

CRUISE REPORT



R/V Aranda

Cruise 01/2020

Combine 1 leg 2
28.1.2020 – 7.2.2020

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

Objectives of the cruise

The objectives of the cruise were:

- 1) Hydrographical and chemical monitoring of the Northern Baltic Proper, the Gulf of Bothnia and of the Archipelago Sea. Monitored parameters were temperature, salinity, conductivity, dissolved oxygen/hydrogen sulphide, pH and fluorescence and nutrients (N_{tot}, P_{tot}, NH₄, NO_{2,3}, PO₄) and silicate;
- 2) Monitoring of harmful substances;
- 3) Maintenance of automated instruments (FMI wave buoys) in the region: and
- 4) Ice coverage and thickness and quality monitoring (results not included in the report);
- 5) Sampling of microplastics in ice (results not included in the report);
- 6) Drive tests on R/V Aranda in ice conditions (results not included in the report)

Table 1 The scientific crew

Name	On board	Organization
Pekka Kotilainen	28.1.-7.2.2020	SYKE
Ilkka Lastumäki	28.1.-7.2.2020	SYKE
Pia Varmanen	28.1.-7.2.2020	SYKE
Jere Riikonen	28.1.-2.2.2020	SYKE
Susanna Hyvärinen	28.1.-7.2.2020	SYKE
Tanja Kinnunen	28.1.-7.2.2020	SYKE
Kirsi Rosendahl	28.1.-7.2.2020	SYKE
Antti Räike	28.1.-7.2.2020	SYKE
Noora Haavisto	28.1.-7.2.2020	FMI
Heini Jalli	28.1.-2.2.2020	FMI
Pekka Kosloff	28.1.-7.2.2020	FMI
Eero Rinne	28.1.-7.2.2020	FMI
Mikko Lensu	28.1.-4.2.2020	FMI
Outi Setälä	2.-4.2.2020	SYKE
Maiju Lehtiniemi	2.-4.2.2020	SYKE
Hermanni Kaartokallio	2.-7.2.2020	SYKE
Eeva Eronen-Rasimus	2.-7.2.2020	SYKE

Nicolas-Xavier Geilfus	2.-7.2.2020	Univ Manitoba
Ice test group		
Jukka Pajala	2.-4.2.2020	SYKE
Lasse Smirnov	2.-4.2.2020	VG-S
Antti Rantanen	2.-4.2.2020	VTT
Ilkka Perälä	2.-4.2.2020	VTT
Pekka Sevola	2.-4.2.2020	Min. Def.
Jarmo Harras	2.-4.2.2020	Min. Def.
Kimmo Ristimäki	2.-4.2.2020	Min. Def.

Cruise Route

The 2nd leg of the COMBINE 1 winter monitoring Cruise started from Hanko on the 27th of January 2020.

Monitoring started in the Northern Baltic Proper and maintenance of the wave bouy in the region was conducted, as well. Archipelago Sea was covered after the main basin and then R/V Aranda headed towards the north, zig-zagging. After the northernmost stations, F2 and CVI the cruise headed to Oulu (2nd of February 2020).

The ice tests, and sampling under and of the ice were carried out in north of Hailuoto, outside the city of Oulu. On the 4th of February 2020 the ice test group and some scientists were left in Oulu. The rest of the group continued towards the south along the Swedish coast and finally the cruise ended up to Rauma on the 7th of February 2020 (Figure 1).

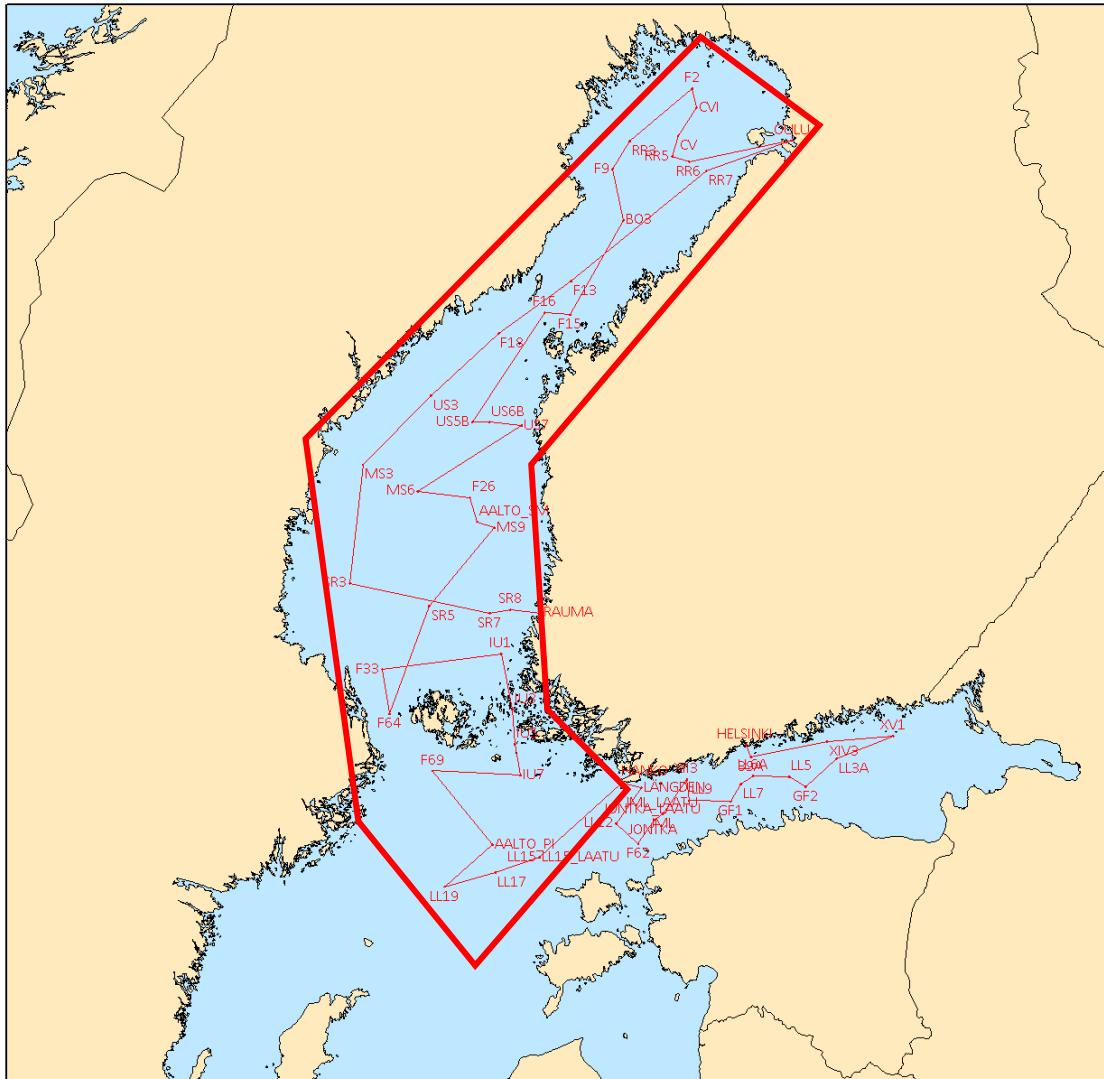


Figure 1. The entire cruise route of the Winter cruise of R/V ARANDA, including the 1st leg of the Cruise in the Gulf of Finland. The 2nd leg framed in red.

Conclusions

Hydrography

Homogenous hydrographic profiles were observed in the western Gulf of Finland (LL12) and in the Archipelago Sea. Hypoxia was found below 80m in the northern Baltic Proper (stations LL15 - LL19). Typical winter stratification at deeper stations were observed in the Bothnian Sea and Bothnian Bay. Oxycline was observed at deep stations in the Bothnian Sea and Bothnian Bay, but concentrations were $> 6 \text{ ml/l}$.

Nutrients

Dissolved nutrients

In the western part of the Gulf of Finland the entire water column was mixed down to the bottom. Clear stratification was observed in the Northern Baltic Proper. NH_4 winter concentrations were higher than in average (2000-2017 in January), but very often the concentrations were very low, close to the LOD (limit of detection).

Higher $\text{NO}_{2,3}$ winter concentrations than in average were observed only in the Northern Baltic Proper. Low concentrations were observed in the Bothnian Sea, Bothnian Bay and in the Archipelago Sea.

High PO_4 winter concentrations were observed. Winter was exceptionally warm and ice cover was found only in the northern part of the Bothnian Bay.

Total nutrients

Nitrogen

N_{tot} winter concentrations were below the long-term average. Only the concentrations of the Northern Baltic Proper (stations LL17 and LL19) were higher than in average.

Phosphorus

Higher concentrations than in average (2000-2017) were observed in the Bothnian Sea and Bothnian Bay and partially also in the Archipelago Sea. In the Northern Baltic Proper concentrations were near to long-term averages (2000-2017).

Silicate

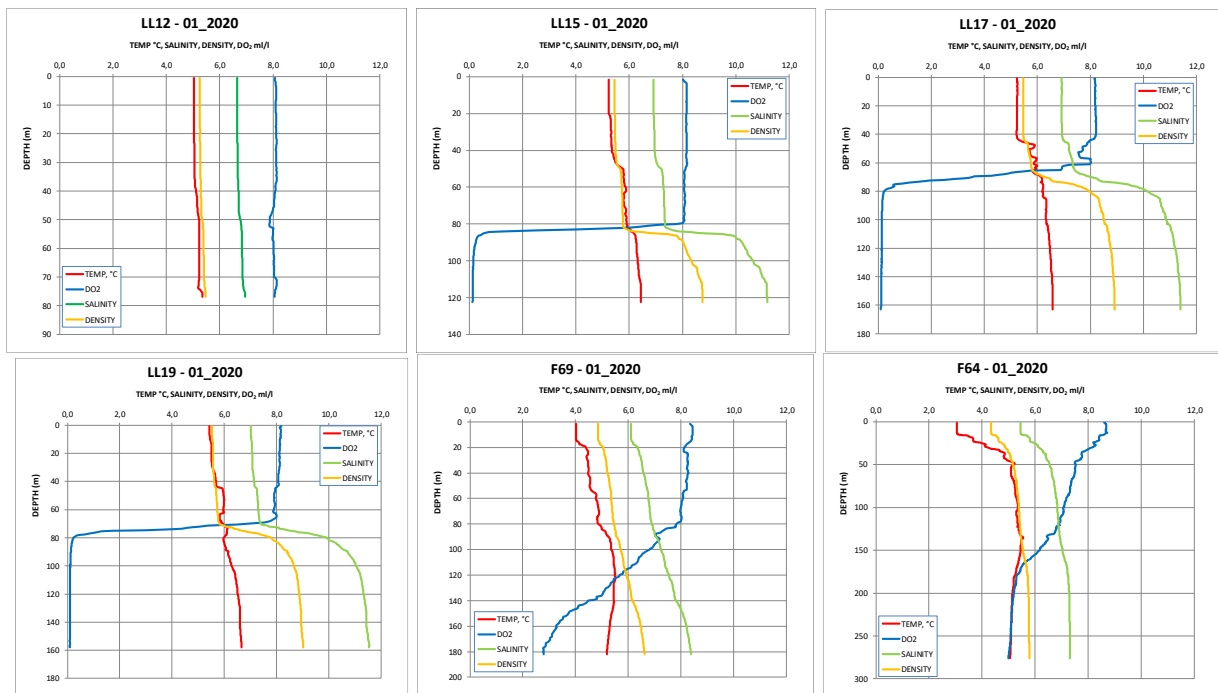
Very high silicate concentrations were observed in the Northern Baltic Proper, Bothnian Sea, Bothnian Bay and in the Archipelago Sea.

Observations

Hydrography

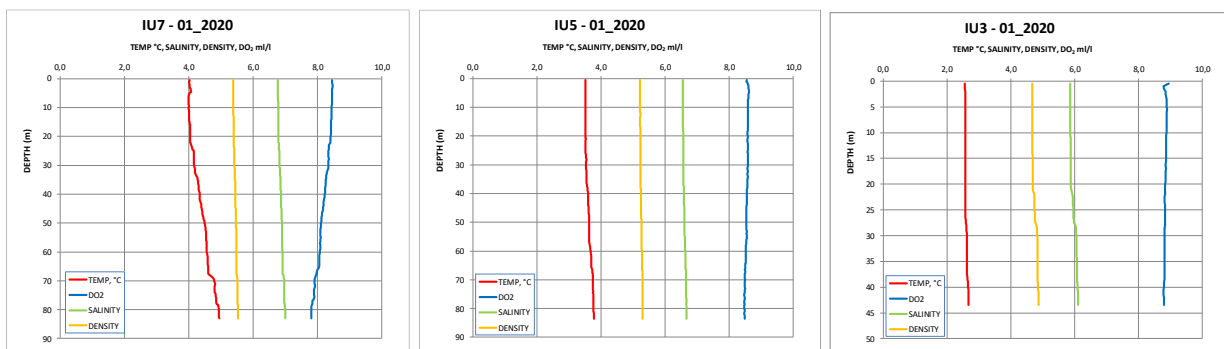
Northern Baltic Proper and western Gulf of Finland

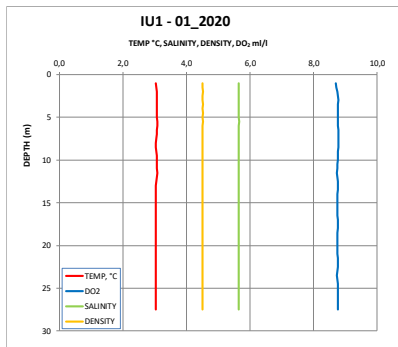
Water column was homogeneous and oxic (~8 ml/l) in the western part of the Gulf of Finland (station LL12) and clearly stratified in the Northern Baltic Proper (stations LL15, LL17 and LL19) and hypoxia was observed below 80m. North of Ålands Hav Tröskeln, at stations F64 and F69 clear oxycline was observed, but even below 150m there was oxygen.



Archipelago Sea

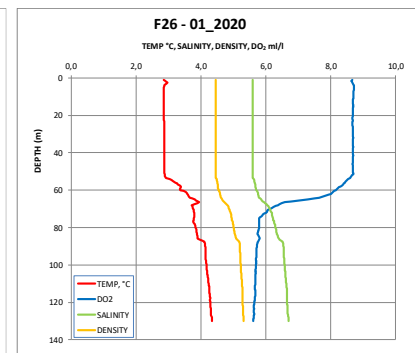
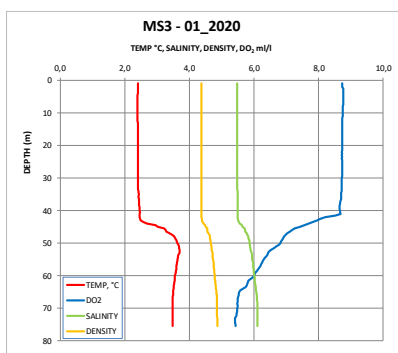
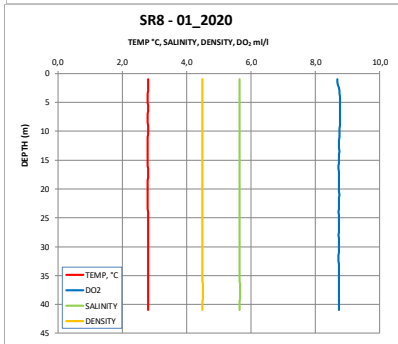
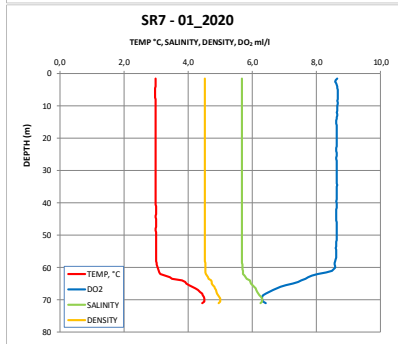
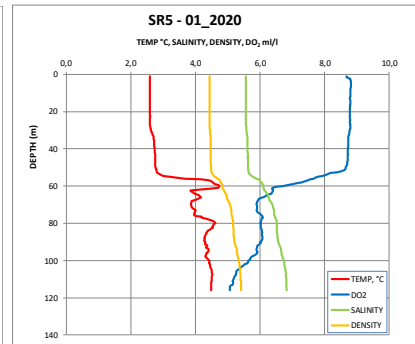
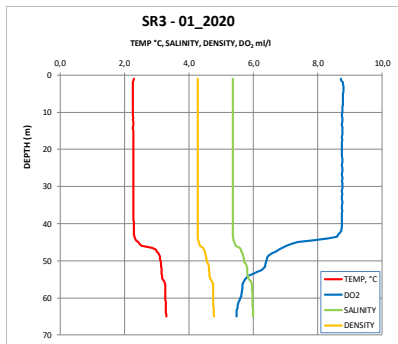
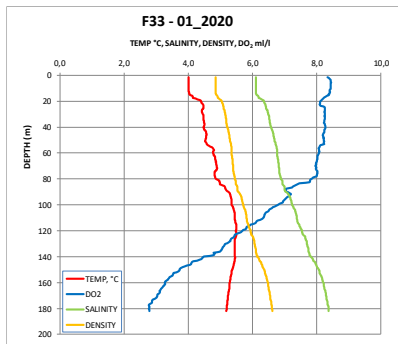
Water column in the Archipelago Sea homogeneous, and thus, no stratification was observed at IU1, IU3 and IU5. At the southernmost station IU7 slight increase in water temperature and decrease in oxygen concentration was observed.

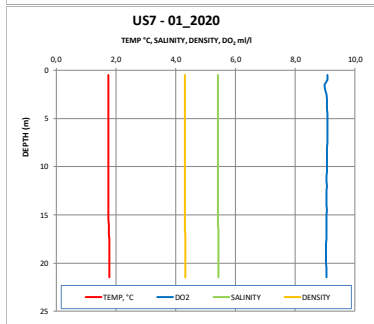
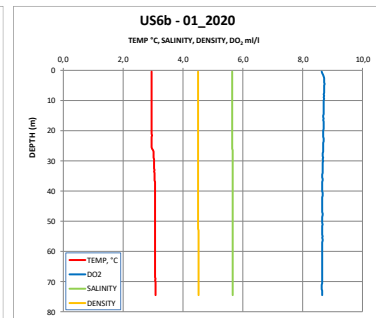
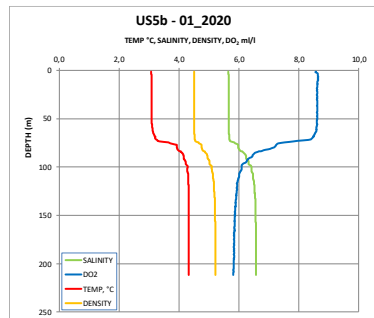
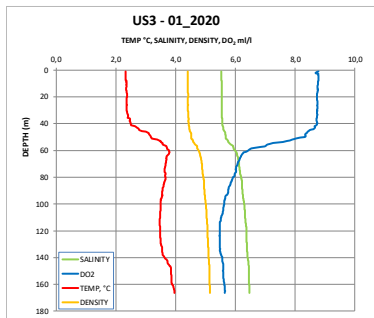
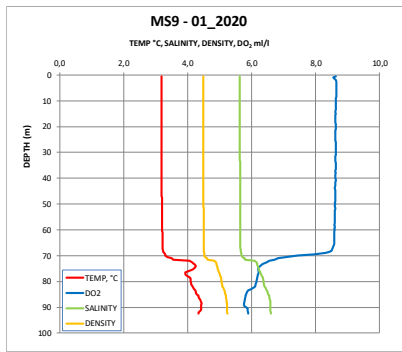




Bothnian Sea

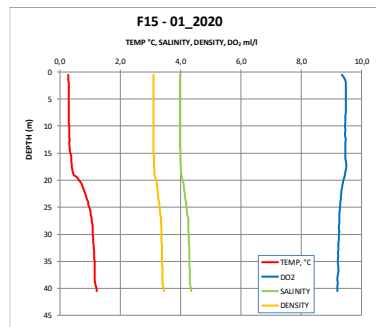
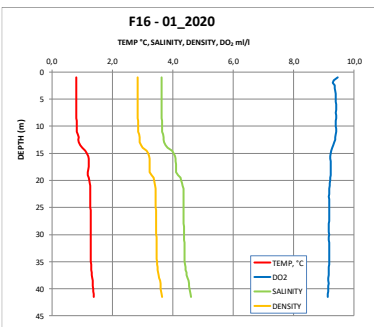
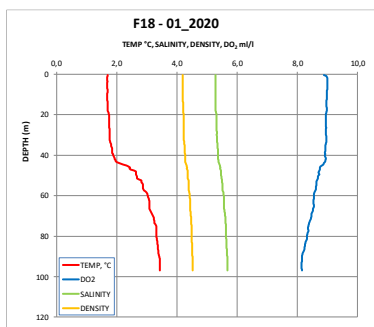
Typical winter stratification was observed. At deeper stations decline in oxygen concentrations were observed but concentrations were in general > 6ml/l. Clearly lower concentrations observed at F33.

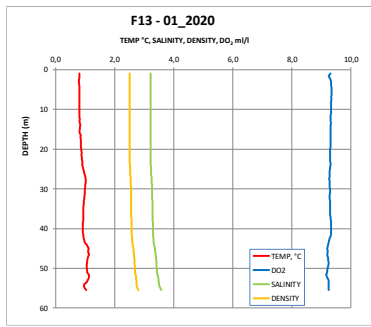




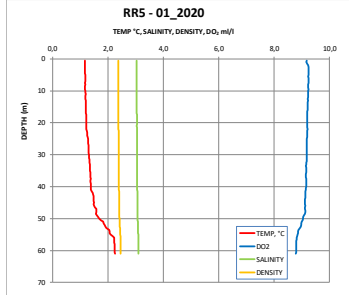
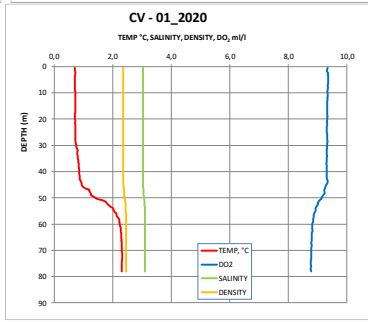
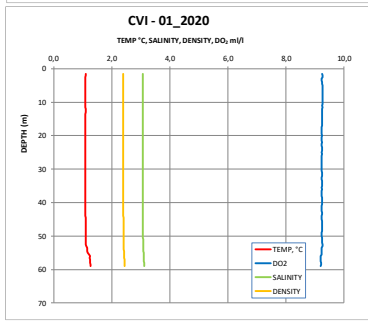
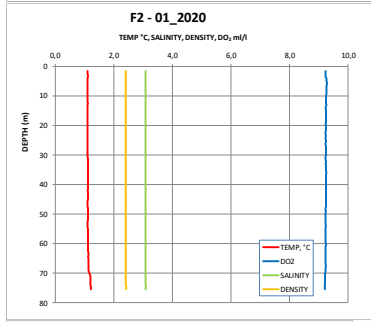
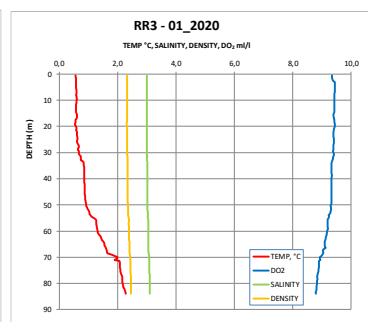
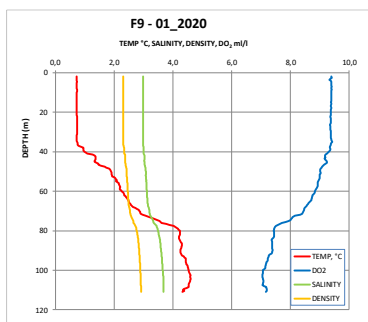
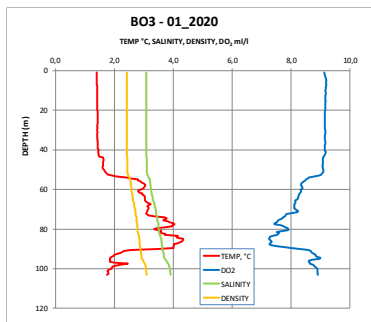
Kvarken

Slightly stratified column observed at station F18 below 40m.





Bothnian Bay stations BO3, F9, RR3, RR5, RR6, RR7, F2, CV and CVI.
Temperature and oxygen stratification observed starting from 50-60m on. Homogeneous water column at shallow stations were observed.



Annex 1.

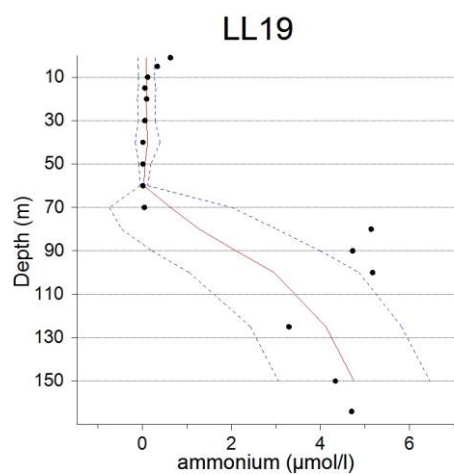
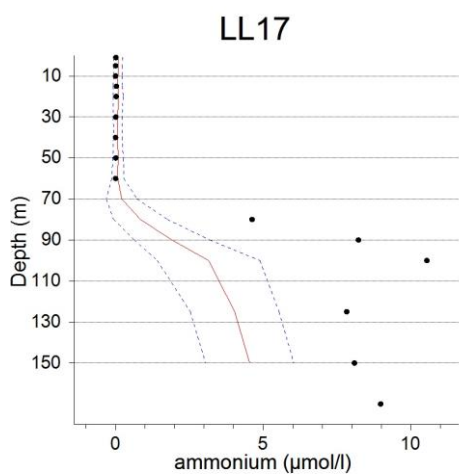
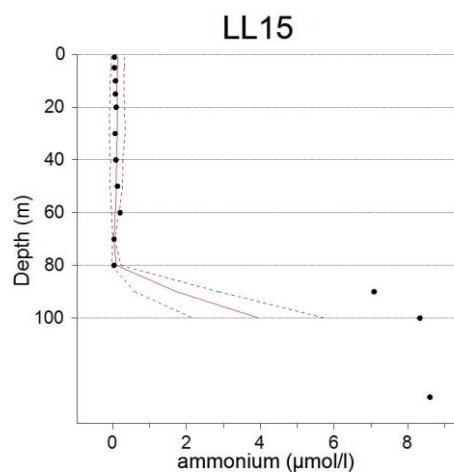
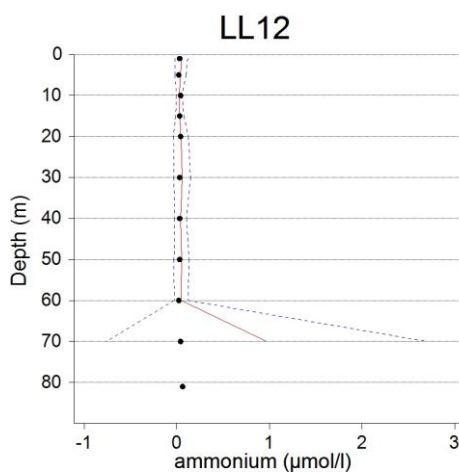
Selected variables at the stations LL12, LL15, LL17, LL19, F69, IU7, IU5, IU3, IU1, F33, F64, SR3, SR5, SR7, SR8, MS3, MS6, F26, MS9, US3, US5B, US6B, US7, F18, F16, F15, F13, BO3, RR3, RR6, RR7, RR5, CVI, CV and F2. Mean (red solid line) and standard deviation (blue dotted lines) represent the data collected at the same time of season since the year 2000.

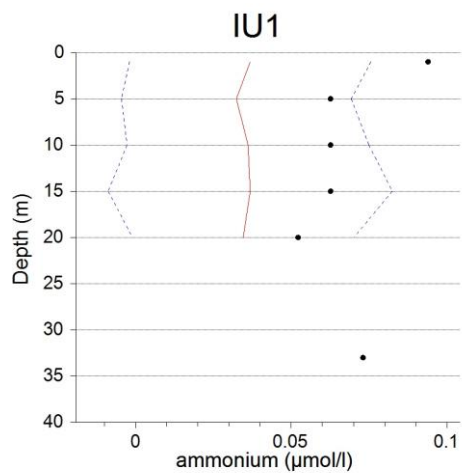
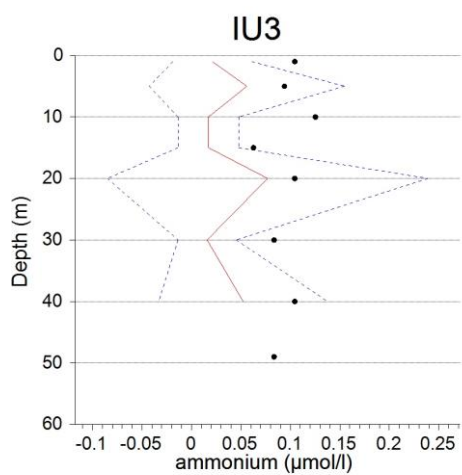
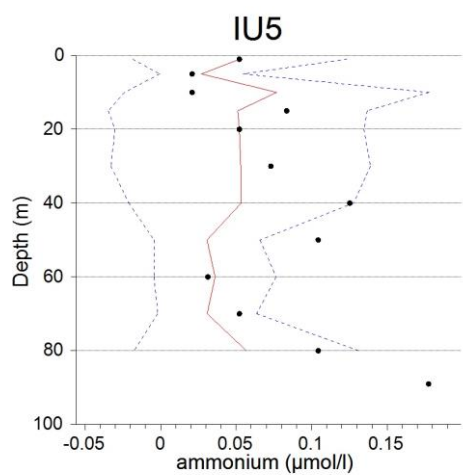
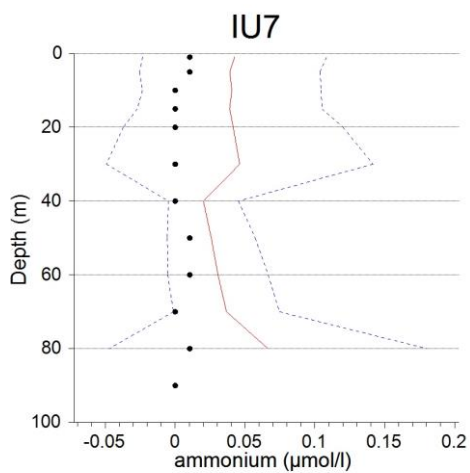
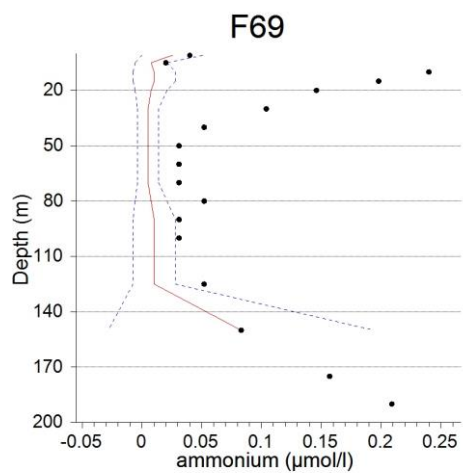
Nutrients

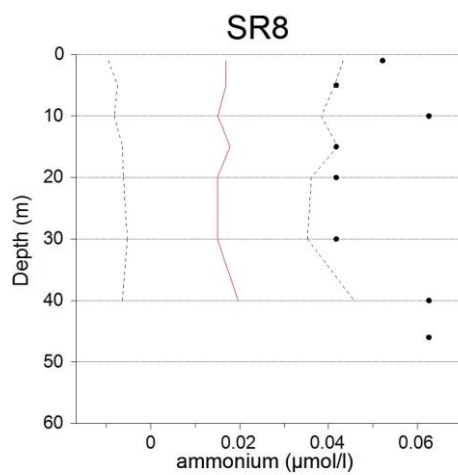
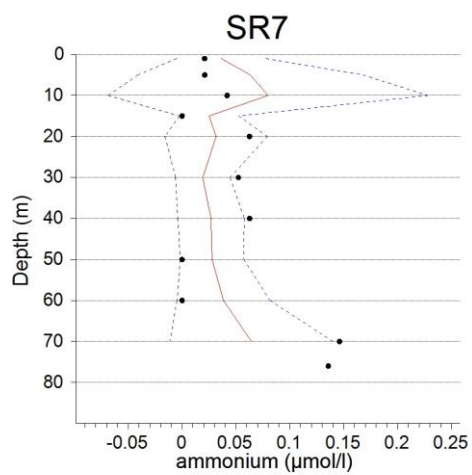
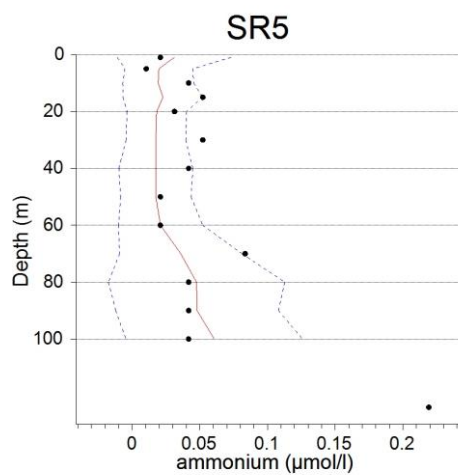
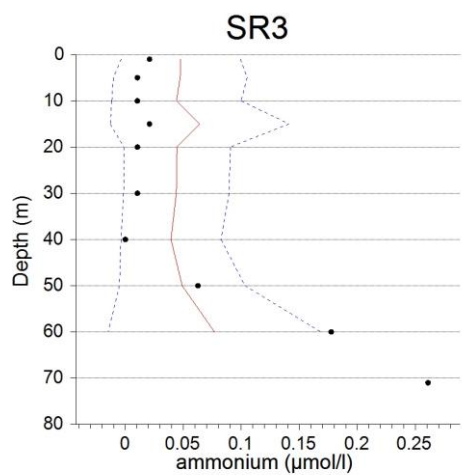
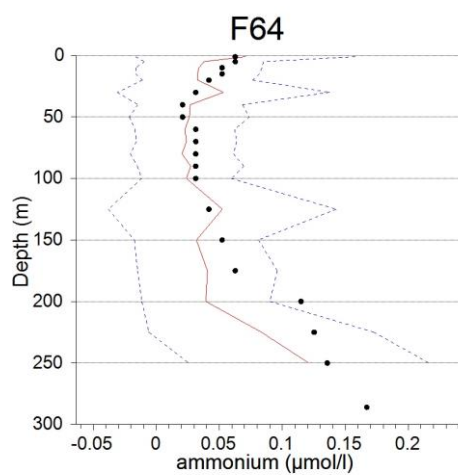
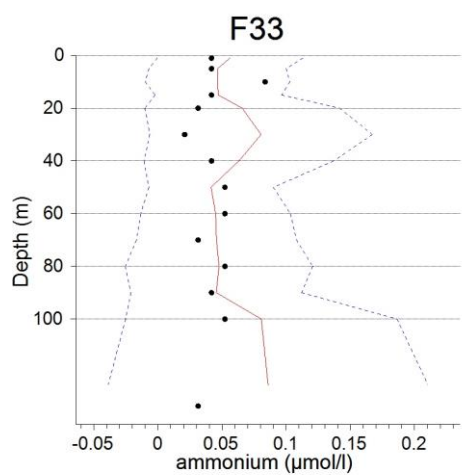
Dissolved nutrients

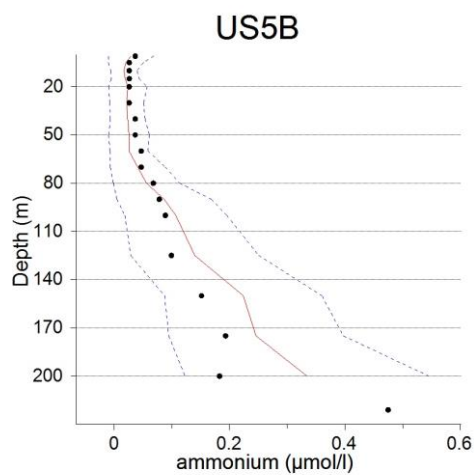
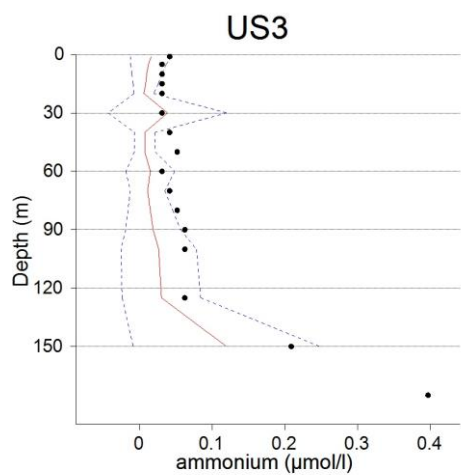
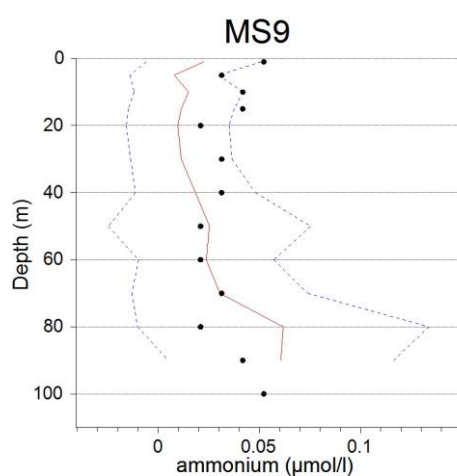
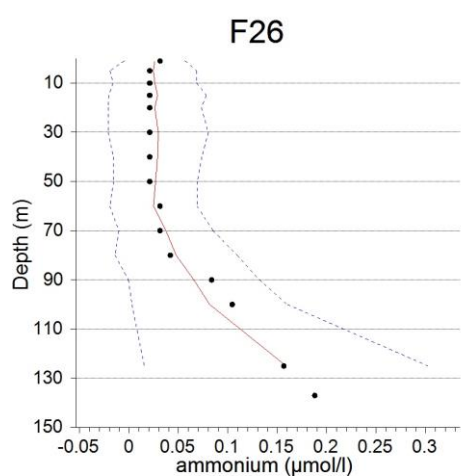
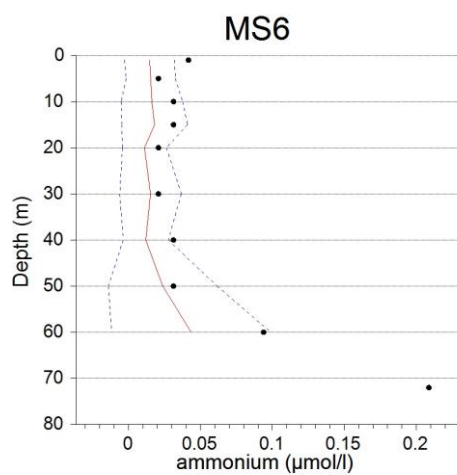
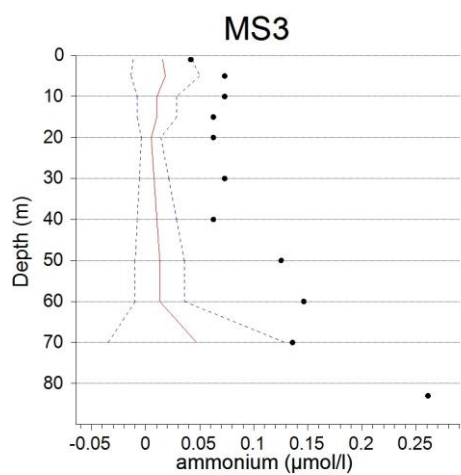
Ammonium

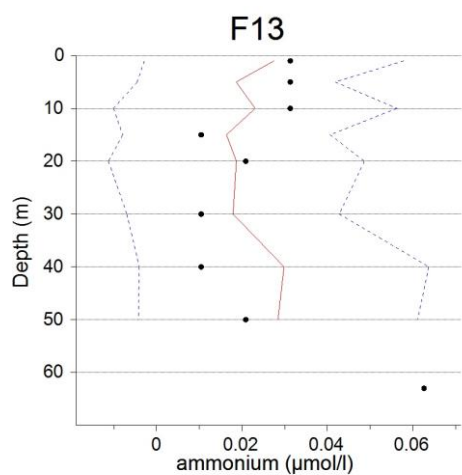
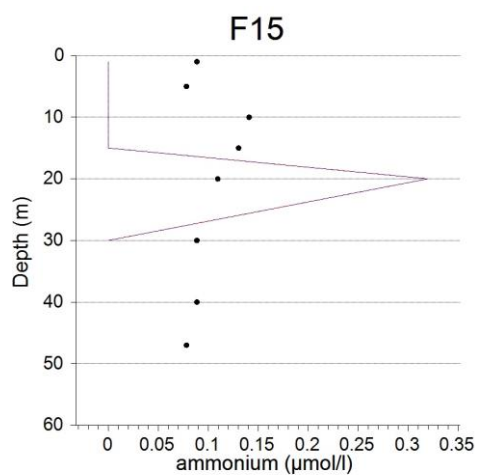
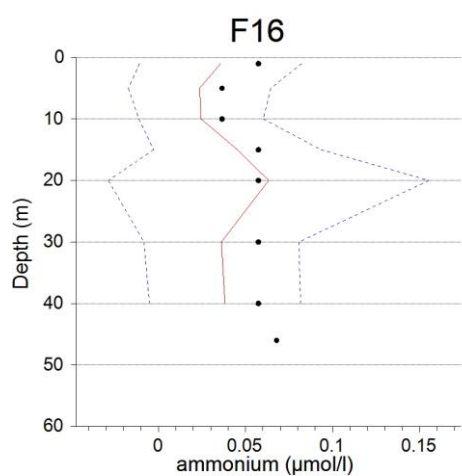
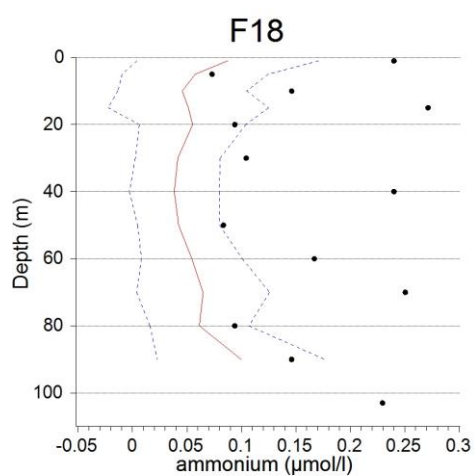
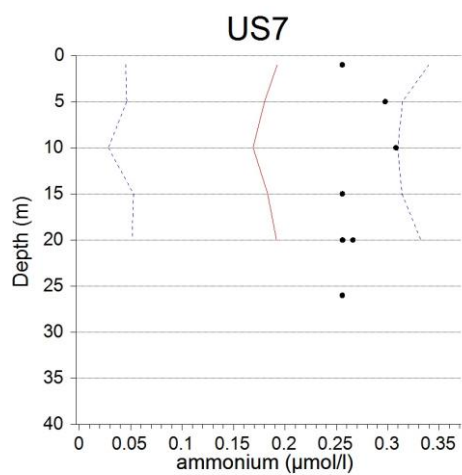
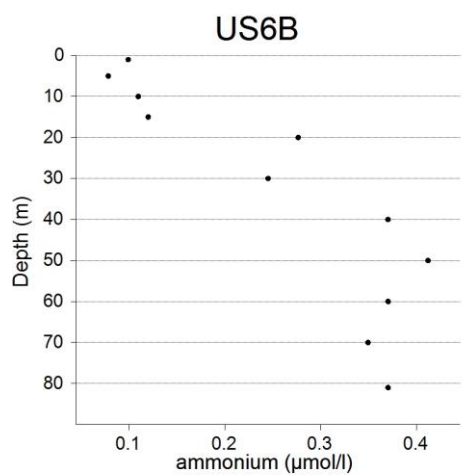
In the western part of the Gulf of Finland the entire water column was mixed down to the bottom. Clear stratification was observed in the Northern Baltic Proper. Winter concentrations of NH_4 were higher than in average (2000-2017 in January), but very often the values were close to the LOD (limit of detection).

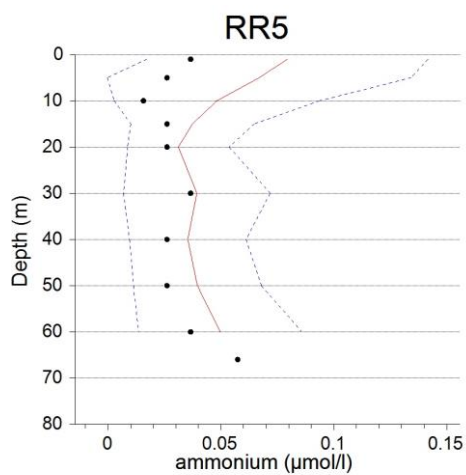
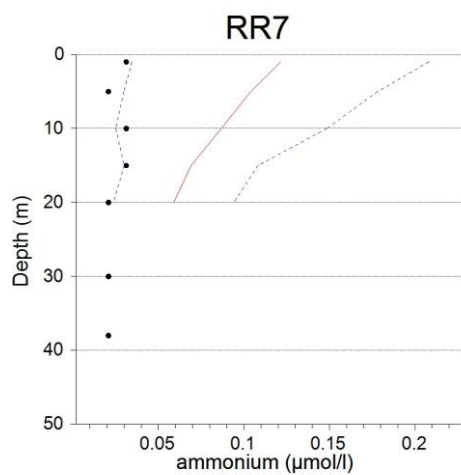
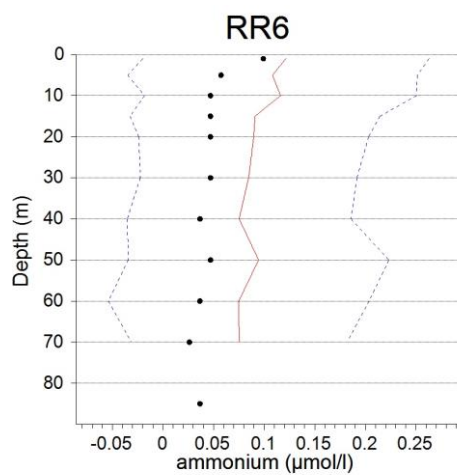
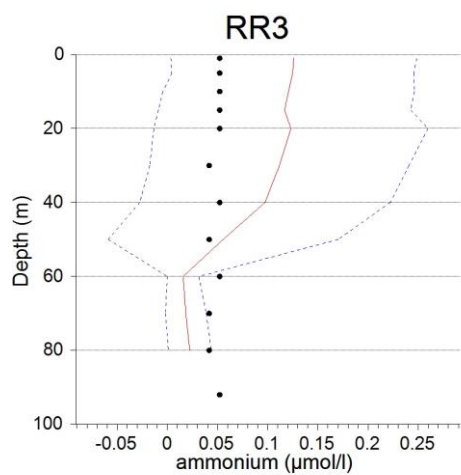
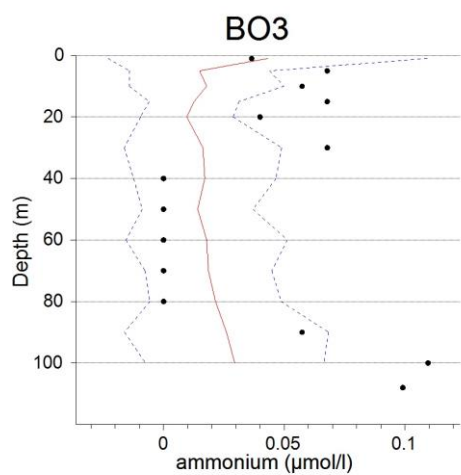


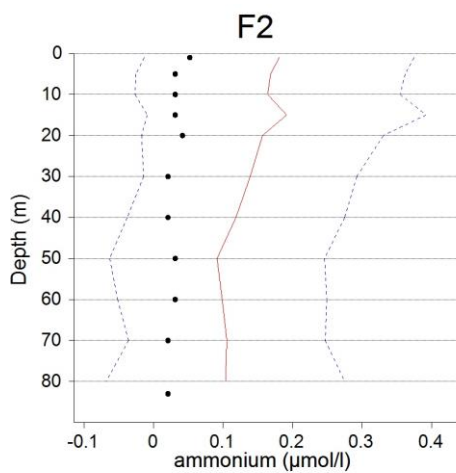
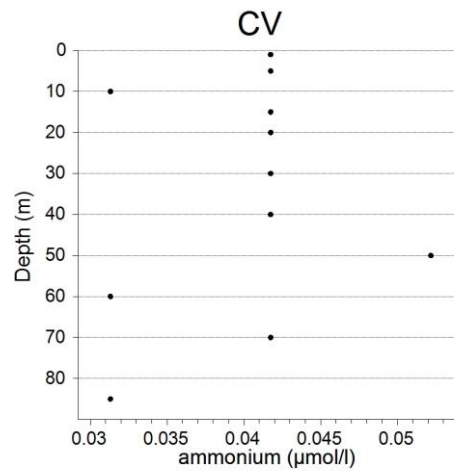
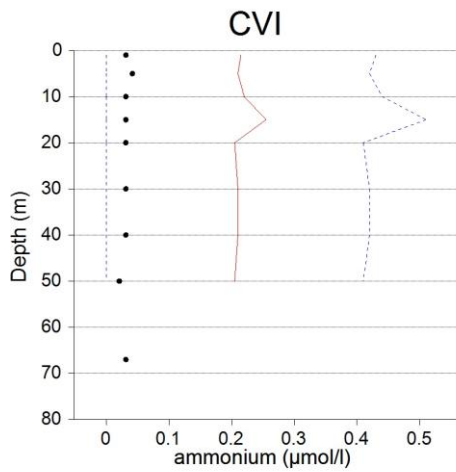






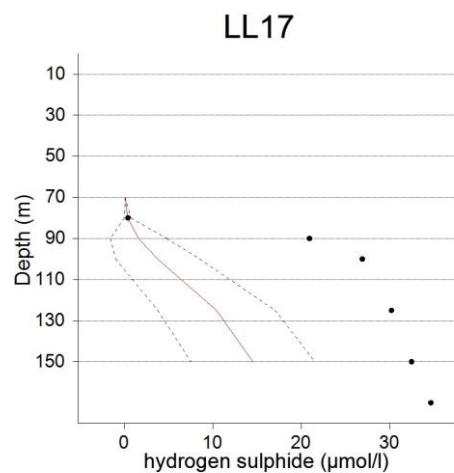
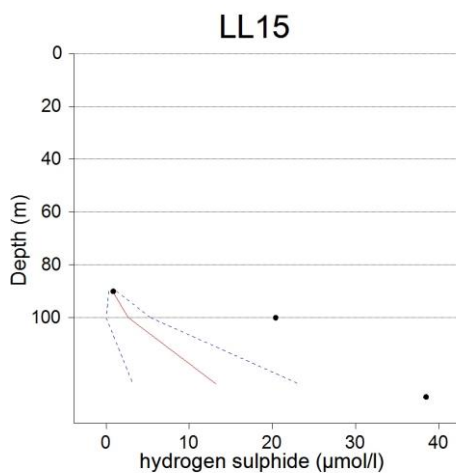




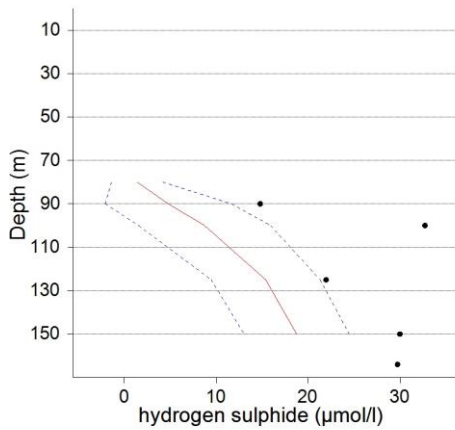


Hydrogen sulphide

H_2S were observed only in the Northern Baltic Proper below 75-80m and it seemed that H_2S concentrations at LL15, LL17 and LL19 were higher than in average. Anywhere else there was oxygen down to the bottom.



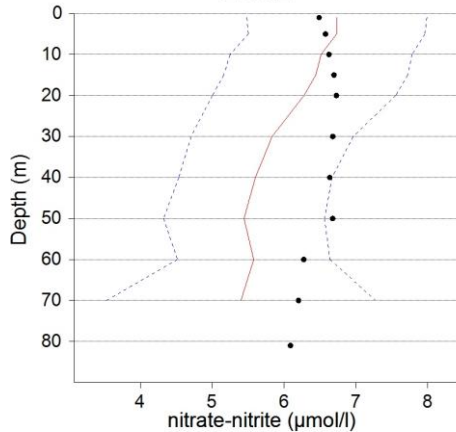
LL19



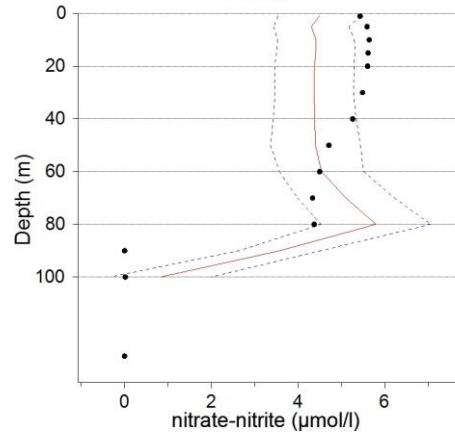
Nitrate-nitrite

Higher NO_{2,3} winter concentrations than in average (2000-2017) were observed only in the northern Baltic Proper. Low concentrations were observed in the Bothnian Sea, Bothnian Bay and in the Archipelago Sea.

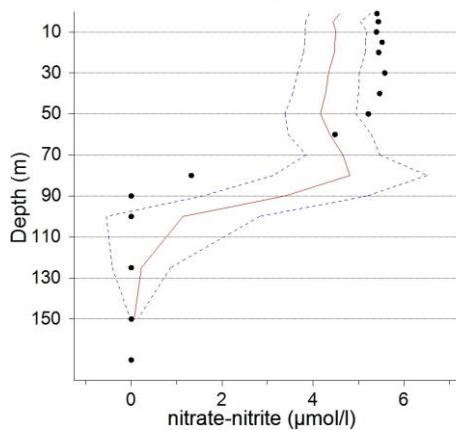
LL12



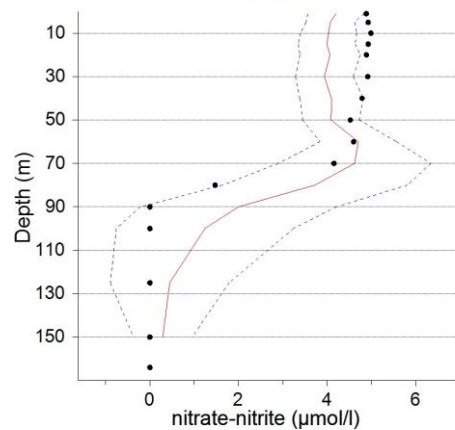
LL15

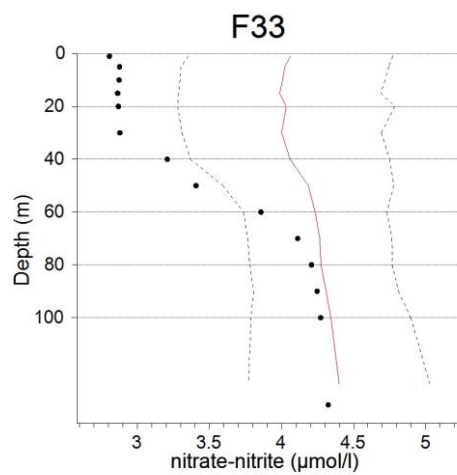
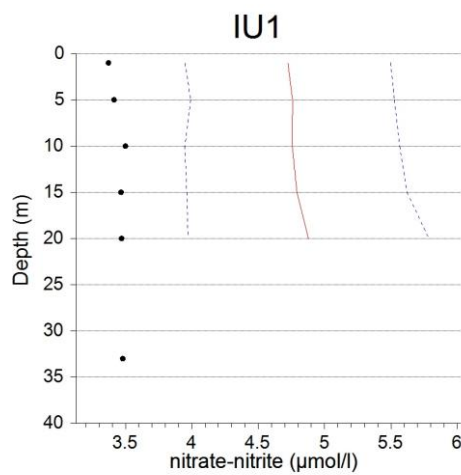
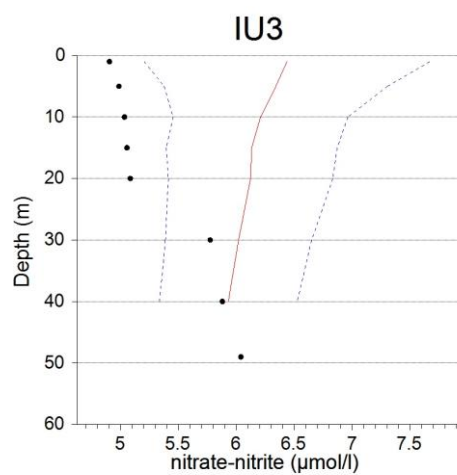
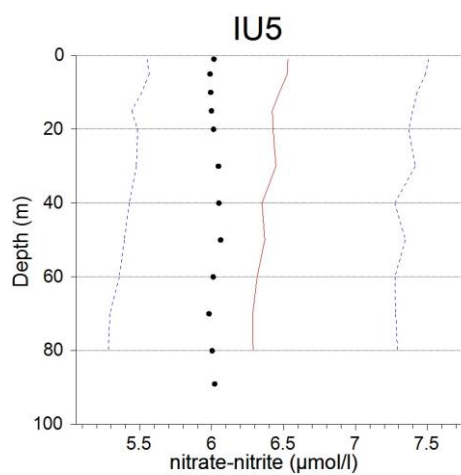
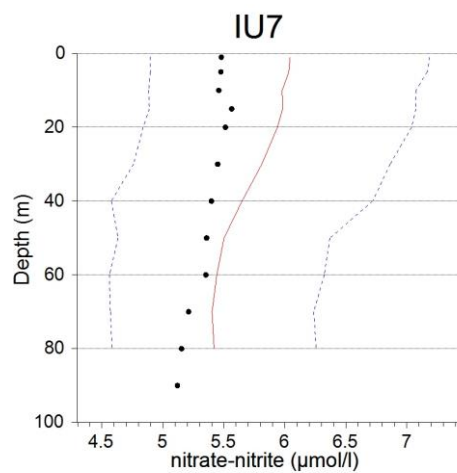
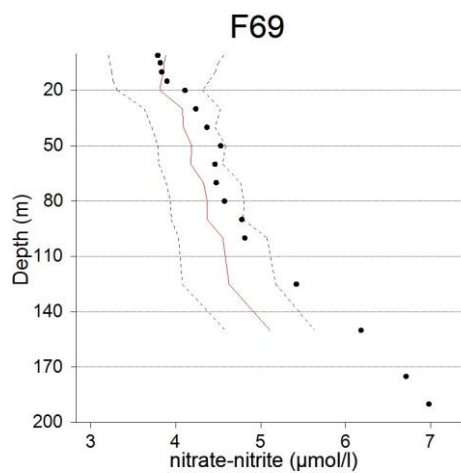


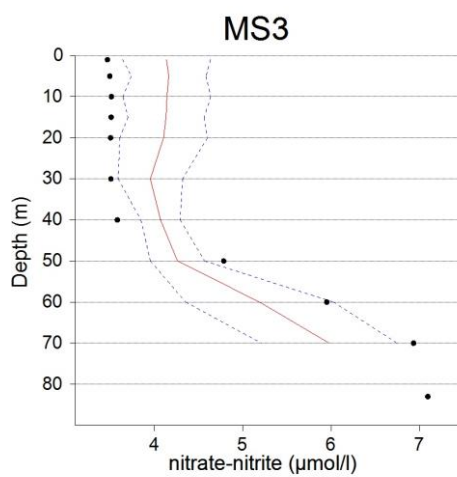
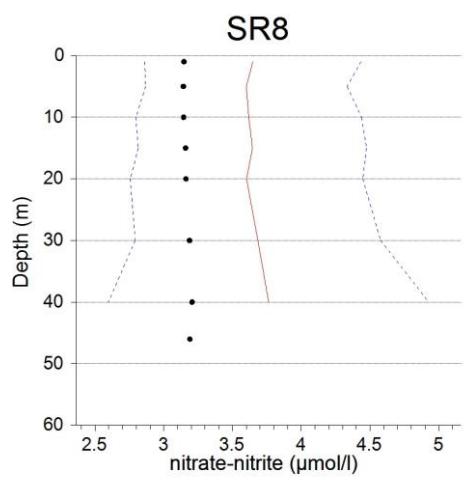
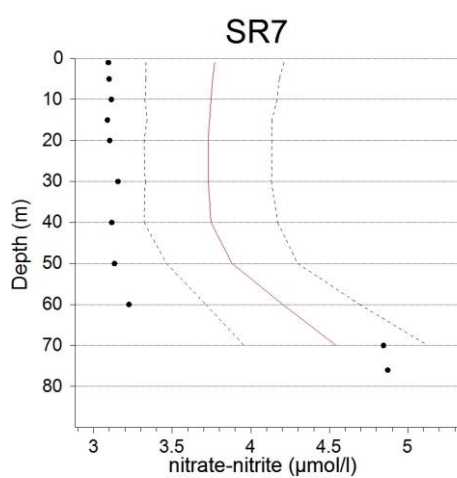
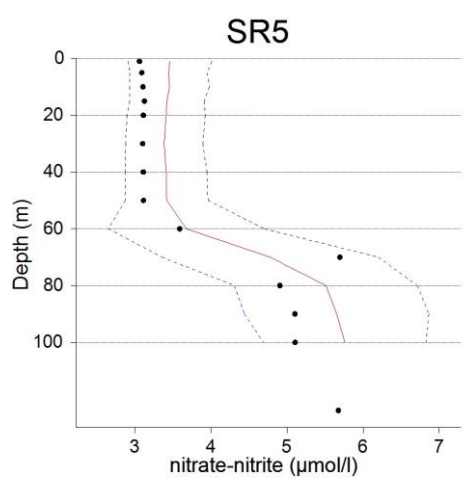
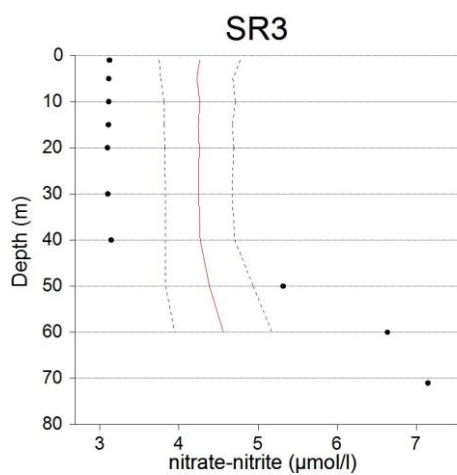
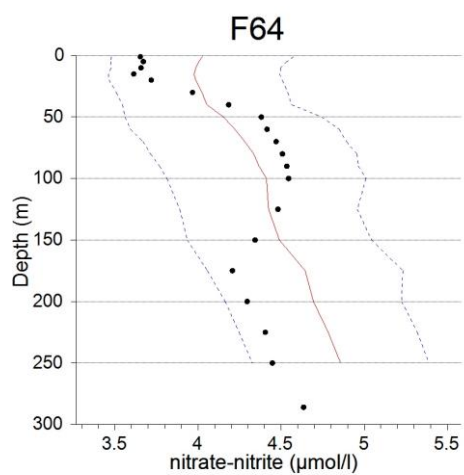
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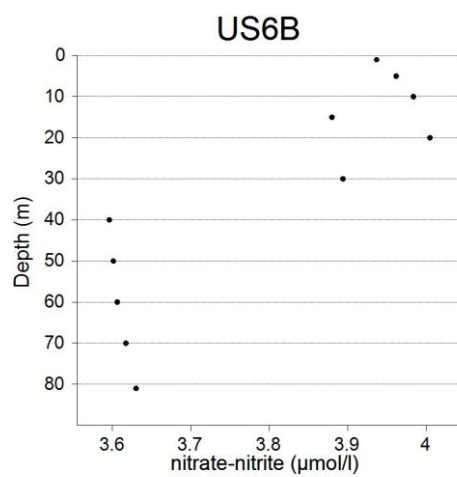
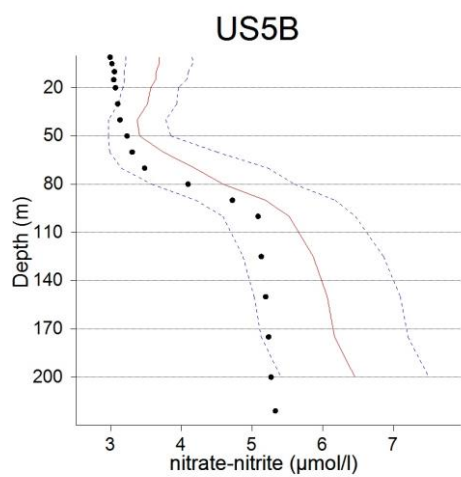
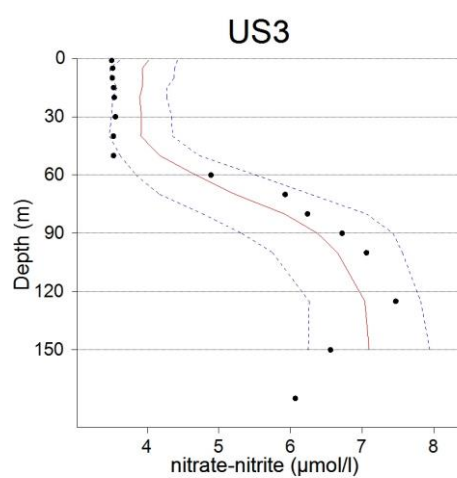
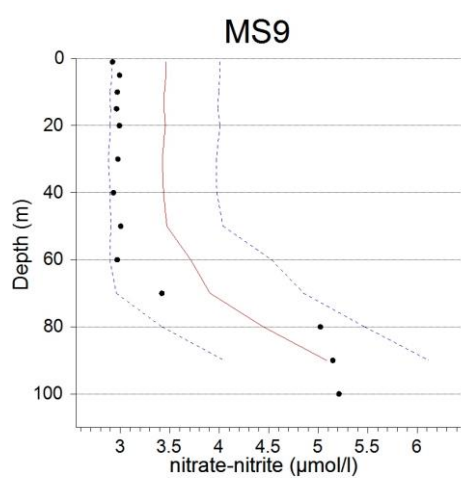
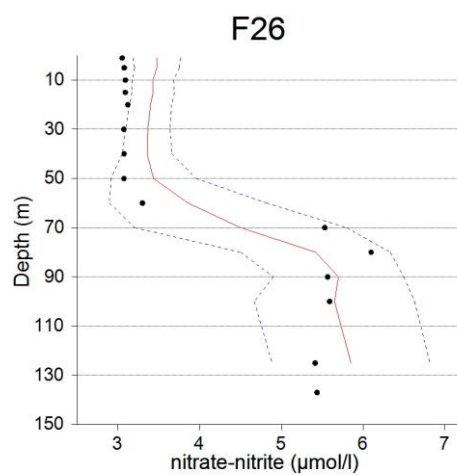
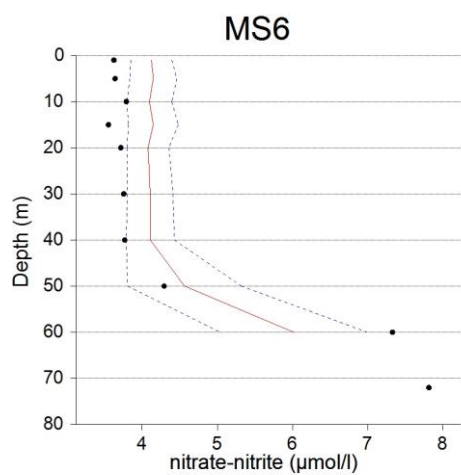


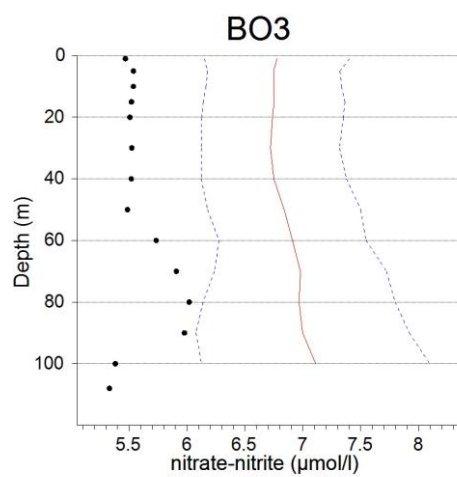
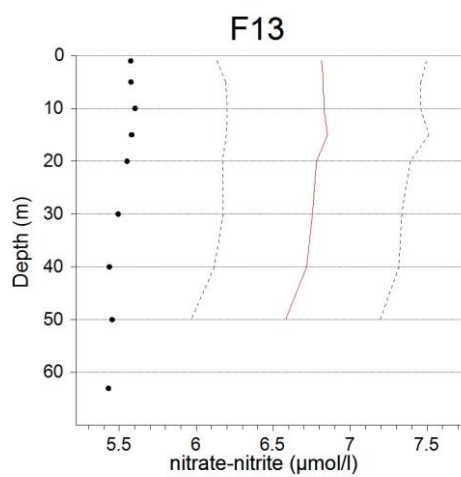
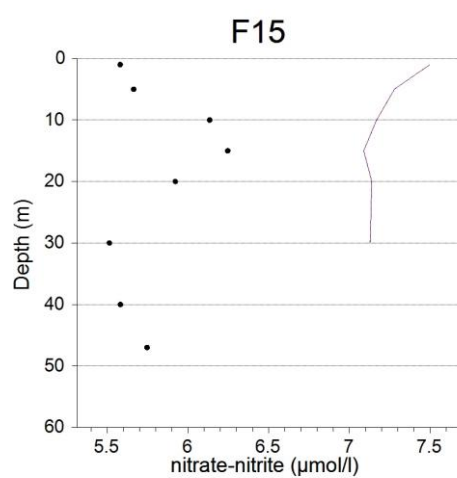
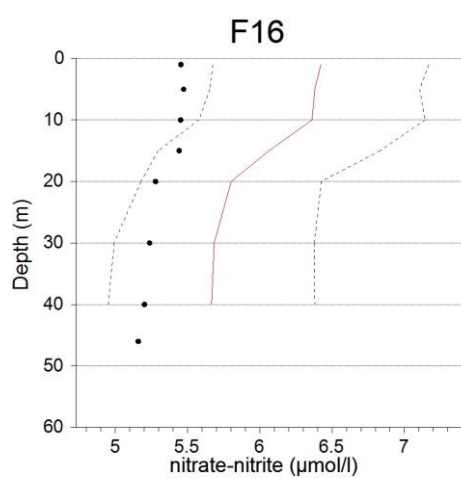
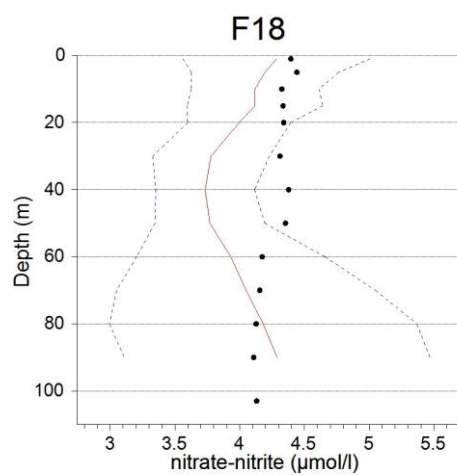
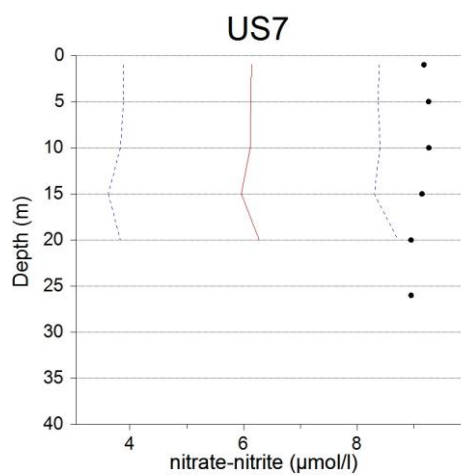
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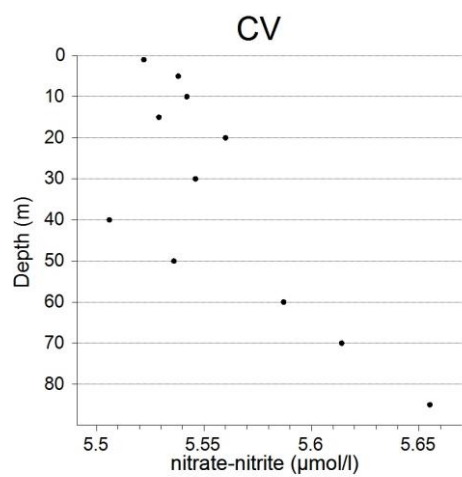
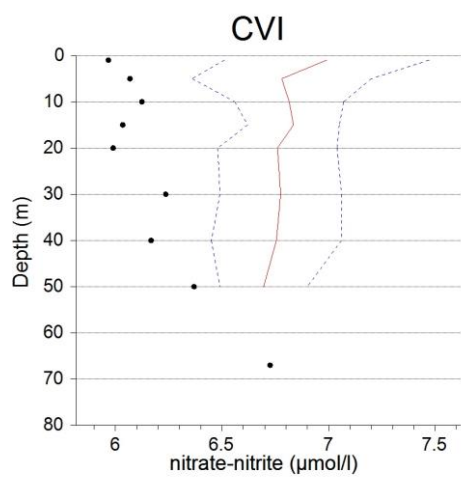
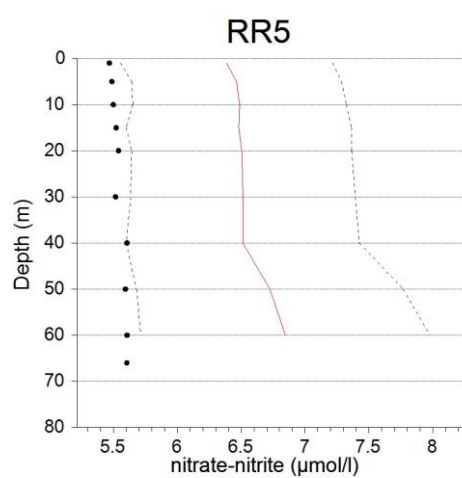
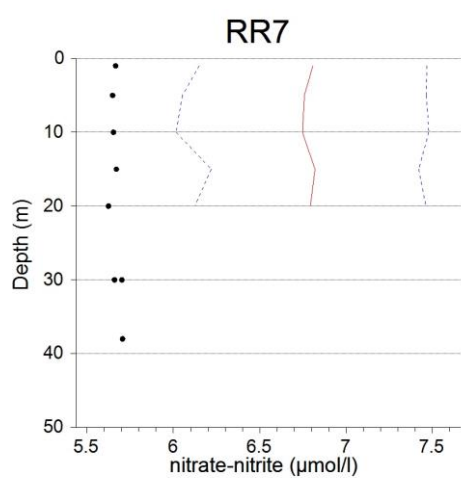
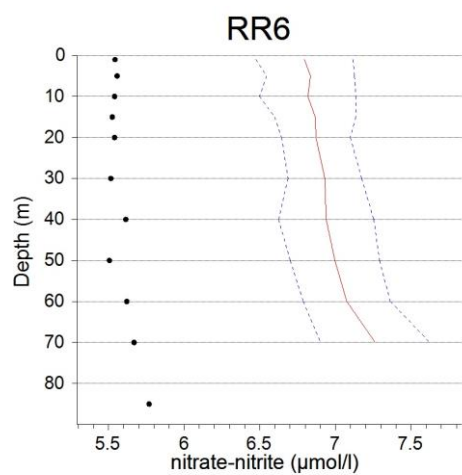
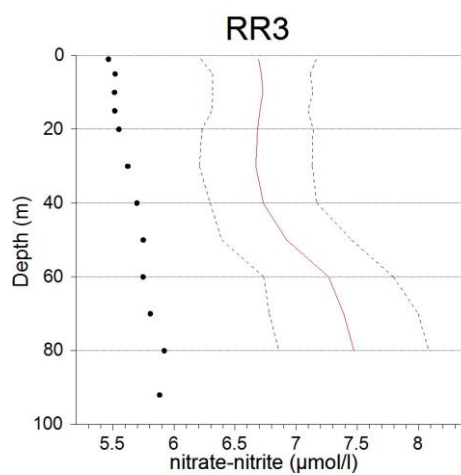


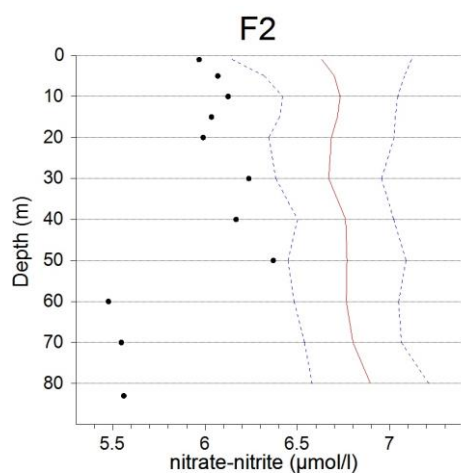






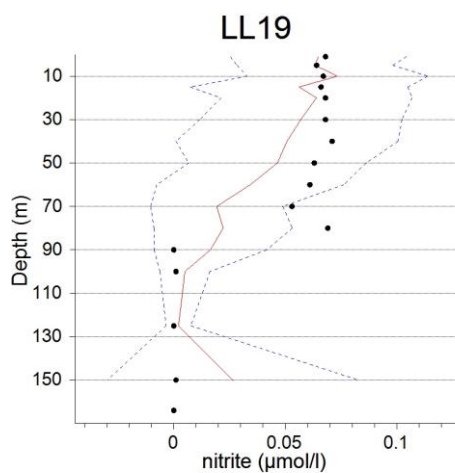
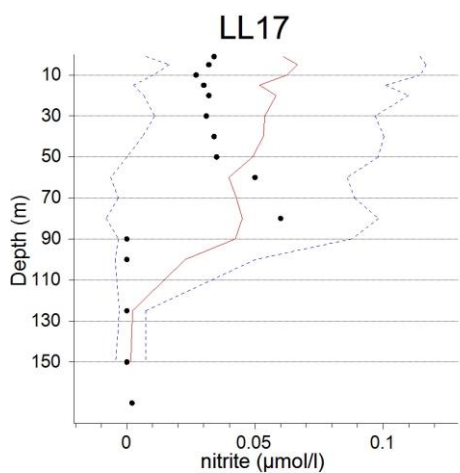
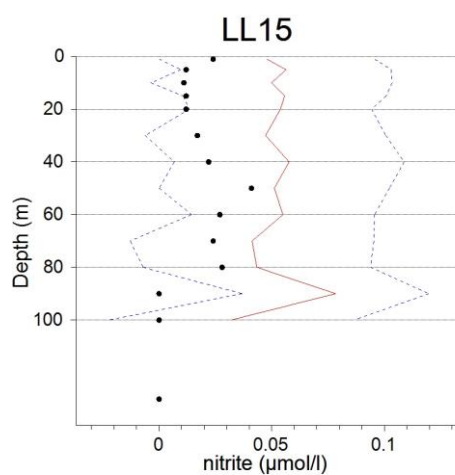
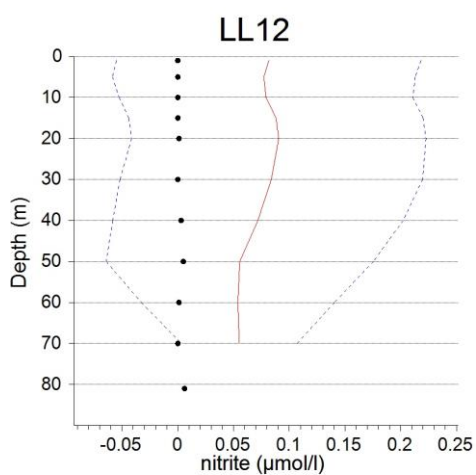


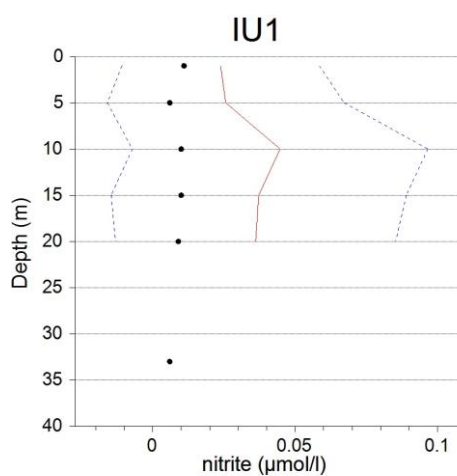
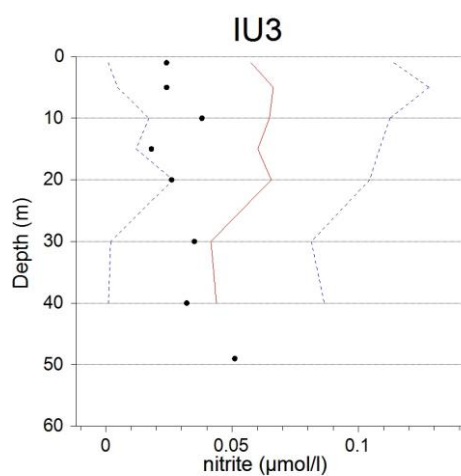
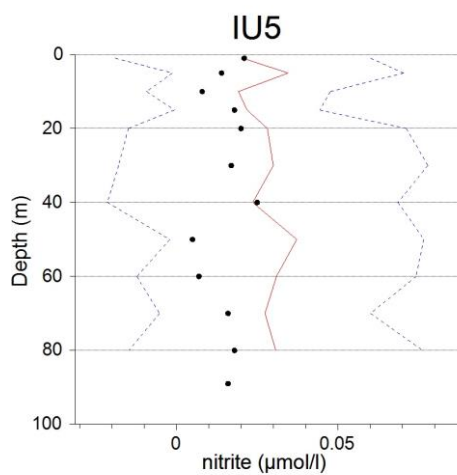
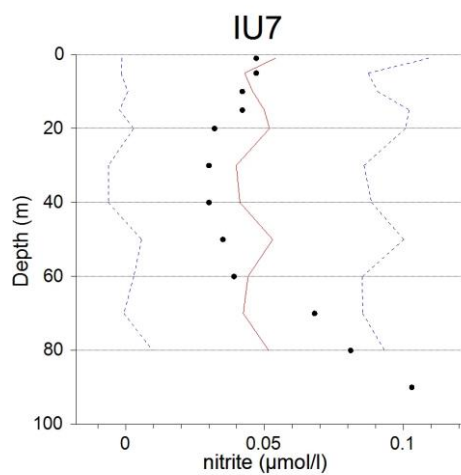
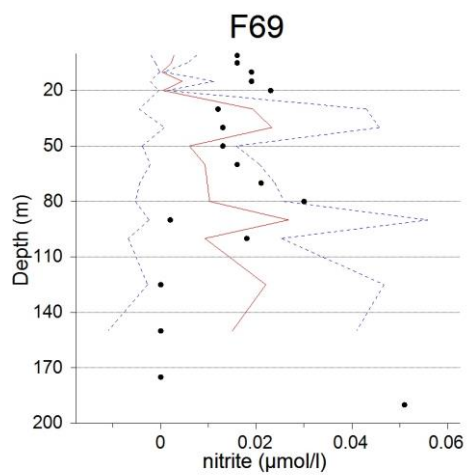


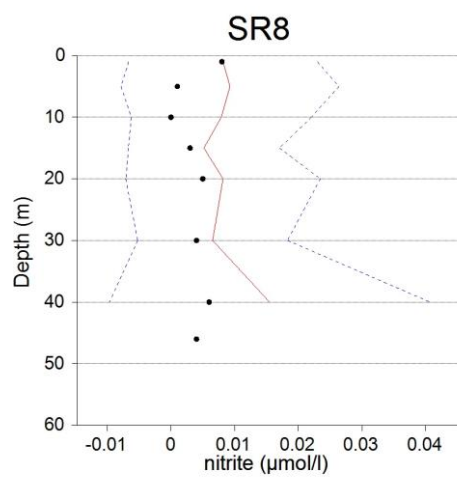
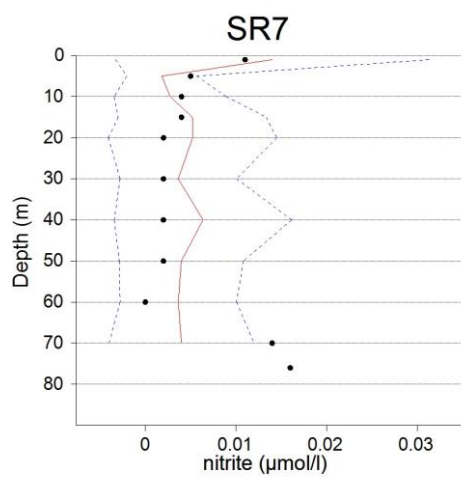
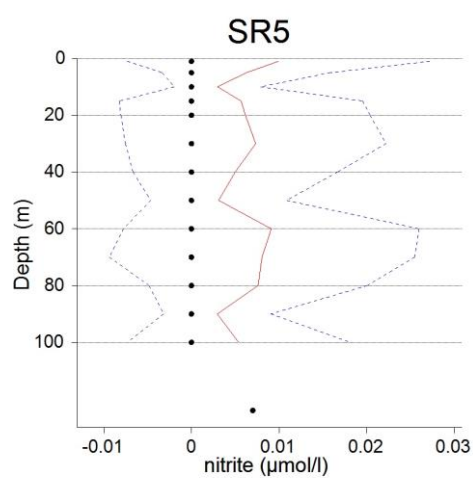
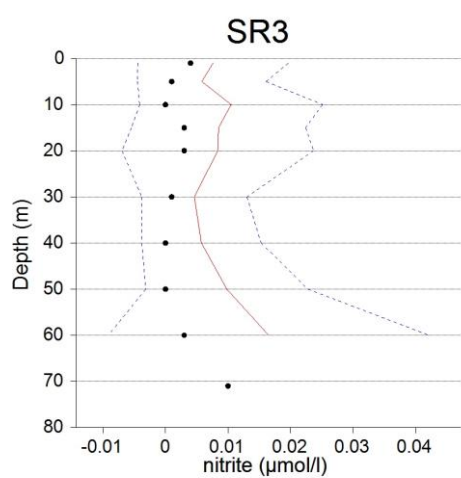
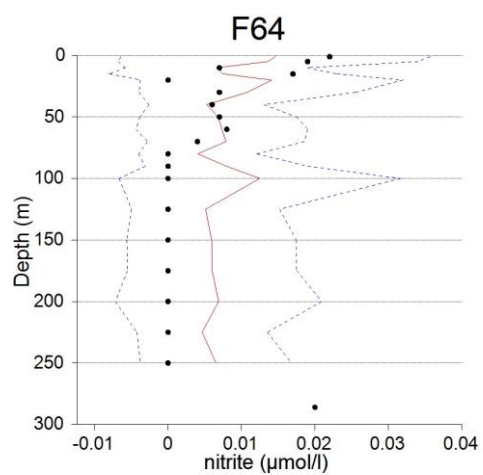
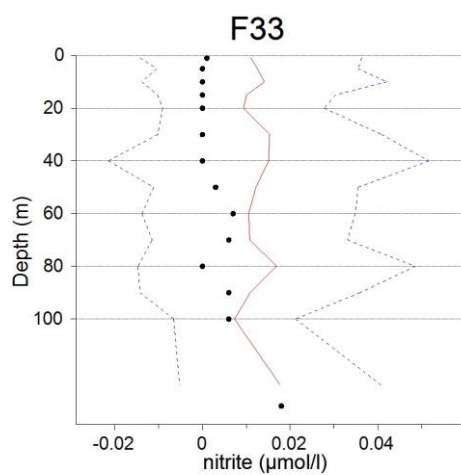


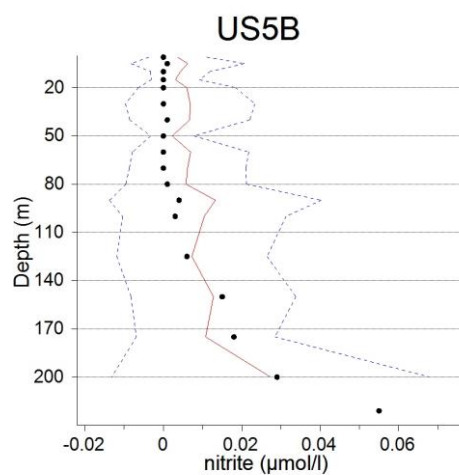
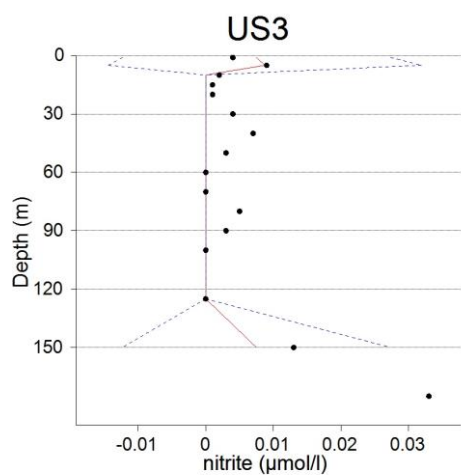
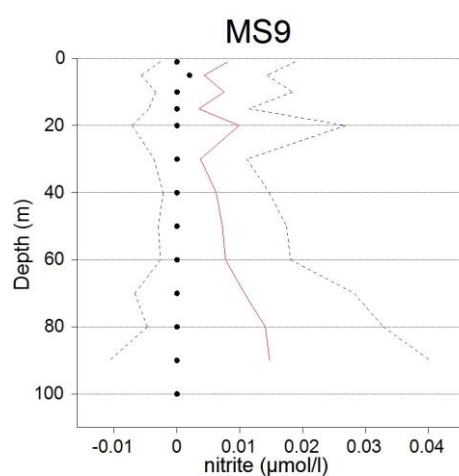
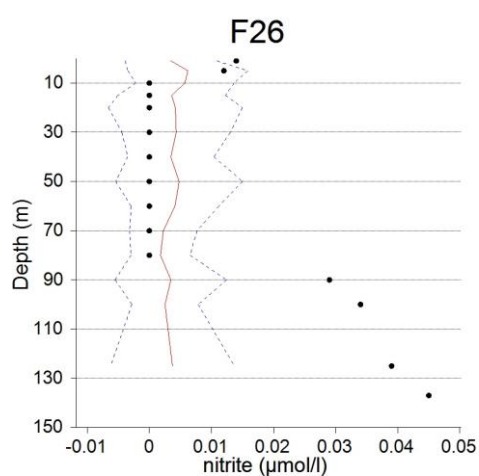
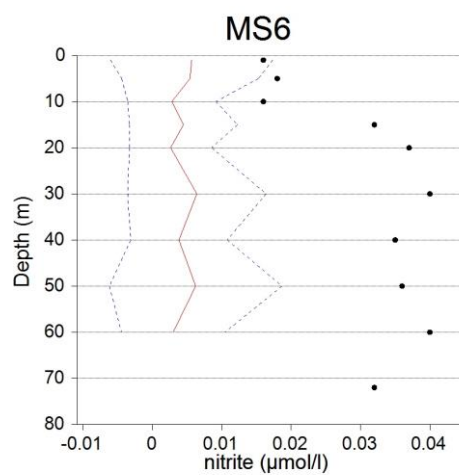
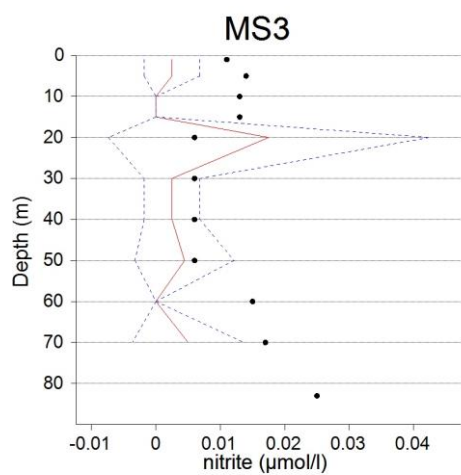
Nitrite

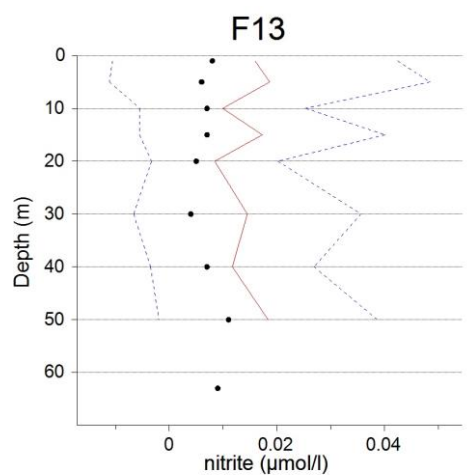
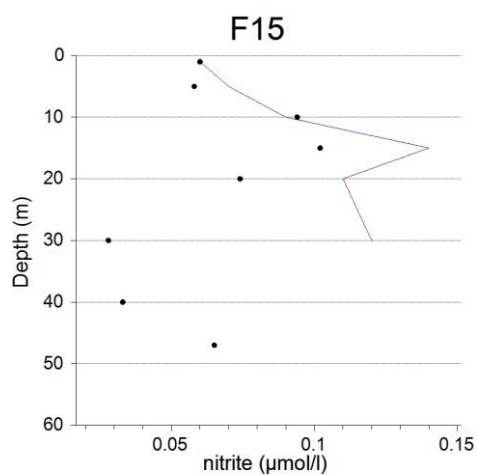
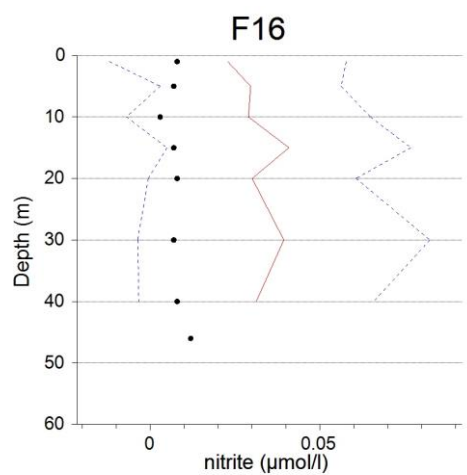
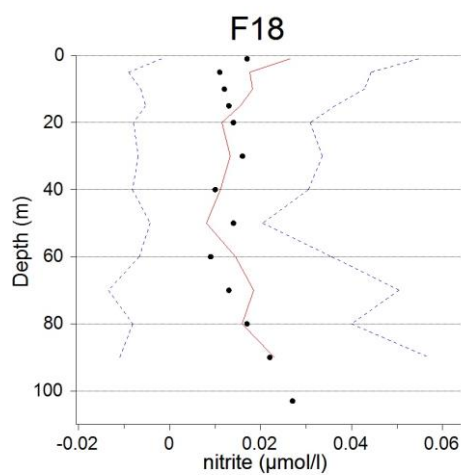
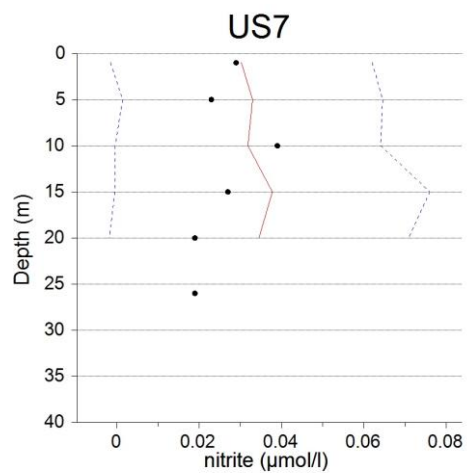
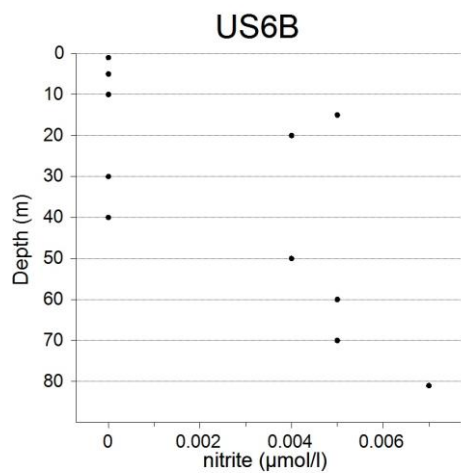
Nitrite concentrations were very low, often close to 0 $\mu\text{mol/mol}$ and below the average, and highest concentrations were observed in the Archipelago Sea and in the Bothnian Bay.

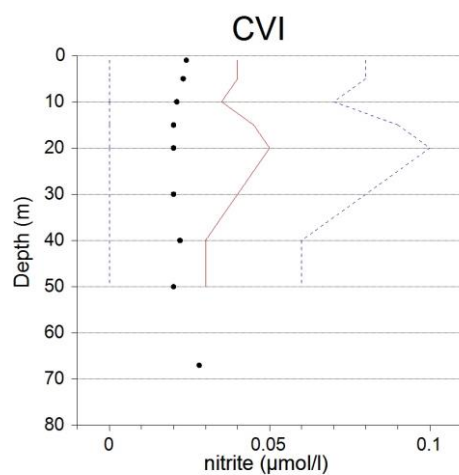
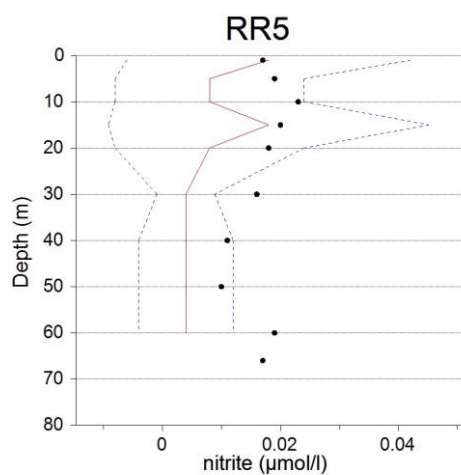
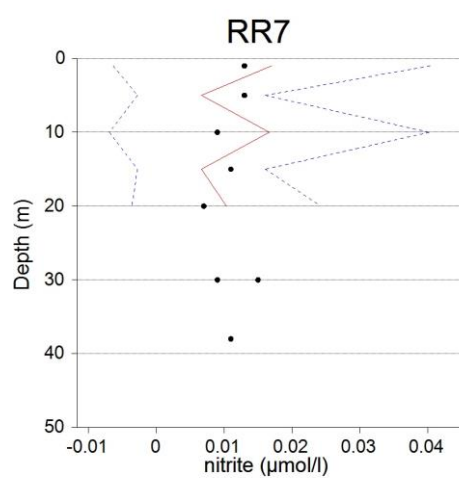
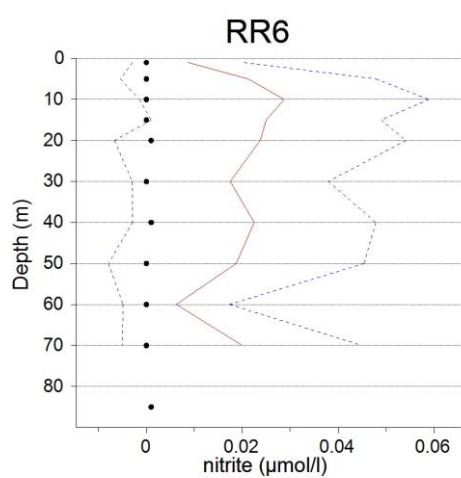
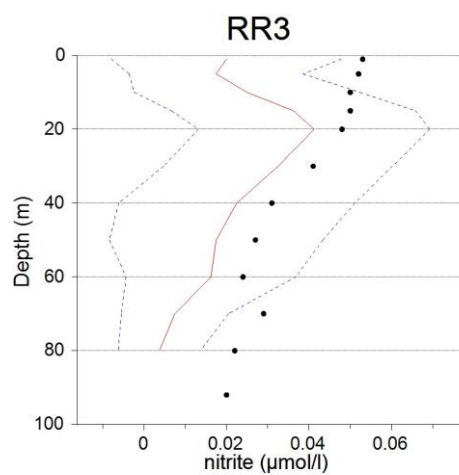
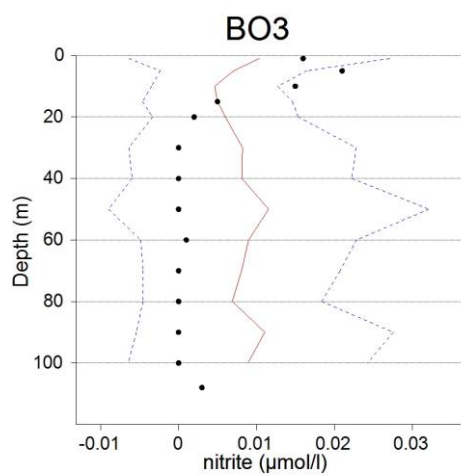


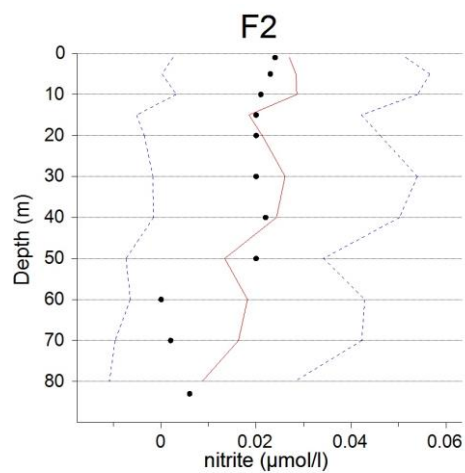
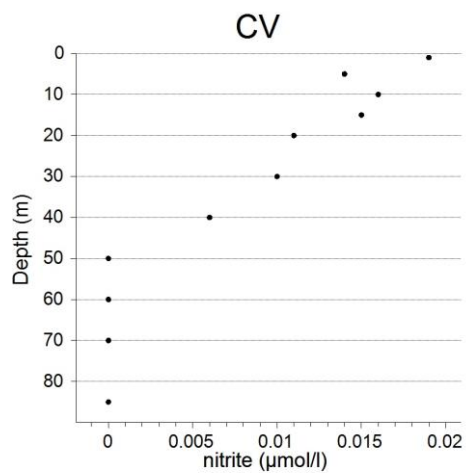






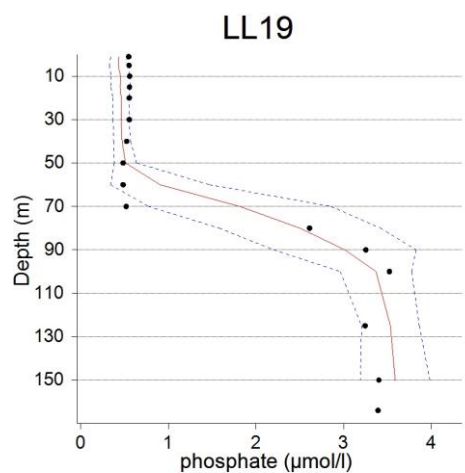
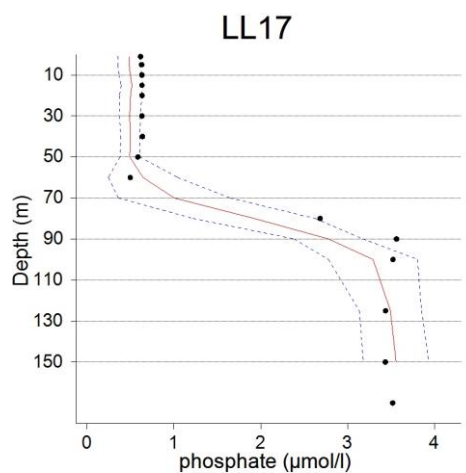
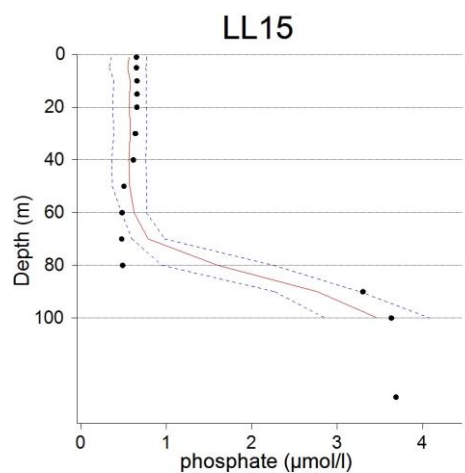
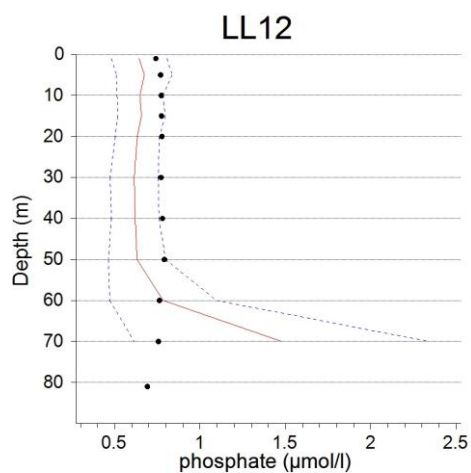


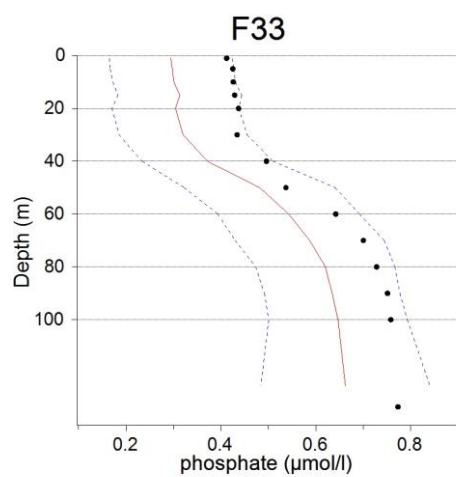
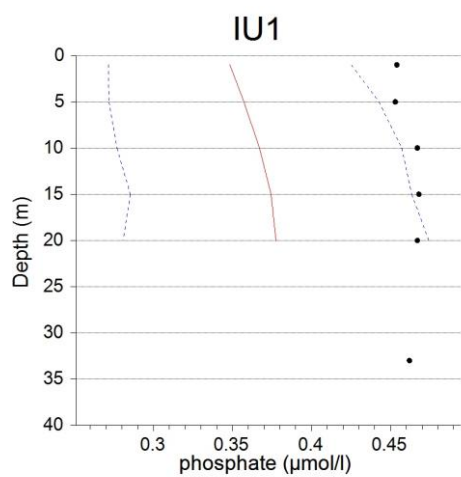
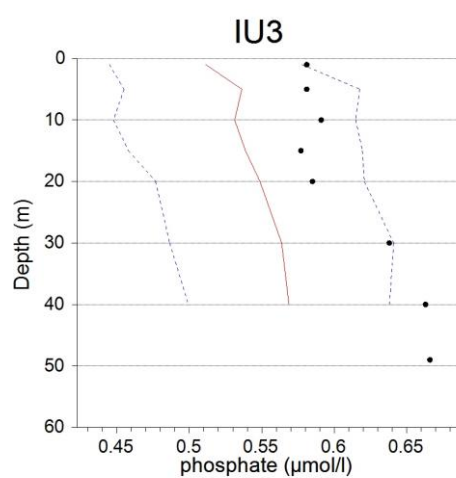
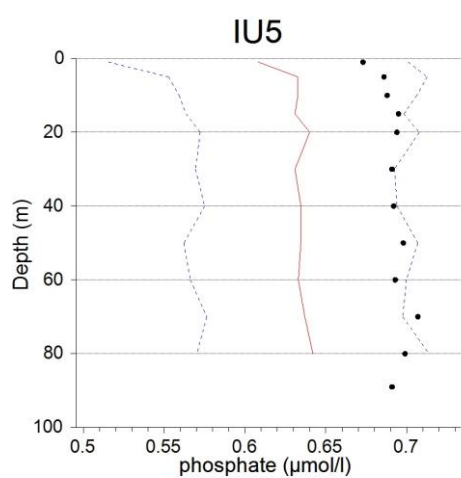
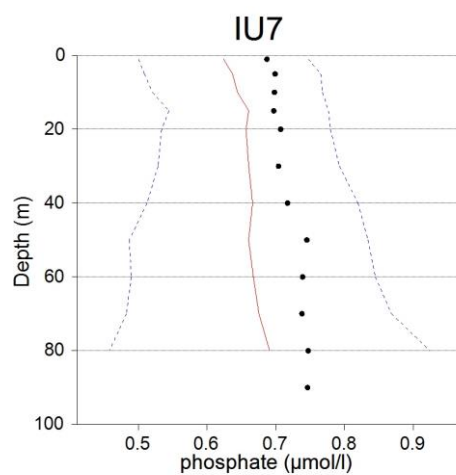
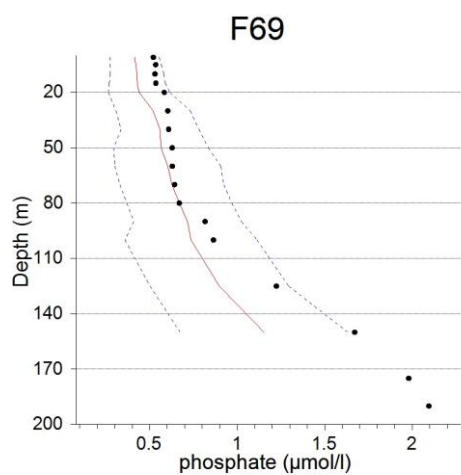


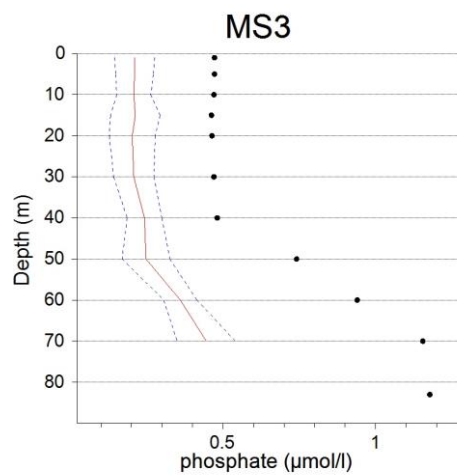
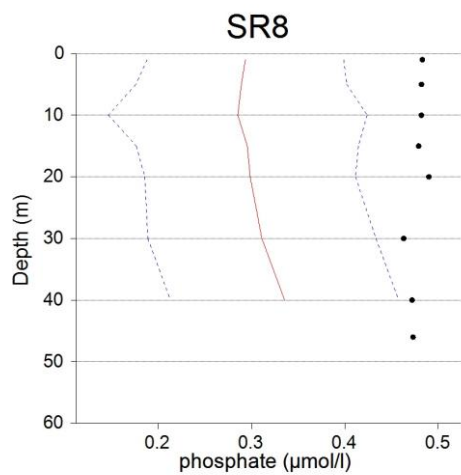
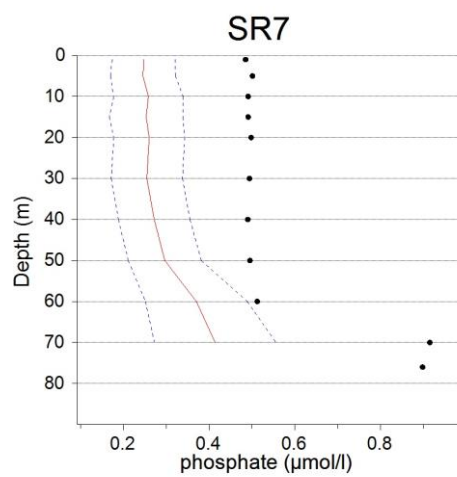
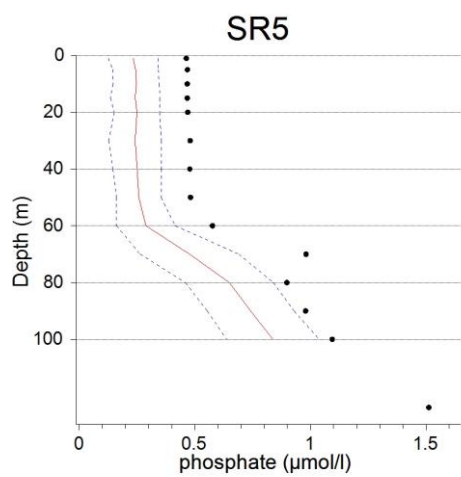
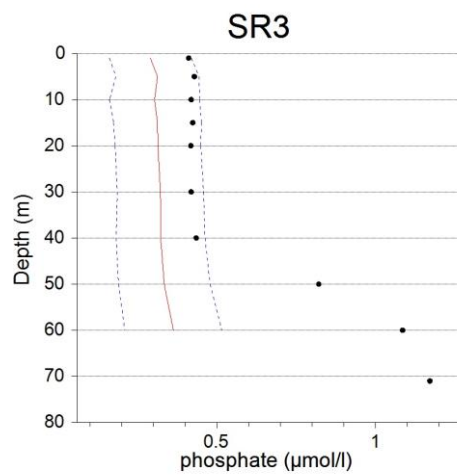
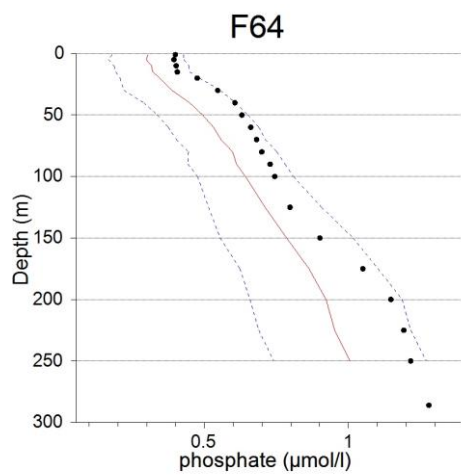


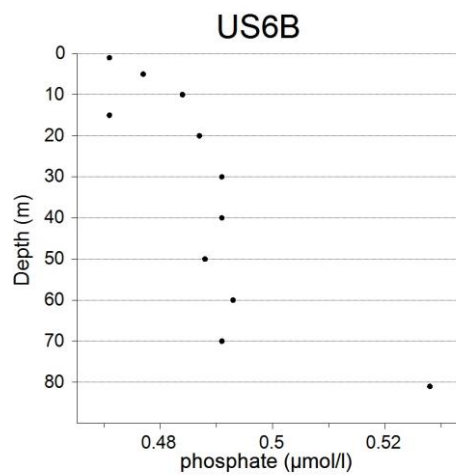
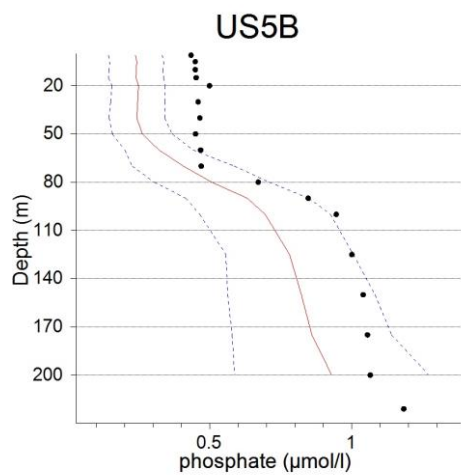
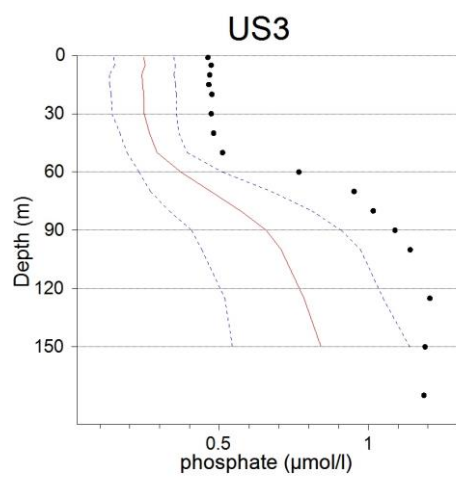
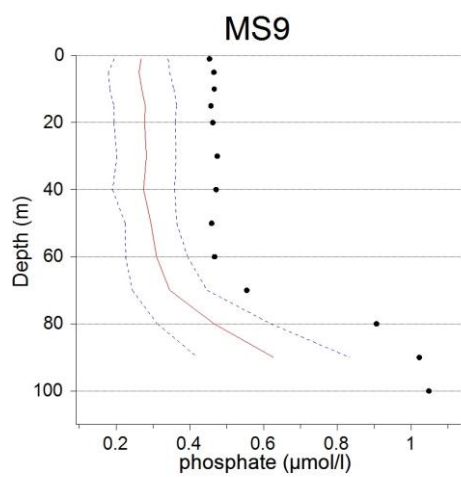
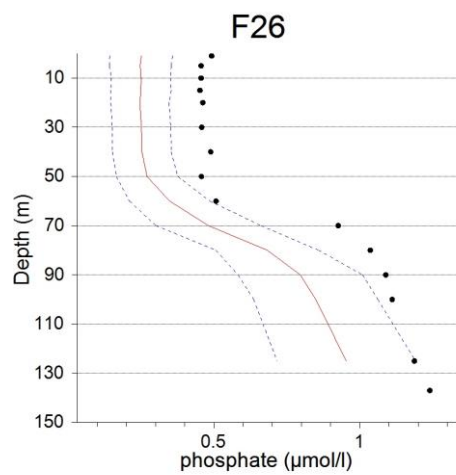
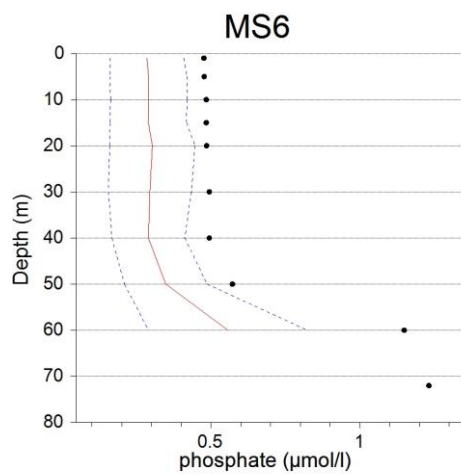
Phosphate

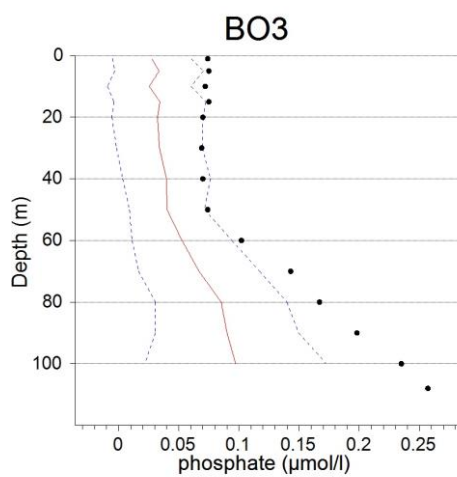
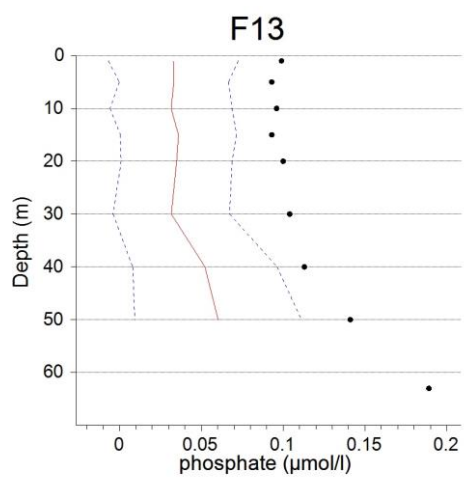
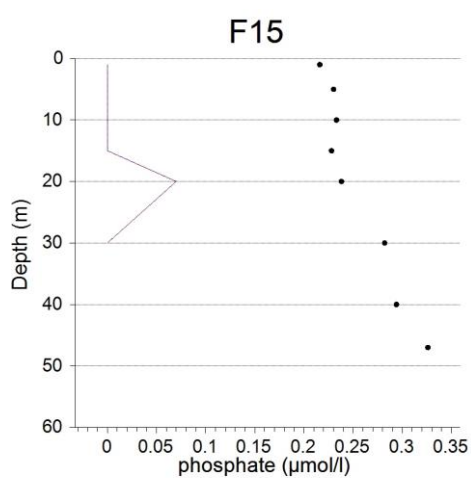
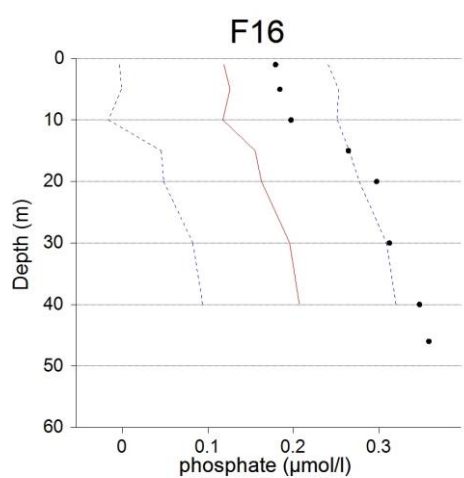
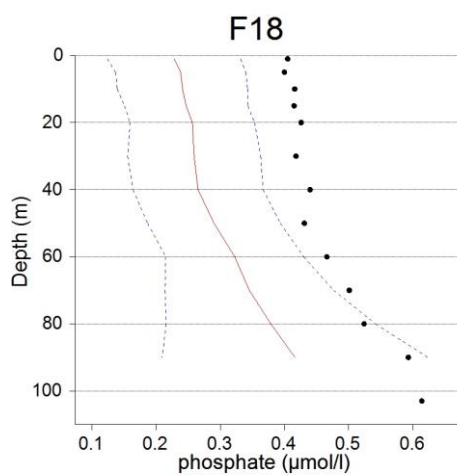
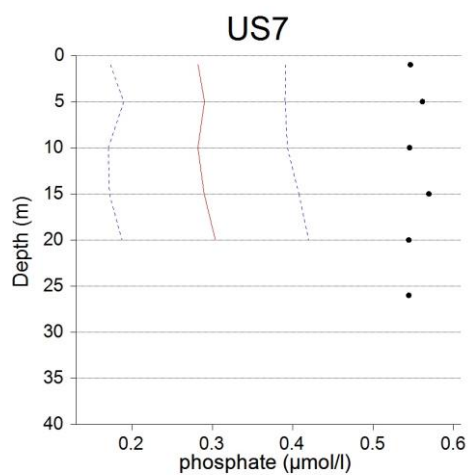
High PO_4 winter concentrations were observed in every basin. Winter was exceptionally warm and ice cover was found only in the northern part of the Bothnian Bay.

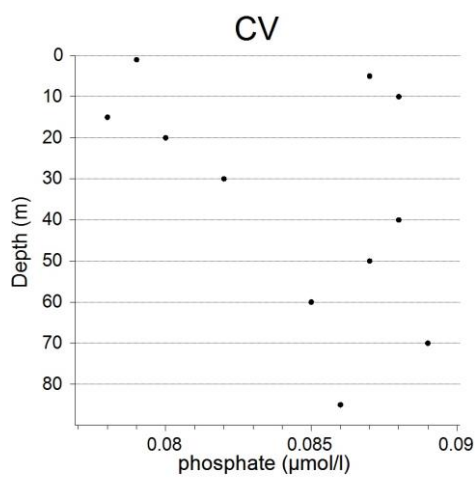
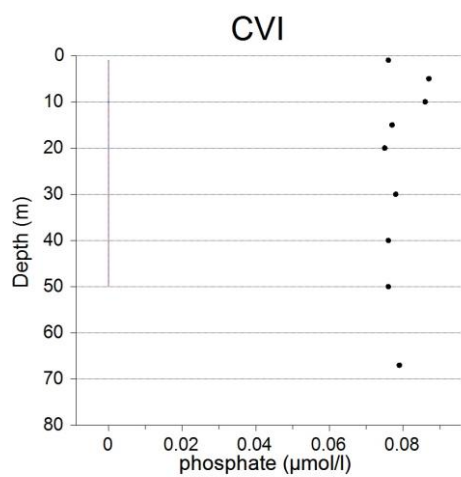
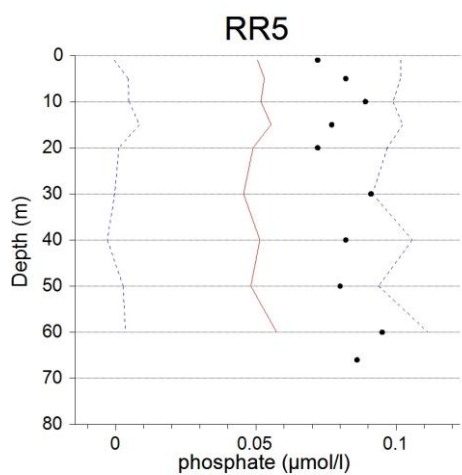
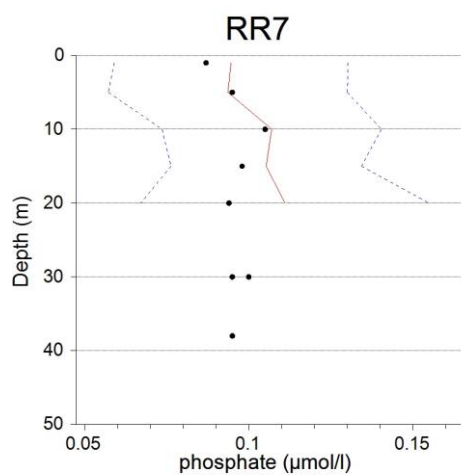
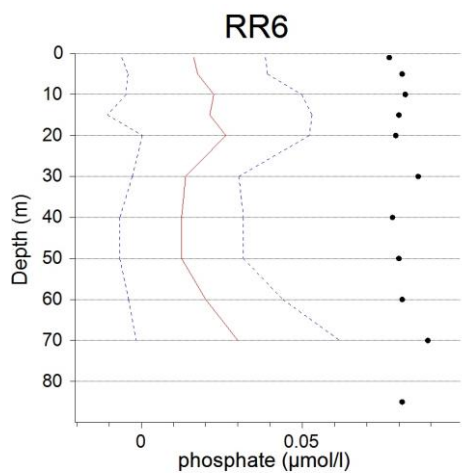
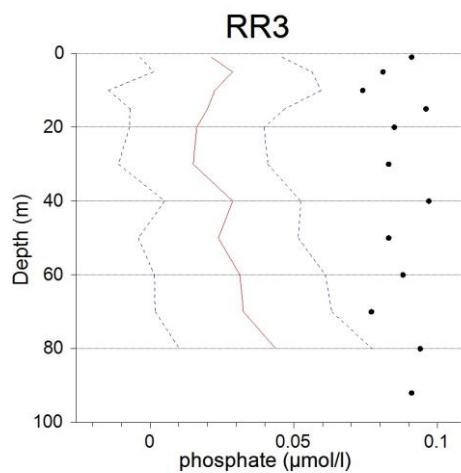


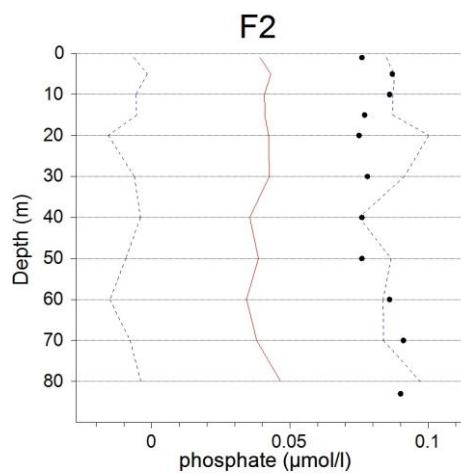






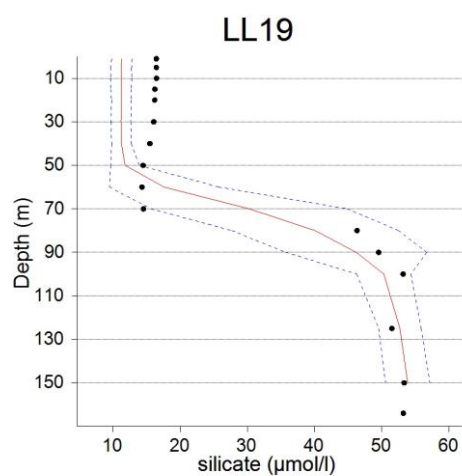
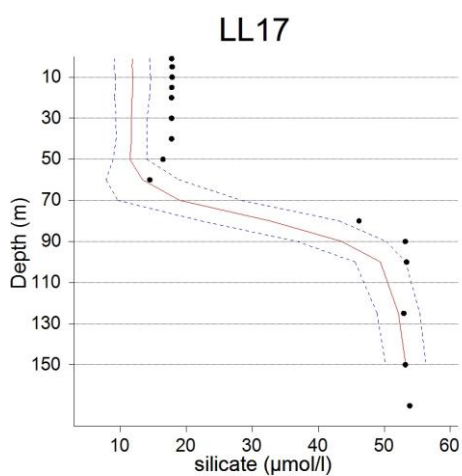
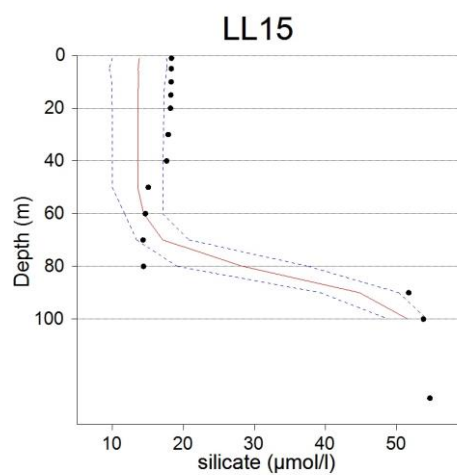
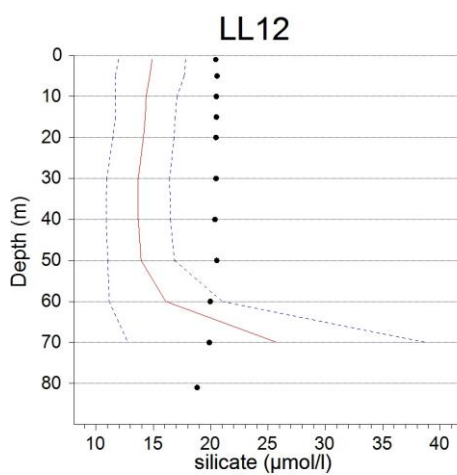


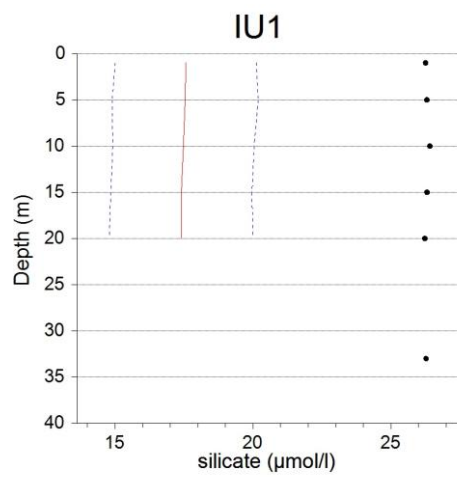
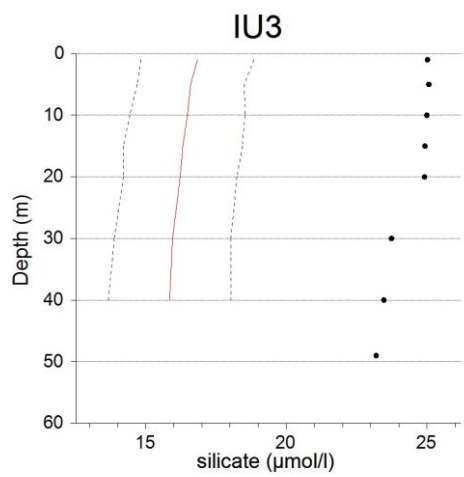
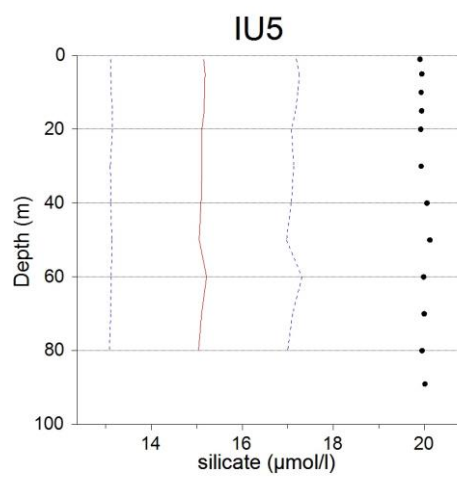
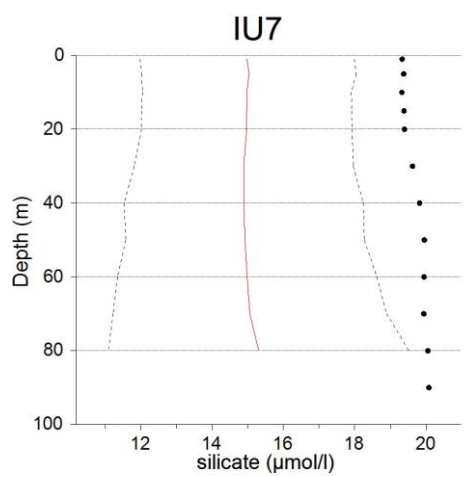
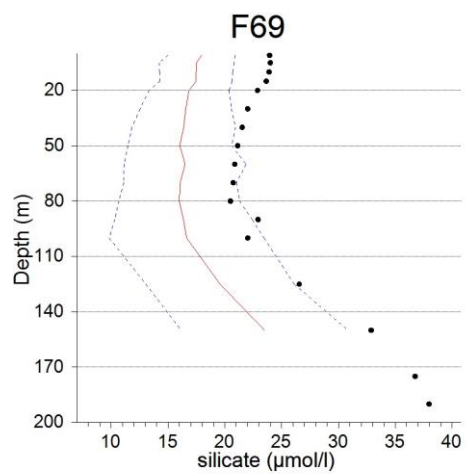


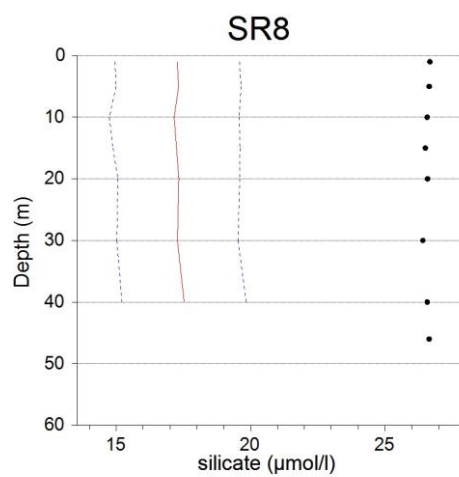
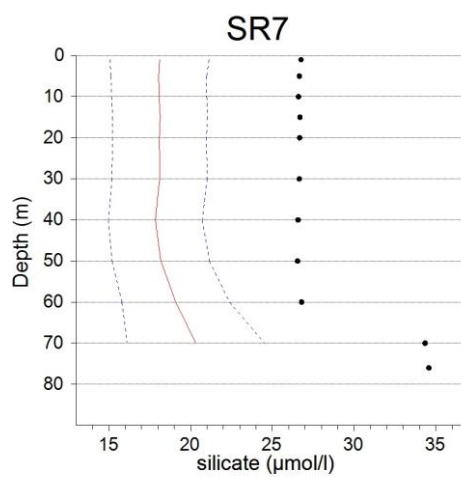
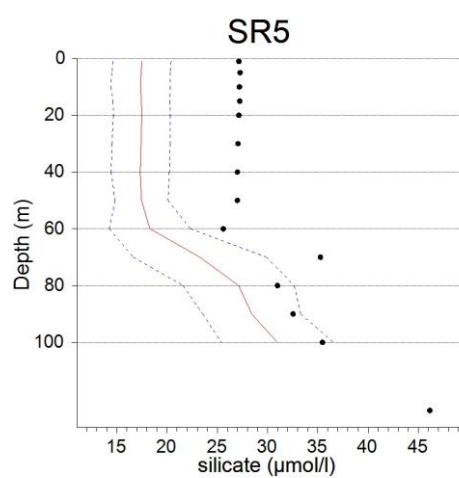
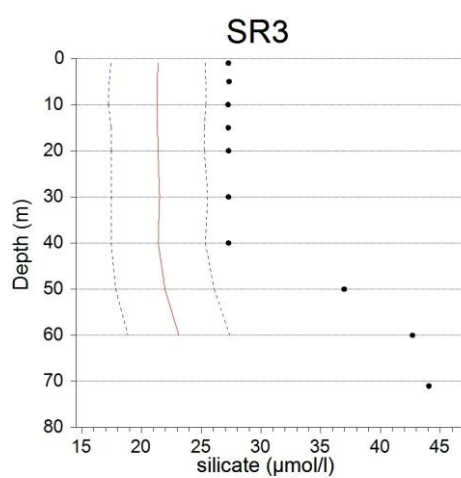
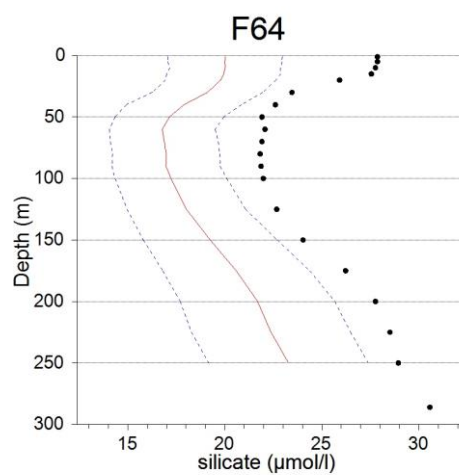
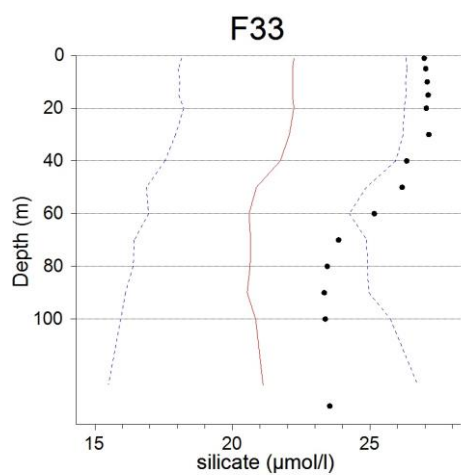


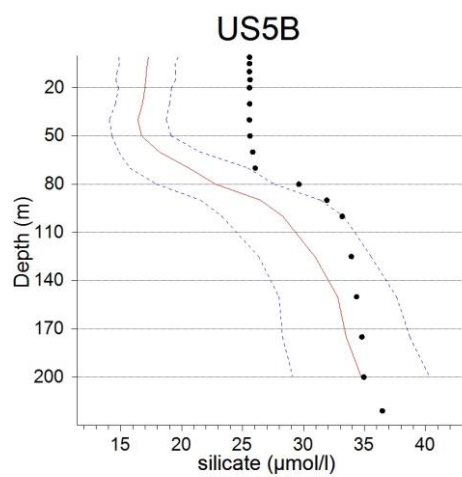
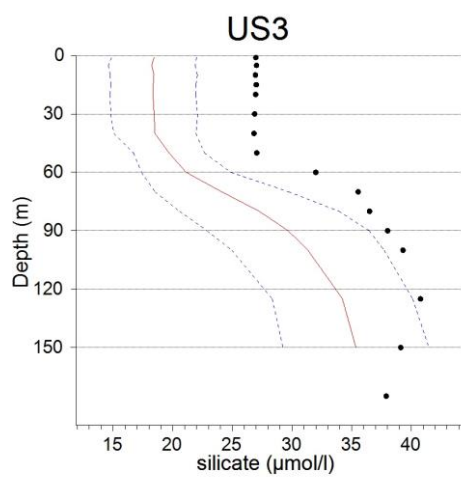
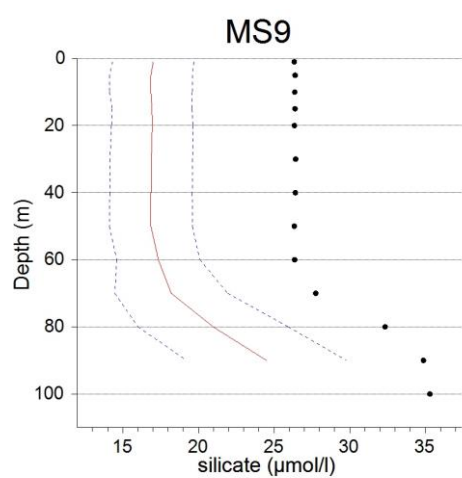
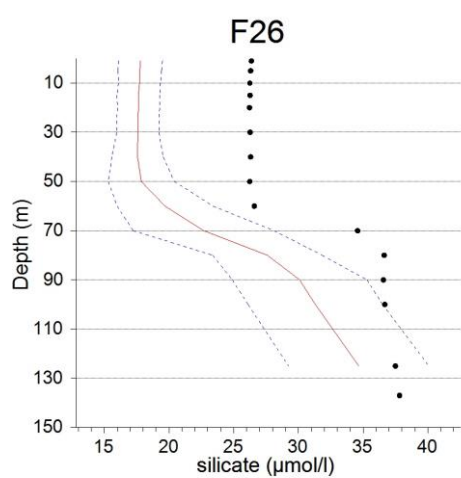
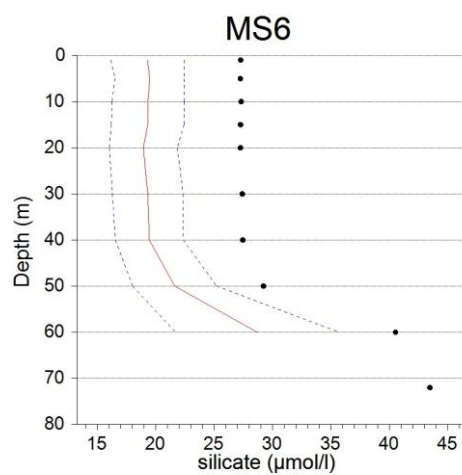
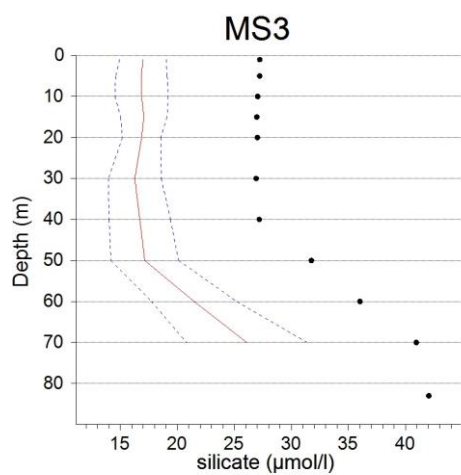
Silicate

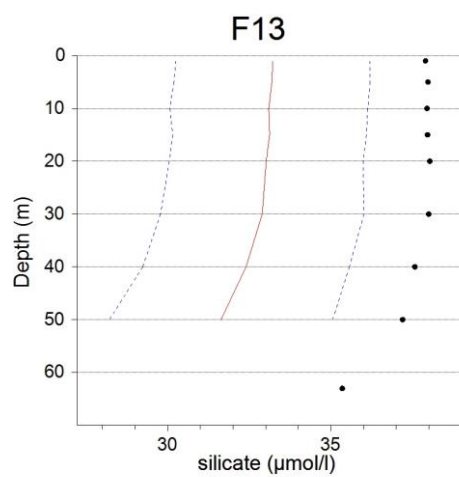
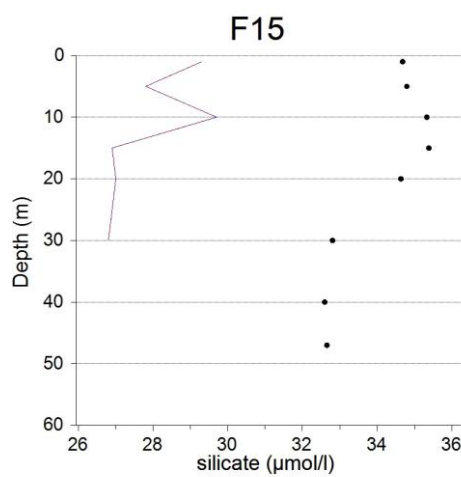
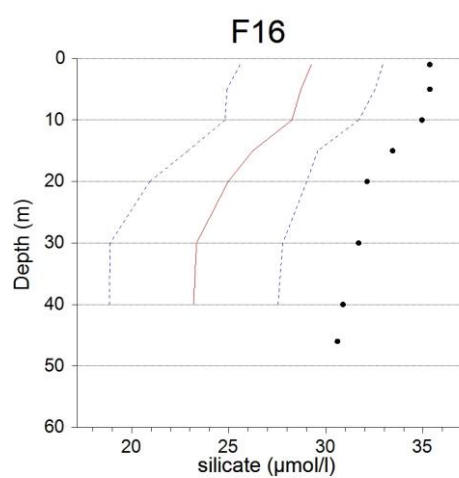
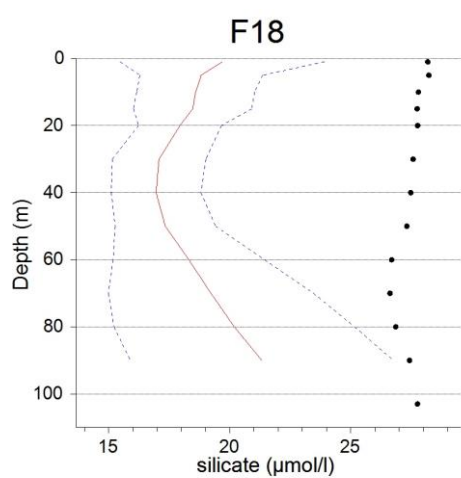
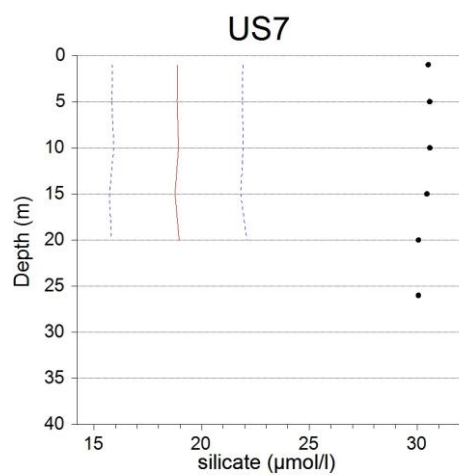
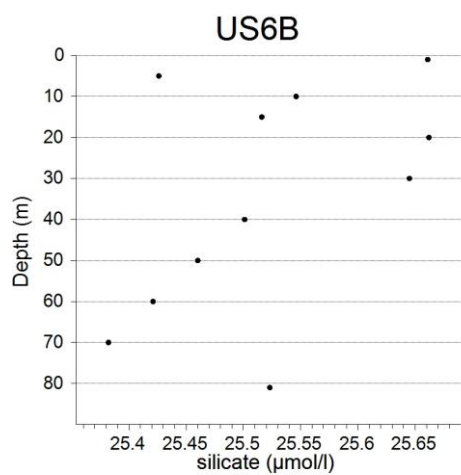
Very high silicate concentrations were observed in the Northern Baltic Proper, Bothnian Sea, Bothnian Bay and in the Archipelago Sea.

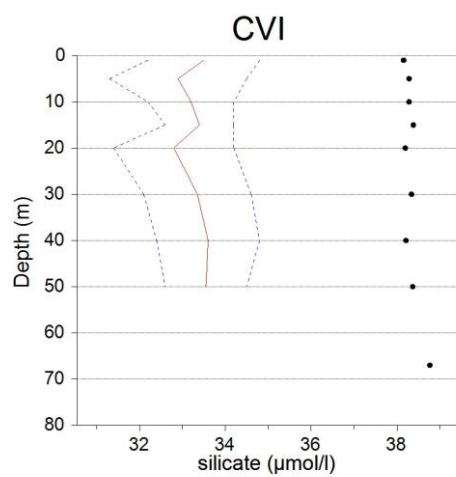
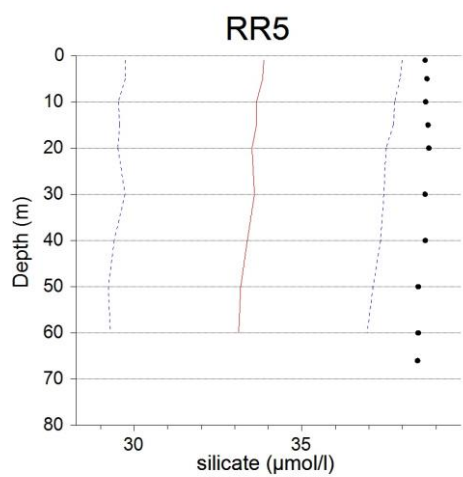
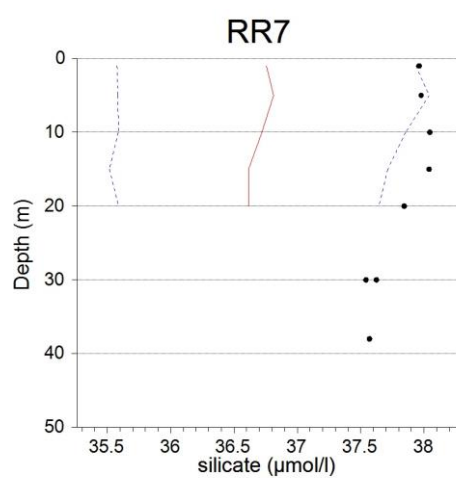
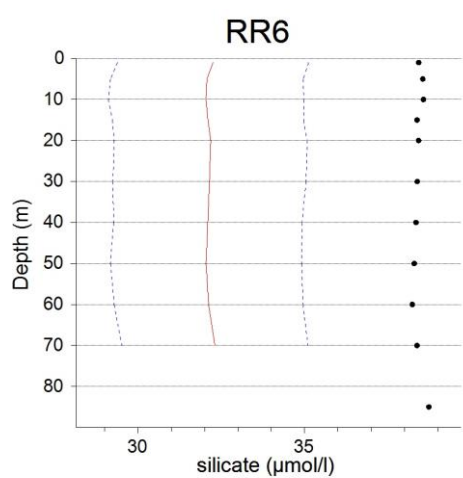
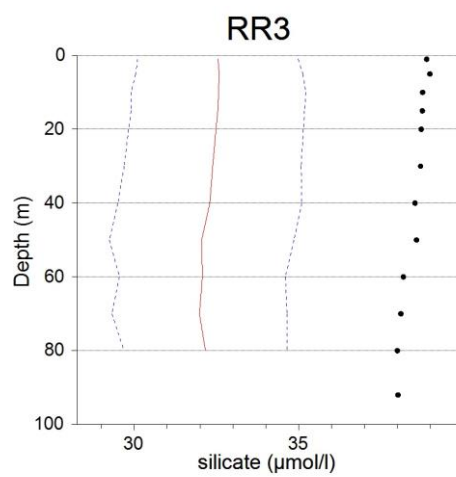
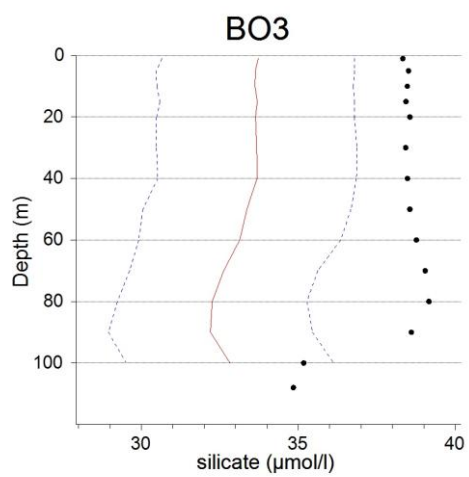


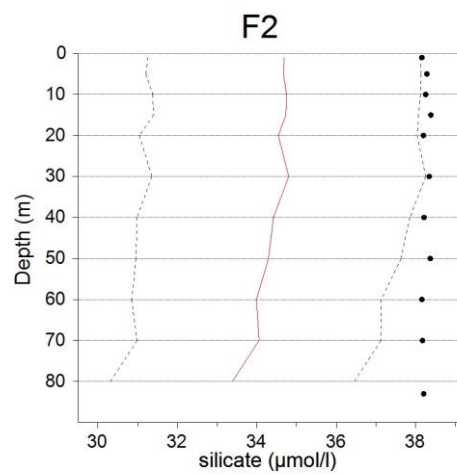
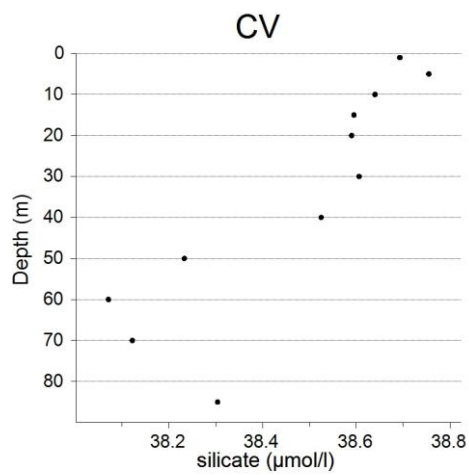








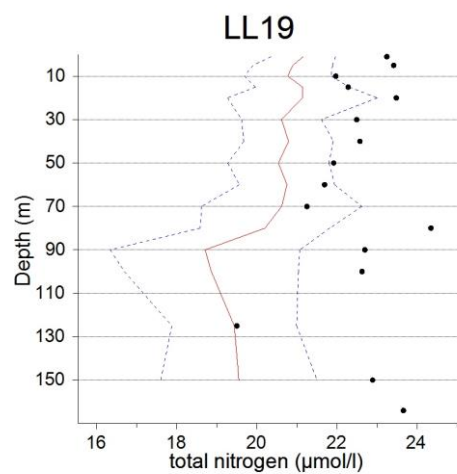
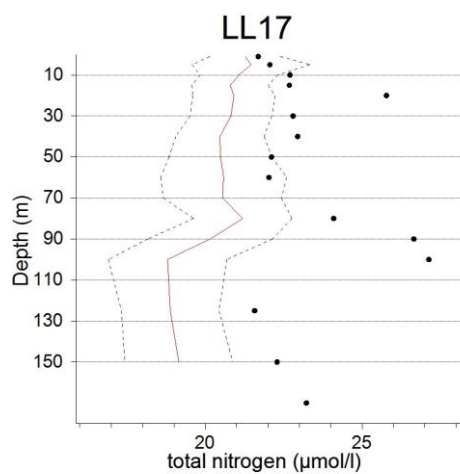
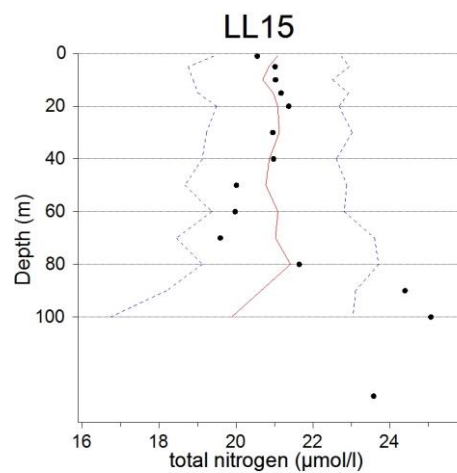
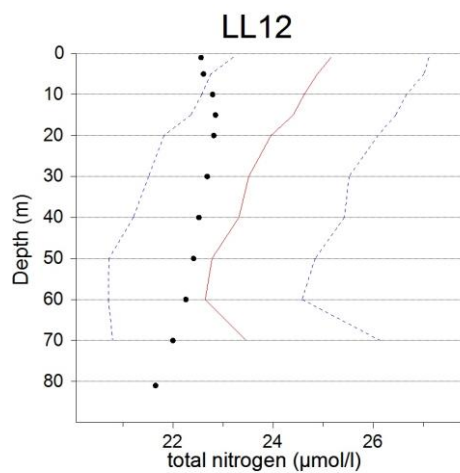


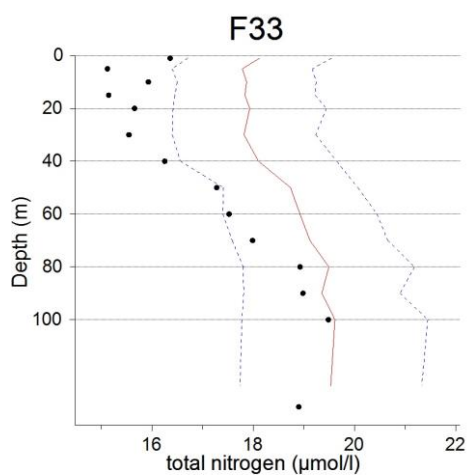
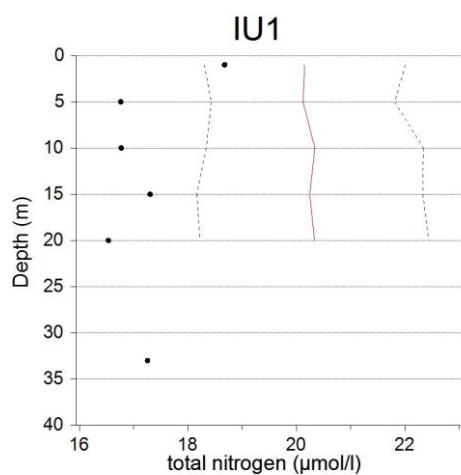
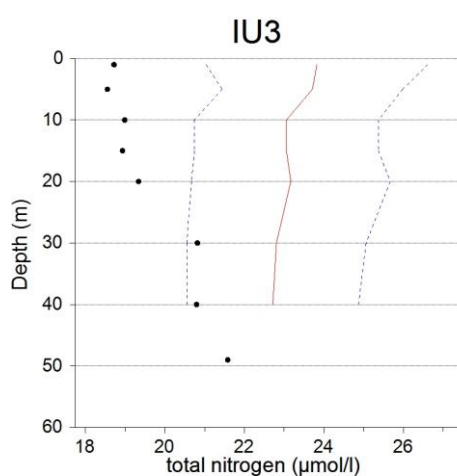
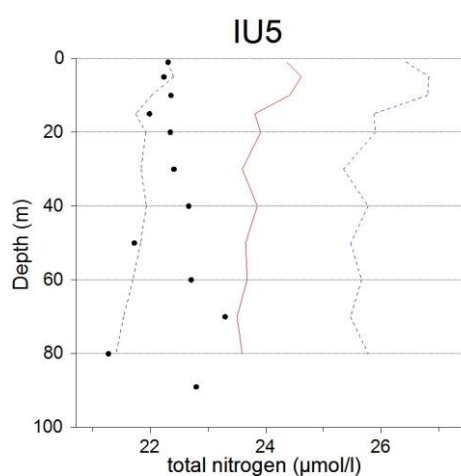
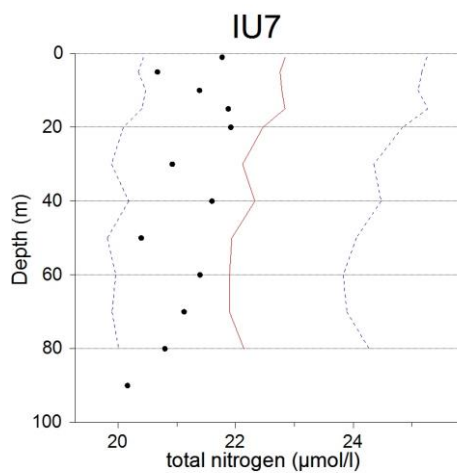
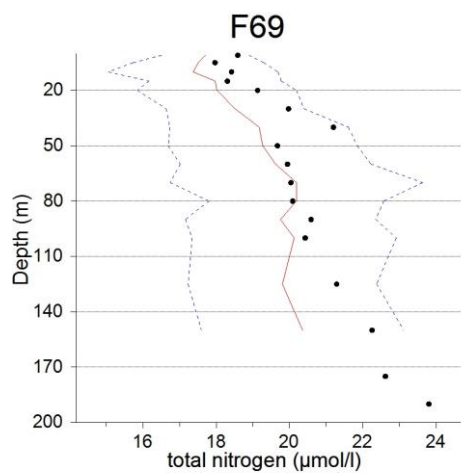


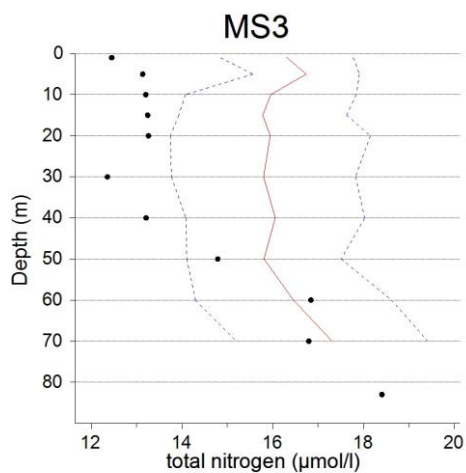
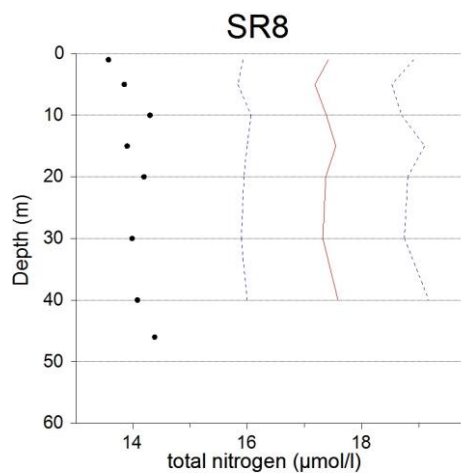
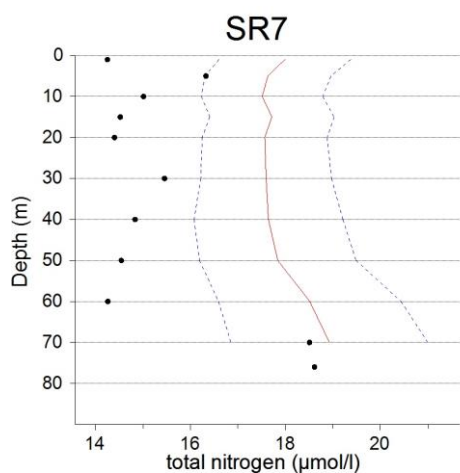
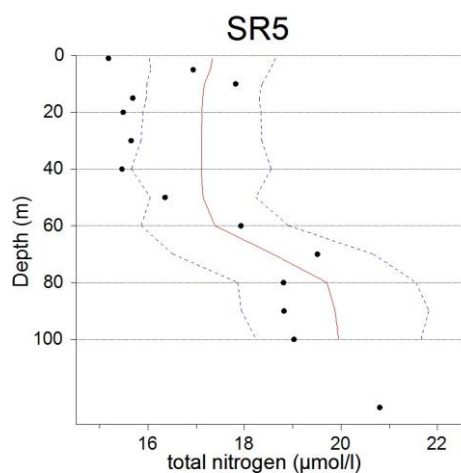
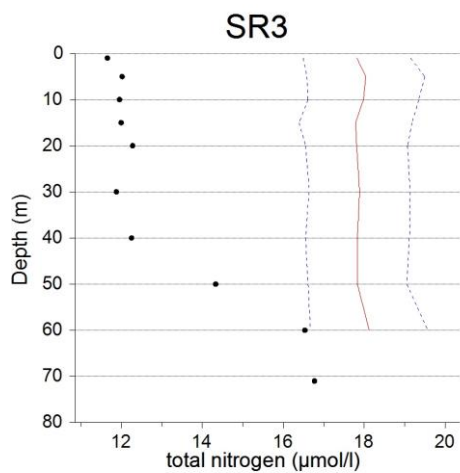
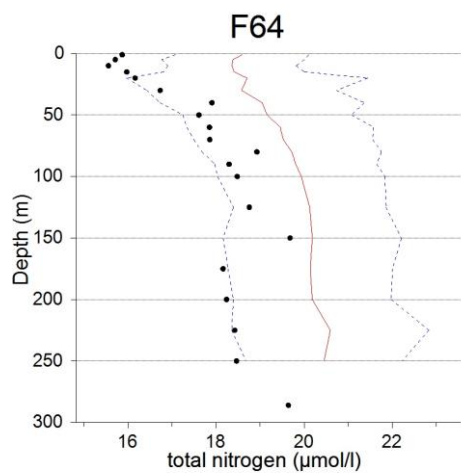
Total nutrients

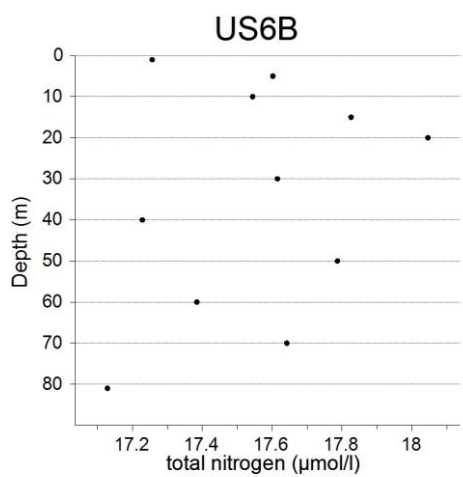
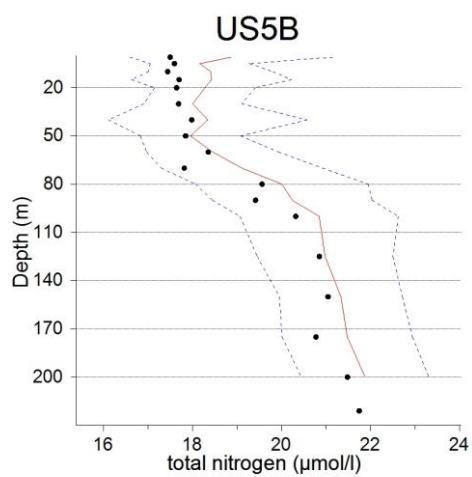
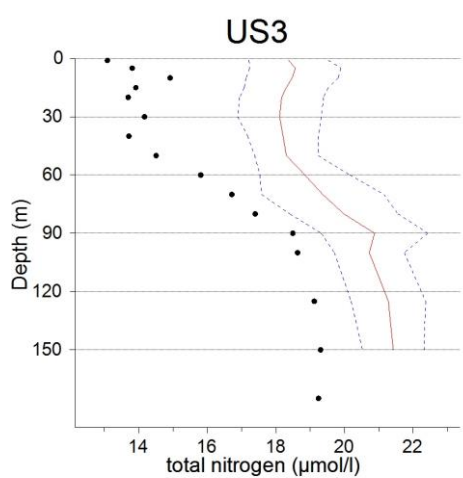
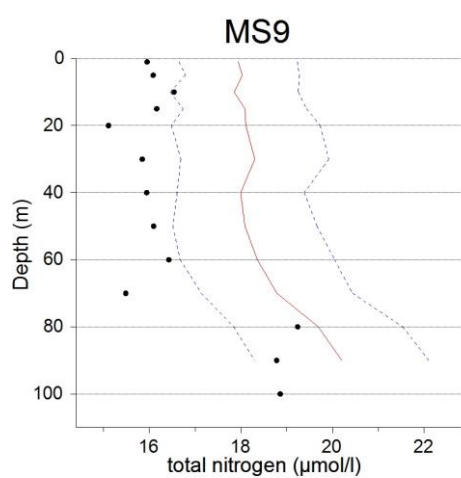
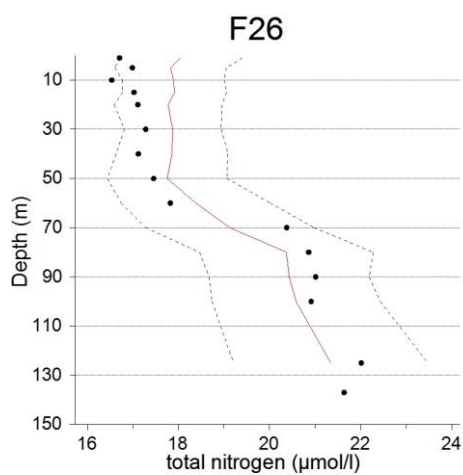
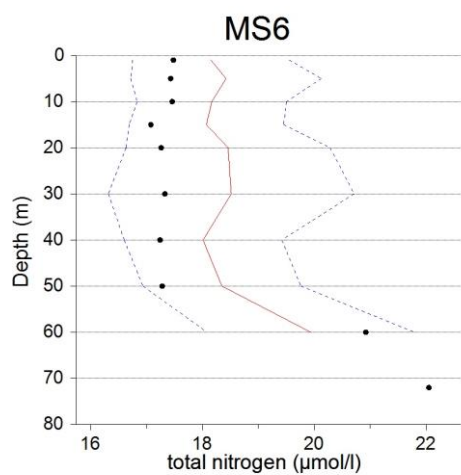
Nitrogen

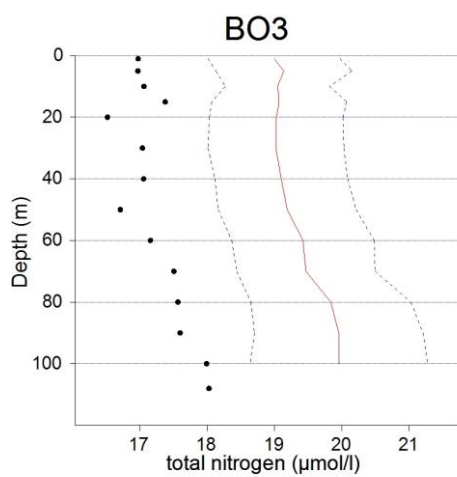
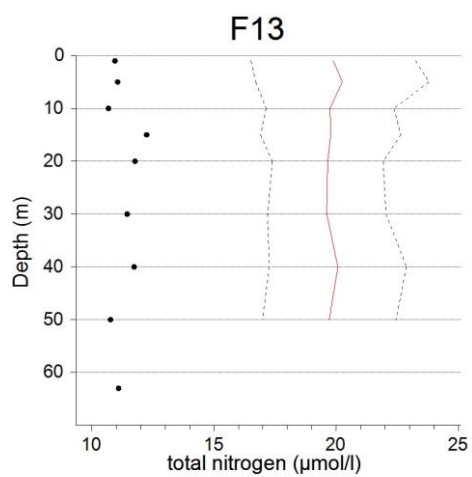
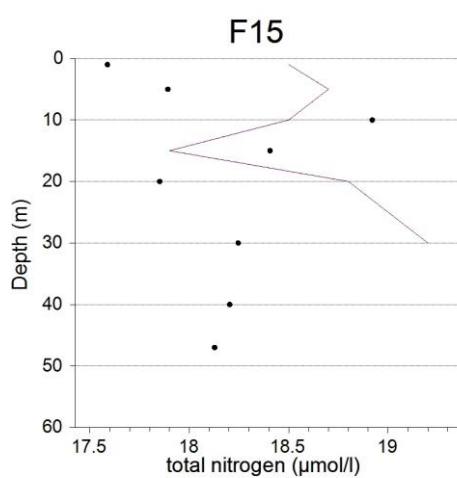
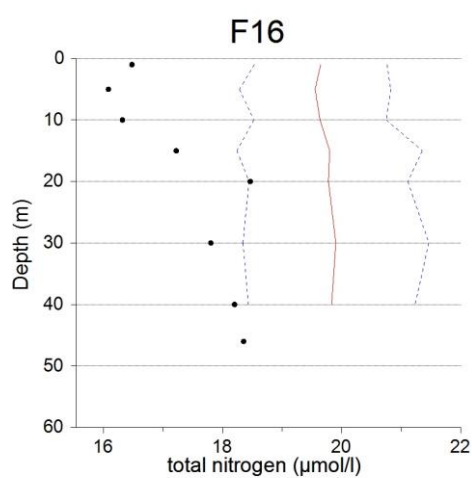
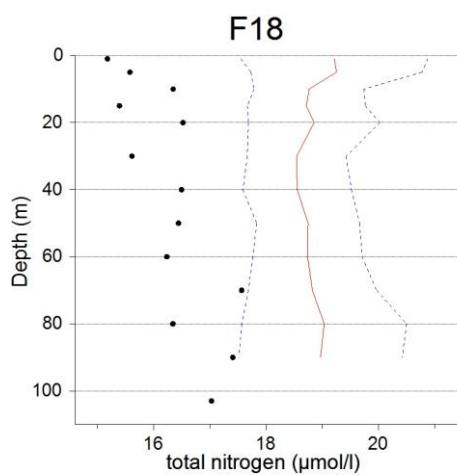
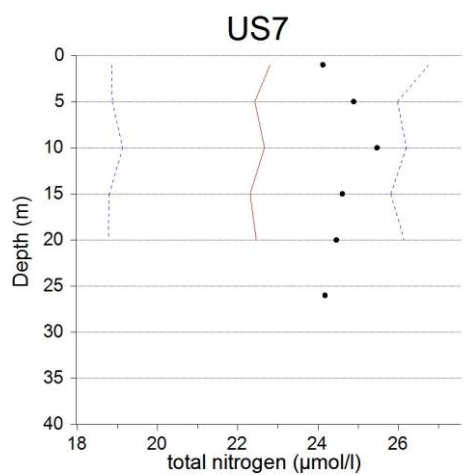
N_{tot} winter concentrations were below the long-term average. Only the concentrations of the Northern Baltic Proper (stations LL17 and LL19) were higher than in average.

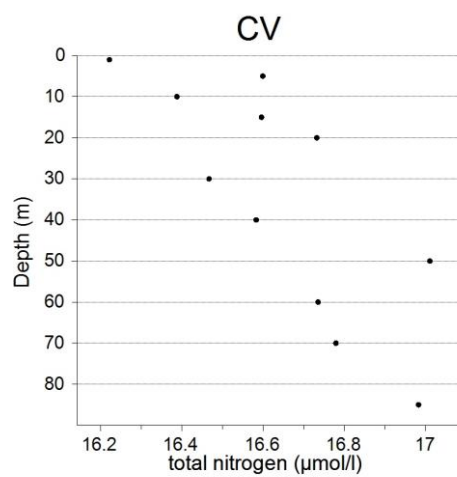
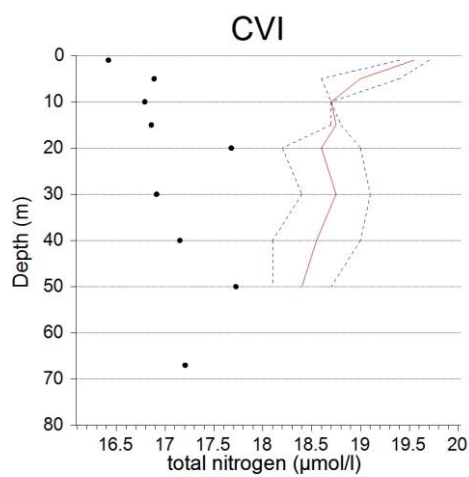
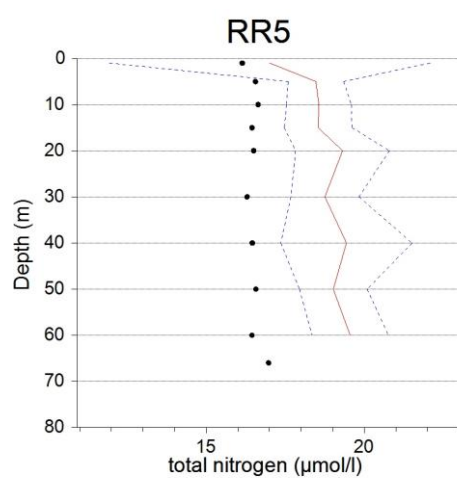
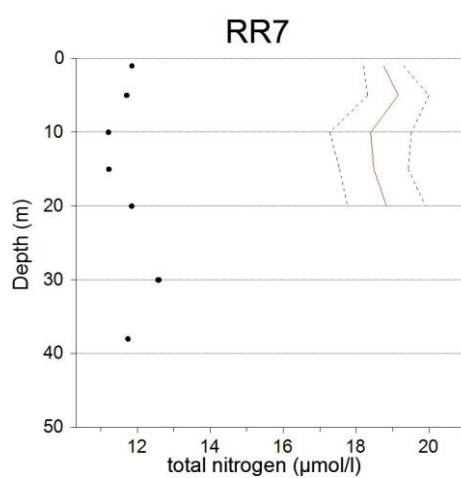
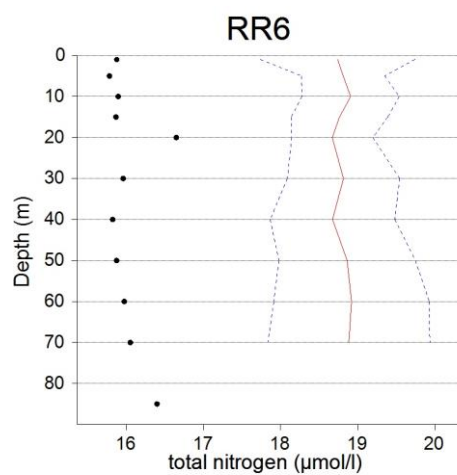
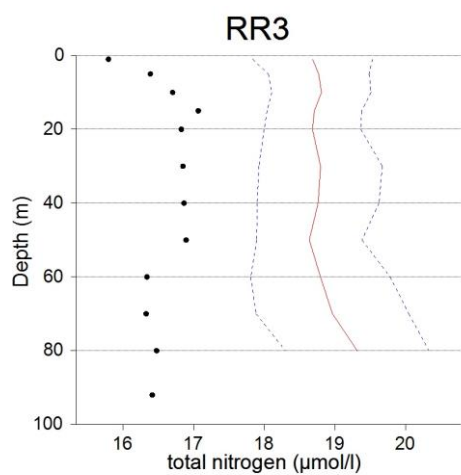


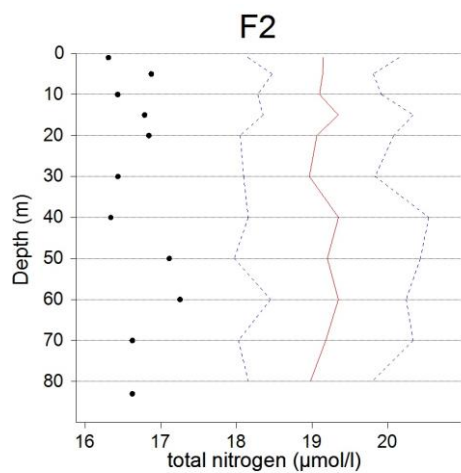






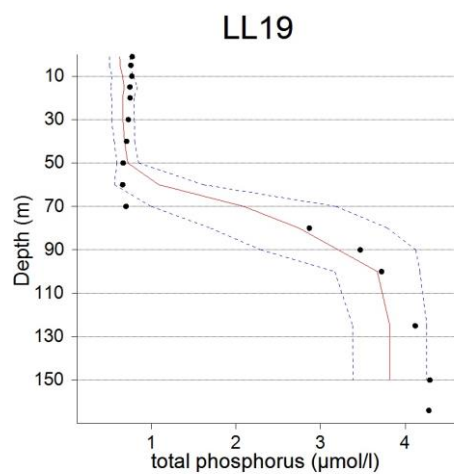
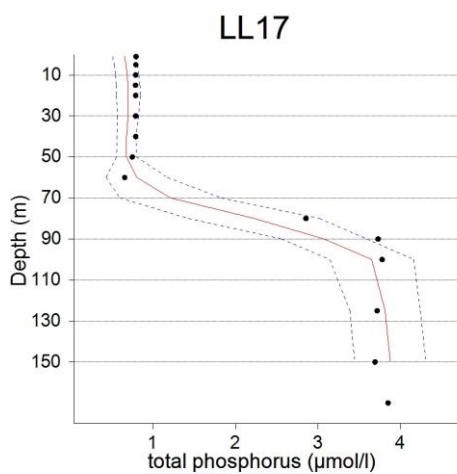
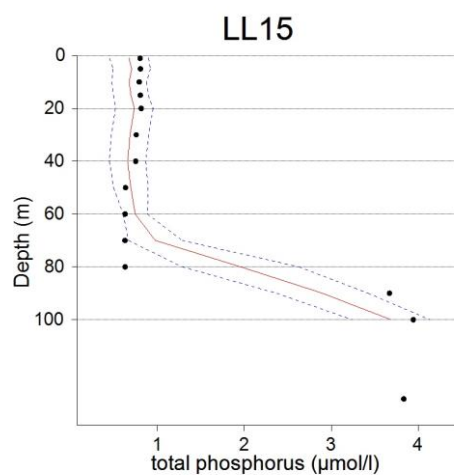
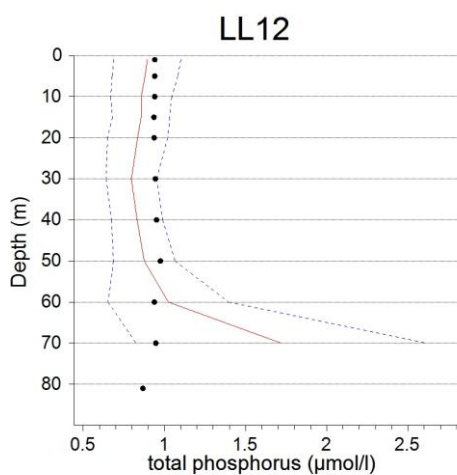




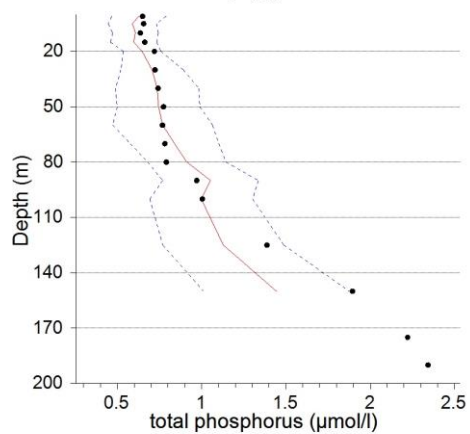


Phosphorus

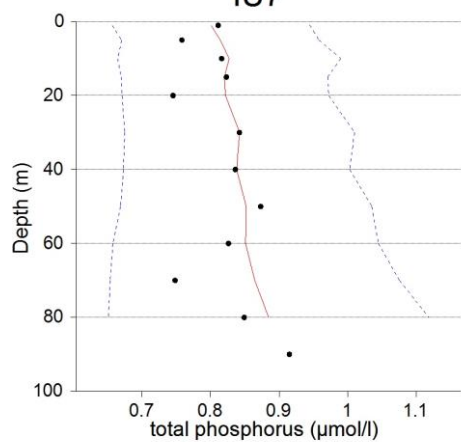
Winter time P_{tot} concentrations were near to long-term averages (2000-2017) in the Northern Baltic Proper. Higher concentrations were observed in the Bothnian Sea and Bothnian Bay and partially also in the Archipelago Sea.



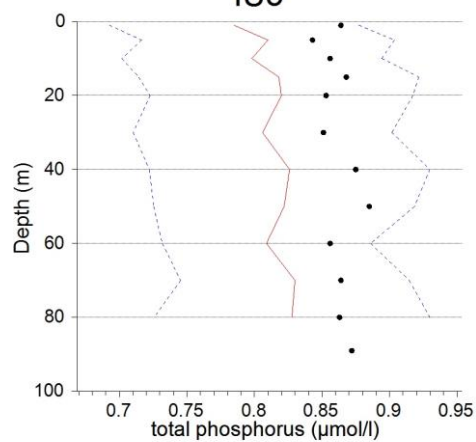
F69



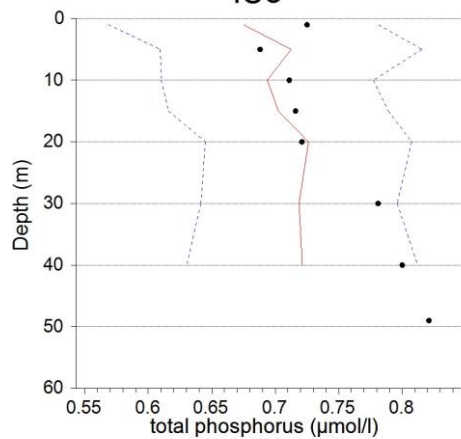
IU7



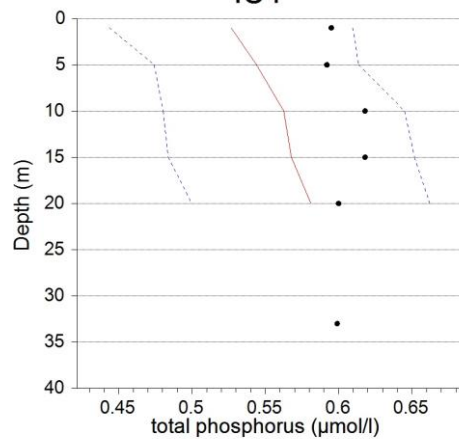
IU5

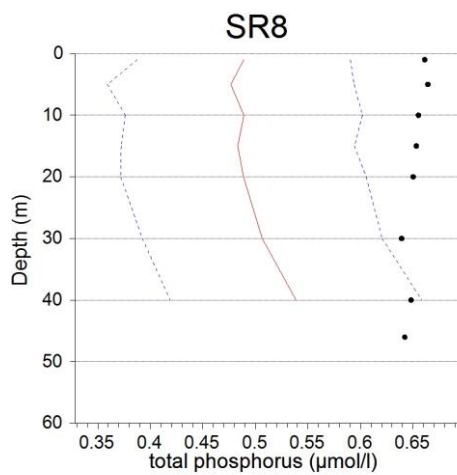
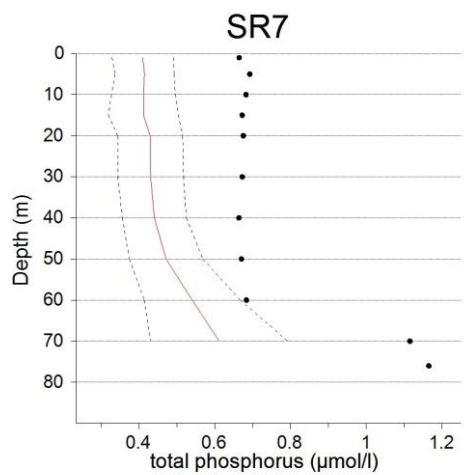
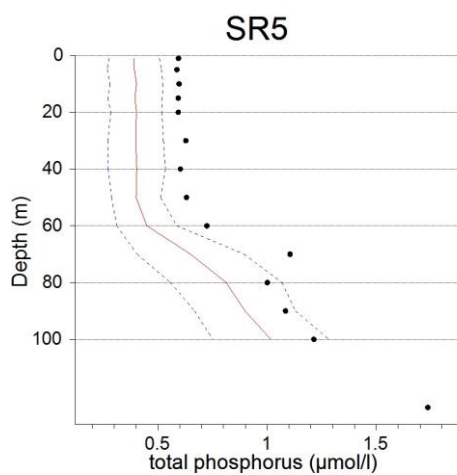
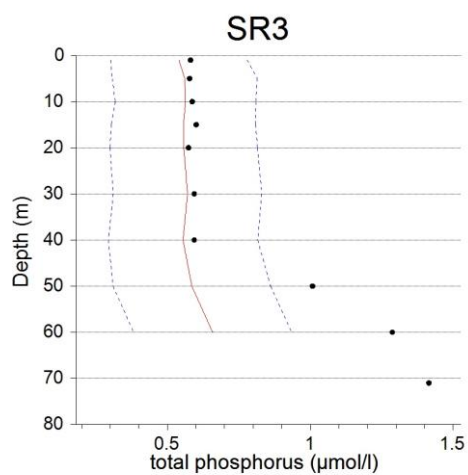
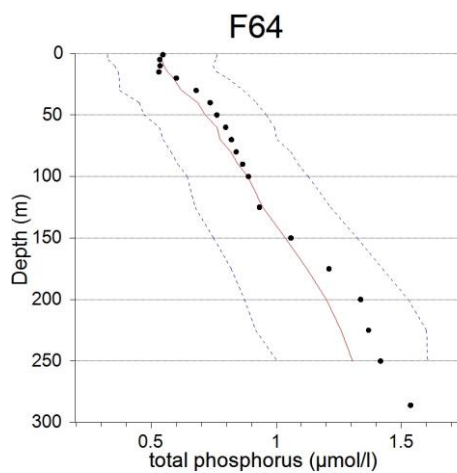
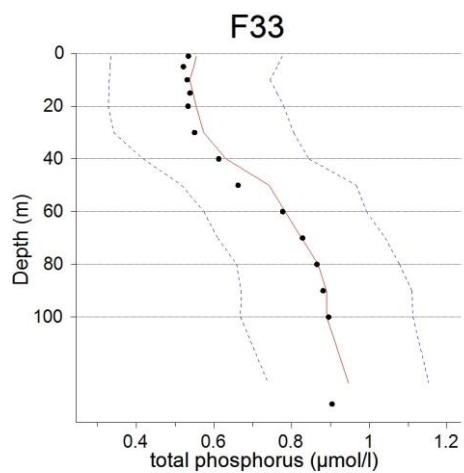


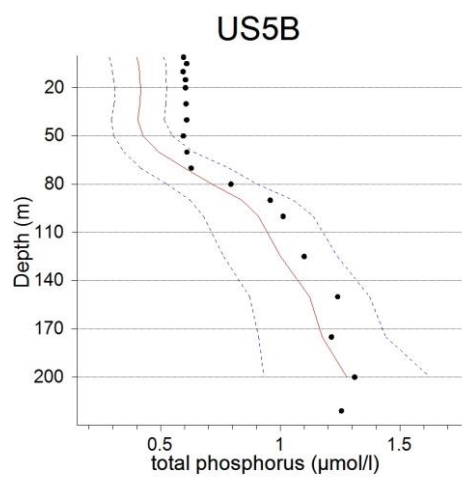
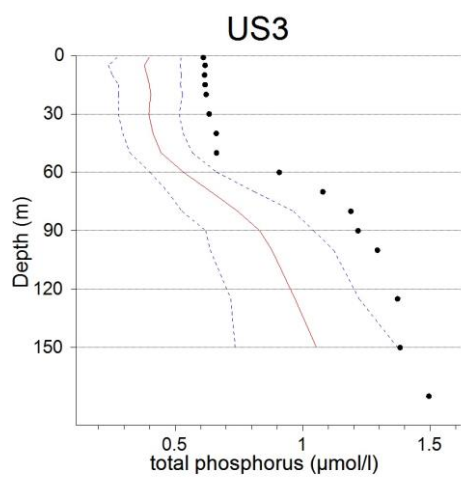
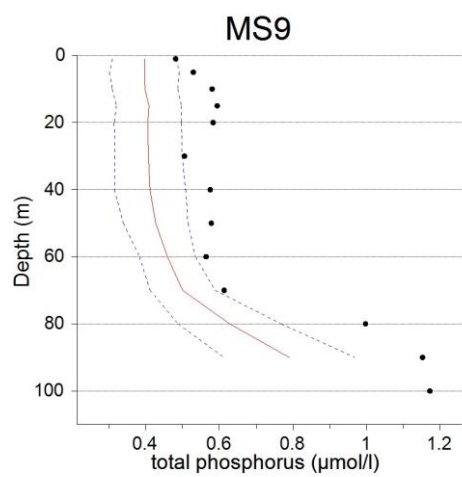
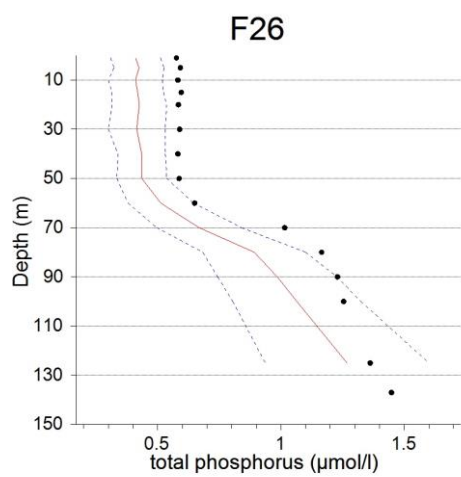
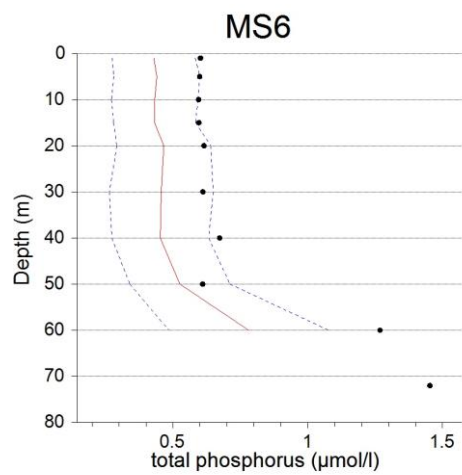
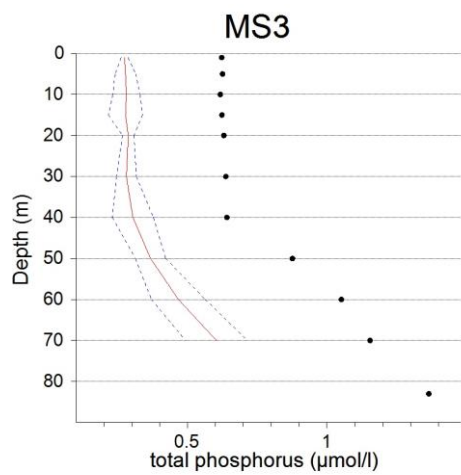
IU3

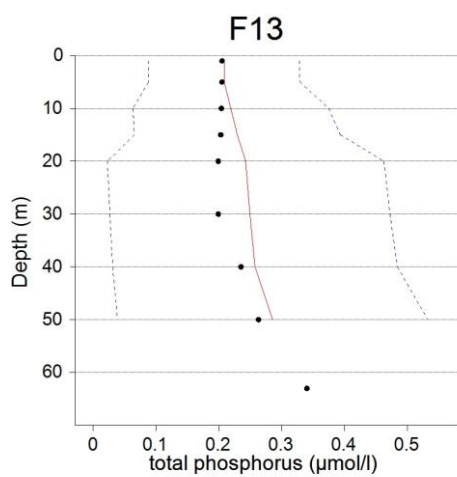
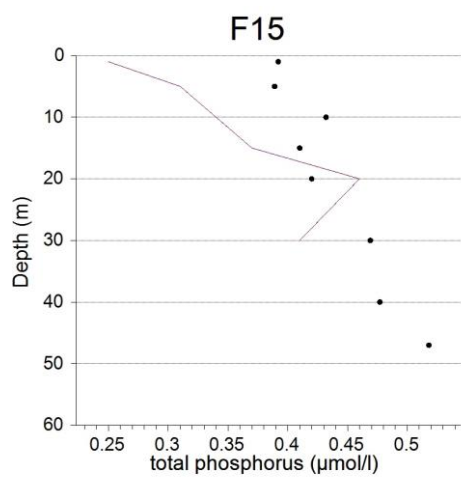
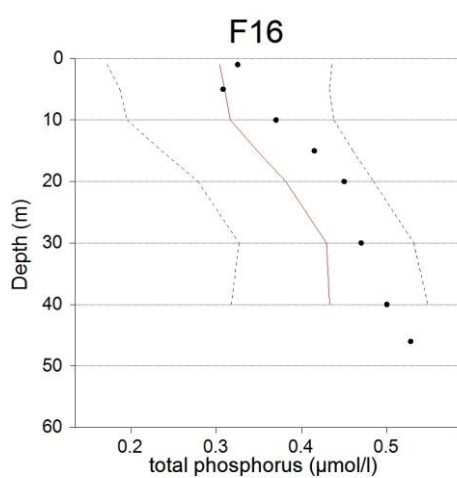
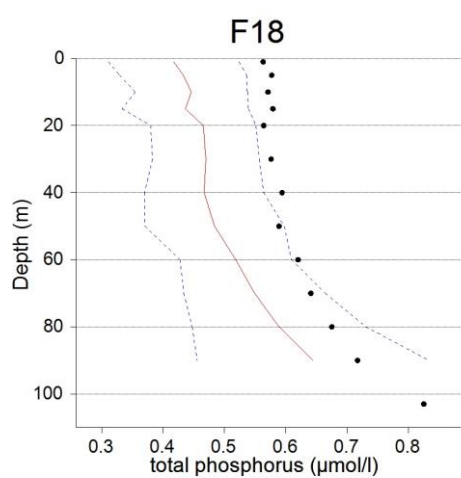
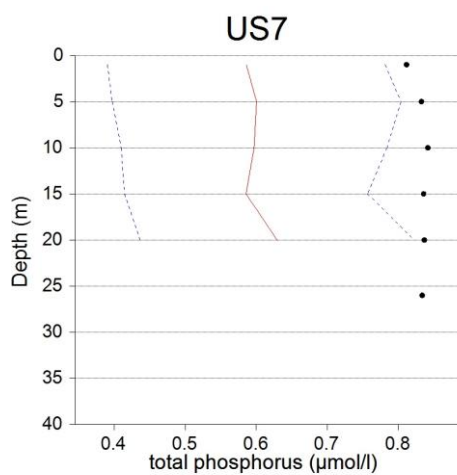
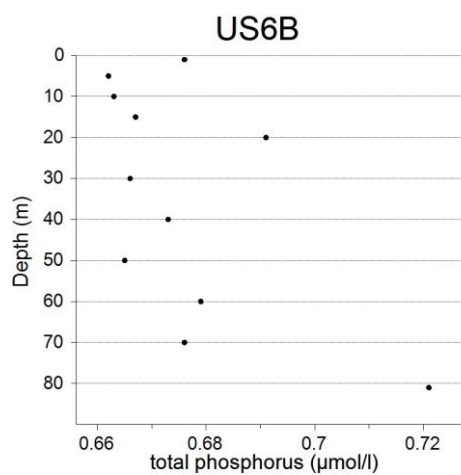


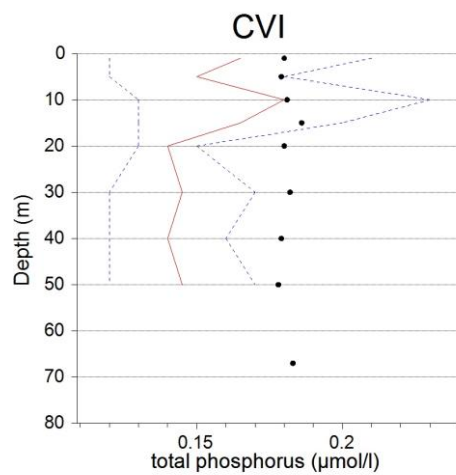
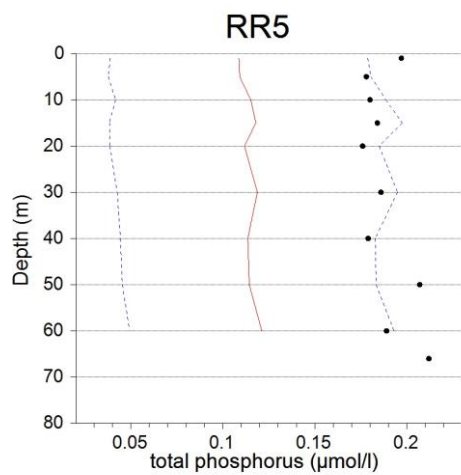
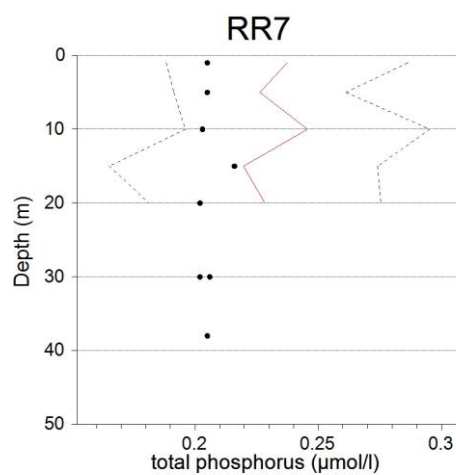
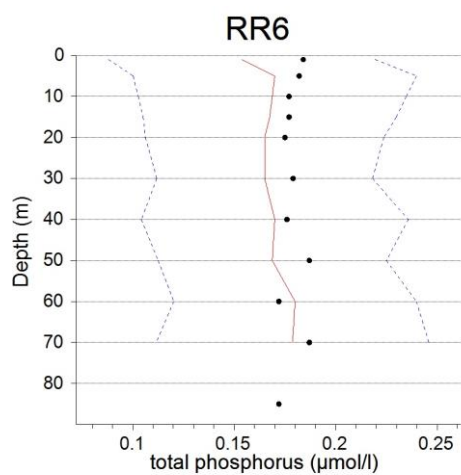
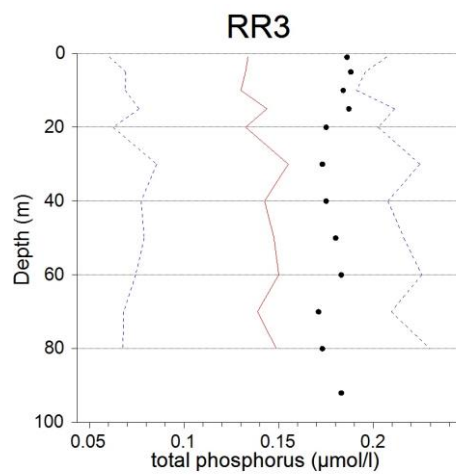
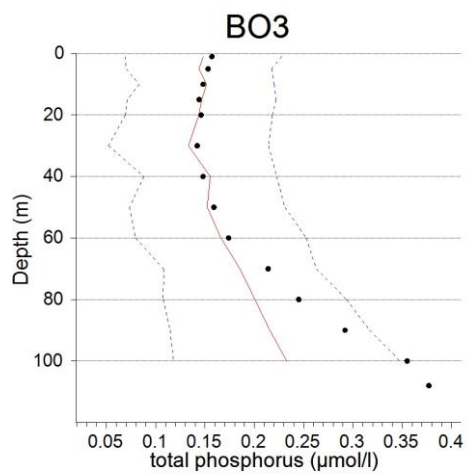
IU1

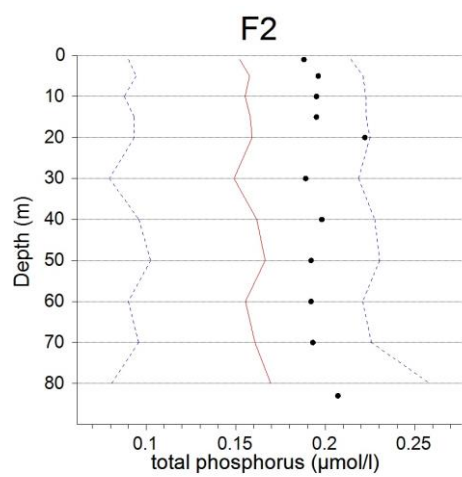
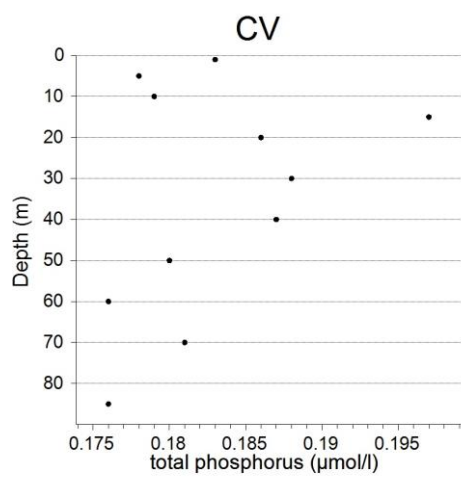












Annex 2. List of sampled stations of the cruise

INDEX	STATION	latitude	longitude	depth	DATE	time	ctd	pH	ox	nu	ph	zo	be	chl	oil	tox	secchi
HELSINKI	HELSINKI	60.16172	24.90170		2020-01-21	07:53											
2020010001	39A	60.06683	24.98030	43	2020-01-21	09:32	x	x	x	x							
2020010002	XIV3	60.20315	26.19285	78	2020-01-21	15:08	x	x	x	x							
2020010003	XV1	60.25003	27.24710	65	2020-01-21	20:03	x	x	x	x					x		
2020010004	LL3A	60.06712	26.34688	67	2020-01-22	01:28	x	x	x	x							
2020010005	GF2	59.83850	25.85675	85	2020-01-22	05:19	x	x	x	x							
2020010006	LL5	59.91680	25.59702	71	2020-01-22	07:42	x	x	x	x							
2020010007	LL6A	59.91685	25.03017	73	2020-01-22	11:36	x	x	x	x							
2020010008	LL7	59.84648	24.83782	102	2020-01-22	14:03	x	x	x	x					x		
2020010009	GF1	59.70503	24.68207	83	2020-01-22	16:40	x	x	x	x							
2020010010	LL9	59.70015	24.03018	66	2020-01-22	21:47	x	x	x	x							
2020010011	XII3	59.86685	23.98022	24	2020-01-23	01:09	x	x	x	x							
2020010012	JML	59.58182	23.62683	81	2020-01-23	04:41	x	x	x	x							
2020010013	JML LAATU	59.58183	23.62685	81	2020-01-23	06:26	x	x	x	x							
2020010014	JONTKA	59.53127	23.48978	121	2020-01-23	13:23	x	x	x	x							
2020010015	JONTKA LAATU	59.53128	23.48980	121	2020-01-23	15:00	x										
2020010016	F62	59.33355	23.26357	96	2020-01-23	18:44	x	x	x	x							
2020010017	LL12	59.48355	22.89683	82	2020-01-23	23:15	x	x	x	x					x		
2020010018	LÄNGDEN	59.77682	23.26283	58	2020-01-24	04:56	x	x	x	x							
HANKO	HANKO	59.81017	22.90308		2020-01-24	08:06											
HANKO	HANKO	59.80572	22.94393		2020-01-27	10:24											
2020010019	LL15	59.18327	21.74690	131	2020-01-27	16:52	x	x	x	x							
2020010020	LL15 LAATU	59.18327	21.74690	131	2020-01-27	18:01											
2020010021	LL17	59.03323	21.07943	171	2020-01-27	21:56	x		x	x							
2020010022	LL19	58.88067	20.31082	165	2020-01-28	02:14	x	x	x	x							
2020010023	AALTO PI	59.24972	20.99673	100	2020-01-28	08:34	x										
2020010024	F69	59.78330	19.93008	191	2020-01-28	15:47	x	x	x	x							
2020010025	IU7	59.81520	21.33662	91	2020-01-28	22:48	x	x	x	x							
2020010026	IU5	60.05822	21.19827	90	2020-01-29	01:49	x	x	x	x							
2020010027	IU3	60.33332	21.11328	50	2020-01-29	05:47	x	x	x	x							
2020010028	IU1	60.76683	20.84675	34	2020-01-29	09:30	x	x	x	x							x
2020010029	F33	60.53318	18.93742	134	2020-01-29	16:35	x	x	x	x							
2020010030	F64	60.18905	19.14253	287	2020-01-29	20:45	x	x	x	x					x		
2020010031	SR5	61.08330	19.57963	125	2020-01-30	04:52	x	x	x	x					x		x
2020010032	MS9	61.76688	20.53043	101	2020-01-30	13:02	x	x	x	x							x
2020010033	AALTO SM	61.79975	20.23365	108	2020-01-30	16:10	x										
2020010034	F26	61.98357	20.06322	138	2020-01-30	19:33	x	x	x	x							
2020010035	MS6	61.98370	19.16355	73	2020-01-30	23:35	x	x	x	x							
2020010036	US7	62.60022	20.82962	27	2020-01-31	06:43	x	x	x	x							
2020010037	US6B	62.60017	20.26288	82	2020-01-31	09:12	x	x	x	x							x
2020010038	US5B	62.58627	19.96872	222	2020-01-31	11:51	x	x	x	x					x		x
2020010039	F16	63.51688	21.06285	47	2020-01-31	20:18	x	x	x	x							
2020010040	F15	63.51683	21.51302	48	2020-01-31	22:33	x	x	x	x							
2020010041	BO3	64.30203	22.34322	109	2020-02-01	05:28	x	x	x	x					x		
2020010042	F9	64.70035	22.06295	120	2020-02-01	09:41	x	x	x	x							
2020010043	RR3	64.93377	22.34593	93	2020-02-01	13:14	x	x	x	x							
2020010044	F2	65.38360	23.46223	84	2020-02-01	18:57	x		x	x							
2020010045	CVI	65.23365	23.56300	68	2020-02-01	21:23	x		x	x							
2020010046	CV	65.00033	23.24618	86	2020-02-02	00:18	x	x	x	x							
2020010047	RR5	64.83368	23.16285	67	2020-02-02	02:34	x	x	x	x							
2020010048	RR6	64.80033	23.47948	86	2020-02-02	04:39	x	x	x	x							
OULU	OULU	65.00020	25.40275		2020-02-02	18:17											
2020010049	RR7	64.73368	23.81278	39	2020-02-05	00:26	x	x	x	x							
2020010050	F13	63.78353	21.47948	64	2020-02-05	09:34	x	x	x	x							x
2020010051	F18	63.31437	20.27272	104	2020-02-05	15:07	x	x	x	x							
2020010052	US3	62.75880	19.19568	176	2020-02-05	20:44	x	x	x	x							
2020010053	MS3	62.13447	18.16297	84	2020-02-06	02:54	x	x	x	x							
2020010054	SR3	61.18328	18.22992	72	2020-02-06	09:49	x	x	x	x							x
2020010055	SR7	61.08350	20.59650	77	2020-02-06	17:44	x	x	x	x							
2020010056	SR8	61.12643	20.92990	47	2020-02-06	19:48	x	x	x	x							
RAUMA	RAUMA	61.12353	21.45265		2020-02-07	06:12											

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