Statlig program for forurensningsovervåking

Long-term monitoring of environmental quality in Norwegian coastal waters.

Levels, trends and effects

HAZARDOUS SUBSTANCES IN FJORDS AND COASTAL WATERS – 2007

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Long-term monitoring of environmental quality in Norwegian coastal waters

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: **LEVELS, TRENDS AND EFFECTS OF HAZARDOUS SUBSTANCES IN FJORDS AND COASTAL WATER - 2007**

Report
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Foreword

This report represents the Norwegian national comments on the 2007 investigations for the Coordinated Environmental Monitoring Programme (CEMP – a part of and referred to in earlier reports as the Joint Assessment and Monitoring Programme JAMP). CEMP is administered by the Oslo and Paris Commissions (OSPAR) in their effort to assess and remedy anthropogenic impact on the marine environment of the North East Atlantic. The current focus of the Norwegian contribution is on the levels, trends and effects of hazardous substances. CEMP-results from Norway and other OSPAR countries provides a basis for a paramount evaluation of the state of the marine environment. OSPAR receives guidance from the International Council for the Exploration of the Sea (ICES).

The Norwegian CEMP for 2007 was carried out by the Norwegian Institute for Water Research (NIVA) by contract from the Norwegian Pollution Control Authority (SFT).

The Norwegian contribution to the CEMP 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 Grenlandsfjord, 1981-), Sørfjord/Hardangerfjord (1983-84, 1987-) and Orkdalsfjord area (1984-89, 1991-93, 1995-96, 2004-05), and stations in merely diffusely contaminated areas of Arendal, Lista and Bømlo-Sotra (1990-), areas from Bergen to Lofoten (1992-) and areas from Lofoten to the Norwegian-Russian border (1994-).

Acknowledgments. *Thanks are due to many colleagues at NIVA, especially: Lise Tveiten, Merete Schøyen, Åse K. Rogne, Sigurd Øxnevad, Jarle Håvardstun, for field work, sample preparations and data entry; Alfhild Kringstad, Katherine Langfjord, and their colleagues for organic analyses; Bente Hiort Lauritzen and her colleagues for metal analyses; Randi Romstad and her colleagues for biological effects measurements, Ling Shi and Anders Mills for data programme management and operation; and to the other authors; Anders Ruus (biological effects methods), Birger Bjerkeng (statistics), Einar M. Brevik (effects of long term sample storage) and Eva Hagebø and her colleagues (analytical quality assurance). Thanks go also to the numerous fishermen and their boat crews for which we have had the pleasure of working with.*

Oslo, 15 November 2008

Norman W. Green
Project co-ordinator
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Contents

1. Executive Summary / *Sammendrag*

The Norwegian CEMP 2007 investigations included the monitoring of micropollutants (contaminants) in blue mussel (51 stations), dogwhelk (9 stations), cod (9 stations) and flatfish (11 stations) from Oslo and Hvaler region in the south-east along the coast of Norway to the Varangerfjord in the north-east. The mussel sites include supplementary stations for the Norwegian Index programme. There were 538 time series that included results from 2007. Of these, 162 showed statistically significant trends; 138 (85%) were downwards and 24 were upwards. Also, there were 126 cases in 2007 of elevated levels of contaminants, i.e. higher than Class I (*insignificantly*[1] polluted) in the Norwegian Pollution Control Authority's (SFT's) classification system (or over provisional "high background"). The general situation for the three major impacted areas of CEMP is as follows:

- Oslofjord was contaminated with PCBs and to a lesser extent mercury and lead. In particular cod liver from the inner Oslofjord was *markedly* polluted with PCB (Class III). A significant downward trend since 1988 was found for PCBs in blue mussel from this area. An upward trend was found for mercury in cod fillet since 1984, and also for one of the five mussel stations in the area (st.I301 Akershuskaia). In addition, an upward trend was found for cadmium in cod liver from the inner Oslofjord 1984-2007, as well as at two of the five blue mussel stations in this area (st.30A Gressholmen and st.I307 Rotonholmen).
- Grenlandsfjord area has been an area of concern partly due to elevated concentrations of HCB in blue mussel. However, since 2002, with the exception of 2005, the blue mussel at Bjørkøya (st.71A Risøyodden) was *insignificantly* (Class I) or *moderately* (Class II) polluted with respect to HCB. A downward trend was found at this station not only for the period 1983-2007 but also for the period 1990-2007 following remedial action in 1989. Blue mussel here were severely polluted with dioxins (Class IV) at this station and were extremely polluted with dioxins (Class V) at two stations in the vicinity, near the mouth of the Frierfjord (st.I712 Gjemesholmen and st.I713 Strømtangen).
- Sørfjord and Hardangerfjord was contaminated with DDT, lead, cadmium, mercury and to a lesser degree PCB. Blue mussel was *severely* polluted (Class IV) with DDT, and as before, *markedly* polluted (Class III) with lead and cadmium. Cod was *moderately* polluted (Class II) with mercury, DDT and PCB. Blue mussel from the inner Sørfjord was also *moderately* polluted with mercury. Significant downward trends was found for cadmium and lead in blue mussel at 5 and 3 stations, respectively in the Sørfjord/Hardangerfjord; since 1987/1990. An upward trend since 1988 was detected for mercury in flounder. A downward trend was found for DDT and PCB in cod liver and flounder fillet from Hardangerfjord, and also for PCB in flounder (fillet and liver) from Sørfjord.

Two environmental indices have been applied annually since 1995 to assess collectively the levels of contamination in blue mussel from anticipated impacted and non-impacted areas; the so-called "Pollution Index" and "Reference Index". In 2007 the Pollution Index, based on samples from nine fjord areas, was between *marked* and *severe* (Class III-IV). This was one level worse than compared to 2006. The Reference Index, based on four fjord areas, was between *insignificantly* and *moderately* polluted (Class I-II), as it has been since the programme was initiated in 1995.

The biological effect parameters OH-pyrene (pyrene metabolite; marker for PAH exposure), δ-aminolevulinic acid dehydrase (ALA-D; marker for lead exposure), and cytochrome P4501A (EROD-activity; marker for planar hydrocarbons, such as certain PCBs/PCNs, PAHs and dioxins) were determined in cod from four stations along the coast from the Oslofjord, Lista, Bømlo-Sotra (Karihavet, only OH-pyrene in 2007) and Sørfjord. In 2007, the inner Oslofjord and the Sørfjord showed higher levels of OH-pyrene than at Lista and in Karihavet (reference). Somewhat lower values were found in the Sørfjord compared to Karihavet likely reflected a reduced level of PAHs after discontinuation of some of the industry in the Sørfjord. In 2007, hepatic EROD activity and amount of CYP1A protein indicated higher levels of planar hydrocarbons in the inner Oslofjord than in the Sørfjord. The same result for EROD has been obtained in some, but not all, of the preceding

[1] Corresponds to Norwegian term *ubetydelig*, and has no statistical implications in this context.

years. The amount of CYP1A protein has been consistently higher in the inner Oslofjord than the Sørfjord and the Karihavet for the period 2003-2006. In 2007, ALA-D levels were somewhat lower (stronger inhibition, indicating greater exposure to lead) in the inner Oslofjord and Sørfjord compared to 2006. The only significant trend found for these biological effects was a downward trend for CYP1A in cod liver from the inner Oslofjord for the period 2003-2007.

The presence of organotin (*inter alia* TBT) in Norwegian waters was still elevated in 2007, most evident close to harbours, but also at stations remote from known point-sources. Concentrations of organotin exceeded Class I (*insignificantly* polluted) in blue mussel in six of the thirteen stations investigated. Biological effects from TBT were found in dogwhelk from eight of the nine investigated stations. Eight of the thirteen time series for TBT in blue mussel 1997-2007 showed significant downward trend. There was also a downward trend in effects of TBT in dogwhelk found at six of the nine stations. These results indicate that regulatory action has lead to an improvement in the investigated areas.

Since 2005 flame retardants (PBDE) and perfluoroalkyl compounds (PFC) have been investigated in cod liver from three stations and on an annual basis. Concentrations of PBDE and PFC were higher in the fish from the inner Oslofjord compared to fish either from inner Sørfjord or fish from the reference station in Karihavet in the Bømlo-Sotra area on the West Coast. The median concentration of PBDE in the inner Sørfjord was higher than the reference station, but for PFC concentrations were similar in the two areas.

With regards to dioxin, two blue mussel stations nearest the mouth of the Frierfjord (Grenlandsfjord area) were extremely polluted (Class V). Blåskjell were moderately polluted (Class II) in the Kristiansand harbour. No trends were found for the entire CEMP-investigation period 2002-2007.

Analyses of cod liver samples stored in the sample bank since 1993 were compared to those of 2007 for a selection of elements (vanadium, titanium, nickel, silver) and persistent organic contaminants (TBT, PBDE and PFC) not routinely investigated in this species. Two stations were selected; the inner Oslofjord and the reference area on the West coast (Karihavet). There was no indication that storage had affected the concentration of the substances analyzed. Generally, no distinct difference between the two years and indicated that cod were exposed to roughly the same environmental levels analysed substances in 2007 as in 1993.

Selected data sets for cadmium, lead, mercury and CB153 (as an indicator for PCB) in cod and blue mussel from the CEMP database have been analysed statistically to estimate the importance of various sources of irregular variation (“noise”) in for detecting and quantifying time trends or geographical differences in contaminant levels in biota. Variance ratios were estimated and combined with variance-cost relations to show how optimal monitoring design can be calculated as function of cost and variance ratios. The purpose is to provide a basis for assessing how resources can be allocated in the most cost-effective way to improve the certainty of monitoring results.

Sammendrag

Det norske bidrag til OSPAR felles overvåkingsprogram CEMP 2007 inkludere overvåking av miljøgifter i blåskjell (51 stasjoner), purpursnegl (9 stasjoner), torsk (9 stasjoner) og flatfisk (11 stasjoner) langs kysten fra Oslofjord området til Varangerfjorden. Blåskjell-stasjonene inkluderte de som inngår for beregning av forurensningsindeks. For 2007 hadde en resultater fra 538 tidsserier, hvorav 162 visste signifikante trender. Av disse 162 viste 138 (85%) en nedadgående og 24 en oppadgående trend. Det var 126 tilfeller hvor 2007-resultatene vist forhøyede konsentrasjoner av miljøgifter, dvs. mer enn Klasse I i SFTs klassifiseringssystem, eller over antatt "høyt bakgrunnsnivå". Tilstand og utvikling i tre områder som hovedsakelig er påvirket av forurensninger er som følgende:

- *Oslofjorden er forurenset med PCBer og i mindre grad kvikksølv og bly. Torskelever fra indre Oslofjord var markert forurenset med PCB (Klasse III). En signifikant nedadgående trend siden 1988 ble registrert for PCB i blåskjell fra dette området. En oppadgående trend ble funnet for kvikksølv i torskefilet siden 1984, og også for en av fem blåskjell-stasjoner i området (st.I301 Akershuskaia). I tillegg, ble det funnet et oppadgående trend for kadmium i torskelever fra indre Oslofjorden 1984-2007, og også for to av fem blåskjell stasjoner (st.30A Gressholmen og st.I307 Rotonholmen).*
- *For Grenlandfjord-området knytter det seg en viss bekymring til de forhøyede konsentrasjoner av HCB i blåskjell. Siden 2002(med unntak av 2005) har en imidlertid kunne klassifisere HCB-konsentrasjonene i skjell fra Bjørkøya (st.71A Risøyodden) som ubetydelige (Klasse I) eller moderat (Klasse II) forurenset. En nedadgående trend i HCB-konsentrasjonen ble også funnet på denne stasjonen, ikke bare for perioden 1983-2007 men også for perioden 1990-2007 etter tiltaket i 1989. Blåskjellene fra Bjørkøya var sterkt forurenset (Klasse IV) med dioksin og meget sterkt forurenset (Klasse V) på to nærliggende stasjoner (st.I712 Gjemesholmen og st.I713 Strømtangen).*
- *Sørfjorden og Hardangerfjorden er forurenset med DDT, bly, kadmium, kvikksølv og i mindre grad PCB. Blåskjellene var sterkt forurenset (Klasse IV) med DDT, og som tidligere markert forurenset (Klasse III) med bly og kadmium. Torsk var moderat forurenset (Klasse II) med kvikksølv, DDT og PCB. Blåskjell fra indre Sørfjorden var også moderat forurenset med kvikksølv. Signifikante nedadgående trender ble funnet for kadmium og bly i blåskjell fra hhv. 5 og 3 stasjoner i Sørfjord/Hardanger regionen, siden 1987/1990. Fra 1988 har det vært en oppadgående trend for kvikksølv i skrubbe. En nedadgående trend ble imidlertid observert for DDT og PCB i torskelever og skrubbefilet fra Hardangerfjord, og også for PCB i skrubbefilet og –lever fra Sørfjorden.*

På basis av forekomst av noen utvalgte miljøgifter i blåskjell har en siden 1995 beregnet en blåskjell-forurensningsindeks og en blåskjell-referanseindeks på basis av resultatene fra en gruppe "forurensede og "referanse" fjordområder. Forurensningsindeksen for 2007 var basert på ni fjordområder og lå mellom "markert" og "sterkt forurenset" (Klasse III-IV). Dette var et nivå verre enn i 2006. Referanseindeksen var basert på fire fjordområder og lå mellom "ubetydelig" og "moderat" forurenset (Klasse I-II).

Biologiske effekt-parametre ble undersøkt i torsk fra fire stasjoner langs kysten: indre Oslofjord, Lista (bare OH-pyren), Bømlø-Sotra (Karihavet, bare OH-pyren i 2007) og Sørfjord.: Effektparameterene er: OH-pyren (pyren metabolitt; markør for PAH-eksponering), δ-aminolevulinsyre dehydrase (ALA-D; markør for bly-eksponering), og aktivitet av cytokrom P4501A (EROD; markør for plane hydrokarboner, slik som PCB/PCN, PAH og dioksoiner). I 2007 var OH-pyren høyere i indre Oslofjord og Sørfjorden enn på Lista og Karihavet (referanse). Noe lavere nivå ble funnet i Sørfjorden sammenlignet med Karihavet. Dette tyder trolig på reduserte tilførsler av PAH etter nedleggelse av noe av industrien i Sørfjorden. I 2007 indikerte den observerte EROD aktivitet og konsentrasjonen av CYP1A protein på en høyere eksponering av plane hydrokarboner i indre Oslofjord enn i Sørfjorden. Tilsvarende observasjoner er også gjort tidligere, men ikke alle årene. Konsentrasjon av CYP1A protein var konsekvent høyere i indre Oslofjorden enn i Sørfjorden og Karihavet i perioden 2003-2006. I 2007 var imidlertid ALA-D nivået var noe lavere (som indikasjon av større eksponering til bly) i indre Oslofjorden og Sørfjorden sammenlignet med 2006.

En nedadgående trend for CYP1A i torskelever fra indre Oslofjorden for perioden 2003-2007 var den eneste signifikante trend registrert for disse biologiske effekt-parametrene.

Effekter av organotin (bl.a. TBT) kunne fortsatt registreres i 2007, tydeligst i havner eller i områder med mye skipstrafikk, men også på stasjoner som var antatt lite påvirket. Konsentrasjoner av TBT i blåskjell viste en høyere forurensningsgrad enn Klasse I (ubetydelig forurenset) på seks av tretten stasjoner. Biologiske effekter av TBT (imposex) ble registrert på åtte av ni stasjoner. Åtte av tretten tidsserier for TBT i blåskjell 1997-2007 visste signifikante nedadgående trend. Det ble også registrert en nedadgående trend for imposex på seks av ni stasjoner. Disse resultatene kan tyde på at forbud mot bruk av TBT som begroingshindrende middel på småbåter og skip har ført til forbedring i de undersøkte områdene.

Hvert år siden 2005 har en spesiell gruppe flammehemmere (PBDE) og perfluoroalkylertestoffer (PFC) blitt undersøkt i torskelever fra tre stasjoner. Konsentrasjonene av PBDE og PFC var høyrere i fisk fra indre Oslofjord sammenlignet med fisk fra både Sørfjorden og Karihavet (referanse stasjonen i Bømlo-Sotra området). Median konsentrasjon av PBDE i Sørfjorden var høyere enn referanse-stasjonen, men PFC-konsentrasjonene var mer lik i disse to områdene.

Når det gjelder dioksin var to blåskjell-stasjoner ved munningen av Frierfjorden meget sterkt forurenset (Klasse V). Blåskjell fra Kristiansandhavn var moderat forurense (Klasse II). Ingen trend ble registrert for hele perioden dioxin har blitt undersøkt under CEMP, dvs. i perioden 2002-2007.

Prøver av torskelever lagret siden 1993 ble sammenlignet med prøver fra 2007 for et utvalg av metaller (vanadium, titanium, nikkel og sølv) og persistente organiske miljøgifter (TBT, PBDE og PFC) som ikke er rutinemessig overvåket i denne arten. To stasjoner ble valgt; indre Oslofjord og en referanse stasjon på vestkysten (Karihavet). Det var ingen indikasjon på at selve lagringen hadde effekt på konsentrasjonen av de analyserte stoffene. I hovedsak ble det ikke funnet noe tydelig forskjell mellom de to årene. Dette indikerer også at torsk hadde omtrent det samme eksponering til disse stoffene i 2007 som i 1993.

Et utvalg av resultater for kadmium, bly, kvikksølv og CB153 (som indikator for PCB) i torsk og blåskjell fra CEMP-databasen ble analysert statistisk for å avdekke betydningen av ulike kilder til uregelmessig variasjon (støy) i data ved påvisning og kvantifisering av tidstrender eller geografiske forskjeller. Forholdstall mellom variasjonskomponenter ble estimert og kombinert med funksjoner for sammenheng mellom varians og kostnad for å vise hvordan optimal utforming av overvåknings-program kan beregnes som funksjon av forhold mellom varianskomponenter og kostnader. Hensikten er å gi grunnlag for å vurdere hvordan ressurser kan brukes mest mulig kostnadseffektivt for å forbedre sikkerheten i overvåkings-resultater.

2. Introduction

2.1. Background

Environmental concerns include the risks due to the pollution of air, soil and water. The Norwegian Pollution Monitoring Programme, administered by the Norwegian Pollution Control Authority (SFT), is designed to deal with these aspects. A part of this programme focuses on the levels, trends and effects of hazardous substances in fjords and coastal waters, which also represents the Norwegian contribution to the *Coordinated Environmental Monitoring Programme* (CEMP)[1]. CEMP is a common European monitoring programme under the auspices of Oslo and Paris Commissions (OSPAR)[2]. The Norwegian contribution to CEMP addresses several aspects of OSPAR's assessment hazardous substances[3]. For this report the term CEMP only refers to the Norwegian contribution.

An overview of CEMP stations in Norway is shown in the tables in Appendix F and maps in Appendix G. It has included the monitoring of sediment, seawater and biota since 1981 with particular emphasis on three areas:

- Oslofjord-area (including the Hvaler area, Singlefjord and Grenland fjords area),
- Sørfjord/Hardangerfjord
- Orkdalsfjord area.

During 1990-1995 Norway has also included

- Arendal and Lista areas.

The previous investigations (cf. Appendix A) have shown that the Inner Oslofjord area has enhanced levels of PCB in cod liver, mercury, lead and zinc in sediments and moderately elevated values of mercury in cod fillet. Investigations of the Sørfjord/Hardangerfjord have shown elevated levels of PCB, DDT, cadmium, mercury and lead. The Norwegian Food Safety Authority - *Mattilsynet* has issued warnings about the consumption of fish and/or mussels in the Oslofjord and Sørfjord partly based on these investigations. Investigations in Orkdalsfjord were discontinued during the period 1996 to 2003 and from 2006.

In addition to the monitoring of Oslofjord area and Sørfjord/Hardangerfjord CEMP also includes selected stations in Lista and Bømlo areas on the south and west coast of Norway, respectively. CEMP includes sampling of blue mussel from "reference" areas along the coast from Lofoten to the Russian border which were included in a 1993-1996 and 2006 survey. The sampling also includes fish from four key areas north of Lofoten: Finnsnes-Skjervøy area, Hammerfest-Honningsvåg area, and Varanger Peninsula area. The intention is to assess the level of contaminants in "reference" areas, areas which are considered to be little affected by contaminants, and to assess possible temporal trends.

The sampling for 2007 involved blue mussel at blue mussel (51 stations), dogwhelk (9 stations), cod (9 stations) and flatfish (11 stations) (**Figure 1**, cf. Appendix F). The Norwegian CEMP 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 blue mussel, 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 in 2007.

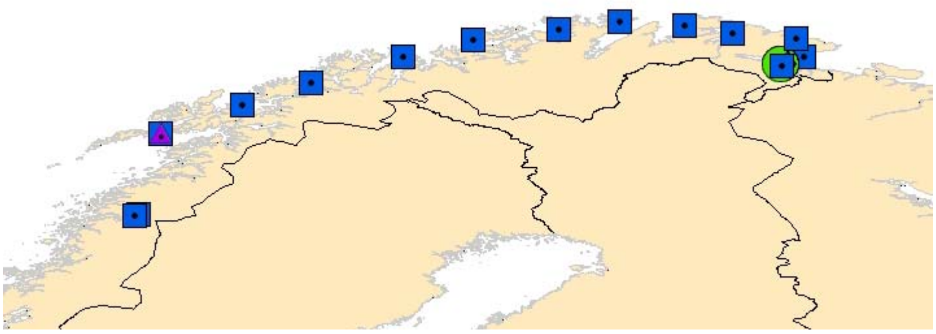
[1] A development from the *Joint Monitoring Programme* (JMP) and later, in 1998, the *Joint Assessment and Monitoring Programme* (JAMP)
[2] There are six CEMP themes: 1) general quality status of the OSPAR maritime area and other general issues, 2) biodiversity, 3) eutrophication, 4) hazardous substances, 5) offshore activities and 6) radioactive substances.
[3] cf. OSPAR products AA-2, HA-4, HA-5, HA6, HM-3, (OSPAR 2007, SIME 2004b).

Concentrations of metals, organochlorines (including pesticides) and polycyclic aromatic hydrocarbons in blue mussel and fish were determined at the Norwegian Institute for Water Research (CEMP code NIVA).

Analytical methods have been described previously (Green *et al*. 2008a). Parameter abbreviations are given in Appendix C.

The data is stored at NIVA in MS ACCESS 1997. The tables are generated using MS ACCESS 97 and MS EXCEL 97. Data are submitted to ICES using the integrated environmental reporting format 3.2.1 (www.ices.dk/env/repfor/), and screening using their DATSU programme (www.ices.dk/datacentre/datsu/).

A



B

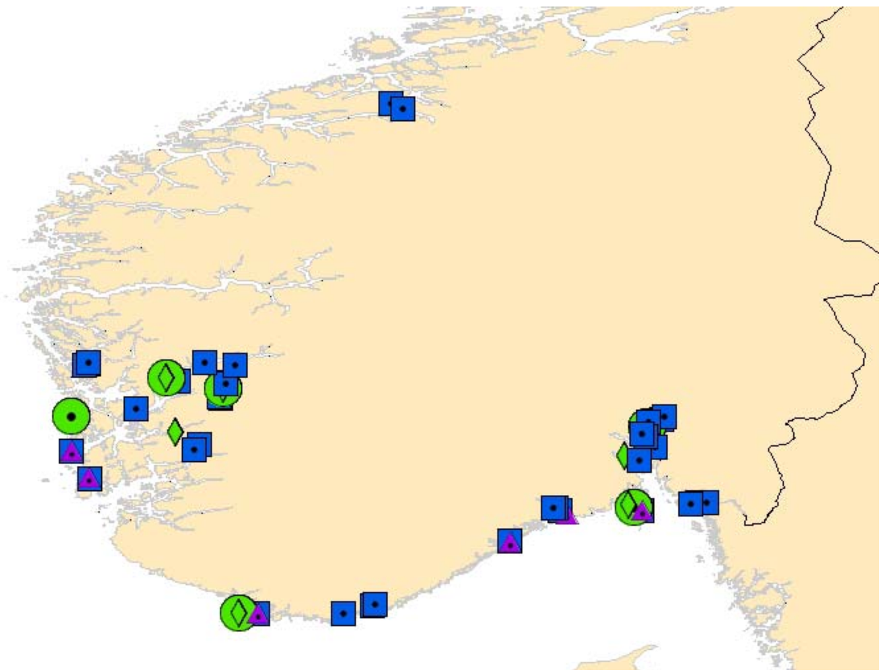


Figure 1. Stations samples in northern (**A**) and southern (**B**) Norway, where sampling of blue mussel (blue square), dogwhelk (purple triangle), cod (green circle) and flatfish (green diamond) in 2007 is indicated. See also station information in Appendix F and detailed maps in Appendix G.

2.2. Purpose

The general purpose of CEMP is to assess the state of contamination in the marine environments in order to provide a basis for remedial action. International initiatives such as The Water Framework Directive (WFD) (2000/60/EC) and the Marine Strategy Framework Directive (MSFD) (2008/56/EC) help drive this process. One of the goals of both of these EU directives is to achieve concentrations of hazardous substances in the marine environment near background values for naturally occurring substances and close to zero for manmade synthetic substances. OSPAR has also adopted this goal

(OSPAR 1998b). The Norwegian contribution to CEMP is designed to address issues relevant to OSPAR (cf., OSPAR 2007, SIME 2004a) including OSPAR priority substances (SIME 2004b). Furthermore it should ensure that their respective experts are as familiar as possible with the detail of their national submissions (ASMO 2007).

The state of contamination is divided into three issues of concern: levels, trends and effects. These are applied to the following regions:

- Oslofjord,
- Sørfjord/Hardangerfjord,
- Selected sites, remote from known point sources, along the entire coast of Norway,
- Selected impacted blue mussel sites used for determination of SFT’s pollution index.

Different monitoring strategies are used, in particular with regards to the selection of indicator media (sediment, blue mussel, cod liver etc.) and sampling frequencies (generally every 5-10 years for sediment, annually for biota). The programme may be supplemented with long or short term investigations of hazardous substances that are not routinely monitored.

Where possible CEMP is integrated with other national monitoring programmes to achieve a better practical and scientific solution to assessing the levels, trends and effects of micropollutants. In particular this concerns Comprehensive Study on Riverine Inputs and Direct Discharges (RID) and *Kystovervåkingsprogrammet* (KYO). Both programmes are operated by NIVA on behalf of SFT and coordinated through NIVA's Land Ocean Interaction Monitoring Programme (LOIMP).

3. Materials and methods

3.1. Sampling

Samples were collected and analysed, where practical, according to OSPAR guidelines[1] and screened and submitted to ICES by agreed procedures (ICES 1996).

The 2007 sampling of biota follows the OSPAR guidelines (1997) as closely as possible. These have replaced relevant portions of earlier guidelines (ICES 1986, 1992 including revisions up to 1994). There is some evidence that the effect of shell length and difference in bulk sample size by the two methods are of little or no significance (WGSAEM 1993; Bjerkeng & Green 1994). For historical reasons, three sizes of mussels (*Mytilus edulis*) have been sampled from most of the stations: 2-3, 3-4 and 4-5 cm. In order to obtain ca. 50 g wet weight, which is necessary for analyses and potential reanalyses of all variables, fifty - hundred individuals were sampled for each class. In 1992 a stricter approach (ICES 1992) was applied for new stations north of the Bømlo area at which 3 pooled samples of 20 individuals each were collected in the size range of 3-4 or 4-5 cm. Pending further investigation, all mussel samples from the new stations are collected according to the new ICES method.

To empty the intestinal canal (depuration) the mussels are kept alive for 12-24 hours in sea water (about 15 litres) collected in close proximity to the station. The shells are spread out on a perforated polyethylene platform and submerged in the seawater in a container. The container used are lined with polyethylene plastic bags. The bags are replaced for each station or sample. The temperature is kept at ambient conditions. Following depuration the mussels are shucked and frozen. The depuration is omitted if there is sufficient evidence that for a specific population/place the process has no significant influence on the body burden of the contaminants measured (cf. Green 1989a; Green *et al.* 1996).

For fish, 25 individuals of Atlantic Cod (*Gadus morhua)* and one flatfish species are sampled for each station. If possible, the same species collected in previous years at the selected stations are to be collected. The order of preference for flatfish species is: dab (*Limanda limanda*), flounder (*Platichthys flesus*), plaice (*Pleuronectes platessa*), lemon sole (*Microstomus kitt*). If possible, the 25 individuals are sampled with five individuals within each of the five length classes (**Table 1**). The fish are either prepared in the field and the samples are stored frozen until analysis or the fish is frozen directly and later prepared at NIVA.

Effects (imposex) and concentrations of organotin in **dogwhelk** (*Nucella lapillus*) are investigated using 50-100 individuals from each station. Individuals are kept alive until the effects (imposex) are measured.

Table 1. Target length groups for sampling of cod and flatfish.

size-class	cod	flatfish
1	370-420 mm	300-320 mm
2	420-475 mm	320-340 mm
3	475-540 mm	340-365 mm
4	540-615 mm	365-390 mm
5	615-700 mm	390-420 mm

[1] OSPAR 1990, 1997, see also www.ospar.org/eng/ > *measures* > *list of other agreements*

3.2. Chemical variables

Hazardous substances have been analyzed in sediment and different species tissues (**Table 2**).

Table 2. Overview of analyses (ICES code, see Appendix C) and indicator media used in CEMP. Indicator media include: selected tissues from blue mussel (Me), dogwhelk (Nl), cod (Gm) and flatfish species (Ff). Selected tissues include: soft body tissue (SB), liver tissue (LI), muscle tissue (MU), blood (BL) and bile (BI).

Description	Me-SB	Nl-SB	Gm-BI	Gm-BL	Gm/Ff-LI	Gm/Ff-MU
Cd, Cu, Pb, Zn	x				x	
Hg	x					x
TBT [1]	x	x			x [3]	
PCBs [2]	x				x	x
HCB	x				x	x
DDT, DDE, DDD	x				x	x
α-, γ-HCH	x				x	x
Dioxins [3]	x					
PBDE [4]					x [3]	
PFC [5]					x [3]	
PAHs [6]	x					
Biological effects methods		Impo-sex	OH-pyrene [7]	ALA-D [7]	EROD-activity, CYP1A [7]	

1) Includes: DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
2) Includes the congeners: CB-28,-52,-101,-105,-118,-138,-153,-156,-180, 209, 5-CB, OCS and, when dioxins are analyzed, the non-orto-PCBs, i.e. CB-77, -81, -126, -169
3) Includes: CDD1N, CDD4X, CDD6P, CDD6X, CDD9X, CDDO, CDF2N, CDF2T, CDF4X, CDF6P, CDF6X, CDF9P, CDF9X, CDFDN, CDFDX, CDFO,TCDD
4) Polybrominated diphenyl ethers (PBDE), including brominated flame retardents and includes: BDE28, BDE47, BDE49, BDE66, BDE71, BDE77, BDE85, BDE99, BDE100, BDE119, BDE138, BDE153, BDE154, BDE183, BDE205 (and for some samples BDE196 and BDE209)
5) Includes: PFNA, PFOA, PFHpA, PFHxA, PFOS, PFBS, PFOSA
6) Includes (with NPDs): ACNE, ACNLE, ANT, BAP, BBJF, BEP, BGHIP, BKF. BAA. CHR, DBA3A, DBT, DBTC1, DBTC2, DBTC3, FLE, FLU, ICDP, NAP, NAPC1, NAPC2, NAPC3, PA, PAC1, PAC2, PAC3, PER, PYR.
7) Cod only

Several laboratories have been used since 1981(cf. Green *et al.* 2008a). However, in general chemical analyses have been done at NIVA. One major exception has been analyses of dioxins carried out by the Norwegian Institute for Air Research (NILU). A brief description of the analytical methods used follows (from Green *et al.* 2008a) below.

Metals, except for mercury, were analyzed at NIVA. Before 2002 these were done using Atomic Absorption Spectrometry (AAS). Samples were extracted using nitric acid and concentrations determined either by Flame AAS (FAAS, for high concentrations) or Graphite furnace AAS (GAAS, for low concentrations). GAAS was always used zinc and often for copper determinations. Since 2002, metals have been determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Mercury (total) has been analyzed using Cold-Vapour AAS (CVAAS).

Polychlorinated biphenyls (PCB) and other chlororganic hazardous substances in biota at Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology – SINTEF or NIVA. Both laboratories have used gas chromatograph, with capillary column, (GC) and an electron capture detector (ECD). Fat content was extracted using a mixture of cyclohexane and acetone on the target tissue. Among the individual PCBs quantified, seven (ΣPCB-7) are commonly used for interpretation of the results[1] (**Table 3**).

Table 3. Suggested PCB-congeners which are to be quantified in biota (ICES 1986).

IUPAC/CB no.	Structure
28	2 4 - 4'
52	2 5 - 2'5'
101	2 4 5 - 2'5'
118	2 4 5 - 3'4'
138	2 3 4 - 2'4'5'
153	2 4 5 - 2'4'5'
180	2 3 4 5 - 2'4'5'

Polycyclic aromatic hydrocarbons (PAH) have been analyzed at NIVA using a GC coupled to a Mass-selective detector (MSD). The individual PAHs are distinguished by the retention time and/or significant ions. All seven potentially carcinogen PAHs (IARC 1987) are included in the list of single components determined to constitute the total concentration of PAH.

Organic tin compounds have been analyzed at NIVA except for the years 2001-2002 when GALAB (Germany) and Eurofins (Denmark) did the analyses. Analyses at NIVA were done using a GC-MSD in Selected Ion Monitoring mode (SIM). The other laboratories used a GC equipped with Atomic Emission Detector (AED), a method comparable to NIVA's.

Analyses of polybrominated diphenylether (PBDE) has been done at NIVA. Determinations are made on the fat content of the target tissue using a GC-MSD-SIM. Some alterations were needed to analyse BDE196 and BDE209 *inter alia* with respect to the temperature programme and steps taken to reduce the samples exposure to light.

Perfluorinated compounds (PFC) are determined using liquid-chromatography coupled to tandem MS (LC/MS/MS) operated in negative electro-spray-ionisation (ESI) mode using multiple reaction monitoring.

For fish, the target tissues are: liver and fillet for hazardous substance and liver, blood and bile for the biological effects methods (BEM) (cf.. **Table 2**). The fish fillet are analysed for the mercury and PCB content. In addition, the age, sex, and visual pathological state for each individual is determined. Other measurements include: fish weight and length, weight of liver, liver dry weight and fat content (% total extractable fat), the fillet dry weight and its % fat content. These measurements are stored in the database and published periodically (e.g. Shi *et al.* 2008).

The mussels are analysed for all contaminants including organotin. The shell length of each mussel is measured. On a bulk basis the total shell weight, total soft tissue weight, dry weight and % fat content is measured.

The dogwhelk are analysed for all organotin compounds and biological effects (imposex[2]).

[1] Several marine conventions (e.g. OSPAR and HELCOM[1]) use ΣPCB-7 to provide a common basis for PCB assessment.
[2] Vas Deferens Stage Index

3.3. Biological-effect analyses

There are currently five BEM applied on an annual basis. Each method is more or less specific on various contaminants. An overview of the methods, tissues sampled and contaminant specificity is shown in **Table 4**. One of the major benefits of biological effects methods (BEM) used at the individual level (biomarkers) is the feasibility of integrating biological and chemical methods, as both analyses are done on the same individual.

BEM-sampling requires that the target fish are kept alive until just prior to sampling in the field by trained personel. Immediately after the fish are rendered unconscious samples are collected and stored in liquid nitrogen. OH-pyrene analyses can also be done on bile samples stored at -20°C.

Table 4. The relevant contaminant-specific biological effects methods applied on an annual basis.

Code	Name	tissue sampled	Specificity
OH-pyrene	Pyrene metabolite	fish bile	PAH
ALA-D	δ-aminolevulinic acid dehydrase inhibition	fish red blood cells	Pb
EROD-activity	Cytochrome P4501A-activity (CYP1A/P4501A1, EROD)	fish liver	planar PCB/PCNs, PAHs, dioxins
CYP1A	Relative amount of cytochrome P450 1A-protein	fish liver	Supporting parameter for EROD-activity
TBT	Imposex/Intersex	snail soft tissue	organotin

3.4. Information on Quality Assurance

NIVA has participated in all the QUASIMEME international intercalibration exercises relevant to chemical and imposex analyses. For chemical analyses, these include Round 52 of January-April 2008 which would apply to the 2007 samples. These QUASIMEME exercises have included nearly all the contaminants as well as imposex analysed in this programme. Quality assurance programme for NIVA is similar to the 2006 programme (cf. Green *et al.* 2008). In addition, NIVA was accredited in 1993 and since 2001 accredited in accordance with the NS-EN ISO/IEC 17025 standard by the Norwegian Accreditation (reference P009). A summary of the quality assurance programme at NIVA is given in Appendix B.

In addition to these QUASIMEME exercises, certified reference materials (CRM) are also analyzed routinely with the CEMP samples. It should be noted that for biota the type of tissue used in the CRMs do not always match the target tissue for analyses. Uncertain values identified by the analytical laboratory or the reporting institute are flagged in the database. The results are also “screened” during the import to the database at NIVA and ICES.

3.5. INDEX - “Pollution” and "reference" indices

The Norwegian Pollution Control Authority (SFT) is interested in obtaining a small group of indices to assess the quality of the environment with respect to contaminants. The target medium indices may vary depending on the purpose, though sediment, cod and mussels are considered to be the most likely choices. The blue mussels have been selected as the target medium since 1995 (Appendix K) mainly because it is widely distributed and more practical to sample. The index for the blue mussel is based on the levels and trends of contaminants in the organism collected annually. Since 1995, 10 of the more contaminated fjords in Norway (Walday *et al*. 1995) have been used as a basis for “Pollution Index”. Analyses are selected for substances that are presumed most relevant for the fjord chosen. Another set of blue mussel stations remote from known point sources were sampled to assess a “Reference Index”. These stations were located along the entire coast of Norway. “Reference” stations are important for the assessment of contaminated fjords (cf. Green 1987b), and are of national and international interest. A general suite of chemicals are analysed at these stations. Some

CEMP results could be used to calculate these indices and it was practical to organise sampling within CEMP.

The use of the indices to assess the general level of pollution in contaminated or reference areas of coastal water for the period 1995 to 1999 has been reviewed by Green & Knutzen (2001). The conclusions were mainly that the sample and analytical strategies lacked adequate coverage of the relevant contaminants and geographical areas. There have been several cases where mussels have not been found at a particular station in the Grenland fjords area, inner Sunndalsfjord and inner Ranfjord. The "pollution" index is particularly sensitive to stations closest to sources of pollution. To reduce random fluctuations in the index due to incomplete sampling an additional station was added to each of these fjord areas. Furthermore, additional relevant chemical analyses were added. The affect of these adjustments was investigated in 2002 and 2003.

Some slight adjustments in the selection of stations, analyses and calculation procedures of the indices have been described in Green *et al.* (2004a, b). A detailed discussion of calculation of the Pollution Index has been given in Walday *et al.* (1995). It should be noted that the supplementary blue mussel stations monitored explicitly for indices, utilized 3 pooled samples of 20 individuals and no depuration procedures have been applied. The relevant contaminants for each of the Pollution Index fjords are summarised in Appendix K. Two to five stations were sampled from each area. One to three stations are sampled from selected areas for the determination of the Reference Index. Some samples were also analysed for PAHs, TBT and dioxins.

Concentrations were classified according to SFT's classification system for contaminants in the marine environment (Molvær *et al.* 1997, Appendix D). The lowest Index value is 1 and means that all median values were in Class I ("insignificantly" contaminated). The highest Index value is 5 and means that all median values were in Class V ("extremely" contaminated).

The results for 2007 have been reported based on investigations in nine fjords for the Pollution Index and 4 fjord/areas for the Reference Index (Green *et al.* 2008b).

3.6. Overconcentrations and classification of environmental quality

Classification used in this report is primarily based on the Norwegian Pollution Control Authority **environmental classification system** (Molvær *et al.* 1997). The revised classification system (SFT 2007) applies to concentrations in water and sediment only and has therefore not been used here. Focus is on the principle cases where *median* concentrations exceeded the upper limit to Class I in the Norwegian Pollution Control Authority's (SFT's) environmental quality classification system (cf. Molvær *et al.* 1997). The relevant extract from the system is shown in Appendix D, and includes unofficial conversion to other bases. The system has five classes from Class I, "insignificantly polluted", to Class V, "extremely polluted". However, the system does not cover all the contaminants in indicator species-tissues used in CEMP. To assess concentrations not included in the system provisional "high background" values were used (cf. Appendix D). The factor by which concentrations exceeded "high background" is termed **overconcentration**. "High background" concentration corresonds to the upper limit to Class I; "slightly" or insignificantly" polluted, which in this context has no statistical implications.

The median concentrations are assessed according to the SFT system, but where this is not possible overconcentrations are used. The term "significant" refers to the results of a statistical analysis of linear trends and can be found in the tables in Appendix I or figures in Appendix J. It should be noted that there is in general a need for periodic 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 over the years may not correspond.

Recommendations for changes to Class I (cf. Knutzen & Green 2001b, Green & Knutzen 2003) have been taken into account in this report. Revisions to corresponding Classes II-V have not been done, SFT is considering these recommendations in a current review of their classification system.

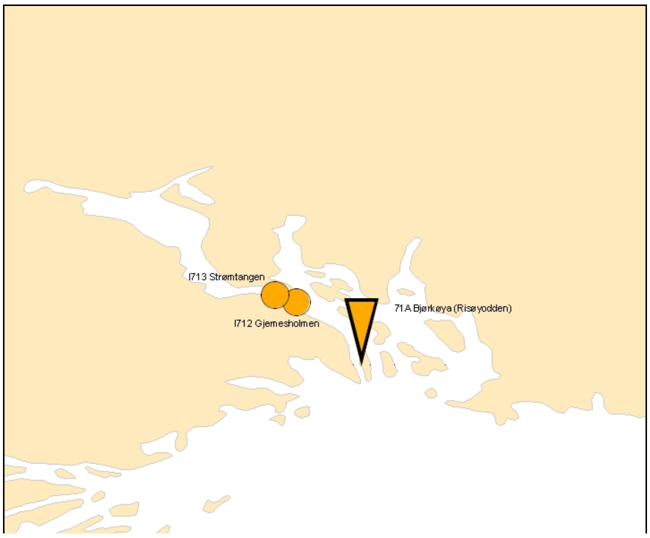
No attempt has been made to compensate for differences in size groups or number of individuals of blue mussel or fish. The exception was with mercury in fish fillet where six data sets in both cod and flatfish in this study showed significant differences between “small” and “large” fish (Appendix I). With respect to blue mussel, 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 Safety Authority (SNT) is responsible for official commentary as to possible health risk due to consumption of seafood. Hence, the results of the CEMP pertaining to this purpose are presented only as a partial basis for evaluation.

3.7. 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). 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 H. The results are presented in a type as shown in Figure 2.

A



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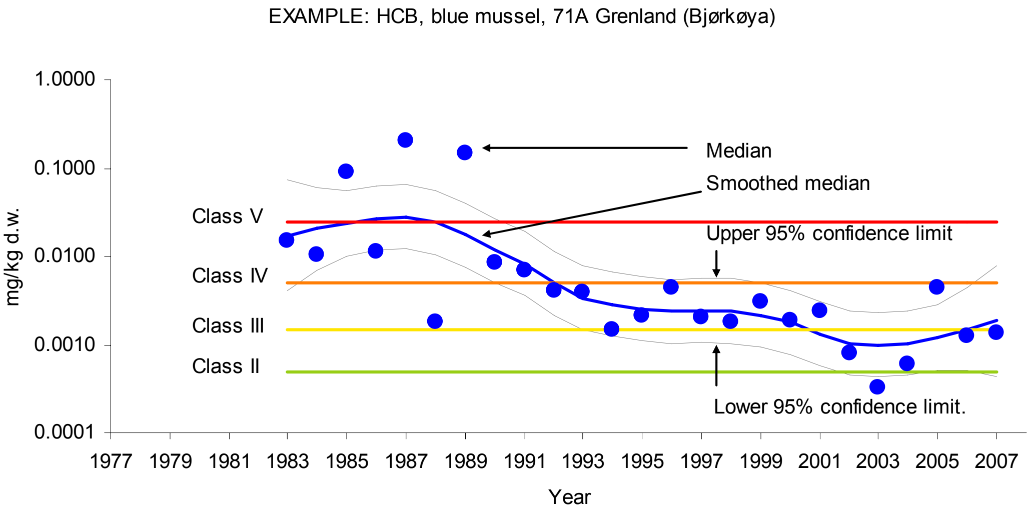


Figure 2. Example time trend with map (**A**) with arrows or circles to indicate upward/downward trend or circles if no trend. The symbols are coloured blue if the sample for the last year in the time series was insignificantly polluted (Class I in SFT's environmental classification system or lacking this, below the upper limit to the provisional "high background") or orange if it was not (i.e. in Class II moderately polluted or worse). The symbol is grey if the limit is lacking. The detail of a time series (**B**) indicates the median concentrations, running mean of median values (Loess smoother), 95% confidence intervals. The horizontal lines indicate the lower boundaries to SFT classes of pollution: Class II (moderate=upper boundary to Class I (insignificant)), III (marked), IV (severe) and V (extreme), or alternatively the Class II boundary is replaced by the upper boundary to provisional "high background level" as in which case no class-boundaries are shown. (see text and refer to Appendix D).

A Loess smoother is based on a running seven-year interval, a non-parametric curve fitted to median log-concentrations (Nicholson *et al.* 1991, 1994 and 1997 with revisions noted by Fryer & Nicholson 1999). 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). No transformation was applied to the imposex (VSDI) data.

The smoothed median for the last three sampling years is linearly projected for the next three years to assess the likelihood of overconcentrations.

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 easier it is to detect a trend. The power is based on the percentage relative standard deviation (RLSD) estimated using the robust method described by 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 mussel from Grenland fjords area (Figure 6).

The statistical analysis was carried out on temporal trend data series for cadmium, mercury, lead, ΣPCB-7 (sum of congeners: 28, 52, 101, 118, 138, 153, 180), ppDDE (ICES code DDEPP), HCB, non-dicyclic PAHs, sum carcinogenic PAHs, B[*a*]P, TBT, and the biological effects parameters imposex (VSDI), PYR10, ALA-D and EROD-activity.

4. Results

4.1. General information on measurements

The stations and sample counts relevant to the 2007 investigations are noted in the tables in Appendix F. Blue mussel was sampled at 51 stations (including supplementary stations for Index and TBT), dogwhelk at 9, and cod at 9 , flatfish at 11 from the border to Sweden in the south to the border to Russia in the north (cf. Appendix G). Generally, blue mussel 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. Time trend analyses were performed on a selection of representative contaminants and totaled nearly 800 data series (cf. Appendix I). The focus of the overview presented below is on the 538 time series that included results from 2007, of which 138 were downwards and 24 were upwards.

4.2. Oslofjord, Hvaler area and Grenlandsfjord area

Investigations for 2007 in this area included 10 blue mussel stations (Figure 3A) and two cod stations (Figure 4A) in the Oslofjord and Hvaler area. Also, one flounder station near Mølen in the mid Oslofjord and one dogwhelk station at Færder (cf. Figure 3A) were investigated. In addition, 3 blue mussel stations in the Grenlandsfjord area were sampled (Figure 6A). Of the 538 time series, 162 concerned the Oslofjord area, including the Hvaler area and Grenlandsfjord area, 130 of these had a concentration in 2007 that could be classed as insignificantly polluted (Class I in the SFT system), or lacking this, did not exceed provisional “high background”. Most of the time series from this region showed no significant trend, and of the 57 significant trends, 75% were downwards. Points of concern are described below.

4.2.1. Oslofjord and Hvaler area

Blue mussel from the inner Oslofjord (Gressholmen) were moderately polluted with **ΣPCB-7**[1] (SFT’s Class II, Figure 3).

Cod liver from the inner Oslofjord (Vestfjord)was markedly polluted with **ΣPCB-7** (Class III, Figure 4). The median concentration was 2100 µg/kg w.w., about 30% lower than in 2006. Nearly all the cod collected during this period have been collected in the Vestfjord area west of Steilene. The range found in 2007 was 1193-4725 µg/kg w.w. The fillet from the same fish were moderately polluted with ΣPCB-7 as it has been since 2000 (Class II, Figure 4C). Cod liver and fillet from the outer Oslofjord were insignificantly polluted with regard to ΣPCB-7 (Færder, st.36B). It can be noted that the Norwegian Food Safety Authority (*Mattilsynet*) has issued advice due to concerns about PCB in cod liver (cf. Appendix E).

A significant linear *downward* trend was detected for **ΣPCB-7** in blue mussel from seven stations in the Oslofjord-Hvaler area (Figure 3A) for the period 1988 to 2007. Power analyses indicated that a hypothetical trend of 10% change per year in ΣPCB-7 concentration in the blue mussel in this area would take 10 to 14 years to be detected with 90% significance (Appendix I). No trends were found in cod, flounder or dab from this area.

The fillet cod from the inner Oslofjord (Vestfjord) in 2007 were moderately polluted with **mercury** (Class II, Figure 5A, B). A significant *upward* trend was detected for the period 1984-2007. No significant trend was found for the period 1998-2007. Considering the entire period, the power, indicated as number of years to detect a hypothetical 10% change per year for mercury in cod fillet from either the inner Oslofjord station or the outer Oslofjord station (Færder), was 11 years) (cf. Appendix I). An upward trend in mercury in cod was found only at one other cod station in the 2007 CEMP investigations (st.23B Karihavet, on West Coast). Therefore the trend in the inner Oslofjord indicates a local impact. Two *upward* trends were found in blue mussel from the mid (st.31A

[1] ΣPCB-7 is the sum of PCB 28, 52, 101, 118, 138, 153 and 180

Solbergstrand) and inner Oslofjord (st.I301, Akershuskaia) but concentrations in 2007 were low (Class I).

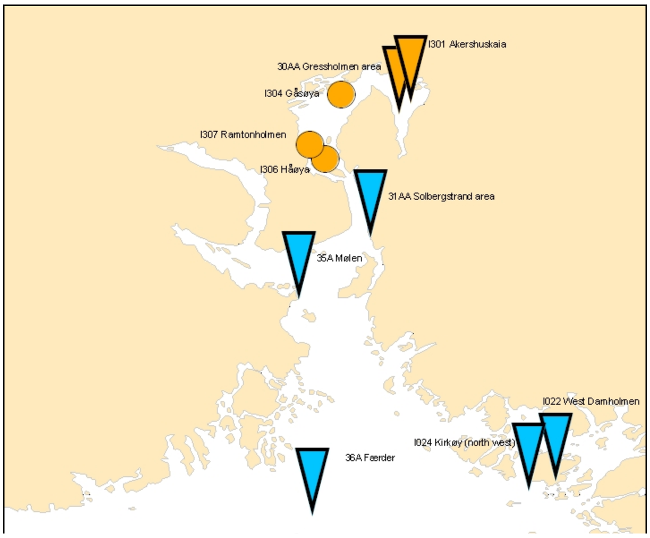
Median concentration of **lead** in cod liver from the inner Oslofjord (Vestfjord) (30B) 2007 was 0.29 mg/kg w.w.. “High background” for this metal is 0.1 mg/kg w.w. Blue mussel from one station in the inner Oslofjord (st. 30A) were moderately polluted with respect to lead in 2007.

Overconcentration in the median for **cadmium** in cod liver from the inner Oslofjord (30B) was found for 2007, and the trend was found to be *upward* for the period 1984-2007. Two of the five blue mussel stations in this area of the fjord also showed *upward* trends, Gressholmen (30A) for the period 1984-2007 and Rotonholmen (I307) for the period 1995-2007, but concentrations were low (Class I).

The SFT's environmental quality classification system does not include cadmium and lead in cod liver.

It should be noted that the Index programme indicated marked concentrations of TBT in blue mussel from a station located in the inner Oslofjord (see chapter 4.9).

A



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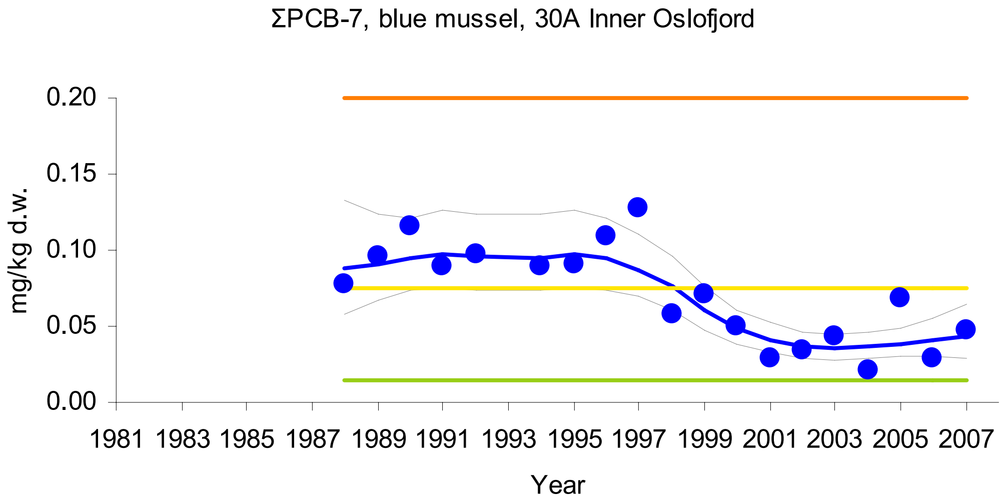
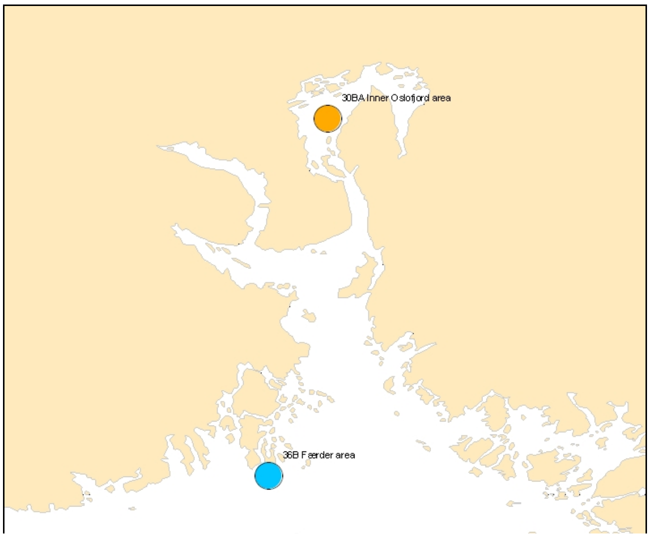


Figure 3. Trend for median ΣPCB-7 concentrations in blue mussel (*Mytilus edulis*) from the Oslofjord region and detail for Gressholmen in the inner Oslofjord (st.30A) (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2).

A



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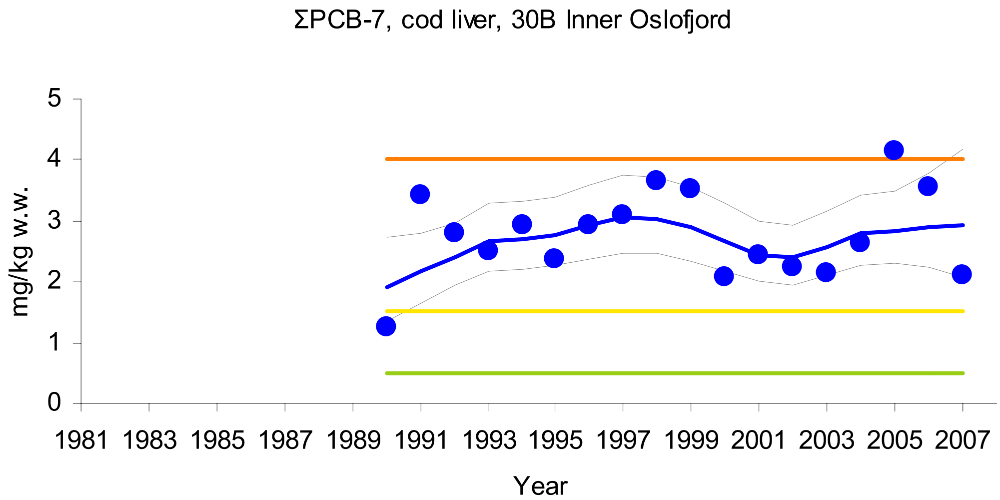

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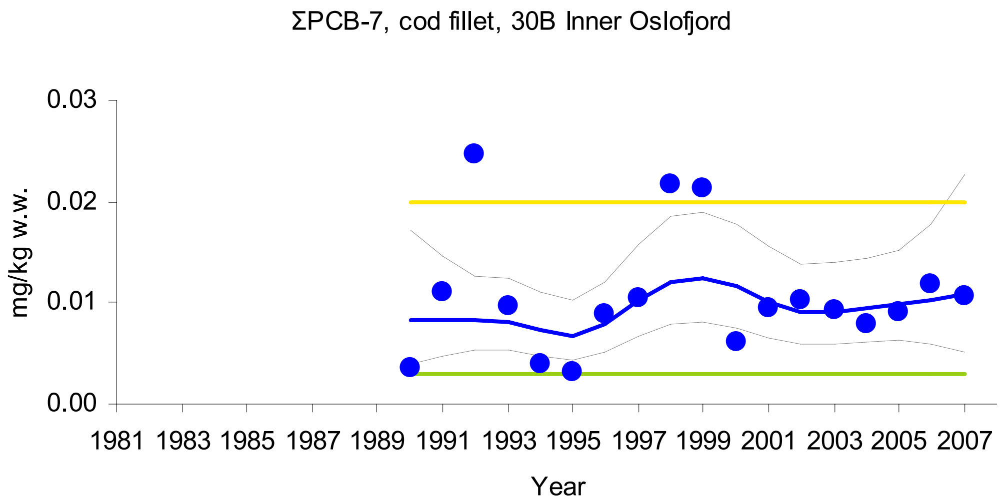
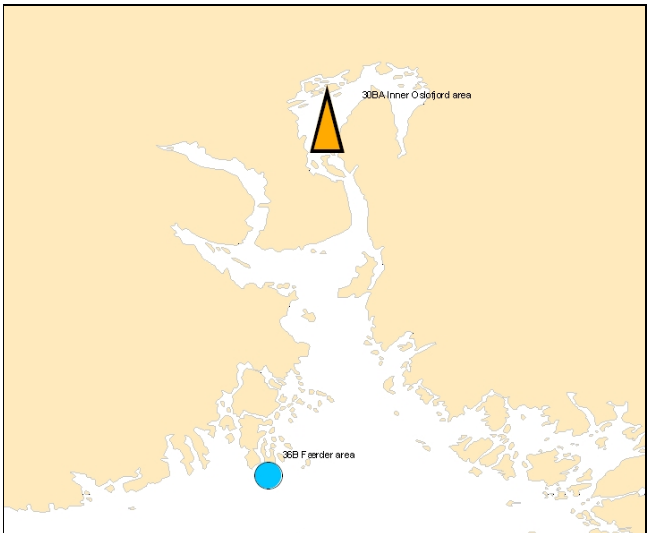


Figure 4. Trend for median ΣPCB-7 concentrations in liver and fillet of cod (*Gadus morhua*) from the Oslofjord region and detail for the inner Oslofjord (st.30B – Vestfjord) (cf. Appendix G and Appendix I. Circles in maps indicate no significant trends and where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2).

A



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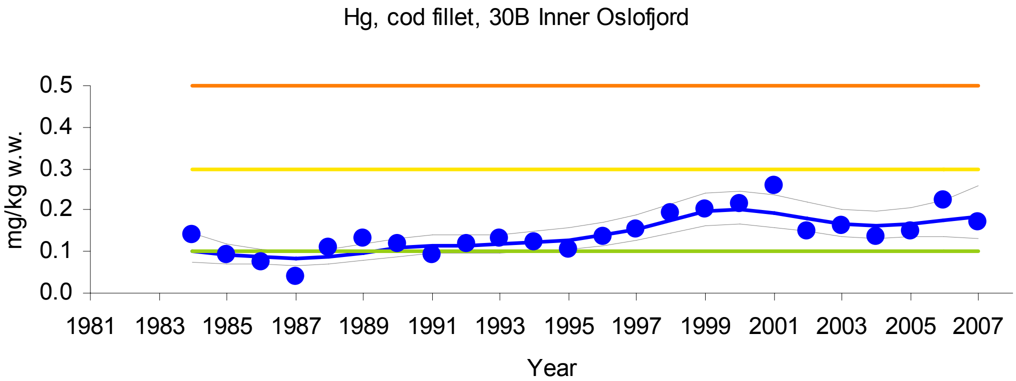


Figure 5. Trend for median mercury (Hg) concentration in fillet of cod (*Gadus morhua*) from the Oslofjord region and detail for the inner Oslofjord (st.30B - Vestfjord) (cf. Appendix G and Appendix I. Direction of significant trend indicated in the map where blue symbol indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2).

4.2.2. Grenlandsfjord area

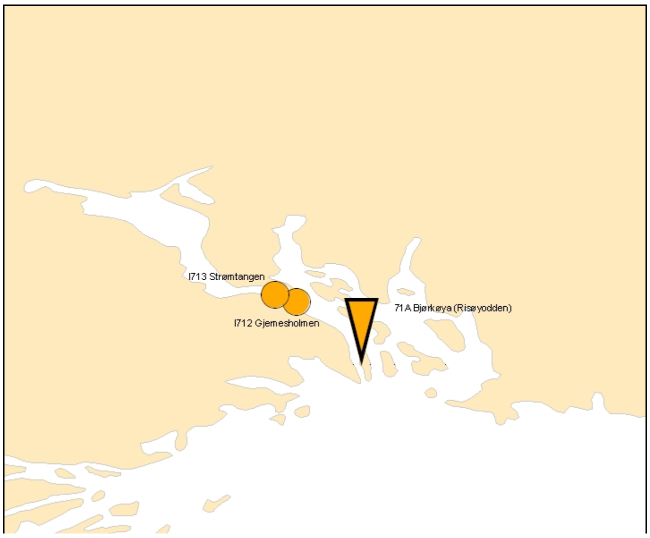
Blue mussel from Bjørkøy (Risøyodden) (st.71A) in 2007 were moderately polluted with **HCB** (Class II, Figure 6A and B). The median concentration for 2007 was 1.33 mg/kg dry weight, about the same as the 2006 median. Median values found at two nearby Index stations near the mouth of the Frierfjord (I712 Gjemesholmen and I713 Strømtangen, Figure 6A) were markedly polluted (Class III), but also lower in 2007 compared to 2006 (Appendix I). Concentrations have varied greatly since 1983 but median values have decreased distinctly since 1989 (Figure 6B) due to about 99% reduction in discharge of HCB and other organochlorines from a magnesium factory (cf. Knutzen *et al.* 2001).

The power of the monitoring programme at Bjørkøy was 18 years for the period 1990-2007 and more than 25 years for the entire period (cf. Appendix I). The 1983-2007 data series for HCB in blue mussel had a significant *downward* trends and also a significant *downward* trend was found for the recent period (1990-2007).

Median concentrations of **ΣPCB-7** and in blue mussel from Gjemesholmen has *decreased* since 1995, as well as **TBT** concentrations from Gjemesholmen and Strømtangen since 2002.

It should be noted that **dioxin** is one of the contaminants monitored to establish the Pollution Index (see chapter 4.9). Dioxin toxicity equivalents based on the Nordic model (TCDDN) showed that the blue mussel was severely polluted (SFT Class IV) at Bjørkøy (st. 71A) and extremely polluted (Class V) at both nearby Index stations (st.I712 Gjemesholmen and st.I713 Strømtangen), (Figure 6A).

A



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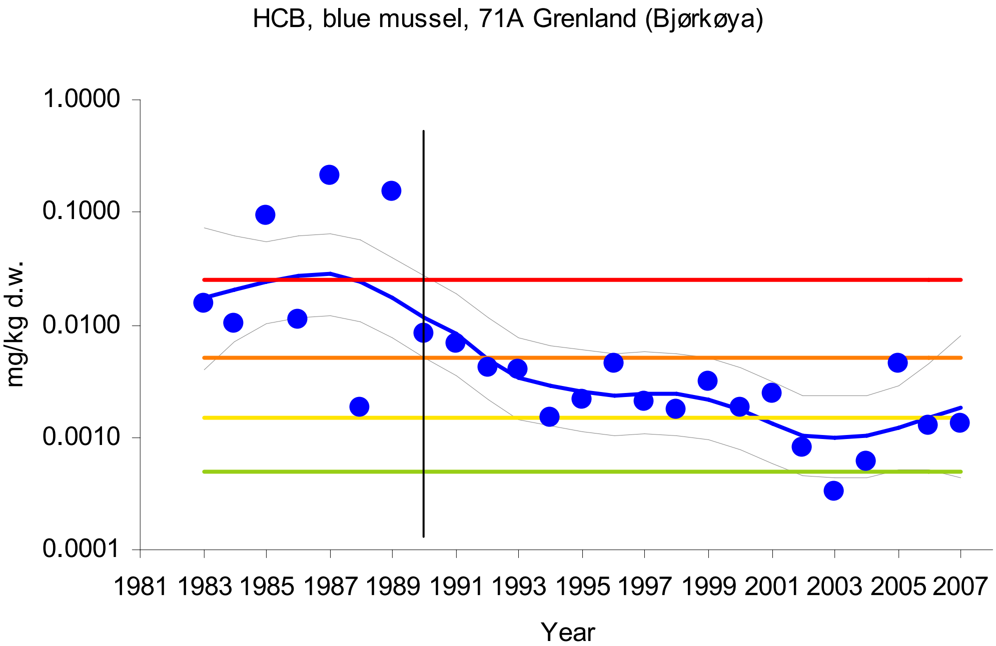


Figure 6. Trend for median HCB concentrations in blue mussel (*Mytilus edulis*) from the Grenlandsfjord area – Frierfjord region (west of Oslofjord) and detail for the Grenlandsfjord station (71A) (cf. Appendix G and Appendix I. Direction of significant trend is indicated in the map where orange symbols indicate that pollution in 2007 was not insignificant. See otherwise key to map and detail in Figure 2). Vertical line indicates when a magnesium factory reduced it's discharge by 99%. **NB: log-scale.**

4.3. Sørfjord and Hardangerfjord

Investigations for 2007 in this area included 6 blue mussel stations (Figure 8A) and two cod and flatfish stations (Figure 10A) in the Sørfjord and Hardangerfjord area. Of flatfish, flounder was collected from inner Sørfjord and both flounder and witch were collected from the Hardangerfjord. Of the 538 time series that included 2007 results, 109 concerned the Sørfjord and Hardangerfjord area. Of these, 67 had a concentration in 2007 that could be classed as insignificantly polluted (Class I in the SFT system), or lacking this, did not exceed provisional “high background”. Most of the time series from this region showed no significant trend, and of the 48 significant trends, all but 2 were downwards. Points of concern are described below.

The development of the contaminant conditions in these connected fjords and the main remedial actions that have been taken, have been outlined earlier 1989 (Green 1991a) and in recent reports concerning Sørfjord in particular (Skei 2000, 2001, Skei & Knutzen 2000, Skei *et al.* 1998). The results from CEMP 2007 are coupled to other studies in this area (cf. Knutzen & Green 2001a, Ruus & Green 2002, 2003, 2004, 2005, 2006, 2007) and confirm that the Sørfjord, and in some cases also Hardangerfjord, continue to be contaminated especially with cadmium (Figure 7), lead (Figure 8), mercury (Figure 9 and Figure 10), ppDDE (Figure 11 and Figure 13), and to a lesser extent PCB (Figure 13). It can be noted that the Norwegian Food Safety Authority (*Mattilsynet*) has issued advice due to concerns about metals and PCB in seafood including deep-water fish (Appendix E).

Metals

Results for blue mussel collected from the Sørfjord indicated that these were moderately (Class II) or markedly polluted (Class III) with **cadmium** in respect to SFT's classification system (Figure 7, Appendix I). Blue mussel as far as Ranaskjær (st.63A. ca.50 km from Odda at the head of the Sørfjord) were moderately polluted with cadmium (Figure 7). A significant *downward* trend over the past ca.20 years was found for cadmium at three stations in Sørfjord (st.52A, 56A and 57A) and two in Hardangerfjord (st.63A and 65A) (Appendix I). There was also a downward trend for this element in cod from Hardangerfjord, but in contrast, an *upward* trend was found in cod from the inner Sørfjord.

The median **lead** concentration at the station nearest Odda (st.51A), Eitreheimsneset (st.52A) and Kvalnes (st.56A), about 15 km distant, were markedly polluted (Class III), whereas the other station in the Sørfjord (st.57A) and the nearest station in the Hardangerfjord (st.63A) were moderately polluted. A *downward* trend was found for lead at Ranaskjær (st.63A), 1990-2007, as well as the other blue mussel and fish stations in the Hardangerfjord. A *downward* trend was also detected for this element in cod from the inner Sørfjord.

Three blue mussel stations in Sørfjord nearest Odda were moderately polluted with respect to **mercury**. Of the seven significant trends found in blue mussel and fish from the Sørfjord and Hardangerfjord, six were *downward* and the only *upward* trend was found in flounder from the inner Sørfjord, which was over the period 1988 to 2007.

Cod fillet from the inner Sørfjord (st.53B) was moderately polluted with **mercury** (Class II). Overconcentrations were found for **cadmium** in cod liver and flounder liver from inner Sørfjord (2.8 and 2.6 times, respectively).

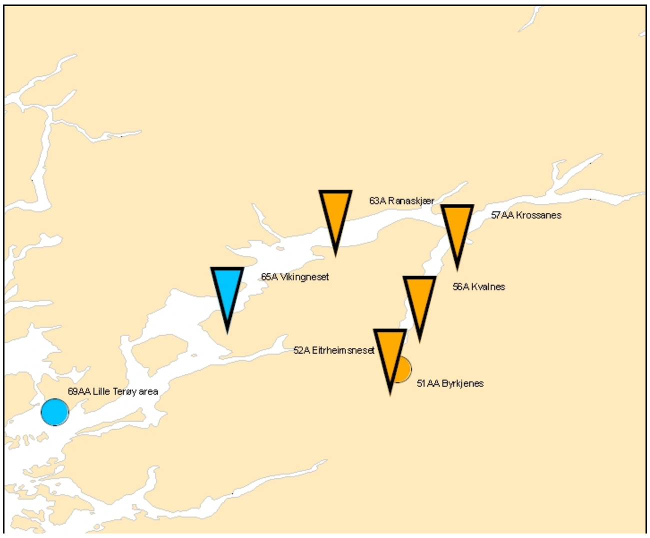
The power of the sampling strategies for blue mussel was relatively poor for samples collected from Odda; the innermost part of Sørfjord (st.51A or 52A). For example for lead in blue mussel from these stations, it is estimated that it would take 18-22 years to detect a hypothetical trend of 10% per year with 90% significance (Appendix I). This reflects the large variability found in the data series from this area. The variability is mostly due to the irregular/accidental input of contaminated discharges. The power improved with distance from Odda, and for example at Ranaskjær (st.63A) and Vikingneset (st.65A) for lead was only 13 years.

DDT and PCB
Blue mussel at Kvalnes (st.56A) in the mid Sørfjord region were severely polluted with **ppDDE** (as a representative for DDT) (Class IV); with a median concentration of 117 µg/kg d.w., and about 30% lower than the 2006 value. The upper limit to Class IV is 150 µg/kg d.w.. Blue mussel at the mouth of the Sørfjord, Krossanes (st.57A) about 20 km to the north, was moderately polluted (Class II, Figure 11). Cod liver from the Sørfjord was moderately polluted with ppDDE (Figure 13B, Appendix I).

The liver of cod from Sørfjord for 2007 were moderately polluted (Class II) with respect to **ΣPCB-7**. Since CEMP monitoring started in the Sørfjord and Hardangerfjord the median values have varied between 100 and 2400 µg/kg w.w. (Appendix I). This indicated that cod is subject to a variable exposure from PCB, but the cause of this variation is not clear.

No trends were evident for **ppDDE** and **ΣPCB-7** in blue mussel and cod from the inner Sørfjord where 2007 median concentrations could be classified as moderately polluted (Class II) or worse (in this case up to Class IV). However, a *downward* trend since 1990 was found for ppDDE and ΣPCB-7 in cod liver from Hardangerfjord. Furthermore, a *downward* trend since 1990 was found for ppDDE in flounder fillet from Sørfjord, and a *downward* trend was found for ΣPCB-7 in both liver and fillet from this species from Sørfjord (since 1990) and Hardangerfjord (since 1996).

A



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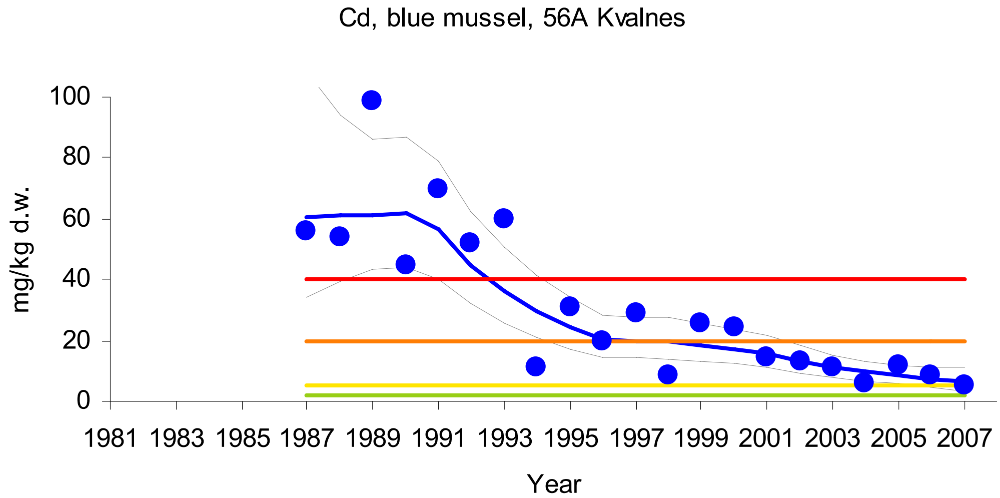
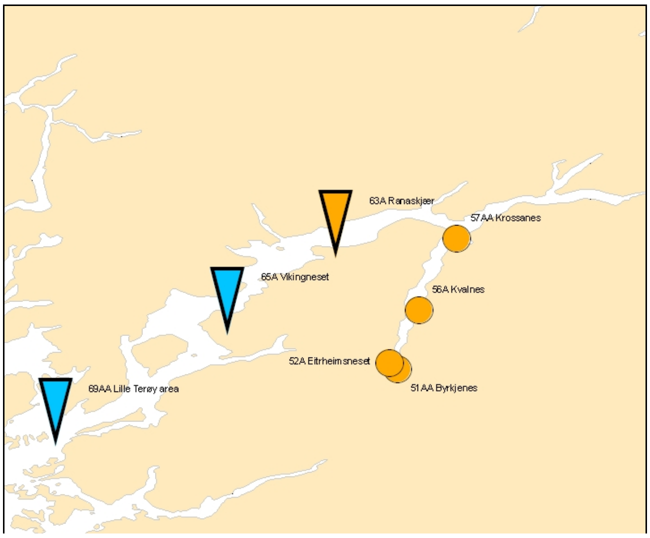


Figure 7. Trend for median cadmium (Cd) concentrations in blue mussel (*Mytilus edulis*) from the Sørfjord and Hardangerfjord region and detail for the mid Sørfjord (st.56A, Kvalnes) (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). **Note: horizontal lines for Classes I and II are near x-axis.**

A



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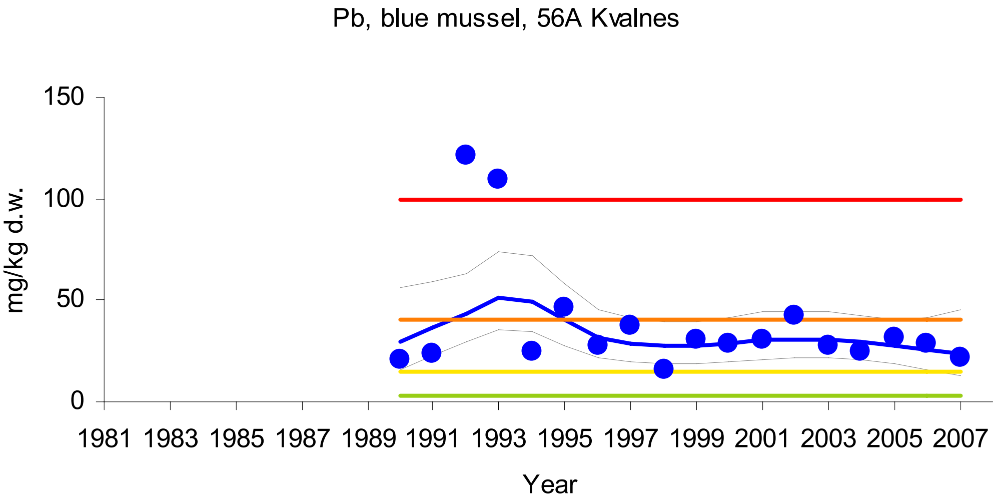

Figure 8. Trend for median lead (Pb) concentrations in blue mussel (*Mytilus edulis*) from the Sørfjord and Hardangerfjord region and detail for the mid Sørfjord (st.56A, Kvalnes). NB: (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). **Note: horizontal lines for Classes I and II are near x-axis.**

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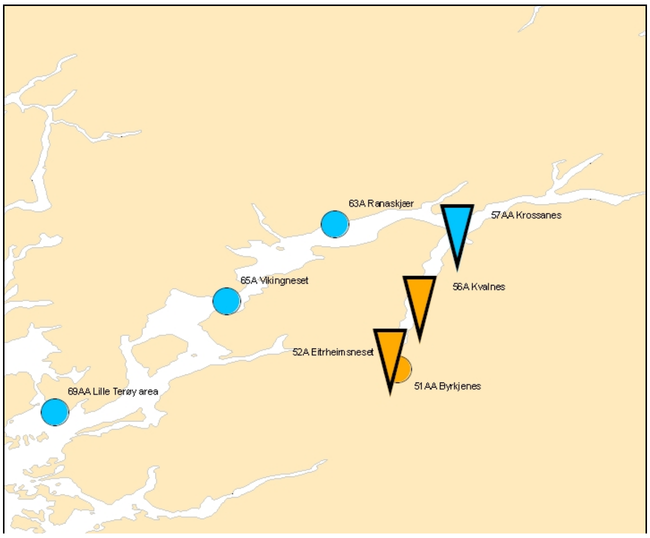

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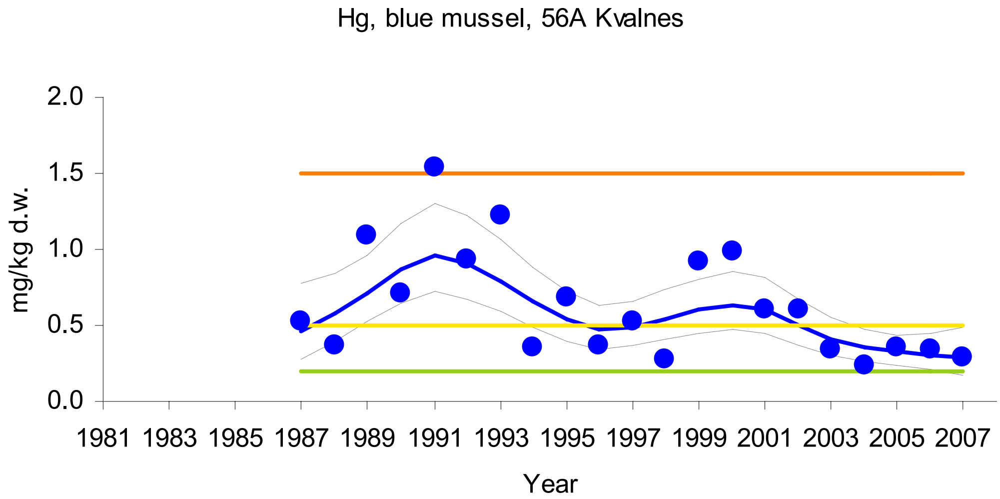
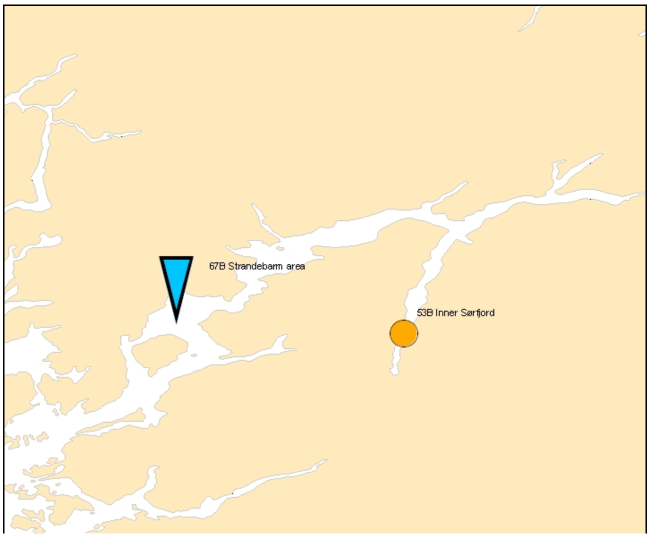


Figure 9. Trend for median mercury (Hg) concentrations in blue mussel (*Mytilus edulis*) from the Sørfjord and Hardangerfjord region and detail for the mid Sørfjord (st.56A, Kvalnes). NB: (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). **Note: horizontal lines for Classes I and II are near x-axis.**

A



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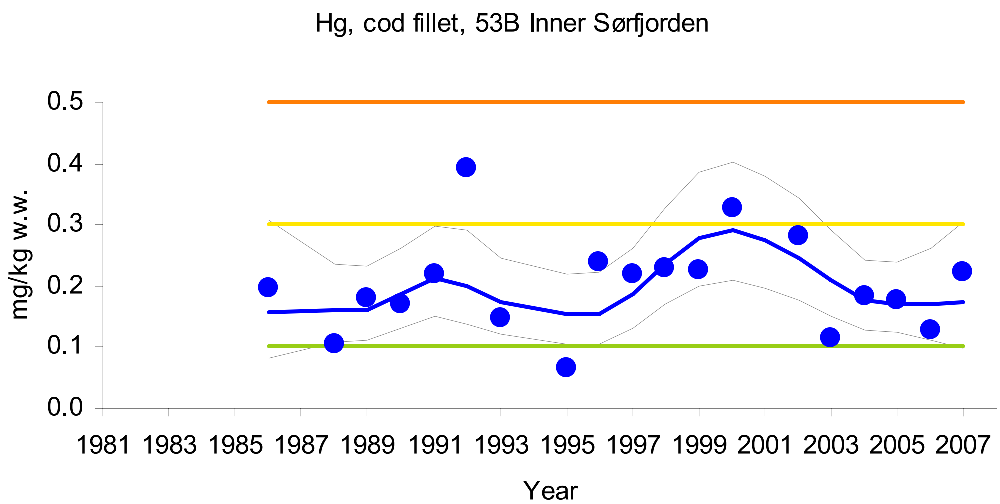

Figure 10. Trend for median mercury (Hg) concentrations in fillet of cod (*Gadus morhua*) from the Sørfjord and Hardangerfjord region and detail for the inner Sørfjord (st.53B) (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2).

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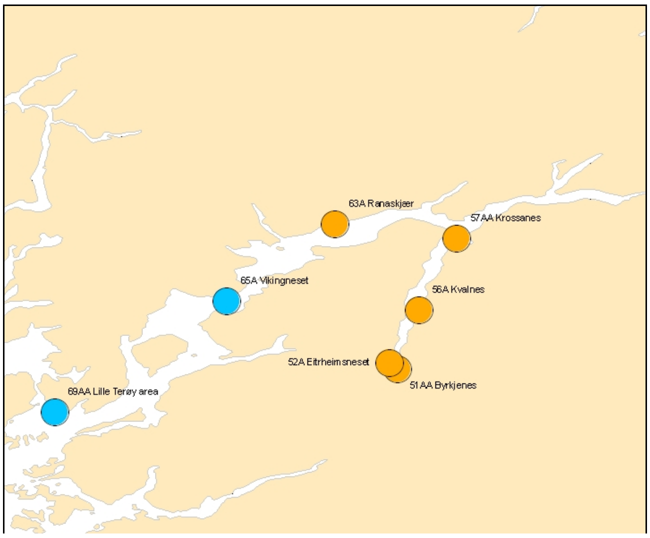

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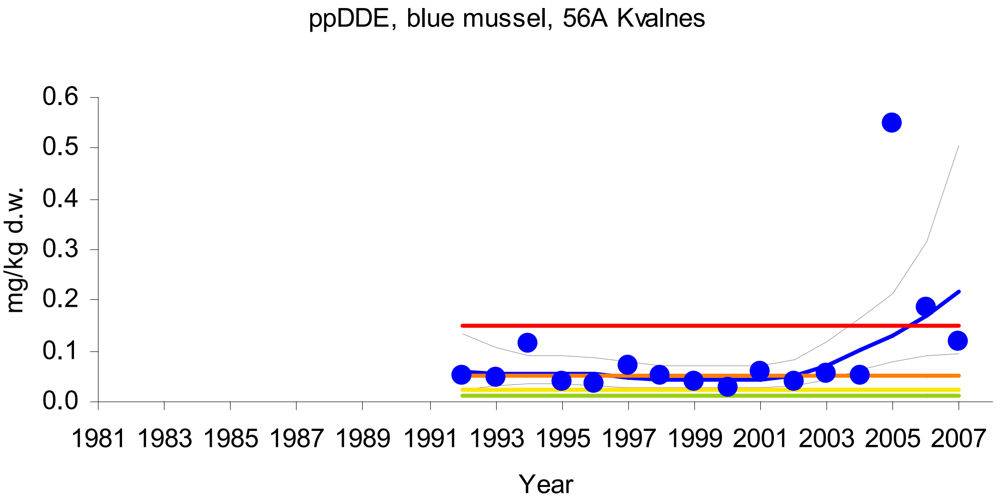
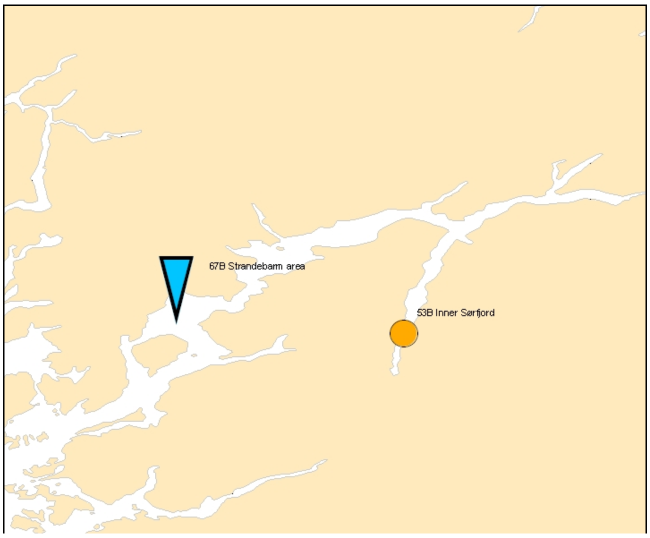


Figure 11. Trend and median ppDDE concentrations in blue mussel (*Mytilus edulis*) from the Sørfjord and Hardangerfjord region and detail for the mid Sørfjord (st.56A, Kvalnes) (cf. Appendix G and Appendix I. Circles in the map indicate that no significant trend was detected and blue symbols in the map indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). **Note: Class limits for ΣDDT used. Horizontal line for Class I is near x-axis.**

A



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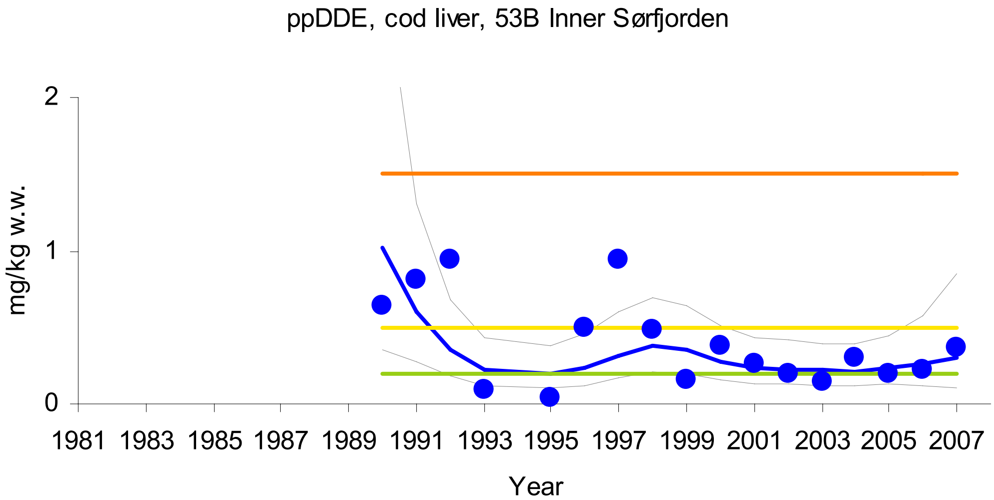
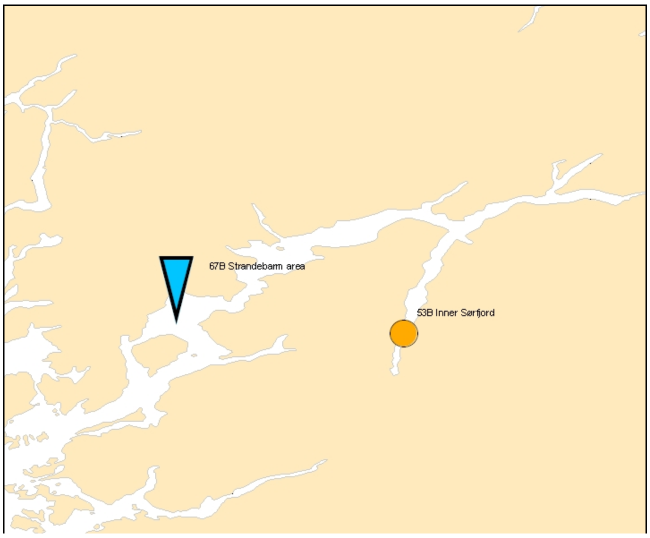


Figure 12. Trend for median ppDDE concentrations in liver of cod (*Gadus morhua*) from the Sørfjord and Hardangerfjord region and detail for the inner Sørfjord (st.53B) (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). **Note: Class limits for ΣDDT used for ppDDE. Note also that for 1989 the upper confidence interval line is off-scale.**



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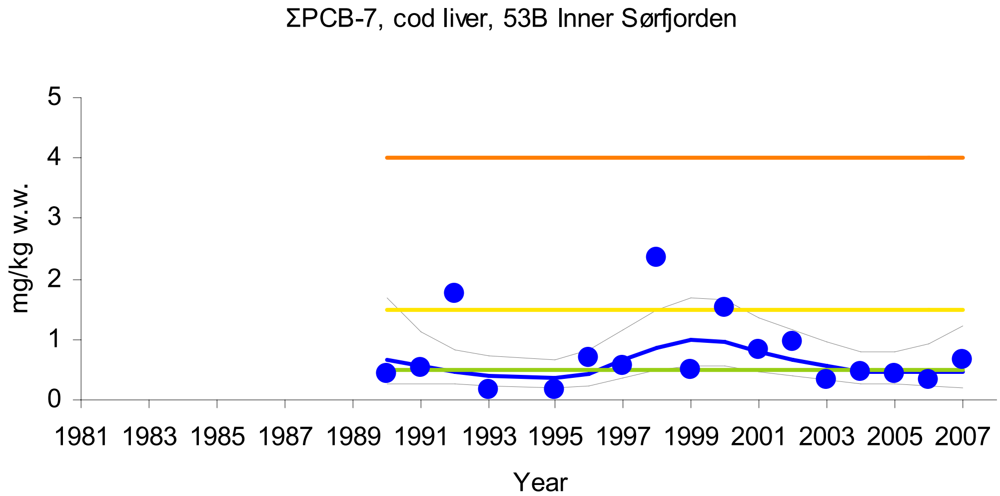

Figure 13. Trend for median ΣPCB-7 concentrations in liver of cod (*Gadus morhua*) from the Sørfjord and Hardangerfjord region and detail for the inner Sørfjord (st.53B) (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2).

4.4. Lista area

A blue mussel, dogwhelk, cod and dab station are monitored here, which involved a total of 29 time series for the different tissues and contaminants. In all cases, the median values from these samples were insignificantly polluted (Class I or below provisional high background) in 2007. Of the 7 significant trends found, 6 were downward and only one was upward and concerned mercury in dab fillet (st.15F, Appendix I and Appendix J).

4.5. Bømlo-Sotra area

During the period 1990-1999 flatfish were sampled at Borøyfjorden (st.22F). From 2000 and onwards flatfish have been sampled from Kyrping in the Åkrafjord (st.21F). This station is located about 82 km south-east of Borøyfjorden, but like this fjord, Kypring is located in a reference area.

Investigations of blue mussel, cod and flounder from this area (CEMP stations 22A, 23B, and 21F, respectively) considered 41 time series. For 37 of these the median concentration in 2007 could be classified as insignificantly polluted (Class I). The exceptions were the severely polluted (Class IV) condition for copper in mussel from Espevær (22A), and moderately polluted (Class II) condition for mercury in the fillet of cod and flounder and TBT in mussels (Appendix I and Appendix J). The median concentration of copper in mussels from Espevær was 145 ppm d.w.. Copper concentrations at this station varied between 4 and 15 ppm d.w. since monitoring started in 1990 and to 2006. The 2007 value was the highest recorded in CEMP and 50% higher than the previous record of 96 ppm d.w. found in Orkdalsfjord in 1986. Possible contamination from mar-culture activity in the Espevær vicinity can not be disregarded. Five significant trends were detected; 3 upwards and 2 downwards.

4.6. Orkdalsfjord area

Blue mussel from this area were monitored for the period 1984-1996, and then not again until 2004-2005 when bulk samples from four stations were investigated (Trossavika – st.84A, Flakk – 82A or Ingdalsbukt – 87A). The results from these investigations have be reported earlier (Green *et al* 2007, Green & Ruus 2008). These stations will probably be revisited within in 2014-2015.

4.7. Open coast areas from Bergen to Lofoten

This stretch of coastline covers 7° of latitude to 68°N (Appendix G). Thirteen mussel stations were investigated in 2004 (excluding Index-stations) and fifteen (including those from 2004) were also investigated in 2005. Fourteen of the fifteen were also investigated prior to 2004-2005, in 1990-1993 (cf. Green & Ruus 2008). The longest time series, from 1997 to 2007, is with blue mussel from the Husvågen area in Lofoten (st. 98A2). Blue mussel have been collected from two sites in the Lofoten area. In 1992-1993 samples were collected from Litj Skarvsundet (98A1) in the Skrova area of Lofoten, and during the period 1994-1996 in the nearby in the Skrova harbour (98X). In 1997 st.98A2 was established at Husvågen, roughly 18 km north of Skrova, in a small fjord remote from any apparent point source of contamination, and hence considered comparable. However, the statistical trend-analysis is based only on the Husvågen data.

In 2007, the blue mussel from Lofoten were only insignificantly contaminated (SFT's Class I), which has been generally the case since 1997 (Appendix I and Appendix J). Plaice from Husholmen (98F2) in the Lofoten area had overconcentrations of cadmium, 3 times “background”. Trends were identified for four time series in this area, all downwards and concerned cadmium, lead, ΣPCB-7 and TBT in blue mussel from Husvågen (98A2).

4.8. Exposed area of Varangerfjord near the Russian border

The remaining and northern area of CEMP in Norway stretches north of 68.5°N (i.e., north of Lofoten) and east from a longitude of 17 to 29°E (Appendix G). Eleven mussel stations were investigated in 2006 and ten of these also in 2007. Nine of which were also investigated during the period 1994-1995. Only two mussel stations, one cod station and one plaice station were investigated in the Varangerfjord (at approximately 70°N) in 2007.

In 2007, the mussels were only insignificantly contaminated (Class I) except for the moderate concentrations (Class II) found at six stations remote from point sources (43A Lyngneset in the Langfjord (Arnøy, northwest of Skjervøy), 45A Sauhamneset in Revsbotn (Sørøysundet), 47A Kifjordneset on the southwest coast of Nordkyn peninsula (Laksefjorden), 49A Norfjorden (Syltefjord), 10A2 Skallneset (north side of Varangerfjord), and 11X Brashavn (south side of Varangerfjord)). Five of these cases were due to cadmium and indicate a natural regional difference (Appendix I and Appendix J). The remaining one (11X) was due to HCB where a median concentration of 0.571 ppb d.w. was found. This was the highest found since monitoring started in 1997, but only slightly exceeded the Class I upper limit of 0.5 ppb d.w.. The liver of plaice from the Varangerfjord (10F) were also moderately polluted (Class II) with cadmium.

There were 23 significant trends detected in this area, 21 were downward – 15 for blue mussel and included mercury, lead, zinc, copper, DDE and TBT and 6 were found in cod from Varangerfjord and included cadmium, mercury, lead, DDE, HCB and ΣPCB-7. The two upward trends concerned cadmium from Trollfjord (Tanafjord st.48A) and copper from Kifjordneset (47A).

4.9. Norwegian Pollution and Reference Indices (The Index Programme)

A specific and small group of indices has been developed to assess the quality of the environment with respect to contaminants - The Index Programme. One index is based on the levels and trends of contaminant concentrations in blue mussel collected annually from a selection of the more contaminated fjords in Norway (Appendix K). SFT has also requested the testing of this index against “reference” stations from selected areas and fjords.

The Index scale varies from 1 to 5. Index 1 means that all areas or fjords are insignificantly polluted (Class I in SFT's classification system), Index 5 means that at least one sample from each area or fjord is extremely polluted or Class V in SFT's system. A value between 3 and 4 would be between “Marked” and “Severe” (Class III and IV) in the SFT system. A value between 2 and 3 would be between “Moderate” and “Marked” (Class II and III). A value between 1 and 2 would be between “Slight” and “Moderate” (Class I and II).

Nine fjord areas were used to calculate the Pollution Index. Taking the supplementary stations (Strømtangen, Flåøya, Moholmen and Toraneskaien) and analyses of TBT and dioxins into consideration, the Index was 3.0 for 2007 compared to 2.9 for 2006 (cf. Appendix K). Indices calculated with and without supplementary stations and analyses have been presented earlier (cf. Green *et al.* 2004a, b).

Five areas were included in the Reference Index for 2007 compared to the same five for 1998-2007, and seven or eight fjords used in previous years. With the new calculation where supplementary analyses of TBT are included, the Reference Index was 1.4 for 2007, unchanged since 2004. Comparison between the old and new calculations has been done for 2002 and 2003 (cf. Green *et al.* 2004a, b). Four of the five fjords/areas included TBT analyses.

The use of the indices to assess the general level of pollution in contaminated or reference areas of coastal water for the period 1995 to 1999 has been reviewed (Green & Knutzen, 2001). The conclusions were mainly that the sample and analytical strategies lacked adequate coverage of the relevant contaminants and geographical areas. Furthermore, the report suggested supplementing the assessment of this type with relevant analyses of sediment. In 2002 the programme was improved by including more stations and parameters relevant to the blue mussel Pollution Index.

It is not the intent of the application of the indices to give a station by station account. However, time trend analyses for the entire period (1995-2007) have been calculated and show both significant upward and downward trends in blue mussel (cf. Appendix I). Some cases are worth noting (2007 median Class / trend):

- Inner Oslofjord, Gressholmen (st.30A, Map 1, Appendix G) – TBT, ΣPCB-7, Class II / *downward*,
- Frierfjord area, Bjørkøya (Risøyodden) (st.71A, Map 3, Appendix G) - HCB, Class II / *downward*,
- Frierfjord area, Gjemesholmen (st.I712) and Strømtangen (st.I713) (Map 3, Appendix G) - TBT, Class II / *downward*,
- Sørfjord, Eitrheimsneset (st.52A, Map 6, Appendix G) – Cd, Hg, Pb, HCB, Class II / *downward*,
- Byfjorden (Bergen), Nordnes (st.I241) in Bergen harbour (Map 7, Appendix G) – HCB, Class III / *upward,*
- Byfjorden (Bergen), Gravdalsneset (st.I242) and Nordneset (st.I243) in Bergen harbour (Map 7, Appendix G) – HCB, Class II / *downward* and *upward*, respectively.

4.10. Biological effects methods for cod

4.10.1. Rationale and overview

The rationale to use biological effects methods within monitoring programmes is to evaluate whether marine organisms are affected by contaminant inputs. Such knowledge can not be derived from tissue levels of contaminants only. In addition to enable conclusions on the health of marine organisms, some biomarkers assist in the interpretation of contaminant exposure and bioaccumulation. The biological effects component of the Norwegian CEMP is possibly the most extensive of its type in Europe and includes imposex in gastropods as well as biomarkers in fish. The four chosen methods for fish were selected for specificity, for robustness and because they are among a limited set of methods proposed by international organisations, including OSPAR and ICES.

The CEMP-programme for 2007 included five biological effects methods (BEM) (cf. **Table 4**). For the 2007 investigations OH-pyrene, ALA-D, EROD-activity and CYP1A were measured in Atlantic cod from the inner Oslofjord (30B), Sørfjord (53B), and Bømlo-Sotra area (23B). Except for OH-pyrene, samples conserved for the BEM parameters were not available from st. 23B in 2007. OH-pyrene was also measured in cod outside Lista (15B).

Under controlled conditions the measures derived from OH-pyrene, EROD-activity and CYP1A increase with increased exposure to their respective inducing contaminants. The activity of ALA-D on the other hand is inhibited by contamination (i.e., lead), thus lower activity means higher exposure.

As in most previous years, 25 individual cod were sampled for biological effects measurements at each station. Since 2002 three stations (four for OH-pyrene) have been sampled, instead of eight stations as in previous years. No samples for BEM have taken from flatfish since 2002. All fish were collected by local fishermen and kept alive until sampling by NIVA staff within 5 days.

4.10.2. OH-pyrene metabolites in bile

Detection methods for OH-pyrene have been improved two times since the initiation of these analyses in the CEMP programme. In 1998 the wavelength for measurement of light absorbance of the support/normalisation parameter biliverdin was changed to 380 nm. In 2000, the use of single-wavelength fluorescence for quantification of OH-pyrene was replaced with HPLC separation proceeding fluorescence detection. The single wavelength fluorescence method is much less specific than the HPLC method. Although there is a good correlation between results from the two methods they can not be compared directly. The interpretation of OH-pyrene data is therefore primarily focused on the differences between the stations within each year.

In 2007, the median concentrations of OH-pyrene metabolites in bile from cod were higher at the stations Oslofjord (st. 30B) and Sørfjord (st. 53B), than at stations Bømlo-Sotra area (reference; st. 23 B) and Lista (st. 25B). No significant trends for the period 2000-2007 were detected (cf. Appendix I).

The Oslofjord (30B, Vestfjord) is a city harbour area, while st. Lista (15B) is located in an area where there has been a large discharge of PAH to water from an aluminium-smelter. The fish were collected on the open coast and the discharge from the smelter occurred in a small bay about 2-3 km away. The higher level of OH-pyrene in cod from Sørfjord (53B), compared to Bømlo-Sotra (23B) also confirm the generally assumed contamination of this area. The downward trend (not statistically significant) reflects the reduction in PAH discharges after the discontinuation of local industry.

PAH is measured in blue mussel from the inner Oslofjord. The changes in concentrations correlate fairly well to the changes in OH-pyrene in cod from the Vestfjord (**Figure 14**). The similar changes indicate general changes in PAH exposure in this fjord area.

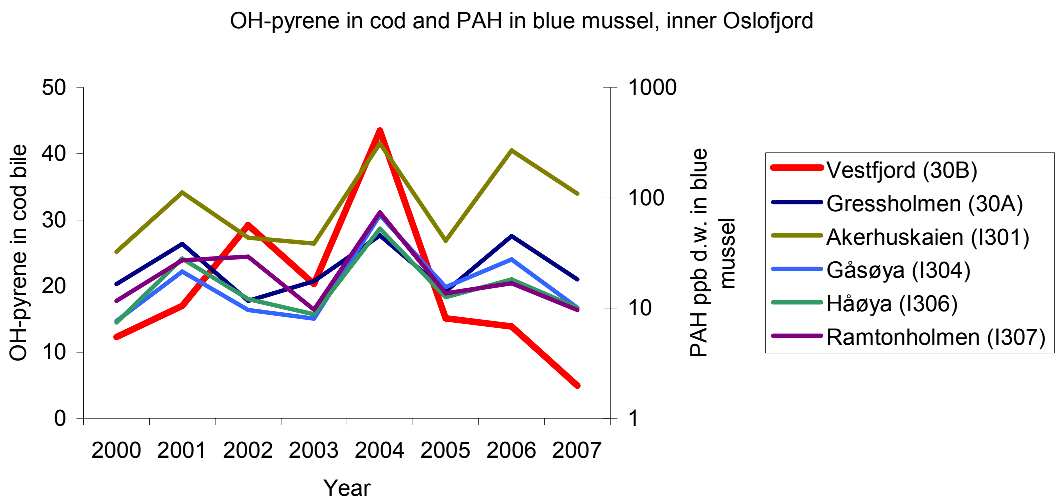

Figure 14. Changes in median concentration of OH-pyrene (µg/kg ABS 380nm) in bile from Atlantic cod collected from the inner Oslofjord (Vestfjord, st.30B) and total PAH in blue mussel from the same area. **NB:** concentrations of PAH are on a log scale.

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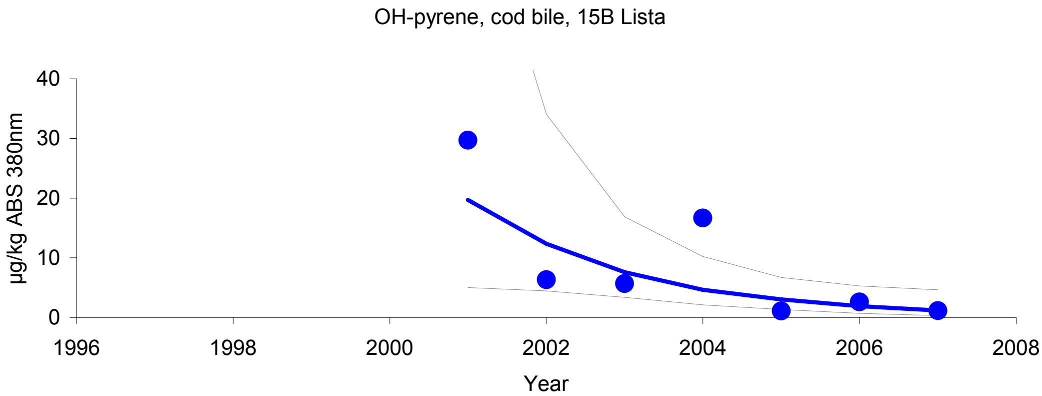

Figure 15. Trend and median concentration of OH-pyrene (µg/kg ABS 380nm) in bile from Atlantic cod collected from southern Norway and detail for Lista (st.15B). (cf. Appendix G and Appendix I. Grey circles in map indicate that no significant trends were detected and that there is no limit to classify the result from 2007. See otherwise key to map and detail in Figure 2).

4.10.3. ALA-D in blood cells

Inhibited activity of ALA-D indicates the influence of lead contamination. Although ALA-D inhibition is lead-specific, it is not possible to rule out interference by other metals or organic contaminants. Previous studies indicate that zinc may ameliorate the effect of lead to some extent, but the effect is variable and weak. Other studies have also shown ALA-D to be a remarkably robust biomarker and factors such as sex, age or season do not appear to affect the response.

Most years the activity of ALA-D in cod was generally inhibited in the inner Oslofjord (st.30B) and inner Sørfjord (st.53B), compared to reference stations, i.e. outer Oslofjord (st.36B), Karihavet in the Bømlo-Sotra area (st.23B), and Varangerfjord (st.10B, Figure 16 and Appendix I,). For all years 1997-2006 the median activity of the enzyme in cod from inner Sørfjord (st.53B) was generally lower than on the open coast (Karihavet - st. 23B), about 130 km to the west. In 2007 samples conserved for analysis of ALA-D could not be secured from Karihavet (st. 23B).

In 2007 ALA-D levels appeared somewhat lower in the blood of cod from the Oslofjord (st.30B) and the Sørfjord (st.53B), as compared to 2006. However no trend could be shown for the period 1997-2007 for neither of the stations (Figure 16, Appendix I).

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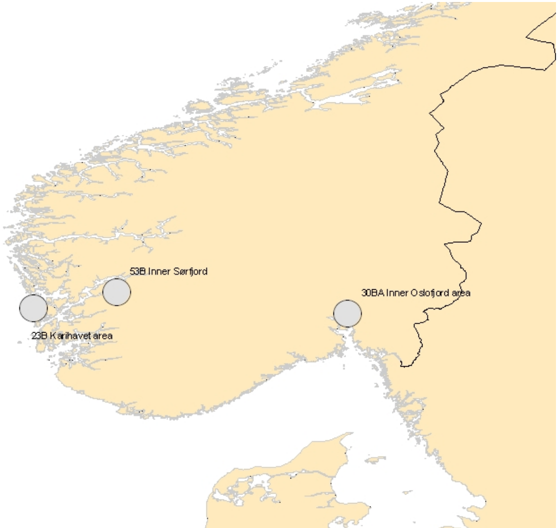

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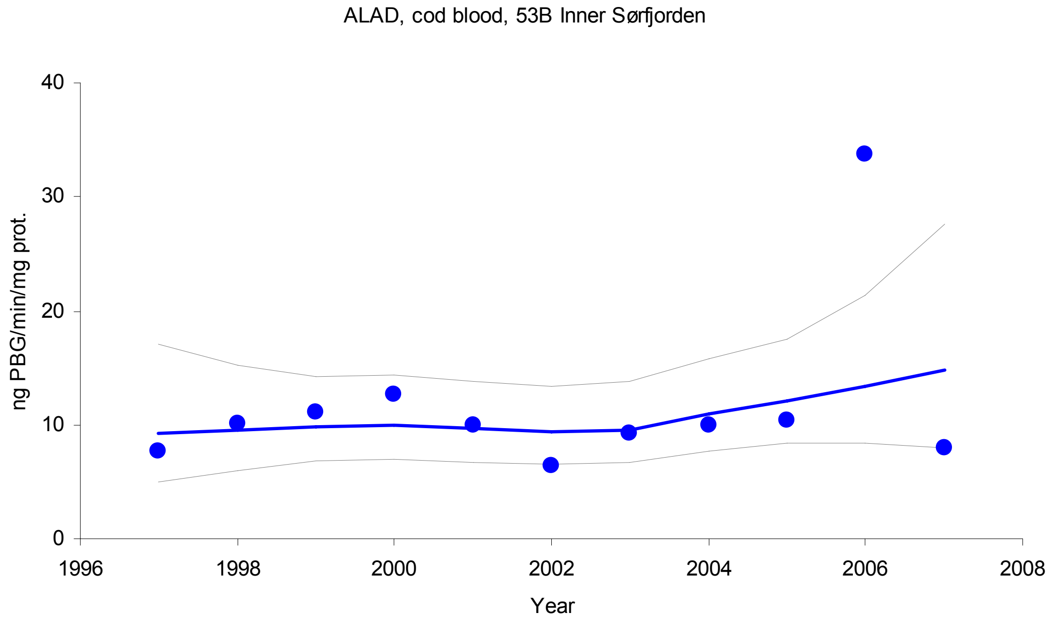

Figure 16. Trend and median activity of δ-aminolevulinic acid dehydrase (ALA-D, ng PBG/min/mg protein) in red blood cells from Atlantic cod collected from southern Norway and detail for inner Sørfjord (st.53B). (cf. Appendix G and Appendix I. Grey circles in map indicate that no significant trends were detected and that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2). Note that lower activity means higher exposure and vice versa.

4.10.4. EROD-activity and amount of CYP1A protein in liver

EROD-activity

High activity of hepatic cytochrome P4501A activity (EROD-activity) normally occurs as a response to the contaminants indicated in **Feil! Fant ikke referansekilden.**. It was expected that higher activity would be found at the stations that were presumed to be most impacted by planar PCBs, PCNs, PAHs or dioxins, i.e. inner Oslofjord (st.30B) and inner Sørfjord (st.53B/F). In 2005, no such differences were evident. In 2006 median EROD-activity was highest in the Oslofjord (st. 30B), although variability was high. In 2007 samples conserved for analysis of EROD and CYP1A could not be secured from Karihavet (st. 23B).

In 2007 median EROD activity in cod from the inner Oslofjord (st. 30B) was twice of that in cod from the Sørfjord (st.53B, Figure 17, Appendix I). The EROD activities appeared lower at both stations than in previous years, although no statistical significant trends were found.

Previous years have also shown that EROD-activity in both fish from the inner Oslofjord and from the inner Sørfjord are not consistently higher than at the reference station on the west coast (st.23B). No significant temporal trends were found at these three stations.

No adjustment for water temperature has been made. Fish are sampled at the same time of year (September-November) when differences between the sexes should be at a minimum. Statistical analyses indicate no clear difference in activity between the sexes (Ruus *et al.* 2003). It has been shown that generally higher activity occurs at more contaminated stations (Ruus *et al.* 2003). However, the response is inconsistent (cf. Appendix I), perhaps due to sampling of populations with variable exposure history. Besides, there is evidence from other fish species that continuous exposure to e.g. PCBs may cause adaptation, i.e. decreased EROD-activity response.

As for the EROD activity, the median amount of CYP1A protein in the liver of cod from the inner Oslofjord (st. 30B) in 2007 was twice as high as in cod from Sørfjord (St. 53B; Appendix I). Compared to previous years, however, the CYP1A level in fish from Oslofjord (st. 30B) seems reduced (Appendix I). No such trend was found in the Sørfjord (st. 53B; Figure 18).

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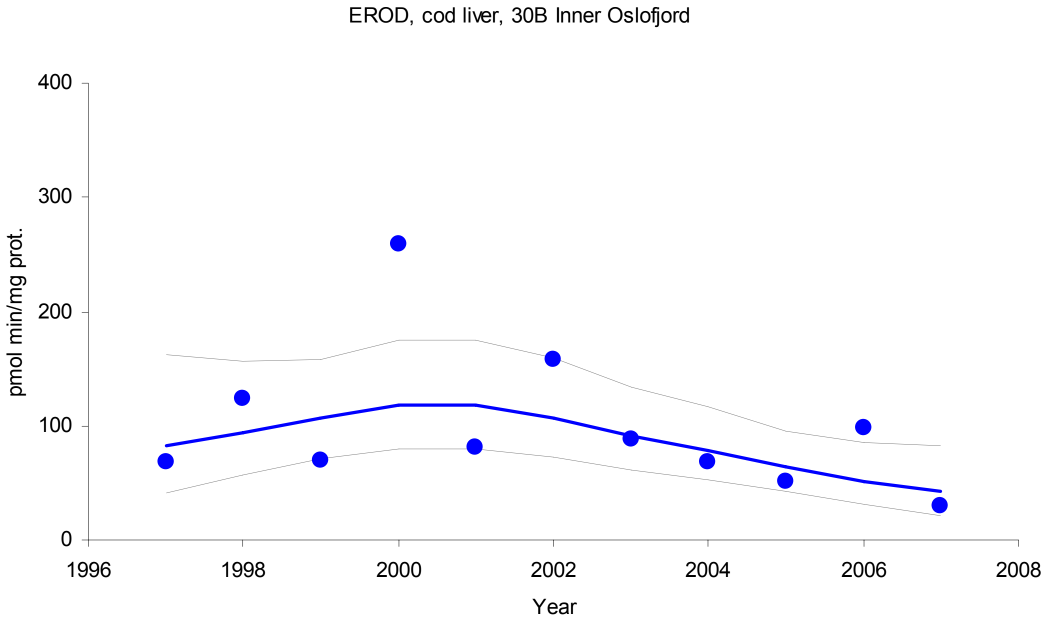

Figure 17. Trend and median activity of cytochrome P4501A (EROD-activity, pmol/min/mg protein) in liver from Atlantic cod collected from southern Norway and detail for the inner Oslofjord (st.30B). (cf. Appendix G and Appendix I. Grey circles in map indicate that no significant trends were detected and that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2).

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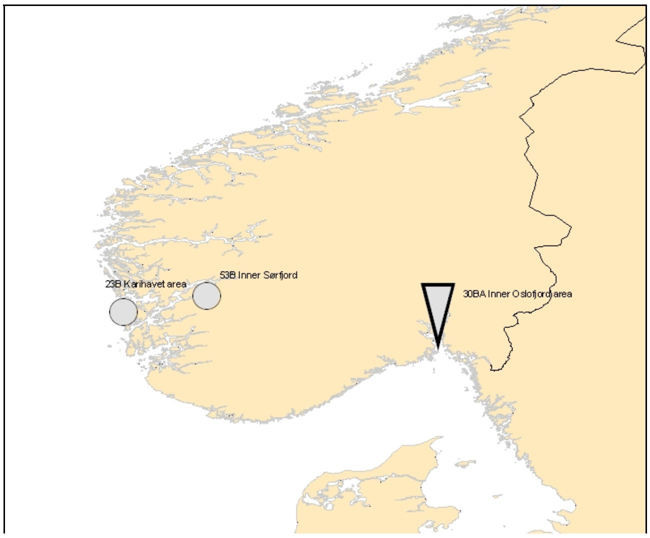

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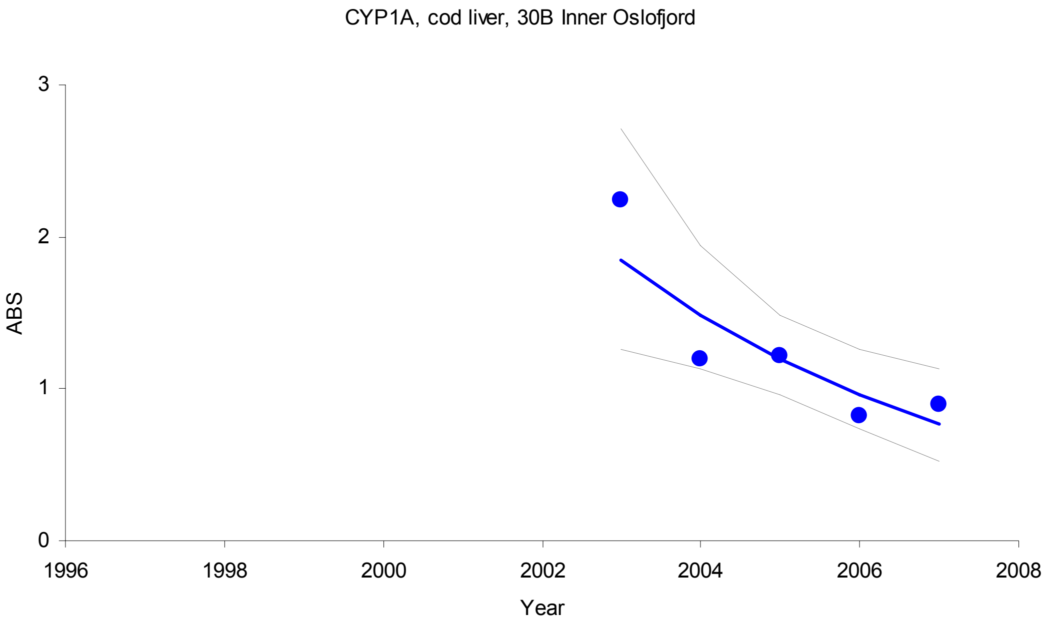

Figure 18. Trend and median activity of cytochrome CYP1A (relative amount of Cytochrome P4501A-protein) in liver from Atlantic cod collected from southern Norway and detail for the inner Oslofjord (st.30B). (cf. Appendix G and Appendix I. Direction of the significant trend is indicated in the map where grey symbols indicate that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2).

4.10.5. Concluding remarks

The application of BEM methods within CEMP through the years 1997-2001 (and 2004) indicated that the location Lista (st. 15B), which was previously regarded as only diffusely polluted, had an input of PAH which was sufficient to affect fish in the area. However, in 2002 and 2003 the median concentrations of OH-pyrene in cod from Lista were lower than those from the inner Oslofjord (st.30B) and inner Sørfjord (st.53B). Since 2005, the OH-pyrene concentrations in cod from Lista have been low (the same level as the reference in 2005 and 2007). The downward trend in Sørfjord (st. 53B) likely reflects the reduction in PAH discharges after the discontinuation of local industry.

Results for the period 1997-2005 indicated that there are lead effects, shown by decreased activity of the enzyme ALA-D in the two most contaminated areas, i.e. cod from the inner Oslofjord (st.30B) and cod from the inner Sørfjord (st.53B). This indication was less evident in 2006. In 2007 ALA-D levels appeared somewhat lower in the Oslofjord (st. 30B) and the Sørfjord (st. 53B), compared to 2006. However no trend could be shown for the period 1997-2007 for neither of the stations.

In 2007 median EROD activity in cod from the inner Oslofjord (st. 30B) was twice of that in the Sørfjord (st. 53B). The EROD activities appeared lower at both stations than in previous years, although no statistical significant trends could be shown. In 2007, samples preserved for biological effect methods (BEM; except OH-pyrene) were not obtained from the reference station (Karihavet, st. 23B). Previous years, however, have shown that EROD-activity in fish from the inner Oslofjord and Sørfjord stations are not consistently higher than at other, presumed cleaner stations. An explanation may be that the inducing effect of specific contaminants may be inhibited by other contaminants present.

As for the EROD activity, the median amount of CYP1A protein in the liver of cod from the inner Oslofjord (st. 30B) in 2007 was twice as high as in cod from Sørfjord (St. 53B). Compared to previous years, however, the CYP1A level in fish from Oslofjord (st. 30B) seems reduced. No such trend could be observed in the Sørfjord (st. 53B).

4.11. Effects and concentrations of organotin

Effects from organotin in dogwhelk (*Nucella lapillus*) were investigated at 9 CEMP and Index stations in 2007. Concentrations of organotin in dogwhelk and blue mussel (*Mytilus edulis*) were quantified at 9 and 12 stations, respectively, and including both the CEMP and Index stations. The stations are located along the coast of Norway and samples were collected August-November 2007 (Appendix F and maps in Appendix G).

TBT-induced development of male sex-characters in females, known as imposex (Vas Deferens Sequence Index - VDSI), was analysed according to OSPAR-CEMP guidelines. The VDSI ranges from zero (no effect) to six (maximum effect) (Gibbs *et al.* 1987). Detailed information about the chemical analyses of the animals is given in Følsvik *et al*. (1999).

4.11.1. Dogwhelk

The effects from organotin were low (<2) at 6 of the 9 stations. One of the exceptions was Espevær (st. 22G) on the West coast which had a VDSI of 3.5 (Appendix J). No effects were found at Lista (st. 15G). A significant *downward* trend was found at all the stations except Fugleøyskjær (71G), Lofoten (98G) and Brashavn (11G) with averages 3.67, 3.49 and 0.05, respectively (Appendix I, Figure 19).

Concentrations of organotin from the nine stations measured were relatively low (<0.16 mg/kg d.w.). As in 2003, 2004 and 2005 the highest organotin levels were found at Haugesund (st. 227G2, Appendix I, Appendix J, Figure 20). A significant *downward* trend was found at period 1997-2007 were found at Lista (15G).

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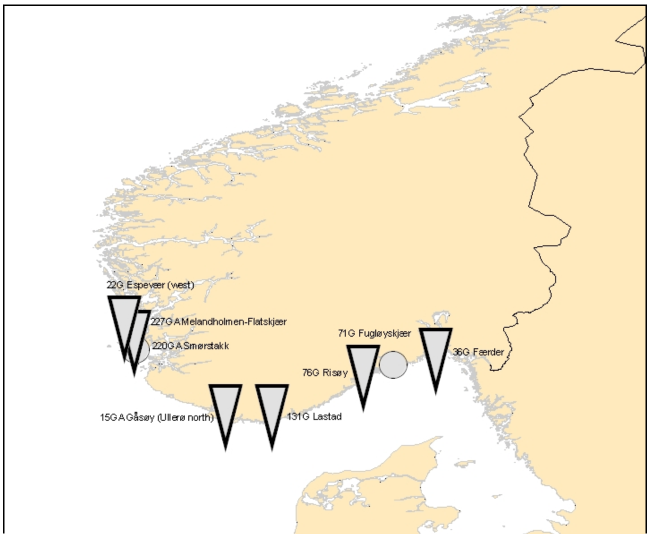

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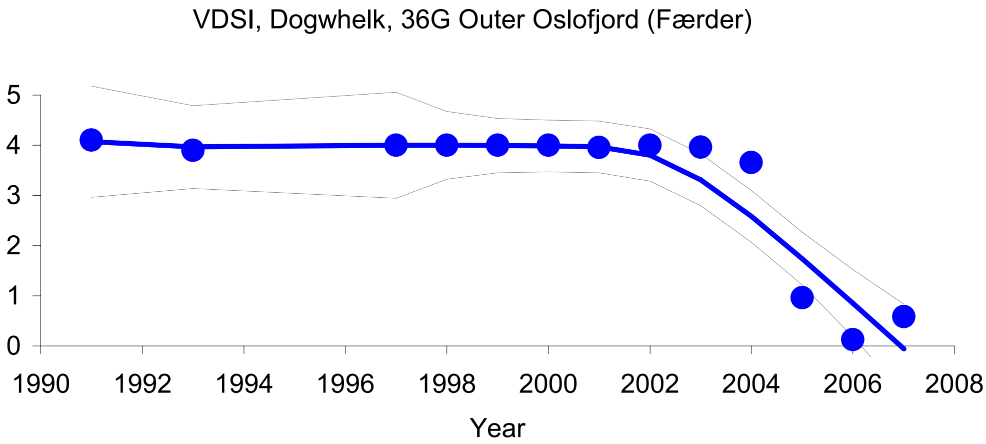

Figure 19. Trends in imposex (VDSI) in dogwhelk (*Nucella lapillus*) from southern Norway and detail for Færder (36G) in the outer Oslofjord. Data from 1991 (Harding *et al*. 1992) and 1993 (Walday *et al*. 1997). (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where grey symbols indicate that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2).

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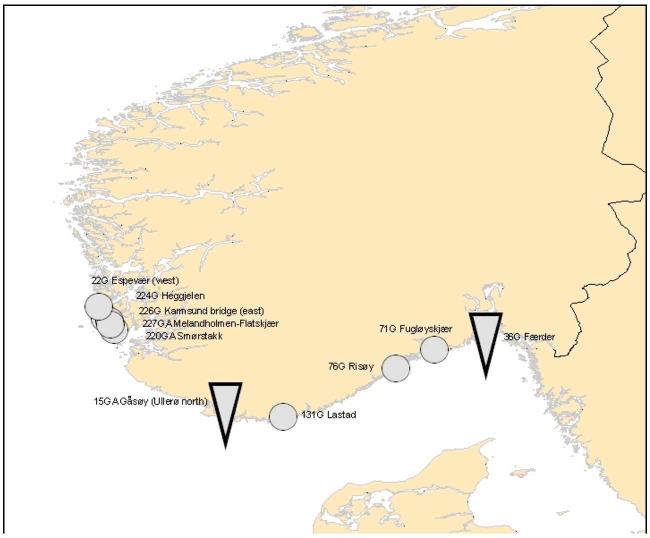

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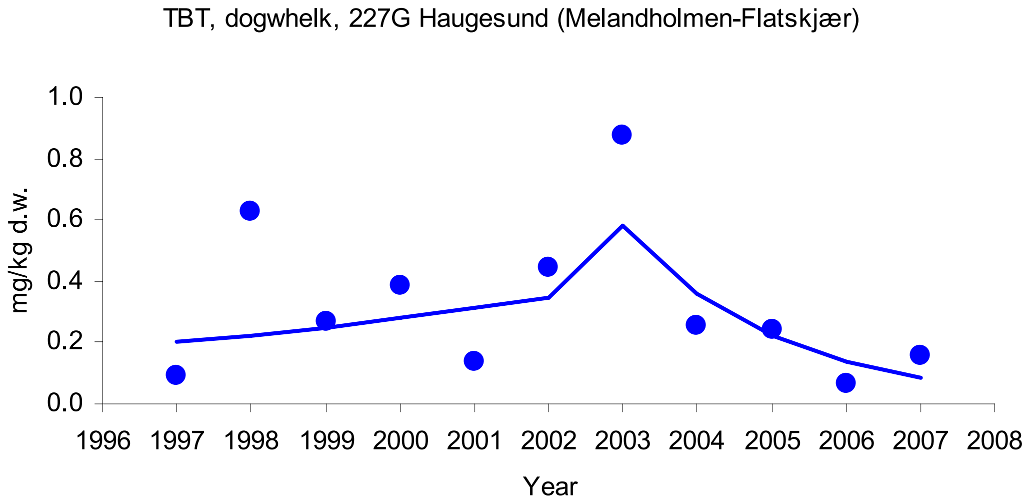

Figure 20. Trend and median concentration of TBT (on a formulation basis) in dogwhelk (*Nucella lapillus*) from southern Norway and detail for Færder (36G) in the outer Oslofjord (36G), mg/kg (mg TBT/kg) dry weight. NB: (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where grey symbols indicate that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2).

4.11.2. Blue mussel

Blue mussel was markedly contaminated with organotin at one station in the inner Oslofjord (Index stations 30A and I301); Class III in SFT's environmental classification system (Appendix J, Figure 21). Moderately (Class II) polluted blue mussel were not only found in other harbour areas (e.g. the Frierfjord (st.I712) and Haugesund (st.227A)) but also in an area in Espevær (st. 22A) on the West coast presumably remote from point sources. Low median concentrations (Class I) were found at the northern stations (st.11X) and at Farsund (st.15A) as well as some stations in western Norway. Significant *downward* trends were found at 8 of the 12 stations, the exceptions being one station in the inner Oslofjord (st.I301), Færder (36A) in the outer Oslofjord, Espevær (22A) and Haugesund (227A).

4.11.3. Concluding remarks

The presence of organotin (as TBT) in Norwegian waters exceeded acceptable levels at 6 of the 12 blue mussel stations monitored in 2007, not only in harbour areas but also one station presumably remote from known point sources. Biological effects from TBT were found in dogwhelk from all but 1 of one of the 9 stations investigated. However, of the 30 time series investigated for either concentrations or effects (imposex) of TBT in blue mussel or dogwhelk, 17 were *downward* and no upward trends were found. This may be an indication that the ban on the use of TBT in antifouling on boats <25 m of length, in effect since 1. January 2003, has had an effect.

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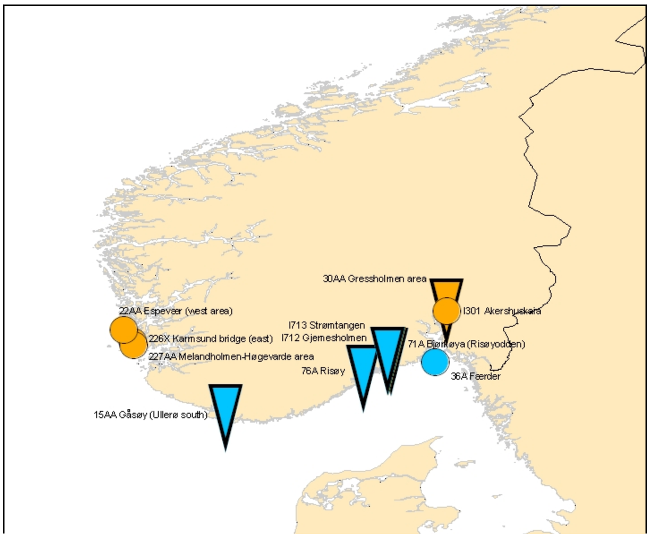

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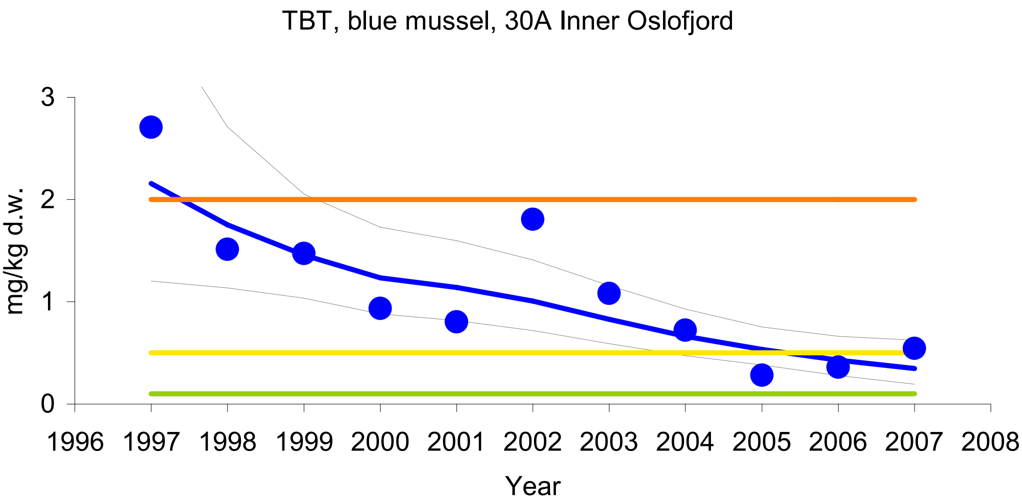

Figure 21. Trend and median concentration of TBT (on a formulation basis) in blue mussel (*Mytilus edulis*) from southern Norway and detail for the inner Oslofjord (st.30A), mg/kg (mg TBT/kg) dry weight. (cf. Appendix G and Appendix I. Direction of significant trends are indicated in the map where blue symbols indicate insignificant pollution in 2007. See otherwise key to map and detail in Figure 2). Note: for 1997 in Figure A the upper confidence interval line is off-scale. Note: horizontal line for Class I is near x-axis.

4.12. Polybrominated diphenyl ethers

For the second year, polybrominated diphenyl ethers (PBDEs[1]) were investigated. Three cod stations were selected: inner Oslofjord (st.30B), inner Sørfjord (st.53B) and Karihavet (st.23B) (Figure 22). In 2007 the median concentration of sum BDE was highest in the inner Oslofjord (108 µg/kg w.w.) and lowest at the reference area in Karihavet (8.3 µg/kg w.w.). Median concentrations found at presumed reference stations of Svolvær, Færder, Utsira and Bømlo-Sotra indicated that a high background in these diffusely contaminated areas might be 30 µg/kg w.w. for cod liver (Fjeld *et al.* 2005) which was higher than the median found in inner Sørfjord and Karihavet. It can not be ruled out a high background concentration might of 30 µg/kg is a conservative estimate. The median concentration of 108 µg/kg in the inner Oslofjord was within the range of 37-112 µg/kg w.w. found in other contaminated areas (Fjeld *et al.* 2005; Berge *et al.* 2006).

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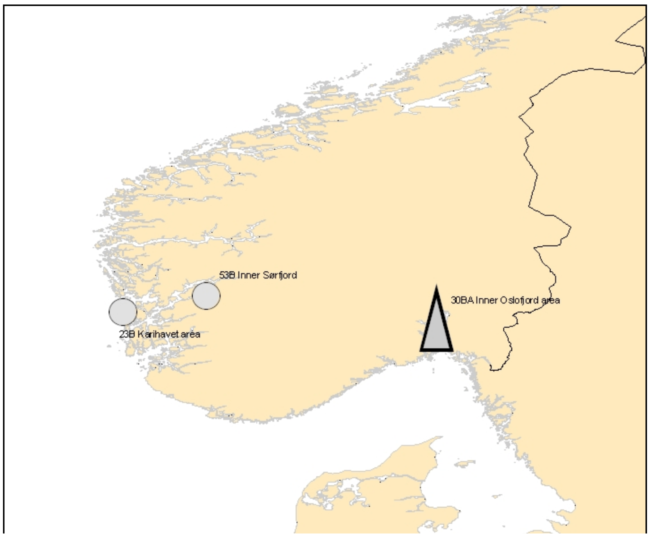

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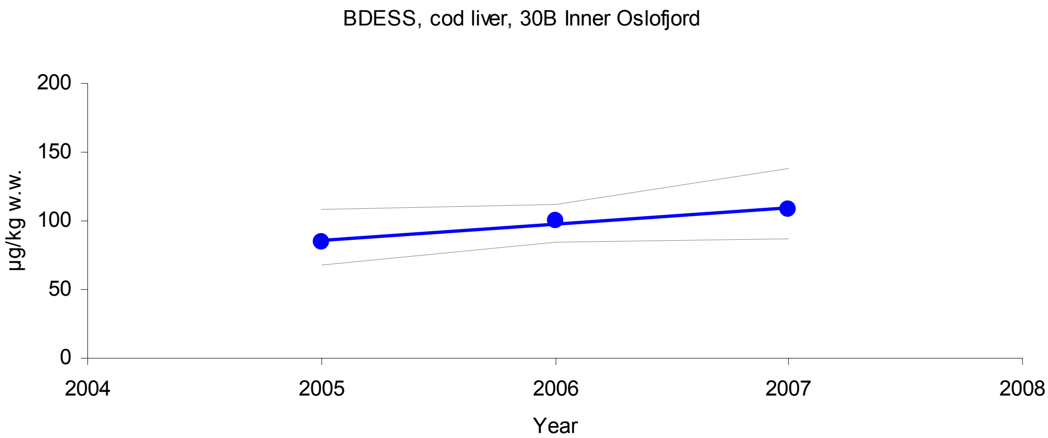

Figure 22. Trend and median concentration of polybrominated diphenyl ethers (sum PBDE = BDESS) in liver of cod (*Gadus morhua*) from southern Norway and detail for inner Oslofjord (st.30B). (cf. Appendix G and Appendix I. Direction of the significant trend is indicated in the map where grey symbols indicate that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2).

[1] PBDEs include: BDE100, BDE119, BDE138, BDE153, BDE154, BDE183, BDE205, BDE209, BDE28, BDE47, BDE49, BDE66, BDE71, BDE77, BDE85, BDE99.

4.13. PFC

Perfluroalkyl compounds (PFC[1]) have been investigated in cod liver since 2005. Three cod stations were selected: inner Oslofjord (st.30B), inner Sørfjord (st.53B) and Karihavet (st.23B) (Figure 22). The median concentration of the indicator PFC compound perfluoroctonoic sulfonate (PFOS) was highest in the inner Oslofjord. Median concentrations found at presumed reference stations in Svolvær, Kvæangen-Leisundet North of Skjervøy, and Varangerfjord indicated that a high background concentration in diffusely contaminated areas might be 10 µg/kg w.w. (Bakke *et al.* 2007a) which was higher than the median found in inner Sørfjord and Karihavet. The highest median found in 2007 was in the inner Oslofjord with 11 µg/kg w.w. and in the lower range found in other contaminated areas (Fjeld *et al.* 2005), Berge *et al.* 2006).

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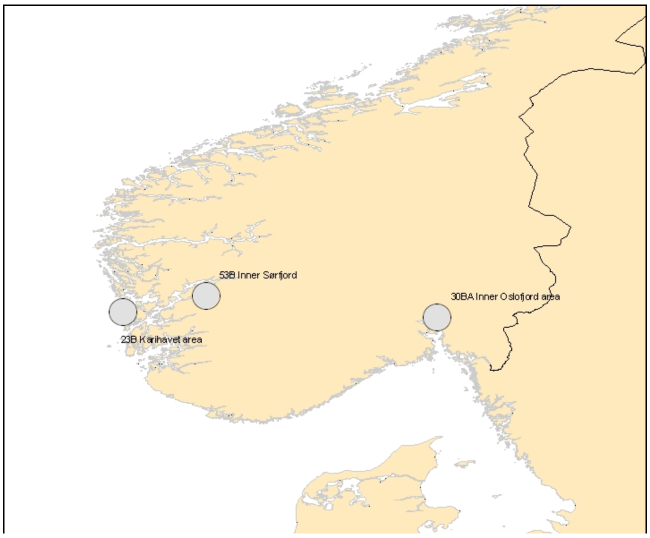

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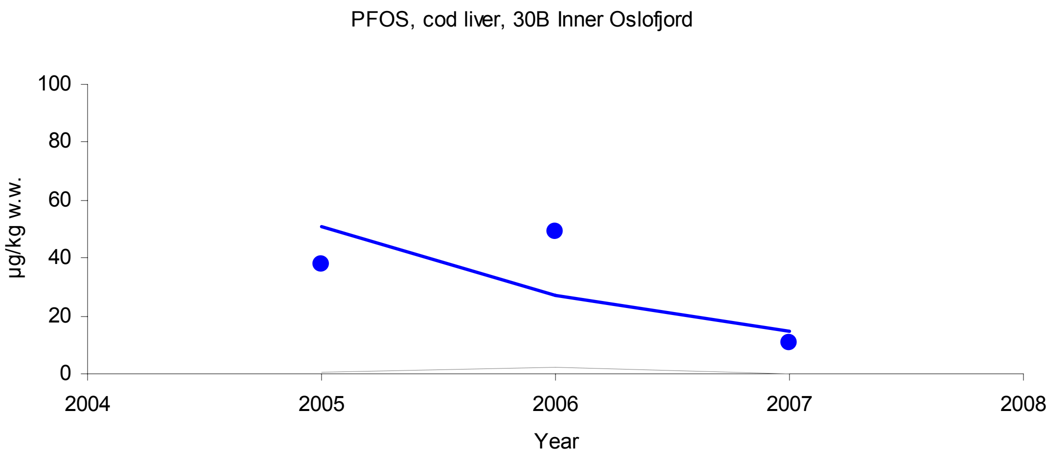

Figure 23. Trend and median concentration of perfluoroctanoic sulfonate (PFOS) in liver of cod (*Gadus morhua*) from southern Norway and detail for the inner Oslofjord (st.30B). (cf. Appendix G and Appendix I. Grey circles in map indicate that no significant trends were detected and that there is no limit to classify the results from 2007. See otherwise key to map and detail in Figure 2). **Note that the upper confidence interval line is off-scale.**

[1] PFCs included PFBS, PFHpA, PFHxA, PFNA, PFOA, PFOS, and PFOSA

4.14. Dioxins

Dioxins have been included in SFT's Pollution Index using blue mussel since 2002 (cf. chapter 4.9). Seven stations were investigated in the impacted areas of the inner Oslofjord, the Grenlandsfjord area and the Kristiansand harbour (**Figure 24**). In 2007 the blue mussel from two stations nearest to the mouth of the Frierfjord (in the Grenlandsfjord area) were extremely polluted (SFT Class V) with dioxin based on the "toxicity equivalency factors" after the Nordic model (Ahlborg 1989). Samples were moderately polluted (Class II) in the Kristiansand harbour. No trends were detected for the period 2002-2007.

Recent assessment of dioxin data from the regional Grenlandsfjord monitoring in cod liver (Bakke *et al.* 2007b) has shown that the downward trend in wet-weight concentrations over the last 16 years in the most polluted fjord area is not confirmed by a corresponding trend in concentrations normalised against fat content. In other words, the fat content in cod liver wet weight has decreased at a rated corresponding to the decrease of dioxins in cod liver wet weight. The decrease in fat content may be due e.g. to (unknown) changes in general life conditions for cod in the fjord. Cod liver samples from the other fjord areas do not show a similar long-term decrease in fat content, and there is not a clear relationship between fat and wet weight normalised dioxin levels for these fjords. This emphasizes the need to investigate the relations between contaminant levels and biological characteristics to interpret observed time series of contaminant levels in biota as evidence for changes in the external environment.

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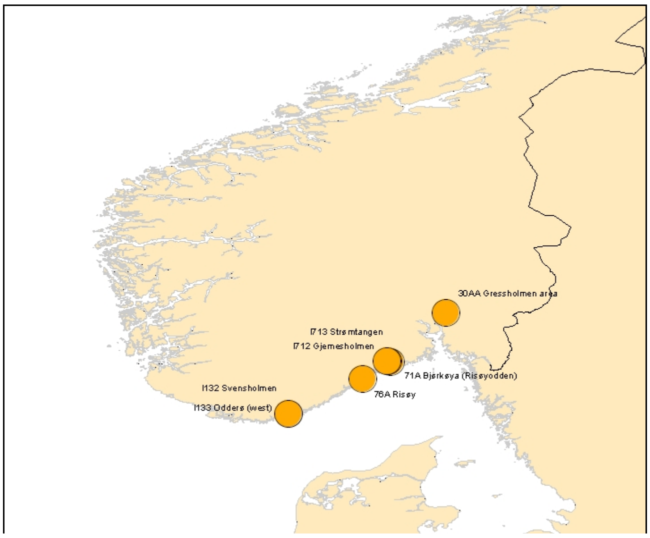

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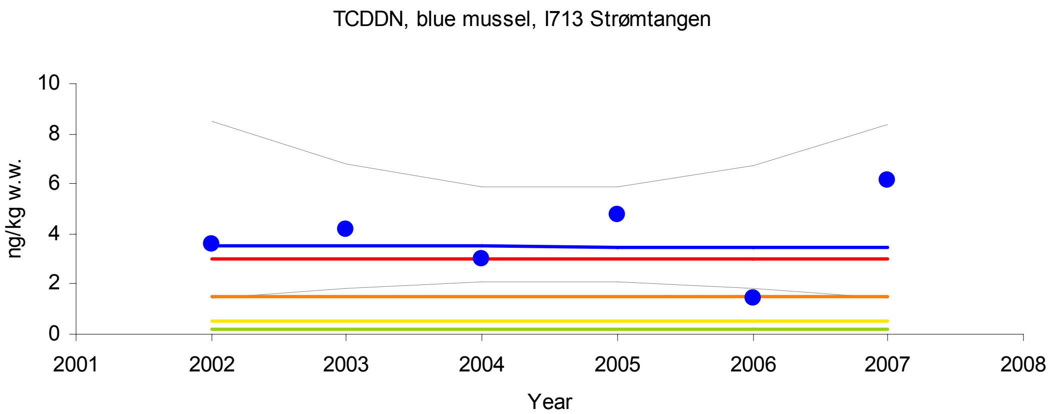

Figure 24. Trend and median concentration of dioxins TCDD-toxicity equivalents after nordic model (TCDDN) in liver of blue mussel(*Mytilus edulis*) from southern Norway and detail from Strømtangen at the mouth of the Frierfjord (Grenlandsfjord area). (cf. Appendix G and Appendix I. Orange circles in map indicate that not significant trend was detected and that pollution in 2007 was not insignificant. See otherwise key to map and detail in Figure 2).

4.15. Analyses of stored samples

Analyses of cod liver samples from 1993 were compared to samples from 2007 for a selection of elements and synthetic compounds not routinely investigated (see Appendix L for full version). Two stations were selected; the inner Oslofjord and the reference area on the West coast (Karihavet). There was no indication that storage had affected the concentration of the substances analyzed. Generally, no distinct difference between the 1993 and 2007 samples indicated that cod were exposed to roughly the same levels of the analysed substances. The metals Ag, V and Ni were for the first time reported in cod liver samples. The levels of silver, organotins and PFC were relatively higher in the Oslofjord area than in samples from the reference area (Karihavet) indicated an ongoing contamination related to urban activities throughout the period 1993 to 2007. The brominated flame retardants, however, showed almost the same levels in cod liver samples from the Oslofjord and the Karihavet area, indicating a more diffusely elevated level of these contaminants than for the other compounds studied. No distinct differences were found between 1993 and 2007.

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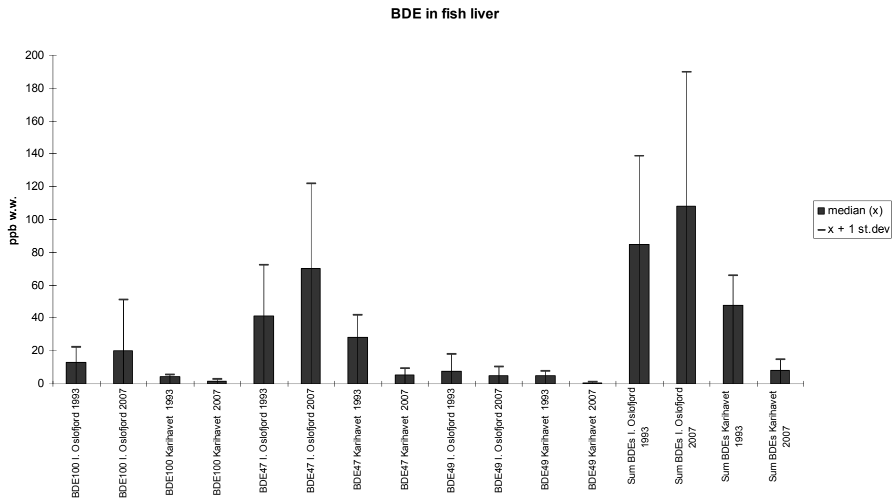

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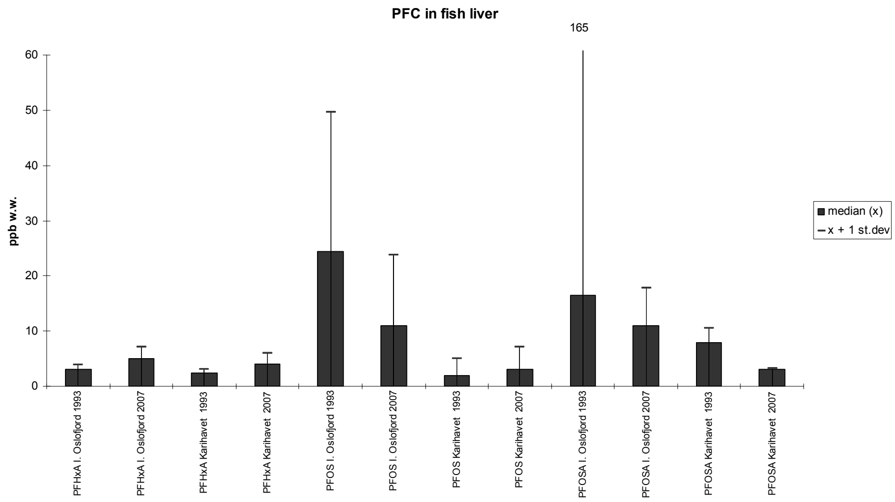

Figure 25. Median concentration of selected brominated flame retardants and perfluoralkyl compounds (PFC) perfluoroctyl sulfonate (PFOS) in liver of cod (*Gadus morhua*) from inner Oslofjord and Karihavet (reference) (cf. Appendix G and Appendix I).

4.16. Concerning optimizing CEMP, analysis of variance components

Selected cod and blue mussel data sets for cadmium, lead, mercury and CB153 (as a main indicator for PCB) from the CEMP monitoring data, have been analysed statistically to estimate impact of sources of variation in data that are not related to long-time trends or systematic geographical differences in contaminant levels in biota (see Appendix M for full version). The purpose is to quantify variance components that can be used to optimize the monitoring program.

One level of optimization is how to use resources as effectively as possible to achieve defined goals of monitoring, i.e. to maximize the ability to classify contamination levels and detect changes. In the current context this means to allocate resources (costs) to different components of the program so that the effect of noise in the data is minimized . Such optimisation will rely on estimation of variance components of different sources of error in the monitoring data, how they depend on design elements of the monitoring program (number of stations, number of samples per station and year, etc.) and how the same design elements relates to costs of the monitoring program. At another level, optimisation of resources can also mean balancing total cost and total benefit. This requires quantifying in some way the benefit of increased ability to detect trends and levels, and depends on policy considerations. This study is restricted to consider optimisation only at the first, technical level.

The sampling design should aim at reducing variance as much as possible. One way to achieve this is by reducing the number of sub-samples analysed per sample, but increase the number of samples. This may or may not imply increased costs.

Considering the current program, the number of fish per sample is about 25. Somewhat simplified, the results from the statistical analysis indicated that for this number to be optimal, the cost related to fish collection at one station should be about 100 times larger than the marginal cost of catching, preparing and analysing one individual fish. If this cost ratio is 10 instead of 100, the analysis indicated that the optimal number of fish would be about 6 for each sample, and that resources would be better used in collecting 4 samples with 6 fish/sample at different sites within the area and/or at different times each year. For mussels, where 3 bulked samples of up to 100 individuals are collected at each station, the optimal ratio is 20 which means x samples with y mussels/sample.

Estimation for different substances give different optimal sample sizes; the monitoring program has to aim for a balance so that it is reasonably good for all important substances. The cost issue is more complex than considered here: the analysis program will be different for different sub-samples, and also for different stations.

5. References

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Appendix A
Overview of previous CEMP investigations

Previous investigations

The results for CEMP have previously been presented for:

- 1981-1983 (only Oslofjord; Enger *et al.* 1984, 1985),
- 1984-1985 (Green 1988),
- 1986 (Green 1987; SFT 1987),
- 1987 (SFT 1988),
- 1988 (Green 1989b; SFT 1989),
- 1989 (Green 1991a, SFT 1990),
- 1990 (Green 1992, JMG 1994),
- 1991 (Green 1993a),
- 1992 (Green 1994, Green & Knutzen 1994),
- 1993 (Green 1995a),
- 1994 (Green 1995b),
- 1995 (Green 1997a),
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- 1997 (Green *et al.* 1999),
- 1998 (Green *et al.* 2000),
- 1999 (Green *et al.*, 2001a),
- 2000 (Green *et al.*, 2002a),
- 2001 (Green, *et al*., 2003),
- 2002 (Green, *et al*., 2004a),
- 2003 (Green, *et al*., 2004b),
- 2004 (Green, *et al*., 2005),
- 2005 (Green, *et al*., 2007), and
- 2006 (Green, *et al*., 2008b).

The results have been incorporated in OSPAR's European regional assessments of sediment (JMG 1993) and biota (ICES 1988, JMG 1992) and temporal trends in biota (ICES 1989; 1991; ASMO 1994).

An overview of the analytical methods (1981-2000) has been presented in Green 1993b; Green *et al.* 2001b, Green *et al.* 2008.

The raw data or statistical summaries have been presented for:
- sediment 1986-1997 (Green & Klungsøyr 1994; Green *et al.* 2002b),
- biota 1981-1992 (Green & Rønningen 1994),
- biota 1993-1997 (Green & Severinsen 1999a, b),
- biota 1998-2001 (Green *et al.* 2002c, d) and
- sediment and biota 1981-2006 (cf. Shi *et al.* 2008)

Summary assessments have been made for the periods:
- 1981-1992 (Green *et al.* 1995),
- 1981-1999 (Green *et al.* 2002c) and
- 1981-2006 (Green & Ruus 2008).

An evaluation of "background" levels of contaminants in biota based on CEMP data has been done by Knutzen & Green (1995, 2001a) and Green & Knutzen (2003). Application of pollution and reference indices using the blue mussel and coordinated with CEMP has also been assessed (Green & Knutzen 2001). Results from biological effects methods 1997-2001 have been assessed as well (Ruus *et al.* 2003).

Appendix B
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/ISO71EC Guide 25. NIVA has reference number P009. The chemical laboratory has satisfied the requirements in NS-EN ISO/IEC 17025 since 2001.

Summary of quality control results
Standard reference materials were analysed regularly (**Table 5**). Dogfish muscle (DORM-2) or dogfish liver (DOLT-3) was used as SRM for the control of the determination of metals. Cod liver oil (1588) and mussel tissue (2977) was used as SRM for controls of PCBs and PAHs, respectively. NIES 11 was used for tin organic compounds. Cyprinid fish (EDF2525) at NILU was used as SRM for control of determination of dioxins.

Following results for round QUASIMEME –Round 52 , January-April 2008, were used. This round would apply to the 2007 samples:

- QTM077BT (no.1) and QTM078BT (no.2) for metals in biota.
  The results were acceptable (z-scores between -2 and 2),except for one result with z-core -7,1 which was Arsenic (no.1), the result is at the present time being checked by NIVA's laboratory , Nickel (no.2) deviated more than NIVA's maximum limit of ± 20 %, but since the uncertainty of the true value is high, the z-score 1,2 is still acceptable.
- QOR094BT (no.1) and QOR095BT (no.2) for organochlorines in biota.
  The results were acceptable except for four results which were classified as questionable, and these were CB 28 (no.1), CB31 (no.1), CB105 (no.2) which had z-scores higher than 2, but since the deviations are lower then our maximum limits no further action will be taken. For CB105 (no.2) the results are systematic too high, the result is at the present time being checked by NIVA's laboratory.
- QPH049BT (no.1)and QPH050BT (no.2) for PAH in biota.
  The results were acceptable except for acenaphtylene (no.1 and 2) where the results were too high and chrysene (no.1) where the results were systematic too low. The deviations are being checked by NIVA's laboratory.

Table 5. Summary of the quality control of results for the 2007 biota samples analysed in 2007-2008. The Standard Reference Materials (SRM) were DORM-2* (dogfish muscle) for blue mussel and fish fillet, DOLT-3* (dogfish liver) for fish liver, 1588** (cod liver oil) for blue mussel and fish liver and 2977** (mussel tissue) for blue mussel. SRM was analysed in series with the CEMP-samples for analyses of metals (mg/kg d.w.), NIES 11 for organochlorines or PAH (µg/kg d.w.) and EDF2525**** for fish (cyprinid) was analysed for dioxin(ng/kg) by NILU (Norwegian Institute for Air Research – results for 2007 material are shown here; cf. Green *et al.*2007). 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
As	**Arsenic**	LI	DOLT-3	10.2 ± 0.5	14	19	10.63	0.53
Cd	**cadmium**	LI	DOLT-3	19.4 ± 0.6	14	19	19.24	0.82
Cr	**Chromium**	LI	DOLT-3	missing	14	19	3.63	0.54
Cu	**copper**	LI	DOLT-3	31.2 ± 1.0	14	19	30.51	1.17
Ni	**Nickel**	LI	DOLT-3	2.72 ± 0.35	13	19	2.77	0.26
Pb	**lead**	LI	DOLT-3	0.319 ± 0.045	14	19	0.32	0.02
Zn	**zinc**	LI	DOLT-3	86.6 ± 2.4	14	19	94.39	3.67
As	**Arsenic**	SB	DORM-2	18 ± 1.1	5	8	20.60	1.03
Cd	**cadmium**	SB	DORM-2	0.043 ± 0.008	5	8	0.047	0.00
Co	**Cobalt**	SB	DORM-2	0.182 ± 0.031	4	4	0.188	0.02
Cr	**Chromium**	SB	DORM-2	34.7 ± 5.5	4	4	33.10	2.69
Cu	**copper**	SB	DORM-2	2.34 ± 0.16	5	8	2.17	0.06
Hg	**Mercury**	MU	DORM-2	4.64 ± 0.26	14	13	4.87	0.15
Hg	**mercury**	SB	DORM-2	4.64 ± 0.26	14	13	4.87	0.15
Ni	**Nickel**	SB	DORM-2	19.4 ± 3.1	4	4	17.75	1.03
Pb	**lead**	SB	DORM-2	0.065 ± 0.007	5	8	0.06	0.00
Zn	**zinc**	SB	DORM-2	25.6 ± 2.3	5	8	24.08	0.91
MPTIN	**Monophenyltin (MPT)**	SB	NIES-11	missing	9	16	293.33	151.33
TBTIN	**Tributyltin**	SB	NIES-11	1159 ± 88	9	16	1312.22	463.30
TPTIN	**Triphenyl-tin**	SB	NIES-11	5109 ± 363	8	16	4700.00	2511.69
BDE100	**2,2',4,4',6-Pentabromidiphenylether**	LI	SRM1588b	1.89 ± 0.45	19	24	2.65	0.68
BDE154	**2,2',4,4',5,6'-Hexabromidiphenylether**	LI	SRM1588b	0.495 ± 0.069	19	24	0.44	0.15
BDE28	**2,2,4'-Tribromodiphenylether**	LI	SRM1588b	1.08 ± 0.23	19	24	1.05	0.15
BDE47	**2,2',4,4',-Tetrabromidiphenylether**	LI	SRM1588b	17.8 ± 2.0	19	24	16.36	3.15
BDE49	**2,2',4,5'-Tetrabromidiphenylether**	LI	SRM1588b	2.25 ± 0.24	19	24	2.57	0.52
BDE99	**2,2',4,4',5-Pentabromidiphenylether**	LI	SRM1588b	0.56 ± 0.20	19	24	0.55	0.19
CB101	**PCB congener CB-101**	LI	SRM1588b	127 ± 9	6	20	118.83	12.66
CB105	**PCB congener CB-105**	LI	SRM1588b	59.2 ± 1.2	6	20	43.67	8.29
CB118	**PCB congener CB-118**	LI	SRM1588b	172 ± 7	6	20	193.33	25.82
CB138	**PCB congener CB-138**	LI	SRM1588b	212 ± 29	6	20	191.67	21.37
CB153	**PCB congener CB-153**	LI	SRM1588b	275 ± 4	6	20	218.33	33.71
CB156	**PCB congener CB-156**	LI	SRM1588b	18.0 ± 2.1	6	20	14.83	3.97
CB180	**PCB congener CB-180**	LI	SRM1588b	98.5 ± 6.3	6	20	81.67	10.25
CB209	**PCB congener CB-209**	LI	SRM1588b	3.2 ± 0.26	5	20	2.76	0.70
CB28	**PCB congener CB-28**	LI	SRM1588b	27.8 ± 1.4	5	20	25.60	3.13
CB52	**PCB congener CB-52**	LI	SRM1588b	82.4 ± 1.7	6	20	63.00	9.67
DDEPP	**4.4'-DDE**	LI	SRM1588b	676 ± 36	6	20	489.17	62.64
DDTPP	**4.4'-DDT**	LI	SRM1588b	570 ± 27	6	20	423.33	92.01
HCB	**Hexachlorobenzene**	LI	SRM1588b	163 ± 16	6	20	130.00	16.73
HCHA	**α -hexachlorohexene**	LI	SRM1588b	99 ± 15	6	20	68.00	9.59
HCHG	**γ -hexachlorohexene**	LI	SRM1588b	23.3 ± 1.7	6	20	18.33	2.58
OCS	**Octachlorostyrene**	LI	SRM1588b	9.14 ± 0.74	6	20	14.00	2.45
QCB	**Pentachlorobenzene**	LI	SRM1588b	16.1 ± 0.6	5	16	16.40	3.29
TDEPP	**4.4'-DDD**	LI	SRM1588b	285 ± 37	6	20	194.00	20.00
ACNE	**Acenaphthene**	SB	SRM2977	4.2 ± 0.4	7	20	2.83	0.88
ACNLE	**Acenaphthylene**	SB	SRM2977	m	8	23	1.97	1.26
ANT	**Anthracene**	SB	SRM2977	8 ± 4	8	23	3.36	1.22
BAP	**benzo[a]pyrene[1)]**	SB	SRM2977	8.35 ± 0.72	8	23	4.93	1.05
BBJF	**Benzo(b+j)flouranthene[2)]**	SB	SRM2977	m	7	23	17.57	3.31
BEP	**benzo[e]pyrene**	SB	SRM2977	13.1 ± 1.1	8	23	18.75	2.05
BGHIP	**benzo[ghi]perylene**	SB	SRM2977	9.53 ± 0.43	8	23	9.98	1.71

Code	Contaminant	Tis-sue type	SRM type	SRM value confidence interval	N	W	Mean value	Standard deviation
BKF	benzo[k]fluoranthene	SB	SRM2977	4 ± 1	8	23	6.40	1.22
BAA	benzo[a]anthracene[1)]	SB	SRM2977	20.34 ± 0.78	8	23	17.88	2.17
CHR	Chrysene	SB	SRM2977	49 ± 2	8	23	46.25	3.81
DBA3A	Dibenz[a,h]anthracene/Dibenz[a,c]anthracene[3)]	SB	SRM2977	2.0 ± 0.2	6	19	1.73	0.52
FLE	Fluorene	SB	SRM2977	10.24 ± 0.43	8	23	8.95	1.90
FLU	fluoranthene	SB	SRM2977	38.7 ± 1.0	8	23	33.63	5.18
ICDP	indeno[1,2,3-cd]pyrene	SB	SRM2977	4.84 ± 0.81	8	23	4.21	0.86
NAP	Naphthalene	SB	SRM2977	19 ± 5	8	23	11.95	5.59
PA	Phenanthrene	SB	SRM2977	35.1 ± 3.8	8	23	40.50	5.53
PER	perylene	SB	SRM2977	3.50 ± 0.76	8	23	2.31	0.34
PYR	pyrene	SB	SRM2977	78.9 ± 3.5	8	23	74.63	8.93
CB126	3,3',4,4',5-PeCB	SB	EDF2525	647 ± 211	5	50	635	17.1
CB169	3,3',4,4',5,5'-HxCB	SB	EDF2525	55.8 ± 12.6	5	50	48.3	0.83
CB77	3,3',4,4'-TeCB	SB	EDF2525	1980 ± 659	5	50	1953	102
CB81	3,4,4',5-TeCB	SB	EDF2525	179 ± 35.1	5	50	175	12.2
CDD1N	1,2,3,7,8-PeCDD	SB	EDF2525	3.88 ± 1.22	5	50	3.8	0.36
CDD4X	1,2,3,4,7,8-HxCDD	SB	EDF2525	0.31 ± 0.14	5	50	0.26	0.03
CDD6X	1,2,3,6,7,8-HxCDD	SB	EDF2525	2.19 ± 0.76	5	50	1.73	0.19
CDD9X	1,2,3,7,8,9-HxCDD	SB	EDF2525	0.32 ± 0.11	5	50	0.32	0.11
CDDO	OCDD	SB	EDF2525	2.57 ± 2.59	5	50	2.1	0.8
CDF2N	2,3,4,7,8-PeCDF	SB	EDF2525	14.5 ± 2.41	5	50	14.9	1.41
CDF2T	2,3,7,8-TCDF	SB	EDF2525	24.5 ± 5.52	5	50	22.2	2.39
CDF4X	2,3,4,6,7,8-HxCDF	SB	EDF2525	1.09 ± 0.55	5	50	0.94	0.12
CDF6P	1,2,3,4,6,7,8-HpCDF	SB	EDF2525	0.59 ± 0.61	5	50	0.46	0.33
CDF6X	1,2,3,6,7,8-HxCDF	SB	EDF2525	1.65 ± 0.56	5	50	1.8	0.36
CDF9P	1,2,3,4,7,8,9-HpCDF	SB	EDF2525	0.08 ± 0.11	5	50	0.17	0.15
CDFDN	1,2,3,7,8/1,2,3,4,8-PeCDF	SB	EDF2525	4.88 ± 1.46	5	50	4.37	0.48
CDFDX	1,2,3,4,7,8/1,2,3,4,7,9-HxCDF	SB	EDF2525	5.8 ± 0.99	5	50	6.37	0.81
CDFO	OCDF	SB	EDF2525	0.78 ± 1	5	50	0.92	0.64
TCDD	2,3,7,8-tetrachl-DiBpD (TCDD)	SB	EDF2525	17.3 ± 2.58	5	50	17.7	1.54

*) 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)
****) CIL, US.
1) Not certified (see NIST certificate)
2) Calculated from separate values for **Benzo(b)fluoranthene** and **Benzo(j)fluoranthene**; respectively, $(3870 + 2090) \pm \sqrt{(420^2 + 440^2)}$
3) Calculated from separate values for **Dibenz(a,c)anthracene and Dibenz(a,h)anthracene**, $(335 + 424) \pm \sqrt{(13^2 + 69^2)}$

Appendix C
Abbreviations

Abbreviation[1]	English	*Norwegian*	Param. group
ELEMENTS			
Al	aluminium	*aluminium*	I-MET
As	arsenic	*arsen*	I-MET
Cd	cadmium	*kadmium*	I-MET
Co	cobalt	*kobolt*	I-MET
Cr	chromium	*krom*	I-MET
Cu	copper	*kobber*	I-MET
Fe	iron	*jern*	I-MET
Hg	mercury	*kvikksølv*	I-MET
Li	lithium	*litium*	I-MET
Mn	manganese	*mangan*	I-MET
Ni	nickel	*nikkel*	I-MET
Pb	lead	*bly*	I-MET
Pb210	lead-210	*bly-210*	I-RNC
Se	selenium	*selen*	I-MET
Ti	titanium	*titan*	I-MET
Zn	zinc	*sink*	I-MET
METAL COMPOUNDS			
TBT	tributyltin	*tributyltinn*	O-MET
MBTIN	monobutyltin	*monobutyltinn*	O-MET
DBTIN	dibutyltin	*dibutyltinn*	O-MET
TBTIN	tributyltin	*tributyltinn*	O-MET
MPTIN	monophenyltin	*monofenyltinn*	O-MET
DPTIN	diphenyltin	*difenyltinn*	O-MET
TPTIN	triphenyltin	*trifenyltinn*	O-MET
PAHs			
PAH	polycyclic aromatic hydrocarbons	*polysykliske aromatiske hydrokarboner*	
ACNE [3]	acenaphthene	*acenaften*	PAH
ACNLE [3]	acenaphthylene	*acenaftylen*	PAH
ANT [3]	anthracene	*antracen*	PAH
BAA [3,4]	benzo[*a*]anthracene	*benzo[a]antracen*	PAH
BAP [3,4]	benzo[*a*]pyrene	*benzo[a]pyren*	PAH
BBF [3,4]	benzo[*b*]fluoranthene	*benzo[b]fluoranten*	PAH
BBJKF [3,4]	benzo[*b,j,k*]fluoranthene	*benzo[b,j,k]fluoranten*	PAH
BBJKF [3,4]	benzo[b+j,k]fluoranthene	*benzo[b+j,k]fluoranten*	PAH
BBKF [3,4]	benzo[*b+k*]fluoranthene	*benzo[b+k]fluoranten*	PAH
BEP	benzo[*e*]pyrene	*benzo[e]pyren*	PAH
BGHIP [3]	benzo[*ghi*]perylene	*benzo[ghi]perylen*	PAH
BIPN [2]	biphenyl	*bifenyl*	PAH
BJKF [3,4]	benzo[*j,k*]fluoranthene	*benzo[j,k]fluorantren*	PAH
BKF [3,4]	benzo[*k*]fluoranthene	*benzo[k]fluorantren*	PAH
CHR [3,4]	chrysene	*chrysen*	PAH
CHRTR [3,4]	chrysene+triphenylene	*chrysen+trifenylen*	PAH
COR	coronene	*coronen*	PAH
DBAHA [3,4]	dibenz[*a,h*]anthracene	*dibenz[a,h]anthracen*	PAH
DBA3A [3,4]	dibenz[*a,c/a,h*]anthracene	*dibenz[a,c/a,h]antracen*	PAH
DBP [4]	dibenzopyrenes	*dibenzopyren*	PAH
DBT	dibenzothiophene	*dibenzothiofen*	PAH
DBTC1	C_1-dibenzothiophenes	*C_1-dibenzotiofen*	PAH
DBTC2	C_2-dibenzothiophenes	*C_2-dibenzotiofen*	PAH
DBTC3	C_3-dibenzothiophenes	*C_3-dibenzotiofen*	PAH
FLE [3]	fluorene	*fluoren*	PAH
FLU [3]	fluoranthene	*fluoranten*	PAH
ICDP [3,4]	indeno[*1,2,3-cd*]pyrene	*indeno[1,2,3-cd]pyren*	PAH
NAP [2]	naphthalene	*naftalen*	PAH
NAPC1 [2]	C_1-naphthalenes	*C_1-naftalen*	PAH
NAPC2 [2]	C_2-naphthalenes	*C_2-naftalen*	PAH
NAPC3 [2]	C_3-naphthalenes	*C_3-naftalen*	PAH
NAP1M [2]	1-methylnaphthalene	*1-metylnaftalen*	PAH
NAP2M [2]	2-methylnaphthalene	*2-metylnaftalen*	PAH
NAPD2 [2]	1,6-dimethylnaphthalene	*1,6-dimetylnaftalen*	PAH
NAPD3 [2]	1,5-dimethylnaphthalene	*1,5-dimetylnaftalen*	PAH
NAPDI [2]	2,6-dimethylnaphthalene	*2,6-dimetylnaftalen*	PAH

Abbreviation[1]	English	*Norwegian*	Param. group
NAPT2 [2]	2,3,6-trimethylnaphthalene	*2,3,6-trimetylnaftalen*	PAH
NAPT3 [2]	1,2,4-trimethylnaphthalene	*1,2,4-trimetylnaftalen*	PAH
NAPT4 [2]	1,2,3-trimethylnaphthalene	*1,2,3-trimetylnaftalen*	PAH
NAPTM [2]	2,3,5-trimethylnaphthalene	*2,3,5-trimetylnaftalen*	PAH
NPD	Collective term for naphthalenes, phenanthrenes and dibenzothiophenes	*Sammebetegnelse for naftalen, fenantren og dibenzotiofens*	PAH
PA [3]	phenanthrene	*fenantren*	PAH
PAC1	C_1-phenanthrenes	*C_1-fenantren*	PAH
PAC2	C_2-phenanthrenes	*C_2-fenantren*	PAH
PAC3	C_3-phenanthrenes	*C_3-fenantren*	PAH
PAM1	1-methylphenanthrene	*1-metylfenantren*	PAH
PAM2	2-methylphenanthrene	*2-metylfenantren*	PAH
PADM1	3,6-dimethylphenanthrene	*3,6-dimetylfenantren*	PAH
PADM2	9,10-dimethylphenanthrene	*9,10-dimetylfenantren*	PAH
PER	perylene	*perylen*	PAH
PYR [3]	pyrene	*pyren*	PAH
DI-Σn	sum of "n" dicyclic "PAH"s (footnote 2)	*sum "n" disykliske "PAH" (fotnote 2)*	
P-Σn / P_S	sum "n" PAH (DI-Σn not included, footnote 3)	*sum "n" PAH (DI-Σn ikke inkludert, fotnot 3)*	
PK-Σn / PK_S	sum carcinogen PAHs (footnote 4)	*sum kreftfremkallende PAH (fotnote 4)*	
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)*	
BAP_P	% BAP of PAHΣΣ	*% BAP av PAHΣΣ*	
BAPPP	% BAP of P-Σn	*% BAP av P-Σn*	
BPK_P	% BAP of PK-Σn	*% BAP av PK-Σn*	
PKn_P	% PK-Σn of PAHΣΣ	*% PK-Σn av PAHΣΣ*	
PKnPP	% PK-Σn of P-Σn	*% PK-Σn av P-Σn*	
PCBs			
PCB	polychlorinated biphenyls	*polyklorerte bifenyler*	
CB	individual chlorobiphenyls (CB)	*enkelte klorobifenyl*	
CB28	CB28 (IUPAC)	*CB28 (IUPAC)*	OC-CB
CB31	CB31 (IUPAC)	*CB31 (IUPAC)*	OC-CB
CB44	CB44 (IUPAC)	*CB44 (IUPAC)*	OC-CB
CB52	CB52 (IUPAC)	*CB52 (IUPAC)*	OC-CB
CB77 [5]	CB77 (IUPAC)	*CB77 (IUPAC)*	OC-CB
CB81 [5]	CB81 (IUPAC)	*CB81 (IUPAC)*	OC-CB
CB95	CB95 (IUPAC)	*CB95 (IUPAC)*	OC-CB
CB101	CB101 (IUPAC)	*CB101 (IUPAC)*	OC-CB
CB105	CB105 (IUPAC)	*CB105 (IUPAC)*	OC-CB
CB110	CB110 (IUPAC)	*CB110 (IUPAC)*	OC-CB
CB118	CB118 (IUPAC)	*CB118 (IUPAC)*	OC-CB
CB126 [5]	CB126 (IUPAC)	*CB126 (IUPAC)*	OC-CB
CB128	CB128 (IUPAC)	*CB128 (IUPAC)*	OC-CB
CB138	CB138 (IUPAC)	*CB138 (IUPAC)*	OC-CB
CB149	CB149 (IUPAC)	*CB149 (IUPAC)*	OC-CB
CB153	CB153 (IUPAC)	*CB153 (IUPAC)*	OC-CB
CB156	CB156 (IUPAC)	*CB156 (IUPAC)*	OC-CB
CB169 [5]	CB169 (IUPAC)	*CB169 (IUPAC)*	OC-CB
CB170	CB170 (IUPAC)	*CB170 (IUPAC)*	OC-CB
CB180	CB180 (IUPAC)	*CB180 (IUPAC)*	OC-CB
CB194	CB194 (IUPAC)	*CB194 (IUPAC)*	OC-CB
CB209	CB209 (IUPAC)	*CB209 (IUPAC)*	OC-CB
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***	
DIOXINs			

Abbreviation[1]	English	*Norwegian*	Param. group
TCDD	2, 3, 7, 8-tetrachloro-dibenzo dioxin	*2, 3, 7, 8-tetrakloro-dibenzo dioksin*	OC-DX
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*	OC-DX
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*	OC-DX
CDD6X	1, 2, 3, 6, 7, 8-hexachloro-dibenzo dioxin	*1, 2, 3, 6, 7, 8-heksakloro-dibenzo dioksin*	OC-DX
CDD9X	1, 2, 3, 7, 8, 9-hexachloro-dibenzo dioxin	*1, 2, 3, 7, 8, 9-heksakloro-dibenzo dioksin*	OC-DX
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*	OC-DX
CDDSP	Sum of heptachloro-dibenzo dioxins	*Sum heptakloro-dibenzo dioksiner*	
CDDO	Octachloro-dibenzo dioxin	*Oktakloro-dibenzo dioksin*	OC-DX
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*	OC-DX
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*	OC-DX
CDF2N	2, 3, 4, 7, 8-pentachloro-dibenzofuran	*2, 3, 4, 7, 8-pentakloro-dibenzofuran*	OC-DX
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*	OC-DX
CDF6X	1, 2, 3, 6, 7, 8-hexachloro-dibenzofuran	*1, 2, 3, 6, 7, 8-heksakloro-dibenzofuran*	OC-DX
CDF9X	1, 2, 3, 7, 8, 9-hexachloro-dibenzofuran	*1, 2, 3, 7, 8, 9-heksakloro-dibenzofuran*	OC-DX
CDF4X	2, 3, 4, 6, 7, 8-hexachloro-dibenzofuran	*2, 3, 4, 6, 7, 8-heksakloro-dibenzofuran*	OC-DX
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*	OC-DX
CDF9P	1, 2, 3, 4, 7, 8, 9-heptachloro-dibenzofuran	*1, 2, 3, 4, 7, 8, 9-heptakloro-dibenzofuran*	OC-DX
CDFSP	Sum of heptachloro-dibenzofurans	*Sum heptakloro-dibenzofuraner*	OC-DX
CDFO	Octachloro-dibenzofurans	*Octakloro-dibenzofuran*	OC-DX
PCDF	Sum of polychlorinated dibenzo-furans	*Sum polyklorinated dibenzo-furaner*	
CDDFS	Sum of PCDD and PCDF	*Sum PCDD og PCDF*	
TCDNN	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***	
PESTICIDES			
ALD	aldrin	*aldrin*	OC-DN
DIELD	dieldrin	*dieldrin*	OC-DN
ENDA	endrin	*endrin*	OC-DN
CCDAN	cis-chlordane (=α-chlordane)	*cis-klordan (=α-klordan)*	OC-DN
TCDAN	trans-chlordane (=γ-chlordane)	*trans-klordan (=γ-klordan)*	OC-DN
OCDAN	oxy-chlordane	*oksy-klordan*	OC-DN
TNONC	trans-nonachlor	*trans-nonaklor*	OC-DN
TCDAN	trans-chlordane	*trans-klordan*	OC-DN
OCS	octachlorostyrene	*oktaklorstyren*	OC-CL
QCB	pentachlorobenzene	*pentaklorbenzen*	OC-CL
DDD	dichlorodiphenyldichloroethane 1,1-dichloro-2,2-bis-(4-chlorophenyl)ethane	*diklordifenyldikloretan 1,1-dikloro-2,2-bis-(4-klorofenyl)etan*	OC-DD

Abbreviation[1]	English	*Norwegian*	Param. group
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*	OC-DD
DDT	dichlorodiphenyltrichloroethane 1,1,1-trichloro-2,2-bis-(4-chlorophenyl)ethane	*diklordifenyltrikloretan 1,1,1-trikloro-2,2-bis-(4-klorofenyl)etan*	OC-DD
DDEOP	o,p'-DDE	*o,p'-DDE*	OC-DD
DDEPP	p,p'-DDE	*p,p'-DDE*	OC-DD
DDTOP	o,p'-DDT	*o,p'-DDT*	OC-DD
DDTPP	p,p'-DDT	*p,p'-DDT*	OC-DD
TDEPP	p,p'-DDD	*p,p'-DDD*	OC-DD
DDTEP	p,p'-DDE + p,p'-DDT	*p,p'-DDE + p,p'-DDT*	OC-DD
DD-nΣ	sum of DDT and metabolites, n = number of compounds	*sum DDT og metabolitter, n = antall forbindelser*	OC-DD
HCB	hexachlorobenzene	*heksaklorbenzen*	OC-CL
HCHG	Lindane γ HCH = gamma hexachlorocyclohexane (γ BHC = gamma benzenehexachloride, outdated synonym)	*Lindan γ HCH = gamma heksaklorsykloheksan (γ BHC = gamma benzenheksaklorid, foreldret betegnelse)*	OC-HC
HCHA	α HCH = alpha HCH	*α HCH = alpha HCH*	OC-HC
HCHB	β HCH = beta HCH	*β HCH = beta HCH*	OC-HC
HC-nΣ	sum of HCHs, n = count	*sum av HCHs, n = antall*	
EOCl	extractable organically bound chlorine	*ekstraherbart organisk bundet klor*	OC-CL
EPOCl	extractable persistent organically bound chlorine	*ekstraherbart persistent organisk bundet klor*	OC-CL
PBDEs			
PBDE	polybrominated diphenyl ethers	*polybromerte difenyletere*	OC-BB
BDE	brominated diphenyl ethers		OC-BB
BDE-28	2,4,4'-tribromodiphenyl ether	*2,4,4'-tribromdifenyleter*	OC-BB
BDE-47	2,2',4,4'-tetrabromodiphenyl ether	*2,2',4,4'-tetrabromdifenyleter*	OC-BB
BDE-49*	2,2',4,5'- tetrabromodiphenyl ether	*2,2',4,5'- tetrabromdifenyleter*	OC-BB
BDE-66*	2,3',4',6- tetrabromodiphenyl ether	*2,3',4',6- tetrabromdifenyleter*	OC-BB
BDE-71*	2,3',4',6- tetrabromodiphenyl ether	*2,3',4',6- tetrabromdifenyleter*	OC-BB
BDE-77	3,3',4,4'-tetrabromodiphenyl ether	*3,3',4,4'-tetrabromdifenyleter*	OC-BB
BDE-85	2,2',3,4,4'-pentabromodiphenyl ether	2,2',3,4,4'-pentabromdifenyleter	OC-BB
BDE-99	2,2',4,4',5-pentabromodiphenyl ether	*2,2',4,4',5-pentabromdifenyleter*	OC-BB
BDE-100	2,2',4,4',6-pentabromodiphenyl ether	*2,2',4,4',6-pentabromdifenyleter*	OC-BB
BDE-119	2,3',4,4',6-pentabromodiphenyl ether	*2,3',4,4',6-pentabromdifenyleter*	OC-BB
BDE-138	2,2',3,4,4',5'-hexabromodiphenyl ether	*2,2',3,4,4',5'-heksabromdifenyleter*	OC-BB
BDE-153	2,2',4,4',5,5'-hexabromodiphenyl ether	*2,2',4,4',5,5'-heksabromdifenyleter*	OC-BB
BDE-154	2,2',4,4',5,6'-hexabromodiphenyl ether	*2,2',4,4',5,6'-heksabromdifenyleter*	OC-BB
BDE-183	2,2',3,4,4',5',6-heptabromodiphenyl ether	*2,2',3,4,4',5',6-heptabromdifenyleter*	OC-BB
BDE-205	2,2',3,3',4,4',5,5',6'-nonabromodiphenyl ether	*2,2',3,3',4,4',5,5',6'-nonabromdifenyleter*	OC-BB
BDE-209	Decabromodiphenyl ether	*Dekabromdifenyleter*	OC-BB
PFAS	perfluorinated alkylated aubstances	perfluoralkylertestoffer	
PFBS	perfluorobutane sulfonate	perfluorbutan sulfonat	PFAS
PFHxA	perfluorohexanoic acid	perfluorhexansyre	PFAS
PFHpA	perfluoroheptanoic acid	perfluorheptansyre	PFAS
PFOA	perfluorooctanoic acid	perfluoroktansyre	PFAS
PFNA	perfluorononanoic acid	perfluornonansyre	PFAS
PFOS	perfluoroctanoic sulfonate	perfluoroktansulfonat	PFAS

Abbreviation[1]	English	*Norwegian*	Param. group
NTOT	total organic nitrogen	*total organisk nitrogen*	I-NUT
CTOT	total organic carbon	*total organisk karbon*	O-MAJ
CORG	organic carbon	*organisk karbon*	O-MAJ
GSAMT	grain size	*kornfordeling*	P-PHY
MOCON	moisture content	*vanninnhold*	P-PHY
INSTITUTES			
EFDH	Eurofins [DK]	*Eurofins [DK]*	
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]*	
GALG	GALAB Laboratories Gmbh [D]	*GALAB Laboratories Gmbh [D]*	
IFEN	Institute for Energy Technology	*Institutt for energiteknikk*	
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*	
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)*	
VETN	Norwegian Veterinary Institute	*Veterinærinstituttet*	
VKID	Water Quality Institute [DK]	*Vannkvalitetsintitutt [DK]*	

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 PCBs and “dioxins” (ICES pers. comm.)

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

3) Indicates the sum of tri- to hexacyclic PAH compounds named in EPA protocol 8310 minus naphthalene (dicyclic), so that the SFT classification system can be applied

4) Indicates PAH compounds potentially cancerogenic for humans according to IARC (1987, updated 14.August 2007 at http://monographs.iarc.fr/ENG/Classification/crthgr01.php), i.e., categories 1, 2A, and 2B (are, possibly and probably carcinogenic). NB.: the update inlcludes Chrysene as cancerogenic and hence, KPAH with Chrysene should not be used in SFT’s classification system for this sum-variable (Molvær *et al.* 1997).

5) Indicates non ortho- co-planer PCB compounds i.e., 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: • polychlorinated dibenzo-p-dioxins and dibenzofurans (**PCDD/PCDFs**). Equivalents calculated after Nordic model (Ahlborg 1989) [1] or international model (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.)	*"Toxisitetsekvivalentfaktorer" for de giftigste forbindelsene innen følgende grupper.* • *polyklorerte dibenzo-p-dioksiner og dibenzofuraner (**PCDD/PCDF**). Ekvivalentberegning etter nordisk modell (Ahlborg 1989) [1] eller etter internasjonal modell (Int./EPA, cf. Van den Berg et al. 1998) [2]* • *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 D
Overconcentrations and classification of environmental quality

Table 6. Norwegian Pollution Control Authority environmental classification system of contaminants in blue mussel and fish (Molvær *et al.* 1997) and proposed revisions (shaded) for Class I concentrations (Knutzen & Green 2001b) used in this report.

Contaminant			Classification (upper limit for Classes I-IV) *Degree of pollution*				
			nsignificant	I *Moderate*	II *Marked*	V *Severe*	/ *Extreme*
BLUE MUSSEL							
Lead	mg/kg	w.w.[2]	*0.6*	*3*	*8*	*20*	*>20*
	mg/kg	d.w.	3	15	40	100	>100
Cadmium	mg/kg	w.w.[2]	*0.4*	*1*	*4*	*8*	*>8*
	mg/kg	d.w.	2	5	20	40	>40
Copper	mg/kg	w.w.[2]	*2*	*6*	*20*	*40*	*>40*
	mg/kg	d.w.	10	30	100	200	>200
Mercury	mg/kg	w.w.[2]	*0.04*	*0.1*	*0.3*	*0.8*	*>0.8*
	mg/kg	d.w.	0.2	0.5	1.5	4	>4
Zinc	mg/kg	w.w.[2]	*40*	*80*	*200*	*500*	*>500*
	mg/kg	d.w.	200	400	1000	2500	>2500
TBT[1]	mg/kg	d.w.	0.1	0.5	2	5	>5
∑PCB-7	µg/kg	w.w.	3[5]	15	40	100	>100
		d.w.[2]	*15*[2]	*75*	*200*	*500*	*>500*
∑DDT	µg/kg	w.w.	2	5	10	30	>30
		d.w.[2]	*10*	*25*	*50*	*150*	*>150*
∑HCH	µg/kg	w.w.	1	3	10	30	>30
		d.w.[2]	*5*	*15*	*50*	*150*	*>150*
HCB	µg/kg	w.w.	0.1	0.3	1	5	>5
		d.w.[2]	*0.5*	*1.5*	*5*	*25*	*>25*
∑PAH	µg/kg	w.w.	50	200	2000	5000	>5000
		d.w.[2]	*250*	*1000*	*10000*	*25000*	*>25000*
∑KPAH	µg/kg	w.w.	10	30	100	300	>300
		d.w.[2]	*50*	*150*	*500*	*1500*	*>1500*
B[*a*]P	µg/kg	w.w.	1	3	10	30	>30
		d.w.[2]	*5*	*15*	*50*	*150*	*>150*
$TE_{PCDF/D}$[3]	µg/t[4]	w.w.	0.2	0.5	1.5	3	>3
COD, fillet							
Mercury	mg/kg	w.w.	0.1	0.3	0.5	1	>1
∑PCB-7	µg/kg	w.w.	3[6]	20	50	150	>150
∑DDT	µg/kg	w.w.	1	3	10	25	>25
∑HCH	µg/kg	w.w.	0.3[7]	2	5	15	>15
HCB	µg/kg	w.w.	0.2	0.5	2	5	>5
COD, liver							
∑PCB-7	µg/kg	w.w.	500	1500	4000	10000	>10000
∑DDT	µg/kg	w.w.	200[8]	500	1500	3000	>3000
∑HCH	µg/kg	w.w.	30[9]	200	500	1000	>1000
HCB	µg/kg	w.w.	20	50	200	400	>400
$TE_{PCDF/D}$[3]	µg/t[4]	w.w.	10[10]	40	100	300	>300

[1]) Tributyltin on a formula basis

[2]) Conversion assuming 20% dry weight

[3]) TCDDN (Appendix C)

[4]) µg/1000 kg (Appendix C)

[5]) Blue mussel - ΣPCB7: Decrease limit from 4 to 3

[6]) Cod fillet - ΣPCB7: Decrease limit from 5 to 3

[7]) Cod fillet - ΣHCH: Decrease limit from 0.5 to 0.3

[8]) Cod liver - ΣDDT: Proposal to either increase limit from 200 to 300 or, preferably, replace ΣDDT with p,p-DDE and keep the limit (Knutzen & Green 2001b)

[9]) Cod liver - ΣHCH: Decrease limit from 50 to 30

[10]) Cod liver: TEPCDD/PCDF: Decrease limit from 0.015 to 0.010

Table 7. Provisional "high background levels" of selected contaminants, in **mg/kg dry weight** (blue mussel) and **mg/kg wet weight** (blue mussel and fish) used in this report. The respective "high background" limits are from Knutzen & Skei (1990) with mostly minor adjustments (Knutzen & Green 1995, 2001b; Molvær *et al.* 1997), except for dab where the suggested limit is based on CEMP-data (Knutzen & Green 1995). Especially uncertain values are marked with "?".

Cont.	**Blue mussel** [1]		**Cod** [1]		**Flounder** [1]		**Dab** [1]		**Plaice** [1]	
			liver	**fillet**	**liver**	**fillet**	**liver**	**fillet**	**liver**	**fillet**
	mg/kg d.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.	mg/kg w.w.
Lead	3.0 [2)]	0.6 [3)]	0.1		0.3 ?		0.3 ?		0.2 ?	
Cadmium	2.0 [2)]	0.4 [3)]	0.3		0.3 ?		0.3 ?		0.2 ?	
Copper	10 [2)]	2 [3)]	20		10 ?		30 ?		10 ?	
Mercury	0.2 [2)]	0.04 [3)]		0.1 [2)]		0.1		0.1		0.1
Zinc	200 [2)]	40 [3)]	30		50 ?		60 ?		50 ?	
∑PCB-7 [8)]	0.015[3,9)]	0.003[2 9)]	0.50 [2)]	0.003[9)]	0.1	0.003 [9)]	0.5	0.005 [9)]	0.05 ?	0.004 [9)]
ppDDE	0.010 [3)]	0.002 [6)]	0.2 [9)]		0.03	0.001 [9)]	0.1	0.002 [9)]	0.01 ? [6)]	0.001 [9)]
γ HCH	0.005 [3)]	0.001 [6)]	0.03 [9)]	0.0003[9)]	0.01	0.0003[9)]	0.03	0.0005 [9)]	0.005 ?[6)]	0.0003[9)]
HCB	0.0005 [3)]	0.0001 [2)]	0.02 [2)]		0.005	0.0001[9)]	0.01	0.0002 [9)]	0.005 ?	0.0002[9)]
TCDDN	0.000001 [3)] 0.0000002 [2)]		0.00001 [9)]							

[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.

[9]) Flounder liver: Decrease limit from 5 to 3 and from 2 to 1 for ΣPCB7 and p,p-DDE, respectively, with regard to revisions suggested by Knutzen & Green (2001b) and Green & Knutzen (2003)

Appendix E
Summary of action taken by Norwegian Food Safety Authority

Table 8. Summary of action taken by the Norwegian Food Safety Authority (*Mattilsynet*) concerning the consumption and sale of fish products along the Norwegian Coast (see www.miljostatus.no > *vannforurensning* > *miljøgifter, vann* > *miljøgifter, marint* > *kostholdsråd* and review by Økland 2005). Restrictions on sale vary and may concern the whole or part of fish product.

Area of concern (km^2)	Main parameters of concern	Last year of issue/ adjustment	Main fish/shellfish product of concerned	Recommendations or restrictions of concern:
Mid [1] and Inner Oslofjord (498.9) (includes Drammensfj.)	PCB	2002	fish liver, eel	Consumption and sale
Tønsberg area (23.7) (includes (Vrengen)	PCB	2003	fish liver, eel, mussels	Consumption
Inner Sandefjordfjord (1.5)	PCB	1999	fish liver	Consumption and sale
Grenland fjords, Langesundsfjord (90.3)	Chl.org [2]/ Dioxins	2004	fish, shellfish	Consumption and sale
Kragerø (3.2)	PAH Dioxins	2002	eel, mussels	Consumption
Tvedestrand (2.3)	PCB	2002	fish liver	Consumption and sale
Arendal (8.0)	PCB	2002	fish liver	Consumption and sale
Inner Kristiansandsfjord (33.3)	Chl.org [2]/ Dioxins/PCB	2002	fish, shellfish	Consumption and sale
Farsund area (42.0)	PCB PAH	2002	fish liver, mussels	Consumption and sale
Fedafjord (11.2)	PAH	2002	mussels	Consumption and sale
Flekkefjord (4.2)	PCB	2002	fish liver	Consumption and sale
Stavanger (4.0)	PCB PAH	2001	fish liver, mussels	Consumption
Sandnes (1.7)	PAH	2001	Mussels	Consumption
Karmsund-Eidsbotn, Vedavågen (24.1 [6])	PCB, PAH	2005	fish liver [3], shellfish	Consumption and sale
Saudafjord (16.6 [7])	PAH	2007	fish liver, mussels	Consumption and sale
Sørfjord (62.2)	Cd Pb Hg PCB	2005	fish, shellfish	Consumption and sale
Bergen area (169.9)	PCB	2002	fish, shellfish	Consumption and sale
Høyangerfjorden (10.2 [7])	Cd Pb	2007	fish, shellfish	Consumption
Årdalsfjord (30.4)	PAH	2002	mussels	Consumption and sale
Ålesund, Åsefjorden (8 [7])	HBCDD [4]	2007	fish, shellfish	Consumption
Sunndalsfjord (100.1)	PAH	2005	fish liver, mussels	Consumption and sale
Hommelvik (2.6)	PAH	2002	mussels	Consumption and sale
Inner Trondheimfjorden (1.2)	PAH PCB	2002	fish liver, mussels	Consumption
Brønnøysund (7.0)	PAH	2003	mussels	Consumption
Vefsnfjord (76.4) [5]				
Sandnessjøen (0.4)	PAH	2005	mussels	Consumption
Inner Ranfjord (16.6)	PAH	2005	mussels	Consumption and sale
Ramsund (5.4)	PCB	2002	fish, shellfish	Consumption and sale
Harstad (2.9)	PCB Pb Cd	2003	fish liver, mussels	Consumption and sale
Narvik (11.6)	PCB PAH	2005	fish, mussels	Consumption
Tromsø (17.7)	PAH	2003	mussels	Consumption and sale
Hammerfest (4.1)	PAH	2003	mussels	Consumption and sale
Honningsvåg (3.3)	PAH	2002	mussels	Consumption and sale

[1] Includes, Hvitsten, Moss, Horten og Holmenstrand
[2] Organochlorine compounds
[3] Concerns only Eidsbotn
[4] A brominated flame retardant
[5] Grounds for concern were cleared in 2005
[6] Exclusive Vedavågen
[7] Estimated from map shown in www.miljostatus.no

Appendix F
Overview of localities and sample count for biota 1981-2007

Nominel station positions are shown on maps in Appendix G

jmpco: CEMP area code (J99 = unclassified)
jmpst: station code
stnam: station name
nom_lon: Longitude (nominel)
nom_lat: Latitude (nominel)
speci: species code (English, Norwegian (Latin))

MYTI EDU - blue mussel, blåskjell (*Mytilus edulis*)
NUCE LAP - dogwhelk, purpursnegl (*Nucella lapillus*)
BROS BRO - tusk, brosme (*Brosme brosme)*
CHIM MON - rat fish, havmus (*Chimaera monstrosa*)
GADU MOR - Atlantic cod, torsk (*Gadus morhua*)
LEPI WHI - megrim, glassvar (*Lepidorhombus whiff-iagonis*)
LIMA LIM - dab, sandflyndre (*Limanda limanda*)
MICR KIT - lemon sole, lomre (*Microstomus kitt*)
MOLV MOL - ling, lange (*Molva molva*)
PAND BOR - shrimp, reker (*Pandalus borealis)*
PLAT FLE - flounder, skrubbe (*Platichthys flesus*)
PLEU PLA - plaice, rødspette (*Pleuronectes platessa*)

tissu: tissue:
SB - soft body
LI - liver
MU - fillet
TM - tail muscle

STATIONS AND SAMPLE COUNT FOR BIOTA

jmpco	jmpst	stnam	nomlat	nomlon	speci	tissu	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
J26	01A	Sponvika	59° 5.31	11°	MYTI EDU	SB		3			3					3																	
J26	02A	Fugleskjær	59° 6.9	10° 59	MYTI EDU	SB		3			3					3																	
J26	03A	Tisler	58° 58.8	10° 57.5	MYTI EDU	SB		2			3					3																	
J26	301	Akershuskaia	59°	10°	MYTI EDU	SB												2															
J26	302	Ormøya	59°	10°	MYTI EDU	SB												2															
J26	303	Malmøya	59°	10°	MYTI EDU	SB												1															
J26	304	Gåsøya	59°	10°	MYTI EDU	SB												3															
J26	305	Lysaker	59°	10° 38.6	MYTI EDU	SB												2															
J26	306	Håøya	59° 42.8	10°	MYTI EDU	SB												3															
J26	30A	Gressholmen	59°	10°	MYTI EDU	SB				3	3	3	4	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3
J26	30B	Oslo City area	59°	10° 33.6	GADU	BI																		18	23	23	25	24	25	25	23	24	24
J26	30B	Oslo City area	59°	10° 33.6	GADU	BL																	20	20	25	25	25	25	25	25			
J26	30B	Oslo City area	59°	10° 33.6	GADU	LI				29	25	25	25	25	25	25	24	21	24	25	25	40	49	50	25	25	28	25	25	25	25	25	25
J26	30B	Oslo City area	59°	10° 33.6	GADU	MU				29	25	25	25	26	26	30	30	21	29	30	30	48	48	60	30	30	30	30	30	30	30	30	30
J26	30C	Oslo City area	59° 49	10° 33	PAND BOR	TM				1								2															
J26	30F	Oslo City area	59° 47	10° 34	PLEU PLA	LI												2		5	5												
J26	30F	Oslo City area	59° 47	10° 34	PLEU PLA	MU												2		5	5												
J26	30J	Spro	59°	10° 33.6	PAND BOR	TM															1												
J26	30K	Storegrunn	59°	10° 33.6	PAND BOR	TM															1												
J26	30X	West of Nesodden	59° 48.5	10° 36	GADU	LI												22															
J26	30X	West of Nesodden	59° 48.5	10° 36	GADU	MU												22															
J26	31A	Solbergstrand	59°	10°	MYTI EDU	SB	2		6	3	3	3	3	3	3	3	3	3	3	3	2	4	3	3	3	3	3	3	3	3	3	3	3
J26	31B	Solbergstrand	59° 36.9	10° 38.4	GADU	LI	10	27																									
J26	31B	Solbergstrand	59° 36.9	10° 38.4	GADU	MU	10	27																									
J26	31F	Solbergstrand	59° 36.9	10° 38.4	PLAT FLE	LI	8																										
J26	31F	Solbergstrand	59° 36.9	10° 38.4	PLAT FLE	MU	8																										
J26	31C	Solbergstrand	59° 36.9	10° 38.4	PAND BOR	TM				1																							
J26	32A	Rødtangen	59° 31.5	10° 25.6	MYTI EDU	SB	1	3			3																						
J26	33F	Sande (east side)	59° 31.7	10° 21	PLAT FLE	LI			25		1	1	1	1	1	5	5	5	5	5	5	10	10	8	5	5	5	5	5	5	5	5	3
J26	33F	Sande (east side)	59° 31.7	10° 21	PLAT FLE	MU			25		25	1	1	1	1	5	5	5	5	5	5	10	10	8	5	5	5	5	5	5	5	5	3
J26	33C	Sande	59° 31.7	10° 21	PAND BOR	TM						1																					
J26	33X	Sande (west side)	59° 31.7	10° 20.4	PLAT FLE	LI										3																	
J26	33X	Sande (west side)	59° 31.7	10° 20.4	PLAT FLE	MU										3																	
J26	35A	Mølen	59°	10°	MYTI EDU	SB	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
J26	35C	Mølen-Moss	59°	10°	PAND BOR	TM		1						1		2																	
J26	35C	Mølen-Moss	59°	10°	PAND BOR	XX								1																			
J26	36A	Færder	59° 1.63	10°	MYTI EDU	SB	1		5	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	3	3
J26	36G	Færder	59° 1.63	10°	NUCE LAP	SB																	1	1	1	1	1	1	1	2	2	2	2
J26	36B	Færder area	59° 2.43	10°	GADU	BI																	21	25	25	23	25						
J26	36B	Færder area	59° 2.43	10°	GADU	BL																	20	25	25	23	25						
J26	36B	Færder area	59° 2.43	10°	GADU	LI	10	27	23	24	14	25	25	25	25	24	25	25	25	25	25	26	25	25	25	23	28	25	25	25	25	25	25
J26	36B	Færder area	59° 2.43	10°	GADU	MU	10	27	23	24	14	25	25	26	26	29	30	30	30	30	30	30	30	30	30	27	30	30	30	30	30	30	30
J26	36F	Færder area	59° 4	10° 23	LIMA LIM	BI																			11	9	20						
J26	36F	Færder area	59° 4	10° 23	LIMA LIM	BL																			20	9	20						
J26	36F	Færder area	59° 4	10° 23	LIMA LIM	LI										5	5	5	5	5	5	5	5	5	25	14	24	5	5	5	5	5	5
J26	36F	Færder area	59° 4	10° 23	LIMA LIM	MU										5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
J26	73A	Lyngholmen	59° 2.68	10°	MYTI EDU	SB										3																	
J26	74A	Langholmane	58° 57.3	9° 52.1	MYTI EDU	SB										3																	
J26	71A	Bjørkøya (Risøyodden)	59° 1.4	9° 45.22	MYTI EDU	SB	1	3	3	3	2	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	4
J26	71G	Fugløyskjær	58°	9° 48.46	NUCE LAP	SB																					1	1	1	1	1	1	2
J99	76A	Risøy	58°	9° 16.32	MYTI EDU	SB										3	3	3	3			3	3	3	3	3	3	3	3	3	3	3	3
J99	76A	Risøy	58°	9° 16.32	NUCE LAP	SB																							1				
J99	76G	Risøy	58°	9° 16.53	NUCE LAP	SB																					1	1		1	2	2	2
J99	77A	Nordstrand	58°	8° 56.51	MYTI EDU	SB										3	3																
J99	77B	Borøy area	58° 33	9° 1	GADU	LI										14	25																
J99	77B	Borøy area	58° 33	9° 1	GADU	MU										17	30																
J99	77F	Borøy area	58° 33	9° 1	LIMA LIM	LI											3																
J99	77C	Borøy area	58° 29	9° 10	PAND BOR	TM										2																	
J99	79A	Gjerdsvoldsøyen (east)	58° 24.8	8° 44.5	MYTI EDU	SB										3	3																
J99	13A	Langøsund	57°	7° 34.6	MYTI EDU	SB										1	4																
J99	131G	Lastad	58° 3.33	7° 42.52	NUCE LAP	SB																					1	1	1	1	2	2	2
J99	14A	Aavigen	58° 1.96	7° 12.97	MYTI EDU	SB										3	4																
J99	15A	Gåsøy (Ullerø)	58° 2.87	6° 53.72	MYTI EDU	SB										4	4		3	3	4	4	3	3	3	3	3	3	3	3	3	3	3
J99	15G	Gåsøy (Ullerø)	58° 2.98	6° 53.74	NUCE LAP	SB																					1	1	1	2	2	2	1
J99	15B	Ullerø area	58° 3	6° 43	GADU	BI																	10	25	25		24	18	24	22	24	24	25
J99	15B	Ullerø area	58° 3	6° 43	GADU	BL																	24	25	25		23						

jmpco	jmpst	stnam	nomlat	nomlon	speci	tissu	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
J99	15B	Ullerø area	58° 3	6° 43	GADU	LI										25	24	23	25	23	24	26	25	25	25	25	25	25	25	25	25	25	25
J99	15B	Ullerø area	58° 3	6° 43	GADU	MU										30	29	27	30	28	29	30	30	30	30	30	30	30	30	30	30	30	30
J99	15F	Ullerø area	58° 3	6° 43	LIMA LIM	BI																			20		22						
J99	15F	Ullerø area	58° 3	6° 43	LIMA LIM	BL																			25		25						
J99	15F	Ullerø area	58° 3	6° 43	LIMA LIM	LI											3		2	4	5	5	5	5	30	5	30	5	5	5	5	5	5
J99	15F	Ullerø area	58° 3	6° 43	LIMA LIM	MU											3		2	4	5	5	5	5	5	5	5	5	5	5	5	5	5
J99	15F	Ullerø area	58° 3	6° 43	PLEU PLA	LI												3	2														
J99	15F	Ullerø area	58° 3	6° 43	PLEU PLA	MU												3	2														
J99	15F	Ullerø area	58° 3	6° 43	MICR KIT	LI														1													
J99	15F	Ullerø area	58° 3	6° 43	MICR KIT	MU														1													
J63	51A	Byrkjenes	60° 5.03	6° 33.03	MYTI EDU	SB							3	3							1	3	3	3	6	3	3	3	3	3	3	3	3
J63	52A	Eitrheimsneset	60° 5.8	6° 31.97	MYTI EDU	SB									3	3	3	3	2	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J63	53B	Inner Sørfjord	60° 10	6° 34	GADU	BI																	15	28	24	25	25	24	24	25	24	24	25
J63	53B	Inner Sørfjord	60° 10	6° 34	GADU	BL																	15	30	25	25	25	25	25	25			
J63	53B	Inner Sørfjord	60° 10	6° 34	GADU	LI							13	1	12	25	25	22	25	25	25	50	30	30	25	25	25	25	25	25	25	25	25
J63	53B	Inner Sørfjord	60° 10	6° 34	GADU	MU							12	1	15	30	30	26	30	30	30	56	36	36	30	30	30	30	30	30	30	30	30
J63	53F	Inner Sørfjord	60° 10	6° 34	PLAT FLE	BI																			25	11	12						
J63	53F	Inner Sørfjord	60° 10	6° 34	PLAT FLE	BL																			23	11	12						
J63	53F	Inner Sørfjord	60° 10	6° 34	PLAT FLE	LI				22				1	30	5	5	5	5	4	4	11	15	11	30	13	17	5	5	5	5		5
J63	53F	Inner Sørfjord	60° 10	6° 34	PLAT FLE	MU				22				1	30	5	5	5	5	4	4	11	15	11	5	2	5	5	5	5	5		5
J63	53F	Inner Sørfjord	60° 10	6° 34	GLYP CYN	LI							3																				
J63	53F	Inner Sørfjord	60° 10	6° 34	GLYP CYN	MU							3																				
J63	53B	Inner Sørfjord	60° 10	6° 34	SALM TRU	LI										12																	
J63	53B	Inner Sørfjord	60° 10	6° 34	SALM TRU	MU										12																	
J63	53D	Digraneset	60° 11	6° 34.5	BROS	LI																					4						
J63	53D	Digraneset	60° 11	6° 34.5	BROS	MU																					4						
J63	53D	Digraneset	60° 11	6° 34.5	MOLV	LI																					5						
J63	53D	Digraneset	60° 11	6° 34.5	MOLV	MU																					5						
J63	53D	Digraneset	60° 11	6° 34.5	CHIM MON	LI																					2						
J63	53D	Digraneset	60° 11	6° 34.5	CHIM MON	MU																					2						
J63	56A	Kvalnes	60°	6° 36.12	MYTI EDU	SB							3	15	3	3	3	3	3	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J63	56A1	Kvalnes (north)	60°	6° 36.26	MYTI EDU	SB																			3			2					
J63	56A2	Kjeken	60°	6° 39.27	MYTI EDU	SB																			3			2					
J63	56A3	Sekse	60°	6° 37.4	MYTI EDU	SB																						2					
J63	56A4	Rosstadnes	60°	6° 37.43	MYTI EDU	SB																						2					
J63	56A5	Lofthus (south)	60°	6° 39.12	MYTI EDU	SB																						2					
J63	56D	Kvalnes	60° 15	6° 36	BROS	LI																			3								
J63	56D	Kvalnes	60° 15	6° 36	BROS	MU																			3								
J63	56D	Kvalnes	60° 15	6° 36	MOLV	LI																			1								
J63	56D	Kvalnes	60° 15	6° 36	MOLV	MU																			1								
J63	56D	Kvalnes	60° 15	6° 36	CHIM MON	LI																			1								
J63	56D	Kvalnes	60° 15	6° 36	CHIM MON	MU																			1								
J63	57A	Krossanes	60°	6° 41.34	MYTI EDU	SB							3	3	3	3	3	3	3	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J63	57A1	Urdheim	60°	6° 40.69	MYTI EDU	SB																			3			2					
J63	57A2	Ernes	60°	6° 39.74	MYTI EDU	SB																						2					
J62	63A	Ranaskjær	60°	6° 25.32	MYTI EDU	SB							3	3	3	3	3	3	3	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J62	65A	Vikingneset	60°	6° 9.16	MYTI EDU	SB							3	15	3	3	3	3	3	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J62	67B	Strandebarm area	60° 16	6° 2	GADU	BI																	25	24	25	15	25						
J62	67B	Strandebarm area	60° 16	6° 2	GADU	BL																	25	25	25	13	24						
J62	67B	Strandebarm area	60° 16	6° 2	GADU	LI							22	1	22	16	19	8	12	18	25	35	25	25	25	25	25	25	25	25	25	25	25
J62	67B	Strandebarm area	60° 16	6° 2	GADU	MU							22	1	23	16	24	9	14	22	30	40	30	30	30	30	30	30	30	30	30	30	30
J62	67F	Strandebarm area	60° 16	6° 2	PLAT FLE	BI																			25	22	25						
J62	67F	Strandebarm area	60° 16	6° 2	PLAT FLE	BL																			25	23	23						
J62	67F	Strandebarm area	60° 16	6° 2	PLAT FLE	LI																3		4	30	28	30	5	5	5	5	5	5
J62	67F	Strandebarm area	60° 16	6° 2	PLAT FLE	MU																3		4	5	5	5	5	5	5	5	5	5
J62	67F	Strandebarm area	60° 16	6° 2	LIMA LIM	LI																		5									
J62	67F	Strandebarm area	60° 16	6° 2	LIMA LIM	MU																		5									
J62	67F	Strandebarm area	60° 16	6° 2	LEPI WHI	LI				19			1	1	30	5	5	3	5	5	5	5	5	5	5	5	5	5	5	2	5	4	5
J62	67F	Strandebarm area	60° 16	6° 2	LEPI WHI	MU				19			1	1	30	5	5	3	5	5	5	5	5	5	5	5	5	5	5	2	5	4	5
J62	69A	Lille Terøy	59°	5° 45.15	MYTI EDU	SB												3	1	3	3	3	3	3	6	3	3	3	3	3	3	3	3
J99	22A	Espevær (west)	59°	5° 8.63	MYTI EDU	SB										3	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	3	3
J99	224G	Heggjelen	59°	5° 13.9	NUCE LAP	SB																	1	1	1	1							
J99	22G	Espevær vest	59°	5° 8.67	NUCE LAP	SB																					1	1	1	2	2	2	2
J99	220G	Smørstakk	59°	5° 21.11	NUCE LAP	SB																	1	1	1					2			
J99	22C	Bømlofjord	59° 34	5° 11	PAND BOR	TM										2																	
J99	221A	Stangeland	59°	5° 19.7	MYTI EDU	SB																		2	3								
J99	221G	Stangeland	59°	5° 19.8	NUCE LAP	SB																		1	1								
J99	21F	Åkrafjord	59° 45	6° 7	PLAT FLE	BI																			11								
J99	21F	Åkrafjord	59° 45	6° 7	PLAT FLE	BL																			11	25							
J99	21F	Åkrafjord	59° 45	6° 7	PLAT FLE	LI																			14	11	5	5		1	5	5	

jmpco	jmpst	stnam	nomlat	nomlon	speci	tissu	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
J99	21F	Åkrafjord	59° 45	6° 7	PLAT FLE	MU																			3	5	5	5		1	5	5	
J99	21F	Åkrafjord	59° 45	6° 7	LIMA LIM	LI																						5	5	5	5		5
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	LIMA LIM	LI										5	5	4		5	2												
J99	21F	Åkrafjord	59° 45	6° 7	LIMA LIM	MU																						5	5	5	5		5
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	LIMA LIM	MU										5	5	4		5	2												
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	PLEU PLA	LI																5	5	5									
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	PLEU PLA	MU																5	5	5									
J99	21F	Åkrafjord	59° 45	6° 7	LEPI WHI	LI																			5				5	5	5	3	5
J99	21F	Åkrafjord	59° 45	6° 7	LEPI WHI	MU																			5				5	5	5	3	5
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	MICR KIT	LI													5														
J99	22F	Borøyfjorden	59° 42.6	5° 19.8	MICR KIT	MU													5														
J99	21D	Åkrafjord	59° 48	6° 11	BROS	LI																			1		4						
J99	21D	Åkrafjord	59° 48	6° 11	BROS	MU																			1		4						
J99	21D	Åkrafjord	59° 48	6° 11	MOLV	LI																			1		4						
J99	21D	Åkrafjord	59° 48	6° 11	MOLV	MU																			1		4						
J99	21D	Åkrafjord	59° 48	6° 11	CHIM MON	LI																			1		2						
J99	21D	Åkrafjord	59° 48	6° 11	CHIM MON	MU																			1		2						
J99	222A	Kopervik harbour	59°	5° 18.94	MYTI EDU	SB																				3							
J99	226X	Karmsund bridge (east)	59°	5° 17.91	MYTI EDU	SB																		1	3	3							
J99	226G	Karmsund bridge (east)	59°	5° 17.91	NUCE LAP	SB																		1	1	1							
J99	226H	Karmsund bridge (west)	59°	5° 17.55	NUCE LAP	SB																	1			1							
J99	227A1	Melandholmen	59°	5° 19.05	MYTI EDU	SB																		2	3								
J99	227A2	Høgevarde	59°	5° 19.05	MYTI EDU	SB																				3	3	3	3	1	2	2	1
J99	227G1	Melandholmen	59°	5° 18.75	NUCE LAP	SB																	1	1	1	1	1	1					
J99	227G2	Flatskjær	59°	5° 18.75	NUCE LAP	SB																							1	1	2	2	1
J99	23A	Austvik	59°	5° 6.47	MYTI EDU	SB										3	3													3	3		
J99	23B	Karihavet area	59° 54	5° 8	GADU	BI																	22	23	24	23	25	25	25	24	25	25	23
J99	23B	Karihavet area	59° 54	5° 8	GADU	BL																	25	25	25	24	25	25	25	25			
J99	23B	Karihavet area	59° 54	5° 8	GADU	LI										25	25	25	25	25	25	26	25	25	25	25	25	25	25	25	25	25	25
J99	23B	Karihavet area	59° 54	5° 8	GADU	MU										30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
J99	23F	Karihavet area	59° 54	5° 8	PLAT FLE	LI														1													
J99	23F	Karihavet area	59° 54	5° 8	PLAT FLE	MU														1													
J99	23F	Karihavet area	59° 54	5° 8	PLEU PLA	LI														3													
J99	23F	Karihavet area	59° 54	5° 8	PLEU PLA	MU														3													
J99	23F	Karihavet area	59° 54	5° 8	MICR KIT	LI														1	4												
J99	23F	Karihavet area	59° 54	5° 8	MICR KIT	MU														1	4												
J99	24A	Vardøy	60°	5° 0.62	MYTI EDU	SB										3	3													3	3		
J99	24G	Vardøy	60°	5° 0.62	NUCE LAP	SB																								1			
J65	80A	Østmarknes	63°	10°	MYTI EDU	SB				1	2																						
J65	81A	Biologisk Stasjon	63° 26.5	10°	MYTI EDU	SB				1																							
J65	82A	Flakk	63°	10°	MYTI EDU	SB				1	2	2	3	1	2		3	2	2		3	3								3	3		
J99	82G	Flakk	63°	10°	NUCE LAP	SB												1												1			
J65	83A	Frøsetskjær	63°	10° 6.4	MYTI EDU	SB				1																							
J65	84A	Tråsåvika	63°	9° 57.43	MYTI EDU	SB				2	3	3	3	3	3		3	3	3		3	3								3	3		
J99	84G	Tråsåvika	63°	9° 57.43	NUCE LAP	SB												1															
J65	84B	Tråsåvika	63°	9° 57.68	GADU	LI				13	1	1	1	1																			
J65	84B	Tråsåvika	63°	9° 57.68	GADU	MU				13	10	1	1	1																			
J65	84F	Tråsåvika	63°	9° 57.68	MICR KIT	LI								1																			
J65	84F	Tråsåvika	63°	9° 57.68	MICR KIT	MU								1																			
J65	84B	Tråsåvika	63°	9° 57.68	MELA AEG	LI						1	1	1																			
J65	84B	Tråsåvika	63°	9° 57.68	MELA AEG	MU						1	1	1																			
J65	84B	Tråsåvika	63°	9° 57.68	MERL	LI							1	1																			
J65	84B	Tråsåvika	63°	9° 57.68	MERL	MU							1	1																			
J65	84B	Tråsåvika	63°	9° 57.68	POLL POL	LI					1	1		1																			
J65	84B	Tråsåvika	63°	9° 57.68	POLL POL	MU					16	1		1																			
J65	84B	Tråsåvika	63°	9° 57.68	POLL VIR	LI								1																			
J65	84B	Tråsåvika	63°	9° 57.68	POLL VIR	MU								1																			
J65	85A	Geitstrand	63°	9° 55.65	MYTI EDU	SB				1																							
J65	86A	Geitnes	63°	9° 58.66	MYTI EDU	SB				1																							
J65	87A	Ingdalsbukt	63°	9° 54.43	MYTI EDU	SB				1	1	1	1	1	1		1	1	1		2	2								1	3		
J99	87G	Ingdalsbukt	63°	9° 54.43	NUCE LAP	SB												1												1			
J65	88A	Rødberg	63° 29.2	10° 0	MYTI EDU	SB				1	1																						
J99	25A	Hinnøy	61°	4° 52.74	MYTI EDU	SB												3	3											3	3		
J99	25G	Hinnøy	61°	4° 52.74	NUCE LAP	SB												1												1			
J99	26A	Hamnen	61°	5° 13.3	MYTI EDU	SB												6	3											3	3		
J99	26G	Hamnen	61°	5° 13.3	NUCE LAP	SB												1												1			
J99	27A	Grinden	62°	5° 25.27	MYTI EDU	SB												2												3	3		
J99	27G	Røydeskjær	62° 11	5° 44.42	NUCE LAP	SB												1												1			
J99	27H	Storholmen	62°	5° 23.59	NUCE LAP	SB												1															
J99	28A	Eiksundet	62° 15.1	5° 51.84	MYTI EDU	SB												5	3											3	3		

jmpco	jmpst	stnam	nomlat	nomlon	speci	tissu	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
J99	28G	Grønevikholmen (Eiksundet)	62° 14.8	5° 53	NUCE LAP	SB												1												1			
J99	28H	Øveråneset (Hareid)	62°	6° 4.67	NUCE LAP	SB												1															
J99	91A	Nerdvika	63°	8° 9.43	MYTI EDU	SB												3	3	3											3		
J99	92A1	Krokholmen	64° 3.21	10° 1.79	MYTI EDU	SB												6	3	3	3	3	3										
J99	92A2	Nygården	64° 3.21	10° 1.79	MYTI EDU	SB																									3		
J99	92B	Stokken area	64°	9° 53.24	GADU	LI													25	24	25	25								25	25		
J99	92B	Stokken area	64°	9° 53.24	GADU	MU													30	29	30	30								30	30		
J99	92F	Stokken area	64°	9° 53.24	LIMA LIM	LI															1												
J99	92F	Stokken area	64°	9° 53.24	LIMA LIM	MU															1												
J99	92F	Stokken area	64°	9° 53.24	PLEU PLA	LI															1										5		
J99	92F	Stokken area	64°	9° 53.24	PLEU PLA	MU															1										5		
J99	93A	Sætervik	64°	10° 29	MYTI EDU	SB												3	3											3	3		
J99	93G	Sætervika (Stadsvikskjæret)	64°	10° 30	NUCE LAP	SB												1															
J99	94A	Landfast	65°	12° 0.36	MYTI EDU	SB												3	3											3	3		
J99	94G	Steinskjær (Landfast)	65°	11°	NUCE LAP	SB												1												1			
J99	95A	Sleipnesodden (south)	66°	13°	MYTI EDU	SB												3	3											3	3		
J99	95G	Sleipnesodden (south)	66° 42.4	13° 14.3	NUCE LAP	SB												1												1			
J99	96A	Breiviken	66°	12°	MYTI EDU	SB												6	3											3	3		
J99	97A	Klokkholmen	67°	14°	MYTI EDU	SB												3	3											3	3		
J99	97G	Varnesodden	67°	14°	NUCE LAP	SB												1												1			
J99	97H	Småfloholmene	67°	14° 49.1	NUCE LAP	SB												1															
J99	98A1	Yitj-Skarvsundet	68° 9.45	14° 39.2	MYTI EDU	SB												3	3														
J99	98A2	Husvaagen area	68°	14°	MYTI EDU	SB																	3		3	3	3	3	3	3	3	3	3
J99	98A3	Vatterfjord	68°	14°	MYTI EDU	SB																		3									
J99	98G	Svolvær området	68°	14° 39.8	NUCE LAP	SB																					1	1	1	2	2	2	2
J99	98B2	Austnesfjorden	68° 14.8	14° 48.2	GADU	BI																				14	22						
J99	98B2	Austnesfjorden	68° 14.8	14° 48.2	GADU	BL																				5	25						
J99	98B1	Bjørnerøya (east)	68° 14.8	14° 48.2	GADU	LI												25	24	25	24	26	25	25	25			25	21	25	25	25	
J99	98B2	Austnesfjorden	68° 14.8	14° 48.2	GADU	LI																				25	25						
J99	98B1	Bjørnerøya (east)	68° 14.8	14° 48.2	GADU	MU												30	29	30	29	30	30	30	30			30	25	30	30	30	
J99	98B2	Austnesfjorden	68° 14.8	14° 48.2	GADU	MU																				30	30						
J99	98F1	Bjørnerøya (east)	68°	14°	LIMA LIM	LI													4	1	1	5											
J99	98F1	Bjørnerøya (east)	68°	14°	LIMA LIM	MU													4	1	1	5											
J99	98F2	Husholmen	68°	14°	PLEU PLA	BI																				18	24						
J99	98F2	Husholmen	68°	14°	PLEU PLA	BL																				13	19						
J99	98F1	Bjørnerøya (east)	68°	14°	PLEU PLA	LI													3		5		4	5	1								
J99	98F2	Husholmen	68°	14°	PLEU PLA	LI																				22	30	4	3	5	2	5	
J99	98F1	Bjørnerøya (east)	68°	14°	PLEU PLA	MU													3		5		4	5	1								
J99	98F2	Husholmen	68°	14°	PLEU PLA	MU																				4	5	4	3	5	2	5	
J99	98F1	Bjørnerøya (east)	68°	14°	MICR KIT	LI														1	1												
J99	98F1	Bjørnerøya (east)	68°	14°	MICR KIT	MU														1	1												
J99	98F1	Bjørnerøya (east)	68°	14°	GLYP CYN	LI															1												
J99	98F1	Bjørnerøya (east)	68°	14°	GLYP CYN	MU															1												
J99	98X	Skrova harbour	68° 9.91	14°	MYTI EDU	SB														3	4	4											
J99	99A	Brunvær	68° 0.3	15° 5.6	MYTI EDU	SB												6	3											3	3		
J99	41A	Fensneset (Grytøya)	68° 56.1	16°	MYTI EDU	SB														3	3	4	3									3	3
J99	41G	Harstad (Trondenes)	68° 49.3	16°	NUCE LAP	SB																				1						2	
J99	41G1	Feneset	68° 56.1	16°	NUCE LAP	SB																										2	
J99	42A	Tennskjær (Malangen)	69°	18°	MYTI EDU	SB														3	3											3	3
J99	42G	Finnsnes	69°	17° 58.5	NUCE LAP	SB																				1							
J99	43A	Lyngneset (Langfjord)	70° 6.03	20°	MYTI EDU	SB														3	3		3									3	3
J99	43G1	Lyngneset (Langfjord)	70° 6.04	20°	NUCE LAP	SB																										2	
J99	43B1	Leisundet	70°	21°	GADU	LI																										25	25
J99	43B1	Leisundet	70°	21°	GADU	MU																										30	30
J99	43F1	Leisundet	70°	21°	PLEU PLA	LI																										4	5
J99	43F1	Leisundet	70°	21°	PLEU PLA	MU																										4	5
J99	43B	Kvænangen (Olderfjord)	70°	21°	GADU	LI														25	25	25											
J99	43B	Kvænangen (Olderfjord)	70°	21°	GADU	MU														30	30	30											
J99	43G	Skjervøy	70° 2.17	20°	NUCE LAP	SB																				1						2	
J99	43F	Kvænangen (Olderfjord)	70°	21°	LIMA LIM	LI																3											
J99	43F	Kvænangen (Olderfjord)	70°	21°	LIMA LIM	MU																3											
J99	43F	Kvænangen (Olderfjord)	70°	21°	MICR KIT	LI																1											
J99	43F	Kvænangen (Olderfjord)	70°	21°	MICR KIT	MU																1											
J99	44A	Elenheimsundet	70°	22°	MYTI EDU	SB														3	3	4	3									3	3
J99	44G	Alta	69° 59.4	23°	NUCE LAP	SB																				1							
J99	44G1	Elenheimsundet	70°	22°	NUCE LAP	SB																										2	
J99	45A	Sauhamneset	70°	24° 19.2	MYTI EDU	SB														3	3											3	3
J99	45G	Sauhamneset	70°	24° 19.2	NUCE LAP	SB																				1						2	
J99	45B	Hammerfest area	70° 46	24° 6.5	GADU	LI														24	25												
J99	45B1	Revsbotn	70° 46	24° 6.5	GADU	LI																										25	25

jmpco	jmpst	stnam	nomlat	nomlon	speci	tissu	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
J99	45B	Hammerfest area	70° 46	24° 6.5	GADU	MU														29	30												
J99	45B1	Revsbotn	70° 46	24° 6.5	GADU	MU																										30	30
J99	45F	Hammerfest area	70° 40	24° 40	PLEU PLA	LI																										5	5
J99	45F	Hammerfest area	70° 40	24° 40	PLEU PLA	MU																										5	5
J99	46A	Smines (Altesula)	70°	25° 48.1	MYTI EDU	SB														3	3	5										3	3
J99	46H	Honningsvåg	70°	25°	MYTI EDU	SB																										3	
J99	46H	Honningsvåg	70°	25°	NUCE LAP	SB																				1						2	
J99	47A	Kifjordneset	70°	27°	MYTI EDU	SB														3	3											2	3
J99	47G	Kifjordneset	70°	27°	NUCE LAP	SB																				1						2	
J99	48A	Trollfjorden (Tanafjord)	70°	28°	MYTI EDU	SB														3	3	3										3	3
J99	48G	Mehamn	71° 2.55	27°	NUCE LAP	SB																				1							
J99	48G1	Trollfjorden (Tanafjord)	70°	28°	NUCE LAP	SB																										2	
J99	49G	Syltefjorden	70°	30° 5.17	NUCE LAP	SB																										2	
J99	49A	Nordfjorden (Syltefjord)	70°	30° 5.17	MYTI EDU	SB														3	3											3	3
J99	10A1	Skagodden	70° 6.21	30°	MYTI EDU	SB														3	3												
J99	10A2	Skallneset	70° 6.21	30°	MYTI EDU	SB																4	3	3	3	3	3	3	3	3	3	3	3
J99	10G3	Vardø	70°	31° 6.5	NUCE LAP	SB																										2	
J99	10G4	Vadsø	70° 4.48	29° 42.9	NUCE LAP	SB																										2	
J99	10B	Varangerfjorden	69° 56	29° 40	GADU	BI																				22	21						
J99	10B	Varangerfjorden	69° 56	29° 40	GADU	BL																				25	25						
J99	10B	Varangerfjorden	69° 56	29° 40	GADU	LI														21	25	25	23	25	25	25	25	25	25	25	25	10	25
J99	10B	Varangerfjorden	69° 56	29° 40	GADU	MU														25	30	30	27	30	30	30	30	30	30	30	30	12	30
J99	10B	Varangerfjorden	69° 56	29° 40	BROS	LI														1													
J99	10B	Varangerfjorden	69° 56	29° 40	BROS	MU														1													
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	LI																											4
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	MU																											4
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	BI																				15	25						
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	BL																				11	24						
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	LI																	5		4	18	30	5	4	4	5		
J99	10F	Skogerøy	69° 55	29° 51	PLEU PLA	MU																	5		4	3	5	5	4	4	5		
J99	11A1	Sildkrokneset (south)	69°	30° 11.1	MYTI EDU	SB														3	3												
J99	11A2	Sildkrokneset (north)	69°	30° 11.1	MYTI EDU	SB																4	3										
J99	11G	Brashavn	69°	29°	NUCE LAP	SB																						1	1	2	2	2	2
J99	11X	Brashavn	69°	29°	MYTI EDU	SB																	3	3	3	3	3	3	3	3	3	3	3
J26	I001	Sponvikskansen	59° 5.41	11°	MYTI EDU	SB															3	3											
J26	I011	Kråkenebbet	59° 6.05	11°	MYTI EDU	SB															3	3											
J26	I021	Kjøkø (south)	59° 7.79	10°	MYTI EDU	SB															3	3	3	3		3	3	3					
J26	I022	West Damholmen	59° 6.11	11° 2.69	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I023	Singlekalven (south)	59° 5.7	11° 8.2	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I024	Kirkøy (north west)	59° 4.8	10°	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I301	Akershuskaia	59°	10°	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I304	Gåsøya	59°	10°	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I306	Håøya	59° 42.8	10°	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J26	I307	Ramtonholmen	59°	10°	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I711	Steinholmen	59° 3.11	9° 40.62	MYTI EDU	SB															3	4	3	3	3	3		3					
J99	I712	Gjemesholmen	59° 2.72	9° 42.41	MYTI EDU	SB															3	4	3	3	3	3	3	3	3	3	3	3	3
J99	I713	Strømtangen	59° 3.02	9° 41.5	MYTI EDU	SB																						3	3	3	3	3	3
J99	I131A	Lastad	58° 3.33	7° 42.52	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I132	Svensholmen	58° 7.5	7° 59.33	MYTI EDU	SB																		3	3	3	3	3	3	3	3	3	3
J99	I1321	Fiskåtangen	58° 7.7	7° 58.6	MYTI EDU	SB															4	4	3										
J99	I133	Odderø (west)	58° 7.9	8° 0.1	MYTI EDU	SB															4	4	3	3	3	3	3	3	3	3	3	3	3
J99	I201	Ekkjegrunn (G1)	59° 38.6	6° 21.44	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I205	Bølsnes (G5)	59° 35.5	6° 18.01	MYTI EDU	SB															3		3	3	3	3	3	3	3	3	3	3	3
J99	I241	Nordnes	60°	5° 18.1	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I242	Gravdalsneset	60°	5° 16.01	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I916	Sundalsfjord (Hydro kai)	62°	8° 33.11	MYTI EDU	SB																								3	3		
J99	I243	Hegreneset	60°	5° 18.29	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	I914	Flåøya (southeast)	62°	8° 26.7	MYTI EDU	SB																							3				
J99	I915	Flåøya (northwest)	62°	8° 26.39	MYTI EDU	SB																							3	3	3	3	3
J99	I911	Horvika	62° 44.1	8° 31.4	MYTI EDU	SB															3	3											
J99	I913	Fjøseid	62°	8° 16.48	MYTI EDU	SB																			3	3	3	3	3	3	3	3	3
J99	I912	Honnhammer	62° 51.2	8° 9.7	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J65	I080	Østmerknes	63°	10°	MYTI EDU	SB															3	3											
J99	I965	Moholmen (B5)	66°	14° 7.55	MYTI EDU	SB																					3	3	3	3	3	3	3
J99	I962	Koksverktomta (B2)	66°	14° 8.38	MYTI EDU	SB															3	3	2	3									
J99	I964	Toraneskaien	66° 19.3	14° 7.97	MYTI EDU	SB																						3	3	3	3	3	3
J99	I969	Bjørnbærviken (B9)	66°	14° 2.08	MYTI EDU	SB															3	3	3	3	3	3	3	3	3	3	3	3	3
J99	R096	Breiviken (Tomma)	66°	12°	MYTI EDU	SB															3	3											
J26	A3*	Svartskjær	°	°	MYTI EDU	SB	1																										

Appendix G
Map of stations

Nominel station positions 1981-2006
(cf. Appendix H and Appendix K)

Appendix G (cont.) Map of stations

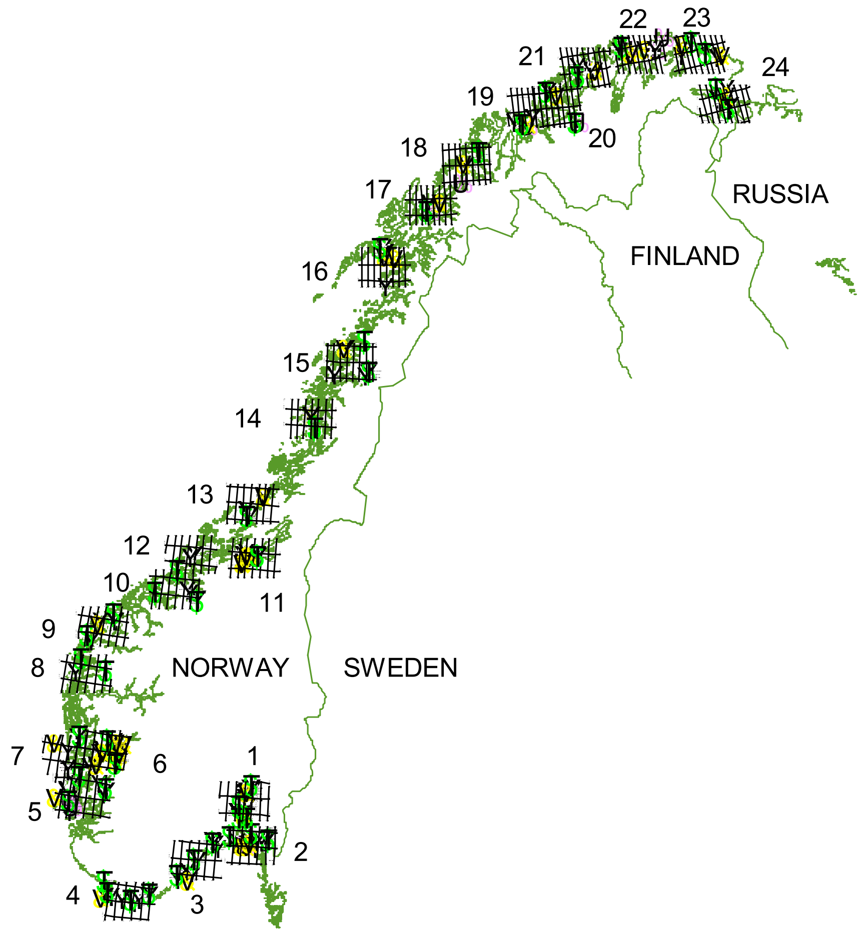
NOTES

The station's nominal position is plotted, and not the specific positions that may have differed from one year to another. The maps are generated using ArcGIS version 9.1.

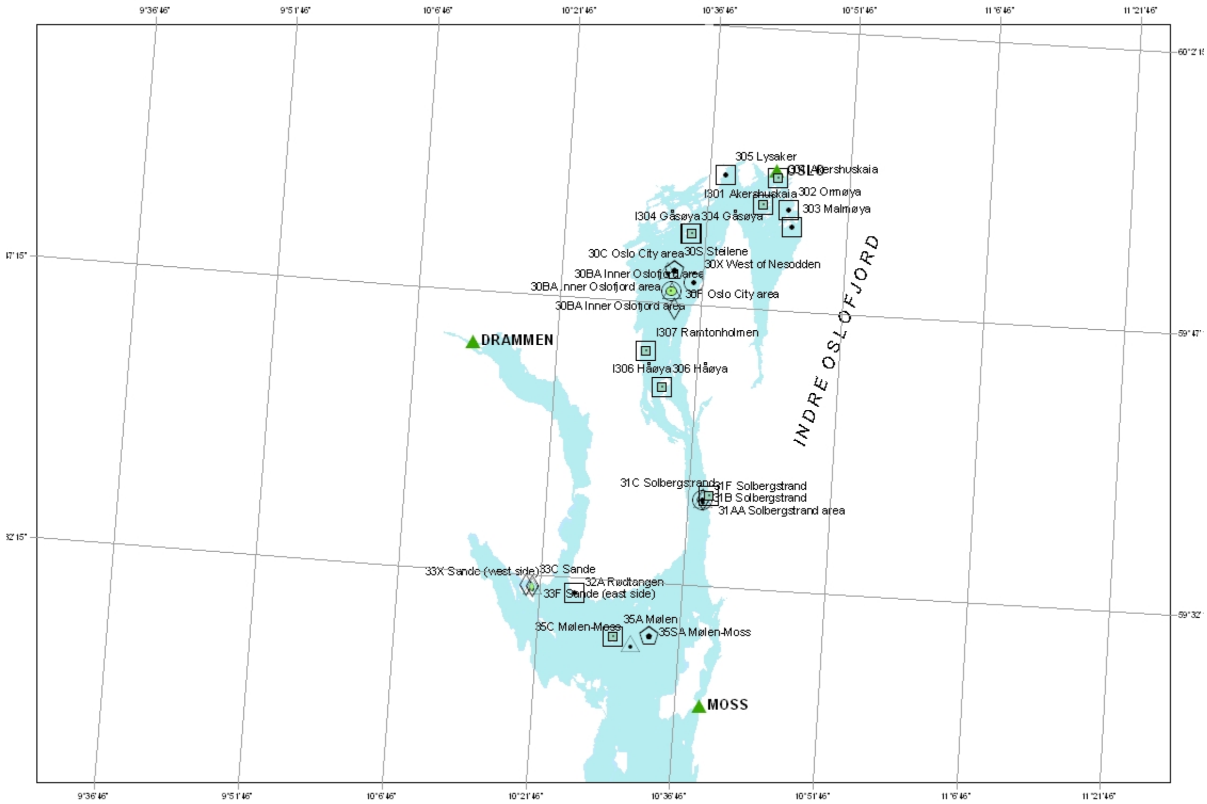
The following symbols and codes apply:

All years	2007	Explanation	Station code
		Sediment	<number>S
		Bluemussel	<number>A
		Bluemussel	I<number/letter> 1)
		Bluemussel	R<number/letter> 1)
		Dogwhelk	<number>F
		Prawn	<number>C
		Atlantic cod	<number>A
		Flatfish	<number>D/E
		Other round fish	
		Town or city	

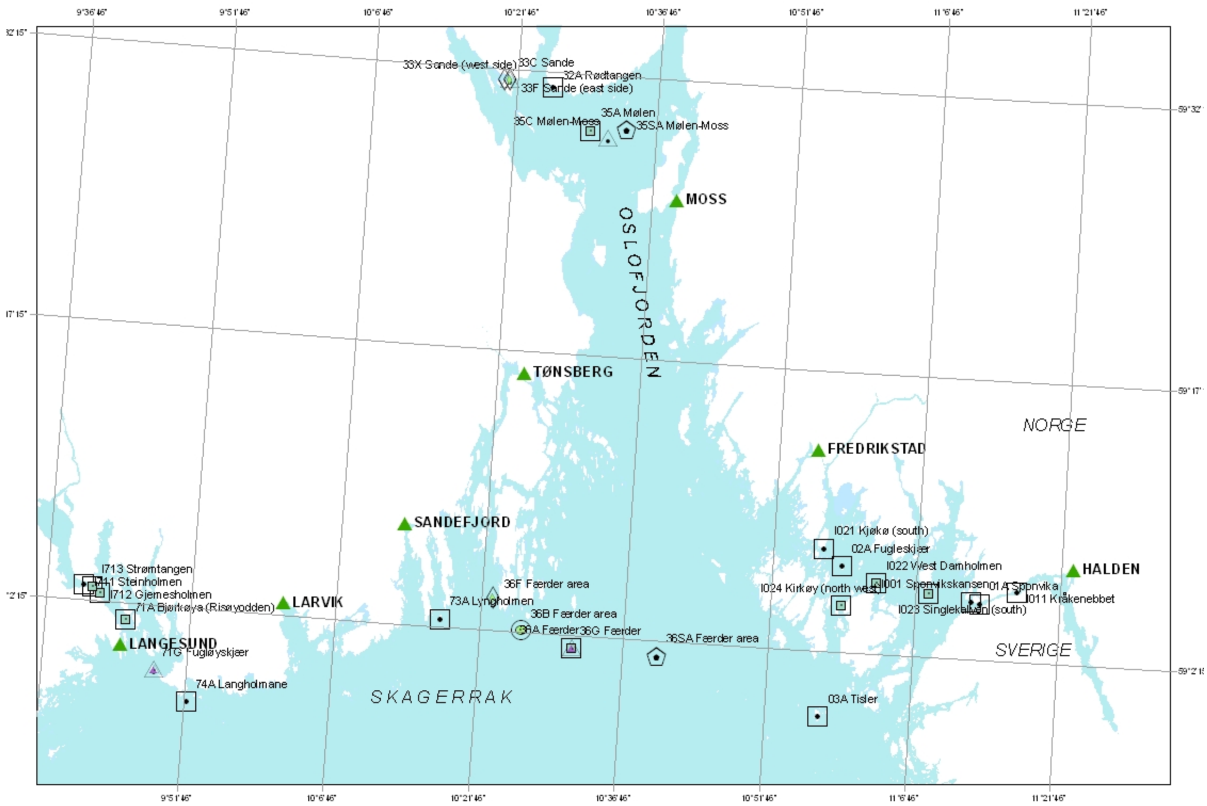
1) Supplementary station used in SFT bluemussel pollution (I) or reference (R) index (cf. Appendix K).



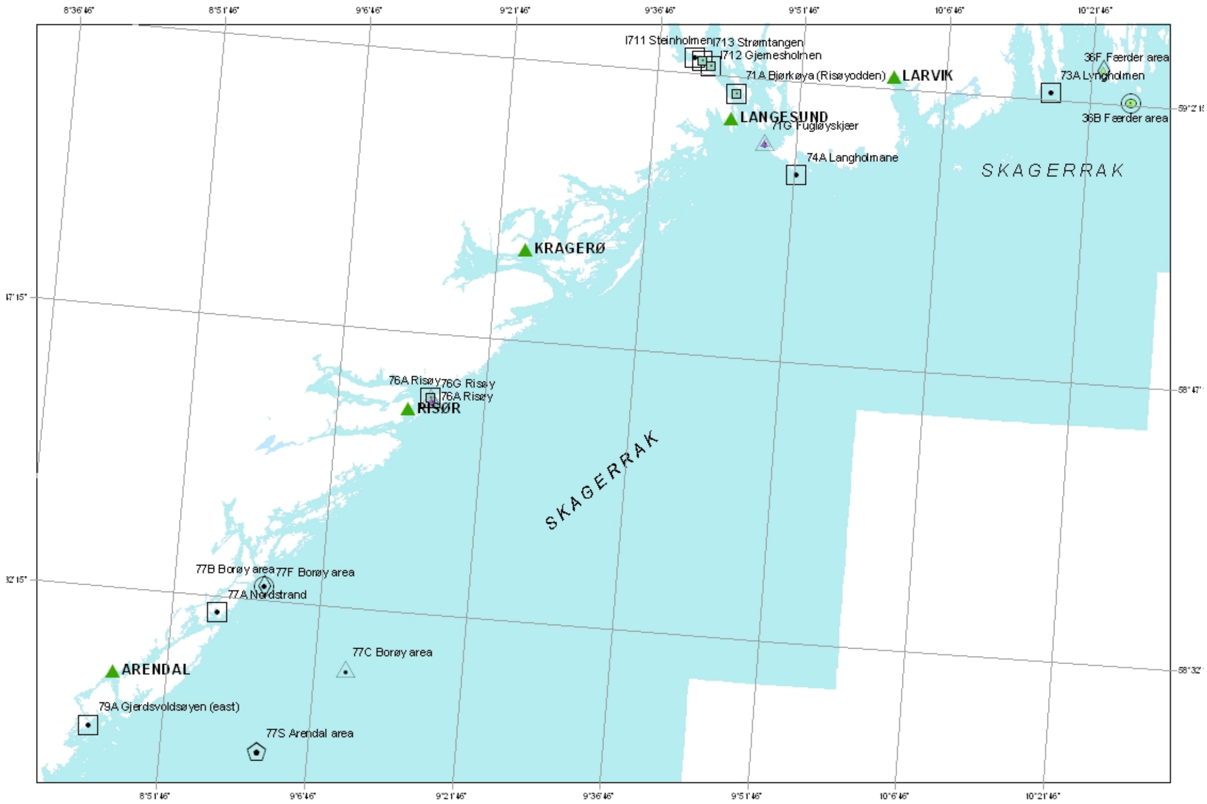
CEMP stations Norway. Numbers indicate map reference that follow.
Note: distance between two lines of latitude is 15 nautical miles (= 27.8 km).


305 Lysaker
OSLO
I301 Akershuskaia
302 Ormøya
303 Malmøya
I304 Gåsøya
304 Gåsøya
30C Oslo City area
30S Steilene
30X West of Nesodden
30BA Inner Oslofjord area
30F Oslo City area
I307 Ramtonholmen
DRAMMEN
I306 Håøya
306 Håøya
INDRE OSLOFJORD
31C Solbergstrand
31F Solbergstrand
31B Solbergstrand
31AA Solbergstrand area
33X Sande (west side)
33C Sande
32A Rødtangen
33F Sande (east side)
35A Mølen
35C Mølen-Moss
35SA Mølen-Moss
MOSS

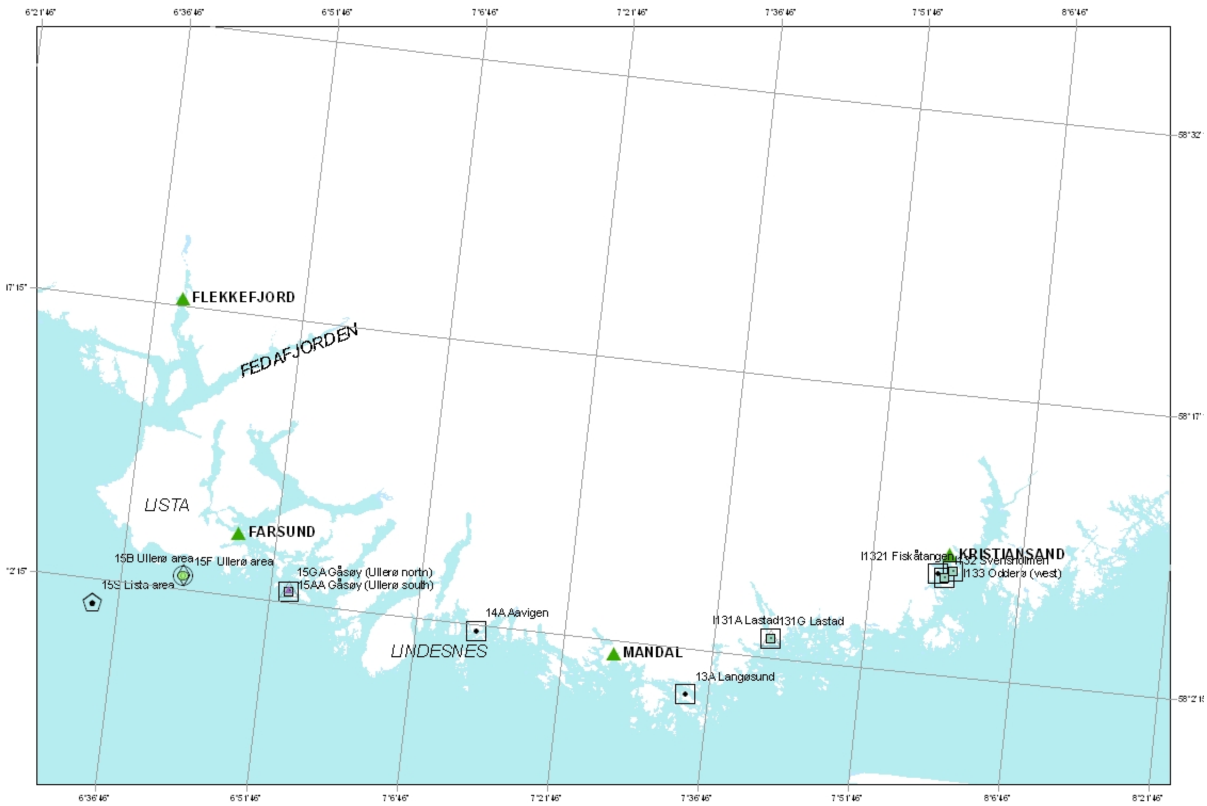
MAP 1


33X Sande (west side)
33C Sande
32A Rødtangen
33F Sande (east side)
35A Mølen
35C Mølen-Moss
35SA Mølen-Moss
MOSS
OSLOFJORDEN
TØNSBERG
NORGE
FREDRIKSTAD
SANDEFJORD
I021 Kjøkø (south)
02A Fugleskjær
I022 West Damholmen
HALDEN
I713 Strømtangen
I712 Gjemesholmen
71A Bjørkøya (Risøyodden)
LARVIK
36F Færder area
73A Lyngholmen
I024 Kirkøy (north west)
I011 Kråkenebbet
36B Færder area
36G Færder
36SA Færder area
LANGESUND
71G Fugløyskjær
SVERIGE
74A Langholmane
SKAGERRAK
03A Tisler

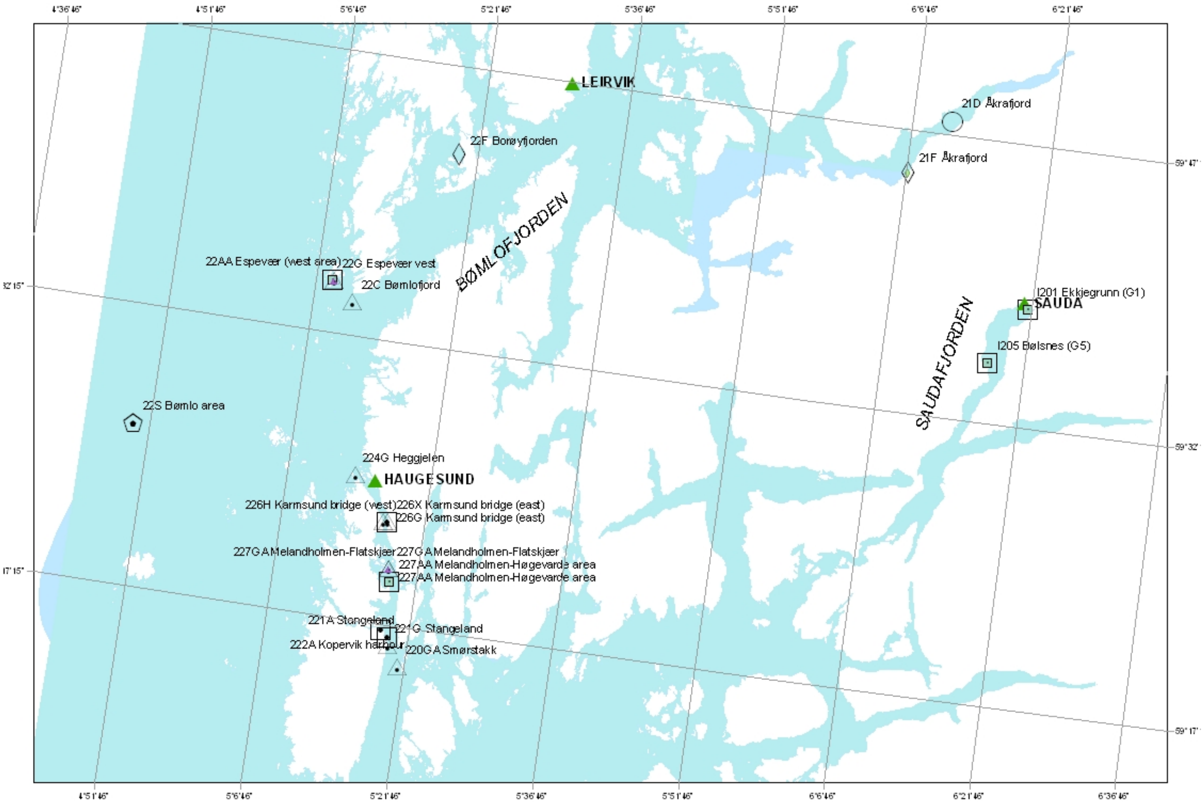
MAP 2


I711 Steinholmen
I713 Strømtangen
I712 Gjemesholmen
71A Bjørkøya (Risøyodden)
LARVIK
36F Færder area
73A Lyngholmen
36B Færder area
LANGESUND
71G Fugløyskjær
74A Langholmane
SKAGERRAK
KRAGERØ
76A Risøy
76G Risøy
76A Risøy
RISØR
SKAGERRAK
77B Borøy area
77F Borøy area
77A Nordstrand
ARENDAL
77C Borøy area
79A Gjerdsvoldsøyen (east)
77S Arendal area

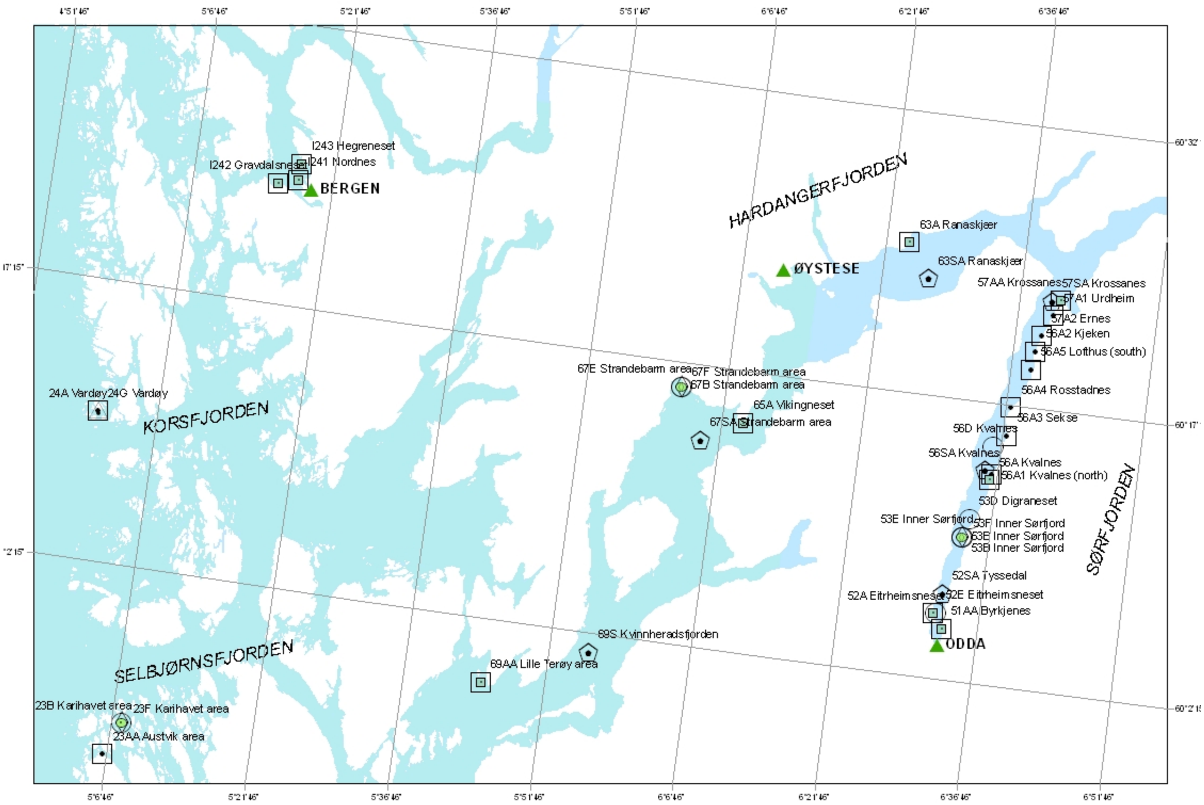
MAP 3


FLEKKEFJORD
FEDAFJORDEN
LISTA
FARSUND
15B Ullerø area
15F Ullerø area
15S Lista area
15GA Gåsøy (Ullerø north)
15AA Gåsøy (Ullerø south)
14A Aavigen
LINDESNES
MANDAL
I131A Lastad
131G Lastad
13A Langøsund
I1321 Fiskåtangen
KRISTIANSAND
I133 Odderø (west)

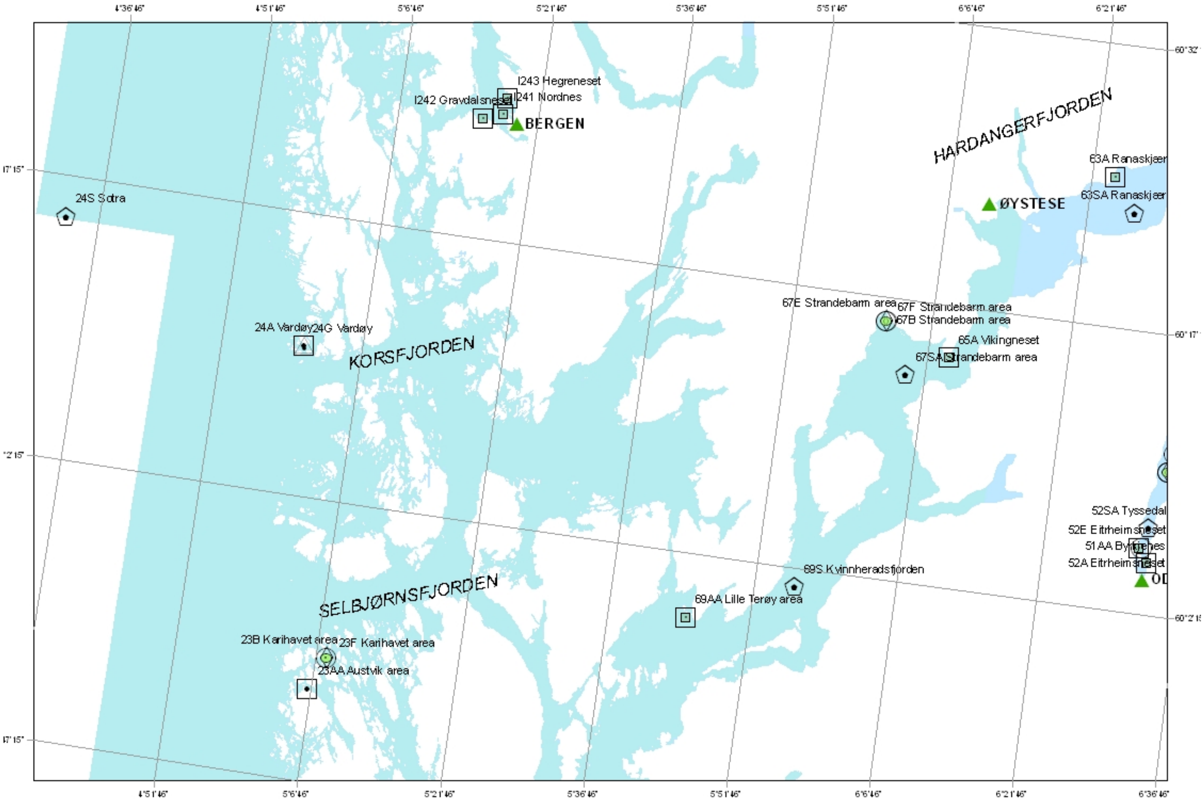
MAP 4


LEIRVIK
21D Åkrafjord
22F Borøyfjorden
21F Åkrafjord
BØMLOFJORDEN
22AA Espevær (west area)
22G Espevær vest
22C Bømlofjord
I201 Ekkjegrunn (G1)
SAUDA
I205 Bølsnes (G5)
SAUDAFJORDEN
22S Bømlo area
224G Heggjelen
HAUGESUND
226H Karmsund bridge (west)
226X Karmsund bridge (east)
226G Karmsund bridge (east)
227GAMelandholmen-Flatskjær
227GAMelandholmen-Flatskjær
227AA Melandholmen-Høgevarde area
227AA Melandholmen-Høgevarde area
221A Stongeland
221G Stangeland
222A Kopervik harbour
220GA Smørstakk

MAP 5


I243 Hegreneset
I241 Nordnes
I242 Gravdalsneset
BERGEN
HARDANGERFJORDEN
63A Ranaskjær
ØYSTESE
63SA Ranaskjær
57AA Krossanes
57SA Krossanes
57A1 Urdheim
57A2 Ernes
56A2 Kjeken
56A5 Lofthus (south)
67E Strandebarm area
67F Strandebarm area
67B Strandebarm area
56A4 Rosstadnes
24A Vardøy
24G Vardøy
65A Vikingneset
KORSFJORDEN
67SA Strandebarm area
56A3 Sekse
56D Kvalnes
56SA Kvalnes
56A Kvalnes
56A1 Kvalnes (north)
53D Digraneset
SØRFJORDEN
53E Inner Sørfjord
53F Inner Sørfjord
63E Inner Sørfjord
53B Inner Sørfjord
52SA Tyssedal
52A Eitrheimsneset
52E Eitrheimsneset
51AA Byrkjenes
69S Kvinnheradsfjorden
ODDA
SELBJØRNSFJORDEN
69AA Lille Terøy area
23B Karihavet area
23F Karihavet area
23AA Austvik area

MAP 6


I243 Hegreneset
I241 Nordnes
I242 Gravdalsneset
BERGEN
HARDANGERFJORDEN
63A Ranaskjær
63SA Ranaskjær
ØYSTESE
24S Sotra
67E Strandebarm area
67F Strandebarm area
67B Strandebarm area
65A Vikingneset
67SA Strandebarm area
24A Vardøy
24G Vardøy
KORSFJORDEN
52SA Tyssedal
52E Eitrheimsneset
51AA Byrkjenes
52A Eitrheimsneset
69S Kvinnheradsfjorden
69AA Lille Terøy area
SELBJØRNSFJORDEN
23B Karihavet area
23F Karihavet area
23AA Austvik area

MAP 7


FLORØ
STAVFJORDEN
FØRDE
25AA Hinnøy area
25G A Hinnøy area
VILNESFJORDEN
SOGNEFJORDEN

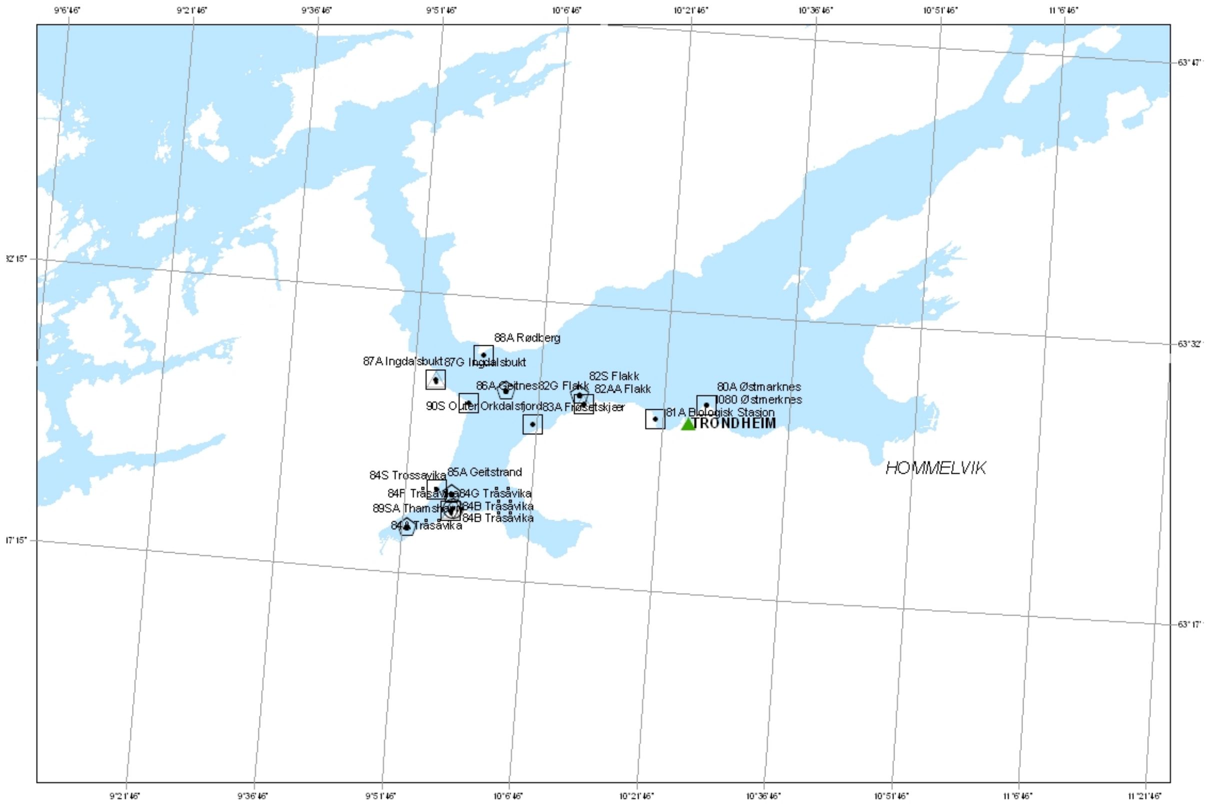
MAP 8


ÅLESUND
ULSTEINVIK
28H Øveråneset (Hareid)
28AA Eiksundet area
28G Grønevikholmen (Eiksundet)
27AA Grinden area
27H Storholmen
27S Stadtlandet (east)
27GA Røydeskjær area
STADTLANDET
MÅLØY
26AA Hamnen area
26G Hamnen

MAP 9


KRISTIANSUND
TINGVOLLSFJORD
I912 Honnhammer
I913 Fjøseid
I914 Flåøya (southeast)
I915 Flåøya (northwest)
I911 Horvika
I916 Sundalsfjord (Hydro kai)
SUNNDALSØRA
MOLDE

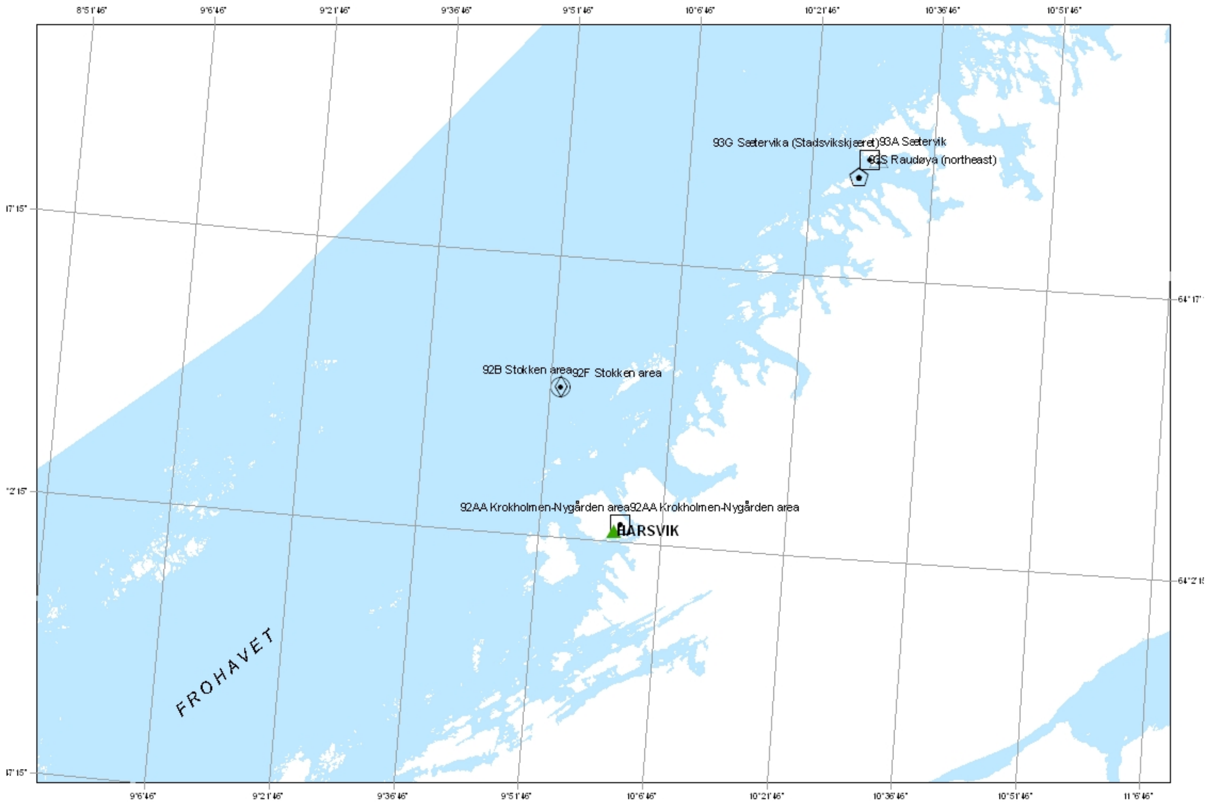
MAP 10


88A Rødberg
87A Ingdalsbukt
87G Ingdalsbukt
86A Geitnes
82G Flakk
82S Flakk
82AA Flakk
80A Østmarknes
1080 Østmerknes
90S Outer Orkdalsfjord
83A Fråsetskjær
81A Biologisk Stasjon
TRONDHEIM
HOMMELVIK
84S Trossavika
85A Geitstrand
84F Tråsavika
84G Tråsavika
89SA Thamshavn
84B Tråsavika
84B Tråsavika
84A Tråsavika

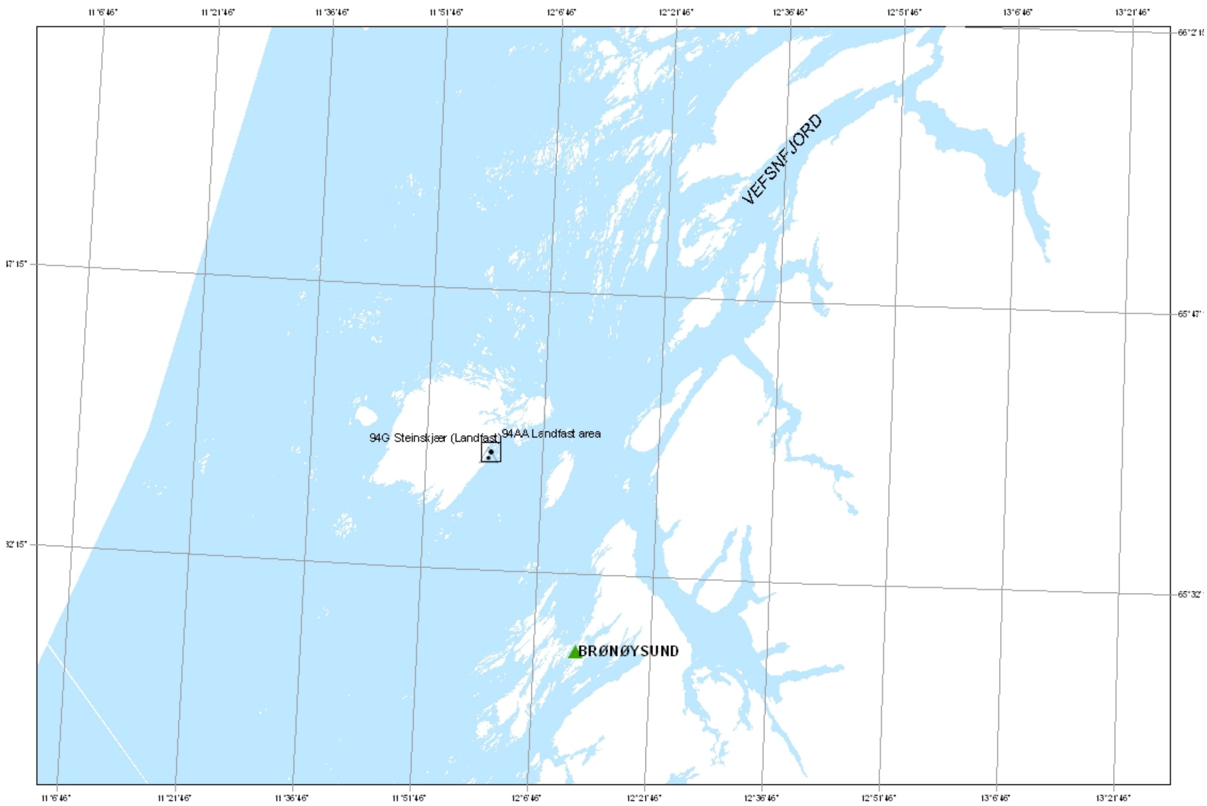
MAP 11


HITRA
SMØLA
TRONDHEIMSLEIA
91A Nerdvika
KRISTIANSUND

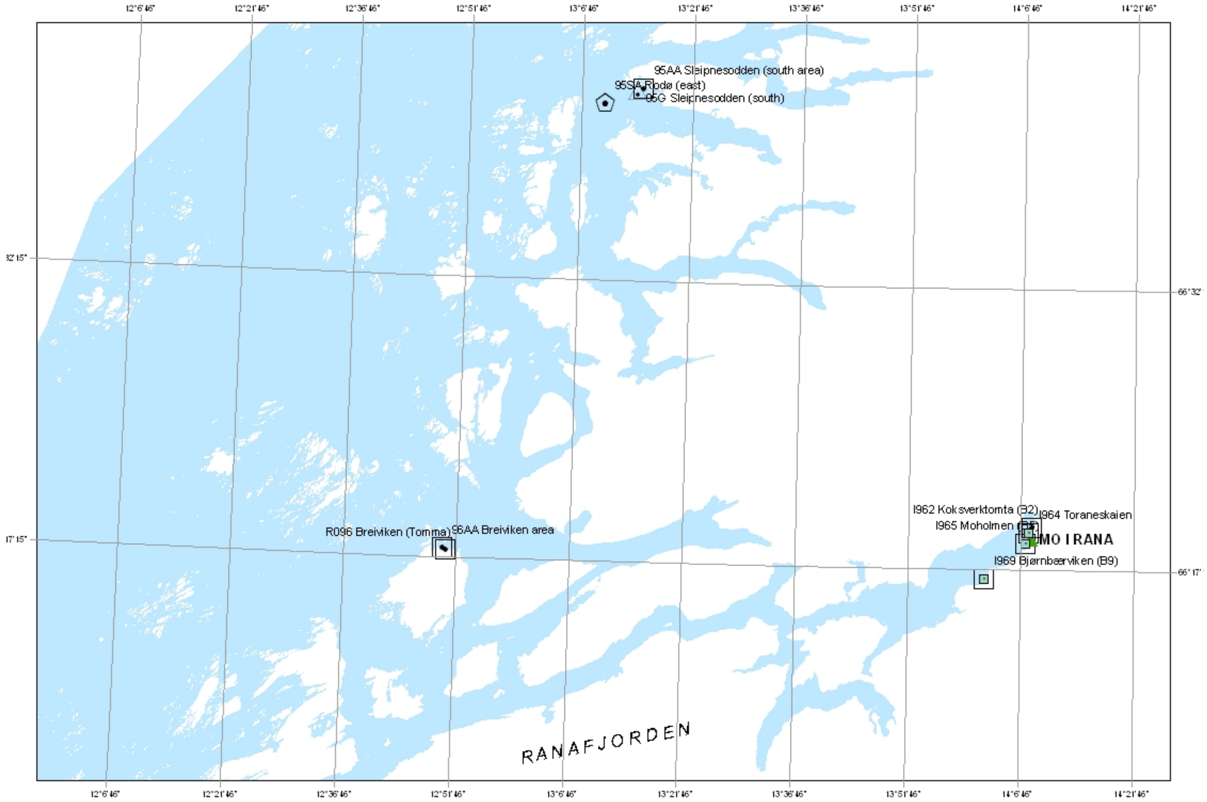
MAP 12


93G Sætervika (Stadsvikskjæret)
93A Sætervik
Raudøya (northeast)
92B Stokken area
92F Stokken area
92AA Krokholmen-Nygården area
92AA Krokholmen-Nygården area
HARSVIK
FROHAVET

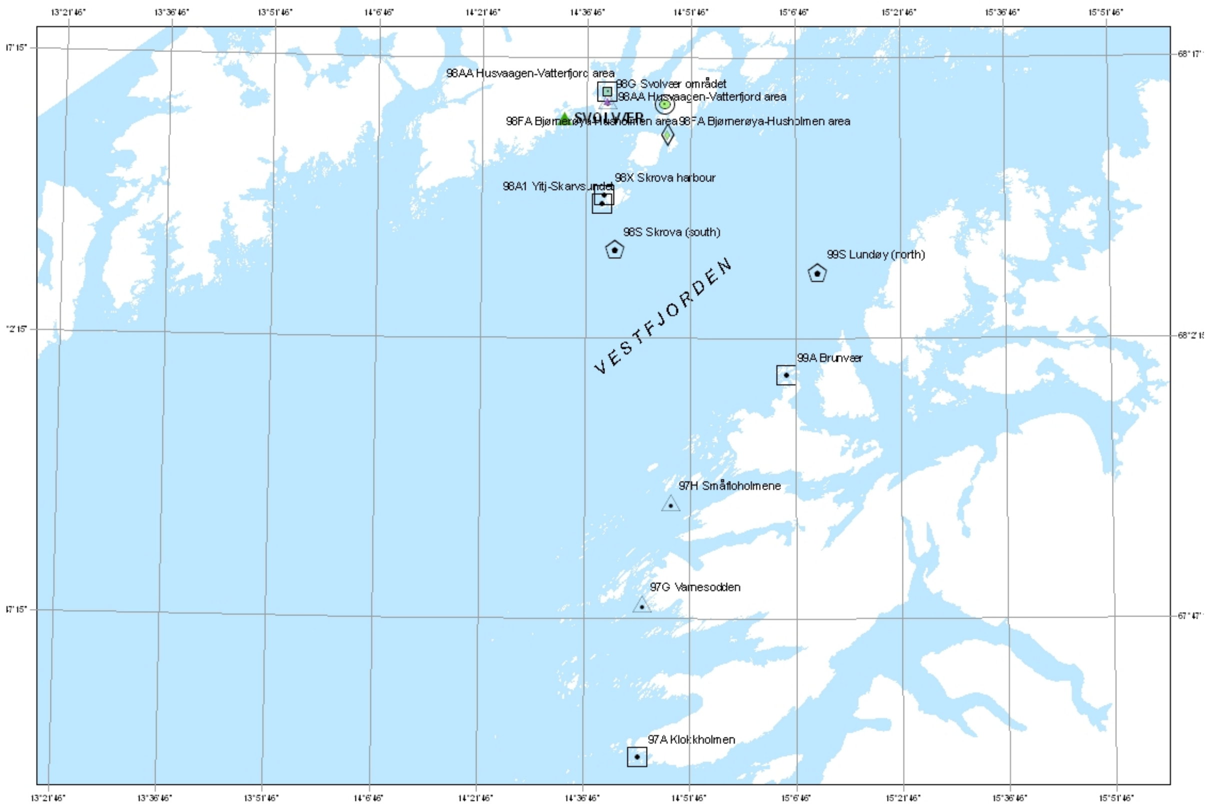
MAP 13


VEFSNFJORD
94G Steinskjær (Landfast)
94AA Landfast area
BRØNØYSUND

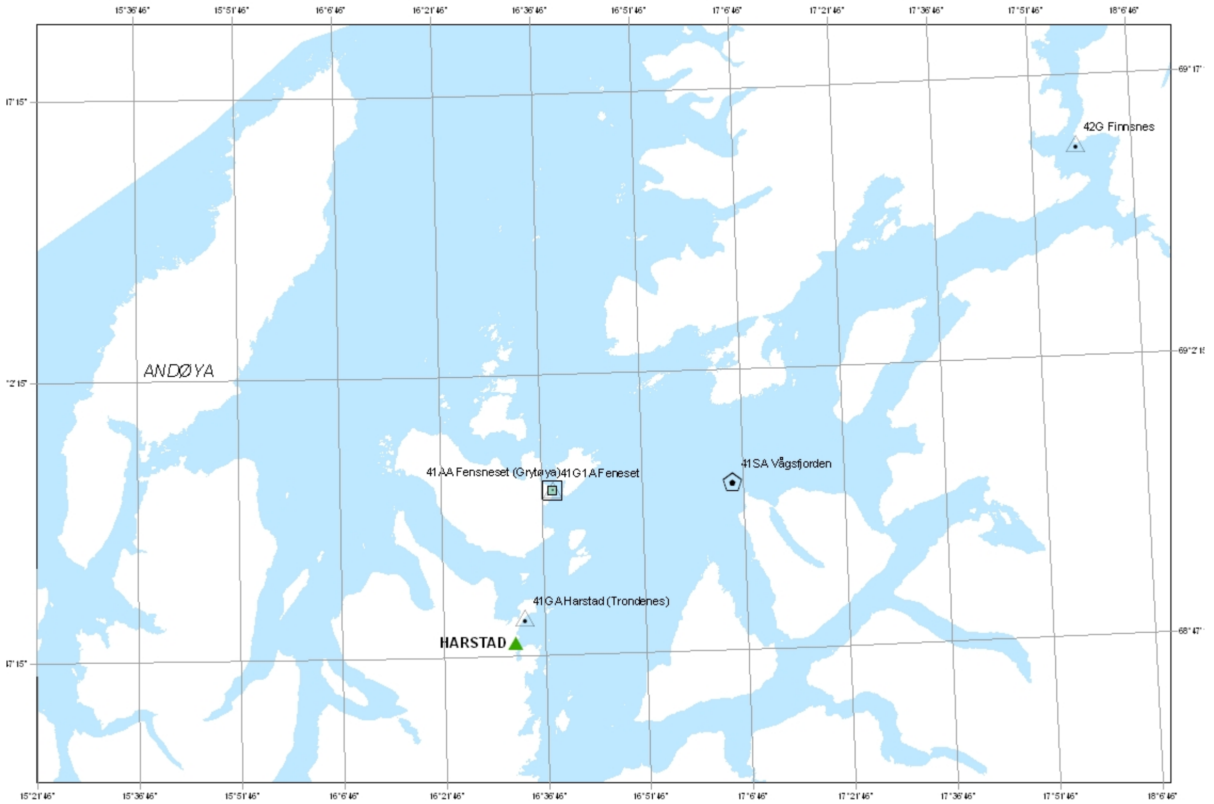
MAP 14


95AA Sleipnesodden (south area)
95SA Rodø (east)
95G Sleipnesodden (south)
R096 Breiviken (Tomma)
96AA Breiviken area
I962 Koksverktomta (B2)
I964 Toraneskaien
MO I RANA
I969 Bjørnbærviken (B9)
RANAFJORDEN

MAP 15


98AA Husvaagen-Vatterfjord area
98G Svolvær området
98AA Husvaagen-Vatterfjord area
98FA Bjørnerøya-Husholmen area
98X Skrova harbour
98S Skrova (south)
99S Lundøy (north)
VESTFJORDEN
99A Brunvær
97G Varnesodden
97A Klokkholmen

MAP 16



42G Finnsnes
ANDØYA
41AA Fensneset (Grytøya)
41G1A Feneset
41SA Vågsfjorden
41GA Harstad (Trondenes)
HARSTAD

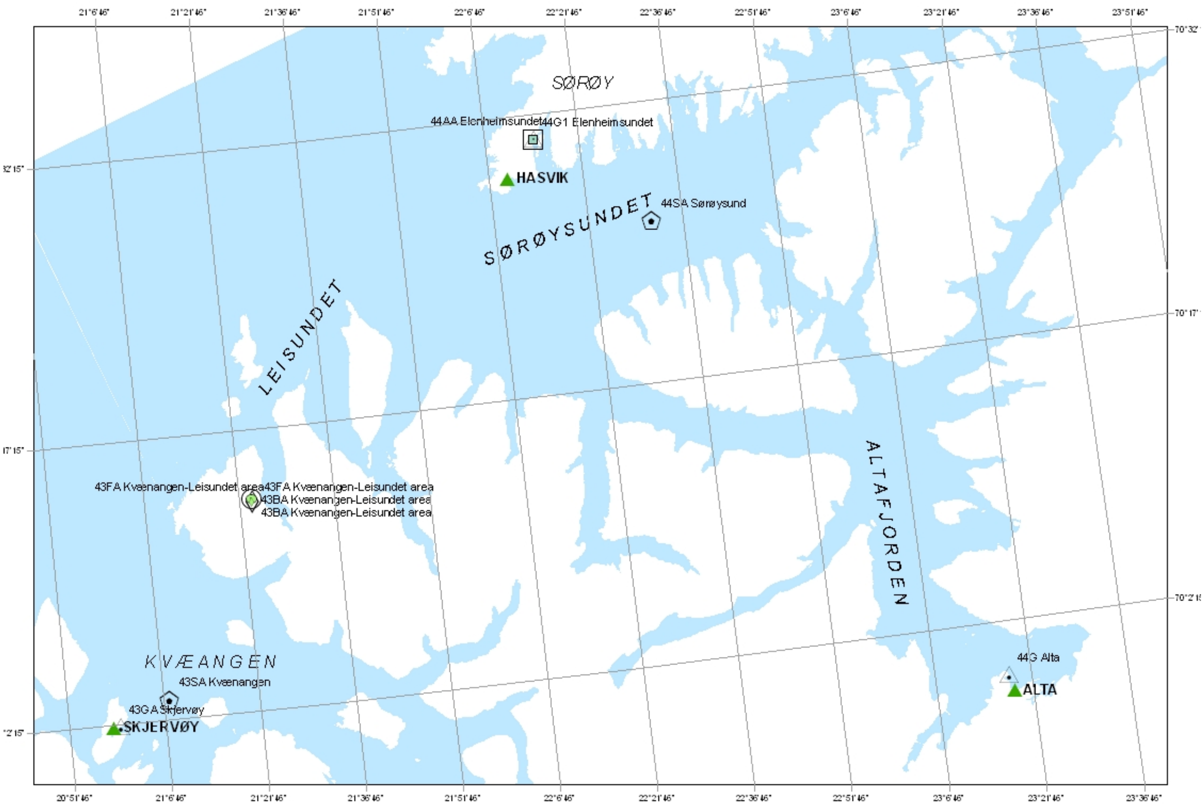
MAP 17

TROMSØ
KVALØY
MALANGEN
42SA Malangen
42AA Tennskjær (Malangen)
42G Finnsnes

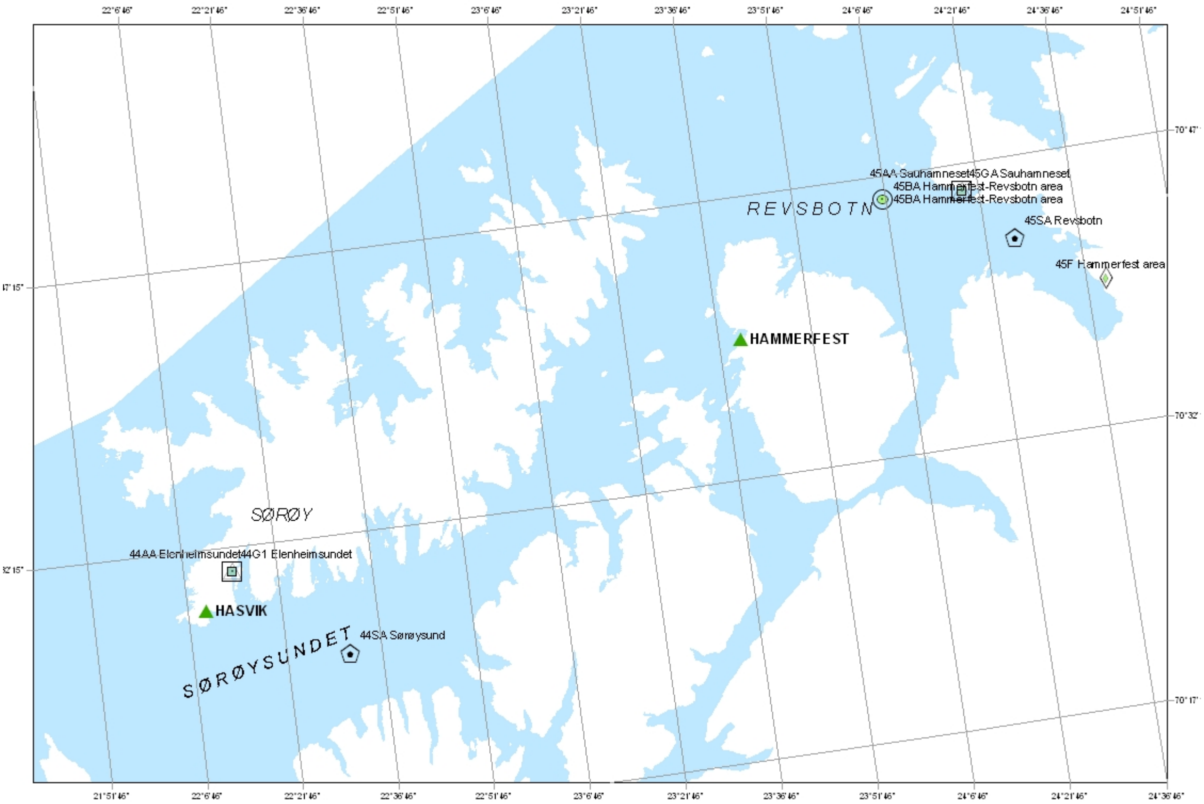
MAP 18


SØRØY
44AA Elenheimsundet
44G1 Elenheimsundet
HASVIK
SØRØYSUNDET
44SA Sørøysund
LOPPHAVET
LEISUNDET
43FA Kvænangen-Leisundet area
43BA Kvænangen-Leisundet area
43G1A Lyngneset (Langfjord)
43AA Lyngneset (Langfjord)
KVÆANGEN
43SA Kvænangen
43GA Skjervøy
SKJERVØY

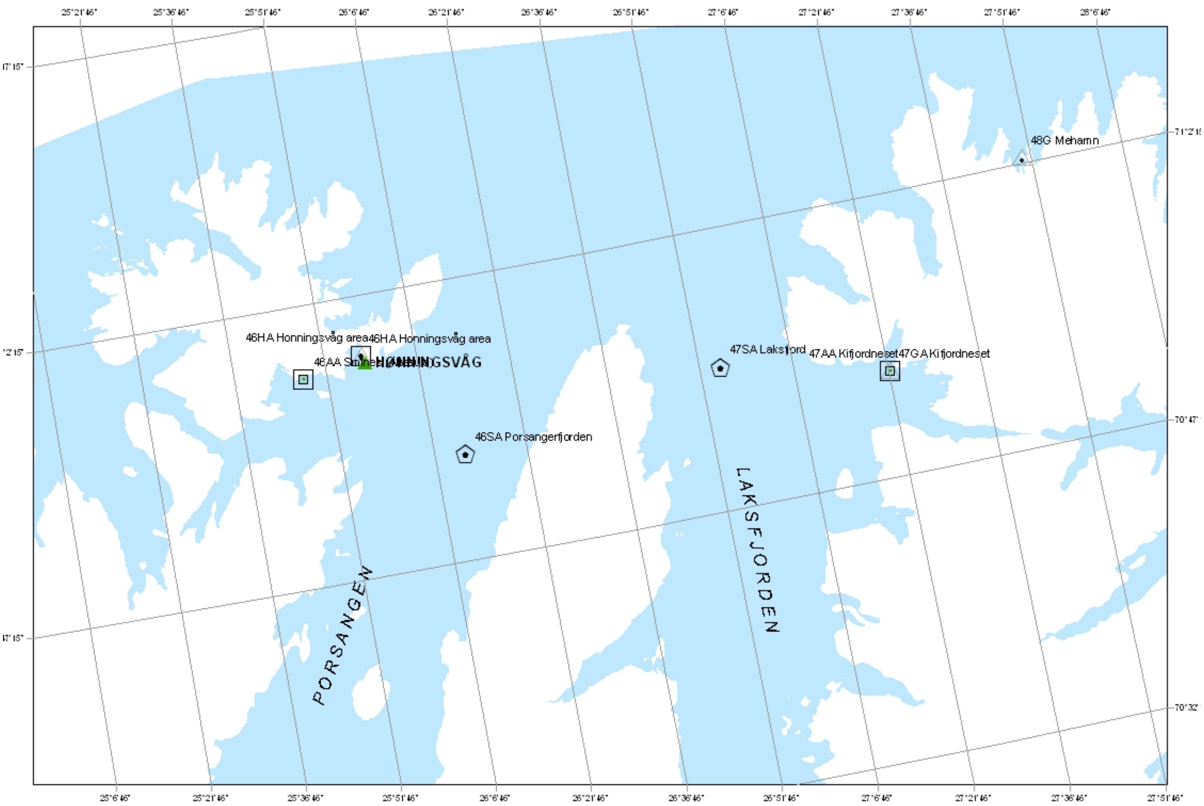
MAP 19


SØRØY
44AA Elenheimsundet
44G1 Elenheimsundet
HASVIK
SØRØYSUNDET
44SA Sørøysund
LEISUNDET
43FA Kvænangen-Leisundet area
43BA Kvænangen-Leisundet area
ALTAFJORDEN
KVÆANGEN
43SA Kvænangen
43GA Skjervøy
SKJERVØY
44G Alta
ALTA

MAP 20


45AA Sauhamneset45GA Sauhamneset
45BA Hammerfest-Revsbotn area
45BA Hammerfest-Revsbotn area
REVSBOTN
45SA Revsbotn
45F Hammerfest area
HAMMERFEST
SØRØY
44AA Elenheimsundet44G1 Elenheimsundet
HASVIK
44SA Sørøysund
SØRØYSUNDET

MAP 21


48G Mehamn
46HA Honningsvåg area46HA Honningsvåg area
HONNINGSVÅG
47SA Laksfjord
47AA Kifjordneset47GA Kifjordneset
46SA Porsangerfjorden
PORSANGEN
LAKSFJORDEN

MAP 22


48SA Tanafjord
BERLEVÅG
TANAFJORDEN
48AA Trollfjorden (Tanafjord)
48G1A Trollfjorden (Tanafjord)
BÅTSFJORD
49SA Syltefjord
49AA Nordfjorden (Syltefjord)
49GA Syltefjorden
SYLTEFJORDEN
10G3 Vardø
VARDØ
VARANGERHALVØYET
10AA Skagodden-Skallneset area
10AA Skagodden-Skallneset area

MAP 23


VARANGERHALVØYET
10AA Skagodden-Skallneset area
10AA Skagodden-Skallneset area
10G4 Vadsø
VADSØ
VARANGERFJORDEN
10SA Varangerfjorden
10B Varangerfjorden
10F Skogerøy
10B Varangerfjorden
11G Brashavn
11X Brashavn
11AA Sildkrokneset
11AA Sildkrokneset
KIRKENES

MAP 24

Appendix H
Overview of materials and analyses 2007

Nominal station positions are shown on maps in Appendix G

Me - Blue Mussel (*Mytilus edulis*)
Nl – Dog whelk (*Nucella lapillus*)
Gm - Atlantic cod (*Gadus morhua*)

Fl – flat fish:

Megrim (*Lepidorhombus whiff-iagonis*)
Dab (*Limanda limanda*)
Flounder (*Platichthys flesus*)

Tissue:

SB - Soft body tissue
LI - Liver tissue, in fish
MU - Muscle tissue, in fish
BL – Blood, in fish
BI – Bile, fish

ICES-parameter-group codes (See Appendix C for descriptions of codes):

ICES code	Description	Me-SB	Nl-SB	Gm-BI	Gm-BL	Gm/Ff-LI	Gm/Ff-MU
I-MET	Cd, Cu, Pb, Zn	x				x	
I-MET	Hg	x					x
O-MET	TBT 1)	x	x			x 3)	
OC-CB	PCBs 2)	x				x	x
OC-CL	HCB	x				x	x
OC-DD	DDT, DDE, DDD	x				x	x
OC-HC	α-, γ-HCH	x				x	x
OC-DX	Dioxins 3)	x					
OC-BB	PBDE 4)					x 3)	
OC-PF	PFC 5)					x 3)	
PAH	PAHs 6)	x					
BEM 7)	Biological effects met.		Impo-sex	OH-pyrene	ALA-D	EROD-activity, CYP1A 8)	

1) Includes: DBTIN, DPTIN, MBTIN, MPTIN, TBTIN, TPTIN
2) Includes the congeners: CB-28,-52,-101,-105,-118,-138,-153,-156,-180, 209, 5-CB, OCS and, when dioxins are analyzed, the non-orto-PCBs, i.e. CB-77, -81, -126, -169
3) Includes: CDD1N, CDD4X, CDD6P, CDD6X, CDD9X, CDDO, CDF2N, CDF2T, CDF4X, CDF6P, CDF6X, CDF9P, CDF9X, CDFDN, CDFDX, CDFO,TCDD
4) Polybrominated diphenyl ethers (PBDE), including brominated flame retardents and includes: BDE28, BDE47, BDE49, BDE66, BDE71, BDE77, BDE85, BDE99, BDE100, BDE119, BDE138, BDE153, BDE154, BDE183, BDE205
5) Includes: PFNA, PFOA, PFHpA, PFHxA, PFOS, PFBS, PFOSA
6) Includes (with NPDs): ACNE, ACNLE, ANT, BAP, BBJF, BEP, BGHIP, BKF. BAA. CHR, DBA3A, DBT, DBTC1, DBTC2, DBTC3, FLE, FLU, ICDP, NAP, NAPC1, NAPC2, NAPC3, PA, PAC1, PAC2, PAC3, PER, PYR.
7) Biological effects methods
8) Cod only

Appendix H. Sampling and analyses for 2007 - biota.

jmpst	stnam	nom_lat	nom_lon	speci	tissu	count	I-MET	OC-BB	OC-CB	OC-CL	OC-DD	OC-DX	OC-HC	O-MET	PAH	PFAS
30B	Oslo City area	59.7993	10.5600	GADU MOR	LI	25	25	25	24	25	24		25			21
30B	Oslo City area	59.7993	10.5600	GADU MOR	MU	30	25		5	5	5		5			
30A	Gressholmen	59.8815	10.7118	MYTI EDU	SB	3	3		3	3	3	2	3	2	3	
31A	Solbergstrand	59.6188	10.6498	MYTI EDU	SB	3	3		3	3	3		3			
33F	Sande (east side)	59.5283	10.3500	PLAT FLE	LI	3	3		3	3	3		3			
33F	Sande (east side)	59.5283	10.3500	PLAT FLE	MU	3	3		3	3	3		3			
35A	Mølen	59.4882	10.4980	MYTI EDU	SB	3	3		3	3	3		3			
36B	Færder area	59.0405	10.4358	GADU MOR	LI	25	25		25	25	25		25			
36F	Færder area	59.0667	10.3833	LIMA LIM	LI	5	5		5	5	5		5			
36B	Færder area	59.0405	10.4358	GADU MOR	MU	30	25		5	5	5		5			
36F	Færder area	59.0667	10.3833	LIMA LIM	MU	5	5		5	5	5		5			
36A	Færder	59.0272	10.5255	MYTI EDU	SB	3	3		3	3	3		3	2		
36G	Færder	59.0272	10.5255	NUCE LAP	SB	1								1		
71A	Bjørkøya (Risøyodden)	59.0233	9.7537	MYTI EDU	SB	4	4		3	3	3	2	3	1		
71G	Fugløyskjær	58.9808	9.8077	NUCE LAP	SB	1								1		
76A	Risøy	58.7308	9.2720	MYTI EDU	SB	3	3		3	3	3	2	3	1		
76G	Risøy	58.7280	9.2755	NUCE LAP	SB	1								1		
131G	Lastad	58.0555	7.7087	NUCE LAP	SB	1								1		
15B	Ullerø area	58.0500	6.7167	GADU MOR	LI	25	25		25	25	25		25			
15F	Ullerø area	58.0500	6.7167	LIMA LIM	LI	5	5		5	5	5		5			
15B	Ullerø area	58.0500	6.7167	GADU MOR	MU	30	25		5	5	5		5			
15F	Ullerø area	58.0500	6.7167	LIMA LIM	MU	5	5		5	5	5		5			
15A	Gåsøy (Ullerø)	58.0478	6.8953	MYTI EDU	SB	3	3		3	3	3		3	2		
15G	Gåsøy (Ullerø)	58.0497	6.8957	NUCE LAP	SB	1								1		
51A	Byrkjenes	60.0838	6.5505	MYTI EDU	SB	3	3		3	3	3		3			
52A	Eitrheimsneset	60.0967	6.5328	MYTI EDU	SB	3	3		3	3	3		3			
53B	Inner Sørfjord	60.1667	6.5667	GADU MOR	LI	25	25	25	24	25	24		24			22
53F	Inner Sørfjord	60.1667	6.5667	PLAT FLE	LI	5	5		5	5	5		5			
53B	Inner Sørfjord	60.1667	6.5667	GADU MOR	MU	30	25		5	5	5		5			
53F	Inner Sørfjord	60.1667	6.5667	PLAT FLE	MU	5	5		5	5	5		5			
56A	Kvalnes	60.2205	6.6020	MYTI EDU	SB	3	3		3	3	3		3			
57A	Krossanes	60.3872	6.6890	MYTI EDU	SB	3	3		3	3	3		3			
63A	Ranaskjær	60.4208	6.4220	MYTI EDU	SB	3	3		3	3	3		3			
65A	Vikingneset	60.2423	6.1527	MYTI EDU	SB	3	3		3	3	3		3			
67B	Strandebarm area	60.2667	6.0333	GADU MOR	LI	25	25		25	25	25		25			
67F	Strandebarm area	60.2667	6.0333	LEPI WHI	LI	5	5		5	5	5		5			
67F	Strandebarm area	60.2667	6.0333	PLAT FLE	LI	5	5		5	5	5		5			
67B	Strandebarm area	60.2667	6.0333	GADU MOR	MU	30	25		5	5	5		5			
67F	Strandebarm area	60.2667	6.0333	LEPI WHI	MU	5	5		5	5	5		5			
67F	Strandebarm area	60.2667	6.0333	PLAT FLE	MU	5	5		5	5	5		5			
69A	Lille Terøy	59.9818	5.7525	MYTI EDU	SB	3	3		3	3	3		3			
22A	Espevær (west)	59.5842	5.1438	MYTI EDU	SB	3	3		3	3	3		3	2		
22G	Espevær vest	59.5837	5.1445	NUCE LAP	SB	1								1		
21F	Åkrafjord	59.7500	6.1167	LEPI WHI	LI	5	5		5	5	5		5			
21F	Åkrafjord	59.7500	6.1167	LIMA LIM	LI	5	5		5	5	5		5			
21F	Åkrafjord	59.7500	6.1167	LEPI WHI	MU	5	5		5	5	5		5			
21F	Åkrafjord	59.7500	6.1167	LIMA LIM	MU	5	5		5	5	5		5			
227A2	Høgevarde	59.3260	5.3175	MYTI EDU	SB	1								1		
227G2	Flatskjær	59.3373	5.3125	NUCE LAP	SB	1								1		
23B	Karihavet area	59.9000	5.1333	GADU MOR	LI	25	25	25	25	25	25		25			23
23B	Karihavet area	59.9000	5.1333	GADU MOR	MU	30	25		5	5	5		5			
98A2	Husvaagen area	68.2577	14.6638	MYTI EDU	SB	3	3		3	3	3		3	2		
98G	Svolvær området	68.2487	14.6633	NUCE LAP	SB	1								1		
41A	Fensneset (Grytøya)	68.9350	16.6412	MYTI EDU	SB	3	3		3	3	3		3			
42A	Tennskjær (Malangen)	69.4775	18.3020	MYTI EDU	SB	3	3		3	3	3		3			
43B1	Leisundet	70.2260	21.3968	GADU MOR	LI	25	25		25	25	25		25			
43F1	Leisundet	70.2238	21.3973	PLEU PLA	LI	5	5		5	5	5		5			
43B1	Leisundet	70.2260	21.3968	GADU MOR	MU	30	25		5	5	5		5			
43F1	Leisundet	70.2238	21.3973	PLEU PLA	MU	5	5		5	5	5		5			
43A	Lyngneset (Langfjord)	70.1005	20.5465	MYTI EDU	SB	3	3		3	3	3		3			
44A	Elenheimsundet	70.5162	22.2460	MYTI EDU	SB	3	3		3	3	3		3			
45B1	Revsbotn	70.7667	24.1083	GADU MOR	LI	25	25		25	25	25		25			
45F	Hammerfest area	70.6667	24.6667	PLEU PLA	LI	5	5		5	5	5		5			
45B1	Revsbotn	70.7667	24.1083	GADU MOR	MU	30	25		5	5	5		5			
45F	Hammerfest area	70.6667	24.6667	PLEU PLA	MU	5	5		5	5	5		5			
45A	Sauhamneset	70.7637	24.3200	MYTI EDU	SB	3	3		3	3	3		3			
46A	Smines (Altesula)	70.9728	25.8017	MYTI EDU	SB	3	3		3	3	3		3			
47A	Kifjordneset	70.8812	27.3698	MYTI EDU	SB	3	3		3	3	3		3			
48A	Trollfjorden (Tanafjord)	70.6935	28.5547	MYTI EDU	SB	3	3		3	3	3		3			
49A	Nordfjorden (Syltefjord)	70.5502	30.0862	MYTI EDU	SB	3	3		3	3	3		3			
10B	Varangerfjorden	69.9333	29.6667	GADU MOR	LI	25	25		25	25	25		25			
10F	Skogerøy	69.9167	29.8500	PLEU PLA	LI	4	4		4	4	4		4			
10B	Varangerfjorden	69.9333	29.6667	GADU MOR	MU	30	25		5	5	5		5			
10F	Skogerøy	69.9167	29.8500	PLEU PLA	MU	4	4		4	4	4		4			
10A2	Skallneset	70.1035	30.2625	MYTI EDU	SB	3	3		3	3	3		3			
11G	Brashavn	69.8987	29.7442	NUCE LAP	SB	1								1		
11X	Brashavn	69.8987	29.7442	MYTI EDU	SB	3	3		3	3	3		3	2		
I022	West Damholmen	59.1018	11.0448	MYTI EDU	SB	3	3		3	3	3		3			
I023	Singlekalven (south)	59.0950	11.1367	MYTI EDU	SB	3	3		3	3	3		3			
I024	Kirkøy (north west)	59.0800	10.9863	MYTI EDU	SB	3	3		3	3	3		3			
I301	Akershuskaia	59.9053	10.7363	MYTI EDU	SB	3	3		3	3	3		3	2	3	
I304	Gåsøya	59.8513	10.5890	MYTI EDU	SB	3	3		3	3	3		3		3	
I306	Håøya	59.7133	10.5552	MYTI EDU	SB	3	3		3	3	3		3		3	
I307	Ramtonholmen	59.7445	10.5228	MYTI EDU	SB	3	3		3	3	3		3		3	
I712	Gjemesholmen	59.0453	9.7068	MYTI EDU	SB	3	3		3	3	3	2	3	2		
I713	Strømtangen	59.0503	9.6917	MYTI EDU	SB	3	3		3	3	3	1	3	2		
I131A	Lastad	58.0555	7.7087	MYTI EDU	SB	3	3		3	3	3		3		3	
I132	Svensholmen	58.1250	7.9888	MYTI EDU	SB	3			3	3	3	1	3	2	3	
I133	Odderø (west)	58.1317	8.0017	MYTI EDU	SB	3			3	3	3	1	3	2	3	
I201	Ekkjegrunn (G1)	59.6433	6.3573	MYTI EDU	SB	3	3								3	
I205	Bølsnes (G5)	59.5917	6.3002	MYTI EDU	SB	3	3								3	
I241	Nordnes	60.4007	5.3017	MYTI EDU	SB	3			3	3	3		3			
I242	Gravdalsneset	60.3948	5.2668	MYTI EDU	SB	3			3	3	3		3			

I243	Hegreneset	60.4153	5.3048	MYTI EDU	SB	3			3	3	3		3			
I915	Flåøya (northwest)	62.7580	8.4398	MYTI EDU	SB	3									3	
I913	Fjøseid	62.8098	8.2747	MYTI EDU	SB	3									3	
I912	Honnhammer	62.8533	8.1617	MYTI EDU	SB	3									3	
I965	Moholmen (B5)	66.3120	14.1258	MYTI EDU	SB	3	3								3	
I964	Toraneskaien	66.3217	14.1328	MYTI EDU	SB	3	3								3	
I969	Bjørnbærviken (B9)	66.2802	14.0347	MYTI EDU	SB	3	3								3	

Appendix I
Temporal trend analyses of contaminants and biomarkers in biota 1981-2007

Sorted by contaminant, species and area/station:

Cadmium (Cd)
Mercury (Hg)
Lead (Pb)
Copper (Cu)
Zinc (Zn)
Sum PCB-7 or **CB_S7** (CB: 28+52+101+118+138+153+180)
DDEPP (ppDDE)
HCB
BAP (benzo[*a*]pyrene)
PK-Σn or PK_S (sum carcinogen PAHs, cf. Appendix B)
P-Σn or P_S (sum of PAHs, dicyclic "PAHs" not included, cf. Appendix B)
TBT (Tributyltin)
TCDDN (Dioxin toxicity equivalents – Nordic model)
BDESS (Sum brominated flame retardents)
ALA-D (δ-amino levulinic acid dehydrase inhibition)
EROD-activity (Cytochrome P4501A-activity)
CYP1A (relative amount of Cytochrome P4501A protein)
OH-pyrene or PYR10 (Pyrene metabolite)
VDSI (measurement of imposex)

CEMP-stations
"Index"-stations
MYTI EDU - Blue Mussel (*Mytilus edulis*)
NUCE LAP – Dog whelk (*Nucella lapillus*)
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

Tsu -tissue:

SB - Soft body tissue
LI - Liver tissue
MU - Muscle tissue
BL - Blood
BI - Bile

OC	**Overconcentration expressed as quotient of median of last year and "high background" ("?" missing background value)**	
TRD	**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**
SM3	**Projected smoothed median for three years expressed as quotient of value and "high background" ("?" if missing background or if number of years is less than seven)**	
PWR	**POWER; estimated number of years to detect a hypothetical situation of 10% trend a year with a 90% power**	

Note on detection limit: for values designated below detection limit, half of this limit is used.

Annual median concentration of CD (ppm)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				1.07	0.81	1.41	0.6	0.61	0.736	0.769	0.769	1.12	1.26	1.17	0.776	0.8	0.857	1.27	1.16	1.13	0.914	1.75	1.56	2.16	1.7	1.72	1.42	no	U-	no	10
31A	MYTI EDU	SB	d.w.			1.39	1.31	0.89	1.93	0.4	0.43	0.412	0.719	0.727	0.914	0.933	0.781	1.32	0.789	0.854	1.07	1.25	1	1.76	1.14	1.33	1.4	1.28	1.11	1.16	no	UY	no	12
35A	MYTI EDU	SB	d.w.			1.35	0.952	1.17	1.3	0.52	0.66	0.647	0.926	1.05	1.35	1.11	0.958	0.894	0.766	0.965	1.14	1.53	1.33	1.53	1.16	1.06	1.23	1.33	0.86	0.855	no	UY	no	9
36A	MYTI EDU	SB	d.w.			0.845	1.19	0.84	1.38	0.59	0.56	0.502	0.407	1.22	1.06	0.899	1.22	1.17	1.6	1.84	0.965	1.01	1.65	2.59	1	0.848	0.956	0.9	0.586	0.633	no	UY	no	12
71A	MYTI EDU	SB	d.w.			2.52	1.98	1.42	2	0.98	2.11	2.02	0.968	1.09	1.66	1.89	1.97	2.25	1.5	2.44	1.53	1.76	1.99	1.43	1.69	1.44	1.57	1.48	1.43	1.17	no	--	no	11
76A	MYTI EDU	SB	d.w.										0.638	0.86	0.957	1.1			1.17	1.19	1.2	1.28	0.823	1.82	1.45	1.05	1.01	0.829	0.816	1.03	no	--	no	10
15A	MYTI EDU	SB	d.w.										0.505	0.831		1.18	0.794	1.44	1.22	1.07	1.03	0.841	1.44	4.4	1.31	0.737	0.926	0.788	1.01	0.718	no	--	no	14
51A	MYTI EDU	SB	d.w.							42.8	58.2							36.8	25.3	5.45	10.3	34.6	27.3	5.35	16.6	14.7	5.21	13.8	2.35	3.42	1.7	--	no	21
52A	MYTI EDU	SB	d.w.									94.4	10.2	80.1	43.1	14.7	8.71	19.8	18.4	13.4	9.14	11.4	10.5	5.59	5	7.38	5.37	7	2.88	4.41	2.2	D-	1.2	18
56A	MYTI EDU	SB	d.w.							55.9	54.2	98.4	45	69.4	51.7	59.7	11.4	30.8	20	28.8	8.71	25.9	24.4	14.5	13.4	11.4	6.18	11.7	8.4	5.29	2.6	D-	1.7	15
57A	MYTI EDU	SB	d.w.							21.1	43.2	36.7	25.7	32.8	32.1	15.4	11.8	12.2	8.48	13.6	5.02	13.6	10.3	8.19	6.96	6.32	3.12	5.94	6.21	2.34	1.2	D-	no	13
63A	MYTI EDU	SB	d.w.							47.2	10.3	19	30.4	35.1	18.2	7.81	4.23	8.16	5.4	6.62	4.43	6.87	5.97	6.73	5.38	5.69	1.3	4	3.98	3.07	1.5	D-	1.4	16
65A	MYTI EDU	SB	d.w.							15	5.96	8.29	14.6	24	5.09	7.73	3.01	5.37	3.53	4.28	1.72	3.82	3.85	4.5	3.74	3.4	1.31	3.42	3.98	1.87	no	D-	1.1	16
69A	MYTI EDU	SB	d.w.												4.26	2.37	2.08	2.91	3.2	3.53	1.58	3.76	2.87	3.8	2.41	2.36	1.19	2.26	1.51	1.41	no	--	no	12
22A	MYTI EDU	SB	d.w.										0.532	1.14	1.12	0.844	1.02	1.41	1.14	1.01	0.851	1.32	2.69	2.01	0.976	1.04	1.18	0.912	0.844	1.24	no	--	no	12
23A	MYTI EDU	SB	d.w.										0.406	0.994													0.832	1.11			no	-?	?	15
24A	MYTI EDU	SB	d.w.										0.52	0.816													0.958	0.944			no	-?	?	10
82A	MYTI EDU	SB	d.w.				1.41	1.15	2.31	0.99	0.4	1.26		1.2	1.21	1.15		0.981	1.22								0.944	1.51			no	--	no	15
84A	MYTI EDU	SB	d.w.				1.39	1.86	2.38	2.1	0.96	1.19		1.82	2.11	1.6		1.64	1.29								1.54	2.05			1.0	--	1.5	11
87A	MYTI EDU	SB	d.w.				0.968	1.02	1.93	0.77	0.69	0.756		0.872	0.978	0.927		1.15	1.27								1	1.08			no	--	no	11
25A	MYTI EDU	SB	d.w.												1.38	1.05											1.25	1.46			no	-?	?	8
26A	MYTI EDU	SB	d.w.												1.07	1											1.24	1.13			no	-?	?	<=5
27A	MYTI EDU	SB	d.w.												1.1												0.856	0.894			no	-?	?	<=5
28A	MYTI EDU	SB	d.w.												1.12	0.841											0.947	1.04			no	-?	?	8
91A	MYTI EDU	SB	d.w.												1.68	1.27	1.82											1.16			no	-?	?	9
92A1	MYTI EDU	SB	d.w.												1.08	0.544	0.939	0.743	0.691	0.716											no	--	no	11
93A	MYTI EDU	SB	d.w.												1.23	0.645											0.888	0.68			no	-?	?	13
94A	MYTI EDU	SB	d.w.												0.87	0.846											1.13	1.2			no	U?	?	<=5
95A	MYTI EDU	SB	d.w.												1.21	1.47											1	1.11			no	-?	?	7
96A	MYTI EDU	SB	d.w.												0.963	0.782											0.718	1.03			no	-?	?	10
97A	MYTI EDU	SB	d.w.												1.31	1.55											1.44	1.44			no	-?	?	6
98A2	MYTI EDU	SB	d.w.																	0.854		2.17	1.68	2.38	2.13	2.27	1.07	1.29	1.18	1.05	no	DY	no	11
98X	MYTI EDU	SB	d.w.														0.712	0.688	0.781												no	-?	?	6
99A	MYTI EDU	SB	d.w.												1.43	1.28											1.35	1.27			no	-?	?	<=5
41A	MYTI EDU	SB	d.w.														1.89	2.95	1.63	1.88									2.67	1.68	no	--	1.0	11
42A	MYTI EDU	SB	d.w.														1.05	1.59											0.952	1.2	no	-?	?	11
43A	MYTI EDU	SB	d.w.														3.47	4.32		3.85									2.53	3.26	1.6	-?	?	8
44A	MYTI EDU	SB	d.w.														1.69	2.74	1.95	1.51									1.86	1.15	no	--	no	11
45A	MYTI EDU	SB	d.w.														1.81	1.61											1.88	2.02	1.0	-?	?	6
46A	MYTI EDU	SB	d.w.														2.7	2.06	2.72										2.53	1.63	no	-?	?	10
47A	MYTI EDU	SB	d.w.														4.55	3.01											2.29	2.51	1.3	-?	?	9
48A	MYTI EDU	SB	d.w.														1.35	1.31	1.38										2.64	1.97	no	U?	?	8
49A	MYTI EDU	SB	d.w.														1.57	1.16											4.07	2.33	1.2	-?	?	13
10A2	MYTI EDU	SB	d.w.																2.34	1.06	2.32	1.61	1.53	1.23	1.41	1.98	1.59	1.12	1.74	2.28	1.1	--	1.1	12
11X	MYTI EDU	SB	d.w.																	1.65	0.67	1.13	1.07	1.32	1.36	1.36	0.911	0.981	0.933	1.16	no	--	no	11

Annual median concentration of CD (ppm)

																															ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				1.07	0.81	1.41	0.6	0.61	0.736	0.769	0.769	1.12	1.26	1.17	0.776	0.8	0.857	1.27	1.16	1.13	0.914	1.75	1.56	2.16	1.7	1.72	1.42	no	U-	no	10
71A	MYTI EDU	SB	d.w.			2.52	1.98	1.42	2	0.98	2.11	2.02	0.968	1.09	1.66	1.89	1.97	2.25	1.5	2.44	1.53	1.76	1.99	1.43	1.69	1.44	1.57	1.48	1.43	1.17	no	--	no	11
51A	MYTI EDU	SB	d.w.							42.8	58.2							36.8	25.3	5.45	10.3	34.6	27.3	5.35	16.6	14.7	5.21	13.8	2.35	3.42	1.7	--	no	21
52A	MYTI EDU	SB	d.w.									94.4	10.2	80.1	43.1	14.7	8.71	19.8	18.4	13.4	9.14	11.4	10.5	5.59	5	7.38	5.37	7	2.88	4.41	2.2	D-	1.2	18
10A2	MYTI EDU	SB	d.w.																2.34	1.06	2.32	1.61	1.53	1.23	1.41	1.98	1.59	1.12	1.74	2.28	1.1	--	1.1	12
I021	MYTI EDU	SB	d.w.															1.73	2.26	2.48	3.31		1.83	2.53	2.41						1.2	--	1.0	10
I022	MYTI EDU	SB	d.w.															1.43	1.36	1.26	2.09	1.94	1.33	1.7	2.69	1.61	1.25	1.42	1.74	2	no	--	no	11
I023	MYTI EDU	SB	d.w.															1.61	1.4	1.77	2.04	1.45	0.948	0.873	1.55	1.48	1.03	1.39	1.79	1.15	no	--	no	11
I024	MYTI EDU	SB	d.w.															1.31	1.63	2.04	2.56	2.45	1.83	2.53	2.7	2.03	1.57	1.46	1.97	1.39	no	DY	no	9
I301	MYTI EDU	SB	d.w.															0.824	0.795	0.817	1.03	1.29	0.716	0.902	0.888	1.15	1.32	1.03	1.49	1.18	no	--	no	9
I304	MYTI EDU	SB	d.w.															1.33	0.719	0.784	1.05	0.994	0.921	1.16	1.3	1.37	1.1	1.34	1.35	0.889	no	--	no	9
I306	MYTI EDU	SB	d.w.															0.81	0.779	0.646	0.707	0.842	0.592	0.734	0.872	1.28	0.992	1.11	0.806	0.65	no	--	no	9
I307	MYTI EDU	SB	d.w.															0.94	0.815	0.687	0.72	0.826	0.719	0.899	1.46	1.44	1.14	1.26	0.933	0.876	no	UY	no	8
I131A	MYTI EDU	SB	d.w.															1.24	0.875	1.14	1.31	1.18	1.98	2.48	1.13	0.862	1.34	0.965	0.831	0.787	no	--	no	11
I201	MYTI EDU	SB	d.w.															0.801	0.856	1.06	0.927	1.27	1.42	1.49	2.8	0.707	0.957	1.47	1.55	1.44	no	--	no	13
I205	MYTI EDU	SB	d.w.															0.819		1.37	0.858	1.49	1.99	1.42	2.43	1.25	1.02	2.02	1.91	1.28	no	--	no	12
I965	MYTI EDU	SB	d.w.																					2.02	2.15	0.813	1.9	1.8	1.78	2.08	1.0	--	1.3	13
I962	MYTI EDU	SB	d.w.															0.746	0.606	0.645	0.518										no	-?	?	6
I964	MYTI EDU	SB	d.w.																						1.57	0.652	0.92	2.15	2.11	2.04	1.0	--	1.5	15
I969	MYTI EDU	SB	d.w.															0.502	0.599	0.318	0.611	0.588	0.827	0.76	0.8	0.557	0.615	1.19	0.432	0.461	no	--	no	12

Annual median concentration of CD (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.				0.01	0.05	0.0619	0.0711	0.0218	0.0267	0.035	0.027	0.1	0.0645	0.063	0.049	0.055	0.0485	0.107	0.165	0.078	0.111	0.106	0.114	0.1	0.0734	0.115	0.19	1.9	U-	1.8	15
36B	GADU MOR	LI	w.w.	0.078	0.06	0.22	0.07	0.05	0.143	0.0611	0.0314	0.028	0.0235	0.01	0.021	0.034	0.021	0.042	0.033	0.0741	0.036	0.065	0.041	0.029	0.0247	0.0088	0.0067	0.029	0.025	0.034	no	DY	no	16
15B	GADU MOR	LI	w.w.										0.026	0.009	0.025	0.016	0.014	0.016	0.024	0.031	0.03	0.026	0.033	0.026	0.0183	0.0374	0.0097	0.019	0.0058	0.023	no	--	no	15
53B	GADU MOR	LI	w.w.						0.658		0.058	0.0929	0.045	0.149	0.215	0.038		0.007	0.18	0.143	0.228	0.726	0.829	0.565	0.431	0.253	0.368	0.414	0.2	0.279	2.8	UY	1.9	22
67B	GADU MOR	LI	w.w.							0.145	0.0519	0.0467	0.069	0.077	0.0514	0.115	0.0989	0.033	0.111	0.277	0.0185	0.0715	0.059	0.032	0.0203	0.01	0.016	0.0252	0.0092	0.015	no	D-	no	19
23B	GADU MOR	LI	w.w.										0.022	0.024	0.02	0.025	0.015	0.026	0.014	0.029	0.025	0.033	0.019	0.025	0.0206	0.0163	0.0228	0.024	0.0379	0.022	no	--	no	11
84B	GADU MOR	LI	w.w.				0.13	0.1	0.0688		0.0291																				no	D?	?	6
92B	GADU MOR	LI	w.w.													0.036	0.029	0.022	0.066								0.0229	0.024			no	--	no	14
98B1	GADU MOR	LI	w.w.												0.069	0.15	0.025	0.113	0.33	0.064	0.047	0.039			0.0291	0.0254	0.0332	0.051	0.0379		no	--	no	20
43B	GADU MOR	LI	w.w.														0.168	0.183	0.097												no	-?	?	12
10B	GADU MOR	LI	w.w.														0.23	0.188	0.095	0.128	0.119	0.137	0.125	0.129	0.059	0.099	0.103	0.079	0.0779	0.0815	no	D-	no	11

Annual median concentration of CD (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	LI	w.w.			0.19		0.2	0.176	0.257	0.061	0.106	0.234	0.196	0.16	0.184	0.087	0.091	0.114	0.119	0.0952	0.126	0.071	0.091	0.0569	0.0627	0.0313	0.025	0.0677	0.039	no	D-	no	14
53F	PLAT FLE	LI	w.w.								2.24	1.53	1.54	1.72	1.79	0.789		0.135	2.53	0.892	1.47	2.55	1.77	2.74	2.74	4.56	1.46	1.31		0.765	2.6	--	no	19
67F	PLAT FLE	LI	w.w.																2.48		0.187	0.185	0.148	0.059	0.065	0.0802	0.0605	0.124	0.14	0.093	no	DY	no	15
21F	PLAT FLE	LI	w.w.																			0.052	0.0979	0.141	0.22		0.0473	0.125	0.129		no	--	no	18
36F	LIMA LIM	LI	w.w.										0.106	0.112	0.23	0.295	0.135	0.147	0.139	0.123	0.202	0.227	0.139	0.232	0.127	0.142	0.188	0.144	0.128	0.208	no	--	no	12
15F	LIMA LIM	LI	w.w.													0.0992	0.136	0.125	0.153	0.076	0.181	0.167		0.313	0.129	0.11	0.189	0.225	0.377	0.153	no	--	1.0	14
22F	LIMA LIM	LI	w.w.										0.095	0.091	0.128		0.169	0.125													no	-?	?	9
21F	LIMA LIM	LI	w.w.																						0.0166	0.0085	0.0747	0.014		0.029	no	-?	?	23
30F	PLEU PLA	LI	w.w.												0.11		0.101	0.222													1.1	-?	?	15
22F	PLEU PLA	LI	w.w.																0.23	0.231	0.244										1.2	-?	?	<=5
98F2	PLEU PLA	LI	w.w.																				0.821	0.521	0.217	0.218	0.0726	1.01	0.593		3.0	--	3.9	23
10F	PLEU PLA	LI	w.w.																	0.571		0.141	0.248	0.302	0.204	0.316	0.307	0.271		0.627	3.1	--	4.4	14
67F	LEPI WHI	LI	w.w.			0.181				0.18	0.109	0.066	0.197	0.085	0.1	0.12	0.304	0.259	0.2	0.097	0.033	0.051	0.037	0.049	0.0342	0.0543	0.0485	0.0609	0.0449	0.028	m	DY	m	14
21F	LEPI WHI	LI	w.w.																							0.0592	0.0812	0.112	0.186	0.049	m	-?	m	18

Annual median concentration of HG (ppm)

																															ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				0.118	0.073	0.147	0.05	0.13	0.0437	0.0641	0.0533	0.0508	0.0703	0.0865	0.0574	0.07	0.0604	0.0778	0.114	0.0599	0.0586	0.0952	0.071	0.153	0.113	0.1	0.0765	no	--	no	13
31A	MYTI EDU	SB	d.w.			0.0757	0.164	0.086	0.12	0.05	0.09	0.0225	0.0599	0.0485	0.0508	0.0446	0.0502	0.0623	0.0435	0.0515	0.0699	0.0881	0.0464	0.051	0.0577	0.0577	0.0935	0.11	0.18	0.159	no	UY	1.4	13
35A	MYTI EDU	SB	d.w.			0.0933	0.0741	0.084	0.17	0.05	0.18	0.05	0.0617	0.0585	0.0578	0.0537	0.0607	0.0369	0.0383	0.0354	0.0667	0.101	0.028	0.0472	0.0575	0.0574	0.0938	0.12	0.045	0.045	no	--	no	15
36A	MYTI EDU	SB	d.w.			0.0516	0.0427	0.084	0.14	0.05	0.14	0.034	0.0452	0.0476	0.0394	0.0321	0.0481	0.0333	0.0442	0.0743	0.0299	0.0455	0.0377	0.0245	0.0342	0.0526	0.108	0.05	0.0364	0.0267	no	--	no	14
71A	MYTI EDU	SB	d.w.			0.393	0.242	0.218	0.247	0.12	0.34	0.249	0.182	0.145	0.178	0.14	0.212	0.201	0.222	0.312	0.11	0.155	0.132	0.123	0.15	0.154	0.189	0.177	0.18	0.133	no	D-	no	11
76A	MYTI EDU	SB	d.w.										0.0709	0.0682	0.0498	0.0205			0.057	0.0824	0.0632	0.101	0.0328	0.0634	0.0585	0.0843	0.101	0.0824	0.0579	0.0824	no	--	no	13
15A	MYTI EDU	SB	d.w.										0.0561	0.0522		0.0244	0.0503	0.0217	0.0488	0.0558	0.0529	0.0437	0.163	0.0354	0.0452	0.0596	0.0946	0.075	0.0632	0.0471	no	--	no	15
51A	MYTI EDU	SB	d.w.							0.24	0.25							1.51	0.901	0.175	0.577	2.89	3.86	0.774	1.45	1.47	0.304	0.607	0.231	0.292	1.5	--	no	22
52A	MYTI EDU	SB	d.w.									2.35	0.321	3.01	0.976	0.372	0.282	0.437	0.178	0.26	0.258	0.58	0.34	0.298	0.264	0.195	0.228	0.163	0.135	0.244	1.2	D-	no	18
56A	MYTI EDU	SB	d.w.							0.53	0.37	1.09	0.71	1.54	0.935	1.22	0.352	0.679	0.365	0.526	0.282	0.917	0.982	0.611	0.602	0.346	0.235	0.358	0.336	0.294	1.5	D-	1.2	14
57A	MYTI EDU	SB	d.w.							0.17	0.21	0.269	0.411	0.758	0.576	0.349	0.35	0.26	0.155	0.319	0.166	0.467	0.451	0.349	0.277	0.193	0.115	0.229	0.229	0.139	no	DY	no	13
63A	MYTI EDU	SB	d.w.							0.31	0.14	0.177	0.394	0.468	0.294	0.143	0.19	0.252	0.172	0.203	0.226	0.268	0.299	0.365	0.289	0.213	0.0695	0.18	0.187	0.194	no	--	no	14
65A	MYTI EDU	SB	d.w.							0.1	0.15	0.104	0.312	0.328	0.124	0.119	0.134	0.148	0.118	0.136	0.0792	0.142	0.155	0.189	0.132	0.135	0.0638	0.133	0.156	0.114	no	--	no	13
69A	MYTI EDU	SB	d.w.												0.106	0.0263	0.0829	0.0704	0.104	0.111	0.0773	0.161	0.107	0.146	0.106	0.0989	0.0586	0.1	0.0778	0.0882	no	--	no	14
22A	MYTI EDU	SB	d.w.										0.0529	0.0732	0.112	0.0476	0.0673	0.0657	0.0723	0.0683	0.046	0.0736	0.0288	0.0545	0.0461	0.126	0.161	0.125	0.106	0.127	no	UY	no	13
23A	MYTI EDU	SB	d.w.										0.0543	0.0759													0.0855	0.107			no	-?	?	9
24A	MYTI EDU	SB	d.w.										0.0578	0.0748													0.0903	0.075			no	-?	?	8
82A	MYTI EDU	SB	d.w.				0.0508	0.11	0.17	0.08	0.12	0.0668		0.0743	0.0519	0.0787		0.0493	0.0691								0.0508	0.0941			no	--	no	13
84A	MYTI EDU	SB	d.w.				0.0766	0.112	0.15	0.08	0.24	0.0571		0.0657	0.0902	0.0568		0.0542	0.0433								0.0511	0.0824			no	--	no	15
87A	MYTI EDU	SB	d.w.				0.178		0.15	0.05	0.26	0.0462		0.0564	0.0543	0.0488		0.0439	0.0623								0.0467	0.045			no	--	no	18
25A	MYTI EDU	SB	d.w.												0.141	0.0368											0.0952	0.0727			no	-?	?	19
26A	MYTI EDU	SB	d.w.												0.0959	0.0459											0.0843	0.0789			no	-?	?	14
27A	MYTI EDU	SB	d.w.												0.107												0.0824	0.0722			no	-?	?	6
28A	MYTI EDU	SB	d.w.												0.0765	0.0619											0.0851	0.125			no	-?	?	10
91A	MYTI EDU	SB	d.w.												0.0539	0.0758	0.0943											0.0647			no	-?	?	12
92A1	MYTI EDU	SB	d.w.												0.0548	0.0335	0.0521	0.0407	0.0234	0.067											no	--	no	14
93A	MYTI EDU	SB	d.w.												0.0679	0.118											0.202	0.126			no	-?	?	13
94A	MYTI EDU	SB	d.w.												0.082	0.0631											0.0508	0.0591			no	-?	?	8
95A	MYTI EDU	SB	d.w.												0.0765	0.0598											0.0526	0.0667			no	-?	?	9
96A	MYTI EDU	SB	d.w.												0.0481	0.0304											0.039	0.04			no	-?	?	10
97A	MYTI EDU	SB	d.w.												0.0765	0.0703											0.0594	0.0619			no	-?	?	<=5
98A2	MYTI EDU	SB	d.w.																	0.104		0.246	0.109	0.109	0.115	0.14	0.0817	0.08	0.0889	0.075	no	--	no	12
98X	MYTI EDU	SB	d.w.														0.335	0.34	0.328												1.6	-?	?	<=5
99A	MYTI EDU	SB	d.w.												0.0881	0.0487											0.0552	0.0588			no	-?	?	12
41A	MYTI EDU	SB	d.w.														0.0686	0.0635	0.064	0.0848									0.05	0.0471	no	--	no	8
42A	MYTI EDU	SB	d.w.														0.0449	0.0492											0.0348	0.0333	no	D?	?	<=5
43A	MYTI EDU	SB	d.w.														0.0844	0.0946		0.104									0.075	0.0733	no	-?	?	7
44A	MYTI EDU	SB	d.w.														0.0552	0.05	0.0517	0.0592									0.0444	0.045	no	--	no	6
45A	MYTI EDU	SB	d.w.														0.0819	0.0667											0.0474	0.05	no	D?	?	7
46A	MYTI EDU	SB	d.w.														0.0387	0.0618	0.0564										0.04	0.0227	no	-?	?	12
47A	MYTI EDU	SB	d.w.														0.064	0.0425											0.0579	0.0368	no	-?	?	12
48A	MYTI EDU	SB	d.w.														0.0726	0.0599	0.0524										0.125	0.1	no	-?	?	10
49A	MYTI EDU	SB	d.w.														0.0651	0.0543											0.0474	0.0389	no	-?	?	7
10A2	MYTI EDU	SB	d.w.																0.0588	0.0617	0.0581	0.0625	0.0503	0.052	0.0494	0.0549	0.0503	0.0368	0.0412	0.0391	no	D-	no	6
11X	MYTI EDU	SB	d.w.																	0.0811	0.0366	0.0564	0.0667	0.065	0.0372	0.0372	0.037	0.0429	0.0389	0.0421	no	--	no	11

Annual median concentration of HG (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				0.118	0.073	0.147	0.05	0.13	0.0437	0.0641	0.0533	0.0508	0.0703	0.0865	0.0574	0.07	0.0604	0.0778	0.114	0.0599	0.0586	0.0952	0.071	0.153	0.113	0.1	0.0765	no	--	no	13
71A	MYTI EDU	SB	d.w.			0.393	0.242	0.218	0.247	0.12	0.34	0.249	0.182	0.145	0.178	0.14	0.212	0.201	0.222	0.312	0.11	0.155	0.132	0.123	0.15	0.154	0.189	0.177	0.18	0.133	no	D-	no	11
51A	MYTI EDU	SB	d.w.							0.24	0.25							1.51	0.901	0.175	0.577	2.89	3.86	0.774	1.45	1.47	0.304	0.607	0.231	0.292	1.5	--	no	22
52A	MYTI EDU	SB	d.w.									2.35	0.321	3.01	0.976	0.372	0.282	0.437	0.178	0.26	0.258	0.58	0.34	0.298	0.264	0.195	0.228	0.163	0.135	0.244	1.2	D-	no	18
10A2	MYTI EDU	SB	d.w.																0.0588	0.0617	0.0581	0.0625	0.0503	0.052	0.0494	0.0549	0.0503	0.0368	0.0412	0.0391	no	D-	no	6
I021	MYTI EDU	SB	d.w.															0.212	0.397	0.496	0.859		0.356	0.436	0.319						1.6	--	no	13
I022	MYTI EDU	SB	d.w.															0.13	0.134	0.321	0.404	0.415	0.182	0.238	0.289	0.197	0.155	0.243	0.215	0.242	1.2	--	1.2	12
I023	MYTI EDU	SB	d.w.															0.14	0.143	0.295	0.31	0.263	0.0944	0.0959	0.15	0.142	0.129	0.164	0.177	0.138	no	--	no	13
I024	MYTI EDU	SB	d.w.															0.107	0.18	0.45	0.543	0.425	0.12	0.295	0.238	0.233	0.21	0.291	0.275	0.225	1.1	--	1.3	15
I301	MYTI EDU	SB	d.w.															0.0656	0.0682	0.0582	0.0675	0.0625	0.0408	0.0677	0.05	0.0732	0.114	0.125	0.0929	0.0778	no	U-	no	10
I304	MYTI EDU	SB	d.w.															0.047	0.0694	0.0395	0.0541	0.0503	0.0294	0.0513	0.0462	0.0491	0.063	0.0702	0.0615	0.0471	no	--	no	10
I306	MYTI EDU	SB	d.w.															0.0447	0.0617	0.0387	0.061	0.0508	0.0355	0.0353	0.0403	0.0507	0.0744	0.069	0.05	0.05	no	--	no	10
I307	MYTI EDU	SB	d.w.															0.0383	0.0705	0.0337	0.0465	0.0542	0.0327	0.0488	0.0541	0.062	0.0893	0.0952	0.0438	0.0438	no	--	no	12
I711	MYTI EDU	SB	d.w.																		0.382	0.287	0.198		0.2						no	-?	?	9
I712	MYTI EDU	SB	d.w.																		0.181	0.257	0.214	0.218	0.211	0.145	0.178	0.184	0.218	0.163	no	--	no	9
I713	MYTI EDU	SB	d.w.																						0.111	0.177	0.157	0.108	0.164	0.117	no	--	no	11
I131A	MYTI EDU	SB	d.w.															0.127	0.0691	0.0601	0.144	0.0635	0.0337	0.0784	0.0503	0.0652	0.1	0.0634	0.0786	0.0533	no	--	no	14
I201	MYTI EDU	SB	d.w.																		0.101	0.132	0.157	0.169	0.313	0.0964	0.13	0.291	0.215	0.292	1.5	--	1.9	14
I205	MYTI EDU	SB	d.w.																		0.0974	0.171	0.205	0.167	0.218	0.151	0.142	0.306	0.285	0.267	1.3	--	2.0	11
I965	MYTI EDU	SB	d.w.																						0.2	0.0904	0.168	0.124	0.107	0.123	no	--	no	12
I964	MYTI EDU	SB	d.w.																						0.136	0.0592	0.0494	0.155	0.17	0.163	no	--	1.1	17
I969	MYTI EDU	SB	d.w.																						0.0632	0.0419	0.0359	0.103	0.0421	0.0667	no	--	no	15

Annual median concentration of HG (ppm)
Cursive values indicate temporal trend analysis based on data since 1998

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	MU	w.w.				0.14	0.09	0.0732	0.0382	0.112	0.13	0.12	0.09	0.12	0.133	0.123	0.105	0.134	0.155	0.195	0.201	0.217	0.26	0.15	0.163	0.134	0.147	0.225	0.17	1.7	U-	2.1	11
30B	GADU MOR	MU	w.w.																		*0.195*	*0.201*	*0.217*	*0.26*	*0.15*	*0.163*	*0.134*	*0.147*	*0.225*	*0.17*	*1.7*	--	*2.1*	*9*
36B	GADU MOR	MU	w.w.	0.0729	0.09	0.12	0.134	0.0995	0.0905	0.0352	0.0644	0.0708	0.1	0.08	0.07	0.079	0.056	0.081	0.068	0.113	0.089	0.094	0.072	0.083	0.082	0.043	0.053	0.085	0.094	0.081	no	--	1.1	11
15B	GADU MOR	MU	w.w.										0.09	0.06	0.042	0.023	0.059	0.0445	0.071	0.089	0.073	0.024	0.046	0.071	0.043	0.035	0.024	0.035	0.034	0.037	no	--	no	14
53B	GADU MOR	MU	w.w.						0.196		0.105	0.18	0.17	0.22	0.392	0.146		0.066	0.238	0.217	0.227	0.227	0.328	0.51	0.28	0.114	0.183	0.176	0.129	0.223	2.2	--	1.8	15
67B	GADU MOR	MU	w.w.							0.115	0.0847	0.0957	0.12	0.125	0.109	0.0925	0.113	0.071	0.087	0.124	0.053	0.059	0.085	0.069	0.064	0.042	0.035	0.058	0.045	0.055	no	D-	no	10
23B	GADU MOR	MU	w.w.										0.11	0.09	0.07	0.062	0.058	0.081	0.058	0.082	0.088	0.079	0.092	0.086	0.089	0.067	0.096	0.08	0.096	0.114	1.1	UY	1.3	8
84B	GADU MOR	MU	w.w.				0.05	0.04	0.0246		0.0439																				no	-?	?	13
92B	GADU MOR	MU	w.w.													0.057	0.087	0.077	0.093								0.058	0.054			no	--	no	10
98B1	GADU MOR	MU	w.w.												0.067	0.0615	0.068	0.074	0.038	0.107	0.081	0.043			0.047	0.064	0.117	0.059	0.071		no	--	no	13
43B	GADU MOR	MU	w.w.														0.056	0.057	0.048												no	-?	?	6
10B	GADU MOR	MU	w.w.														0.044	0.041	0.037	0.018	0.016	0.02	0.012	0.009	0.012	0.016	0.015	0.018	0.019	0.018	no	DY	no	10

Annual median concentration of HG (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	MU	w.w.			0.12		0.09	0.0769	0.019	0.0694		0.18	0.11	0.126	0.081	0.074	0.051	0.052	0.0795	0.049	0.078	0.05	0.049	0.042	0.038	0.036	0.045	0.031	0.071	no	DY	no	13
53F	PLAT FLE	MU	w.w.								0.111	0.107	0.12	0.14	0.124	0.104		0.0352	0.207	0.185	0.201	0.159	0.259	0.338	0.625	0.5	0.328	0.845		0.231	2.3	U-	no	15
67F	PLAT FLE	MU	w.w.																0.18		0.0555	0.037	0.069	0.05	0.057	0.066	0.064	0.061	0.041	0.045	no	D-	no	11
21F	PLAT FLE	MU	w.w.																			0.075	0.078	0.04	0.042		0.021	0.046	0.043		no	--	no	13
36F	LIMA LIM	MU	w.w.										0.07	0.06	0.086	0.078	0.056	0.058	0.073	0.038	0.09	0.054	0.066	0.053	0.068	0.061	0.074	0.12	0.1	0.111	1.1	--	1.6	10
15F	LIMA LIM	MU	w.w.											0.09		0.0359	0.036	0.034	0.056	0.055	0.049	0.0459		0.064	0.07	0.045	0.082	0.115	0.074	0.076	no	U-	no	11
22F	LIMA LIM	MU	w.w.										0.13	0.08	0.257		0.082	0.153													1.5	-?	?	17
21F	LIMA LIM	MU	w.w.																						0.021	0.006	0.084	0.009		0.137	1.4	-?	?	>25
30F	PLEU PLA	MU	w.w.												0.0451		0.038	0.039													no	-?	?	<=5
22F	PLEU PLA	MU	w.w.																0.045	0.051	0.074										no	-?	?	7
98F2	PLEU PLA	MU	w.w.																				0.115	0.072	0.032	0.041	0.016	0.0732	0.045		no	--	no	17
10F	PLEU PLA	MU	w.w.																	0.038		0.0216	0.029	0.023	0.023	0.0155	0.0273	0.024		0.0364	no	--	no	10
67F	LEPI WHI	MU	w.w.			0.39				0.35	0.329	0.253	0.52	0.07	0.174	0.205	0.477	0.379	0.418	0.284	0.11	0.154	0.114	0.111	0.123	0.131	0.199	0.096	0.108	0.09	m	D-	m	15
21F	LEPI WHI	MU	w.w.																							0.122	0.19	0.192	0.215	0.203	m	-?	m	8

Annual median concentration of PB (ppm)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.										1.86	1.36	3.95	2.27	2.54	1.58	2.12	2.69	36.7	2.13	1.74	1.76	2.24	2.58	3.74	3.38	4.12	3.06	1.0	--	1.4	20
31A	MYTI EDU	SB	d.w.										1.38	1.21	1.26	1.03	1.37	1.68	1.79	0.732	1.54	0.629	0.629	0.51	1.43	0.805	0.781	0.869	0.855	0.647	no	--	no	12
35A	MYTI EDU	SB	d.w.										1.44	1.07	1.68	1.2	1.28	0.507	0.628	0.664	0.759	0.714	0.522	0.866	0.571	0.574	0.813	1.21	0.805	0.571	no	D-	no	11
36A	MYTI EDU	SB	d.w.										1.01	0.847	0.787	1.12	1.39	1.24	2.04	2.17	1.57	0.995	0.943	0.618	0.449	0.585	0.956	0.578	0.559	1.13	no	DY	no	11
71A	MYTI EDU	SB	d.w.										1.16	0.745	1.72	1.42	1.92	1.49	2.21	2.83	0.867	0.903	0.774	1.45	0.919	0.915	0.866	0.962	0.98	0.797	no	--	no	12
76A	MYTI EDU	SB	d.w.										1.77	0.968	1.5	0.913			0.796	1.84	1.23	1.99	0.602	0.829	0.766	0.938	1.48	0.778	1.19	1.06	no	--	no	13
15A	MYTI EDU	SB	d.w.										1.46	0.777		0.976	1.05	0.522	0.671	1.12	1.28	1.66	2.2	0.96	0.714	0.76	0.857	1.66	0.781	1.06	no	--	no	13
51A	MYTI EDU	SB	d.w.															149	60.3	17.2	29.6	37.1	91.7	32.4	98.4	108	42.2	77.5	17.6	29.8	9.9	--	no	18
52A	MYTI EDU	SB	d.w.										12.1	313	189	65.5	16.4	17.5	9.84	20.6	14.7	11.6	11	21.8	21.8	16.9	16.3	9.27	8.44	15.8	5.3	--	2.5	22
56A	MYTI EDU	SB	d.w.										20.7	23.4	121	109	24.7	46.4	27.8	37.5	15.7	30.3	28.5	30.5	42.9	27.8	24.7	32	28.9	21.4	7.1	--	6.2	16
57A	MYTI EDU	SB	d.w.										10.5	12.1	33.3	19.2	15.1	13.2	5.6	13.7	6.15	10.4	10.3	11.9	9.59	7.02	5.79	11.3	10.4	4.57	1.5	--	1.8	14
63A	MYTI EDU	SB	d.w.										12.1	10.1	15.4	10.9	7.22	12.1	7.6	6.1	6.39	4.84	4.52	7.05	6.57	6.3	1.92	4.53	5.36	4.05	1.4	D-	1.3	13
65A	MYTI EDU	SB	d.w.										5.61	3.78	5.19	6.53	3.28	4.73	2.41	3	1.77	1.63	2.45	2.84	3.05	2.82	1.25	3	4.01	1.56	no	D-	no	13
69A	MYTI EDU	SB	d.w.												4.62	3.42	2.8	3.17	4.02	3.66	1.98	3.4	2.27	3.91	2.76	2.53	0.957	1.74	2.01	1.65	no	D-	no	12
22A	MYTI EDU	SB	d.w.										1.37	1.46	2.78	1.87	1.39	1.18	1.51	1.37	1.21	1.7	1.3	1.21	0.884	1.46	1.79	1.88	1.31	2.6	no	--	no	11
23A	MYTI EDU	SB	d.w.										1.42	1.47													0.878	2.13			no	-?	?	15
24A	MYTI EDU	SB	d.w.										1.42	1.21													2.01	1.44			no	-?	?	9
82A	MYTI EDU	SB	d.w.											1.28	0.933	0.916		0.622	0.674								0.558	0.529			no	--	no	7
84A	MYTI EDU	SB	d.w.											1.01	1.15	1.38		1.38	0.833								1.11	1			no	--	no	9
87A	MYTI EDU	SB	d.w.											0.974	0.87	0.634		1.4	2.47								0.421	0.3			no	--	no	13
25A	MYTI EDU	SB	d.w.												2.68	1.77											2.01	1.09			no	-?	?	13
26A	MYTI EDU	SB	d.w.												1.42	1.38											1.87	1.4			no	-?	?	8
27A	MYTI EDU	SB	d.w.												1.83												0.941	0.833			no	D?	?	<=5
28A	MYTI EDU	SB	d.w.												1.39	1.87											0.957	1.29			no	-?	?	10
91A	MYTI EDU	SB	d.w.												0.898	1.46	2.01											0.778			no	-?	?	15
92A1	MYTI EDU	SB	d.w.												0.933	0.628	1.09	0.664	0.654	2.18											no	--	no	16
93A	MYTI EDU	SB	d.w.												1.14	1.62											2.13	1.05			no	-?	?	14
94A	MYTI EDU	SB	d.w.												0.765	1.18											0.305	0.482			no	-?	?	13
95A	MYTI EDU	SB	d.w.												1.04	2.16											0.585	0.463			no	-?	?	14
96A	MYTI EDU	SB	d.w.												1.13	0.988											0.488	0.835			no	-?	?	12
97A	MYTI EDU	SB	d.w.												1.37	1.26											0.495	0.47			no	D?	?	<=5
98A2	MYTI EDU	SB	d.w.																	1.54		1.59	1.49	1.34	0.892	1.16	1.09	0.54	0.667	0.699	no	D-	no	10
98X	MYTI EDU	SB	d.w.														4.34	3.12	4.11												1.4	-?	?	11
99A	MYTI EDU	SB	d.w.												1.2	0.752											0.697	0.529			no	-?	?	11
41A	MYTI EDU	SB	d.w.														1.29	0.9	0.793	0.651									0.63	0.356	no	Dm	no	11
42A	MYTI EDU	SB	d.w.														1.54	0.761											0.557	0.384	no	-?	?	13
43A	MYTI EDU	SB	d.w.														1.56	1.51		0.855									0.713	0.572	no	D?	?	10
44A	MYTI EDU	SB	d.w.														2.81	2.57	1.66	1.15									0.82	1.81	no	--	no	14
45A	MYTI EDU	SB	d.w.														1.1	1.99											0.69	0.639	no	-?	?	12
46A	MYTI EDU	SB	d.w.														1.26	1.57	1.38										0.87	0.681	no	D?	?	8
47A	MYTI EDU	SB	d.w.														1.09	1.18											0.603	0.675	no	D?	?	7
48A	MYTI EDU	SB	d.w.														0.682	1.08	0.333										0.451	0.448	no	-?	?	15
49A	MYTI EDU	SB	d.w.														2.38	7.65											2.73	1.87	no	-?	?	18
10A2	MYTI EDU	SB	d.w.																0.735	0.807	2.34	1.57	1.44	1.39	1.8	1.65	1.02	0.674	0.988	1.63	no	--	no	13
11X	MYTI EDU	SB	d.w.																	0.743	0.521	0.314	1.09	2.32	0.74	0.279	0.37	0.323	0.539	0.331	no	--	no	18

Annual median concentration of PB (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.										1.86	1.36	3.95	2.27	2.54	1.58	2.12	2.69	36.7	2.13	1.74	1.76	2.24	2.58	3.74	3.38	4.12	3.06	1.0	--	1.4	20
71A	MYTI EDU	SB	d.w.										1.16	0.745	1.72	1.42	1.92	1.49	2.21	2.83	0.867	0.903	0.774	1.45	0.919	0.915	0.866	0.962	0.98	0.797	no	--	no	12
51A	MYTI EDU	SB	d.w.															149	60.3	17.2	29.6	37.1	91.7	32.4	98.4	108	42.2	77.5	17.6	29.8	9.9	--	no	18
52A	MYTI EDU	SB	d.w.										12.1	313	189	65.5	16.4	17.5	9.84	20.6	14.7	11.6	11	21.8	21.8	16.9	16.3	9.27	8.44	15.8	5.3	--	2.5	22
10A2	MYTI EDU	SB	d.w.																0.735	0.807	2.34	1.57	1.44	1.39	1.8	1.65	1.02	0.674	0.988	1.63	no	--	no	13
I021	MYTI EDU	SB	d.w.															1.06	2.29	1.65	2.12		0.99	1.65	1.19						no	--	no	13
I022	MYTI EDU	SB	d.w.															1	0.599	1.18	1.31	1.94	1.05	0.952	1.27	1.36	3.51	1.26	1.34	1.67	no	--	no	14
I023	MYTI EDU	SB	d.w.															0.774	1.27	1.38	1.7	1.38	0.636	0.616	0.754	1.28	2.34	0.901	1.05	0.846	no	--	no	13
I024	MYTI EDU	SB	d.w.															0.971	1.1	1.16	1.7	1.79	0.617	1.33	1.1	1.73	2.68	1.06	1.18	0.917	no	--	no	13
I301	MYTI EDU	SB	d.w.																		2.47	2.11	1.32	3.16	1.98	1.77	3.07	2.15	5.38	2.94	no	--	1.7	13
I304	MYTI EDU	SB	d.w.																		2.23	1.19	0.765	1.88	1.3	1.16	1.73	1.95	2.16	1.59	no	--	no	13
I306	MYTI EDU	SB	d.w.																		1.34	0.678	0.542	1.03	0.658	0.704	1.08	1.09	0.938	0.867	no	--	no	12
I307	MYTI EDU	SB	d.w.																		1.05	0.798	0.513	1.01	1.26	1.01	1.07	1.39	1.04	0.875	no	--	no	11
I201	MYTI EDU	SB	d.w.															3.54	4.39	4.77	4.67	4.43	6.41	3.78	8.21	1.87	3.33	4.31	3.41	4.75	1.6	--	1.6	13
I205	MYTI EDU	SB	d.w.															4.77		6.96	4	5.97	7.09	6.15	9.27	3.4	2.76	6.3	5.26	3.33	1.1	--	1.2	14
I965	MYTI EDU	SB	d.w.																					20	12.7	6.45	13.1	12.5	13.7	16.6	5.5	--	6.8	13
I962	MYTI EDU	SB	d.w.															4.44	5.34	3.55	2.99										no	-?	?	9
I964	MYTI EDU	SB	d.w.																						8.75	3.49	6.57	13	13.3	13.7	4.6	--	7.2	15
I969	MYTI EDU	SB	d.w.															2.47	2.08	1.62	2.91	5.13	3	2.57	2.58	1.85	1.59	3.92	2.11	1.94	no	--	no	13

Annual median concentration of PB (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.										0.2	0.115	0.249	0.105	0.12	0.11	0.06	0.0949	0.163	0.85	0.24	0.22	0.513	0.24	0.17	0.138	0.101	0.29	2.9	--	1.3	17
36B	GADU MOR	LI	w.w.										0.115	0.05	0.03	0.02	0.03	0.02	0.03	0.04	0.03	0.04	0.04	0.03	0.0061	0.02	0.02	0.02	0.02	0.02	no	D-	no	14
15B	GADU MOR	LI	w.w.										0.17	0.06	0.03	0.03	0.03	0.02	0.03	0.04	0.03	0.03	0.04	0.03	0.01	0.02	0.02	0.02	0.02	0.02	no	DY	no	13
53B	GADU MOR	LI	w.w.										0.19	0.26	0.14	0.03		0.02	0.0748	0.07	0.105	0.115	0.13	0.13	0.142	0.04	0.09	0.082	0.0453	0.1	1.0	DY	no	16
67B	GADU MOR	LI	w.w.										0.13	0.18	0.03	0.0748	0.09	0.04	0.04	0.09	0.03	0.04	0.04	0.03	0.0149	0.02	0.02	0.0075	0.02	0.02	no	D-	no	16
23B	GADU MOR	LI	w.w.										0.06	0.08	0.03	0.03	0.03	0.02	0.03	0.04	0.03	0.04	0.03	0.03	0.0061	0.02	0.02	0.02	0.0423	0.02	no	--	no	15
92B	GADU MOR	LI	w.w.													0.02	0.03	0.03	0.04								0.02	0.02			no	--	no	11
98B1	GADU MOR	LI	w.w.												0.03	0.03	0.03	0.04	0.04	0.05	0.03	0.03			0.01	0.02	0.02	0.02	0.02		no	DY	no	10
43B	GADU MOR	LI	w.w.														0.03	0.03	0.03												no	-?	?	<=5
10B	GADU MOR	LI	w.w.														0.03	0.02	0.04	0.04	0.04	0.03	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	no	D-	no	9

Annual median concentration of PB (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	LI	w.w.										0.24	0.35	0.06	0.03	0.03	0.02	0.03	0.04	0.04	0.04	0.04	0.03	0.0295	0.03	0.02	0.03	0.0439	0.02	no	DY	no	13
53F	PLAT FLE	LI	w.w.										0.71	0.81	0.41	0.23		0.0245	0.46	0.35	0.52	0.46	0.357	0.57	1.29	0.73	0.44	1.35		0.56	1.9	--	1.5	21
67F	PLAT FLE	LI	w.w.																0.35		0.03	0.03	0.03	0.03	0.0078	0.02	0.02	0.02	0.02	0.02	no	DY	no	16
21F	PLAT FLE	LI	w.w.																			0.04	0.0447	0.06	0.0461		0.04	0.1	0.11		no	--	no	12
36F	LIMA LIM	LI	w.w.										0.6	0.07	0.04	0.07	0.03	0.02	0.03	0.05	0.05	0.05	0.06	0.04	0.0477	0.03	0.05	0.05	0.0473	0.05	no	DY	no	15
15F	LIMA LIM	LI	w.w.											0.07		0.0408	0.03	0.02	0.03	0.05	0.04	0.0346		0.05	0.0212	0.02	0.03	0.03	0.037	0.02	no	--	no	12
22F	LIMA LIM	LI	w.w.										0.25	0.16	0.0424		0.06	0.07													no	-?	?	18
21F	LIMA LIM	LI	w.w.																						0.0293	0.02	0.05	0.02		0.08	no	-?	?	17
30F	PLEU PLA	LI	w.w.												0.739		0.54	0.57													2.9	-?	?	7
22F	PLEU PLA	LI	w.w.																0.28	0.28	0.46										2.3	-?	?	9
98F2	PLEU PLA	LI	w.w.																				0.104	0.04	0.0682	0.04	0.02	0.204	0.15		no	--	1.1	21
10F	PLEU PLA	LI	w.w.																	0.15		0.0648	0.08	0.05	0.0583	0.0447	0.0447	0.03		0.0346	no	D-	no	10
67F	LEPI WHI	LI	w.w.										0.19	0.07	0.06	0.07	0.04	0.07	0.03	0.04	0.04	0.03	0.03	0.04	0.0312	0.02	0.0245	0.02	0.02	0.02	m	D-	m	11
21F	LEPI WHI	LI	w.w.																							0.02	0.02	0.02	0.031	0.02	m	-?	m	10

Annual median concentration 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	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				4.57		7.45	4.96	5.48	5.97	10.3	10.5	5.84	6.67	8.56	6.94	7.69	9.47	7.72	8.01	6.49	5.81	6.29	7.68	8.55	9.31	8.2	7.35	no	--	no	9
31A	MYTI EDU	SB	d.w.			7.03	6.57			4.44	4.52	4.51	9.04	11	5.49	5.67	6.21	7.26	6.61	6.08	8.08	7.55	5.54	5.82	5.47	6.31	6.73	6.86	8.4	6.38	no	--	no	9
35A	MYTI EDU	SB	d.w.			6.32	3.62		8.06	4.89	4.58	5.26	8.02	10.1	6.56	6.34	6.61	6.41	6.94	6.81	7.23	7.14	5.49	6.19	6.51	7.38	8.31	7.94	6.55	5.57	no	--	no	10
36A	MYTI EDU	SB	d.w.			6.29	3.57		6.08	4.47	4.87	4.3	5.5	9.23	5.16	5.51	5.63	7.67	9.06	6.86	6.83	6.2	5.52	5.83	5.21	6.32	6.96	6.24	6.27	6.19	no	--	no	9
71A	MYTI EDU	SB	d.w.			8.47	5.24			6.08	8.43	6.99	8.33	10.3	7.4	7.88	7.18	8.11	7.66	9.44	7.5	7.57	8.81	7.53	7.12	11.2	8.81	8.93	10.1	8.13	no	--	no	8
76A	MYTI EDU	SB	d.w.										8.51	10.8	5.65	5.57			6.65	7.8	9.14	10.2	6.93	7.67	6.39	9.76	7.99	7.76	7	6.29	no	--	no	9
15A	MYTI EDU	SB	d.w.										5.72	7.21		5.5	5.25	5.26	7.32	6.14	7.62	7.34	7.62	9.47	5.68	8.07	6.47	6.81	6.81	7.59	no	--	no	8
51A	MYTI EDU	SB	d.w.							7.14	6.14							10.2	10.2	7.44		8.21									no	--	1.0	9
52A	MYTI EDU	SB	d.w.									8.4	7.49	72.1	9.35	8.45	6.98	7.03	6.28	7.73	6.47	5.53	6.97	5.88	7.45	9.19	6.21	7.47	5.56	8.11	no	--	no	17
56A	MYTI EDU	SB	d.w.							8.07	7.87	8.82	5.37	7.54	7.4	9.15	6.36	7.71	6.59	7.79	7.18	8.17	8.72	5.77	6	9.1	5.36	8	7.47	5.61	no	--	no	9
57A	MYTI EDU	SB	d.w.							8.21	6.33	6.01	6.16	7.27	6.59	6.77	6.43	5.62	5.54	6.98	6.91	6.39	5.13	5.81	7.21	5.98	3.26	6.88	8.29	4.33	no	--	no	10
63A	MYTI EDU	SB	d.w.							9.84	6.16	5.11	6.84	11.1	6.32	6.11	6.71	6.84	6.56	6.12	5.61	5.13	5.69	5.46	6.67	7.95	2.39	6.27	7	5.57	no	--	no	12
65A	MYTI EDU	SB	d.w.							7.98	4.94	5.19	12.2	8.14	5.51	6	5.12	5.66	5.82	5.59	5.14	5.05	5.27	5.93	6.54	7.71	2.81	6.94	6.76	4.62	no	--	no	12
69A	MYTI EDU	SB	d.w.												6.19	5.32	5.41	6.26	7.28	5.56	5.22	7.22	8.51	6.82	5.81	12.6	3.06	5.84	5.55	6.06	no	--	no	12
22A	MYTI EDU	SB	d.w.										6.35	6.69	5.38	5.76	6.28	6.81	9.29	4.16	8.56	7.47	8.54	5.27	5.86	7.81	14.9	6.82	8.72	145	14.5	U-	8.5	17
23A	MYTI EDU	SB	d.w.										5.58	6.52													6.64	6.93			no	-?	?	6
24A	MYTI EDU	SB	d.w.										5.78	7.01													6.78	5.91			no	-?	?	7
82A	MYTI EDU	SB	d.w.				6.38			4.69	5.77	7.49		11.8	6.87	9.61		7.44	7.93								5.52	6.94			no	--	no	10
84A	MYTI EDU	SB	d.w.				10.3		96.8	56.8	39.3	26.8		17.1	22.2	24		9.51	7.21								8.07	8.39			no	--	1.1	17
87A	MYTI EDU	SB	d.w.				4.57			20.1	8.35	5.88		7.28	6.3	6.88		7.63	7.52								6.92	5.95			no	--	no	13
25A	MYTI EDU	SB	d.w.												6.48	5.77											6.48	6.05			no	-?	?	6
26A	MYTI EDU	SB	d.w.												6.98	6.28											6.41	6.75			no	-?	?	<=5
27A	MYTI EDU	SB	d.w.												6.92												5.89	5.52			no	-?	?	<=5
28A	MYTI EDU	SB	d.w.												5.36	5.18											5.69	8.12			no	-?	?	9
91A	MYTI EDU	SB	d.w.												6.59	6.36	8.36											7.33			no	-?	?	8
92A1	MYTI EDU	SB	d.w.												6.65	6.03	7.56	6.26	7.48	6.4											no	--	no	7
93A	MYTI EDU	SB	d.w.												6.46	6.79											7.93	8.11			no	U?	?	<=5
94A	MYTI EDU	SB	d.w.												6.81	6.72											6.72	5.77			no	-?	?	6
95A	MYTI EDU	SB	d.w.												7.84	6.44											7.95	7.28			no	-?	?	7
96A	MYTI EDU	SB	d.w.												7.22	6.2											6.46	6.68			no	-?	?	6
97A	MYTI EDU	SB	d.w.												8.12	7.01											6.77	7.35			no	-?	?	6
98A2	MYTI EDU	SB	d.w.																	5.5		5.94	6.84	6.1	6.58	7.22	8.34	7.13	8.2	5.94	no	--	no	7
98X	MYTI EDU	SB	d.w.														8.99	8.91	7.74												no	-?	?	<=5
99A	MYTI EDU	SB	d.w.												8.65	7.29											6.72	7.11			no	-?	?	6
41A	MYTI EDU	SB	d.w.														6.83	8.16	7.64	4.76									7.5	7.29	no	--	no	10
42A	MYTI EDU	SB	d.w.														7.4	7.61											7.09	6.33	no	-?	?	<=5
43A	MYTI EDU	SB	d.w.														7.79	9.32		6.32									9.38	5.84	no	-?	?	11
44A	MYTI EDU	SB	d.w.														6.56	9.56	7.78	6.86									9.1	5.81	no	--	no	10
45A	MYTI EDU	SB	d.w.														6.22	7.39											5.95	5.89	no	-?	?	6
46A	MYTI EDU	SB	d.w.														6.63	7.43	8										8.15	6.61	no	-?	?	7
47A	MYTI EDU	SB	d.w.														5.7	5.84											6.5	6.32	no	U?	?	<=5
48A	MYTI EDU	SB	d.w.														6.57	7.74	7.1										5.76	5.26	no	D?	?	6
49A	MYTI EDU	SB	d.w.														7.36	9.68											8	6.17	no	-?	?	9
10A2	MYTI EDU	SB	d.w.																7.84	5.71	7.9	6.93	6.17	5.43	6.4	7.42	6.95	6.79	8	6.26	no	--	no	8
11X	MYTI EDU	SB	d.w.																	5.51	5.45	6.49	5.27	5.45	6.51	7.07	6.54	6.1	8.61	5.9	no	--	no	8

Annual median concentration of ZN (ppm)

																															ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				138	90.5	140	120	93.1	76.2	161	116	147	104	117	109	114	126	173	106	93.4	92.3	116	123	141	118	125	106	no	--	no	10
31A	MYTI EDU	SB	d.w.			88.1	132	76.9	106	66.3	67.7	58.1	181	128	125	96.4	96.8	151	103	128	120	112	84	83.1	92.9	127	128	116	108	100	no	--	no	11
35A	MYTI EDU	SB	d.w.			91.9	79.6	75.9	89.8	68.4	81.5	83.2	166	139	131	119	97.6	82.9	94.3	103	112	111	66.1	72.3	84.6	106	131	118	80.5	83.5	no	UY	no	9
36A	MYTI EDU	SB	d.w.			66.5	85.8	66.1	57.7	61.5	73.6	65.3	126	127	104	84	121	115	137	145	105	95.5	125	100	102	125	98.6	90.6	83.6	91.9	no	UY	no	9
71A	MYTI EDU	SB	d.w.			124	125	77	115	101	169	128	162	143	166	120	157	150	122	192	114	114	99.4	97.9	134	121	117	105	95.3	85.6	no	DY	no	9
76A	MYTI EDU	SB	d.w.										158	127	124	57.6			112	135	137	132	83.1	116	123	127	128	107	92.6	121	no	--	no	9
15A	MYTI EDU	SB	d.w.										157	144		71.4	88.9	62.6	232	107	127	105	127	83.3	110	101	114	103	112	102	no	--	no	12
51A	MYTI EDU	SB	d.w.							378	253							386	223	120		170									no	--	no	14
52A	MYTI EDU	SB	d.w.									824	272	453	408	218	141	196	183	247	160	143	134	180	90.6	137	106	104	90.6	106	no	D-	no	12
56A	MYTI EDU	SB	d.w.							869	410	1170	572	479	418	388	211	290	246	377	143	271	225	158	146	151	178	171	140	99.3	no	D-	no	12
57A	MYTI EDU	SB	d.w.							378	263	441	520	292	256	147	173	182	115	223	121	207	167	124	108	98.8	84.4	112	105	63.8	no	D-	no	11
63A	MYTI EDU	SB	d.w.							579	216	241	509	392	207	122	122	189	147	170	129	115	115	127	106	119	54.6	110	113	98.2	no	D-	no	13
65A	MYTI EDU	SB	d.w.							191	156	199	424	308	131	139	118	166	147	184	121	152	154	155	145	151	69.6	139	147	94.8	no	--	no	12
69A	MYTI EDU	SB	d.w.												135	102	135	163	161	218	144	201	133	190	136	177	84	123	92.5	106	no	--	no	10
22A	MYTI EDU	SB	d.w.										172	162	135	116	98	144	221	110	128	122	72.1	117	90.3	134	142	121	88.8	147	no	--	no	11
23A	MYTI EDU	SB	d.w.										136	133													105	113			no	D?	?	<=5
24A	MYTI EDU	SB	d.w.										175	133													130	99.4			no	-?	?	9
82A	MYTI EDU	SB	d.w.				127	106	132	109	76.1	129		145	123	112		109	87.6								81.2	88.2			no	--	no	9
84A	MYTI EDU	SB	d.w.				118	160	163	133	132	142		185	180	113		121	85.8								93	108			no	--	no	9
87A	MYTI EDU	SB	d.w.				100	92.8	97.7	102	105	96.6		117	114	90.2		109	97.2								72.4	75.7			no	--	no	6
25A	MYTI EDU	SB	d.w.												184	117											119	111			no	-?	?	10
26A	MYTI EDU	SB	d.w.												125	118											146	110			no	-?	?	8
27A	MYTI EDU	SB	d.w.												164												128	131			no	-?	?	<=5
28A	MYTI EDU	SB	d.w.												141	96.1											103	174			no	-?	?	12
91A	MYTI EDU	SB	d.w.												96.2	102	116											99.4			no	-?	?	7
92A1	MYTI EDU	SB	d.w.												88.7	61.1	90.2	77.5	59.2	97.8											no	--	no	10
93A	MYTI EDU	SB	d.w.												94.4	95.9											103	89.5			no	-?	?	6
94A	MYTI EDU	SB	d.w.												74.3	81.3											65.9	59.5			no	-?	?	6
95A	MYTI EDU	SB	d.w.												94.7	81											76.6	71.7			no	-?	?	6
96A	MYTI EDU	SB	d.w.												102	71.6											68.3	82			no	-?	?	9
97A	MYTI EDU	SB	d.w.												91.7	91.6											89.6	79			no	-?	?	<=5
98A2	MYTI EDU	SB	d.w.																	89.9		82.1	96	100	84.5	87	88	91.7	81.7	97.9	no	--	no	6
98X	MYTI EDU	SB	d.w.														187	182	146												no	-?	?	6
99A	MYTI EDU	SB	d.w.												107	70.3											84	77.6			no	-?	?	10
41A	MYTI EDU	SB	d.w.														85.1	89	94.8	90.9									81	83.9	no	--	no	<=5
42A	MYTI EDU	SB	d.w.														87.1	80.9											64.3	68.1	no	D?	?	<=5
43A	MYTI EDU	SB	d.w.														98.7	96.6		89.2									75	82.1	no	D?	?	<=5
44A	MYTI EDU	SB	d.w.														67.2	91.3	81	78.8									71.9	85	no	--	no	7
45A	MYTI EDU	SB	d.w.														115	117											97.9	102	no	D?	?	<=5
46A	MYTI EDU	SB	d.w.														88.4	112	93.3										85	73.3	no	-?	?	7
47A	MYTI EDU	SB	d.w.														122	88.2											121	109	no	-?	?	9
48A	MYTI EDU	SB	d.w.														74.9	87	68.8										69.4	73.1	no	-?	?	7
49A	MYTI EDU	SB	d.w.														95.7	101											64.8	66.5	no	D?	?	<=5
10A2	MYTI EDU	SB	d.w.																94.6	114	102	103	125	114	134	100	149	87.4	87.5	100	no	--	no	8
11X	MYTI EDU	SB	d.w.																	104	70.2	81	101	121	89.6	72.4	78.2	80.5	85.6	59.5	no	--	no	9

Annual median concentration of CB_S7 (ppb)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.								77.5	96.5	116	89.6	97		89.3	90.4	110	128	58.5	71.1	49.9	29.6	33.9	43.4	20.7	67.9	28.8	47.7	3.2	D-	3.4	12
31A	MYTI EDU	SB	d.w.								21.7	24.9	37.1	24.7	34.6		52.2	49	63.8	24.6	12.9	18	6.49	8.87	8.97	7.58	3.79	13.8	9.3	5.83	no	DY	no	14
35A	MYTI EDU	SB	d.w.								21.5	33.6	27.5	14.2	22.1		13.4	13.6	10.7	16.5	12.5	14.6	5.52	7.32	6.97	8.2		12.3	4.91	5.06	no	D-	no	12
36A	MYTI EDU	SB	d.w.								11	17.9	19.3	7.94	11.2		5.69	10.5	12.3	12.7	8.62	12.1	5.28	5.54	6.03	5.75	5.58	6.92	3.61	2.94	no	D-	no	12
71A	MYTI EDU	SB	d.w.								17	34.4	25	14.2	15.3		16.5	10.5		9.27	11.8	13.6	8.52	12.7	7.55	9.74		14.3	9.33	9.3	no	D-	no	11
76A	MYTI EDU	SB	d.w.										16.6	6.49	7.21				16.3	19.1	14.4	16.4	6.34	6.78	5.12	5.06		3.29	4.59	4.68	no	DY	no	11
15A	MYTI EDU	SB	d.w.										11.8				6.29	3.06	2.41	3.88	4.72	5.28	2.56	4.19	3.15	2.73	2.74	3.34	2.56	4.38	no	D-	no	11
51A	MYTI EDU	SB	d.w.															26.2	9.69	14.7	10.5	11.5	12	28	16.9	16	10.6	14.5	11.2	11.2	no	--	no	12
52A	MYTI EDU	SB	d.w.									40.2	14.9		11.3	11.3	17.1	16.9	10	19	10.6	11.2	7.19	74.2	12.5	12	10.3	9.97	11.1	15.4	1.0	--	no	17
56A	MYTI EDU	SB	d.w.								12.5	45.8	37.7	12.1	12	9.41	13.8	11.9		16.8	9.55	11.2	5.98	216	13	13.1	6.73	9.33	6.04	9.53	no	--	no	22
57A	MYTI EDU	SB	d.w.									28		7.63	7.55	4.74	8.38	6.54	4.18	8.41	10.3	8.16	3.89	55.9	5.89	6.16	2.89	7.47	4.28	3.74	no	--	no	19
63A	MYTI EDU	SB	d.w.									21.8		9.71	6.45	3.68	5.7	5.72		4.15	7.95	7.26	4.09	13.8	3.54	6.05	1.25	5.3	4.09	5.07	no	--	no	16
65A	MYTI EDU	SB	d.w.								6.05	11.1	33.4	9.29	5.59	3.69	5.55	3.37	5.19	3.76	7.62	6.44	3	8.31	2.73	3.73	1.24	4.75	3.28	3.9	no	--	no	17
69A	MYTI EDU	SB	d.w.												4.82		4.97	4.51	2.77	5.41	12.6	5.83	2.53	5.7	3.18	4.01	1.27	4.03	2.48	2.18	no	--	no	16
22A	MYTI EDU	SB	d.w.										18.9	8.23	8.61		7.97	6.84	5.19	4.69	11.5	6.01	5.14	4.69	3.24	8.5	5.51	8.74	5.76	6.43	no	--	no	13
82A	MYTI EDU	SB	d.w.								8.4	15.6															2.39	3.09			no	-?	?	14
84A	MYTI EDU	SB	d.w.								5.25	20.5		5.05	8.44			3.6	6.37								0.852	5.11			no	--	no	21
87A	MYTI EDU	SB	d.w.								3.9	12.8																3.38			no	-?	?	23
91A	MYTI EDU	SB	d.w.												2.81		7.64											3.14			no	-?	?	20
92A1	MYTI EDU	SB	d.w.												4.46	2.49	5.83	4.05	2.89	7.74											no	--	no	15
96A	MYTI EDU	SB	d.w.												3.35	1.52											0.785	2.83			no	-?	?	21
98A2	MYTI EDU	SB	d.w.																	10.7		4.14	3.54	4.56	3.23	3.62	1.85	2.72	3.27	2.7	no	D-	no	11
98X	MYTI EDU	SB	d.w.														87.3	78.4	46.4												3.1	-?	?	9
99A	MYTI EDU	SB	d.w.												3.42	1.97											0.871	1.29			no	-?	?	13
41A	MYTI EDU	SB	d.w.														3.49	4.26	2.39	2.58									2.35	1.78	no	--	no	10
43A	MYTI EDU	SB	d.w.														2.92	3.1		3.02									2.5	1.57	no	-?	?	9
44A	MYTI EDU	SB	d.w.															7.31	8.46	29.4									15.7	11.1	no	-?	?	18
45A	MYTI EDU	SB	d.w.														6.45	5.31											4.25	2.7	no	-?	?	10
46A	MYTI EDU	SB	d.w.														5.74	4.16	3.11										5.53	2.86	no	-?	?	13
48A	MYTI EDU	SB	d.w.														6.22	4.04	3.1										5.16	2.21	no	-?	?	15
10A2	MYTI EDU	SB	d.w.																4.66	6.29		5.11	4.33	3.03	2.13	2.58	1.28	2.29	4.59	1.89	no	--	no	13
11X	MYTI EDU	SB	d.w.																	3.34	3.56	4.48	2.79	3.1	1.93	1.93	1.28	3.02	2.11	1.9	no	--	no	11

Annual median concentration of CB_S7 (ppb)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.								77.5	96.5	116	89.6	97		89.3	90.4	110	128	58.5	71.1	49.9	29.6	33.9	43.4	20.7	67.9	28.8	47.7	3.2	D-	3.4	12
71A	MYTI EDU	SB	d.w.								17	34.4	25	14.2	15.3		16.5	10.5		9.27	11.8	13.6	8.52	12.7	7.55	9.74		14.3	9.33	9.3	no	D-	no	11
51A	MYTI EDU	SB	d.w.															26.2	9.69	14.7	10.5	11.5	12	28	16.9	16	10.6	14.5	11.2	11.2	no	--	no	12
52A	MYTI EDU	SB	d.w.									40.2	14.9		11.3	11.3	17.1	16.9	10	19	10.6	11.2	7.19	74.2	12.5	12	10.3	9.97	11.1	15.4	1.0	--	no	17
10A2	MYTI EDU	SB	d.w.																4.66	6.29		5.11	4.33	3.03	2.13	2.58	1.28	2.29	4.59	1.89	no	--	no	13
I021	MYTI EDU	SB	d.w.															43.1	31.8	32.2	24.1		22.2	20	25.1						1.7	D-	1.3	7
I022	MYTI EDU	SB	d.w.															32.1	25.9	41.2	22.4	28.9	19.2	22.4	20.8	15.2	17.1	11	11.1	5.79	no	D-	no	10
I023	MYTI EDU	SB	d.w.															19.6	20.9	26	15	22.2	10.8	17.4	15.9	12.3	12.6	9.73	8.91		no	D-	no	10
I024	MYTI EDU	SB	d.w.															31.8	36.1	45.6	36.6	28.7	16.8	17.7	26	15	15.8	11.3	10.6	3.54	no	D-	no	12
I301	MYTI EDU	SB	d.w.															118	113	182	86.5	125	58.7	64.6	62.6	70.4	57.9	84.7	75.4	63.2	4.2	D-	4.9	11
I304	MYTI EDU	SB	d.w.															35.2	23.8	44.4	35.9		19.9	25	24.4	27.5	30	21.4	23.4	23.9	1.6	--	1.4	10
I306	MYTI EDU	SB	d.w.															16.4	15.7	54.2	26.1		21.8	17.2	15.7	15.4	17.9	12.9	20.1	20.7	1.4	--	1.5	13
I307	MYTI EDU	SB	d.w.															20.6	28.5	40.2	17.3		20.3	16.9	17.5	15.4	13	11.7		15.4	1.0	--	no	11
I711	MYTI EDU	SB	d.w.															24.8	13.3	13.3	20.6	21.6	18.4		13.4						no	--	no	11
I712	MYTI EDU	SB	d.w.															33.3	31.2	25.3	22.4	24.9	13.9	12.5	10.9	16.9		16.2	14.2		no	DY	1.2	9
I713	MYTI EDU	SB	d.w.																						12.5	15	21.4	18.1	15.7		1.0	-?	?	9
I131A	MYTI EDU	SB	d.w.															7.94	11.7	13.1	22.4	12.7	10.1	14	29.4	8.13	3.98	9.65	4.65	3.53	no	--	no	16
I132	MYTI EDU	SB	d.w.																		31.1	22.5	10.2	15.8	11.8	13.3		11.5	10.9	6.19	no	D-	no	11
I133	MYTI EDU	SB	d.w.															22.8	22.3	21.5	24.7	23	10.4	11.7	9.24	9.23	12.5	10	9.68	9.58	no	D-	no	9
I241	MYTI EDU	SB	d.w.															54.3	78.9	47.2	55.2	80.8	55.5	36.3	96.4	125	118	61.8	48.5	46.4	3.1	--	no	13
I242	MYTI EDU	SB	d.w.															63	81.6	29.6	45.6	59.5	36.6	26.2	44.6	81.9	55.9	36.8	31.7	29.4	2.0	--	no	13
I243	MYTI EDU	SB	d.w.															115	169	122	78.2	92.4	47.9	29.3	52.5	326	288	217	75.2	48.9	3.3	--	no	18

Annual median concentration of CB_S7 (ppb)

																															ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.										1240	3430	2800	2500	2910	2350	2930	3090	3660	3520	2080	2440	2230	2140	2620	4160	3550	2100	4.2	--	6.2	11
36B	GADU MOR	LI	w.w.										441	344	396	636	376	1650	974	720	736	766	482	288	269	425	535	542	591	210	no	--	no	14
15B	GADU MOR	LI	w.w.										182	349	266	182	295	307	274	399	279	257	153	377	244	213	154	186	131	166	no	--	no	11
53B	GADU MOR	LI	w.w.										435	524	1760	166		162	701	576	2370	487	1520	842	956	317	463	422	340	672	1.3	--	no	20
67B	GADU MOR	LI	w.w.										316	293	268	226	329	210	269	627	206	273	148	225	145	92.6	94.4	134	56.1	109	no	D-	no	13
23B	GADU MOR	LI	w.w.										222	244	228	208	128	193	196	125	179	229	207	167	111	114	202	210	141	146	no	--	no	11
92B	GADU MOR	LI	w.w.													135	152	311	369								119	42.8			no	--	no	19
98B1	GADU MOR	LI	w.w.												239	183	114	197	278	372	165	147			62.6	110	183	91.6	102		no	--	no	14
43B	GADU MOR	LI	w.w.														325	329	140												no	-?	?	13
10B	GADU MOR	LI	w.w.														645	485	210	189	168	255	99.4	109	151	146	127	104	96.6	116	no	D-	no	11
30B	GADU MOR	MU	w.w.										3.58	11.1	24.7	9.65	3.94	3.12	8.9	10.5	21.7	21.4	6.06	9.4	10.3	9.31	7.91	9.01	11.9	10.6	3.5	--	4.1	17
36B	GADU MOR	MU	w.w.										1.62	1.29	2	3.65	0.525	15.6	4.14	4.54	3.78	2.86	2.26	2.19	1.9	2.52	2.88	2.71	9.34	0.63	no	--	no	22
15B	GADU MOR	MU	w.w.										1.35	1.22	1.38	0.65	0.38	1.03	1.14	1.44	1.41	0.81	1.42	1.88	0.655	1.23	0.2	0.675	0.575	0.421	no	--	no	16
53B	GADU MOR	MU	w.w.										8.2	2.23	15	1.1		0.37	21.9	3.76	138	6.61	36.3	1.08	23.6	4.84	3.09	2.2	1.12	5.72	1.9	--	no	>25
67B	GADU MOR	MU	w.w.										0.835	1.43	1.1	0.624	1.15	0.605	3.5	7.07	0.73	1.72	1.18	9.98	0.61	0.35	0.407	0.865	0.235	0.255	no	--	no	23
23B	GADU MOR	MU	w.w.										0.64	2.26	0.75	0.85	0.18	0.625	0.46	0.81	1.49	0.95	0.45	0.62	0.38	0.495	0.325	0.7	1.01	0.53	no	--	no	17
92B	GADU MOR	MU	w.w.													0.55	0.225	0.36	0.905								0.225	0.255			no	--	no	17
98B1	GADU MOR	MU	w.w.												0.9	0.9	0.135	0.34	0.475	1.4	0.44	0.585			0.24	0.385	0.32	0.435	0.385		no	--	no	18
43B	GADU MOR	MU	w.w.														0.515	0.815	0.39												no	-?	?	16
10B	GADU MOR	MU	w.w.														1.77	2.49	0.367	0.9	0.79	1.39	0.5	0.55	0.635	0.555	1.15	0.535	0.609	0.804	no	--	no	16

Annual median concentration of CB_S7 (ppb)

																															ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	LI	w.w.										36	31.1	97.5	69	57	86	54.9	30.3	35.3	47.2	90.7	158	53	60.1	62.8	63.4	68.9	67.3	no	--	no	14
53F	PLAT FLE	LI	w.w.										509	517	309	36		22.8	115	113	111	156	95.8	95.1	158	165	108	363		119	1.2	DY	1.3	18
67F	PLAT FLE	LI	w.w.																70		96.9	45.8	44	36.3	32	27.6	33.1	39	42.7	42.5	no	DY	no	10
21F	PLAT FLE	LI	w.w.																			22.9	6.97	33.6	48.9		121	15.5	20.1		no	--	no	23
33F	PLAT FLE	MU	w.w.										2.04	3.96	1.8	0.95	0.51	1.37	1.91	0.935	1.14	5.32	1.14	1.76	1.53	1.25	0.675	0.48	0.805	0.675	no	--	no	17
53F	PLAT FLE	MU	w.w.										27.4	33.2	14.2	1.45		0.757	3.19	2.74	2.19	2.73	3	2.67	2.02	1.13	1.96	6.73		1.76	no	DY	no	19
67F	PLAT FLE	MU	w.w.																0.775		1.8	1.66	1.48	0.95	0.845	0.82	0.295	0.565	0.47	1.1	no	D-	no	14
21F	PLAT FLE	MU	w.w.																			0.76	0.2	0.61	1.33		1.56	0.957	1.19		no	--	no	18
36F	LIMA LIM	LI	w.w.										301	217	339	418	404	433	386	387	236	412	838	527	297	272	538	511	620	650	1.3	--	1.9	12
15F	LIMA LIM	LI	w.w.											124		58.2	77	74	62.5	64.5	51.1	69.6		106	50.2	49.8	66.8	105	47.1	55.5	no	--	no	12
22F	LIMA LIM	LI	w.w.										170	127	140		60	88.7													no	-?	?	11
21F	LIMA LIM	LI	w.w.																						149	115	136	123		115	no	-?	?	7
36F	LIMA LIM	MU	w.w.										2.76	7.05	5.6	7.8	5.9	8.18	9.62	5.19	9.41	3.88	8.38	7.73	6.56	3.73	4.34	4.47	7.18	10.4	2.1	--	2.4	12
15F	LIMA LIM	MU	w.w.											3.72		0.806	0.369	1.14	1.81	1.28	1.42	0.959		1.21	0.665	0.94	0.349	1.25	0.695	0.575	no	--	no	16
22F	LIMA LIM	MU	w.w.										1.97	5	3.82		1.24	5.14													1.0	-?	?	20
21F	LIMA LIM	MU	w.w.																						1.54	1.12	1.12	1.62		1.82	no	-?	?	10
30F	PLEU PLA	LI	w.w.												313		207	216													4.3	-?	?	8
22F	PLEU PLA	LI	w.w.																21	20.1	14.5										no	-?	?	7
98F2	PLEU PLA	LI	w.w.																				40.8	25.5	10.3	10.5	8.4	24.1	13.8		no	--	no	15
10F	PLEU PLA	LI	w.w.																	42.1		62.8	45	24.9	86.2	16.6	22.3	25.7		14.9	no	--	no	17
30F	PLEU PLA	MU	w.w.												6.82		3.01	1.46													no	-?	?	9
22F	PLEU PLA	MU	w.w.																1.39	0.95	3.33										1.7	-?	?	19
98F2	PLEU PLA	MU	w.w.																				1.54	0.6	0.291	0.25	0.175	0.862	0.74		no	--	no	18
10F	PLEU PLA	MU	w.w.																	0.97		2.58	1.78	1.12	1	0.457	0.175	0.435			no	--	no	17
67F	LEPI WHI	LI	w.w.										111	100	143	101	172	166	97.2	91.5	118	82.3	83.9	63.8	105	85.2	73.3	58	52.5	50.4	m	D-	m	10
21F	LEPI WHI	LI	w.w.																							101	78.5	101	112	87.6	m	-?	m	8
67F	LEPI WHI	MU	w.w.										0.84	0.935	1.4	0.55	0.48	1.46	0.445	0.68	0.42	1.03	0.82	0.673	0.37	0.43	0.464	0.639	0.428	0.22	m	--	m	15
21F	LEPI WHI	MU	w.w.																							0.45	0.345	1.11	0.93	0.855	m	-?	m	14

Annual median concentration of DDEPP (ppb)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.												5.24	3.86	7.08	5.7	2.56	5.88	3.87	5.91	3.47	1.99	1.97	2.08	1.22	2.56	1.77	3.29	no	D-	no	13
31A	MYTI EDU	SB	d.w.												3.3	1.89	3.45	1.84	0.505	3.37	3.49	5.47	1.19	2.1	1.79	1.01	1.25	3.17	6.32	3.94	no	--	no	19
35A	MYTI EDU	SB	d.w.												4.91	2.08	3.13	2.84	0.57	3.91	3.73	5.93	1.61	3.29	2.17	1.8	2.94	5.47	2.4	2.86	no	--	no	18
36A	MYTI EDU	SB	d.w.												2.76	1.06	1.03	1.76	0.442	2.11	1.79	2.98	1.48	1.51	1.34	0.76	1.47	1.56	1.41	0.733	no	--	no	16
71A	MYTI EDU	SB	d.w.												2.61	1.58	3.21	1.29	0.736	1.02	2.2	2.41	2.26	3.58	1.1	1.67	0.763	1.8	2.17	1.8	no	--	no	15
76A	MYTI EDU	SB	d.w.												1.4	0.794			0.355	1.21	2.29	2.49	0.779	0.829	0.746	0.621	1.1	0.611	1.38	0.588	no	--	no	16
15A	MYTI EDU	SB	d.w.													0.976	1.72	0.735	0.294	1.02	1.41	2.05	0.536	0.622	0.854	0.667	0.857	0.688	0.722	0.706	no	--	no	16
51A	MYTI EDU	SB	d.w.															33.9	6.67	14.7	17.1	13.2	16.9	5.48	9.52	10	10.5	14.7	7.5	11.7	1.2	--	1.1	16
52A	MYTI EDU	SB	d.w.												12.3	25.5	19.4	18.5	9.53	13.1	16.7	13.7	11.9	6.47	6.82	8.86	10.5	12.5	4.71	12.2	1.2	--	no	13
56A	MYTI EDU	SB	d.w.												50	47.5	115	40.8	33.9	72.3	52.6	39.8	26.2	60.6	40	55.1	49.3	550	186	117	11.7	--	35.0	19
57A	MYTI EDU	SB	d.w.												25.9	18.3	35	25.3	15.8	50	82.9	35.2	27.5	24.7	14.7	27.8	16.6	53.3	12.1	23	2.3	--	2.0	16
63A	MYTI EDU	SB	d.w.												12.9	9.29	9.68	8.36	5.53	13	15.5	11.4	10.2	7.09	4.76	11.3	3.82	14	5.67	13.6	1.4	--	1.4	14
65A	MYTI EDU	SB	d.w.												7.6	5.19	7.79	4.12	5	6.9	11.9	7.38	6.76	5.43	3.61	6.47	2.55	8.33	3.63	6.67	no	--	no	13
69A	MYTI EDU	SB	d.w.												3.55	3.16	3.54	2.91	0.4	3.69	6.52	2.61	2.7	2.25	1.61	2.62	0.909	3	0.85	3.29	no	--	no	20
22A	MYTI EDU	SB	d.w.												2.22	1.31	1.88	1.45	0.387	1.37	5.11	1.96	1.49	0.909	0.725	1.46	0.861	1.65	4.78	0.933	no	--	no	19
84A	MYTI EDU	SB	d.w.												3.13	2.23		0.985	0.736								0.509	0.889			no	--	no	16
25A	MYTI EDU	SB	d.w.												1.29	1.03											0.879	1.05			no	-?	?	8
26A	MYTI EDU	SB	d.w.												2.74												1.35	1.84			no	-?	?	11
27A	MYTI EDU	SB	d.w.												1.8												0.442	0.833			no	-?	?	16
28A	MYTI EDU	SB	d.w.												1.11	0.858											0.378	0.765			no	-?	?	14
91A	MYTI EDU	SB	d.w.												0.625		1.32											0.667			no	-?	?	17
92A1	MYTI EDU	SB	d.w.												0.68	2.09	1.41	0.766	0.275	1.93											no	--	no	22
96A	MYTI EDU	SB	d.w.												1.03	0.435											0.262	0.7			no	-?	?	19
98A2	MYTI EDU	SB	d.w.																	1.59		0.87	0.575	1.31	0.625	0.725	0.415	0.778	0.867	0.5	no	--	no	13
98X	MYTI EDU	SB	d.w.														31.6	22.9	5.16												no	-?	?	15
99A	MYTI EDU	SB	d.w.												0.621	0.873											0.254	0.294			no	-?	?	10
41A	MYTI EDU	SB	d.w.														0.621	0.423	0.291	0.61									0.35	0.333	no	--	no	12
43A	MYTI EDU	SB	d.w.															0.608		0.855									0.313	0.357	no	-?	?	11
44A	MYTI EDU	SB	d.w.															0.486	0.343	1.41									3.3	1.35	no	-?	?	19
45A	MYTI EDU	SB	d.w.														1.74	2											0.8	0.889	no	D?	?	8
46A	MYTI EDU	SB	d.w.														1.05	0.756	0.273										0.6	0.524	no	-?	?	17
48A	MYTI EDU	SB	d.w.														1.71	1.13	0.286										1.24	0.438	no	-?	?	22
10A2	MYTI EDU	SB	d.w.																0.439	1.49		1.45	0.611	0.867	0.61	0.576	0.267	0.474	0.588	0.318	no	--	no	15
11X	MYTI EDU	SB	d.w.																	0.811	1.04	1.04	0.769	0.758	0.472	0.465	0.317	0.524	0.389	0.286	no	D-	no	10

Annual median concentration of DDEPP (ppb)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.												5.24	3.86	7.08	5.7	2.56	5.88	3.87	5.91	3.47	1.99	1.97	2.08	1.22	2.56	1.77	3.29	no	D-	no	13
71A	MYTI EDU	SB	d.w.												2.61	1.58	3.21	1.29	0.736	1.02	2.2	2.41	2.26	3.58	1.1	1.67	0.763	1.8	2.17	1.8	no	--	no	15
51A	MYTI EDU	SB	d.w.															33.9	6.67	14.7	17.1	13.2	16.9	5.48	9.52	10	10.5	14.7	7.5	11.7	1.2	--	1.1	16
52A	MYTI EDU	SB	d.w.												12.3	25.5	19.4	18.5	9.53	13.1	16.7	13.7	11.9	6.47	6.82	8.86	10.5	12.5	4.71	12.2	1.2	--	no	13
10A2	MYTI EDU	SB	d.w.																0.439	1.49		1.45	0.611	0.867	0.61	0.576	0.267	0.474	0.588	0.318	no	--	no	15
I021	MYTI EDU	SB	d.w.															4.6	1.45	4.8	3.25		5.19	2.73	4.73						no	--	no	16
I022	MYTI EDU	SB	d.w.															3.95	1.38	7.13	4.58	7.96	4.92	3.73	4.51	2.54	2.7	1.43	1.31	0.75	no	DY	no	14
I023	MYTI EDU	SB	d.w.															1.81	1.32	3.79	2.32	6.1	2.39	2.91	3.31	1.42	1.29	1.47	1.45	0.923	no	DY	no	14
I024	MYTI EDU	SB	d.w.															3.5	3.52	8.91	7.17	8.96	4.94	2.52	5.15	2.4	2.32	1.7	1.33	0.615	no	DY	no	13
I301	MYTI EDU	SB	d.w.															2.59	3.75	17.8	5.96	7.45	5.58	4.51	5.06	3.54	4.47	5.17	3.57	4.06	no	--	no	15
I304	MYTI EDU	SB	d.w.															2.14	0.751	3.42	3.89		1.95	2.71	2.62	1.73	2.71	1.43	1.85	3.17	no	--	no	16
I306	MYTI EDU	SB	d.w.															1.84	0.455	4.25	3.31		2.37	1.88	1.92	1.12	1.74	1.09	2.47	1.86	no	--	no	18
I307	MYTI EDU	SB	d.w.															2.18	1.03	3.42	2.74		2.12	4.13	2.28	1.09	1.34	0.873	2.5	2.31	no	--	no	15
I711	MYTI EDU	SB	d.w.															3.46	0.719	1.49	2.19	2.18	3.85		1.26						no	--	no	19
I712	MYTI EDU	SB	d.w.															2.43	1.34	3.14	3.09	3.49	3.46	2.48	1.6	2.65	2.94	1.36	2.36	1.75	no	--	no	12
I713	MYTI EDU	SB	d.w.																						1.61	2.26	2.96	0.676	2.19	2.17	no	--	no	17
I131A	MYTI EDU	SB	d.w.															1.46	0.691	1.89	2.06	1.67	1.11	0.915	1.11	0.942	1.37	2.39	0.846	0.733	no	--	no	14
I132	MYTI EDU	SB	d.w.																		2.02	2.06	1.19	1.15	1.26	1.17	0.917	1.83	1.13	0.5	no	--	no	13
I133	MYTI EDU	SB	d.w.															2.16	0.879	1.62	1.93	2.73	1.16	1.11	1.03	0.925	0.94	1.55	1.35	0.643	no	--	no	14
I241	MYTI EDU	SB	d.w.															6.4	6.21	2.3	6.49	5.59	4.45	2.93	4.4	4.37	5.49	6.17	3	3.88	no	--	no	13
I242	MYTI EDU	SB	d.w.															6.52	9.74	1.58	3.53	9.47	3.52	2.22	2.88	3.38	4.41	2.57	1.93	3.06	no	--	no	18
I243	MYTI EDU	SB	d.w.															7.47	6.12	1.72	5.43	5.11	4.01	1.99	3.32	3.88	6.41	19.5	5.88	4.41	no	--	no	18

Annual median concentration of DDEPP (ppb)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.										163	440	182	159	191	194	321	380	260	230	160	180	180	240	210	260	190	130	no	--	no	12
36B	GADU MOR	LI	w.w.										91.9	51	50	75	55	105	141	129	45	86	47	46	39	32	34	40	59	26	no	D-	no	13
15B	GADU MOR	LI	w.w.										50	136	48	57	86	33.5	75	140	72.5	76	46	60	78	74	50	58	51	55	no	--	no	14
53B	GADU MOR	LI	w.w.										637	806	939	85		42	491	936	490	160	380	260	200	145	300	199	220	360	1.8	--	1.9	21
67B	GADU MOR	LI	w.w.										776	554	347	392	471	109	460	2060	270	200	177	140	110	89	74	110	34	130	no	D-	no	19
23B	GADU MOR	LI	w.w.										68	85.4	42	41	35	31	49	33	49	48	59	52.9	24	37	52	46	33	40	no	--	no	11
92B	GADU MOR	LI	w.w.													53	50.5	50	196								50	22			no	--	no	20
98B1	GADU MOR	LI	w.w.												73	83.4	43	49	138	198	78	41			29	64	73	22	37		no	--	no	17
43B	GADU MOR	LI	w.w.														126	69	60												no	-?	?	9
10B	GADU MOR	LI	w.w.														211	71	75	99	65	90	32	38.5	54	51.5	50	37	34	35	no	D-	no	12
30B	GADU MOR	MU	w.w.										0.45	1.21	2	1	0.32	0.29	1.01	0.989	1.5	1.5	0.44	0.67	0.73	0.7	0.66	0.73	0.65	0.58	no	--	no	17
36B	GADU MOR	MU	w.w.										0.34	0.29	0.2	0.5	0.09	0.93	0.58	0.88	0.31	0.32	0.171	0.24	0.22	0.21	0.26	0.41	0.38	0.08	no	--	no	18
15B	GADU MOR	MU	w.w.										0.47	0.36	0.346	0.2	0.12	0.26	0.35	0.514	0.23	0.32	0.31	0.19	0.22	0.39	0.07	0.21	0.18	0.15	no	--	no	15
53B	GADU MOR	MU	w.w.										2.36	2.16	6.75	1.8		0.08	4.09	4.59	4.64	3.2	2.5	0.6	1.79	2.4	1.9	4.2	0.63	1.9	1.9	--	1.0	>25
67B	GADU MOR	MU	w.w.										2.25	3.03	1.4	1	2.46	1.08	6.96	19	1	1.1	1.1	1.8	0.44	0.24	0.31	0.66	0.12	0.34	no	D-	no	22
23B	GADU MOR	MU	w.w.										0.21	0.59	0.1	0.2	0.04	0.16	0.14	0.18	0.14	0.18	0.12	0.16	0.1	0.13	0.08	0.17	0.29	0.15	no	--	no	17
92B	GADU MOR	MU	w.w.													0.1	0.09	0.17	0.49								0.11	0.1			no	--	no	20
98B1	GADU MOR	MU	w.w.												0.4	0.4	0.06	0.05	0.24	0.6	0.18	0.15			0.09	0.12	0.21	0.14	0.09		no	--	no	21
43B	GADU MOR	MU	w.w.														0.23	0.23	0.14												no	-?	?	9
10B	GADU MOR	MU	w.w.														0.74	0.68	0.12	0.4	0.26	0.41	0.15	0.18	0.23	0.18	0.41	0.17	0.175	0.26	no	--	no	16

Annual median concentration of DDEPP (ppb)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	LI	w.w.										13	9.1	24	14	13	7	12.7	9.29	8.99	6.8	27	27	17	22	19	16	20	16	no	--	no	13
53F	PLAT FLE	LI	w.w.										94	70.1	32	41		8	25	45	38	44	17.5	39	42	40	29	45		51	1.7	--	2.1	15
67F	PLAT FLE	LI	w.w.																27		84.5	40	35	25	24	20	21	22	26	26	no	--	no	12
21F	PLAT FLE	LI	w.w.																			11	2.6	16	7.4		90	7.7	4.8		no	--	no	>25
33F	PLAT FLE	MU	w.w.										0.9	1.93	0.6	0.2	0.15	0.25	0.495	0.299	0.26	1.5	0.3	0.56	0.43	0.53	0.25	0.16	0.25	0.22	no	--	no	18
53F	PLAT FLE	MU	w.w.										4.67	5.3	3.8	1.3		0.373	1.79	1.36	0.96	0.93	0.61	0.88	0.66	0.81	0.57	1.3		0.67	no	D-	no	16
67F	PLAT FLE	MU	w.w.																0.85		1.31	1.4	1.2	0.54	0.63	0.68	0.11	0.33	0.26	0.7	no	--	no	17
21F	PLAT FLE	MU	w.w.																			0.32	0.1	0.43	0.16		1.2	0.61	0.3		no	--	no	22
36F	LIMA LIM	LI	w.w.										28	34.4	28	21	50	40	40	22	18	52	45	27	31	36	17	21	35	19	no	--	no	13
15F	LIMA LIM	LI	w.w.											39		13.4	23.5	9	20.7	20	13	32		41	15	17	23	26	15	16	no	--	no	14
22F	LIMA LIM	LI	w.w.										68.9	48	39.9		21	9.17													no	D?	?	10
21F	LIMA LIM	LI	w.w.																						74	82	56	69		40	no	-?	?	9
36F	LIMA LIM	MU	w.w.										0.41	1.15	0.7	0.5	0.96	0.91	0.91	0.46	0.67	0.49	0.52	0.51	0.61	0.53	0.13	0.31	0.38	0.46	no	--	no	14
15F	LIMA LIM	MU	w.w.											1.21		0.173	0.143	0.3	0.55	0.42	0.38	0.324		0.55	0.18	0.28	0.1	0.46	0.24	0.16	no	--	no	18
22F	LIMA LIM	MU	w.w.										1.1	2	1.18		0.56	0.83													no	-?	?	14
21F	LIMA LIM	MU	w.w.																						1.4	0.82	0.51	1.1		0.79	no	-?	?	14
30F	PLEU PLA	LI	w.w.												21.2		13	12													1.2	-?	?	6
22F	PLEU PLA	LI	w.w.																7.8	12	2.8										no	-?	?	21
98F2	PLEU PLA	LI	w.w.																				10.8	8	5.1	3.6	2.8	9.19	4.6		no	--	no	15
10F	PLEU PLA	LI	w.w.																	15		34.7	28	8.9	19	4.74	5.79	10		3.9	no	--	no	18
30F	PLEU PLA	MU	w.w.												0.693		0.32	0.17													no	-?	?	8
22F	PLEU PLA	MU	w.w.																0.47	0.34	0.76										no	-?	?	15
98F2	PLEU PLA	MU	w.w.																				0.465	0.24	0.135	0.09	0.05	0.434	0.34		no	--	no	20
10F	PLEU PLA	MU	w.w.																	0.4		0.859	1.1	0.3	0.4	0.134	0.0671	0.18		0.2	no	--	no	17
67F	LEPI WHI	LI	w.w.										294	240	183	163	250	145	143	167	160	160	130	58	64	73	71.1	55	61.6	48	m	D-	m	10
21F	LEPI WHI	LI	w.w.																							44	27.9	48	45	36	m	-?	m	11
67F	LEPI WHI	MU	w.w.										2.56	1.51	2.5	0.8	0.8	3.04	0.78	1.27	0.56	1.4	1.1	0.54	0.39	0.59	0.483	0.57	0.37	0.28	m	D-	m	16
21F	LEPI WHI	MU	w.w.																							0.27	0.15	0.6	0.38	0.46	m	-?	m	16

Annual median concentration of HCB (ppb)
Cursive values indicate data from 1990 and since

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				1.18	0.877	2.06	0.917	1.15	0.866	0.35	0.592	0.952	0.541	0.27	0.239	0.251	0.275	0.298		0.361	0.225	0.34	0.323	0.242	0.188	0.25	0.353	no	D-	no	13
31A	MYTI EDU	SB	d.w.			13.4	1.38	3.83	1.89	0.93	0.893	0.361	0.317	0.606	0.549	0.446	0.243	0.312	0.219	0.258	0.21		0.226	0.265	0.321	0.327	0.216	0.207	0.421	0.5	no	DY	1.1	14
35A	MYTI EDU	SB	d.w.			12.8	0.952	3.33	0.793	0.976	1.12	0.474	0.42	0.585	0.578	0.505	0.234	0.276	0.219	0.522	0.2	0.336	0.36	0.3	0.287	0.273	0.313	0.533	0.35	0.381	no	DY	no	16
36A	MYTI EDU	SB	d.w.			15	0.948	3.83	2.9	2.37	0.957	0.426	0.33	0.546	0.394	0.529	0.24	0.333	0.276	0.311	0.149		0.252	0.197	0.214	0.292	0.216	0.353	0.182	0.2	no	DY	no	17
71A	MYTI EDU	SB	d.w.			15.3	10.4	91.4	11.1	207	1.83	149	8.48	6.91	4.14	3.91	1.47	2.13	4.48	2.04	1.78	3.1	1.85	2.42	0.809	0.327	0.606	4.47	1.27	1.33	2.7	D-	5.6	>25
71A	MYTI EDU	SB	d.w.										*8.48*	*6.91*	*4.14*	*3.91*	*1.47*	*2.13*	*4.48*	*2.04*	*1.78*	*3.1*	*1.85*	*2.42*	*0.809*	*0.327*	*0.606*	*4.47*	*1.27*	*1.33*	*2.7*	*D-*	*5.6*	*18*
76A	MYTI EDU	SB	d.w.										0.378	0.568	0.498	0.794			0.254	0.289	0.4	0.256	0.216	0.244	0.299	0.311	0.974	0.294	0.188	0.235	no	--	no	14
15A	MYTI EDU	SB	d.w.										0.203			0.488	0.253	0.217	0.294	0.254	0.159	0.224	0.179	0.253	0.296	0.331	0.291	0.313	0.167	0.353	no	--	no	12
51A	MYTI EDU	SB	d.w.															0.612	0.333	0.313	0.4	0.4	0.385	0.196	0.476	0.403	0.49	0.575	0.5	0.769	1.5	--	1.8	11
52A	MYTI EDU	SB	d.w.									0.855	0.378		0.813	0.811	0.276	0.316	0.262	0.333	0.214	0.334	0.199	0.376	0.318		0.458	0.313	0.5	0.667	1.3	DY	1.6	13
56A	MYTI EDU	SB	d.w.								0.2	0.787	0.413	0.794	0.935	1.04	0.309	0.382	0.309	0.442	0.348	0.704	0.183	0.336	0.301	0.451	0.526	0.333	0.6	0.722	1.4	--	1.7	15
57A	MYTI EDU	SB	d.w.									0.769		0.763	0.719	0.794	0.357	0.301	0.262	0.431	0.576	0.625	0.262	0.361	0.254	0.397	0.237	0.533	0.538	0.696	1.4	DY	2.0	12
63A	MYTI EDU	SB	d.w.									1.05		0.971	0.74	0.625	0.316	0.329	0.333	0.407	0.452	0.51	0.23	0.321	0.329	0.352	0.154	0.533	0.235	0.882	1.8	D-	1.6	14
65A	MYTI EDU	SB	d.w.								0.2	0.427	0.516	0.862	0.621	0.667	0.284	0.296	0.294	0.345	0.377	0.524	0.15	0.272	0.258	0.294	0.179	0.556	0.188	1.1	2.2	--	1.9	15
69A	MYTI EDU	SB	d.w.												0.532	0.526	0.286	0.251	0.286	0.5	0.483	0.361	0.207	0.331	0.311	0.266	0.247	0.368	0.158	1.3	2.6	--	1.7	15
22A	MYTI EDU	SB	d.w.										0.265	0.61	0.559	0.444	0.248	0.253	0.301	0.311	0.172	0.316	0.202	0.298	0.242	0.329	0.219	0.176	0.167	0.2	no	D-	no	12
82A	MYTI EDU	SB	d.w.				2.26	10.7	0.656	0.617	0.8	0.535															0.181	0.235			no	--	no	25
84A	MYTI EDU	SB	d.w.				3.41	8.79	3.33	2.04	1.23	0.476		0.505	0.625	0.532		0.246	0.215								0.292	0.188			no	DY	no	15
87A	MYTI EDU	SB	d.w.								0.917	0.42															0.14	0.19			no	-?	?	14
25A	MYTI EDU	SB	d.w.												0.704	0.513											0.35	0.364			no	-?	?	8
26A	MYTI EDU	SB	d.w.												0.614												0.318	0.474			no	-?	?	12
27A	MYTI EDU	SB	d.w.												0.599												0.188	0.222			no	-?	?	9
28A	MYTI EDU	SB	d.w.												0.556	0.429											0.16	0.353			no	-?	?	15
91A	MYTI EDU	SB	d.w.												0.625		0.314											0.278			no	-?	?	14
92A1	MYTI EDU	SB	d.w.												0.68	0.418	0.244	0.225	0.23	0.254											no	Dm	no	12
96A	MYTI EDU	SB	d.w.												0.525	0.422											0.146	0.3			no	-?	?	14
98A2	MYTI EDU	SB	d.w.																	0.336		0.435	0.286	0.291	0.313	0.362	0.433	0.294	0.167	0.4	no	--	no	12
98X	MYTI EDU	SB	d.w.														0.559	0.318	0.26												no	-?	?	8
99A	MYTI EDU	SB	d.w.												0.621	0.442											0.152	0.176			no	D?	?	9
41A	MYTI EDU	SB	d.w.														0.292	0.263	0.291	0.303									0.15	0.444	no	--	no	14
43A	MYTI EDU	SB	d.w.														0.325	0.338		0.45									0.188	0.286	no	-?	?	11
44A	MYTI EDU	SB	d.w.															0.273	0.286	0.329									0.25	0.381	no	-?	?	9
45A	MYTI EDU	SB	d.w.														0.292	0.278											0.263	0.222	no	-?	?	6
46A	MYTI EDU	SB	d.w.														0.263	0.291	0.273										0.15	0.391	no	-?	?	14
48A	MYTI EDU	SB	d.w.														0.279	0.294	0.238										0.188	0.25	no	-?	?	8
10A2	MYTI EDU	SB	d.w.																0.245	0.309		0.284	0.278	0.289	0.305	0.275	0.279	0.263	0.188	0.227	no	--	no	7
11X	MYTI EDU	SB	d.w.																	0.34	0.208	0.249	0.242	0.253	0.236		0.279	0.381	0.167	0.571	1.1	--	no	13

Annual median concentration of HCB (ppb)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.				1.18	0.877	2.06	0.917	1.15	0.866	0.35	0.592	0.952	0.541	0.27	0.239	0.251	0.275	0.298		0.361	0.225	0.34	0.323	0.242	0.188	0.25	0.353	no	--	no	12
71A	MYTI EDU	SB	d.w.			15.3	10.4	91.4	11.1	207	1.83	149	8.48	6.91	4.14	3.91	1.47	2.13	4.48	2.04	1.78	3.1	1.85	2.42	0.809	0.327	0.606	4.47	1.27	1.33	2.7	D-	5.6	>25
51A	MYTI EDU	SB	d.w.															0.612	0.333	0.313	0.4	0.4	0.385	0.196	0.476	0.403	0.49	0.575	0.5	0.769	1.5	--	1.8	11
52A	MYTI EDU	SB	d.w.									0.855	0.378		0.813	0.811	0.276	0.316	0.262	0.333	0.214	0.334	0.199	0.376	0.318		0.458	0.313	0.5	0.667	1.3	--	1.6	13
10A2	MYTI EDU	SB	d.w.																0.245	0.309		0.284	0.278	0.289	0.305	0.275	0.279	0.263	0.188	0.227	no	--	no	7
I021	MYTI EDU	SB	d.w.															0.833	0.916	0.48	0.375		0.481	0.636	0.549						1.1	--	1.3	10
I022	MYTI EDU	SB	d.w.															0.421	0.479	0.97	0.312	0.783	0.455	0.543	0.549	0.379	0.513	0.476	0.692	0.667	1.3	--	1.7	13
I023	MYTI EDU	SB	d.w.															0.482	0.424	0.431	0.259	0.615	0.347	0.342	0.417	0.394	0.446	0.541	0.545	0.615	1.2	--	1.6	10
I024	MYTI EDU	SB	d.w.															0.488	0.602	1.16	0.426	0.66	0.556	0.536	0.495	0.388	0.404	0.532	0.615	0.308	no	--	no	12
I301	MYTI EDU	SB	d.w.															0.294	0.284	0.695	0.818	1.55	0.508	0.677	0.423	0.318	0.965	0.735	0.357	0.667	1.3	--	1.3	15
I304	MYTI EDU	SB	d.w.															0.336	0.281	0.719	0.486		0.294	0.526	0.385	0.307	0.5	0.439	0.286	0.333	no	--	no	12
I306	MYTI EDU	SB	d.w.															0.299	0.307	0.774	0.253		0.296	0.294	0.336	0.352	0.462	0.431	0.438	0.357	no	--	no	12
I307	MYTI EDU	SB	d.w.															0.273	0.318	0.674	0.174		0.327	0.336	0.45	0.365	0.357	0.238	0.5	0.471	no	--	1.0	14
I711	MYTI EDU	SB	d.w.															4.45	5.54	0.575	4.46	6.96	2.56		4						8.0	--	11.2	24
I712	MYTI EDU	SB	d.w.															3.43	16.4	7.9	4.83	5	3.31	1.78	2.75	3.27	2.9	6.72	2.09	1.64	3.3	--	2.5	17
I713	MYTI EDU	SB	d.w.																						3.49	2.64	4.17	11.1	3.56	2.44	4.9	--	8.0	18
I131A	MYTI EDU	SB	d.w.															0.316	0.298	0.273	0.196	0.582	0.288	0.327	0.292	0.373	1.4	0.724	0.643	0.625	1.3	--	1.8	14
I132	MYTI EDU	SB	d.w.																		44.2	1.89	4.73	3.11	2.36	1.56	1.94	6.42	4.93	0.625	1.3	--	2.0	25
I133	MYTI EDU	SB	d.w.															18.1	43.5	8.12	28	1.7	6.18	2.3	1.62	2.45	3.76	7.18	4.09	0.615	1.2	D-	no	23
I241	MYTI EDU	SB	d.w.															1.28	0.706	0.69	0.753	0.698	0.618	0.293	0.55	0.299	1.14	1.33	1.55	1.65	3.3	UY	6.6	13
I242	MYTI EDU	SB	d.w.															1.2	0.923	0.562	0.604	0.651	0.552	0.241	0.5	0.463	0.593	0.857	1.07	0.778	1.6	DY	2.7	11
I243	MYTI EDU	SB	d.w.															1.03	0.663	0.516	1.24	0.662	0.67	0.262	0.444	0.34	0.611	0.92	1.19	0.889	1.8	--	3.6	13

Annual median concentration of HCB (ppb)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.										10	17	7.48	16	11	11	12	7	5.3	5.1	9.1	8.9	6.7	6	8.9	6.3	5.5	7.8	no	--	no	11
36B	GADU MOR	LI	w.w.										7	9	9	10	9	5	9	6	4.4	6.5	5.4	4.6	3.1	3.3	4	3.3	3.5	3.7	no	D-	no	10
15B	GADU MOR	LI	w.w.										5	20.5	10	14	14	9	11	13	11.5	11	6.2	6.6	8.2	6.4	9.7	9.1	13	9.9	no	--	no	12
53B	GADU MOR	LI	w.w.										10	10	16.5	7		5	7	7	5	4.7	12	2.1	3	2.25	2.6	1.3	3.9	6.1	no	D-	no	16
67B	GADU MOR	LI	w.w.										14	8	7.94	8	8.49	10	8	15.5	9.9	4.6	5.63	4.9	4.6	5.1	5.3	7.7	5.3	8	no	D-	no	11
23B	GADU MOR	LI	w.w.										6	9.49	12	9	8	6	10	6	8.4	7.8	7.6	9.25	4.7	7.9	5.8	6.9	5.5	8.5	no	--	no	11
92B	GADU MOR	LI	w.w.													17	11	14	13								9.8	6			no	Dm	no	10
98B1	GADU MOR	LI	w.w.												20	9.95	12	18	35	20.5	16	13			10	13	11	10	13		no	--	no	12
43B	GADU MOR	LI	w.w.														15	16.5	13												no	-?	?	8
10B	GADU MOR	LI	w.w.														13	11	16	17	17	25	9	9.9	11	9.43	5.1	7.7	6.8	8.5	no	D-	no	11
30B	GADU MOR	MU	w.w.										0.09	0.09	0.1	0.1	0.04	0.03	0.05	0.05	0.06	0.06	0.06	0.05	0.06	0.05	0.06	0.06	0.05	0.04	no	DY	no	10
36B	GADU MOR	MU	w.w.										0.11	0.07	0.1	0.1	0.04	0.05	0.06	0.06	0.05	0.06	0.04	0.05	0.03	0.03	0.03	0.04	0.04	0.03	no	D-	no	10
15B	GADU MOR	MU	w.w.										0.11	0.11	0.1	0.1	0.06	0.07	0.08	0.0748	0.1	0.06	0.1	0.04	0.06	0.07	0.05	0.06	0.07	0.06	no	D-	no	10
53B	GADU MOR	MU	w.w.										0.1	0.03	0.1	0.1		0.03	0.0648	0.06	0.05	0.05	0.09	0.04	0.05	0.08	0.03	0.04	0.03	0.04	no	--	no	15
67B	GADU MOR	MU	w.w.										0.1	0.0849	0.1	0.1	0.0748	0.06	0.05	0.07	0.06	0.05	0.05	0.04	0.05	0.05	0.04	0.07	0.04	0.05	no	D-	no	9
23B	GADU MOR	MU	w.w.										0.08	0.08	0.1	0.1	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.04	0.05	0.03	0.07	0.08	0.05	no	--	no	11
92B	GADU MOR	MU	w.w.													0.1	0.07	0.05	0.09								0.07	0.07			no	--	no	11
98B1	GADU MOR	MU	w.w.												0.2	0.2	0.07	0.1	0.11	0.1	0.1	0.08			0.07	0.09	0.08	0.11	0.08		no	--	no	11
43B	GADU MOR	MU	w.w.														0.09	0.13	0.06												no	-?	?	15
10B	GADU MOR	MU	w.w.														0.16	0.11	0.09	0.2	0.17	0.26	0.09	0.11	0.13	0.09	0.09	0.1	0.0849	0.09	no	--	no	12

Annual median concentration of HCB (ppb)

																															ANALYSIS			
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRND	SM+3	POWER
33F	PLAT FLE	LI	w.w.										1	0.5	5	2	1	1	0.648	0.693	0.643	0.54	1.6	1.6	1.6	1.9	1.2	1.3	1.8	1.7	no	--	no	16
53F	PLAT FLE	LI	w.w.										6	4.47	5	2		1	2	3	1.8	2.5	2.39	2	2.9	1.4	1	1.2		1.6	no	D-	no	13
67F	PLAT FLE	LI	w.w.																3		6.39	3.6	4.2	4.3	3.5	3.7	3.1	4.3	3.8	4.5	no	--	no	10
21F	PLAT FLE	LI	w.w.																			3.1	1.1	2.4	0.9		3.6	2.1	1.2		no	--	no	18
33F	PLAT FLE	MU	w.w.										0.06	0.07	0.1	0.1	0.03	0.03	0.03	0.05	0.03	0.06	0.04	0.04	0.05	0.06	0.03	0.03	0.04	0.04	no	--	no	13
53F	PLAT FLE	MU	w.w.										0.45	0.3	0.2	0.1		0.0837	0.05	0.1	0.06	0.06	0.09	0.06	0.05	0.13	0.03	0.07		0.04	no	D-	no	14
67F	PLAT FLE	MU	w.w.																0.05		0.098	0.19	0.16	0.12	0.14	0.12	0.03	0.08	0.07	0.07	no	--	no	14
21F	PLAT FLE	MU	w.w.																			0.1	0.03	0.06	0.04		0.09	0.08	0.06		no	--	no	15
36F	LIMA LIM	LI	w.w.										5.48	3	5	2	3	2	2.3	3	1.1	2.5	3	2.6	2	2.5	1.8	1.6	2.2	1.5	no	--	no	12
15F	LIMA LIM	LI	w.w.											4		4	4	2	3	3.2	3	3.64		5.9	2.5	4.3	3.1	4	2.6	3.7	no	--	no	11
22F	LIMA LIM	LI	w.w.										6	3	5		1	1.41													no	-?	?	15
21F	LIMA LIM	LI	w.w.																						4.8	9.1	3.1	8		2.6	no	-?	?	17
36F	LIMA LIM	MU	w.w.										0.1	0.09	0.1	0.1	0.06	0.06	0.07	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.03	0.03	0.04	0.04	no	D-	no	9
15F	LIMA LIM	MU	w.w.											0.2		0.1	0.0447	0.07	0.09	0.07	0.09	0.08		0.15	0.04	0.09	0.03	0.09	0.05	0.06	no	--	no	15
22F	LIMA LIM	MU	w.w.										0.12	0.2	0.1		0.05	0.0742													no	-?	?	14
21F	LIMA LIM	MU	w.w.																						0.13	0.13	0.06	0.15		0.08	no	-?	?	14
30F	PLEU PLA	LI	w.w.												5		2	2													no	-?	?	11
22F	PLEU PLA	LI	w.w.																0.5	0.9	0.3										no	-?	?	19
98F2	PLEU PLA	LI	w.w.																				1.3	1.8	0.955	0.68	1.2	1.09	0.45		no	--	no	14
10F	PLEU PLA	LI	w.w.																	6.1		8.77	6.4	2.4	1.6	2.15	1.99	2.9		1.35	no	--	no	14
30F	PLEU PLA	MU	w.w.												0.141		0.05	0.03													no	D?	?	<=5
22F	PLEU PLA	MU	w.w.																0.03	0.03	0.04										no	-?	?	7
98F2	PLEU PLA	MU	w.w.																				0.07	0.04	0.0447	0.04	0.03	0.0648	0.04		no	--	no	12
10F	PLEU PLA	MU	w.w.																	0.22		0.303	0.49	0.15	0.43	0.0648	0.0346	0.07		0.06	no	--	no	19
67F	LEPI WHI	LI	w.w.										9	4	5	4	5	2	4.6	4	5	2.8	4.8	3.4	3.8	3.9	3.45	2	2.2	2.3	m	D-	m	12
21F	LEPI WHI	LI	w.w.																							4.8	1	2.9	4.2	3.2	m	-?	m	20
67F	LEPI WHI	MU	w.w.										0.09	0.07	0.1	0.1	0.03	0.04	0.03	0.07	0.03	0.04	0.05	0.03	0.04	0.04	0.0346	0.04	0.03	0.03	m	D-	m	12
21F	LEPI WHI	MU	w.w.																							0.04	0.03	0.07	0.06	0.03	m	-?	m	15

Annual median concentration of BDESS (ppb)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.																									60.3	72.2	88.4	m	U?	m	<=5
53B	GADU MOR	LI	w.w.																									25.5	11.5	39.7	m	-?	m	22
23B	GADU MOR	LI	w.w.																									6.82	5.95	5.86	m	-?	m	<=5

Annual median concentration of PFOS (ppb)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.																									38	49	11	m	-?	m	20
53B	GADU MOR	LI	w.w.																									6.48	10	2	m	-?	m	22
23B	GADU MOR	LI	w.w.																									5.48	16.5	3	m	-?	m	>25

Annual median concentration of BAP (ppb)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	ANALYSIS OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.												2.53			3.35	3.52		3.57	2.99	2.99	3.29	3.4	3.23	4.26	3.85	6.07	2.94	no	--	no	9
I301	MYTI EDU	SB	d.w.															4.44	19.3	18.8	6.02	13.1	2.55	9.77	3.13	3.18	34.2	3.47	42.1	14.4	2.9	--	7.2	24
I304	MYTI EDU	SB	d.w.															3.36	2.81	3.29	3.38	2.76	2.94	3.76	3.85	3.07	5.33	4.39	3.85	2.94	no	--	no	9
I306	MYTI EDU	SB	d.w.															2.99	3.07	2.87	3.05	3.07	2.96	2.94	3.36	3.52	4.79	4.31	3.13	3.57	no	U-	no	7
I307	MYTI EDU	SB	d.w.															2.73	3.21	2.75	2.91	3.01	3.27	3.36	4.5	3.65	5.27	3.97	3.13	3.13	no	UY	no	7
I131A	MYTI EDU	SB	d.w.															3.25	2.66	2.73	3.6	5.02	2.4	3.27	2.79	3.73	8	3.4	3.85	3.33	no	--	no	12
I132	MYTI EDU	SB	d.w.																		22.6	300	10.8	32.7	49.6	89.7	52.4	150	61.3	80	16.0	--	19.3	25
I133	MYTI EDU	SB	d.w.															80.6	13.7	51.7	18.6		8.47	19	23.7	39.3	135	67.3	50	22.3	4.5	--	4.5	19
I201	MYTI EDU	SB	d.w.															93.2	207	679	10.5	83.8	47.4	31.7	188	7.23	3.79	8.55	5	6.08	1.2	--	no	>25
I205	MYTI EDU	SB	d.w.															7.39		23.1	64.5	7.51	5.59	7.55	33	3.16	48.2	4.5	3.85	4.17	no	--	no	>25
I913	MYTI EDU	SB	d.w.																			5.85	15.6	2.96	13.3	3.65	1.36	3.29	2.78	3.85	no	--	no	20
I912	MYTI EDU	SB	d.w.															7.02		9.46	5.35	16.4	135	4.17	20	3.97	1.46	3.65	3.33	3.38	no	--	no	25
I965	MYTI EDU	SB	d.w.																					233	30.8	43.6	87.7	19.3	58	115	23.1	--	19.9	22
I962	MYTI EDU	SB	d.w.															246	33.5		87										17.4	-?	?	>25
I964	MYTI EDU	SB	d.w.																						37.3	289	251	55.4	200	232	46.5	--	64.4	23
I969	MYTI EDU	SB	d.w.															14.2	10.7	17.6	8.42	10.3	17.1	23.5	3.68	46.7	34.7	7.27	24.2	23.9	4.8	--	4.8	21

Annual median concentration of PK_S (ppb)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.												38.1			27.5	28.3		38.5	20.4	16.5	38.3	11.6	17.6	45.7	14.2	45.1	18.2	no	--	no	17
I301	MYTI EDU	SB	d.w.															73	257	197	100	175	32.4	112	43.7	38.4	313	40.9	269	109	2.2	--	4.3	22
I304	MYTI EDU	SB	d.w.															14.4	16.7	13.7	36.8	33.2	7.62	21.4	9.62	8.01	69.9	15.5	27.7	10.1	no	--	no	20
I306	MYTI EDU	SB	d.w.															12.8	15.1	34.8	31.3	27.9	7.4	28.2	12.1	8.8	52.7	12.6	18.2	10.1	no	--	no	19
I307	MYTI EDU	SB	d.w.															11.8	18.9	19.9	27.7	41.7	11.6	27.2	29.3	9.69	74	13.6	16.8	9.65	no	--	no	18
I131A	MYTI EDU	SB	d.w.															48.4	17.9	35.4	61.4	57.1	26.9	28	15.5	26.6	127	20.1	9.62	8.33	no	--	no	19
I132	MYTI EDU	SB	d.w.																		581	2730	243	389	783	1520	570	813	401	405	8.1	--	1.9	21
I133	MYTI EDU	SB	d.w.															602	121	647	287		150	339	476	580	1200	451	345	197	3.9	--	no	18
I201	MYTI EDU	SB	d.w.															705	1590	7970	281	999	903	638		189	111	212	119	149	3.0	--	2.1	23
I205	MYTI EDU	SB	d.w.															96.4		470	1380	197	187	189	1650	97.5	808	98.2	57.2	56.3	1.1	--	no	>25
I913	MYTI EDU	SB	d.w.																			107	604	76.7	405	28.8	20.9	8.22	8.67	14.3	no	D-	no	24
I912	MYTI EDU	SB	d.w.															109		342	195	187	1560	58.9	412	27.9	10.6	9.12	8.33	30.1	no	D-	no	>25
I965	MYTI EDU	SB	d.w.																					1330	431	468	854	181	357	612	12.2	--	7.4	18
I962	MYTI EDU	SB	d.w.															1450	265		665										13.3	-?	?	>25
I964	MYTI EDU	SB	d.w.																						368	2370	2090	501	915	1070	21.5	--	23.1	22
I969	MYTI EDU	SB	d.w.															139	108	230	131	285	192	169	39.7	625	361	73.6	188	170	3.4	--	2.4	21

Annual median concentration of P_S (ppb)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.												215			179	219		268	216	140	124	54.9	126	163	74.6	292	107	no	--	no	15
I301	MYTI EDU	SB	d.w.															486	1810	1880	657	1050	438	645	312	216	1040	271	1730	647	2.6	--	5.6	20
I304	MYTI EDU	SB	d.w.															75.5	111	182	228	326	60.4	136	51.5	66.1	215	53.6	179	68.8	no	--	no	18
I306	MYTI EDU	SB	d.w.															73.7	87	188	172	225	53.8	115	121	45.9	147	53.9	155	51.5	no	--	no	17
I307	MYTI EDU	SB	d.w.															59.6	90.4	153	155	325	64.4	112	244	64.8	178	40.6	170	50.3	no	--	no	19
I131A	MYTI EDU	SB	d.w.															120	98.4	140	213	240	181	91.8	95	133	344	109	80.6	70	no	--	no	14
I132	MYTI EDU	SB	d.w.																		1590	6470	1270	1000	1750	2440	1060	2800	1760	1380	5.5	--	6.0	18
I133	MYTI EDU	SB	d.w.															1940	715	1710	1000		908	863	1120	1070	2530	1410	1320	709	2.8	--	2.4	14
I201	MYTI EDU	SB	d.w.															2170	4450	15500	793	3400	2300	1130		579	381	569	303	358	1.4	D-	no	21
I205	MYTI EDU	SB	d.w.															476		1630	3210	801	603	457		384	2170	309	221	204	no	--	no	20
I913	MYTI EDU	SB	d.w.																			559	2200	578	2000	128	98.1	55.1	75.7	103	no	D-	no	23
I912	MYTI EDU	SB	d.w.															648		1390	873	1510	5990	735	1970	164	42.3	32.9	42.9	305	1.2	D-	no	25
I965	MYTI EDU	SB	d.w.																					2770	720	1320	2930	587	1500	2620	10.5	--	9.4	20
I962	MYTI EDU	SB	d.w.															3400	982		1600										6.4	-?	?	21
I964	MYTI EDU	SB	d.w.																						643	6270	7960	1010	2590	2990	11.9	--	15.3	>25
I969	MYTI EDU	SB	d.w.															695	803	673	551	807	988	675	136	2340	1540	283	660	832	3.3	--	2.4	22

Annual median concentration of TBT (ppm)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	d.w.																	2.71	1.51	1.47	0.935	0.802	1.81	1.08	0.723	0.282	0.36	0.543	5.4	D-	no	14
36A	MYTI EDU	SB	d.w.																	0.0336	0.179	0.217	0.0831	0.0591	0.0792	0.103	0.0603	0.0224	0.0172	0.0283	no	--	no	19
71A	MYTI EDU	SB	d.w.																	1.02				0.431	0.702	0.375	0.119	0.136	0.0567	0.0934	no	D-	no	16
76A	MYTI EDU	SB	d.w.																	0.188				0.0529	0.092	0.106	0.034	0.0318	0.0206	0.0135	no	D-	no	13
15A	MYTI EDU	SB	d.w.																					0.098	0.0811	0.0622	0.0179	0.0179	0.0078	0.0137	no	D-	no	14
22A	MYTI EDU	SB	d.w.																					0.17	0.138	0.587	0.291	0.249	0.1	0.297	3.0	--	1.4	19
226X	MYTI EDU	SB	d.w.																		1.61	0.854	0.555								5.6	-?	?	6
227A2	MYTI EDU	SB	d.w.																				0.375	0.417	0.672	0.709	0.314	0.277	0.134	0.193	1.9	--	no	13
98A2	MYTI EDU	SB	d.w.																					0.108	0.105	0.114	0.0468	0.0252	0.0165	0.0268	no	D-	no	14
10A2	MYTI EDU	SB	d.w.																					0.0224	0.0123	0.0067					no	D?	?	<=5
11X	MYTI EDU	SB	d.w.																						0.0348	0.0201	0.00401	0.00233	0.00278	0.00238	no	Dm	no	18
I301	MYTI EDU	SB	d.w.																						2.59	2.11	2.83	2.94	1.27	1.42	14.2	--	8.4	12
I712	MYTI EDU	SB	d.w.																						1.2	0.912	0.3	0.268	0.219	0.18	1.8	Dm	no	12
I713	MYTI EDU	SB	d.w.																						1.37	0.668	0.22	0.213	0.13	0.0795	no	Dm	no	11
36G	NUCE LAP	SB	d.w.																	0.105	0.203	0.142	0.0951	0.0496	0.155	0.0846	0.0412	0.0344	0.00625	0.0293	m	D-	m	19
71G	NUCE LAP	SB	d.w.																					0.133	0.344	0.235	0.115		0.0429	0.0563	m	--	m	17
76G	NUCE LAP	SB	d.w.																					0.0409	0.196		0.0679	0.0467	0.0165	0.0294	m	--	m	20
131G	NUCE LAP	SB	d.w.																					0.0326	0.064	0.075	0.0507	0.022		0.00629	m	--	m	19
15G	NUCE LAP	SB	d.w.																					0.0706	0.091	0.0652	0.0264	0.0215	0.00641	0.00897	m	D-	m	14
224G	NUCE LAP	SB	d.w.																	0.0769	0.295		0.12								m	-?	m	24
22G	NUCE LAP	SB	d.w.																					0.0699	0.101	0.322	0.2	0.13	0.0262	0.0611	m	--	m	20
220G	NUCE LAP	SB	d.w.																	0.0815	0.1	0.0851					0.113				m	-?	m	7
226G	NUCE LAP	SB	d.w.																		0.844	0.225	0.21								m	-?	m	16
227G1	NUCE LAP	SB	d.w.																	0.0891	0.625	0.267	0.387	0.135	0.446						m	--	m	21
227G2	NUCE LAP	SB	d.w.																							0.878	0.258	0.239	0.065	0.16	m	-?	m	19
98G	NUCE LAP	SB	d.w.																					0.026	0.0629	0.0612	0.0492	0.0394	0.014	0.0253	m	--	m	16
11G	NUCE LAP	SB	d.w.																						0.0133	0.0261	0.0103	0.0184	0.00862	0.0111	m	--	m	14

Annual median concentration of TCDDN (ppp)
NB: including suspect/questionable data

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30A	MYTI EDU	SB	w.w.																						0.11	0.108	0.127	0.169	0.153	0.143	no	--	m	7
71A	MYTI EDU	SB	w.w.																						2.37	2.36	2.02	2.64	2.76	2.2	11	--	m	7
76A	MYTI EDU	SB	w.w.																						0.0566	0.078	0.133	0.142	0.111	0.106	no	--	m	12
I712	MYTI EDU	SB	w.w.																						4.31	4.29	3.26	1.51	3.24	4.02	20.1	--	m	15
I713	MYTI EDU	SB	w.w.																						3.59	4.16	2.98	4.77	1.41	6.14	30.7	--	m	17
I132	MYTI EDU	SB	w.w.																						0.479	0.611	0.211	1.53	0.303	0.373	1.87	--	m	21
I133	MYTI EDU	SB	w.w.																						0.277	0.24	0.371	0.249	0.227	0.256	1.28	--	m	9

Annual median concentration of ALAD (NG/MIN/MG PROTEIN)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	BL	w.w.																	8.98	14.7	13	14.6	12.7	10.4	6.91	14.2	15	32.3	14.1	m	--	m	13
36B	GADU MOR	BL	w.w.																	13	26.2	9.93	22	19.4							m	-?	m	15
15B	GADU MOR	BL	w.w.																	17.2	23.4	8.45		18.9							m	-?	m	17
53B	GADU MOR	BL	w.w.																	7.64	10.1	11.1	12.7	10	6.44	9.32	9.95	10.4	33.7	7.98	m	--	m	15
67B	GADU MOR	BL	w.w.																	7.17	28.2	16.9	22.4	19							m	-?	m	16
23B	GADU MOR	BL	w.w.																	15.8	24.8	18.1	19.8	24	19.4	16.8	19.7	25.8	38		m	--	m	9

Annual median concentration of EROD (PMOL/MIN/MG PROTEIN)

																																ANALYSIS		
St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	TRD	SM3	PWR
30B	GADU MOR	LI	w.w.																	68.8	124	70	260	81.2	158	88.3	69	50.9	98.7	29.7	m	--	m	16
36B	GADU MOR	LI	w.w.																	95.1	11.4	60.2	64.9	76.2							m	-?	m	24
15B	GADU MOR	LI	w.w.																	49.9	52.3	184		61							m	-?	m	20
53B	GADU MOR	LI	w.w.																	86.5	119	90.1	128	34.7	93.9	11.7	20	53.9	54.2	14.3	m	--	m	20
67B	GADU MOR	LI	w.w.																	103	76.2	84.6	103	72.9							m	-?	m	9
23B	GADU MOR	LI	w.w.																	94.1	28.6	70.1	73.5	76.5	103	41.9	45.9	50.8	57.2		m	--	m	15

Annual median concentration of CYP1A (ABS)

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	ANALYSIS TRD	SM3	PWR
30B	GADU MOR	LI	w.w.																							2.24	1.2	1.22	0.822	0.902	m	D?	m	10
53B	GADU MOR	LI	w.w.																							0.132	0.207	0.201	0.0655	0.428	m	-?	m	21
23B	GADU MOR	LI	w.w.																							0.113	0.212	0.199	0.0795		m	-?	m	17

Annual median concentration of PYR1O (µG/KG/ABS 380 NM)
Cursive values from 1998-1999 indicate data that were not included in the temporal trend analysis because they were derived from a method that can not be compared to method used during the following years

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	ANALYSIS TRD	SM3	PWR
30B	GADU MOR	BI	w.w.																		*116*	*130*	12.3	17	29.2	20.3	43.5	15.1	13.9	4.95	m	--	m	14
36B	GADU MOR	BI	w.w.																		*42.9*	*28.9*	5.14	3.72							m	--	m	--
15B	GADU MOR	BI	w.w.																		*3770*	*253*		29.7	6.32	5.66	16.7	1.1	2.61	1.14	m	--	m	23
53B	GADU MOR	BI	w.w.																		*83*	*58.6*	9.23	3.81	18.8	3.65	3.39	3.04	2.18	4.84	m	--	m	19
67B	GADU MOR	BI	w.w.																		*19.8*	*16.5*	1.62	1.66							m	--	m	--
23B	GADU MOR	BI	w.w.																		*12.7*	*11.2*	4.15	2.55	3.1	5.32	1.62	3.46	1.34	1.72	m	--	m	15

Annual median concentration of VDSI ()

St	Species	Tissue	Base	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	OC	ANALYSIS TRD	SM3	PWR
36G	NUCE LAP	WO	w.w.											4.1		3.9				4	4	4	4	3.95	4	3.96	3.65	0.96	0.125	0.583	m	DY	m	19
71G	NUCE LAP	WO	w.w.																					4	4.1	4	4	4	4	1.61	m	--	m	19
76G	NUCE LAP	WO	w.w.																					3.41	3.03		3.28	0.643	0.778	0.0667	m	Dm	m	21
131G	NUCE LAP	WO	w.w.																					3.89	3.77	3.47	3.63	1.86	1.08	0.118	m	D-	m	15
15G	NUCE LAP	WO	w.w.																					3.69	3.86	3.42	3.43	1.28	0.125	0	m	D-	m	19
22G	NUCE LAP	WO	w.w.																					4	4	3.95	4	4	2.96	2.41	m	D-	m	12
220G	NUCE LAP	WO	w.w.																	4.05	4	4					4				m	-?	m	<=5
227G1	NUCE LAP	WO	w.w.											4.1						4	4.15	4.09	4.5	4.3	4.5						m	--	m	8
227G2	NUCE LAP	WO	w.w.																							4.13	3.92	3.65	3.66	3.52	m	D?	m	6
98G	NUCE LAP	WO	w.w.																					3.5	3.76	3.8	4	3.43	2.97	2.95	m	--	m	11
11G	NUCE LAP	WO	w.w.																						0.0333	0	0.289	0	0	0.0345	m	--	m	7

Appendix J
Geographical distribution of contaminants and biomarkers in biota 1990-2007

Sorted by contaminant and species:

Cadmium (Cd)
Mercury (Hg)
Lead (Pb)
Sum of 7 CBs (CB-28, -52, 101, -118, -138, -153 and -180)
DDEPP (ppDDE)
HCB
TCDDN
PBDE
OH-pyrene
ALA-D (δ-amino levulinic acid dehydrase inhibition)
EROD-activity (Cytochrome P4501A-activity)
CYP1A (relative amount of cytochrome P4501A-protein)
TBT
VDSI

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*)

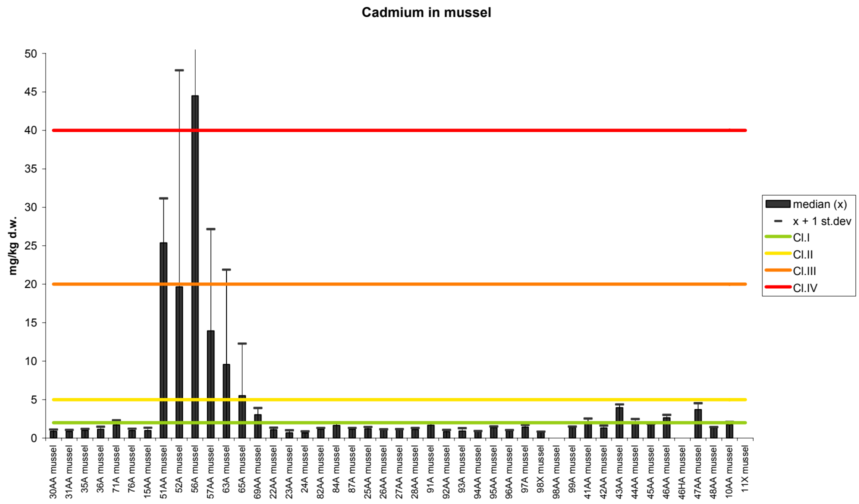
Station positions are shown on maps in Appendix G

Results are presented for three periods: 1990-1996, 2006 and 2007.
The average of the median concentrations was used for each period.
Cf. Appendix F. sample overview

Appendix J
Geographical distribution of contaminants and biomarkers in biota 1990-2007

(cont.)

A



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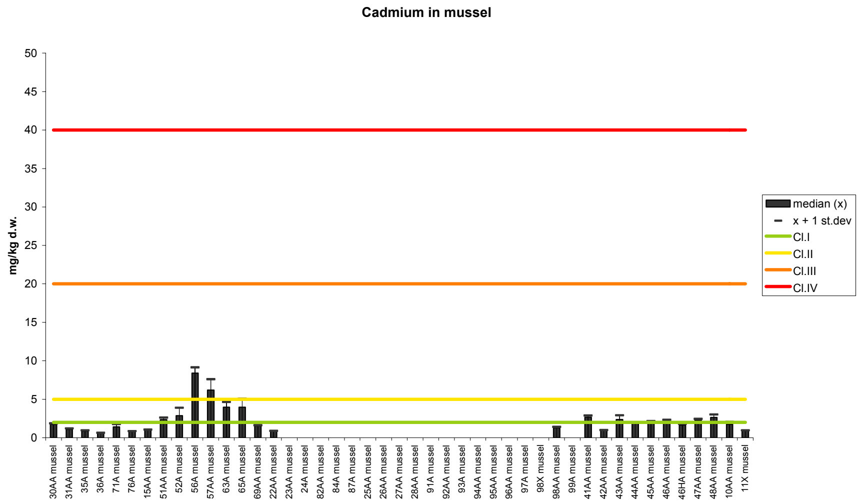

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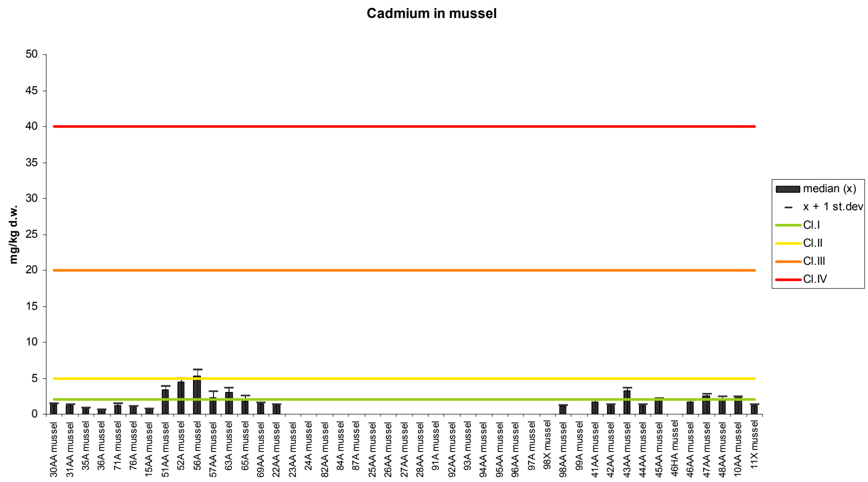
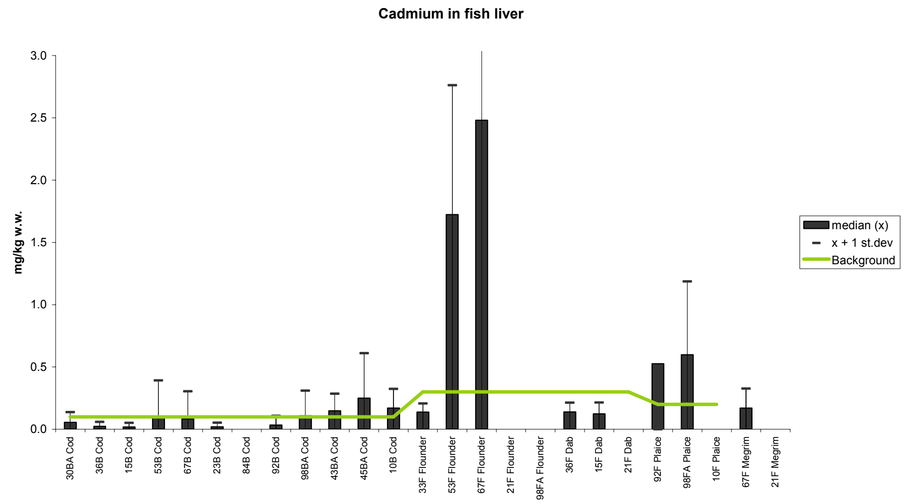


Figure 26. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for cadmium in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight (see maps in Appendix G). **Note: for some stations the standard deviation is off-scale in figures A.**

A



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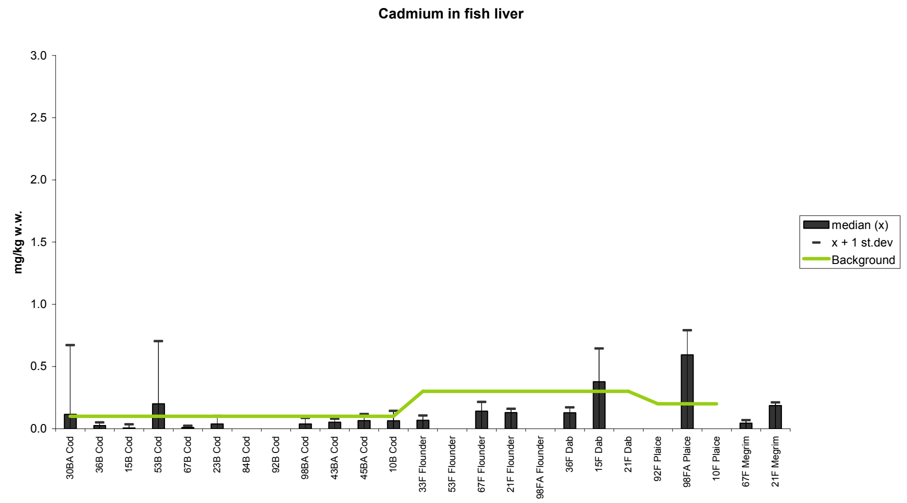


C

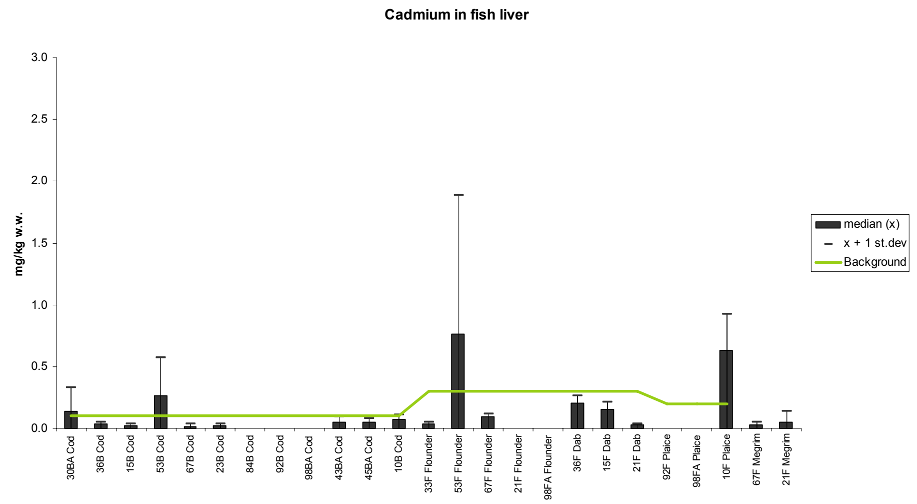


Figure 27. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for cadmium in fish liver 1990-1996 **(A),** 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight, "Cl. – B" indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for all fish, (see maps in Appendix G).

A

B

C

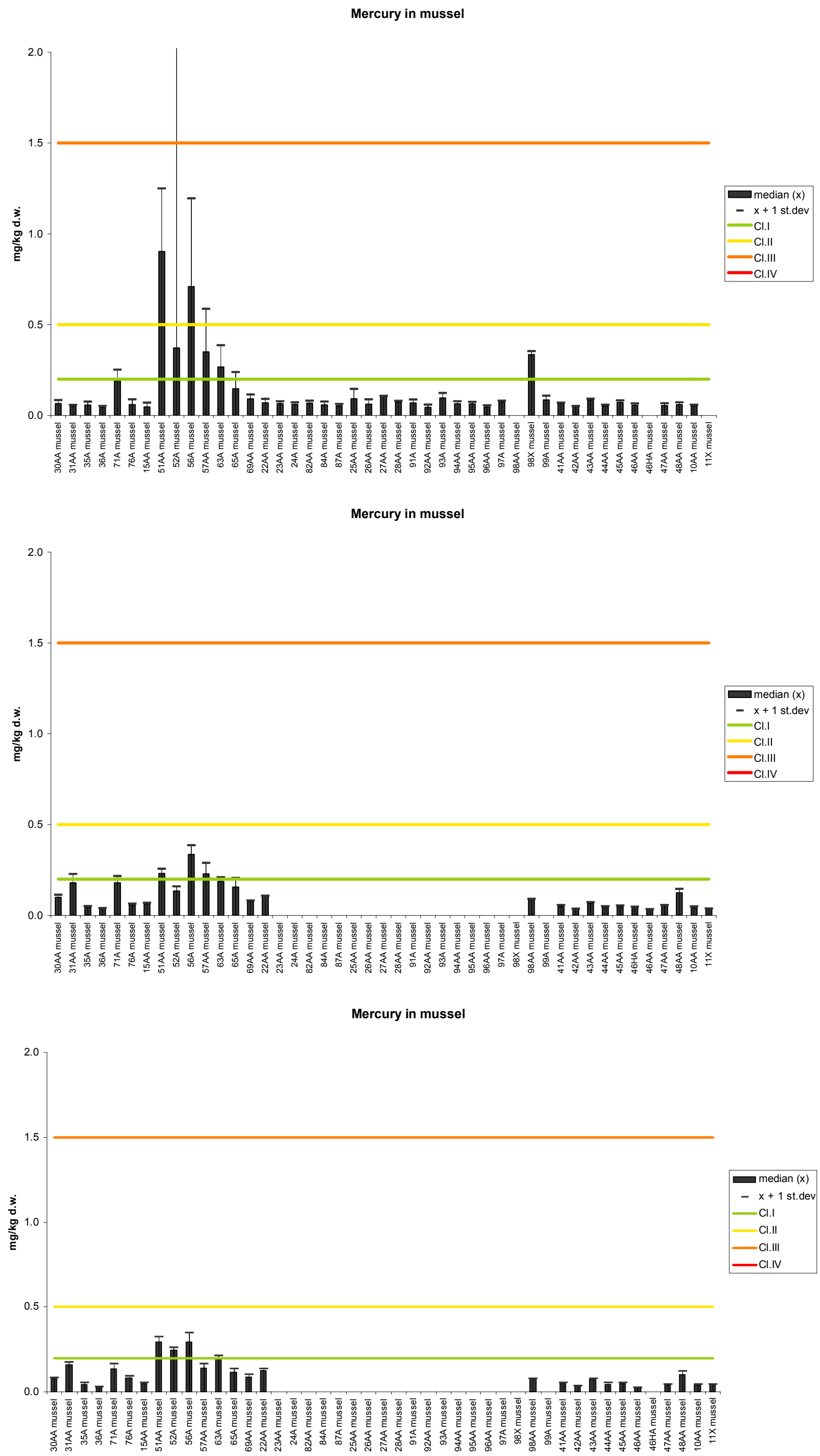


Figure 28. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for mercury in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight (see maps in Appendix G).

A

B

C

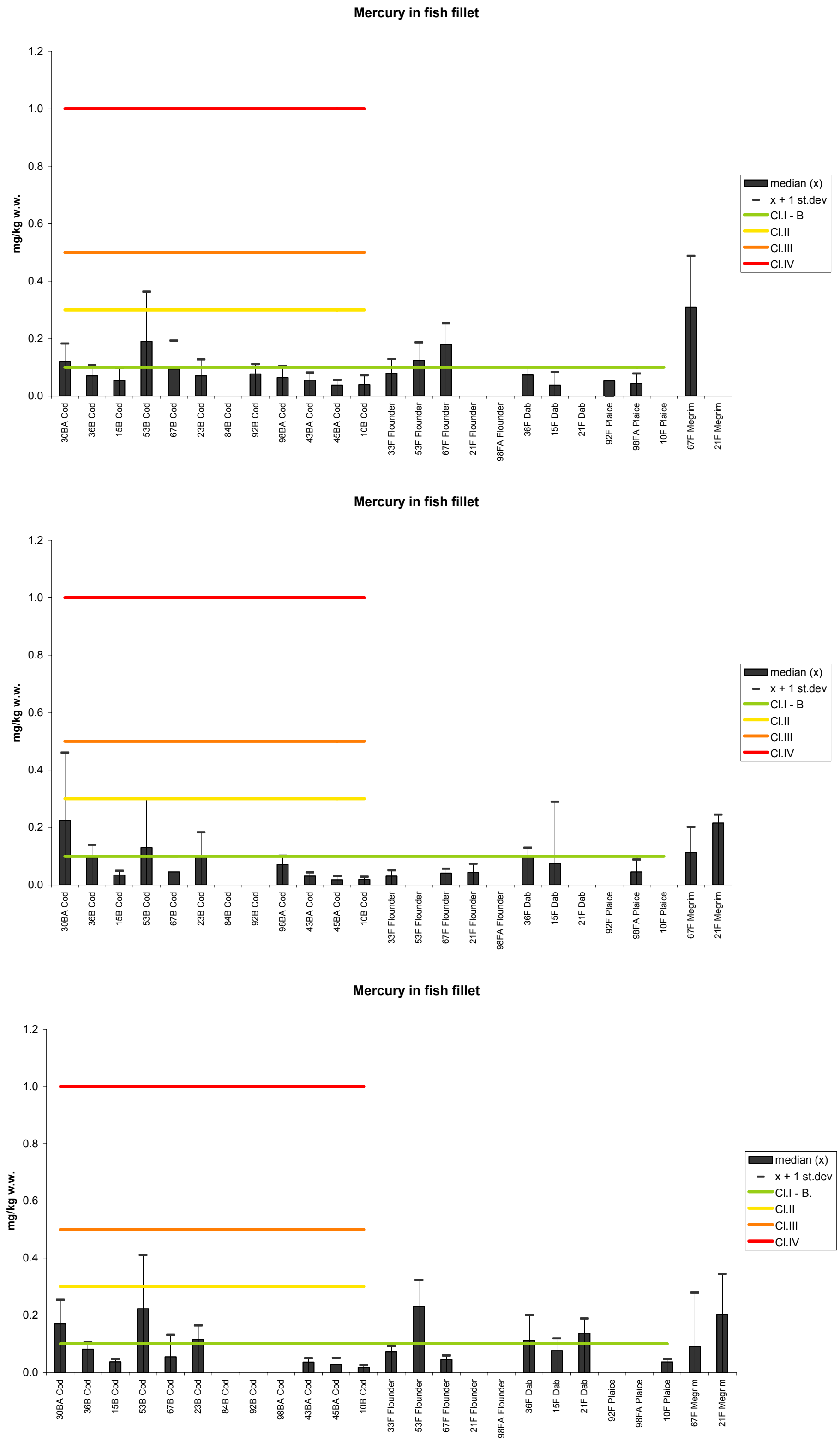


Figure 29. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for mercury in fish fillet 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight, “Cl. – B” indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for flatfish, (see maps in Appendix G).

A

B

C

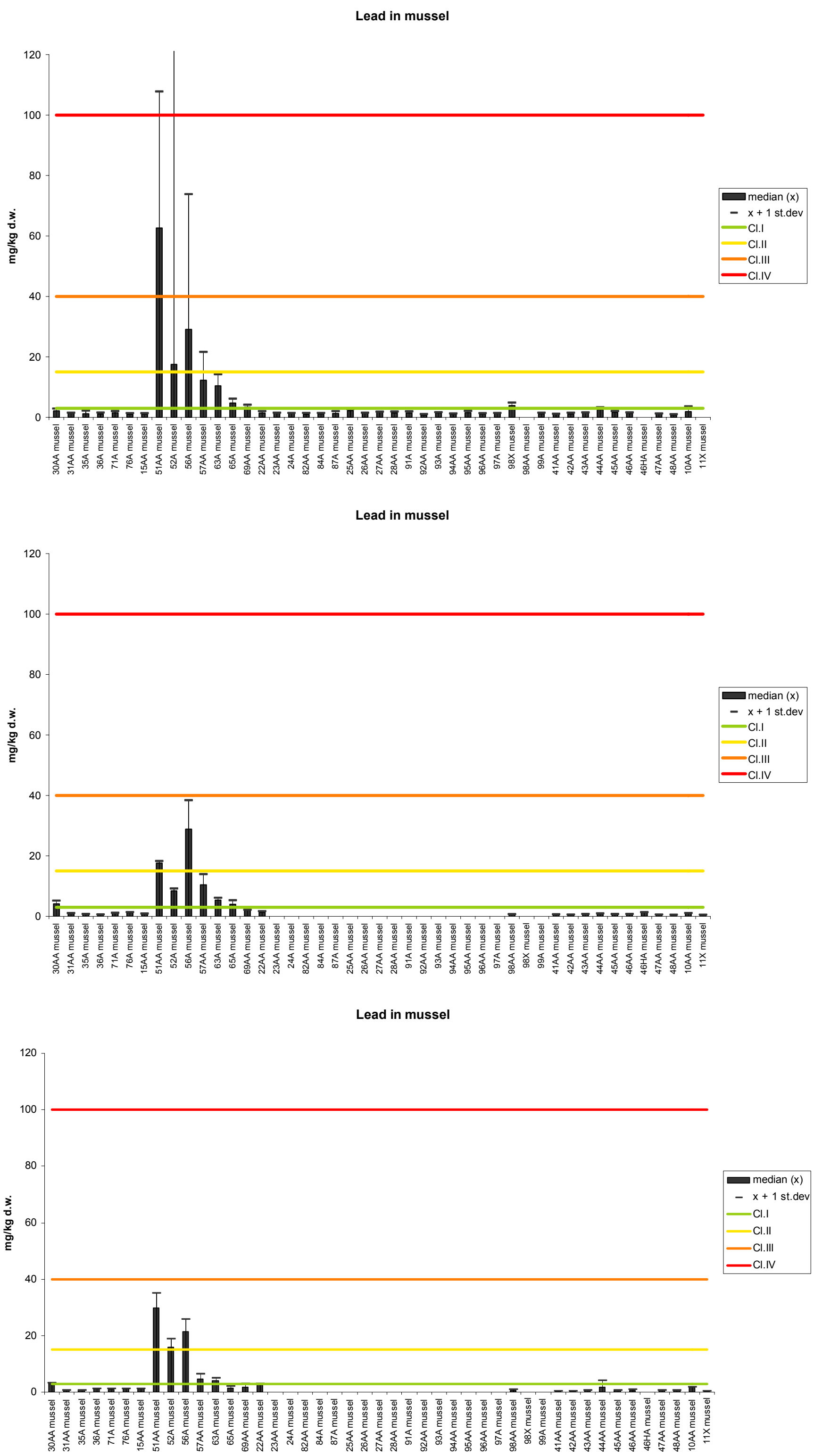


Figure 30. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for lead in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight (see maps in Appendix G). **Note: for some stations the standard deviation is off-scale in figure A.**

A B C

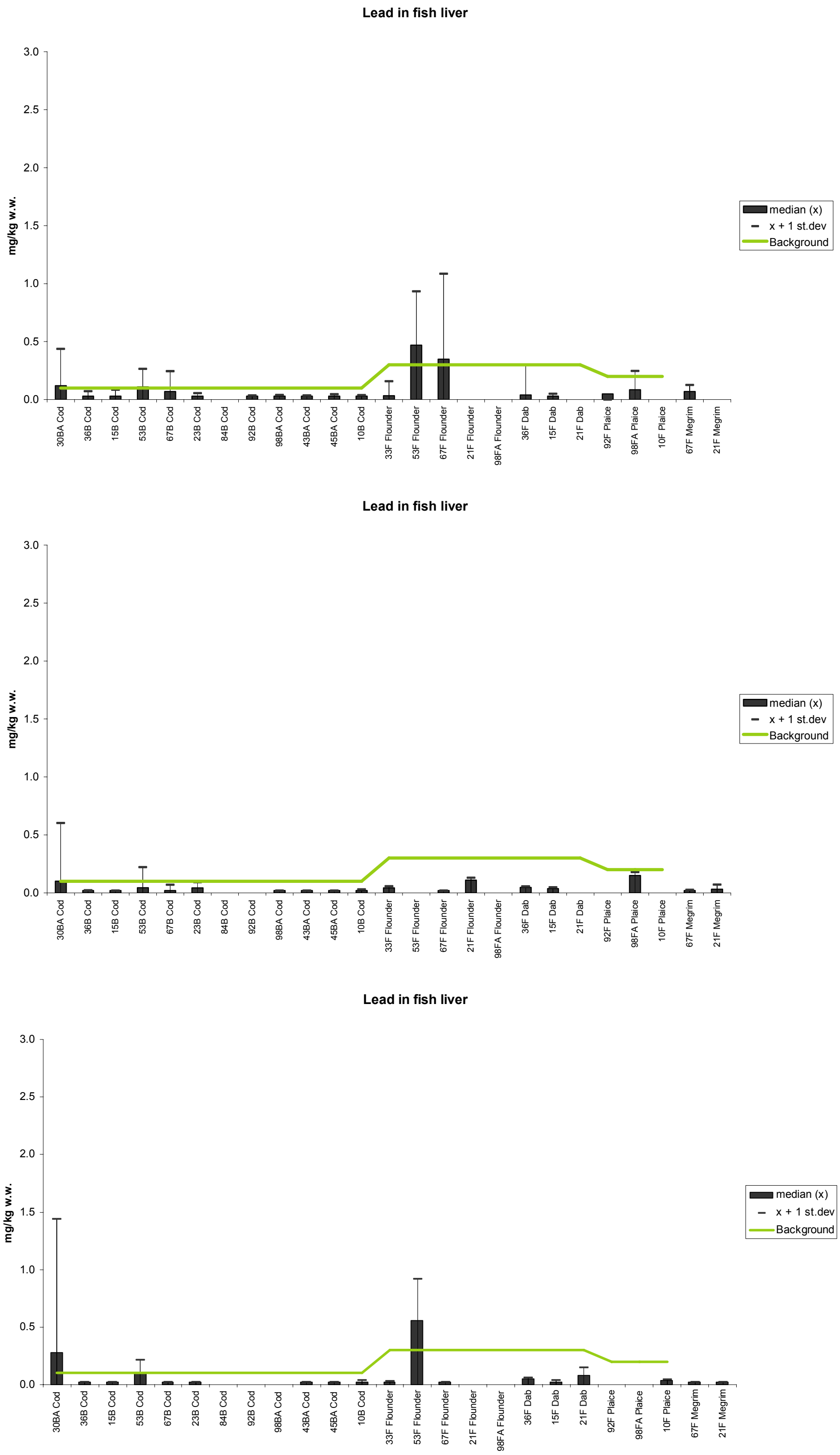
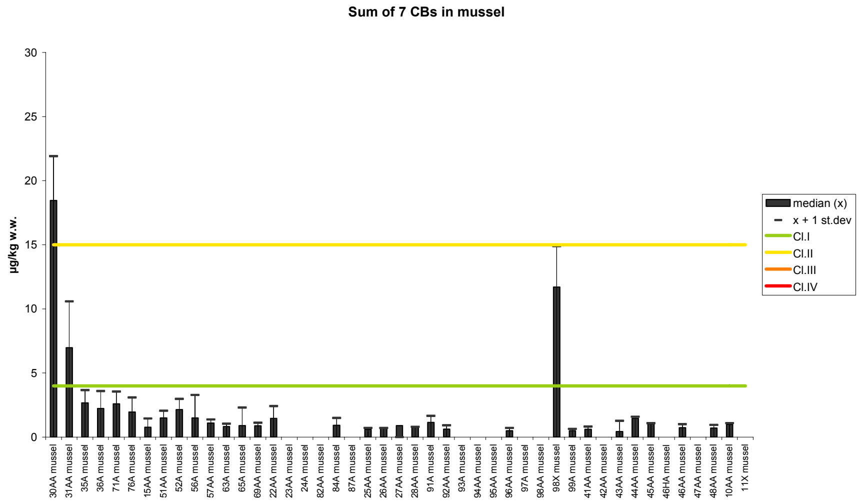
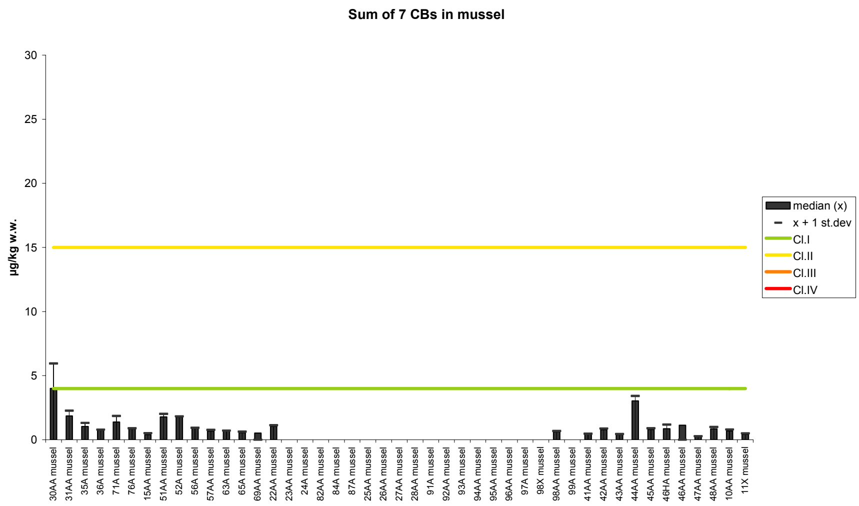


Figure 31. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for lead in fish liver 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppm (mg/kg) wet weight, "Cl. – B" indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for all fish, (see maps in Appendix G).

A



B



C

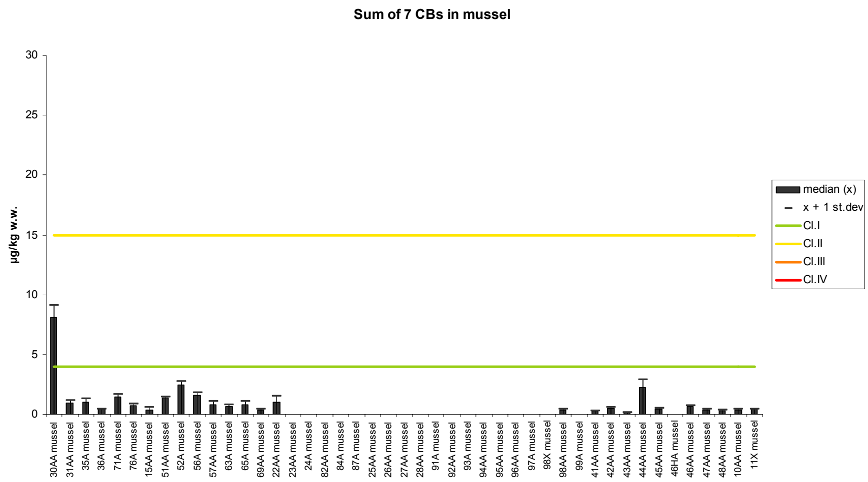
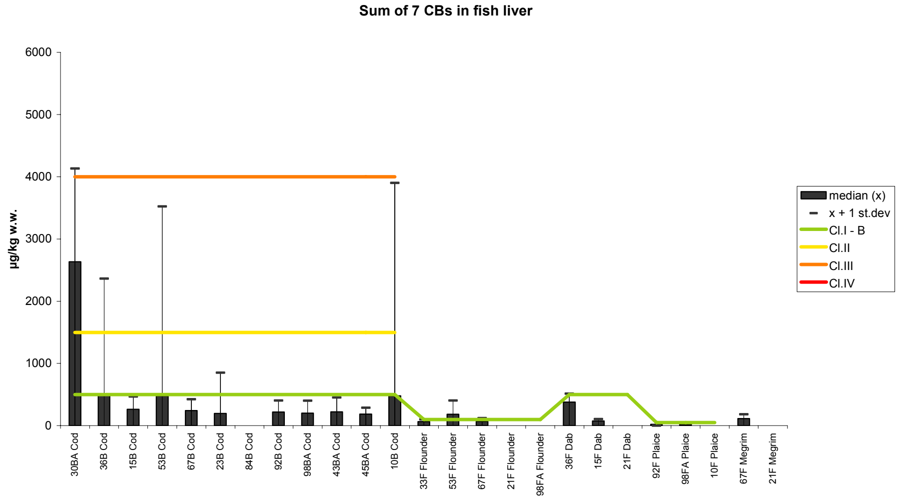
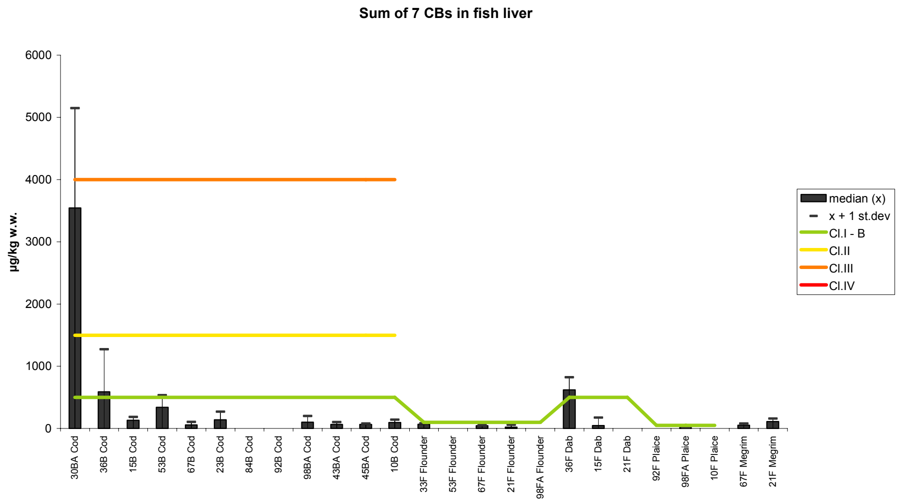


Figure 32. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight (see maps in Appendix G).

A



B



C

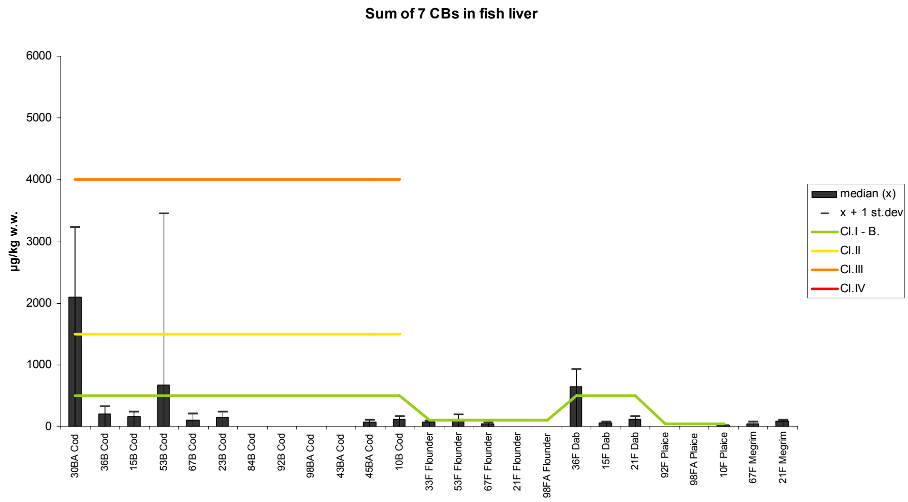


Figure 33. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for sum of 7 PCBs (CB-28, -52, 101, -118, -138, -153 and -180) in fish liver 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight, "Cl. – B" indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for flatfish, (see maps in Appendix G). **Note: for some stations the standard deviation is off-scale in figures A-C.**

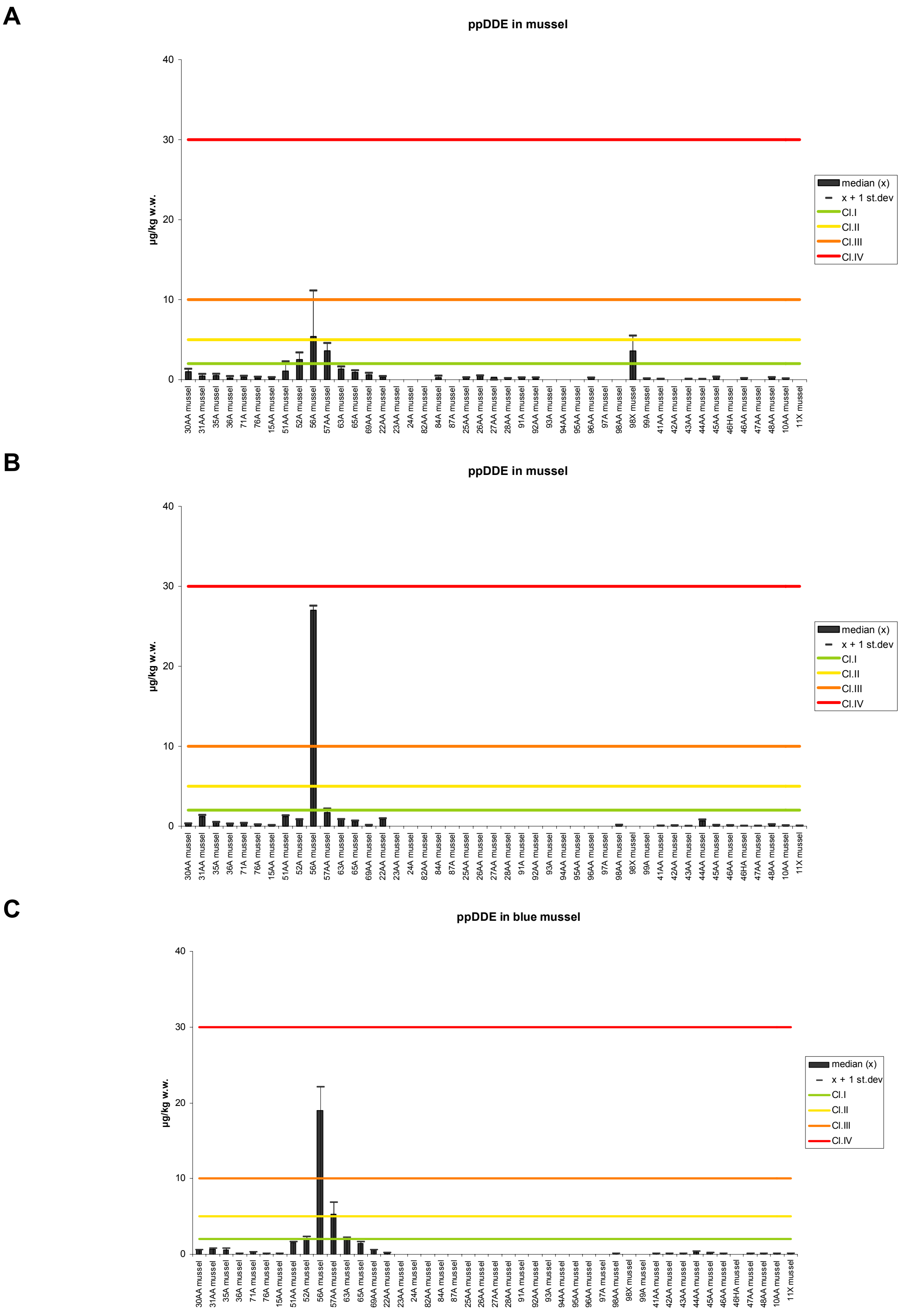
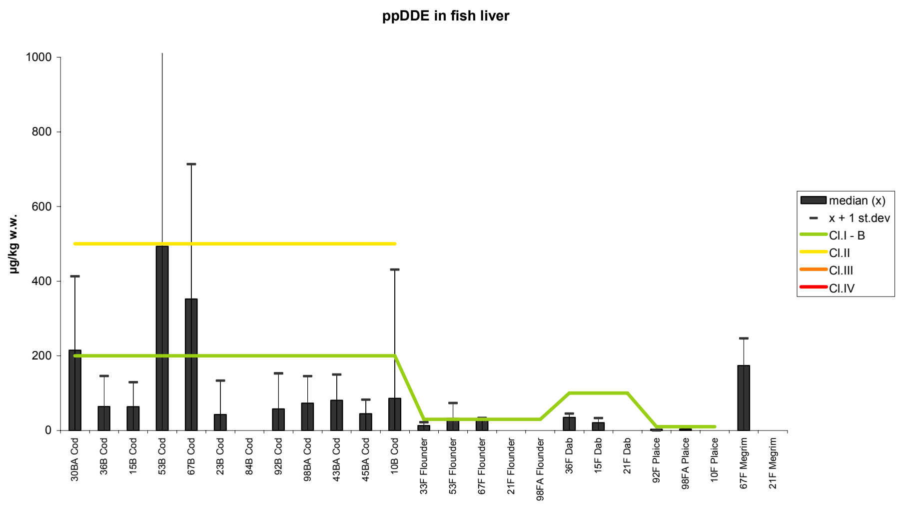


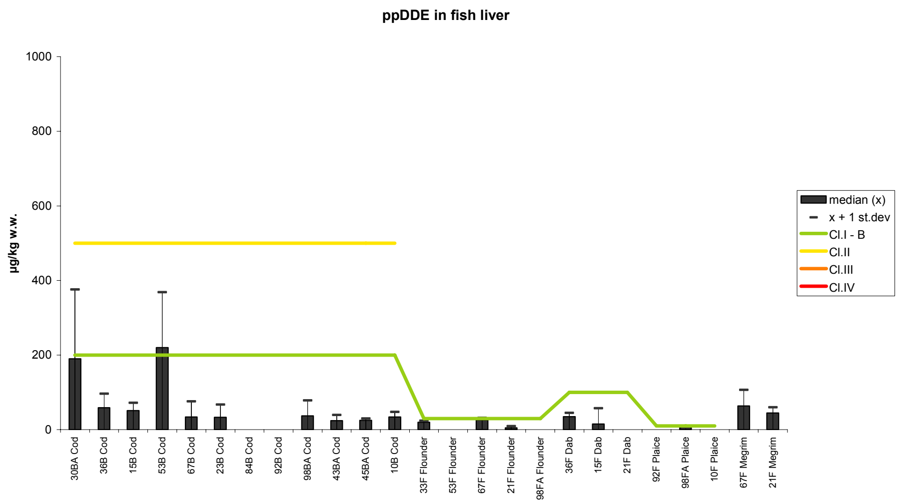
Figure 34. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for ppDDE (DDEPP) in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight (see maps in Appendix G). (See also footnote in **Table 7**). **Note: Class limits for ΣDDT used, and for some stations the standard deviation is off-scale in figure B.**

Table 9.

A



B



C

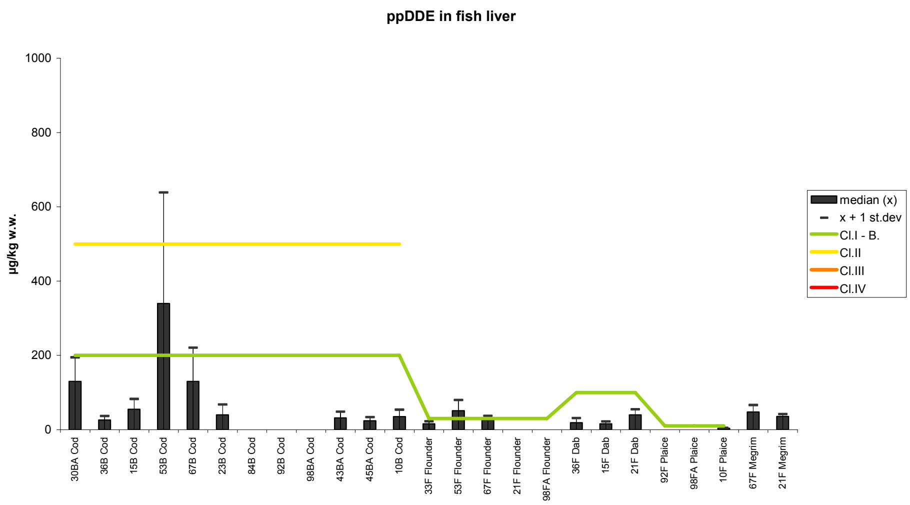


Figure 35. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for ppDDE (DDEPP) in fish liver 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight, "Cl. – B" indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for flatfish, (see maps in Appendix G). (See also footnote in **Table 7**). **Note: Class limits for ΣDDT used**

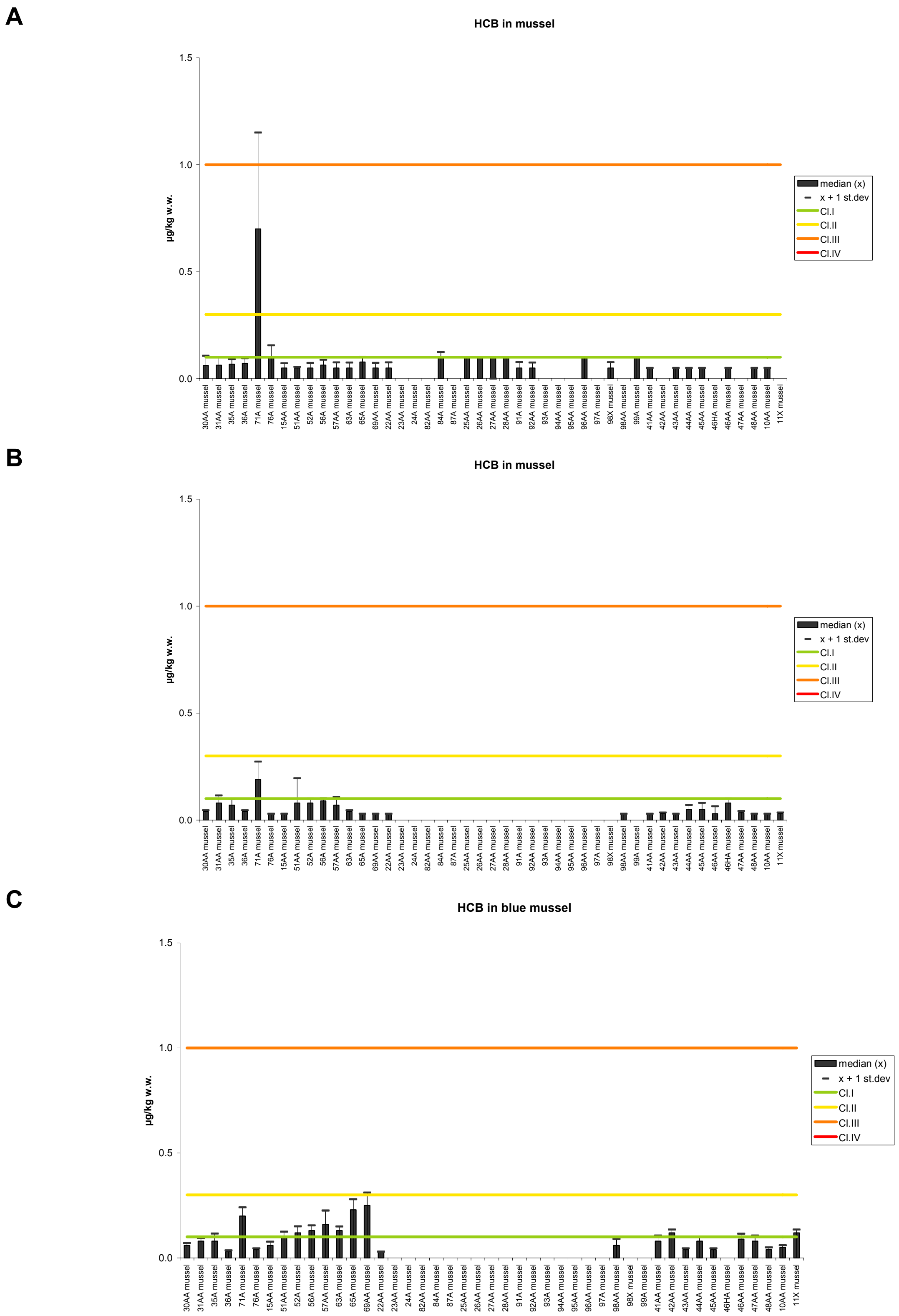


Figure 36. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for HCB in blue mussel (*Mytilus edulis*) 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight (see maps in Appendix G).

A B C

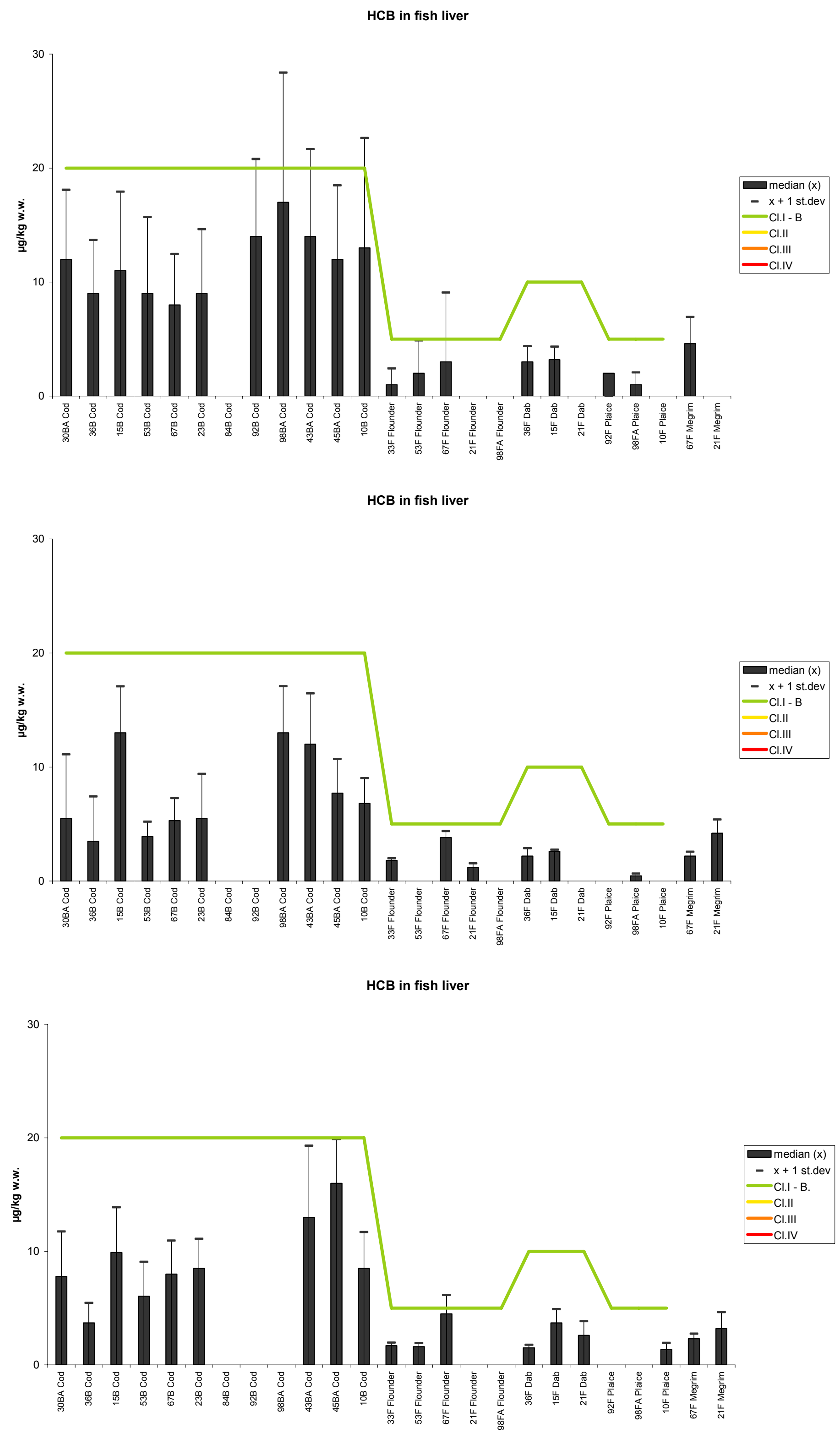


Figure 37. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for HCB in fish liver 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppb (µg/kg) wet weight, "Cl. – B" indicates that only upper limit to SFT Classes or provisional high back ground concentration is indicated for all fish, (see maps in Appendix G).

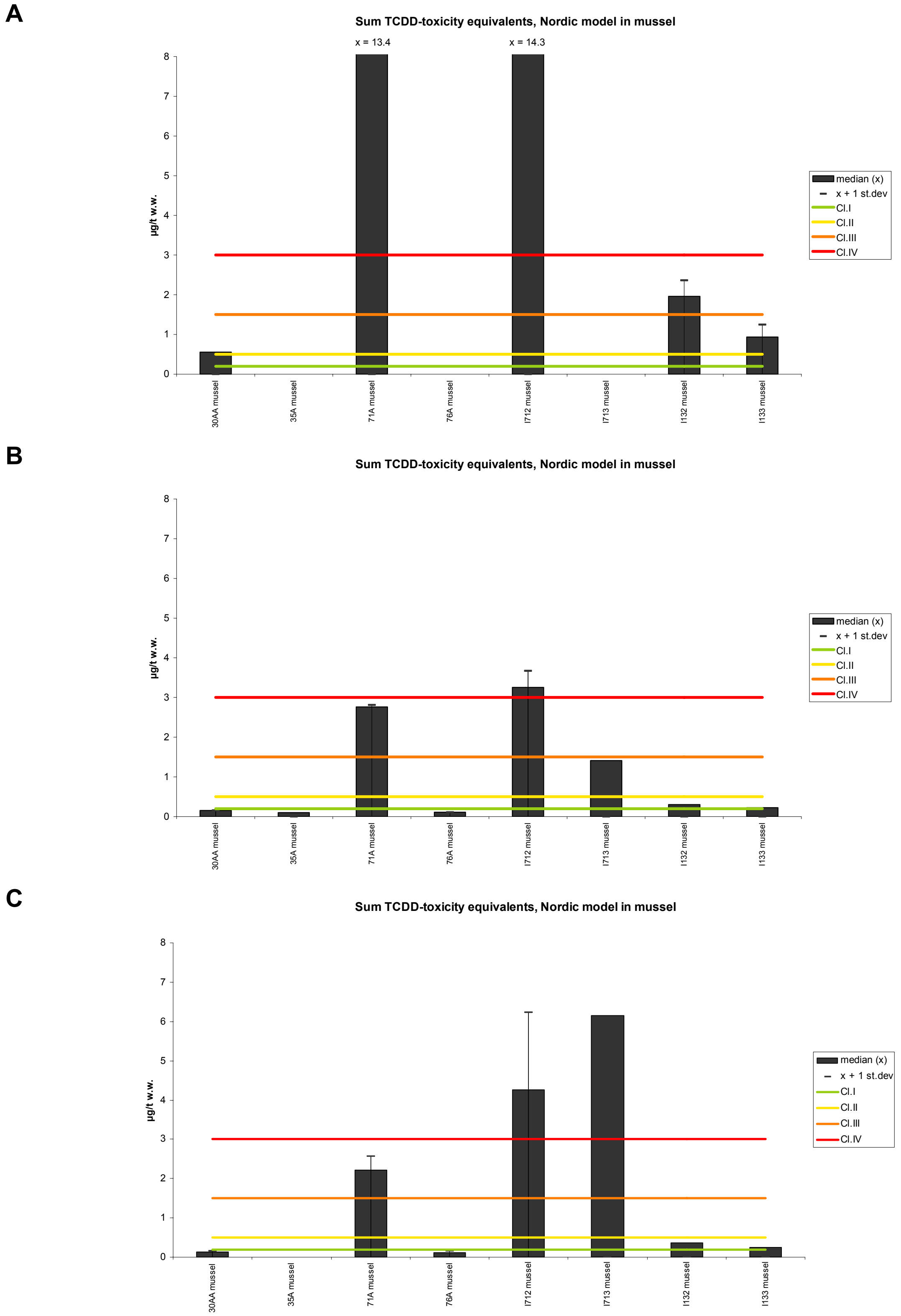
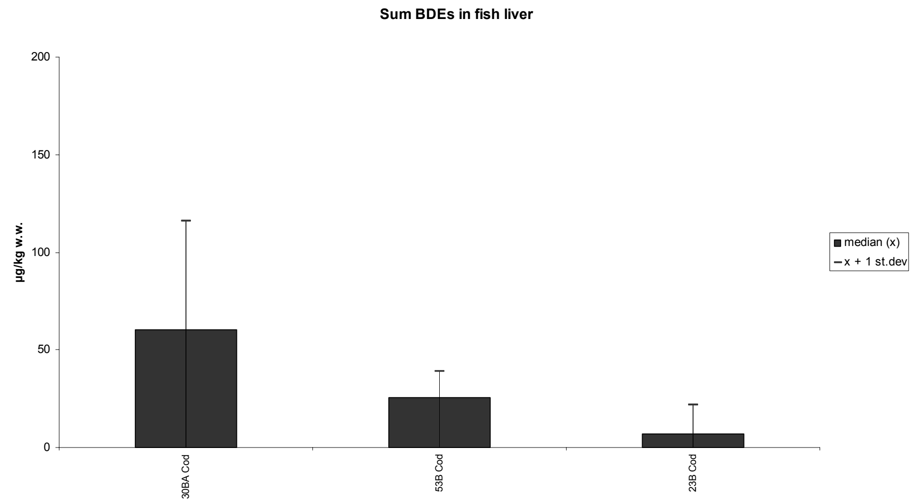
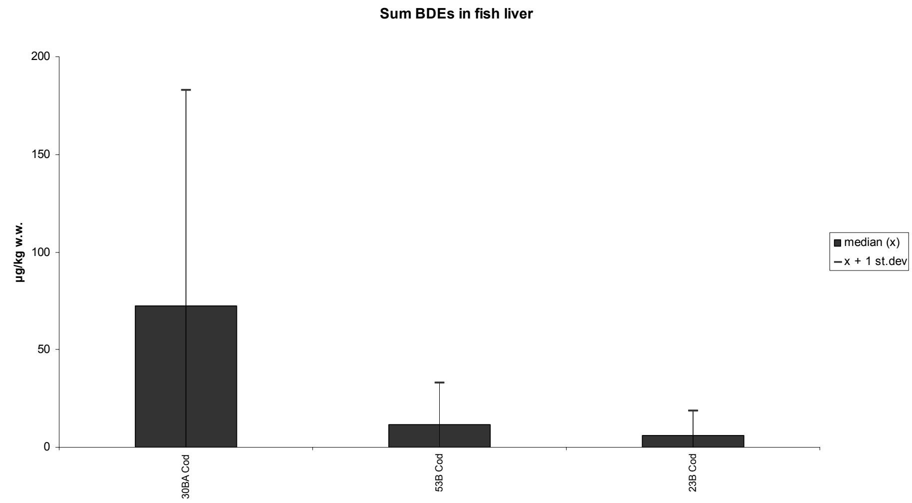


Figure 38. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for dioxin TCDD-toxicity equivalents after nordic model (TCDDN) in blue mussel 1990-1996 (**A**), 2006 (**B**) and 2007 (**C**), ppp (ng/kg) wet weight (see maps in Appendix G). NB: TCDDN is a sum of specific dioxin compounds of which may include compounds of uncertain quantification.

A



B



C

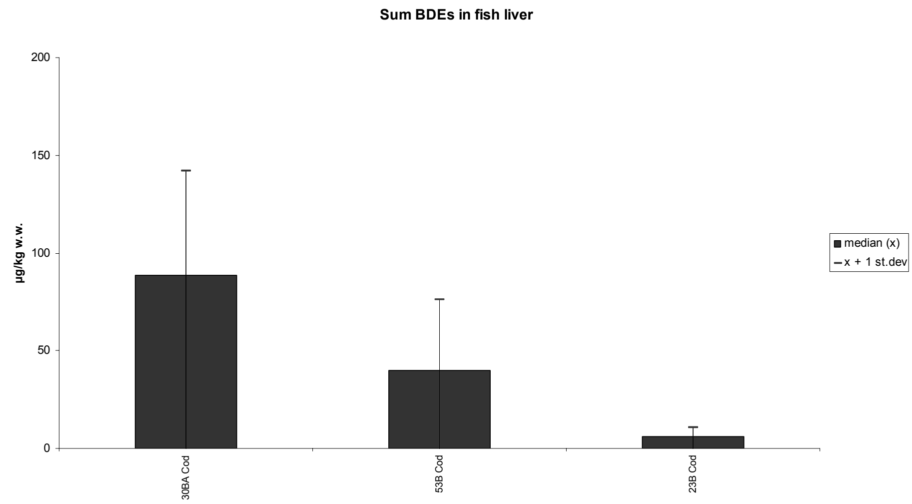


Figure 39. Median concentration for brominated flame retardent in cod liver 2005 (**A**), 2006 (**B**) and 2007 (**C**) ppb (µg/kg) wet weight for three CEMP stations (inner Oslofjord - st.30B, inner Sørfjord - st.53B and Karihavet - st.23B) (see maps in Appendix G), and from two other investigations (see text).

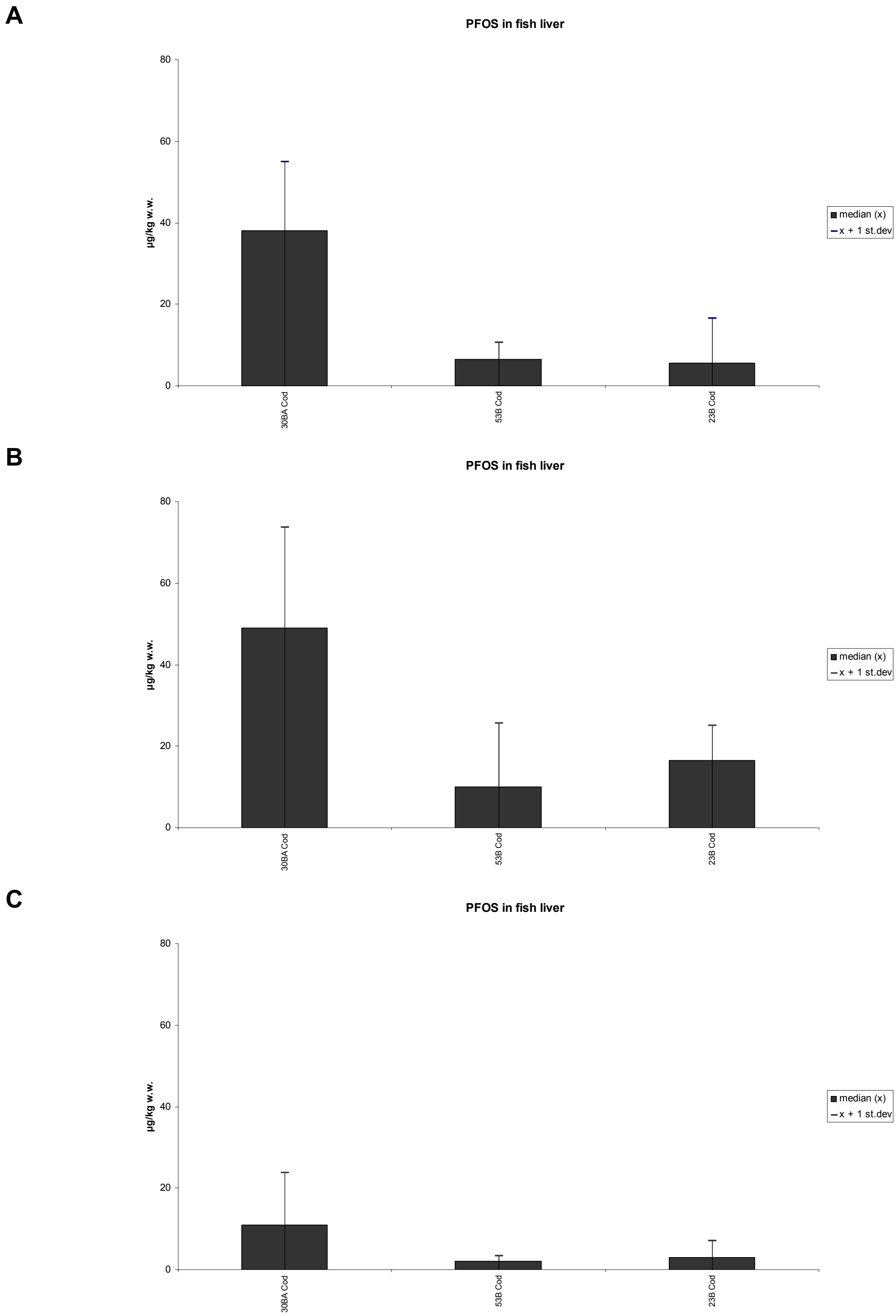
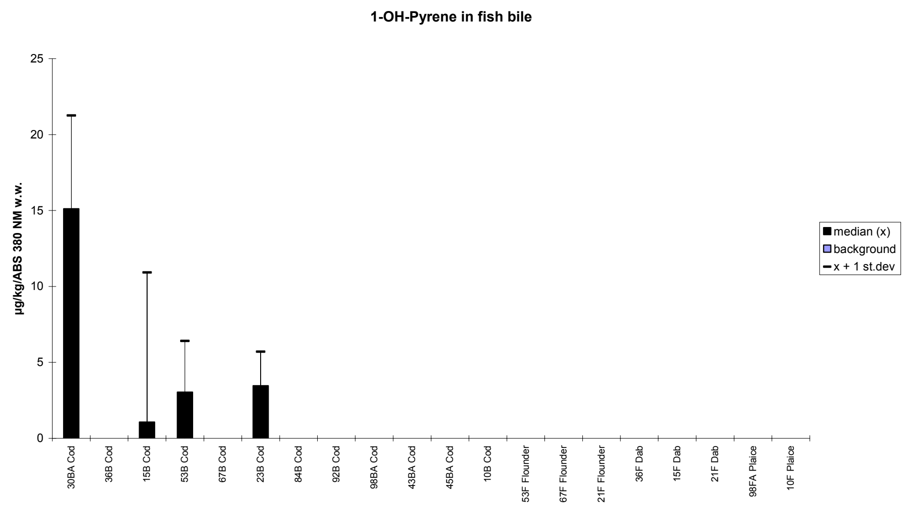
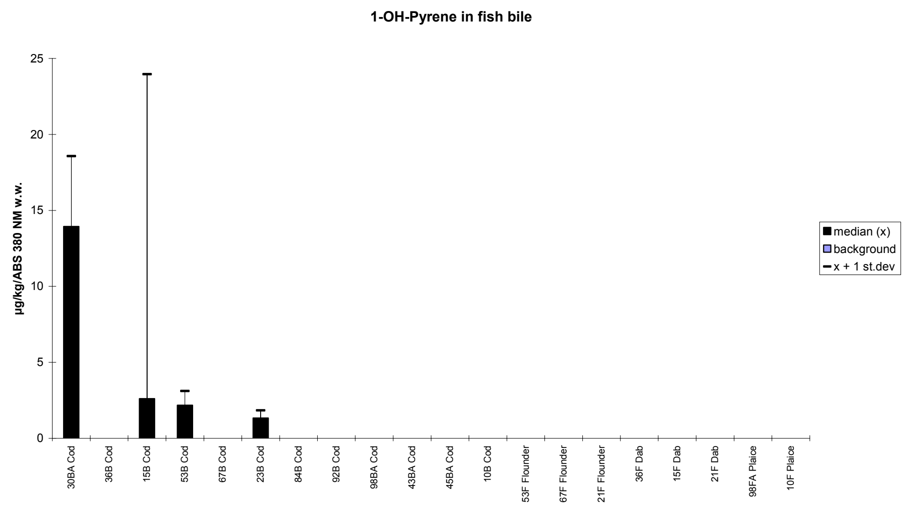


Figure 40. Median concentration for perfluoroctanoic sulfonate (PFOS) in cod liver 2005 (**A**), 2006 (**B**) and 2007 (**C**) ppb (µg/kg) wet weight for three CEMP stations (inner Oslofjord - st.30B, inner Sørfjord - st.53B and Karihavet - st.23B) (see maps in Appendix G), and from two other investigations (see text).

A



B



C

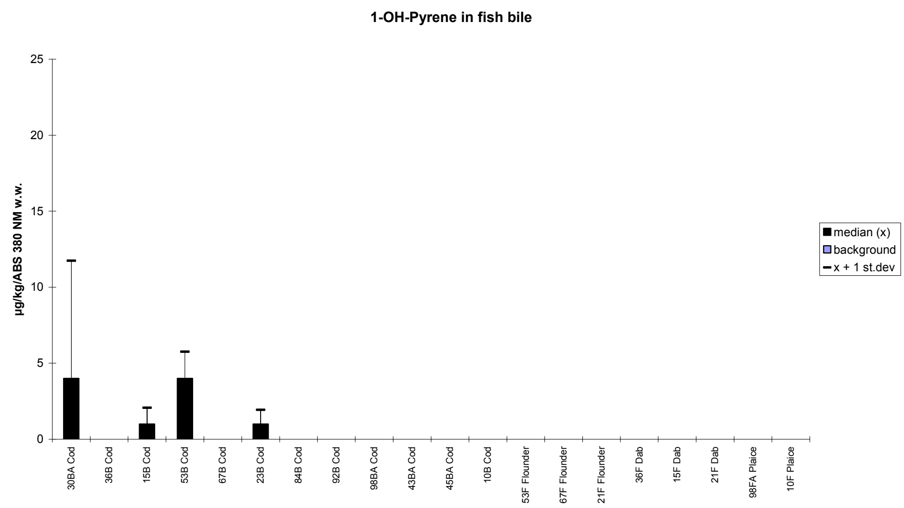
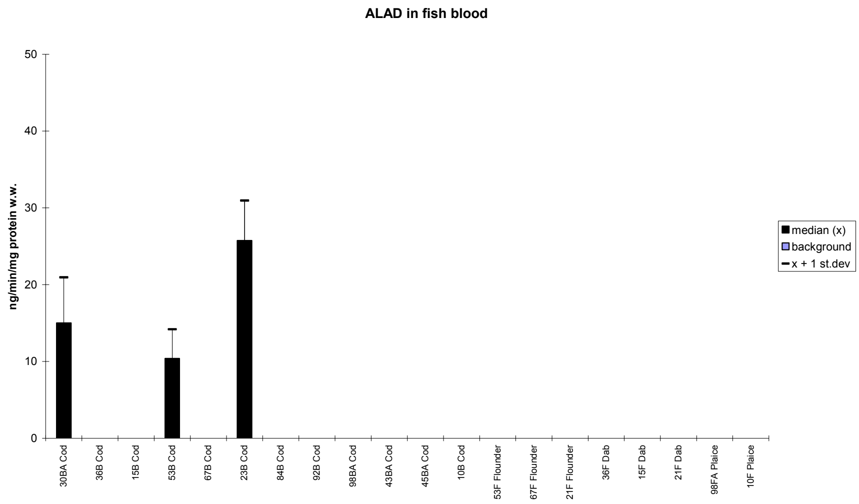
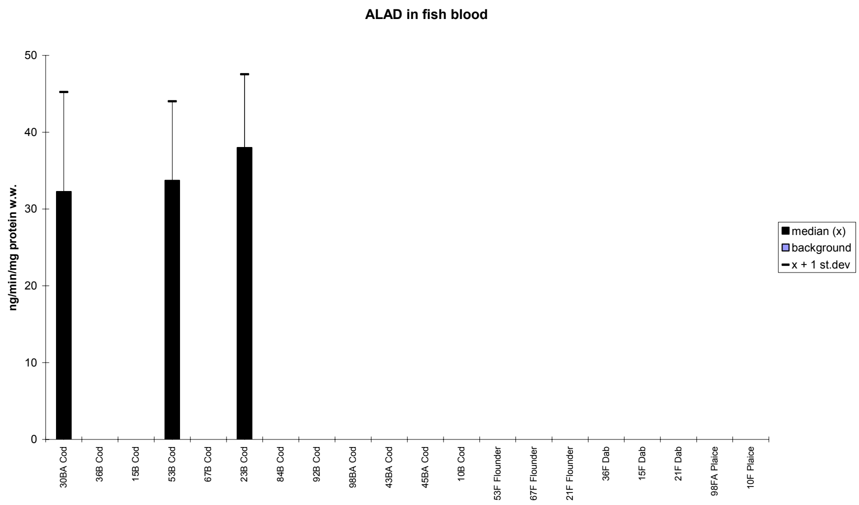


Figure 41. Median and standard deviation concentration for OH-pyrene (Pyrene metabolite) in fish bile 2005 (**A**), 2006 (**B**) and 2007 (**C**), µg/kg/ABS (absorbance) 380 nm (see maps in Appendix G).

A



B



C

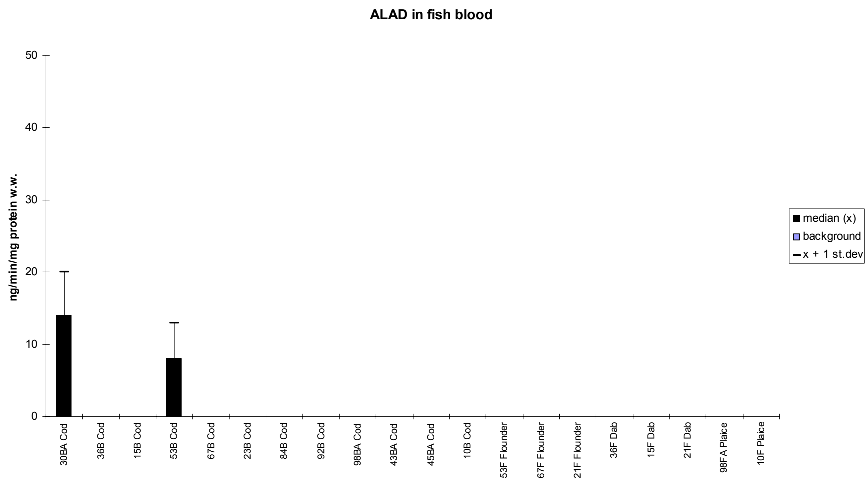
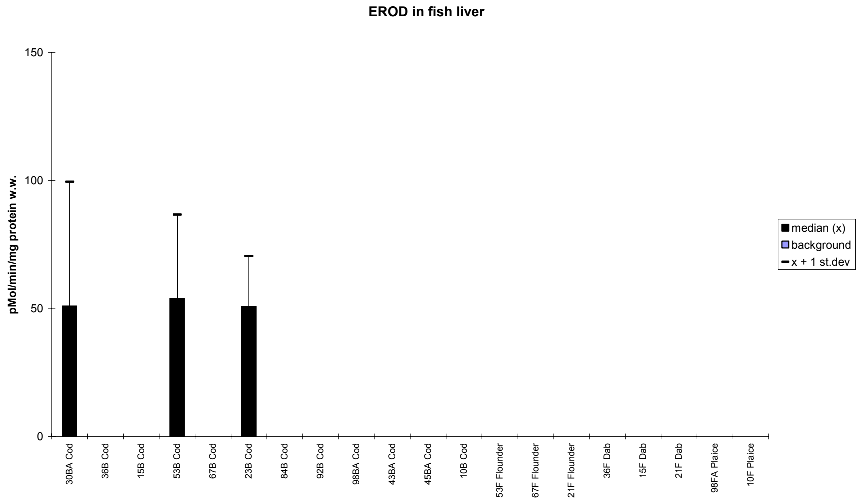
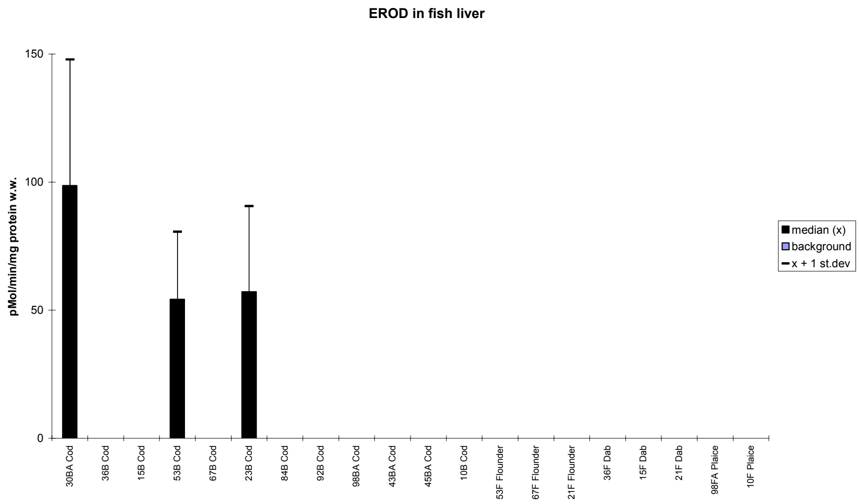


Figure 42. Median and standard deviation activity for ALA-D (δ-amino levulinic acid dehydrase inhibition) in fish liver 2005 (**A**), 2006 (**B**) and 2007 (**C**), ng PBG (porphobilinogen)/min/mg protein (see maps in Appendix G).

A



B



C

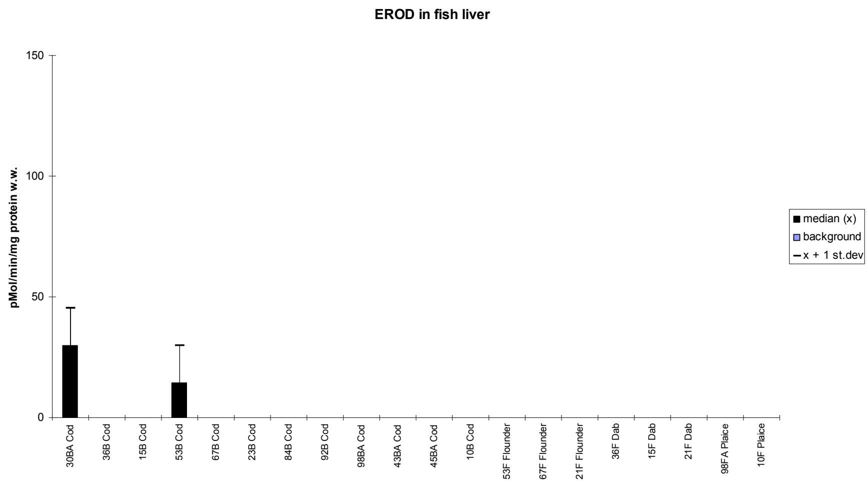


Figure 43. Median and standard deviation activity for EROD (Cytochrome P4501A-activity) in fish liver 2005 (**A**), 2006 (**B**) and 2007 (**C**), pmol/min/mg protein (see maps in Appendix G).

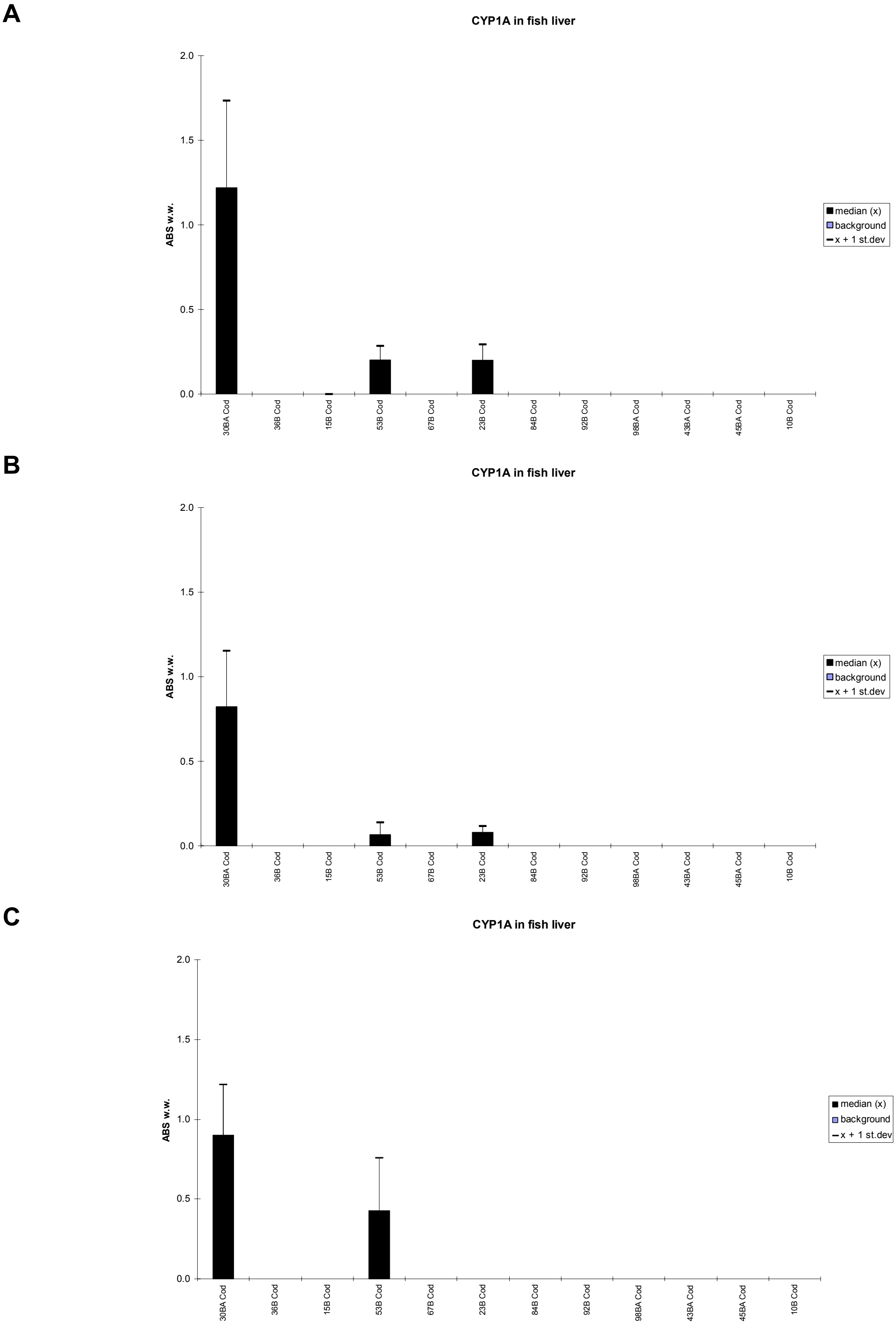
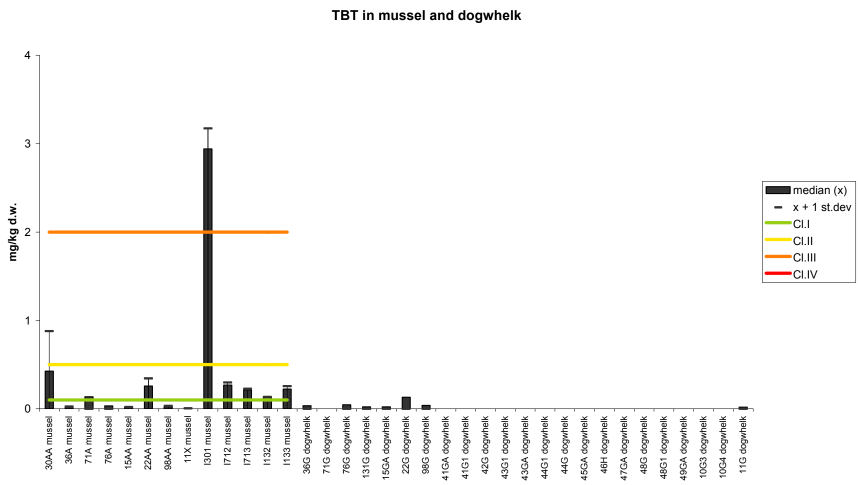
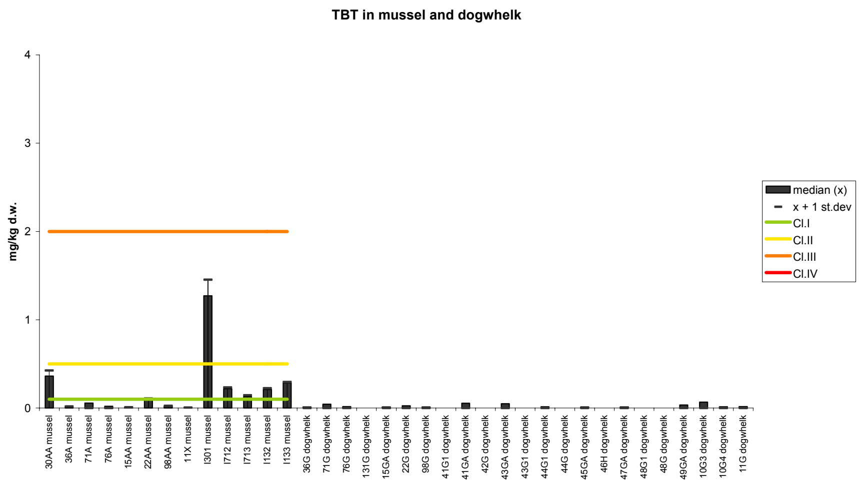


Figure 44. Median and standard deviation activity for CYP1A (relative amount of Cytochrome P4501A-protein) in fish liver 2005 (**A**), 2006 (**B**) and 2007 (**C**), pmol/min/mg protein (see maps in Appendix G).

A



B



C

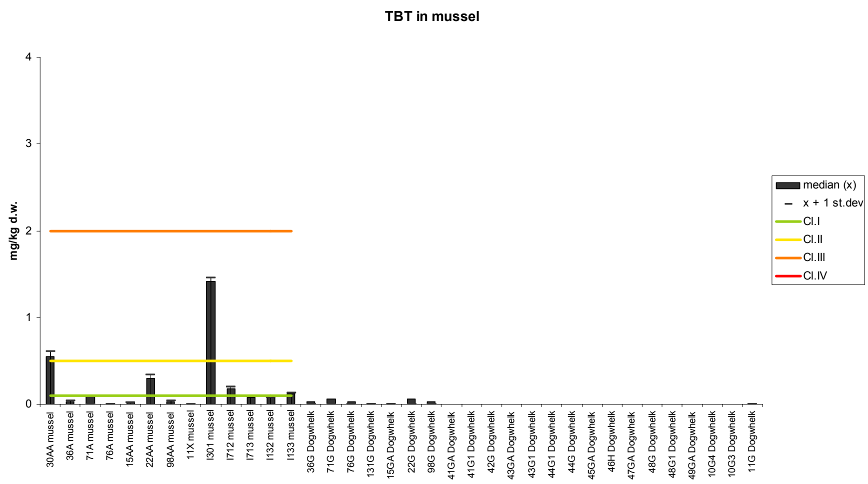
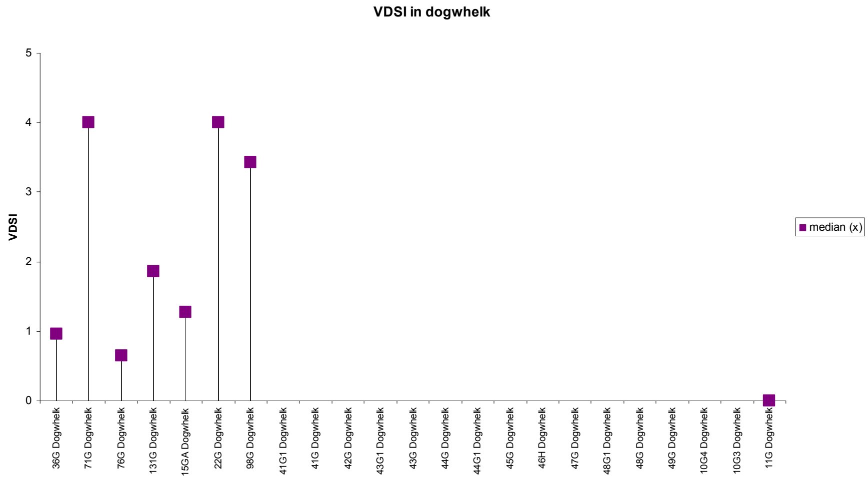
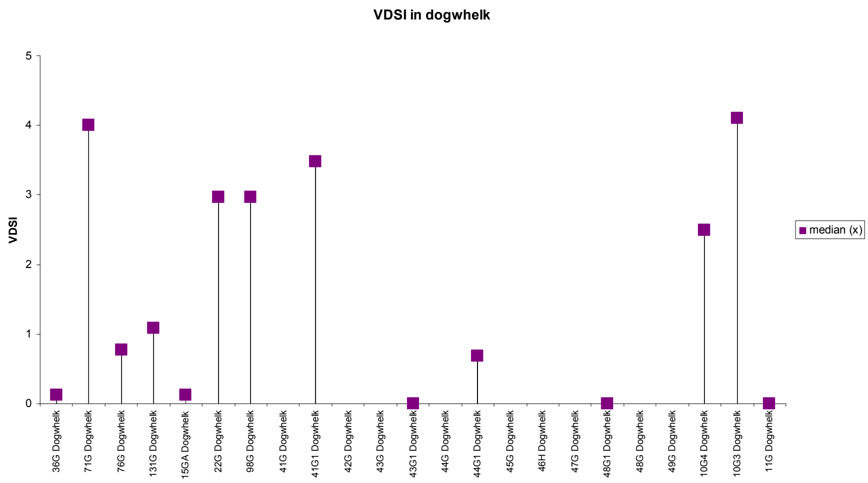


Figure 45. Median, standard deviation and upper limit to SFT Classes or provisional "high background" concentration for tributyl tin (TBT-concentration on a formulation basis) in blue mussel and dogwhelk 2005 (**A**), 2006 (**B**) and 2007 (**C**), ppm (2.44* mg Sn/kg) dry weight (see maps in Appendix G).

A



B



C

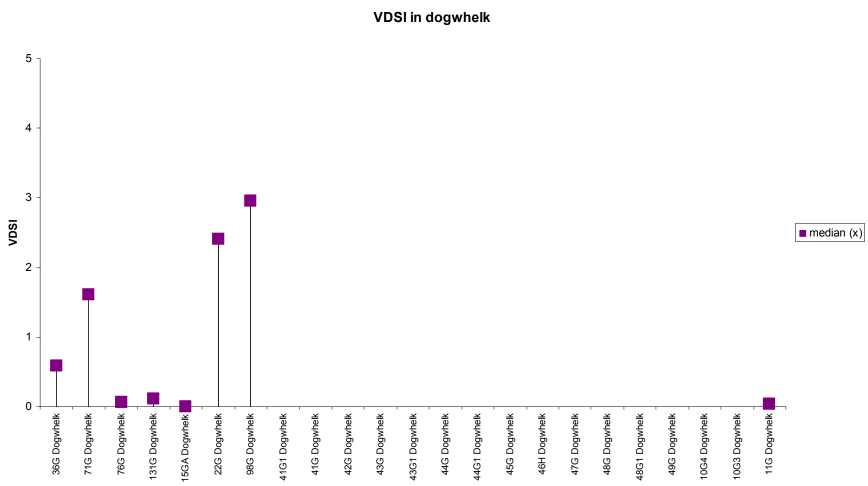


Figure 46. Average VDSI in dogwhelk 2005 (**A**), 2006 (**B**) and 2007 (**C**) (see maps in Appendix G).

Appendix K
Results from INDEX determinations 1995-2007

Introduction

The Norwegian Pollution Control Authority (SFT) has requested that a small group of indices be established to assess the quality of the environment with respect to contaminants. The target indicator medium for both indices may vary depending on what purpose is defined, however sediment, cod and blue mussel are considered to be the most relevant choices. Blue mussel was selected for this investigation (Appendix K1).

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 CEMP. Some CEMP 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 blue mussel were collected at CEMP 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. Initially 8 areas were involved but since 1998 only 5 have been sampled.

Calculation of the index

Sampling strategy and 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 Appendix K2 and J3. Their selection is based on earlier investigations. Two to five stations were sampled from each area. Three replicate samples with 20 individuals with a shell length of 3-5 cm were collected from each station. Each sample was analysed for the contaminants according to the scheme in Appendix K2. "Dioxins" were only investigated in 1995-96, but reinstated for some stations in 2002 as part of the annual investigations. Assessment of TBT concentrations was introduced in 2002 even though it is not identified as a selection criteria by Walday *et al.* (1995).

One to three stations were sampled from selected areas for the determination of the Reference Index. Each station included three replicates which were analysed for the usual CEMP contaminants (cf. analysis code A, Appendix K2). Some samples were also analysed for PAHs and dioxins.

The strategy for sampling blue mussel differed depending on whether the blue mussel were to be used for the Index or for CEMP 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 CEMP and that the blue mussel 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 K4 and Appendix K5). 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 this was the calculation of sum-PAH that included the dicyclic PAHs. As analytical methods improved through the years more non-dicyclic PAHs could be quantified, and included the C1-, C2-, and C3-dibenzpthiophenes, and C1-, C2-, C3- and methylated phenathrenes. These were included in the sum of all non-dicyclic PAHs, and comparison between years could be misleading. For this report, PAH_Σ was re-calculated, also for previous years, using only the 15 non-dicyclic PAH listed in the EPA protocol 8310[1]. The recalculation revealed only one difference from previously reported index values, and that was for the Reference Index 2006 reported to SFT as 1.6 in June of 2007, but the recalculation was 1.4 because PAH_Σ at Lista dropped into Cl.I from Cl.II.

"Dioxins" were assessed based on toxicity equivalency factors (TEQ) according to a Nordic model (Ahlborg 1989) which differs insignificantly from the recently revised WHO-model (van den Berg *et al.* 1998). 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 blue mussel. Likewise, there are contaminants which are included in the classification system but have not been measured in any area (e.g., tributyltin (TBT), arsenic, fluoride, 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 (insignificantly polluted). The highest Index value is 5 and means that at least one median value from each of the areas was in Class V (extremely polluted).

Conclusion from application of the indices

The indices have been in used since 1995 based on contaminant concentrations in blue mussel from 14-19 areas (cf. Green *et al.* 2004). An assessment of their application suggested that the pollution index needed mainly two improvements (Green & Knutzen 2001): 1) more stations to avoid the consequences of insufficient sample size and 2) inclusion of more relevant contaminant analyses with respect to the pollution load expected and in relation to the SFT classification system for environmental quality (Molvær *et al.* 1997). SFT provided funds to improve the index in 2002. Three additional stations have since been established: one in the Frierfjord area (I713 Strømtangen, about 800 m east of I711 Steinsholmen), one in the inner Ranfjord (I964 Toraneskaien, about 500 m north of I965 Moholmen) and one in the Sunndalsfjord area (I915 Flåøya, northwest, about halfway between I913 and the inner most part of the fjord). Dioxin and TBT analyses were added to the programme for samples collected in the Frierfjord area, inner Oslofjord and the inner Kristiansandsfjord. TBT-analyses were also included for some of the reference stations (see Annex). These changes affect the outcome of the index and comparison to previous years should be cautioned. For results up to and including 2001 SFT has presented only the results using the old method of calculation, for 2002 the results for both the old and new methods are presented, and for 2003 and since then only the results for the new method are presented (cf. SFT's website at www.miljøstatus.no >> *Vannforurensning* >> *Miljøgifter, marint*). Comparison of the two methods for 2002 and 2003 has been done earlier (Green *et al.*, 2004 a, b).

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 this was the calculation of sum-PAH that included the dicyclic PAHs. As analytical methods improved through

[1] Acenaphthene, acenaphthylene, anthracene, benzo[*a*]anthracene, benzo[*a*]pyrene, benzo[b]fluoranthene, benzo[ghi]perlyene, benzo[*k*]fluoranthene, chrysene, dibenzo[*a,h*]anthracene, fluoranthene, indeno[*1,2,3-cd*]pyrene, phenanthrene and pyrene. NB. for NIVA's PAH_Σ, a where these cannot be distinguished but included in a group, such as benzo[*b*]fluoranthene benzo[*b,b,f*]fluoranthene, the value for the group is used. A single compound can not be included in more than one group.

the years more non-dicyclic PAHs could be quantified, and included the C1-, C2-, and C3-dibenzpthiophenes, and C1-, C2-, C3- and methylated phenathrenes. These were included in the sum of all non-dicyclic PAHs, and comparison between years could be misleading. For the *National Comments* 2006 (Green *et al.,* 2008a), PAH_Σ was re-calculated, also for previous years, using only the 15 non-dycyclic PAH listed in the EPA protocol 8310[1]. The recalculation revealed only one difference from previously reported index values, and that was for the Reference Index 2006 reported to SFT as 1.6 in June of 2007, but the recalculation was 1.4 because PAH_Σ at Lista dropped into Cl.I from Cl.II.

It should also be noted that the SFT classification system is under revision and may affect calculations of the indices in the future. One likely change will be the lowering of limits to the classes for PCBs taking into consideration a lower background from 4 to 3 ppb wet weight suggested by Green & Knutzen (2003).

No special considerations were made when one but not all the stations within an area were sampled. The lack of sufficient samples has occurred several times for the Pollution Index: (st. I205 Bølsnes from Saudafjord 1996, st. I911 Horvika in the Sunndalsfjord since 1999, st. I021 in the Hvaler area 1999, st.I962 in the Inner Ranfjord since 1999, and st. I711 Steinholmen in the Frierfjord 2001).

Because insufficient amount of blue mussel were found at station Horvika in the Sunndalsfjord, two new stations were introduced; Fjøseid (I913) in 1999 and Flåøya, northwest (I915), in 2003, about 15 and 5 km farther out the fjord from Horvika, respectively. It can be noted that inclusion of supplementary analyse of blue mussel from the "Hydro kai" (I916), innermost in Sunndalsfjord, would have increased the index. Because sufficient amount of blue mussel were not found at station I962 Koksverktomta in the Ranfjord since 1999, a new station (I965 - Moholmen) was introduced in 2001 about 2 km south of Koksverktomta.

Based on the new calculation with the mentioned supplementary stations and supplementary analyses of dioxin and TBT, the **Pollution Index for 2007was 3.0** compared to 2.9 for 2006 (Table 10, Appendix K4). A value between 3 and 4 would be termed by the SFT system as between "Severe" and "Marked" and between 2 and 3 as between "Moderate" and "Marked". The index increased one class for Inner Kristiansandsfjord and Sunndalsfjord, because of higher benzo[a]pyrene, decreased one class in the Bergen harbour because of lower HCB. Statistical analyses did not reveal any significant trends for benzo[a]pyrene from Kristiansandsfjord or Sunndalsfjord, however both a significant *downward* and *upward* trend for HCB at Gravdalsneset (st.I242) and Nordneset (st.I241), repsectively, in the Bergen harbour.

Only 5 fjords/areas were monitored for the Reference Index for 1998-2007 compared to 7 for 1997 and 8 for 1995-1996 (Table 11, Appendix K5). However, only four of these provided a common basis (cf., Table 11). Similar to the application Pollution Index, the Reference Index made no special considerations when one but not all the stations within an area were sampled. For the four common areas, this has occurred several times, all in the Varangerfjord area (st.48A since 1997 and st.11A

[1] Acenaphthene, acenaphthylene, anthracene, benzo[*a*]anthracene, benzo[*a*]pyrene, benzo[b]fluoranthene, benzo[ghi]perlyene, benzo[*k*]fluoranthene, chrysene, dibenzo[*a,h*]anthracene, fluoranthene, indeno[*1,2,3-cd*]pyrene, phenanthrene and pyrene. NB. for NIVA's PAH_Σ, a where these cannot be distinguished but included in a group, such as benzo[*b*]fluoranthene benzo[*b,b,f*]fluoranthene, the value for the group is used. A single compound can not be included in more than one group.

since 1998). With Lofoten and the supplementary analyses of TBT included, the **Reference Index for 2007 was 1.4**, unchanged from 2004 (Table 11, Appendix K5). All five fjords/areas included the TBT analyses. The index increased one class for the Varanger Peninsula because of cadmium. An index value between 1 and 2 would be termed by the SFT system as “Moderate”. No statistically significant temporal trends were found for Cd from Varangerfjord (st.10A2).

Table 10. Maximum environmental classification for fjords selected for Pollution INDEX. (See text and Appendix K4).

Index Area [1]	1995	1996	1997 [2]	1998	1999	2000	2001	2002	2002 new [7]	2003	2003 new [7]	2004 new [7]	2005 new [7]	2006 new [7]	2007 new [7]
Hvaler/Singlefjord	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
Iddefjord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inner Oslofjord	3	3	4	2	3	2	2	2	4	2	4	4	4	3	3
Frierfjord (Grenland)	3	4	3	3	3	3	3	5 [6]	5	3 [6]	5	5	5	5	5
Inner Kristiansandsfjord	5	5	5	5	5	4	3	3	3	4	4	4	4	3	4
Saudafjord	4	5	5	3	4	3	3	4	4	2	2	3	2	2	2
Sørfjord	5	4	3	3	4	4	3	4	4	5	5	4	4	3	3
Byfjorden, Bergen [3]	3	3	3	2	2	2	2	3	3	4	4	3	3	3	2
Sunndalsfjord	3	3	3 [4]	2	3	4	2	3	3	1 [6]	1	1	1	1	2
Orkdalsfjord	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inner Ranfjord	5	3	3 [5]	4	2	2	3	3 [6]	3	3 [8]	5	5	3	4	4
AVERAGE (Pollution INDEX)	**3.7**	**3.6**	**3.4**	**3.0**	**3.1**	**2.9**	**2.7**	**3.2**	**3.4**	**2.9**	**3.6**	**3.4**	**3.1**	**2.9**	**3.0**

[1] Iddefjord and Orkdalsfjord not sampled since 1997, hence the indices 1995-96 do not include the local indices from these fjords
[2] Copper, zinc and TCDDN excluded since 1997, hence indices 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
[6] Results from supplementary station would not influence the outcome of classification
[7] Inclusion of supplementary a station in Frierfjord, Inner Ranfjord, and Sunndalsfjord (2003), and supplementary dioxin and TBT analyses for Inner Oslofjord, Frierfjord, and Inner Kristiansandfjord.
[8] Results from supplementary station would influence the outcome of classification.

Table 11. Maximum environmental classification for fjords selected for Reference INDEX. (See text and Appendix K5).

Index Area	1995	1996	1997	1998	1999	2000	2001	2002	2002 new 5)	2003	2003 new 5)	2004 new 5)	2005 new 5)	2006 new 5)	2007 new 5)
Mid and outer Oslofjord 1)	2	2	2	1	1	1	2	1	1	1	2	1	1	2	1
Lista	1	1	1	1	2	2	2	2	2	1	1	2	2	1	1
Bømlo-Sotra	1	1	1	1	1	2	2	1	2	1	3	2	2	2	2
Outer Ranfjord, Helgeland 2)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-
Lofoten 3)	(2)	(2)	(1)	(2)	(2)	(1)	(2)	(2)	2	(2)	2	1	1	1	1
Finnsnes-Skjervøy 2)	(2)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-
Hammerfest-Honningsvåg 2)	(2)	(3) 4)	(2)	-	-	-	-	-	-	-	-	-	-	-	-
Varanger Peninsula	1	2	1	2	1	1	1	1	1	1	1	1	1	1	2
AVERAGE (Reference INDEX)	**1.3**	**1.5**	**1.3**	**1.3**	**1.3**	**1.5**	**1.8**	**1.3**	**1.6**	**1.2**	**1.8**	**1.4**	**1.4**	**1.4**	**1.4**

1) Inclusion of results for arsenic, nickel and silver in 1996 did not affect the classification

2) Inconsistency in sampling from sites from Outer Ranfjord, Finnsnes-Skjervøy and Hammerfest-Honningsvåg, hence, results were excluded. See cf., Green *et al.* 2000 for more details for outer Ranfjord.

3) Inconsistency in sampling from this site, hence, results from Lofoten excluded. See cf., Green *et al.* 2000 for more details for st 98X.

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

5) Inclusion of supplementary TBT analyses for Mid and outer Oslofjord, Lista, Bømlo-Sotra, Lofoten and Varangerfjord Peninsula.

Appendix K1
INDEX - Sampling and analyses for 1995-2007

Appendix K1. Blue mussel samples planned or used in INDEX and other purposes besides CEMP 1995-2006, where P = “Pollution Index” and R = “Reference Index” (contaminated and assumed “background” stations, respectively). + indicates CEMP sampling and analyses (i.e. equivalent to analysis code A). The number indicates the number samples analysed. Codes for analysis (A, B etc.) are defined in Appendix K2. See Walday *et al.* (1995) for discussion of selection of stations and analyses.

	st.	STATION	INDEX	+	A	B	C	D	E	F	G	H	I	J	K	CM
		HVALER/SINGLEFJORD AREA														
	I021	Kjøkø, south	P	.	3	.	.	.	.	.	.	.	.	.	.	
	I024	Kirøy, north west	P	.	3	.	.	.	.	.	.	.	.	.	.	
	I022	West Damholmen	P	.	3	.	.	.	.	.	.	.	.	.	.	
	I023	Singlekalven, south	P	.	3	.	.	.	.	.	.	.	.	.	.	
		IDDEFJORD														
	I001	Sponvikskansen	P	.	.	3	.	.	.	.	.	.	.	.	.	
	I011	Kråkenebbet	P	.	.	3	.	.	.	.	.	.	.	.	.	
		OSLOFJORD, inner														
	30A	Gressholmen	P	+	3	.	.	.	.	.	.	3	.	2	2	
	I301	Akershuskaia	P	.	.	.	3	.	.	.	.	.	.	.	2	
	I304	Gåsøya	P	.	.	.	3	.	.	.	.	.	.	.	.	
	I307	Ramtonholmen	P	.	.	.	3	.	.	.	.	.	.	.	.	
	I306	Håøya	P	.	.	.	3	.	.	.	.	.	.	.	.	
		OSLOFJORD, mid and outer														
	31A	Solbergstrand	R	+	3	.	.	.	.	.	.	.	.	.	.	
	35A	Mølen	R	+	3	.	.	.	.	.	.	.	.	.	.	
	36A	Færder	R	+	3	.	.	.	.	.	.	.	.	.	2	
		FRIERFJORD AREA, west of outer Oslofjord														
	I712	Gjermundsholmen	P	.	.	.	.	3	.	.	.	.	.	2	2	
	I713	Strømtangen	P	.	.	.	.	3	.	.	.	.	.	1	2	
	71A	Bjørkøya	P	+	3	.	.	.	.	.	.	.	.	2	1	
	76A	Risøy	R	+	3	.	.	.	.	.	.	.	.	2	1	
		INNER KRISTRIANSANDSFJORD														
	I1321	Fiskåtangen	P	.	.	.	.	.	3	.	.	.	.	2	2	
	I133	Odderø, west	P	.	.	.	.	.	3	.	.	.	.	1	2	
		LISTA AREA														
	15A	Gåsøya	R	+	3	.	.	.	.	.	.	.	.	.	2	
	I131A	Lastad	R	.	.	.	3.	.	.	.	.	.	.	.	.	g
		SAUDAFJORD														
	I201	Ekkjegrunn (G1)	P	.	.	.	.	.	.	3	.	.	.	.	.	
**	I205	Bølsnes (G5)	P	.	.	.	.	.	.	3	.	.	.	.	.	
		[HAUGESUND AREA not related to INDEX investigation]														
	227A1	Melandsholmen	O	.	3	.	.	.	.	.	.	.	.	.	1	
		BØMLO-SOTRA AREA														
	22A	Espevær, west	R	+	3	.	.	.	.	.	.	.	.	.	2	c,a
		SØRFJORD														
*	51A	Byrkjeneset	P	.	3	.	.	.	.	.	.	.	.	.	.	
	52A	Eirtrheimsneset	P	+	3	.	.	.	.	.	.	.	.	.	.	c

Appendix K1 (cont'd)

	st.	STATION	INDEX	+	A	B	C	D	E	F	G	H	I	J	K	CM
				-----	-----	-----	-----	ANALYSIS	CODE	-----	-----	-----	-----	-----	-----	CM
		BYFJORDEN, BERGEN														
	I242	Valheimsneset	P	.	.	.	.	.	.	.	3	.	.	.	.	
	I241	Nordnes	P	.	.	.	.	.	.	.	3	.	.	.	.	
	I243	Hagreneset	P	.	.	.	.	.	.	.	3	.	.	.	.	
		SUNNDALSFJORD														
	I912	Honnhammer	P	.	.	.	.	.	.	.	.	3	.	.	.	
	I913	Fjøseid	P	.	.	.	.	.	.	.	.	3	.	.	.	
	I914	Flåøya, southeast	P	.	.	.	.	.	.	.	.	3	.	.	.	
	I915	Flåøya, northwest	P	.	.	.	.	.	.	.	.	3	.	.	.	
		[TRONDHEIM AREA - not related to index investigation]														
*	80A	Østmarknes	-	.	.	.	.	.	.	.	.	.	3	.	.	
		ORKDALSFJORD AREA (not suggested in Walday *et al.* 1995)														
	82A	Flakk	P	+	3	.	.	.	.	.	.	.	.	.	.	
	84A	Trossavika	P	+	3	.	.	.	.	.	.	.	.	.	.	
	87A	Ingdalsbukta	P	+	3	.	.	.	.	.	.	.	.	.	.	
		INNER RANFJORD														
	I962	Koksverkkaien (B2)	P	.	.	.	.	.	.	.	.	.	3	.	.	c
	I964	Toraneskaien	P	.	.	.	.	.	.	.	.	.	3	.	.	
	I965	Moholmen (B5)	P	.	.	.	.	.	.	.	.	.	3	.	.	
	I969	Bjørnbærviken (B9)	P	.	.	.	.	.	.	.	.	.	3	.	.	
		OUTER RANFJORD, HELGELAND AREA														
*	R096	Breivika, Tomma	R	.	3	.	.	.	.	.	.	.	.	.	.	a
	96A	Breivika, Tomma	R	.	3	.	.	.	.	.	.	.	.	.	.	a
		LOFOTEN AREA														
	98A	Husvågen	R	+	3	.	.	.	.	.	.	.	.	.	2	e
		FINNSNES-SKJERVØY AREA														
	41A	Fensneset, Grytøya	R	.	3	.	.	.	.	.	.	.	.	.	.	c
		HAMMERFEST-HONNINGSVÅG AREA														
	44A	Elenheimsundet	R	.	3	.	.	.	.	.	.	.	.	.	.	a,f
	46A	Smineset in Altesula	R	.	3	.	.	.	.	.	.	.	.	.	.	c,f
		VARANGER PENINSULA AREA														
	48A	Trollfjorden i Tanafjord	R	.	3	.	.	.	.	.	.	.	.	.	.	
	10A1	Skagoodden	R	+	3	.	.	.	.	.	.	.	.	.		b
	11X	Brashavn	R	+	3	.	.	.	.	.	.	.	.	.	2	

* - CEMP station but not sampled in accordance to CEMP guidelines, see Appendix text.
** - Sufficient mussel-sample not found in 1996.

Notes (CM):
- a - blue mussel collected from buoy and/or buoy anchor lines
- b - blue mussel collected from sand/gravel bottom
- c - blue mussel collected from iron/cement pilings
- d - blue mussel collected from metal navigation buoys
- e - blue mussel collected from floating dock
- f - blue mussel collected from wooden docks
- g - blue mussel collected from tire on jetty

Appendix K2
INDEX - Key to analysis codes and sample counts
(Used in Appendix K1)

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

	Analysis code										
Contaminant	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
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	..
TBT [4])	.	.	.	.	.	.	.	.	.	.	x

[1]) Concerns MUSSEL - 1 size group (3-5 cm), 3 replicate samples each a bulk of 20 individuals (see text)
[2]) Concerns MUSSEL - discontinued since 1996
[3]) Concerns MUSSEL - discontinued since 1995, but reinstated 2002 for st.30A, 71A, I711, I712, I713, 76A, I132 and I133
[4]) Concerns MUSSEL – not included in Walday *et al.* (1995).

Appendix K3
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
TBT	Tributyltin
PAH_S	total PAH excluding dicyclic (=PAH_Σ)*
BAP	benzo[*a*]pyrene
DDTSS	DDTPP+DDEPP+TDEPP (=DDTΣΣ)*
HCB	hexachlorobenzene
HCHSS	HCHG+HCHA+HCHB (=HCHΣΣ)*
CBSSe	sum of CB: 28+52+101+118+138+153+180 *
TCDDN	Sum of TCDD-toxicity equivalents *

*) See also Appendix C for definitions.

Basis: D = dry weight, W = wet weight
Units: M = ppm (mg/kg), U = ppb (µg/kg), P = ppp (ng/kg)

SFT's Environmental quality classes for blue mussel (Molvær *et al.* 1997).

Contaminant	basis	unit	Class I	Class II	Class III	Class IV	Class V
As	D	M	<10	10-30	30-100	100-200	>200
Pb	D	M	<3	3-15	15-40	40-100	>100
F	D	M	<15	15-50	50-150	150-300	>300
Cd	D	M	<2	2-5	5-20	20-40	>40
Cu	D	M	<10	10-30	30-100	100-200	>200
Cr	D	M	<3	3-10	10-30	30-60	>60
Hg	D	M	<0.2	0.2-0.5	0.5-1.5	1.5-4	>4
Ni	D	M	<5	5-20	20-50	50-100	>100
Zn	D	M	<200	200-400	400-1000	1000-2500	>2500
Ag	D	M	<0.3	0.3-1	1-2	2-5	>5
TBT	D	M	<0.1	0.1-0.5	0.5-2	2-5	>5
PAH_S	W	U	<50	50-200	200-2000	2000-5000	>5000
BAP	W	U	<1	1-3	3-10	10-30	>30
DDTSS	W	U	<2	2-5	5-10	10-30	>30
HCB	W	U	<0.1	0.1-0.3	0.3-1	1-5	>5
HCHSS	W	U	<1	1-3	3-10	10-30	>30
CBSSe	W	U	<4	4-15	15-40	40-100	>100
TCDDN	W	P	<0.2	0.2-0.5	0.5-1.5	1.5-3	>3

Appendix K4
INDEX - Summary table "Pollution index"
2006-2007

Pollution index 2006-new (with supplementary analyses and stations)

Max(median). Statistics for alle areas: (n = Index-station measured, N = Station programmed for index)

Average of Max E.C is 2.9

Index areaname (Pollution area) 2006	n	N	As ppm d.wt	Pb ppm d.wt	F ppm d.wt	Cd ppm d.wt	Cu ppm d.wt	Cr ppm d.wt	Hg ppm d.wt	Ni ppm d.wt	Zn ppm d.wt	Ag ppm d.wt	PAH_S ppb w.wt	BAP ppb w.wt	DDTSS ppb w.wt	HCB ppb w.wt	HCHSS ppb w.wt	CBSSe ppb w.wt	TCDDN ppp w.wt	TBT ppm d.wt	Max E.C I:V
Hvaler/Singlefjorden	3	4	i	1.34	i	1.97	i	i	0.28	i	i	i	i	i	<0.37	0.09	<0.12	1.44	i	i	II
Iddefjord	0	2	i	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	1.72	i	i	0.1	i	i	i	241.6	5.9	1.2	0.08	<0.05	10.55	<0.15	1.27	III
Frierfjorden	3	4	i	i	i	i	i	i	i	i	i	i	i	i	<0.71	0.26	<0.10	<1.56	3.25	0.22	V
Inner Kristiandsfjord	2	3	i	i	i	i	i	i	i	i	i	i	<249.07	8.5	<0.37	0.71	<0.11	<1.68	0.3	0.29	III
Saudafjord	2	2	i	5.26	i	1.91	i	i	i	i	i	i	<45.48	0.71	i	i	i	i	i	i	II
Sørfjord	2	2	i	17.63	i	2.88	i	i	0.23	i	i	i	i	i	2.18	0.08	<0.05	1.79	i	i	III
Byfjorden	3	3	i	i	i	i	i	i	i	i	i	i	i	i	3.18	0.31	0.11	12.78	i	i	III
Sunndalsfjord	3	4	i	i	i	i	i	i	i	i	i	i	<14.82	<0.50	i	i	i	i	i	i	I
Orkdalsfjord area	0	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	miss
Inner Ranfjord	3	4	i	13.71	i	2.11	i	i	i	i	i	i	<259.61	21	i	i	i	i	i	i	IV

Pollution index 2007-new (with supplementary analyses and stations)

Max(median). Statistics for alle areas: (n = Index-station measured, N = Station programmed for index)

Average of Max E.C is 3.0

Index areaname (Pollution area) 2007	n	N	As ppm d.wt	Pb ppm d.wt	F ppm d.wt	Cd ppm d.wt	Cu ppm d.wt	Cr ppm d.wt	Hg ppm d.wt	Ni ppm d.wt	Zn ppm d.wt	Ag ppm d.wt	PAH_S ppb w.wt	BAP ppb w.wt	DDTSS ppb w.wt	HCB ppb w.wt	HCHSS ppb w.wt	CBSSe ppb w.wt	TCDDN ppp w.wt	TBT ppm d.wt	Max E.C I:V
Hvaler/Singlefjorden	3	4	i	1.67	i	2	i	i	0.24	i	i	i	i	i	<0.35	0.08	<0.05	<0.67	i	i	II
Iddefjord	0	2	i	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	1.42	i	i	0.08	i	i	i	<110.70	2.5	<1.13	0.12	<0.14	11.37	0.14	1.42	III
Frierfjorden	3	4	i	i	i	i	i	i	i	i	i	i	i	i	1.01	0.43	<0.05	<1.42	6.14	0.18	V
Inner Kristiandsfjord	2	3	i	i	i	i	i	i	i	i	i	i	<205.20	12	<0.29	0.1	<0.14	<1.20	0.37	0.12	IV
Saudafjord	2	2	i	4.75	i	1.44	i	i	i	i	i	i	<42.99	0.77	i	i	i	i	i	i	II
Sørfjord	2	2	i	29.83	i	4.41	i	i	0.29	i	i	i	i	i	3.5	0.12	<0.05	2.47	i	i	III
Byfjorden	3	3	i	i	i	i	i	i	i	i	i	i	i	i	2.01	0.28	<0.05	8.45	i	i	II
Sunndalsfjord	3	4	i	i	i	i	i	i	i	i	i	i	<42.64	2.1	i	i	i	i	i	i	II
Orkdalsfjord area	0	3	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	miss
Inner Ranfjord	3	4	i	16.62	i	2.11	i	i	i	i	i	i	<315.67	21.5	i	i	i	i	i	i	IV

Appendix K5
INDEX - Summary table "Reference Index" 2006-2007

Reference index 2006-new (with supplementary analyses and stations)

Max(median). Statistics for alle areas: (n = Index-station measured, N = Station programmed for index)

Average of Max E.C is 1.4

Index areaname	n	N	As	Pb	F	Cd	Cu	Cr	Hg	Ni	Zn	Ag	PAH_S	BAP	DDTSS	HCB	HCHSS	CBSSe	TCDDN	TBT	Max
(Reference area)			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppp	ppm	E.C
2006			d.wt	d.wt	d.wt	d.wt	d.wt	d.wt	d.wt	d.wt	d.wt	d.wt	w.wt	w.wt	w.wt	w.wt	w.wt	w.wt	w.wt	d.wt	I:V
Mid and outer Oslofjord	3	3	w	0.86	w	1.11	i	w	0.18	w	i	w	w	w	2.3	0.08	<0.05	1.86	<0.10	0.02	II
Lista area	2	2	w	0.78	w	1.01	i	w	0.08	w	i	w	<9.14	<0.50	<0.33	0.09	<0.05	<0.63	w	0.01	I
Bømlo-Sotra area	1	1	w	1.31	w	0.84	i	w	0.11	w	i	w	w	w	<1.06	<0.03	<0.05	<1.04	w	0.1	II
Outer Ranfjord, Helgeland are	0	2	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Lofoten area	1	3	w	0.67	w	1.18	i	w	0.09	w	i	w	<3.55	<0.50	<0.36	<0.03	<0.05	<0.61	w	0.02	I
Finnsnes- Skjervøy area	0	1	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Hammerfest-Honningsvåg are	0	2	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Varanger peninsula area	1	5	w	0.99	w	1.74	i	w	0.04	w	i	w	w	w	<0.29	<0.03	<0.05	<0.69	w	w	I

Reference index 2007-new (with supplementary analyses and stations)

Max(median). Statistics for alle areas: (n = Index-station measured, N = Station programmed for index)

Average of Max E.C is 1.4

Index areaname (Reference area) 2007	n	N	As ppm d.wt	Pb ppm d.wt	F ppm d.wt	Cd ppm d.wt	Cu ppm d.wt	Cr ppm d.wt	Hg ppm d.wt	Ni ppm d.wt	Zn ppm d.wt	Ag ppm d.wt	PAH_S ppb w.wt	BAP ppb w.wt	DDTSS ppb w.wt	HCB ppb w.wt	HCHSS ppb w.wt	CBSSe ppb w.wt	TCDDN ppp w.wt	TBT ppm d.wt	Max E.C I:V
Mid and outer Oslofjord	3	3	w	1.13	w	1.16	i	w	0.16	w	i	w	w	w	1.1	0.08	<0.05	1.04	w	0.03	I
Lista area	2	2	w	1.06	w	0.79	i	w	0.05	w	i	w	<7.09	<0.50	<0.30	0.09	<0.05	<0.53	w	0.02	I
Bømlo-Sotra area	1	1	w	2.6	w	1.24	i	w	0.13	w	i	w	w	w	<0.24	<0.03	<0.05	<0.99	w	0.3	II
Outer Ranfjord, Helgeland are	0	2	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Lofoten area	1	3	w	0.7	w	1.05	i	w	0.08	w	i	w	w	w	<0.28	0.06	<0.05	<0.38	w	0.03	I
Finnsnes- Skjervøy area	0	1	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Hammerfest-Honningsvåg are	0	2	w	w	w	w	i	w	w	w	i	w	w	w	w	w	w	w	w	w	miss
Varanger peninsula area	1	5	w	1.63	w	2.28	i	w	0.04	w	i	w	w	w	<0.27	0.05	<0.05	<0.39	w	w	II

Appendix L
Analyses of stored cod liver samples
1993 and 2007

Introduction

An environment sample bank project in 2007 indicated that several POPs as PCBs, DDT, HCH and HCB are generally stable in cod liver and their corresponding extracts when stored at - 20°C over a 13 year period (Brevik *et al.* 2007). This was an important criteria to meet for the development of a Norwegian sample-bank. This supports the feasibility to investigate time trends for persistent environmental and lipophilic contaminants, an important step in assessing when these substances started to polluted the environment.

This study has focused on cod liver samples from the impacted Oslo fjord and "background" Karihavet sea area. Samples from 1993 and 2007 were investigated to assess levels and trends in other contaminants than those reported earlier (Brevik *at al*. 2007). There are several reasons for analysing the group of contaminants chosen, which include tin-compounds, heavy metals (vanadium, nickel, silver and titanium), polybrominated flame retardants (PBDE), and perfluorinated compounds (PFC). For tin organic compounds earlier studies have indicated that triphenyl tin (TPhT) might be more persistent than tributyl tin (TBT) and the relative levels might elucidate this question (cf. Berge 2002). For heavy metals generally only cadmium (Cd) is elevated compared to other heavy metals usually studied in fish liver samples. If heavy metals are to be found in fatty tissue, such as cod liver, they must have some affinity to fatty/oily tissue. There is evidence that vanadium (V) and nickel (Ni) commonly occur together in fuel oil (Genoni *et al.* 2000). Another attribute of concern is ability to be transported through the lipoid barriers into the cod liver, and here silver (Ag) and titanium (Ti) are likely candidates.

PBDE have been focused on during the last 5 to 10 years (SFT 2003) and the distribution and fate of PFCs and related chemicals in the Nordic environment have been addressed for the first time in Berger *et al*. (2004).

None of these compounds have been determined in cod liver sampled as early as 1993. The aim of this study is to indicate the level of these compounds present in samples from 1993 compared to current levels, and if they have been introduced to the environment during the last few years and hence provide grounds to establish background/reference levels.

Materials and Methods

The samples were collected and analysed by the same procedures as otherwise employed in the CEMP programme (cf. chapter 3).

Results and Discussion

TBT

Environment Specimen Banks (ESB) have been established in several countries. For example by using the German ESB an retrospective monitoring study of Organotin compounds in marine biota such as mussels (*Mytilus edulis*) and eelpole (*Zoarces viviparous*) muscle tissue samples from the North Sea 1994 – 2004 have indicated that TPT has been decreasing since the mid-1980s and that TBT levels have started to decrease in more recent years (Ruedel *et al*. 2008). Although such retrospective studies on stored biological samples may give important information on time trends and levels of different persistent environmental pollutions only few data on cod liver levels are available. However, in survey on organotin compounds in seafood from Denmark (Sloth *et al.*, 2006) the following range of organotins are reported for: MBT <0.15 – 0,44; DBT: 1.1 – 4.8; TBT: 0.91 – 3.6; MPT 1.3 – 2.0; DPT 0.39 – 3.1; TPT 0.88 – 3.8 ng/g Sn-ion wet weight, respectively. The study concluded that organotins were detected in all samples , generally in the low ppb range. Liver samples of several fish species collected in certain Asian and Oceanic countries have been analysed and for Atlantic salmon the TBT levels ranged from 1.9 to 10 ng/g wet wt.(Kennan *et al.* 1995).

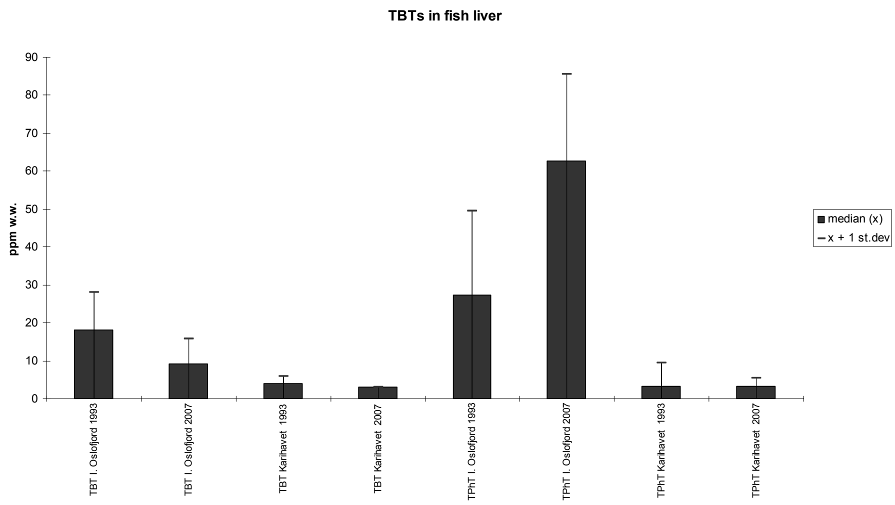
Our study showed that TBT level in cod liver from the Oslofjord decreased from 1993 to 2007 showing the effect of the successful ban on the use of organotin containing antifoulants. However, the level of TPhT as a co-toxicant in antifouling coating seems to increase during the same time period also relative to TBT reflecting that TPhT may be more environmentally persistent than TBT (**Figure 47**A).

Elements

In a review from 2007 on heavy metals in Pacific cod (Burger et al. 2007) As, Cd and Se have higher levels in liver than in muscle indicating some lipophilic character for these metals. The heavy metals Ag, Ni, Ti and V were not included in the review, indicating that these have not been analysed in cod liver samples until now.

In this study the level of Ag in cod liver was higher in the Oslofjord, almost at the same level in 1993 as in 2007, than in cod liver from the background area Karihavet. Ti-compounds were not detected in any of the cod liver samples. For V and Ni both elements were detected at low levels in cod liver from the Oslofjord area in 1993 and 2007, but they are not detected through the lipoid barriers into the cod liver at levels reflecting the supposed general higher pollution in urban fjord areas ((**Figure 47**B).

A



B

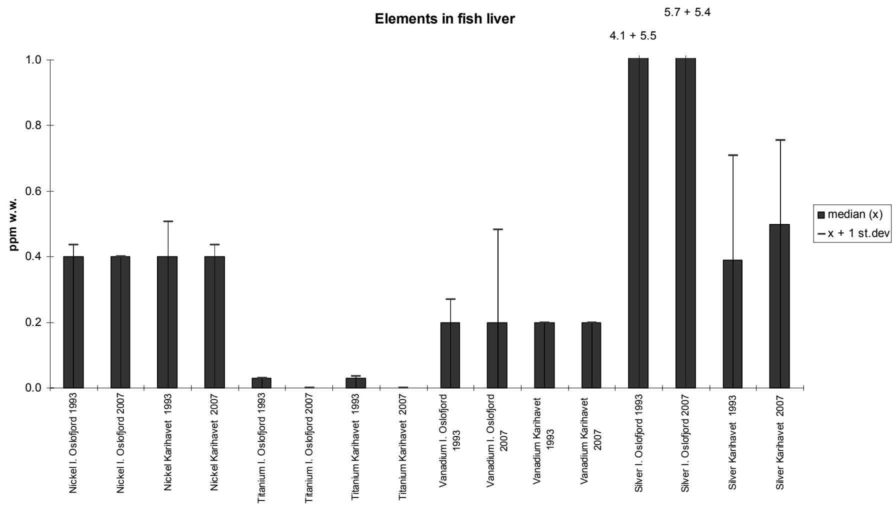


Figure 47. Median concentration of the elements nickel, titanium, vanadium and silver and the TBT compounds tributyl tin (TBT) and triphenyl tin in liver of cod (*Gadus morhua*) from the inner Oslofjord and Karihavet, on the West coast of Norway 1993 and 2007.

Brominated flame retardants

Levels of brominated flame retardants are reported as a part of a North sea Food web study (Boon et al. 2002) giving the following lipid-normalized concentrations in ng/g mean levels in cod liver for the following compounds: BDE28: 6.7; BDE47: 133; BDE100: 40; BDE99: 15. The range for levels of polybrominated diphenyl ethers (PBDEs) in polar cod liver are reported for 10 compounds ΣPBDE(10): 0.88 – 2.34 ng/g w.w. The main compounds were PBDE-28: 0.27 – 0.54 and PBDE-47: 0.52 – 1.41 ng/g w.w. (Haukås *et al*. 2007).

In the present study the levels of brominated flame retardant in the 1993 cod liver samples from both the Oslofjord area and the Karihavet were almost the same indicating general contamination ranging for the main compounds: BDE47: 10 – 99, BDE49: 1 – 32, MDE100: 2 – 27 ng/g w.w.

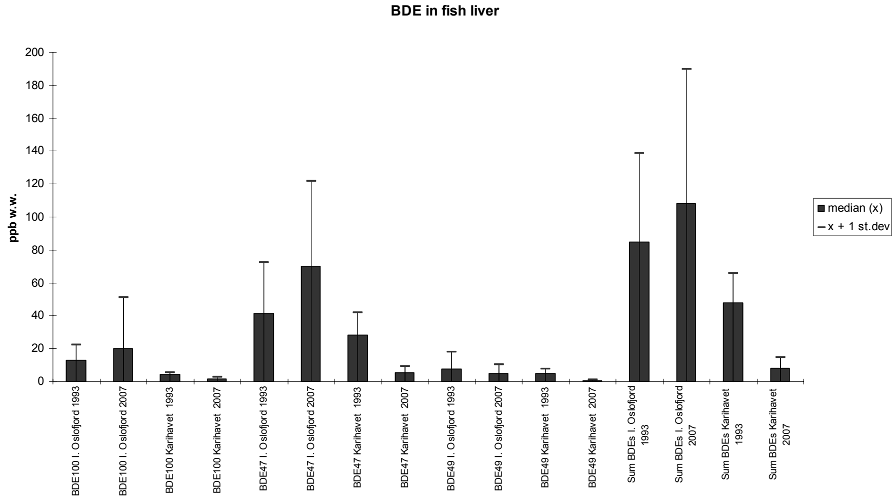
Polyfluoralkyl compounds

Polyfluoralkyl compounds (PFC) are analysed in polar cod liver (Haukås *et al.* 2007) and the Range of ΣPFC (7) is reported as 2.25 – 8.01 ng/g w.w.. The main compounds were PFOS ranging from 1.07 to 2.85 and PFHxA ranging from 0.64 to 5.38 ng/g w.w. The mean Lipid % for cod liver was for this study reported to be 41.8%. In an other Nordic study (Kallenborn, Berger; Järnberg: SFT-report) the highest PFC levels was found in cod from Sweden: PFOS: 62 ng/g w.w., and the lowest levels of PFC was found in samples from the Faroe Islands were the PFOSA compound was the dominating one. Our results for 1993 samples shows distinct higher levels of PFOS and PFOSA in cod liver from the Oslofjord than in samples from Karihavet ranging from 9 to 75 and from <2 to 9 ng/g w.w., respectively.

Conclusion

The heavy metals Ag, V and Ni were for the first time reported in cod liver samples. These results and the levels of organotins and PFC were relatively higher in the Oslofjord area than in samples from the background area Karihavet indicating a ongoing contamination related to urban activities during the period 1993 to 2007. The brominated flame retardants, however, have almost the same levels in cod liver samples from the Oslofjord and the Karihavet area indicating a more general environmental contamination than for the other compounds studied.

A



B

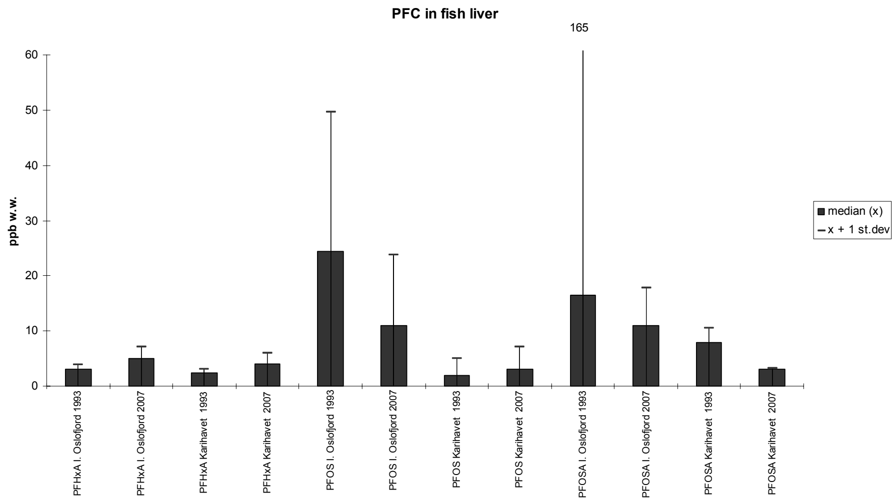


Figure 48. Median concentration of polybrominated flame retardants (PBDE), perfluroalkyl compounds (PFC): perfluorohexanoic acid (PFHxA), perfluoroktylsulfonate (PFOS) and perfluoroctanoic sulfonate acid (PFOSA) in liver of cod (*Gadus morhua*) from the inner Oslofjord and Karihavet, on the West coast of Norway 1993 and 2007.

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Appendix M
Concerning optimising CEMP, analysis of variance components

Estimation of variance components in the Norwegian CEMP data as basis for optimizing the monitoring program

Estimation of variance components in the Norwegian CEMP data as basis for optimizing the monitoring program

Purpose

Selected data sets from the CEMP monitoring data have been analysed statistically to estimate impact of sources of variation in data that are not related to long-time trends or systematic geographical differences in contaminant levels in biota. The purpose is to quantify variance components that can be used to optimize the monitoring program. The study focuses on the estimation of a population average (e.g. contaminant concentrations in some fish stock within a geographical area) by varying number of samples (material collected together at one time and place) vs. size of each sample (how many sub-samples from each sample are analysed).

One level of optimization is how to use resources as effectively as possible to achieve defined goals of monitoring. In the current context this means to design monitoring to maximize the ability to detect changes and classify levels, by allocating resources (costs) to different components of the program so that the effect of noise in the data analysis is minimized. Such optimisation will rely on estimation of variance components of different sources of variation in the monitoring data whose effect depends on design elements of the monitoring program (number of stations, number of samples per station and year, etc.) and of how cost depends on the same design elements. At another level, optimisation of resources can also mean balancing total cost and total benefit. This requires quantifying in some way the benefit of increased ability to detect trends and levels, and depends on policy considerations. This study is restricted to look at optimisation only at the first, technical level.

Basic model of variance structure of yearly means

Assume that the population is sampled by taking *S* samples, where each sample is a batch consisting of *I* sub-samples that are analysed individually. The samples could be from different locations in the area and/or at different times within a designated sampling period.

If the sampling is repeated, for instance over a number of years, to estimate a time trend, a statistical model for the contaminant level in specimen no. $i=1,\ldots,I$ of sample *s* in year *t* can be set up like this:

$$y_{t,s,i} = f(s,t) + \alpha_t + \beta_{s(t)} + \varepsilon_{i(s,t)} \qquad (1)$$

In this expression $f(s,t)$ is a long-term trend function, either common for all samples or with possible differences between sample sites built in. The irregular variation around the trend function consists of:

α_t = variation between years
$\beta_{s(t)}$ = the difference between the mean value of sample *s* and the overall yearly mean
$\varepsilon_{i(s,t)}$ = the residual variation of sub-sample *i* from the sub-sample mean.

The parentheses in the indices show that sample index is nested within years and sub-sample index is nested within sample. Variation between samples can be related both to differences in space and time within sampling season and area, and may have a more or less “random” (=irregular) character.

The model presupposes that a suitable transformation of concentrations can be used so that different terms combine additively. To achieve this, all statistical analyses here are done on natural log-transforms of contaminant concentrations and biological characteristics. This means that results relate to arithmetic averages on log-transformed values, which can be back-transformed to geometric averages on the concentrations. The statistical analysis of time series in the main body of the report is based on yearly medians, but results derived for estimating average of log-transformed values are assumed to be relevant for optimal design also for assessments based on medians.

The problem we address here is sampling from a large and heterogeneous population, where the within-year variation cannot be controlled by stratified sampling. The between-sample variation within year must accordingly be treated as a random component. It is assumed that samples are distributed in space and time so that they give independent small-scale variation around the overall average.
The variance components involved are:

σ_T^2 = irregular variance between years, unrelated to the long-term trend functions, but common over all samples within a year.
σ_S^2 = variation between samples (a function of small-scale variance in time and/or space)
σ_I^2 = variation between individual fish within samples, including analysis error.

The variance for a randomly selected sub-sample around the trend function $f(t)$ is

$$V(y_{t,s,i}) = \sigma_T^2 + \sigma_S^2 + \sigma_I^2 \qquad (2)$$

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

$$V(\bar{y}_{t\bullet\bullet}) = \sigma_T^2 + \frac{\sigma_S^2 + \frac{\sigma_I^2}{I}}{S} \qquad (3)$$

where • indicates averaging over the corresponding index. The sampling design should aim at reducing this variance as much as possible. The equation can be written:

$$V(\bar{y}_{t\bullet\bullet}) = \sigma_T^2 + \sigma_I^2 \frac{1 + I \cdot \sigma_S^2 / \sigma_I^2}{S \cdot I} \qquad (4)$$

The effect of the between-year variance component σ_T^2 cannot be reduced, and the size of that component will limit what can be achieved by improving within-year sampling. If σ_S^2 is not negligible compared to σ_I^2, one may achieve a better precision by reducing I, the number of sub-samples analysed per sample, but increase the number of samples so that $S{\cdot}I$ is kept constant. How much is achieved by increasing number of samples (S) and decreasing number of individuals within sample (I) with fixed total number of fish $S{\cdot}I$ depends only on the ratio σ_S^2/σ_I^2. Consequently, the interest is primarily on estimating this variance ratio. This can be done through analysis of variance as described below. The optimal set of values for I and S is found by combining the statistical estimate for the variance ratio with information about the additional resource requirements (costs) for increasing number of samples and sub-samples.

Cost optimisation

We assume that each of the S batch samples has a basic cost C_S independent of the number of sub-samples, and that each sub-sample has an additional cost C_I for preparing and analysing the sample . The total variable cost of one sampling year is then

$$C_{sum} = S \cdot (C_S + I \cdot C_I) \qquad (5)$$

The most cost-effective balance of samples and sub-samples can be found either by minimising the cost for a specified standard error or by minimising the standard error for a given cost; the two approaches give the same solution. The optimal number of sub-samples depends only on the variance and cost ratios and is given simply by:

$$I = \frac{\sigma_I}{\sigma_S}\sqrt{\frac{C_S}{C_I}} \qquad (6)$$

The corresponding number of samples allowed for a total cost C_{sum} is given by:

$$S = \frac{C_{sum}}{C_S + I \cdot C_I} \qquad (7)$$

while the number of samples required for a total variance $V\left(\bar{x}_{T\bullet\bullet}\right)$ is given by

$$S = \frac{\sigma_S^2 + \sigma_I^2 / I}{V\left(\bar{x}_{T\bullet\bullet}\right) - \sigma_T^2} \qquad (8)$$

If the between-year variance is of importance, and the purpose of the sampling program is to determine confidence limits for the average conditions based on repeated sampling over a number of years with independent year effects α_t, there is also a question of optimising the number of sampling times against size of sampling program each time. In that case, we will look at the total cost for T sampling times:

$$C_{sum} = T \cdot \left(C_T + S \cdot \left(C_S + I \cdot C_I\right)\right) \qquad (9)$$

The optimal value of I is not affected, but the optimal S is now given by:

$$S = \frac{\sigma_S + \sigma_I / I}{\sigma_T} \sqrt{\frac{C_T}{C_S + I \cdot C_I}} \qquad (10)$$

The corresponding number of sampling times allowed for a total cost C_{sum} is

$$T = \frac{C_{sum}}{C_T + S \cdot \left(C_S + I \cdot C_I\right)} \qquad (11)$$

and the number required for a total variance $V\left(\bar{y}_{\bullet\bullet\bullet}\right)$ is

$$T = \frac{\sigma_T^2 + \frac{\left(\sigma_S^2 + \sigma_I^2 / I\right)}{S}}{V\left(\bar{y}_{\bullet\bullet\bullet}\right)} \qquad (12)$$

In practice, the standard deviations are not known, but only estimated. It is common practice to use the same formulas, but with estimated standard deviations instead of the unknown true values. If the estimates are based on few samples, the calculation of the optimal sampling requirements will be correspondingly inaccurate. Costs will also be more or less approximate, contributing further to uncertainty in the design of an optimal sampling program.

Estimation of confidence limits for variance component ratios

When detrended data for an area over a number of years are analysed in a GLM model with random factors station and year, the ANOVA table lists largely independent estimates of variation between sub-samples and within-sample (residual or error) mean squares. The expected mean squares for sample effect and residual (sub-sample) are:

$$EMS_S = n\sigma_S^2 + \sigma_I^2 \qquad (13)$$

$$EMS_I = \sigma_I^2 \qquad (14)$$

where σ^2_S and σ^2_I are the variance components due to variation between samples and individual specimens within sample, respectively.

For a balanced data set with equal number in all samples the coefficient *n* is equal to the number of sub-samples *I* in each sample, and in that case the variance of the average over sub-samples is $\sigma_S^2 + \sigma_I^2 / n$. Otherwise *n* is a weighted mean of these numbers. The numbers used here are calculated by the GLM module in *Statistica* v. 8.0 according to Satterthwaite, (Milliken and Johnson 1992).

In general, for independent estimates s^2_A and s^2_B with ν_A and ν_B degrees of freedom of two variances σ^2_A and σ^2_B, the ratio of the estimates follow the $F(\nu_A, \nu_B)$ distribution under the null hypothesis of equal variances, and this is used to test for significant difference between the variances in the ordinary F test.

The normalised ratio $(s^2_A/ s^2_B)\cdot(\sigma^2_B/\sigma^2_A)$ is F distributed by definition, and this can be used to determine confidence limits for the ratio between the two variances. For a chosen two-sided significance level α, the two-sided confidence interval of the F-distributed adjusted ratio is defined by the upper- and lower α/2-percentage points of the F distribution: $F_{\alpha/2}(\nu_A, \nu_B)>1$ and $F_{1-\alpha/2}(\nu_A, \nu_B)<1$.

The estimated ratio (s^2_A/ s^2_B) will then with confidence $1-\alpha$ be found between the numerically unknown limits:

$$\frac{\sigma_A^2}{\sigma_B^2} F_{(1-\alpha/2),\nu_A,\nu_B} \le \frac{s_A^2}{s_B^2} \le \frac{\sigma_A^2}{\sigma_B^2} F_{(\alpha/2),\nu_A,\nu_B} \qquad (15)$$

These relations can be inverted into a confidence interval for the unknown ratio between variances:

$$\frac{s_A^2 / s_B^2}{F_{(\alpha/2),\nu_A,\nu_B}} \le \frac{\sigma_A^2}{\sigma_B^2} \le \frac{s_A^2 / s_B^2}{F_{(1-\alpha/2),\nu_A,\nu_B}} \qquad (16)$$

If we assume that $\sigma_A^2 = k\sigma_C^2 + \sigma_B^2$, as in a test of random effects in ANOVA models, this becomes:

$$\left(\frac{s_A^2 / s_B^2}{F_{(\alpha/2),\nu_A,\nu_B}} - 1\right)\frac{1}{k} \le \frac{\sigma_C^2}{\sigma_B^2} \le \left(\frac{s_A^2 / s_B^2}{F_{(1-\alpha/2),\nu_A,\nu_B}} - 1\right)\frac{1}{k} \qquad (17)$$

If an effect is found significant, both limits of this last interval are positive, and the interval can then be used to indicate the precision of the variance ratio. Note that the actual confidence level of this interval is strongly dependent on residuals being normally distributed, or on having a large data set.

Adapted to the sample and sub-sample mean square estimates from ANOVA analyses on the de-trended CEMP data, this leads to the following confidence limits for the ratio of variance components for sample and sub-sample:

$$\left(\frac{EMS_S / EMS_I}{F_{(\alpha/2),\nu_S,\nu_I}} - 1\right)\frac{1}{n} \le \frac{\sigma_S^2}{\sigma_I^2} \le \left(\frac{EMS_S / EMS_I}{F_{(1-\alpha/2),\nu_S,\nu_I}} - 1\right)\frac{1}{n} \qquad (18)$$

Analyzing CEMP data for variance components

Analysis procedure

Variance components for selected parts of the CEMP data are determined by GLM analysis on each species/tissue/parameter combination separately. In this analysis, Monitoring year[1] is treated as a random factor, so that the random variances modelled are:

- Between years as average across stations or sites
- Interaction Year*station (i.e. changes over time in differences between stations)
- Residual within-sample variation (station and year).

In the CEMP program each station is sampled once each year, so variation between stations and random sample variation as discussed above are compounded. The variations around smooth trend functions at each station are treated as irregular variations between samples. To see if this assumption is warranted, results are compared with earlier estimates based on the Norwegian part of the program *Voluntary International Contaminant-monitoring for temporal trends* conducted as part of the monitoring in 1996 and 1997 (Bjerkeng *et al.* 1998).

It is primarily the short-term components of last two terms (interaction and residual) which acts as noise in trend analysis, and which we want to quantify so that we can minimize the effect of them by optimizing the monitoring program. If the original observations are analysed in this way, the between-year variation will in addition include overall long-time trends across stations in addition, and the year*station interaction term will include long-term changes in the difference between stations. The long-term components can be part of the signal one wants to detect, rather than the noise (depending on the time scale considered).

In order to get better estimates of the short-term variance components, the data have first been subjected to a pre-processing, where smooth curves are adapted to each time series by using a 7-year smoother in accordance with OSPAR procedure (Nicholson and Fryer 1999). The smoother fit is applied directly on the individual observations, using the same algorithm that is also applied to yearly median concentrations for time trend analysis in the main body of the report[2].

By calculating residuals as the differences between the original log(concentration) values and the smoother estimates, we are left with a ‘de-trended’ data set where long-term variation have been removed from the data while the short-term variation is preserved. The purpose is to take out the term $f(s,t)$ in equation from the data, so that only the irregular variation is left. The residual data are scaled individually for each year to have the same variance as individual observations around a perceived “true” smooth curve[3], and are considered as independent reduced observations, although in reality they are slightly correlated.

The choice of a 7-year time span for the smoother is of course in a way arbitrary, but is seems to work fairly well. The time series are inspected visually in graphs showing both original data and fitted smoother. Only long, fairly continuous time series are included in the GLM analysis for variance components, since it is here that the smoother works best in separating short-term and long-term variation. Running GLM analysis on the de-trended data aims will estimate only the short-term part of the variance components listed above, and these variances can be used for optimising monitoring.

Selecting datasets for statistical analysis

Combinations of species/tissue and parameters for the current statistical exercise have been selected by considering how much data is available for different combinations, and how environmentally

[1] Beginning year of period August-February; only data from that period is included.
[2] The developed algorithm is a generalised version of the OSPAR procedure, implementing that procedure for time series consisting of at most one value for each year (missing years allowed), but also valid for series with a varying number of observations each year, and in fact also random tie intervals.
[3] The scaling corrects for the fact that the smooth values are (of course) not independent of the observations, the factor is normally very close to 1.

critical the parameters are. The selection is also restricted by how well parameters are quantified; measured by the lack of observations below detection limit. For the most part, only subsets that are free from such observations are included; in a few cases the condition has been fulfilled by excluding a small number of stations. The selection is shown in **Table 12**.

Table 12. Primary selection of species, tissue and parameters, with total number of observations and number of observations below detection limit (<DL) when all stations with data are included. The shaded cells show combinations with observations below detection limit. In two cases (lighter shade) these observations are avoided by excluding a few stations for mercury in blue mussel (15A, 69A, 76A and 92A1) and for cadmium in cod liver (23B, 30B, 53B and 67B).

Parameter	Statistic	Species MYTI EDU Mussels	GADU MOR Cod	LIMA LIM Dab	PLAT FLE Flounder	Fish tissue
CB138	$N_{<DL}$	*47*	0	0	0	LI
	N_{total}	*1143*	3347	206	261	
CB153	$N_{<DL}$	*28*	0	0	0	
	N_{total}	*1154*	3341	206	261	
CD	$N_{<DL}$	0	22	0	0	
	N_{total}	1343	3528	207	283	
PB	$N_{<DL}$	0	*2258*	*58*	*87*	
	N_{total}	1318	*3386*	*207*	*258*	
HG	$N_{<DL}$	6	0	0	0	MU
	N_{total}	1338	3640	206	311	

In addition to the station/year identification and contaminant values, the extracted data also include sampling information (type of sample, number of individuals in sample), and biological descriptors (mean length and/or weight, mean tissue weight, dry weight % and lipid weight %). Biological covariates have been included in preliminary GLM models to see if correcting for them can contribute to reduce residual variation, but although statistically significant relations have been found, it does not appear to be very important, and can sometimes distort data considerably, so it has been left out of the final estimates.

The CEMP database contains replicate analysis results for some samples (e.g. blue mussels in 1983, cod and flounder in 1985 and mussel in 1996 and 1997.In all these cases, the sample with *repno*=1 has data, and there are only small differences between replicates where both have data. By restricting the analysis to data with repno<=1 inclusion of replicate analyses is avoided.

Only data for the 10-year period from 1995-2004 are included in the GLM analysis. Many series are only continuous from 1992, and the weighted local regression used for the smoother has homogeneous properties only for 'inner' data points which are 3 or more years from the end of the continuous series. Series with large and sudden changes in levels or trends during the data period 1992-2007 are also excluded, since in these cases the smoother will leave part of the change as residual variance. Examples of time series with fitted smoothers are shown in **Figure 49**.

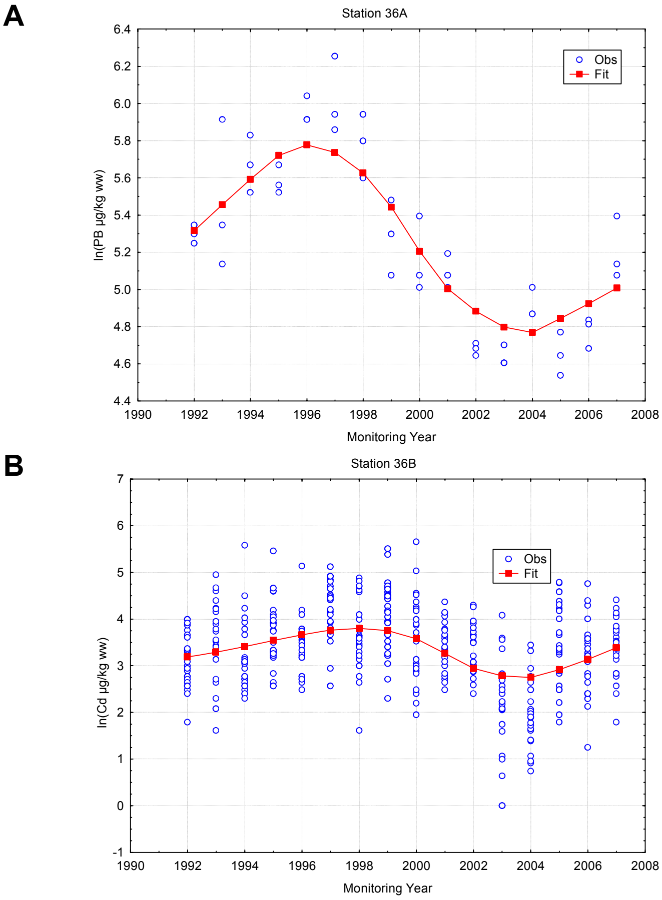

Figure 49. Examples of time series plots with smoother fits for lead (Pb) in blue mussel (**A**) and cadmium (Cd) in cod liver (**B**) from the Færder area in outer Oslofjord (36A and 36B, respectively).

In the final stage, only data for Mussels and Cod has been analysed. Data for Dab (LIMA LIM) and flounder (PLAT FLE) was considered, but it was found that there is too little data for these species to give reliable estimates for variance component ratios.

For **mussels**, only the three metals are analysed. After de-trending data and inspecting time-series plots of observations and smoother fit, the following list of stations are found suitable for the GLM analysis:

15A; 22A; 30A; 31A; 35A; 36A; 52A; 56A; 57A; 63A; 65A; 69A;71A

This list of stations is used for cadmium and lead; stations 15A, 69A and 76A are excluded for analysis of mercury because of observations <detection limit.

For **cod,** the contaminants selected for variance analysis is CB153 and cadmium measured in liver, and mercury measured in filet. Included stations are:

10B; 15B; 23B; 30B; 36B; 53B; 67B; 98B1

Results of GLM analysis

The results from the analysis is shown in **Table 13**.

Table 13. ANOVA tables and variance components from GLM analysis, with synthesised error terms for the random Year effect. Analysis results are for natural log-transforms of concentrations, on de-trended data from 7-year smoother fit.

			ANOVA statistics for natural-log transforms of concentrations on wet-weight basis							
Species	parameter	Effect	Effect statistics			Synthesised error		Significance test		Variance estimate
			SS	df	MS	df	MS	F	p	
Mussels	Cd	Year	8.03	9	0.892	108	0.172	5.19	7.6E-06	0.018
		Station*Year	18.77	108	0.174	277	0.021	8.29	8.9E-46	0.049
		Residual	5.81	277	0.021					0.021
	Hg	Year	5.21	9	0.579	81	0.159	3.65	0.00073	0.014
		Station*Year	12.99	81	0.16	214	0.017	9.23	7.5E-39	0.046
		Residual	3.72	214	0.017					0.017
	Pb	Year	2.69	9	0.299	108	0.322	0.93	0.50302	-0.001
		Station*Year	35.11	108	0.325	277	0.06	5.4	6.8E-30	0.085
		Residual	16.67	277	0.06					0.060
Cod	CB_{153}	Year	33.4	15	2.227	109	2.782	0.8	0.67479	-0.004
		Station*Year	309.5	107	2.893	3066	0.469	6.17	4.6E-71	0.109
		Residual	1437.6	3066	0.469					0.483
	Cd	Year	96.6	18	5.365	103	3.924	1.37	0.16435	0.010
		Station*Year	415.3	101	4.112	2963	0.711	5.78	1.8E-61	0.141
		Residual	2107.5	2963	0.711					0.711
	Hg	Year	20.5	10	2.051	69	1.651	1.24	0.2804	0.002
		Station*Year	115.2	69	1.669	2165	0.225	7.42	2.2E-60	0.056
		Residual	486.9	2165	0.225					0.225

According to this analysis, the between-year residual variation is statistically significant only for cadmium and mercury in mussels ($p=7.6\cdot10^{-6}$ and 0.00073), which means that there is a tendency for all stations included to have the same short-term variation between years relative to the smooth long-term trend at each station. The between-year variance is about 0.014 and 0.018, which means a standard deviation of 0.125 on natural-log scale. A deviation of 0.125 on natural-log-scale corresponds to a relative change of about 30 % in untransformed concentrations. For lead in mussels and for the cod data, the year effect is not significant, which means that there is sign of a common component over different stations in the between-year variation.

In any case, the Station*Year effect include only the variations between years that are independent for each station. The ratio between variance components for Station*Year and Residual is the same as the ratio σ_S^2 / σ_I^2 defined above. The estimates and confidence limits for this ratio, calculated as described above are shown in **Table 14**.

Table 14. Estimated values and 80 % confidence intervals for the between:within variance ratio. Confidence intervals are calculated for balanced 80 % confidence level, with 10 % tail probability to each side of the interval.

Species	parameter	n: Effective number of sub-samples per sample	Variance ratio interaction:error σ_S^2/σ_I^2 for natural-log transforms of concentrations on wet-weight basis		
			Lower conf. limit	Best estimate	Upper conf. limit
Mussels	Cd	3.11	1.86	2.34	2.97
	Hg	3.12	2.03	2.64	3.46
	Pb	3.11	1.10	1.41	1.83
Cod	CB_{153}	23.8	0.18	0.23	0.27
	Cd	24.2	0.16	0.20	0.25
	Hg (filet)	25.8	0.20	0.25	0.33

Comparison with estimates from the VIC program 1996-1997
In 1996 and 1997 the CEMP program was expanded with multiple catches of cod at stations 30B, 53B and 67B (Bjerkeng *et al.* 1998, see also Green & Nicholson 1996; SIME 1997 and WGSAEM 2000 for more on the back ground of VIC). Analysis of the data from this exercise gave between-sample variances that are compatible with the estimates for interaction station*year found from the analysis on de-trended CEMP data. The table below summarizes the comparison

Parameter	Variances for natural-log transformations of concentrations on a wet-weight basis	
	Between-sample variance for VIC data	Interaction station*year for de-trended CEMP data
CB153	0.161	0.109
Cd	0.179	0.141
Hg	0.018	0.056

The estimates agrees quite well, considering that the VIC estimates have very few degrees of freedom, and are much more uncertain than the results of the analysis on the de-trended CEMP data. Thus, the analysis of the de-trended data seems to give results for interaction Station*Year variation that can be reasonable also for small-scale variation for repeated sampling within area and year, either at different times or at different sites in the area.

Discussion

The variance ratios are estimated with reasonable accuracy; the 10 % and 90 % confidence limits are within ±20 % of the estimated value. For Cod, where individual fish are analysed, the residual variance is from 0.23 to 0.8, which means that the relative standard deviation on a linear scale is from 0.5 to 0.8,. The interaction:residual variance ratio for cod liver is estimated with 80 % confidence to be between 0.15 and 0.3. This means that the within-sample deviation between individual fish is from 1.8 to 2.6 times higher than the interaction standard deviation. The optimal sample size in that case will be:

$$I = 2\sqrt{\frac{C_S}{C_I}}$$

In the current program the number of fish per sample is about 25. For this number to be optimal, the cost ratio should be at about $C_S : C_I = 100$, that is, the cost related to visiting a site should be about 100 times larger than the marginal cost of catching, preparing and analysing one individual fish. If the cost ratio is $C_S : C_I = 10$, the statistical analysis indicates that the optimal number of fish is about 6 for each sample, and that resources would be better used in collecting 4 samples at different sites within the area and/or at different times each year.

For Mussels, with about 3 sub-samples from each station consisting of up to 100 individual shells, the residual variance between sub-samples are much smaller from 0.02 to 0.06 on natural log-scale, and the interaction:residual variance is estimated to be about 2. This means that optimal sample size is given by:

$$I = 0.7\sqrt{\frac{C_S}{C_I}}$$

In that case, I=3 is about optimal if $C_S : C_I = 20$.

The optimisation may include more complex issues. In the current program, individual fish are analysed for metals and a number of organic pollutants, while mussels are analysed in sub-samples composed of 50-100 specimens. The optimisation should also consider varying how many specimens to include in each sub-sample.

Final comments

Estimation for different substances give different optimal ratios; the monitoring program has to aim for a balance so that it is reasonably good for all important substances.

The cost issue is more complex than considered here: the analysis program will differ between sub-samples, and also between stations.

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REPORT

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Abstract

This report is part of the Norwegian contribution to OSPAR's Coordinated Environmental Monitoring Programme (CEMP). CEMP 2007 included the monitoring of contaminants in blue mussel (51), dogwhelk (9), cod (9) and flatfish (11) along the coast of Norway from Oslo to Varangerfjord. The results showed elevated, in a few cases up to severely contaminated, levels of contaminants in the inner Oslofjord (PCBs, mercury and lead in cod; PCBs in blue mussel), and Sørfjord and Hardangerfjord (DDT, lead, cadmium and mercury in blue mussel; mercury and DDT in cod). The results from the remaining stations showed low or moderate levels of contamination in 2007. Considering the whole monitoring period (1984-2007), a significant upward trend was found for mercury in cod from the inner Oslofjord. A significant downward trend was found for lead and cadmium in blue mussel from Sørfjord/Hardangerfjord. The "Pollution" index was between "marked" and "severe". Contamination of organotin in blue mussel and imposex in dogwhelk were still apparent, however, most of the trends were downward indicating that regulatory action has lead to an improvement in the investigated areas. The results from studies using biological effects methods in cod, indicated reduced contaminant levels in the Sørfjord. Analyses of brominated flame retardents, perfluoralkyl compounds, and TBT in stored samples of cod liver from the Oslofjord indicated similar exposure in 1993 as in 2007. The sources of statistical variance is also discussed in respect to optimization of CEMP sampling strategies.

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Title

Coordinated Environmental Monitoring Programme (CEMP)
Levels, trends and effects of hazardous substances in fjords and coastal waters - 2007

Summary

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Statlig program for forurensningsovervåking omfatter overvåking av forurensningsforholdene i luft og nedbør, skog, vassdrag, fjorder og havområder. Overvåkingsprogrammet dekker langsiktige undersøkelser av:

- overgjødsling
- forsuring (sur nedbør)
- ozon (ved bakken og i stratosfæren)
- klimagasser
- miljøgifter

Overvåkingsprogrammmet skal gi informasjon om tilstanden og utviklingen av forurensningssituasjonen, og påvise eventuell uheldig utvikling på et tidlig tidspunkt. Programmet skal dekke myndighetenes informasjonsbehov om forurensningsforholdene, registrere virkningen av iverksatte tiltak for å redusere forurensningen, og danne grunnlag for vurdering av nye tiltak. SFT er ansvarlig for gjennomføringen av overvåkningsprogrammet.

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