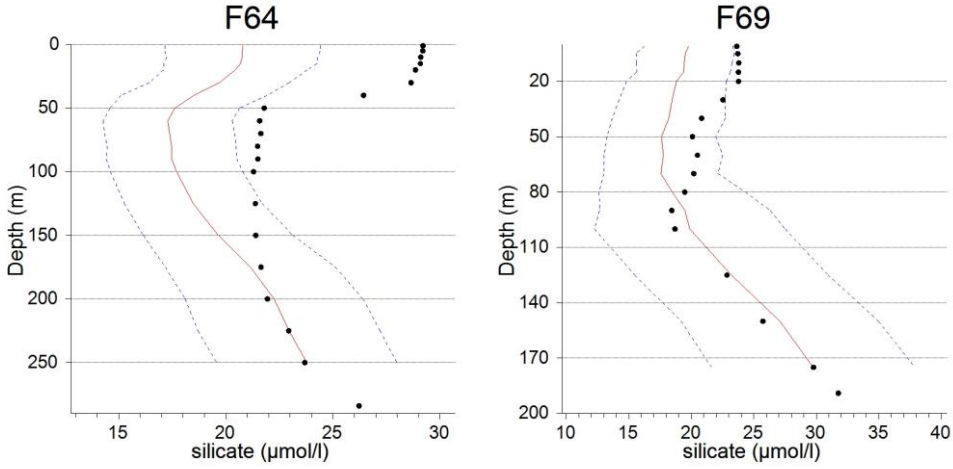
Higher concentrations were observed than on average (2000-2020) in winter.

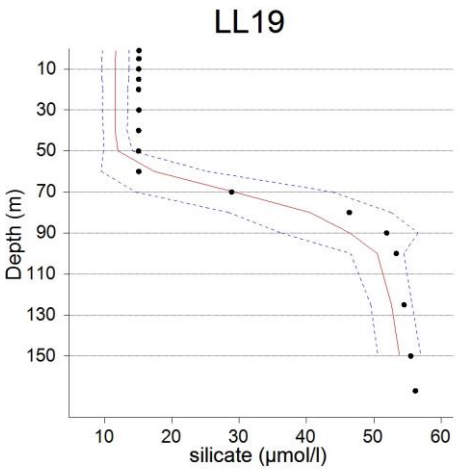


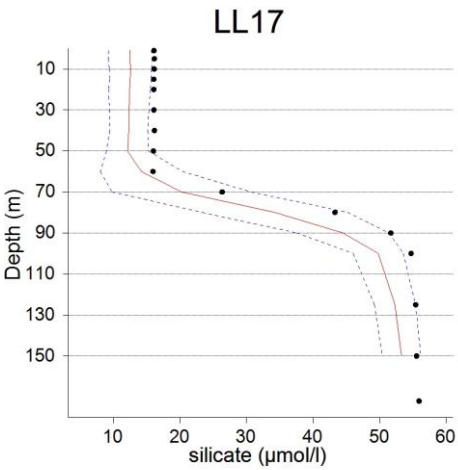


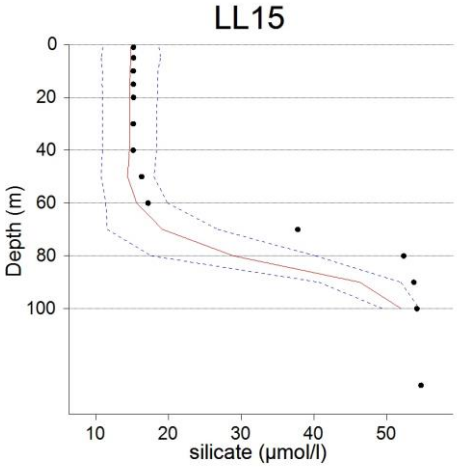
Åland Sea and the Northern Baltic Proper

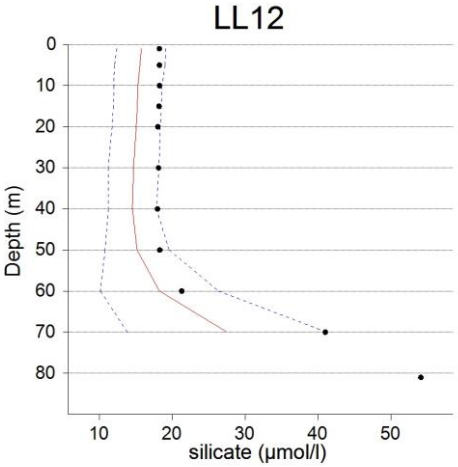
High concentrations in surface layers were observed and in deep waters the highest concentrations were between 50-60 µmol/l.

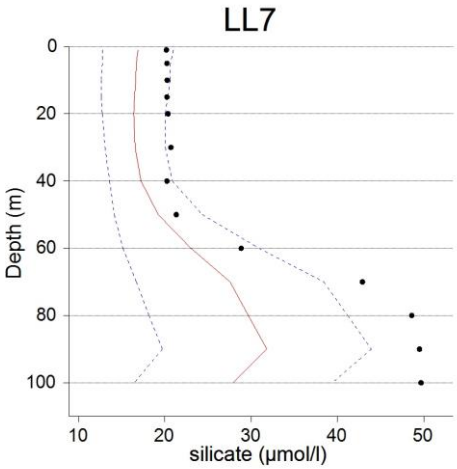



LL19
Depth (m)
10
30
50
70
90
110
130
150
10
20
30
40
50
60
silicate (µmol/l)


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


LL15
Depth (m)
0
20
40
60
80
100
10
20
30
40
50
silicate (µmol/l)


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


LL7
Depth (m)
0
20
40
60
80
100
10
20
30
40
50
silicate (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
HANKO	HANKO	59.82223	22.94742		2021-01-22	11:43											
2021010023	IU7	59.81520	21.33662	92	2021-01-22	17:23	x	x	x	x							
2021010024	IU5	60.05815	21.19822	89	2021-01-22	20:31	x	x	x	x							
2021010025	IU3	60.33338	21.11342	51	2021-01-23	00:17	x	x	x	x							
2021010026	IU1	60.76690	20.84665	33	2021-01-23	04:17	x	x	x	x							
2021010027	KAJAKULMAW	60.99120	20.86747	53	2021-01-23	08:00	x	x	x	x							x
2021010028	SR8	61.12653	20.92997	47	2021-01-23	09:53	x	x	x	x							x
2021010029	SR7	61.08347	20.59655	78	2021-01-23	12:45	x	x	x	x							x
2021010030	SR5	61.08322	19.57950	126	2021-01-23	17:57	x	x	x	x					x		
2021010031	MS9	61.76680	20.53058	100	2021-01-24	01:53	x	x	x	x							
2021010032	AALTO_SM	61.79777	20.23098	105	2021-01-24	05:48	x										
2021010033	F26	61.98348	20.06297	138	2021-01-24	07:44	x	x	x	x							x
2021010034	MS6	61.98358	19.16357	72	2021-01-24	11:32	x	x	x	x							x
2021010035	US7	62.60018	20.82972	27	2021-01-24	18:29	x	x	x	x							
2021010036	US6B	62.60020	20.26307	82	2021-01-24	20:45	x	x	x	x							
2021010037	US5B	62.58615	19.96888	218	2021-01-24	23:18	x	x	x	x					x		
2021010038	F15	63.51687	21.51303	47	2021-01-25	09:42	x	x	x	x							x
2021010039	BO3	64.30210	22.34325	109	2021-01-25	17:39	x	x	x	x					x		
2021010040	BIAS_11(*	64.68537	23.23923	81	2021-01-25	23:00											
2021010041	RR7	64.73365	23.81300	39	2021-01-26	00:57	x	x	x	x							
2021010042	RR6	64.80023	23.47955	86	2021-01-26	03:11	x	x	x	x							
2021010043	CV	65.00033	23.24608	86	2021-01-26	06:06	x	x	x	x							
2021010044	CVI	65.23253	23.56458	68	2021-01-26	09:38	x	x	x	x							x
2021010045	F2	65.37705	23.46910	76	2021-01-26	13:59	x	x	x	x					x		
2021010046	RR3	64.93360	22.32923	89	2021-01-26	20:35	x	x	x	x							
2021010047	F13	63.78352	21.47950	59	2021-01-27	05:04	x	x	x	x							
2021010048	F16	63.51678	21.06278	48	2021-01-27	08:01	x	x	x	x							x
2021010049	F18	63.31432	20.27272	104	2021-01-27	11:29	x	x	x	x							x
2021010050	US3	62.75890	19.19562	177	2021-01-27	17:26	x	x	x	x							
2021010051	MS3	62.13443	18.16287	84	2021-01-27	23:41	x	x	x	x							
2021010052	SR3	61.18338	18.23008	72	2021-01-28	06:29	x	x	x	x							
2021010053	F33	60.53315	18.93765	134	2021-01-28	12:15	x	x	x	x							x
2021010054	F64	60.18895	19.14260	285	2021-01-28	17:06	x	x	x	x					x		
2021010055	F69	59.78338	19.93003	190	2021-01-28	23:45	x	x	x	x							
2021010056	UTO_S	59.75508	21.37043	78	2021-01-29	06:27	x										
2021010057	AALTO_PI	59.25058	20.99917	104	2021-01-29	16:02	x										
2021010058	BIAS_15(*	59.25027	21.01653	93	2021-01-29	16:42											
2021010059	LL19	58.88072	20.31083	168	2021-01-29	20:42	x	x	x	x					x		
2021010060	LL17	59.03403	21.07987	173	2021-01-30	13:07	x	x	x	x							
2021010061	LL15	59.18328	21.74750	130	2021-01-30	20:08	x	x	x	x							
2021010062	LL12	59.48343	22.89660	82	2021-01-31	02:21	x	x	x	x							
2021010063	JML (**	59.58185	23.62683	80	2021-01-31	06:11											
2021010064	LL7	59.84648	24.83788	99	2021-01-31	13:07	x		x								

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

(* Installation of a hydrophone
(** Only sediment samples taken at the station.