CRUISE REPORT

R/V Aranda

Cruise 05/2020

COMBINE3 leg 2

11.8.2020 – 14.8.2020

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

Objectives of the cruise

The objectives of the cruise were:

1) Based on the HELCOM Monitoring Programme of the Baltic Sea, to conduct summer monitoring in the Gulf of Finland. Measured parameters were water temperature, salinity, conductivity and oxygen / hydrogen sulfide, silicate and nutrient concentrations.

2) Phyto- and zooplankton sampling following the HELCOM monitoring programme;

3) Sampling of phycotoxins and oil for later analysis;

4) Sampling of benthic animals and sediment cores; and

5) Maintenance of automated recorders of Finnish Meterorological Institute (FMI).

Table 1. The scientific crew

Name	On board	Organization
Maiju Lehtiniemi (chief scientist)	**11-14.08.2020**	**SYKE**
Heidi Hällfors	**11-14.08.2020**	**SYKE**
Heini Jalli	**11-14.08.2020**	**FMI**
Tanja Kinnunen	**11-14.08.2020**	**SYKE**
Pekka Kosloff	**11-14.08.2020**	**FMI**
Ilkka Lastumäki	**11-14.08.2020**	**SYKE**
Okko Outinen	**11-14.08.2020**	**SYKE**
Sirpa Lehtinen	**11-14.08.2020**	**SYKE**
Jere Riikonen	**11-14.08.2020**	**SYKE**
Kirsi Rosendahl	**11-14.08.2020**	**SYKE**
Antti Räike	**11-14.08.2020**	**SYKE**
Petri Krook	**11-14.08.2020**	**Kuvaaja**
Vanessa Riki	**11-14.08.2020**	**Kuvaaja**

Cruise Route

The 2nd leg started from Hanko and headed to UUS-23, LL11 and F62. After the station F62, Aranda headed east to JML. LL9, XII3 and then in the middle of the Gulf, GF1, LL7, LL6A, LL5. The wave buoy outside Helsinki was lifted, cleaned and recorded data downloaded between the stations LL6a and LL5. After the station GF2 the stations LL3A and HAAPASAARI, which are located close to the Finnish coast, where sampled. The easternmost monitored station was XVI. The cruise turned west to the stations FEI-1, XVI3, FEI-2 and FEI-3. Once they were sampled, cruise turned towards Helsinki where it ended. Observations and results of the station 39A have been included in here, although it was already sampled during the 1st leg.

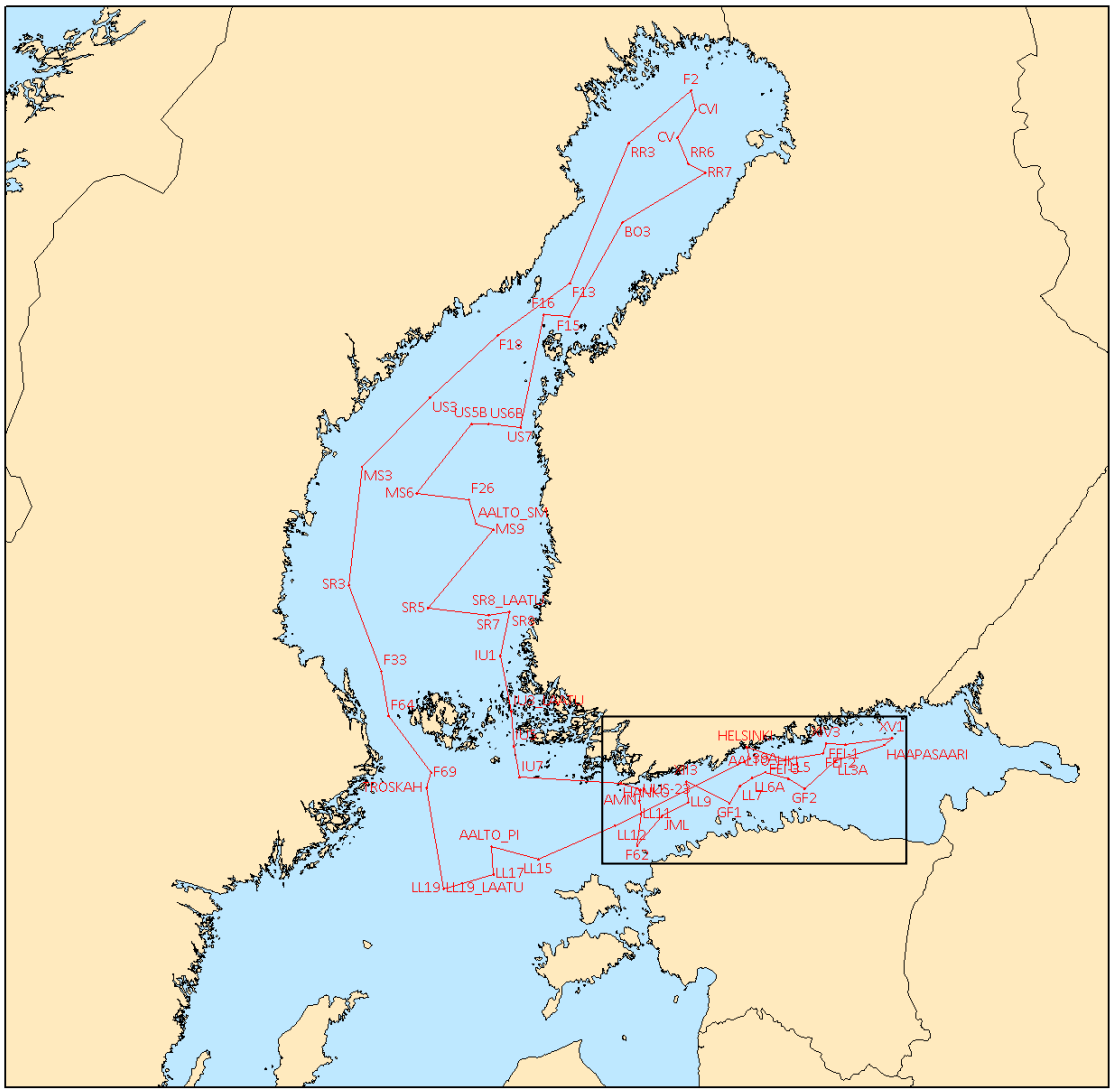


Figure 1. Cruise route of the 2nd leg of COMBINE 3 5/2020 (framed).

Sampling

Sampled stations have been listed in Table 2. CTD profiles were taken at every station and included the following parameters: temperature, salinity, oxygen and conductivity.

Sampled nutrients were: PO_4, NH_4-N, $NO_{2,3}$-N and NO_2-N), total nutrients (P_{tot}, N_{tot}) silicate were measured at depths, 1, 5, 10, 15, 2, 30, 40, 50, 60, 70, 80, 90 and 100 meters depending on the depth of a station. In addition, chlorophyll *a*, silicate and pH were also sampled.

Both phytoplankton and zooplankton samples, as well as, oil and phycotoxin samples were taken at certain stations (Table 2) for later analysis.

Benthic animals and sediment cores were sampled at 5 stations (HAAPASAARI, XV1, FEI-1, FEI-2, FEI-3). The stations have earlier been included in the annual coastal monitoring cruise of SYKE.

Table 2. List of stations

INDEX	STATION	latitude	longitude	depth	DATE	time	ctd	pH	ox	nu	ph	zo	be	chl	oil	tox	secchi
HANKO	HANKO	59.81683	22.94683		2020-08-11	15:51											
2020010162	UUS-23	59.77695	23.26287	57	2020-08-11	16:39	x	x	x	x	x	x		x			x
2020010163	AMN	59.69043	23.25687	55	2020-08-11	18:40	x	x	x	x				x			
2020010164	LL11	59.58352	23.29667	67	2020-08-11	20:52	x	x	x	x				x			
2020010165	F62	59.33350	23.26350	97	2020-08-11	23:27	x	x	x	x				x			
2020010166	JML	59.58183	23.62685	80	2020-08-12	02:32	x	x	x	x				x			x
2020010167	LL9	59.70025	24.03035	66	2020-08-12	05:05	x	x	x	x	x	x		x			
2020010168	XII3	59.86423	23.98573	36	2020-08-12	07:56	x	x	x	x				x			x
2020010169	GF1	59.70498	24.68205	84	2020-08-12	11:27	x	x	x	x	x	x		x			x
2020010170	LL7	59.84658	24.83790	101	2020-08-12	14:35	x	x	x	x	x	x		x	x	x	x
2020010171	LL6A	59.91692	25.03042	73	2020-08-12	17:43	x	x	x	x				x			x
2020010172	AALTO_HKI	59.96473	25.23493	67	2020-08-12	20:24	x										
2020010173	LL5	59.91683	25.59717	69	2020-08-12	22:20	x	x	x	x				x			
2020010174	GF2	59.83847	25.85678	84	2020-08-13	00:34	x	x	x	x				x			
2020010175	LL3A	60.06717	26.34663	69	2020-08-13	03:48	x	x	x	x	x	x		x	x	x	x
2020010176	HAAPASAARI	60.19322	27.11573	62	2020-08-13	10:39	x	x	x	x			x	x			x
2020010177	XV1	60.24997	27.24697	66	2020-08-13	12:57	x	x	x	x	x	x	x	x		x	x
2020010178	FEI-1	60.19365	26.49772	49	2020-08-13	18:03	x	x	x	x			x	x			x
2020010179	XIV3	60.20322	26.19257	79	2020-08-13	20:26	x	x	x	x				x			
2020010180	FEI-2	60.12390	26.14332	37	2020-08-13	22:18	x		x	x			x	x			
2020010181	FEI-3	60.06733	25.54390	53	2020-08-14	02:37	x	x	x	x			x	x			x
HELSINKI	HELSINKI	60.15910	24.92750		2020-08-14	07:04											

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

Conclusions

Hydrography

Clear summer thermocline was observed mainly in 20-30 meters, some mixing had occurred in shallow stations. Most of the stations were oxic even close to the bottom. Only at some stations, GF1, GF2, JML and LL7 oxygen concentrations near the bottom were low and oxygen depletion and H_2S was observed only at one station, F62. The station is in the southwestern part of the Gulf of Finland (Figure 1).

Nutrients and silicate

Observations of dissolved and total nutrients and silicate (as dots) including average summer concentrations (red line) and standard deviations (cut lines) by each have been compiled in Annex 1.

Phosphate concentrations in the mid-water column were higher than summer averages of 2000-2017 at stations of LL transect but at average concentrations or lower close to the bottom.

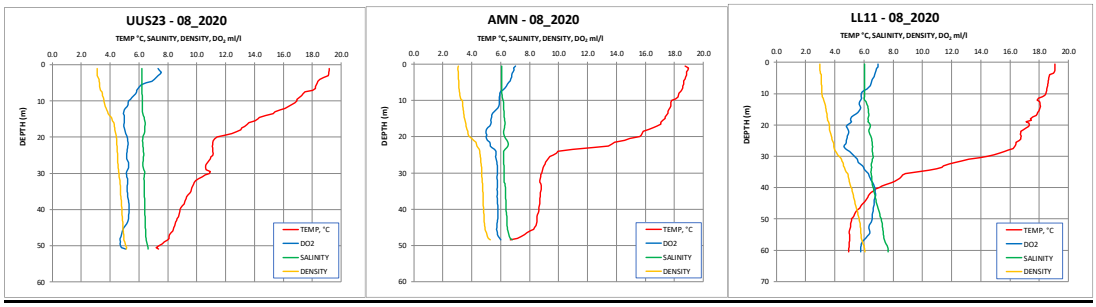
Ammonium and nitrate-nitrite concentrations were high compared with the average summer concentrations. Observed nitrite concentrations were close to the LOD.

Observed P_{tot} and N_{tot} concentrations were higher than in average, indicating some mixing or upwelling. In January 2020 the entire water column was mixed down to the bottom.

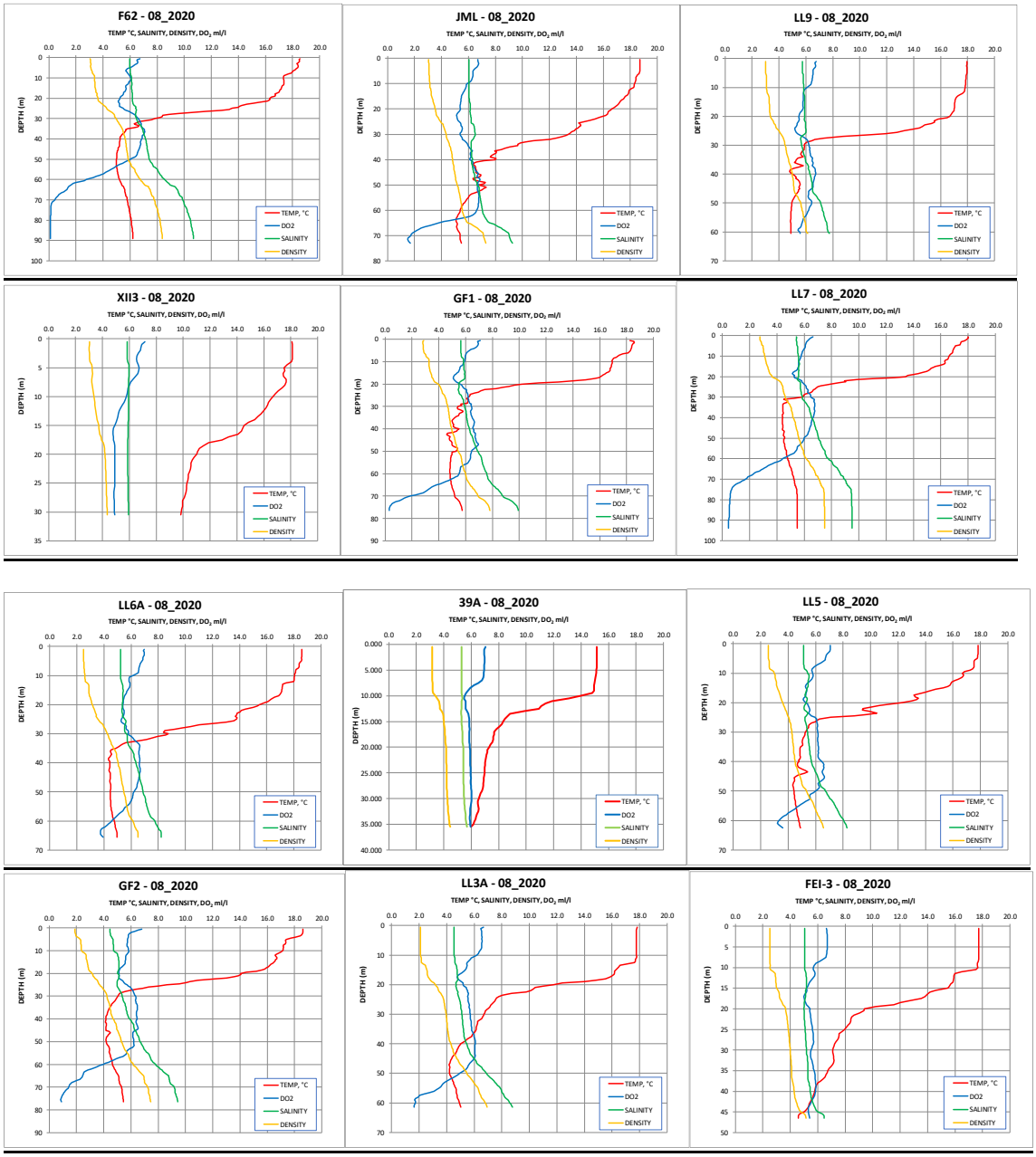
Silicate concentrations were also higher than in average.

Observations

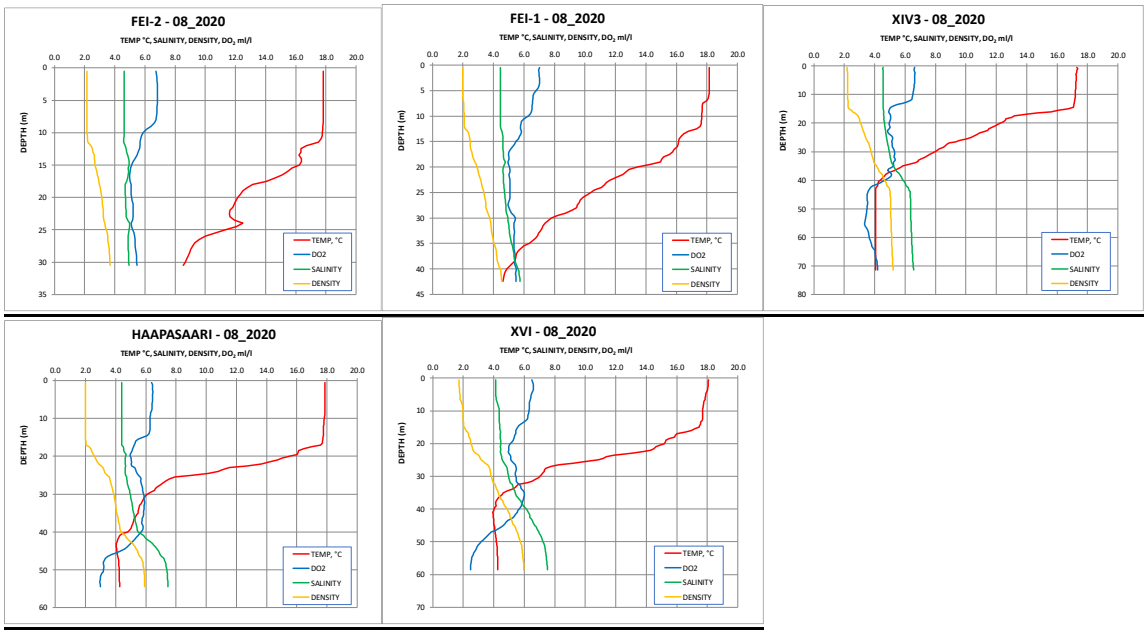
Hydrography



Figures 2-4. CTD profiles in the western part of the Gulf of Finland UUS-23, AMN and LL11.

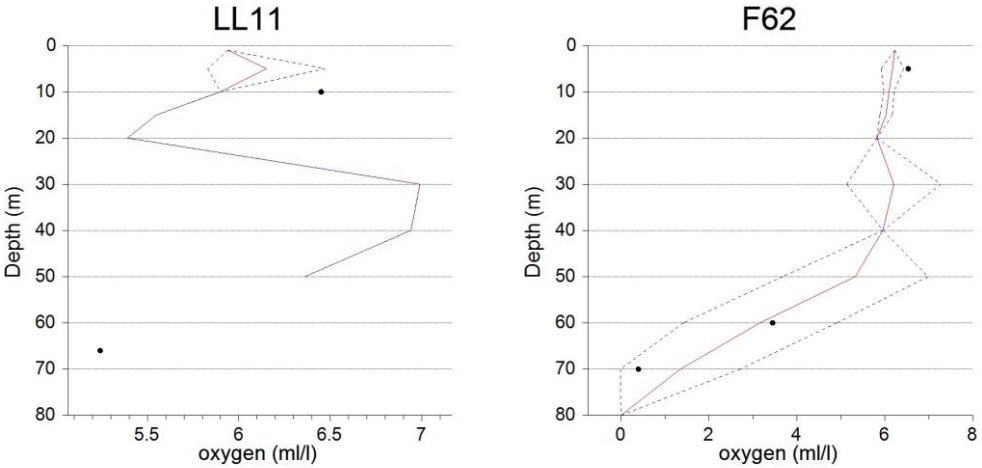


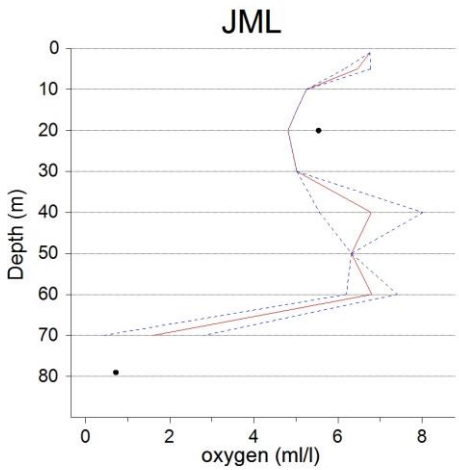
Figures 5-15. CTD profiles of F62, JML, LL9, XII3, GF1, LL7, LL6A, 39A, LL5, GF2, LL3A and FEI3. The station 39A was monitored during the 1st leg of the Cruise on 3rd of August.

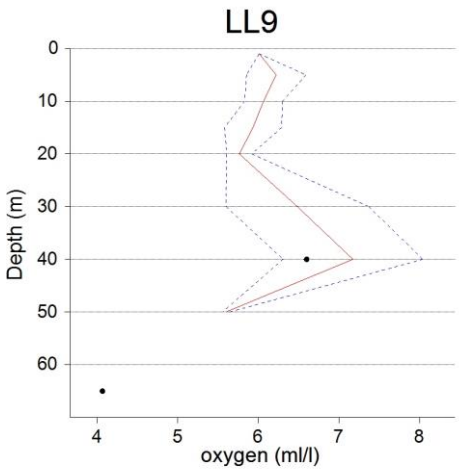


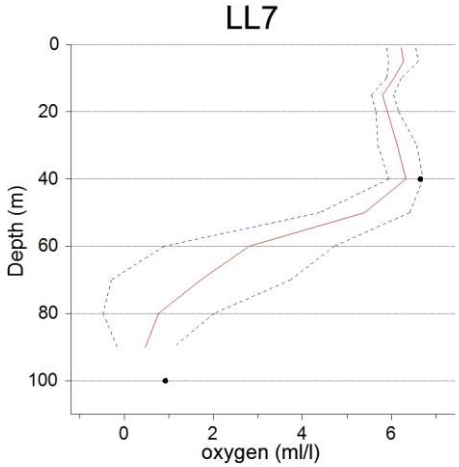
Figures 16-20. CTD profiles of FEI-2, FEI1, XIV3, HAAPASAARI and XVI.

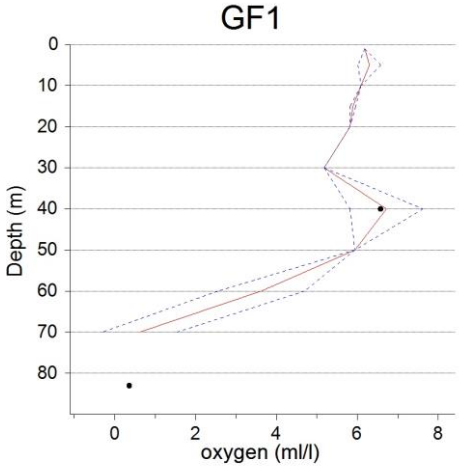
Annex 1. Selected variables at the stations UUS-23, AMN, LL11, F62, JML, LL9, XII3, GF1, LL7, LL6A, 39A, LL5, FEI-3, GF2, FEI-2, XIV3, LL3A, FEI-1 and HAAPASAARI. Mean (red solid line) and standard deviation (blue dotted lines) represent the data collected at the same time of season since the year 2000.

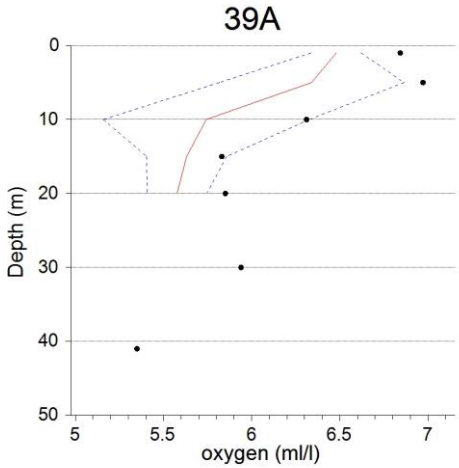


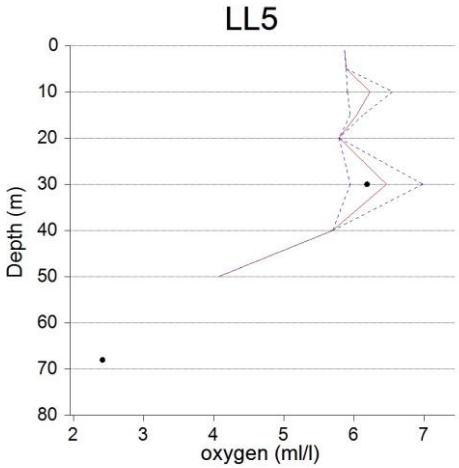

JML
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
8
oxygen (ml/l)

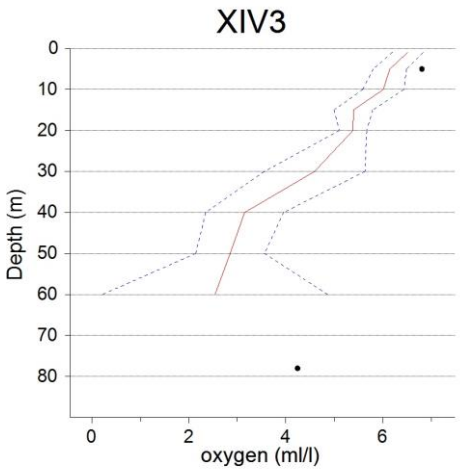

LL9
Depth (m)
0
10
20
30
40
50
60
4
5
6
7
8
oxygen (ml/l)

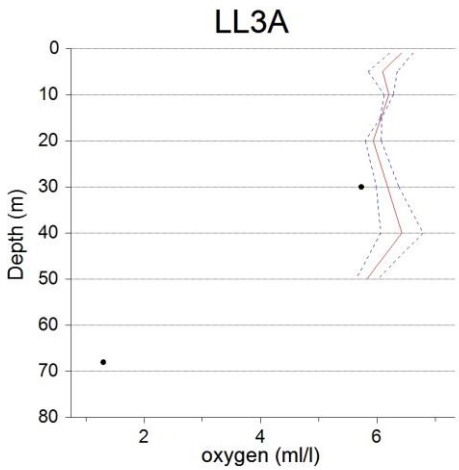

LL7
Depth (m)
0
20
40
60
80
100
0
2
4
6
oxygen (ml/l)


GF1
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
8
oxygen (ml/l)

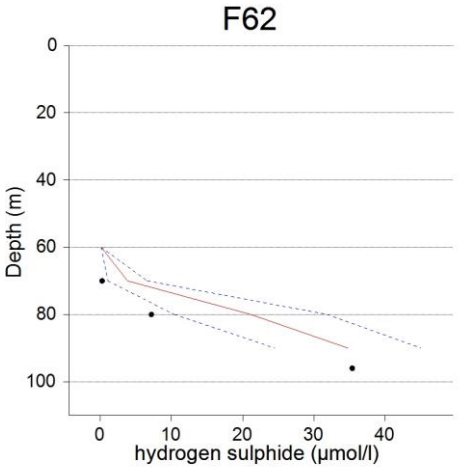

39A
Depth (m)
0
10
20
30
40
50
5
5.5
6
6.5
7
oxygen (ml/l)

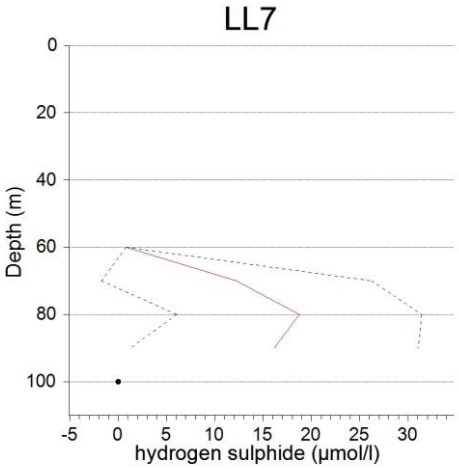

LL5
Depth (m)
0
10
20
30
40
50
60
70
80
2
3
4
5
6
7
oxygen (ml/l)



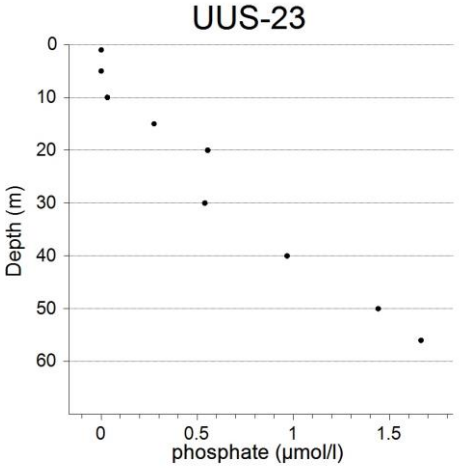


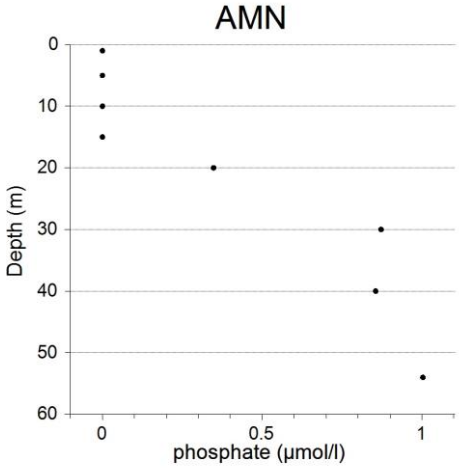
Hydrogen sulphide

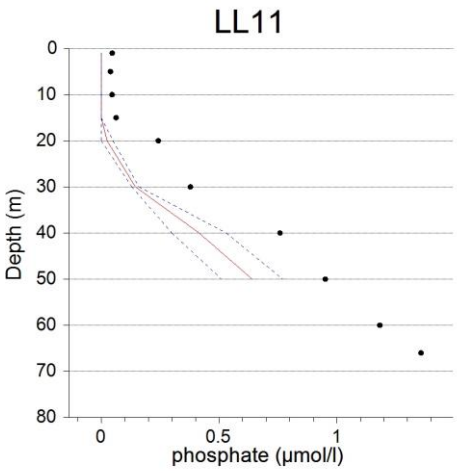


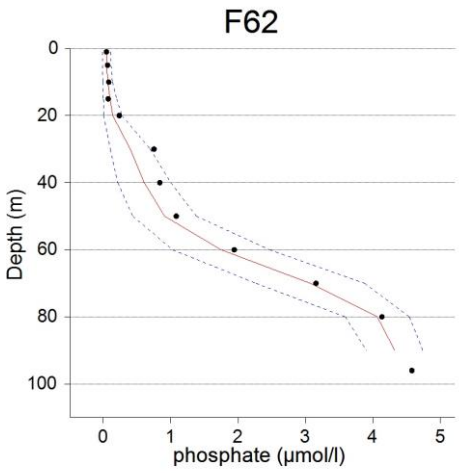


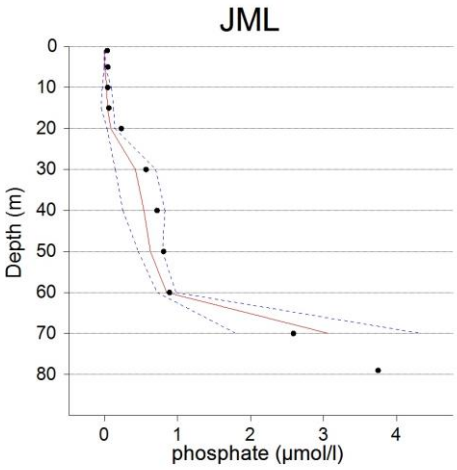
Phosphate

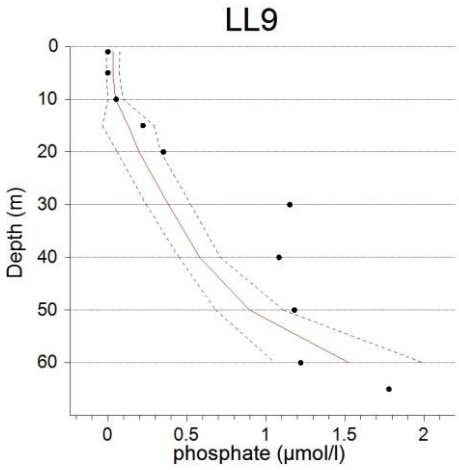


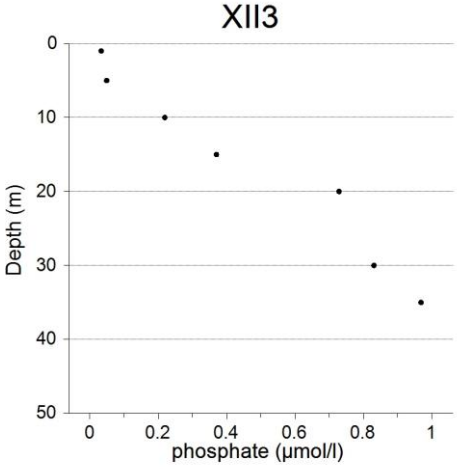


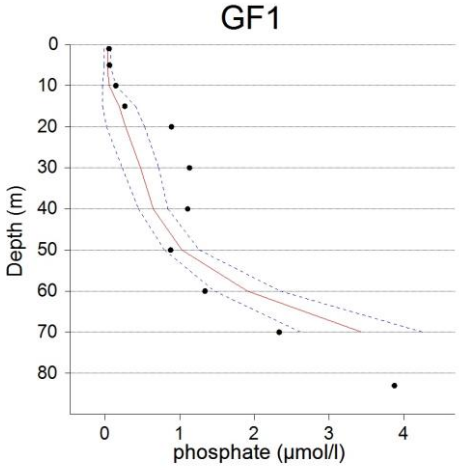

LL11
Depth (m)
phosphate (µmol/l)

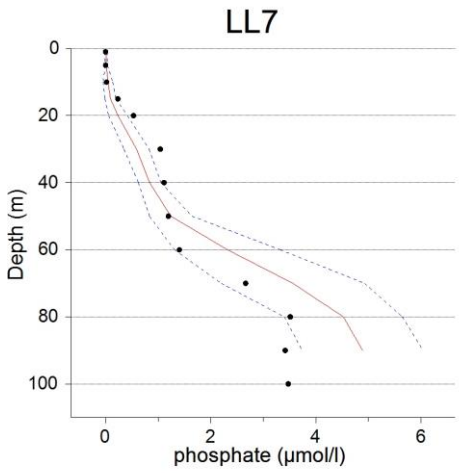

F62
Depth (m)
phosphate (µmol/l)

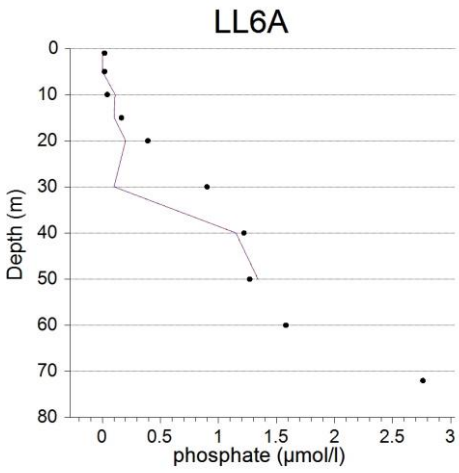

JML
Depth (m)
phosphate (µmol/l)

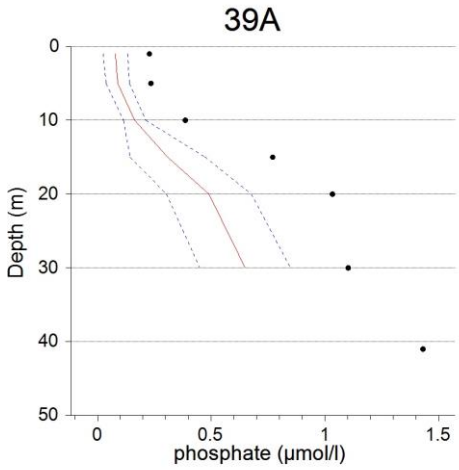

LL9
Depth (m)
phosphate (µmol/l)

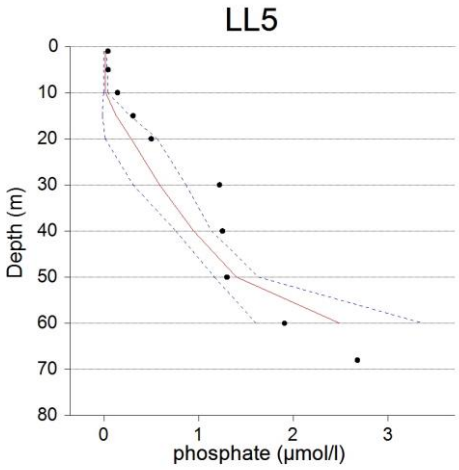

XII3
Depth (m)
phosphate (µmol/l)

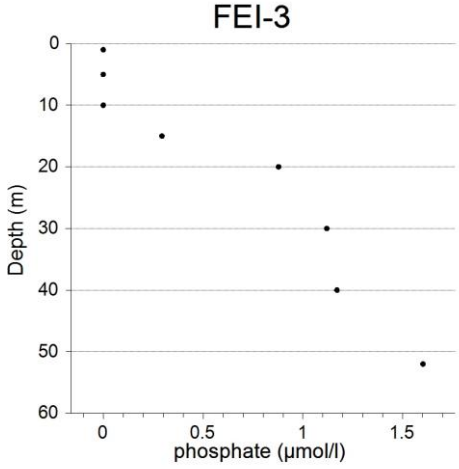

GF1
Depth (m)
phosphate (µmol/l)

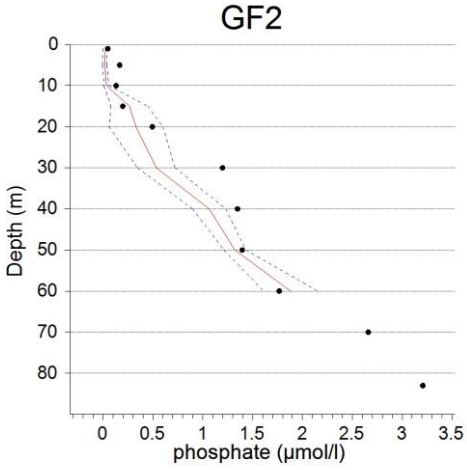

LL7
Depth (m)
phosphate (µmol/l)

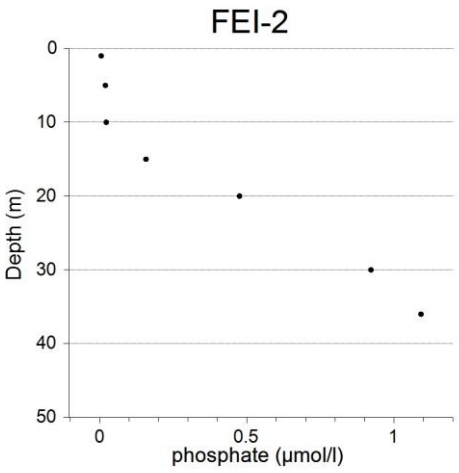

LL6A
Depth (m)
phosphate (µmol/l)

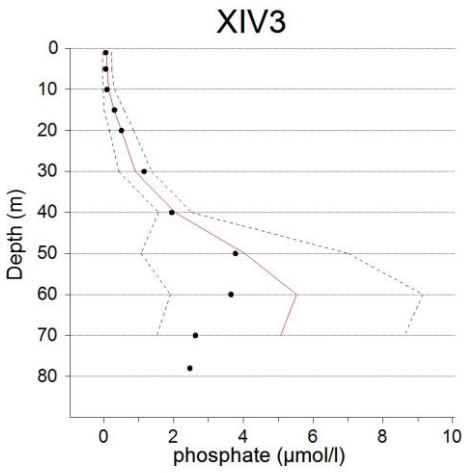

39A
Depth (m)
phosphate (µmol/l)

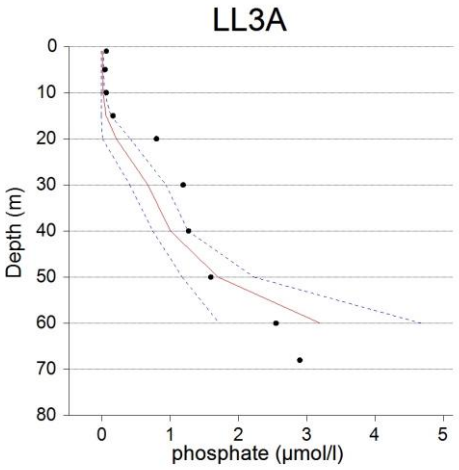

LL5
Depth (m)
phosphate (µmol/l)

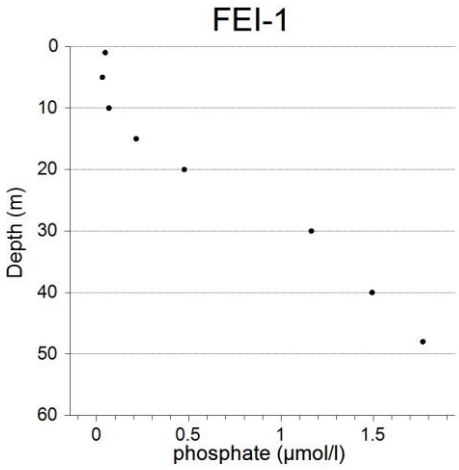

FEI-3
Depth (m)
phosphate (µmol/l)

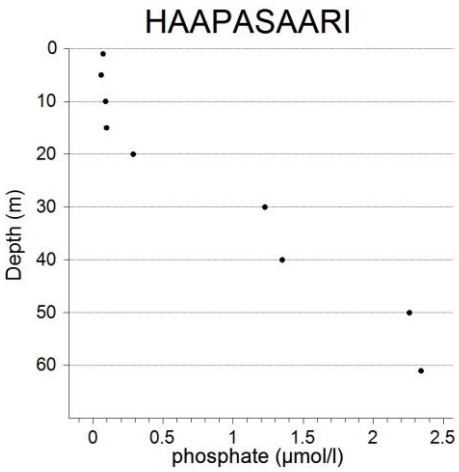

GF2
Depth (m)
phosphate (µmol/l)


FEI-2
Depth (m)
0
10
20
30
40
50
0
0.5
1
phosphate (µmol/l)

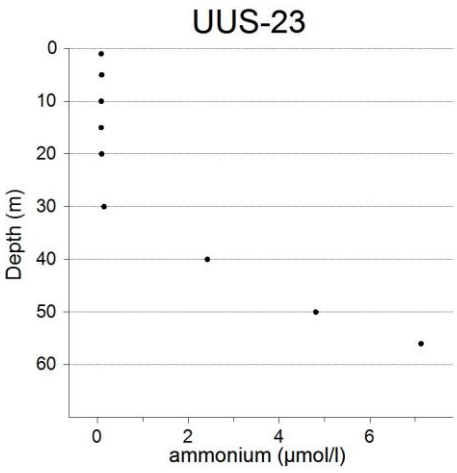

XIV3
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
8
10
phosphate (µmol/l)

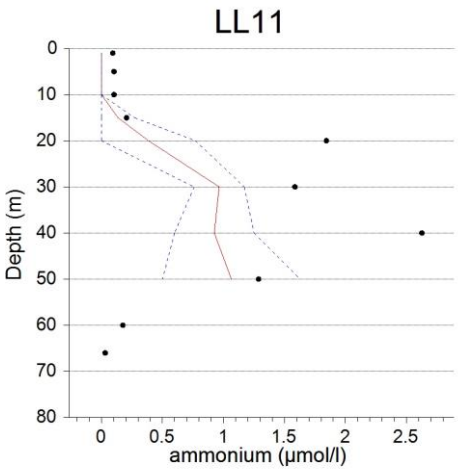

LL3A
Depth (m)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
phosphate (µmol/l)

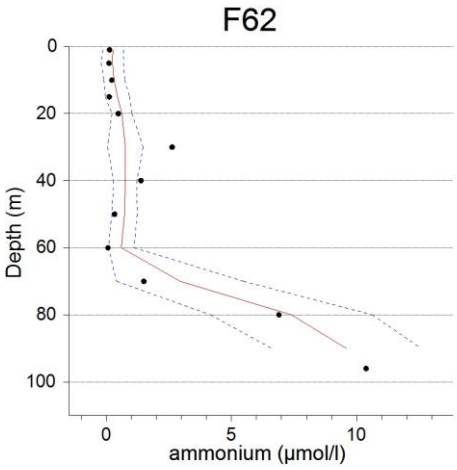

FEI-1
Depth (m)
0
10
20
30
40
50
60
0
0.5
1
1.5
phosphate (µmol/l)


HAAPASAARI
Depth (m)
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
phosphate (µmol/l)

Ammonium


UUS-23
Depth (m)
0
10
20
30
40
50
60
0
2
4
6
ammonium (µmol/l)


LL11
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
2.5
ammonium (µmol/l)


F62
Depth (m)
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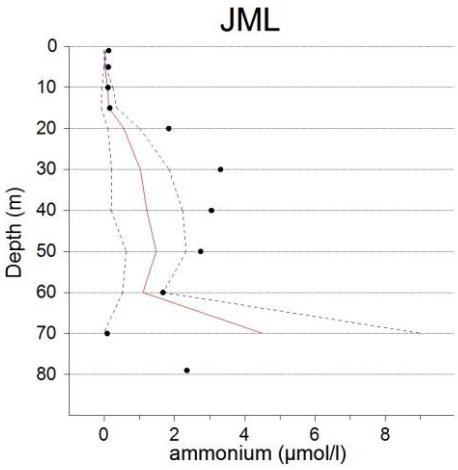
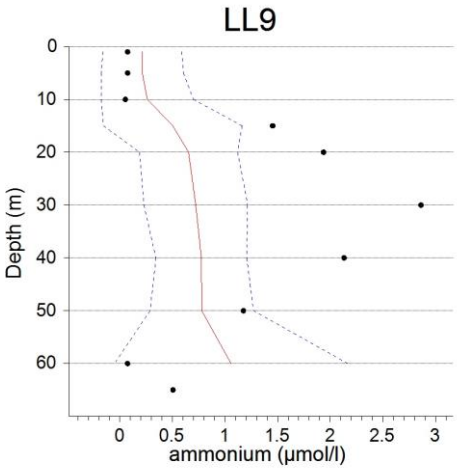
20
40
60
80
100
0
5
10
ammonium (µmol/l)


JML
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
8
ammonium (µmol/l)


LL9
Depth (m)
0
10
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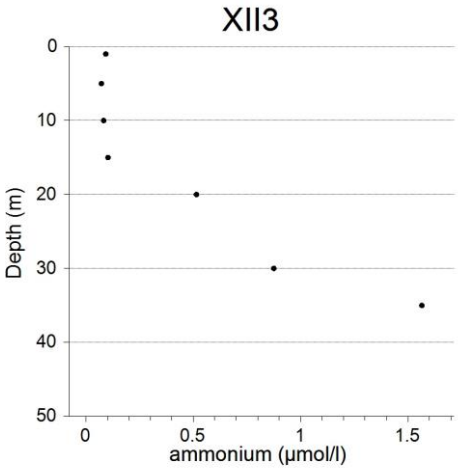
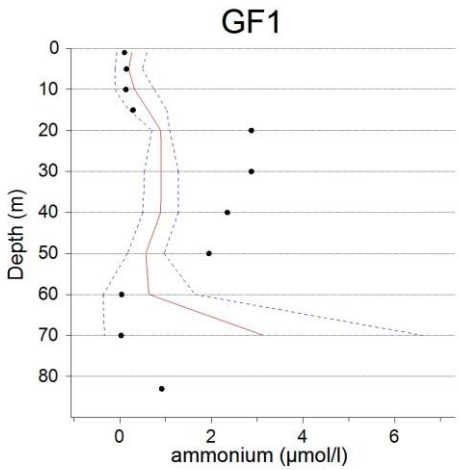
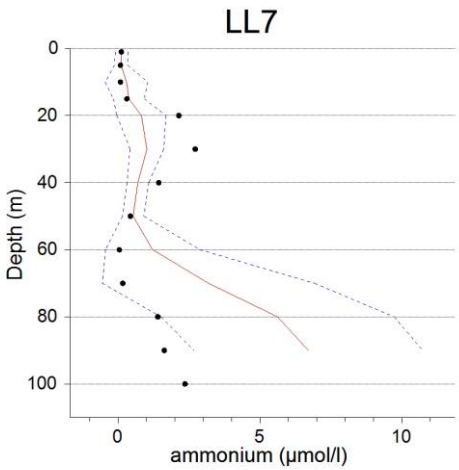
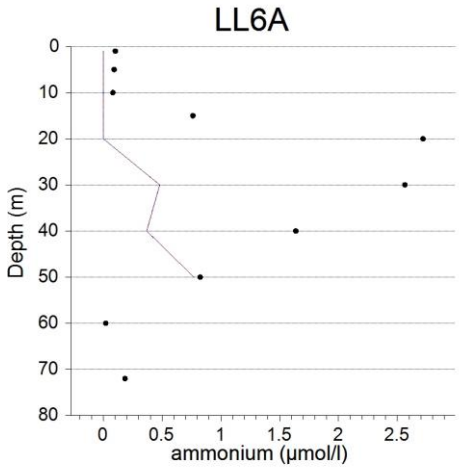
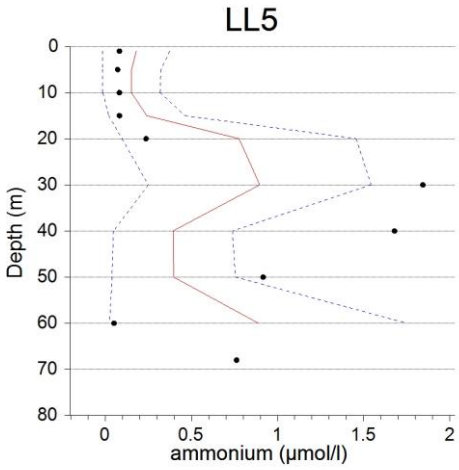
30
40
50
60
0
0.5
1
1.5
2
2.5
3
ammonium (µmol/l)

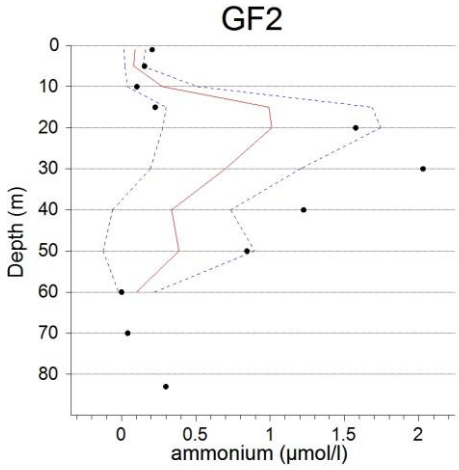

XII3
Depth (m)
0
10
20
30
40
50
0
0.5
1
1.5
ammonium (µmol/l)

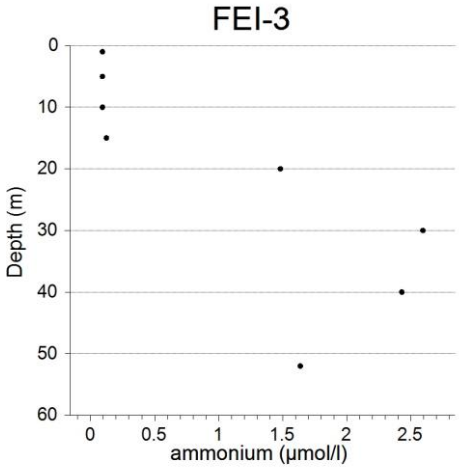

GF1
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
ammonium (µmol/l)

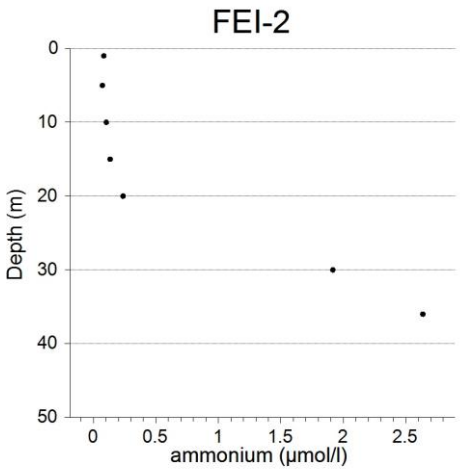

LL7
Depth (m)
0
20
40
60
80
100
0
5
10
ammonium (µmol/l)

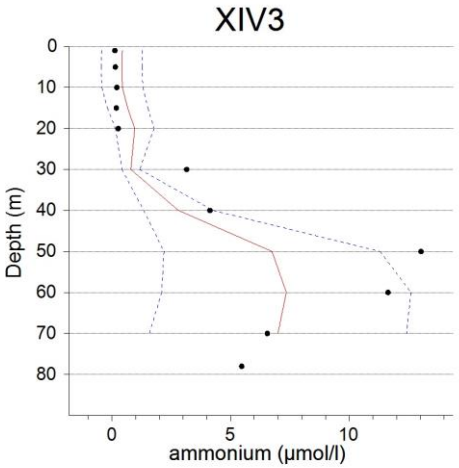

LL6A
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
2.5
ammonium (µmol/l)

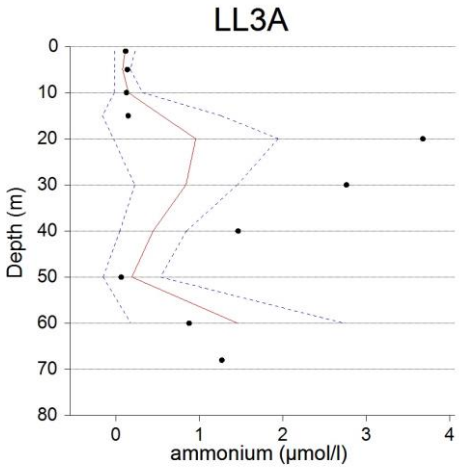

LL5
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
ammonium (µmol/l)

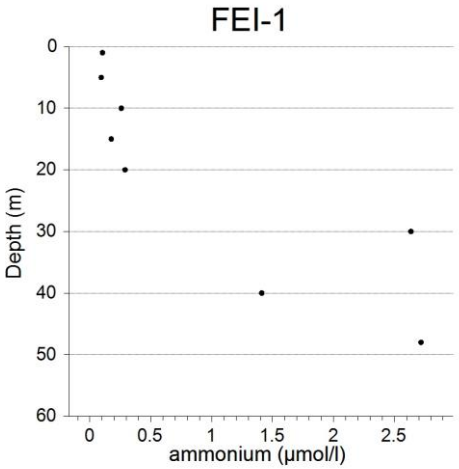

GF2
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
ammonium (µmol/l)

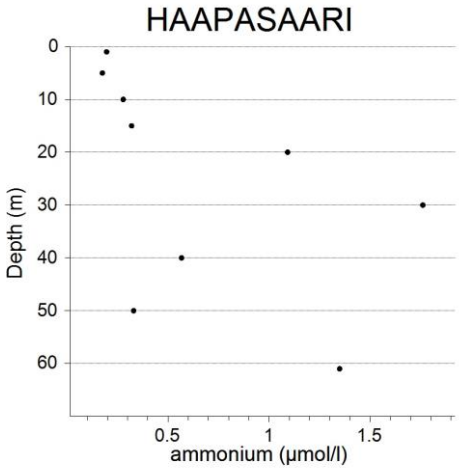

FEI-3
Depth (m)
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
ammonium (µmol/l)



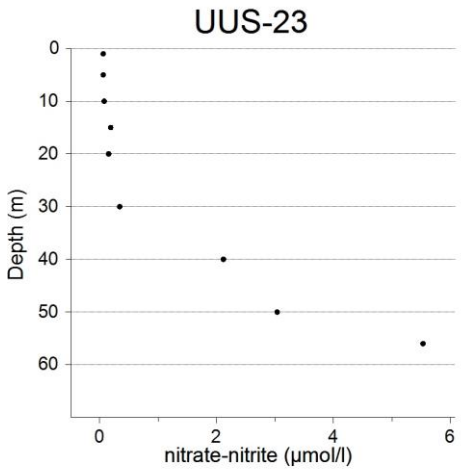


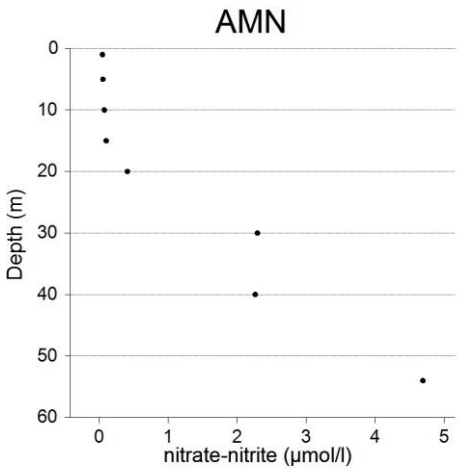


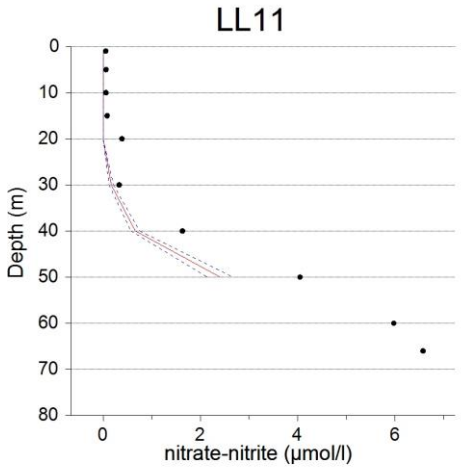


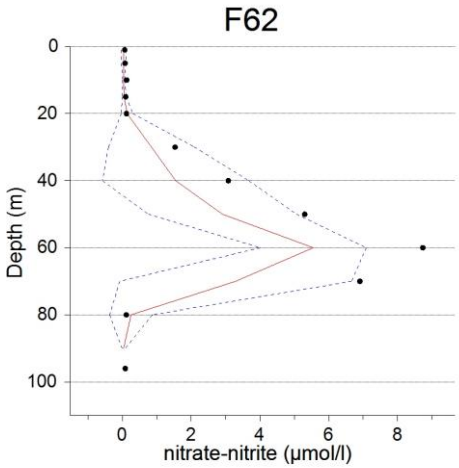


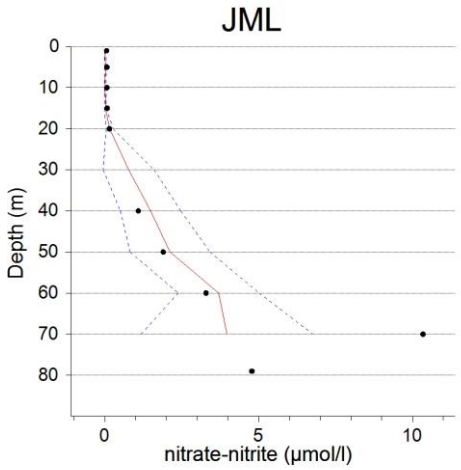
Nitrate-nitrite

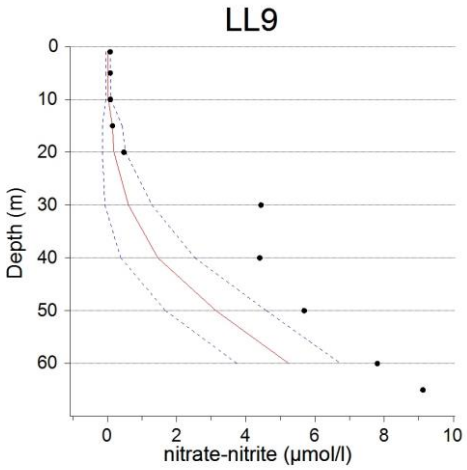

UUS-23
Depth (m)
0
10
20
30
40
50
60
0
2
4
6
nitrate-nitrite (µmol/l)

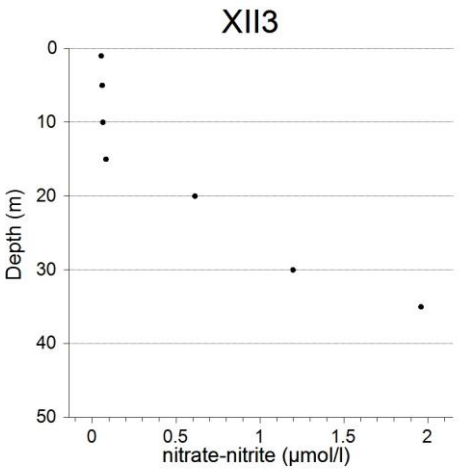

AMN
Depth (m)
0
10
20
30
40
50
60
0
1
2
3
4
5
nitrate-nitrite (µmol/l)

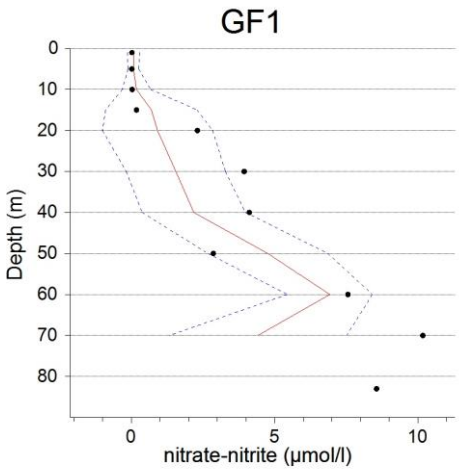

LL11
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
nitrate-nitrite (µmol/l)

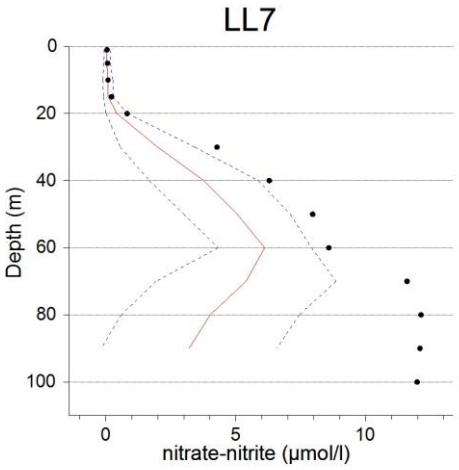

F62
Depth (m)
0
20
40
60
80
100
0
2
4
6
8
nitrate-nitrite (µmol/l)

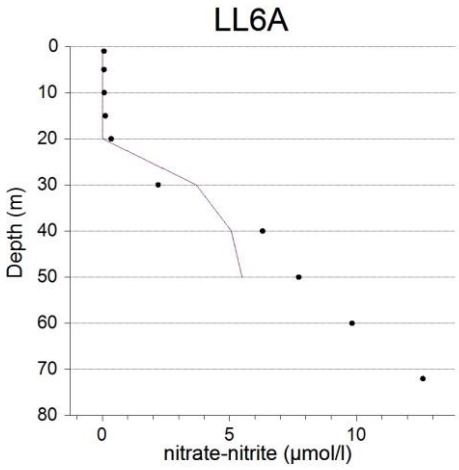

JML
Depth (m)
0
10
20
30
40
50
60
70
80
0
5
10
nitrate-nitrite (µmol/l)

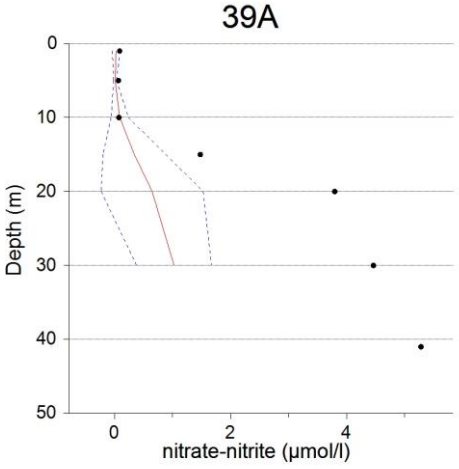

LL9
Depth (m)
0
10
20
30
40
50
60
0
2
4
6
8
10
nitrate-nitrite (µmol/l)

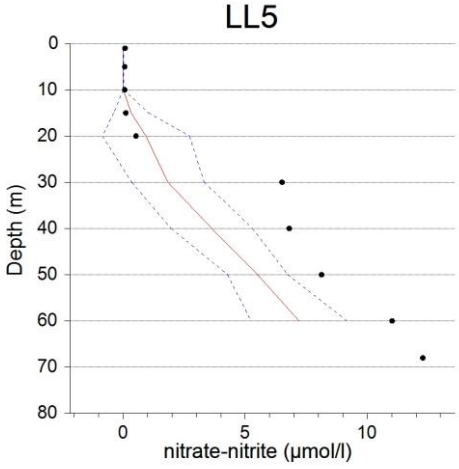

XII3
Depth (m)
nitrate-nitrite (µmol/l)

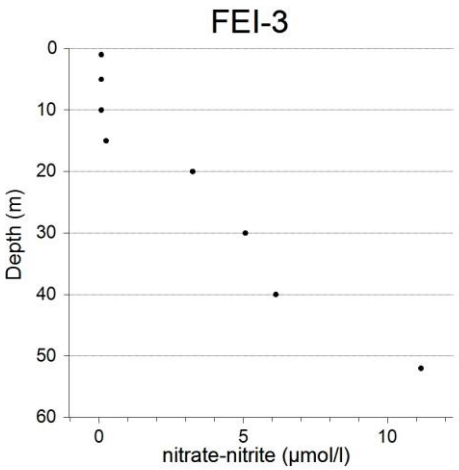

GF1
Depth (m)
nitrate-nitrite (µmol/l)

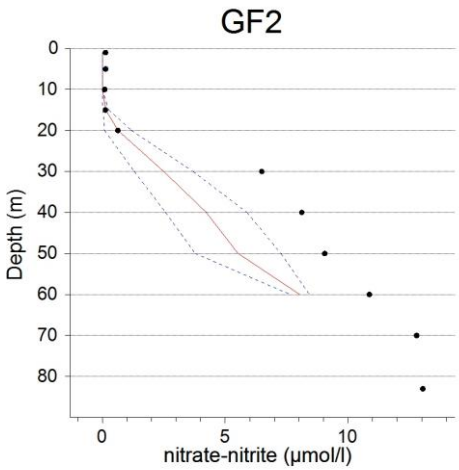

LL7
Depth (m)
nitrate-nitrite (µmol/l)

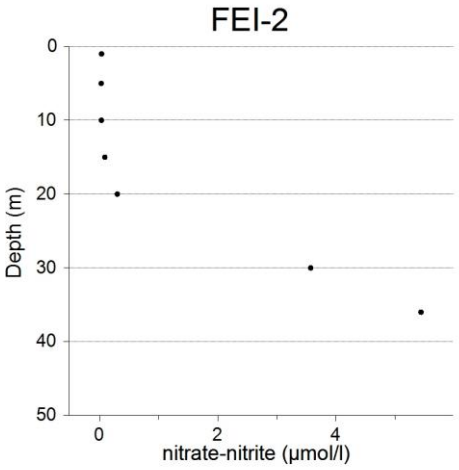

LL6A
Depth (m)
nitrate-nitrite (µmol/l)

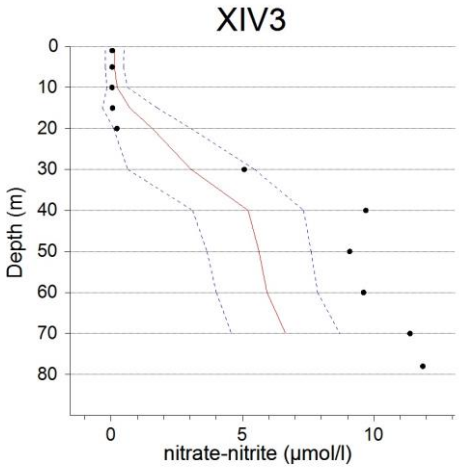

39A
Depth (m)
nitrate-nitrite (µmol/l)

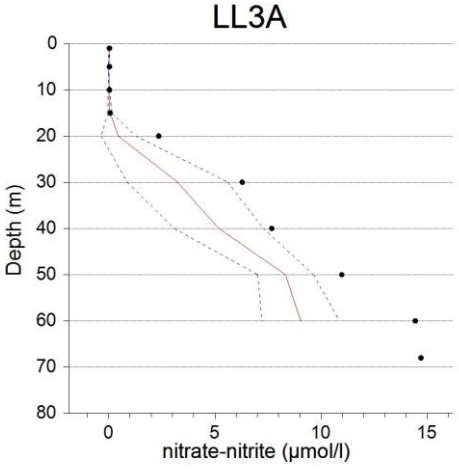

LL5
Depth (m)
nitrate-nitrite (µmol/l)

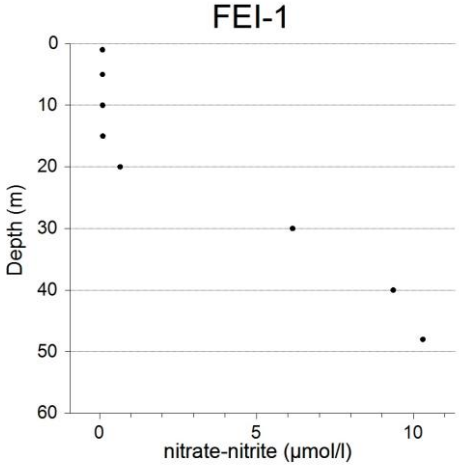

FEI-3
Depth (m)
nitrate-nitrite (µmol/l)

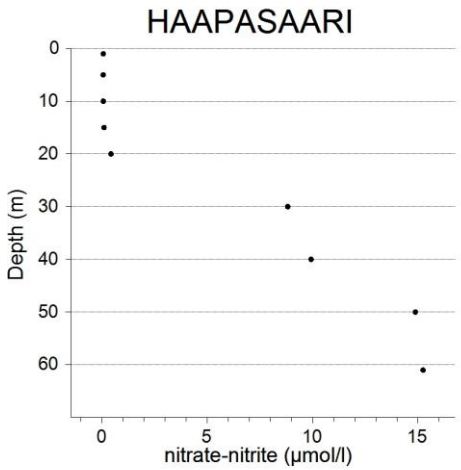

GF2
Depth (m)
nitrate-nitrite (µmol/l)


FEI-2
Depth (m)
nitrate-nitrite (µmol/l)

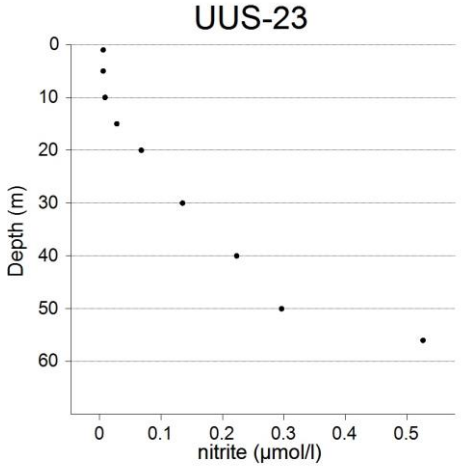

XIV3
Depth (m)
nitrate-nitrite (µmol/l)


LL3A
Depth (m)
nitrate-nitrite (µmol/l)


FEI-1
Depth (m)
nitrate-nitrite (µmol/l)


HAAPASAARI
Depth (m)
0
10
20
30
40
50
60
0
5
10
15
nitrate-nitrite (µmol/l)

Nitrite


UUS-23
Depth (m)
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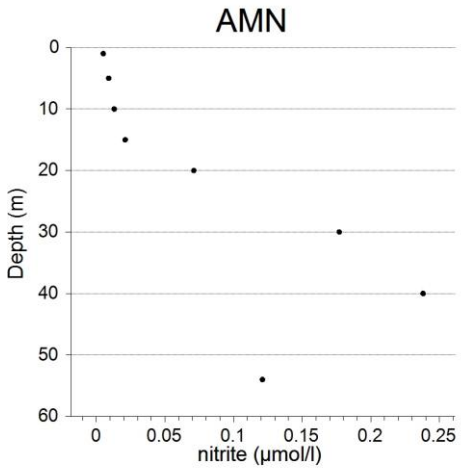
10
20
30
40
50
60
0
0.1
0.2
0.3
0.4
0.5
nitrite (µmol/l)


AMN
Depth (m)
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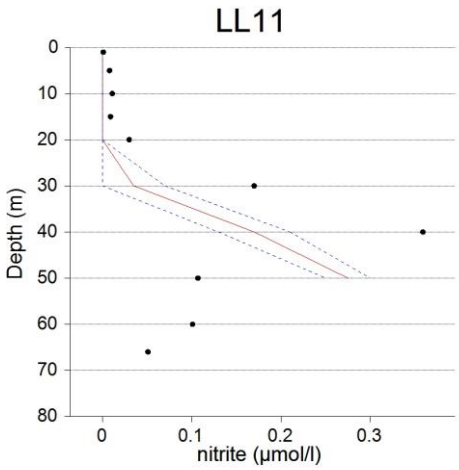
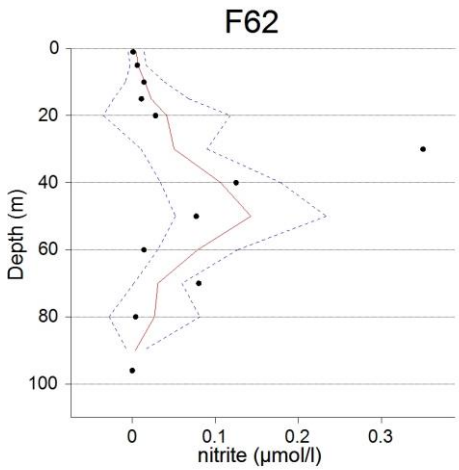
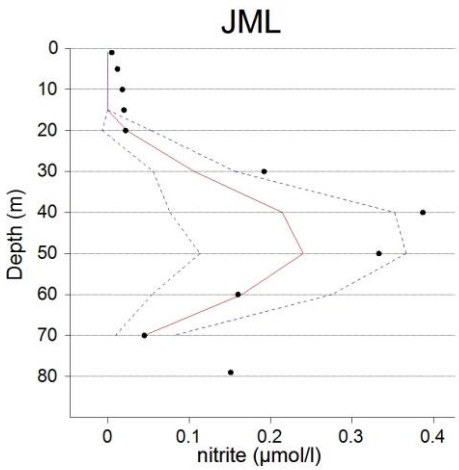
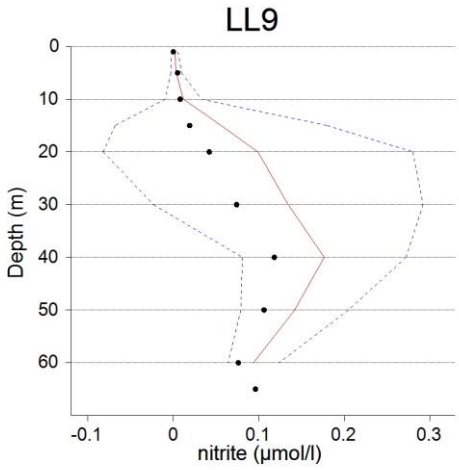
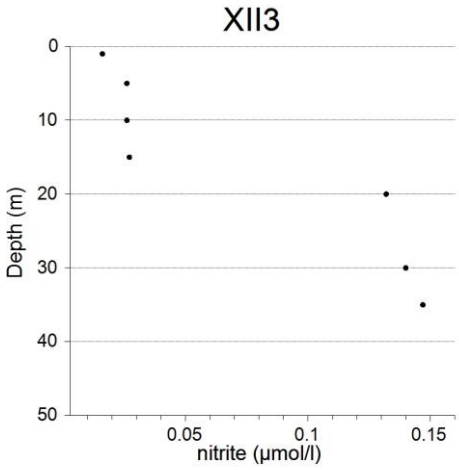
10
20
30
40
50
60
0
0.05
0.1
0.15
0.2
0.25
nitrite (µmol/l)

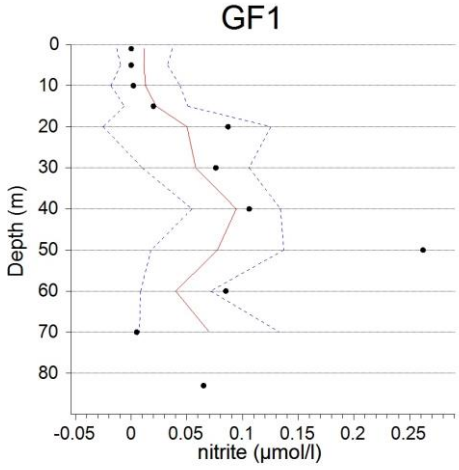

LL11
Depth (m)
0
10
20
30
40
50
60
70
80
0
0.1
0.2
0.3
nitrite (µmol/l)

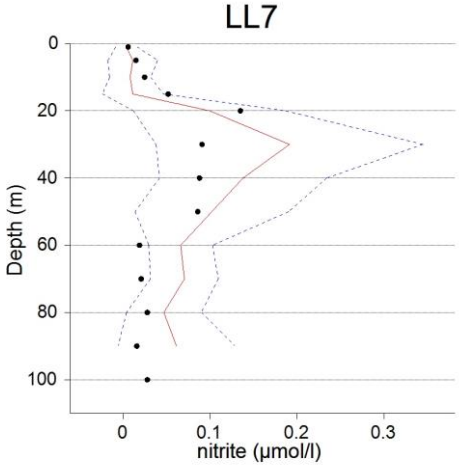

F62
Depth (m)
nitrite (µmol/l)

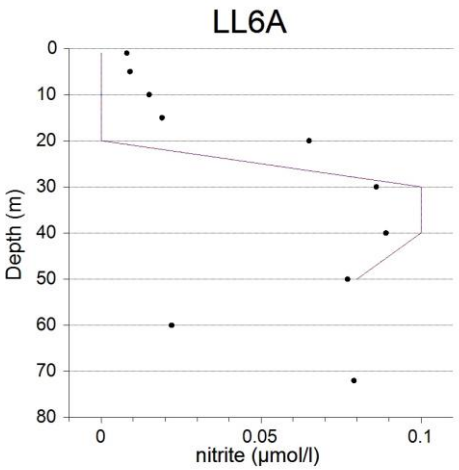

JML
Depth (m)
nitrite (µmol/l)

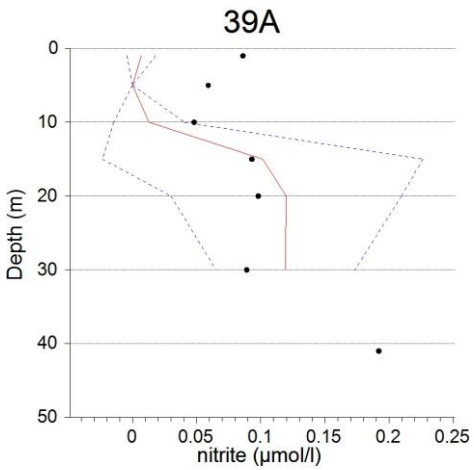

LL9
Depth (m)
nitrite (µmol/l)

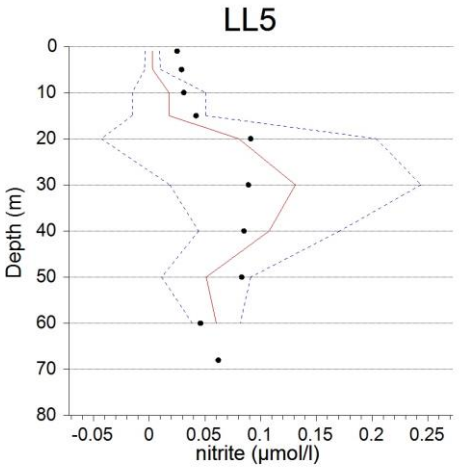

XII3
Depth (m)
nitrite (µmol/l)

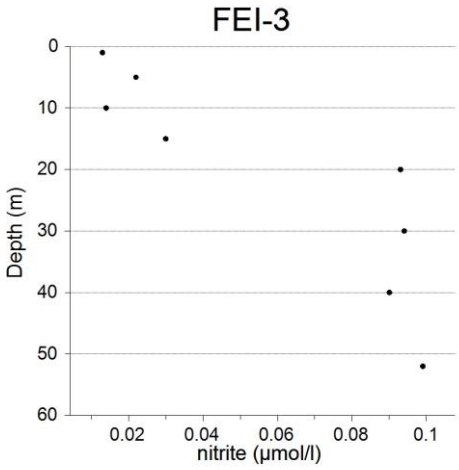

GF1
Depth (m)
nitrite (µmol/l)

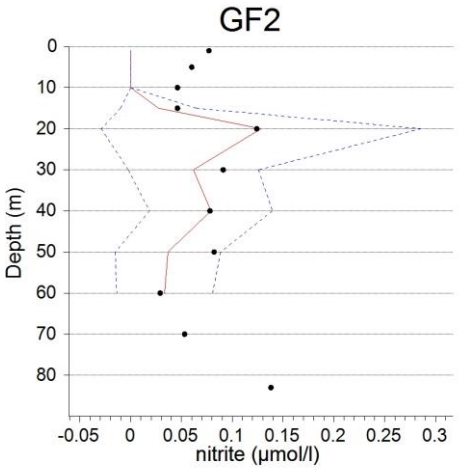

LL7
Depth (m)
nitrite (µmol/l)

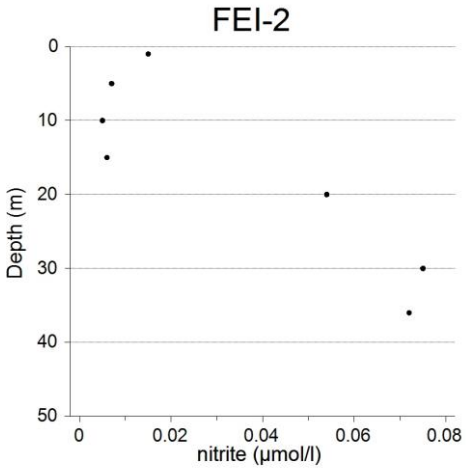

LL6A
Depth (m)
nitrite (µmol/l)

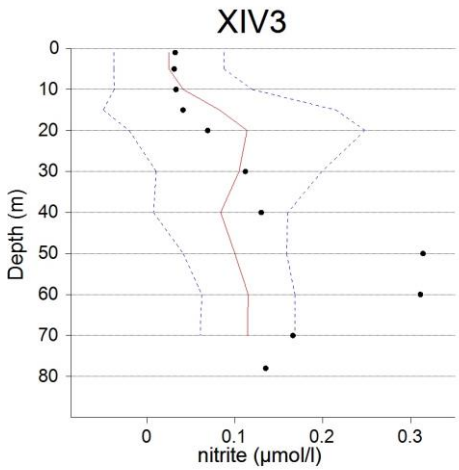

39A
Depth (m)
nitrite (µmol/l)

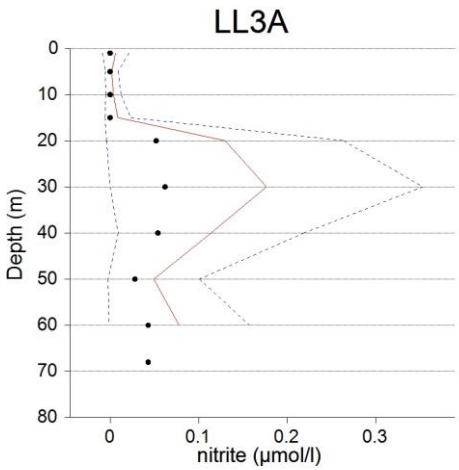

LL5
Depth (m)
nitrite (µmol/l)

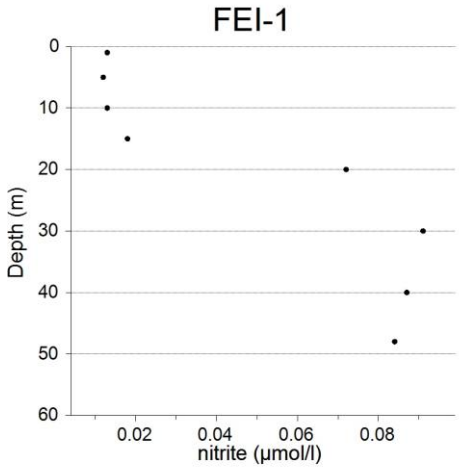

FEI-3
Depth (m)
nitrite (µmol/l)

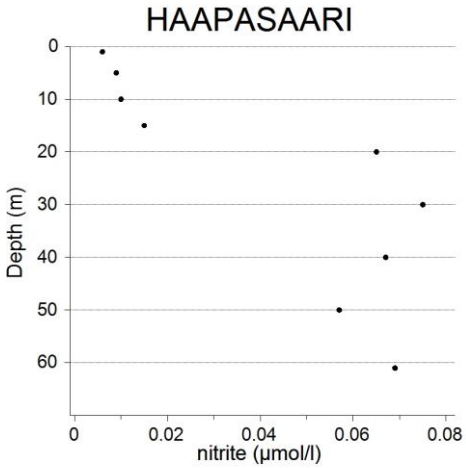

GF2
Depth (m)
nitrite (µmol/l)


FEI-2
Depth (m)
nitrite (µmol/l)

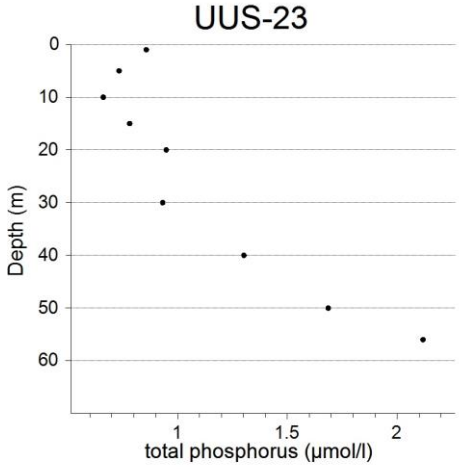


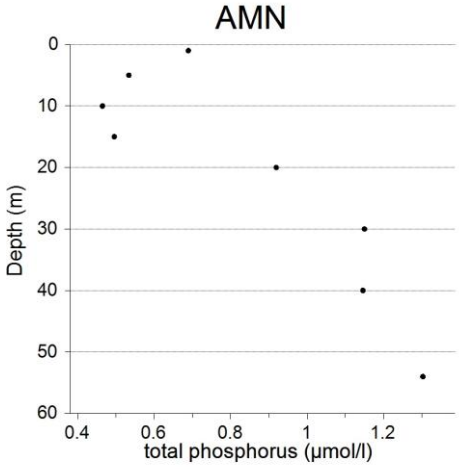


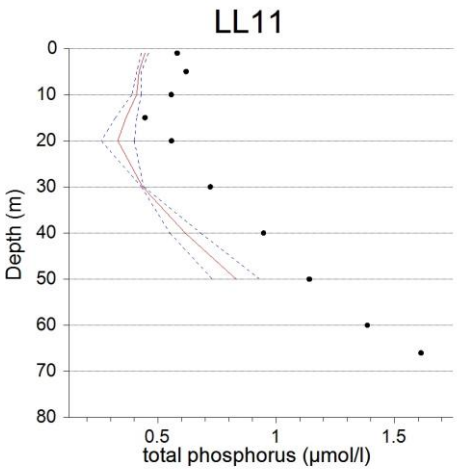


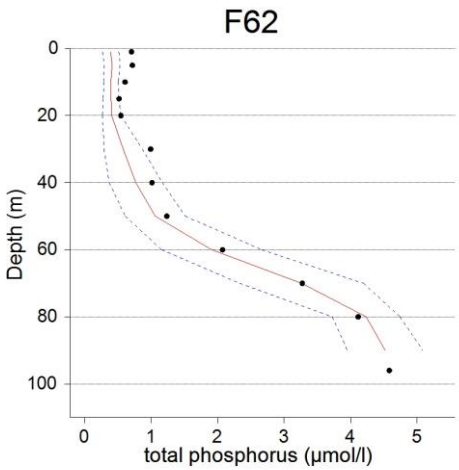


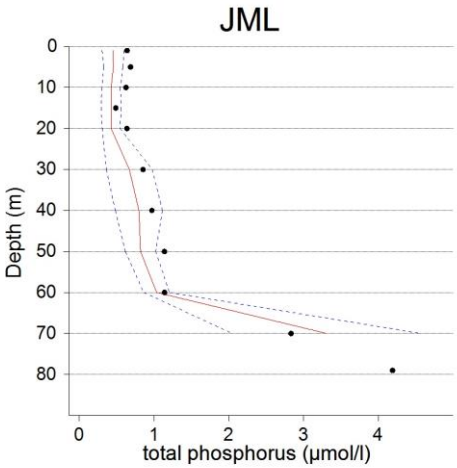
Total Phosphorus

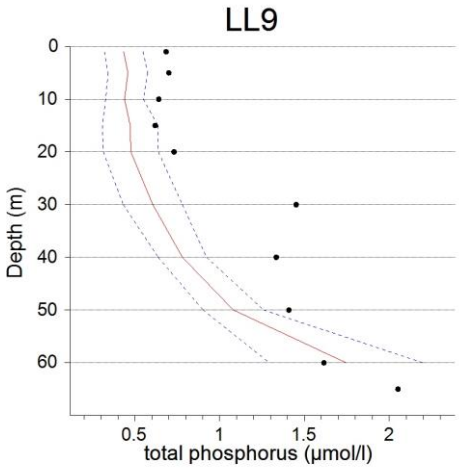


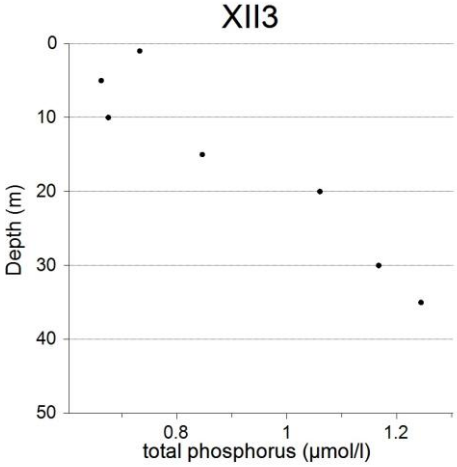


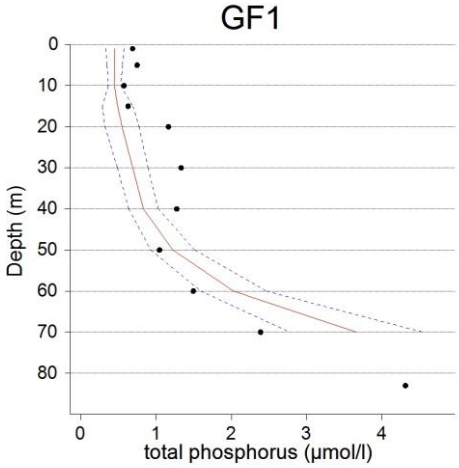

LL11
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
1.5
total phosphorus (µmol/l)

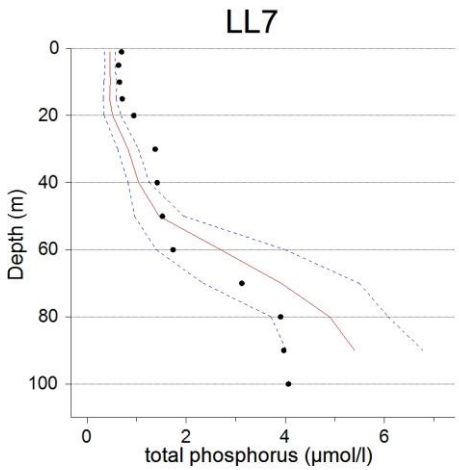

F62
Depth (m)
0
20
40
60
80
100
0
1
2
3
4
5
total phosphorus (µmol/l)

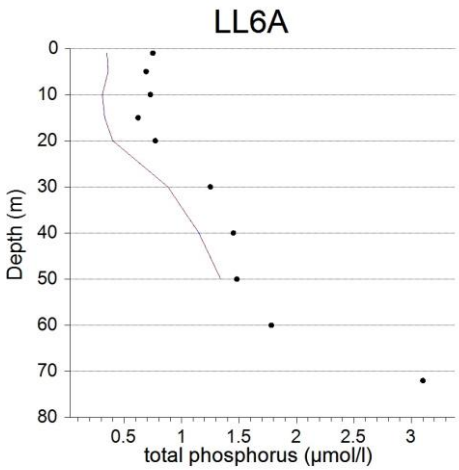

JML
Depth (m)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
total phosphorus (µmol/l)

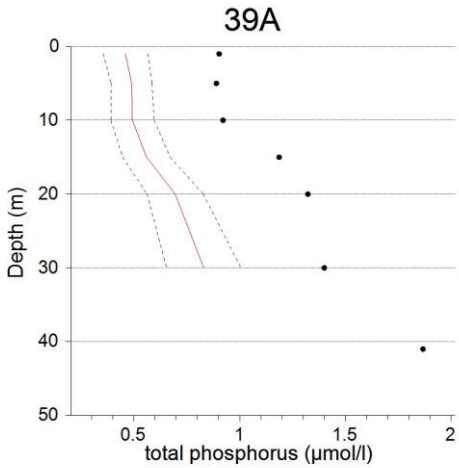

LL9
Depth (m)
0
10
20
30
40
50
60
0.5
1
1.5
2
total phosphorus (µmol/l)

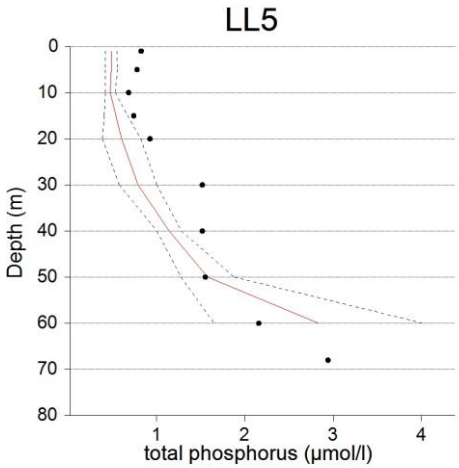

XII3
Depth (m)
0
10
20
30
40
50
0.8
1
1.2
total phosphorus (µmol/l)

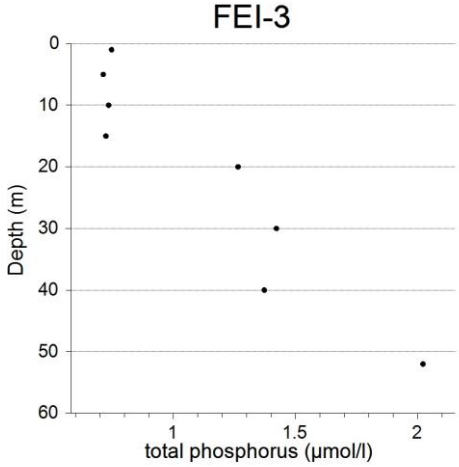

GF1
Depth (m)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
total phosphorus (µmol/l)

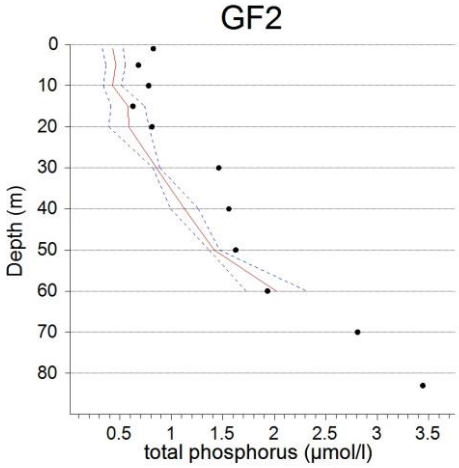

LL7
Depth (m)
0
20
40
60
80
100
0
2
4
6
total phosphorus (µmol/l)

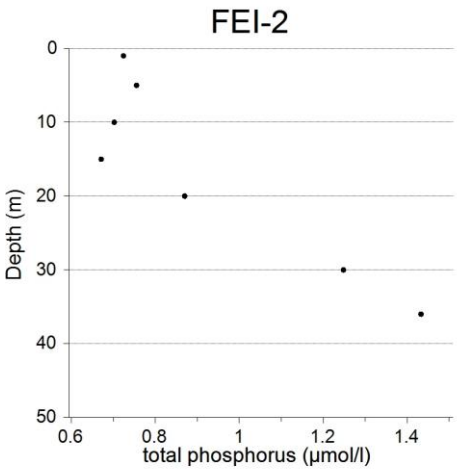

LL6A
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
1.5
2
2.5
3
total phosphorus (µmol/l)

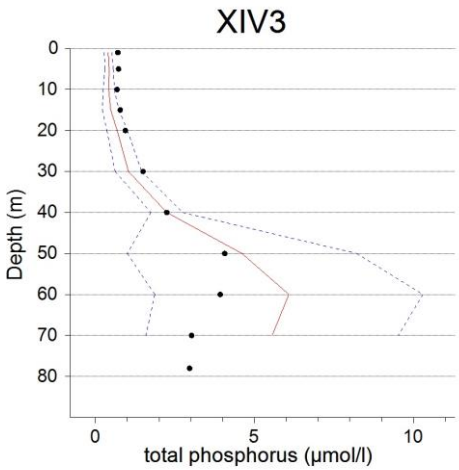

39A
Depth (m)
0
10
20
30
40
50
0.5
1
1.5
2
total phosphorus (µmol/l)

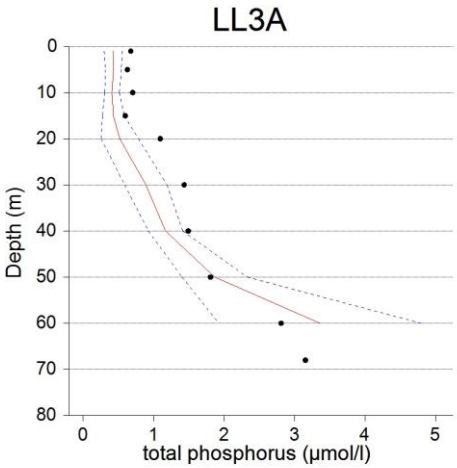

LL5
Depth (m)
0
10
20
30
40
50
60
70
80
1
2
3
4
total phosphorus (µmol/l)

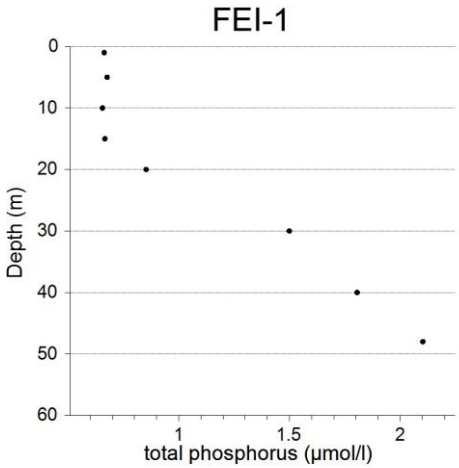

FEI-3
Depth (m)
0
10
20
30
40
50
60
1
1.5
2
total phosphorus (µmol/l)

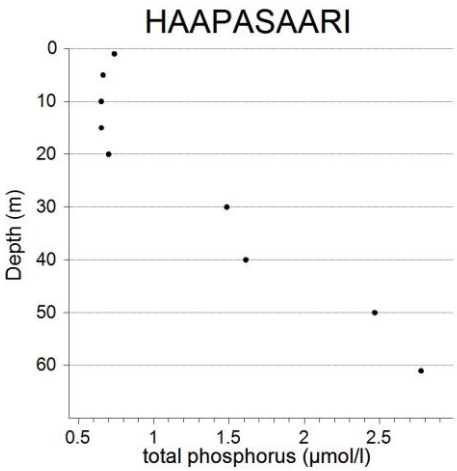

GF2
Depth (m)
0
10
20
30
40
50
60
70
80
0.5
1
1.5
2
2.5
3
3.5
total phosphorus (µmol/l)



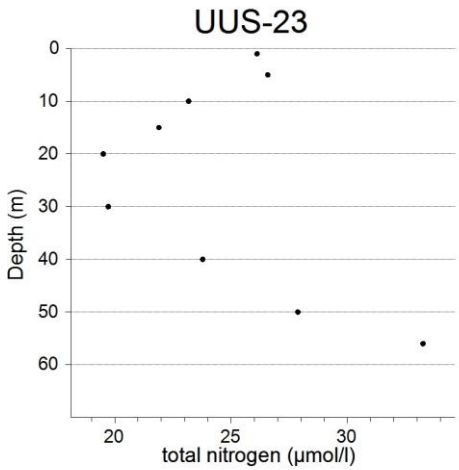


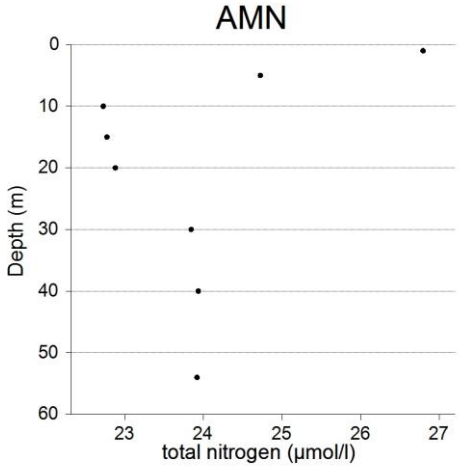


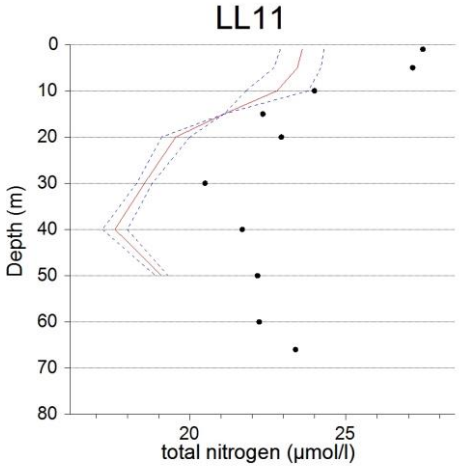


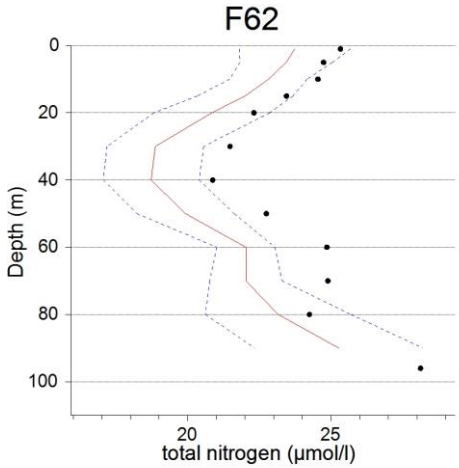


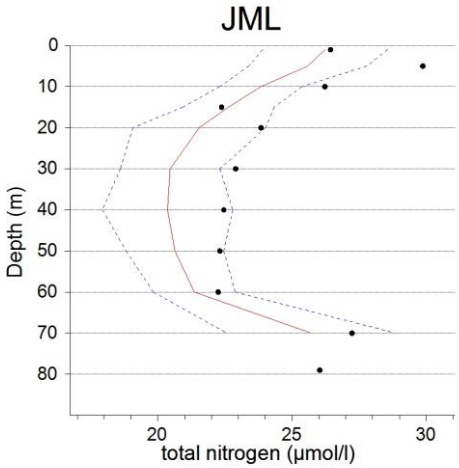
Total Nitrogen

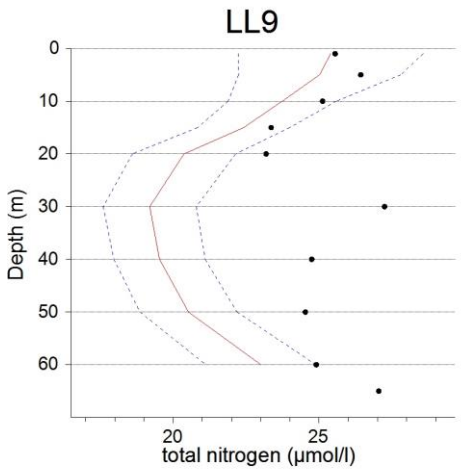

UUS-23
Depth (m)
0
10
20
30
40
50
60
20
25
30
total nitrogen (µmol/l)

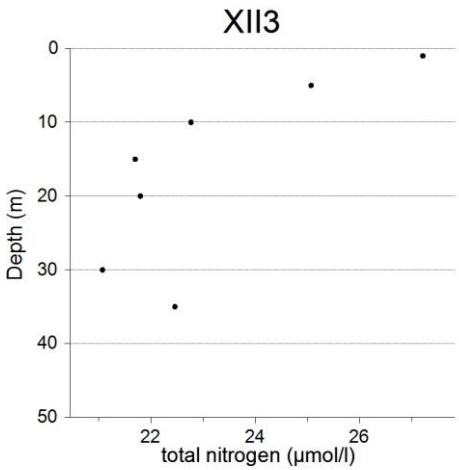

AMN
Depth (m)
0
10
20
30
40
50
60
23
24
25
26
27
total nitrogen (µmol/l)

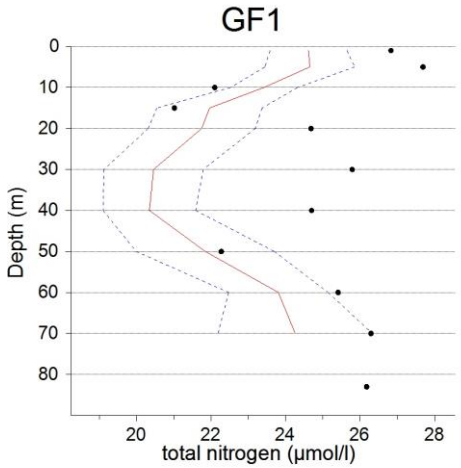

LL11
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
total nitrogen (µmol/l)

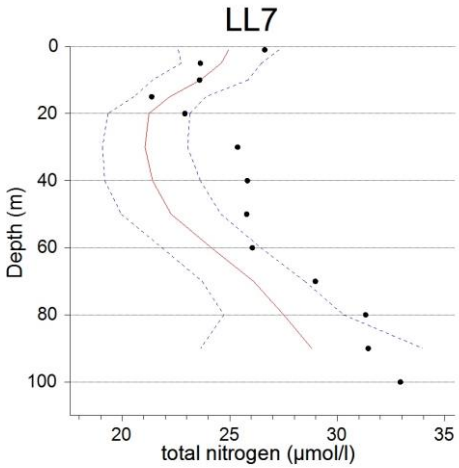

F62
Depth (m)
0
20
40
60
80
100
20
25
total nitrogen (µmol/l)

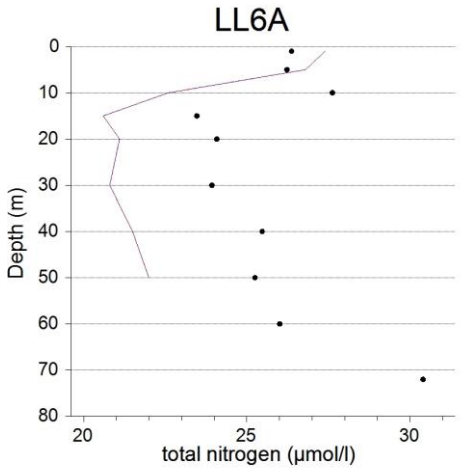

JML
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
total nitrogen (µmol/l)

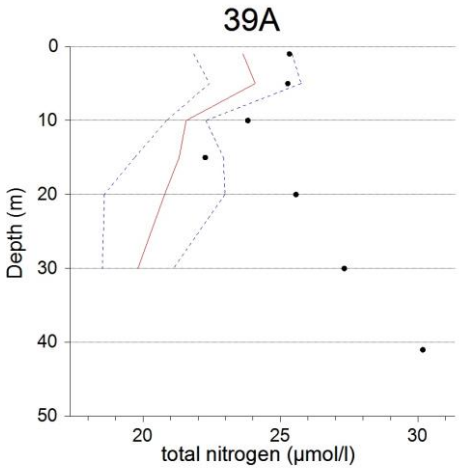

LL9
Depth (m)
0
10
20
30
40
50
60
20
25
total nitrogen (µmol/l)

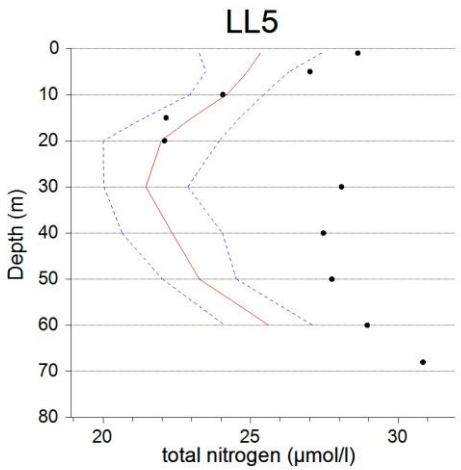

XII3
Depth (m)
0
10
20
30
40
50
22
24
26
total nitrogen (µmol/l)

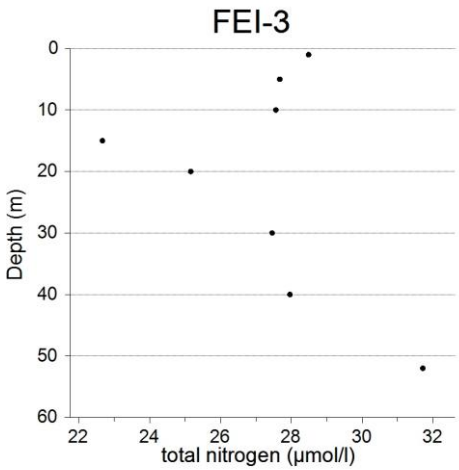

GF1
Depth (m)
0
10
20
30
40
50
60
70
80
20
22
24
26
28
total nitrogen (µmol/l)

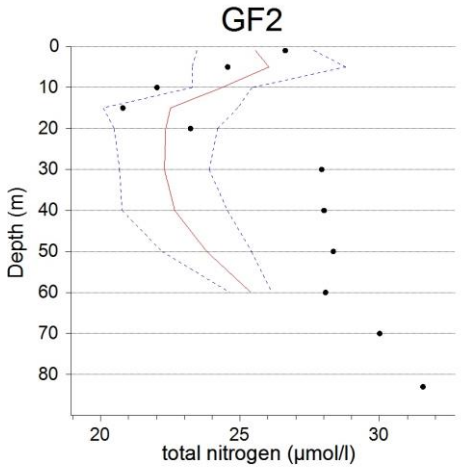

LL7
Depth (m)
0
20
40
60
80
100
20
25
30
35
total nitrogen (µmol/l)

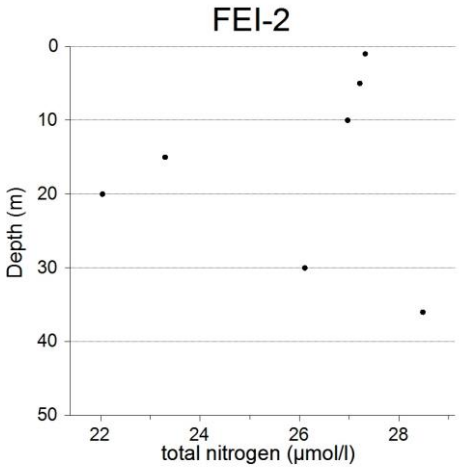

LL6A
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
total nitrogen (µmol/l)

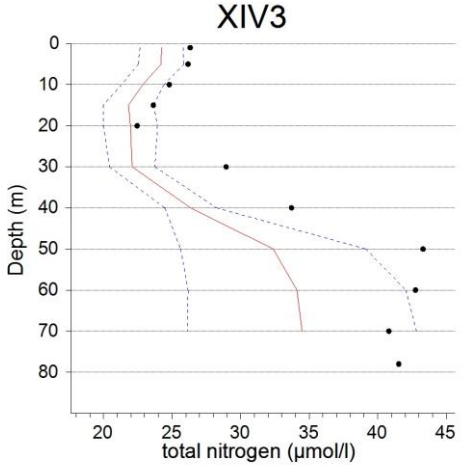

39A
Depth (m)
0
10
20
30
40
50
20
25
30
total nitrogen (µmol/l)

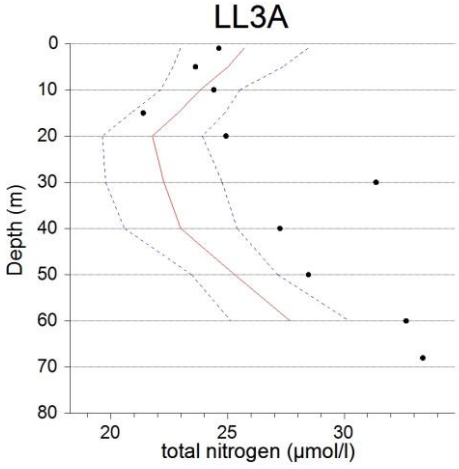

LL5
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
total nitrogen (µmol/l)

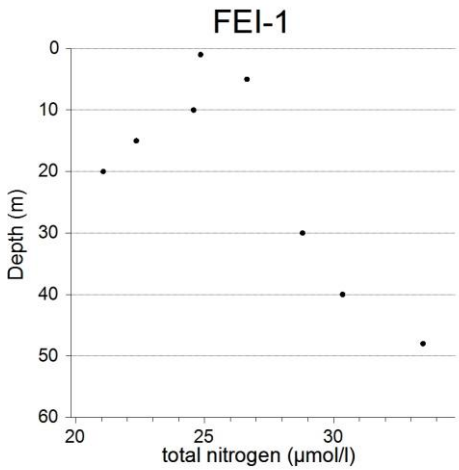

FEI-3
Depth (m)
0
10
20
30
40
50
60
22
24
26
28
30
32
total nitrogen (µmol/l)

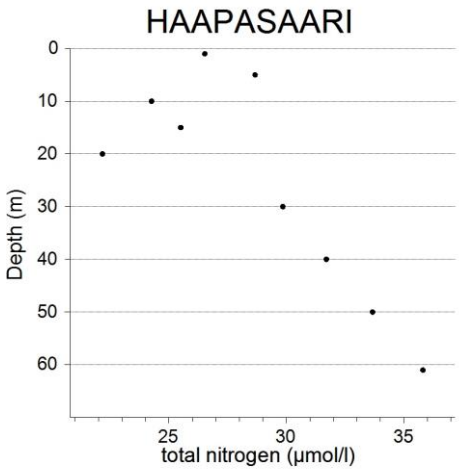

GF2
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
total nitrogen (µmol/l)


FEI-2
Depth (m)
0
10
20
30
40
50
22
24
26
28
total nitrogen (µmol/l)

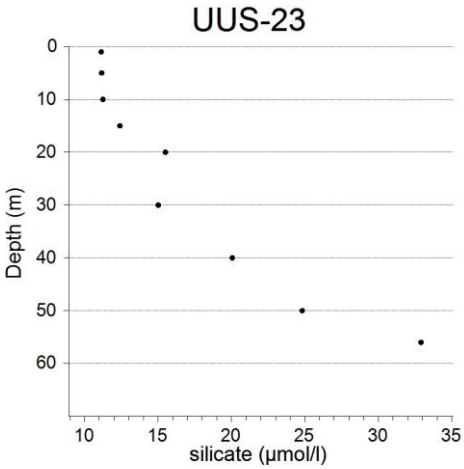

XIV3
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
35
40
45
total nitrogen (µmol/l)

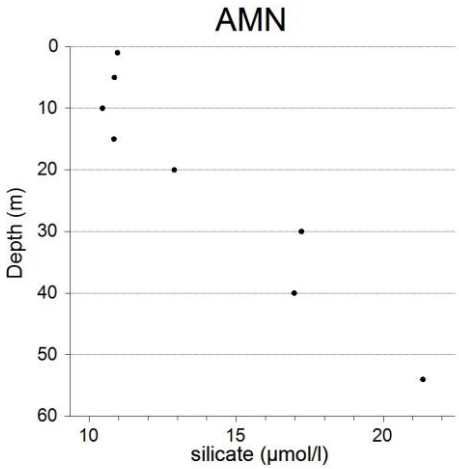

LL3A
Depth (m)
0
10
20
30
40
50
60
70
80
20
25
30
total nitrogen (µmol/l)

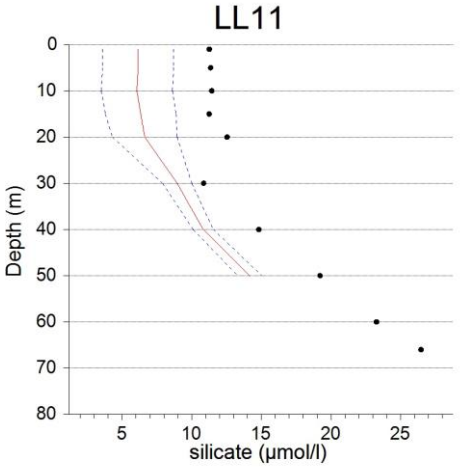

FEI-1
Depth (m)
0
10
20
30
40
50
60
20
25
30
total nitrogen (µmol/l)

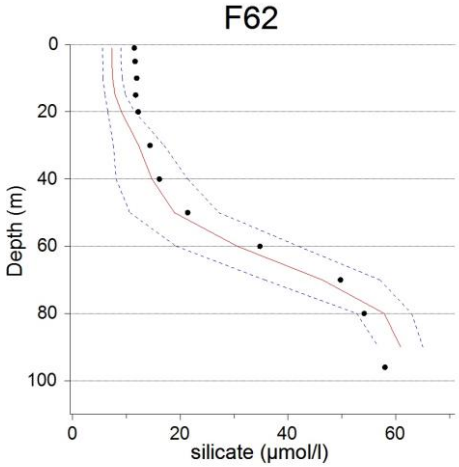

HAAPASAARI
Depth (m)
0
10
20
30
40
50
60
25
30
35
total nitrogen (µmol/l)

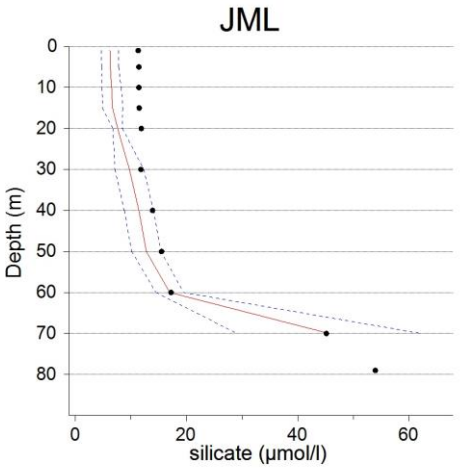
Silicate

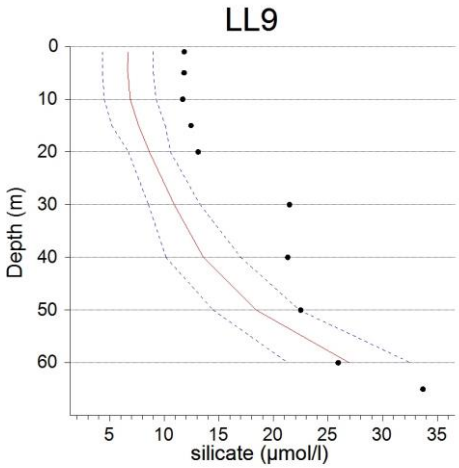

UUS-23
Depth (m)
silicate (µmol/l)

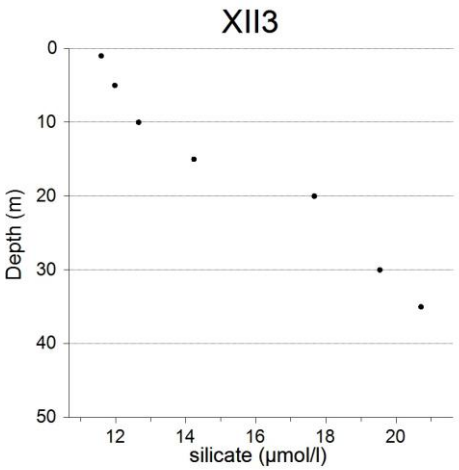

AMN
Depth (m)
silicate (µmol/l)

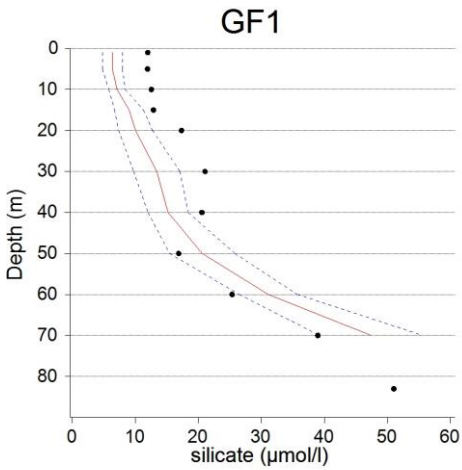

LL11
Depth (m)
silicate (µmol/l)

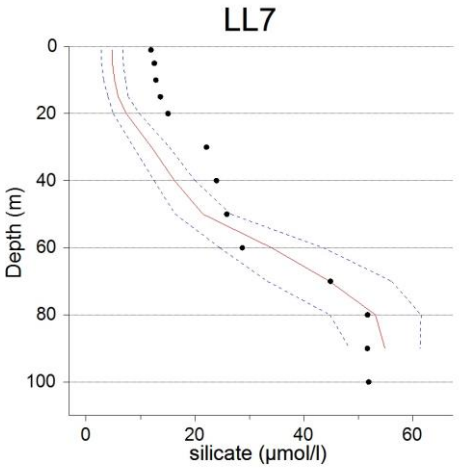

F62
Depth (m)
silicate (µmol/l)

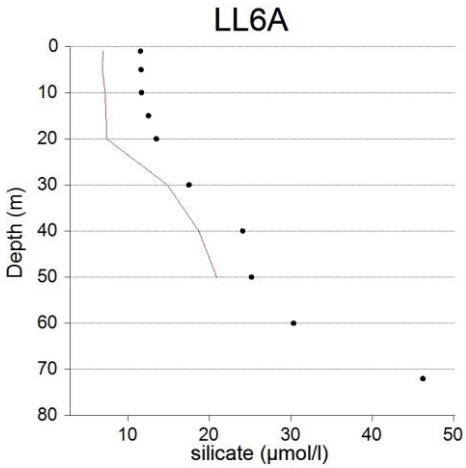

JML
Depth (m)
silicate (µmol/l)

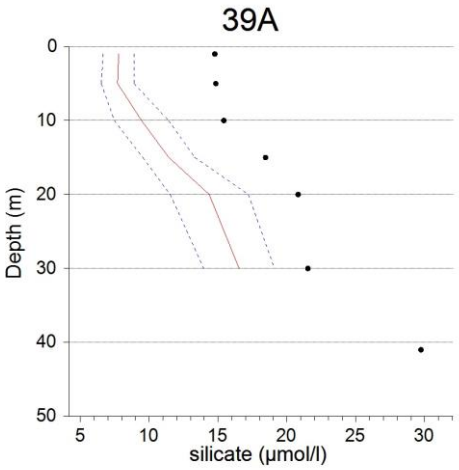

LL9
Depth (m)
silicate (µmol/l)

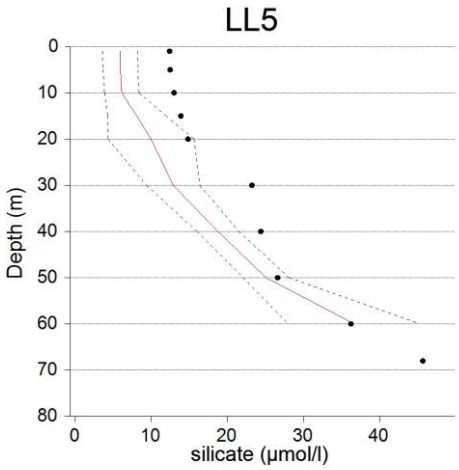

XII3
Depth (m)
silicate (µmol/l)

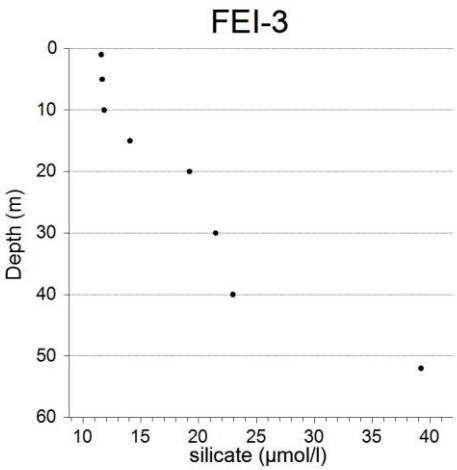

GF1
Depth (m)
silicate (µmol/l)

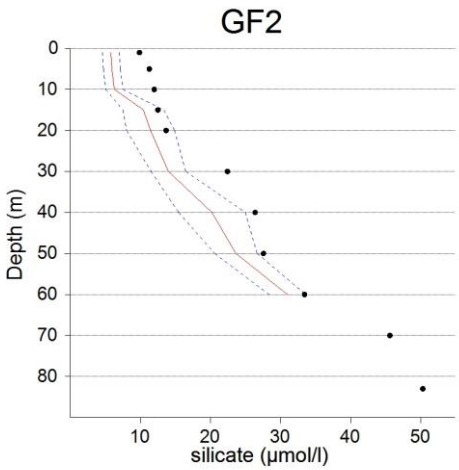

LL7
Depth (m)
silicate (µmol/l)

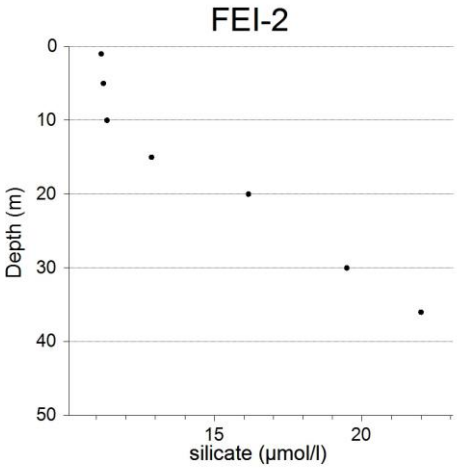

LL6A
Depth (m)
silicate (µmol/l)

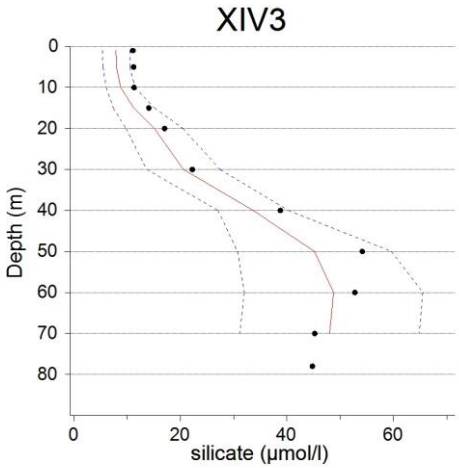

39A
Depth (m)
silicate (µmol/l)

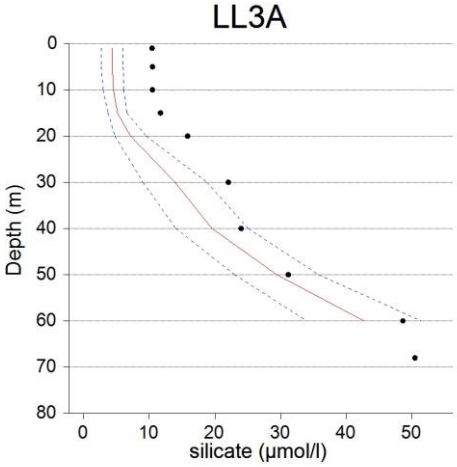

LL5
Depth (m)
silicate (µmol/l)

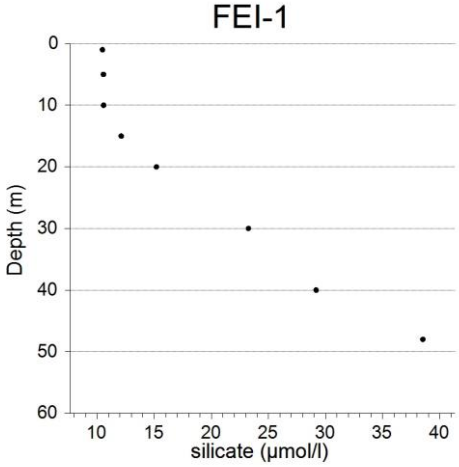

FEI-3
Depth (m)
silicate (µmol/l)

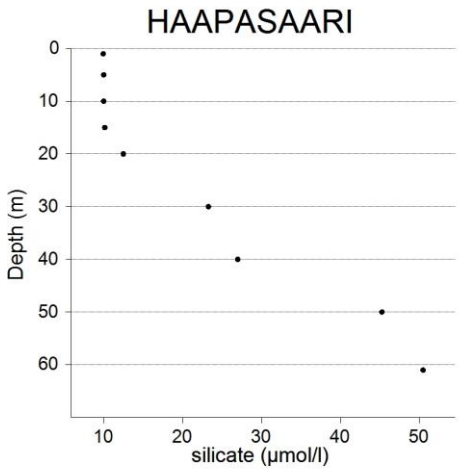

GF2
Depth (m)
silicate (µmol/l)


FEI-2
Depth (m)
silicate (µmol/l)


XIV3
Depth (m)
silicate (µmol/l)


LL3A
Depth (m)
silicate (µmol/l)


FEI-1
Depth (m)
silicate (µmol/l)


HAAPASAARI
Depth (m)
0
10
20
30
40
50
60
10
20
30
40
50
silicate (µmol/l)