

## CRUISE REPORT



*R/V Aranda*

Cruise 01/2018

Combine3 2<sup>nd</sup> leg /2018  
*14. September - 19. September 2018*

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

### **Objectives of the cruise**

The objectives of the cruise were:

- 1) Monitoring of the Northern Baltic Proper, Åland sea and the Southern part of the Bothnian Sea. Measured parameters were water temperature and density, salinity, oxygen/ hydrogen sulfide content, nutrients, silica, zooplankton, benthic animals and micro plastics in sediments;
- 2) Maintenance of the FMI (Finnish Meteorological Institute) instruments in the Northern Baltic Proper, the Bothnian Sea and the Archipelago Sea;
- 3) Sampling of toxins in phytoplankton in the region;
- 4) Sampling of the benthic animals for micro plastics; and
- 5) Validation of sampling procedures and their quality on R/V Aranda after renovation.

Table 1. The scientific crew

<b>Scientist</b>	<b>On board</b>	<b>Organization</b>
Kotilainen Pekka	14. - 19.9.2018	SYKE/MRC
Jalli Heini	14. - 19.9.2018	FMI
Kosloff Pekka	14. - 19.9.2018	FMI
Riikonen Jere	14. - 19.9.2018	SYKE/MRC
Hyvärinen Susanna	14. - 19.9.2018	SYKE/MRC
Varmanen Pia	14. - 19.9.2018	SYKE/MRC
Flinkman Juha	14. - 19.9.2018	SYKE/MRC
Lastumäki Ilkka	14. - 19.9.2018	SYKE/MRC
Setälä Outi	14. - 19.9.2018	SYKE/MRC
Hänninen Panu	14. - 19.9.2018	SYKE/MRC
Jaale Marko	14. - 19.9.2018	SYKE/MRC
Bruun Jan-Erik	14. - 19.9.2018	SYKE/MRC

### **Cruise route**

The 2nd leg of the Combine 3 cruise (Figure 1) started from Hanko (on 14.9.2018) heading to the station LL12 and then continued at LL15, which was also the first analytical quality control station (LL15LAATU in Figure 1), continued with maintenance of the wave buoy and sampling at the station LL17 and at the station (LL17LAATU) in order to conduct validation of some sampling. Then the cruise headed to NW, station F64. The Workhorse of the FMI was tried to recover at MARKET\_WH, but without any success. The cruise headed to the Bothnian Sea and the stations SR5, F26, MS9 and SR7 were sampled. Before the return to Helsinki, three stations were sampled in the Archipelago Sea (IU1, IU5 and IU7). Outside Helsinki, a complementary sampling was carried out at LL7 (validation of the oil sampling procedure and additional zooplankton samples).

Figure 1. The 2nd leg of the Combine 3 cruise (14-19.9.2018) from Hanko to Helsinki.

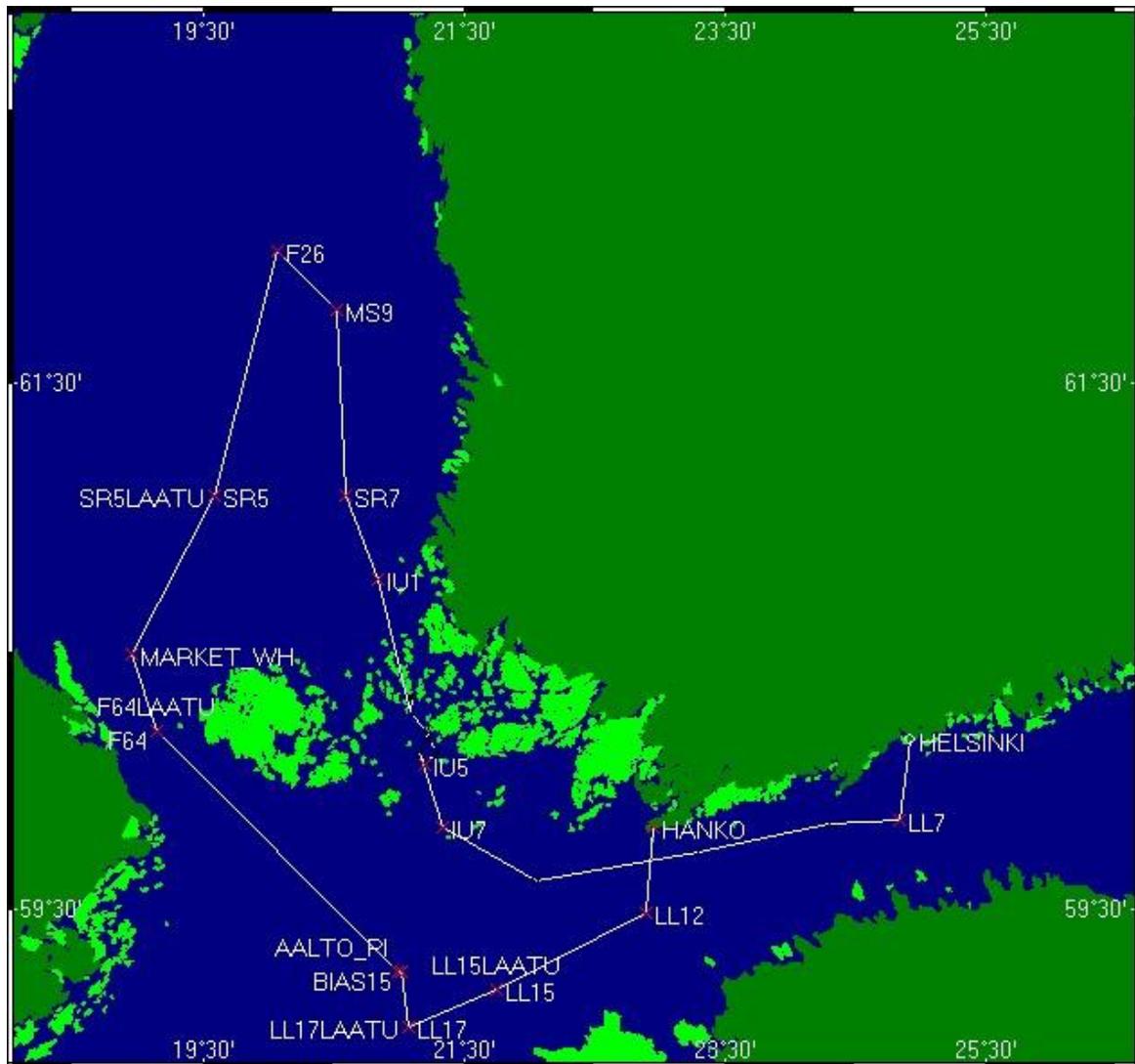


Table 2. List of sampled stations of the cruise.

INDEX	STATION	LAT (NORTH)	LON (EAST)	DEPTH (m)	DATE	TIME (UTC + 2)
	HANKO				2018-09-14	12:02
2018010015	LL12	59.29002	22.5381	83	2018-09-14	14:14
2018010016	LL15	59.11998	21.4481	131	2018-09-14	21:25
2018010017	LL15LAATU	59.11998	21.4481	131	2018-09-14	23:18
2018010018	LL17	59.02	21.04774	172	2018-09-16	0:30
2018010019	LL17LAATU	59.02	21.04774	172	2018-09-16	0:30
2018010020	BIAS15	59.1498	21.0092	99	2018-09-16	10:26
2018010021	AALTO_PI	59.14962	20.59938	99	2018-09-16	10:40
2018010022	F64	60.11335	19.08553	287	2018-09-16	22:00
2018010023	F64LAATU	60.11335	19.08553	287	2018-09-16	23:00
2018010025	SR5	61.04997	19.34788	125	2018-09-17	11:35
2018010026	SR5LAATU	61.04997	19.34788	125	2018-09-17	13:00
2018010027	F26	61.59008	20.03781	139	2018-09-17	21:30
2018010028	MS9	61.5101	20.03311	101	2018-09-18	1:30
2018010029	SR7	61.0501	20.35786	78	2018-09-18	4:00
2018010030	IU1	60.46014	20.50801	33	2018-09-18	10:00
2018010031	IU5	60.03499	21.11903	89	2018-09-18	15:30
2018010032	IU7	59.48912	21.202	93	2018-09-18	18:30
2018010033	LL7	59.51001	24.50202	102	2018-09-19	8:00
	HELSINKI				2018-09-19	11:00

### Summary of the sampling

The Cruise consisted of 18 stations (Table 2). CTD was deployed at 16 of them, and hydrography and nutrients were done at 15 monitoring stations. Quality control of sampling and analysis procedure were carried out at 3 stations (xxLAATU). In addition, chlorophyll a, pooled quantitative phytoplankton samples, and zooplankton hauls were taken at several stations. Oil sampling procedure was verified at the station LL7 and 4 samples of phytoplankton to analysis toxins were taken. The wave buoy of the Finnish Meteorological Institute (FMI) was lifted, cleaned and put back. The entire sampling scheme of the cruise is shown in Table 3.

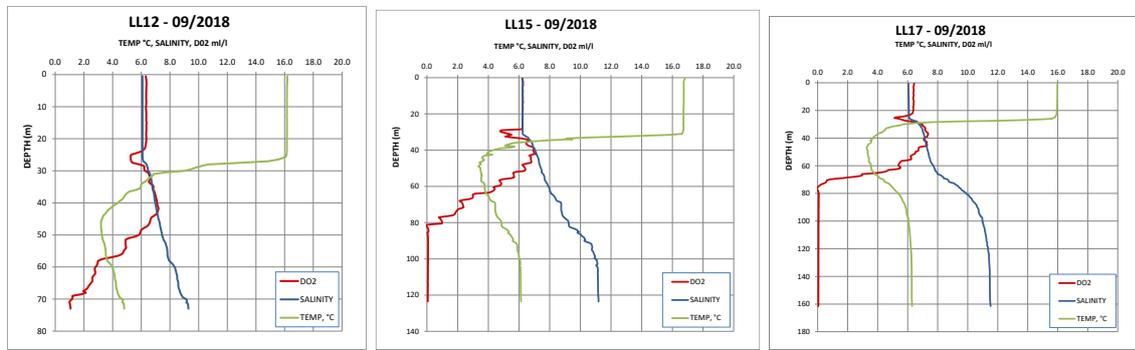
Table 3. The sampling scheme of the Cruise Combine 3 01/2018 (2<sup>nd</sup> leg).

STATION	REGION	MAA (EEZ)	LAT	LON	Secchi	Oil	Hydrography	Chemistry	Chla	Phytopl	Zoopl	Benthos	Litter	NIVA Benthos	Fytox	STUK	Note
LL12	Nbaltic	SUOMI	59°29.01'	22°53.81'			x	x	x	x	x		x		x		
LL15	Nbaltic	VIRO	59°11.00'	21°44.81'			x	x	x								
LL15LAATU	Nbaltic	VIRO	59°11.00'	21°44.81'			x	x									
LL17	Nbaltic	VIRO	59°02.00'	21°04.77'			x	x	x	x	x		x		x	x	
LL17LAATU	Nbaltic	VIRO	59°02.00'	21°04.77'			x	x									
BIAS15	Nbaltic	SUOMI	59°15.00'	21°00.98'													
AALTO_PI	Nbaltic	SUOMI	59°15.00'	20°59.81'			CTD										
F64	ÅlandS	SUOMI	60°11.335'	19°08.553'			x	x	x	x	x	x	x	x (MAR)	x		
F64LAATU	ÅlandS	SUOMI	60°11.335'	19°08.553'			x	x	x								
MARKET_WH	ÅlandS	SUOMI	60°29.98'	18°57.00'													
SR5	öthnian Sd	SUOMI	61°05.00'	19°34.78'			x	x	x	x	x	x	x		x	x	Replacing Station
F26	öthnian Sd	SUOMI	61°59.01'	20°03.78'			x	x	x					x (MAR)			
MS9	öthnian Sd	SUOMI	61°46.01'	20°31.83'			x	x	x			x		x (MAR)			
SR7	öthnian Sd	SUOMI	61°05.01'	20°35.79'			x	x	x			x		x (MAR)			
IU1	öthnian Sd	SUOMI	60°46.01'	20°50.80'	x		x	x	x								
IU5	rchipelag	SUOMI	60°03.49'	21°11.90'			x	x	x					x (MAC)			
IU7	rchipelag	SUOMI	59°48.91'	21°20.20'			x	x	x	x	x						
LL7	Gulf of F	SUOMI	59°51.00'	24°50.20'			x	x	x	x	x						
MAC	20 ind. of Macoma																
MAR	20 ind. Marenzelleria																

### Key results

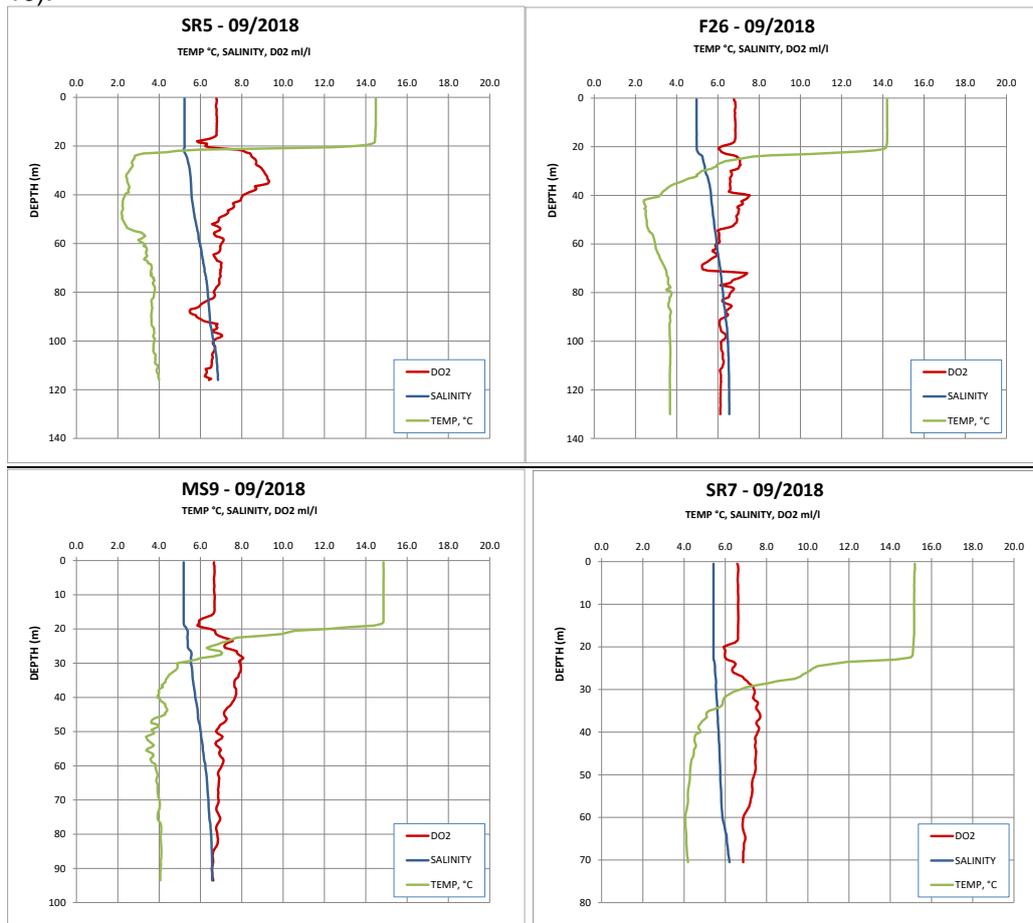
The cruise can be considered as a test cruise and due to its' late schedule, mid-September, as the obtained results might not be comparable with the results of other Combine summer cruises, which usually have been conducted late July or early August. Also the coverage of the cruise was less extensive than usual. Northern part of the Bothnian Bay had to be skipped due to time limit.

The profiles along the LL transect showed that in the western part of the Gulf of Finland was oxic down to the bottom (LL12), but at some 30Nm to the west, at LL15 and LL17, the layer below 80m was anoxic. Salinity at the station LL17 was just below 12 (Figures 4-6).



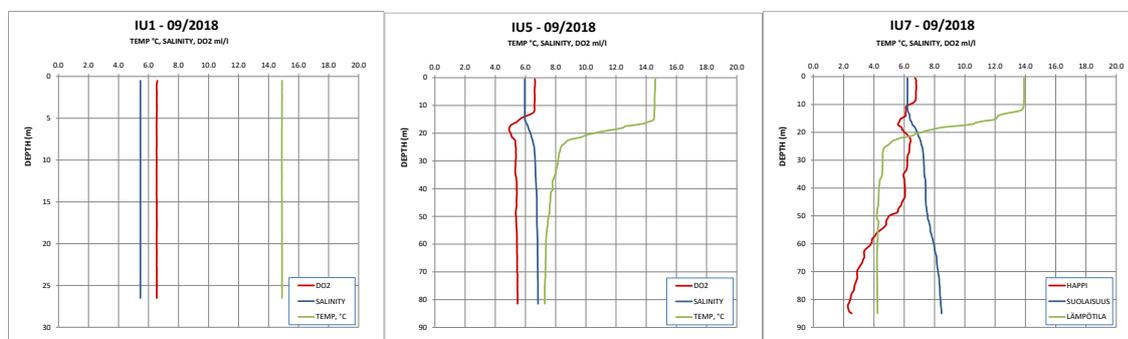
Figures 4-6. Temperature, salinity and oxygen profiles in September 2018 at LL12, LL15 and LL17.

In the Bothnian Sea, salinity, oxygen and temperature profiles were typical of the season and region, clearly defined thermocline, less variable salinity and oxic down to the bottom (Figures 7-10).



Figures 7-10. Temperature, salinity and oxygen profiles in the Bothnian Sea (at SR5, F26, MS9 and SR7) in September 2018.

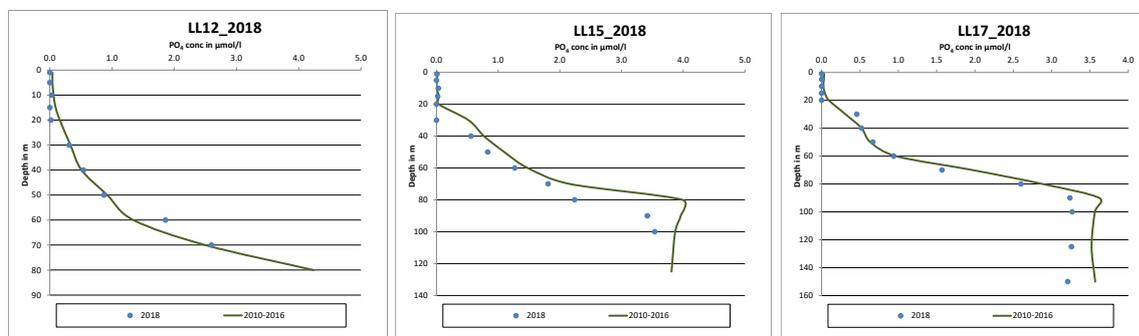
In the Archipelago Sea the results showed that at station IU1 the water column was entirely mixed due to its' shallow nature. A clear stratification was seen at the stations IU5 and IU7.



Figures 11-13. Salinity and oxygen profiles in September 2018 at IU1, IU5 and IU7.

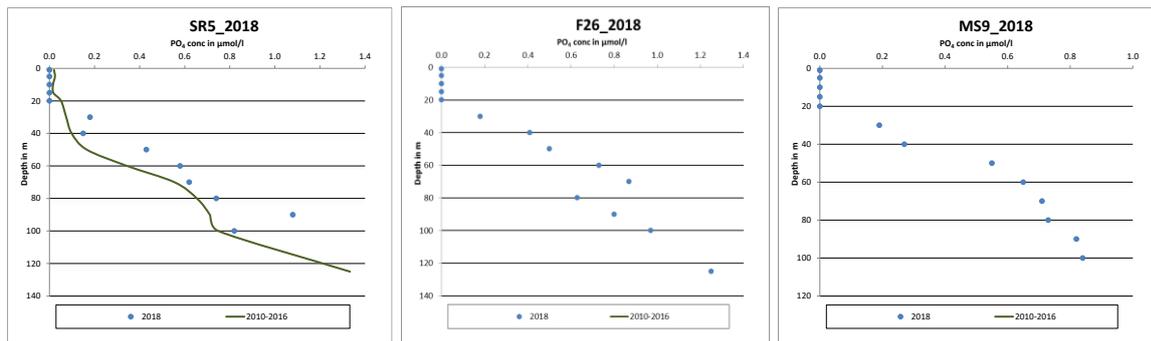
### Dissolved phosphorus

PO<sub>4</sub> concentrations below 80 m in September 2018 were slightly lower than in average (in August 2010-2016) at LL15 and LL17 (Figures 14-16).

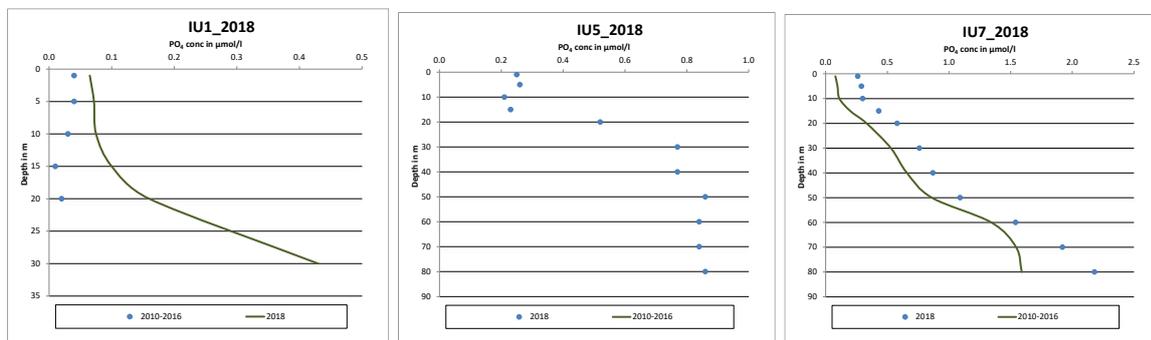


Figures 14-16. PO<sub>4</sub> concentrations in September 2018 (blue dots) and in average (August 2010-2016, green line) at stations LL12, LL15 and LL17.

PO<sub>4</sub> concentrations in September 2018 were slightly higher than in average (2010-2016) at SR5. Stations F26 and MS9, we monitored for the first time during the Combine 3 cruise and no comparison was possible (Figures 17-19).



Figures 17-19. PO<sub>4</sub> concentrations in September 2018 (blue dots) and in average (August 2010-2016, green line) at stations SR5, F26 and MS9.

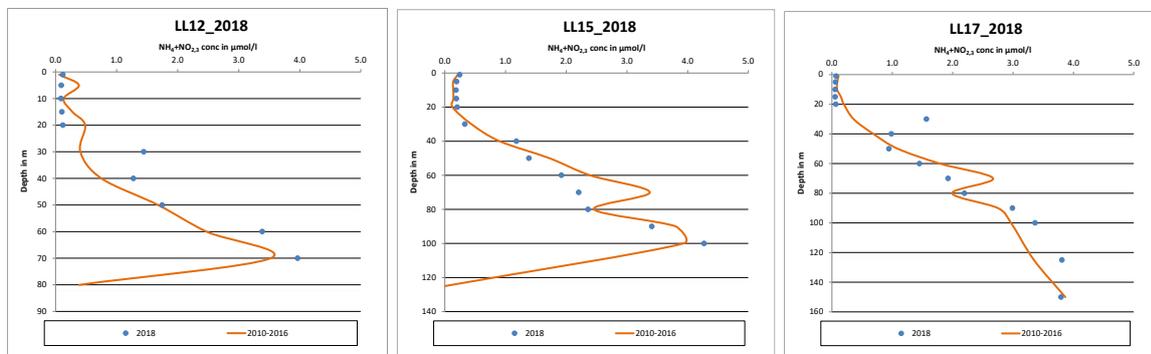


Figures 20-22. PO<sub>4</sub> concentrations in September 2018 (blue dots) and in average (August 2010-2016, green line) in the Archipelago at stations IU1, IU5 and IU7.

In the northern part of the Archipelago Sea, at IU1, PO<sub>4</sub> concentrations were close to zero (0.04 µmol/l) and in the southern part of the Archipelago (IU5 and IU7) concentrations were at the level of 0.25 µmol/l. The concentrations were slightly higher in September 2018 than in average in 2010-2016 at IU7 (Figures 20-22).

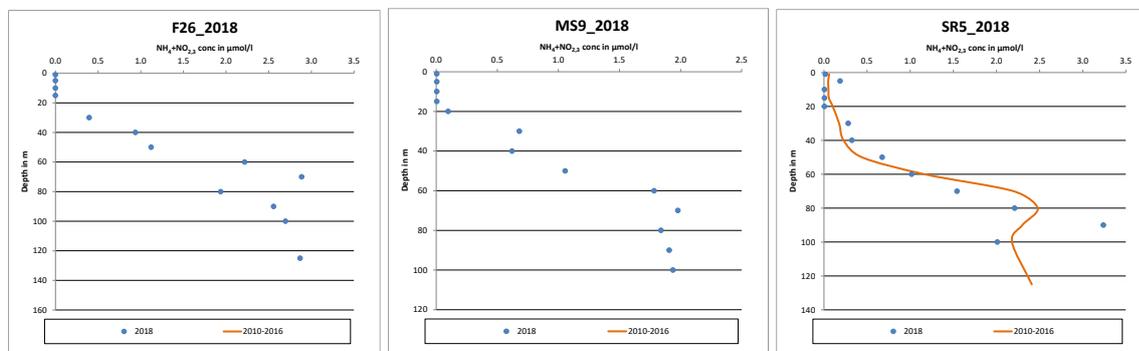
## Dissolved N

Dissolved N concentrations (NH<sub>4</sub> + NO<sub>2,3</sub>) in September 2018 were very much the same in the productive layer down to 20 meters than in average 2010-2016. (Figures 23-25).

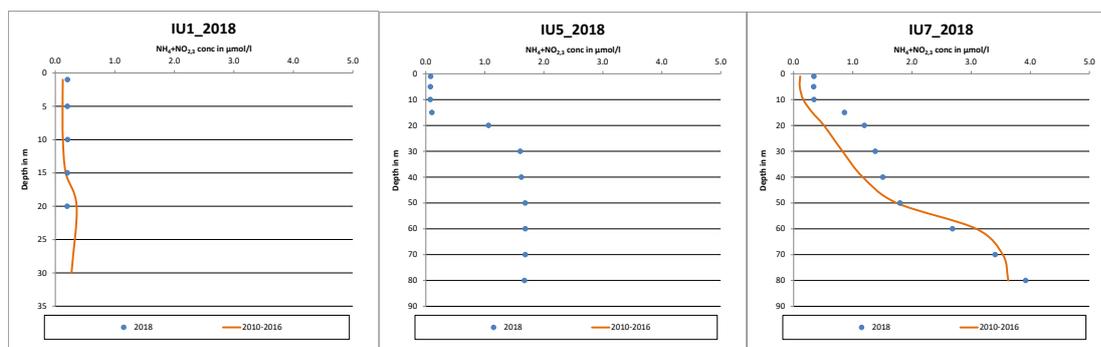


Figures 23-25. NH<sub>4</sub> + NO<sub>2,3</sub> concentrations at LL12, LL15 and LL17 stations in September 2018 (blue dots) and in average 2010-2016 (orange line).

There is no reference of the same period data available at the two stations F26 and MS9 in the Bothnian Sea. The highest concentrations of dissolved nitrogen were observed at deeper layers, below 60 meters. The observed concentrations in September 2018 at SR5 followed much the average of 2010-2016 in August.



Figures 26-28. NH<sub>4</sub> + NO<sub>2,3</sub> concentrations at F26, MS9 and SR5 in September 2018 (blue dots) and in average 2010-2016 (average of 2010-2016 i.e., orange line only in SR5).



Figures 29-31. NH<sub>4</sub> + NO<sub>2,3</sub> -concentrations in the Archipelago Sea IU1, IU5 and IU7 in September 2018 (blue dots) and in average in August 2010-2016 (orange line in IU1 and IU7).

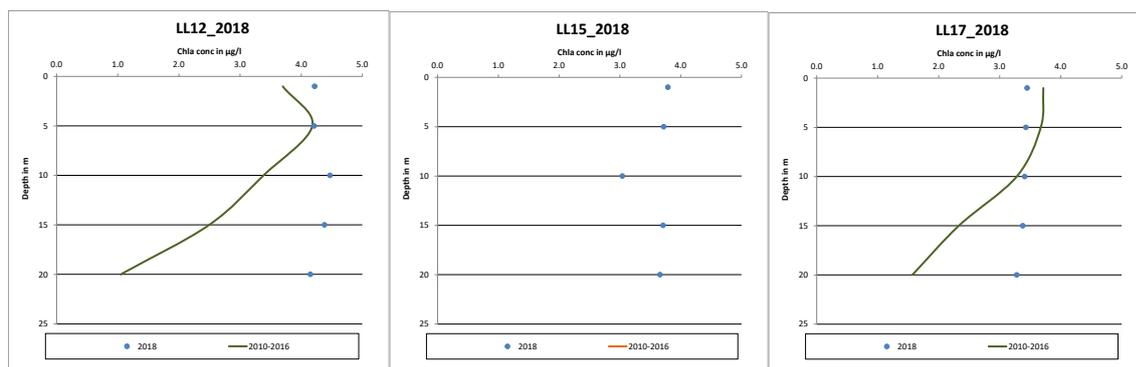
Due to the shallow character of IU1, the NH<sub>4</sub> + NO<sub>2,3</sub> concentrations were the same from surface to bottom. No reference data of the period was available at IU5, but the observed concentrations showed that the column was clearly stratified. The highest concentrations were observed at the southernmost station IU7. A slight increase in September 2018 in concentrations in the first 30 meters was observed compared with the average concentrations of August 2010-2016. (Figures 29-31). The observed concentrations in 2018 at deep layers followed the average concentrations of 2010-2016.

## Other results

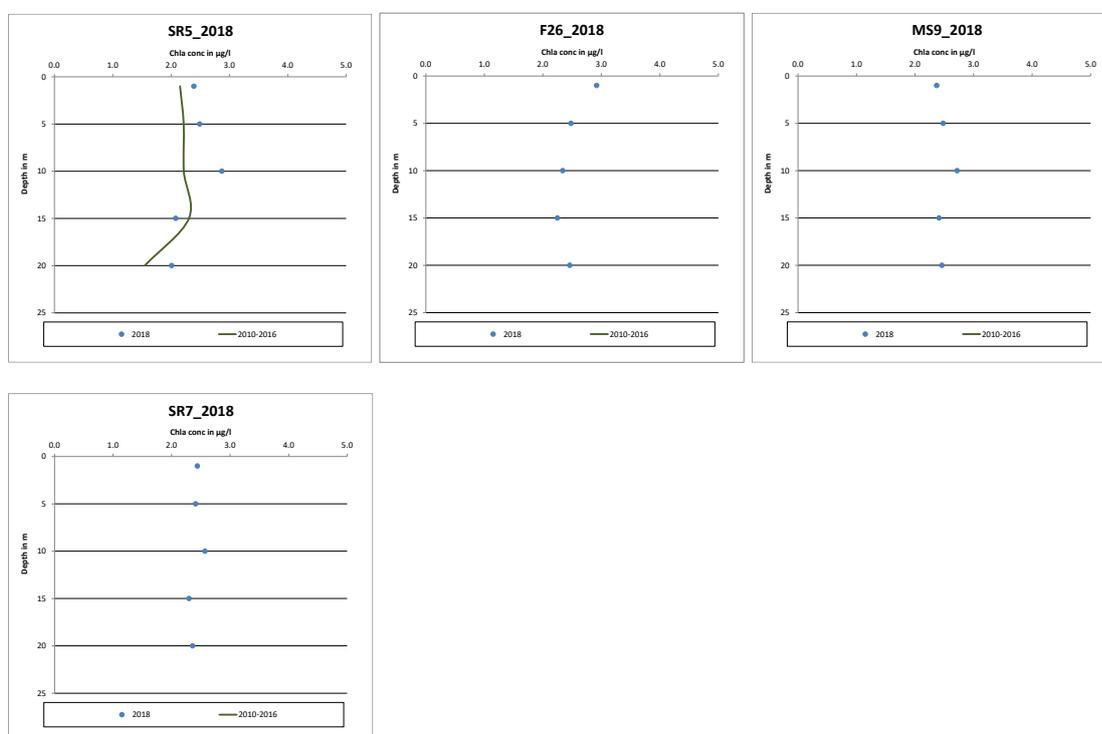
### Chlorophyll a concentrations in September 2018

In general, chlorophyll a concentrations were higher in the main basin (Baltic Proper) than in the Gulf of Bothnia. In September 2018 the observed chl a concentrations of 0-20m were vertically very much alike.

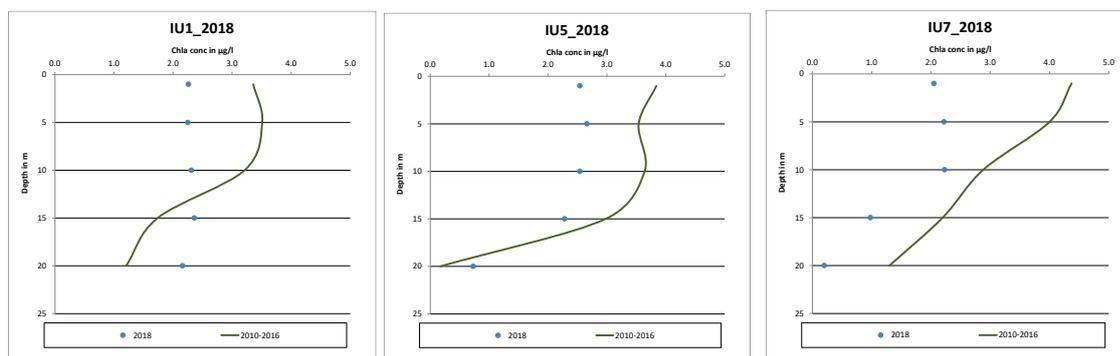
The highest concentrations were observed at LL12 and the lowest concentrations in the Archipelago Sea at the stations IU1 and IU7.



Figures 32-34. Chla -concentrations in the Northern Baltic Proper LL12, LL15 and LL17 in September 2018 (blue dots) and in average in August 2010-2016 (green line in LL12 and LL17).



Figures 35-38. Chla -concentrations in the Bothnian Sea SR5, F26, MS9 and SR7 in September 2018 (as blue dots) and in average in August 2010-2016 (green line only at the station SR5).



Figures 39-41. Chla-concentrations in the Archipelago Sea IU1, IU5 and IU7 in September 2018 (blue dots) and in average in August 2010-2016 (as green line).

### Additional sampling

#### Phytoplankton

Phytoplankton samples were taken at 6 stations, 2 in the Baltic Proper, 3 in the Bothnian Sea and the Åland/Archipelago Sea regions and 1 sample which were missed during the first leg in the Gulf of Finland (station LL7). The samples will be analyzed later on in the laboratory (Table 2). Sampling was conducted by pooling an equal volume of water from 5 depths (1m, 2.5m, 5.0m, 7.5m and 10m). No extensive algal blooms were detected during the cruise.

#### Zooplankton

Zooplankton samples were taken at 6 stations (Table 3). At each station 2 vertical hauls were conducted. The range of the hauls at each station was defined based on stratification of temperature and oxygen. Anoxic layers were not sampled.

Table 4. List of Zooplankton stations and hauling depths in September 2018

INDEX	DATE	STATION	1. HAUL (range in m)	2. HAUL (range in m)
15	14.9.2018	LL12	78-26	26-0
19	16.9.2018	LL17	75-25	25-0
22	16.9.2018	F64	180-12	12-0
25	17.9.2018	SR5	120-20	20-0
32	18.9.2018	IU7	88-12	12-0
33	19.9.2018	LL7	97-31	31-0

#### Phytoplankton samples

Phytoplankton was sampled at 4 stations, LL12, LL17, F64 and at SR5 in order to measure toxins in phytoplankton. Sampled depths were: 1, 2.5, 5, 7.5 and 10m. Sampled volume varied between 60 to 90ltr/depth and samples were filtered through a 50µm net. Total volume of concentrated and pooled sample was approx. 250 ml. As a reference filtered water was also sampled from each depth (50ml/depth). The collected samples were frozen for analysis.

#### Sampling for STUK and NIVA

Some additional sampling was conducted for STUK (Radiation and Nuclear Safety Authority in Finland) at 2 stations (LL17 and SR5). Sea water samples were taken at surface and close to the

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 Mechelininkatu 34a  
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 FI-00251 Helsinki  
 Finland  
<http://www.syke.fi/en>

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

bottom 30 liters samples at each depth. Sediment samples were taken as 2 cm slices down to 30cm.

Additionally, sampling of micro plastics in benthos were conducted for NIVA (Norwegian institute for water research) in order to collect a sufficient amount (20 ind./station) of *Marenzelleria* sp. / *Macoma balthica*. *Marenzelleria* sp. samples were taken at the stations F64, F26, SR7 and MS9, and *Macoma balthica* samples at IU5, respectively.

#### Validation

Validation of the sampling was carried out at LL15LAATU (90m), L17 LAATU (90m), F64 and SR5. The validation was carried out by taking parallel samples at certain depth with three different samplers: Rosette (6 bottles), Hydrobios bottles (6 bottles) and Jussi –sampler of 30ltrs. The samples of different samplers were analyzed and obtained results were compared.

At LL15LAATU validation of H<sub>2</sub>S was interrupted due to electrical problems and H<sub>2</sub>S validation was repeated at LL17LAATU. At the station F64LAATU nutrients and hydrography sampling were validated at 80m and chlorophyll at 10m depth. Nutrient validation was repeated at SR5LAATU. At the station LL7 validation of oil sampling was carried out.