Norwegian State Pollution
Monitoring Programme

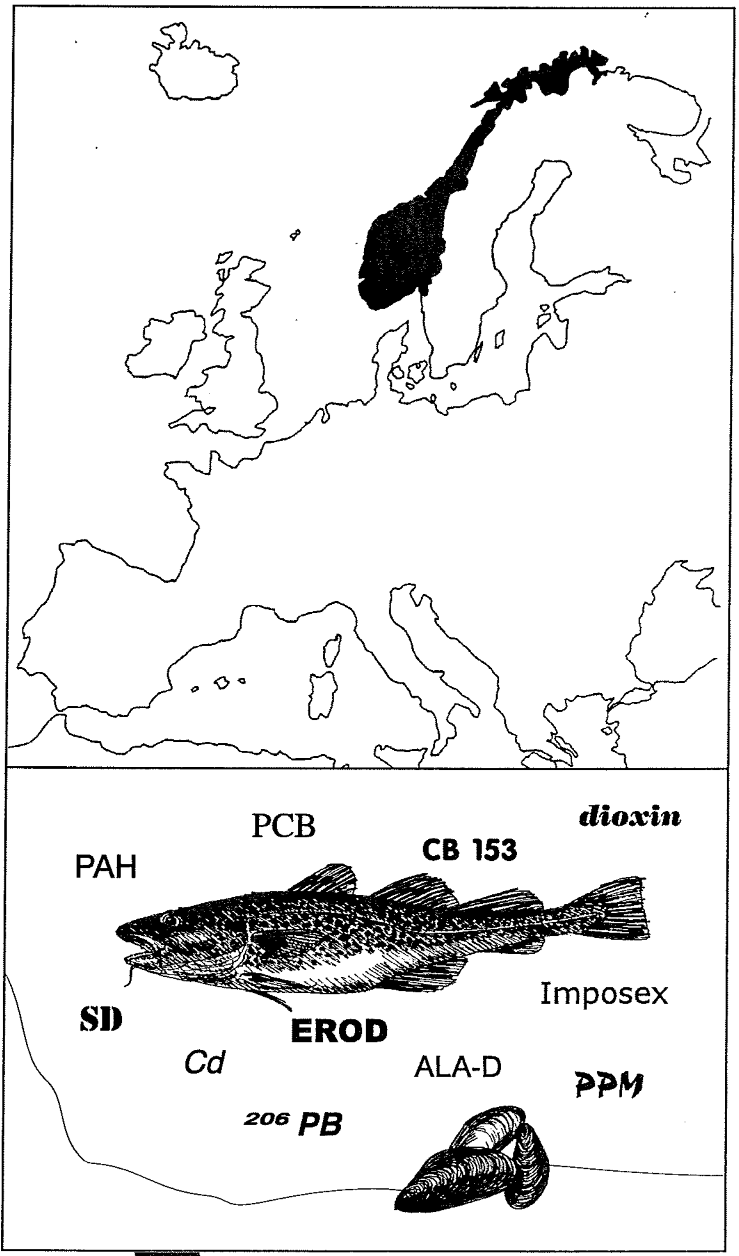
Report 788/00

Client	**Norwegian Pollution Control Authority**
Contractor	**NIVA**

Joint Assessment and Monitoring Programme (JAMP)

National Comments regarding the Norwegian Data for 1998 and

Supplementary investigations on cod (1996) and sediment (1996 - 1997)



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TA 1702/2000

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REPORT

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Title
Joint Assessment and Monitoring Programme (JAMP).
National Comments regarding the Norwegian Data for 1998 and supplementary investigations on cod (1996) and sediment (1996-1997).

(Norwegian State Pollution Monitoring Programme
Report no. 788/00. TA-no. 1702/2000)

Serial No.
4171-2000

Date
2000.01.20

Report No. Sub-No.
O-80106

Pages Price
206

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Topic group
Marine ecology

Distribution

Geographical area
Oslofjord to Varangerfjord

Printed
NIVA

Client(s)
Norwegian Pollution Control Authority (SFT)

Client ref.

Abstract

This report is part of the Norwegian contribution to the SIME 2000 meeting administrated by OSPAR. JAMP 1998 included the monitoring of micropollutants in blue mussels (39 stations) and fish (20 stations) along the coast of Norway from Oslo to Bergen, Lofoten and Varangerfjord. The results indicated elevated levels of contaminants (i.e. over provisional "high background") in: Oslofjord proper (PCBs, ppDDE and mercury in fish) and Langesundsfjord (HCB in mussels) and Sørfjord and Hardangerfjord (cadmium, lead, mercury and ppDDE in mussels). Significant downward trends were found for cadmium in mussels from the Sørfjord and Hardangerfjord for the period 1987-1998. The results from the remaining stations showed primarily low levels of contamination. No change in "pollution" or "reference" index classification was found from 1997 to 1998. Studies were also conducted on the southern/south-western coast using biological effects methods in cod (6 stations) and imposex/intersex in dogwhelks (6 stations). Furthermore, this report includes supplementary investigations of sediment (13 stations, 1996-1997), dioxins and other persistent halogenated chlorines and bromines in cod liver (4 stations, 1996).

4 keywords, Norwegian		4 keywords, English	
1.	Miljøgifter	1.	Micropollutants
2.	Organismer	2.	Organisms
3.	Marin	3.	Marine
4.	Norge	4.	Norway

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ISBN 82-577-3787-9

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OSLO AND PARIS CONVENTIONS FOR THE PREVENTION OF MARINE POLLUTION

WORKING GROUP ON CONCENTRATIONS, TRENDS AND EFFECTS OF SUBSTANCES IN THE MARINE ENVIRONMENT (SIME)

STOCKHOLM 21-25 FEBRUARY 1999

O-80106

JOINT ASSESSMENT AND MONITORING PROGRAMME (JAMP)

NATIONAL COMMENTS REGARDING THE NORWEGIAN DATA FOR 1998 AND SUPPLEMENTARY INVESTIGATIONS ON COD (1996) AND SEDIMENT (1996-1997)

Oslo, 20. January 2000

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Foreword

This report presents the Norwegian national comments on the 1998 investigations for the Joint Assessment and Monitoring Programme (JAMP). JAMP is administered by the Oslo and Paris Commissions (OSPAR) and their Environmental Assessment and Monitoring Committee (ASMO). JAMP receives guidance from the International Council for the Exploration of the Sea (ICES). ASMO has delegated implementation of part of the programme to the Working Group on Concentrations, Trends and Effects of Substances in the Marine Environment (SIME). The Norwegian 1998 investigations are directed to particular JAMP issues relating to contaminants and implemented by SIME. Some JAMP issues to be addressed lack adequate guidelines, in such cases guidelines used by the Joint Monitoring Programme (JMP) were applied.

The Norwegian JAMP for 1998 was carried out by the Norwegian Institute for Water Research (NIVA) by contract from the Norwegian Pollution Control Authority (SFT), (NIVA contract O-80106).

The Norwegian contribution to the JAMP was initiated by SFT in 1981 as part of the national monitoring programme. It now comprises three areas: the Oslofjord and adjacent areas (Hvaler-Singlefjord area and Langesundsfjord, 1981-), Sørfjord/Hardangerfjord (1983-84, 1987-) and Orkdalsfjord area (1984-89, 1991-93, 1995-96).

Since the North Sea Task Force Monitoring Master Plan was implemented in 1990 additional areas have also been monitored. These include: Arendal, Lista and Bømlo-Sotra areas. On the initiative of SFT and NIVA "reference" or merely diffusely contaminated areas from Bergen to Lofoten have been monitored since 1992 and from Lofoten to Norwegian-Russian border from 1994.

These comments are considered as preliminary notes on the 1998 results and are not to be viewed as a final assessment.

The comments are presented in accordance with the agreed standardised format (ASMO 1997, Annex 12).

Thanks are due to many colleagues at NIVA, especially: Unni Efraimsen, Frank Kjellberg, Sigurd Oxenvad, Tom Tellefsen for field work, sample preparations, data entry; Einar Brevik and his colleagues for organic analyses; Norunn Følsvik for organotin analyses; Bente Hiort Lauritzen and her colleagues for metal analyses; Gunnar Severinsen for data programme management, Oddbjørn Pettersen for running data programmes; and to the authors Birger Bjerkeng (VIC), Aud Helland (sediment) Ketil Hylland (biological effects methods), Jon Knutzen (dioxins) and Mats Walday (organotin). Thanks go also to the numerous fishermen and their boat crews we have had the pleasure of working with.

Oslo, 20 January 2000.

Norman W. Green
Project co-ordinator

Contents

1. General Details

1.1 Executive Summary

The Norwegian JAMP 1998 included the monitoring of micropollutants (contaminants) in blue mussels (39 stations including Index) and fish (20 cod/flatfish stations including VIC) from the border of Sweden in the south along the coast of Norway to Bergen area, Lofoten and the Varangerfjord bordering Russia. The results indicated elevated levels of contaminants (i.e. over provisional “high background”) in:

- JAMP area 26: Oslofjord proper (PCBs, and to a lesser extent mercury, lead, zinc and ppDDE) and Langesundsfjord (HCB, less so for cadmium, mercury and CB153). Marked overconcentrations of lead found in mussels were found from one station in the inner Oslofjord, were probably due to very local influences. A significant downward trend was found for HCB in mussels from Langesundsfjord for the period 1990-1998.

- JAMP areas 63 and 62: Sørfjord and Hardangerfjord (cadmium, lead, PCB and ppDDE and to a lesser extent mercury, zinc and CB153). Marked overconcentrations of PCBs were found in cod liver from inner Sørfjord but not in flounder from the same area. Significant downward trends were found for cadmium in mussels from the Sørfjord and Hardangerfjord 1987-1998.

JAMP area 65: Orkdalsfjord has not been monitored since 1996. The remainder of stations are mostly from presumed “reference” areas, where only diffuse contamination is expected. The results indicated primarily low levels of contamination.

Two environmental indices were applied for the fourth year to assess the levels of contamination of mussels in “polluted” and “reference” areas. The results indicated a “bad” condition when applying the “pollution” index and a "fair" condition when applying the “reference” index indicated a “fair”. There was no change in classification from the 1997 results and no trend is evident.

The biological effects methods OH-pyrene (pyrene metabolite), δ-aminolevulinic acid dehydratase (ALA-D), cytochrome P4501A activity (EROD) and metallothionein (MT) were determined in cod from six stations from the southern and south-western coast for 1997 and 1998. Three stations were merely diffusely contaminated and three were from two moderately polluted areas. In both years there were very high levels of OH-pyrene metabolites at a presumed clean site (Lista) and somewhat elevated levels at sites where fish would be expected to be exposed to PAHs (inner Sørfjord, inner Oslofjord). Results for the two years for ALA-D indicated consistent effects in the two most contaminated areas (again, inner Sørfjord and inner Oslofjord). Similarly, for 1998, EROD values were elevated in cod collected in polluted areas. The results for EROD in 1997 gave higher values for most areas and only fish from the most strongly polluted site (inner Sørfjord) was significantly higher EROD activity than fish from clean areas. Results for MT from the two years did not indicate clear trends.

The presence of organotin (e.g. TBT) in Norwegian waters was still a problem in 1998, more severe close to harbours and major ship-routes. Concentrations of organotin in dogwhelks and mussels were elevated, and biological effects from TBT were found in all dogwhelks from the investigated areas. The prohibition against the use of TBT in antifouling on boats <25m of length has not lead to a clear improvement in the investigated areas.

Indications of ”background levels” of dioxins, dioxin-like PCBs, polychlorinated naphtalenes, polybrominated diphenylethers, Toxaphene (sum of selected congeners) and chlordanes have been obtained by analysis of pooled samples of cod liver from four different parts of the coast; from south in the Oslofjord to north at Lofoten. The main contributing groups to sum toxicity equivalents of dioxins and dioxin-like substances were non- and mono-ortho PCBs with 58-66 and 17-33%, respectively. Cod from the outer Oslofjord area was markedly more contaminated with PCBs than cod sampled in the southernmost part of Skagerrak, on the west coast, and in northern Norway. The distribution of the other substance groups was variable, but with a tendency of comparatively high levels of Toxaphene and chlordanes in the north. The ratio between ΣPCB_7 and ΣToxaphene (3 indicator congeners) varied from 1.3 to about 7.

The sediments in the inner part of the Sørfjord and Oslofjord are contaminated of both metals and organic micro pollutants. The concentrations decrease gradually to background or "high background" levels out to the open coast, with the exception of lead. Atmospheric fallout is probably the explanation for the rather high concentrations in remote areas. There is a difference between the Skagerrak and the west coast sediments in the PCB composition. A new ^{210}Pb-age dating was done in 1996 and exceptionally high deposition rates (31 mm year^{-1}) were detected in the outer Oslofjord, in the deep Hvaler accumulation basin.

Small-scale temporal and geographical variation in contaminant concentrations has been assessed by the Norwegian VIC program. VIC includes monitoring of cod and flounder from Sørfjord and Hardangerfjord as well as from the Oslofjord, annually 1996-1998. The results of a preliminary analysis for cod indicate that a better cost efficiency in terms of trend detection power might be achieved if yearly sampling were distributed on 3 or 4 catches each year separated by a few weeks or months, instead of the current practice of sampling all fish at one time and place if possible. The total number of fish should probably not be reduced if power is to be retained for all substances, but for some contaminants a new sampling scheme might allow for reduced analysis effort by subsampling for the total yearly sample. The issue must be further analysed, also taking differences between species, seasonal effects and possible regional differences into account.

1.2 Introduction

The Norwegian contribution to the "Joint Assessment and Monitoring Programme (JAMP) was initiated by the Norwegian Pollution Control Authority (SFT) and is integrated with SFT's State Pollution Monitoring Programme. The procedures and practice of JAMP has also provided a basis for other investigations of interest to SFT but not necessarily requested by JAMP (e.g. SFT's Pollution and Reference Indexes, Chapter 1.3.8).

Data are submitted to ICES under three categories: for Purpose A (Health assessment) on a voluntary basis, Purpose C (spatial distribution) on a voluntary basis and Purpose D (temporal trend assessment) on a mandatory basis. Where practical, data collection was in accordance to agreed procedures (OSPAR 1990, 1997). Data were screened and submitted to ICES in accordance with procedures outlined by ICES (1996).

This report focuses on issues and situations in Norway concerning contaminants and considered of interest to the implementation of JAMP (Table 1).

Table 1. JAMP issues to which the Norwegian investigations for 1998 can be addressed (cf. ASMO 1997, Annex 30).

Issue	Subject	Description
1.2	Hg, Cd, and Pb	What are the concentrations and fluxes in sediments and biota?
1.3	TBT	To what extent do biological effects occur in the vicinity of major shipping routes, offshore installations, marinas and shipyards?
1.7	PCBs	Do high concentrations pose a risk to the marine ecosystem?
1.8	PCBs	Do high concentrations of non-ortho and mono-ortho CBs in seafood pose a risk to human health?
1.10	PAHs	What are the concentrations in the maritime area?
1.11	PAHs	Do PAHs affect fish and shellfish?
1.12	Other synthetic compounds	How widespread are synthetic organic compounds within the maritime area?
1.15	Chlorinated dioxins and dibenzofurans	What concentrations occur and have the policy goals (for the relevant parts of the maritime area) been met?
1.17	Biological effects of pollutants	Where do pollutants cause deleterious biological effects?
5.3	Chemical used [mariculture]	In which areas do pesticides and antibiotics affect marine biota?
6.1	Ecosystem health	How can ecosystem health be assessed in order to determine the extent of human impact

This report is structured at the first and second level according to agreed format (ASMO 1997, Annex 12) which *inter alia* presents results before methodology.

1.3 Information on measurements

An overview of JAMP stations in Norway is shown in the tables in Appendix E and maps in Appendix F. The stations and sample counts relevant to the 1998 investigations are noted in the tables in Appendix E and Appendix G, respectively.

Blue mussels were sampled at 39 stations (including the Index programme) and fish from 20 cod/flatfish stations (including VIC) from the border to Sweden in the south to the border to Russia in the north. Generally, mussels are not abundant on the exposed coastline from Lista (south Norway) to the North of Norway. A number of samples were collected from dock areas, buoys or anchor lines (see footnotes in Appendix E).

1.3.1 Oslofjord area

Moderate overconcentrations of CB153 in mussels were found in the inner Oslofjord (st.30A, up to 3 times provisional "high background" - see Chapter 2.1.2) (Figure 1 and temporal trend analyses in Appendix H). Overconcentrations were also found in cod liver from the inner Oslofjord (st.30B, up to 6 times "high background"; Figure 2). The median concentration of CB153 in cod liver from the inner Oslofjord was over 1200 ppb w.w. and higher than previous years (1990-1997[1], Figure 2, Appendix H and Appendix I). Similarly, the median concentration in cod fillet for 1998 was 8.35 ppb and higher than previous years except 1992 (Appendix H).

Overconcentrations were also found for sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in mussels and cod liver from inner Oslofjord stations (st.30A and 30B), about 2 and 6 times "high background", respectively (Appendix H). Slight overconcentrations (less than 2 times "high background") were found in cod livers from the outer Oslofjord (st.36B). In 1994 the Norwegian Food Control Authority (SNT) advised not to consume liver of cod from the inner Oslofjord (north of st.31A) due to concerns about PCB contamination (Table 2, page 35).

No significant linear trend was detected based on the newly applied Loess smoother (see Chapter 2.1.3) for CB153 for mussel from four stations (30A, 31A, 35A and 36A) from 1987 to 1998 or for cod (30B and 36B) from 1990 to 1998.

Power analyses (see Chapter 2.1.3) indicated that a hypothetical trend of 10% change per year in CB153 concentration in the blue mussel or cod liver from the inner Oslofjord would take up to 15 years to be detected with 90% significance (Appendix H).

Sight overconcentrations of mercury (less than twice "high background") were found in the fillet of both "large" and "small" cod (st.30B) from the inner Oslofjord (Figure 3). No significant trend was detected for the period 1984-1998. The power, indicated as number of years, to detect a change in mercury in cod fillet from the inner Oslofjord was slightly better for "small" fish (11 years) than "large" fish (14 years) (cf. Appendix H). Concentration of mercury were in general (considering the entire period) significantly higher in "large" cod compared to "small" cod.

In cod liver, slight overconcentrations (less than 2 times "high background") were also found for lead and ppDDE (st. 30B, inner Oslofjord) and zinc (st.36B, outer Oslofjord).

Marked overconcentrations of lead (12 times "high background") were found in mussels from the inner Oslofjord (st.30A) and higher that any previous year (from 1990). In 1998 abnormally high-water covered the shoal where mussels were usually collected and instead they were gathered on a island within about 50m. The lead concentrations from the four other mussel stations from the inner Oslofjord that are included in the Pollution Index (se Chapter 1.3.8, Appendix J) were low and similar to the results found in 1997. The new site was close to an artist's atelier that was possibly the source of lead contamination.

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[1] Regarding 1997 results for cod from st.30B; the median values calculated in this report are based on 50 individuals from the VIC programme, see Chapter 1.8, compared to 40 individuals from the same programme that was reported earlier (cf. Green *et al.* 1999). Hence, the meadian values for 1997 for these two reports can not be compared.

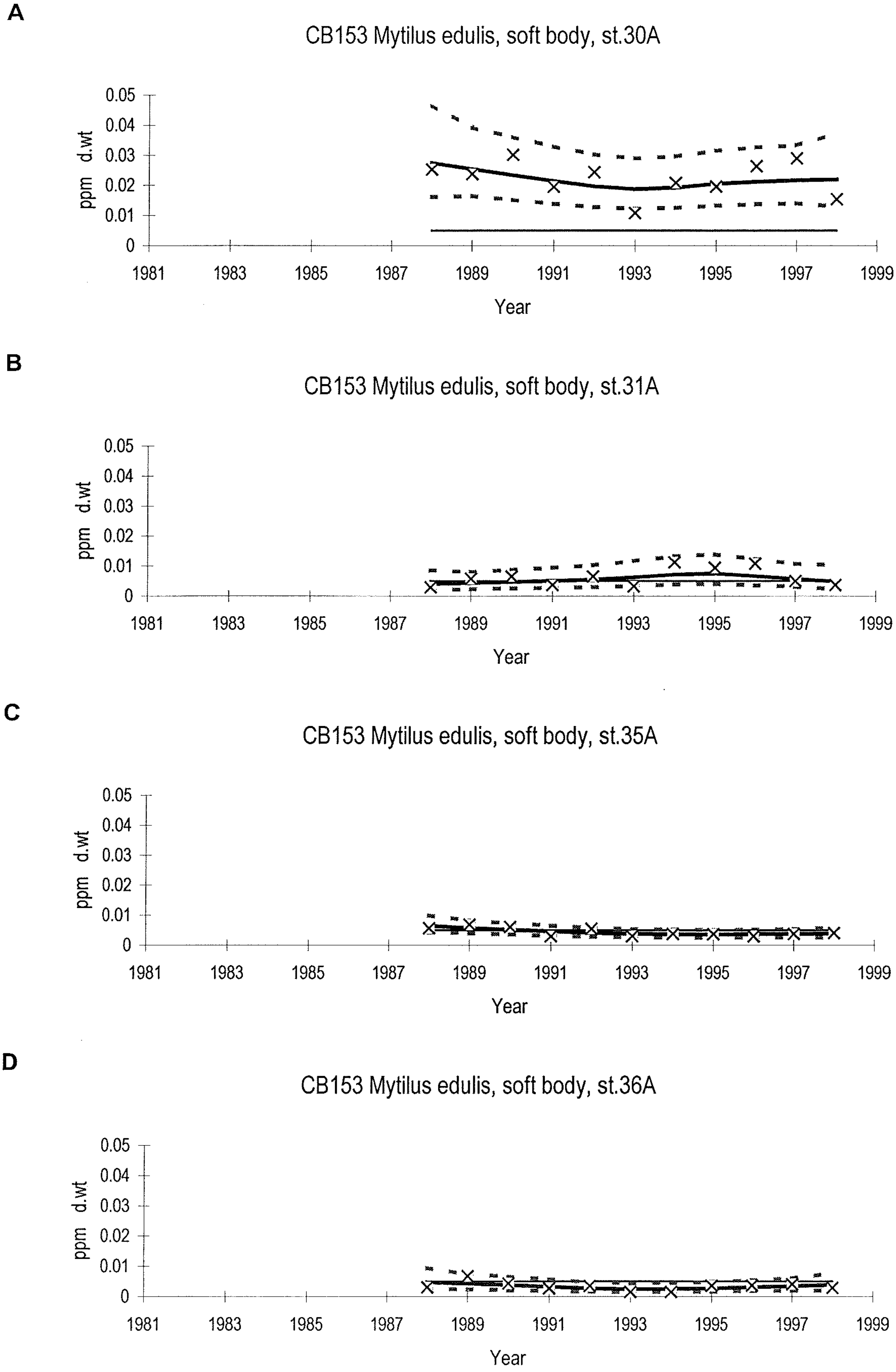

Figure 1. Median CB153 concentration in blue mussel (*Mytilus edulis*) from inner (st.30A) to outer (st.36A) Oslofjord. (cf. Appendix F and key in Figure 24).

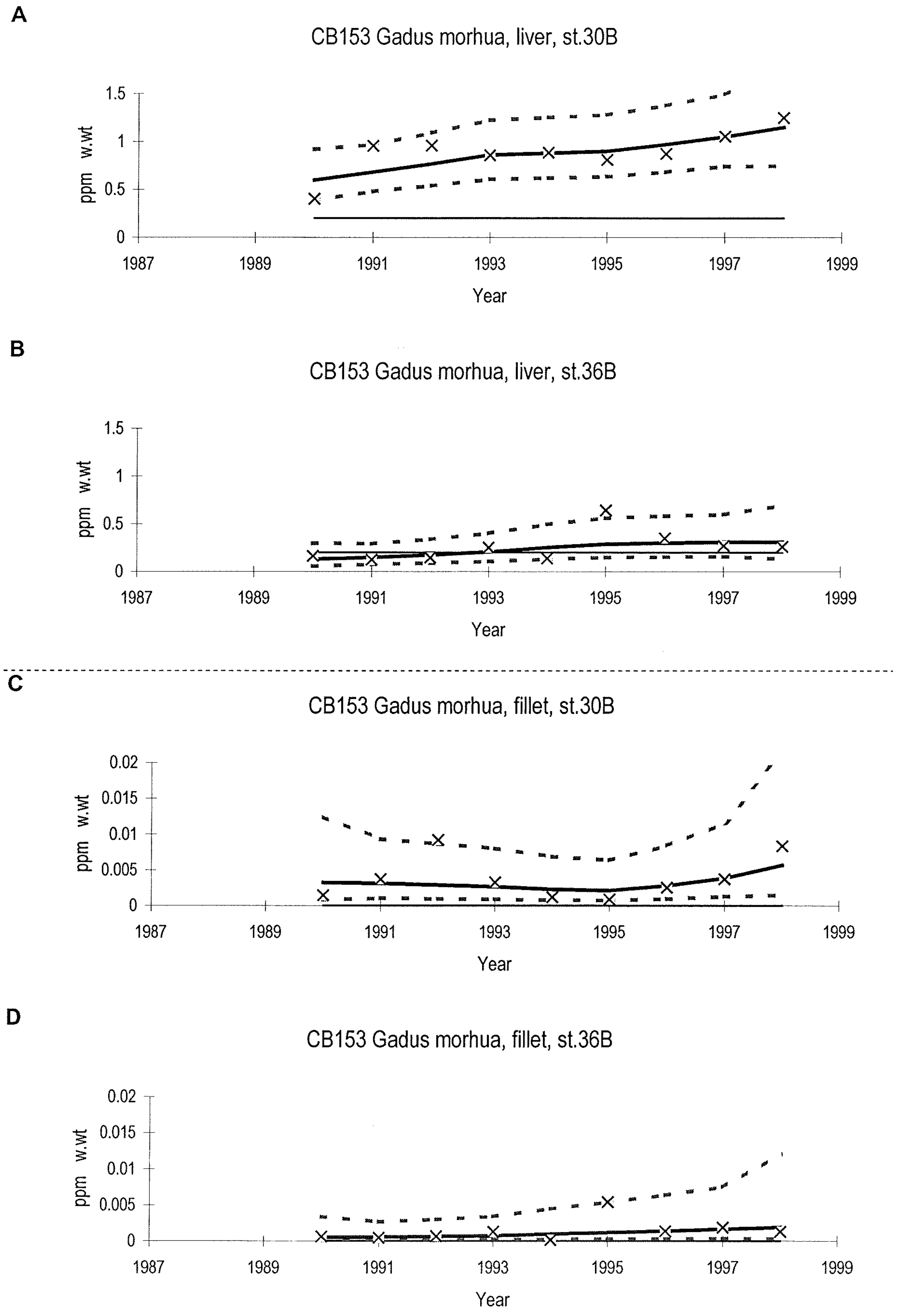

Figure 2. Median CB-153 concentration in liver and fillet of cod (*Gadus morhua*) from the inner (st.30B) to outer (st.36B) Oslofjord. (cf. Appendix F and key in Figure 24). **Note: for some years the upper confidence interval line is off-scale in Figure D. Note: horizontal line for Class I near x-axis.**

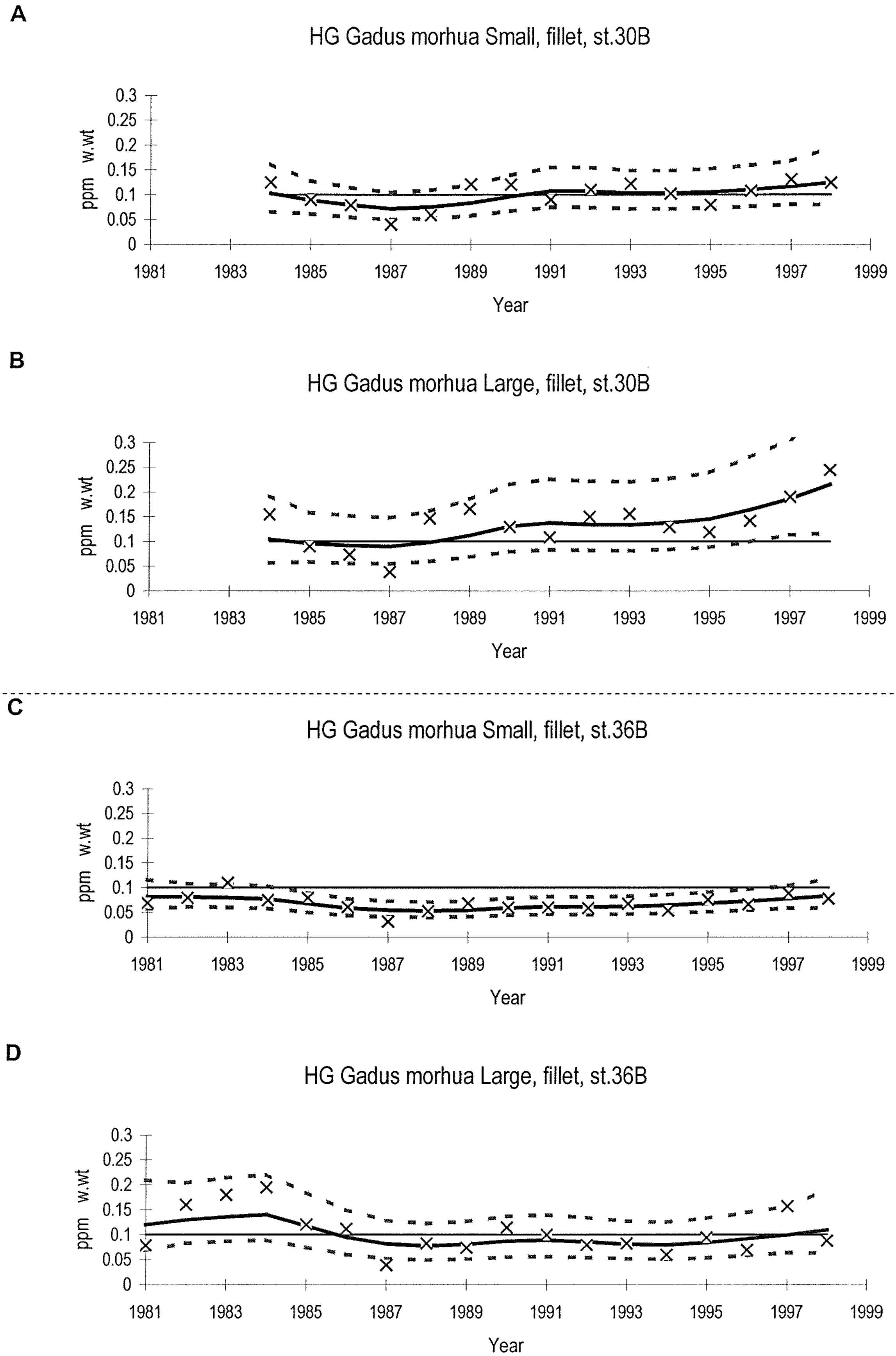

Figure 3. Median mercury (Hg) concentration in fillet of cod (*Gadus morhua*): for the inner Oslofjord (st.30B) "small" (**A**) and "large" (**B**) fish, and for the outer Oslofjord (st.36B) "small" (**C**) and "large" (**D**) fish. (cf. Appendix F and key in Figure 24).

Mussels from Langesundsfjord (st.71A) had in 1998 marked overconcentrations of HCB (over 3 times "high background", Appendix H). Concentrations have varied greatly during the investigation period (since 1983) but median value have decreased distinctly since 1989 (Figure 4) due to about a 99% reduction in discharge of HCB and other organochlorines from a magnesium factory after 1990 (cf. Knutzen *et al.* 1999a).

The variability in the data is much less after 1989. The relatively large variability found in this series prior to 1990 accounts for the poor power. The power of the monitoring program for the period 1990-1998 is 14 years and better than the power for the entire period which is over 25 years (cf. Appendix H for entire period). Separate analysis for the 1990-1998 data also indicated a significant *downward* trend for this period.

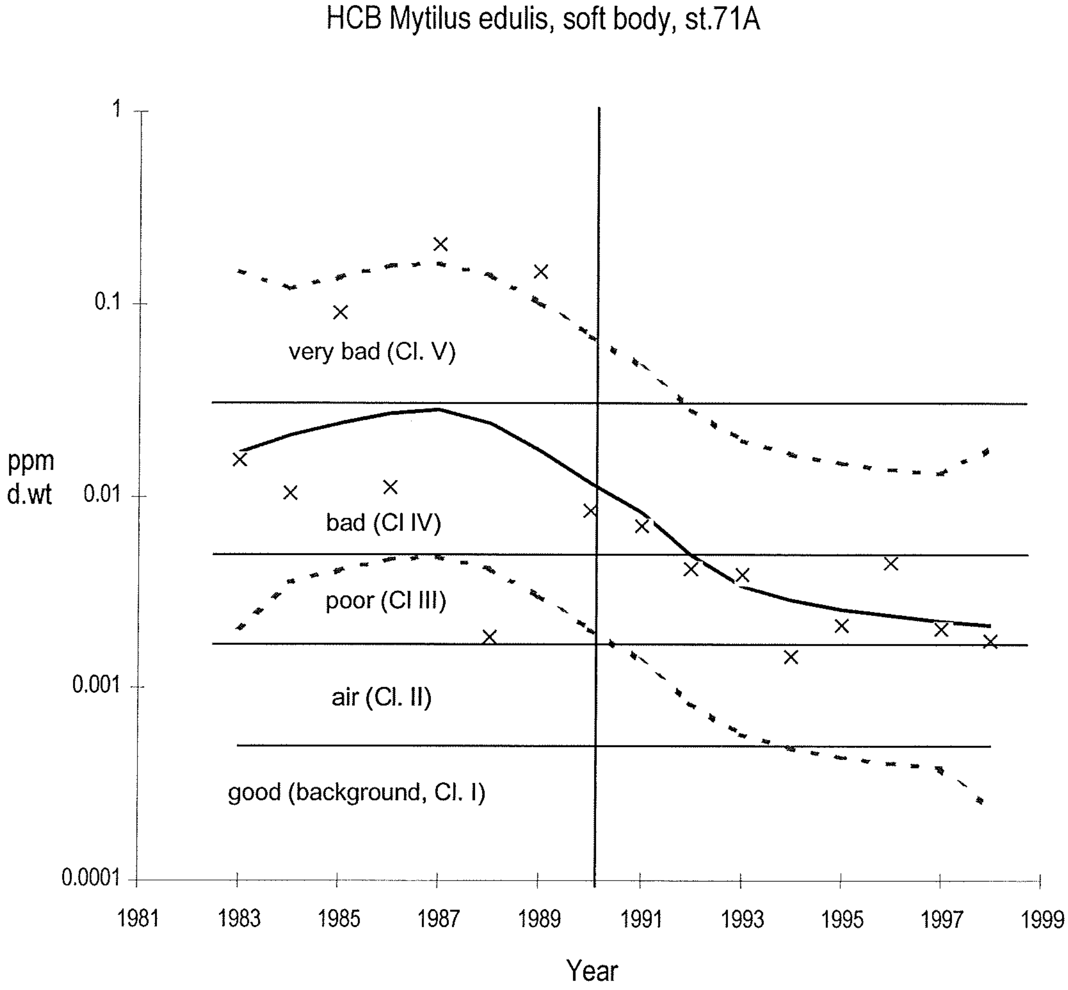

Figure 4. Median HCB concentration in blue mussel (*Mytilus edulis*) from Langesundsfjord (west of Oslofjord). (cf. Appendix Fand key in Figure 24). Vertical line indicates when a magnesium factory reduced it's discharge by 99%. Horizontal lines indicate classes as defined in Table 5. **NB: log-scale.**

1.3.2 Sørfjord and Hardangerfjord

The development of the contaminant conditions in these connected fjords and the main remedial actions that have been taken, have been outlined in the national comments for 1989 (Green 1991) and in a recent report concerning Sørfjord in particular (Skei *et al.* 1998). The results from JAMP 1997 are coupled to other studies in this area (cf. Knutzen *et al.* 1997, 1999c) and confirm that the fjords continue to be contaminated especially with cadmium (e.g. Figure 5 and Figure 6), lead and to a lesser extent ppDDE (e.g. Figure 7 and Figure 8) PCB and mercury.

Results for mussels collected from the Sørfjord (st. 51A, 52A, 56A and 57A) indicated marked overconcentrations of cadmium (up to 5 times provisional "high background", Appendix H) and lead (up to 9 times "high background"), more moderately for mercury (up to 3 times). Overconcentrations of cadmium and lead could be traced to Ranaskjær (st.63A) in the Hardangerfjord, about 60 km from the head of Sørfjord. A significant *downward* trend was found for cadmium at st. 56A, 57A and 63A from 1987 to 1998 (Appendix H). In 1997 the Norwegian Food Control Authority (SNT) has advised against consumption of mussels from the inner Sørfjord (Table 2) due to concerns about metal contamination.

Moderate overconcentrations of cadmium (about 5 times "high background") and of a lesser extent also mercury and lead were found in liver of flounder from the Sørfjord[1]. Slight overconcentrations up to 3 times "high background" were found for cadmium, mercury and zinc in liver of cod from the inner Sørfjord.

The power of the sampling strategies for mussels was relatively poor for samples collected from Odda; the inner most part of Sørfjord (st.52A). For example for lead in mussels, it is estimated that it would take over 25 years to detect a hypothetical trend of 10% per year with 90% significance (Appendix H). This reflects the large variability found in the data series from this area. The variability is largely due to the irregular/accidental input of contaminated discharges. The power improved with distance from Odda, and at Ranaskjær it was only 11 years.

Slight overconcentrations of ppDDE were found in the liver of cod and flounder from Sørfjord (st.53B) and in cod liver from Hardangerfjord (st.67B), up to 2 times "high background" (Figure 9, Appendix H). Overconcentrations were found in mussels to about 60 km from the head of the Sørfjord (Figure 7 and Figure 8). The highest median concentration in mussels was 83 ppb d.w. (overconcentrations of over 8 times) and was found at the mouth of Sørfjord (st. 57A). This was the second highest median concentration found in mussels since 1992 (cf. Appendix H). A maximum in 1998 at st.57A differed from previous years where the highest median concentration was found midway in Sørfjord (st. 56A). Slight overconcentrations (less than 2 times) were found in flounder liver from the inner Sørfjord (st.53B).

The source of ppDDE is uncertain but the Sørfjord and Hardangerfjord area has a considerable number of fruit orchards. Earlier use and persistence of DDT and leaching from contaminated soil is probably the main reason for the elevated levels found. DDT products have been prohibited in Norway since 1970 (excepting the dipping of spruce seedling until 1987). One possible source may be DDT-contaminated material buried in the vicinity of st.56A (Knutzen *et al.* 1999c).

Marked overconcentrations of sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) and CB153 (about 5 times "high background", Appendix H and Appendix I) were found in cod liver from Sørfjord. This was among the highest values registered from either Sørfjord or Hardangerfjord since

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[1] Regarding 1997 results for cod and flounder from st.53B; the median values calculated in this report are based on 30 and 15 samples from the VIC programme, respectively, see Chapter 1.8, compared to 14 and 10 samples from the same programme that was reported earlier (cf. Green *et al.* 1999). Hence, the meadian values for 1997 for these two reports can not be compared.

1990. In 2000 the Norwegian Food Control Authority (SNT) has advised against consumption of cod liver from the inner Sørfjord (Table 2) due to concerns about PCB contamination.There was considerable variation in the individuals of cod as indicated by the relatively high standard deviation (cf. Appendix I). Concentrations of these compounds in flounder liver were below "high background".

Slight overconcentrations of HCB (less than 2 times "high background") were found in mussels from the mouth of Sørfjord (st.57A).

No trends were evident in these organisms for ppDDE and CB153 during the period 1990-1998.

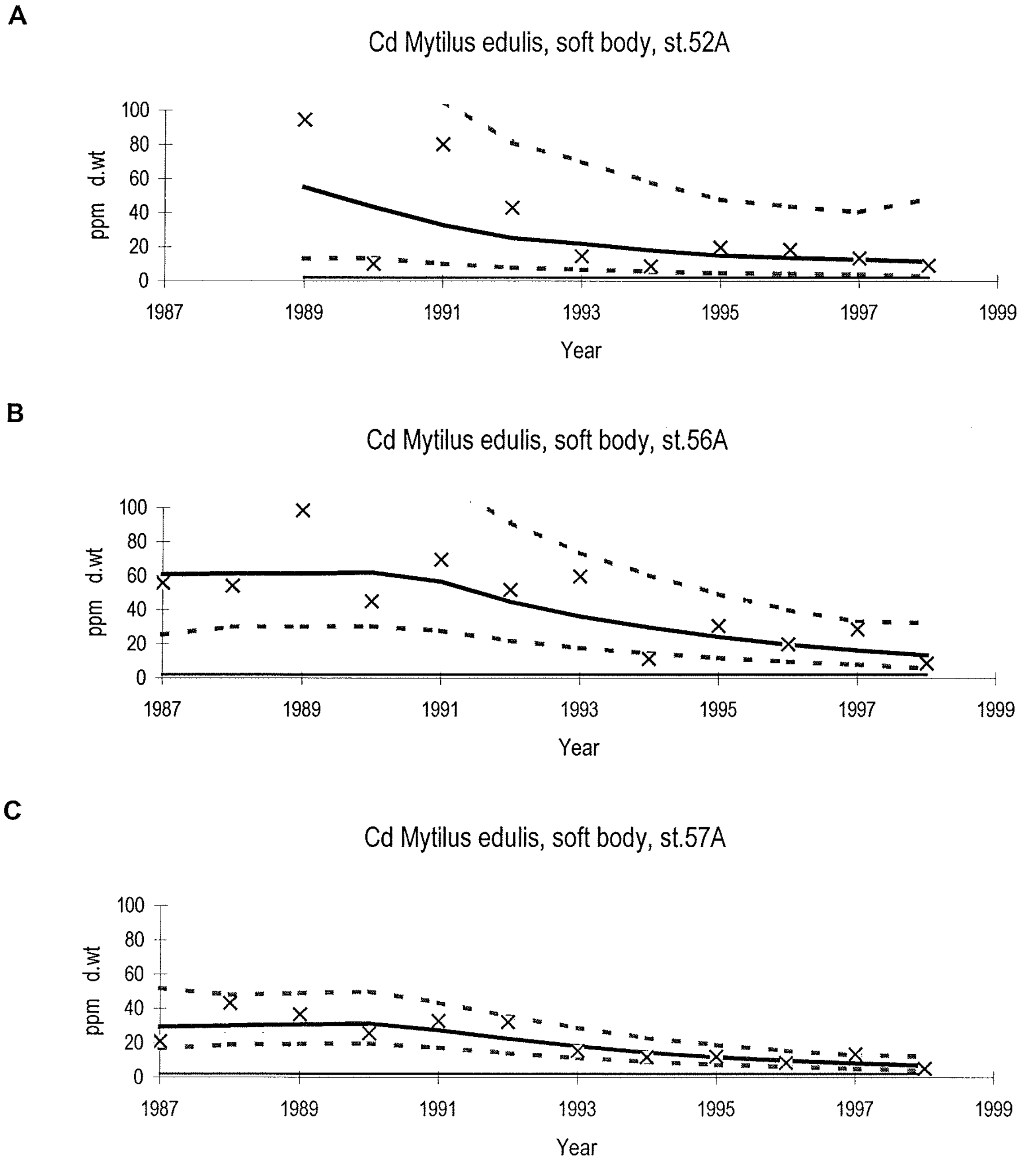
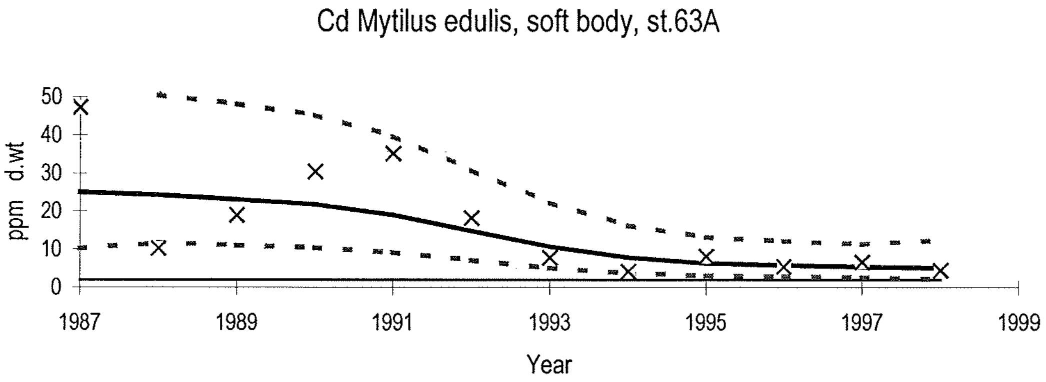


Figure 5. Median cadmium (Cd) concentration in blue mussel (*Mytilus edulis*) from inner (st.52A) to outer (st.57A) Sørfjord. NB: (cf. Appendix F and key in Figure 24). **Note: for some years the upper confidence interval line is off-scale in figures A and B. Note: horizontal line for Class I near x-axis.**

A



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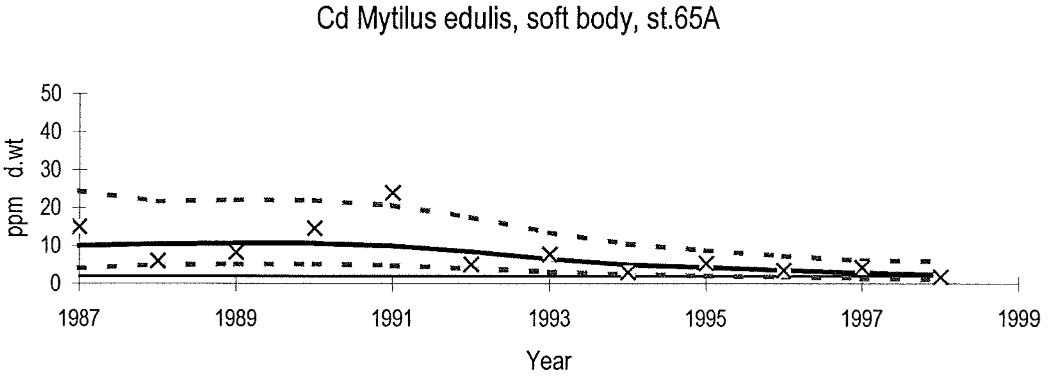

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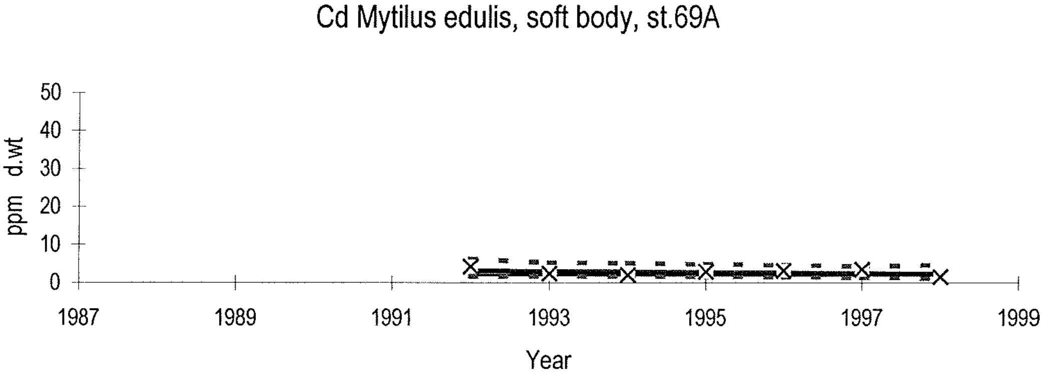


Figure 6. Median cadmium (Cd) concentration in blue mussel (*Mytilus edulis*) from Hardangerfjord (st. 63A, 65A and 69A). (cf. Appendix F and key in Figure 24). **Note difference in scale from Figure 5 and that for some years the upper confidence interval line is off-scale in Figure A. Note: horizontal line for Class I near x-axis.**

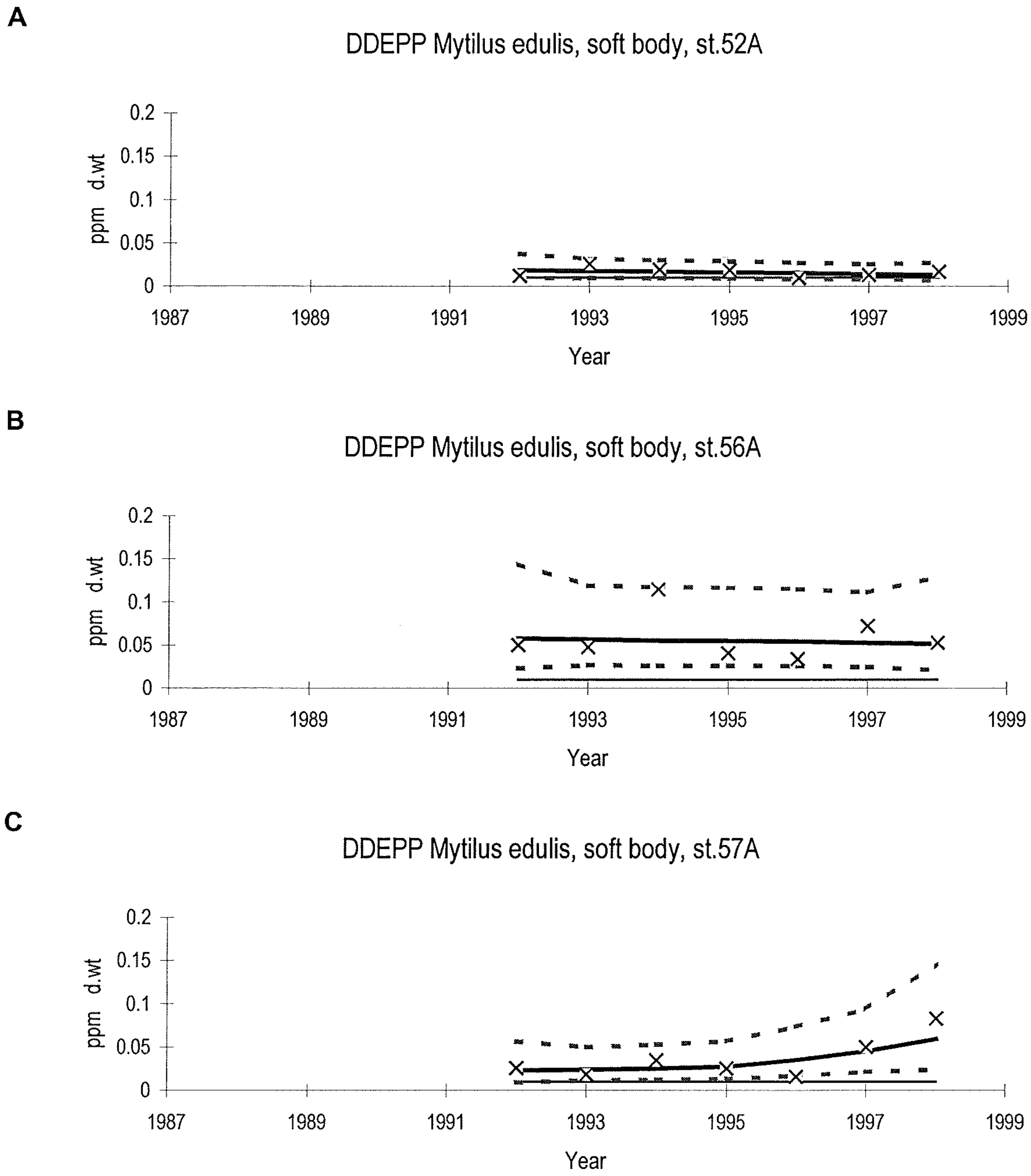


Figure 7. Median ppDDE (DDEPP) concentration in blue mussel (*Mytilus edulis*) from inner (st.52A) to outer (st.57A) Sørfjord. (cf. Appendix F and key in Figure 24).

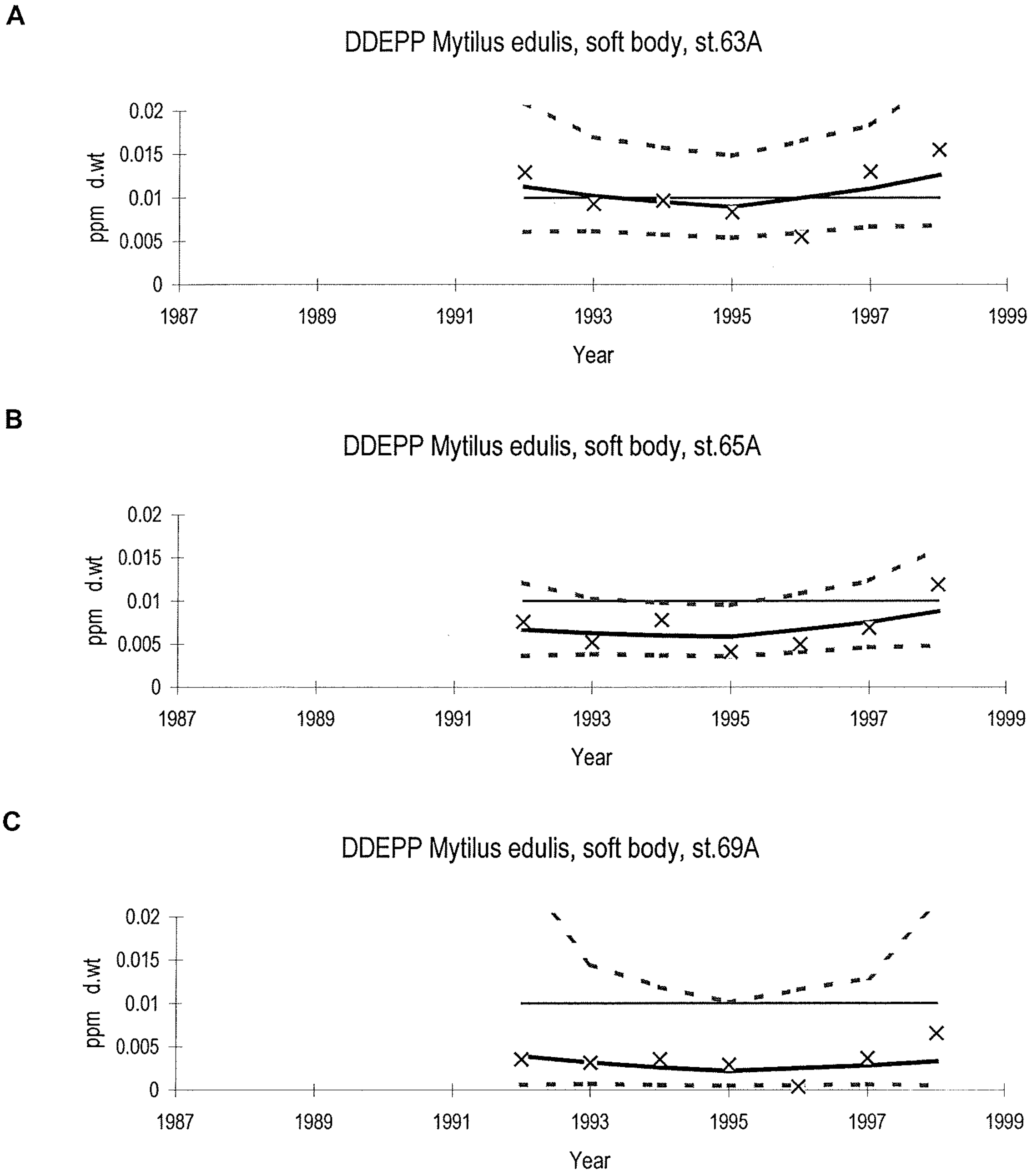


Figure 8. Median ppDDE (DDEPP) concentrations in blue mussel (*Mytilus edulis*) from Hardangerfjord (st. 63A, 65A and 69A). (cf. Appendix F and key in Figure 24). **Note difference in scale compared to Figure 7.**

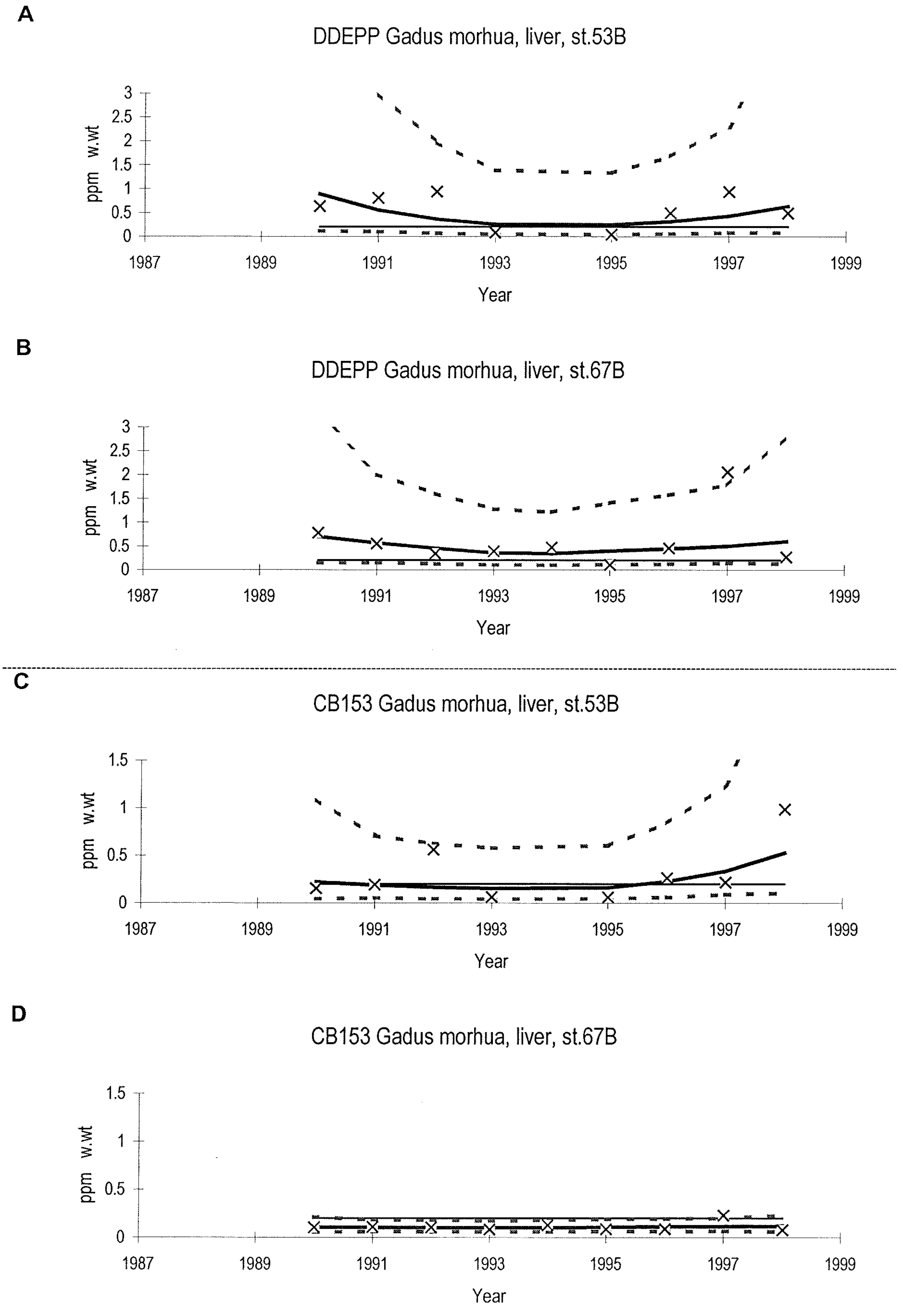


Figure 9. Median ppDDE (DDEPP) and CB153 concentrations in cod (*Gadus morhua*) from Sørfjord (st.53B) and Hardangerfjord (st.67B) (cf. Appendix F and key in Figure 24). **Note that for some years the upper confidence interval line is off-scale in Figures A and B.**

1.3.3 Lista area

No overconcentrations of metals or chlorinated hydrocarbons were found in mussels, cod or dab (st.15A/B/F, Appendices H and I), with the exception of a slight overconcentration of zinc in cod liver (less than 2 times).

1.3.4 Bømlo-Sotra area

With one exception there were no overconcentrations of metals or chlorinated hydrocarbons found in mussels, cod, or plaice from this area (st. 22A/F and 23B, Appendices G and H). The exception was for mercury in cod fillet and lead in plaice liver where only a slight overconcentration was found (less than 2 times "high background") (Appendix H). Dab was not collected at this station (22F) as was the case during the period 1990-95.

1.3.5 Orkdalsfjord area

Investigations in the area have been discontinued. Data for mussels is available for the period 1984-1996.

1.3.6 Open coast areas from Bergen to Lofoten

This stretch of coastline covers 7° of latitude to 68°N (Appendix F). Only one mussel station (st.98A) was investigated. Mussels were collected from 98A in 1992-1993. However, during the period 1994-1996 mussels were not found at this station but were collected from nearby Skrova harbour (98X). Since 1997 a "new" 98A location was found roughly 18 km north in a small fjord remote from apparent point source of contamination.

No overconcentrations of metals or chlorinated hydrocarbons were found in mussels, cod, or dab (st.98A/B/F, Appendices H and I).

1.3.7 Exposed area of Varangerfjord near the Russian border

The remaining and northern area of JAMP in Norway stretches north of 68°N and a longitude from 17 to 29°E (Appendix F). In 1998 only two mussel stations, one cod and one plaice station were investigated in the Varangerfjord (at approximately 70°N) that borders with Russia.

Slight overconcentrations (less than 2 times “high background”) of cadmium were found at one mussel station (st. 10A) and cod station (st.10B) (Appendix H and Appendix I).

1.3.8 Norwegian Pollution and Reference Indexes

The Norwegian Pollution Control Authority (SFT) has requested a select and small group of indices to assess the quality of the environment with respect to contaminants. One index is based on the levels and trends of contaminant concentrations in the blue mussel collected annually from a selection of the more contaminated fjords in Norway (Appendix J). SFT has also requested the testing of this index against "reference" stations from selected areas and fjords.

The Index scale varies from 1, in which no overconcentrations were found at any station, to 5, in which at least one sample from each area or fjord could be classified as "very bad" in SFT's system.

Nine fjord areas were used to calculate the Pollution Index compared to eight for 1997 material. The index for Byfjord at Bergen had to be recalculated for 1995-96 using analyses of stored samples. The Index for 1998 is 3.0 and lower than the results for previous years. A value between 3 and 4 would be classified as "bad" in the SFT system.

Only four fjord/areas were included in Reference Index for 1998 compared to seven to eight used in previous years. The Index for 1998 is 1.3. A value between 1 and 2 would be classified as "Fair".

1.4 Biological effects methods for cod

The JAMP-programme for 1998 included four biological effects methods (BEM), i.e. OH-pyrene metabolites in bile, ALA-D (δ-aminolevulinic acid dehydratase) in blood cells, cytochrome P4501A-activity (EROD) in liver, and metallothionein (MT) in liver. All parameters were measured in Atlantic cod.

At the sites 15B and 23B, 25 individual cod were sampled. At sites 30B, 53B and 67B, 30 individual cod were sampled and at site 36B, 27 were sampled. The biological responses in cod collected at the six sites were compared using two-way analysis of variance with two factors (year and site) and an interaction term (year*site). For pyrene metabolites, the statistical analysis was limited to a comparison between sites due to a change in methodology (standardisation to 380 nm rather than biliverdin). EROD and MT were log-transformed prior to statistical analysis. Due to large differences in individual variability between sites, the statistical analysis for pyrene metabolites was performed using the non-parametric Kruskal-Wallis test. The summary results including statistical analyses are presented in Appendix K.

1.4.1 OH-pyrene metabolites in bile

The concentrations of OH-pyrene metabolites in bile were significantly elevated in cod from site 15B both in 1997 and in 1998 ($p<0.0001$, Appendix K) (Figure 10) . In 1997, there were also significantly increased levels in cod from sites 53B and 67B (but see below), whereas there were increased concentrations of pyrene metabolites in cod from sites 53B and 30B in 1998. The consistently high levels in cod from site 15B merit further study. This is an area with input from an aluminium-smelter, but there are otherwise no known sources of PAH. It has been thought that holding conditions prior to sampling could at least partly explain the observed response (the fish are held close to the fishing vessel), but measures were taken in 1998 to minimise this exposure. The increased level of pyrene metabolites in cod from site 67B in 1997 were presumably due to holding conditions as the fisherman moved the fish (contrary to instructions) to a more contaminated location before sampling could be effected (see comment under ALA-D). The increased levels of pyrene metabolites at sites 53B and 30B (1998) presumably reflect the general contamination of the two areas (inner Sørfjord and inner Oslofjord).

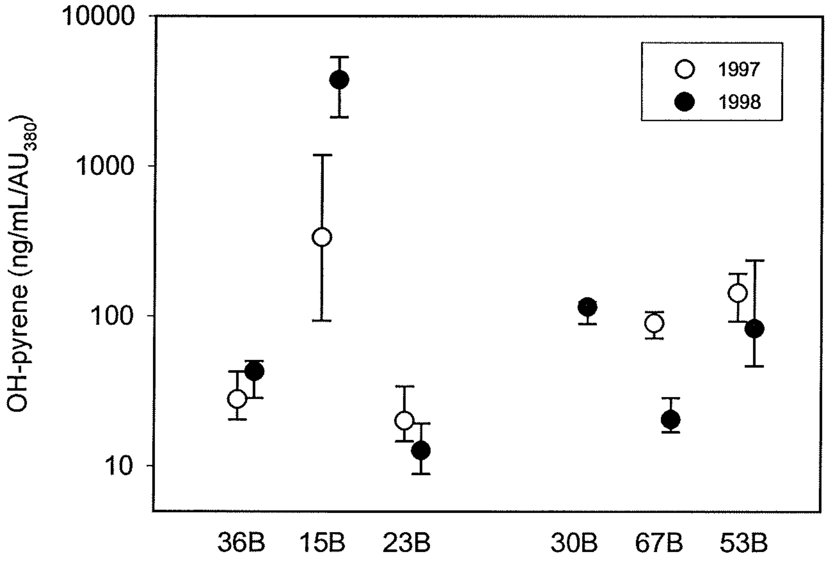


Figure 10. Concentration of OH-pyrene in bile from Atlantic cod collected at the indicated sites in 1997 and 1998. Medians and quartiles (25%, 75%). Note logarithmic axis and that values were standardised to biliverdin in 1997 (recalculated to absorbance at 38 nm) and to the absorbance at 380 nm in 1998. No values available for 30B in 1997. Stations 36B, 15B and 23B are considered less perturbed than stations 30B, 67B and 53B.

1.4.2 ALA-D in blood cells

The activity of ALA-D in cod blood was very consistent at most of the sites between years. In both 1997 and 1998, the activity of ALA-D was significantly inhibited at the two most contaminated sites, i.e. 30B and 53B, compared to cleaner sites (i.e. 23B, 36B) (Figure 11). In 1997, ALA-D was also inhibited in fish at site 67B, presumably due to post-capture exposure near site 53B. The activity of this enzyme is inhibited by exposure to lead.

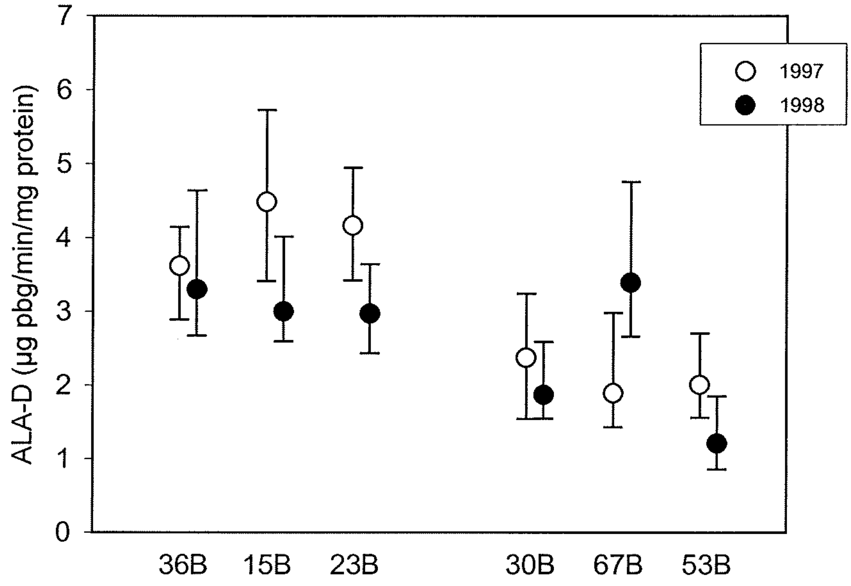


Figure 11. Activity of δ-aminolevulinic acid dehydratase in red blood cells from Atlantic cod collected at the indicated sites in 1997 and 1998. Median and quartiles (25%, 75%).

1.4.3 EROD in liver

In 1997, the activity of hepatic cytochrome P4501A (EROD) was significantly elevated at the most polluted site, 53B, whereas 30B, 53B and 67B were all significantly elevated in 1998 compared to the other stations that year but were about the same or a little lower as compared to 1997 (Figure 12). Thus, EROD in cod was found to be consistently increased in areas with some industrial input, but there were no strong trends. At four of the six sites, the activity was higher in 1997 than in 1998, but it is not clear whether this was caused by natural factors (e.g. temperature), different exposures or analytical procedures. No adjustment for water temperature, season, size or sex was made although it is recognised these factors might be important (OSPAR 1998). EROD is induced by planar organic contaminants, e.g. PAH, dioxins and planar PCBs.

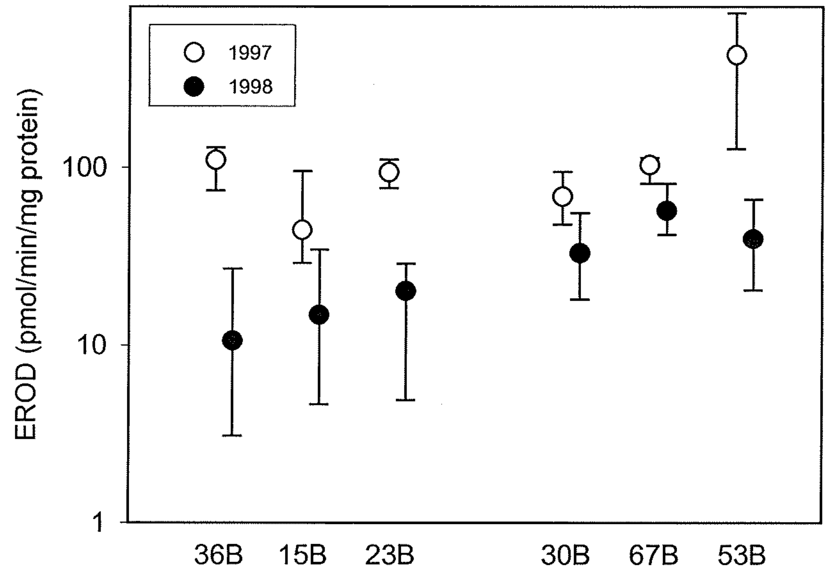


Figure 12. Activity of cytochrome P4501A (EROD) in liver from Atlantic cod collected at the indicated sites in 1997 and 1998. Median and quartiles (25%, 75%). Note logarithmic axis.

1.4.4 Metallothionein in liver

There were no clear trends in the hepatic concentrations of the metal-binding protein metallothionein (MT) at the six sites over the two years (Figure 13). In 1997, MT concentrations were significantly lower at the most polluted site, 53B, compared to levels at the other five sites, which were similar. In 1998, the concentrations were highest in cod at a clean site, 23B and lowest at the Oslofjord sites, 30B and 36B. This protein is induced by and binds the metals Cd, Zn, Cu and Hg. As for EROD, no adjustment has been made for sex, size or metal levels in tissues (cf. OSPAR 1998).

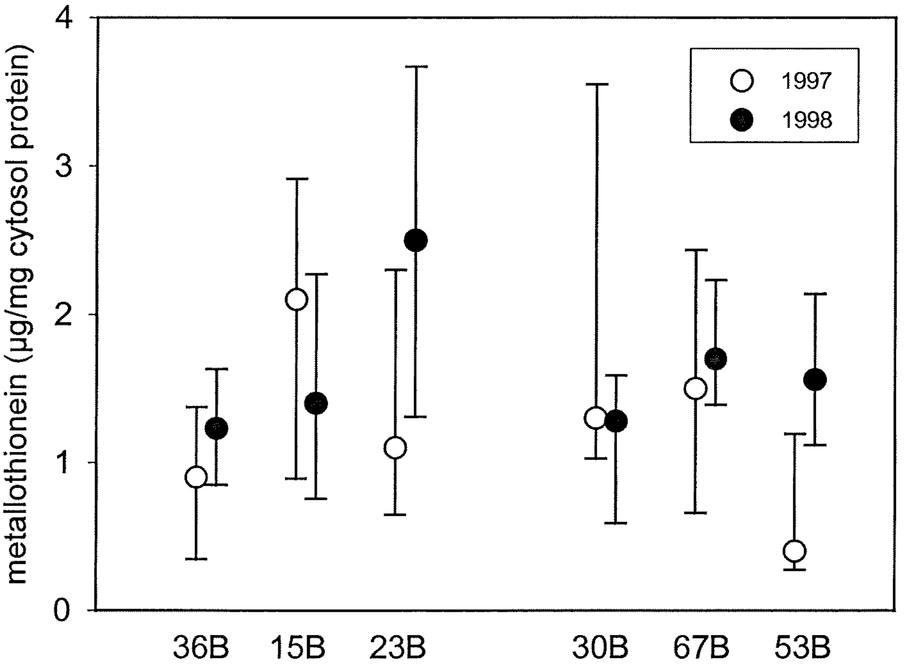


Figure 13. Hepatic concentrations of metallothionein (MT) in Atlantic cod collected at the indicated sites in 1997 and 1998. Median and quartiles (25%, 75%).

1.4.5 Concluding remark

Results for the two years for ALA-D indicated consistent effects in the two most contaminated areas (inner Sørfjord and Oslofjord). Similarly, for 1998, EROD values were elevated in cod collected in polluted areas. The results for EROD in 1997 gave higher values for most areas and only fish from the most strongly polluted site (inner Sørfjord) showed significantly higher in EROD activity than fish from clean areas. Results for MT from the two years did not indicate clear trends If anything, the concentrations of the protein were lower in fish from polluted areas where it would have been expected to be higher. In conclusion, the two first years of using biological effects methods in JAMP has given consistent results for effects at polluted sites for some methods and indicated possible effects at a site that was expected to be clean. By including flatfish from the same sites, as will be done for 1999, it will be possible to do an in-depth assessment of selected biological effects methods in relevant fish species.

1.5 Effects and concentrations of organotin

Effects from and concentrations of organotin in dogwhelk (*Nucella lapillus*) and concentrations in blue mussels (*Mytilus edulis*) were investigated along the coast of southern Norway, 1998.

Dogwhelks (*Nucella lapillus*) were sampled at five stations in the Haugesund area and one in outer Oslofjord (st.36G) during October 1998 (Appendix F, map 5 and 2, respectively). Whelks were present at all stations, but less abundant at st. 226G in the Haugesund area. Mussels (*Mytilus edulis*) were sampled from three stations in the Haugesund area, and one in outer Oslofjord and one in inner Oslofjord area. TBT-induced development of male sex-characters in females, known as imposex (VDSI and RPSI), was analysed according to OSPAR-JAMP guidelines. Detailed information about the chemical analyses of the animals is given in Følsvik *et al.* (1999). The results are shown in Figure 14 to Figure 17 and Appendix L.

1.5.1 Dogwhelks

Elevated levels- and effects from organotin was observed at all stations, least in the open area at Færder (st. 36G), and the southernmost station in the (st. 220G) in the Haugesund area. Dogwhelks from st.36G were analysed for organotin in 1993 and concentrations of TBT in the whelks have changed little since that time; from 57 to 83 µg Sn/kg d.w. in females. TBT-concentrations in whelks was higher at all stations in 1998 compared with 1997 (Figure 14).

Concentrations of TBT, VDSI and RPSI for dogwhelks from all stations in 1998 are compared in Figure 16. TBT body burden was rather consistent with the biological index RPSI. VDSI was stage 4 on all more stations, and sterile females were found on stations 224G, 226G and 227G in the Haugesund area. Concentrations of TBT in the snails were between 41 and 346 µg Sn/kg d.w. (Table 12 in Appendix L and Appendix F, map 5).

Generally, there is an apparent improvement in VDSI from 1991/-93 to 1997/-98 (Figure 15), and thus fewer sterile females. The development of the 'relative penis size index' (RPSI) is not as consistent over the years, but there is also a clear overall decrease in this index during the same period.

The Færder area (st. 36) seems to be the less affected area, particularly according to the RPSI-index. TBT-body burden in the whelks from st. 36 is however close to those in the dogwhelks from the Haugesund area.

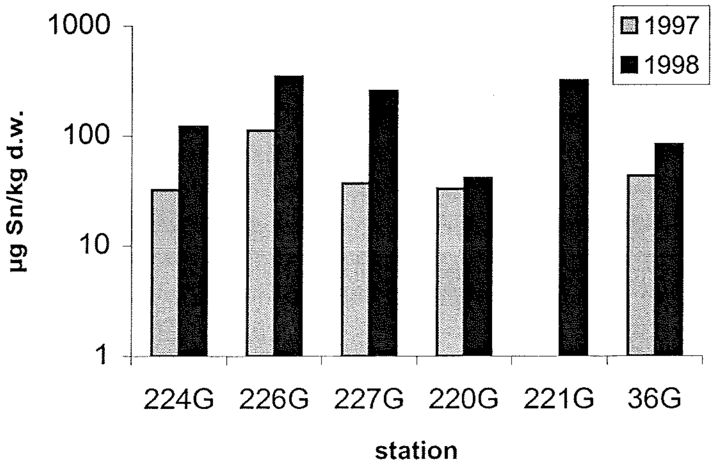
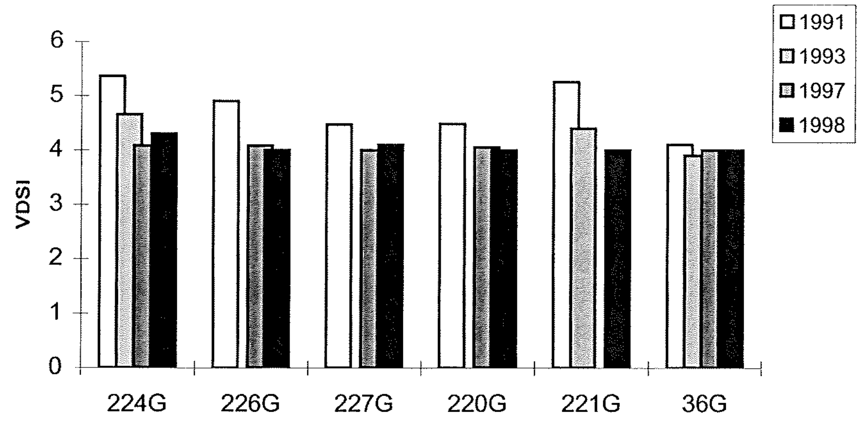


Figure 14. Levels of TBT (µg Sn/kg d.w.) in dogwhelks (*Nucella lapillus*) at 6 stations in southern Norway in 1997 and 1998. St. 221G was not analysed in 1997. Logarithmic scale on y-axis. (cf. Appendix F, maps 2 and 5).



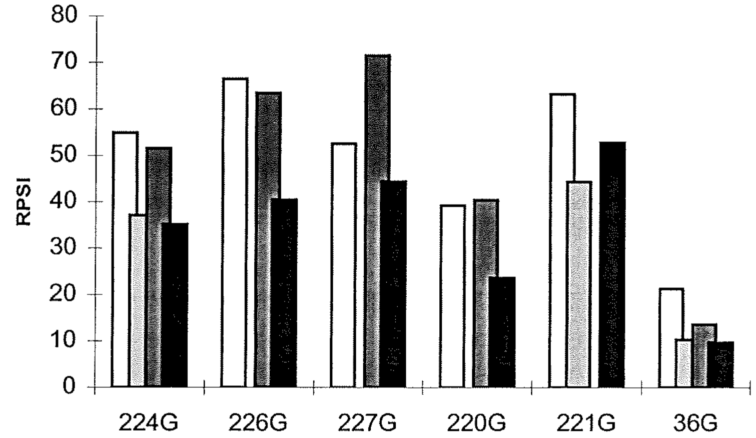


Figure 15. Imposex (VDSI and RPSI) in dogwhelks (*Nucella lapillus*) at 6 stations in southern Norway in 1991 (Harding *et al.* 1992), 1993 (Walday *et al.* 1997), 1997 and 1998. (cf. Appendix F, maps 2 and 5).

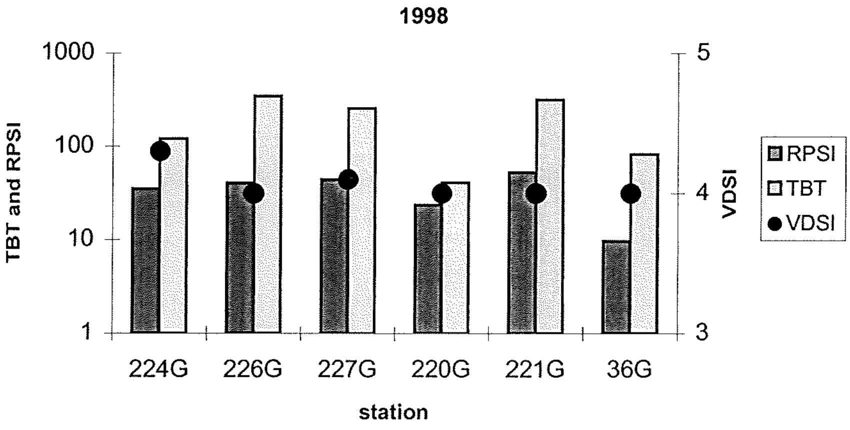


Figure 16. Imposex (RPSI and VDSI) and levels of TBT (µg Sn/kg d.w.) in dogwhelks (*Nucella lapillus*) at 6 stations in southern Norway in 1998. Note scale on y-axis. (cf. Appendix F, maps 2 and 5).

1.5.2 Mussels

Two parallels were analysed, except for station 226X where too few mussels were found. Concentrations of organotin in mussels were high in most areas, except for the Outer Oslofjord, and ranged between 71 and 840 μg Sn/kg d.w. (Figure 17 and Table 13 in Appendix L). According to the Norwegian classification of environmental quality (Molvær *et al.* 1997) was the Inner Oslofjord- and Haugesund area markedly polluted with TBT, while outer Oslofjord was moderately polluted.

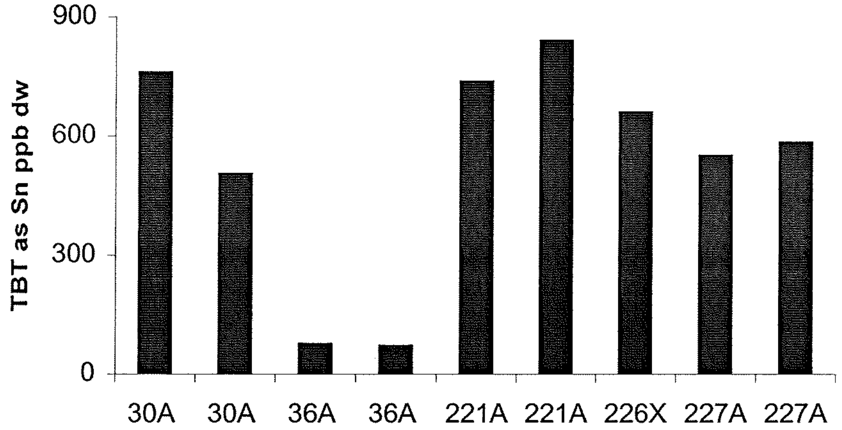


Figure 17. Levels of organotin (μg Sn/kg d.w.) in *Mytilus edulis* at five stations in Southern Norway in 1998. (cf. Appendix F, maps 2 and 5).

1.5.3 Concluding remark

The presence of organotin (as TBT) in Norwegian waters was still a problem in 1998, more severe close to harbours and major ship-routes. Concentrations of organotin in dogwhelks and mussels were elevated, and biological effects from TBT were found in all dogwhelks from the investigated areas. The prohibition against the use of TBT in antifouling on boats <25 m of length has not lead to a clear improvement in the investigated areas. This is a cause of concern.

1.6 Dioxins and other persistent halogenated chlorine and bromine compounds in cod liver 1996

To get some indication of the occurrence and "background levels" of persistent halogenated compounds other than the routinely monitored substances, homogenate JAMP-samples (n=25) of cod liver from four open coast localities collected in 1996 have been analysed for polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/PCDFs), non-ortho and 32 other congeners of PCBs, polychlorinated naphtalenes (PCNs), Toxaphene, brominated flame retardants (BFR), o,p- and p,p-isomers of DDT/DDE/DDD, chlordanes and also the sum variables extractable organic chlorines/bromines (EOCl/EOBr) and extractable persistent (sulfuric acid resistant) organic chlorines/bromines (EPOCl/EPOBr).

The four localities were selected to represent different parts of the coast (Appendix F, maps 2, 4, 7 and 16, respectively):

SE Norway: 36B Færder, outer Oslofjord
S. Norway (Skagerrak coast): St. 15B Lista
West coast: St. 23B Karihavet
N Norway: St 98B Little Molla, Lofoten

A summary of results for dioxin and dioxin-like compounds was reported in the 1997 National Comments report (Green *et al.* 1999) but is repeated here together with results of supplementary analyses of the other mentioned persistent halogenated compounds (Table 14 in Appendix M).

1.6.1 PCDD/PCDFs, dioxin like PCBs and PCNs

The results from analyses of PCDD/PCDFs, non-ortho PCBs and PCNs were reported earlier as mentioned but are repeated here due to supplementary results from analysis of selected mono-, ortho-PCBs and recalculation of sum toxicity equivalents according to a recent model (Van den Berg *et al.* 1998). This model deviates from the previously used Nordic model for $TEF_{PCDF/PCDD}$ (Ahlborg 1989) and TEF_{PCB} (Ahlborg *et al.* 1994) by TEFs for 1,2,3,7,8-PeCDD of 1.0 against 0.5; OCDF/OCDD 0.0001 against 0.001, CB77 0.0001 vs. 0.0005, and withdrawal of TEFs for di-ortho PCBs. Tentatively proposed TEFs for PCN are from Hanberg *et al.* (1990).

The largest contribution to ΣTEQ came from dioxin-like PCBs with 74-93 % of the total, and mainly from non-ortho PCBs (58-66 %) whereas mono-ortho congeners contributed 17-33 % (Figure 18). Predominant among the non-ortho PCBs was CB126: from 20.4 ng/kg w.w. in cod at st. 23B Bømlo to 86.3 ng/kg in the sample from st. 36B Færder. The most important mono-ortho congeners were CB118 and CB156 (CBs 114, 123 and 167 were not analysed). The contribution from PCNs was negligible (total tetra- to hepta-PCNs were 907 - 3114 ng/kg w.w., the highest in cod from st.36B Færder).

$TEQ_{PCDD/PCDF}$ in the range 8-11 ng/kg is in accordance with previously recorded values from Norwegian reference areas (Knutzen 1995 and later data).

The concentrations indicate considerable variation in load of dioxin-like PCBs along the open coast from Skagerrak in the south to Lofoten in the north. On lipid-weight basis the maximum:minimum ratio (st. 36B vs. st. 23B) was 7.6:1 against 2.4:1 for dioxins (st. 36B vs. st. 98B). Excepting the Færder values, the concentrations of TEQs from non-ortho and mono-ortho PCBs are within the interval of levels of other (scarce) records from "uncontaminated" parts of the Norwegian coast (Knutzen *et al.* 1999b with references).

The relatively high concentrations of dioxin-like PCBs in cod from the outer Oslofjord agrees with the frequent observations here that routinely monitored ΣPCB_7 often have exceeded the estimated "high background" for this group in Norwegian cod (Green 1997a).

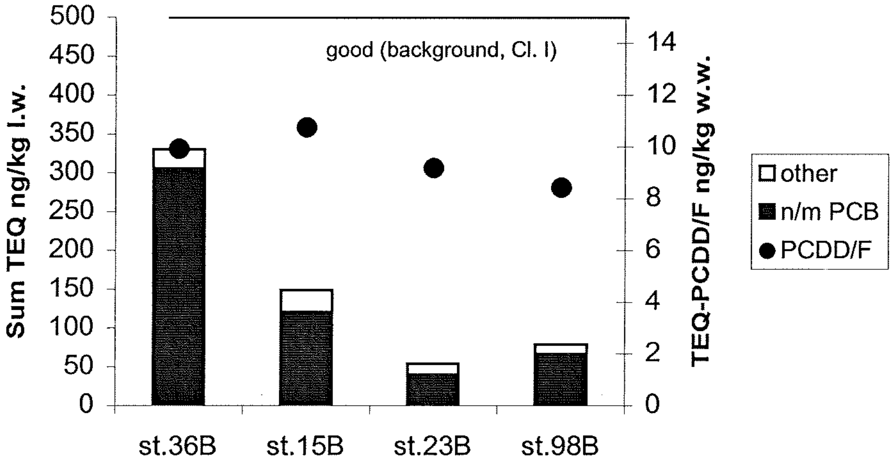


Figure 18. TEQs for PCDD/PCDFs, dioxin-like PCBs (non-ortho and mono-ortho PCBs (n/m PCB)) in liver of cod (*Gadus morhua*) from open coast localities in Norway 1996 (cf. Appendix M). The horizontal line indicates Class I (good) for $TE_{PCDD/F}$ on a wet weight basis in the Norwegian classification system for environmental quality (cf. Table 5).

1.6.2 PCBs, pesticides, HCB and OCS

In Table 14 (Appendix M) the above mentioned south-west/north gradient is also seen for $\Sigma PCB_7/\Sigma PCB_{32}$, with a maximum ratio for lipid based concentrations of about 10:1 (st. 36B vs. st.23B, Figure 19). (ΣPCB_7 is defined in Appendix B and ΣPCB_{32} refers to the sum of 32 congeners compared to the usually monitored 10[1].)

Except at st. 36B the ΣPCB_7 levels were below the estimated "high background" of 500 µg/kg w.w. (= Cl. I in the classification system of the Norwegian Pollution Control Authority, cf. Molvær *et al.* 1997). ΣPCB_7 constituted 51-67 % of ΣPCB_{32}, the lowest figure was found for cod from st. 98B Lofoten which contained relatively more of low molecule weight PCBs (CB28-CB101) than the other samples.

In contrast to PCB the highest levels of HCB and chlordanes were found in the north, the HCB-value exceeding the "high background" about two times. Such moderately elevated HCB concentrations have been observed sporadically in cod from the Lofoten area before (Green 1997a), and also in cod from other parts of northern Norway (Solberg *et al.* 1997). The chlordane results are in the lower part of the range of previously reported results in Norwegian cod (cf. ref. in Knutzen *et al.* 1999b). Also noteworthy is the relatively high concentration of ΣDDT at the Lofoten locality.

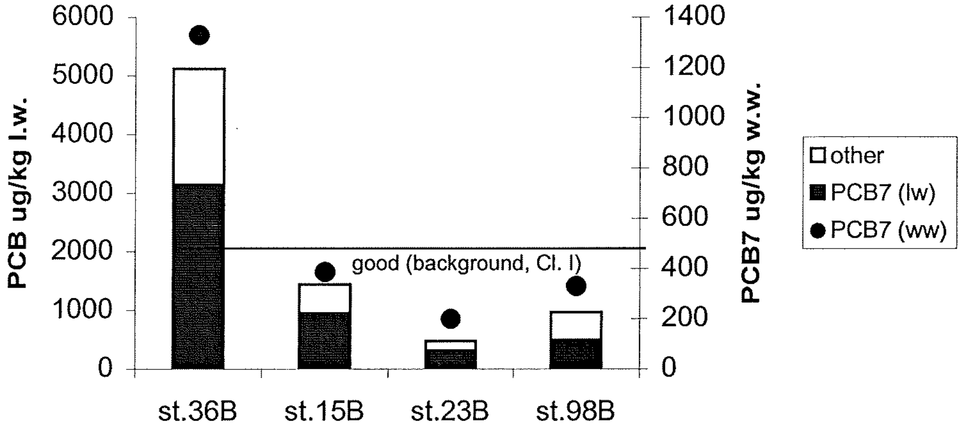


Figure 19. PCBs (32 congeners) and PCB_7 analysed (Appendix M). The horizontal line indicates Class I (good) for PCB_7 on a wet weight basis in the Norwegian classification system for environmental quality (cf. Table 5).

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[1] ΣPCB_{32} includes CB: 18, 28**, 31, 44, 47, 49, 52**, 66, 74, 87, 99, 101**, 105*, 110, 118**, 126, 128, 138**, 141, 149, 151, 153**, 156*, 157, 170, 180**, 183, 187, 189, 194, 206, and 209*. */** indicates the 10 that are usually monitored where of ** indicates the 7 in ΣPCB_7.

1.6.3 Brominated flame retardants

The data presented in this report (Figure 20, Table 14 in Appendix M) are the first records of brominated flame retardants (BFR) in fish from Norway. It is seen that the levels of sum BFR are about 3-13% of ΣPCB_7.

The only published results regarding BFR in cod (cf. de Wit 1999) appears to be in de Boer (1989, 1990), who for the sum of BFR (tetra- and pentabrominated diphylethers) found 38-360 µg/kg l.w. and for 2,2`,4,4`TeBDE alone 31-310 in samples from different regions of the North Sea (highest levels in the Southern North Sea, lowest in the northern part).

The values in Appendix M also are in the low/intermediate part of the range of levels observed in other marine fish as referred in the review of de Wit (1999) and reported by Allchin *et al.* (1999) from estuaries in Great Britain.

So far there are little or no restrictions on the use polybrominated diphenylethers as flame retardants, in spite of their persistence and bioaccumulating properties. As a consequence BFR levels in environmental samples probably will increase in the coming years. This has most clearly been demonstrated in Baltic sediments, whereas data from biota are more variable and difficult to interpret (Bernes 1998, Darnerud *et al.* 1998)

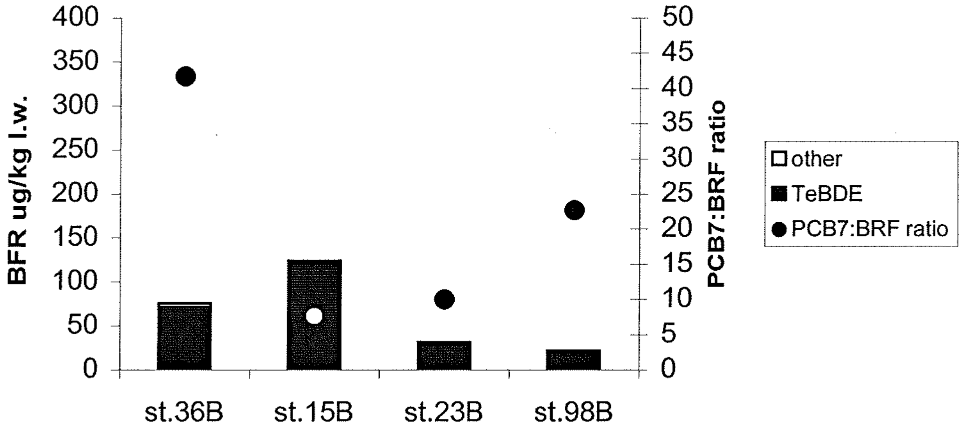

Figure 20. Sum brominated flame retardants (BFR) and tetrabrominated diphylethers (TeBDE) compared with ΣPCB_7 in liver of cod (*Gadus morhua*) from open coast localities in Norway 1996 (cf. Table 14 in Appendix M).

1.6.4 Toxaphene

As proposed by Alder and Vieth (1996) Toxaphene has been quantified by the sum of the three indicator compounds Parlar nos. 26, 50 and 62 (Figure 21), these being among the most prominent Toxaphene congeners represented in fish from the North Atlantic and North Sea (Parlar 1998). According to the results of Krock *et al.* (1997) the sum of nos. 26, 52 and 60 constituted about 70 % of the sum of 6 dominating compound in cod liver, and Kimmel *et al.* (1998) claimed that these six congeners represented at least 80 % of Toxaphene in fish oils. Taken together, this indicate that Σ26/50/62 is about 50 % of the total Toxaphene content (with reservations for the analytical problems regarding determination of total Toxaphene).

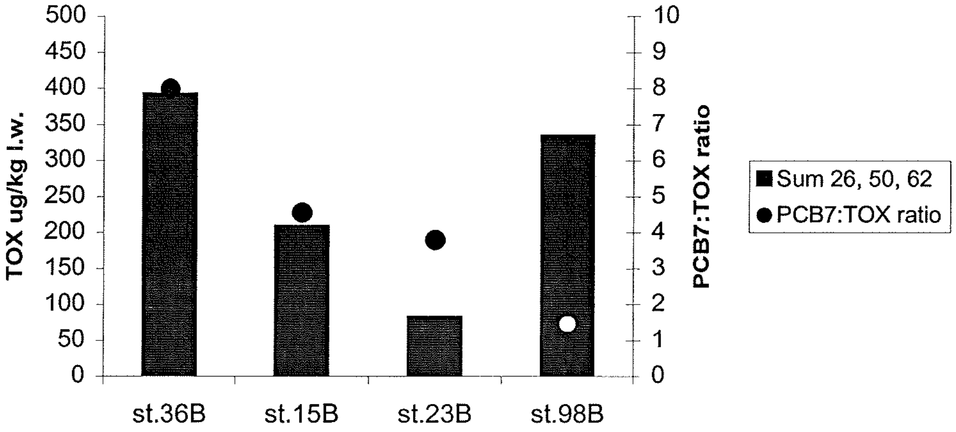

Figure 21. Sum of selected Toxaphene congeners (Parlar nos. 26, 50, and 62) compared with ΣPCB_7 in liver of cod (*Gadus morhua*) from open coast localities in Norway 1996 (cf. Table 14 in Appendix M).

The fourth congener, Parlar no. 32; is of less relevance in areas far from active sources.

The levels of ΣTOX recorded here are about the same as Solberg *et al.* (1999) observed in two samples of cod liver from southern Norway. In the same species from Icelandic waters Krock *et al.* (1997) found 42-79 µg/kg w.w. Somewhat lower levels of the three compounds were found both by Krock *et al.* and Fromberg *et al.* (1998) in liver of cod collected in the Baltic.

The ratio between ΣPCB_7 and ΣTOX varied considerably: from above 7 in the Færder sample to only 1.3 in the Lofoten cod (l.w. basis, Figure 21).

Toxaphene data for other fish species from Norwegian waters are reported in Alder *et al.* (1997) and de Geus *et al.* (1999). On lipid basis the levels are of the same order of magnitude as reported here for cod liver. Generally, however, comparisons between results from different (in particular elder) studies should be with care and with reservation for the considerable difficulties in Toxaphene analysis, notably the lack of standardisation of analytical methods, nomenclature and quantification procedures (e.g. Alder *et al.* 1997, Carlin and Hoffman 1997, Dybing *et al.* 1997, de Geus *et al.* 1999).

These problems also make it difficult to evaluate results from toxicity studies for the purpose of risk analysis and the establishing of tolerable daily intake or safe concentrations in food (Dybing *et al.* 1997). So far Norway has no guidelines in this respect, but the German maximum limit of 100 µg/kg w.w. (de Geus *et al.* 1999) for the sum of the three indicator compounds in Appendix M is seen to be exceeded in the Færder and Lofoten samples.

1.6.5 Extractable organic chlorine and bromine

The sum variables EOCl and EOBr (extractable organic chlorine/bromine) include both anthropogenic and natural substances (Gribble 1994, 1999). The fractions remaining after treatment of the extract with sulfuric acid are denoted EPOCl/EPOBr (extractable persistent organic chlorine/bromine) and include the halogenated organic micropollutants.

The results of the analyses are shown in Figure 22 and Table 14 in Appendix M. To our knowledge there are no published observations of these sum variables in liver of cod from other countries. 1986-1990 EPOCl data from assumed reference localities in Norway varied between 1800 and 15400 µg/kg w.w. (Green and Rønningen 1995), except at st. 36B Færder where the range was <2400-127000 µg/kg. The 1996 EPOCl concentration at st. 36B was about 19000 µg/kg (Appendix M).

Attempts to use EPOCl and EPOBr as monitoring parameters in biological samples from heavily contaminated Norwegian fjord have given confusing results, i.e. inconsistent both with distance from the source and variations with time in discharged quantities of industrial effluents (Knutzen *et al.* 1994 with references). The great range in concentrations at reference sites indicate that the problem is caused by the unpredictable presence and uptake of natural substances in marine indicator organisms. This argument against the use of sum parameters probably will even more relevant with respect to EOCl and EOBr. Gustavson and Jonsson (1999), however, found EOCl/EPOCl in mussels (together with sediments) helpful for the description of large-scale distribution patterns in the Baltic and Skagerrak.

Assuming a mean content of 60 % chlorine in the substances/groups listed in Appendix M, chlorine in identified substances amounts to about 520, 310, 1570 and 800 µg/kg w.w., respectively in the samples from st. 15B, 23B, 36B and 98B. Compared to the total content of persistent organochlorine (EPOCl) in Appendix M the sum of identified compounds represent (in the same order) about 9, 4, 20 and 25 %. The fractions of identified EPOBr were even less: <0.5-2 %. Little can be said of the rest of unidentified substances. Probably most of them are produced naturally by marine algae, sponges, etc. (Gribble *et al.* 1994, 1999), but a minor part will be unknown pollutants or persistent metabolites of PCB and DDT. Bernes (1998) refer to recent observations from the Baltic of nearly a hundred persistent substances previously unknown in nature. At the same time identified substances in sediment often cannot explain more than a part of the sediment toxicity (Bernes 1998). Such observations illustrate the challenges of future monitoring.

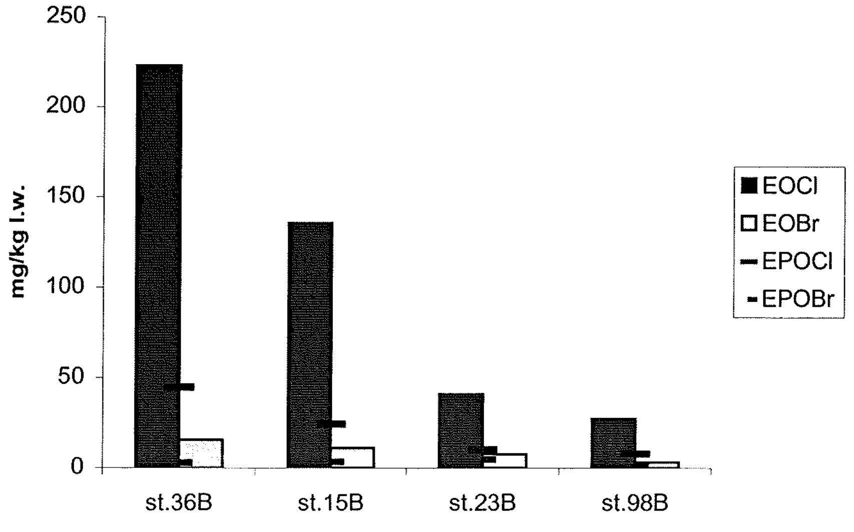

Figure 22. Extractable organic chorine/bromine (EOCl/EOBr) and the sulfuric acid resistant fractions (EPOCl/EPOBr) in liver of cod from four Norwegian open coast localities in 1996 (cf. Appendix M).

1.7 Sediment investigations of Southern Norway 1996-1997

1.7.1 Oslofjord area

Three stations were sampled for chemical analyses of sediments in 1996, these were station 30S, 35S and 36S. The stations are located from inner (30S) to outer fjord (36S) (Appendix N).

The inner fjord has concentrations above "high background" level of all parameters, with the exception of cadmium. There is a gradually decrease in the concentrations towards Skagerrak. Two exceptions are ppDDE and HCB, which in the outer fjord are slightly above "high background" concentrations. These elements are often related to pesticides, carried to the sea from agriculture areas. Station 36S, which is located in the deep accumulation basin outside the Glomma estuary receives these pollutants both from the river Glomma and from the north-going coastal current.

Mercury and lead occur at high concentrations in the inner fjord and the concentrations were higher than in 1990. Mercury was 60 times higher, lead 2 times higher and also copper was 6 times higher than corresponding 1990 values. Compared to findings in other parts of the inner fjord, the concentrations of lead and copper could be explained. There has, however, never been reported high mercury concentrations in this area. Two of three parallel cores had the same high content (48 and 47 ppm d.w.). Reanalyses confirmed the high concentrations of these two samples. Additional analyses of two samples from the same station, but of the 0–2 cm fraction, did not show such high concentrations. The five samples were collected within a deposition basin of about 150 m across, and the sampling has a precision of about 25x25 m. The contaminated area must therefore be very local. Contamination of the samples can of course not be excluded, but does not seem likely after evaluation of the sampling procedure.

1.7.2 Arendal – Lista area

One station was sampled in the Arendal area (77S) and one in the Lista area (15S) (Appendix N). All analysed parameters were at background levels except lead. This influence is probably from atmospheric fallout of lead. The concentration of ppDDE was slightly above back ground level in the Arendal area.

1.7.3 Sørfjord – Hardangerfjord area

Three stations were sampled in the Sørfjord (52S, 56S and 57S), three in the Hardangerfjord (63S, 67S and 69S) and one at the outer Bømlo coast (22S). The stations lay in a gradient from Odda at the head of Sørfjord (st.52S) to the outer Hardangerfjord (st.69S) to outer coast (22S).

There was a clear decreasing concentration gradient of contaminants from the inner Sørfjord to the open coast. Mercury, cadmium, lead and zinc contribute most to pollution of the sediments. Analyses performed on 1991 and 1996 samples (Rygg & Skei, 1997) suggest decreasing concentrations of metals in the inner part of the fjord from 1991 to 1996. Due to higher sedimentation rates in the inner fjord, it is possible to detect changes in sediment concentrations earlier than in the outer fjord. Sediment cores (Rygg & Skei, 1997) support the findings, but the decreasing concentration trends towards surface sediment are disturbed by the effect of borrowing organisms.

The outer part of the Hardangerfjord and outer coast were not polluted by any of the components except lead. As for other parts of the Norwegian coast this influence is probably due to atmospheric fallout of lead than pollution from local sources.

1.7.4 Comparison of PCB profiles

The concentrations of ΣPCB_7 were above high background level only in the inner Oslofjord and inner Sørfjord (Appendix N). Additional statistical analyses (PCA) indicate however that there is a difference in the PCB composition of the sediments in the Skagerrak region (30S to 15S) and the west coast (22S), including the Hardangerfjord and Sørfjord (52S to 69S). The Skagerrak sediments are characterised by CB-28, -52 and -118, rather than CB-101, -153 and -180.

1.7.5 Sediment cores from the Oslofjord area

The station Færder (36S) in the outer Oslofjord was sampled for ^{210}Pb age dating in 1990, but the quality of the dating was characterised as not very good, probably because the deep basins in the outer Oslofjord is used for trawling. The station 36S was therefore moved to the deep Hvaler basin, to a position stated by the fishermen not to be trawling area due to a wreck near by. The new dating performed on a sediment core from this position turned out to be acceptable. The accumulation rate in this area was very high about 31mm/year (30.9 mm derived from a rate of 9332 ± 611g m^{-2} $year^{-1}$ ± s.d.).

Due to the high deposition rate the core which penetrated deposits down to 70 cm sediment depth, representing the 1970ies did not catch pre industrial deposits. The highest concentrations of cadmium, mercury and lead were detected in the deepest samples, with lower and uniform concentrations from about 20 cm. The surface sample (0-0.5 cm) had slightly lower concentrations. Based on the dating and model estimations described by Larsen & Jensen (1989) it is suggested that by sampling every 5th year it is possible to detect a 10 % change in the input flux of pollutants to the sediments (provided a 10 % relative standard deviation for the chemical analyses).

1.7.6 Concluding remark

The sediments in the inner part of the Sørfjord and Oslofjord are contaminated with both metals and organic micropollutants. The concentrations decrease gradually to background or "high background" levels out to the open coast, with the exception of lead. Atmospheric fallout is probably the explanation for the rather high concentrations in remote areas. There is a difference between the Skagerrak and the west coast sediments in the PCB composition. A new ^{210}Pb-age dating was done in 1996 and exceptionally high deposition rates (31 mm $year^{-1}$) were detected in the outer Oslofjord, in the deep Hvaler accumulation basin.

1.8 Testing sampling strategies - VIC

1.8.1 Introduction

Tissue levels of metals and organochlorine compounds in various fish species have been used in spatial and temporal monitoring for over 30 years. According to ICES (1996) and OSPAR (1990, 1997) guidelines, 25 individual fish within a predetermined size range should be sampled at any given site.

In order to achieve statistical power for detecting trends in contaminant levels in fish in as cost-effective way as possible, it is important to identify and estimate the different variance components involved. If the yearly estimates are based on catching a number of fish at one occasion each year, the within-year variation between samples (i.e. between subpopulations of fish) will be included in the between-year residual variance in the data series. Even if the design is to collect one sufficiently large sample each year at a specific location, this may not always be possible. In order to get a sufficient number of fish it may sometimes be necessary to move to a nearby location, do more than one catch, or use a sample of fish deviating from the specified size distribution. This may affect the residual variance in the estimated yearly means used to detect trends.

If the between-site or seasonal variation is systematic, the best sampling scheme will be to keep to a specific location and a specific season. If, on the other hand, there is a random variation between locations and sampling times due to fish migrating within the area, this variation is mpossible to control. In that case, changing the sampling program into collecting a smaller number of fish from each of a number of locations, and/or at different times, may increase the precision of the yearly mean estimate.

A related issue is the question of using the physiological measurements on the fish as covariates to reduce residual variance. If variations in contaminant levels are due to physiological variations over time or between fish sub-populations, the adjustment for such factors may reduce residual variance and increase the ability to detect trends.

A Oslo-Paris Commission (OSPAR) Ad Hoc Group on Monitoring (MON) sub-group proposed a simple international programme called Voluntary International Contaminant-monitoring for temporal trends with the aim to test sampling strategies for a co-operative revision of guidelines by 1999 (VIC. cf. SIME 1996, 1997a). VIC aimed at compiling solid scientific evidence in parallel to developing a consensus. VIC is based on testing different sampling strategies annually over a 3-4 year period by a few countries (Germany, Netherlands, Norway and Sweden). The basic structure of testing is the same though the details may vary from country to country depending on practicalities. The Norwegian VIC includes monitoring of cod and flounder from Sørfjord and Hardangerfjord since 1996 as well as from the Oslofjord since 1997 (cf. Appendix F, maps 1 and 6). It involves supplemental analyses to OSPAR's Joint Assessment and Monitoring Programme (JAMP) to obtain better quantitative information of the variability in time and space within the guidelines of the sampling strategy.

The VIC program focuses on station 30B in the inner Oslofjord and stations 53B and 67B in the Sørfjord and Hardangerfjord system. The contaminants analysed so far are CB153, pp'DDE, Cd and Zn in liver, and Hg in muscle. Both unadjusted and adjusted concentrations have been analysed. Bjerkeng and Green (1999) give a more detailed presentation of these results.

1.8.2 Summary of results

The results (cf. Table 16 in Appendix O) show that even for a low 'Between-sample'/'Within-sample' variance ratio (R=0.05), the total number of fish analysed may be cut by 50% if they are distributed equally between 3 or 4 different samples instead of one for an unchanged total variance in the yearly means. If the variance between samples is as large as 50% of the within-sample variance, as indicated by the data from 30B for organic contaminants, one would get the same precision by analysing three fish altogether, each caught at a different time, as by sampling 25 fish at a single time.

However, the estimates of between-sample variances are still quite uncertain, even when based on all three years of Norwegian VIC data, and one should not rely too much on them. Reducing the total number of fish that are analysed and increasing number of sub-samples with the aim of keeping variance unchanged should be based on reasonably certain lower limits for the ratio of 'Between-sample' to 'Within-sample' variance. Further analysis is required in order to make recommendations.

A more cautionary approach would be to keep unchanged the total number of fish analysed, but draw them from an increased number of sampling times, and thus achieve an improved precision, rather than aiming at cutting the costs to keep a certain precision (Table 16 in Appendix O). For R=0.1 one can achieve a doubling of the precision, with a corresponding increase in trend detection power, by sampling 25 fish altogether, separated 8 or 9 fish at each of three different occasions, rather than catching all 25 fish at once.

Such a change would represent a smaller or larger improvement in trend-detection power depending on the ratio of between-sample over within-sample variance, but should not lead to increased yearly mean variance, as long there are no systematic seasonal variation across years within the suggested sampling period. And also provided that the sampling period is outside the spawning time and when the fish are in a stable physiological state OSPAR (1997).

The results differ for different contaminants. For some contaminants, the between-sample variance appears to be negligible and the trend-detection power then depends mainly on total number of fish, independently of how the catches are distributed in time. A way to preserve trend detection power and still achieve a reduction of total cost might be to catch the same number of fish as today, but distributed over a number of times, and then adjust the analysis effort for different contaminants according to their variance patterns. For contaminants with a high between-sample/within-sample variance ratio, one could analyse only is smaller number of fish from the total sample, drawn randomly or by stratified sampling.

A closer analysis should consider differences between species and maybe also between regions in both covariate adjustment models and in variance patterns.

1.9 Overall conclusions

In regards to JMP/JAMP Purpose A (health assessment), attention should be called to the list from Norwegian Food Control Authority (SNT) which names the restrictions and recommendations concerning the sale and consumption of seafoods in Norway (Table 2).

Table 2. Summary of action taken by the Norwegian Food Control Authority (SNT) concerning the consumption and sale of fish products along the Norwegian Coast (SFT, pers. comm. 1999).

Area of concern (km^2)	Last year of issue/ evaluation	Main parameters of concern	Main fish/shellfish product of concerned	Recommendations or restrictions of concern:
Inner Oslofjord (190)	1994	PCB	fish liver	Consumption
Drammensfjord (45)	1992	Dioxins/PCB	fish liver¹⁾	Consumption and Sale
Sandefjordfjord (3)	1993	PCB	round fish liver	Consumption and Sale
Grenlandsfjords, Langesundsfjord (84)	1997	Dioxins	fish, shellfish	Consumption and Sale
Kristiansandsfjord (29)	1994	Dioxins/PCB	fish, shellfish	Consumption and Sale
Fedafjord (13)	1995	PAH	shellfish²⁾	Consumption
Saudafjord (21)	1992	PAH	fish liver, mussels	Consumption
Hardangerfjord/Sørfjord (80)	2000	Cd Pb Hg PCB	fish liver, mussels	Consumption
Bergen area including Herdlefjord, Byfjord, Hjeltefjord, Grimstadfjord and Raunefjord (180)	1998	PCB	fish, shellfish	Consumption and Sale
Årdalsfjord (8)	1995	PAH	mussels	Consumption
Sunndalsfjord (15)	1993	PAH	fish liver, mussels	Consumption
Hommelvik (Trondheimsfjord) (5)	1985	PAH	mussels	Consumption
Ranfjord (15)	1997	PAH Pb Hg	mussels	Consumption
Vefsnfjord (50)	1992	PAH	mussels	Consumption

¹⁾ Up to 1997 included only cod

²⁾ Up to 1997 included fish

In regards to JMP/JAMP Purpose C (spatial distribution assessment), the concentrations found in 1998 are indicated in the bar graphs shown in Appendix I. Provisional "high background" levels were used to identify elevated concentrations. This initial assessment revealed no new areas of concern that are not currently under surveillance.

In regards to JMP/JAMP Purpose D (temporal trend assessment) there is evidence that the median concentrations of cadmium in mussels from the Sørfjord have decreased since 1987. An analysis of HCB concentrations in mussels from the Langesundsfjord 1990-1998 have shown a decrease.

Study of the power of temporal trend monitoring was useful in assessing existing sampling strategies, however, modifications might be needed to account for local conditions (see Appendix O on VIC results). The 1998 investigation also includes results on Norwegian Pollution Control Authority Pollution Indices (Appendix J), discussion of the results of biological effects methods including imposex and intersex (Chapter 1.4 and Chapter 1.5), analyses of dioxins and dioxin-like compounds (Chapter 1.6) and investigations of sediment samples from 1996-1997 (Chapter 1.7, Appendix N).

The JAMP issues to which these investigations are relevant are shown in Table 3.

Table 3. JAMP issues relating to the Norwegian JAMP (cf., SIME 1997b, Annex 11).

Subject	JAMP issue	Question	Recent Norwegian contribution
Hg, Cd and Pb	JAMP issue 1.2.	What are the concentrations and fluxes in sediments and biota?	1996-1997: Levels in sediment (cf., Chapter 1.7) 1998: Levels and trends in biota (annual investigations since 1981, Chapter 1.3) 1998: INDEX for blue mussels from selected stations (annual investigations since 1995, cf. Chapter 1.3.8)
TBT	JAMP issue 1.3.	To what extent do biological effects occur in the vicinity of major shipping routes offshore installations, marinas and shipyards	1998: Levels and trends in mussels and snails (annual investigations since 1997, cf. Chapter 1.5)
PCBs	JAMP issue 1.7.	Do high concentrations pose a risk to the marine ecosystem	[as for JAMP issue 1.2]
PCBs	JAMP issue 1.8.	Do high concentrations of non-ortho and mono-ortho CBs in seafood pose a risk to human health?	1995: INDEX for blue mussels from selected stations (cf. Green 1997b) 1996: Levels in cod (cf. Chapter 1.6)
PAHs	JAMP issue 1.10.	What are the concentrations in the maritime 1) area?	1992: Levels in shellfish (Green *et al.* 1995) 1992-93: Levels in fish for selected stations (Knutzen & Green 1995) 1996-1997: Levels in sediment (cf., Chapter 1.7) 1998: INDEX for blue mussels from selected stations (annual investigations since 1995, Chapter 1.3.8)
PAHs	JAMP issue 1.11.	Do PAHs affect fish and shellfish?	1998: Biological effects methods in cod (cf. Chapter 1.4)
Other synthetic organic compounds	JAMP issue 1.12.	How widespread are synthetic organic compounds within the maritime 1) area?	1998: Levels and trends in biota (annual investigations since 1983 of selected chlorinated organics, cf. Chapter 1.3) 1996: Introductory investigation of chlorinated organics in cod livers (cf. Chapter 1.6)
Chlorinated dioxins and dibenzofurans	JAMP issue 1.15.	What concentrations occur and have the policy goals (for the relevant parts of the maritime 1) area) been met?	1995: INDEX for blue mussels from selected stations (cf. Green 1997b) 1996: Introductory investigation of chlorinated organics in cod livers (cf. Chapter 1.6)
Biological effects of pollutants	JAMP issue 1.17.	Where do pollutants cause deleterious biological effects?	1998: Southern Coast, planar PCBs, metals, PAHs in cod (annual investigations since 1997, cf. Chapter 1.4)
Chemicals used	JAMP issue 5.3.	In which areas do pesticides and antibiotics affect marine biota?	1997: Levels and trends in biota (cf. Chapter 1.3)
Ecosystem health	JAMP issue 6.1.	How can ecosystem health be assessed in order to determine the extent of human impact	Results for the other issues are also relevant here

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1) Not defined in original text

2. Technical Details

2.1 Compliance with guidelines/procedures

2.1.1 JAMP programme

Samples were collected and analysed, where practical, according to OSPAR guidelines (OSPAR 1990, 1997) and screened and submitted to ICES by agreed procedures (ICES 1996). The most important point of concern are those stations where insufficient number of fish were collected (cf. Appendix G).

2.1.2 Overconcentrations and classification of environmental quality

This report focuses on the principle cases where *median* concentrations exceeded provisional "high background" ("normal"). The median concentration can be derived from the tables in Appendix H or figures in Appendix I, depending on the year and concentration basis in question. The provisional "high background" limits are summarised in Table 4. The factor by which concentrations exceeded “high background” is termed **overconcentration**. “High background” limits have not been set for all contaminants and species. It should be noted that there is in general a need for periodical review and supplement of this list of limits in the light of results from reference localities and introduction of new analytical methods, and/or units. Because of changes in the limits, assessments of overconcentrations for years prior to 1997 made in this report may not correspond to figures and assessments made in previous national comments.

In addition to the use of "high background", the Norwegian Pollution Control Authority’s (SFT’s) system for **classification of environmental quality** has been applied (Table 5).

No attempt has been made to compensate for differences in size groups or number of individuals of mussels or fish. The exception was with mercury in fish fillet where seven and seventeen data sets in this study showed significant differences between “small” and “large” fish (Appendix H). In regards to mussels, there is some evidence that concentrations do not vary significantly among the three size groups employed for this study (i.e. 2-3, 3-4 and 4-5 cm) (WGSAEM 1993).

With respect to Purpose A (health risk assessment), the Norwegian Food Control Authority (SNT) is responsible for official commentary as to possible health risk due to consumption of seafood. Hence, the results of the JAMP pertaining to this purpose are presented only as a partial basis for evaluation.

Table 4. Provisional "high background levels" of selected contaminants, in **ppm (mg/kg) dry weight** (blue mussel) and **ppm (mg/kg wet weight)** (blue mussel and fish). The respective "high background" limits are from Knutzen & Skei (1990) with mostly minor adjustments (Knutzen & Green 1995; Molvær *et al.* 1997), except for dab where the suggested limit is based on JAMP-data (Knutzen & Green 1995). Especially uncertain values are marked with "?".

Cont.	**Blue mussel** ^{1}		**Cod** ^{1}		**Flounder** ^{1}		**Dab** ^{1}	
			liver	**fillet**	**liver**	**fillet**	**liver**	**fillet**
	ppm d.w.	ppm w.w.	ppm w.w.	ppm w.w.	ppm w.w.	ppm w.w.	ppm w.w.	ppm w.w.
Lead	3.0 $^{2)}$	0.6 $^{3)}$	0.1		0.3 ?		0.3 ?	
Cadmium	2.0 $^{2)}$	0.4 $^{3)}$	0.1		0.3 ?		0.3 ?	
Copper	10 $^{2)}$	2 $^{3)}$	20		30 ?		10 ?	
Mercury	0.2 $^{2)}$	0.04 $^{3)}$		0.1 $^{2)}$		0.1		0.1 ?
Zinc	200 $^{2)}$	40 $^{3)}$	30		60 ?		50 ?	
ΣPCB-7 $^{8)}$	0.020 $^{3)}$	0.004 $^{2)}$	0.5 $^{2)}$	0.005	0.10 ?	0.005 ? $^{2)}$	0.5 ?	0.010 ?
CB-153	0.005 $^{3)}$	0.001 $^{4)}$	0.2 ? $^{5)}$		0.05 ? $^{7)}$		0.20 ? $^{7)}$	
ppDDE	0.010 $^{3)}$	0.002 $^{6)}$	0.2 $^{2)}$		0.03 ? $^{6)}$		0.1 ? $^{6)}$	
γ HCH	0.005 $^{3)}$	0.001 $^{6)}$	0.05 $^{2,6)}$		0.01 ? $^{6)}$		0.03 ? $^{6)}$	
HCB	0.0005 $^{3)}$	0.0001 $^{2)}$	0.02 $^{2)}$		0.005 ?		0.01 ?	
TCDDN	0.000001 $^{3)}$	0.0000002 ^{2}						

[1]) Respectively: *Mytilus edulis, Gadus morhua, Platichthys flesus* and *Limanda limanda.*

[2]) From the Norwegian Pollution Control Authority Environmental Class I ("good") (Molvær *et al.* 1997).

[3]) Conversion assuming 20% dry weight.

[4]) Approximately 25% of ΣPCB-7 (Knutzen & Green 1995)

[5]) 1.5-2 times 75% quartile (cf. Annex B in Knutzen & Green 1995)

[6]) Assumed equal to limit for ΣDDT or ΣHCH, respectively, from the Norwegian Pollution Control Authority Environmental Class I ("good") (Molvær *et al.* 1997). Hence, limits for ppDDE and γHCH are probably too high (lacking sufficient and reliable reference values)

[7]) Mean plus 2 times standard deviation (cf. Annex B in Knutzen & Green 1995)

[8]) Estimated as sum of 7 individual PCB compounds (CB-28, -52, -101, -118, -138, -153 and -180) and assumed to be ca. 50% and 70 % of total PCB for blue mussel and cod/flatfish, respectively.

Table 5. Extracts of the Norwegian Pollution Control Authority revised environmental classification system of contaminants in blue mussels and fish (from Molvær *et al.* 1997).

Contaminant		Classification (upper limit for classes I-IV)				
		I	II	III	IV	V
		"good"	*"fair"*	*"poor"*	*"bad"*	*"very bad"*
SEDIMENT						
Lead	ppm d.w.	30	120	600	1500	>1500
Cadmium	ppm d.w.	0.25	1	5	10	>10
Copper	ppm d.w.	35	150	700	1500	>1500
Mercury	ppm d.w.	0.15	0.6	3	5	>5
Zinc	ppm d.w.	150	700	3000	10000	>10000
ΣPCB-7	ppb d.w.	5	25	100	300	>300
CB153 1)	ppb d.w.	*1*	*5*	*20*	*60*	*>300*
ΣDDT	ppb d.w.	0.5	2.5	10	50	>50
HCB	ppb d.w.	0.5	2.5	10	50	>50
BLUE MUSSEL						
Lead	ppm d.w.	3	15	40	100	>100
Cadmium	ppm d.w.	2	5	20	40	>40
Copper	ppm d.w.	10	30	100	200	>200
Mercury	ppm d.w.	0.2	0.5	1.5	4	>4
Zinc	ppm d.w.	200	400	1000	2500	>2500
TBT 1)	ppm d.w.	0.1	0.5	2	5	>5
ΣPCB-7	ppb w.w.	4	15	40	100	>100
ΣDDT	ppb w.w.	2	5	10	30	>30
ΣHCH	ppb w.w.	1	3	10	30	>30
HCB	ppb w.w.	0.1	0.3	1	5	>5
$TE_{PCDF/D}$ 2)	ppp w.w.	0.2	0.5	1.5	3	>3
COD, fillet						
Mercury	ppm w.w.	0.1	0.3	0.5	1	>1
COD, liver						
ΣPCB-7	ppb w.w.	500	1500	4000	10000	>10000
ΣDDT	ppb w.w.	200	500	1500	3000	>3000
ΣHCH	ppb w.w.	50	200	500	1000	>1000
HCB	ppb w.w.	20	50	200	400	>400
$TE_{PCDF/D}$ 2)	ppp w.w.	15	40	100	300	>300

1) Unofficial limits based on ca.20% of ΣPCB_7 measured in diffusely polluted areas (cf. Appendix N)

1) Tributyltin on a formula basis

2) TCDDN (cf. Appendix B)

2.1.3 Comparison with previous data

A simple 3-model approach has been developed to study time trends for contaminants in biota based on *median* concentrations (ASMO 1994). A variation of this method was applied to mercury in fish fillet to distinguish trends in "large" and "small" individuals. The method was first used on a large-scale basis by the Ad Hoc Working Group on Monitoring that met in Copenhagen 8-12. November 1993 (MON 1993). At this meeting it was agreed to apply the method on contaminants in fish muscle and liver on a wet weight basis and contaminants in soft tissue of mussels on a dry weight basis. The results for this assessment are presented earlier (cf. ASMO 1994). The method has been applied to Norwegian data and results are shown in Appendix G. The results can be presented as in Figure 23.

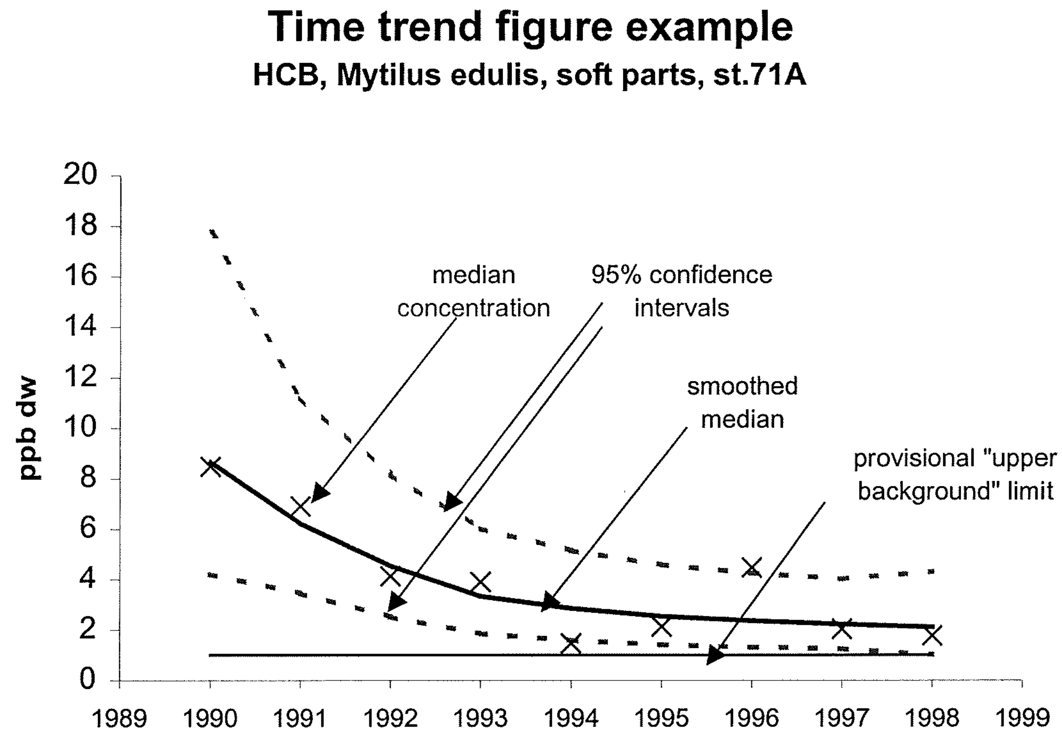

Figure 23. Example presentation and variation in contaminant concentration with time, indicating median concentrations, running mean of median values (Loess smoother), 95% confidence intervals. The provisional "high background level" is marked with a horizontal line and corresponds to values listed in Table 4 (see text).

The method of calculating the smoother in previous reports was based on the a running three-year intervals that was simple to apply but had a tendency to over estimate the residual variance and hence, result in loss of statistical power (Nicholson and Fryer 1994). In accordance to the methods employed at Ad Hoc Working Group on Monitoring that met in Copenhagen 23-27. February 1998 (MON 1998) this has been changed to a Loess smoother based on a running seven-year interval, a non-parametric curve fitted to median log-concentrations (Nicholson *et al.*1997). For statistical tests based on a fitted smoother to be valid the contaminants indices should be independent to a constant level of variance and the residuals for the fitted model should be lognormally distributed (cf. Nicholson *et al.* 1998). The difference in the two smoothing methods is illustrated in Figure 24.

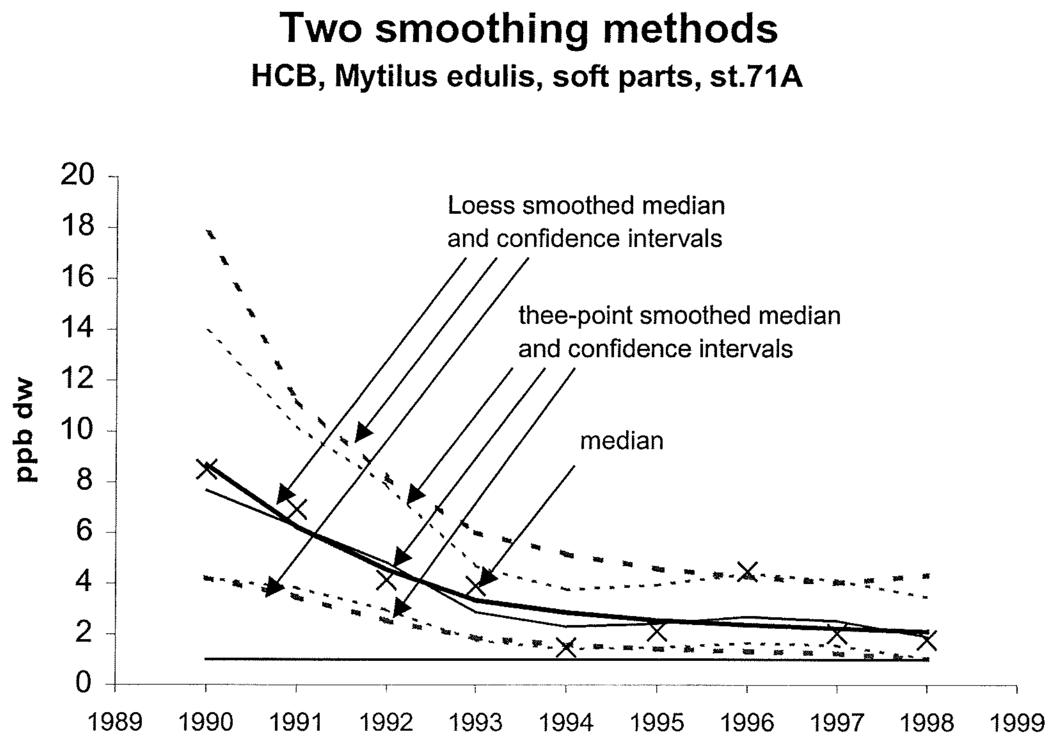

Figure 24. Two smoothing methods: Loess smoother used in this report and three point smoother used prior to 1998 assessment (see text).

The National Comments since 1994 have included two additional analyses. The first is that the upper 95% confidence interval for the last three sampling years is linearly projected for the next three years. This is in line with a proposal submitted earlier (Nicholson, *et al.* 1994) and is used to assess the likelihood of overconcentrations. The projected estimate is based on the results for the temporal trend analyses of at least 6 years of data.

The second is an estimate of the power of the temporal trend series expressed as the number of years to detect a 10% change per year with a 90% power (cf. Nicholson, *et al.*, 1997). The fewer the years the harder it is detect a trend. The power is based on the percentage relative standard deviation (RLSD) estimated using the robust method described ASMO (1994) and Nicholson *et al.* (1998). The estimate was made for series with at least 3 years of data and covers the *entire* period monitored. This fixed means of treating all the datasets may give misleading results especially where non-linear temporal changes are known to occur, such as for HCB in blue mussels from Langesundsfjord (Figure 4).

The statistical analysis was carried out on temporal trend data series for cadmium, copper, mercury, lead, zinc, the PCB congener CB153, ppDDE (ICES code DDEPP), γ-HCH (ICES code HCHG) and HCB. Assessment focused on individual compounds instead of "sum variables". CB153 was chosen because it is persistent and may act as an indicator for other congeners (Atuma *et al.* 1996). Furthermore, there is some evidence that CB153 may correlate with TCDD-equivalents (de Boer *et al.* 1993).

2.2 Information on Quality Assurance

NIVA has participated in all the QUASIMEME international intercalibration exercises, including Round 16 (1998-1999). These exercises have included nearly all the contaminants analysed for JAMP. Quality assurance programme for NIVA is similar to the 1997 programme (cf. Green *et al.* 1999). In addition, NIVA was accredited in 1993 in accordance with the EN45000 standard by the Norwegian Accreditation (reference P009). A summary of the quality assurance programme at NIVA is given in Appendix A. A summary of the intercalibrations exercises that NIVA has participated in is given in Appendix C.

2.3 Description of the Programme

The sampling for 1998 involved sampling of blue mussel at 39 stations and at least one flatfish species or cod was sampled at 20 stations. The Norwegian JAMP has been expanded since 1989 to include monitoring in more diffusely polluted areas. Though new stations are initially intended for annual monitoring (temporal trends), there has not always been sufficient funds to do this for every station. Sample/station reduction measures have been taken to reduce costs. Furthermore, sufficient samples have not always been practical to obtain. When this applies to mussels a new site in the vicinity is often chosen. As for fish, the quota of 25 individuals (±10%), indicated in Appendix F as either 25 individuals or 5 bulked samples consisting of 5 fish per bulked sample, was met for all stations except for flounder caught at st.67B (3.Appendix G). Flounder was caught for the first time at this station. Extra sampling may occur where a bi-catch of fish provides 5 or more fish of a priority species or in co-ordination with VIC (SIME 1996, 1997a). Initiation of the VIC programme allowed supplementary sampling at st.30B (cod), 33B (flounder), 53B (cod and flounder) and 67B (cod). Appendix E and Appendix F gives an overview of the planned and realised sampling.

Concentrations of metals, chlorinated hydrocarbons (including pesticides) and polycyclic aromatic hydrocarbons in mussels and fish were determined at the Norwegian Institute for Water Research (JAMP code NIVA). An overview of the methods applied up to and including 1992 sample material has been presented by Green (1993, also JMG document 19/7 info 3). Only minor modifications have been made since. An overview of analyses applied from 1981 to 1998 (1999) for biological material is given in Appendix D. Parameter abbreviations are given in Appendix B.

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Appendix A
Quality assurance programme

Accreditation

The laboratories at NIVA, both the chemical, microbiological and the ecotoxicological laboratories, were accredited in 1993 for quality assurance system by the National Measurement Service - Norwegian Accreditation and based on European Standard EN45000. NIVA has reference number P009.

Summary of quality control results

A summary of the results for the analyses of the SRM for sediment and biota are shown in Table A1 and A2, respectively.

Marine sediment standard reference material (SRM) MESS-2 and 1941 was used as control for determinations of metals and PCBs/PAHs, respectively.

Dogfish muscle (DORM-2) or dogfish liver (DOLT-2) was used as SRM for the control of the determination of metals (see Table A1). Mackerel oil (350) and mussel tissue (2974) was used as SRM for controls of PCBs and PAHs, respectively. In addition to SRM 2974, an internal standard was used for quality control.

The results were generally satisfactory, the mean was within 2 standard deviations of SRM-mean. Based on these findings, PCBs, DDE and naphthalenes in **sediment** may have been underestimated, whereas benzo(a)pyrene and benzo(ghi)perylene may have been overestimated. It should be noted that SRM values for PCBs, DDE and naphthalenes are listed as not certified. Based on the results for **biota** SRM, lead, benzo(a)pyrene and benzo(e)pyrene may have been underestimated and zinc overestimated. It should be noted that the SRM value for lead is close to the detection limit for this reporting lab.

See also results from intercalibrations exercises listed in Appendix C.

NIVA has also participated in QUASIMEME exercises up to and including: Round 16 : Matrix QTM045MS for metals, QOR057MS for CBs/OCPs and QPH020MS - PAHs in sediment; and Matrix QTM041BT for metals, QOR057BT for CBs/OCPs and QPH010BT - PAHs in biota. The latest round would apply to the 1998 samples analysed in 1999. The results from this round were generally acceptable (z-scores between -2 and 2).

Table A1. Summary of the quality control results for the 1996-97 sediment samples analysed 1998-99. The Standard Reference Materials (SRM) was marine sediment MESS-2* or 1941** analysed together with the JAMP-samples for metals (µg/g), organic chlorines (µg/kg) or polycyclic aromatic hydrocarbons (PAHs) (µg/kg). SRMs were measured several times (N) over a number of weeks (W).

Code	Contaminant	SRM type	SRM value ± confidence interval	N	W	Mean value	Standard deviation
Cd	cadmium	MESS 2	0.24 ± 0.014	4	3	0.22	0.01
Pb	lead	MESS 2	21.9 ± 1.2	4	4	22.3	0.8
Cu	copper	MESS 2	39.3 ± 2.0	4	3	37.7	1.3
Zn	zinc	MESS 2	172 ± 16	4	3	156	1
Hg	mercury	MESS 2	0.092 ± 0.009	3	1	0.087	0.001
Li	lithium	MESS 2	73.9 ± 0.7	4	3	74.0	2.0
CB28	CB28(IUPAC)	1941	16.1 ± 0.4 1)	3	1	6.04	0.18
CB52	CB52(IUPAC)	1941	10.4 ± 0.4 1)	3	1	7.04	0.07
CB101	CB101(IUPAC)	1941	22.0 ± 0.7 1)	3	1	10.7	0.4
CB105	CB105(IUPAC)	1941	5.76 ± 0.23 1)	3	1	4.13	0.81
CB118	CB118(IUPAC)	1941	15.2 ± 0.7 1)	3	1	8.99	0.37
CB138	CB138(IUPAC)	1941	24.9 ± 1.8 1)	3	1	12.9	0.3
CB153	CB153(IUPAC)	1941	22.0 ± 1.4 1)	3	1	14.9	0.6
CB180	CB180(IUPAC)	1941	14.3 ± 0.3 1)	3	1	9.78	0.42
CB209	CB209(IUPAC)	1941	8.35 ± 0.21 1)	3	1	11.1	1.0
DDEPP	p,p' DDE	1941	9.71 ± 0.17 1)	3	1	6.21	0.54
NAP	naphthelene	1941	1322 ± 14 1)	2	8	1050	101
PA	phenanthrene	1941	577 ± 59	2	8	511	90
ANT	anthracene	1941	202 ± 42	2	8	200	36
FLU	fluoranthene	1941	1220 ± 240	2	8	1010	167
PYR	pyrene	1941	1080 ± 200	2	8	819	104
BAA	benzo(a)anthracene	1941	550 ± 79	2	8	407	37
CHR	chrysene	1941	449 1)				
TRI	triphenylene	1941	192 ± 3 1)				
CHRTR	chrysene+triphenylene			2	8	554	31
BBF	benzo(b)fluoranthene	1941	780 ± 190				
BKF	benzo(k)fluoranthene	1941	444 ± 49				
BJKF	benzo(j+k)fluoranthene			2	8	1392	6
BAP	benzo(a)pyrene	1941	670 ± 130	2	8	729	69
PER	perylene	1941	422 ± 33	2	8	500	34
ICDP	indeno(1,2,3-cd)pyrene	1941	569 ± 40	2	8	572	62
BGHIP	benzo(ghi)perylene	1941	516 ± 83	2	8	732	95

1) Not certified SRM value.

*) National Research Council Canada, Marine Analytical Chemistry Standards Program

**) National Institute of Standards & Technology (NIST)

Table A2. Summary of the quality control results for the 1998 biota samples analysed 1998-99. The Standard Reference Materials (SRM) were DORM-2* (dogfish muscle) for mussels and fish fillet, DOLT-2* (dogfish liver) for fish liver, 350** (mackerel oil) for mussels and fish liver and 2974*** (mussel tissue) for mussels. SRM was analysed in series with the JAMP-samples for analyses of metals (mg/kg), organic chlorines or PAH (µg/kg). Tissue types were: mussel softbody (SB), fish liver (LI) and fish fillet (MU). SRMs were measured several times (N) over a number of weeks (W).

Code	Contaminant	Tissue type	SRM type	SRM value ± confidence interval	N	W	Mean value	Standard deviation
Cd	cadmium	SB	DORM	0.043 ± 0.008	1	1	0.047	-
		LI	DOLT	20.80 ± 0.5	15	27	20.5	0.7
Cu	copper	SB	DORM	2.34 ± 0.16	1	1	2.27	-
		LI	DOLT	25.80 ± 1.1	14	27	27.1	1.4
Pb	lead	SB	DORM	0.065 ± 0.007	1	1	0.038	-
		LI	DOLT	0.22 ± 0.02	17	27	0.21	0.03
Hg	mercury	SB	DORM	4.64 ± 0.26	13	25	4.65	0.17
Zn	zinc	SB	DORM	25.6 ± 2.3	1	1	26.3	-
		LI	DOLT	85.8 ± 2.5	14	27	97.8	5.2
CB-28	PCB congener CB-28	(all)	350	22.5 ± 4	20	27	19.0	2.0
CB-52	PCB congener CB-52	(all)	350	62. ± 9	20	27	60	6.0
CB-101	PCB congener CB-101	(all)	350	164 ± 9	20	27	173	10.0
CB-118	PCB congener CB-118	(all)	350	142 ± 20	20	27	147	9.0
CB-153	PCB congener CB-153	(all)	350	317 ± 20	20	27	360	39.0
CB-180	PCB congener CB-180	(all)	350	73. ± 13	20	27	84	5.0
PA	phenanthrene	SB	2974	22.2 ± 2.5	4	20	17.2	2.4
ANT	anthracene	SB	2974	6.1 ± 1.7	3	20	3.0	0.9
FLU	fluoranthene	SB	2974	163.7 ± 10.3	4	20	160	18
PYR	pyrene	SB	2974	151.6 ± 8.0	4	20	149	16
BAA	benzo[*a*]anthracene	SB	2974	32.5 ± 4.8	4	20	31.7	5.1
CHR	chrysene	SB	2974	44.2 ± 2.7				
TRI	triphenylene	SB	2974	50.7 ± 6.1				
CHRTR	chrysene+triphenylene				4	20	83.8	16.1
BBF	benzo[*b*]fluoranthene	SB	2974	46.4 ± 4.0				
BKF	benzo[*k*]fluoranthene	SB	2974	20.2 ± 1.0				
BBJKF	benzo[*b+j,k*]fluoranthene				4	20	60.8	17.8
BAP	benzo[a]pyrene	SB	2974	15.63 ± 0.80	3	20	8.2	3.2
BEP	benzo[e]pyrene	SB	2974	84.0 ± 3.2	4	20	66.2	14.9
PER	perylene	SB	2974	7.68 ± 2.3	3	20	6.9	2.5
ICDP	indeno[1,2,3-*cd*]pyrene	SB	2974	14.2 ± 2.8	4	20	13.3	1.0
BGHIP	benzo[*ghi*]perylene	SB	2974	22.0 ± 2.3	4	20	20.0	3.1

*) National Research Council Canada, Division of Chemistry, Marine Analytical Chemistry Standards

**) BCR, Community Bureau of Reference, Commission of the European Communities

***) National Institute of Standards & Technology (NIST)

Appendix B
Abbreviations

Abbreviation[1]	English	*Norwegian*
ELEMENTS		
Al	aluminium	*aluminium*
As	arsenic	*arsen*
Cd	cadmium	*kadmium*
Co	cobalt	*kobolt*
Cr	chromium	*krom*
Cu	copper	*kobber*
Fe	iron	*jern*
Hg	mercury	*kvikksølv*
Li	lithium	*litium*
Mn	manganese	*mangan*
Ni	nickel	*nikkel*
Pb	lead	*bly*
Pb210	lead-210	*bly-210*
Se	selenium	*selen*
Ti	titanium	*titan*
Zn	zinc	*sink*
PAHs		
PAH	polycyclic aromatic hydrocarbons	*polysykliske aromatiske hydrokarboner*
ACNE	acenaphthene	*acenaften*
ACNLE	acenaphthylene	*acenaftylen*
ANT	anthracene	*antracen*
BAA[3]	benzo[*a*]anthracene	*benzo[a]antracen*
BAP[3]	benzo[*a*]pyrene	*benzo[a]pyren*
BBF[3]	benzo[*b*]fluoranthene	*benzo[b]fluoranten*
BBJKF[3]	benzo[*b,j,k*]fluoranthene	*benzo[b,j,k]fluoranten*
BBJKF[3]	benzo[b+j,k]fluoranthene	*benzo[b+j,k]fluoranten*
BBKF[3]	benzo[*b*+*k*]fluoranthene	*benzo[b+k]fluoranten*
BEP	benzo[*e*]pyrene	*benzo[e]pyren*
BGHIP	benzo[*ghi*]perylene	*benzo[ghi]perylen*
BIPN[2]	biphenyl	*bifenyl*
BJKF[3]	benzo[*j,k*]fluoranthene	*benzo[j,k]fluorantren*
BKF[3]	benzo[*k*]fluoranthene	*benzo[k]fluorantren*
CHR	chrysene	*chrysen*
CHRTR	chrysene+triphenylene	*chrysen+trifenylen*
COR	coronene	*coronen*
DBAHA[3]	dibenz[*a,h*]anthracene	*dibenz[a,h]anthracen*
DBA3A[3]	dibenz[*a,c/a,h*]anthracene	*dibenz[a,c/a,h]antracen*
DBP[3]	dibenzopyrenes	*dibenzopyren*
DBT	dibenzothiophene	*dibenzothiofen*
DBTC1	C_1-dibenzothiophenes	C_1*-dibenzotiofen*
DBTC2	C_2-dibenzothiophenes	C_2*-dibenzotiofen*
DBTC3	C_3-dibenzothiophenes	C_3*-dibenzotiofen*
FLE	fluorene	*fluoren*
FLU	fluoranthene	*fluoranten*

Abbreviation[1]	English	*Norwegian*
PAHs (cont.)		
ICDP [3]	indeno[*1,2,3-cd*]pyrene	*indeno[1,2,3-cd]pyren*
NAP [2]	naphthalene	*naftalen*
NAPC1 [2]	C_1-naphthalenes	C_1-*naftalen*
NAPC2 [2]	C_2-naphthalenes	C_2-*naftalen*
NAPC3 [2]	C_3-naphthalenes	C_3-*naftalen*
NAP1M [2]	1-methylnaphthalene	*1-metylnaftalen*
NAP2M [2]	2-methylnaphthalene	*2-metylnaftalen*
NAPD2 [2]	1,6-dimethylnaphthalene	*1,6-dimetylnaftalen*
NAPD3 [2]	1,5-dimethylnaphthalene	*1,5-dimetylnaftalen*
NAPDI [2]	2,6-dimethylnaphthalene	*2,6-dimetylnaftalen*
NAPT2 [2]	2,3,6-trimethylnaphthalene	*2,3,6-trimetylnaftalen*
NAPT3 [2]	1,2,4-trimethylnaphthalene	*1,2,4-trimetylnaftalen*
NAPT4 [2]	1,2,3-trimethylnaphthalene	*1,2,3-trimetylnaftalen*
NAPTM [2]	2,3,5-trimethylnaphthalene	*2,3,5-trimetylnaftalen*
NPD	Collective term for naphthalenes, phenanthrenes and dibenzothiophenes	*Sammebetegnelse for naftalen, fenantren og dibenzotiofens*
PA	phenanthrene	*fenantren*
PAC1	C_1-phenanthrenes	C_1-*fenantren*
PAC2	C_2-phenanthrenes	C_2-*fenantren*
PAM1	1-methylphenanthrene	*1-metylfenantren*
PAM2	2-methylphenanthrene	*2-metylfenantren*
PAMD1	3,6-dimethylphenanthrene	*3,6-dimetylfenantren*
PAMD2	9,10-dimethylphenanthrene	*9,10-dimetylfenantren*
PER	perylene	*perylen*
PYR	pyrene	*pyren*
DI-Σn	sum of "n" dicyclic "PAH"s (footnote 2)	*sum "n" disykliske "PAH" (fotnote 2)*
P-Σn	sum "n" PAH	*sum "n" PAH*
PK-Σn	sum carcinogen PAH's (footnote 3)	*sum kreftfremkallende PAH (fotnote 3)*
PAHΣΣ	DI-Σn + P-Σn etc.	*DI-Σn + P-Σn mm..*
SPAH	"total" PAH, specific compounds not quantified (outdated analytical method)	*"total" PAH, spesifikk forbindelser ikke kvantifisert (foreldret metode)*

Abbreviations (cont'd.)

Abbreviation[1]	English	*Norwegian*
PCBs		
PCB	polychlorinated biphenyls	*polyklorerte bifenyler*
CB	individual chlorobiphenyls (CB)	*enkelte klorobifenyl*
CB28	CB28 (IUPAC)	*CB28 (IUPAC)*
CB31	CB31 (IUPAC)	*CB31 (IUPAC)*
CB44	CB44 (IUPAC)	*CB44 (IUPAC)*
CB52	CB52 (IUPAC)	*CB52 (IUPAC)*
CB77 [4]	CB77 (IUPAC)	*CB77 (IUPAC)*
CB81 [4]	CB81 (IUPAC)	*CB81 (IUPAC)*
CB95	CB95 (IUPAC)	*CB95 (IUPAC)*
CB101	CB101 (IUPAC)	*CB101 (IUPAC)*
CB105	CB105 (IUPAC)	*CB105 (IUPAC)*
CB110	CB110 (IUPAC)	*CB110 (IUPAC)*
CB118	CB118 (IUPAC)	*CB118 (IUPAC)*
CB126 [4]	CB126 (IUPAC)	*CB126 (IUPAC)*
CB128	CB128 (IUPAC)	*CB128 (IUPAC)*
CB138	CB138 (IUPAC)	*CB138 (IUPAC)*
CB149	CB149 (IUPAC)	*CB149 (IUPAC)*
CB153	CB153 (IUPAC)	*CB153 (IUPAC)*
CB156	CB156 (IUPAC)	*CB156 (IUPAC)*
CB169 [4]	CB169 (IUPAC)	*CB169 (IUPAC)*
CB170	CB170 (IUPAC)	*CB170 (IUPAC)*
CB180	CB180 (IUPAC)	*CB180 (IUPAC)*
CB194	CB194 (IUPAC)	*CB194 (IUPAC)*
CB209	CB209 (IUPAC)	*CB209 (IUPAC)*
CB-Σ7	CB: 28+52+101+118+138+153+180	*CB: 28+52+101+118+138+153+180*
CB-ΣΣ	sum of CBs, includes CB-Σ7	*sum CBer, inkluderer CB-Σ7*
TECBW	Sum of CB-toxicity equivalents after WHO model, see **TEQ**	*Sum CB- toksitets ekvivalenter etter WHO modell, se* ***TEQ***
TECBS	Sum of CB-toxicity equivalents after SAFE model, see **TEQ**	*Sum CB-toksitets ekvivalenter etter SAFE modell, se* ***TEQ***

Abbreviations (cont'd.)

Abbreviation[1]	English	*Norwegian*
DIOXINs		
TCDD	2, 3, 7, 8-tetrachloro-dibenzo dioxin	*2, 3, 7, 8-tetrakloro-dibenzo dioksin*
CDDST	Sum of tetrachloro-dibenzo dioxins	*Sum tetrakloro-dibenzo dioksiner*
CDD1N	1, 2, 3, 7, 8-pentachloro-dibenzo dioxin	*1, 2, 3, 7, 8-pentakloro-dibenzo dioksin*
CDDSN	Sum of pentachloro-dibenzo dioxins	*Sum pentakloro-dibenzo dioksiner*
CDD4X	1, 2, 3, 4, 7, 8-hexachloro-dibenzo dioxin	*1, 2, 3, 4, 7, 8-heksakloro-dibenzo dioksin*
CDD6X	1, 2, 3, 6, 7, 8-hexachloro-dibenzo dioxin	*1, 2, 3, 6, 7, 8-heksakloro-dibenzo dioksin*
CDD9X	1, 2, 3, 7, 8, 9-hexachloro-dibenzo dioxin	*1, 2, 3, 7, 8, 9-heksakloro-dibenzo dioksin*
CDDSX	Sum of hexachloro-dibenzo dioxins	*Sum heksakloro-dibenzo dioksiner*
CDD6P	1, 2, 3, 4, 6, 7, 8-heptachloro-dibenzo dioxin	*1, 2, 3, 4, 6, 7, 8-heptakloro-dibenzo dioksin*
CDDSH	Sum of heptachloro-dibenzo dioxins	*Sum heptakloro-dibenzo dioksiner*
CDDO	Octachloro-dibenzo dioxin	*Oktakloro-dibenzo dioksin*
PCDD	Sum of polychlorinated dibenzo-p-dioxins	*Sum polyklorinaterte-dibenzo-p-dioksiner*
CDF2T	2, 3, 7, 8-tetrachloro-dibenzofuran	*2, 3, 7, 8-tetrakloro-dibenzofuran*
CDFST	Sum of tetrachloro-dibenzofurans	*Sum tetrakloro-dibenzofuraner*
CDFDN	1, 2, 3, 7, 8/1, 2, 3, 4, 8-pentachloro-dibenzofuran	*1, 2, 3, 7, 8/1, 2, 3, 4, 8-pentakloro-dibenzofuran*
CDF2N	2, 3, 4, 7, 8-pentachloro-dibenzofurans	*2, 3, 4, 7, 8-pentakloro-dibenzofuran*
CDFSN	Sum of pentachloro-dibenzofurans	*Sum pentakloro-dibenzofuraner*
CDFDX	1, 2, 3, 4, 7, 8/1, 2, 3, 4, 7, 9-hexachloro-dibenzofuran	*1, 2, 3, 4, 7, 8/1, 2, 3, 4, 7, 9-heksakloro-dibenzofuran*
CDF6X	1, 2, 3, 6, 7, 8-hexachloro-dibenzofuran	*1, 2, 3, 6, 7, 8-heksakloro-dibenzofuran*
CDF9X	1, 2, 3, 7, 8, 9-hexachloro-dibenzofuran	*1, 2, 3, 7, 8, 9-heksakloro-dibenzofuran*
CDF4X	2, 3, 4, 6, 7, 8-hexachloro-dibenzofuran	*2, 3, 4, 6, 7, 8-heksakloro-dibenzofuran*
CDFSX	Sum of hexachloro-dibenzofurans	*Sum heksakloro-dibenzofuraner*
CDF6P	1, 2, 3, 4, 6, 7, 8-heptachloro-dibenzofuran	*1, 2, 3, 4, 6, 7, 8-heptakloro-dibenzofuran*
CDF9P	1, 2, 3, 4, 7, 8, 9-heptachloro-dibenzofuran	*1, 2, 3, 4, 7, 8, 9-heptakloro-dibenzofuran*
CDFSP	Sum of heptachloro-dibenzofurans	*Sum heptakloro-dibenzofuraner*
CDFO	Octachloro-dibenzofurans	*Octakloro-dibenzofuran*
PCDF	Sum of polychlorinated dibenzo-furans	*Sum polyklorinated dibenzo-furaner*
CDDFS	Sum of PCDD and PCDF	*Sum PCDD og PCDF*
TCDDN	Sum of TCDD-toxicity equivalents after Nordic model, see **TEQ**	*Sum TCDD- toksitets ekvivalenter etter Nordisk modell, se **TEQ***
TCDDI	Sum of TCDD-toxicity equivalents after international model, see **TEQ**	*Sum TCDD-toksitets ekvivalenter etter internasjonale modell, se **TEQ***

Abbreviations (cont'd.)

Abbreviation[1]	English	*Norwegian*
PESTICIDES		
ALD	aldrin	*aldrin*
DIELD	dieldrin	*dieldrin*
ENDA	endrin	*endrin*
CCDAN	cis-chlordane (=α-chlordane)	*cis-chlordan (=α-chlordan)*
TCDAN	trans-chlordane (=γ-chlordane)	*trans-chlordan (=γ-chlordan)*
OCDAN	oxy-chlordane	*oxy-chlordan*
TNONC	trans-nonachlor	*trans-nonaklor*
TCDAN	trans-chlordane	*trans-chlordan*
OCS	octachlorostyrene	*octaklorstyren*
QCB	pentachlorobenzene	*pentaklorbenzen*
DDD	diphenyldichloroethane 1,1-dichloro-2,2-bis-(4-chlorophenyl)ethane	*diklordifenyldikloretan* *1,1-dikloro-2,2-bis-(4-klorofenyl)etan*
DDE	dichlorodiphenyldichloroethylene (principle metabolite of DDT) 1,1-dichloro-2,2-bis-(4-chlorophenyl)ethylene*	*diklordifenyldikloretylen* *(hovedmetabolitt av DDT)* *1,1-dikloro-2,2-bis-(4-klorofenyl)etylen*
DDT	diphenyltrichloroethane 1,1,1-trichloro-2,2-bis-(4-chlorophenyl)ethane	*diklordifenyltrikloretan* *1,1,1-trikloro-2,2-bis-(4-klorofenyl)etan*
DDEOP	o,p'-DDE	*o,p'-DDE*
DDEPP	p,p'-DDE	*p,p'-DDE*
DDTOP	o,p'-DDT	*o,p'-DDT*
DDTPP	p,p'-DDT	*p,p'-DDT*
TDEPP	p,p'-DDD	*p,p'-DDD*
DDTEP	p,p'-DDE + p,p'-DDT	*p,p'-DDE + p,p'-DDT*
DD-nΣ	sum of DDT and metabolites, n = number of compounds	*sum DDT og metabolitter,* *n = antall forbindelser*
HCB	hexachlorobenzene	*heksaklorbenzen*
HCHG	Lindane γ HCH = gamma hexachlorocyclohexane (γ BHC = gamma benzenehexachloride, outdated synonym)	*Lindan* *γ HCH = gamma heksaklorsykloheksan* *(γ BHC = gamma benzenheksaklorid, foreldret betegnelse)*
HCHA	α HCH = alpha HCH	*α HCH = alpha HCH*
HCHB	β HCH = beta HCH	*β HCH = beta HCH*
HC-nΣ	sum of HCHs, n = count	*sum av HCHs, n = antall*
EOCl	extractable organically bound chlorine	*ekstraherbart organisk bundet klor*
EPOCl	extractable persistent organically bound chlorine	*ekstraherbart persistent organisk bundet klor*
NTOT	total organic nitrogen	*total organisk nitrogen*
CTOT	total organic carbon	*total organisk karbon*
CORG	organic carbon	*organisk karbon*
GSAMT	grain size	*kornfordeling*
MOCON	moisture content	*vanninnhold*

Abbreviations (cont'd.)

Abbreviation[1]	English	*Norwegian*
INSTITUTES		
IFEN	Institute for Energy Technology	*Institutt for energiteknikk*
FIER	Institute for Nutrition, Fisheries Directorate	*Fiskeridirektoratets Ernæringsinstitutt*
FORC	FORCE Institutes, Div. for Isotope Technique and Analysis [DK]	*FORCE Institutterne, Div. for Isotopteknik og Analyse [DK]*
IMRN	Institute of Marine Research (IMR)	*Havforskningsinstituttet*
NACE	Nordic Analytical Center	*Nordisk Analyse Center*
NILU	Norwegian Institute for Air Research	*Norsk institutt forluftforskning*
NIVA	Norwegian Institute for Water Research	*Norsk institutt for vannforskning*
SERI	Swedish Environmental Research Institute	*Institutionen för vatten- och luftvårdsforskning*
VETN	Norwegian Veterinary Institute	*Veterinærinstituttet*
SIIF	Fondation for Scientific and Industrial Research at the Norwegian Institute of Technology - SINTEF (a division, previously: Center for Industrial Research SI)	*Stiftelsen for industriell og teknisk forskning ved Norges tekniske høgskole- SINTEF (en avdeling, tidligere: Senter for industriforskning SI)*

[1]) After: ICES Environmental Data Reporting Formats. International Council for the Exploration of the Sea. July 1996 and supplementary codes related to non-ortho and mono-ortho PCB's and "dioxins" (ICES pers. comm.)

[2]) Indicates "PAH" compounds that are dicyclic and not truly PAH's typically identified during the analyses of PAH, include naphthalenes and "biphenyls".

[3]) Indicates PAH compounds potentially cancerogenic for humans according to IARC (1987), i.e., categories 2A+2B (possibly and probably carcinogenic).

[4]) Indicates non ortho- co-planer PCB compounds ie., those that lack Cl in positions 1, 1', 5, and 5'

*) The Pesticide Index, second edition. The Royal Society of Chemistry, 1991.

Other abbreviations *andre forkortelser*

	English	*Norwegian*
TEQ	"Toxicity equivalency factors" for the most toxic compounds within the following groups:	*"Toxisitetsekvivalentfaktorer" for de giftigste forbindelsene innen følgende grupper.*
	• polychlorinated dibenzo-p-dioxins and dibenzofurans (**PCDD/PCDFs**). Equivalents calculated after Nordic model (Ahlborg *et al.*, 1989) [1] or international model (Int./EPA, cf. Ahlborg *et al.*, 1992) [2]	• *polyklorerte dibenzo-p-dioksiner og dibenzofuraner (**PCDD/PCDF**). Ekvivalentberegning etter nordisk modell (Ahlborg et al., 1989) [1] eller etter internasjonal modell (Int./EPA, cf. Van den Berg et al. 1998) [2]*
	• non-ortho and mono-ortho substituted chlorobiphenyls after WHO model (Ahlborg *et al.*, 1994) [3] or Safe (1994, cf. NILU pers. comm.)	• *non-orto og mono-orto substituerte klorobifenyler etter WHO modell (Ahlborg et al., 1994) [3] eller Safe (1994, cf. NILU pers. medd.)*
ppm	parts per million, mg/kg	*deler pr. milliondeler, mg/kg*
ppb	parts per billion, µg/kg	*deler pr. milliarddeler, µg/kg*
ppp	parts per trillion, ng/kg	*deler pr. tusen-milliarddeler, ng/kg*
d.w.	dry weight basis	*tørrvekt basis*
w.w.	wet weight or fresh weight basis	*våtvekt eller friskvekt basis*

[1]) Ahlborg, U.G., 1989. Nordic risk assessment of PCDDs and PCDFs. Chemosphere 19:603-608.

[2]) Van den Berg, Birnbaum, L, Bosveld, A. T. C. and co-workers, 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Hlth. Perspect. 106:775-792.

[3]) Ahlborg, U.G., Becking G.B., Birnbaum, L.S., Brouwer, A, Derks, H.J.G.M., Feely, M., Golor, G., Hanberg, A., Larsen, J.C., J.C., Liem, A.K.G., Safe, S.H., Schlatter, C., Wärn, F., Younes, M., Yrjänheikki, E., 1994. Toxic equivalency factors for dioxin-like PCBs. Report on a WHO-ECEH and IPSC consultation , December 1993. Chemosphere 28:1049-1067.

Appendix C
Participation in intercalibration exercises

Participation in intercalibration exercises

General: The main contributor to JAMP in 1996 has been NIVA which has participated in all QUASIMEME exercises relevant to the parameter and tissues monitored

Sea water:

4H	ICES/JMG Fifth Round Intercalibration on Trace Metals in Sea Water - Section 4, analysis for Hg - 1983 - (5/TM/SW:4).
4I	JMG Sixth Intercalibration on Trace Metals in Estuarine Waters - 1986 - (6/TM/SW).
4Z	Intercalibration exercise for SIIF/SERI (Cd) and NIVA/IAMK (IAMK=Chalmers Inst., Göteborg) - 1985.

Seabed sediment:

7E	ICES, First Intercalibration Exercise on Trace metals in Marine Sediments - 1984 - (1/TM/MS).
8B	ICES/OSPAR, First Intercomparison Exercise on Organochlorines (individual chlorobiphenyl congeners) in Marine Sediments - Phase 1, analysis of standard solutions - 1989 - (1/OC/MS:1).
8C	ICES/OSPAR, First Intercomparison Exercise on Organochlorines (individual chlorobiphenyl congeners) in Marine Sediments - Phase 2, analysis of standard solutions - 1991 - (1/OC/MS:2).
8B	ICES/IOC/OSPAR Intercomparison Programme on the Analysis of Chlorobiphenyls in Marine Media - Step 1 - (analysis of standard solutions) - 1989 - (1/OC/MS-1).
8C	ICES/IOC/OSPAR Intercomparison Programme on the Analysis of Chlorobiphenyls in Marine Media - Step 2 - 1990 - (1/OC/MS-2).
8D	ICES/IOC/OSPAR Intercomparison Programme on the Analysis of Chlorobiphenyls in Marine Media - Step 3a (1/OC/MS-3a) 1991.
8E	ICES/IOC/OSPAR Intercomparison Programme on the Analysis of Chlorobiphenyls in Marine Media - Step 3b - (1/OC/MS-3b) 1992.
8F	ICES/IOC/OSPAR Intercomparison Programme on the Analysis of Chlorobiphenyls in Marine Media - Step 4 - (1/OC/MS-4) 1993.

Marine biota:

1E	ICES, Fifth Intercalibration Exercise on Trace Metals in Biological Tissues - 1978 - (5/TM/BT).
1F	ICES, Sixth Intercalibration Exercise on Trace Metals (Cadmium and Lead only) in Biological Tissues - 1979 - (6/TM/BT).
1G	ICES, Seventh Intercalibration Exercise on Trace Metals in Biological Tissues - Part A - 1983 - (7/TM/BT).

Appendix D.
Analytical overview

Sorted in three ways:
- **Method, laboratory**
- **Laboratory, method**
- **Contaminant, year, laboratory, intercalibration**

Abbreviations are defined in Appendices B and C

Filename : I:\TBX\JMG\SED\TAB-3OVE.TB1 Niva 25/02-1997

Analytical overview; SEDIMENT Data.
Sorted by CONTAMINANT, Monitoring Year, Lab and Intercalibration.

Contam.	Year-Lab	Inter-calib-ration	Basis	Analys Method Code	Detection Limit (ppb)	Total Value Count	Count Below Det.Lim	N (<) Above Det.Lim
ACNE	1994-NIVA		D	369	1.000	24	23	
ACNLE	1994-NIVA		D	369	1.000	24	23	
ANT	1994-NIVA		D	369	1.000	24	22	
AS	1994-NIVA		D	354	500.000	12		
BAA	1994-NIVA		D	369	1.000	24	11	
BAP	1994-NIVA		D	369	1.000	24	12	
BBF	1994-NIVA		D	369	1.000	24	9	
BEP	1994-NIVA		D	369	1.000	24	8	
BGHIP	1994-NIVA		D	369	1.000	24	9	
BIPN	1994-NIVA		D	369	1.000	24	21	
BJKF	1994-NIVA		D	369	1.000	24	11	
CB101	1994-NIVA	8Z	D	360	0.050	24		12
CB105	1994-NIVA	8Z	D	360	0.050	24		24
CB118	1994-NIVA	8Z	D	360	0.050	24		13
CB138	1994-NIVA	8Z	D	360	0.050	24		12
CB153	1994-NIVA	8Z	D	360	0.050	24		12
CB156	1994-NIVA	8Z	D	360	0.050	24		22
CB180	1994-NIVA	8Z	D	360	0.050	24		13
CB209	1994-NIVA	8C	D	360	0.050	24		12
CB28	1994-NIVA	8Z	D	360	0.050	24		2
CB52	1994-NIVA	8Z	D	360	0.050	24		2
CD	1994-NIVA	7Z	D	353	1.000	114		
CHRTR	1994-NIVA		D	369	0.500	24		
CORG	1994-NIVA		D	390	200000.000	114		
CR	1994-NIVA	7Z	D	353	5.000	12		
CTOT	1994-NIVA		D	390	1000000.000	12		
CU	1994-NIVA	7Z	D	351	10.000	114		
DBA3A	1994-NIVA		D	369	1.000	23	11	
DDEPP	1994-NIVA	8Z	D	360	0.050	24		12
FLE	1994-NIVA		D	369	1.000	24	23	
FLU	1994-NIVA		D	369	1.000	24	10	
GSAMT	1994-NIVA		D	m	miss	204		
HCB	1994-NIVA	8Z	D	360	0.050	24		10
HCHA	1994-NIVA	8Z	D	360	0.050	24		23
HCHG	1994-NIVA	8Z	D	360	0.050	24		15
HG	1994-NIVA	7Z	D	350	10.000	114	2	
ICDP	1994-NIVA		D	369	1.000	24	12	
LI	1994-NIVA	7E	D	353	1.000	114		
MOCON	1994-NIVA		D	340	~1.000	62		
NAP	1994-NIVA		D	369	1.000	24	18	
NAP1M	1994-NIVA		D	369	1.000	24	19	
NAP2M	1994-NIVA		D	369	1.000	24	17	
NAPDI	1994-NIVA		D	369	1.000	24	18	
NAPTM	1994-NIVA		D	369	1.000	24	24	
NI	1994-NIVA	7Z	D	353	50.000	12		
NTOT	1994-NIVA		D	390	1000000.000	114		
OCS	1994-NIVA		D	360	0.050	24		24
PA	1994-NIVA		D	369	1.000	24	11	
PAM1	1994-NIVA		D	369	1.000	24	17	
PB	1994-NIVA	7Z	D	353	1.000	114		
PB210	1994-VKID		D	650	~1.000	62	25	
PER	1994-NIVA		D	369	1.000	24	3	
PYR	1994-NIVA		D	369	1.000	24	12	
QCB	1994-NIVA		D	360	0.050	24		22
TDEPP	1994-NIVA	8Z	D	360	0.050	24		21
ZN	1994-NIVA	7Z	D	351	100.000	114		
Sum of Counts						2271	371	251

~(2) ! Converting to ppb ignored, due to missing UNIT.
m(1) > Include missing value(s).

Filename: C:\TBX\JMG\SED\TAB-4OVE.TB1 Niva 07/12-1999

SEDIMENT Data.

Analytical overview sorted by METHOD and LAB.

Method	Lab.	Monitoring Year	Contaminants
...	NIVA	1986-1987,1990,1992,1994, 1996-1997	GSAMT
	NIVA	1990,1992	MOCON
	VKID	1996-1997	GSAMT
340	NIVA	1994,1996	MOCON
	VKID	1996-1997	MOCON
350	NIVA	1986-1987,1990,1992,1994, 1996-1997	HG
351	NIVA	1986-1987,1990,1992,1994, 1996-1997	CU , ZN
352	NIVA	1986-1987	CD , PB
	NIVA	1987,1990	AL
353	NIVA	1990,1992,1994,1996-1997	CD , LI , PB
	NIVA	1994	CR , NI
354	NIVA	1994	AS
360	NIVA	1992,1994,1996-1997	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
369	NIVA	1992	CHR , COR , DBP
	NIVA	1992,1994	BBF , BJKF
	NIVA	1992,1994,1996-1997	ACNE , ACNLE, ANT , BAA , BAP , BEP , BGHIP, BIPN , DBA3A, FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
	NIVA	1994,1996-1997	CHRTR
	NIVA	1996-1997	BBJKF, DBT , NAPD2, NAPD3, NAPT2, NAPT3, NAPT4, PAM2 , PAMD1, PAMD2
390	NIVA	1986-1987,1990,1992,1994, 1996-1997	CORG
	NIVA	1994,1996-1997	CTOT , NTOT
650	VKID	1990,1992,1994,1996-1997	PB210
760	IMRN	1990	ALD , CB101, CB105, CB118, CB128, CB138, CB149, CB153, CB156, CB170, CB180, CB28 , CB31 , CB52 , DDEOP, DDEPP, DDTOP, DDTPP, HCB , HCHA , HCHB , HCHG , TDEOP, TDEPP
769	IMRN	1990	ANT , BAA , BAP , BBKF , BEP , BGHIP, CHR , DBAHA, DBT , DBTC1, DBTC2, DBTC3, FLE , FLU , ICDP , NAP , NAPC1, NAPC2, NAPC3, PA , PAC1 , PAC2 , PER , PYR , SPAH
999	NIVA	1996-1997	DDTPP

Analytical overview sorted by LAB and METHOD.

Lab.	Method	Monitoring Year	Contaminants
IMRN	760	1990	ALD , CB101, CB105, CB118, CB128, CB138, CB149, CB153, CB156, CB170, CB180, CB28 , CB31 , CB52 , DDEOP, DDEPP, DDTOP, DDTPP, HCB , HCHA , HCHB , HCHG , TDEOP, TDEPP
	769	1990	ANT , BAA , BAP , BBKF , BEP , BGHIP, CHR , DBAHA, DBT , DBTC1, DBTC2, DBTC3, FLE , FLU , ICDP , NAP , NAPC1, NAPC2, NAPC3, PA , PAC1 , PAC2 , PER , PYR , SPAH
NIVA	...	1986-1987,1990,1992,1994, 1996-1997	GSAMT
	...	1990,1992	MOCON
	340	1994,1996	MOCON
	350	1986-1987,1990,1992,1994, 1996-1997	HG
	351	1986-1987,1990,1992,1994, 1996-1997	CU , ZN
	352	1986-1987	CD , PB
	352	1987,1990	AL
	353	1990,1992,1994,1996-1997	CD , LI , PB
	353	1994	CR , NI
	354	1994	AS
	360	1992,1994,1996-1997	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
	369	1992	CHR , COR , DBP
	369	1992,1994	BBF , BJKF
	369	1992,1994,1996-1997	ACNE , ACNLE, ANT , BAA , BAP , BEP , BGHIP, BIPN , DBA3A, FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
	369	1994,1996-1997	CHRTR
	369	1996-1997	BBJKF, DBT , NAPD2, NAPD3, NAPT2, NAPT3, NAPT4, PAM2 , PAMD1, PAMD2
	390	1986-1987,1990,1992,1994, 1996-1997	CORG
	390	1994,1996-1997	CTOT , NTOT
	999	1996-1997	DDTPP
VKID	...	1996-1997	GSAMT
	340	1996-1997	MOCON
	650	1990,1992,1994,1996-1997	PB210

Analytical overview B I O T A ;
Sorted by CONTAMINANT, MonitoringYear & Lab, Intercalibration+Basis and ordered by TISSUE.

Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter- calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
ACNE	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		20
	1996-NIVA	W						309	0.20	65		19
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
ACNLE	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		49
	1996-NIVA	W						309	0.20	65		42
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
AG	1996-NIVA	W						999	miss	3		
ANT	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	72		28
	1996-NIVA	W						309	0.20	65		30
	1997-NIVA	W						309	0.50	35		
	1998-NIVA	W						309	0.50	39		
AS	1996-NIVA	W						999	miss	3		
BAA	1992-NIVA	W	309	0.20	8			309	0.20	44		
	1995-NIVA	W						309	0.20	72		9
	1996-NIVA	W						309	0.20	65		8
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
BAP	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	72		21
	1996-NIVA	W						309	0.20	65		26
	1997-NIVA	AL W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
BBF	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	59		9
	1996-NIVA	W						309	0.20	57		6
BBJKF	1995-NIVA	W						309	0.20	12		
	1996-NIVA	W						309	0.20	8		
	1997-NIVA	W						309	0.20	36		1
	1998-NIVA	W						309	0.20	39		
BEP	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	72		5
	1996-NIVA	W						309	0.20	65		6
	1997-NIVA	W						309	0.20	36		
	1998-NIVA	W						309	0.20	38		
BGHIP	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		20
	1996-NIVA	W						309	0.20	65		10
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	35		
BIPN	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		52
	1996-NIVA	W						309	0.20	62		39
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39	1	
BJKF	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	24		21
	1996-NIVA	W						309	0.20	57		16
CB101	1987-SIIF	W						111	0.20	21	1	
	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	22		
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169	1		341	0.05	58		
	1990-SIIF	2G W						111	0.40	41	6	
	1991-NIVA	2H W	340	1.00	179		8	341	0.05	62		
	1991-SIIF	2H W						111	0.20	35		1
	1992-NIVA	2J W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	2K W	340	4.00	212	12		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	3		341	0.05	165	39	
	1995-NIVA	W	340	3.00	318	10		341	0.05	225	10	
	1996-NIVA	W	340	3.00	332	14		341	0.05	237	9	
	1997-NIVA	W	340	3.00	260	24						
	1997-NIVA	AJ W						341	0.05	221	4	
	1998-NIVA	W	340	3.00	284	19	1	341	0.05	197	1	3
CB105	1991-NIVA	2H W	340	1.00	87		1	341	0.05	47		
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	QM W	340	4.00	212	21		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	8		341	0.05	165	53	
	1995-NIVA	W	340	3.00	318	13		341	0.05	224	34	
	1996-NIVA	W	340	3.00	332	22		341	0.05	231	23	
	1997-NIVA	W	340	3.00	260	24		341	0.05	221	3	1
	1998-NIVA	W	340	3.00	284	31	19	341	0.05	201	11	16
CB118	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169			341	0.05	58		
	1990-SIIF	2G W						111	0.20	41	1	
	1991-NIVA	2H W	340	1.00	179			341	0.05	62		
	1991-SIIF	2H W						111	0.20	35		1
	1992-NIVA	2J W	340	5.00	192	2		341	0.10	140		
	1993-NIVA	2K W	340	4.00	212	10		341	0.10	133		

Tab.length cont'd.

Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter-calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1994-NIVA	2Z W	340	3.00	300	2		341	0.05	165	25	
	1995-NIVA	W	340	3.00	318	2		341	0.05	225	2	
	1996-NIVA	W	340	3.00	332	6		341	0.05	237	4	
	1997-NIVA	W	340	3.00	260	5						
	1997-NIVA	AJ W						341	0.05	221		
	1998-NIVA	W	340	3.00	284	6	1	341	0.05	203	3	1
CB126	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
CB138	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	21		
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169			341	0.05	58		
	1990-SIIF	2G W						111	0.30	41		
	1991-NIVA	2H W	340	1.00	179			341	0.05	62		
	1991-SIIF	2H W						111	0.30	35		1
	1992-NIVA	2J W	340	5.00	192			341	0.10	137		
	1993-NIVA	QM W	340	4.00	212	3		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300			341	0.05	165	12	
	1995-NIVA	W	340	3.00	318	2		341	0.05	225		
	1996-NIVA	W	340	3.00	331	1		341	0.05	235		
	1997-NIVA	W	340	3.00	260	1						
	1997-NIVA	AJ W						341	0.05	221		1
	1998-NIVA	W	340	3.00	284	3		341	0.05	203		
CB153	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	22		
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169			341	0.05	58		
	1990-SIIF	2G W						111	0.30	41		
	1991-NIVA	2H W	340	1.00	179			341	0.05	62		
	1991-SIIF	2H W						111	0.50	35		1
	1992-NIVA	2J W	340	5.00	192			341	0.10	140		
	1993-NIVA	2K W	340	4.00	212	3		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300			341	0.05	165	9	
	1995-NIVA	W	340	3.00	318	1		341	0.05	225		
	1996-NIVA	W	340	3.00	332	1		341	0.05	237		
	1997-NIVA	W	340	3.00	260							
	1997-NIVA	AJ W						341	0.05	221		
	1998-NIVA	W	340	3.00	284	1		341	0.05	203	1	1
CB156	1991-NIVA	2H W	340	1.00	87		15	341	0.05	47		5
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	QM W	340	4.00	212	31		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	24	1	341	0.05	162	70	
	1995-NIVA	W	340	3.00	317	27		341	0.05	225	67	
	1996-NIVA	W	340	3.00	332	48		341	0.05	237	62	
	1997-NIVA	W	340	3.00	260	46						
	1997-NIVA	AJ W						341	0.05	221	9	10
	1998-NIVA	W	340	3.00	284	52	70	341	0.05	203	37	47
CB169	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18	2	
CB180	1987-SIIF	W						111	0.20	21	6	
	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	22		
	1989-NACE	W	510	20.00	93	1						
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169			341	0.05	58		
	1990-SIIF	2G W						111	0.20	41	8	
	1991-NIVA	2H W	340	1.00	179			341	0.05	62		
	1991-SIIF	2H W						111	0.20	35		
	1992-NIVA	2J W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	2K W	340	4.00	212	15		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	3		341	0.05	162	49	
	1995-NIVA	W	340	3.00	318	5		341	0.05	225	22	
	1996-NIVA	W	340	3.00	332	14		341	0.05	237	25	
	1997-NIVA	W	340	3.00	260	18						
	1997-NIVA	AJ W						341	0.05	221	1	1
	1998-NIVA	W	340	3.00	284	20	14	341	0.05	203	18	44
CB209	1990-NIVA	W	340	2.00	169	24	11	341	0.05	58		
	1991-NIVA	W	340	2.00	179	11	88	341	0.05	62	5	7
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		1
	1993-NIVA	W	340	4.00	212	46	14	341	0.10	133		
	1994-NIVA	W	340	3.00	300	29	24	341	0.05	165	91	
	1995-NIVA	W	340	3.00	318	36		341	0.05	225	92	5
	1996-NIVA	W	340	3.00	332	255		341	0.05	237	107	9
	1997-NIVA	W	340	3.00	260	196		341	0.05	221	30	14
	1998-NIVA	W	340	3.00	283	120	121	341	0.05	203	50	69
CB28	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	22		
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		1
	1990-NIVA	2G W	340	1.00	169	2	2	341	0.05	58		
	1990-SIIF	2G W						111	0.20	41	7	
	1991-NIVA	2H W	340	1.00	179	2	52	341	0.05	62	5	1
	1991-SIIF	2H W						111	0.30	35		
	1992-NIVA	2J W	340	5.00	192	3		341	0.10	137		
	1993-NIVA	2K W	340	4.00	212	44	5	341	0.10	133		
	1994-NIVA	2Z W	340	3.00	282	18	4	341	0.05	163	73	

Tab.length cont'd.

Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter- calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1995-NIVA	W	340	3.00	313	27		341	0.05	225	75	
	1996-NIVA	W	340	3.00	332	107		341	0.05	236	70	
	1997-NIVA	W	340	3.00	260	81						
	1997-NIVA	AJ W						341	0.05	221	22	14
	1998-NIVA	W	340	3.00	284	96	99	341	0.05	201	33	46
CB52	1987-SIIF	W						111	0.20	20	1	
	1988-SIIF	D						111	0.10	6		
	1988-SIIF	W						111	0.10	22		
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	0.10	36		
	1990-NIVA	2G W	340	1.00	169	2	6	341	0.05	58		
	1990-SIIF	2G W						111	0.40	41	7	
	1991-NIVA	2H W	340	1.00	179	1	37	341	0.05	62	5	1
	1991-SIIF	2H W						111	0.30	35		
	1992-NIVA	2J W	340	5.00	192	3		341	0.10	137		
	1993-NIVA	2K W	340	4.00	212	40		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	9		341	0.05	165	64	
	1995-NIVA	W	340	3.00	312	19		341	0.05	214	28	
	1996-NIVA	W	340	3.00	332	49		341	0.05	235	31	
	1997-NIVA	W	340	3.00	260	116						
	1997-NIVA	AJ W						341	0.05	221	25	10
	1998-NIVA	W	340	3.00	281	47	44	341	0.05	168	12	17
CB77	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
CB81	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
CD	1981-SIIF	1E W	130	10.00	28			130	5.00	27		
	1981-SIIF	1F W						130	10.00	7		
	1982-SIIF	1F W						130	10.00	18		
	1982-VETN	W	230	10.00	54							
	1983-SIIF	1F W						130	10.00	17		
	1983-VETN	1Z W	230	10.00	46							
	1984-FIER	1H W	402	1.00	23							
	1984-SIIF	1G W						130	10.00	27		
	1984-VETN	1Z W	230	10.00	66							
	1985-SIIF	1G D						130	10.00	35		
	1985-VETN	1Z W	230	10.00	45		3					
	1986-NIVA	1H D	312	30.00	56	1		312	30.00	20		
	1987-FIER	1G W	402	1.00	37							
	1987-NIVA	1H D	312	30.00	57		4	312	30.00	37		
	1988-NIVA	1H D	312	30.00	61	11	1	312	30.00	55		
	1989-NIVA	1H D	312	30.00	135	11	8					
	1989-NIVA	1H W						312	30.00	36		
	1990-NIVA	1H W	312	10.00	189	9	2	312	30.00	77	5	
	1991-NIVA	1H W	312	10.00	190	29	2	312	10.00	67		
	1992-NIVA	1H W	312	10.00	191	4		312	10.00	111		
	1993-NIVA	1H W	312	50.00	221	98		312	50.00	79		
	1994-NIVA	1Z W	312	50.00	302	134		312	50.00	81		
	1995-NIVA	W	312	50.00	318	129		312	50.00	137	2	
	1996-NIVA	V1 W						312	50.00	125		
	1996-NIVA	V2 W	312	50.00	368	128						
	1997-NIVA	W	312	50.00	287	90						
	1997-NIVA	AH W						312	50.00	107		
	1998-NIVA	W	312	50.00	285	101		312	50.00	93		
CDD1N	1995-NILU	W						841	.20E-04	6	1	1
	1996-NILU	W						841	.10E-04	18		2
CDD4X	1995-NILU	W						841	.20E-04	6	3	1
	1996-NILU	W						841	.200E+08	18	18	
CDD6P	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.40E-04	18		
CDD6X	1995-NILU	W						841	.20E-04	6		1
	1996-NILU	W						841	.20E-04	18		1
CDD9X	1995-NILU	W						841	.20E-04	6	2	1
	1996-NILU	W						841	.20E-04	18		1
CDDO	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
CDDSN	1995-NILU	W						841	.20E-04	5		
	1996-NILU	W						841	.10E-04	18		3
CDDSP	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.40E-04	18		
CDDST	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		
CDDSX	1995-NILU	W						841	.20E-04	5		
	1996-NILU	W						841	.20E-04	18		2
CDF2N	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		1
CDF2T	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		
CDF4X	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.20E-04	18		1
CDF6P	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.40E-04	18	2	1
CDF6X	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.20E-04	18		1
CDF9P	1995-NILU	W						841	.20E-04	6	2	1
	1996-NILU	W						841	.80E-04	17	3	1
CDF9X	1995-NILU	W						841	.20E-04	6	3	1
	1996-NILU	W						841	.20E-04	18		1

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Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter-calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
CDFDN	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		1
CDFDX	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.20E-04	18		1
CDFO	1995-NILU	W						841	.20E-04	6		1
	1996-NILU	W						841	.10E-03	18	3	1
CDFSN	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		1
CDFSP	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.80E-04	18	6	1
CDFST	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-04	18		
CDFSX	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.20E-04	18		1
CHR	1992-NIVA	W	309	0.20	8			309	0.20	44		
	1995-NIVA	W						309	0.20	56		
	1996-NIVA	W						309	0.20	65		3
CHRTR	1995-NIVA	W						309	0.20	15		2
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
CO	1996-NIVA	W						999	miss	3		
COR	1992-NIVA	W	309	0.20	8			309	0.20	46		
CR	1992-NIVA	W						312	10.00	6		
	1996-NIVA	W						999	miss	3		
CU	1983-SIIF	1G W						130	10.00	12		
	1984-SIIF	1G W						130	10.00	27		
	1986-NIVA	1H D	311	150.00	56			311	150.00	20		
	1987-FIER	1G W	404	50.00	37							
	1987-NIVA	1H D	311	150.00	57			311	150.00	37		
	1988-NIVA	1H D	311	150.00	61			311	150.00	55		
	1989-NIVA	1H D	311	150.00	135							
	1989-NIVA	1H W						311	150.00	36		
	1990-NIVA	1H W	311	150.00	189			311	150.00	77		
	1991-NIVA	1H W	311	50.00	193	2		311	50.00	67		
	1992-NIVA	1H W	311	10.00	191			311	10.00	111		
	1993-NIVA	1H W	311	10.00	221			311	10.00	79		
	1994-NIVA	1Z W	311	10.00	302			311	10.00	81		
	1995-NIVA	W	311	10.00	318			311	10.00	122		
	1996-NIVA	V1 W						311	10.00	113		
	1996-NIVA	V2 W	311	10.00	368							
	1997-NIVA	W	311	5000.00a	287	1						
	1997-NIVA	AH W						311	10.00	96		
	1998-NIVA	W	311	10.00	285			311	10.00	51		
DBA3A	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	71		48
	1996-NIVA	W						309	0.20	65		53
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
DBP	1992-NIVA	W	309	0.20	8			309	0.20	46		
DBT	1998-NIVA	W						309	0.50	39		
DBTC1	1995-NIVA	W						309	0.20	57		14
	1996-NIVA	W						309	0.20	65		9
DBTC2	1995-NIVA	W						309	0.20	56		9
	1996-NIVA	W						309	0.20	62		11
DBTC3	1995-NIVA	W						309	0.20	57		4
	1996-NIVA	W						309	0.20	65		5
DBTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15		
DBTIO	1997-NIVA	W						309	0.50	34		
DDEPP	1982-VETN	W	210	50.00	53							
	1983-VETN	2E W	210	50.00	48			211a	50.00	48		
	1984-VETN	2E W	210	50.00	66							
	1985-VETN	2E W	210	50.00	45							
	1986-NACE	2Z W	510	20.00	56							
	1987-NACE	2Z W	510	40.00	53							
	1988-NACE	2Z W	510	40.00	61							
	1989-NACE	2Z W	510	20.00	93							
	1990-NIVA	W	340	1.00	169			341	0.05	58		
	1991-NIVA	W	340	1.00	179			341	0.05	62		
	1992-NIVA	W	340	5.00	192	2		341	0.10	140		
	1993-NIVA	W	340	4.00	212	3		341	0.10	133		
	1994-NIVA	2Z W	340	4.00	300			341	0.10	165	27	
	1995-NIVA	W	340	4.00	318	2		341	0.10	225	30	
	1996-NIVA	W	340	4.00	332	2		341	0.10	237	47	
	1997-NIVA	W	340	4.00	260	3		341	0.10	221	1	
	1998-NIVA	W	340	4.00	284	6		341	0.10	203	4	
DDTEP	1983-SIIF	W						111	0.50	12		
	1984-SIIF	W						111	0.50	24		1
	1985-SIIF	W						111	0.50	27	1	5
	1986-SIIF	W						111	0.50	21		
	1987-SIIF	W						111	0.50	21	1	
	1988-SIIF	D						111	0.50	6		
	1988-SIIF	W						111	0.50	22	1	
	1989-SIIF	W						111	0.50	36	1	
	1990-SIIF	W						111	0.20	41	1	
	1991-SIIF	W						111	0.30	35		
DDTPP	1986-NACE	W	510	40.00	56							
	1987-NACE	W	510	40.00	53							

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Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Year Lab.	Inter-calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1988-NACE	W	510	40.00	61							
	1989-NACE	W	510	20.00	93							
	1995-NIVA	W						340	0.05	69		
	1996-NIVA	W	340	0.05	54		4	340	0.05	45		
	1997-NIVA	W	340	2.00	32							
	1997-NIVA	AJ W						340	0.05	48		
	1998-NIVA	W	340	2.00	37	1	8	340	0.05	68		24
DPTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15	9	
EOCL	1989-SIIF	W						605	170.00	5		
EPOCL	1986-NACE	W	610	800.00	56							
	1986-SIIF	W						605	5000.00	21	21	
	1987-NACE	W	610	800.00	53							
	1987-SIIF	W						605	40.00	20		
	1988-NACE	W	610	800.00	60							
	1988-SIIF	W						605	40.00	27		
	1989-NACE	W	610	800.00	89	1						
	1989-SIIF	W						605	40.00	35		
	1990-NIVA	W	615	40.00	117		3					
	1990-SIIF	W						605	40.00	41		
	1991-NIVA	W	615	40.00	116		12					
	1991-SIIF	W						605	130.00	35		
	1997-IFEN	W						607	50.00	6		
	1998-IFEN	W						607	1.00	6		
FLE	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	72		22
	1996-NIVA	W						309	0.20	65		6
	1997-NIVA	AL W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
FLU	1992-NIVA	W	309	0.20	8			309	0.20	44		
	1995-NIVA	W						309	0.20	72		
	1996-NIVA	W						309	0.20	65		
	1997-NIVA	AL W						309	0.20	36		
	1998-NIVA	W						309	0.20	39		
HCB	1983-SIIF	W						111	0.50	12		
	1983-VETN	2Z W	210	10.00	48			211a	10.00	48		
	1984-SIIF	W						111	0.20	24		1
	1984-VETN	2Z W	210	10.00	66							
	1985-SIIF	W						111	0.20	30	6	2
	1985-VETN	2Z W	210	10.00	45		4					
	1986-NACE	2Z W	510	10.00	56							
	1986-SIIF	2Z W						111	0.20	21	3	
	1987-NACE	2Z W	510	40.00	53							
	1987-SIIF	2Z W						111	0.20	21	4	
	1988-NACE	2Z W	510	40.00	61							
	1988-SIIF	2Z D						111	0.20	6		
	1988-SIIF	2Z W						111	0.20	22	2	
	1989-NACE	2Z W	510	20.00	93							
	1989-SIIF	2Z W						111	0.05	36		
	1990-NIVA	W	340	1.00	169	2		341	0.05	58		
	1990-SIIF	2Z W						111	0.05	41	3	
	1991-NIVA	W	340	1.00	179	4	13	341	0.05	62	5	
	1991-SIIF	2Z W						111	0.10	35		
	1992-NIVA	W	340	5.00	189	3		341	0.10	140		
	1993-NIVA	W	340	4.00	212	31		341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	24	1	341	0.05	165	33	
	1995-NIVA	W	340	3.00	317	37		341	0.05	225	30	
	1996-NIVA	W	340	3.00	332	52		341	0.05	237	37	
	1997-NIVA	W	340	2.00	260	39						
	1997-NIVA	AJ W						341	0.05	221	7	
	1998-NIVA	W	340	2.00	284	48	13	341	0.05	203	67	2
HCHA	1990-NIVA	W	340	1.00	168			341	0.05	58		
	1991-NIVA	W	340	1.00	179	2	111	341	0.05	62	5	10
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	W	340	4.00	212	45	22	341	0.10	133		
	1994-NIVA	2Z W	340	3.00	296	32	3	341	0.05	165	85	
	1995-NIVA	W	340	3.00	318	45		341	0.05	225	98	
	1996-NIVA	W	340	3.00	332	111		341	0.05	231	100	
	1997-NIVA	W	340	0.50	260	2	10	341	0.05	221	20	11
	1998-NIVA	W	340	0.50	284	8	208	341	0.05	202	25	121
HCHG	1986-NACE	W	510	30.00	56	1						
	1986-SIIF	W						111	3.00	21		
	1987-NACE	W	510	40.00	53							
	1987-SIIF	W						111	5.00	21		1
	1988-NACE	W	510	40.00	61							
	1989-NACE	W	510	20.00	93							
	1989-SIIF	W						111	50.00	36		
	1990-NIVA	W	340	1.00	169	1	9	341	0.05	58		
	1990-SIIF	W						111	0.10	41		
	1991-NIVA	W	340	1.00	179	3	18	341	0.05	62	5	1
	1991-SIIF	W						111	0.30	35		
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	W	340	4.00	212	42	17	341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	24	1	341	0.05	165	46	
	1995-NIVA	W	340	3.00	313	31		341	0.05	213	29	
	1996-NIVA	W	340	3.00	330	68		341	0.05	220	8	
	1997-NIVA	W	340	2.00	260	47						
	1997-NIVA	AJ W						341	0.05	221	3	9

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Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter-calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1998-NIVA	W	340	2.00	284	25	63					
	1998-NIVA	AJ W						341	0.05	203	10	23
HG	1981-SIIF	1E W	120	10.00	15		1	120	10.00	35		
	1982-SIIF	1E W						120	10.00	18		
	1982-VETN	W	220	10.00	51			220	10.00	54		
	1983-SIIF	1E W						120	10.00	17		
	1983-VETN	1Z W						220	10.00	48		
	1984-FIER	1G W						401	10.00	39		
	1984-SIIF	1G W						120	10.00	27	6	
	1984-VETN	1Z W						220	10.00	66		
	1985-SIIF	1G D						120	10.00	30		
	1985-VETN	1Z W						220	10.00	90		
	1986-NIVA	1H D						310	10.00	74		
	1987-FIER	1G W						401	10.00	38		
	1987-NIVA	1H D						310	10.00	93		14
	1988-NIVA	1H D						310	10.00	116		
	1989-NIVA	1H D						310	100.00	134		
	1989-NIVA	1H W						310	10.00	36	5	
	1990-NIVA	1H W						310	10.00	266		
	1991-NIVA	1H W						310	100.00a	264	126	
	1992-NIVA	1H W						310	100.00a	303	122	
	1993-NIVA	1H W						310	5.00	300		
	1994-NIVA	1Z W						310	5.00	381		
	1995-NIVA	W						310	5.00	440	1	
	1996-NIVA	V1 W						310	5.00	481		
	1997-NIVA	AH W						310	5.00	383		
	1998-NIVA	W						310	5.00	375		
ICDP	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		29
	1996-NIVA	W						309	0.20	65		23
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	37	2	
MBTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15		
MN	1984-SIIF	W						132	40.00	27		
	1985-SIIF	D						132	40.00	35		
MPTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15	9	
NAP	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	70		21
	1996-NIVA	W						309	0.20	61		11
	1997-NIVA	W						309	0.20	34		1
	1998-NIVA	W						309	0.20	37		
NAP1M	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	15		13
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	37		
NAP2M	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	15		13
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	37		
NAPC1	1995-NIVA	W						309	0.20	55		6
	1996-NIVA	W						309	0.20	61		
NAPC2	1995-NIVA	W						309	0.20	57		6
	1996-NIVA	W						309	0.20	60		
NAPC3	1995-NIVA	W						309	0.20	57		5
	1996-NIVA	W						309	0.20	60		
NAPD2	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPD3	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPDI	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	15		6
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPT2	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPT3	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPT4	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NAPTM	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	15		11
	1997-NIVA	W						309	0.50	34		
	1998-NIVA	W						309	0.50	39		
NI	1983-SIIF	1G W						130	20.00	12		
	1992-NIVA	W						312	10.00	6		
	1996-NIVA	W						999	miss	3		
OCS	1990-NIVA	W	340	2.00	169	31	24	341	0.05	58		1
	1991-NIVA	W	340	2.00	179	14	81	341	0.05	62	5	8
	1992-NIVA	W	340	5.00	192	3		341	0.10	140		
	1993-NIVA	W	340	4.00	212	51	16	341	0.10	133		
	1994-NIVA	W	340	3.00	300	39	22	341	0.05	165	96	
	1995-NIVA	W	340	3.00	318	44		341	0.05	225	102	
	1996-NIVA	W	340	3.00	332	287		341	0.05	237	114	
	1997-NIVA	W	340	2.00	260	100		341	0.05	221	30	14
	1998-NIVA	W	340	2.00	277	132	101	341	0.05	203	182	1
PA	1992-NIVA	W	309	0.20	8			309	0.20	45		

Tab.length cont'd.

Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter-calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1995-NIVA	W						309	0.20	72		
	1996-NIVA	W						309	0.20	65		
	1997-NIVA	AL W						309	0.20	36		
	1998-NIVA	W						309	0.20	39		
PAC1	1995-NIVA	W						309	0.20	57		1
	1996-NIVA	W						309	0.20	65		
PAC2	1995-NIVA	W						309	0.20	56		
	1996-NIVA	W						309	0.20	65		2
PAH	1987-NIVA	W	309	0.02	1							
PAM1	1992-NIVA	W	309	0.20	8			309	0.20	45		
	1995-NIVA	W						309	0.20	15		2
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
PAM2	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
PAMD1	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
PAMD2	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
PB	1983-SIIF	1G W						130	20.00	12		
	1984-SIIF	1G W						130	20.00	27		2
	1985-SIIF	1G D						130	20.00	35		
	1986-NIVA	1Z D	312	150.00	56	4		312	150.00	20		
	1987-FIER	1G W	403	10.00	37	1						
	1987-NIVA	1Z D	312	150.00	57		12	312	150.00	37		
	1988-NIVA	1Z D	312	150.00	61	17	3	312	150.00	55		
	1989-NIVA	1Z D	312	150.00	135	9	9					
	1989-NIVA	1Z W						312	150.00	36		
	1990-NIVA	1Z W	312	50.00	187	3	1	312	150.00	77	3	
	1991-NIVA	1Z W	312	50.00	193	14		312	50.00	67		
	1992-NIVA	1Z W	312	50.00	191	119		312	50.00	111	2	
	1993-NIVA	1H W	312	30.00	221	40		312	30.00	79		
	1994-NIVA	1Z W	312	30.00	302	3		312	30.00	81		
	1995-NIVA	W	312	30.00	318	162	30	312	30.00	122		
	1996-NIVA	V1 W						312	30.00	110		
	1996-NIVA	V2 W	312	30.00	368		109					
	1997-NIVA	W	312	40.00	287	10	28	312	40.00	92		
	1998-NIVA	W	312	40.00	285	126	2	312	40.00	90		
PCB	1981-SIIF	2D W	110	10.00	27			110	10.00	35		
	1982-SIIF	2D W						111	5.00	17		
	1982-VETN	W	210	50.00	53			211	50.00	54		
	1983-SIIF	2E W						111	5.00	14		
	1983-VETN	2E W						211	50.00	48		
	1983-VETN	2Z W	210	50.00	48							
	1984-SIIF	2E W						111	5.00	24		
	1984-VETN	2E W						211	50.00	66		
	1984-VETN	2Z W	210	50.00	66							
	1985-SIIF	2E W						111	5.00	32		6
	1985-VETN	2E W						211	50.00	90		1
	1985-VETN	2Z W	210	50.00	45							
	1986-NACE	2Z W	511a	40.00a	56			511	20.00	56		
	1986-SIIF	2E W						111	5.00	21		
	1987-NACE	2Z W	510	40.00	53			511	20.00	54		
	1987-NIVA	W	340	0.10	2							
	1987-SIIF	2E W						111	5.00	21		
	1988-NACE	2Z W	510	40.00	61			511	20.00	13		
	1988-SIIF	2E D						111	5.00	6		
	1988-SIIF	2E W						111	5.00	22	4	
	1989-NACE	2Z W	510	20.00	93			511	20.00	17		
	1989-SIIF	2E W						111	5.00	36	6	
	1990-SIIF	2E W						111	5.00	41		
	1991-SIIF	2E W						111	5.00	35		
PCC26	1996-NILU	W						842	.10E-02	6		
PCC32	1996-NILU	W						842	.30E-02	6		4
PCC50	1996-NILU	W						842	.10E-02	6		
PCC62	1996-NILU	W						842	0.03	6		6
PCDD	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
PCDF	1995-NILU	W						841	.20E-04	6		
	1996-NILU	W						841	.10E-03	18		
PER	1992-NIVA	W	309	0.20	8			309	0.20	46		
	1995-NIVA	W						309	0.20	72		32
	1996-NIVA	W						309	0.20	65		40
	1997-NIVA	W						309	0.50	36		
	1998-NIVA	W						309	0.50	39		
PYR	1992-NIVA	W	309	0.20	8			309	0.20	44		
	1995-NIVA	W						309	0.20	72		4
	1996-NIVA	W						309	0.20	65		1
	1997-NIVA	AL W						309	0.20	36		
	1998-NIVA	W						309	0.20	39		
QCB	1990-NIVA	W	340	2.00	169	33	39	341	0.05	58		
	1991-NIVA	W	340	2.00	178	13	97	341	0.05	57	5	7
	1992-NIVA	W	340	5.00	192	3		341	0.10	125		
	1993-NIVA	W	340	4.00	212	52	24	341	0.10	133		
	1994-NIVA	W	340	3.00	299	38	23	341	0.05	165	93	
	1995-NIVA	W	340	3.00	318	45		341	0.05	225	103	
	1996-NIVA	W	340	3.00	332	306		341	0.05	237	109	
	1997-NIVA	W	340	2.00	260	79		341	0.05	221	27	10

Tab.length cont'd.

Tissue			Fish liver					Fish fillet, Shrimptail, Mussel, Other				
Contam. . .	Mon. Lab. Year	Inter- calibr. +Basis	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim	Analys Method Code	Detect Limit (ppb)	Total Value Count	Count Below D.Lim	N (<) Above D.Lim
	1998-NIVA	W	340	2.00	284	121	101	341	0.05	203	171	1
SE	1982-VETN	W	240	10.00	46			240	10.00	54		
TBTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15		
TCDD	1995-NILU	W						841	.20E-04	6	1	
	1996-NILU	W						841	.10E-04	18		
TDEPP	1991-NIVA	W	340	1.00	138		1	341	0.05	62		
	1992-NIVA	W	340	5.00	191	3		341	0.10	140		
	1993-NIVA	W	340	4.00	212	24	3	341	0.10	133		
	1994-NIVA	2Z W	340	3.00	300	17	5	341	0.05	165	47	
	1995-NIVA	W	340	3.00	318	36		341	0.05	222	51	
	1996-NIVA	W	340	3.00	332	23		341	0.05	237	16	
	1997-NIVA	W	340	3.00	260	23						
	1997-NIVA	AJ W						341	0.05	221	11	
	1998-NIVA	W	340	3.00	278	19	26	341	0.05	203	1	44
TPTIN	1997-NIVA	W						320	5.00	8		
	1998-NIVA	W						320	5.00	15		5
V	1996-NIVA	W						999	miss	3		
ZN	1983-SIIF	1G W						131	400.00	12		
	1984-SIIF	1G W						132	400.00	27		
	1985-SIIF	1G D						132	400.00	35		
	1986-NIVA	1H D	311	3000.00	56			311	3000.00	20		
	1987-FIER	1G W	405	20.00	37							
	1987-NIVA	1H D	311	3000.00	57			311	3000.00	37		
	1988-NIVA	1H D	311	3000.00	61			311	3000.00	55		
	1989-NIVA	1H D	311	3000.00	135		1					
	1989-NIVA	1H W						311	3000.00	36		
	1990-NIVA	1H W	311	3000.00	189			311	3000.00	77		
	1991-NIVA	1H W	311	1000.00	193			311	1000.00	67		
	1992-NIVA	1H W	311	1000.00	191			311	1000.00	111		
	1993-NIVA	1H W	311	1000.00	221			311	1000.00	79		
	1994-NIVA	1Z W	311	1000.00	302			311	1000.00	81		
	1995-NIVA	W	311	1000.00	318			311	1000.00	140		
	1996-NIVA	V1 W						311	1000.00	131		
	1996-NIVA	V2 W	311	1000.00	368							
	1997-NIVA	W	311	1000.00	287							
	1997-NIVA	AH W						311	1000.00	110		
	1998-NIVA	W	311	1000.00	285			311	1000.00	51		
Sum of Counts					51953	5498	1936			43614	3736	1542

a(7) > Ambiguous value in cell (Maximum value displayed).

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Analytical overview BIOTA; Sorted by METHOD, LAB. and TISSUE.

Method	Lab.	Tissue	Monitoring Year	Contaminants
110	SIIF	Fish fillet	1981	PCB
		Fish liver	1981	PCB
		Mussel	1981	PCB
111	SIIF	Mussel	1982-1991	PCB
		Mussel	1983-1991	DDTEP, HCB
		Mussel	1986-1987,1989-1991	HCHG
		Mussel	1987-1991	CB101, CB180, CB52
		Mussel	1988-1991	CB138, CB153, CB28
		Mussel	1989-1991	CB118
		Shrimp tail	1982,1984,1986,1988,1990	PCB
		Shrimp tail	1984,1986,1988,1990	DDTEP, HCB
		Shrimp tail	1986,1990	HCHG
		Shrimp tail	1988,1990	CB101, CB138, CB153, CB180, CB28 , CB52
		Shrimp tail	1990	CB118
		~Other	1988	CB101, CB138, CB153, CB180, CB28 , CB52 , DDTEP, HCB , PCB
120	SIIF	Fish fillet	1981	HG
		Fish liver	1981	HG
		Mussel	1981-1985	HG
		Shrimp tail	1982,1984	HG
130	SIIF	Fish fillet	1981	CD
		Fish liver	1981	CD
		Mussel	1981-1985	CD
		Mussel	1983	NI
		Mussel	1983-1984	CU
		Mussel	1983-1985	PB
		Shrimp tail	1982,1984	CD
		Shrimp tail	1984	CU , PB
131	SIIF	Mussel	1983	ZN
132	SIIF	Mussel	1984-1985	MN , ZN
		Shrimp tail	1984	MN , ZN
210	VETN	Fish fillet	1983	DDEPP, HCB
		Fish liver	1982-1985	DDEPP, PCB
		Fish liver	1983-1985	HCB
211	VETN	Fish fillet	1982-1985	PCB
		Fish fillet	1983	DDEPP, HCB
220	VETN	Fish fillet	1982-1985	HG
		Fish liver	1982	HG
230	VETN	Fish liver	1982-1985	CD
240	VETN	Fish fillet	1982	SE
		Fish liver	1982	SE
309	NIVA	Fish fillet	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
		Fish liver	1987	PAH
		Fish liver	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
		Mussel	1992	COR , DBP
		Mussel	1992,1995-1996	BBF , BJKF , CHR
		Mussel	1992,1995-1998	ACNE , ACNLE, ANT , BAA , BAP , BEP , BGHIP, BIPN , DBA3A, FLE , FLU , ICDP , NAP , PA , PER , PYR
		Mussel	1992,1995,1997-1998	NAP1M, NAP2M, NAPDI, NAPTM, PAM1
		Mussel	1995-1996	DBTC1, DBTC2, DBTC3, NAPC1, NAPC2, NAPC3, PAC1 , PAC2
		Mussel	1995-1998	BBJKF
		Mussel	1995,1997-1998	CHRTR
		Mussel	1997	DBTIO
		Mussel	1997-1998	NAPD2, NAPD3, NAPT2, NAPT3, NAPT4, PAM2 , PAMD1, PAMD2
		Mussel	1998	DBT
		Shrimp tail	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
310	NIVA	Fish fillet	1986-1998	HG
		Mussel	1986-1998	HG
		Shrimp tail	1986,1988,1990,1992,1995	HG
		~Other	1988	HG
311	NIVA	Fish liver	1986-1998	CU , ZN
		Mussel	1986-1998	CU , ZN
		Shrimp tail	1986,1988,1990,1992,1995	CU , ZN
		~Other	1988	CU , ZN
312	NIVA	Fish liver	1986-1998	CD , PB
		Mussel	1986-1998	CD , PB
		Mussel	1992	CR , NI
		Shrimp tail	1986,1988,1990,1992,1995	CD , PB
		~Other	1988	CD , PB
320	NIVA	????	1998	DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
		Mussel	1997-1998	DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
340	NIVA	Fish fillet	1998	DDTPP
		Fish liver	1987	PCB
		Fish liver	1990-1998	CB101, CB118, CB138, CB153, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
		Fish liver	1991-1998	CB105, CB156
		Fish liver	1996-1998	DDTPP
		Mussel	1995-1998	DDTPP
341	NIVA	Fish fillet	1990-1998	CB101, CB118, CB138, CB153, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
		Fish fillet	1991-1998	CB105, CB156
		Mussel	1992-1998	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
		Shrimp tail	1992,1995	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP

Tab.length cont'd.

Method	Lab.	Tissue	Monitoring Year	Contaminants
401	FIER	Fish fillet	1984,1987	HG
402	FIER	Fish liver	1984,1987	CD
403	FIER	Fish liver	1987	PB
404	FIER	Fish liver	1987	CU
405	FIER	Fish liver	1987	ZN
510	NACE	Fish liver	1986-1989	DDEPP, DDTPP, HCB , HCHG , PCB
		Fish liver	1989	CB101, CB118, CB138, CB153, CB180, CB28 , CB52
511	NACE	Fish fillet	1986-1989	PCB
		Fish liver	1986	PCB
605	SIIF	Mussel	1986-1991	EPOCL
		Mussel	1989	EOCL
		Shrimp tail	1986,1988,1990	EPOCL
		˜Other	1988	EPOCL
607	IFEN	Mussel	1997-1998	EPOCL
610	NACE	Fish liver	1986-1989	EPOCL
615	NIVA	Fish liver	1990-1991	EPOCL
841	NILU	Mussel	1995-1996	CB126, CB169, CB77 , CB81 , CDD1N, CDD4X, CDD6P, CDD6X, CDD9X, CDDO , CDDSN, CDDSP, CDDST, CDDSX, CDF2N, CDF2T, CDF4X, CDF6P, CDF6X, CDF9P, CDF9X, CDFDN, CDFDX, CDFO , CDFSN, CDFSP, CDFST, CDFSX, PCDD , PCDF , TCDD
842	NILU	Mussel	1996	PCC26, PCC32, PCC50, PCC62
999	NIVA	Mussel	1996	AG , AS , CO , CR , NI , V

Analytical overview BIOTA; sorted by TISSUE, METHOD and LAB.

Tissue	Method	Lab.	Monitoring Year	Contaminants
????	320	NIVA	1998	DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
Fish fillet	110	SIIF	1981	PCB
	120	SIIF	1981	HG
	130	SIIF	1981	CD
	210	VETN	1983	DDEPP, HCB
	211	VETN	1982-1985	PCB
	211	VETN	1983	DDEPP, HCB
	220	VETN	1982-1985	HG
	240	VETN	1982	SE
	309	NIVA	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
	310	NIVA	1986-1998	HG
	340	NIVA	1998	DDTPP
	341	NIVA	1990-1998	CB101, CB118, CB138, CB153, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
	341	NIVA	1991-1998	CB105, CB156
	401	FIER	1984,1987	HG
	511	NACE	1986-1989	PCB
Fish liver	110	SIIF	1981	PCB
	120	SIIF	1981	HG
	130	SIIF	1981	CD
	210	VETN	1982-1985	DDEPP, PCB
	210	VETN	1983-1985	HCB
	220	VETN	1982	HG
	230	VETN	1982-1985	CD
	240	VETN	1982	SE
	309	NIVA	1987	PAH
	309	NIVA	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
	311	NIVA	1986-1998	CU , ZN
	312	NIVA	1986-1998	CD , PB
	340	NIVA	1987	PCB
	340	NIVA	1990-1998	CB101, CB118, CB138, CB153, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
	340	NIVA	1991-1998	CB105, CB156
	340	NIVA	1996-1998	DDTPP
	402	FIER	1984,1987	CD
	403	FIER	1987	PB
	404	FIER	1987	CU
	405	FIER	1987	ZN
	510	NACE	1986-1989	DDEPP, DDTPP, HCB , HCHG , PCB
	510	NACE	1989	CB101, CB118, CB138, CB153, CB180, CB28 , CB52
	511	NACE	1986	PCB
	610	NACE	1986-1989	EPOCL
	615	NIVA	1990-1991	EPOCL
Mussel	110	SIIF	1981	PCB
	111	SIIF	1982-1991	PCB
	111	SIIF	1983-1991	DDTEP, HCB
	111	SIIF	1986-1987,1989-1991	HCHG
	111	SIIF	1987-1991	CB101, CB180, CB52
	111	SIIF	1988-1991	CB138, CB153, CB28
	111	SIIF	1989-1991	CB118
	120	SIIF	1981-1985	HG
	130	SIIF	1981-1985	CD
	130	SIIF	1983	NI
	130	SIIF	1983-1984	CU
	130	SIIF	1983-1985	PB
	131	SIIF	1983	ZN
	132	SIIF	1984-1985	MN , ZN
	309	NIVA	1992	COR , DBP
	309	NIVA	1992,1995-1996	BBF , BJKF , CHR
	309	NIVA	1992,1995-1998	ACNE , ACNLE, ANT , BAA , BAP , BEP , BGHIP, BIPN , DBA3A, FLE , FLU , ICDP , NAP , PA , PER , PYR
	309	NIVA	1992,1995,1997-1998	NAP1M, NAP2M, NAPDI, NAPTM, PAM1
	309	NIVA	1995-1996	DBTC1, DBTC2, DBTC3, NAPC1, NAPC2, NAPC3, PAC1 , PAC2
	309	NIVA	1995-1998	BBJKF
	309	NIVA	1995,1997-1998	CHRTR
	309	NIVA	1997	DBTIO
	309	NIVA	1997-1998	NAPD2, NAPD3, NAPT2, NAPT3, NAPT4, PAM2 , PAMD1, PAMD2
	309	NIVA	1998	DBT
	310	NIVA	1986-1998	HG
	311	NIVA	1986-1998	CU , ZN
	312	NIVA	1986-1998	CD , PB
	312	NIVA	1992	CR , NI
	320	NIVA	1997-1998	DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
	340	NIVA	1995-1998	DDTPP
	341	NIVA	1992-1998	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
	605	SIIF	1986-1991	EPOCL
	605	SIIF	1989	EOCL
	607	IFEN	1997-1998	EPOCL
	841	NILU	1995-1996	CB126, CB169, CB77 , CB81 , CDD1N, CDD4X, CDD6P, CDD6X, CDD9X, CDDO , CDDSN, CDDSP, CDDST, CDDSX, CDF2N, CDF2T, CDF4X, CDF6P, CDF6X, CDF9P, CDF9X, CDFDN, CDFDX, CDFO , CDFSN, CDFSP, CDFST, CDFSX, PCDD , PCDF , TCDD
	842	NILU	1996	PCC26, PCC32, PCC50, PCC62
	999	NIVA	1996	AG , AS , CO , CR , NI , V
Shrimp tail	111	SIIF	1982,1984,1986,1988,1990	PCB
	111	SIIF	1984,1986,1988,1990	DDTEP, HCB

Tab.length cont'd.

Tissue	Method	Lab.	Monitoring Year	Contaminants
	111	SIIF	1986,1990	HCHG
	111	SIIF	1988,1990	CB101, CB138, CB153, CB180, CB28 , CB52
	111	SIIF	1990	CB118
	120	SIIF	1982,1984	HG
	130	SIIF	1982,1984	CD
	130	SIIF	1984	CU , PB
	132	SIIF	1984	MN , ZN
	309	NIVA	1992	ACNE , ACNLE, ANT , BAA , BAP , BBF , BEP , BGHIP, BIPN , BJKF , CHR , COR , DBA3A, DBP , FLE , FLU , ICDP , NAP , NAP1M, NAP2M, NAPDI, NAPTM, PA , PAM1 , PER , PYR
	310	NIVA	1986,1988,1990,1992,1995	HG
	311	NIVA	1986,1988,1990,1992,1995	CU , ZN
	312	NIVA	1986,1988,1990,1992,1995	CD , PB
	341	NIVA	1992,1995	CB101, CB105, CB118, CB138, CB153, CB156, CB180, CB209, CB28 , CB52 , DDEPP, HCB , HCHA , HCHG , OCS , QCB , TDEPP
	605	SIIF	1986,1988,1990	EPOCL
Other	111	SIIF	1988	CB101, CB138, CB153, CB180, CB28 , CB52 , DDTEP, HCB , PCB
	310	NIVA	1988	HG
	311	NIVA	1988	CU , ZN
	312	NIVA	1988	CD , PB
	605	SIIF	1988	EPOCL

Appendix E
Overview of localities

Station positions are shown on maps in Appendix F.

JAMP stations and programme 1998

Appendix E1. JMP station positions and sampling overview for 1998. WSBOFR: W=water, S=sediment, B=blue mussel, O=other shellfish, F=flatfish, R=roundfish. second station position indicates previous location. NSTF=North Sea Task Force. Mussels were sampled from rock surfaces unless otherwise noted.

JAMP area	St.	Locality name	North latitude	East longitude	ICES position	1998						notes
						W	S	B	O	F	R	
26 OSLOFJORD AREA EAST, Hvaler and Singlefjorden												
26	01A	Sponvika	59°05.4'	11°12.5'	47G13							
			59°05.1'	11°13.9'	47G13							
26	02A	Fugleskjær	59°06.6'	10°59.3'	47G09							
			59°06.9'	10°59.0'	47G09							
26	03A	Tisler	58°59.0'	10°57.8'	46G07							C
			58°58.8'	10°57.5'	46G07							
26 OSLOFJORD AREA CENTRAL, Oslofjord proper												
26	30A	Gressholmen	59°52.8'	10°43.0'	48G07	+		+				
26	30A	Gressholmen (- 1996)	59°52.5'	10°43.0'	48G07							
26	30B	Oslo city area / Håøya	59°49'	10°33'	48G04							
			59°44'	10°32'	48G04						+	
26	30B	Oslo city area / Nesodden	59°52'	10°39'	48G04							
26	30F	Oslo city area / Håøya	59°47'	10°34'	48G04							
26	30X	West of Nesodden	59°48.5'	10°36'	48G04							
26	30G	Steilene area (Spro)	59°45.8'	10°34.5'	48G05							
26	30H	Steilene area (Storegrunn)	59°48.5'	10°33.5'	48G05							
26	40C	Steilene	59°49'	10°33'	48G05							
			59°49'	10°39'	48G05							
26	30S	Steilene	59°49.1'	10°33.8'	48G05							
26	31A	Solbergstrand	59°36.9'	10°39.4'	48G06	+		+				
26	31B	Solbergstrand (Filtvet, 1982)	59°37'	10°39'	47G07							
26	32A	Rødtangen	59°31.5'	10°25.6'	48G06							
26	33X	Sande, west side	59°31.7'	10°20.4'	48G06							
26	33B	Sande, east side	59°31.7'	10°21.0'	48G06					+		
26	35A	Mølen	59°29.2'	10°30.1'	47G04	+		+				
26	35C	Holmenstrand-Mølen	59°29'	10°27'	47G04							
26	35S	Mølen	59°30'	10°35'	47G04							
26	36A	Færder	59°01.6'	10°31.7'	47G06	+		+				
26	36B	Færder area	59°02'	10°27'	47G06							
			59°02'	10°32'	47G06						+	
26	36F	Færder area	59°04'	10°23'	47G06					+		
26	36S	Færder area (NSTF-54)	59°00.4'	10°41.6'	47G09							N
26 OSLOFJORD AREA WEST, outer Sandefjord-Langesundsfjord												
26	73A	Lyngholmen	59°02.6'	10°18.1'	47G03							C
26	74A	Oddeneskjær	58°57.3'	09°52.1'	46F97							C
26	71A	Bjørkøya (Risøyodden)	59°01.4'	09°45.4'	47F99	+		+				
ARENDAL AREA												
	76A	Risøy	58°43.6'	09°17.0'	46F92	+		+				C
	77A	Flostafjord	58°31.5'	08°56.9'	46F89							C
	77B	Borøy area	58°33'	09°01'	46F93							
	77F	Borøy area	58°33'	09°01'	46F93							
	77C	Borøy area	58°29'	09°10'	45F91							

Appendix E (cont'd)

JAMP area	St.	Locality name	North latitude	East longitude	ICES position	1998						notes
						W	S	B	O	F	R	
ARENDAL AREA (cont.)												
	77S	Arendal area (NSTF-57)	58°24.2'	09°01.8'	45F91							N, C
	79A	Gjerdvoldsøyen, east	58°25.0'	08°45.3'	45F87							C
LISTA AREA												
	13A	Langøsund	57°59.8'	07°34.6'	44F74							C
	14A	Aavigen	58°02.2'	07°13.2'	45F73							C
	15A	Gåsøy (Ullerø area)	58°03.1'	06°53.3'	45F69	+		+				
	15B	Ullerø area	58°03'	06°43'	45F69						+	
	15F	Ullerø area	58°03'	06°43'	45F69					+		
	15S	Lista area (NSTF-39)	58°01.0'	06°34.3'	45F66							N, C
BØMLO AREA												
	224G	Heggjelen	59°25.2'	05°13.90'	47F51				+			
	226A	Karmsund bridge (east)	59°22.6'	05°17.91'	47F51			+				
	226G	Karmsund bridge (east)	59°22.6'	05°17.91'	47F51				+			
	227A	Melandholmen	59°20.0'	05°18.90'	47F51			+				
	227G	Melandholmen	59°20.0'	05°18.90'	47F51				+			
	220G	Smørstakk	59°15.2'	05°21.14'	47F55				+			
	221A	Stangeland	59°16.6'	05°19.70'	47F52			+				
	221G	Stangeland	59°16.6'	05°19.70'	47F52				+			
	22A	Espevær, west	59°35.2'	05°00.5'	48F59	+		+				C, 1
	22F	Borøyfjorden	59°43'	05°21'	48F55					+		
	22C	Bømlofjorden	59°34'	05°11'	48F53							
	22S	Bømlo (NSTF-36)	59°25.9'	04°50.2'	47F47							N
	23A	Austvik	59°52.2'	05°06.6'	48F51							
	23B	Karihavet area	59°55'	05°07'	48F51						+	
	24A	Vardøy	60°10.2'	05°00.8'	49F52							C
	24S	Sotra	60°15.1'	04°33.3'	49F45							N
62 HARDANGERFJORDEN												
62	69A	Lille Terøy	59°58.8'	05°45.4'	49F59	+		+				
62	69S	Kvinnheradsfjorden	60°01.3'	05°56.1'	49F59							
62	67B	Strandebarm	60°16'	06°02'	49F62					+	+	
62	67S	Strandebarm	60°13.5'	06°05.1'	49F62							
62	65A	Vikingneset	60°14.5'	06°09.6'	49F62	+		+				
62	63A	Ranaskjær	60°25.1'	06°24.5'	49F64	+		+				
62	63S	Ranaskjær	60°23.6'	06°27.1'	49F64							
63 SØRFJORD												
63	51A	Byrkjenes	60°05.1'	06°33.1'	49F66							
63	52A	Eitrheimsneset	60°05.8'	06°32.2'	49F66	+		+				3
63	52S	Tyssedal	60°06.9'	06°32.9'	49F66							
63	53B	Inner Sørfjord	60°10'	06°34'	49F65					+	+	
63	56A	Kvalnes	60°13.4'	06°36.1'	49F65	+		+				
63	56S	Kvalnes	60°13.7'	06°35.6'	49F65							
63	57A	Krossanes	60°23.2'	06°41.2'	49F67	+		+				
63	57S	Krossanes	60°23.1'	06°40.7'	49F67							
ÅLESUND AREA												
	25A	Hinnøy	61°22.2'	04°52.8'	51F47							5
	26A	Hamnen	61°52.7'	05°13.6'	52F51							5
	27A	Grinden	62°12.2'	05°25.4'	53F55							1
	27X	Kvame area	62°12.3'	05°22.2'	53F55							
	27S	Stattlandet (east of)	62°09.3'	05°21.3'	53F56							
	28A	Eiksundet	62°14.9'	05°54.5'	53F58							1
		Eiksundet (1992)	62°14.9'	05°54.5'	53F58							1

Appendix E (cont'd)

JAMP area	St.	Locality name	North latitude	East longitude	ICES position	1998						notes
						W	S	B	O	F	R	
65 ORKDALSFJORDEN												
65	80A	Østmerknes	63°27.5'	10°27.5'	56G04							
65	81A	Biologisk station	63°26.5'	10°21.4'	56G04							
65	82A	Flakk	63°27.1'	10°12.6'	56G01							
65	82S	Flakk	63°27.5'	10°11.8'	56G01							
65	83A	Frøsetskjær	63°25.5'	10°07.8'	56G01							
65	84A	Trossavika	63°20.8'	09°57.8'	55F97							
65	84B	Trossavika	63°20.8'	09°57.8'	55F97							
65	84S	Trossavika	63°21.7'	09°57.4'	55F97							
		(1987)	63°21.2'	09°57.2'	55F97							
65	89S	Thamshavn (indre Orkdal)	63°19.7'	09°52.3'	55F98							
		(1987)	63°19.8'	09°52.5'	55F98							
65	90S	Outer Orkdalsfjord	63°27.4'	10°03.0'	56G01							
		(1987)	63°27.4'	10°04.3'	56G01							
65	85A	Geitastrand	63°21.9'	09°56.3'	55F97							
65	86A	Geitnes	63°26.6'	09°59.2'	55F97							
65	87A	Ingdalsbukt	63°27.8'	09°54.8'	55F97							
65	88A	Rødberg	63°27.2'	10°00.0'	55G01							
FROAN AREA												
	91A	Nerdvika	63°21.2'	08°09.6'	55F81							3
		Fosflua (1992)	63°23.8'	08°17.6'	55F81							4
	92A	Stokken	64°02.2'	10°01.1'	57G03							5
		(-1996)	64°04.6'	10°00.7'	57G03							4
	92B	Stokken area	64°09.9'	09°53.0'	57F99							
	92F	Stokken area	64°09.9'	09°53.0'	57F99							
	93S	Raudøya (northeast of)	64°22.7'	10°27.8'	57G04							
	93A	Låven (Sætervik)	64°23.7'	10°29.0'	57G04							4
		Låven (Sætervik, 1992))	64°23.5'	10°28.0'	57G04							4
HELGELAND AREA												
	94A	Landfast	65°38.4'	12°00.5'	60G23							1
	96A	Breiviken	66°17.6'	12°50.5'	61G28							1
	95S	Rodø (east of)	66°41.8'	13°09.9'	62G32							
	95A	Flatskjær	66°42.6'	13°15.8'	62G32							4
LOFOTEN AREA												
	97A	Klakholmen	67°39.9'	14°44.6'	64G49							4
	99A	Brunvær	68°00.3'	15°05.6'	65G53							4
	98B	Lille Molla	68°12.0'	14°48.0'	65G48						+	
	98F	Lille Molla	68°12.0'	14°48.0'	65G48					+		
	98S	Skrova (south of)	68°07.0'	14°41.0'	65G49							
	98A	Husvågen (1997)	68°15.4'	14°40.6'	65G46	+		+				5
		(1992)	68°09.4'	14°39.3'	65G46							1
	98X	Skrova	68°10.5'	14°40.2'	65G48							7
	99S	Lundøy (north of)	68°05.8'	15°10.1'	65G53							

Appendix E (cont'd)

JAMP area	St.	Locality name	North latitude	East longitude	ICES position	1998						notes
						W	S	B	O	F	R	
FINNSNES-SKJERVØY AREA												
	41S	Andfjord	68°56.3'	17°05.2'	66G71							
	41A	Fensneset, Grytøya	68°56.9'	16°38.5'	66G64							3
	42S	Tromsø area	69°60.4'	18°06.8'	68G83							
	42A	Tennskjær, Malangen	69°28.6'	18°18.0'	67G81							3
	43S	Kvænangen	70°03.3'	21°07.9'	69H13							
	43A	Lyngneset, Langjforden	70°06.2'	20°32.8'	69H06							2
	43B	Kvænangen	70°09.0'	21°22.0'	69H16							
	43F	Kvænangen	70°09.0'	21°22.0'	69H16							
HAMMERFEST-HONNINGSVÅG AREA												
	44S	Sørøya, south	70°25.9'	22°31.8'	69H24							
	44A	Elenheimsundet	70°30.8'	22°14.8'	70H23							1, 6
	45S	Hammerfest area	70°42.9'	24°26.6'	70H45							
	45A	Ytre Sauhamnneset	70°45.8'	24°19.2'	70H42							
	46S	Porsangen area	70°52.9'	26°11.9'	70H61							
	46A	Smineset in Altesula	70°58.4'	25°48.1'	70H57							3, 6
	46B	Hammerfest area	70°50.0'	23°44.0'	70H37							
	46F	Honningsvåg area	00°00.0'	00°00.0'								
	47S	Laksefjord	70°55.0'	26°55.1'	70H67							
	47A	Kifjordeneset	70°52.9'	27°22.2'	70H74							
VARANGER PENINSULA AREA												
	48S	Tanafjord	70°52.5'	28°38.5'	70H84							
	48A	Trollfjorden i Tanafjord	70°41.6'	28°33.3'	70H85							
	49S	Syltefjord	70°33.9'	30°19.9'	70J03							
	49A	Nordfjorden, Syltefjord	70°33.1'	30°05.2'	70J03							
	10S	Varangerfjord	69°56.1'	30°06.7'	68J01							
	10A	Skagodden	70°04.2'	30°09.8'	69J03	+		+				2
	10B	Varangerfjorden	69°54.5'	29°30.0'	68H97						+	
	10F	Varangerfjorden	69°55.0'	29°51.5'	68H97					*		
	11A	Sildkroneset, Bøkfjorden	69°47.2'	30°11.1'	68J02							
	11X	Brashavn	69°53.9'	29°44.7'	68J02	+		+				4

notes:

+ - samples collected
* - planned but innsufficient material
x - collected but not analysed
N - official NSTF station
C - at or near SFT's coastal monitoring programme station
1 - mussels collected from buoy and/or buoy anchor lines
2 - mussels collected from sand/gravel bottom
3 - mussels collected from iron/cement pilings
4 - mussels collected from metal navigation buoys
5 - mussels collected from floating dock
6 - mussels collected from wooden docks
7 - mussels collected from rocks under ferry terminal

Appendix F
Map of stations

Station positions 1981-1998
(cf. Appendix G and Appendix J)

Appendix F (cont.) Map of stations

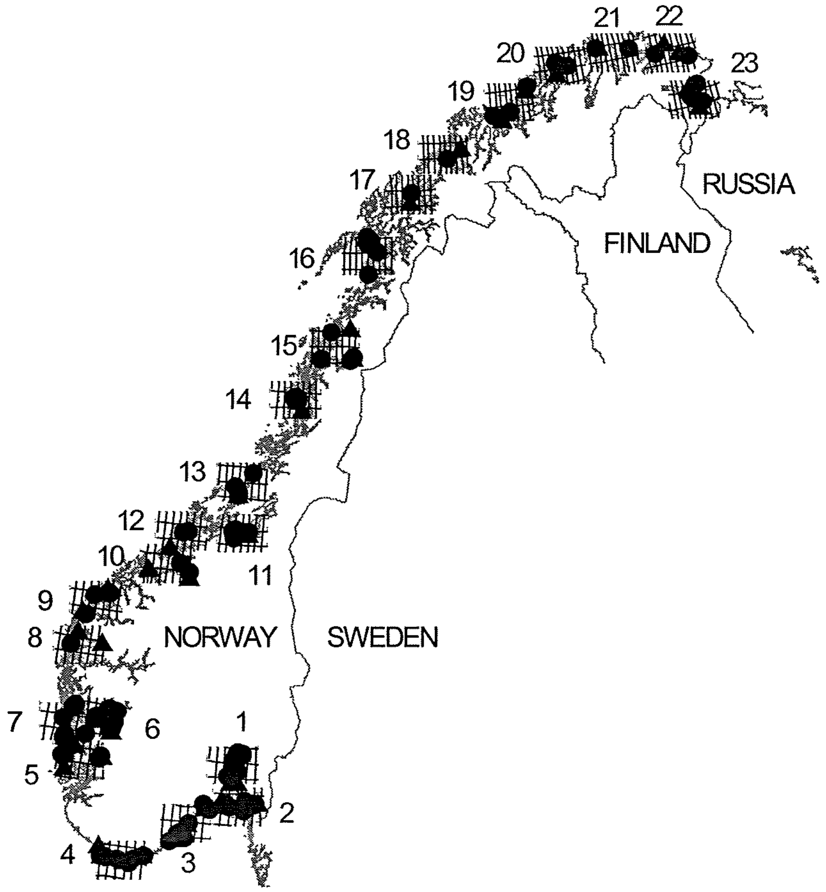
NOTES

For a few station the positions of sampling has varied in order to collect sufficient material (e.g., st. 36B and 98A) or investigate local geographical variations (e.g., in the inner Oslofjord and Sørfjord). Hence, the same station name may appear more than once on a map.

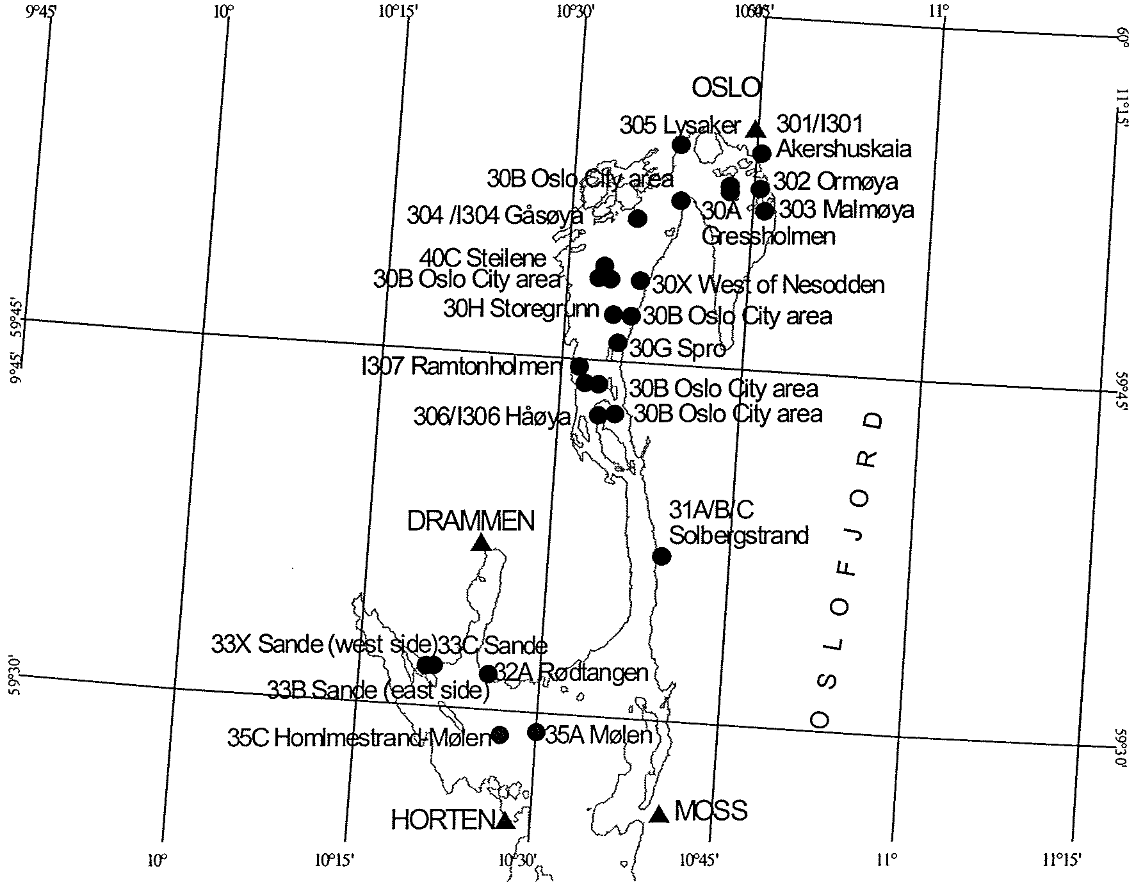
The letter A following the station identification number indicates that blue mussels were sampled. The letter B indicates sampling for cod and the letter F indicates sampling for flatfish. This system for fish is not consistent for some older stations (30, 33, 52 and 67) where only the letter B is used indicating that either cod or flatfish or both were sampled.

The letter "I" preceding the station identification number indicates an INDEX station for evaluating a "pollution" index. The letter R indicates a station for evaluating a "reference" index. Only blue mussels are used for these indices. The indices are based on a selection of JAMP and INDEX stations (cf. Green *et al.* 1999).

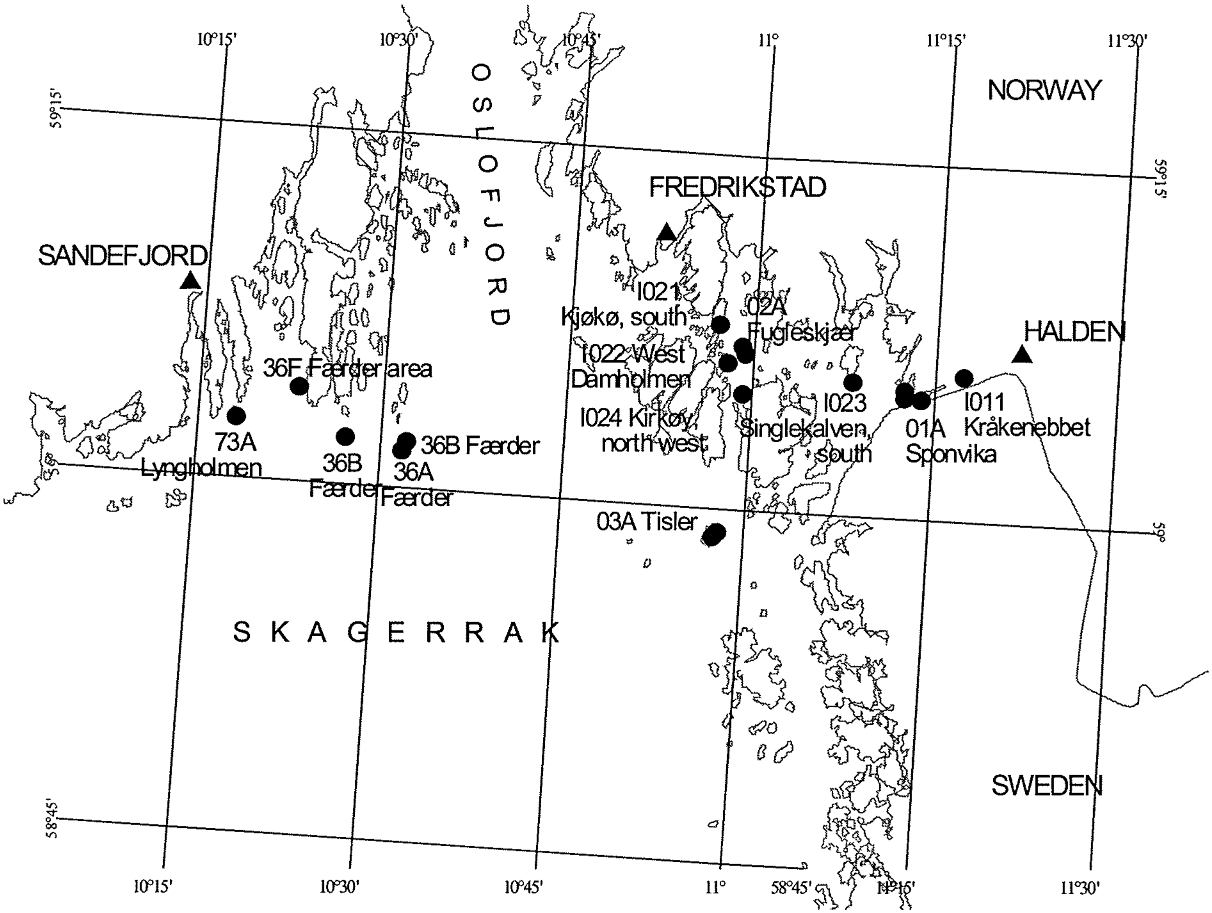
The maps are generated using ArcView GIS version 3.1.



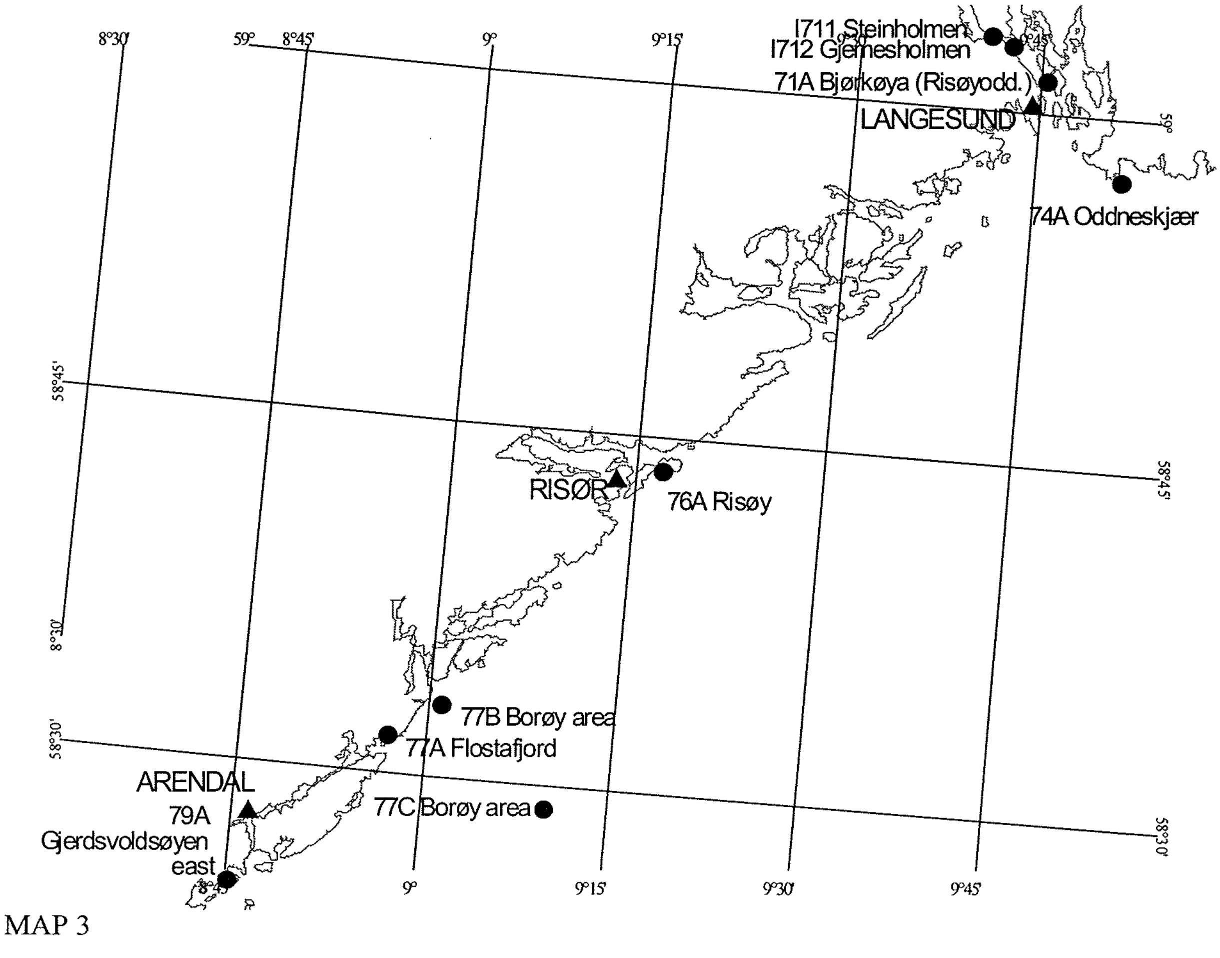
JAMP stations in Norway. Numbers refer to detail maps below.



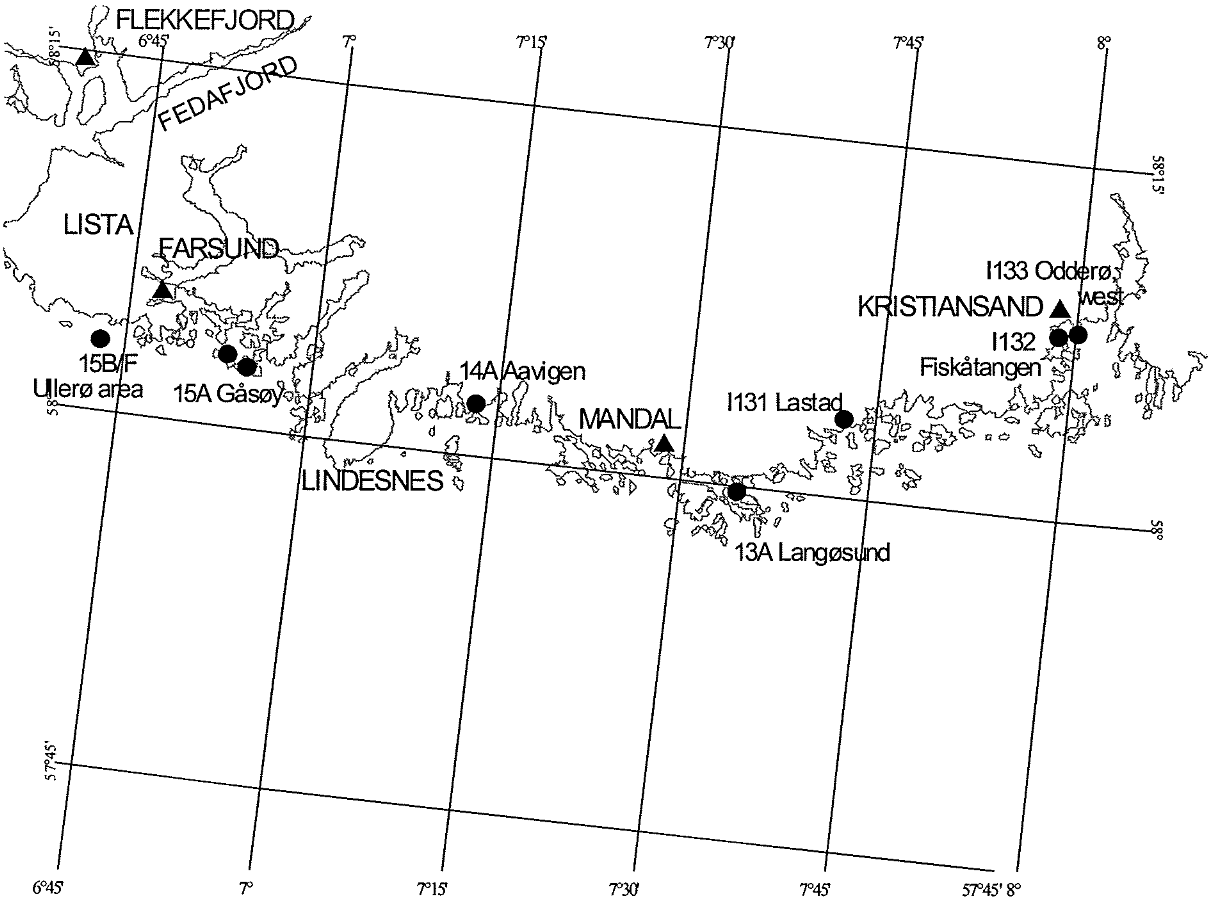
MAP 1


10°15'
10°30'
10°45'
11°
11°15'
11°30'
59°15'
59°
58°45'
NORWAY
OSLOFJORD
FREDRIKSTAD
SANDEFJORD
HALDEN
I021
Kjøkø, south
02A
Fugleskjær
I022 West
Damholmen
36F Færder area
I023
Singlekalven,
south
I011
Kråkenebbet
01A
Sponvika
I024 Kirkøy,
north west
73A
Lyngholmen
36B
Færder
36B Færder
36A
Færder
03A Tisler
SKAGERRAK
SWEDEN
58°45'

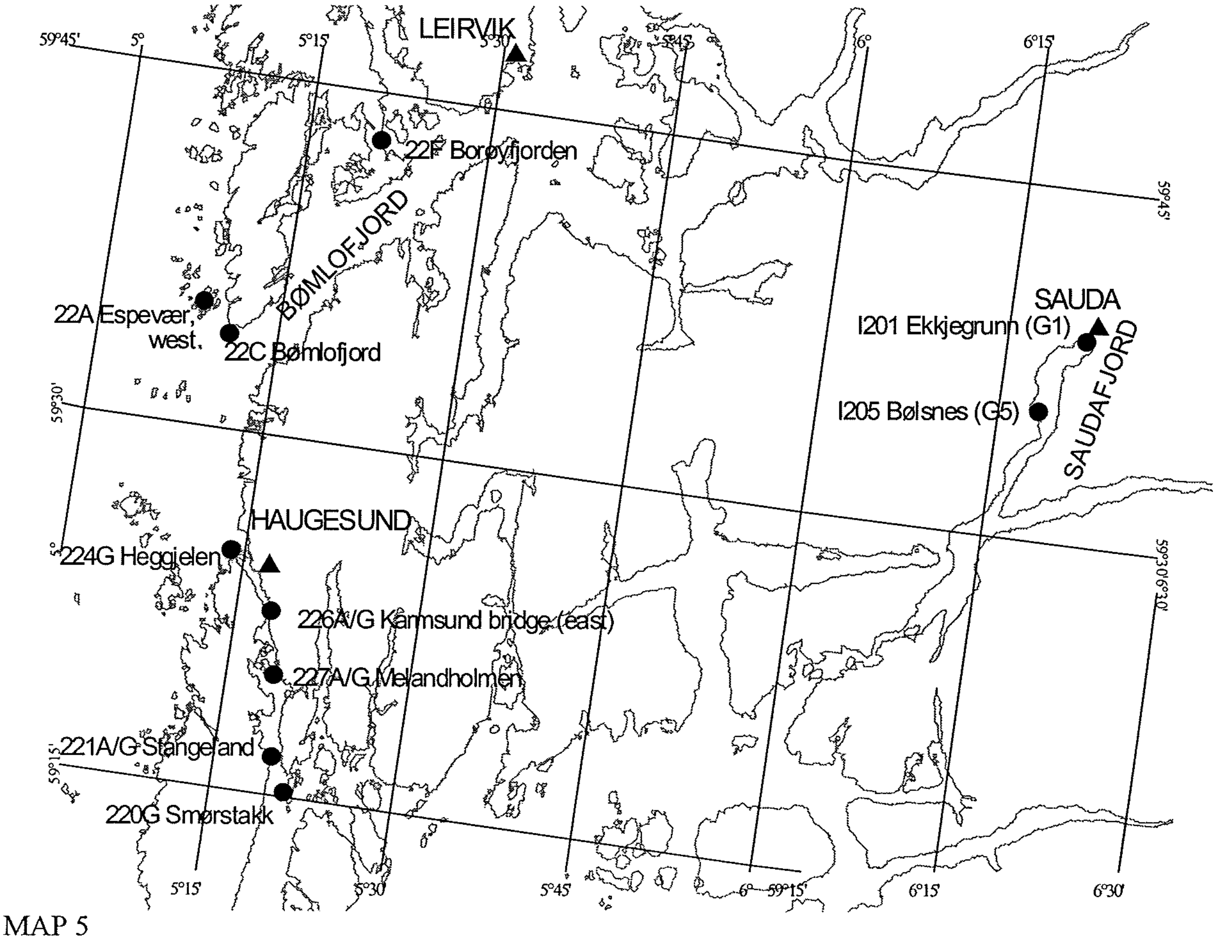
MAP 2


8°30'
59°
8°45'
9°
9°15'
I711 Steinholmen
I712 Gjemesholmen
9°45'
71A Bjørkøya (Risøyodd.)
LANGESUND
74A Oddneskjær
58°45'
RISØR
76A Risøy
8°30'
77B Borøy area
77A Flostafjord
58°30'
ARENDAL
79A
Gjerdsvoldsøyen
east
77C Borøy area
9°
9°15'
9°30'
9°45'

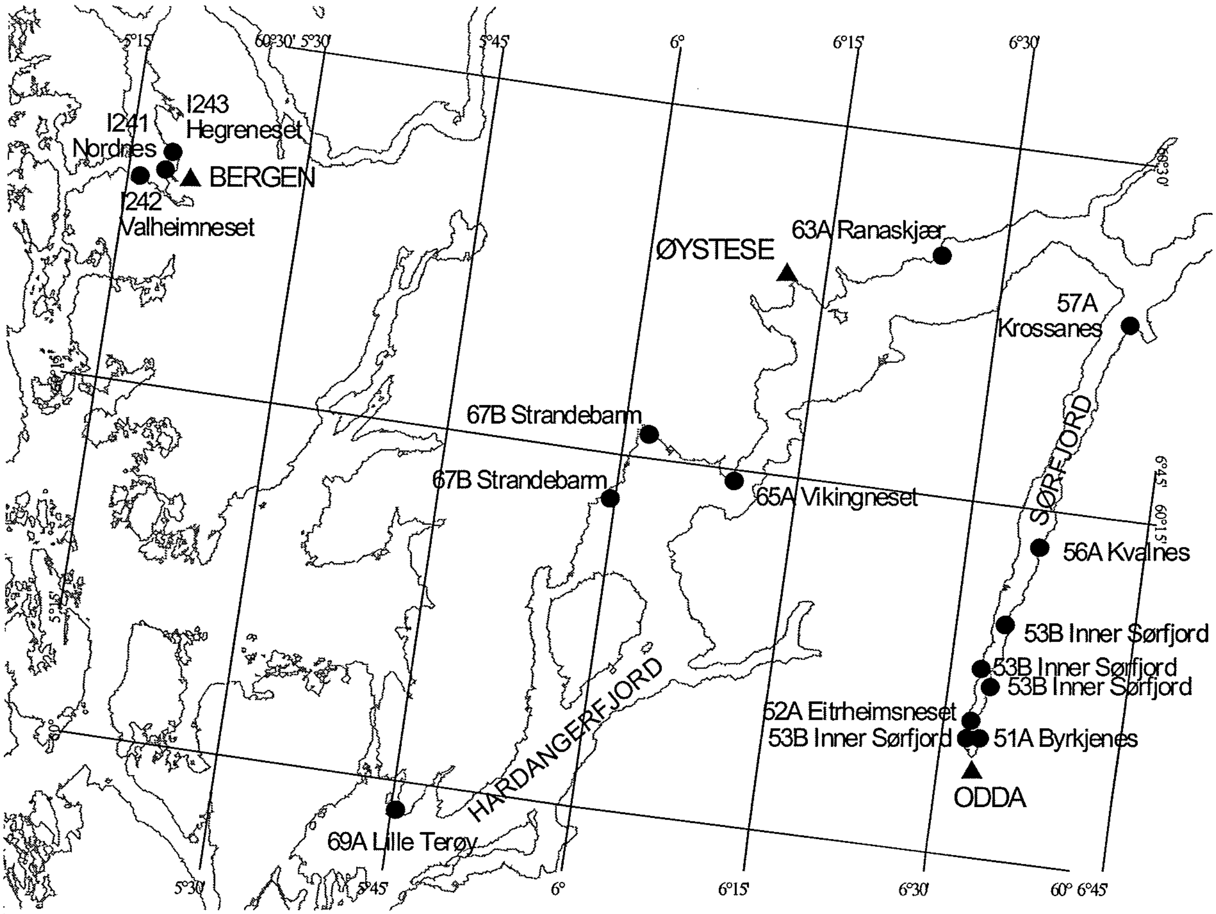
MAP 3


FLEKKEFJORD
FEDAFJORD
LISTA
FARSUND
15B/F Ullerø area
15A Gåsøy
LINDESNES
14A Aavigen
MANDAL
13A Langøsund
I131 Lastad
KRISTIANSAND
I133 Odderø, west
I132 Fiskåtangen
58°15'
58°
57°45'
6°45'
7°
7°15'
7°30'
7°45'
8°

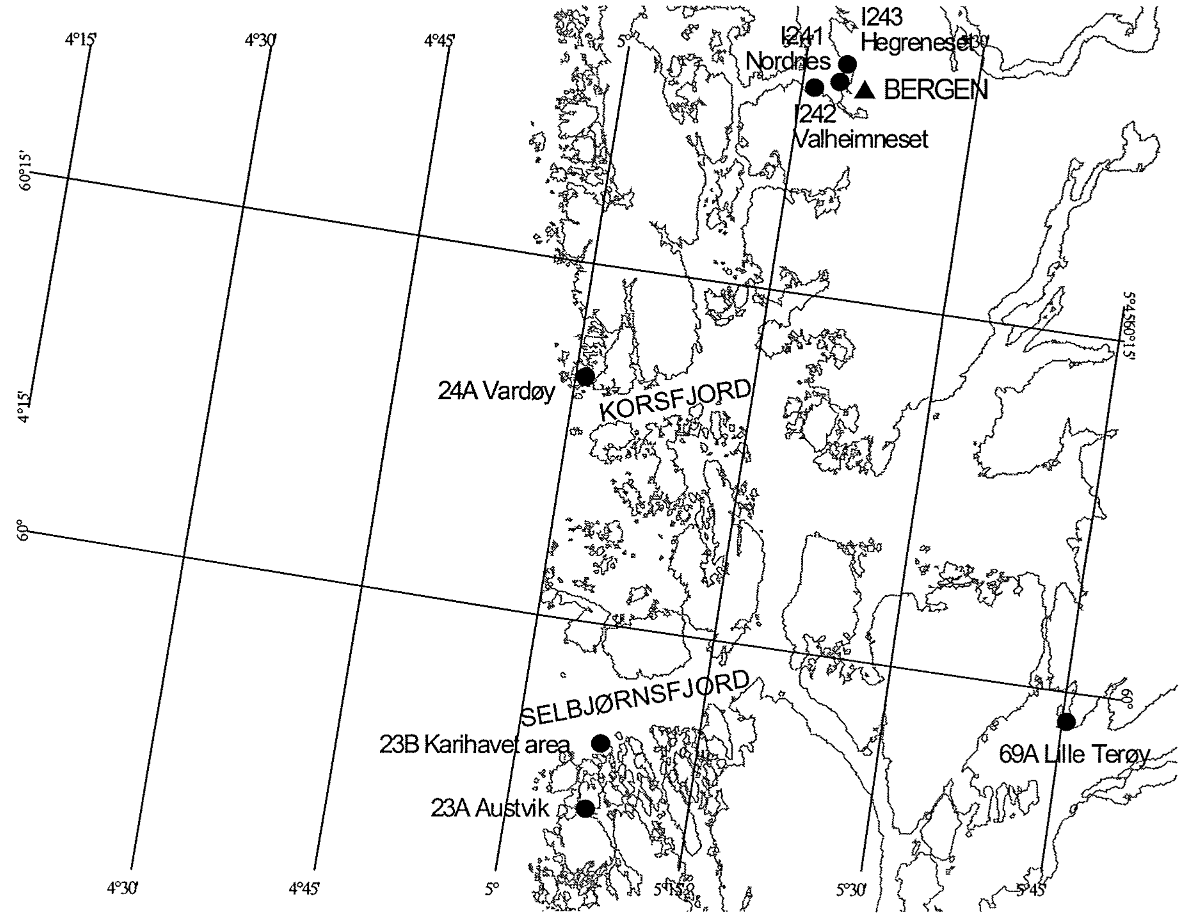
MAP 4


LEIRVIK
22F Borøyfjorden
BØMLOFJORD
22A Espevær, west.
22C Bømlofjord
SAUDA
I201 Ekkjegrunn (G1)
SAUDAFJORD
I205 Bølsnes (G5)
HAUGESUND
224G Heggjelen
226A/G Kårnsund bridge (east)
227A/G Melandholmen
221A/G Stangeland
220G Smørstakk
59°45'
59°30'
59°15'
5°
5°15'
5°30'
5°45'
6°
6°15'
6°30'

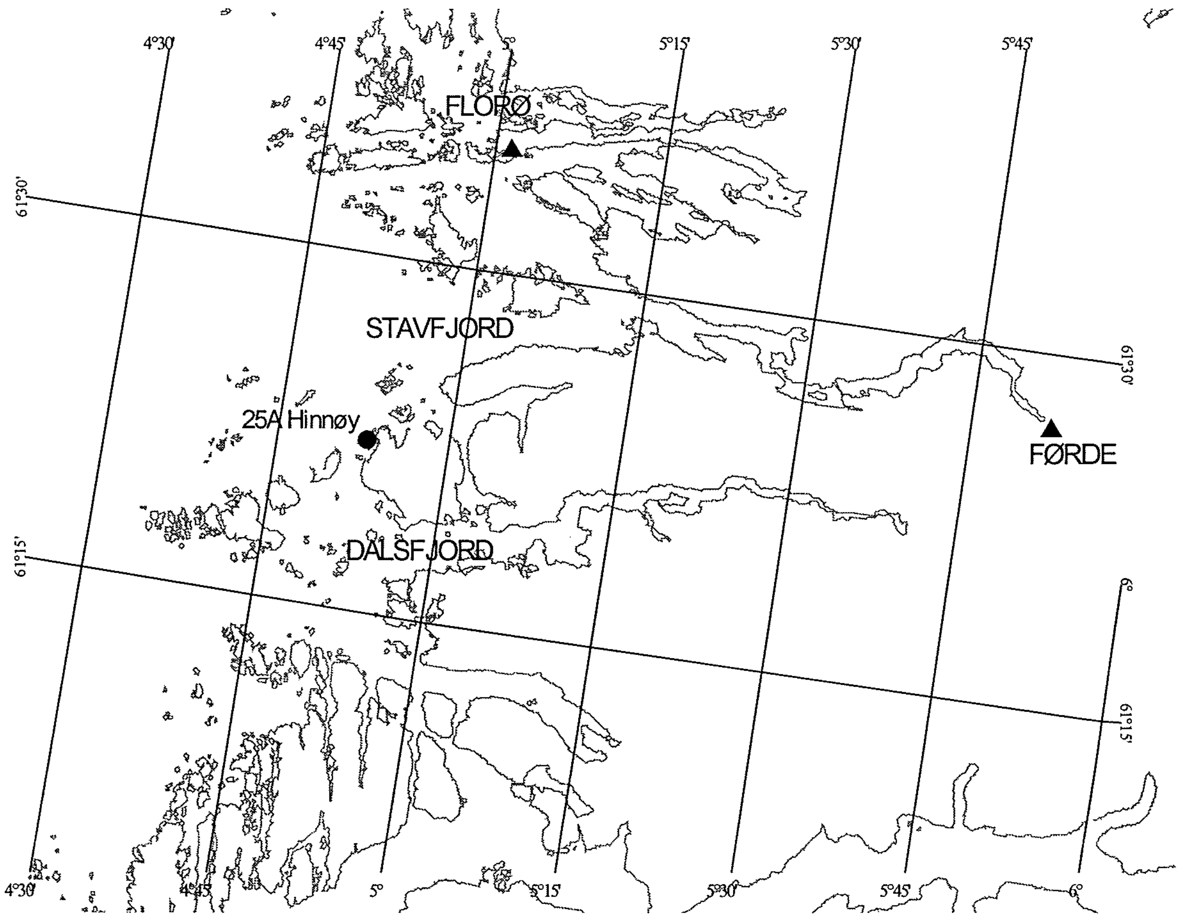
MAP 5


5°15'
60°30' 5°30'
5°45'
6°
6°15'
6°30'
60°30'
I243
Hegreneset
I241
Nordnes
BERGEN
I242
Valheimneset
ØYSTESE
63A Ranaskjær
57A
Krossanes
60°15'
67B Strandebarm
67B Strandebarm
65A Vikingneset
SØRFJORD
6°45'
60°15'
56A Kvalnes
5°15'
53B Inner Sørfjord
53B Inner Sørfjord
53B Inner Sørfjord
HARDANGERFJORD
52A Eitrheimsneset
53B Inner Sørfjord
51A Byrkjenes
60°
ODDA
69A Lille Terøy
5°30'
5°45'
6°
6°15'
6°30'
60° 6°45'

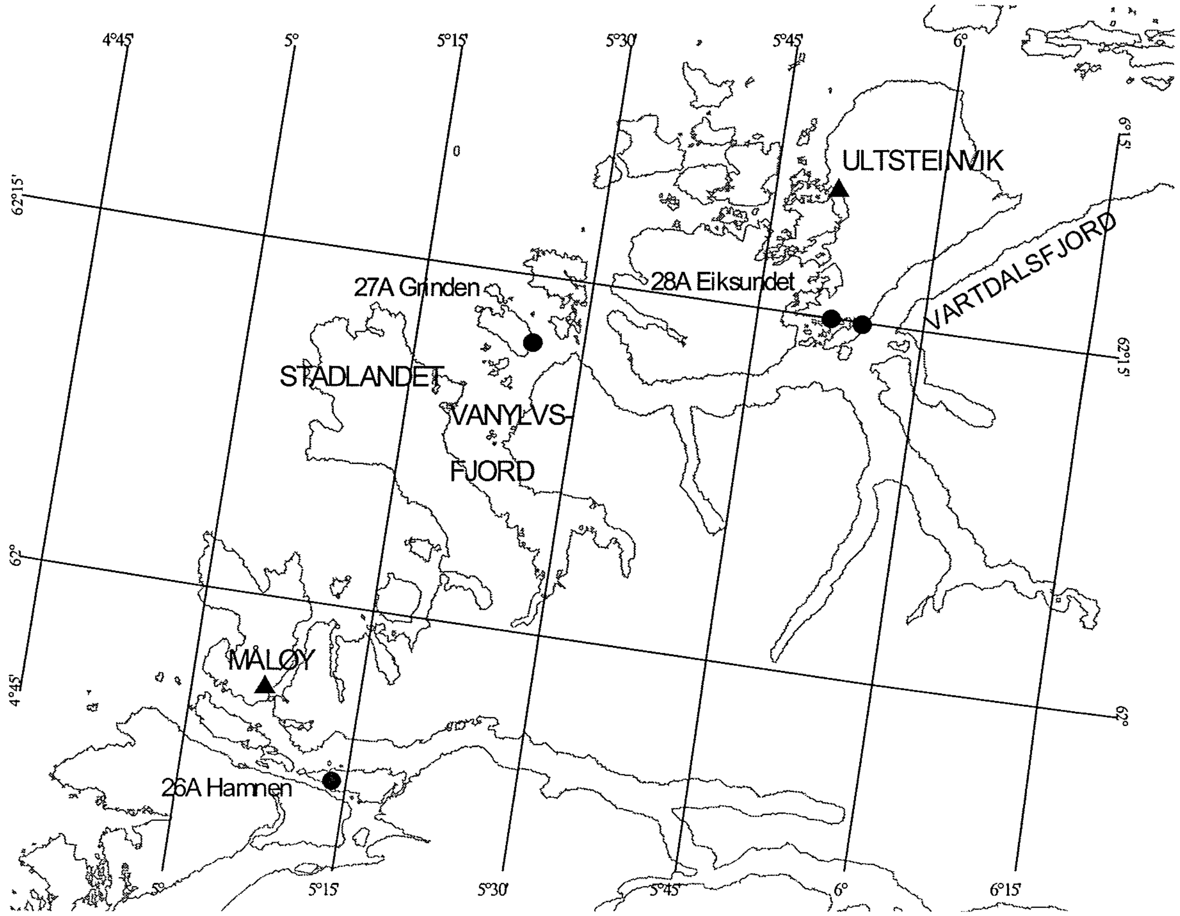
MAP 6


4°15'
4°30'
4°45'
5°
I243
Hegreneset
I241
Nordnes
BERGEN
I242
Valheimneset
60°15'
5°45'60°15'
24A Vardøy
KORSFJORD
4°15'
60°
SELBJØRNSFJORD
60°
23B Karihavet area
69A Lille Terøy
23A Austvik
4°30'
4°45'
5°
5°15'
5°30'
5°45'

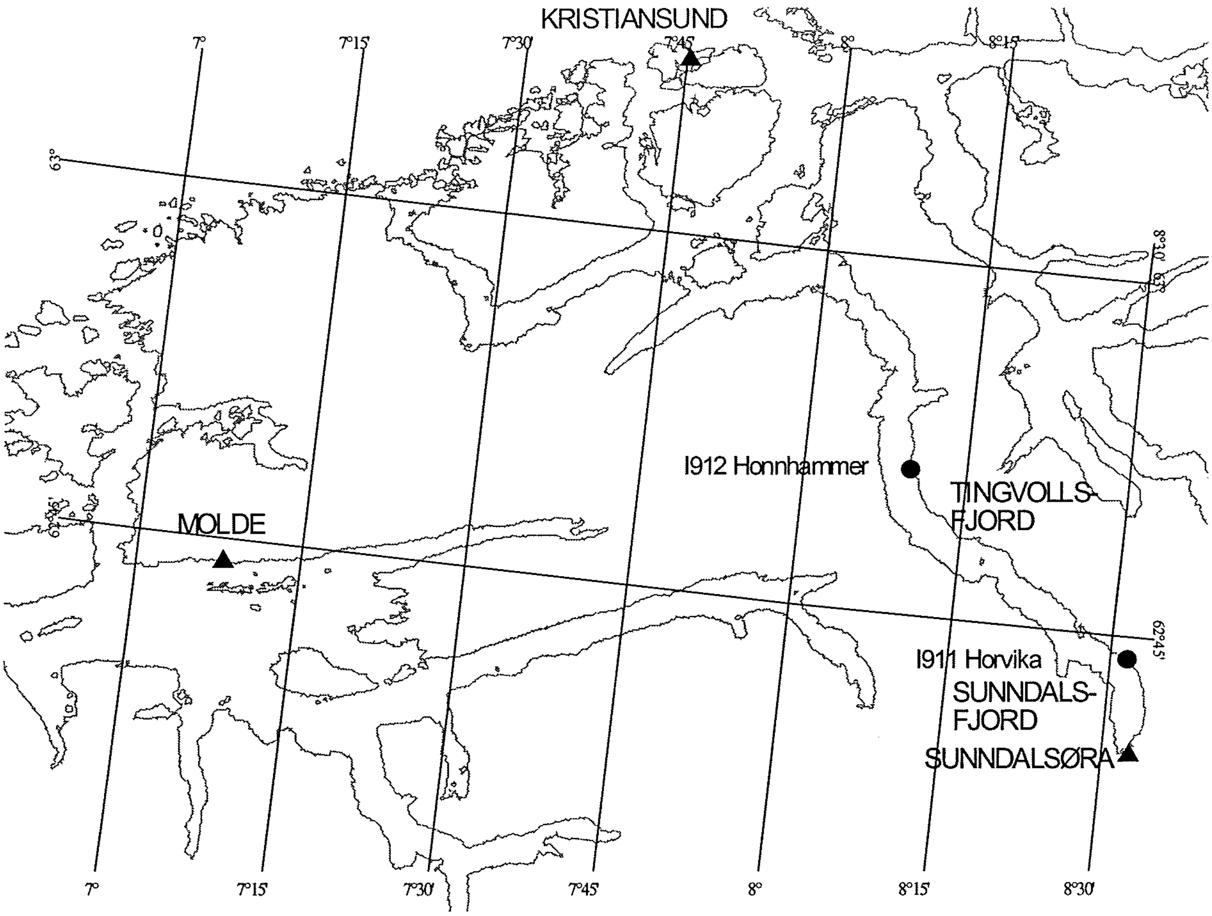
MAP 7


4°30'
4°45'
5°
5°15'
5°30'
5°45'
FLORØ
61°30'
STAVFJORD
61°30'
25A Hinnøy
FØRDE
DALSFJORD
61°15'
6°
61°15'
4°30'
4°45'
5°
5°15'
5°30'
5°45'
6°

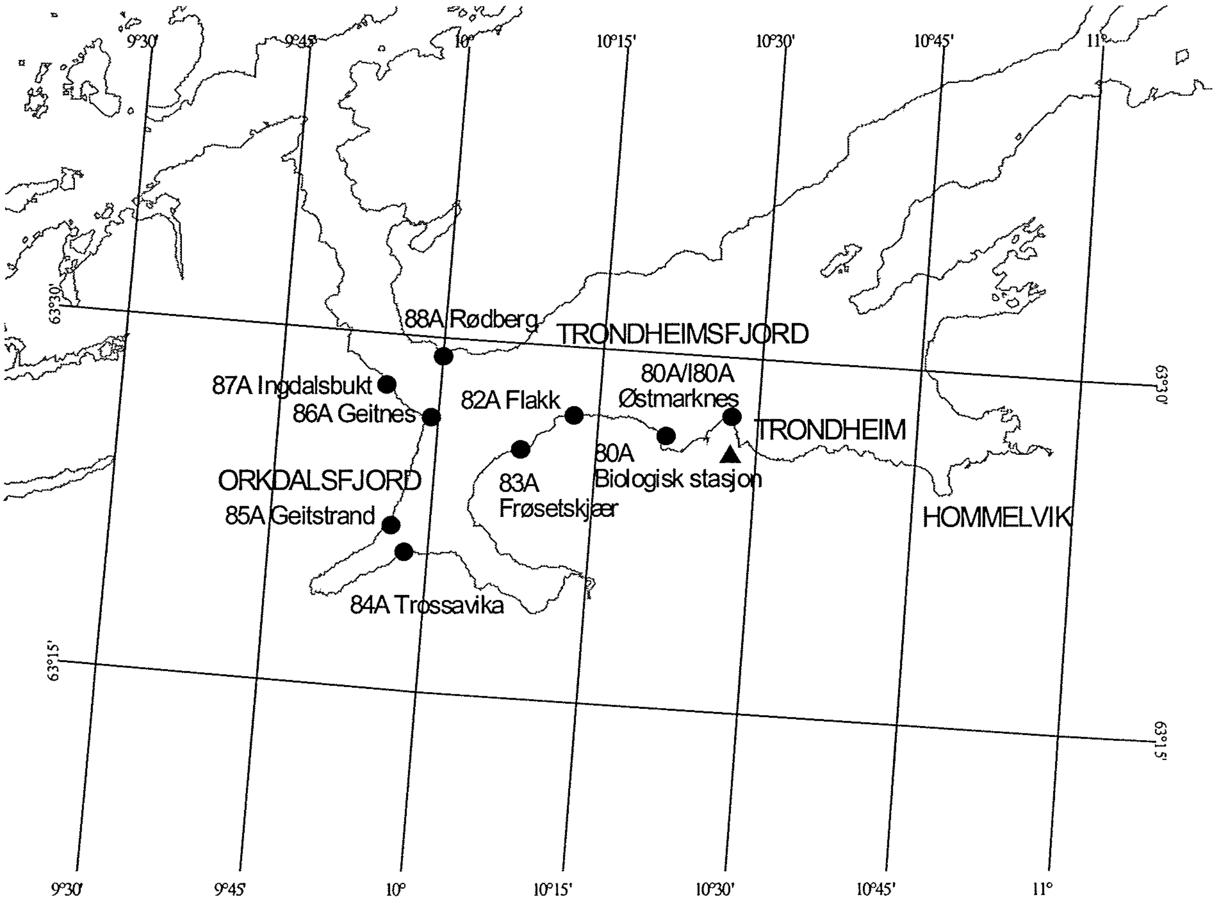
MAP 8


4°45'
5°
5°15'
5°30'
5°45'
6°
0
ULTSTEINVIK
62°15'
6°15'
27A Grinden
28A Eiksundet
VARTDALSFJORD
62°15'
STADLANDET
VANYLVS-
FJORD
62°
MÅLØY
4°45'
62°
26A Hamnen
5°
5°15'
5°30'
5°45'
6°
6°15'

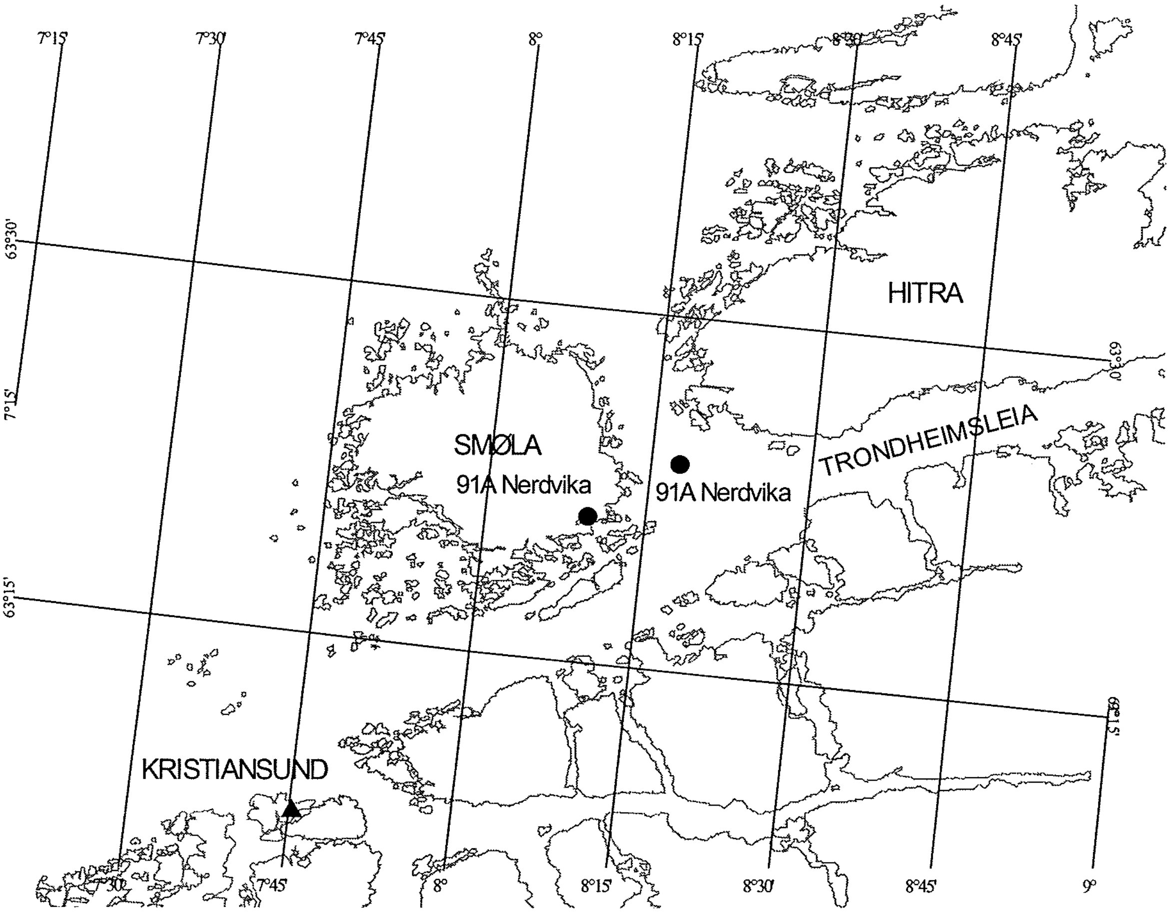
MAP 9


KRISTIANSUND
7°
7°15'
7°30'
7°45'
8°
8°15'
8°30'
63°
I912 Honnhammer
TINGVOLLS-
FJORD
MOLDE
62°45'
I911 Horvika
SUNNDALS-
FJORD
SUNNDALSØRA

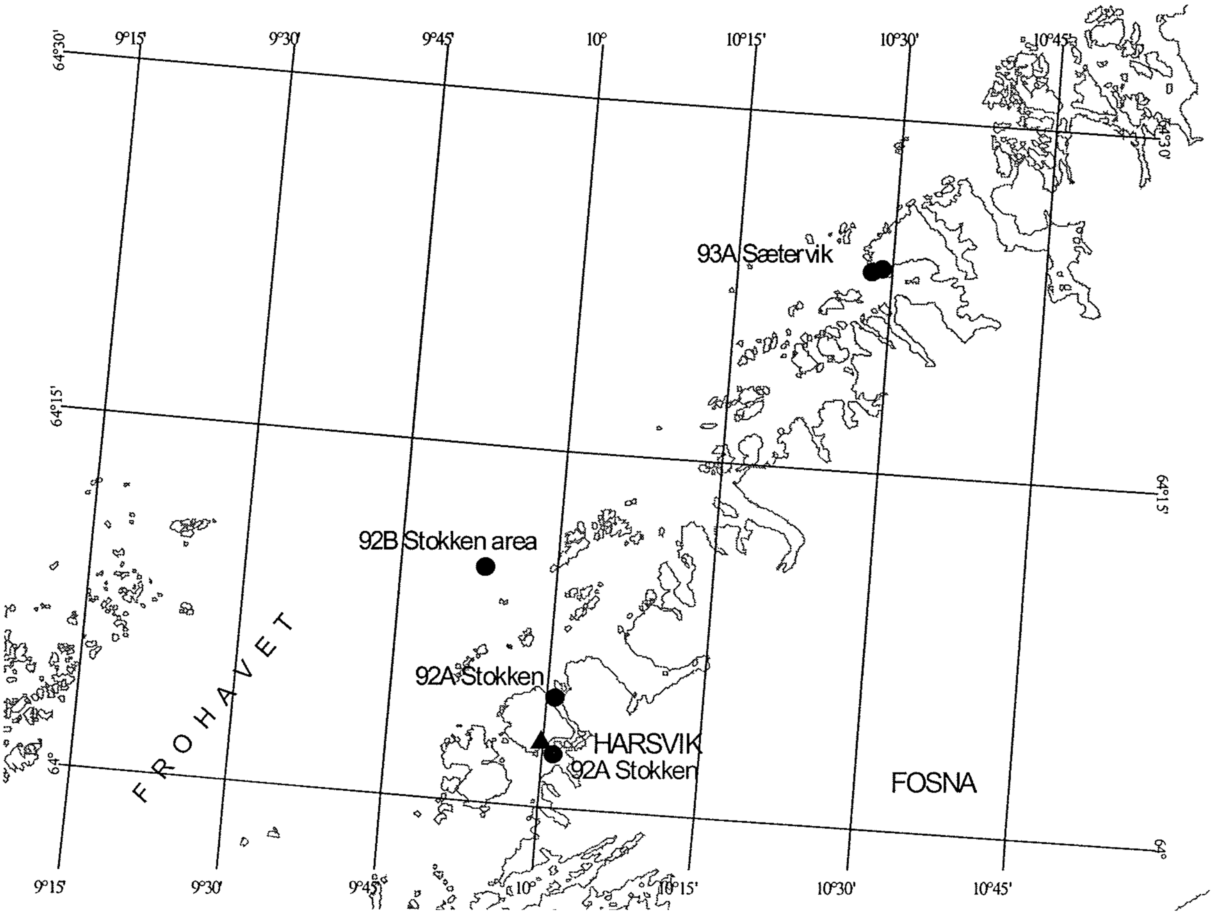
MAP 10


9°30'
9°45'
10°
10°15'
10°30'
10°45'
11°
63°30'
88A Rødberg
TRONDHEIMSFJORD
87A Ingdalsbukt
86A Geitnes
82A Flakk
80A/I80A
Østmarknes
TRONDHEIM
80A
Biologisk stasjon
ORKDALSFJORD
83A
Frøsetskjær
85A Geitstrand
HOMMELVIK
84A Trossavika
63°15'

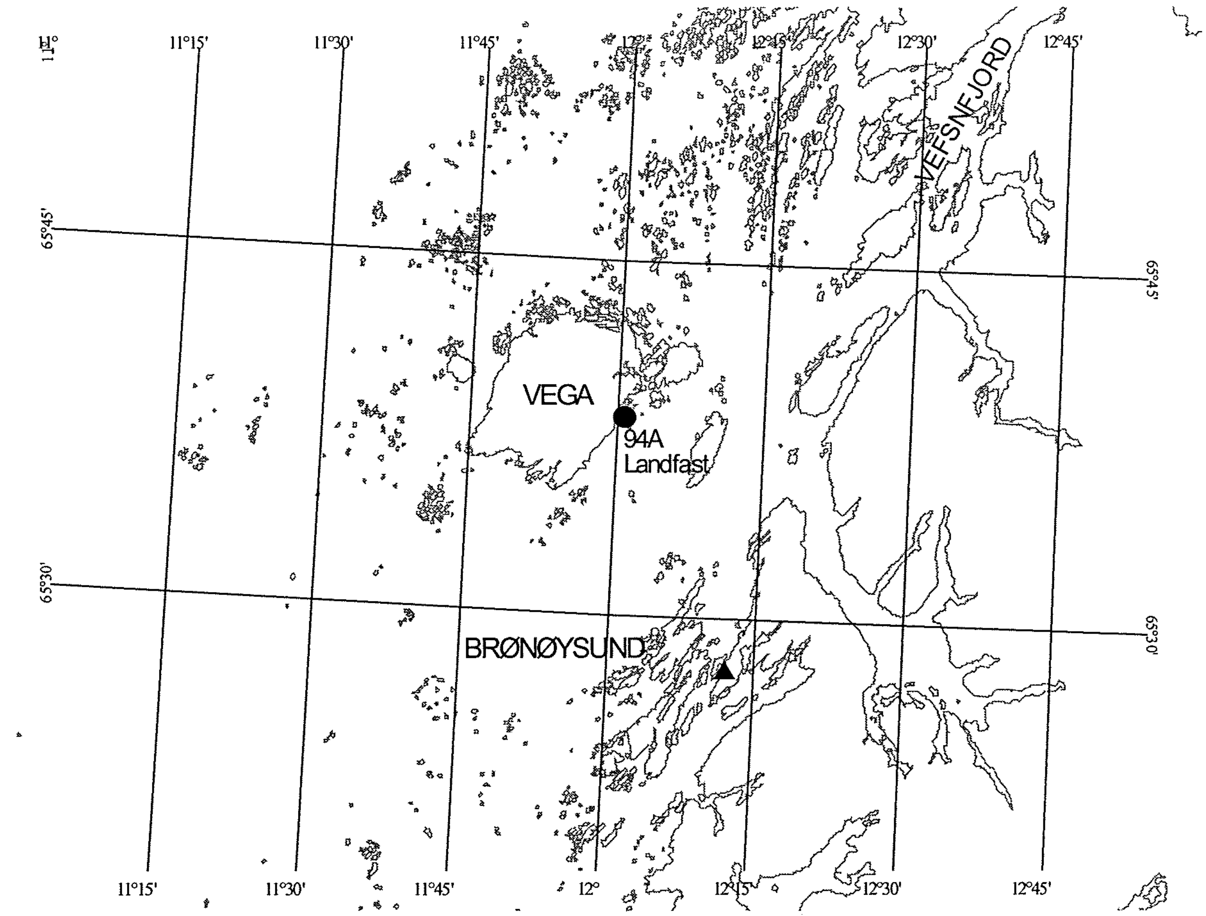
MAP 11


7°15'
7°30'
7°45'
8°
8°15'
8°30'
8°45'
63°30'
7°15'
63°15'
HITRA
SMØLA
91A Nerdvika
91A Nerdvika
TRONDHEIMSLEIA
KRISTIANSUND
7°45'
8°
8°15'
8°30'
8°45'
9°
63°30'
63°15'

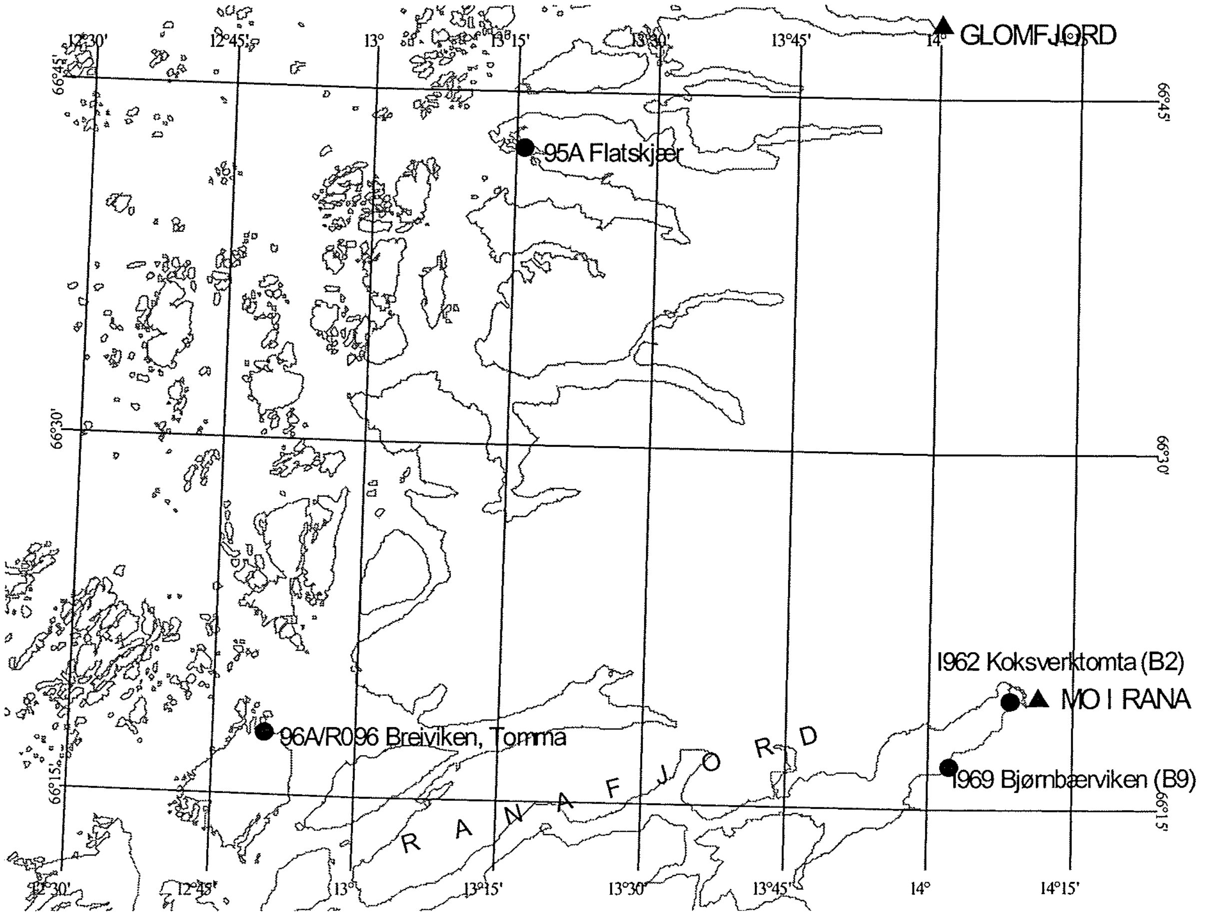
MAP 12


64°30'
9°15'
9°30'
9°45'
10°
10°15'
10°30'
10°45'
64°30'
93A Sætervik
64°15'
64°15'
92B Stokken area
FROHAVET
92A Stokken
HARSVIK
92A Stokken
FOSNA
64°
64°
9°15'
9°30'
9°45'
10°
10°15'
10°30'
10°45'

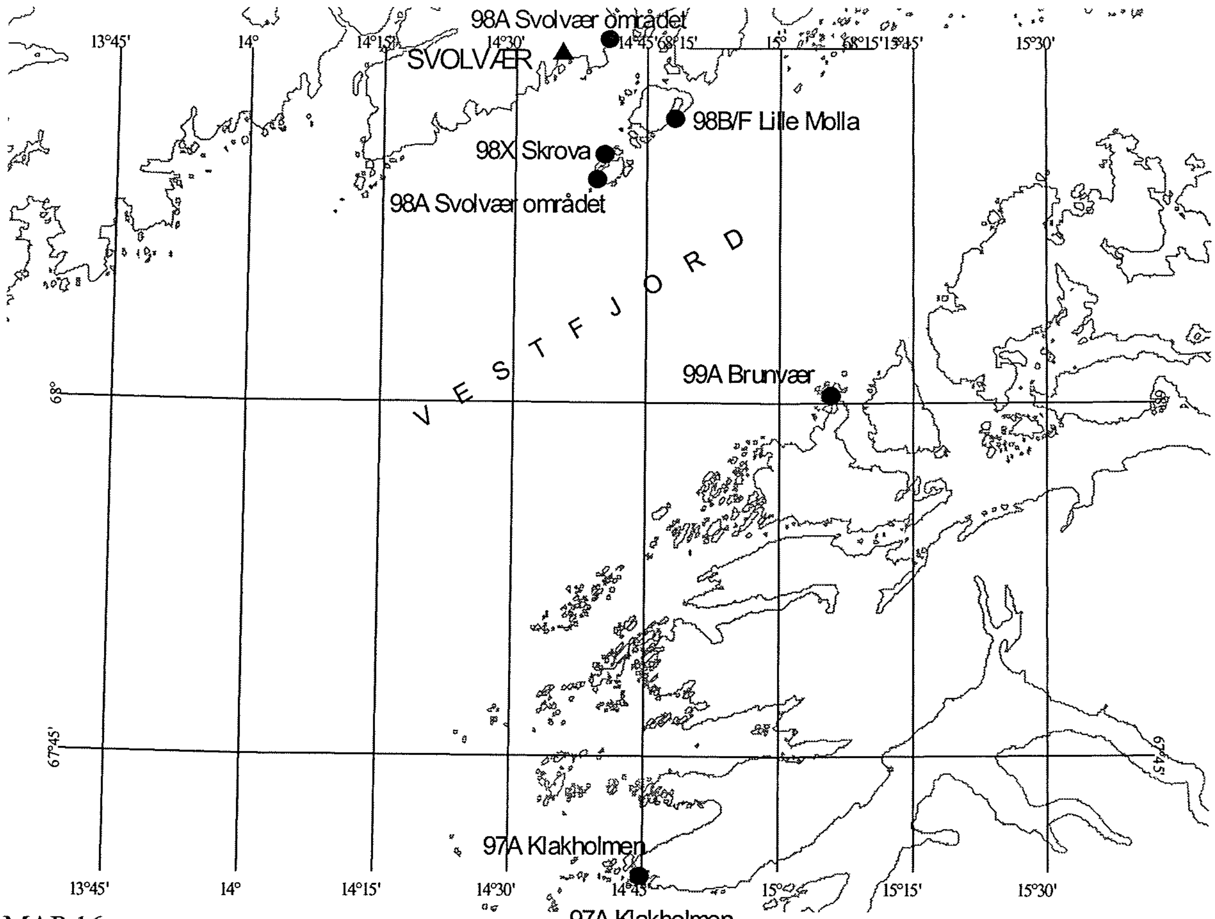
MAP 13


11°
11°15'
11°30'
11°45'
12°
12°15'
12°30'
12°45'
VEFSNFJORD
65°45'
VEGA
94A
Landfast
65°30'
BRØNØYSUND
11°15'
11°30'
11°45'
12°
12°15'
12°30'
12°45'

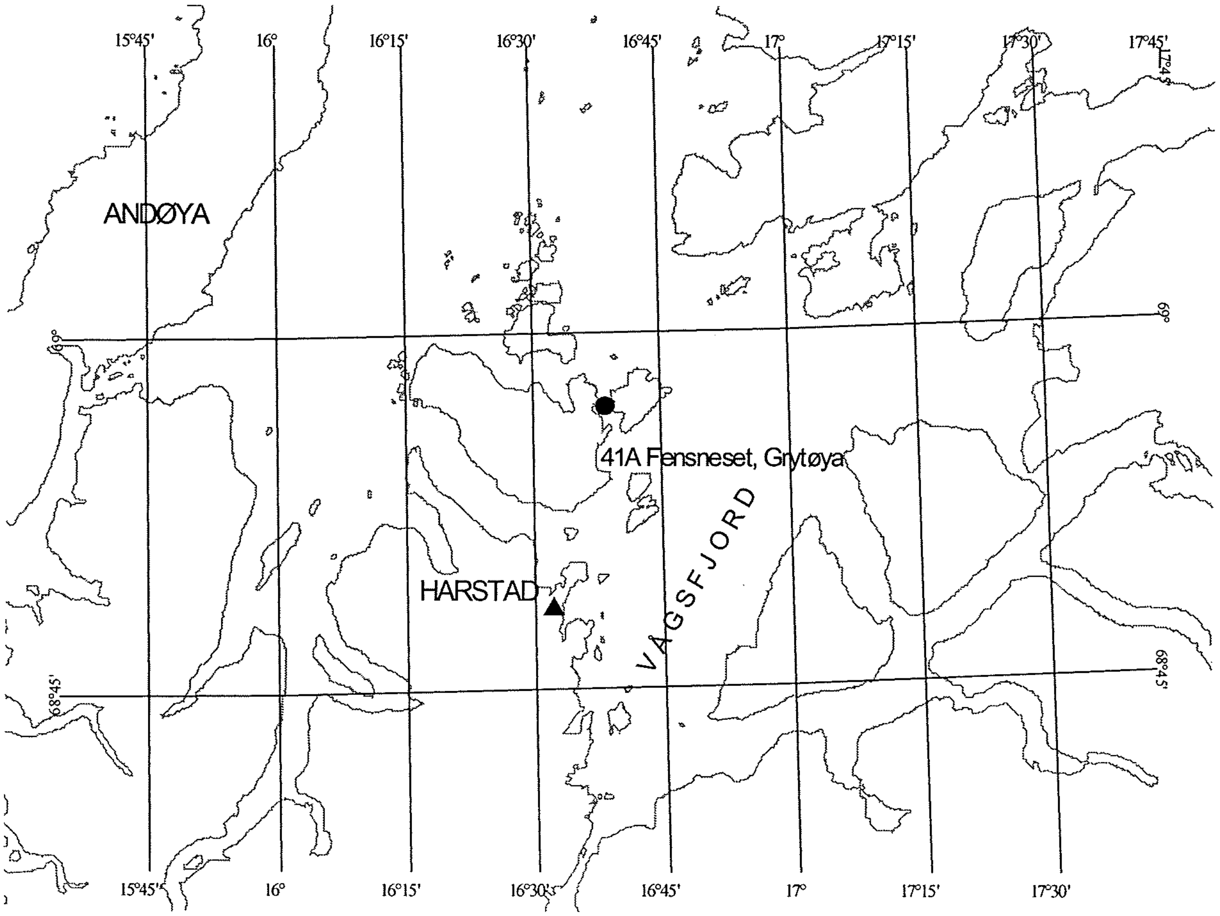
MAP 14


12°30'
12°45'
13°
13°15'
13°30'
13°45'
14°
14°15'
GLOMFJORD
66°45'
95A Flatskjær
66°30'
I962 Koksverktomta (B2)
MO I RANA
96A/R096 Breiviken, Tomma
R A N A F J O R D
I969 Bjørnbærviken (B9)
66°15'
12°30'
12°45'
13°
13°15'
13°30'
13°45'
14°
14°15'

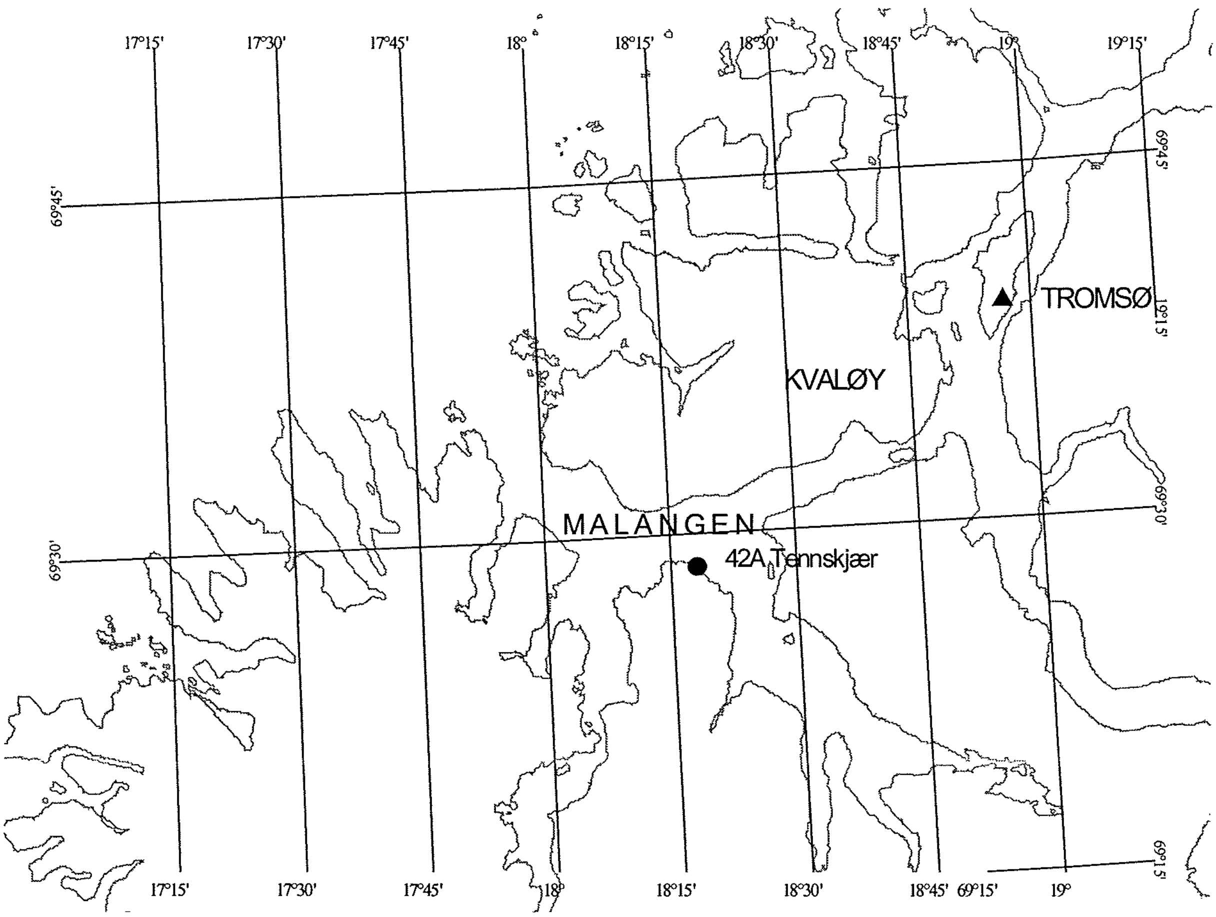
MAP 15


98A Svolvær området
SVOLVÆR
98B/F Lille Molla
98X Skrova
98A Svolvær området
VESTFJORD
99A Brunvær
97A Klakholmen
97A Klakholmen
13°45'
14°
14°15'
14°30'
14°45'
15°
15°15'
15°30'
68°
67°45'

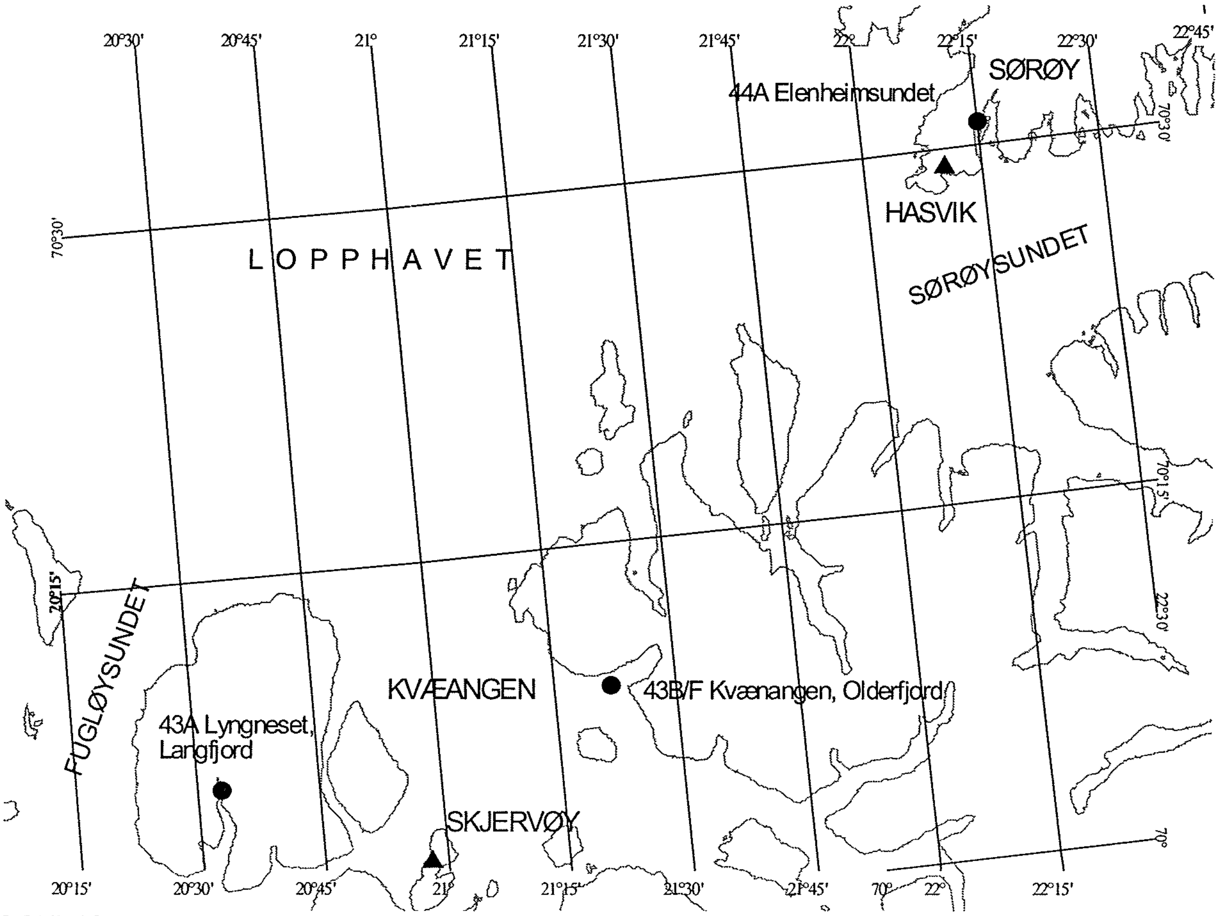
MAP 16


ANDØYA
41A Fensneset, Grytøya
HARSTAD
VÅGSFJORD
15°45'
16°
16°15'
16°30'
16°45'
17°
17°15'
17°30'
17°45'
69°
68°45'

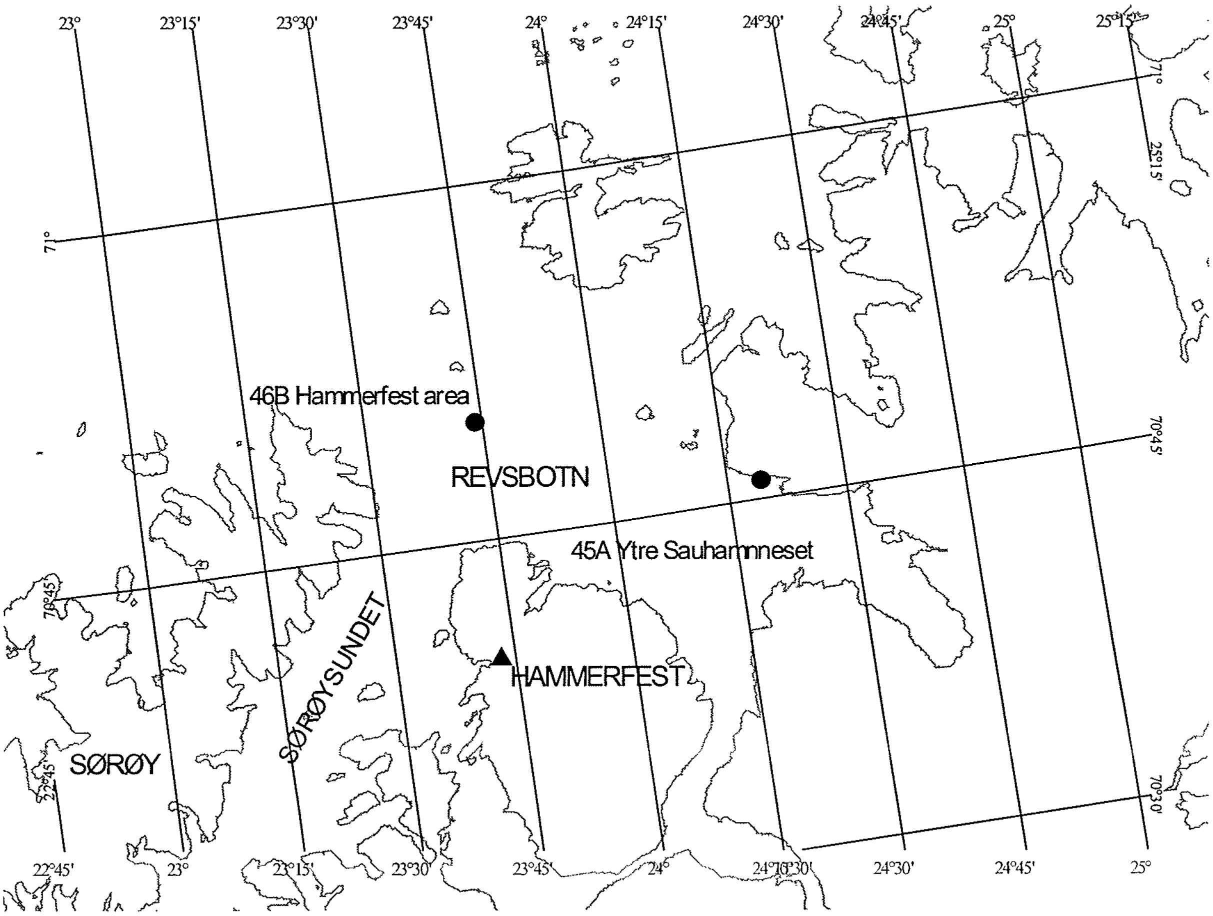
MAP 17


17°15'
17°30'
17°45'
18°
18°15'
18°30'
18°45'
19°
19°15'
69°45'
69°45'
TROMSØ
19°15'
KVALØY
MALANGEN
69°30'
69°30'
42A Tennskjær
17°15'
17°30'
17°45'
18°
18°15'
18°30'
18°45'
69°15'
19°
69°15'

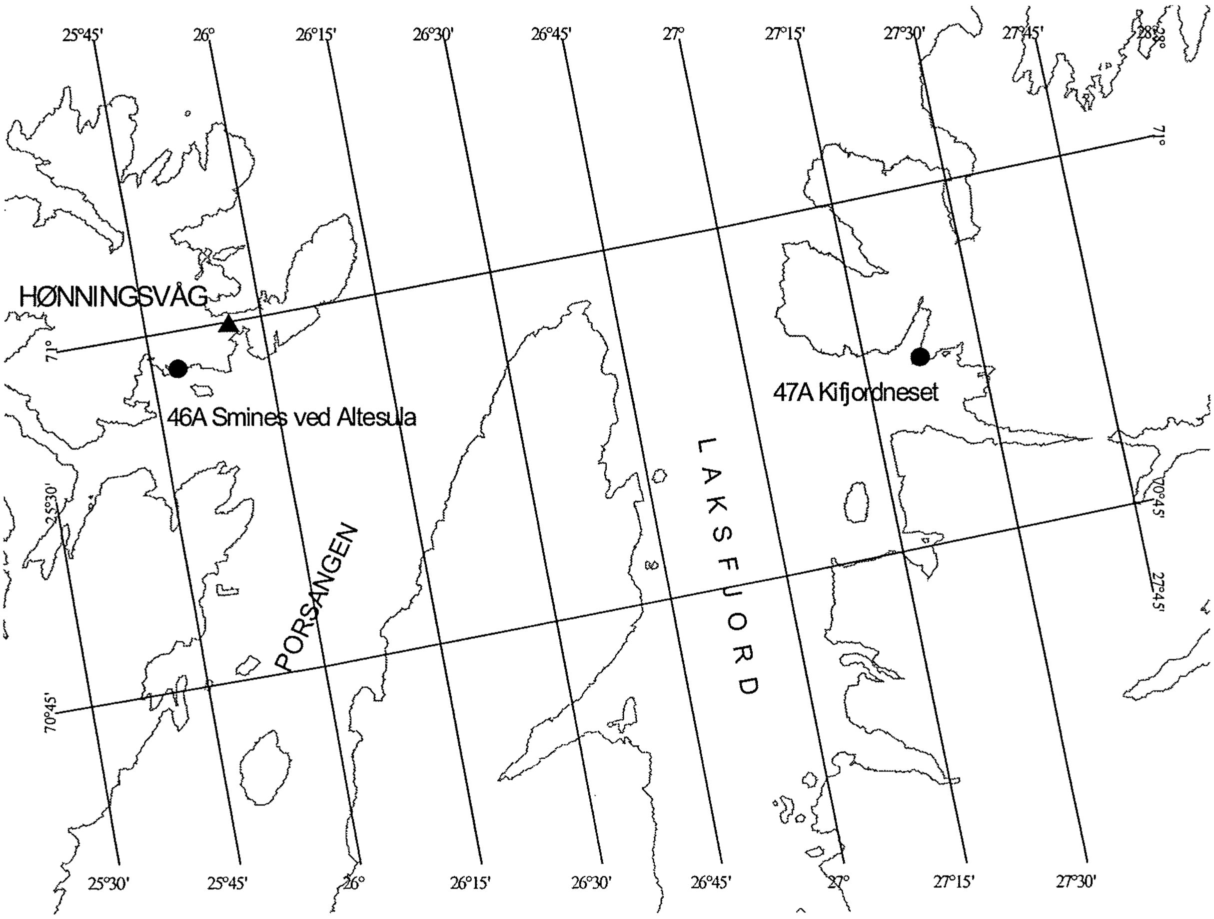
MAP 18


20°30'
20°45'
21°
21°15'
21°30'
21°45'
22°
22°15'
22°30'
22°45'
SØRØY
44A Elenheimsundet
70°30'
HASVIK
70°30'
LOPPHAVET
SØRØYSUNDET
70°15'
20°15'
22°30'
FUGLØYSUNDET
KVÆANGEN
43B/F Kvænangen, Olderfjord
43A Lyngneset, Langfjord
SKJERVØY
70°
20°15'
20°30'
20°45'
21°
21°15'
21°30'
21°45'
70°
22°
22°15'

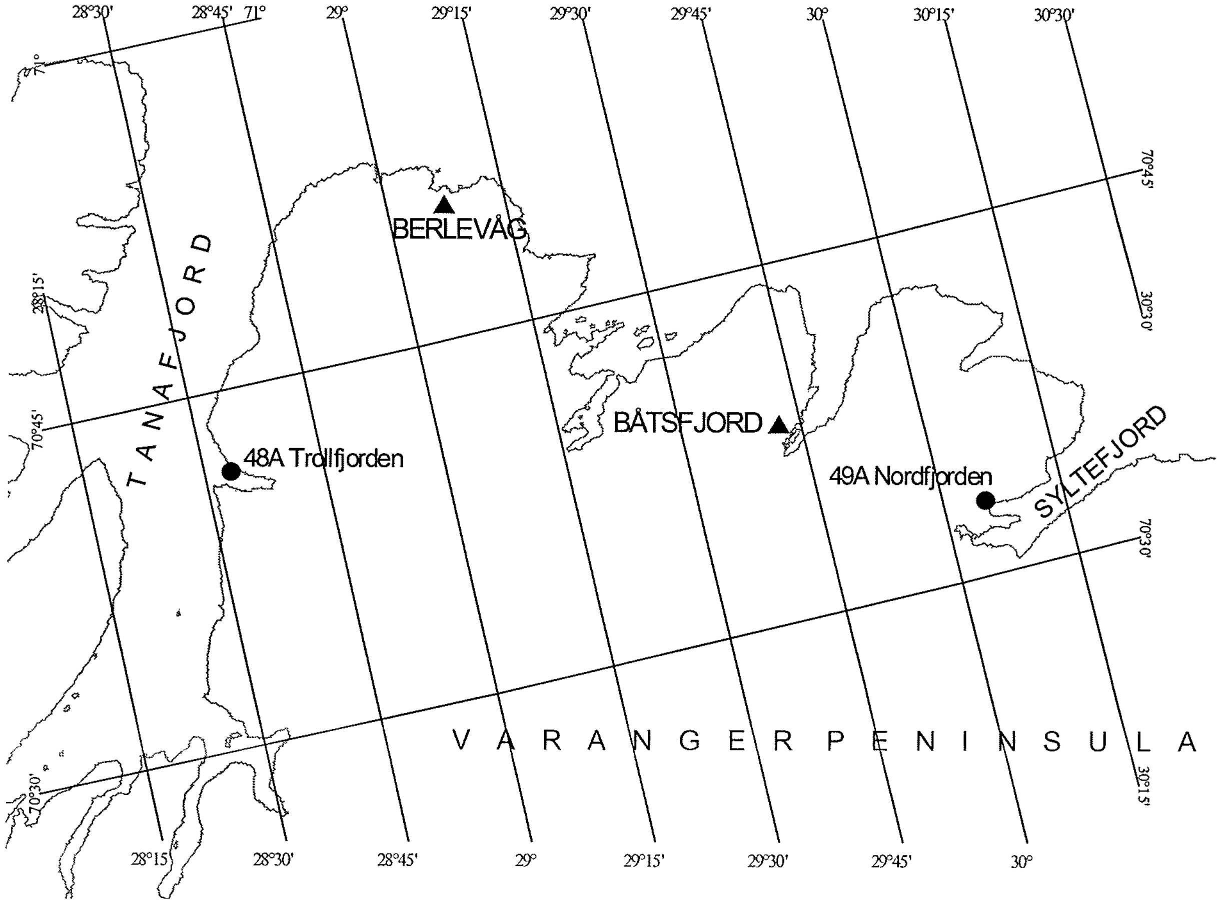
MAP 19


46B Hammerfest area
REVSBOTN
45A Ytre Sauhamneset
HAMMERFEST
SØRØYSUNDET
SØRØY
23°
23°15'
23°30'
23°45'
24°
24°15'
24°30'
24°45'
25°
25°15'
71°
70°45'
70°30'
22°45'

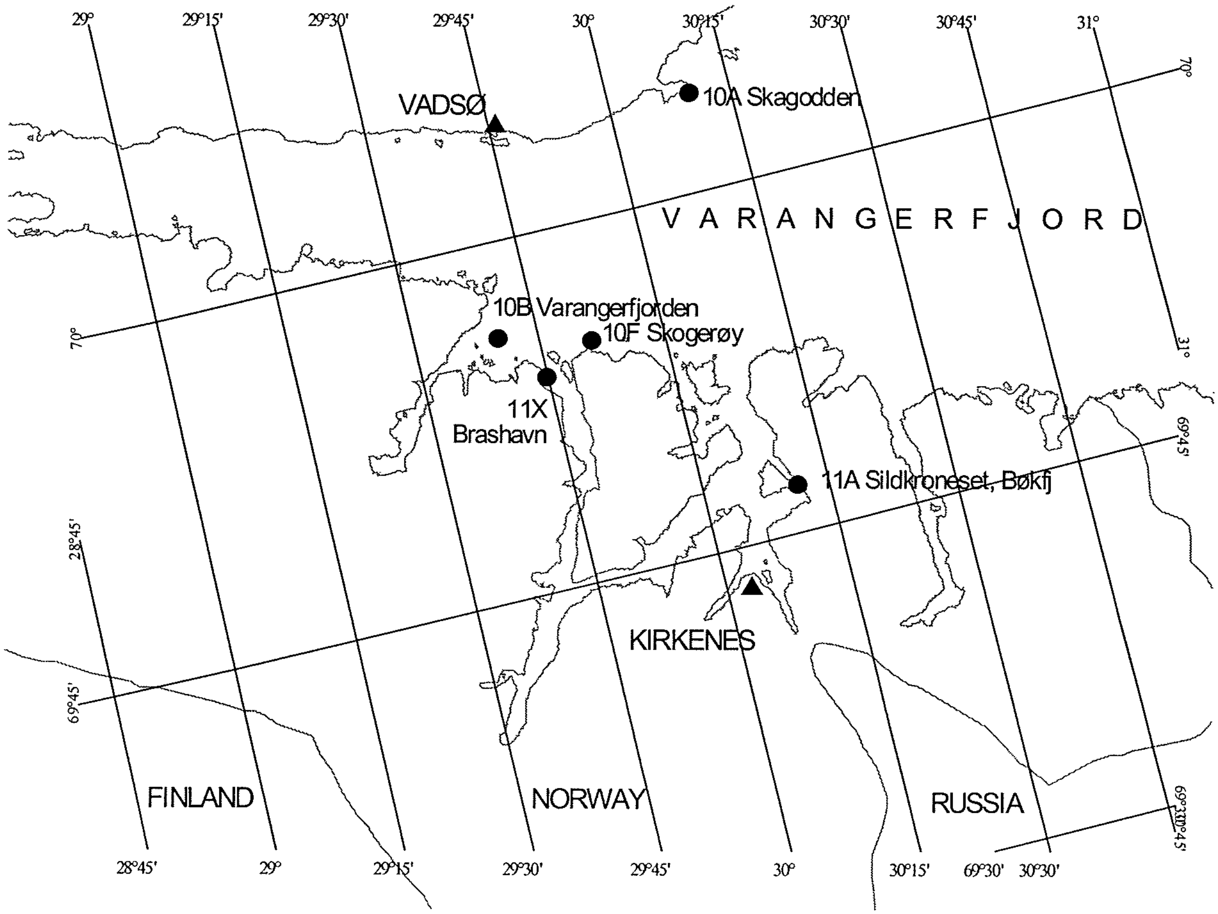
MAP 20


HØNNINGSVÅG
46A Smines ved Altesula
47A Kifjordneset
PORSANGEN
LAKSFJORD
25°30'
25°45'
26°
26°15'
26°30'
26°45'
27°
27°15'
27°30'
27°45'
28°
71°
70°45'

MAP 21


28°30'
28°45' 71°
29°
29°15'
29°30'
29°45'
30°
30°15'
30°30'
70°45'
30°30'
70°30'
30°15'
28°15'
70°45'
70°30'
28°15
28°30'
28°45'
29°
29°15'
29°30'
29°45'
30°
BERLEVÅG
TANAFJORD
48A Trollfjorden
BÅTSFJORD
49A Nordfjorden
SYLTEFJORD
VARANGERPENINSULA

MAP 22


29°
29°15'
29°30'
29°45'
30°
30°15'
30°30'
30°45'
31°
70°
31°
69°45'
69°30'
30°45'
28°45'
70°
69°45'
28°45'
29°
29°15'
29°30'
29°45'
30°
30°15'
69°30'
30°30'
VADSØ
10A Skagodden
VARANGERFJORD
10B Varangerfjorden
10F Skogerøy
11X
Brashavn
11A Sildkroneset, Bøkfj
KIRKENES
FINLAND
NORWAY
RUSSIA

MAP 23

Appendix G
Overview of materials and analyses 1998

Including sampling for VIC (cf. SIME 1996, 1997a)

Station positions are shown on maps in Appendix F.

Appendix G1. Sampling and analyses for 1998, L-liver, F-fillet. (See Appendix G2 for descriptions of codes for analysis (M0, M1, M3, M4, M5, C2, C4, A1, G1), fish (P, F, D, L, M, C) and counts). Analytical overview for liver (-L) or fillet (-F) tissue is distinguished.

JAMP area	STATION	WATER	SEDIMENT				MUSSEL/			OTHER		FISH FLAT- (P,F,D,M)				COD- (C)			
												-L	M4	C2	A1	-L	M4	C2	A1
		M0	M1	C4	A1	G1	M3	C2	A1	M3	C2	-F	M5	C2	A1	-F	M5	C2	A1
26	**OSLOFJORD AREA CENTRAL**, Oslofjord proper																		
26	30A Gressholmen	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
26	30S Steilene	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	30B Oslo city Area / Håøya	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	VIC: Steilene-14.1.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	10	10	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	10	2B	.
	VIC: Steilene-21.1.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	10	10	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	10	2B	.
	VIC: Steilene-28.2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	10	10	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	10	2B	.
	VIC: Svestad-21.1.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	10	10	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	10	2B	.
	VIC: Håøya-18.1.99	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	10	10	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	10	2B	.
26	31A Solbergstrand	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
26	33B Sande, east side	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	VIC: 10.98	.	.	.	.	.	.	.	.	.	.	F-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	5B	5B	.	.	.	.	.
	VIC: 11.98	.	.	.	.	.	.	.	.	.	.	F-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	5B	5B	.	.	.	.	.
	VIC: 12.98	.	.	.	.	.	.	.	.	.	.	F-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	5B	5B	.	.	.	.	.
26	35S Mølen	.	3	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	35A Mølen	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
26	36S Færder	.	17	4	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.
26	36A Færder	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
26	36B Færder area	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	25	25	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	25	5B	.
20	36F Færder area	.	.	.	.	.	.	.	.	.	.	D-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	D-F	5B	5B	.	.	.	.	.
26	**OSLOFJORD AREA WEST**, outer Sandefjord-Langesundsfjord																		
26	71A Bjørkøya	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
	ARENDAL AREA																		
	76A Risøy	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.

Appendix G1 (cont.)

JAMP area	STATION	WATER	SEDIMENT				MUSSEL/			OTHER		FISH							
												FLAT- (P,F,D,M)				COD- (C)			
												-L	M4	C2	A1	-L	M4	C2	A1
		M0	M1	C4	A1	G1	M3	C2	A1			-F	M5	C2	A1	-F	M5	C2	A1
	LISTA AREA																		
	15A Ullerø area	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
	15B Ullerø area	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	25	25	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	25	5B	.
	15F Ullerø area	.	.	.	.	.	.	.	.	.	.	D-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	D-F	5B	5B	.	.	.	.	.
	BØMLO-SOTRA AREA																		
	22A Espevær, west	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
	22F Borøyfjorden	.	.	.	.	.	.	.	.	.	.	P-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	P-F	5B	5B	.	.	.	.	.
	23B Karihavet	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	25	25	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	25	5B	.
62	**HARDANGERFJORDEN**																		
62	69A Lille Terøy	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
62	67B Strandebarm	.	.	.	.	.	.	.	.	.	.	MF	5B	5B	.	C-L	25	25	.
		.	.	.	.	.	.	.	.	.	.	MF	5B	5B	.	C-F	25	5B	.
		.	.	.	.	.	.	.	.	.	.	F-L	4B	4B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	4B	4B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	D-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	D-F	5B	5B	.	.	.	.	.
62	65A Vikingneset	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
62	63A Ranaskjær	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
63	**SØRFJORD**																		
63	52A Eitrheimsneset	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
63	53B Inner Sørfjord	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	VIC: Odda - 20.11.98	.	.	.	.	.	.	.	.	.	.	F-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	5B	5B	.	.	.	.	.
	VIC: Tyssedal - 5.11.98	.	.	.	.	.	.	.	.	.	.	F-L	3B	3B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	3B	3B	.	.	.	.	.
	VIC: Edna - 1.11.98	.	.	.	.	.	.	.	.	.	.	F-L	3B	3B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	F-F	3B	3B	.	.	.	.	.
	VIC: Tyssedal- 24.10.98	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	15	15	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	15	3B	.
	VIC: Edna - 24.10.98	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	15	15	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	15	3B	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	15	15	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	15	3B	.
63	56A Kvalnes	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
63	57A Krossanes	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.

Appendix G1 (cont.)

JAMP area	STATION	WATER	SEDIMENT				MUSSEL/			OTHER		FISH FLAT- (P,F,D,M)				FISH COD- (C)			
		M0	M1	C4	A1	G1	M3	C2	A1			-L -F	M4 M5	C2 C2	A1 A1	-L -F	M4 M5	C2 C2	A1 A1
65	**ORKDALSFJORD AREA**																		
65	82A Flakk	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
65	84A Trossavika	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
65	87A Ingdalsbukta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	FROAN AREA																		
	92A Stokken	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	92B Stokken	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	92F Stokken	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	LOFOTEN AREA																		
	98A Husvågen	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
	98B Lille Molla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	25	25	
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	25	5B	
	98F Lille Molla	.	.	.	.	.	.	.	.	.	.	P-L	5B	5B	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	P-F	5B	5B	.	.	.	.	.
	FINNSNES-SKJERVØY AREA																		
	41A Fensneset, Grytøya	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	42A Tennskjær, Malangen	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	43A Lyngneset, Langjforden	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	43B Kvænangen	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	43F Kvænangen	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	HAMMERFEST-HONNINGSVÅG AREA																		
	44A Elenheimsundet	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	45A Ytre Sauhamnneset	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	45B Hammerfest area	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	45F Honningsvåg area	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	46A Smineset in Altesula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	47A Kifjordeneset	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	VARANGER PENINSULA AREA																		
	48A Trollfjorden i Tanafjord	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	49A Nordfjorden, Syltefjord	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	10A Skagodden	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.
	10B Varangerfjorden	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-L	25	25	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	C-F	25	5	
	10F Varangerfjorden	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	11A Sildkroneset, Bøkfjorden	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	11X Brashavn	1	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	.	.

Appendix G2: Key to analysis codes and sample counts used in Appendix G1.

ANALYSIS CODES:

Code	Analyses
M0	suspended matter
M1	Hg, Cd, Cu, Pb, Zn, Li (normalising element) total organic carbon (TOC)
M3	Hg, Cd, Cu, Pb, Zn
M4	Cd Cu Pb Zn (for fish liver)
M5	Hg (for fish fillet)
C1	CB-28,-52,-101,-105,-118,-138,-153,-156,-180, 209, 5-CB, OCS, a+gHCH, HCB, DDE, DDD, EPOCl (optional), dry weight percent
C2	CB-28,-52,-101,-105,-118,-138,-153,-156,-180, 209, 5-CB, OCS, a+gHCH, HCB, DDE, DDD, EPOCl (optional), fat and dry weight percent
A1	PAH
G1	Sediment core geological dating

SAMPLE COUNT CODES:

Medium	Count	Explanation
SEAWATER	1	sample for suspended matter determination
SEDIMENT	17	17 samples for metal analyses; two cores each with samples from 0-1, 1-2, 2-4, 4-6, 6-10, 10-15, 15-20 cm and deepest 5 cm slice plus one core with sample from 0-1 cm.
	4	4 samples for PCB or PAH analyses; two each cores with samples from 0-1cm and deepest 5cm slice.
	3	3 samples for metal analyses; three cores each with samples from 0-1cm.
MUSSEL	3/6	3 size groups (2-3, 3-4, 4-5 cm) each a bulk of ca.50 individuals and/or 1 size group (3-4 or 4-5 cm), 3 parallel samples each a bulk of 20 individuals.
	1/2	1 size group (2-3 or 3-4 cm), 2 parallel samples each a bulk of 50 individuals.
SHRIMP	2	2 samples of 100 individuals (edible size)
FISH		The number of individual fish or bulk samples of fish (-B) for analyses is shown. Bulk samples of fish consist of 5 fish. The five longest fish make up one bulk sample, the next five longest fish make up the another bulk sample and so on. The letter following the number indicates the fish type: D=dab, F=flounder, L=lemon sole, M=megrim, P=plaice, W=witch and C=cod.

Appendix H
Temporal trend analyses of contaminants in biota 1981-1998

Sorted by contaminant, species and area/station:

Cadmium (Cd)
Copper (Cu)
Mercury (Hg)
Lead (Pb)
Zinc (Zn)
CB-153
DDEPP (ppDDE)
γHCH (HCHG)
HCB

MYTI EDU - Blue Mussel (*Mytilus edulis*)
GADU MOR - Atlantic cod (*Gadus morhua*)
LEPI WHI - Megrim (*Lepidorhombus whiff-iagonis*)
LIMA LIM - Dab (*Limanda limanda*)
PLAT FLE - Flounder (*Platichthys flesus*)
(s) - Small fish
(l) - Large fish
SB - Soft body tissue
LI - Liver tissue
MU - Muscle tissue

OC	**Overconcentration expressed as quotient of median of last year and "high background" ("?" missing background value)**	
TRND	**trend**	
	D-	**Significant linear trend, downward**
	U-	**Significant linear trend, upward**
	--	**No significant trend**
	-?	**No significant linear trend, systematic non-linear trend can not be tested because of insufficient data (<6 years)**
	-Y	**No significant linear trend, but a systematic non-linear trend**
	DY or UY	**Significant linear trend (downward or upward) and a significant non-linear trend. This is considered the same as "-Y"**
	SIZE length effect (mercury in fillet)	
	L	**Significant difference in concentration levels but pattern of variation same**
	D	**As "L" but pattern of variation significantly different**
	-	**No significant difference between "small" and "large" fish**
U95+3	**Projected upper 95% confidence interval in three years expressed as quotient of value and "high background" ("?" if missing background or if number of years is less than seven)**	
POWER	**Estimated number of years to detect a hypothetical situation of 10% trend a year with a 90% power**	

Annual Median Concentrations of C d (ppm).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt				1.065	0.810	1.410	0.600	0.610	0.736	0.769	0.769	1.117	1.257	1.174	0.776	0.800	0.857	1.274	no	--	no	11
31A	MYTI EDU	SB	D.wt			1.386	1.314	0.890	1.930	0.400	0.430	0.412	0.719	0.727	0.914	0.933	0.781	1.324	0.789	0.854	1.070	no	--	1.0	13
35A	MYTI EDU	SB	D.wt			1.347	0.952	1.170	1.300	0.520	0.660	0.647	0.926	1.053	1.350	1.111	0.958	0.894	0.766	0.965	1.140	no	--	no	10
36A	MYTI EDU	SB	D.wt			0.845	1.191	0.840	1.380	0.590	0.560	0.502	0.407	1.217	1.063	0.899	1.215	1.172	1.602	1.839	0.965	no	--	1.4	13
71A	MYTI EDU	SB	D.wt			2.520	1.975	1.419	2.004	0.980	2.110	2.021	0.968	1.088	1.657	1.895	1.974	2.253	1.497	2.440	1.532	no	--	1.5	12
76A	MYTI EDU	SB	D.wt										0.638	0.860	0.957	1.098			1.168	1.190	1.200	no	UY	no	6
15A	MYTI EDU	SB	D.wt										0.505	0.831		1.182	0.794	1.439	1.220	1.066	1.027	no	--	no	11
51A	MYTI EDU	SB	D.wt							42.800	58.200							36.837	25.272	5.448	10.341	5.2	--	4.6	19
52A	MYTI EDU	SB	D.wt									94.400	10.160	80.083	43.089	14.651	8.713	19.759	18.377	13.400	9.144	4.6	--	26.9	22
56A	MYTI EDU	SB	D.wt							55.900	54.194	98.413	45.034	69.444	51.667	59.681	11.357	30.761	20.000	28.793	8.708	4.4	D-	11.4	17
57A	MYTI EDU	SB	D.wt							21.100	43.200	36.692	25.685	32.803	32.121	15.397	11.800	12.207	8.482	13.607	5.024	2.5	D-	4.0	13
63A	MYTI EDU	SB	D.wt							47.200	10.300	19.006	30.394	35.140	18.212	7.811	4.228	8.160	5.400	6.621	4.426	2.2	D-	6.2	17
65A	MYTI EDU	SB	D.wt							15.000	5.962	8.291	14.604	23.964	5.088	7.733	3.006	5.367	3.529	4.280	1.722	no	--	2.1	17
69A	MYTI EDU	SB	D.wt												4.261	2.368	2.084	2.910	3.195	3.525	1.582	no	--	2.4	13
22A	MYTI EDU	SB	D.wt										0.532	1.139	1.117	0.844	1.020	1.414	1.145	1.012	0.851	no	--	no	11
82A	MYTI EDU	SB	D.wt				1.412	1.155	2.315	0.990	0.400	1.257		1.200	1.213	1.147		0.981	1.223			no	--	1.5	15
84A	MYTI EDU	SB	D.wt				1.389	1.860	2.380	2.100	0.960	1.191		1.818	2.105	1.596		1.639	1.288			no	--	1.3	12
87A	MYTI EDU	SB	D.wt				0.968	1.020	1.930	0.770	0.690	0.756		0.872	0.978	0.927		1.150	1.270			no	--	1.5	12
91A	MYTI EDU	SB	D.wt												1.677	1.275	1.818					no	-?	?	11
92A	MYTI EDU	SB	D.wt												1.078	0.544	0.939	0.743	0.691	0.716		no	--	no	11
98A	MYTI EDU	SB	D.wt												1.084	1.087				0.854	1.584	no	-?	?	12
98X	MYTI EDU	SB	D.wt														0.712	0.688	0.781			no	-?	?	6
41A	MYTI EDU	SB	D.wt														1.891	2.947	1.628	1.884		no	-?	?	12
43A	MYTI EDU	SB	D.wt														3.469	4.320		3.855		1.9	-?	?	8
44A	MYTI EDU	SB	D.wt														1.691	2.741	1.954	1.506		no	-?	?	12
46A	MYTI EDU	SB	D.wt														2.696	2.058	2.718			1.4	-?	?	10
48A	MYTI EDU	SB	D.wt														1.352	1.305	1.381			no	-?	?	<=5
10A	MYTI EDU	SB	D.wt														1.737	1.710	2.342	1.058	2.321	1.2	-?	?	13
11A	MYTI EDU	SB	D.wt														1.308	1.281	1.074	1.587		no	-?	?	9
30B	GADU MOR	LI	W.wt				0.010	0.050	0.062	0.071	0.022	0.027	0.035	0.027	0.100	0.064	0.063	0.049	0.045	0.045	0.107	1.1	--	2.6	17
36B	GADU MOR	LI	W.wt	0.078	0.060	0.220	0.070	0.050	0.137	0.061	0.031	0.028	0.023	0.010	0.021	0.034	0.021	0.042	0.033	0.074	0.036	no	D-	1.9	16
15B	GADU MOR	LI	W.wt										0.026	0.009	0.025	0.016	0.014	0.016	0.024	0.031	0.030	no	--	1.2	14
53B	GADU MOR	LI	W.wt						0.658		0.058	0.093	0.045	0.149	0.215	0.038		0.007	0.180	0.143	0.228	2.3	--	81.4	>25
67B	GADU MOR	LI	W.wt							0.145	0.052	0.047	0.069	0.077	0.051	0.115	0.099	0.033	0.111	0.277	0.018	no	--	2.1	22
23B	GADU MOR	LI	W.wt										0.022	0.024	0.020	0.025	0.015	0.026	0.014	0.029	0.025	no	--	no	11
84B	GADU MOR	LI	W.wt				0.130	0.095	0.069		0.029											no	D?	?	6
92B	GADU MOR	LI	W.wt													0.036	0.029	0.022	0.066			no	-?	?	16
98B	GADU MOR	LI	W.wt												0.069	0.150	0.025	0.113	0.330	0.064	0.047	no	--	6.3	24
43B	GADU MOR	LI	W.wt														0.168	0.183	0.097			no	-?	?	12
10B	GADU MOR	LI	W.wt														0.230	0.188	0.095	0.128	0.119	1.2	-?	?	11
67B	LEPI WHI	LI	W.wt			0.181				0.180	0.109	0.066	0.197	0.085	0.100	0.120	0.304	0.259	0.200	0.097	0.033	?	--	?	16
36F	LIMA LIM	LI	W.wt										0.106	0.112	0.230	0.295	0.135	0.147	0.139	0.123	0.202	no	--	1.1	13
15F	LIMA LIM	LI	W.wt													0.099	0.136	0.125	0.153	0.076	0.181	no	--	1.4	13
22F	LIMA LIM	LI	W.wt										0.095	0.091	0.128		0.169	0.125				no	-?	?	9
98F	LIMA LIM	LI	W.wt														0.980	0.182	0.225			no	-?	?	21
33B	PLAT FLE	LI	W.wt			0.190		0.195	0.176	0.251	0.061	0.106	0.234	0.196	0.160	0.184	0.087	0.091	0.110	0.107	0.108	no	--	no	14
53B	PLAT FLE	LI	W.wt								2.236	1.527	1.537	1.724	1.790	0.789		0.135	2.530	0.892	1.470	4.9	--	46.8	23

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of Cu (ppm).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt				4.57		7.45	4.96	5.48	5.97	10.26	10.47	5.84	6.67	8.56	6.94	7.69	9.47	7.72	no	--	1.5	11
31A	MYTI EDU	SB	D.wt			7.03	6.57			4.44	4.52	4.51	9.04	11.00	5.49	5.67	6.21	7.26	6.61	6.08	8.08	no	--	1.4	11
35A	MYTI EDU	SB	D.wt			6.32	3.62		8.06	4.89	4.58	5.26	8.02	10.06	6.56	6.34	6.61	6.41	6.94	6.81	7.23	no	--	1.3	11
36A	MYTI EDU	SB	D.wt			6.29	3.57		6.08	4.47	4.87	4.30	5.50	9.23	5.16	5.51	5.63	7.67	9.06	6.86	6.83	no	--	1.4	11
71A	MYTI EDU	SB	D.wt			8.47	5.24			6.08	8.43	6.99	8.33	10.26	7.40	7.88	7.18	8.11	7.66	9.44	7.50	no	--	1.2	9
76A	MYTI EDU	SB	D.wt										8.51	10.80	5.65	5.57			6.65	7.80	9.14	no	--	1.7	10
15A	MYTI EDU	SB	D.wt										5.72	7.21		5.50	5.25	5.26	7.32	6.14	7.62	no	--	1.3	8
51A	MYTI EDU	SB	D.wt							7.14	6.14							10.20	10.20	7.44		no	-?	?	9
52A	MYTI EDU	SB	D.wt									8.40	7.49	72.08	9.35	8.45	6.98	7.03	6.28	7.73	6.47	no	--	3.2	21
56A	MYTI EDU	SB	D.wt							8.07	7.87	8.82	5.37	7.54	7.40	9.15	6.36	7.71	6.59	7.79	7.18	no	--	1.0	8
57A	MYTI EDU	SB	D.wt							8.21	6.33	6.01	6.16	7.27	6.59	6.77	6.43	5.62	5.54	6.98	6.91	no	--	no	7
63A	MYTI EDU	SB	D.wt							9.84	6.16	5.11	6.84	11.07	6.32	6.11	6.71	6.84	6.56	6.12	5.61	no	--	no	11
65A	MYTI EDU	SB	D.wt							7.98	4.94	5.19	12.23	8.14	5.51	6.00	5.12	5.66	5.82	5.59	5.14	no	--	no	11
69A	MYTI EDU	SB	D.wt												6.19	5.32	5.41	6.26	7.28	5.56	5.22	no	--	no	8
22A	MYTI EDU	SB	D.wt										6.35	6.69	5.38	5.76	6.28	6.81	9.29	4.16	8.56	no	--	1.4	11
82A	MYTI EDU	SB	D.wt				6.38			4.69	5.77	7.49		11.77	6.87	9.61		7.44	7.93			no	--	1.2	10
84A	MYTI EDU	SB	D.wt				10.27		96.80	56.80	39.30	26.76		17.07	22.24	23.99		9.51	7.21			no	--	1.7	20
87A	MYTI EDU	SB	D.wt				4.57			20.10	8.35	5.88		7.28	6.30	6.88		7.63	7.52			no	--	2.3	15
91A	MYTI EDU	SB	D.wt												6.59	6.36	8.36					no	-?	?	7
92A	MYTI EDU	SB	D.wt												6.65	6.03	7.56	6.26	7.48	6.40		no	--	no	7
98A	MYTI EDU	SB	D.wt												8.86	6.57				5.50	5.34	no	-?	?	7
98X	MYTI EDU	SB	D.wt														8.99	8.91	7.74			no	-?	?	<=5
41A	MYTI EDU	SB	D.wt														6.83	8.16	7.64	4.76		no	-?	?	10
43A	MYTI EDU	SB	D.wt														7.79	9.32		6.32		no	-?	?	9
44A	MYTI EDU	SB	D.wt														6.56	9.56	7.78	6.86		no	-?	?	10
46A	MYTI EDU	SB	D.wt														6.63	7.43	8.00			no	-?	?	<=5
48A	MYTI EDU	SB	D.wt														6.57	7.74	7.10			no	-?	?	7
10A	MYTI EDU	SB	D.wt														7.25	10.85	7.84	5.71	7.90	no	-?	?	11
11A	MYTI EDU	SB	D.wt														9.93	9.74	11.61	8.35		no	-?	?	8
30B	GADU MOR	LI	W.wt						7.00	28.00	5.12	4.21	4.52	3.74	8.54	6.80	8.10	5.10	5.11	7.01	9.33	no	--	1.3	16
36B	GADU MOR	LI	W.wt						14.20	20.00	6.98	12.18	10.70	8.74	9.65	7.43	10.70	8.00	9.82	13.50	10.30	no	--	1.2	11
15B	GADU MOR	LI	W.wt										11.30	1.63	5.83	2.28	1.70	3.64	8.95	5.93	5.50	no	--	3.1	20
53B	GADU MOR	LI	W.wt						12.27		7.11	5.86	2.40	3.29	4.68	6.01		5.40	6.34	8.15	15.05	no	UY	2.2	12
67B	GADU MOR	LI	W.wt							8.00	6.91	13.90	8.94	8.76	5.15	7.98	9.66	4.50	7.17	18.90	10.25	no	--	2.2	14
23B	GADU MOR	LI	W.wt										8.15	11.10	5.83	7.06	7.10	10.00	8.75	9.09	7.39	no	--	no	10
92B	GADU MOR	LI	W.wt													7.78	6.08	7.40	6.98			no	-?	?	7
98B	GADU MOR	LI	W.wt												5.87	8.20	3.80	2.35	6.17	3.94	5.94	no	--	no	15
43B	GADU MOR	LI	W.wt														6.00	5.60	5.41			no	-?	?	<=5
10B	GADU MOR	LI	W.wt														9.90	7.80	4.31	5.30	4.31	no	-?	?	10
67B	LEPI WHI	LI	W.wt							15.30	14.19	18.63	10.70	13.80	13.00	12.40	14.20	20.00	19.50	13.40	9.41	?	--	?	10
36F	LIMA LIM	LI	W.wt										13.40	5.29	8.49	8.09	7.30	8.90	7.06	9.56	7.57	no	--	1.5	11
15F	LIMA LIM	LI	W.wt											2.77		4.11	3.00	5.90	9.12	1.91	9.01	no	--	3.7	19
22F	LIMA LIM	LI	W.wt										9.83	6.66	3.38		2.20	3.46				no	-?	?	14
98F	LIMA LIM	LI	W.wt														3.51	5.00	5.65			no	-?	?	6
33B	PLAT FLE	LI	W.wt						21.74	34.98	16.26	34.32	20.30	18.80	15.70	18.10	18.40	13.20	13.60	15.40	14.90	no	--	no	11
53B	PLAT FLE	LI	W.wt								13.99	9.02	8.19	18.90	10.50	17.20		8.28	14.50	8.40	18.60	no	--	1.2	14

SB Soft body tissue.
LI Liver tissue.
OC Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3 Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of Hg (ppm).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt				0.118	0.073	0.147	0.050	0.130	0.044	0.064	0.053	0.051	0.070	0.086	0.057	0.070	0.060	0.078	no	--	no	13
31A	MYTI EDU	SB	D.wt			0.076	0.164	0.086	0.120	0.050	0.090	0.022	0.060	0.048	0.051	0.045	0.050	0.062	0.043	0.052	0.070	no	--	no	14
35A	MYTI EDU	SB	D.wt			0.093	0.074	0.084	0.170	0.050	0.180	0.050	0.062	0.058	0.058	0.054	0.061	0.037	0.038	0.035	0.067	no	--	no	14
36A	MYTI EDU	SB	D.wt			0.052	0.043	0.084	0.140	0.050	0.140	0.034	0.045	0.048	0.039	0.032	0.048	0.033	0.044	0.074	0.030	no	--	no	15
71A	MYTI EDU	SB	D.wt			0.393	0.242	0.218	0.247	0.120	0.340	0.249	0.182	0.145	0.178	0.140	0.212	0.201	0.222	0.312	0.110	no	--	1.5	13
76A	MYTI EDU	SB	D.wt										0.071	0.068	0.050	0.020			0.057	0.082	0.063	no	--	1.4	15
15A	MYTI EDU	SB	D.wt										0.056	0.052		0.024	0.050	0.022	0.049	0.056	0.053	no	--	no	14
51A	MYTI EDU	SB	D.wt							0.240	0.250							1.510	0.901	0.175	0.577	2.9	--	7.6	22
52A	MYTI EDU	SB	D.wt									2.352	0.321	3.008	0.976	0.372	0.282	0.437	0.178	0.260	0.258	1.3	--	4.7	21
56A	MYTI EDU	SB	D.wt							0.530	0.370	1.087	0.710	1.540	0.935	1.223	0.352	0.679	0.365	0.526	0.282	1.4	--	2.5	15
57A	MYTI EDU	SB	D.wt							0.170	0.210	0.269	0.411	0.758	0.576	0.349	0.350	0.260	0.155	0.319	0.166	no	DY	1.2	12
63A	MYTI EDU	SB	D.wt							0.310	0.140	0.177	0.394	0.468	0.294	0.143	0.190	0.252	0.172	0.203	0.226	1.1	--	2.7	14
65A	MYTI EDU	SB	D.wt							0.100	0.150	0.104	0.313	0.328	0.124	0.119	0.134	0.148	0.118	0.136	0.079	no	--	no	14
69A	MYTI EDU	SB	D.wt												0.106	0.026	0.083	0.070	0.104	0.111	0.077	no	--	2.6	17
22A	MYTI EDU	SB	D.wt										0.053	0.073	0.112	0.048	0.067	0.066	0.072	0.068	0.046	no	--	no	12
82A	MYTI EDU	SB	D.wt				0.051	0.110	0.170	0.080	0.120	0.067		0.074	0.052	0.079		0.049	0.069			no	--	no	13
84A	MYTI EDU	SB	D.wt				0.077	0.112	0.150	0.080	0.240	0.057		0.066	0.090	0.057		0.054	0.043			no	--	no	15
87A	MYTI EDU	SB	D.wt				0.178		0.150	0.050	0.260	0.046		0.056	0.054	0.049		0.044	0.062			no	--	no	17
91A	MYTI EDU	SB	D.wt												0.054	0.076	0.094					no	-?	?	<=5
92A	MYTI EDU	SB	D.wt												0.055	0.033	0.052	0.041	0.023	0.067		no	--	1.5	14
98A	MYTI EDU	SB	D.wt												0.086	0.086				0.104	0.155	no	-?	?	9
98X	MYTI EDU	SB	D.wt														0.335	0.340	0.328			1.6	-?	?	<=5
41A	MYTI EDU	SB	D.wt														0.069	0.063	0.064	0.085		no	-?	?	8
43A	MYTI EDU	SB	D.wt														0.084	0.095		0.104		no	-?	?	<=5
44A	MYTI EDU	SB	D.wt														0.055	0.050	0.052	0.059		no	-?	?	6
46A	MYTI EDU	SB	D.wt														0.039	0.062	0.056			no	-?	?	10
48A	MYTI EDU	SB	D.wt														0.073	0.060	0.052			no	-?	?	<=5
10A	MYTI EDU	SB	D.wt														0.053	0.049	0.059	0.062	0.058	no	-?	?	6
11A	MYTI EDU	SB	D.wt														0.182	0.145	0.086	0.146		no	-?	?	13

SB	Soft body tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of H G (ppm).

St. Species Tissue Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																			OC	TRND	U95+3	POWER
30B GADU MOR(s) MU W.wt				0.125	0.089	0.079	0.040	0.059	0.121	0.120	0.090	0.110	0.122	0.102	0.080	0.108	0.131	0.117	1.2	--L	2.4	11
30B GADU MOR(l) MU W.wt				0.155	0.090	0.073	0.038	0.147	0.166	0.130	0.108	0.150	0.155	0.129	0.119	0.142	0.190	0.232	2.3	--L	6.5	14
36B GADU MOR(s) MU W.wt	0.069	0.080	0.110	0.075	0.080	0.061	0.032	0.053	0.068	0.060	0.060	0.059	0.067	0.053	0.076	0.066	0.088	0.078	no	--L	1.6	10
36B GADU MOR(l) MU W.wt	0.079	0.160	0.180	0.195	0.120	0.112	0.039	0.083	0.074	0.115	0.100	0.080	0.083	0.060	0.095	0.069	0.157	0.088	no	--L	2.8	13
15B GADU MOR(s) MU W.wt										0.065	0.040	0.026	0.018	0.045	0.043	0.058	0.076	0.043	no	--L	2.1	14
15B GADU MOR(l) MU W.wt										0.120	0.070	0.063	0.039	0.081	0.045	0.087	0.108	0.090	no	--L	3.1	12
53B GADU MOR(s) MU W.wt						0.223		0.105	0.160	0.184	0.204	0.360	0.090		0.053	0.229	0.128	0.151	1.5	---	5.5	18
53B GADU MOR(l) MU W.wt						0.196		0.105	0.203	0.170	0.269	0.396	0.141		0.090	0.277	0.243	0.298	3.0	---	10.8	16
67B GADU MOR(s) MU W.wt							0.100	0.085	0.090	0.079	0.100	0.085	0.092	0.120	0.071	0.073	0.117	0.050	no	---	no	11
67B GADU MOR(l) MU W.wt							0.170	0.085	0.102	0.255	0.130	0.141	0.083	0.106	0.072	0.089	0.160	0.068	no	---	2.1	14
23B GADU MOR(s) MU W.wt										0.065	0.070	0.060	0.041	0.051	0.069	0.059	0.073	0.075	no	--L	1.4	8
23B GADU MOR(l) MU W.wt										0.170	0.110	0.084	0.098	0.073	0.109	0.057	0.105	0.116	1.2	--L	2.2	11
84B GADU MOR(s) MU W.wt				0.035	0.040	0.025		0.044											no	-?-	?	12
84B GADU MOR(l) MU W.wt				0.060	0.040	0.025		0.044											no	-?-	?	14
92B GADU MOR(s) MU W.wt													0.046	0.078	0.079	0.077			no	-?-	?	10
92B GADU MOR(l) MU W.wt													0.058	0.091	0.074	0.117			1.2	-?-	?	10
98B GADU MOR(s) MU W.wt												0.066	0.054	0.069	0.068	0.039	0.095	0.066	no	---	1.6	12
98B GADU MOR(l) MU W.wt												0.065	0.064	0.069	0.086	0.037	0.128	0.089	no	---	3.2	14
43B GADU MOR(s) MU W.wt														0.065	0.054	0.047			no	-?-	?	<=5
43B GADU MOR(l) MU W.wt														0.050	0.059	0.057			no	-?-	?	6
10B GADU MOR(s) MU W.wt														0.044	0.034	0.028	0.011	0.013	no	D?-	?	11
10B GADU MOR(l) MU W.wt														0.055	0.052	0.039	0.020	0.019	no	D?-	?	9
67B LEPI WHI(s) MU W.wt			0.235				0.350	0.329	0.210	0.343	0.075	0.174	0.187	0.305	0.364	0.398	0.172	0.066	?	--L	?	16
67B LEPI WHI(l) MU W.wt			0.499				0.350	0.329	0.320	0.589	0.147	0.327	0.336	0.422	0.341	0.372	0.331	0.275	?	--L	?	13
36F LIMA LIM(s) MU W.wt										0.045	0.071	0.066	0.070	0.049	0.054	0.049	0.031	0.061	no	--L	no	11
36F LIMA LIM(l) MU W.wt										0.098	0.074	0.133	0.101	0.076	0.100	0.066	0.091	0.091	no	--L	1.4	10
15F LIMA LIM(s) MU W.wt											0.090		0.038	0.037	0.024	0.037	0.047	0.042	no	---	1.1	12
15F LIMA LIM(l) MU W.wt											0.150		0.034	0.036	0.056	0.108	0.073	0.088	no	---	6.6	18
22F LIMA LIM(s) MU W.wt										0.084	0.040	0.207		0.045	0.063				no	-?-	?	20
22F LIMA LIM(l) MU W.wt										0.174	0.152	0.282		0.223	0.372				3.7	-?-	?	11
33B PLAT FLE(s) MU W.wt			0.110		0.090	0.077	0.021	0.069		0.175	0.088	0.116	0.092	0.069	0.053	0.048	0.076	0.038	no	---	no	16
33B PLAT FLE(l) MU W.wt			0.139		0.100	0.077	0.021	0.069		0.195	0.135	0.196	0.103	0.088	0.049	0.060	0.087	0.070	no	---	1.8	16
53B PLAT FLE(s) MU W.wt								0.111	0.074	0.139	0.154	0.141	0.071		0.035	0.165	0.130	0.165	1.7	---	8.1	16
53B PLAT FLE(l) MU W.wt								0.111	0.128	0.090	0.124	0.100	0.116		0.036	0.208	0.221	0.257	2.6	---	17.8	16

(s)	Small fish
(l)	Large fish
MU	Muscle tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of P b (ppm).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt										1.859	1.361	3.952	2.270	2.543	1.579	2.120	2.692	36.726	12.2	--	94.5	21
31A	MYTI EDU	SB	D.wt										1.383	1.212	1.264	1.027	1.370	1.679	1.789	0.732	1.539	no	--	no	12
35A	MYTI EDU	SB	D.wt										1.437	1.071	1.676	1.198	1.284	0.507	0.628	0.664	0.759	no	--	no	12
36A	MYTI EDU	SB	D.wt										1.009	0.847	0.787	1.123	1.394	1.238	2.044	2.174	1.571	no	U-	1.4	10
71A	MYTI EDU	SB	D.wt										1.161	0.745	1.716	1.421	1.923	1.494	2.209	2.830	0.867	no	--	1.0	14
76A	MYTI EDU	SB	D.wt										1.773	0.968	1.505	0.913			0.796	1.839	1.229	no	--	1.2	13
15A	MYTI EDU	SB	D.wt										1.457	0.777		0.976	1.053	0.522	0.671	1.117	1.276	no	--	1.0	12
51A	MYTI EDU	SB	D.wt															148.980	60.274	17.178	29.563	9.9	-?	?	18
52A	MYTI EDU	SB	D.wt										12.073	312.500	189.430	65.504	16.354	17.532	9.843	20.600	14.652	4.9	--	35.1	>25
56A	MYTI EDU	SB	D.wt										20.738	23.413	121.500	109.380	24.691	46.418	27.784	37.500	15.672	5.2	--	15.1	19
57A	MYTI EDU	SB	D.wt										10.548	12.137	33.258	19.194	15.071	13.195	5.596	13.707	6.146	2.0	--	3.7	16
63A	MYTI EDU	SB	D.wt										12.137	10.093	15.430	10.938	7.215	12.086	7.600	6.098	6.387	2.1	--	2.5	11
65A	MYTI EDU	SB	D.wt										5.605	3.784	5.190	6.533	3.277	4.725	2.412	3.000	1.768	no	D-	no	11
69A	MYTI EDU	SB	D.wt												4.619	3.421	2.800	3.166	4.024	3.660	1.981	no	--	1.4	11
22A	MYTI EDU	SB	D.wt										1.371	1.456	2.778	1.867	1.390	1.183	1.506	1.367	1.207	no	--	no	11
82A	MYTI EDU	SB	D.wt											1.278	0.933	0.916		0.622	0.674			no	D?	?	7
84A	MYTI EDU	SB	D.wt											1.010	1.152	1.383		1.378	0.833			no	-?	?	11
87A	MYTI EDU	SB	D.wt											0.974	0.870	0.634		1.402	2.468			no	-?	?	14
91A	MYTI EDU	SB	D.wt												0.898	1.465	2.013					no	-?	?	6
92A	MYTI EDU	SB	D.wt												0.933	0.628	1.094	0.664	0.654	2.183		no	--	11.5	16
98A	MYTI EDU	SB	D.wt												1.868	1.848				1.544	2.360	no	-?	?	10
98X	MYTI EDU	SB	D.wt														4.341	3.121	4.115			1.4	-?	?	11
41A	MYTI EDU	SB	D.wt														1.287	0.900	0.793	0.651		no	D?	?	6
43A	MYTI EDU	SB	D.wt														1.563	1.509		0.855		no	-?	?	8
44A	MYTI EDU	SB	D.wt														2.813	2.568	1.657	1.154		no	D?	?	7
46A	MYTI EDU	SB	D.wt														1.257	1.570	1.385			no	-?	?	8
48A	MYTI EDU	SB	D.wt														0.682	1.078	0.333			no	-?	?	19
10A	MYTI EDU	SB	D.wt														1.939	2.781	0.735	0.807	2.335	no	-?	?	20
11A	MYTI EDU	SB	D.wt														1.539	1.475	0.336	0.367		no	-?	?	16
30B	GADU MOR	LI	W.wt										0.200	0.115	0.249	0.105	0.120	0.110	0.060	0.100	0.163	1.6	--	3.1	14
36B	GADU MOR	LI	W.wt										0.115	0.050	0.030	0.020	0.030	0.020	0.030	0.040	0.030	no	DY	no	12
15B	GADU MOR	LI	W.wt										0.170	0.060	0.030	0.030	0.030	0.020	0.030	0.040	0.030	no	DY	no	13
53B	GADU MOR	LI	W.wt										0.190	0.260	0.140	0.030		0.020	0.075	0.070	0.105	1.0	--	6.2	19
67B	GADU MOR	LI	W.wt										0.130	0.180	0.030	0.075	0.090	0.040	0.040	0.090	0.030	no	--	1.2	19
23B	GADU MOR	LI	W.wt										0.060	0.080	0.030	0.030	0.030	0.020	0.030	0.040	0.030	no	--	no	12
92B	GADU MOR	LI	W.wt													0.020	0.030	0.030	0.040			no	-?	?	7
98B	GADU MOR	LI	W.wt												0.030	0.030	0.030	0.040	0.040	0.050	0.030	no	--	no	9
10B	GADU MOR	LI	W.wt														0.030	0.020	0.040	0.040	0.040	no	-?	?	11
67B	LEPI WHI	LI	W.wt										0.190	0.070	0.060	0.070	0.040	0.070	0.030	0.040	0.040	?	D-	?	13
36F	LIMA LIM	LI	W.wt										0.600	0.070	0.040	0.070	0.030	0.020	0.030	0.050	0.050	no	D-	no	19
15F	LIMA LIM	LI	W.wt											0.070		0.041	0.030	0.020	0.030	0.050	0.040	no	--	no	13
22F	LIMA LIM	LI	W.wt										0.250	0.160	0.042		0.060	0.070				no	-?	?	18
98F	LIMA LIM	LI	W.wt														0.020	0.040	0.030			no	-?	?	14
33B	PLAT FLE	LI	W.wt										0.240	0.350	0.060	0.030	0.030	0.020	0.030	0.040	0.040	no	DY	no	16
53B	PLAT FLE	LI	W.wt										0.710	0.810	0.410	0.230		0.024	0.460	0.350	0.520	1.7	--	32.7	25

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of Zn (ppm).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt				137.80	90.50	140.30	120.00	93.10	76.19	160.90	115.98	147.14	104.32	117.30	108.77	114.00	126.20	173.21	no	--	1.5	10
31A	MYTI EDU	SB	D.wt			88.14	132.41	76.90	106.00	66.30	67.70	58.05	180.84	127.88	124.87	96.43	96.80	151.20	103.21	127.64	119.58	no	--	1.2	12
35A	MYTI EDU	SB	D.wt			91.89	79.63	75.90	89.80	68.40	81.50	83.19	166.05	139.18	131.29	118.54	97.56	82.88	94.26	103.48	112.03	no	UY	no	9
36A	MYTI EDU	SB	D.wt			66.50	85.78	66.10	57.70	61.50	73.60	65.27	125.69	126.98	104.33	83.96	121.15	115.35	137.02	144.63	104.76	no	U-	1.0	9
71A	MYTI EDU	SB	D.wt			123.61	125.00	77.04	114.93	101.00	169.00	128.18	161.81	143.03	165.68	120.22	157.05	150.00	122.16	192.45	114.12	no	--	1.0	10
76A	MYTI EDU	SB	D.wt										158.16	127.27	124.35	57.65			112.44	134.71	136.57	no	--	1.7	12
15A	MYTI EDU	SB	D.wt										156.56	143.70		71.43	88.95	62.61	231.71	106.94	127.03	no	--	2.8	15
51A	MYTI EDU	SB	D.wt							378.00	253.00							385.71	222.52	119.63		no	-?	?	15
52A	MYTI EDU	SB	D.wt									824.00	271.74	452.50	408.13	217.83	141.15	196.20	182.81	247.33	160.10	no	D-	2.0	13
56A	MYTI EDU	SB	D.wt							869.00	410.31	1174.60	571.61	478.57	417.59	388.12	210.91	289.55	246.11	376.79	143.28	no	D-	1.7	14
57A	MYTI EDU	SB	D.wt							378.00	263.00	440.56	519.86	291.60	256.06	146.83	172.86	181.66	114.62	223.42	121.47	no	D-	1.2	12
63A	MYTI EDU	SB	D.wt							579.00	216.00	241.44	508.66	391.59	207.28	121.86	122.15	188.73	146.67	169.53	129.19	no	--	1.7	14
65A	MYTI EDU	SB	D.wt							191.00	155.89	198.70	424.46	307.76	131.06	138.67	117.51	166.27	147.06	184.00	121.29	no	--	1.5	13
69A	MYTI EDU	SB	D.wt												134.52	101.58	134.86	162.81	160.57	217.65	143.78	no	--	1.8	10
22A	MYTI EDU	SB	D.wt										171.96	162.03	135.00	115.72	98.02	143.94	220.65	109.94	127.84	no	--	1.3	11
82A	MYTI EDU	SB	D.wt				126.55	106.09	131.99	109.00	76.10	129.15		145.24	122.63	111.75		109.09	87.57			no	--	no	9
84A	MYTI EDU	SB	D.wt				118.47	160.00	163.00	133.00	132.00	141.67		184.85	180.45	113.30		121.18	85.84			no	--	no	9
87A	MYTI EDU	SB	D.wt				100.05	92.80	97.70	102.00	105.00	96.64		116.92	114.13	90.24		108.88	97.22			no	--	no	6
91A	MYTI EDU	SB	D.wt												96.15	102.45	116.35					no	-?	?	<=5
92A	MYTI EDU	SB	D.wt												88.72	61.09	90.24	77.48	59.17	97.85		no	--	1.1	10
98A	MYTI EDU	SB	D.wt												117.47	105.14				89.93	81.60	no	D?	?	<=5
98X	MYTI EDU	SB	D.wt														187.15	181.53	146.24			no	-?	?	6
41A	MYTI EDU	SB	D.wt														85.09	89.00	94.77	90.91		no	-?	?	<=5
43A	MYTI EDU	SB	D.wt														98.66	96.60		89.15		no	-?	?	<=5
44A	MYTI EDU	SB	D.wt														67.19	91.26	81.03	78.85		no	-?	?	8
46A	MYTI EDU	SB	D.wt														88.40	112.28	93.33			no	-?	?	9
48A	MYTI EDU	SB	D.wt														74.86	87.01	68.75			no	-?	?	8
10A	MYTI EDU	SB	D.wt														127.27	120.49	94.63	113.58	102.40	no	-?	?	7
11A	MYTI EDU	SB	D.wt														86.71	98.29	76.51	88.26		no	-?	?	7
30B	GADU MOR	LI	W.wt						13.77	67.03	30.26	12.85	16.60	22.60	31.70	23.50	24.80	19.70	20.60	24.90	29.15	no	--	2.7	16
36B	GADU MOR	LI	W.wt						46.35	64.45	35.40	36.35	31.80	19.70	25.85	22.60	24.30	31.10	25.70	47.30	29.90	no	DY	2.5	10
15B	GADU MOR	LI	W.wt										33.80	14.10	20.40	17.00	14.20	21.15	26.40	22.90	33.30	1.1	--	2.9	11
53B	GADU MOR	LI	W.wt						28.98		26.83	27.87	10.90	24.40	30.05	20.40		17.50	29.60	27.20	32.40	1.1	--	2.7	13
67B	GADU MOR	LI	W.wt							26.40	22.26	26.37	27.00	25.70	19.42	29.19	27.44	15.80	30.70	47.30	25.55	no	--	2.5	12
23B	GADU MOR	LI	W.wt										29.00	33.80	24.80	21.20	18.70	25.10	21.90	27.40	27.50	no	--	1.5	8
92B	GADU MOR	LI	W.wt													20.60	17.89	21.60	25.00			no	-?	?	7
98B	GADU MOR	LI	W.wt												19.90	24.00	14.60	13.55	16.20	20.00	14.10	no	--	no	10
43B	GADU MOR	LI	W.wt														17.10	15.10	15.70			no	-?	?	6
10B	GADU MOR	LI	W.wt														29.30	23.40	15.90	23.40	18.80	no	-?	?	10
67B	LEPI WHI	LI	W.wt							80.50	106.39	68.29	85.70	94.10	73.20	78.80	58.70	80.80	83.50	61.00	98.60	?	--	?	9
36F	LIMA LIM	LI	W.wt										39.30	26.60	32.20	27.20	28.40	28.00	31.10	34.70	35.60	no	--	1.1	7
15F	LIMA LIM	LI	W.wt											25.00		29.73	24.72	34.70	34.80	22.10	32.60	no	--	no	10
22F	LIMA LIM	LI	W.wt										41.30	29.00	34.32		27.50	37.02				no	-?	?	9
98F	LIMA LIM	LI	W.wt														23.50	34.80	31.70			no	-?	?	9
33B	PLAT FLE	LI	W.wt						52.71	91.08	54.61	48.31	56.90	47.30	45.10	50.00	49.40	38.00	51.20	43.60	44.70	no	--	1.1	9
53B	PLAT FLE	LI	W.wt								54.38	46.27	43.30	51.40	49.20	51.90		35.79	40.50	27.10	56.70	no	--	1.1	10

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of C B 1 5 3 (ppb).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt								25.29	23.81	30.13	19.53	24.37	10.86	20.87	19.65	26.36	29.01	15.48	3.1	--	9.0	12
31A	MYTI EDU	SB	D.wt								2.86	5.78	6.59	3.66	6.59	3.30	11.23	9.41	10.88	5.03	3.72	no	--	1.6	15
35A	MYTI EDU	SB	D.wt								5.65	6.90	6.11	2.92	5.52	3.03	3.76	3.69	3.07	3.76	4.13	no	--	1.4	11
36A	MYTI EDU	SB	D.wt								3.09	6.81	4.36	2.73	3.54	1.59	1.59	3.62	3.72	4.10	2.90	no	--	2.5	14
71A	MYTI EDU	SB	D.wt								5.13	12.71	5.87	3.03	4.59	3.35	5.45	3.02	7.24	2.78	3.82	no	--	1.7	15
76A	MYTI EDU	SB	D.wt										4.62	2.84	2.49	1.18			4.21	4.00	3.77	no	--	3.8	15
15A	MYTI EDU	SB	D.wt										2.84			0.98	2.00	0.90	0.79	1.27	1.19	no	--	no	14
51A	MYTI EDU	SB	D.wt															10.20	3.49	4.17	3.03	no	-?	?	14
52A	MYTI EDU	SB	D.wt									17.95	3.47		3.77	3.62	5.00	5.32	2.62	4.89	2.73	no	--	1.5	16
56A	MYTI EDU	SB	D.wt								2.80	14.50	5.57	3.97	2.80	2.08	4.00	3.97	3.09	4.34	1.76	no	--	1.3	17
57A	MYTI EDU	SB	D.wt									8.46		3.82	1.44	1.59	2.69	2.04	1.81	2.76	2.88	no	--	1.7	14
63A	MYTI EDU	SB	D.wt									8.84		4.85	1.48	1.23	1.77	1.91	1.40	1.54	2.45	no	D-	1.2	14
65A	MYTI EDU	SB	D.wt								0.10	4.70	4.45	4.31	1.17	0.74	1.69	1.30	1.83	1.24	2.48	no	--	5.8	>25
69A	MYTI EDU	SB	D.wt												1.02	1.58	1.66	1.85	0.93	2.19	3.78	no	--	2.4	14
22A	MYTI EDU	SB	D.wt										2.96	3.05	2.78	1.31	2.33	2.12	1.94	1.61	3.81	no	--	1.5	12
84A	MYTI EDU	SB	D.wt								0.69	9.36		2.53	3.13	1.70		1.43	2.40			no	--	1.9	23
92A	MYTI EDU	SB	D.wt												1.27	0.45	1.82	1.17	0.89	2.39		no	--	4.8	18
98A	MYTI EDU	SB	D.wt												7.96	2.29				3.36	2.73	no	-?	?	18
98X	MYTI EDU	SB	D.wt														27.42	25.29	14.64			2.9	-?	?	9
41A	MYTI EDU	SB	D.wt														0.99	0.84	0.73	0.73		no	-?	?	<=5
43A	MYTI EDU	SB	D.wt														0.97	0.88		0.85		no	-?	?	<=5
44A	MYTI EDU	SB	D.wt															2.83	3.62	9.08		1.8	-?	?	11
46A	MYTI EDU	SB	D.wt														1.68	1.28	0.98			no	D?	?	<=5
48A	MYTI EDU	SB	D.wt														2.38	1.47	1.10			no	-?	?	6
10A	MYTI EDU	SB	D.wt														1.88	1.46	1.85	2.55		no	-?	?	10
11A	MYTI EDU	SB	D.wt														2.44	2.22	1.43	1.84		no	-?	?	10
30B	GADU MOR	LI	W.wt										405.00	955.00	957.39	856.41	885.00	807.00	871.90	1055.32	1200.00	6.0	--	12.0	10
36B	GADU MOR	LI	W.wt										164.86	126.00	147.00	254.00	138.00	642.00	350.00	272.00	260.00	1.3	--	4.4	15
15B	GADU MOR	LI	W.wt										60.00	104.44	99.00	66.50	97.00	117.73	112.00	140.00	110.00	no	--	1.3	10
53B	GADU MOR	LI	W.wt										156.00	193.97	560.74	65.00		61.00	262.44	219.00	985.98	4.9	--	67.3	23
67B	GADU MOR	LI	W.wt										106.00	111.00	105.76	83.50	128.45	85.00	92.00	230.84	80.00	no	--	1.5	14
23B	GADU MOR	LI	W.wt										80.00	103.88	86.00	79.00	48.00	75.00	73.00	52.00	80.05	no	--	no	10
92B	GADU MOR	LI	W.wt													51.00	50.99	102.00	129.00			no	-?	?	9
98B	GADU MOR	LI	W.wt												65.00	72.97	33.00	55.00	80.00	129.45	62.00	no	--	1.9	15
43B	GADU MOR	LI	W.wt														110.00	113.00	50.00			no	-?	?	13
10B	GADU MOR	LI	W.wt														201.00	171.00	66.00	55.00	46.00	no	D?	?	10
30B	GADU MOR	MU	W.wt										1.47	3.70	9.20	3.30	1.23	0.89	2.54	3.71	7.79	?	--	?	21
36B	GADU MOR	MU	W.wt										0.63	0.45	0.70	1.30	0.15	5.42	1.37	1.87	1.30	?	--	?	25
15B	GADU MOR	MU	W.wt										0.52	0.39	0.49	0.20	0.13	0.36	0.43	0.50	0.58	?	--	?	14
53B	GADU MOR	MU	W.wt										3.36	0.97	4.79	0.40		0.12	6.43	1.34	32.25	?	--	?	>25
67B	GADU MOR	MU	W.wt										0.24	0.56	0.40	0.14	0.47	0.19	1.23	2.65	0.26	?	--	?	25
23B	GADU MOR	MU	W.wt										0.26	0.94	0.20	0.20	0.05	0.27	0.16	0.31	0.66	?	--	?	21
92B	GADU MOR	MU	W.wt													0.10	0.06	0.10	0.26			?	-?	?	16
98B	GADU MOR	MU	W.wt												0.20	0.30	0.03	0.08	0.12	0.50	0.13	?	--	?	25
43B	GADU MOR	MU	W.wt														0.14	0.21	0.13			?	-?	?	13
10B	GADU MOR	MU	W.wt														0.55	0.85	0.11	0.20	0.20	?	-?	?	20
67B	LEPI WHI	LI	W.wt										37.00	42.00	61.00	45.00	87.00	79.00	38.80	35.00	49.00	?	--	?	12
67B	LEPI WHI	MU	W.wt										0.27	0.33	0.60	0.10	0.17	0.63	0.17	0.24	0.12	?	--	?	20
36F	LIMA LIM	LI	W.wt										129.48	92.49	138.00	171.00	148.00	161.00	150.80	155.00	89.00	no	--	no	10
15F	LIMA LIM	LI	W.wt											53.00		21.54	28.93	28.00	22.80	25.00	20.00	no	--	no	11
22F	LIMA LIM	LI	W.wt										65.41	48.96	52.44		24.00	29.60				no	D?	?	9
36F	LIMA LIM	MU	W.wt										1.13	2.70	2.30	3.20	2.06	3.22	3.33	1.63	3.10	?	--	?	13
15F	LIMA LIM	MU	W.wt											1.42		0.24	0.12	0.41	0.69	0.48	0.53	?	--	?	22
22F	LIMA LIM	MU	W.wt										0.70	2.00	1.28		0.50	1.66				?	-?	?	19
98F	LIMA LIM	MU	W.wt														0.27	0.44	1.16			?	-?	?	9
33B	PLAT FLE	LI	W.wt										11.00	10.00	30.00	22.00	17.00	17.00	9.40	11.10	8.70	no	--	no	13
53B	PLAT FLE	LI	W.wt										123.00	125.94	80.00	10.00		7.94	37.00	39.00	38.00	no	--	7.2	21
33B	PLAT FLE	MU	W.wt										0.65	1.24	0.50	0.30	0.12	0.22	0.34	0.22	0.20	?	--	?	16
53B	PLAT FLE	MU	W.wt										5.88	8.20	3.40	0.40		0.22	0.93	0.92	0.70	?	--	?	22

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Annual Median Concentrations of DDEPP (ppb).

				1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
St.	Species	Tissue	Base																			OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt												5.24	3.86	7.08	5.70	2.56	5.88	3.87	no	--	no	14
31A	MYTI EDU	SB	D.wt												3.30	1.89	3.45	1.84	0.50	3.37	3.49	no	--	2.0	21
35A	MYTI EDU	SB	D.wt												4.91	2.08	3.13	2.84	0.57	3.91	3.73	no	--	2.2	21
36A	MYTI EDU	SB	D.wt												2.76	1.06	1.03	1.76	0.44	2.11	1.79	no	--	no	19
71A	MYTI EDU	SB	D.wt												2.61	1.58	3.21	1.29	0.74	1.02	2.20	no	--	no	17
76A	MYTI EDU	SB	D.wt												1.40	0.79			0.36	1.21	2.29	no	-?	?	21
15A	MYTI EDU	SB	D.wt													0.98	1.72	0.73	0.29	1.02	1.41	no	--	9.3	19
51A	MYTI EDU	SB	D.wt															33.88	6.67	14.68	17.14	1.7	-?	?	21
52A	MYTI EDU	SB	D.wt												12.26	25.48	19.43	18.48	9.53	13.13	16.67	1.7	--	2.6	13
56A	MYTI EDU	SB	D.wt												50.00	47.53	114.57	40.84	33.89	72.32	52.63	5.3	--	15.0	16
57A	MYTI EDU	SB	D.wt												25.90	18.25	34.97	25.31	15.80	50.00	82.93	8.3	--	39.6	15
63A	MYTI EDU	SB	D.wt												12.94	9.29	9.68	8.36	5.53	13.01	15.53	1.6	--	3.9	12
65A	MYTI EDU	SB	D.wt												7.60	5.19	7.79	4.12	5.00	6.90	11.88	1.2	--	2.8	12
69A	MYTI EDU	SB	D.wt												3.55	3.16	3.54	2.91	0.40	3.69	6.52	no	--	5.1	24
22A	MYTI EDU	SB	D.wt												2.22	1.31	1.88	1.45	0.39	1.37	5.11	no	--	2.6	21
84A	MYTI EDU	SB	D.wt												3.13	2.23		0.99	0.74			no	D?	?	<=5
92A	MYTI EDU	SB	D.wt												0.68	2.09	1.41	0.77	0.28	1.93		no	--	3.8	22
98A	MYTI EDU	SB	D.wt												5.81	2.29				1.59	1.87	no	-?	?	14
98X	MYTI EDU	SB	D.wt														31.65	22.87	5.16			no	-?	?	15
41A	MYTI EDU	SB	D.wt														0.62	0.42	0.29	0.61		no	-?	?	15
44A	MYTI EDU	SB	D.wt															0.49	0.34	1.41		no	-?	?	20
46A	MYTI EDU	SB	D.wt														1.05	0.76	0.27			no	-?	?	11
48A	MYTI EDU	SB	D.wt														1.71	1.13	0.29			no	-?	?	14
10A	MYTI EDU	SB	D.wt														0.85	0.78	0.44	1.49		no	-?	?	18
11A	MYTI EDU	SB	D.wt														1.30	1.88	0.41	1.23		no	-?	?	21
30B	GADU MOR	LI	W.wt										163.00	440.00	182.46	158.97	191.00	194.00	312.50	383.50	260.00	1.3	--	5.8	14
36B	GADU MOR	LI	W.wt										91.90	51.00	50.00	75.00	55.00	105.00	141.00	129.00	45.00	no	--	no	15
15B	GADU MOR	LI	W.wt										50.00	135.99	48.00	56.99	86.00	33.47	75.00	140.00	72.48	no	--	2.1	17
53B	GADU MOR	LI	W.wt										637.00	805.84	939.42	85.00		42.00	491.39	936.00	489.59	2.4	--	115.1	>25
67B	GADU MOR	LI	W.wt										776.00	554.00	347.15	391.80	471.14	109.00	460.00	2057.93	270.00	1.4	--	31.5	23
23B	GADU MOR	LI	W.wt										68.00	85.38	42.00	41.00	35.00	31.00	49.00	33.00	49.00	no	--	no	10
92B	GADU MOR	LI	W.wt													53.00	50.50	50.00	196.00			no	-?	?	17
98B	GADU MOR	LI	W.wt												73.00	83.40	43.00	48.96	138.00	197.96	78.00	no	--	4.1	17
43B	GADU MOR	LI	W.wt														126.00	69.00	60.00			no	-?	?	9
10B	GADU MOR	LI	W.wt														211.00	71.00	75.00	99.00	65.00	no	-?	?	14
67B	LEPI WHI	LI	W.wt										294.00	240.00	183.00	163.00	250.00	145.00	142.60	167.00	160.00	?	--	?	9
36F	LIMA LIM	LI	W.wt										27.98	34.41	28.00	21.00	50.00	40.00	40.00	22.00	18.00	no	--	no	12
15F	LIMA LIM	LI	W.wt											39.00		13.42	23.49	9.00	20.70	20.00	13.00	no	--	no	16
22F	LIMA LIM	LI	W.wt										68.93	47.96	39.95		21.00	9.17				no	D?	?	10
33B	PLAT FLE	LI	W.wt										13.00	9.10	24.00	14.00	13.00	7.00	10.20	9.70	8.60	no	--	no	13
53B	PLAT FLE	LI	W.wt										94.00	70.14	32.00	41.00		8.00	25.00	45.00	38.00	1.3	--	6.4	18

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Annual Median Concentrations of H C H G (ppb).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt										2.05	3.55	1.52	1.62	1.73	1.48	0.65	1.60	1.79	no	--	no	14
31A	MYTI EDU	SB	D.wt										2.04	3.66	2.20	1.42	1.37	0.78	0.66	2.73	1.23	no	--	1.0	16
35A	MYTI EDU	SB	D.wt										2.65	4.09	2.31	1.52	1.61	1.13	0.84	4.51	1.00	no	--	1.3	18
36A	MYTI EDU	SB	D.wt										3.63	5.46	2.76	1.59	0.77	1.25	0.56	2.88	2.00	no	--	2.1	17
71A	MYTI EDU	SB	D.wt										2.08	4.85	1.96	2.11	0.96	0.79	0.48	1.02	1.91	no	--	no	16
76A	MYTI EDU	SB	D.wt										1.59	2.15	1.40	2.35			0.61	1.68	2.40	no	--	1.4	17
15A	MYTI EDU	SB	D.wt										1.68			1.95	1.11	1.06	0.37	1.99	2.32	no	--	2.3	19
51A	MYTI EDU	SB	D.wt															1.73	1.13	1.22	2.29	no	-?	?	13
52A	MYTI EDU	SB	D.wt										1.04		0.94	1.15	1.30	1.27	2.57	1.22	2.20	no	--	1.0	11
56A	MYTI EDU	SB	D.wt										1.75	2.38	0.93	1.04	1.21	1.22	1.74	1.25	2.29	no	--	1.1	12
57A	MYTI EDU	SB	D.wt											2.29	1.44	0.79	0.86	1.01	2.46	1.03	3.56	no	--	3.3	16
63A	MYTI EDU	SB	D.wt											2.91	1.48	0.71	0.98	0.86	1.27	0.78	2.84	no	--	1.8	15
65A	MYTI EDU	SB	D.wt										2.16	2.59	1.27	0.74	1.22	0.65	2.88	1.00	2.92	no	--	2.8	17
69A	MYTI EDU	SB	D.wt												1.60	1.05	0.94	0.65	0.36	1.31	3.10	no	--	3.0	18
22A	MYTI EDU	SB	D.wt										0.80	1.90	1.67	1.33	1.07	1.03	0.58	1.20	2.33	no	--	1.1	15
84A	MYTI EDU	SB	D.wt											1.52	0.63	1.06		0.79	0.52			no	-?	?	13
92A	MYTI EDU	SB	D.wt												0.68	0.84	0.99	0.77	0.41	0.86		no	--	no	13
98A	MYTI EDU	SB	D.wt												0.62	0.57				0.60	1.24	no	-?	?	13
98X	MYTI EDU	SB	D.wt														1.45	0.64	0.42			no	-?	?	8
41A	MYTI EDU	SB	D.wt														0.68	0.53	0.29	0.43		no	-?	?	12
43A	MYTI EDU	SB	D.wt														0.52	0.41		0.45		no	-?	?	8
44A	MYTI EDU	SB	D.wt															0.54	0.29	0.64		no	-?	?	18
46A	MYTI EDU	SB	D.wt														0.44	0.47	0.33			no	-?	?	8
48A	MYTI EDU	SB	D.wt														0.34	0.48	0.33			no	-?	?	12
10A	MYTI EDU	SB	D.wt														0.52	0.54	0.44	0.40		no	-?	?	6
11A	MYTI EDU	SB	D.wt														0.44	0.51	0.34	0.46		no	-?	?	10
30B	GADU MOR	LI	W.wt										3.00	15.00	5.00	5.00	10.00	7.00	10.00	11.00	4.00	no	--	no	18
36B	GADU MOR	LI	W.wt										6.48	14.00	9.00	9.00	17.00	3.00	11.00	6.00	8.10	no	--	no	17
15B	GADU MOR	LI	W.wt										11.00	37.50	7.00	9.00	10.00	6.00	13.00	10.00	8.15	no	--	no	17
53B	GADU MOR	LI	W.wt										12.00	8.49	5.00	6.00		6.00	7.00	8.00	10.00	no	-Y	no	10
67B	GADU MOR	LI	W.wt										12.00	7.00	10.00	7.00	6.32	5.00	10.00	11.00	21.00	no	UY	1.3	11
23B	GADU MOR	LI	W.wt										13.00	5.92	11.00	5.00	8.00	5.00	13.00	8.00	9.40	no	--	no	14
92B	GADU MOR	LI	W.wt													6.00	6.00	4.00	6.00			no	-?	?	10
98B	GADU MOR	LI	W.wt												5.00		8.00	3.00	6.00	3.00	8.00	no	--	no	16
43B	GADU MOR	LI	W.wt														3.00	3.00	4.00			no	-?	?	7
10B	GADU MOR	LI	W.wt														3.00	3.00	4.00	3.00	8.00	no	-?	?	13
67B	LEPI WHI	LI	W.wt										3.00	2.00	5.00	2.00	2.00	1.00	3.70	3.00	4.60	?	--	?	16
36F	LIMA LIM	LI	W.wt										8.94	3.00	5.00	1.00	4.00	3.00	8.00	5.00	2.00	no	--	no	20
15F	LIMA LIM	LI	W.wt											3.00		4.00	3.46	3.00	5.10	5.60	4.10	no	--	no	10
22F	LIMA LIM	LI	W.wt										6.93	3.00	5.00		1.00	1.00				no	D?	?	14
33B	PLAT FLE	LI	W.wt										2.00	0.50	5.00	2.00	2.00	1.00	1.90	1.80	1.10	no	--	no	20
53B	PLAT FLE	LI	W.wt										3.00	2.00	5.00	2.00		1.41	2.00	3.00	2.00	no	--	no	15

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

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Annual Median Concentrations of H C B (ppb).

St.	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	A N A L Y S E S			
																						OC	TRND	U95+3	POWER
30A	MYTI EDU	SB	D.wt				1.18	0.88	2.06	0.92	1.15	0.87	0.35	0.59	0.95	0.54	0.27	0.24	0.25	0.27	0.30	no	D-	no	14
31A	MYTI EDU	SB	D.wt			13.37	1.38	3.83	1.89	0.93	0.89	0.36	0.32	0.61	0.55	0.45	0.24	0.31	0.22	0.26	0.21	no	D-	no	16
35A	MYTI EDU	SB	D.wt			12.83	0.95	3.33	0.79	0.98	1.12	0.47	0.42	0.58	0.58	0.51	0.23	0.28	0.22	0.52	0.20	no	D-	1.6	18
36A	MYTI EDU	SB	D.wt			15.02	0.95	3.83	2.90	2.37	0.96	0.43	0.33	0.55	0.39	0.53	0.24	0.33	0.28	0.31	0.15	no	D-	no	19
71A	MYTI EDU	SB	D.wt			15.25	10.37	91.37	11.11	206.90	1.84	149.17	8.48	6.92	4.14	3.91	1.47	2.13	4.48	2.04	1.78	3.6	--	52.0	>25
76A	MYTI EDU	SB	D.wt										0.38	0.57	0.50	0.79			0.25	0.29	0.40	no	--	2.0	14
15A	MYTI EDU	SB	D.wt										0.20			0.49	0.25	0.22	0.29	0.25	0.16	no	--	no	13
51A	MYTI EDU	SB	D.wt															0.61	0.33	0.31	0.40	no	-?	?	12
52A	MYTI EDU	SB	D.wt									0.85	0.38		0.81	0.81	0.28	0.32	0.26	0.33	0.21	no	--	no	14
56A	MYTI EDU	SB	D.wt								0.20	0.79	0.41	0.79	0.93	1.04	0.31	0.38	0.31	0.44	0.35	no	--	1.4	15
57A	MYTI EDU	SB	D.wt									0.77		0.76	0.72	0.79	0.36	0.30	0.26	0.43	0.58	1.2	--	2.0	12
63A	MYTI EDU	SB	D.wt									1.05		0.97	0.74	0.63	0.32	0.33	0.33	0.41	0.45	no	DY	1.2	9
65A	MYTI EDU	SB	D.wt								0.20	0.43	0.52	0.86	0.62	0.67	0.28	0.30	0.29	0.34	0.38	no	DY	1.2	12
69A	MYTI EDU	SB	D.wt												0.53	0.53	0.29	0.25	0.29	0.50	0.48	no	--	2.4	12
22A	MYTI EDU	SB	D.wt										0.26	0.61	0.56	0.44	0.25	0.25	0.30	0.31	0.17	no	--	no	13
82A	MYTI EDU	SB	D.wt				2.26	10.73	0.66	0.62	0.80	0.53										1.1	--	10.0	24
84A	MYTI EDU	SB	D.wt				3.41	8.79	3.33	2.04	1.23	0.48		0.51	0.63	0.53		0.25	0.21			no	D-	no	15
92A	MYTI EDU	SB	D.wt												0.68	0.42	0.24	0.23	0.23	0.25		no	D-	2.0	12
98A	MYTI EDU	SB	D.wt												0.62	0.57				0.34	0.31	no	D?	?	<=5
98X	MYTI EDU	SB	D.wt														0.56	0.32	0.26			no	-?	?	8
41A	MYTI EDU	SB	D.wt														0.29	0.26	0.29	0.30		no	-?	?	6
43A	MYTI EDU	SB	D.wt														0.32	0.34		0.45		no	-?	?	<=5
44A	MYTI EDU	SB	D.wt															0.27	0.29	0.33		no	-?	?	<=5
46A	MYTI EDU	SB	D.wt														0.26	0.29	0.27			no	-?	?	6
48A	MYTI EDU	SB	D.wt														0.28	0.29	0.24			no	-?	?	7
10A	MYTI EDU	SB	D.wt														0.29	0.27	0.25	0.31		no	-?	?	7
11A	MYTI EDU	SB	D.wt														0.35	0.43	0.34	0.46		no	-?	?	8
30B	GADU MOR	LI	W.wt										10.00	17.00	7.48	16.00	11.00	11.00	12.00	7.00	5.30	no	--	no	12
36B	GADU MOR	LI	W.wt										7.00	9.00	9.00	10.00	9.00	5.00	9.00	6.00	4.40	no	--	no	11
15B	GADU MOR	LI	W.wt										5.00	20.49	10.00	14.00	14.00	9.00	11.00	13.00	11.49	no	--	1.4	14
53B	GADU MOR	LI	W.wt										10.00	10.00	16.49	7.00		5.00	7.00	7.00	5.00	no	--	no	13
67B	GADU MOR	LI	W.wt										14.00	8.00	7.94	8.00	8.49	10.00	8.00	15.49	9.90	no	--	1.2	11
23B	GADU MOR	LI	W.wt										6.00	9.49	12.00	9.00	8.00	6.00	10.00	6.00	8.40	no	--	no	11
92B	GADU MOR	LI	W.wt													17.00	11.00	14.00	13.00			no	-?	?	9
98B	GADU MOR	LI	W.wt												20.00	9.95	12.00	18.00	35.00	20.49	16.00	no	--	3.9	15
43B	GADU MOR	LI	W.wt														15.00	16.49	13.00			no	-?	?	8
10B	GADU MOR	LI	W.wt														13.00	11.00	16.00	17.00	17.00	no	-?	?	8
67B	LEPI WHI	LI	W.wt										9.00	4.00	5.00	4.00	5.00	2.00	4.60	4.00	5.00	?	--	?	13
36F	LIMA LIM	LI	W.wt										5.48	3.00	5.00	2.00	3.00	2.00	2.30	3.00	1.10	no	--	no	14
15F	LIMA LIM	LI	W.wt											4.00		4.00	4.00	2.00	3.00	3.20	3.00	no	--	no	10
22F	LIMA LIM	LI	W.wt										6.00	3.00	5.00		1.00	1.41				no	-?	?	15
33B	PLAT FLE	LI	W.wt										1.00	0.50	5.00	2.00	1.00	1.00	0.60	0.80	0.59	no	--	no	20
53B	PLAT FLE	LI	W.wt										6.00	4.47	5.00	2.00		1.00	2.00	3.00	1.80	no	--	1.0	15

SB	Soft body tissue.
LI	Liver tissue.
OC	Overconcentration; Median(LastYear)/Background (="?" if missing Background)
U95+3	Upper 95% ConfidenceInterval(Last+3years)/Background (="?" if missing Background or N(years)<=5)
POWER	Number of years to detect a 10% trend/year with 90% power.

Appendix I
Geographical distribution of contaminants in biota 1997-1998

Sorted by contaminant and species:

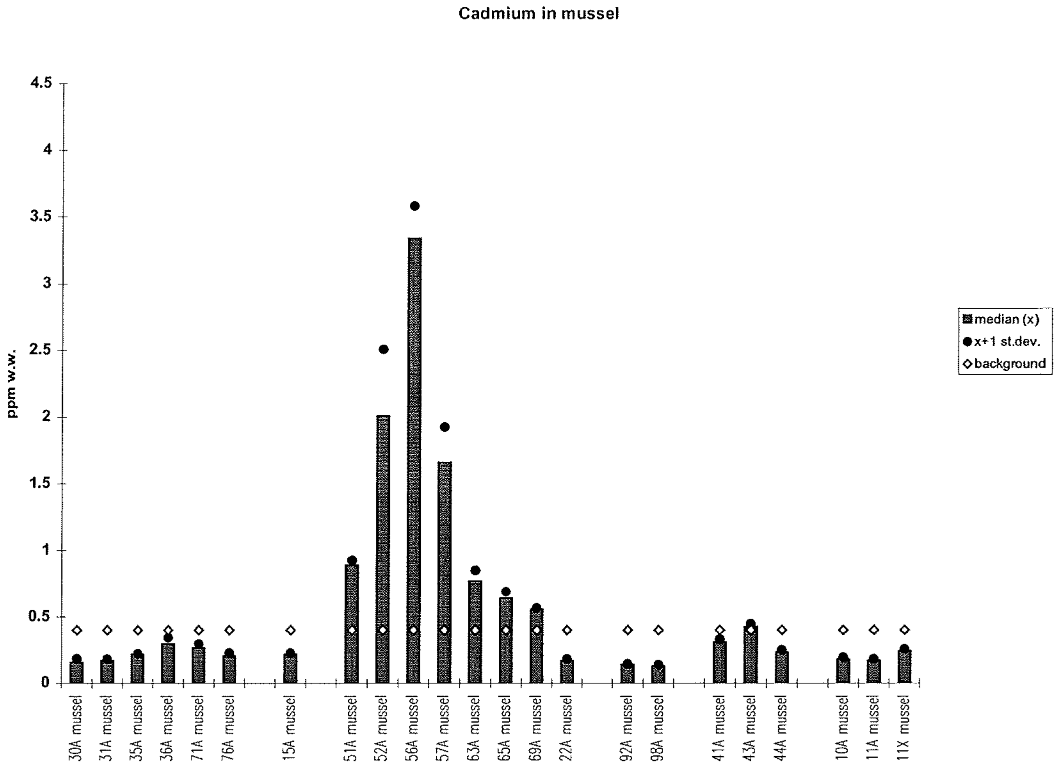
Cadmium (Cd)
Copper (Cu)
Mercury (Hg)
Lead (Pb)
Zinc (Zn)
Sum of 7 CBs (CB-28, -52, 101, -118, -138, -153 and -180)
CB-153
DDEPP (ppDDE)
γ-HCH
HCB

MYTI EDU - Blue Mussel (*Mytilus edulis*)
GADU MOR - Atlantic cod (*Gadus morhua*)
PLAT FLE - Flounder (*Platichthys flesus*)
LIMA LIM - Dab (*Limanda limanda*)
PLEU PLA - Plaice (*Pleuronectes platessa*)
MICR KIT - Lemon sole (*Microstomus kitt*)
LEPI WHI - Megrim (*Lepidorhombus whiff-iagonis*)

Station positions are shown on maps in Appendix F.

Appendix I
Geographical distribution of contaminants in biota 1997-98 (cont.)

A



B

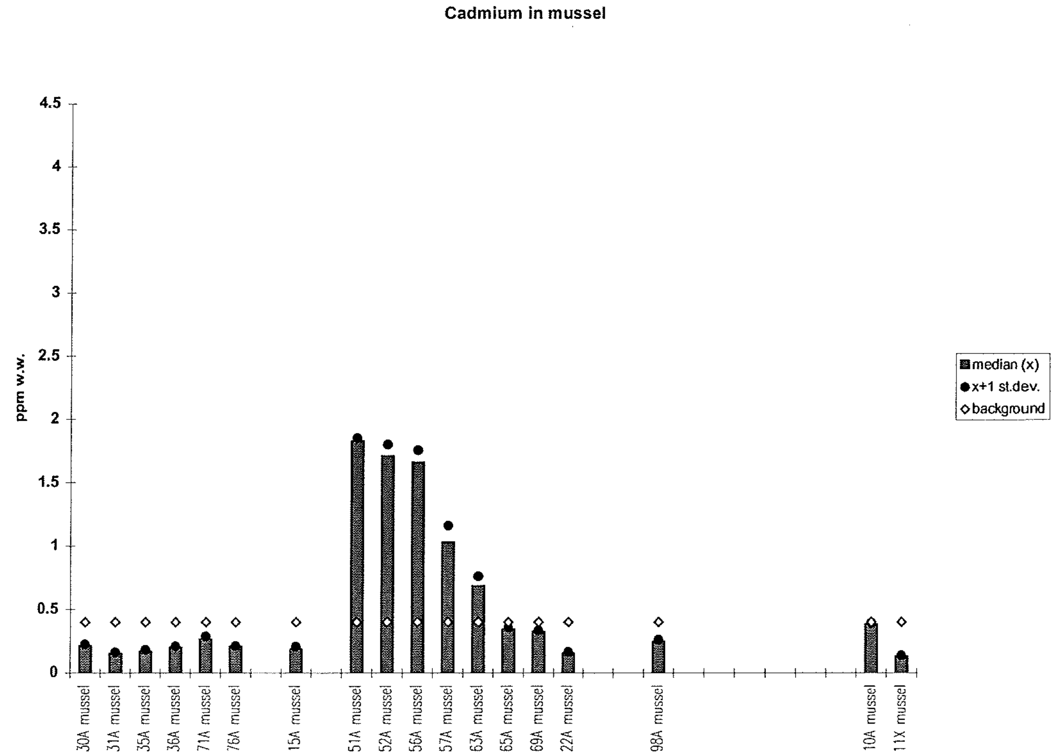


Figure 25. Median, standard deviation and provisional "high background" concentration for cadmium in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

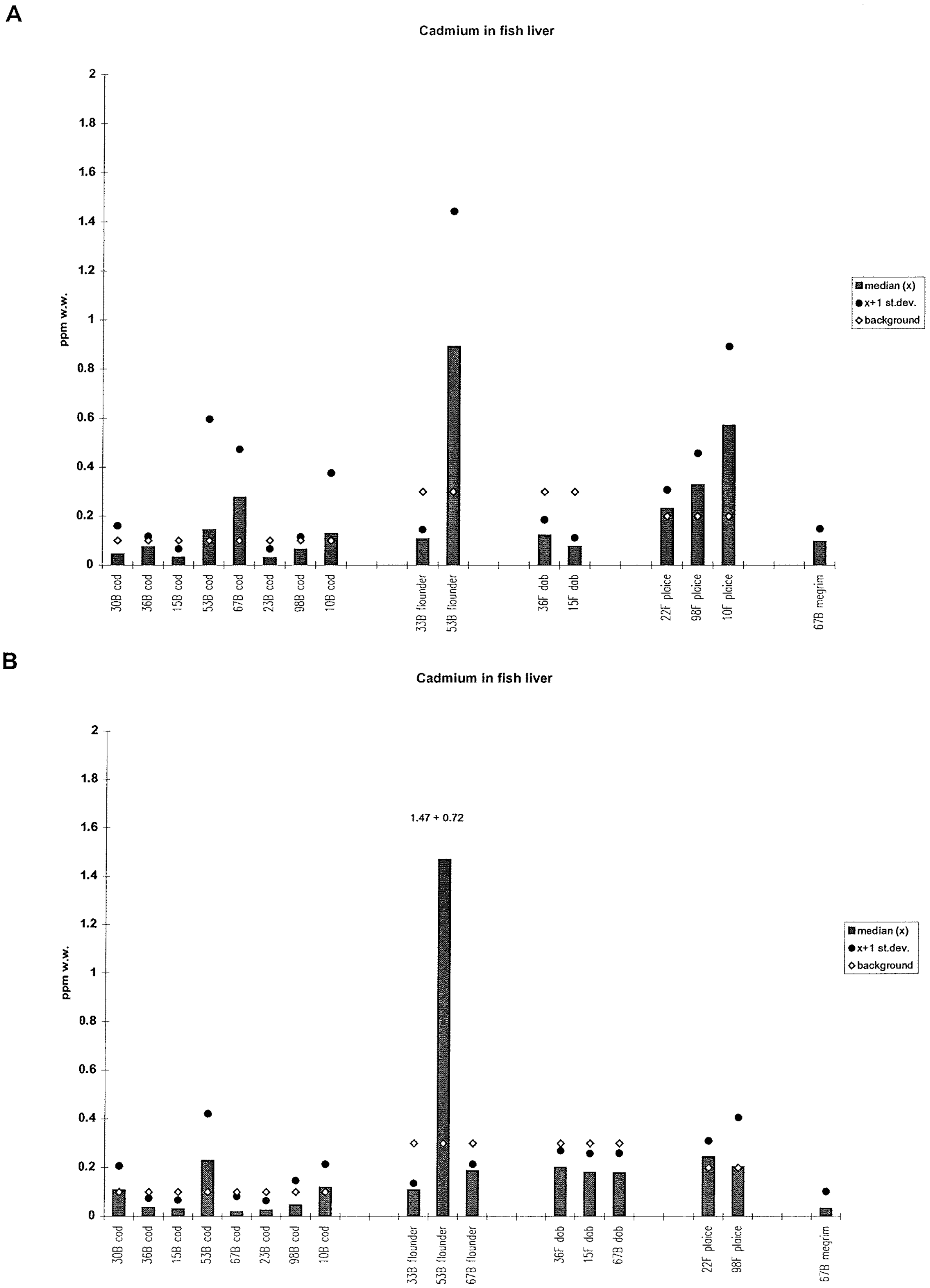


Figure 26. Median, standard deviation and provisional "high background" concentration for cadmium in fish liver 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

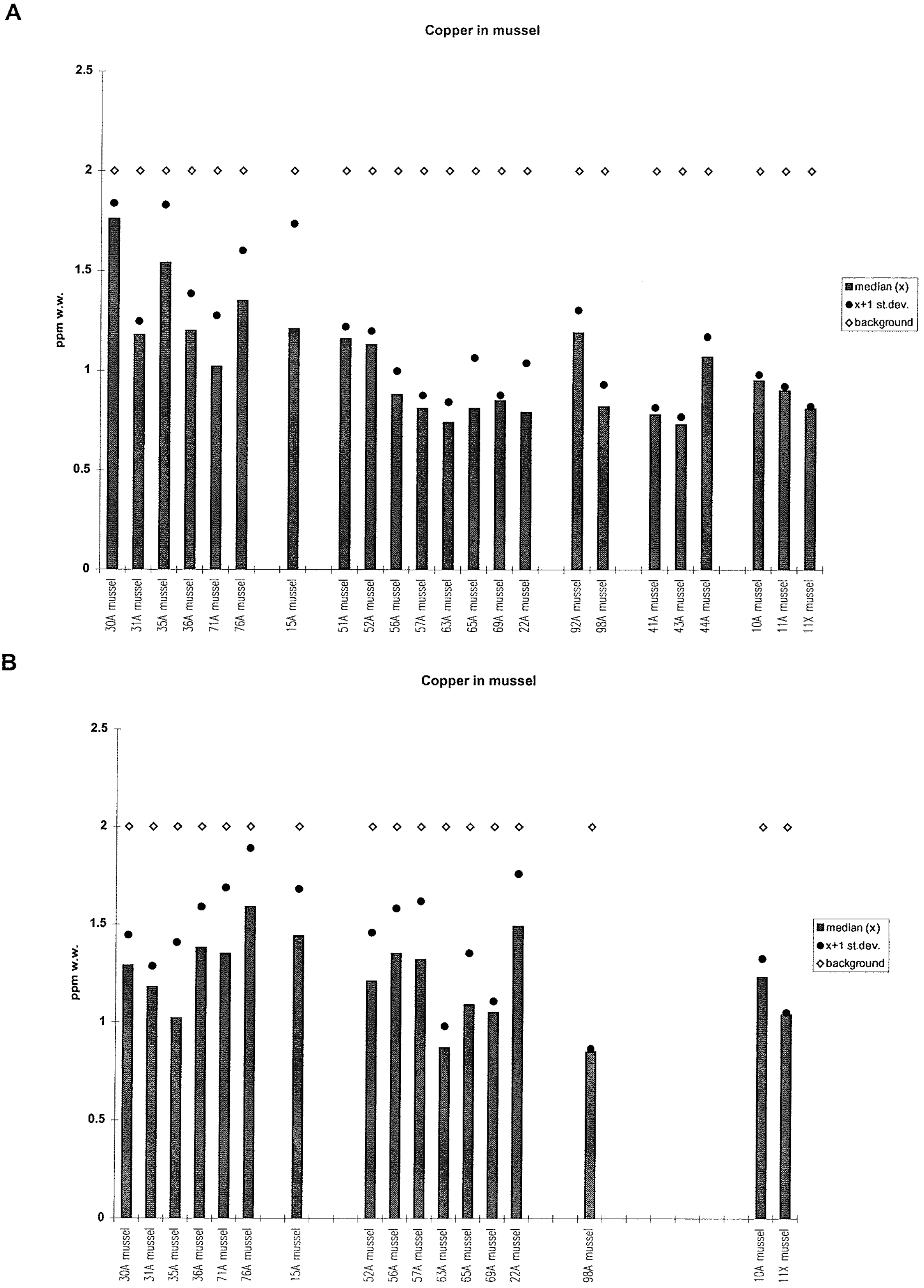


Figure 27. Median standard deviation and provisional "high background" concentration for copper in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

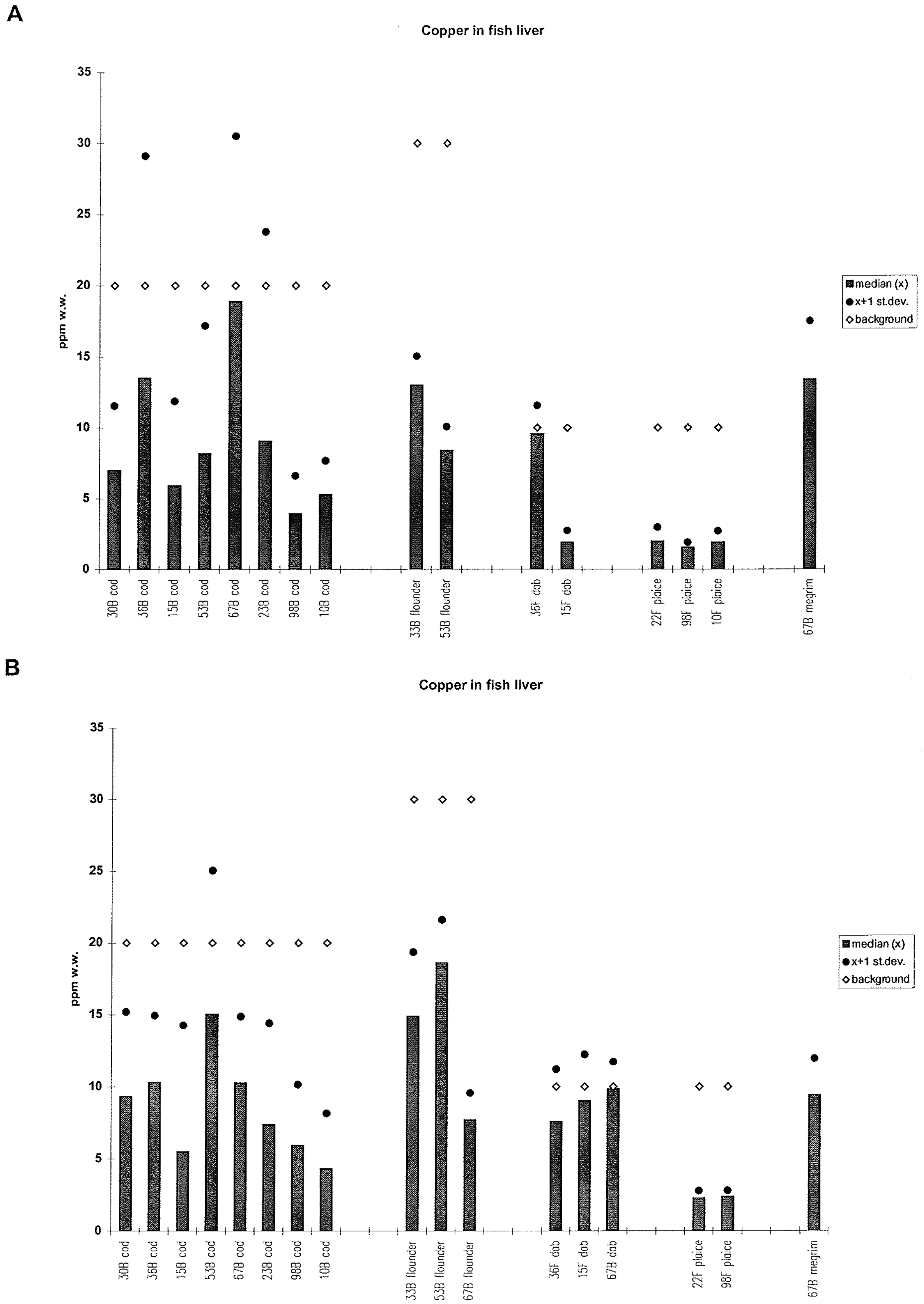
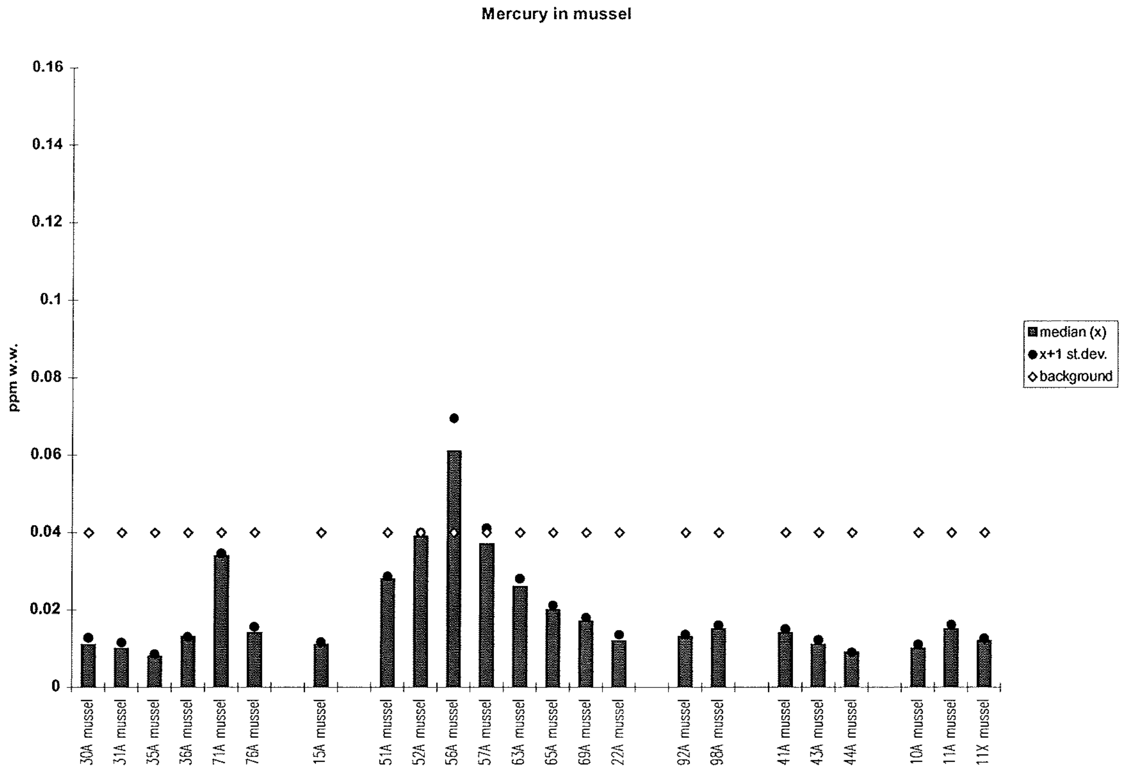


Figure 28. Median, standard deviation and provisional "high background" concentration for copper in fish liver 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

A



B

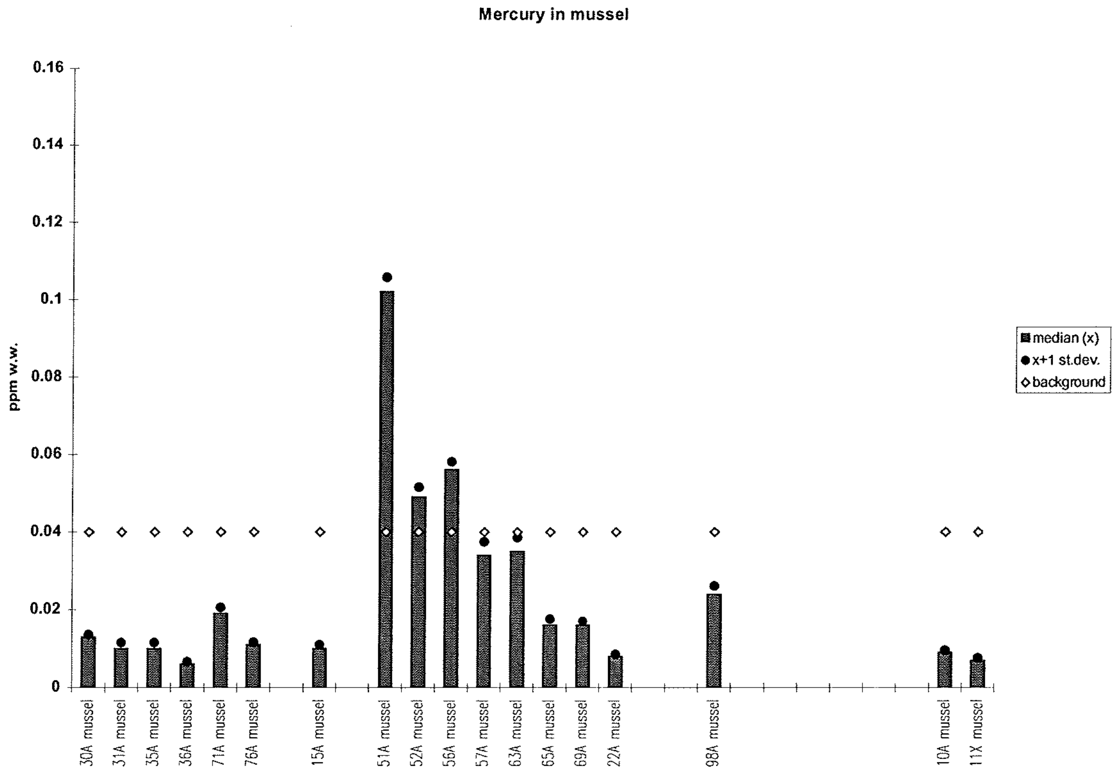


Figure 29. Median, standard deviation and provisional "high background" concentration for mercury in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

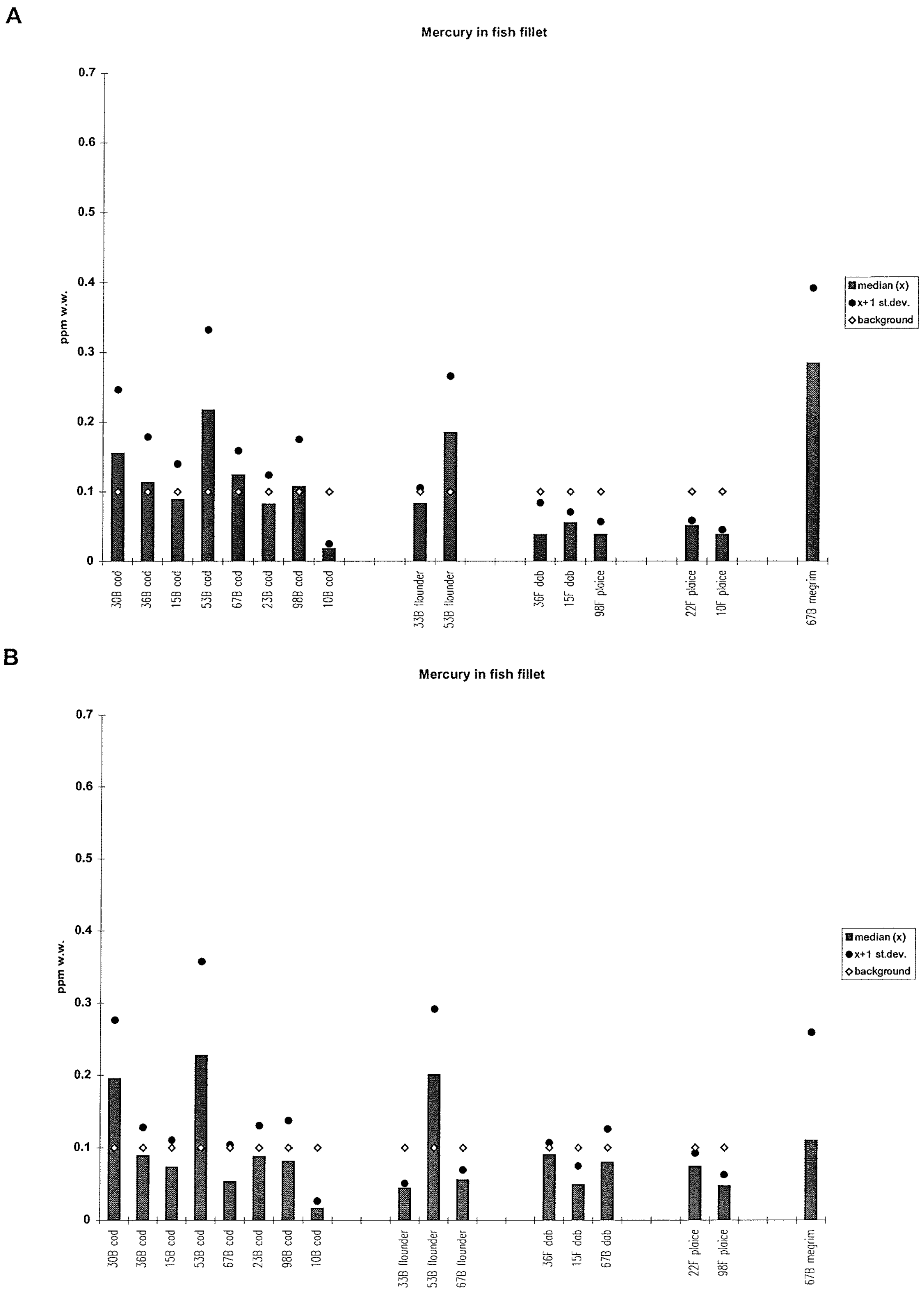


Figure 30. Median, standard deviation and provisional "high background" concentration for mercury in fish fillet 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

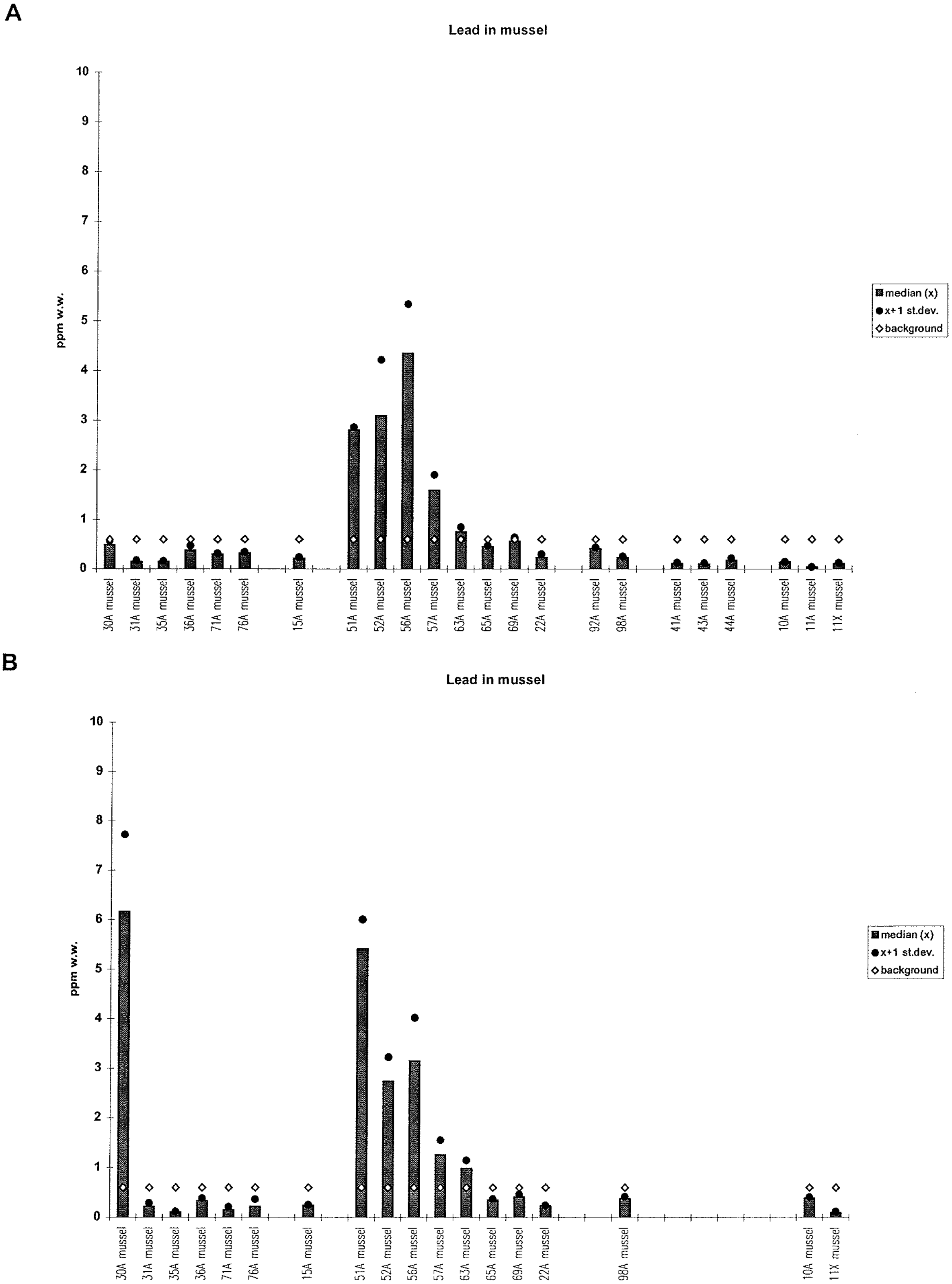


Figure 31. Median, standard deviation and provisional "high background" concentration for lead in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

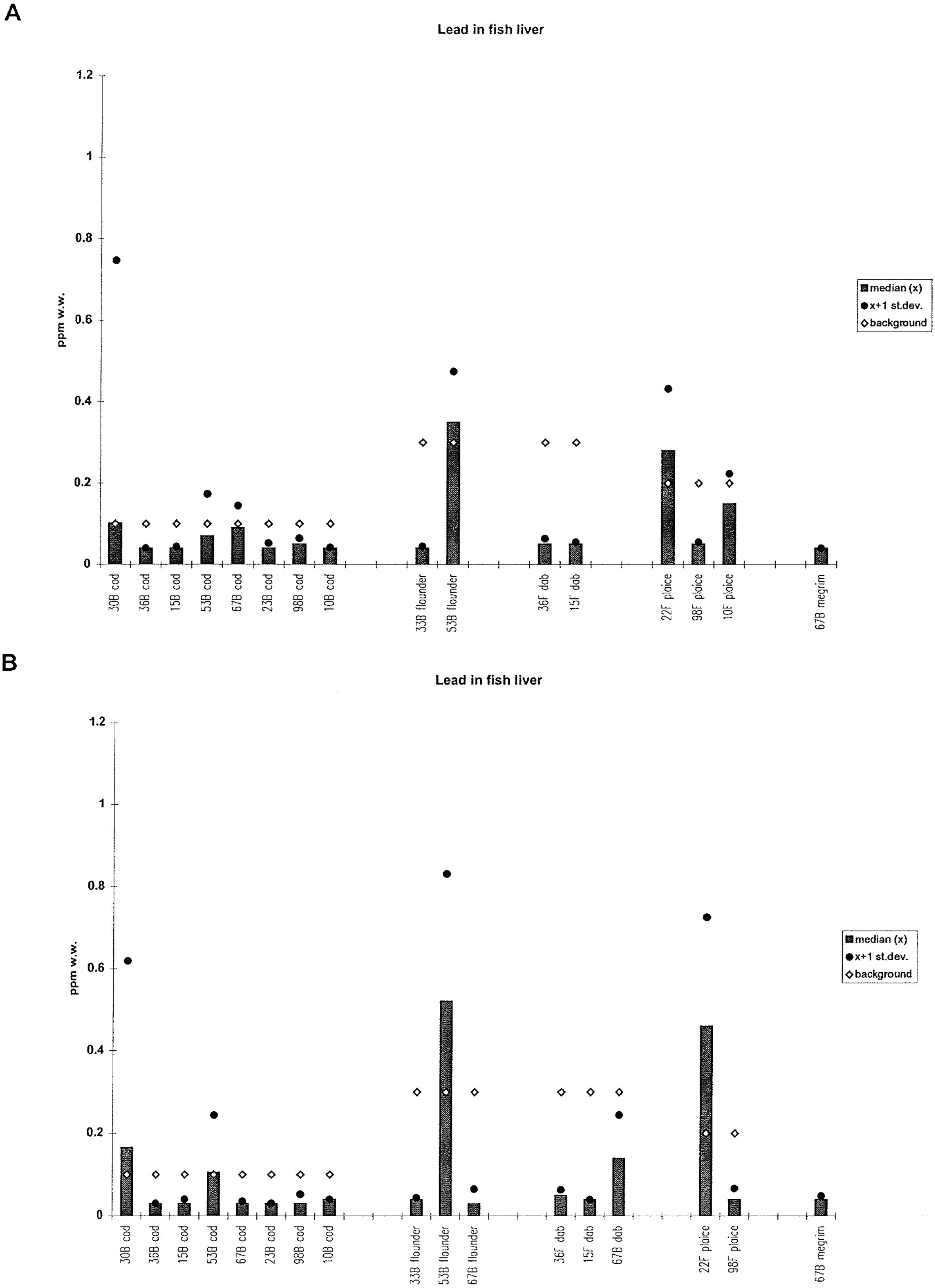


Figure 32. Median, standard deviation and provisional "high background" concentration for lead in fish liver 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

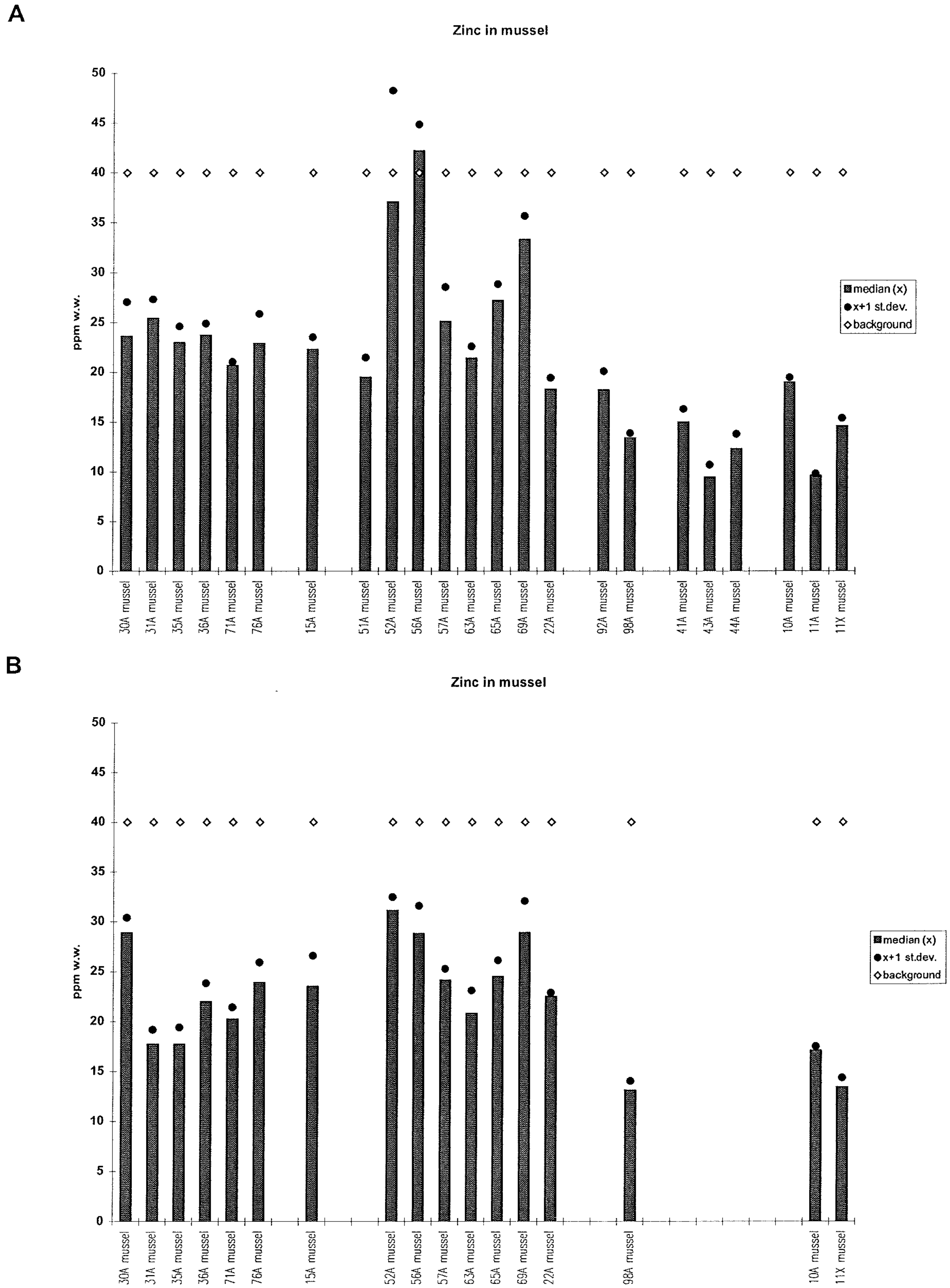


Figure 33. Median, standard deviation and provisional "high background" concentration for zinc in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

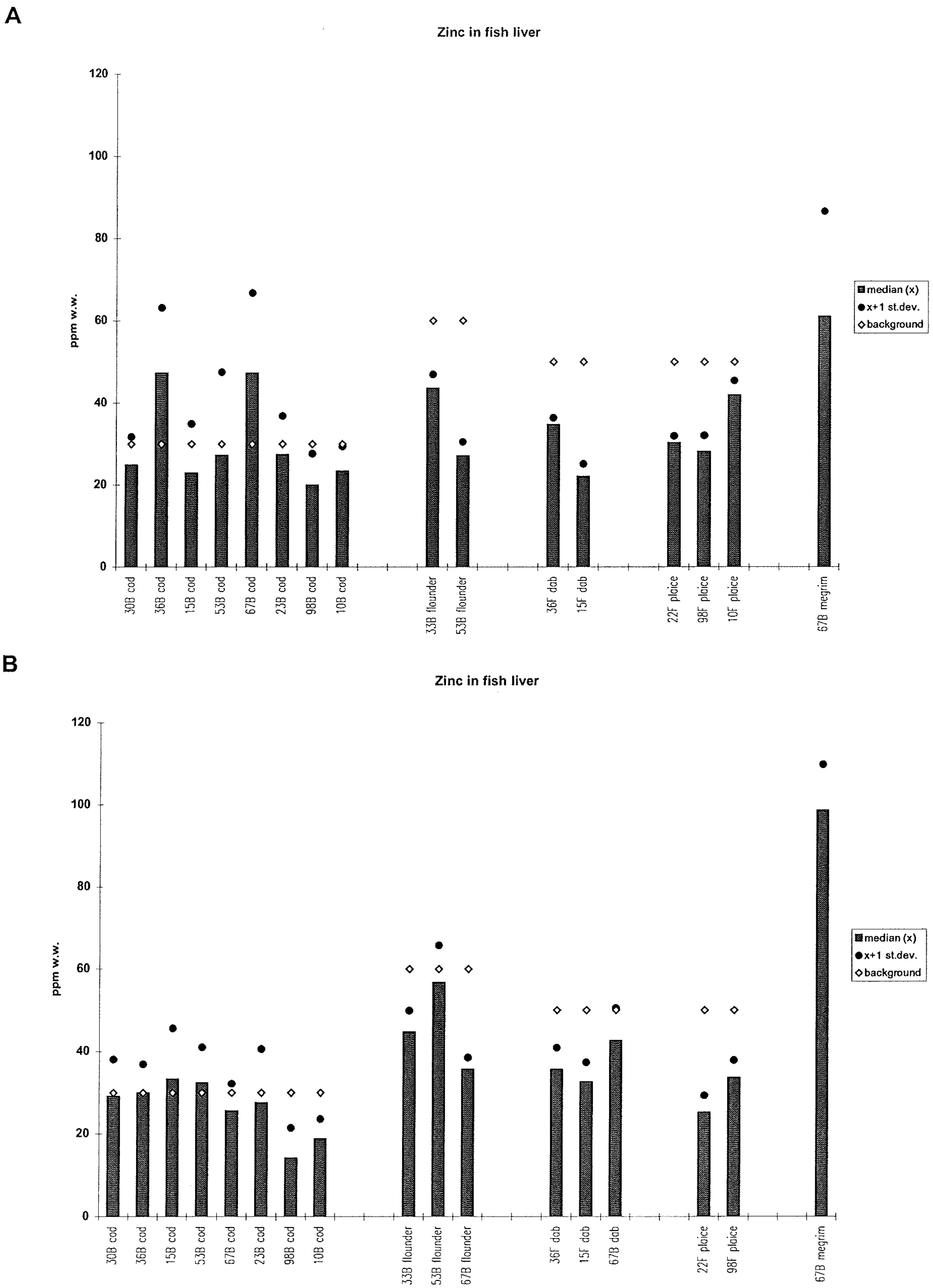
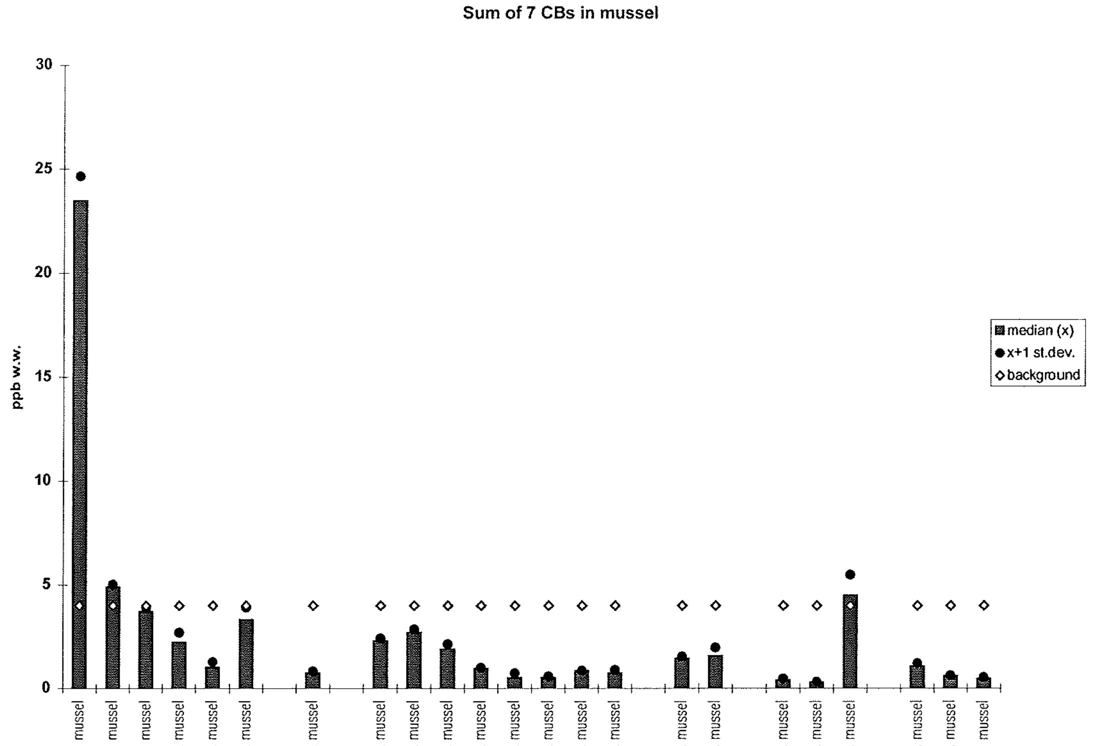


Figure 34. Median, standard deviation and provisional "high background" concentration for zinc in fish liver 1997 (**A**) and 1998 (**B**), ppm wet weight (see maps in Appendix F).

A



B

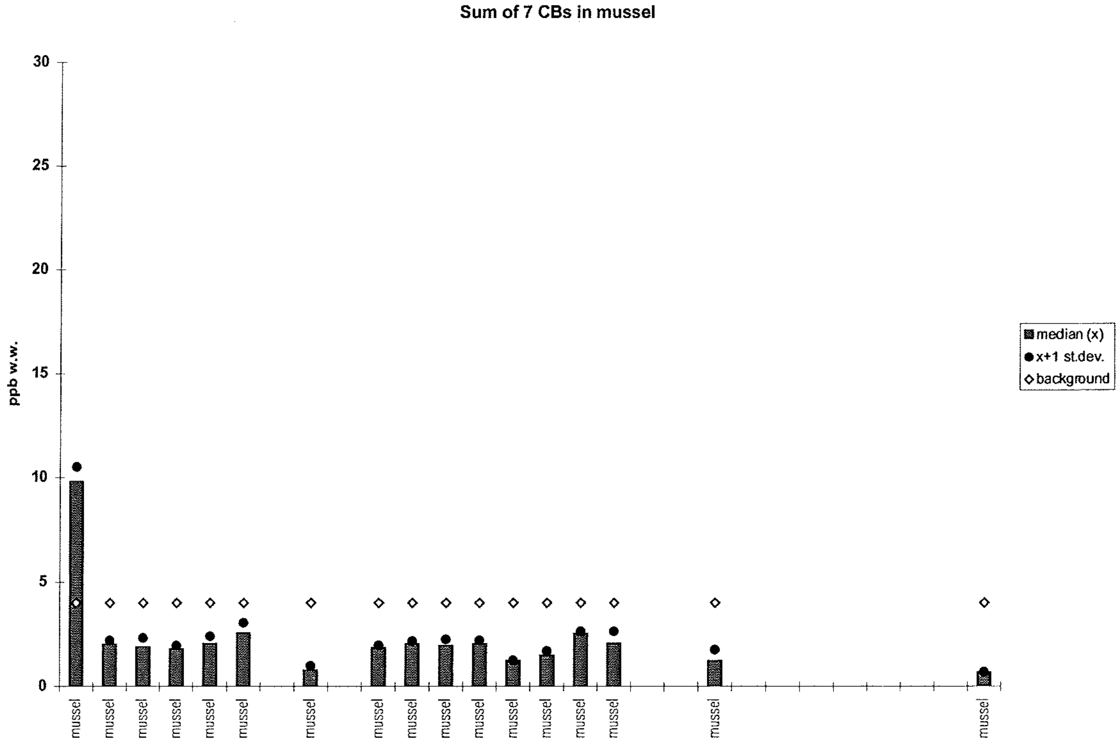


Figure 35. Median, standard deviation and provisional "high background" concentration for sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

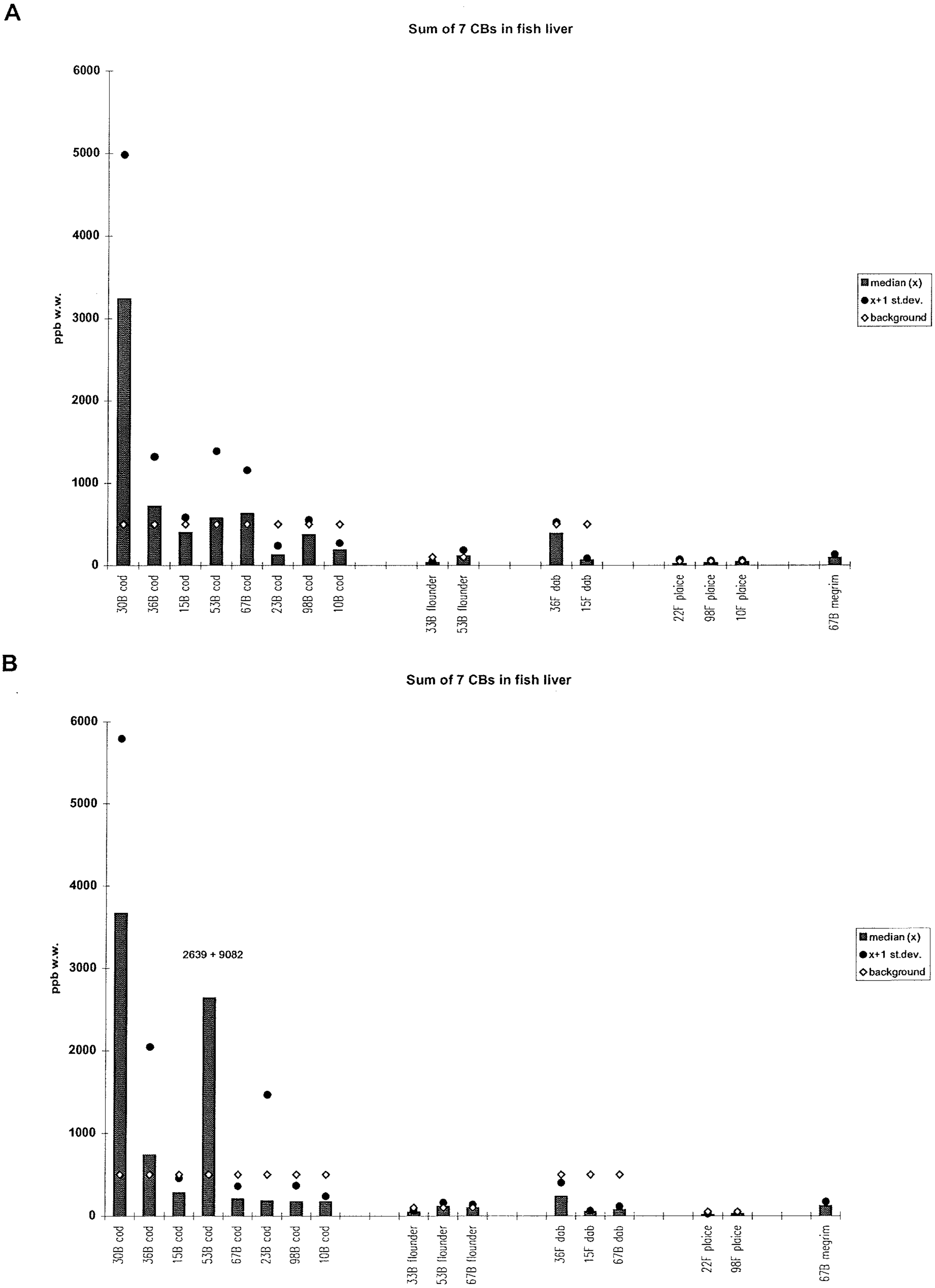


Figure 36. Median, standard deviation and provisional "high background" concentration for sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in fish liver 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

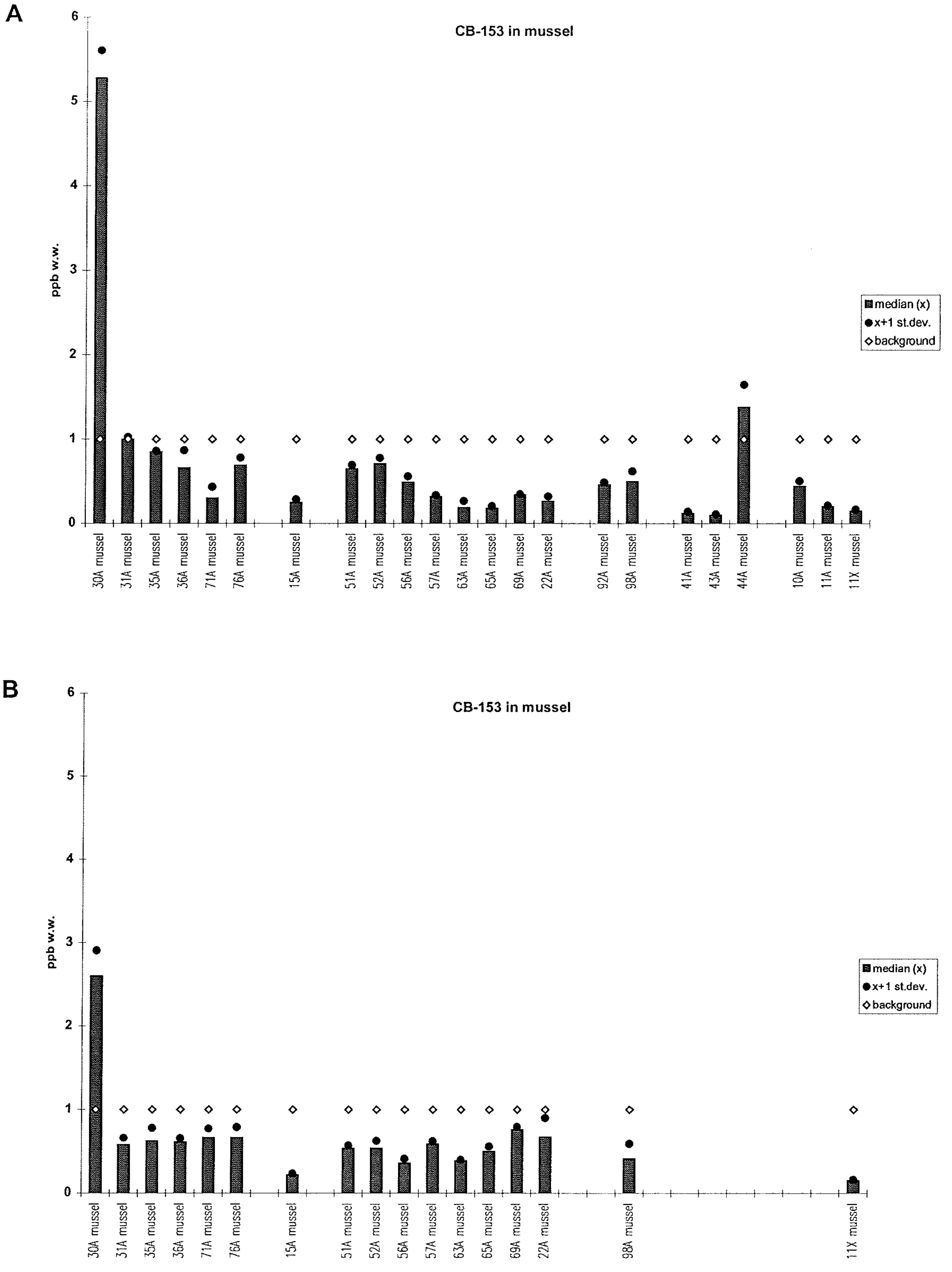


Figure 37. Median, standard deviation and provisional "high background" concentration for CB-153 in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

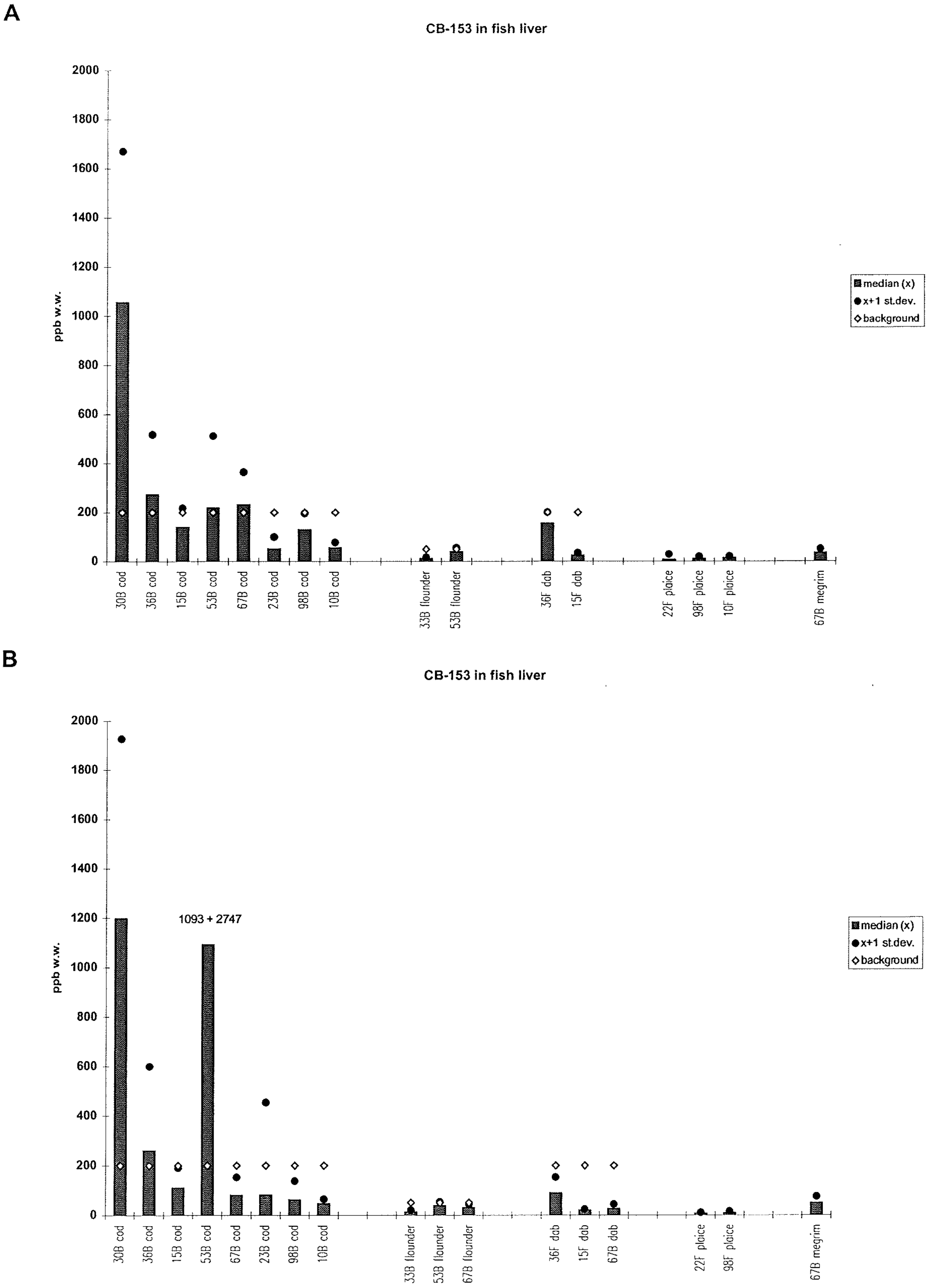


Figure 38. Median, standard deviation and provisional "high background" concentration for CB-153 in fish liver 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

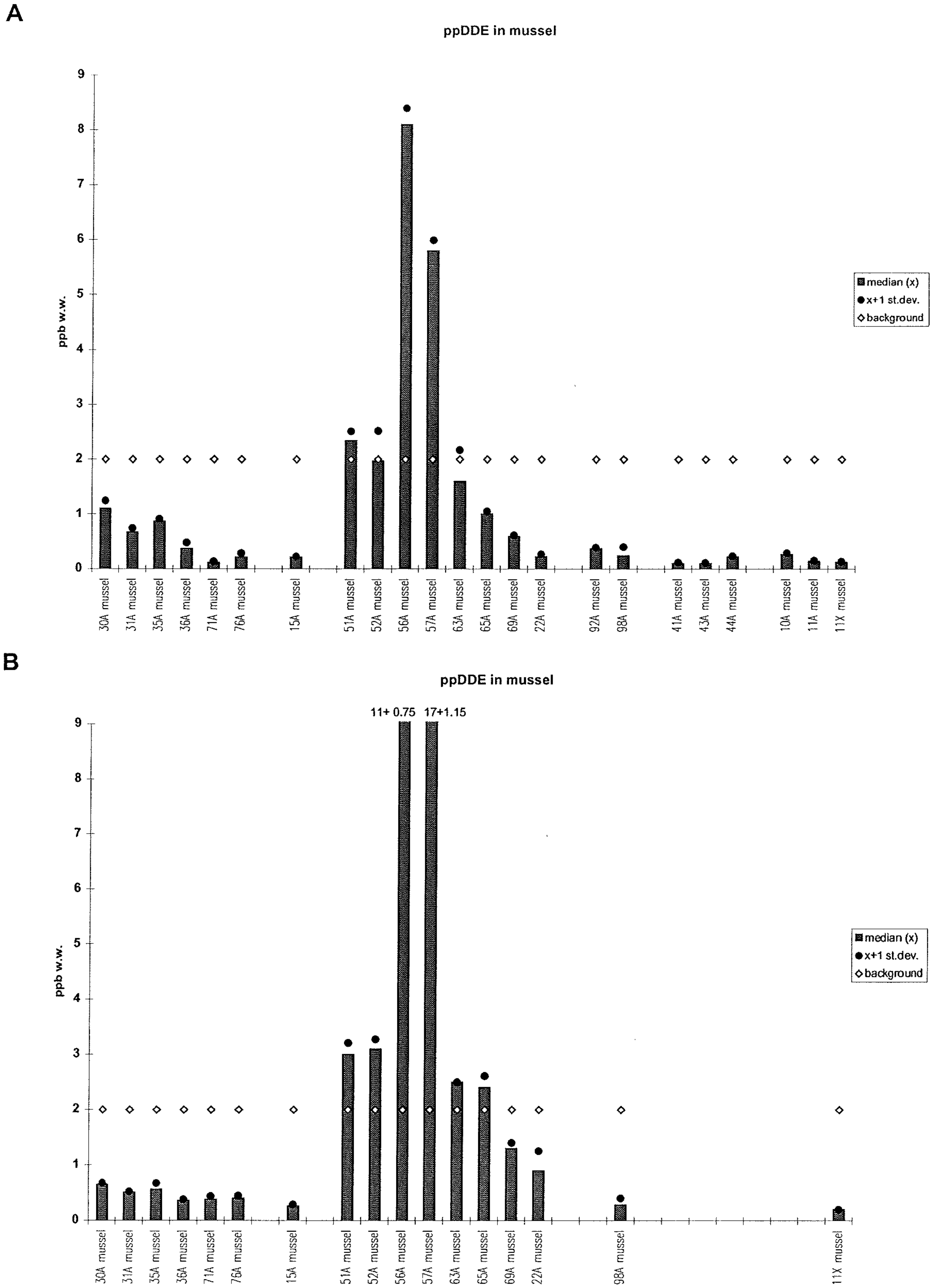


Figure 39. Median, standard deviation and provisional "high background" concentration for ppDDE (DDEPP) in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F). (See also footnote in Table 4.)

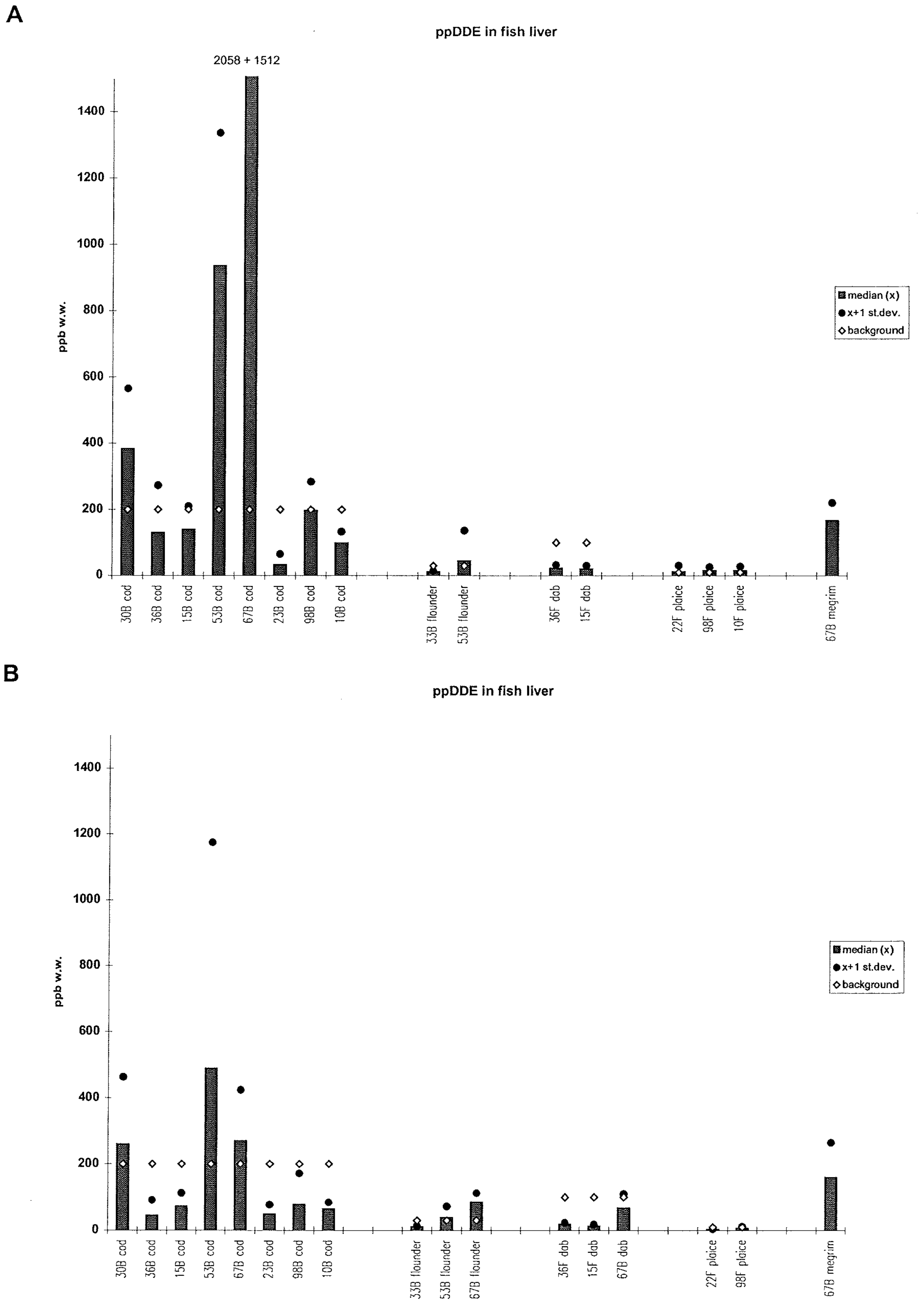


Figure 40. Median, standard deviation and provisional "high background" concentration for ppDDE (DDEPP) in fish liver 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F). (See also footnote in Table 4.)

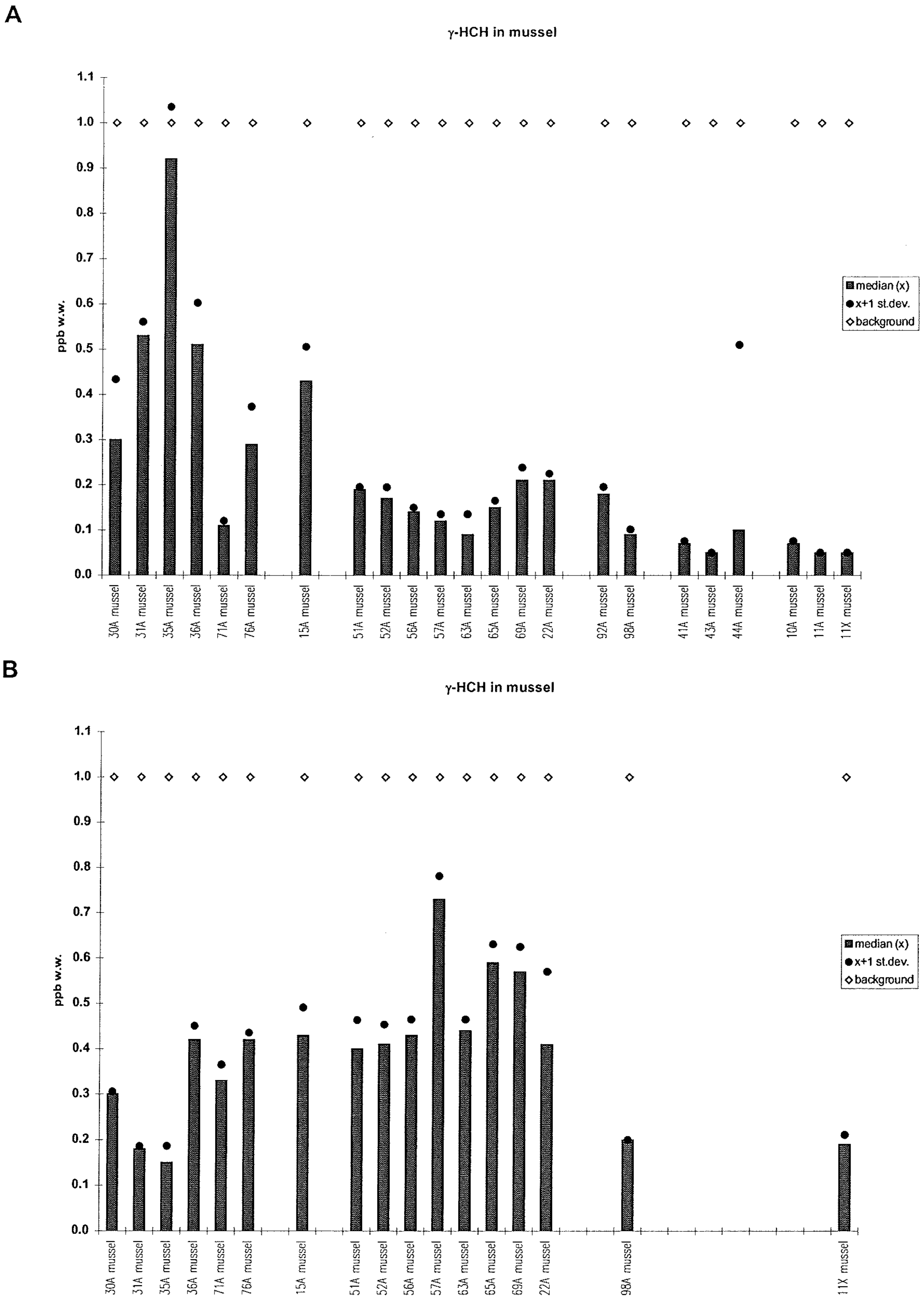
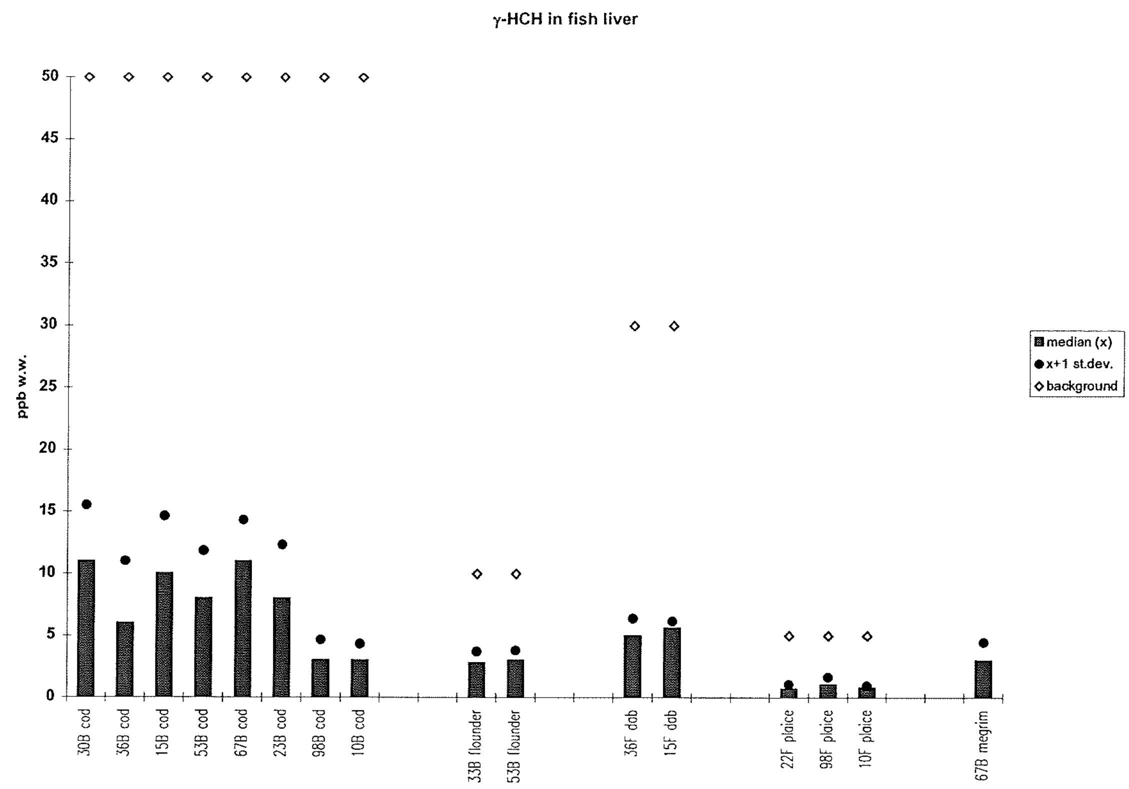


Figure 41. Median, standard deviation and provisional "high background" concentration for γ-HCH (Lindan) in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F). (See also footnote in Table 4.)

A



B

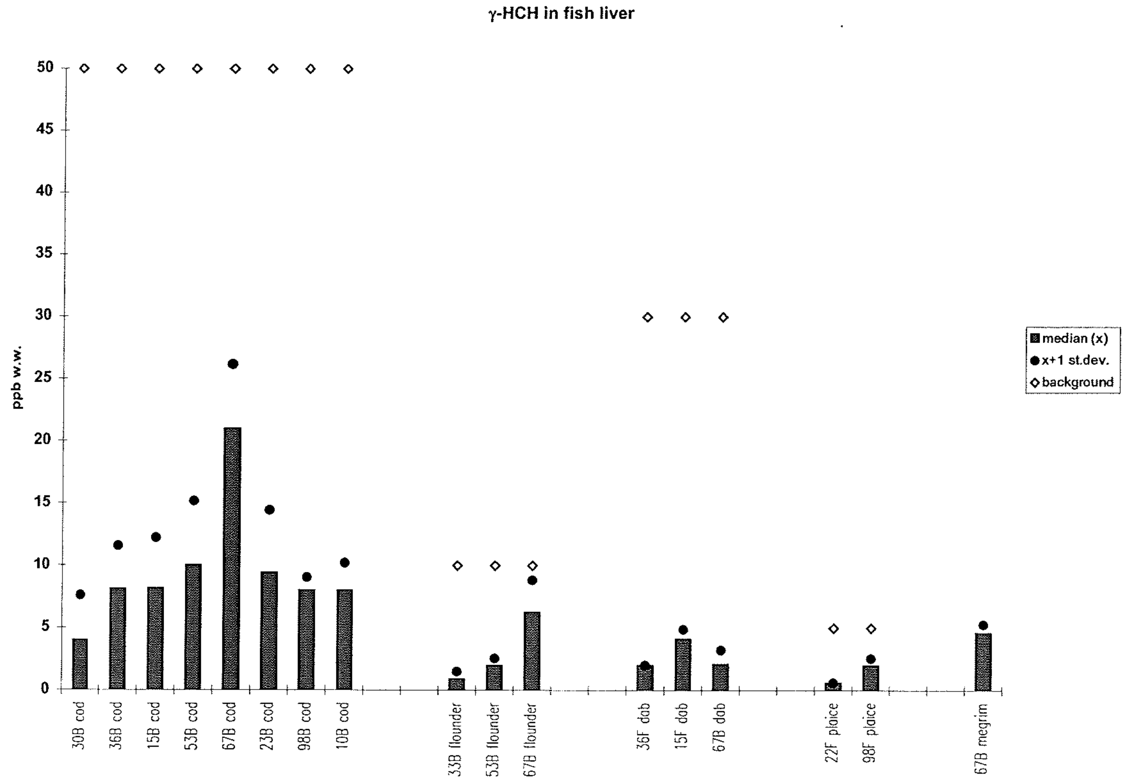


Figure 42. Median, standard deviation and provisional "high background" concentration for γ-HCH (Lindane) in fish liver 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F). (See also footnote in Table 4.)

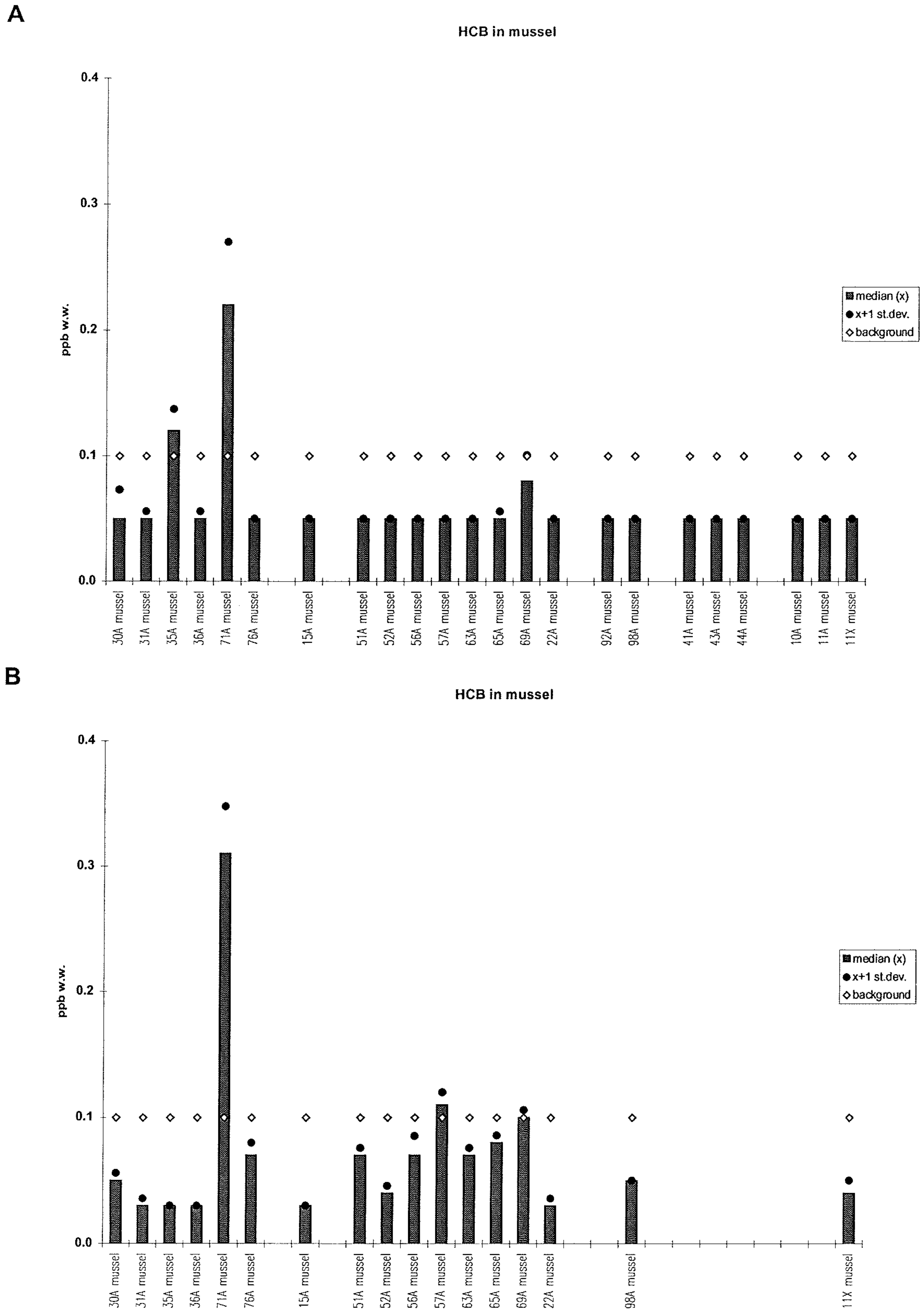
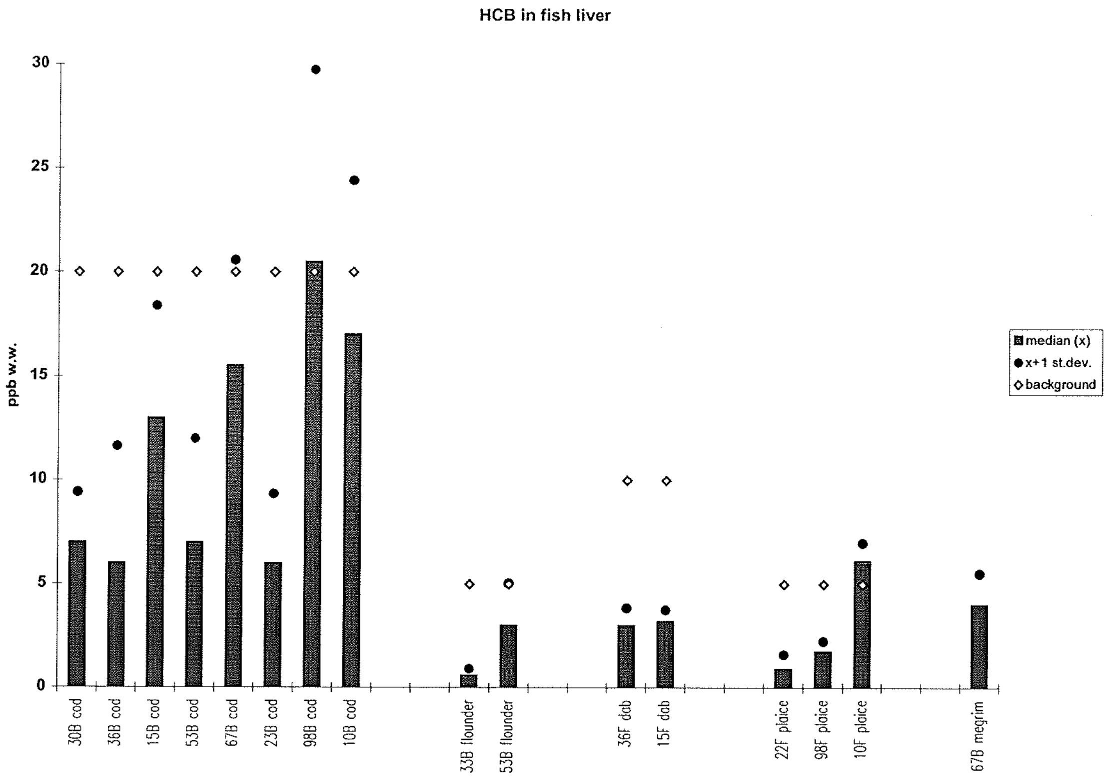


Figure 43. Median, standard deviation and provisional "high background" concentration for HCB in mussels (*Mytilus edulis*) 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

A



B

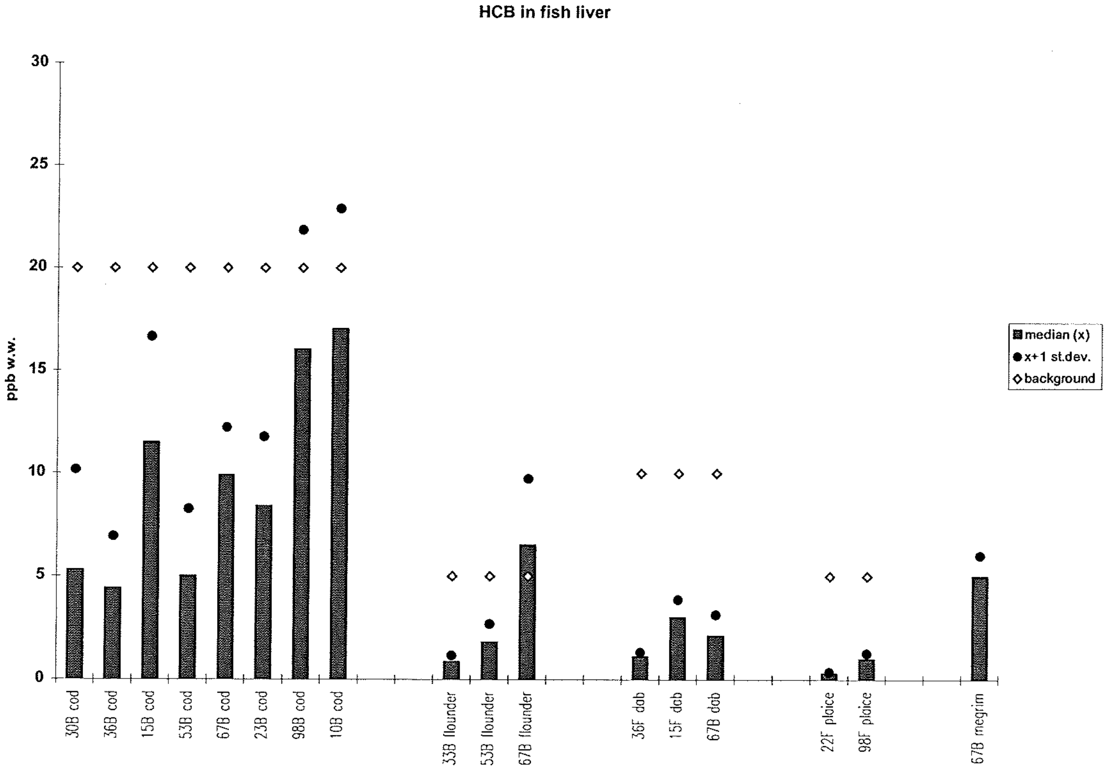


Figure 44. Median, standard deviation and provisional "high background" concentration for HCB in fish liver 1997 (**A**) and 1998 (**B**), ppb wet weight (see maps in Appendix F).

Appendix J
Results from INDEX determinations 1995-98

Introduction

The Norwegian Pollution Control Authority (SFT) has requested in obtaining a small group of indices to assess the quality of the environment with respect to contaminants. The target medium for both indices may vary depending on the purpose, however sediment, cod and mussels are considered to be the most likely choices. Blue mussels were selected for this investigation (Appendix J1 and Appendix J2).

Two indices are calculated. One index is based on the contaminant concentrations in the blue mussel collected annually from 9 of the more contaminated fjords in Norway (Walday *et al.* 1995), herein designated "Pollution Index". This index was initiated in 1995. Initially there were 11 fjords but sampling from Orkdalsfjord and Iddefjord was discontinued in 1997. It was practical to organise sampling within JAMP. Some JAMP results could be used to calculate the index value.

In addition, a "Reference Index" was initiated in 1995 based on annual contaminant concentrations in the blue mussel. The mussels were collect at JAMP stations along the entire coast where there is presumably low levels of contamination. The importance of "reference" stations for monitoring of contaminants has been discussed earlier (cf. Green 1987). One of the main reasons for this work is to establish points of reference for contaminated fjords.

Calculation of the index

A detailed discussion of calculation of the Pollution Index has been given earlier (cf. Walday *et al.* 1995) and only a brief summary will be given here. The relevant contaminants for each of the Pollution Index fjords are summarised in Appendices I2 and I3. Their selection is based on earlier investigations. Two to five stations were sampled from each area. Three parallels of 20 individuals from 3-5 cm are collected from each station. Each sample was analysed for the contaminants according to the scheme in Appendix J3. "Dioxins" were only investigated in 1995-96.

One to three stations were sampled from selected areas for the determination of the Reference Index. Each station included three parallels which were analysed for the usual JAMP contaminants (cf. analysis code A, Appendix J3). Some samples were also analysed for PAHs and dioxins.

The strategy for sampling mussels differed depending on whether the mussels were to be used for the Index or for JAMP and Index in that stations that were exclusively to be used for Index calculations allowed a slightly greater size range (3-5 cm) compared to JAMP and that the mussels were frozen directly and not depurated.

The maximum median for each contaminant for all the stations in an area was determined. These concentrations were classified according to SFT's classification system for contaminants in the marine environment (Appendix J4). The highest class found for any contaminant measured in an area determined the index value for that area.

The SFT Classes are based on the provisional "high background" levels. This system has been revised (Molvær *et al.* 1997); where among other changes the sum of CB-28, -52, -101, -118, -138, -153, and -180 (CBΣΣe) is now a distinct parameter for classification. The sum of all PAHs excluding the dicyclic PAHs (PAH_Σ) was compared to the system's "sum-PAH". Previously the calculation of sum-PAH included the dicyclic PAHs. For this report PAH_Σ was calculated for previous years and hence, the classification may vary a class from what has been previously reported. "Dioxins" were assessed based on toxicity equivalency factors (TEQ) according to a Nordic model (Ahlborg 1989). Note that EPOCl is considered a relevant contaminant for one area but is not included in the part of the classification system based on levels in mussels. Likewise, there are contaminants which are included in the classification system but have not been measured in any area (e.g., arsenic, flouride, nickel, silver).

The maximum class found for any contaminant determined the Class (I-V) of the area. The average Class for all the contaminated sub areas and all the reference localities determined the Pollution or Reference Index, respectively. The lowest Index value is 1 and means that all median values were in Class I ("Good"). The highest Index value is 5 and means that all median values were in Class V ("Very bad").

Conclusion from application of the indices

To compare the 1998 results with previous years the calculations were be done on a common basis with respect to areas and contaminants. Nine fjord areas were used to calculate the Pollution Index for 1998 compared to eight for 1995-97. Byfjord at Bergen was included due to reanalyses of stored material from 1995-96. No special considerations were made when not all the stations within an area were sampled. This occured three times for the Pollution Index (st.I205 Bølsnes from Saudafjord 1996 and st.I911 Horvika in the Sunndalsfjord 1997 and 1998). The Pollution Index for 1998 is 3.0 (Table 6, Appendix J5). A value between 3 and 4 would be termed by the SFT system as “Bad”.

Only 5 fjords/areas were monitored for the Reference Index for 1998 compared to 7 for 1997 and 8 for 1995-96 (Table 7, Appendix J6). However only four of these provided a common basis. As for Pollution Index, no special considerations were made when not all the stations within an area were sampled. This occured in three areas for the Pollution Index (Lofoten area st.98X 1996-1998; Hammerfest area st.46A 1997-1998; Varangerfjord st.48A 1997-1998 and st.11A 1998). The value for 1998 is 1.3 and the same as for 1997. A value between 1 and 2 would be termed by the SFT system as “Fair”.

Table 6. Maximum environmental classification for fjords selected for Pollution INDEX. (See text and Appendix J5).

Index Area [1]	1995	1996	1997 [2]	1998
Hvaler/Singlefjord	2	2	2	3
Iddefjord	-	-	-	-
Inner Oslofjord	3	3	4	2
Frierfjord, Grenlandsfjords	3	4	3	3
Inner Kristiansandsfjord	5	5	5	5
Saudafjord	4	5	5	3
Sørfjorden	5	4	3	3
Byfjorden, Bergen [3]	3	3	3	2
Sunndalsfjord	3	3	3 [4]	2
Orkdalsfjord	-	-	-	-
Inner Ranfjord	5	3	3 [5]	4
AVERAGE (Pollution INDEX)	**3.7**	**3.6**	**3.4**	**3.0**

[1] Iddefjord and Orkdalsfjord not sampled since 1997, hence the index 1995-96 excludes these fjords

[2] Copper, zinc and TCDDN excluded since 1997, hence index for 1995-96 excludes these contaminants

[3] PCB (DDTΣ, HCB, HCHΣΣ and CBΣΣ) analysed in stored samples for 1995-1996

[4] Change in classification (cf. Green *et al.* 1999) due to recalculation of PAHs that excluded the dicyclic compounds

[5] Change in classification (cf. Green *et al.* 1999) due to calculation error

Table 7. Maximum environmental classification for fjords selected for Reference INDEX. (See text and Appendix J6).

Index Area	1995	1996	1997	1998
Mid and outer Oslofjord [1]	2	2	2	1
Lista	1	1	1	1
Bømlo-Sotra	1	1	1	1
Outer Ranfjord, Helgeland [2]	(1)	(1)	-	-
Lofoten [3]	(2)	(2)	(1)	(2)
Finnsnes-Skjervøy [2]	(2)	(1)	(1)	-
Hammerfest-Honningsvåg [2]	(2)	(3) [4]	(2)	-
Varanger Peninsula	1	2	1	2
AVERAGE (Reference INDEX)	**1.3**	**1.5**	**1.3**	**1.3**

[1] Inclusion of results for arsenic, nikkel and silver in 1996 (see Appendix J6) did not effect the classification

[2] Outer Ranfjord, Finnsnes-Skjervøy and Hammerfest-Honningsvåg stations were not sampled in 1998, hence, the index for 1995-97 did not take these results into account

[3] Inconsistancy in sampling site, st.98X in 1995-96 and st.98A in 1997, hence, results from Lofoten excluded

[4] Change in classification (cf. Green *et al.* 1999) due to recalculation of PAHs that excluded the dicyclic compounds

Appendix J1.
INDEX - Stations and programme 1995-98

Appendix J1. INDEX station positions and sampling overview for blue mussels 1995-98, where P = "Pollution Index" and R = "Reference Index" (contaminated and assumed "background" stations, respectively). Mussels were sampled from rock surfaces unless otherwise noted. See Walday *et al.* (1995) for discussion of station selection and analyses.

Station	Locality name	North latitude	East longitude	ICES position	INDEX type P/R	notes
HVALER/SINGLEFJORDEN, east of outer OSLOFJORD						
I021	Kjøkø, south	59°07.8'	10°57.1'	47G13	P	
I024	Kirkø, north west	59°04.9'	10°59.2'	47G09	P	
I022	West Damholmen	59°06.2'	10°57.9'	47G09	P	
I023	Kirkø, north west	59°05.7'	11°08.2'	47G09	P	
IDDEFJORD, east of outer OSLOFJORD						
I001	Sponvikskansen	59°05.4'	11°12.5'	47G09	P	
I011	Kråkenebbet	59°06.1'	11°17.3'	47G09	P	
INNER OSLOFJORD						
JAMP 30A	Gressholmen	59°52.5'	10°43.0'	48G07	P	
I301	Akershuskaia	59°54.2'	10°45.5'	48G07	P	
I304	Gåsøya	59°51.0'	10°35.5'	48G04	P	
I307	Ramtonholmen	59°44.7'	10°31.4'	48G05	P	
I306	Håøya	59°24.7'	10°33.4'	48G04	P	
MID and OUTER OSLOFJORD						
JAMP 31A	Solbergstrand	59°36.9'	10°39.4'	48G06	R	
JAMP 35A	Mølen	59°29.2'	10°30.1'	47G04	R	
JAMP 36A	Færder	59°01.6'	10°31.7'	47G06	R	
FRIERFJORD AREA, west of outer Oslofjord						
I711	Steinholmen	59°31.7'	09°40.7'	48F99	P	
I712	Gjermundsholmen	59°21.7'	09°42.6'	47F99	P	
JAMP 71A	Bjørkøya (Risøyodden)	59°01.4'	09°45.4'	47F99	P	
INNER KRISTIANSANDSFJORD						
I132	Fiskåtangen	57°07.7'	07°59.2'	43F79	P	
I133	Odderø, west	57°07.9'	08°00.3'	43F83	P	
LISTA AREA						
JAMP 15A	Gåsøy (Ullerø area)	58°03.1'	06°53.3'	45F69	R	
I131	Lastad	58°03.3'	07°42.4'	45F79	R	7
SAUDAFJORD						
I201	Ekkjegrunn (G1)	59°38.7'	06°21.4'	48F66	P	
** I205	Bølsnes (G5)	59°35.5'	06°18.3'	48F63	P	
BØMLO AREA						
JAMP 22A	Espevær, west	59°35.2'	05°58.5'	48F59	R	C, 1
SØRFJORD						
* 51A	Byrkjenes	60°05.1'	06°33.1'	49F66	P	
JAMP 52A	Eitrheimsneset	60°05.8'	06°32.2'	49F66	P	3

Appendix J1 (cont'd)

Station	Locality name	North latitude	East longitude	ICES position	INDEX type P/R	notes
BYFJORDEN, Bergen						
I242	Valheimneset	60°23.7'	05°16.1'	49F51	P	
I241	Nordnes	60°24.1'	05°18.2'	49F51	P	
I243	Hagreneset	60°24.9'	05°18.3'	49F51	P	
SUNNDALSFJORDen						
I912	Honnhammer	62°51.2'	08°09.7'	54F81	P	
I911	Horvika	62°44.1'	08°31.4'	54F85	P	
[**TRONDHEIM AREA** - not related to INDEX investigation]						
* 80A	Østmerknes	63°27.5'	10°27.5'	56G04	P	
ORKDALSFJORD AREA, supplementary area (cf. Walday *et al.* 1995)						
JAMP 82A	Flakk	63°27.1'	10°12.6'	56G01	P	
JAMP 84A	Trossavika	63°20.8'	09°57.8'	55F97	P	
JAMP 87A	Ingdalsbukt	63°27.8'	09°54.8'	55F97	P	
INNER RANFJORD						
I969	Bjørnbærviken (B9)	66°16.8'	14°02.1'	61G42	P	
I962	Koksverkkaien (B2)	66°19.4'	14°08.0'	61G42	P	3
OUTER RANFJORD, Helgeland area						
* 96A	Breiviken	66°17.6'	12°50.5'	61G28	R	1
LOFOTEN AREA						
JAMP 98A	Husvågen (1997)	68°15.4'	14°40.6'	65G46	R	5
JAMP 98A	Husvågen (1998)	68°16.9'	14°40.1'	65G46	R	
FINNSNES-SKJERVØY AREA						
JAMP 41A	Fensneset, Grytøya	68°56.9'	16°38.5'	66G64	R	3
HAMMERFEST-HONNINGSVÅG AREA						
JAMP 44A	Elenheimsundet	70°30.8'	22°14.8'	70H23	R	1, 6
JAMP 46A	Smineset in Altesula	70°58.4'	25°48.1'	70H57	R	3, 6
VARANGER PENINSULA AREA						
JAMP 48A	Trollfjorden i Tanafjord	70°41.6'	28°33.3'	70H85	R	
JAMP 10A	Skagoodden	70°04.2'	30°09.8'	69J03	R	2
JAMP 11A	Sildkroneset, Bøkfjorden	69°47.0'	30°11.1'	68J02	R	

notes:

* - JAMP station but not sampled in accordance to JAMP guidelines, see appendix text.
** - Sufficient mussel-sample not found in 1996.
1 - mussels collected from buoy and/or buoy anchor lines
2 - mussels collected from sand/gravel bottom
3 - mussels collected from iron/cement pilings
4 - mussels collected from metal navigation buoys
5 - mussels collected from floating dock
6 - mussels collected from wooden docks
7 - mussels collected from tire on jettty

Appendix J2.
INDEX - Sampling and analyses for 1995-98

Appendix J2. Blue mussel samples planned or used in INDEX 1995-98, where P = "Pollution Index" and R = "Reference Index" (contaminated and assumed "background" stations, respectively). + indicates JAMP sampling and analyses (i.e. equivalent to analysis code A). The number indicates the number samples analyzed. Codes for analysis (A, B etc.) are defined in Appendix J3. See Walday *et al.* (1995) for discussion of selection of stations and analyses.

	STATION	INDEX	ANALYSIS CODE										
JAMP st.			+	A	B	C	D	E	F	G	H	I	J
	HVALER/SINGLEFJORD AREA												
021	Kjøkø, south	P	.	3	.	.	.	.	.	.	.	.	.
024	Kirøy, north west	P	.	3	.	.	.	.	.	.	.	.	.
022	West Damholmen	P	.	3	.	.	.	.	.	.	.	.	.
023	Singlekalven, south	P	.	3	.	.	.	.	.	.	.	.	.
	IDDEFJORD												
01A	Sponvikskansen	P	.	.	3	.	.	.	.	.	.	.	.
011	Kråkenebbet	P	.	.	3	.	.	.	.	.	.	.	.
	OSLOFJORD, inner												
30A	Gressholmen	P	+	.	.	.	.	.	.	.	3	.	.1
301	Akershuskaia	P	.	.	.	3	.	.	.	.	.	.	.
304	Gåsøya	P	.	.	.	3	.	.	.	.	.	.	.
307	Ramtonholmen	P	.	.	.	3	.	.	.	.	.	.	.
306	Håøya	P	.	.	.	3	.	.	.	.	.	.	.
	OSLOFJORD, mid and outer												
31A	Solbergstrand	R	+	.	.	.	.	.	.	.	.	.	1
35A	Mølen	R	+	.	.	.	.	.	.	.	.	.	.
36A	Færder	R	+	.	.	.	.	.	.	.	.	.	2*
	FRIERFJORD AREA, west of outer Oslofjord												
711	Steinholmen	P	.	.	.	.	3	.	.	.	.	.	1
712	Gjermundsholmen	P	.	.	.	.	3	.	.	.	.	.	1
71A	Bjørkøya	P	+	.	.	.	.	.	.	.	.	.	1
	INNER KRISTRIANSANDSFJORD												
132	Fiskåtangen	P	.	.	.	.	.	3	.	.	.	.	1
133	Odderø, west	P	.	.	.	.	.	3	.	.	.	.	1
	LISTA AREA												
15A	Gåsøya	R	+	.	.	.	.	.	.	.	.	.	1
131	Lastad	R	.	.	.	3.	.	.	.	.	.	.	.
	SAUDAFJORD												
201	Ekkjegrunn (G1)	P	.	.	.	.	.	.	3	.	.	.	.
205	Bølsnes (G5)	P	.	.	.	.	.	.	3	.	.	.	.
	BØMLO-SOTRA AREA												
22A	Espevær, west	R	+	.	.	.	.	.	.	.	.	.	2*
	SØRFJORD												
51A	Byrkjeneset	P	.	3	.	.	.	.	.	.	.	.	.
52A	Eirtrheimsneset	P	+	.	.	.	.	.	.	.	.	.	.

*) indicates Toxaphene included

Appendix J2 (cont'd)

JAMP st.	STATION	INDEX	+	A	B	C	D	E	F	G	H	I	J
	BYFJORDEN, BERGEN												
242	Valheimsneset	P	.	.	.	.	.	.	.	3	.	.	.
241	Nordnes	P	.	.	.	.	.	.	.	3	.	.	.
243	Hagreneset	P	.	.	.	.	.	.	.	3	.	.	.
	SUNNDALSFJORD												
912	Honnhammer	P	.	.	.	.	.	.	.	.	3	.	.
911	Horvika	P	.	.	.	.	.	.	.	.	3	.	.
	[TRONDHEIM AREA - not related to index investigation]												
80A	Østmarknes	-	.	.	.	.	.	.	.	.	.	3	.
	ORKDALSFJORD AREA (not suggested in Walday *et al.* 1993)												
82A	Flakk	P	+	.	.	.	.	.	.	.	.	.	.
84A	Trossavika	P	+	.	.	.	.	.	.	.	.	.	.
87A	Ingdalsbukta	P	+	.	.	.	.	.	.	.	.	.	.
	INNER RANFJORD												
962	Koksverkkaien (B2)	P	.	.	.	.	.	.	.	.	.	3	.
969	Bjørnbærvikenn (B9)	P	.	.	.	.	.	.	.	.	.	3	.
	OUTER RANFJORD, HELGELAND AREA												
96A	Breivika, Tomma	R	.	3	.	.	.	.	.	.	.	.	.
	LOFOTEN AREA												
98A	Husvågen	R	+	.	.	.	.	.	.	.	.	.	1
	FINNSNES-SKJERVØY AREA												
41A	Fensneset, Grytøya	R	+	.	.	.	.	.	.	.	3	.	1
	HAMMERFEST-HONNINGSVÅG AREA												
44A	Elenheimsundet	R	+	.	.	.	.	.	.	.	3	.	2*
46A	Smineset in Altesula	R	+	.	.	.	.	.	.	.	3	.	1*
	VARANGER PENINSULA AREA												
48A	Trollfjorden i Tanafjord	R	+	.	.	.	.	.	.	.	3	.	.
10A	Skagoodden	R	+	.	.	.	.	.	.	.	3	.	1
11A	Sildkroneset	R	+	.	.	.	.	.	.	.	.	.	1

*) indicates Toxaphene included

Appendix J3.
INDEX - Key to analysis codes and sample counts

(Used in Appendix J2.)

ANALYSIS CODES[1]) See Walday *et al.* (1995) for discussion of selection of analyses.

Contaminant	**Analysis code**									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Lead	x	x	.	.	.	x	.	.	x	.
Cadmium	x	x	x	.	.	x	.	.	x	.
Copper [2])	x	x	x	.	.	.	.	.	.	.
Mercury	x	x	x	.	.	.	.	.	.	.
Zinc [2])	x	x	x	.	.	.	x	.	x	.
EPOCl	.	.	.	.	x	.	.	.	.	.
PAHs	.	.	x	.	x	x	.	x	x	.
PCBs	x	.	x	x	x	.	x	.	.	.
"Dioxin" [3])	.	.	.	.	.	.	.	.	.	x

[1]) Concerns MUSSEL	1 size group (3-5 cm), 3 parallel samples each a bulk of 20 individuals (see text)
[2]) Concerns MUSSEL	discontinued since 1996
[3]) Concerns MUSSEL	discontinued since 1995

Appendix J4.
INDEX - SFT Environmental quality classes

(Molvær *et al.* 1997)

As	arsenic
Pb	lead
F	fluoride
Cd	cadmium
Cu	copper
Cr	chromium
Hg	mercury
Ni	nickel
Zn	zinc
Ag	silver
PAH_Σ	total PAH excluding dicyclic *
BAP	benzo[*a*]pyrene
DDTΣΣ	DDTPP+DDEPP+TDEPP *
HCB	hexachlorobenzene
HCHΣΣ	HCHG+HCHA+HCHB *
CBΣΣe	sum of CB: 28+52+101+118+138+153+180 *
TCDDN	Sum of TCDD-toxicity equivalents *

*) See also Appendix B for definitions.

LIMIT-CHECK-file; **I:\TPX\JMG\LIM\NI991118.ISH** 19/11-99

CLASS-limits for **M Y T I E D U** (Mytilus edulis, GB: Blue mussel, N: Blåskjell).
Tissue : **WHOLE SOFT BODY.**

Limit Level=>		Class I		Class II		Class III		Class IV		Class V	
Basis ======> Param.	Unit	Wet weight	Dry weight	Wet weight	Dry weight	Wet weight	Dry weight	Wet weight	Dry weight	Wet weight	Dry weight
As	ppm	.	<10.0	.	<30.0	.	<100.0	.	<200.0	.	>=200.0
Pb	ppm	.	<3.0	.	<15.0	.	<40.0	.	<100.0	.	>=100.0
F	ppm	.	<15.0	.	<50.0	.	<150.0	.	<300.0	.	>=300.0
Cd	ppm	.	<2.0	.	<5.0	.	<20.0	.	<40.0	.	>=40.0
Cu	ppm	.	<10.0	.	<30.0	.	<100.0	.	<200.0	.	>=200.0
Cr	ppm	.	<3.0	.	<10.0	.	<30.0	.	<60.0	.	>=60.0
Hg	ppm	.	<0.2	.	<0.5	.	<1.5	.	<4.0	.	>=4.0
Ni	ppm	.	<5.0	.	<20.0	.	<50.0	.	<100.0	.	>=100.0
Zn	ppm	.	<200.0	.	<400.0	.	<1000.0	.	<2500.0	.	>=2500.0
Ag	ppm	.	<0.3	.	<1.0	.	<2.0	.	<5.0	.	>=5.0
PAHΣΣ	ppb	<50.0	.	<200.0	.	<2000.0	.	<5000.0	.	>=5000.0	.
BAP	ppb	<1.0	.	<3.0	.	<10.0	.	<30.0	.	>=30.0	.
DDTΣΣ	ppb	<2.0	.	<5.0	.	<10.0	.	<30.0	.	>=30.0	.
HCB	ppb	<0.1	.	<0.3	.	<1.0	.	<5.0	.	>=5.0	.
HCHΣΣ	ppb	<1.0	.	<3.0	.	<10.0	.	<30.0	.	>=30.0	.
CBΣΣe	ppb	<4.0	.	<15.0	.	<40.0	.	<100.0	.	>=100.0	.
TCDDN	ppp	<0.2	.	<0.5	.	<1.5	.	<3.0	.	>=3.0	.

Appendix J5.
INDEX - Summary table "Pollution index" 1995-1998

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (PollutionAreas) . 1995	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	**Max E.C I:V**
Hvaler/Singlefjord	4	4	i	0.20A	i	0.27A	i	i	0.03B	i	i	i	i	i	0.93a	0.13b	0.53a	6.73b	i	**II**
Iddefjord	2	2	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Oslofjord	5	5	i	i	i	0.20A	i	i	0.01A	i	i	i	<132.30b	0.80a	1.95a	<0.05a	0.41a	20.60c	i	**III**
Frierfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	0.85a	0.60c	0.27a	4.74b	i	**III**
Inner Kristiansandsfjord	2	2	i	i	i	i	i	i	i	i	i	i	1085.10c	15.00d	0.65a	9.55e	s1.01b	5.08b	i	**V**
Saudafjord	2	2	i	0.92B	i	0.16A	i	i	i	i	i	i	<421.50c	15.00d	i	i	i	i	i	**IV**
Sørfjorden	2	2	i	14.60E	i	3.61D	i	i	0.15D	i	i	i	i	i	6.01c	0.06a	0.28a	2.67a	i	**V**
Byfjorden, Bergen	3	3	i	i	i	i	i	i	i	i	i	i	i	i	3.76b	0.22b	0.74a	19.00c	i	**III**
Sunndalsfjord	2	2	i	i	i	i	i	i	i	i	i	i	804.20c	8.00c	i	i	i	i	i	**III**
Orkdalsfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Ranfjord	2	2	i	0.56B	i	0.11A	i	i	i	i	i	i	780.10c	31.00e	i	i	i	i	i	**V**
Count			0	4	0	5	0	0	3	0	0	0	5	5	6	6	6	6	0	9
Min			.	0.20A	.	0.11A	.	.	0.01A	.	.	.	<132.30b	0.80a	0.65a	<0.05a	0.27a	2.67a	.	II
Max			.	14.60E	.	3.61D	.	.	0.15D	.	.	.	1085.10c	31.00e	6.01c	9.55e	s1.01b	20.60c	.	V
Mean			.	4.07C	.	0.87C	.	.	0.06C	.	.	.	<644.64c	13.96d	2.36b	<1.77d	s0.54a	9.80b	.	**3.7**

i (141) ! Value ignored when calculating Environment Class.
a/A(28) > Below Class-I limit.
b/B(15) > Below Class-II limit.
c/C(16) > Below Class-III limit.
d/D(8) > Below Class-IV limit.
e/E(6) > Below Class-V limit.

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Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames	n	N	AS	Pb	F	CD	CU	CR	HG	NI	ZN	AG	PAH_Σ	BAP	DDTΣΣ	HCB	HCHΣΣ	CBΣΣe	TCDDN	Max
(PollutionAreas)			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppp	E.C
· 1996			d.wt	w.wt	d.wt	w.wt	d.wt	d.wt	w.wt	d.wt	d.wt	d.wt	w.wt	w.wt	w.wt	w.wt	w.wt	w.wt	w.wt	I:V
Hvaler/Singlefjord	4	4	i	0.30A	i	0.28B	i	i	0.05B	i	i	i	i	i	<0.56a	0.12b	0.27a	4.83b	i	II
Iddefjord	2	2	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Oslofjord	5	5	i	i	i	0.15A	i	i	0.01A	i	i	i	644.30c	3.30c	1.08a	<0.05a	0.30a	20.86c	i	III
Frierfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	0.26a	2.20d	0.19a	4.18b	i	IV
Inner Kristiansandsfjord	2	2	i	i	i	i	i	i	i	i	i	i	540.90c	17.00d	0.61a	17.55e	1.32b	6.64b	i	V
Saudafjord	1	2	i	0.75B	i	0.15A	i	i	i	i	i	i	884.70c	35.00e	i	i	i	i	i	V
Sørfjorden	2	2	i	8.80D	i	3.82D	i	i	0.13C	i	i	i	i	i	4.08b	<0.05a	0.60a	1.92a	i	IV
Byfjorden, Bergen	3	3	i	i	i	i	i	i	i	i	i	i	i	i	s8.00c	0.17b	1.03b	30.72c	i	III
Sunndalsfjord	2	2	i	i	i	i	i	i	i	i	i	i	<287.50c	3.80c	i	i	i	i	i	III
Orkdalsfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Ranfjord	2	2	i	1.03B	i	0.12A	i	i	i	i	i	i	298.70c	6.20c	i	i	i	i	i	III
Count			0	4	0	5	0	0	3	0	0	0	5	5	6	6	6	6	0	9
Min			.	0.30A	.	0.12A	.	.	0.01A	.	.	.	<287.50c	3.30c	0.26a	<0.05a	0.19a	1.92a	.	II
Max			.	8.80D	.	3.82D	.	.	0.13C	.	.	.	884.70c	35.00e	s8.00c	17.55e	1.32b	30.72c	.	V
Mean			.	2.72C	.	0.90C	.	.	0.07B	.	.	.	<531.22c	13.06d	s<2.43b	<3.36d	0.62a	11.53b	.	3.6

i (141) ! Value ignored when calculating Environment Class.
a/A(24) > Below Class-I limit.
b/B(16) > Below Class-II limit.
c/C(21) > Below Class-III limit.
d/D(8) > Below Class-IV limit.
e/E(4) > Below Class-V limit.

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (PollutionAreas) ·1997	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	Max E.C I:V
Hvaler/Singlefjord	4	4	i	0.20A	i	0.31B	i	i	0.06B	i	i	i	i	i	1.14a	0.13b	0.42a	5.61b	i	II
Iddefjord	0	2	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Oslofjord	5	5	i	i	i	0.16A	i	i	0.01A	i	i	i	<400.60c	3.50c	12.08d	0.13b	0.79a	33.81c	i	IV
Frierfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	0.65a	0.83c	0.26a	<2.68a	i	III
Inner Kristiansandsfjord	2	2	i	i	i	i	i	i	i	i	i	i	352.40c	9.10c	1.22a	7.59e	0.81a	<6.00b	i	V
Saudafjord	2	2	i	1.28B	i	0.24A	i	i	i	i	i	i	2721.90d	108.00e	i	i	i	i	i	V
Sørfjorden	2	2	i	3.09C	i	2.01C	i	i	0.04B	i	i	i	i	i	5.07c	<0.05a	0.29a	<2.71a	i	III
Byfjorden, Bergen	3	3	i	i	i	i	i	i	i	i	i	i	i	i	2.94b	0.12b	0.40a	24.54c	i	III
Sunndalsfjord	1	2	i	i	i	i	i	i	i	i	i	i	<238.90c	1.40b	i	i	i	i	i	III
Orkdalsfjord	0	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Ranfjord	2	2	i	0.52B	i	0.09A	i	i	i	i	i	i	<131.40b	3.10c	i	i	i	i	i	III
Count			0	4	0	5	0	0	3	0	0	0	5	5	6	6	6	6	0	9
Min			.	0.20A	.	0.09A	.	.	0.01A	.	.	.	<131.40b	1.40b	0.65a	<0.05a	0.26a	<2.68a	.	II
Max			.	3.09C	.	2.01C	.	.	0.06B	.	.	.	2721.90d	108.00e	12.08d	7.59e	0.81a	33.81c	.	V
Mean			.	1.27B	.	0.56B	.	.	0.04B	.	.	.	<769.04c	25.02d	3.85b	<1.48d	0.50a	<12.56b	.	3.4

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i  ( 141) ! Value ignored when calculating Environment Class.
a/A(  26) > Below Class-I   limit.
b/B(  21) > Below Class-II  limit.
c/C(  16) > Below Class-III limit.
d/D(   6) > Below Class-IV  limit.
e/E(   4) > Below Class-V   limit.
```

Missing INDEX Areas and their programmed stations:

Iddefjord................: I001,I011
Orkdalsfjord.............: 82A,84A,87A

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Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (PollutionAreas) · 1998	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	**Max E.C I:V**
Hvaler/Singlefjord	4	4	i	0.20A	i	0.30B	i	i	0.07C	i	i	i	i	i	1.13a	0.05a	<0.23a	<4.42b	i	III
Iddefjord	0	2	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Oslofjord	5	5	i	i	i	0.21A	i	i	0.01A	i	i	i	<147.30b	1.00b	2.34b	0.13b	0.59a	13.75b	i	II
Frierfjord	3	3	i	i	i	i	i	i	i	i	i	i	i	i	<0.63a	0.69c	0.41a	3.18a	i	III
Inner Kristiansandsfjord	2	2	i	i	i	i	i	i	i	i	i	i	<278.20c	3.80c	0.53a	7.20e	<0.65a	<5.09b	i	V
Saudafjord	2	2	i	0.77B	i	0.15A	i	i	i	i	i	i	<548.20c	9.80c	i	i	i	i	i	III
Sørfjorden	2	2	i	5.41C	i	1.83C	i	i	i	i	i	i	i	i	s6.20c	0.07a	0.51a	2.04a	i	III
Byfjorden, Bergen	3	3	i	i	i	i	i	i	0.10C	i	i	i	i	i	s3.04b	0.16b	0.79a	10.87b	i	II
Sunndalsfjord	1	2	i	i	i	i	i	i	i	i	i	i	<175.40b	1.00b	i	i	i	i	i	II
Orkdalsfjord	0	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	Miss
Inner Ranfjord	2	2	i	0.54A	i	0.12A	i	i	i	i	i	i	254.30c	12.00d	i	i	i	i	i	IV
Count			0	4	0	5	0	0	3	0	0	0	5	5	6	6	6	6	0	9
Min			.	0.20A	.	0.12A	.	.	0.01A	.	.	.	<147.30b	1.00b	0.53a	0.05a	<0.23a	2.04a	.	II
Max			.	5.41C	.	1.83C	.	.	0.10C	.	.	.	<548.20c	12.00d	s6.20c	7.20e	0.79a	13.75b	.	V
Mean			.	1.73B	.	0.52B	.	.	0.06C	.	.	.	<280.68c	5.52c	s<2.31b	1.38d	<0.53a	<6.56b	.	s3.0

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i   ( 141) ! Value ignored when calculating Environment Class.
a/A(  28) > Below Class-I   limit.
b/B(  21) > Below Class-II  limit.
c/C(  19) > Below Class-III limit.
d/D(   3) > Below Class-IV  limit.
e/E(   2) > Below Class-V   limit.
```

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Missing INDEX Areas and their programmed stations:

Iddefjord................: I001,I011
Orkdalsfjord.............: 82A,84A,87A

Appendix J6.
INDEX - Summary table "Reference Index" 1995-1998

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (ReferenceAreas) · 1995	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	Max E.C I:V
Mid and outer Oslofjord	3	3	w	0.27A	w	0.25A	i	w	0.01A	w	i	w	w	w	<0.95a	0.07a	0.40a	7.86b	i	II
Lista	2	2	w	0.12A	w	0.33A	i	w	0.02A	w	i	w	<30.80a	0.50a	<0.34a	0.05a	0.38a	<1.28a	i	I
Bømlo-Sotra	1	1	w	0.22A	w	0.28A	i	w	0.01A	w	i	w	w	w	<0.46a	<0.05a	0.31a	<1.38a	i	I
Outer Ranfjord, Helgeland	1	1	w	0.18A	w	0.15A	i	w	0.01A	w	i	w	<36.60a	<0.50a	0.21a	<0.05a	0.38a	<0.90a	i	I
Lofoten	1	2	w	0.47B	w	0.11A	i	w	0.05B	w	i	w	w	w	4.20b	<0.05a	0.15a	12.31b	i	II
Finnsnes-Skjervøy	1	1	w	0.18A	w	0.56B	i	w	0.01A	w	i	w	w	w	<0.18a	<0.05a	0.16a	<0.81a	i	II
Hammerfest-Honningsvåg	2	2	w	0.47A	w	0.51B	i	w	0.01A	w	i	w	<125.60b	0.70a	<0.23a	<0.05a	<0.15a	<1.34a	i	II
Varanger Peninsula	3	3	w	0.57A	w	0.32A	i	w	0.02A	w	i	w	<6.80a	<0.50a	<0.36a	<0.05a	0.16a	<0.88a	i	I
Count			0	8	0	8	0	0	8	0	0	0	4	4	8	8	8	8	0	8
Min			.	0.12A	.	0.11A	.	.	0.01A	.	.	.	<6.80a	<0.50a	<0.18a	<0.05a	<0.15a	<0.81a	.	I
Max			.	0.57B	.	0.56B	.	.	0.05B	.	.	.	<125.60b	0.70a	4.20b	0.07a	0.40a	12.31b	.	II
Mean			.	0.31A	.	0.31A	.	.	0.02A	.	.	.	<49.95a	<0.55a	<0.87a	<0.05a	<0.26a	<3.34a	.	1.5

i (24) ! Value ignored when calculating Environment Class.
w (48) ! Missing value. Should be included when calculating Environment Class E.C
a/A(77) > Below Class-I limit.
b/B(14) > Below Class-II limit.

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (ReferenceAreas) . 1996	n	N	AS ppm w.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm w.wt	HG ppm w.wt	NI ppm w.wt	ZN ppm d.wt	AG ppm w.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	Max E.C I:V
Mid and outer Oslofjord	3	3	1.66A	0.39A	w	0.29A	i	0.11A	0.01A	0.20A	i	0.03A	w	w	<0.25a	<0.05a	0.25a	13.95b	i	II
Lista	2	2	w	0.11A	w	0.20A	i	w	0.01A	w	i	w	<44.10a	<0.50a	<0.20a	0.05a	0.29a	<2.14a	i	I
Bømlo-Sotra	1	1	w	0.25A	w	0.19A	i	w	0.01A	w	i	w	w	w	<0.11a	<0.05a	<0.14a	<0.78a	i	I
Outer Ranfjord, Helgeland	1	1	w	0.17A	w	0.16A	i	w	0.01A	w	i	w	w	w	<0.12a	<0.05a	0.21a	<0.62a	i	I
Lofoten	1	2	w	0.79B	w	0.15A	i	w	0.06B	w	i	w	w	w	<1.15a	<0.05a	<0.13a	8.90b	i	II
Finnsnes-Skjervøy	1	1	w	0.13A	w	0.28A	i	w	0.01A	w	i	w	<23.45a	<0.50a	<0.05a	<0.05a	<0.05a	<0.40a	i	I
Hammerfest-Honningsvåg	2	2	w	0.29A	w	0.48B	i	w	0.01A	w	i	w	<210.00c	0.80a	<0.11a	<0.05a	<0.11a	<1.59a	i	III
Varanger Peninsula	3	3	w	0.15A	w	0.47B	i	w	0.01A	w	i	w	<20.30a	<0.50a	<0.14a	<0.05a	0.14a	<0.98a	i	II
Count			1	8	0	8	0	1	8	1	0	1	4	4	8	8	8	8	0	8
Min			1.66A	0.11A	.	0.15A	.	0.11A	0.01A	0.20A	.	0.03A	<20.30a	<0.50a	<0.05a	<0.05a	<0.05a	<0.40a	.	I
Max			1.66A	0.79B	.	0.48B	.	0.11A	0.06B	0.20A	.	0.03A	<210.00c	0.80a	<1.15a	0.05a	0.29a	13.95b	.	III
Mean			1.66A	0.29A	.	0.28A	.	0.11A	0.02A	0.20A	.	0.03A	<74.46b	<0.58a	<0.27a	<0.05a	<0.17a	<3.67a	.	1.6

i (24) ! Value ignored when calculating Environment Class.
w (44) ! Missing value. Should be included when calculating Environment Class E.C
a/A(94) > Below Class-I limit.
b/B(11) > Below Class-II limit.
c/C(2) > Below Class-III limit.

169

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (ReferenceAreas) · 1997	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	**Max E.C I:V**
Mid and outer Oslofjord	3	3	w	0.38A	w	0.30A	i	w	0.01A	w	i	w	w	w	2.75b	0.12b	1.16b	4.90b	i	II
Lista	2	2	w	0.22A	w	0.22A	i	w	0.01A	w	i	w	<36.00a	<0.50a	0.58a	<0.05a	0.53a	2.43a	i	I
Bømlo-Sotra	1	1	w	0.23A	w	0.17A	i	w	0.01A	w	i	w	w	w	<0.39a	<0.05a	0.26a	<0.73a	i	I
Outer Ranfjord, Helgeland	0	1	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	i	Miss
Lofoten	1	2	w	0.23A	w	0.13A	i	w	0.02A	w	i	w	w	w	0.61a	<0.05a	0.14a	<1.57a	i	I
Finnsnes-Skjervøy	1	1	w	0.11A	w	0.31A	i	w	0.01A	w	i	w	w	w	<0.15a	<0.05a	0.12a	<0.40a	i	I
Hammerfest-Honningsvåg	1	2	w	0.18A	w	0.24A	i	w	0.01A	w	i	w	w	w	0.27a	0.05a	0.18a	<4.49b	i	II
Varanger Peninsula	2	3	w	0.14A	w	0.18A	i	w	0.02A	w	i	w	w	w	0.33a	0.05a	0.13a	<1.07a	i	I
Count			0	7	0	7	0	0	7	0	0	0	1	1	7	7	7	7	0	7
Min			.	0.11A	.	0.13A	.	.	0.01A	.	.	.	<36.00a	<0.50a	<0.15a	<0.05a	0.12a	<0.40a	.	I
Max			.	0.38A	.	0.31A	.	.	0.02A	.	.	.	<36.00a	<0.50a	2.75b	0.12b	1.16b	4.90b	.	II
Mean			.	0.21A	.	0.22A	.	.	0.01A	.	.	.	<36.00a	<0.50a	<0.73a	<0.06a	0.36a	<2.23a	.	1.3

i (24) ! Value ignored when calculating Environment Class.
w (61) ! Missing value. Should be included when calculating Environment Class E.C
a/A(69) > Below Class-I limit.
b/B(9) > Below Class-II limit.

Missing INDEX Areas and their programmed stations:

Outer Ranfjord, Helgeland: R096

Max(Median). Statistics om ALL AREAs: (n = INDEX-Stations measured, N = Station programmed for INDEX)

INDEX.AreaNames (ReferenceAreas) · 1998	n	N	AS ppm d.wt	Pb ppm w.wt	F ppm d.wt	CD ppm w.wt	CU ppm d.wt	CR ppm d.wt	HG ppm w.wt	NI ppm d.wt	ZN ppm d.wt	AG ppm d.wt	PAH_Σ ppb w.wt	BAP ppb w.wt	DDTΣΣ ppb w.wt	HCB ppb w.wt	HCHΣΣ ppb w.wt	CBΣΣe ppb w.wt	TCDDN ppp w.wt	Max E.C I:V
Mid and outer Oslofjord	3	3	w	0.33A	w	0.20A	i	w	0.01A	w	i	w	w	w	<1.30a	0.03a	<0.52a	<2.01a	i	I
Lista	2	2	w	0.24A	w	0.20A	i	w	0.02A	w	i	w	<41.70a	<0.50a	0.60a	<0.03a	<0.53a	3.58a	i	I
Bømlo-Sotra	1	1	w	0.23A	w	0.16A	i	w	0.01A	w	i	w	w	w	<1.77a	<0.03a	<0.51a	<2.05a	i	I
Outer Ranfjord, Helgeland	0	1	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	i	Miss
Lofoten	1	2	w	0.38A	w	0.25A	i	w	0.02A	w	i	w	w	w	<2.28b	<0.05a	<0.20a	<1.21a	i	II
Finnsnes-Skjervøy	0	1	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	i	Miss
Hammerfest-Honningsvåg	0	2	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	i	Miss
Varanger Peninsula	1	3	w	0.39A	w	0.38B	i	w	0.01A	w	i	w	w	w	w	w	w	w	i	II
Count			0	5	0	5	0	0	5	0	0	0	1	1	4	4	4	4	0	5
Min			.	0.23A	.	0.16A	.	.	0.01A	.	.	.	<41.70a	<0.50a	0.60a	<0.03a	<0.20a	<1.21a	.	I
Max			.	0.39A	.	0.38B	.	.	0.02A	.	.	.	<41.70a	<0.50a	<2.28b	<0.05a	<0.53a	3.58a	.	II
Mean			.	0.31A	.	0.24A	.	.	0.01A	.	.	.	<41.70a	<0.50a	<1.49a	<0.04a	<0.44a	<2.21a	.	1.4

i (24) ! Value ignored when calculating Environment Class.
w (79) ! Missing value. Should be included when calculating Environment Class E.C
a/A(56) > Below Class-I limit.
b/B(4) > Below Class-II limit.

Missing INDEX Areas and their programmed stations:

Outer Ranfjord, Helgeland: R096
Finnsnes-Skjervøy........: 41A
Hammerfest-Honningsvåg...: 46A,44A

Appendix K
Biological effects methods summary results 1997-1998

Table 8. Summary statistics for biological effects parameters measured in cod, 1997 and 1998.

Station:	36B	15B	23B	30B	53B	67B
1997						
count	21	25	22	16	25	25
Weight, median	**1.1**	**1.4**	**1.3**	**0.8**	**1.2**	**1.1**
Weight, st.dev.	0.4	0.5	0.3	0.3	0.3	0.5
380 nm, median	**966.7**	**628.0**	**674.4**	**--**	**410.0**	**663.4**
380 nm, st.dev.	806.1	173.1	363.0	–	395.9	286.8
microsomal protein (mg/mL), median	**8.5**	**5.3**	**6.1**	**3.9**	**6.6**	**6.4**
microsomal protein (mg/mL), st.dev.	2.6	2.6	2.2	2.2	1.4	1.6
cytosol protein (mg/mL), median	**16.8**	**13.3**	**14.4**	**8.5**	**17.9**	**17.4**
cytosol protein (mg/mL), st.dev.	5.5	6.5	6.1	4.6	4.1	5.1
OH-pyrene/380 nm, median	**22.5**	**265.1**	**15.9**	**--**	**113.3**	**71.1**
OH-pyrene/380 nm, st.dev.	12.9	1073.1	12.5	–	72.6	29.5
ALA-D (µg pbg/min/mg protein), median	**3.6**	**4.5**	**4.2**	**2.4**	**2.0**	**1.9**
ALA-D (µg pbg/min/mg protein), st.dev.	1.2	1.7	1.3	1.6	1.6	2.1
EROD (pmol/min/mg protein), median	**110.0**	**44.5**	**94.1**	**68.8**	**429.6**	**103.4**
EROD (pmol/min/mg protein), st.dev.	53.4	61.6	27.4	38.8	376.7	51.9
MT (µg/mg protein), median	**0.9**	**2.1**	**1.1**	**1.3**	**0.4**	**1.5**
MT (µg/mg protein), st.dev.	0.8	3.3	2.8	1.7	1.5	1.3
1998						
count	27	25	25	30	30	30
Weight, median	**0.6**	**1.1**	**1.2**	**1.0**	**1.1**	**0.5**
Weight, st.dev.	0.2	0.3	0.5	0.1	0.4	0.5
380 nm, median	**26.1**	**23.4**	**42.0**	**15.3**	**16.9**	**18.4**
380 nm, st.dev.	15.0	11.4	25.2	9.5	8.5	11.3
microsomal protein (mg/mL), median	**1.6**	**3.2**	**2.7**	**3.6**	**2.8**	**1.2**
microsomal protein (mg/mL), st.dev.	0.9	1.7	1.8	1.6	1.4	1.3
cytosol protein (mg/mL), median	**5.3**	**10.4**	**8.0**	**10.2**	**9.1**	**3.1**
cytosol protein (mg/mL), st.dev.	2.2	4.3	5.8	2.9	4.2	4.4
OH-pyrene/380 nm, median	**42.7**	**3770.4**	**12.7**	**115.4**	**83.0**	**20.5**
OH-pyrene/380 nm, st.dev.	16.9	3625.4	26.8	33.6	172.1	11.5
ALA-D (µg pbg/min/mg protein), median	**3.3**	**2.9**	**3.0**	**1.9**	**1.2**	**3.4**
ALA-D (µg pbg/min/mg protein), st.dev.	2.2	2.9	1.4	0.8	1.0	2.9
EROD (pmol/min/mg protein), median	**9.1**	**14.8**	**20.2**	**33.0**	**39.7**	**60.8**
EROD (pmol/min/mg protein), st.dev.	18.2	25.2	20.8	32.8	31.9	44.0
MT (µg/mg protein), median	**1.2**	**1.4**	**2.5**	**1.3**	**1.6**	**1.7**
MT (µg/mg protein), st.dev.	0.8	1.8	1.6	0.6	1.0	1.2

Table 9. Results from ANOVA with ALA-D activity in blood cells as dependent variable and indicated explanatory variables. For the entire model, adjusted $R^2 = 0.22$, $p < 0.0001$, n=300.

Factor	DF	F ratio	probability
Year (1997-1998)	1	0.19	0.66
Site	5	7.4	<0.0001
Interaction (year*site)	5	4.7	0.0004

Table 10. Results from ANOVA with EROD activity (log-transformed) in liver as dependent variable and indicated explanatory variables. For the entire model, adjusted $R^2 = 0.35$, $p < 0.0001$, n=277.

Factor	DF	F ratio	probability
Year (1997-1998)	1	95	<0.0001
Site	5	4.7	0.0004
Interaction (year*site)	5	4.5	0.0006

Table 11. Results from ANOVA with MT concentration (log-transformed) in liver as dependent variable and indicated explanatory variables. For the entire model, adjusted $R^2 = 0.15$, $p < 0.0001$, n=283.

Factor	DF	F ratio	probability
Year (1997-1998)	1	5.4	0.02
Site	5	8.4	<0.0001
Interaction (year*site)	5	5.7	<0.0001

Appendix L
Effects and concentrations of organotin 1998

Table 12. Imposex (VDSI, RPSI) and levels of organotin (µg Sn/kg d.w.) in dogwhelks (*Nucella lapillus*) in Haugesund (st. 224G, 226G, 227G, 220G, 221G) and Outer Oslofjord (36G), 1998. ∑BT = TBT+DBT+MBT, SH = avg. shell height in mm, PS = avg. penis length in mm, nm = not measured. (cf. Appendix F, maps 2 and 5).

St.	Area	Sex	SH	TBT	∑BT	TPhT	VDSI	PS	RPSI
224G	Heggjelen	F/M	28.4/27.6	121/nm	154/nm	35/nm	4.3	2.2/3.1	35.2
226G	Karmsund bridge (east)	F/M	27.3/27.6	346/nm	427/nm	63/nm	4	3.4/3.4	40.5
227G	Melandholmen	F/M	27.7/27.8	256/nm	351/nm	48/nm	4.1	3.1/3.4	44.4
220G	Smørstakk	F/M	32.2/31.2	41/nm	65/nm	10/nm	4	3.1/4.1	23.6
221G	Stangeland	F/M	28.2/28.7	317/nm	405/nm	58/nm	4	3.3/3.7	52.8
36G	Færder	F/M	30.5/29.1	83/nm	130/nm	15/nm	4	2.4/4.7	9.7

Table 13. Levels of organotin (µg Sn/kg d.w.) in mussels (*Mytilus edulis*) at five stations in Southern Norway; Oslofjord (st.30A, 36A) and Haugesund area (st.226X, 227A, 221A) in 1998. Sh.length = avg. shell length in mm, ∑BT = TBT+DBT+MBT. Class condition for TBT on a dry weight basis in the Norwegian classification system for environmental quality (cf.Table 5) (cf. Appendix F, maps 2 and 5).

St.	Area	Sh. length	TBT	∑BT	TPhT	TBT* (ppm)	Class
30A	Gressholmen	34.9	760	990	118	**1.9**	III
30A	Gressholmen	43.8	505	777	100	**1.2**	III
36A	Færder	34.7	76	110	<10	**0.2**	II
36A	Færder	44.3	71	108	<10	**0.2**	II
226X	Karmsund bridge (east)	28.5	660	836	<10	**1.6**	III
227(a)	Melandholmen	40.4	551	761	<10	**1.3**	III
227(b)	Melandholmen	38.9	584	769	<10	**1.4**	III
221(a)	Stangeland	37.7	738	1126	68	**1.8**	III
221(b)	Stangeland	40.7	840	1133	60	**2.0**	IV

*) TBT ppb dw converted to formulation basis ppm dw by a factor of 2.44/1000.

Appendix M
Dioxins and other persistent halogenated chlorine and bromine compounds in cod liver 1996

Table 14. Summary of results from analysis of dioxins and other persistant halogentated chlorine and bromine compounds including: dioxin-like PCBs/PCNs and other organochlorines and organobromines in four homogenate samples of cod liver collected for JAMP in 1996.

Substances	**St. 36B Færder**	**St. 15B Lista**	**St. 23B Karihavet**	**St. 98B Lofoten**
% lipid	42.3	40.5	63.1	66.8
PCBs, pesticides, HCB and OCS				
ΣPCB$_{32}$ 3) µg/kg w.w.	2165	583	299	645
ΣPCB$_{7}$ 4) µg/kg w.w.	1329	385	199	330
α-HCH µg/kg w.w.	5.5	4.2	5.6	6.5
γ-HCH µg/kg w.w.	9.4	9.1	11	5.3
QCB µg/kg w.w.	<1	<1	<2	<2
HCB µg/kg w.w.	9.5	12	9.3	39
OCS µg/kg w.w.	<1	<1	<2	<2
Trans-heptachloro-epoxide µg/kg w.w.	8.8	4.5	<3	4.7
Trans-chlordane µg/kg w.w.	<3	<3	<4	10
Cis-chlordane µg/kg w.w.	8.0	5.9	8.9	40
Trans-nonachlor µg/kg w.w.	24	18	17	71
Σ chlordanes 5) µg/kg w.w.	42	30	30	126
DDTPP µg/kg w.w.	24	13	15	30
DDTOP µg/kg w.w.	15	14	11	54
DDEPP µg/kg w.w.	130	92	55	130
DDEOP µg/kg w.w.	<3	<3	<4	<4
TDEPP µg/kg w.w.	35	22	18	36
TDEOP µg/kg w.w.	<3	<3	<4	<4
ΣDDT 5) µg/kg w.w.	208	144	103	254
% lipid	45.2	40	67.7	75.2
Dioxin and dioxin-like PCBs and PCNs				
TEQ-PCDD/F ng/kg w.w.	9.93	10.75	9.19	8.43
TEQ-non-ortho-PCB ng/kg w.w. 1)	88.4	36.98	21.09	39.18
TEQ-mono-ortho-PCB ng/kg w.w. 2)	49.75	11.2	5.96	11.1
TEQ-PCB ng/kg w.w.	138.15	48.18	27.05	50.28
TEQ-PCN ng/kg w.w.	1.03	0.52	0.23	0.24
ΣTEQ ng/kg w.w.	149.11	59.45	36.47	58.95
ΣTEQ ng/kg l.w.	329.9	148.6	53.9	78.4
Brominated flame retardents				
4,4`-DiBB ng/kg w.w.	<100 6)	<2 6)	7 7)	<4 6)
2,2`,5,5`TeBB ng/kg w.w.	20 7)	18 7)	16 7)	6 7)
2,2`,4,4`,5,5`HxBB ng/kg w.w.	<850 7)	<300 6)	<1000 6)	<600 7)
2,2`,4,4`TeBDE ng/kg w.w.	32300	48800	19500	15000
2,2`,4,4`,5PeBDE ng/kg w.w.	784	517 7)	830 7)	768 7)

Appendix M, Table 14 (cont.)

Substances	**St. 36B Færder**	**St. 15B Lista**	**St. 23B Karihavet**	**St. 98B Lofoten**
% lipid	45.2	40	67.7	75.2
Toxaphene				
Parlar no. 26 µg/kg w.w.	14.7	17.4	10.9	69.2
Parlar no. 32 µg/kg w.w.	0.2	0.1	0.3 [7,8]	3.2 [7]
Parlar no. 50 µg/kg w.w.	17.5	21	15.2	118
Parlar no. 62 µg/kg w.w.	146 [7]	45.3	30	68
ΣTOX µg/kg w.w.	178	83.7	56.1	255
ΣTOX µg/kg l.w.	393	209	83	339
Extractable organic chlorine and bromine				
EOCl µg/kg w.w. [9]	113100	64660	32260	23490
EPOCl µg/kg w.w. [9,10]	18860	9810	6450	5260
EOBr µg/kg w.w. [9]	7760	5860	7730	3210
EPOBr µg/kg w.w. [9,10]	1230	1400	2880	1110

[1] CB-77, -126, -169

[2] CB-105, -118, -156, -157, -189 (less than detection limit)

[3] ΣPCB_{32} includes CB: 18, 28*, 31, 44, 47, 49, 52*, 66, 74, 87, 99, 101*, 105*, 110, 118*, 126, 128, 138*, 141, 149, 151, 153*, 156*, 157, 170, 180*, 183, 187, 189, 194, 206, and 209*. * indicates the 10 that are usually monitored.

[4] ΣPCB_{7} includes CB: 28, 52, 101, 118, 138, 153, 180

[5] Half detection limit used in summation

[6] Less than detection limit at signal:noise 3:1

[7] Below 10 times blind value

[8] Isotope ratio deviating more than 20 % from theoretical value

[9] Recalculated from dry weight basis

[10] Sulfuric acid resistant fractions (EPOCl/EPOBr)

Appendix N
Sediment investigations of Southern Norway 1996-1997

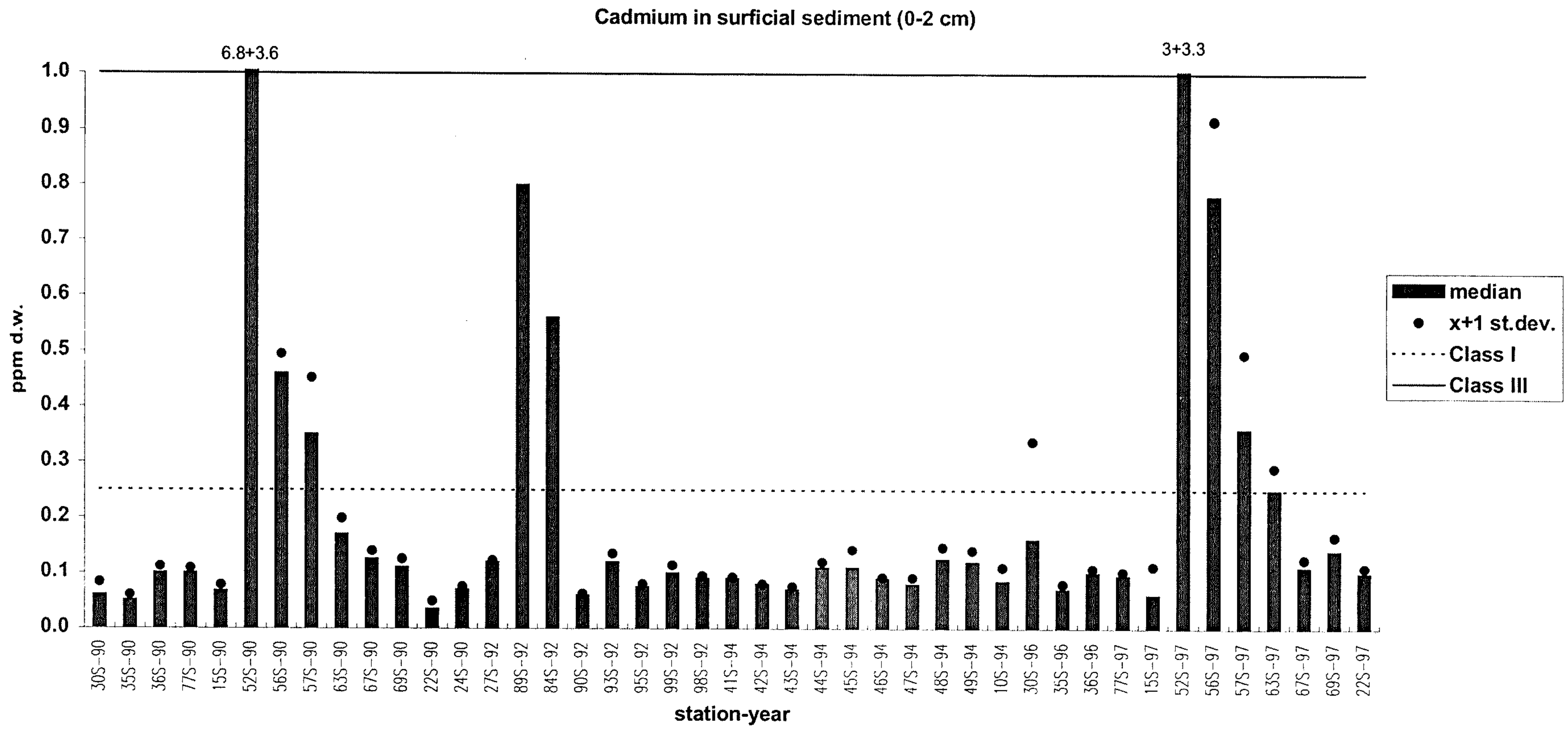

Figure 45. Median, standard deviation and provisional "high background" concentration (Class I) for cadmium in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

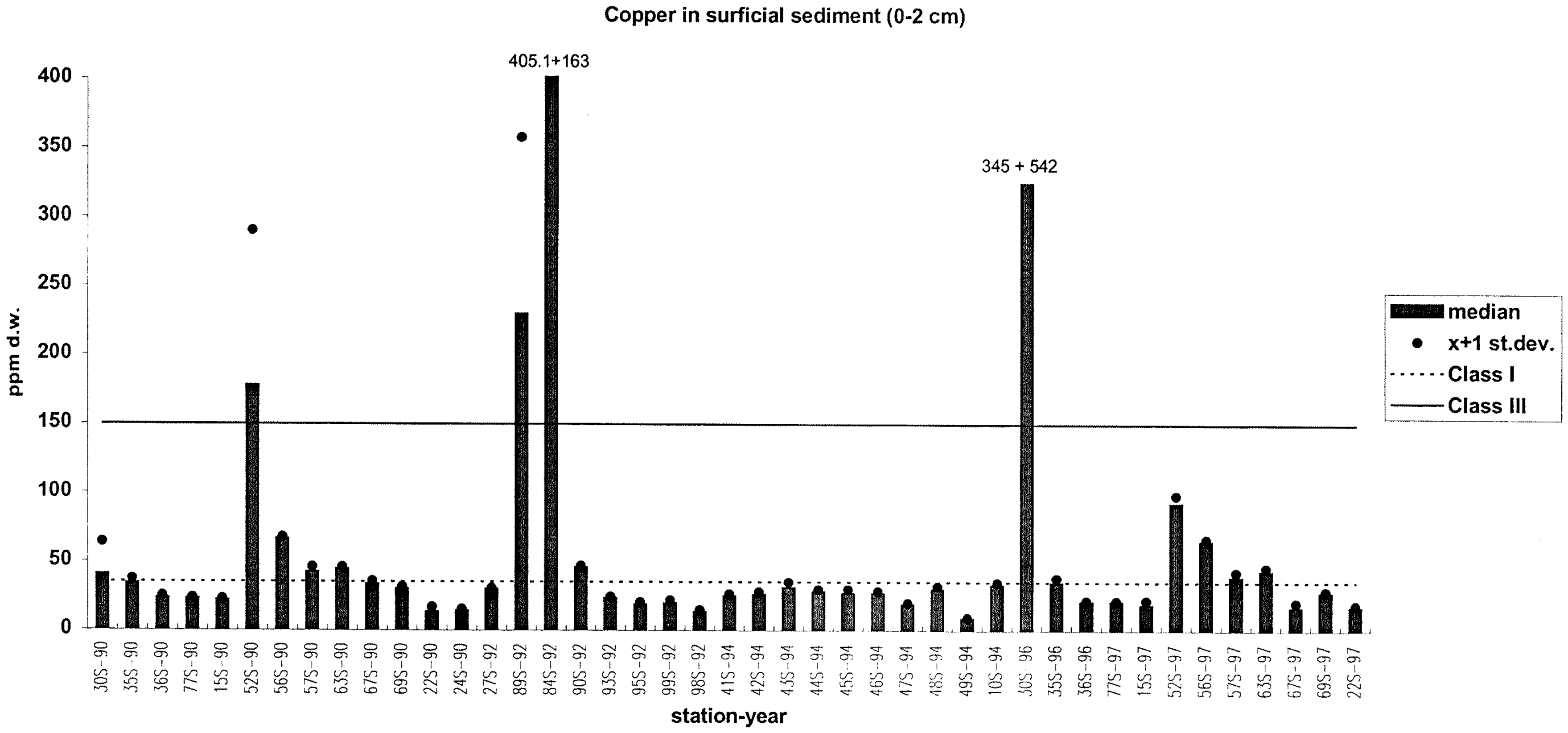

Figure 46. Median, standard deviation and provisional "high background" concentration (Class I) for copper in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

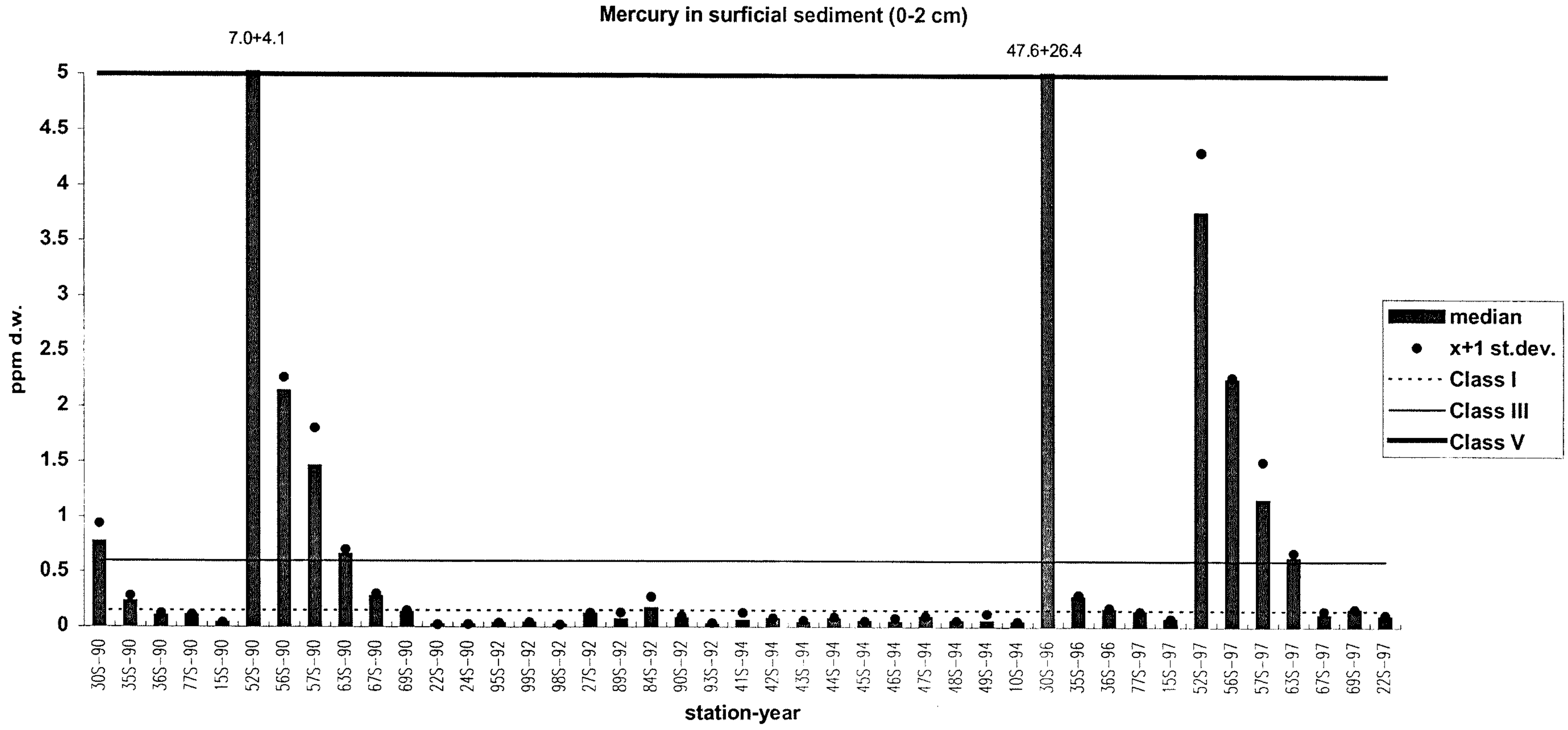

Figure 47. Median, standard deviation and provisional "high background" concentration (Class I) for mercury in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

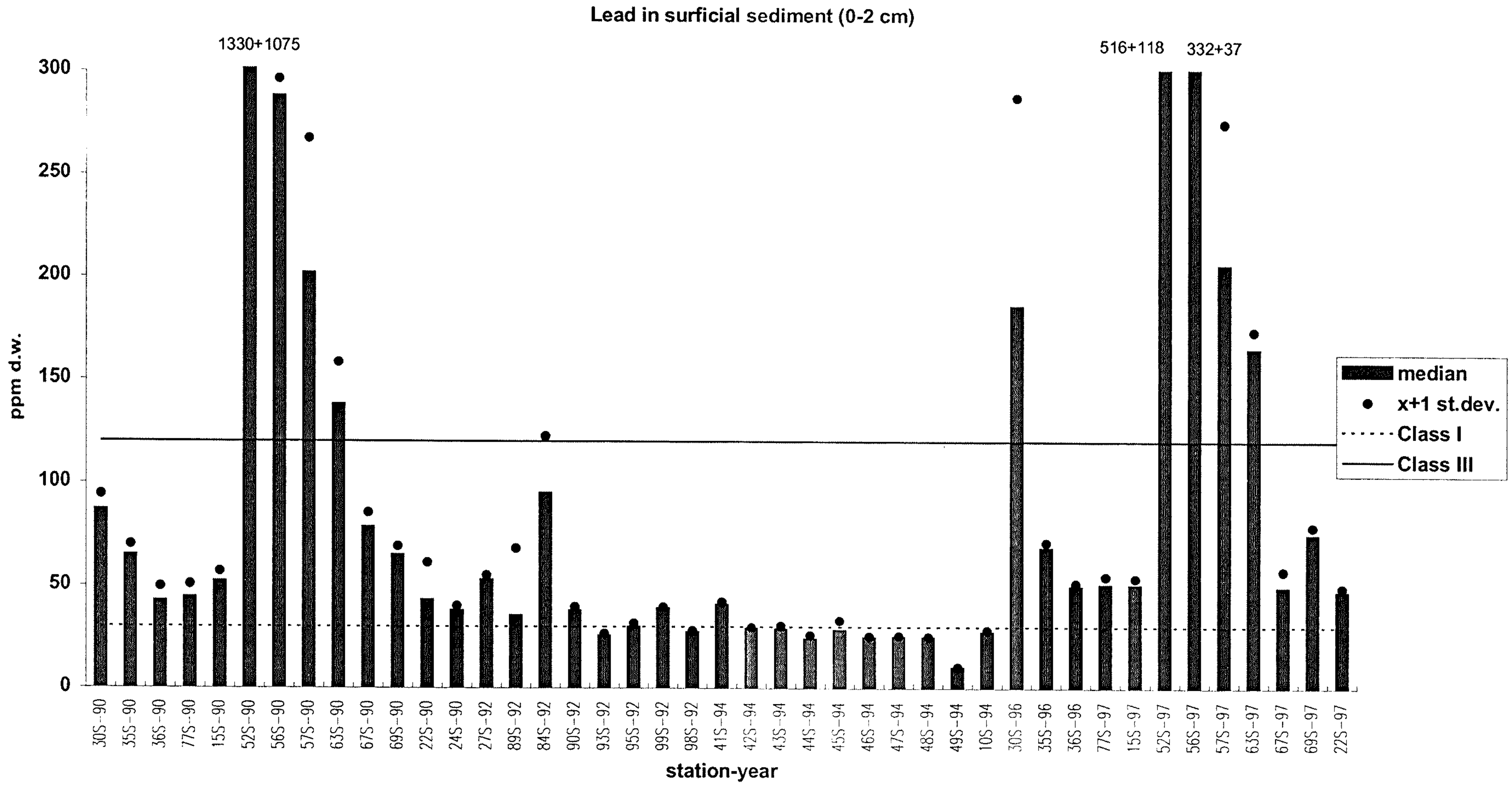

Figure 48. Median, standard deviation and provisional "high background" concentration (Class I) for lead in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

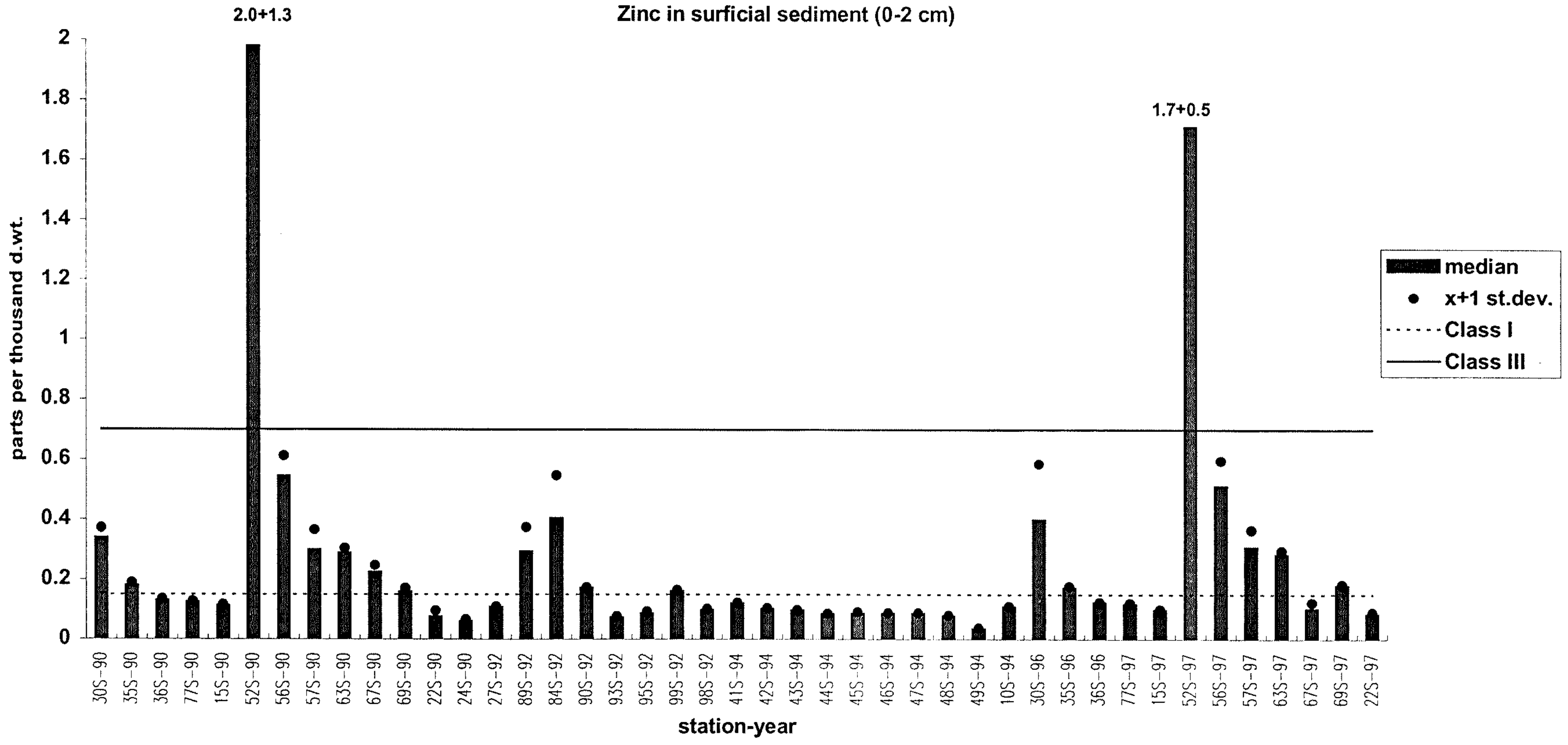

Figure 49. Median, standard deviation and provisional "high background" concentration (Class I) for zinc in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

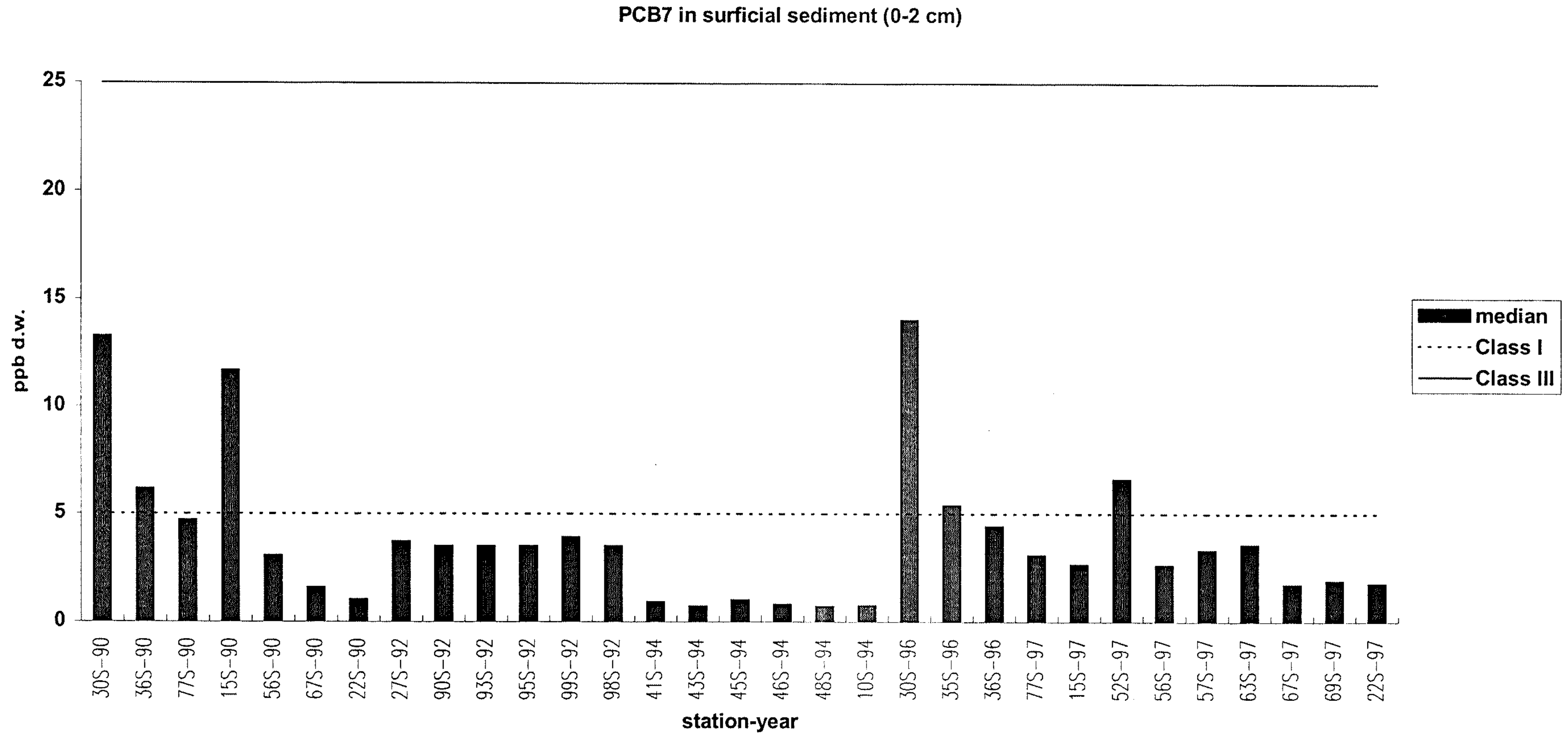

Figure 50. Median and provisional "high background" concentration (Class I) for ΣPCB7, sum of seven PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

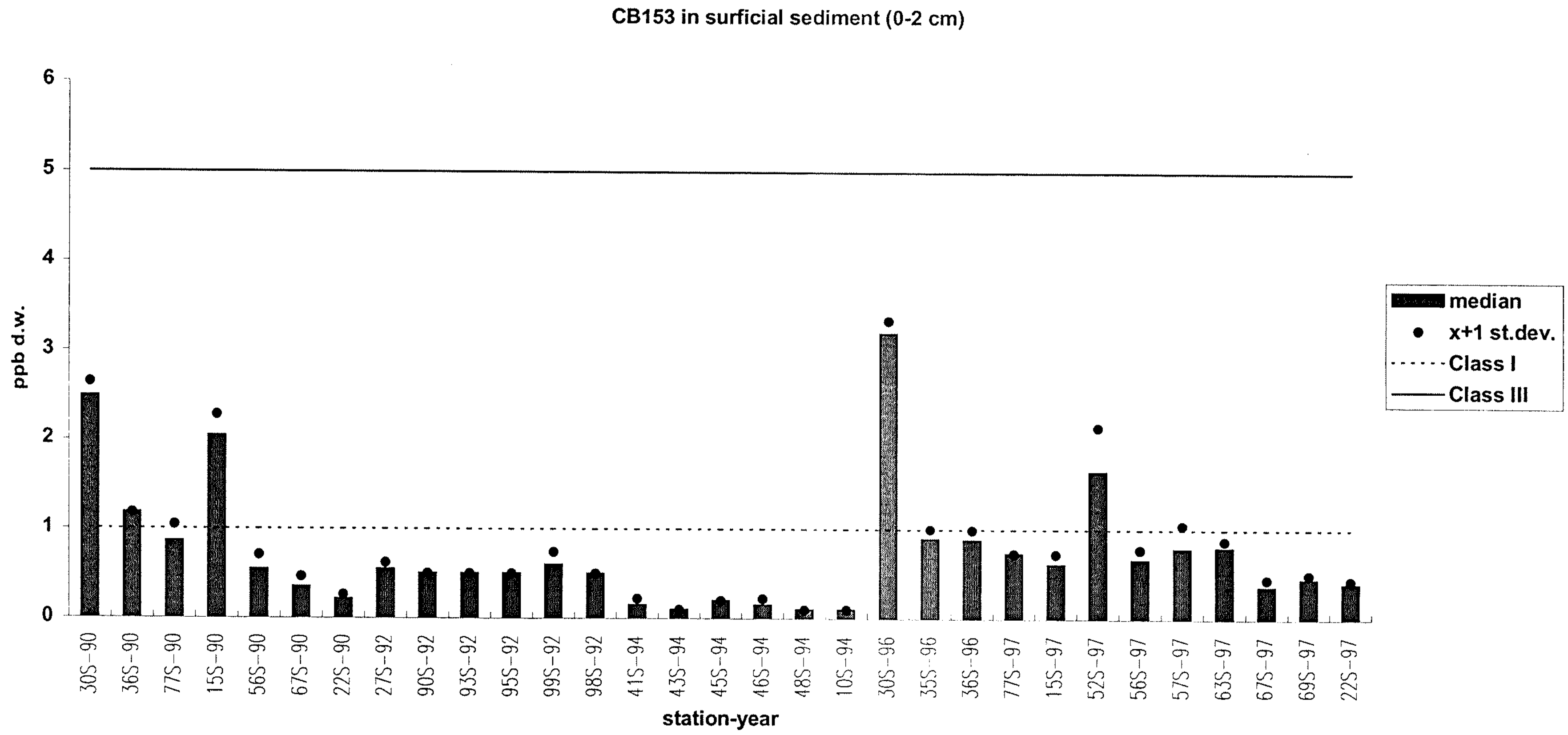

Figure 51. Median, standard deviation and provisional "high background" concentration (Class I) for CB-153 in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

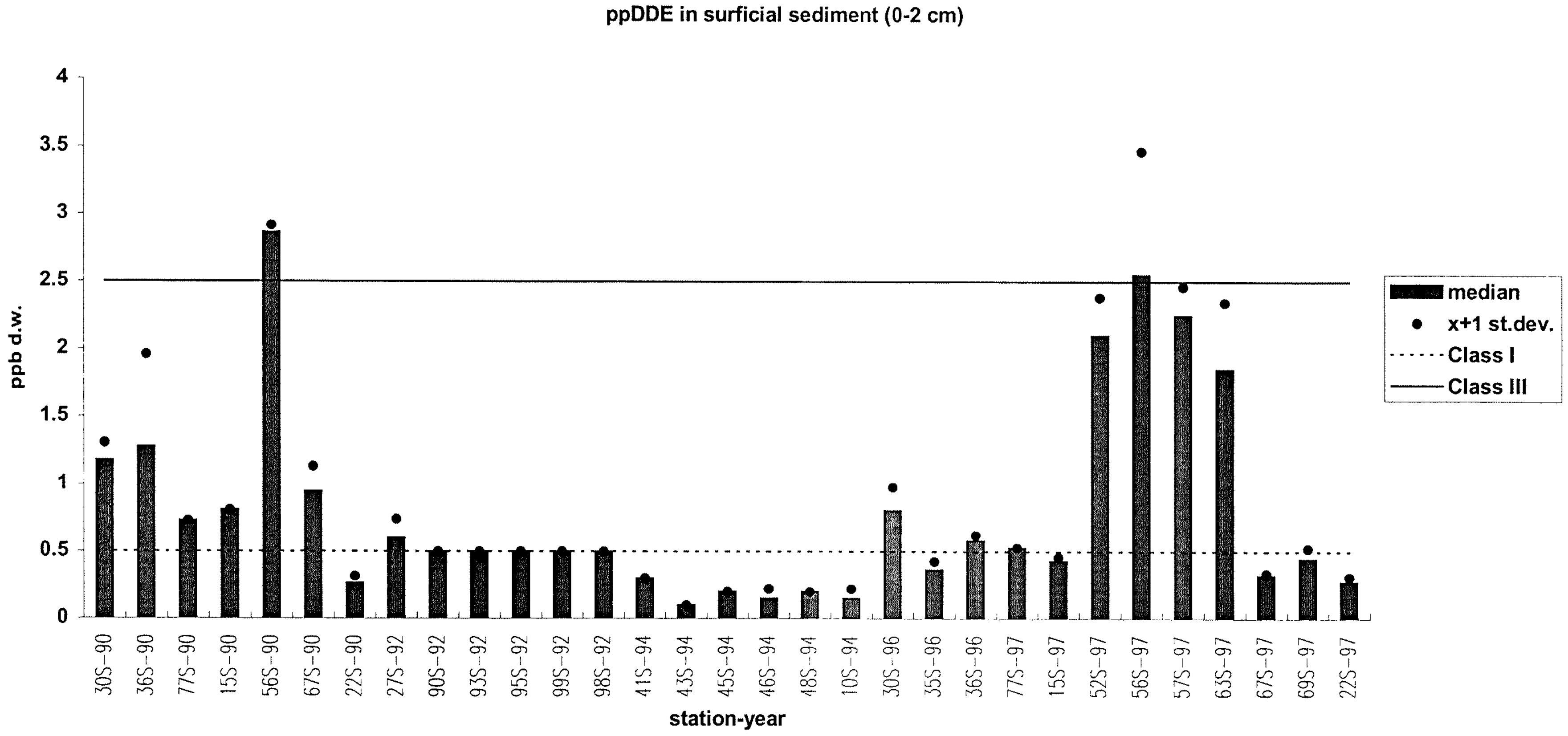

Figure 52. Median, standard deviation and provisional "high background" concentration (Class I) for DDEpp in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight. Class-concentrations (Class I and III) for ΣDDT are used. (See maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

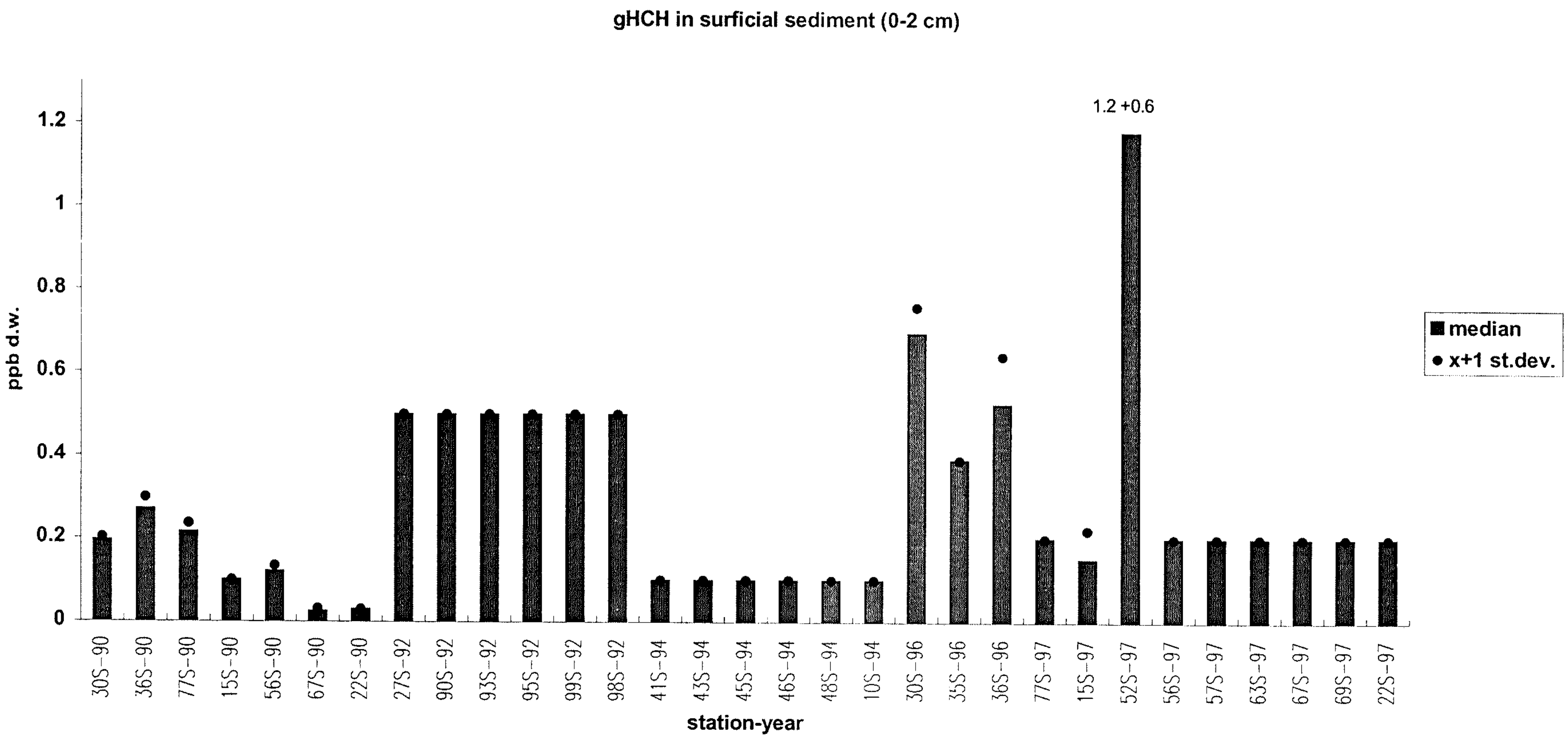

Figure 53. Median, standard deviation concentration for γHCH (gHCH) in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight. (See maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

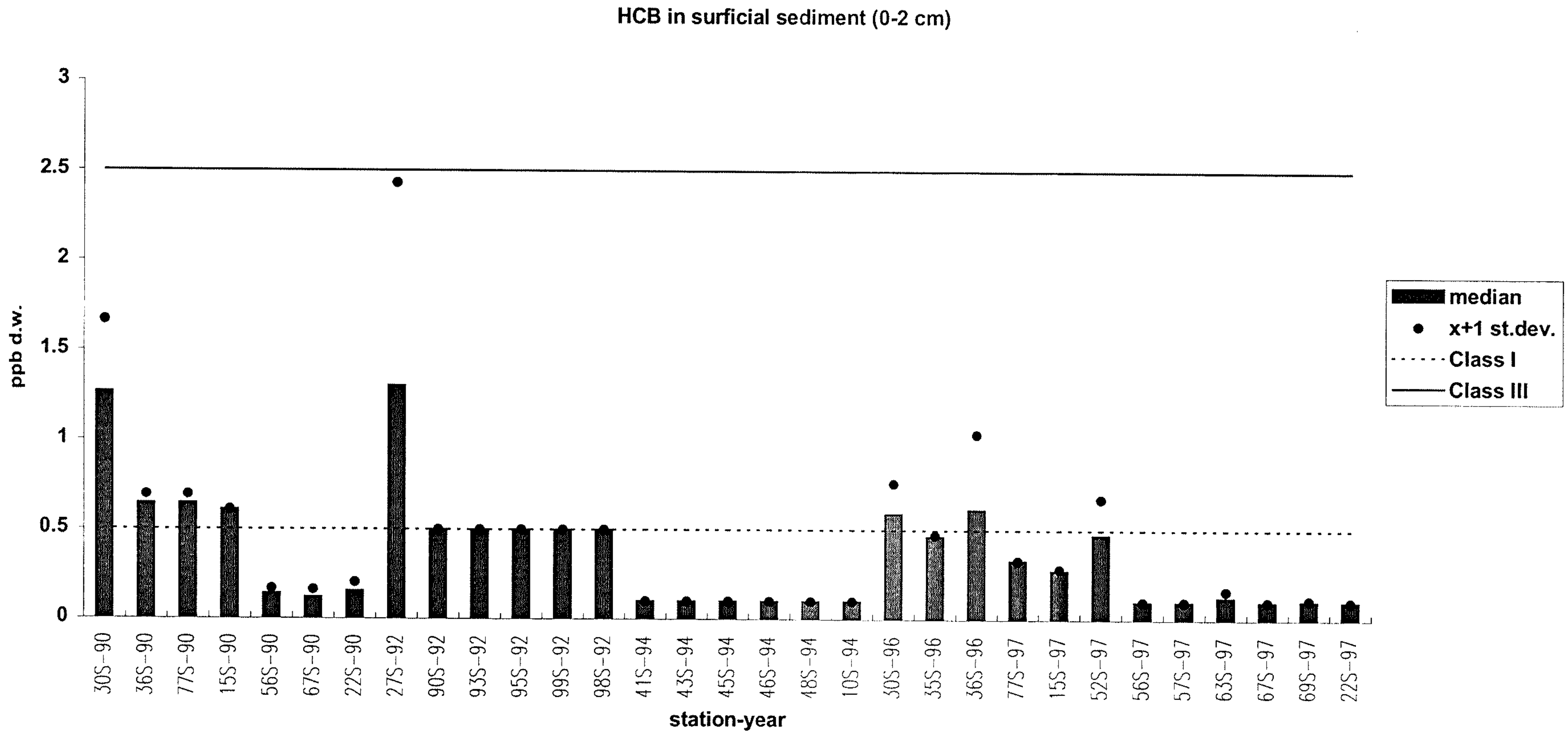

Figure 54. Median, standard deviation and provisional "high background" concentration (Class I) for HCB in surficial sediment (0-1(2)cm) 1990-1997, ppm dry weight (see maps in Appendix F, and notes on background and classification system footnote in Table 4 and Table 5.)

Appendix O
Testing sampling strategies - VIC

Introduction

Tissue levels of metals and organochlorine compounds in various fish species have been used in spatial and temporal monitoring for over 30 years. According to ICES (1996) and OSPAR (1990, 1997) guidelines, 25 individual fish within a predetermined size range should be sampled at any given site.

In order to achieve statistical power for detecting trends in contaminant levels in fish in as cost-effective way as possible, it is important to identify and estimate the different variance components involved. If the yearly estimates are based on catching a number of fish at one occasion each year, the within-year variation between samples (i.e. between subpopulations of fish) will be included in the between year residual variance in the data series. Even if the design is to collect one sufficiently large sample each year at a specific location, this may not always be possible. In order to get a sufficient number of fish it may sometimes be necessary to move to a nearby location, do more than one catch, or use a sample of fish deviating from the specified size distribution. This may affect the residual variance in the estimated yearly means used to detect trends.

If the between-site or seasonal variation is systematic, the best sampling scheme will be to keep to a specific location and a specific season. If, on the other hand, there is a random variation between locations and sampling times due to fish migrating within the area, this variation is impossible to control. In that case, changing the sampling program into collecting a smaller number of fish from each of a number of locations, and/or at different times, may increase the precision of the yearly mean estimate.

A related issue is the question of using the physiological measurements on the fish as covariates to reduce residual variance. If variations in contaminant levels are due to physiological variations over time or between fish sub-populations, the adjustment for such factors may reduce residual variance and increase the ability to detect trends.

A Oslo-Paris Commission (OSPAR) Ad Hoc Group on Monitoring (MON) sub-group proposed a simple international programme called Voluntary International Contaminant-monitoring for temporal trends with the aim to test sampling strategies for a co-operative revision of guidelines by 1999 (VIC. cf. SIME 1996, 1997a). VIC aimed at compiling solid scientific evidence in parallel to developing a consensus. VIC is based on testing different sampling strategies annually over a 3-4 year period by a few countries (Germany, Netherlands, Norway and Sweden). The basic structure of testing is the same though the details may vary from country to country depending on practicalities. The Norwegian VIC includes monitoring of cod and flounder from Sørfjord and Hardangerfjord since 1996 as well as from the Oslofjord since 1997 (cf. map Appendix F). It involves supplemental analyses to OSPAR's Joint Assessment and Monitoring Programme (JAMP) to obtain better quantitative information of the variability in time and space within the guidelines of the sampling strategy.

The VIC program focuses on station 30B in the inner Oslofjord and stations 53B and 67B in the Sørfjord and Hardangerfjord system (Table 15 for cod). The contaminants analysed so far are CB153, pp'DDE, Cd and Zn in liver, and Hg in muscle. Both unadjusted and adjusted concentrations have been analysed. Bjerkeng and Green (1999) give a more detailed presentation of the results.

Table 15. Summary of sampling program for Atlantic cod carried out under the Norwegian VIC program for monitoring years 1996, 1997 and 1998.
For each sample, the table lists sampling date as month.day (mm.dd) followed by the number of specimens analysed within parentheses (n). Footnotes are found at bottom of page.

JAMP YEAR	Calenda yea	**JAMP Stations with Area names and Locations**					
		30B Inner Oslofjord			**53B Sørfjorden**		**67B Hardangerfjord**
		(Måsene)	**(Håøya)**	**(Svestad)**	**(Tyssedal)**	**(Edna)**	**(Strandebarm)**
		mm.dd (n)	*mm.dd* (n)	*mm.dd* (n)	*mm.dd* (n)	*mm.dd* (n)	*mm.dd* (n)
1996	1996				*08.07* (15)[1] *12.01* (10)[5]	*08.14* (15)[2] *12.02* (10)[6]	*08.17* (25)[3] *10.31* (10)[4]
	1997	*01.15* (10) *01.22* (10) *02.03* (10)	*01.16* (10)	*01.18* (10)			
1997	1997				*09.30* (15)[7]	*10.04* (15)	*09.30* (25)[8]
	1998	*01.15* (10) *01.21* (10) *02.02* (10)	*01.16* (10)	*01.17* (10)			
1998	1998 :[9]				*10.24* (15)	*10.24* (15)[10]	*10.28-11.05*(25)
	1999	*01.14* (10) *01.21* (10) *01.28* (10)	*01.18* (10)	*01.21* (10)			

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[1] Lipid % and organic contaminants missing for 5 specimens.

[2] Lipid % and organic contaminants missing for one specimen.

[3] Lipid % only in 7 specimens, organic contaminants in 5 specimens

[4] 10 specimens collected

[5] 10 specimens collected

[6] 10 specimens. Lipid % in liver was not measured, so adjusted organic contaminants can not be analysed.

[7] Livid % and organic contaminants measured for only 7 of 15 specimens, dry wt % missing for one of the others.

[8] Lipid % in liver and organic contaminants was measured for only 10 of the 25 specimens

[9] Data on mercury in muscle from 1998 was not available in time for this analysis

[10] Data on liver composition and organic contaminants for 13 of the 15 specimens

Relations between contaminant levels and physiological parameters.

The relations between contaminant levels and physiological parameters have been analysed to see how adjusting concentrations for physiological variation might influence the ability to detect trends. The physiological covariates investigated are sex, age, length, fish wet weight and liver wet weight, as well as dry-wt % and extracted lipid % in liver.[1] All covariates except age were analysed on log scale, as were the contaminant concentrations.

The physiological measures are correlated to each other to various degrees, and using them as covariates directly will not give well-defined relations. A model with more precise regression coefficients were achieved by using instead a derived set of more linearly independent parameters. The derived parameters represent different combinations of the original parameters (e.g. ratio between actual weight and mean weight for given length).

The measurements of liver composition before 1990 seem to be very uncertain, varying much more around the ordinary trend than in later data. Thus only data from 1990 or later have been used in the analysis. A few specimens from after 1989 with strongly deviating liver composition data, possibly showing analytical errors, were not used in the covariate analysis. Further, some cases with levels below detection limit for Cd in liver or for Hg in muscle were ignored for these contaminants. Obviously, cases with missing values for some of the covariates used in the final ANCOVA model are also excluded from the covariate analysis.

The main features of the results for cod are presented below. Bjerkeng and Green (1999) give a more detailed presentation of the results.

CB153 in liver on wet weight basis increases significantly with age, and with length for given age, but decreases with length-adjusted fish weight. For fish of given age, length and weight concentrations vary with liver composition and size. The variation is too complex to be reduced to normalising the concentration on a single parameter such as lipid content. The covariate adjustment reduces residual within-sample variance with about 30%, while the differences between samples stays about the same. The covariate adjustment thus increases the signal/noise variance ratio with about 30%, so the power for detecting trends should increase.

pp'DDE in liver shows much of the same picture as CB153, with similar sums of squares and regression coefficients for the different covariates. Correcting concentrations for covariate variation reduces residual variance within samples by one third, while the between-sample variance increases with about 6%, increasing the signal/noise variance ratio by about 40%.

Cadmium in liver shows a tendency to increase with age but decrease both with age-adjusted length and length-adjusted weight. The dominant physiological factor is a decrease with increasing dry-weight fraction in the range above 30%, i.e. with reduced lean fraction. Both within- and between-sample variances are reduced considerably by the covariate adjustment (by 46 and 25% respectively). This can be seen as a strong confirmation that the variation between samples are really in part caused by physiological variations and not by differences in exposure. In particular there is a tendency that covariate adjustment reduce the between-sample (between-year) variation within each station. The signal/noise ratio increases by about 40%, again leading to improved trend detection ability.

Mercury in muscle is mainly related to age. The concentrations tend to be higher in older fish, and in particular if the fish is long for its age. Weight given length and age is relatively unimportant. The concentrations in muscle are also related to liver conditions, presumably only as indicators of fish condition. Fish with high dry weight fraction in livers, i.e. with fat livers, tend to contain less mercury in the muscle. The covariate adjustment reduces the within-sample variance by 28%, but the

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[1] Dry-weight % and lipid % in tissue have also been analysed, but varies little, and has not been included in this analysis.

between-sample variance simultaneously increase with about 30%. A further inspection shows that this is because the covariate adjustment tends to reduce further levels at stations with low concentrations (st. 10B, 43B, 46B, 92B and 98B) and increase levels at stations with high unadjusted levels (station 53B, 67B, 77B). The between-sample variation at each station is, however, reduced by about 20%, so the power of detecting time trends at one station should increase. It remains an open question whether the adjusted concentrations give differences between stations that better represents exposure differences, or whether the adjustment introduces artifacts into the mercury data for comparison between stations. The artifacts could be due to incidental geographical correlations between exposure levels and physiological conditions following a different pattern than the within-sample variation.

Analysis of variance components in Norwegian VIC data.

A preliminary statistical analysis have been made based on most of the data up to and including the monitoring year 1998, mainly for individually analysed Atlantic cod (*Gadus morhua*).

Both the raw and the covariate-adjusted contaminant data from the Norwegian VIC program for cod have been analysed by ANOVA models to estimate the variance between samples within station and year. The covariate adjustments are based on the models derived from all data since 1990, as described above.

For station 30B, location Måsene was sampled three times in January/February each of the three years. Data from this location can thus be used separately to estimate between-time variance for a given location. The other two locations were sampled once each year, at approximately the same time as one of the other samples. This allows for a separate testing of the variation between locations.

The analysis indicates that organic contaminants (CB153 and pp'DDE) have a strongly significant variation between samples from the same location repeated with weekly intervals in winter ($p<10^{-4}$). The variance between times (weekly intervals) within-year is estimated to be about 50% of the within-sample residual variation for unadjusted values, and around 100% for covariate adjusted values[1]. The covariate adjustment based on all data after 1989 increases the total variation between samples in the VIC data from station 30B, Måsene, without affecting residual within-sample variance. This may indicate that the covariate model is not generally applicable, but because the samples are so few it could also be just incidental.

Cadmium in liver do not appear to vary significantly between times within year (p=0.12 unadjusted, p=0.3 adjusted). The variance between times may still be considerable, maybe 20-40% of the within-sample variance) for unadjusted Cd, but only 5% for covariate-adjusted values.

Mercury in muscle has no significant variation between times within a year for the mean of the unadjusted values (p=0.87), and only a weak indication of significant variation if we rely on the adjusted values (p=0.075). The covariate adjustment for Hg reduces the difference between years, but increases the differences between times within years. The samples are so few that this change in variance decomposition between and within years may well be just incidental. For adjusted mercury the estimated variance between repeated samples within year may be around 15% of the residual within-sample variance.

The other two locations at station 30B have only been sampled once per year, so for these data only the between-location effect can be tested. The data from VIC sampling times 6131, 7131 and 8132 constitute a balanced data set across the locations of stations 30B.

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[1] The results presented by Bjerkeng and Green (1999) differ in details from the ones given here, because full data for monitoring year 1998 were then not available.

For metals in liver the design is complete, but for organic contaminants and mercury in muscle the data from 1998 are not available from location Håøya and Måsene, so for these contaminants only 1996 and 1997 can be used. For cadmium in liver there is a significant mean difference between locations compared to the within-sample variance, about 30 and 40-50% of the residual variance for unadjusted and adjusted values, and p-values of 0.0008 and 0.0006 respectively. However, the differences between locations is not significant when compared with the interaction between years and locations, so it might be just a residual effect of irregular variations between samples. The interaction term, although not significant (p=0.1 to 0.2), is of about the same size as the variance between times within year for the analysis of location Måsene. The data have too few degrees of freedom to establish the variance components with any certainty. However, the indication of systematic location differences could be taken as a warning against using samples from different locations, even within an area of a few kilometers. For zinc there is no indication of significant differences between locations at station 30B compared to the residual within-sample variance or the interaction. For covariate-adjusted pp'DDE there is a weak indication of significant variation between locations, both compared to the residual within-catch variance and the interaction between year and location (p=0.06). The estimated location variance component is about 15% of the residual variance. For mercury in muscle the two years of data indicate that there may be a significant difference between locations in the adjusted values. It is not present in the unadjusted values, so it may possibly just reflect an artifact introduced by the adjustment for physiological conditions, due to incidental between-sample correlation between conditions and exposure.

For station 53B, with two locations, repeated samples during the sampling year were only made in 1996. The sampling was done in different months each year, and the difference in time between the two sampling occations in 1996 is larger than the difference in season between years. It is therefore not possible to use these data by themselves to test for within-year vs. between-year variance. The data can, however, be used to check for systematic differences between the two locations. Due to imbalance in lipid and organic contaminant data and missing data at the time of the analysis (see notes to Table 15) only metals in liver have been analysed. The results show significant variation between sampling times (year and/or season) compared to residual variance, but no significant variation between locations. Statoin 67B has little data, and have not been analysed in this paper.

The main preliminary conclusion from these analyses appears to be that for the organic contaminants there appears to be a considerable short-term variation between times within year, maybe of the same size as the within-sample variation. For metals there are no clear indications, but the between-sample variance might still be as high as 20% of the within-sample variance. These results indicate that it may be of advantage to base yearly means on a number of repeated samples from each station, rather than using only one sampling time.

The data from the Oslofjord indicate some systematic differences between locations, particularly for Cd, and more uncertain for organic contaminants and Hg in muscle. The implication may be that one should avoid taking subsamples from different locations.

These preliminary conclusions may of course be area specific, and the full VIC data set should be analysed before drawing conclusions.

Preliminary assessment of possible effects of changing within year*station sampling design

Assume a sampling scheme for one station where a total of K fish are collected each year, distributed as equally as possible among C samples, and analysed individually. The samples could be distributed between different locations in the station area and/or over different points in time within the designated sampling period (i.e. outside the normal spawning season when physiological changes are

stable). If there are systematic differences between locations, as indicated by the analysis above, the samples should represent different sampling times for a single selected location.
The variance components involved are:

σ_c^2 = variation between samples (a function of small-scale variance in time and/or space)
σ_k^2 = variation between fish within samples, including analysis error.

The linear statistical model for the contaminant level in the individual fish (*k*) for a certain year (y) is

$$x_{yck} = \mu_y + \varepsilon_{c(y)} + \varepsilon_{k(cy)} \tag{1}$$

The variance of each value around the "true" expectation for the year

$$V(x_{yck}) = \sigma_c^2 + \sigma_k^2 \tag{2}$$

The yearly mean estimate based on these values has variance around the true expectation

$$V(x_{y\bullet\bullet}) = \frac{\sigma_c^2}{C} + \frac{\sigma_k^2}{K} \tag{3}$$

If *C* is increased by δ*C*, the variance of the yearly mean will be roughly the same if *K* is simultaneously reduced by δ*K* equal approximately to

$$\delta K = \frac{R \cdot K^2 \cdot \delta C}{R \cdot K \cdot \delta C + C(C + \delta C)} \quad \text{where } R = \frac{\sigma_c^2}{\sigma_k^2} \tag{4}$$

assuming that the reduced number of fish are also distributed as equally as possible on the *C* samples.

Table 16 summarizes the results for a few sets of alternative scenarios, with the ratio (*R*) between variance components defined in eq. 19 ranging from 0.05 to 0.5 (column I). This range is somewhat on the conservative side of what is indicated by the different results of the analysis in the previous section. Table 16 shows for each R a series of values of *C* from 1 to 3 or 4 subsamples (column II). Column III gives for each C the K value that gives approximately the same variance as C=1, K=25. Column IV shows the corresponding variances, scaled relative to within-sample variance. Finally, column V shows the variances that would be achieved if C were increased as indicated by column II, but the total number of fish K was kept at 25, i.e. with the same analysis effort, but a different sampling procedure.

Table 16. Comparison between alternative sampling scenarios giving approximately unchanged variance of yearly means.

(I)	(II)	(III)	(IV)	(V)
R = assumed ratio of 'Between sample' to 'Within sample' variance	C = number of samples per year	K= total number of fish	Variance of yearly means relative to varianc between fish within sample $V(x_{y\bullet\bullet})/\sigma_k^2$	
			For K=value in column III	At fixed K=25
0.05	1	25	0.090	0.090
	2	16	0.088	0.065
	3	14	0.088	0.057
	4	13	0.089	0.053
0.1	1	25	0.140	0.140
	2	12	0.133	0.090
	3	10	0.133	0.073
	4	9	0.136	0.065
0.2	1	25	0.240	0.240
	2	8	0.225	0.140
	3	6	0.233	0.107
0.5	1	25	0.540	0.540
	2	4	0.500	0.290
	3	3	0.500	0.207

The table shows that even for a low 'Between-sample'/'Within-sample' variance ratio (R=0.05), the total number of fish analysed may be cut by 50% if they are distributed equally between 3 or 4 different samples instead of one for an unchanged total variance in the yearly means. If the variance between samples is as large as 50% of the within-sample variance, as indicated by the data from 30B for organic contaminants, one would get the same precision by analysing three fish altogether, each catched at a different time, as by sampling 25 fish at a single time.

However, the estimates of between-sample variances are still quite uncertain, even when based on all three years of Norwegian VIC data, and one should not rely too much on them. Reducing the total number of fish that are analysed and increasing number of sub-samples with the aim of keeping variance unchanged should be based on reasonably certain lower limits for the ratio of 'between-sample' to'Within-sample' variance. Further analysis is required in orderto make recommendations.

A more cautionary approach would be to keep unchanged the total number of fish analysed, but draw them from an increased number of sampling times, and thus achieve an improved precision, rather than aiming at cutting the costs to keep a certain precision. This is illustrated in the rightmost column of Table 16. For R=0.1 one can achieve a doubling of the precision, with a corresponding increase in trend detection power, by sampling 25 fish altogether, separated into 8 or 9 fish at each of three different occasions, rather than catching all 25 fish at once.

Such a change would represent a smaller or larger improvement in trend-detection power depending on the ratio of between-sample over within-sample variance, but should never lead to increased yearly mean variance, as long there are no systematic seasonal variation across years during the sampling period. And also provided that the sampling period is outside the spawning time and when the fish are in a stabel physiological state OSPAR (1997).

The results differ for different contaminants. For some contaminants, the between-sample variance appears to be negligible and the trend-detection power then depends mainly on total number of fish, independently of how the catches are distributed in time. A way to preserve trend detection power and still achieve a reduction of total cost might be to catch the same number of fish as today, but distributed over a number of times, and then adjust the analysis effort for different contaminants according to their variance patterns. For contaminants with a high between-sample/within-sample variance ratio, one could analyse only s smaller number of fish from the total sample, drawn randomly or by stratified sampling.

It closer analysis should consider differences between species and maybe also between regions in both covariate adjustment models and in variance patterns.