



Lars Andersson  
Lars Edler  
Mikael Krysell

Swedish Meteorological and Hydrological Institute  
Oceanographical Laboratory

1997-08-31  
Dnr: SaO-1997-171

## CRUISE REPORT FROM R/V ARGOS

**Survey period :** 970824-970831

**Survey area:** The Skagerrak, the Kattegat, the Sound,  
the Baltic Proper, the  
Pomeranian Bay and the Bay of Gdansk

**Principal:** SMHI, NSEPA

### SUMMARY

*The expedition was performed within SMHI's regular marine monitoring programme and covered the Skagerrak, the Kattegat, the Sound and the Baltic Proper. Because of the flooding of the rivers Wisla and Oder a part of the expedition was destined to study the effect of the overflow in the areas of the Pomeranian Bay and the Bay of Gdansk. Temperature, salinity and fluorescence (biological activity) at 4m depth were registered continuously throughout the expedition. The surface water temperatures were unusually high in the whole investigated area. No visible algae blooms were present. The bottom water oxygen situation in the Kattegat was satisfying. In the pomerian Bay a 2.5-5 m thick surface layer with elevated phosphate and silicate concentrations was discovered. The secchi depth was 1.5-3.5 m. In the Bay of Gdansk the traces of contaminated water were less evident. The central parts of the Bay contained, however, elevated silicate levels in the surface. The phosphate concentrations were just slightly elevated. The secchi depth was 2-3 m. Hydrogen sulphide was found in the Eastern Gotland Basin (BY15 and BY20) and at a station just north of the Bay of Gdansk.*

## **PRELIMINARY RESULTS**

The expedition, which was a part of SMHI:s regular monitoring programme, both commenced and ended in Göteborg. Due to the floodings in Poland and Germany earlier this summer part of the survey was carried out along the polish and german coasts in order to investigate the fate of the overflow water. These investigations are carried out in a cooperation inbetween SMHI, NSEPA, the Fisheries Board, IVL (Institute of Environmental Research), the Swedish Coast Guard and the corresponding authorities in Poland and Germany. Samples were taken for later determination of heavy metals, mercury and organic contaminants. In addition, two persons from Uppsala University carried out light transmittance measurements.

### **The Skagerrak**

The surface water temperature was around 21°C. The surface layer was depleted of silicate, nitrite and nitrate, but low amounts of phosphate (0.05 µmol/l) and ammonia (0.20-0.40 µmol/l) were detected. The secchi depth was around 10 m. A subsurface maximum of chlorophyll (5 µg/l) was found at 15-20 metres depth. The plankton flora was dominated by dinoflagellates. *Ceratium furca*, *C. fusus* and *C. tripos* were most common. The potentially toxic *Dinophysis acuminata* was present in low numbers.

### **The Kattegat and the Sound**

The temperature of the upper 10 metres was more than 22°C. The surface water was depleted of nitrate and contained low concentrations of phosphate (0.04-0.07 µmol/l) and silicate (0.5-1 µmol/l). The lowest oxygen concentrations were found at Anholt E, 3.66 ml/l, which equals a saturation of 55%. Relatively high silicate concentrations (6-6.5 µmol/l) were measured in the Sound, while the other nutrients were at or below their respective detection limit. The concentration of chlorophyll varied between 1-2.0 µg l<sup>-1</sup> in the upper 5 m, while at 10 and 20 m depth 2-5.9 µg l<sup>-1</sup> was observed

The Kattegat:

The flora in this area resembled the Skagerrak. Dinoflagellates dominated completely. High numbers of *Ceratium furca*, *C. fusus*, *C. tripos*, *Dinophysis acuminata*, *D. norwegica*, *Lingulodinium polyedra*, *Prorocentrum micans* were observed. Among diatoms *Guinardia flaccida* was most common. The high amounts of bluegreen algae, which were common a few days before had now disappeared and only few specimens of *Aphanizomenon "baltica"*, *Anabaena* spp. and the potential toxic *Nodularia spumigena* were observed.

The Sound:

The plankton flora was similar to that of the Kattegat. The further south in The Sound, the more of bluegreen algae were seen. In the south part of the Sound the bloom of *Prorocentrum minimum* which was present already two weeks ago continued.

### **The Arkona and Bornholm Basins**

The surface water temperature varied between 21.5-22.5°C. No nitrate was detected while thier were measurable concentrations of phosphate (0.05-0.08 µmol/l) and a fair amount of silicate (6.5-12.5 µmol/l). The deep water oxygen concentration in the Bornholm Basin was low (0.33 ml/l) while 1.62-2.07 ml/l was found in the Arkona Basin.

Along the polish coast an area of upwelling was observed. In this area the surface water temperature was around 13°C, almost 10 degrees lower than in the surrounding waters. Just north of the Bay of Gdansk hydrogen sulphide was found in the bottom water.

In the Arkona Sea the bluegreen algae *Nodularia spumigena*, *Aphanizomenon "baltica"* and *Anabaena* sp. were present, but could not be seen by the naked eye. Dinoflagellates, such as *Prorocentrum minimum*, *P. micans* and *Dinophysis acuminata* dominated.

## The Pomeranian Bay (Oder outflow) and the Polish coast

Riverine water was found in a 2.5-5 metres thick layer in the western part of the Pomeranian Bay. Elevated concentrations of phosphate (0.25-2.4  $\mu\text{mol/l}$ ) and silicate (25-50  $\mu\text{mol/l}$ ) were observed. With the exception of the station closest to the river mouth, where the nitrate concentration was 2.65  $\mu\text{mol/l}$ , the riverine water was depleted of nitrate. The concentrations of chlorophyll varied between 3-13  $\mu\text{g/l}$  and the Secchi depth varied between 1.5-3.5 m.

The phytoplankton flora was rich in this area and clearly influenced by the flooding water from the river Oder. Among Baltic species *Nodularia spumigena*, *Aphanizomenon "baltica"*, *Anabaena sp.*, *Oocystis cf. borgerii*, *Thalassiosira levanderi* and *Dinophysis acuminata* were present. There was also a freshwater flora with *Scenedesmus spp.*, *Pediastrum spp.*, *Melosira spp.* as common species. At the innermost station we found a considerable bloom of *Microcystis spp.*

The Polish coastal water:

North of Leba there was a mixture of dinoflagellates and diatoms dominating the phytoplankton. *Prorocentrum minimum* and *Heterocapsa triquetra* were the most common dinoflagellates and *Coscinodiscus lacustris* and *Chaetoceros cf. eibonii* the most abundant diatoms.

Further east, between Stilo and Roziewo there was a considerable upwelling where the temperature dropped about 10 degrees. The plankton flora was similar, but less abundant.

## The Bay of Gdansk (Wisla outflow)

The influence of riverine water was less pronounced than in the Pomeranian Bay. An area 9 nm northeast of Hela and the central parts of the Bay showed the strongest signs, with Secchi depths of 2-3 metres. The silicate concentrations were elevated compared to the southern Baltic, the phosphate concentrations slightly elevated, and nitrate not at all detectable in the surface water.

In Gdansk Bay we found flooding river water in isolated packages. The presence of freshwater species was very obvious (*Pediastrum spp.*, *Scenedesmus spp.*, *Melosira spp.* and *Cyclotella*). Among Baltic species the diatoms *Coscinodiscus granii* and *Coscinodiscus lacustris* together with the bluegreens *Nodularia spumigena* and *Aphanizomenon "baltica"* dominated.

## The Central Baltic

The surface water temperatures were more than 21°C except for in the northern part where they were down to 20.5°C. Nitrate was undetectable all the way down to 60 m depth. The concentrations of phosphate varied between 0.5-0.9  $\mu\text{mol/l}$ , whereas the concentrations of silicate were around 5  $\mu\text{mol/l}$ . Hydrogen sulphide was found in the deep water of the East Gotland Basin (Gotland and Fårö Deeps). The Secchi depth varied between 6-8 metres.

The typical bluegreens were common (*Nodularia spumigena*, *Aphanizomenon "baltica"* and *Anabaena sp.*). In the deeper layer (i.e. below 15 m depth) *Dinophysis acuminata*, *D. norwegica* and *D. rotundata* were very common and colored the chlorophyll filters red. Small amounts of the diatoms *Chaetoceros cf. eibonii* and *Coscinodiscus lacustris* were also present.

On the west side of Gotland the plankton flora was richer with several species of dinoflagellates and diatoms as well as bluegreen algae. *Dinophysis spp.* were common as *Gonyaulax triacantha*, The diatom species and the bluegreens were the same as in the other areas.

## Participants

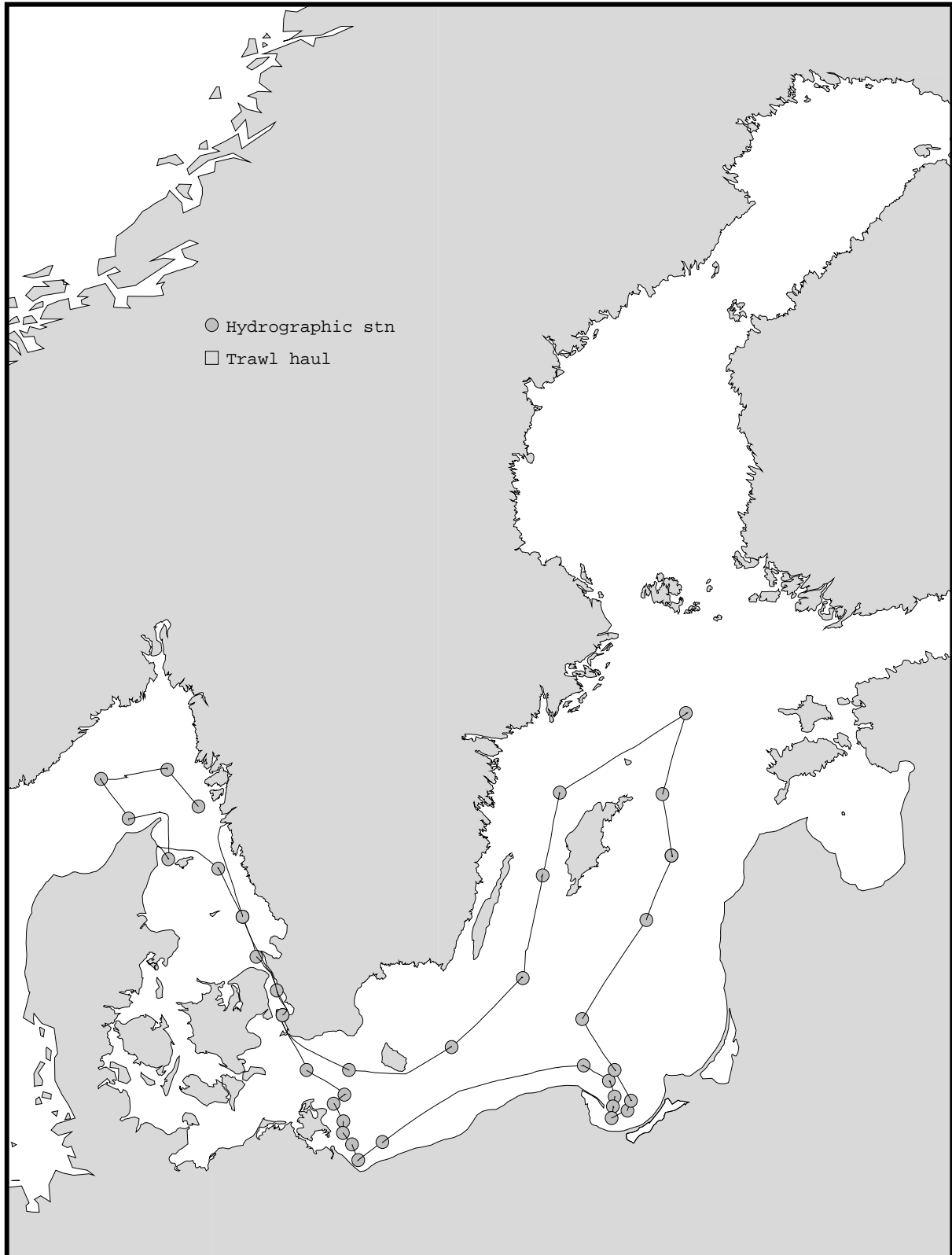
Name	From
Lars Andersson, Chief Scientist	SMHI Oceanographical lab.
Lars Edler	- " -
Mikael Krysell	- " -
Eva Nyberg	- " -
Bodil Thorstensson	- " -
Jorge Valderrama	- " -
Niklas Strömbeck	Uppsala University
Paul Königer	- " -

## Appendices

- Cruise track
- Table of stations, parameters and sampling
- Bottom water oxygen map
- Plots of monthly averages for selected stations
- Profiles from selected stations

# TRACK CHART

Country: Sweden  
Ship : Argos  
Date : 970824-970831  
Series : 0512-0550



# Bottom water oxygen concentration (ml/l)

Country: Sweden  
Ship: Argos  
Date: 970825-970831  
Series: 0517-0550



SMHI Ocean lab                      \*\*\*\*\* Hydrographic series                      Ship: 14-Argos Year: 1997                      \*\*\*\*\*                      Date: 1997-09-01 Time: 11:27

Ser no	Stat code	P r o j	Station-----	Lat-----	Lon-----	Date yymmdd	Time hhmm utc	Bott m	Mld m	Secc m	Wind di ve	Air temp C	Air pres hPa	WCSI elec tua	PCPZTT Cilyooa motPBw PrP l	No de e a h x 2 o o o o h o l i u i O O O o	T m l y S 4 t 2 3 4 t k O m g N C C m	S p i g P P N N N N a 3 u n	P o o o o h o l i u i O O O o	T N N N T A S H L P P T C	
0512	SKEX23BAS	P2		N5752	E1118	970824	1405	96		10.5	27 5	20	1014	2720	x --x----	11	xx - x - x x x x x x - x - - - - - x				
0513	SKEX17BAS	Å16		N5816	E1043.5	970824	1725	205			27 3	20	1013	2730	x --x----	14	xx - x - x x x x x x - x - - - - -				
0514	SKNX21BAS	M6		N5810	E0930	970824	2140	643			23 3	20.3	1013	6920	x xxx---	18	xx x x - x x x x x x x - - - - - x				
0515	SKEX69BAS	HS5		N5744.2	E1000.4	970825	0115	85			32 7	16	1012	9920	x --x----	11	xx - x - x x x x x x - x - - - - - x				
0516	KANX09BAS	LÄSÖ RÄNNA		N5717.6	E1044.5	970825	0600	41			36 2	20	1012	2820	x --x----	8	xx - x - x x x x x x - x - - - - -				
0517	KANX25BAS	FLADEN		N5711.5	E1140	970825	1855	83			11 4	22.2	1009	2820	x --x----	12	xx x x - x x x x x x - x - - - - - x				
0518	KAEX29BAS	ANHOLT E		N5640.0	E1207.0	970825	2230	54			16 7	23.6	1008	9930	x xxx---	10	xx x x - x x x x x x x x x x - - - - -				
0519	KAEX33BAS	KULLEN		N5614	E1222.2	970826	0130	23			14 7	22.5	1008	9920	x --x----	6	xx - x - x x x x x x - x - - - - -				
0520	SOCX39BAS	W LANDSKRONA		N5552.0	E1245.0	970826	0415	47			16 5	21.5	1009	9920	x --x----	9	xx - x - x x x x x x - x - - - - -				
0521	SOCX00BAS	OSKARSGRUNDET NÄRA		N5535.9	E1251.3	970826	0615	9			16 6	23.2	1009	1120	x -----	2	- - - - -				
0522	BPSA02BAS	BY1		N5500	E1318	970826	1045	47		5	16 8	24	1010	1330	x -----	7	xx - x - x x x x x x - x - - - - -				
0523	BPSA00BAS	A2		N5444.0	E1400.0	970826	1345	28		3.5	16 8	24	1010	1330	x xx---	7	- - - x - x - x x - - - x - - - - - x				
0524	BPSA00BAS	PB-1		N5438	E1348.1	970826	1520	27			3 14	6	24	1010	1120	x --x----	7	- - - x - x x x x x x - x - - - - - x			
0525	BPSA00BAS	PB-4		N5426.6	E1358.8	970826	1655	15		1.5	16 3	25.4	1010	1120	x xxx---	5	- - - x - x - x x - - - x - - - - -				
0526	BPSA00BAS	PB-7		N5419	E1358.3	970826	1755	16		1.8	16 3	25.4	1010	1220	x --x----	5	- - - x - x - xx - - - x - - - - -				
0527	BPSA00BAS	PB-10		N5411.5	E1408.4	970826	1910	12			16 3	25.4	1010	9990	x --x----	4	- - - x - x - xx - - - x - - - - -				
0528	BPSA00BAS	PB-14		N5401.2	E1415.3	970826	2030	12			16 3	25.4	1010	9990	x --x----	4	- - - x - x x x x x x - x - - - - - x				
0529	BPSA00BAS	PB-19		N5413.1	E1442.2	970826	2305	15			14 4	22	1010	9990	x xxx---	4	xx - x - x x x x x x - x - - - - -				
0530	BPSE00BAS	PLX-3		N5503	E1825.5	970827	1235	73		6.5	09 3	21	1012	1120	x --x----	8	- - - x - x x x x x x - x - - - - -				
0531	BPSE00BAS	PLX-4		N5453	E1853.6	970827	1520	101		3.5	11 3	24	1012	1120	x --x----	8	- - - x - x - xx - - - x - - - - - x				
0532	BPSG00BAS	9NE HELA		N5442.7	E1900	970827	1650	93		2	16 3	24.5	1011	1120	x --x----	8	- - - x - x x x x x x - x - - - - - x				
0533	BPSG00BAS	4NE HELA		N5436.2	E1858.0	970827	1800	78			16 3	23.5	1011	1220	x --x----	8	- - - x - x - xx - - - x - - - - - x				
0534	BPSG00BAS	8SE HELA		N5428.6	E1856.5	970827	1900	66			16 2	22.5	1011	9920	x --x----	8	- - - x - x x x x x x - x - - - - - x				
0535	BPSG00BAS	PLX-5S		N5433.6	E1914.2	970827	2055	80			16 2	22.5	1011	9920	x --x----	8	- - - x - x - xx - - - x - - - - - x				
0536	BPSG00BAS	PLX-5		N5440	E1918.1	970827	2200	93			16 2	23.4	1011	9920	x --x----	8	- - - x - x - xx - - - x - - - - - x				
0537	BPSE00BAS	A3		N5500	E1900	970828	0040	102			14 3	22	1012	9920	x --x----	8	- - - xx x x x x x x - x - - - - - x				
0538	BPSE11BAS	BCS III-10		N5533.3	E1824	970828	0530	91		8	16 2	22.5	1010	1120	x xxx---	13	xx x x - x x x x x x x - - - - -				

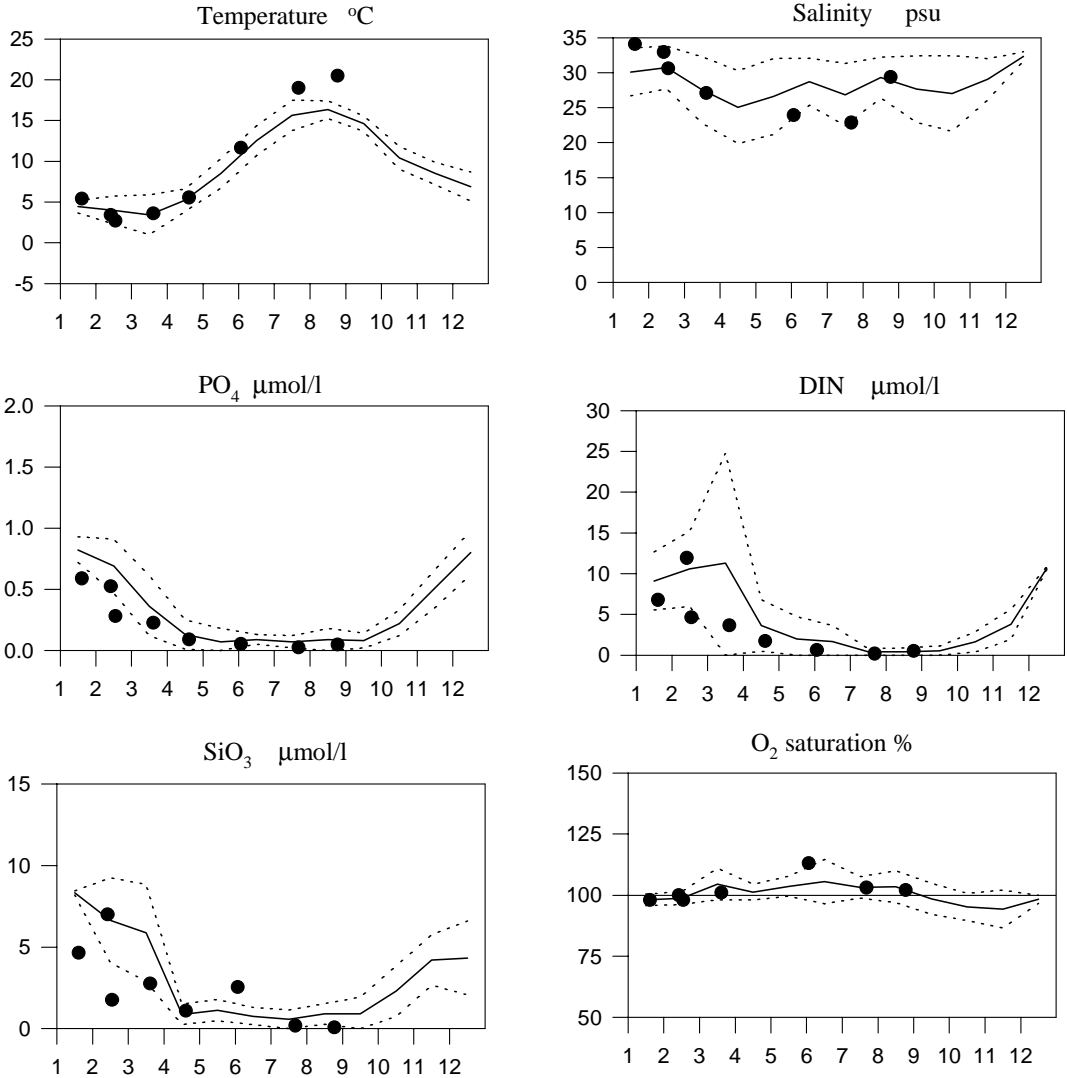




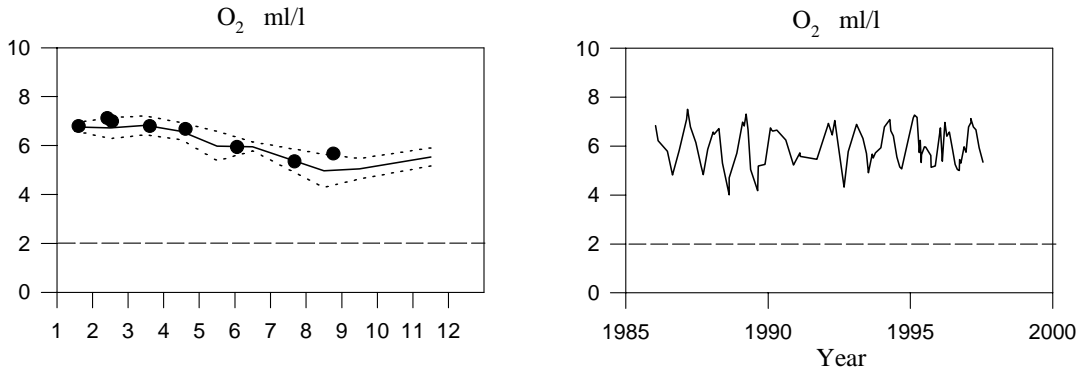
## STATION P2 SURFACE WATER (0-15 m)

### Annual Cycles

— Mean 1986-1995      - - - - St.Dev.      ● 1997



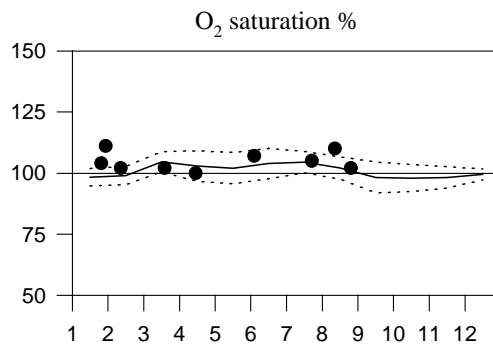
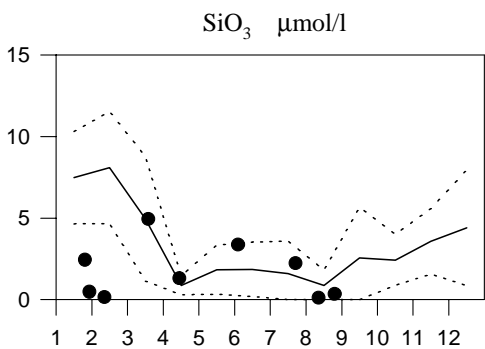
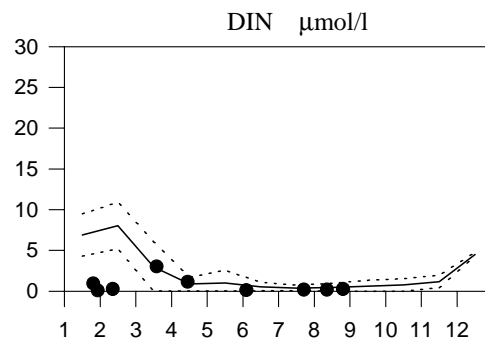
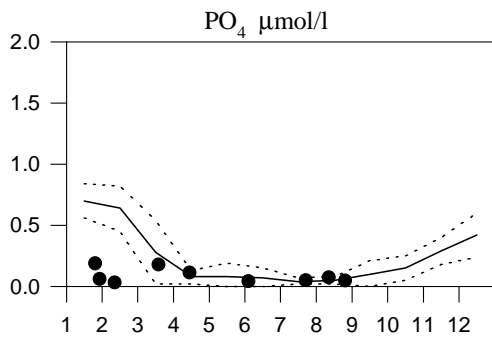
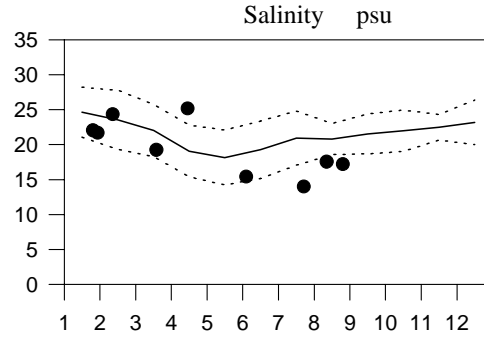
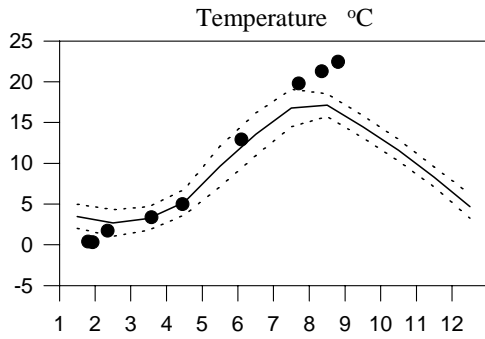
### OXYGEN IN BOTTOM WATER



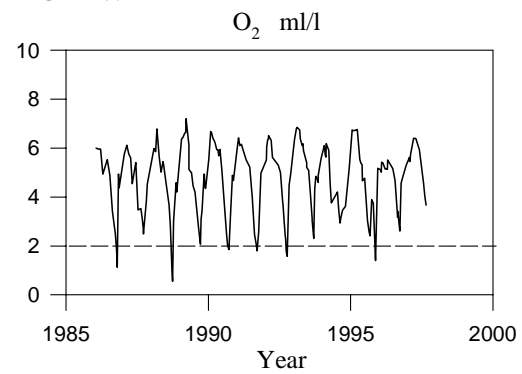
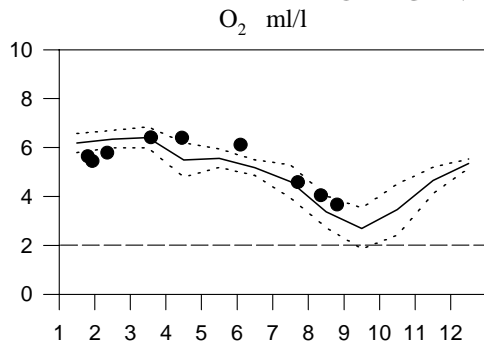
# STATION ANHOLT E SURFACE WATER (above halocline)

## Annual Cycles

— Mean 1986-1995    - - - St.Dev.    ● 1997



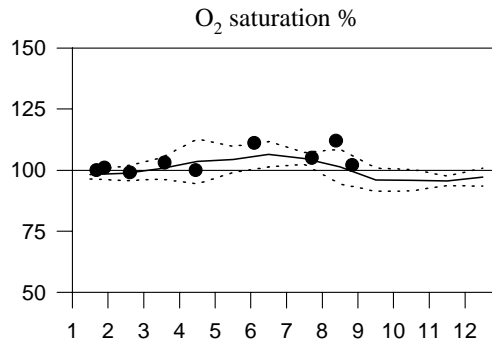
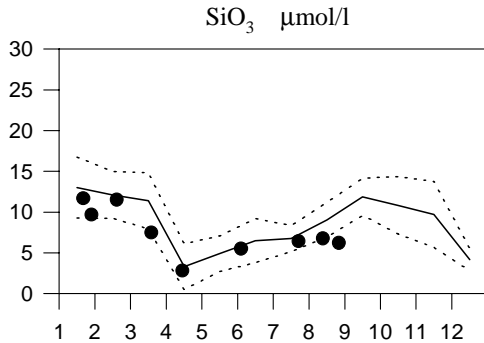
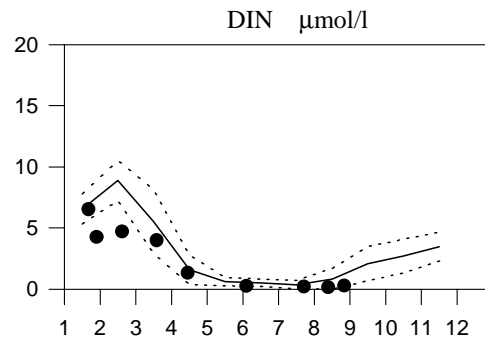
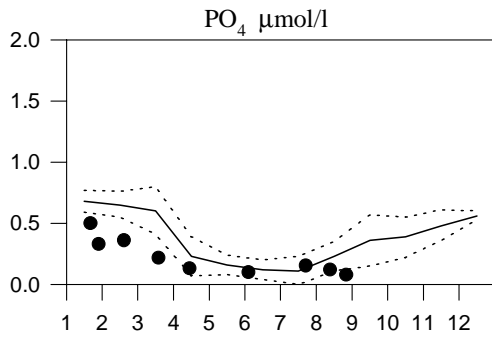
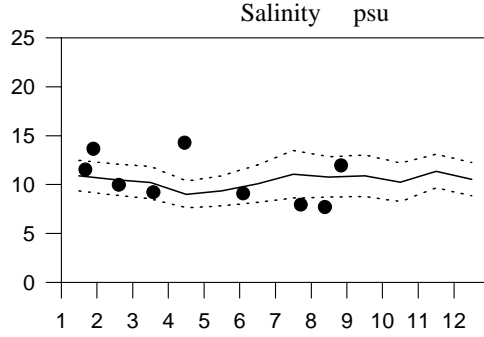
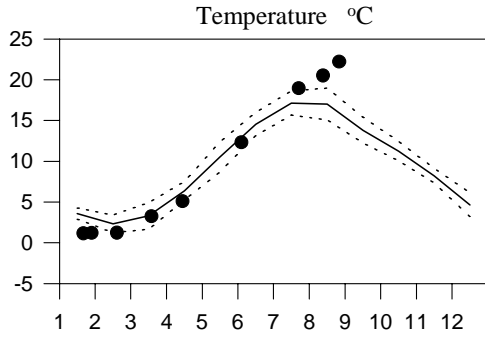
## OXYGEN IN BOTTOM WATER



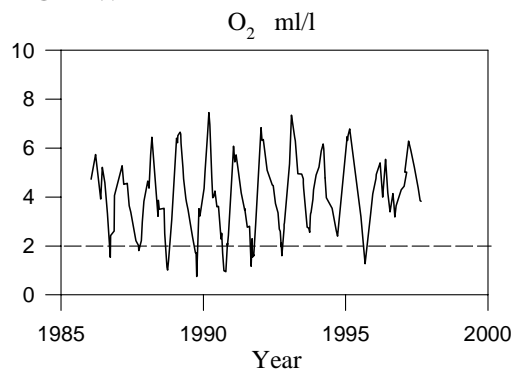
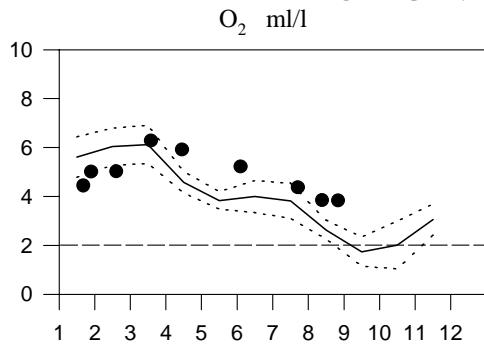
# STATION W LANDSKRONA SURFACE WATER (0-15 m)

## Annual Cycles

— Mean 1986-1995    - - - St.Dev.    ● 1997



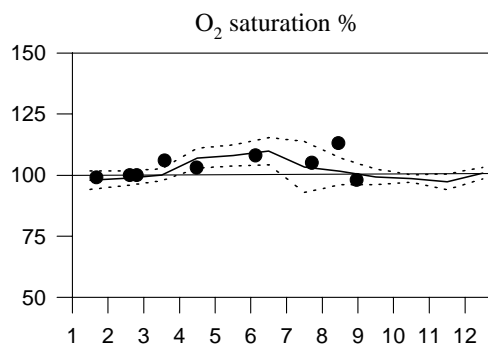
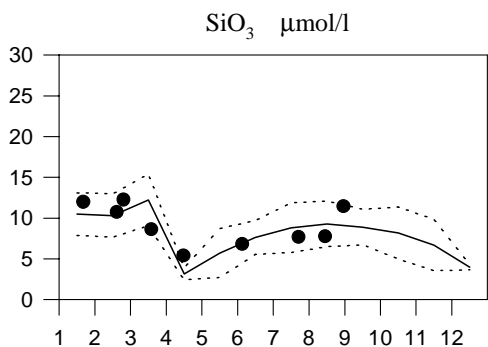
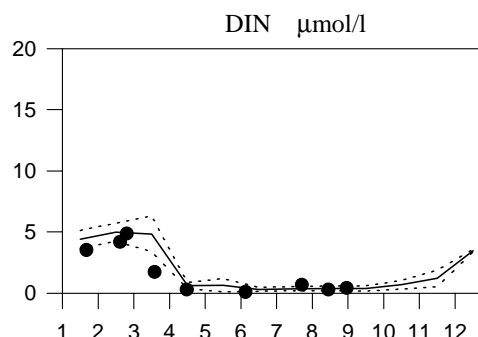
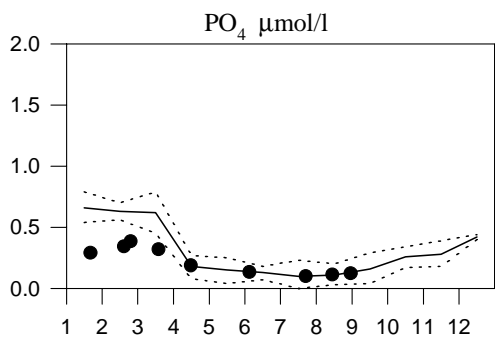
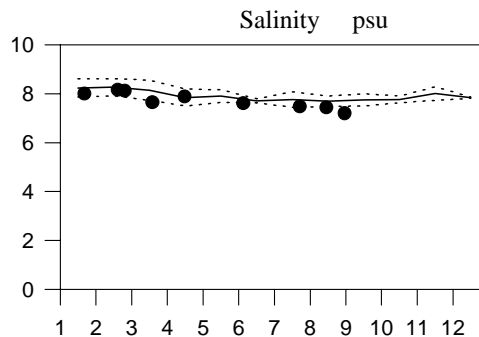
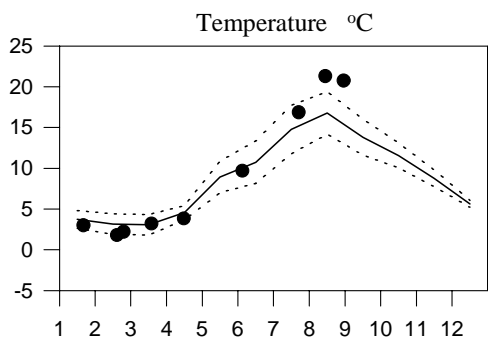
## OXYGEN IN BOTTOM WATER



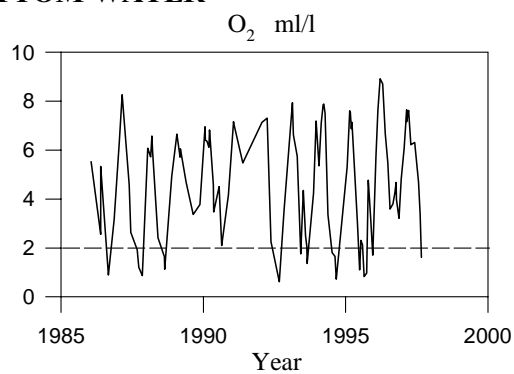
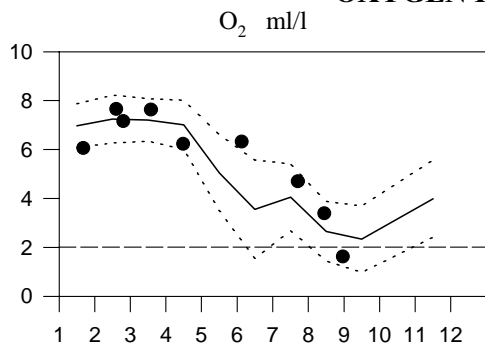
## STATION BY2 SURFACE WATER (0-15 m)

### Annual Cycles

— Mean 1986-1995    - - - St.Dev.    ● 1997



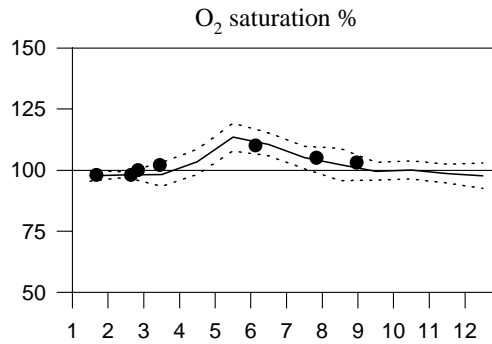
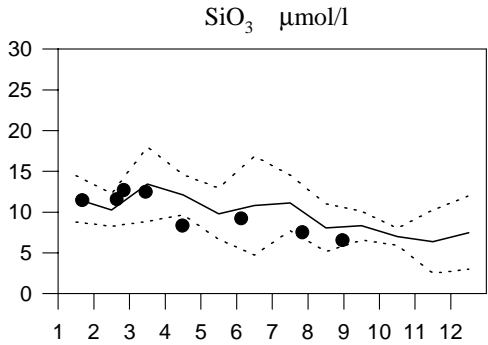
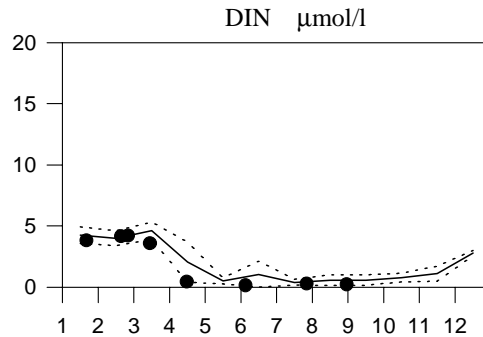
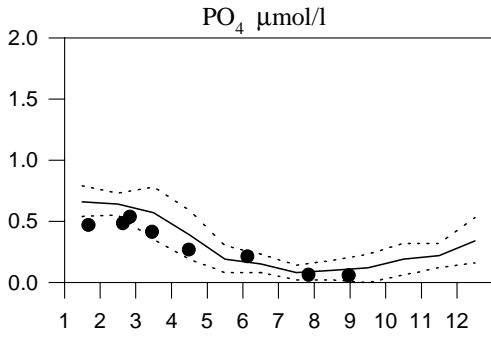
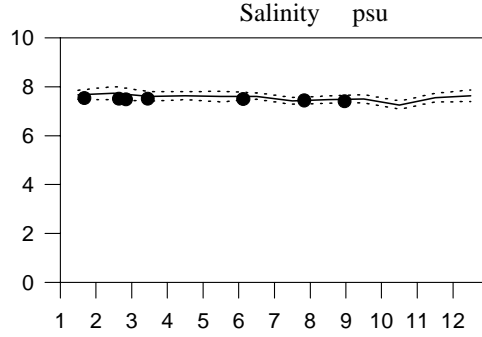
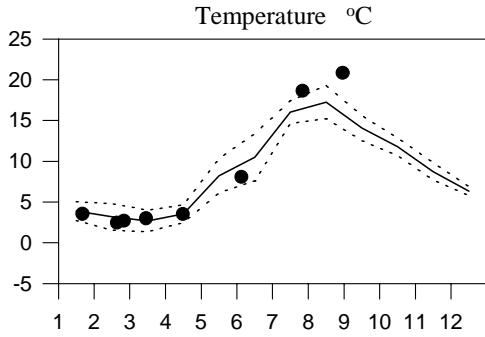
### OXYGEN IN BOTTOM WATER



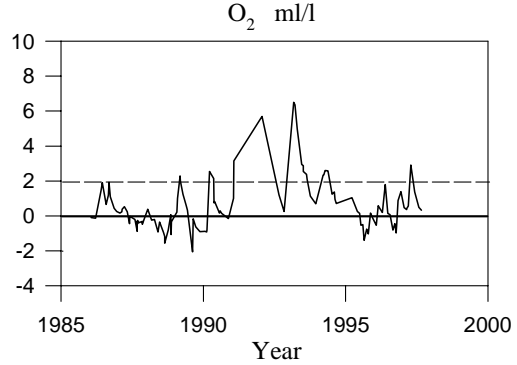
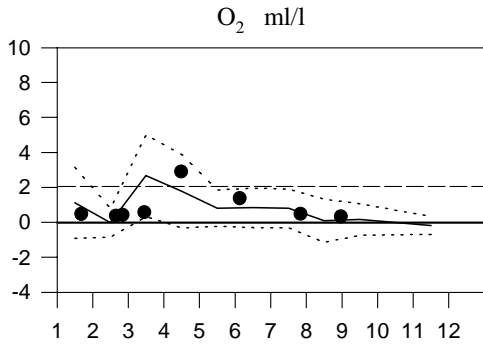
# STATION BY5 SURFACE WATER (0-15 m)

## Annual Cycles

— Mean 1986-1995    - - - St.Dev.    ● 1997



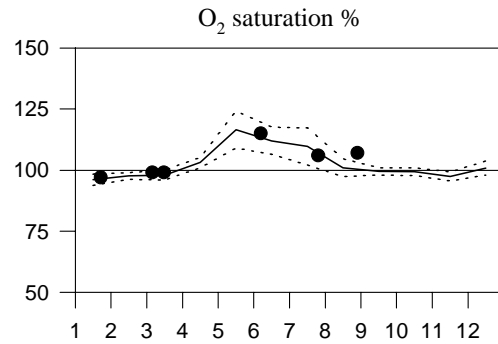
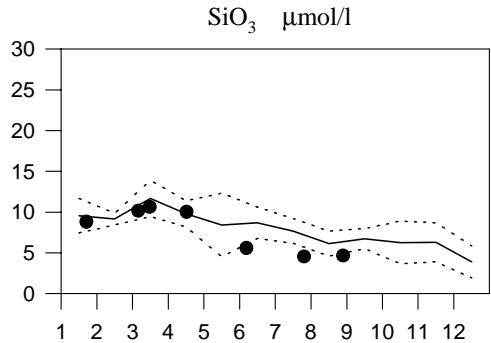
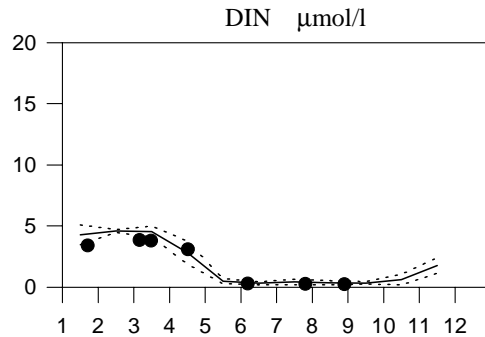
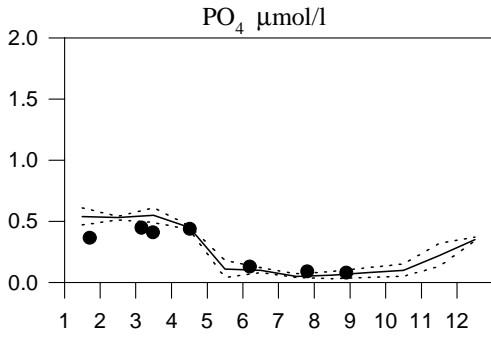
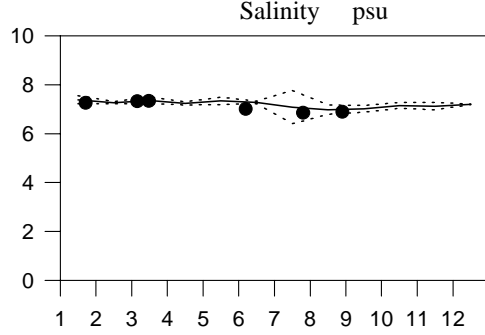
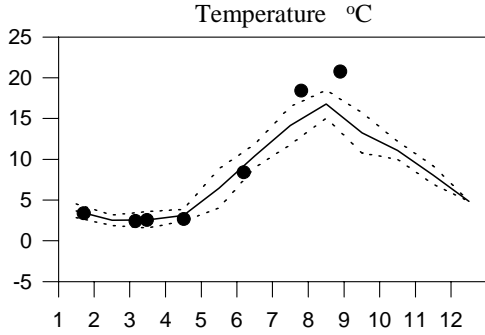
## OXYGEN IN BOTTOM WATER



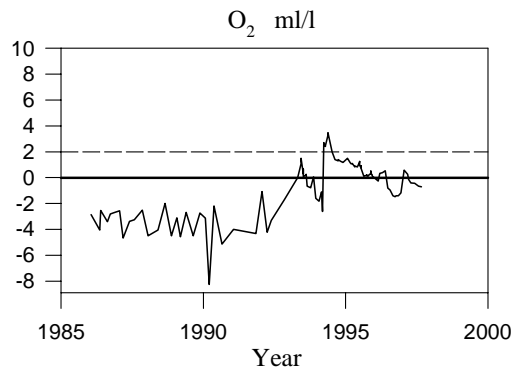
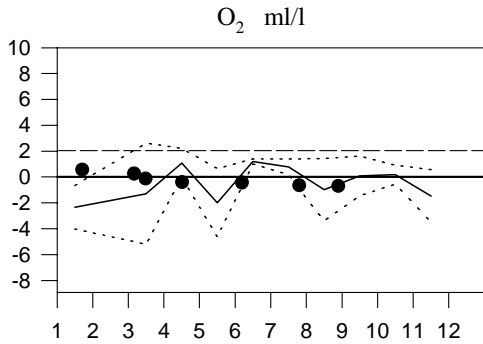
# STATION BY15 SURFACE WATER (0-15 m)

## Annual Cycles

— Mean 1986-1995    - - - - St.Dev.    ● 1997



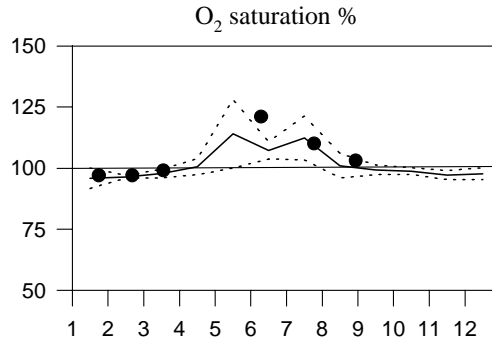
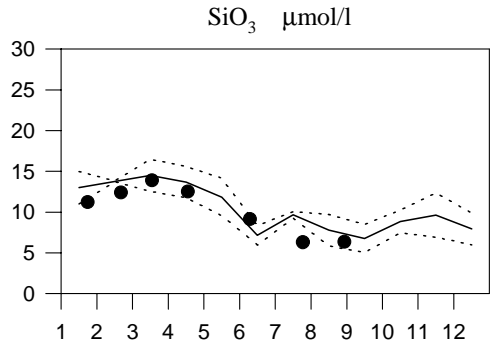
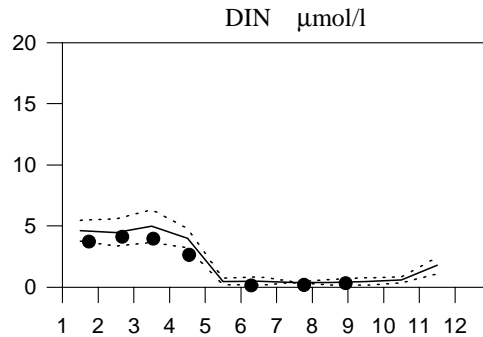
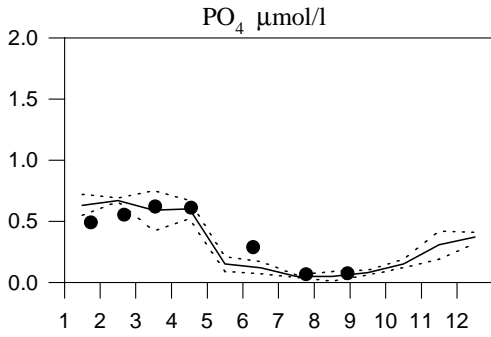
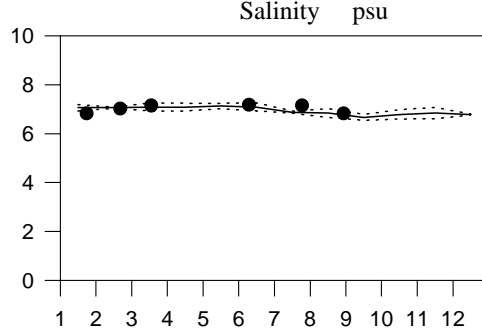
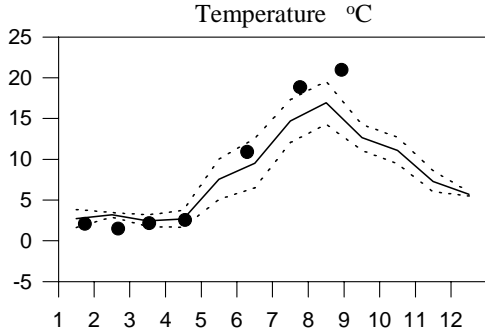
## OXYGEN IN BOTTOM WATER



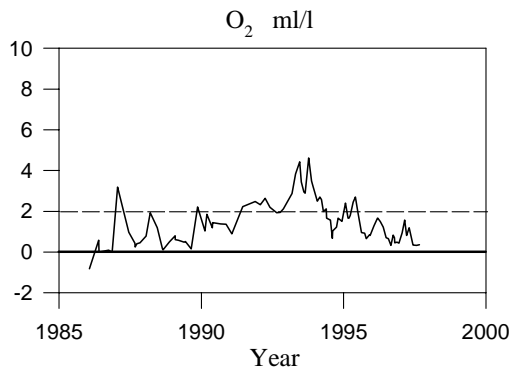
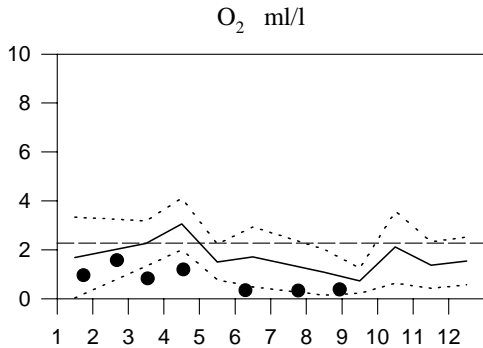
# STATION BY38 SURFACE WATER (0-15 m)

## Annual Cycles

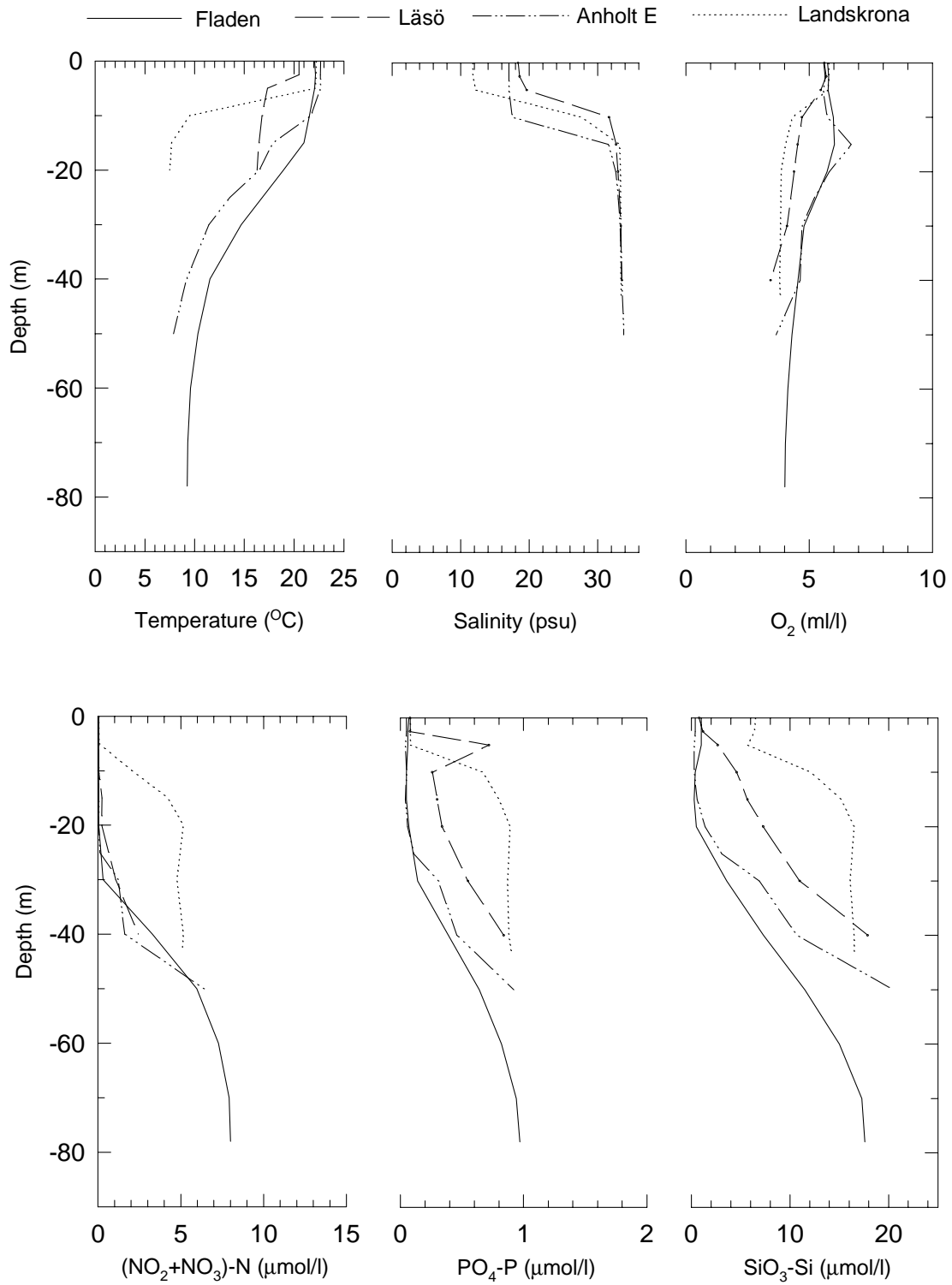
— Mean 1986-1995    - - - St.Dev.    ● 1997



## OXYGEN IN BOTTOM WATER

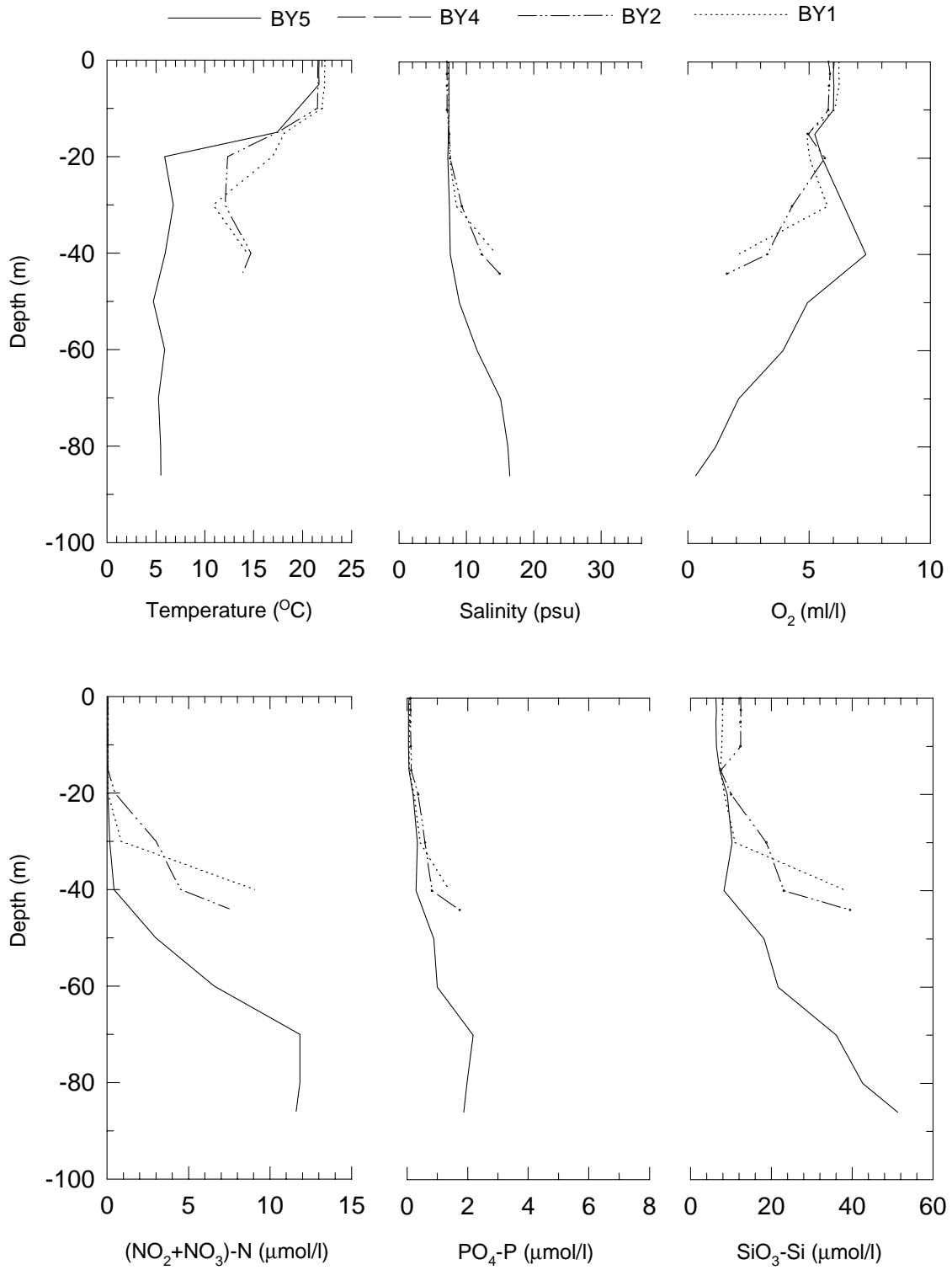


# KATTEGAT and THE SOUND week 35 -97





# SOUTH BALTIC week 35 -97



# EAST BALTIC week 35 -97

