# Trace Metal Concentrations and Trends in Baltic Surface and Deep Waters

*Baltic Sea Environment Fact Sheet 2009*

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## Key Message

For mercury we observed a general decrease of the surface concentrations in Baltic Sea waters by a factor of 5-10 since 2000 (Fig. 5).

In general the 2009 (February) results of lead (Pb), and cadmium (Cd) concentrations in Baltic Sea surface and deep waters revealed no pronounced changes compared to previous years. Regional and temporal limited variations of trace metal concentrations, which have been observed periodically in the western Baltic (Pomeranian Bay), have been attributed to the inflow from the Odra river, influenced by the prevailing wind directions.

## Results and Assessment

Lead, Mercury, and Cadmium are hazardous metals in the Baltic marine environment. Because of their large impact by rivers and the atmosphere (HELCOM 1997; 2004), their toxic effects on the ecosystem and their complex biogeochemical behaviour, it was recommended by HELCOM to monitor these contaminants isochronous.

The enrichment of metals in biota is dependent on their bioavailability. In this context it is useful to differentiate between dissolved and particle bounded (volume related) metal species as also implemented by OSPAR in the North Sea.

To study the development of trace metal trends in the water column and to establish comparable time series, it was recommended to perform the sampling of these contaminants once a year in wintertime (February), when the biological activities are limited.

### Background Concentrations

The valuation of background concentrations for trace metals in Baltic waters to centuries, when anthropogenic pollution was reduced to a minimum, is limited. One possibility is the use of comparable data from areas which are less influenced by human activities e.g. the northern Atlantic waters (Tab.1).

The trace metal concentrations in Baltic waters are still higher than in Atlantic waters, although a decreasing trend of 6 % per year for Cd and Cu was revealed between 1980 and 1993 (HELCOM 1996) in Baltic surface waters.

***Tab.: 1***

*Concentrations of dissolved trace metals (ng/kg) from the North Atlantic and the Baltic Sea. (1)Kremling, K. & Streu, P. (2001); (2)Pohl, C. et al. (1993); (3)Pohl, C. et al. (2005); (4)Dalziel, J. A. (1995)*

| *Element* | *North Atlantic* | *Baltic Sea* | *Factor* |
|---|---|---|---|
| *Hg* | *0.15-0.3* (4) | *0.5-1.5* (3) | *~ 5* |
| *Cd* | *4 (+-2)* (1) | *12-16* (3) | *~ 4* |
| *Pb* | *7 (+-2)* (1) | *12-20* (3) | *~ 3* |
| *Cu* | *75 (+-10)* (2) | *500-700* (3) | *~ 10* |
| *Zn* | *10-75* (1) | *600-1000* (3) | *~ 10-50* |

## Geographical Distribution

Like in past years, also in 2009 regional differences between the surface waters of the western Baltic and the central Baltic Sea were observed for lead and cadmium (Fig. 1) with higher concentrations in the western Baltic and the Odra river outflow, a station which has been considered additionally in 2009. Also for mercury (Fig. 2), lower concentrations were observed in the central Baltic. One explanation is, that in the 1960th a dumping area highly contaminated in trace metals was established in the Bay of Lübeck. In combination with wind induced mixing and bioturbation of marine organism this area is still more or less a source for SPM and trace metal (Pb) enrichment in the water column.

A decrease of the mercury concentrations in the Baltic Proper was observed since 2000. In 2009 concentrations ranges mostly below <3pmol/kg.

Short-term changes induced during the main saltwater inflow event in February 2003 were only reflected in the trends “Below Halocline” for Cddiss and Cudiss. Stagnant conditions with anoxia and decreasing dissolved trace metal conditions below the oxic-anoxic interface were noticed in the near bottom layer of the Bornholm Basin at 80 m depth, below ~130 m in the Gotland Deep and below 100 m in the Landsort Deep.

For the contents of CdSPM and CuSPM an increase was observed with depth in the central Baltic, a hint for the stabilisation of the stagnation period. Altogether the saltwater inflow event in 2003 had influenced the trace metal long-term trends in the deepwater of the central Baltic Sea. Now there is another chance to study changes in trace metal concentrations during the stabilisation of an anoxic deep water body as well as the "feedback mechanism" on the trace metal concentrations in the surface water body.

## Long term Development

*General Decrease of Mercury*

For mercury we observed a general decrease of the surface concentrations in Baltic Sea waters by a factor of 5-10 between February 2000 and February 2005 and which was proved true and stabilised also in the following years as shown in Fig. 5.

As Hg belongs to the elements with a higher affinity to the particulate fraction this result is possible due to an increasing elimination from surface waters with the particulate phases in combination with a decrease of atmospheric mercury input. We updated the mercury results in Tab. 1, were the mean concentrations in relation to Atlantic water masses are given.

*Western Baltic*

Inter annual differencesat the sampling stations in the western Baltic for the period 1993-2009 demonstrated that not only salinity but also heavy metal concentrations are subject to fluctuations especially in the transition area between the North Sea and Baltic Sea (Fig. 3 – Fig. 5).

The observation period was perhaps too short for the detection of clear temporal trends in this transition area, especially because the Baltic was influenced by a major saltwater inflow in 1993/1994 and 2003.

*Baltic Proper "Above Halocline"*

Since 1999 we observed, that the water body "Above Halocline" is characterised by slightly decreasing trends (not significant) over the passed 10 years for the dissolved phases of Cd, Pb, and total Hg (Fig. 3 – Fig. 5). The question has been discussed, if long-term trace metal trends in surface- and deep waters of the Gotland Basin (Central Baltic) are a result of enhanced / reduced input to the Baltic Sea or if they are related to a "feedback mechanism" including the stabilisation of the anoxic deep water regime and the irreversible trace metal export by diffusive exchange across the oxic-anoxic interface.

Estimations of the diffusive and particulate internal trace metal fluxes and export rates showed under consideration of the data from the pollution load compilation (latest revision) (HELCOM 2004), that about 50% of the Cd-input; 53% of the Pb-input; 63% of the Zn-input and 60% of the Cu-input into the Baltic Sea, are eliminated by internal biogeochemical processes at the oxic-anoxic interface (Pohl & Hennings 2005, 2008).

*Baltic Proper "Below Halocline"*

In the last years decreasing lead concentrations were also observed in the Baltic. Since 2000 they stabilised on a low level (<0.1nmol/kg) "Below Halocline" in the Baltic Proper. Reasons for that are the use of unleaded petrol, the fast vertical transport of lead bounded to particles and there enrichment in the sediments. Baltic Sea sediments are still high contaminated in trace metals.

Assuming that the Baltic deep water system changes to oxic conditions it is expected, that remobilisation of metals and their release back into the water column will take place.

Since 1995 / 1996 a decrease of the Cd(dissolved) and Cu(dissolved) concentrations were observed for the waters "Below Halocline" in the central Baltic Sea, due to the precipitation of sulphidic Cd species under anoxic conditions in the deep water body (Fig. 4) and their enrichment in surface sediments. This example demonstrates, how variations in the trace metal concentrations are linked to eutrophication.

# References


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## Metadata and Quality Assurance

We successfully participate in the Quasimeme QA for Mercury in seawater, trace metals in seawater, trace metals SPM and trace metals in sediments.

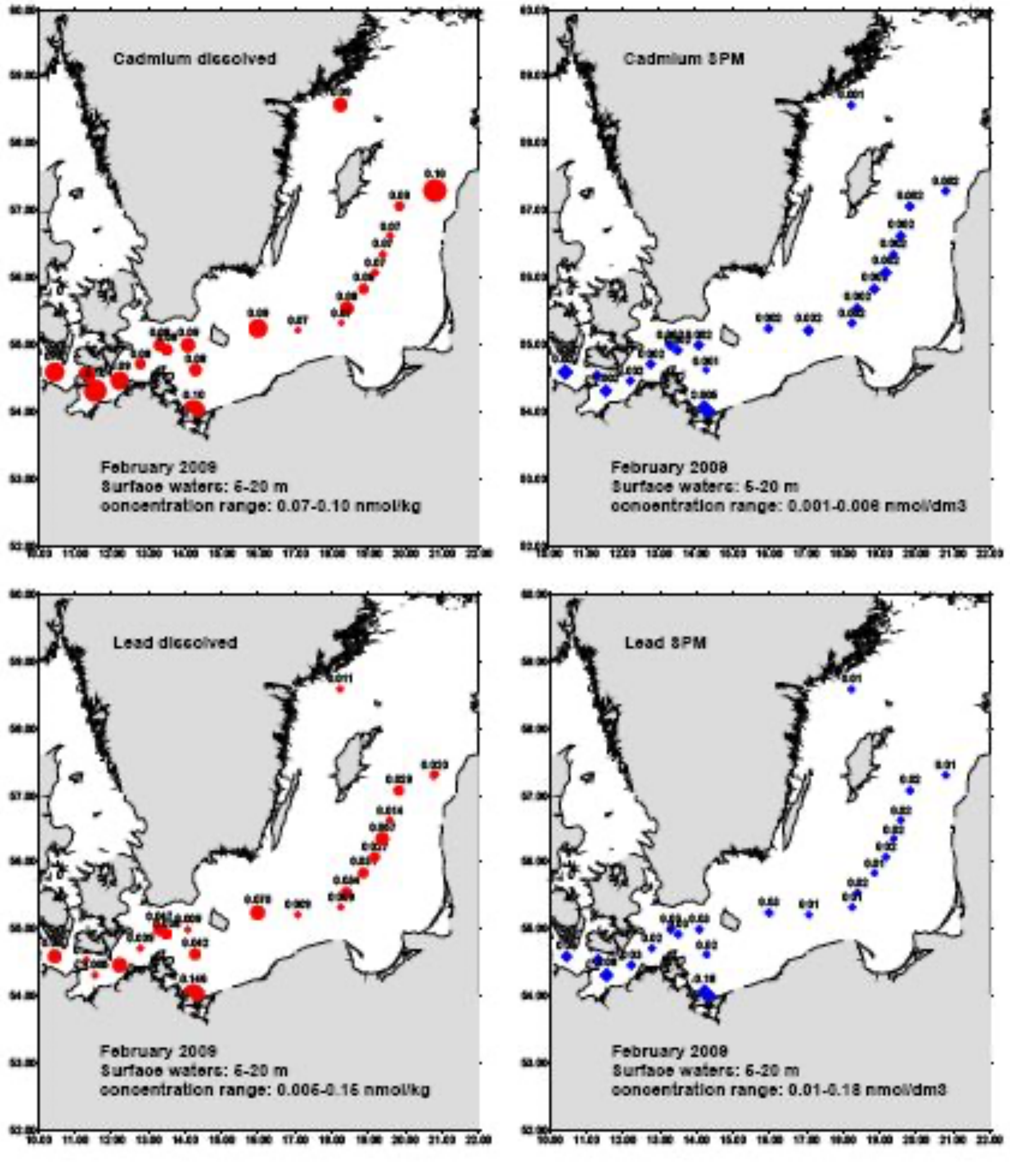



Fig. 1
Distribution of Cd and Pb in the dissolved and particulate phases in surface waters of the Baltic Sea; February 2009

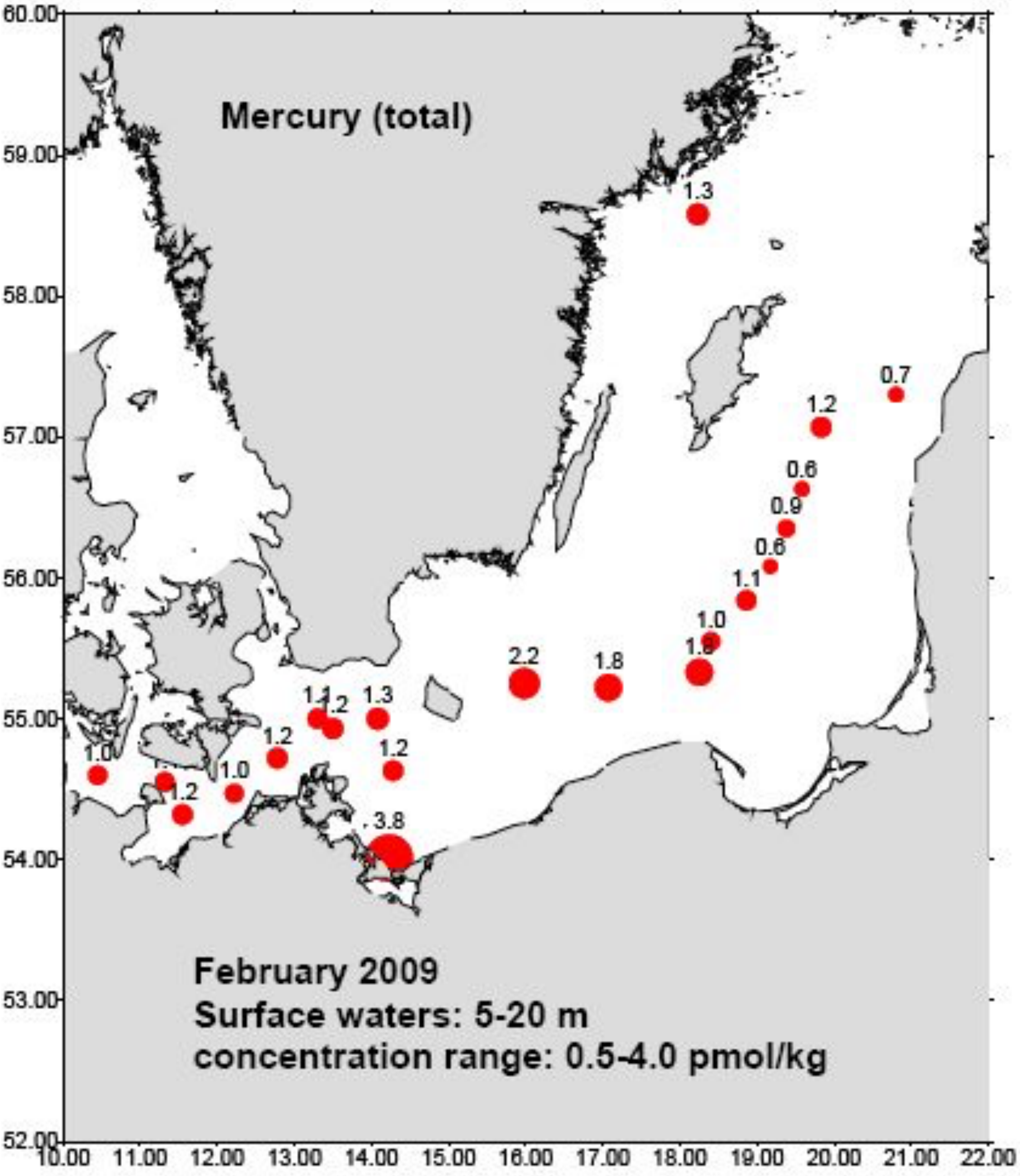



Fig. 2
Distribution of Mercury (total) in surface waters of the Baltic Sea; February 2009

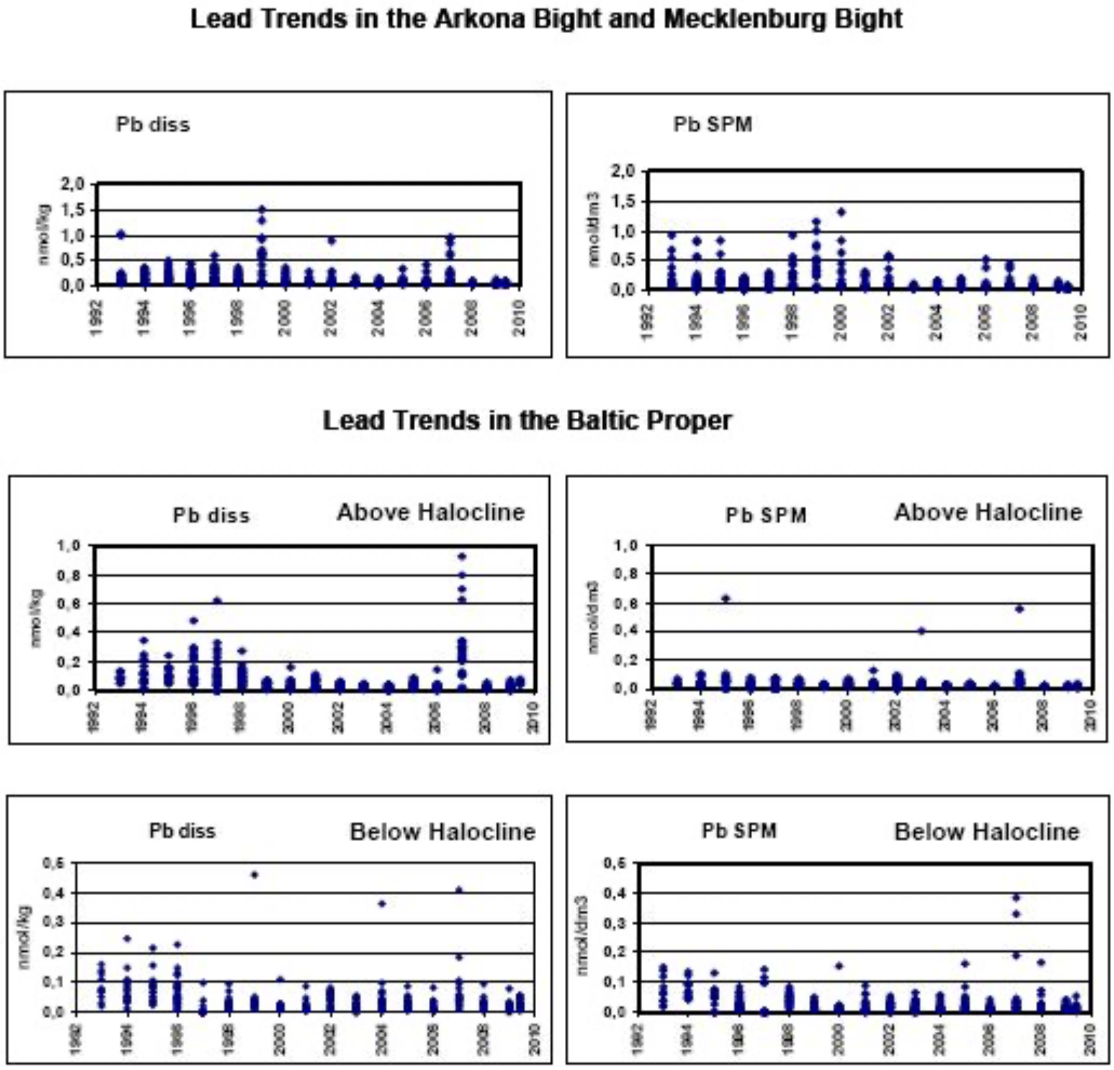



**Fig. 3**

**Analysis of trends for dissolved (diss) and particulate (SPM) Pb in the western Baltic as well as above and below the halocline in the central Baltic between 1993-2009.**

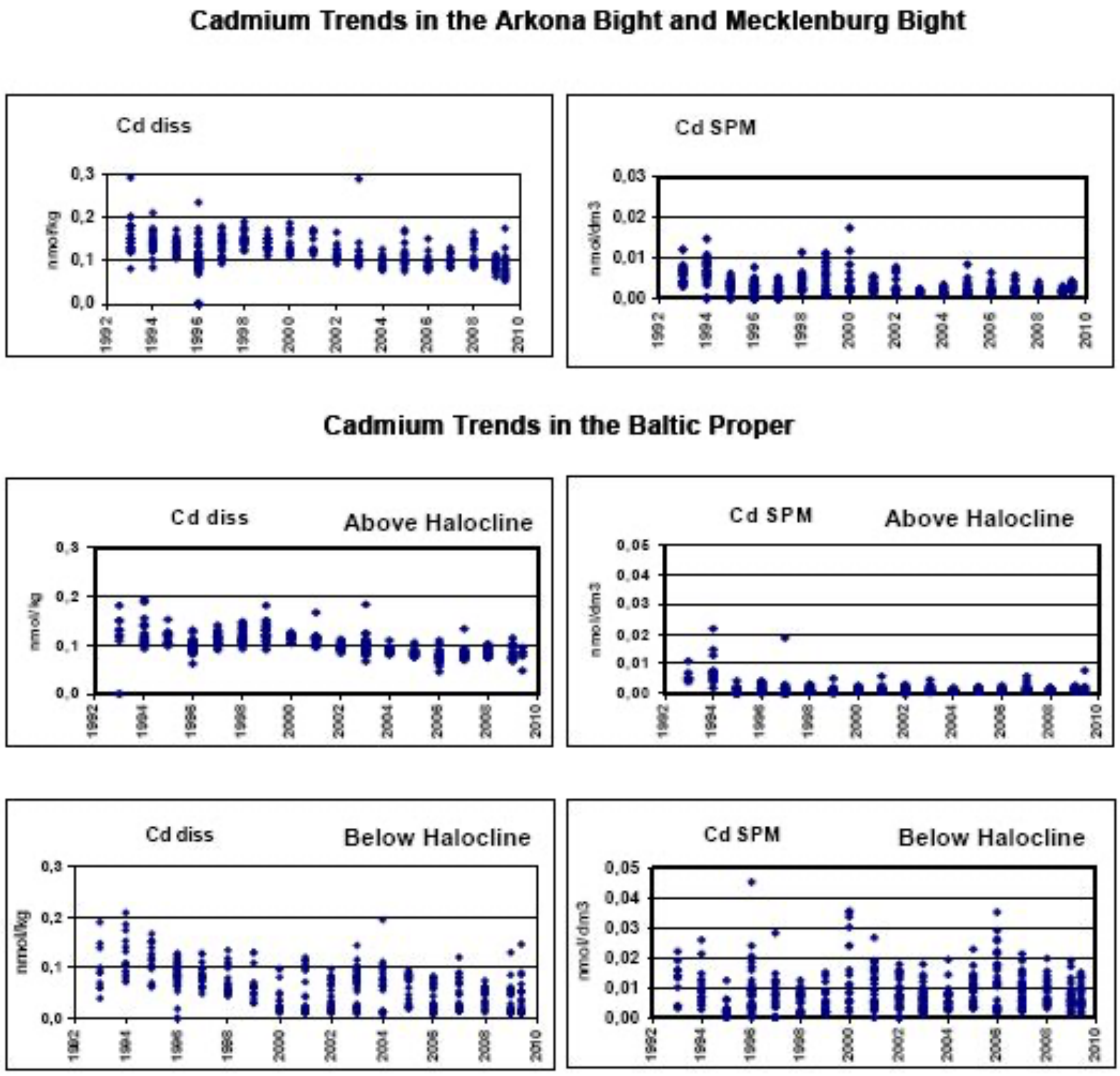
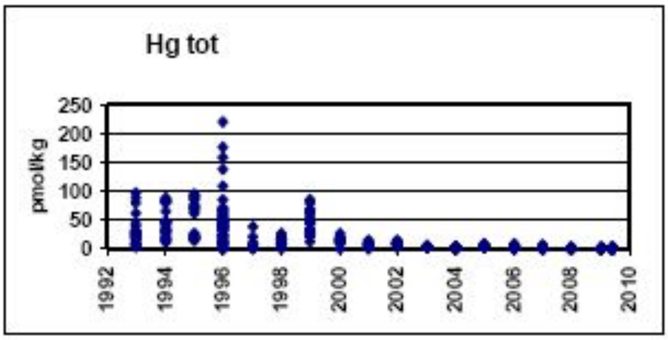


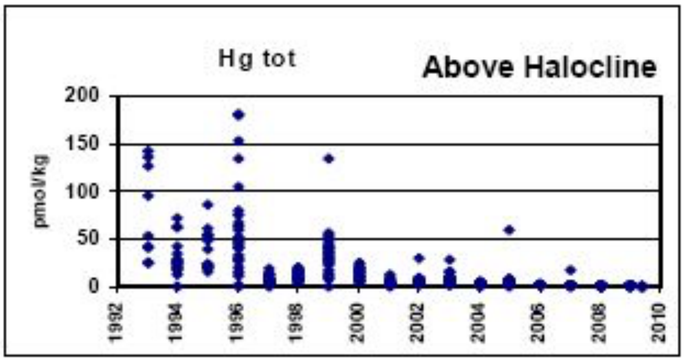

**Fig. 4**
**Analysis of trends for dissolved (diss) and particulate (SPM) Cd in the western Baltic as well as above and below the halocline in the central Baltic between 1993-2009.**

**Mercury Trends in the**

**Arkona Bight and Mecklenburg Bight**




**Mercury Trends in the Baltic Proper**



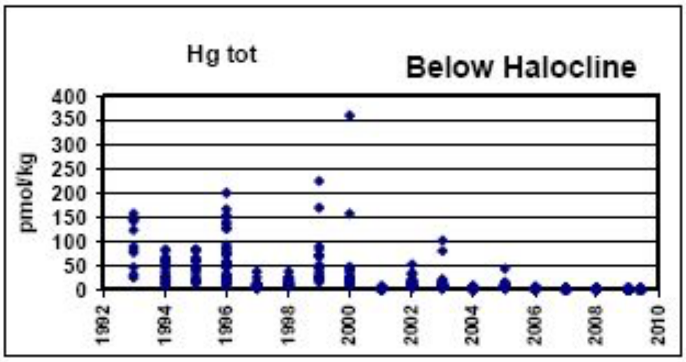




**Fig. 5**

**Analysis of trends for total Hg in the western Baltic as well as above and below the halocline in the central Baltic between 1993-2009.**

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