Indicator Fact Sheet

(WHS6) Hazardous substances in marine organisms
Authors: Norman W. Green, Birger Bjerkeng, Brage Rygg, Ketil Hylland (Norwegian Institute for Water Research)
EEA project manager: Niels Thyssen

<table>
<thead>
<tr>
<th>Indicator code / ID</th>
<th>WHS6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis made on (Assessment date)</td>
<td>7 May 2004</td>
</tr>
<tr>
<td>EEA contact / fact sheet responsible</td>
<td>Fact sheet development contact point</td>
</tr>
<tr>
<td>Name: Pavla Chyska</td>
<td>Name: Norman W. Green, NIVA</td>
</tr>
<tr>
<td>Email: <a href="mailto:pavla.chyska@eea.eu.int">pavla.chyska@eea.eu.int</a></td>
<td>Email: <a href="mailto:norman.green@niva.no">norman.green@niva.no</a></td>
</tr>
<tr>
<td></td>
<td>Name: Birger Bjerkeng, NIVA</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:birger.bjerkeng@niva.no">birger.bjerkeng@niva.no</a></td>
</tr>
<tr>
<td></td>
<td>Name: Brage Rygg, NIVA</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:brage.rygg@niva.no">brage.rygg@niva.no</a></td>
</tr>
<tr>
<td></td>
<td>Name: Ketil Hylland, NIVA</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:ketil.hylland@niva.no">ketil.hylland@niva.no</a></td>
</tr>
</tbody>
</table>

Key message
😊 There is an indication of decreasing concentrations of cadmium, mercury, lead, DDT, lindane and PCB in mussels from the north-east Atlantic. There is an indication of decreasing concentrations of lead, and to a lesser degree cadmium in mussels from the Mediterranean Sea, and in mercury, lindane and to a lesser degree PCB in herring from the Baltic Sea, showing the effects of abatement policies.

Figure 1. Concentrations of selected metals and organic contaminants in mussels in the north-east Atlantic Ocean (A), Mediterranean Sea (B) and herring (muscle) for the Baltic Sea (C).
Notes. It should be noted that the lack of consistent or reliable data from the marine conventions or EEA counties inhibits adequate assessment of concentrations and trends of hazardous substances in European marine water. Aggregated data do not necessarily convey the uncertainty these problems cause. A minimum of 10 mussels and 3 herring stations were used.

*) Comparisons are based on average of yearly regional and adjusted medians for the indicated time periods. For the 1990-1992 period for DDT in mussels from NE Atlantic there is only data from 1992.

Source. Data from Helcom, Ospar and EEA member countries.

Results and assessment

Policy relevance:
The objective of indicators is to convey the levels and trends of hazardous substances of inputs to European seas. The observed load of hazardous substances may be detrimental to marine ecosystems.

Policy context:
The main policy for the control of pollution in EU waters is the Dangerous Substances Directive (76/464/EEC). This will be taken over by the Water Framework Directive (2000/60/EC) once the latter becomes fully implemented in 2015. Remedial actions are currently being directed to comply with the Water Framework Directive. The aim of Water Framework Directive is to achieve zero, near zero or background concentrations, depending on the contaminant, in the marine environment through abatement actions on inputs. The aim is to be achieved by 2020. Goals similar to the Water Framework Directive have also been outlined by Ospar, Helcom and North Sea conferences. No similar target has been formulated for the Mediterranean Sea or the Black Sea.

The Dangerous Substance Directive and Water Framework Directive have a priority list of 33 substances, both naturally occurring and synthetic (2455/2001/EC). The list includes cadmium, mercury, lead and lindane but not DDT and PCB. All six of these hazardous substances are considered in this fact sheet. They are also on the list of 15 chemicals for priority action for the Ospar Marine Convention (Ospar 1998). Within the framework of Helcom DDT and PCB are both on their list of priority substances and are banned substances according to Annex I, Part 2 of the 1992 Helsinki Convention (Helcom 1992). With regard to cadmium, lead, mercury, PCB as well as other hazardous substances, numerous Helcom recommendations have been
The concentrations and trends of cadmium, mercury, lead, DDT, lindane and PCB are assessed in this fact sheet. The metals and lindane are on the Dangerous Substances Directive list of 33 priority substances. The decrease in inputs to the north-east Atlantic since 1990-1992 (EEA 2003c) is reflected in the general decrease in concentrations in mussels and fish in this region (Figure 1 and 2). This indicates that the measures and initiatives to reduce the input of these substances and to protect the marine environment are of some success.

Abatement policies have also been in effect for the Baltic Sea and concentrations in herring have decreased for mercury, DDT, lindane and PCB, but concentrations for cadmium and lead have increased in the period 1993-1997 compared to 1990-1992 (Figure 1). Considering that values are generally low for cadmium but "moderate" for lead, attention should be given to lead loads the Baltic.

The assessment of the Mediterranean is based on contributions from only three countries, France, Italy and Greece. Policies to reduce pollution have been in effect here and regional time trends indicate that cadmium, lead and lindane in mussels has been most influenced (Figure 1). Concentrations of PCBs in mussels (only Italian data) are "moderate" for many stations and warrant some concern. There was insufficient data to do a trend analysis on the PCB data so the effect of policies can not be assessed.

Data for the Black Sea concerned only 1-3 measurement stations for one year (2001) and it is not justified to make any general conclusion about this Sea region.
**Sub-indicator**

**Summary assessment: regional trends of hazardous substances in fish from north-east Atlantic.**

**Key message**

In the north-east Atlantic there are indications of decreasing concentrations of mercury and lindane in both cod and flounder. DDT also decreased in cod and decreasing concentrations of cadmium, lead and PCB and to a lesser degree DDT in flounder. There is no apparent change in the concentrations of PCB and lead in cod.

**Figure 2.** Concentrations of selected metals and organic contaminants in cod (A) and flounder (B) in the north-east Atlantic Ocean.

**Notes.** It should be noted that the lack of consistent or reliable data from the marine conventions or EEA counties inhibits adequate assessment of concentrations and trends of hazardous substances in European marine water. Aggregated data do not necessarily convey the uncertainty these problems cause. Contaminants were measured in liver of cod and flounder except for mercury for which muscle was used. A minimum of 6 cod and 3 flounder stations were used.

* Comparisons are based on average of yearly regional and adjusted medium for the indicated time periods. The 1990-1992 period for DDT in flounder contained only data from 1991-1992.

**Sources:** Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

These subindicators concern only the north-east Atlantic. There are notable differences between the two species cod and flounder in temporal changes of concentrations. Only for mercury and lindane were there clearly decreasing concentrations in both species. The increased concentrations of cadmium in cod could be attributed to methods of regional assessments (see Meta data), but there were no changes in lead and PCB concentrations in cod and in DDT concentrations in flounder. A station-by-station analysis showed mostly low and no increasing trends for this metal (Figure 3 and 4). These results indicate some success of abatement policies implemented.
**Sub-indicator**

**Summary assessment: concentrations and trends of hazardous substances in biota**

**Key message**

😊 Generally low concentrations and low or decreasing trends were found in mussels and cod of the north-east Atlantic, herring in the Baltic Sea, and mussels in the Mediterranean.

<table>
<thead>
<tr>
<th></th>
<th>NE Atlantic cod</th>
<th>NE Atlantic mussels</th>
<th>Baltic herring</th>
<th>Mediterranean mussels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
<tr>
<td>Mercury</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
<tr>
<td>Lead</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
<tr>
<td>DDT</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
<tr>
<td>Lindane</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
<tr>
<td>PCBs</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
<td>🙂</td>
</tr>
</tbody>
</table>

😊 decreasing trend; 😊 no trend;

**Notes.** It should be noted that the lack of consistent or reliable data from the marine conventions or EEA counties inhibits adequate assessment of concentrations and trends of hazardous substances in European marine water. Aggregated data do not necessarily convey the uncertainty these problems cause. Liver analysed in cod except for mercury where muscle was used; muscle was analysed in herring;

**Sources.** Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Table 1 summarises the main results from assessment of concentrations and trends of cadmium, mercury, lead, DDT, lindane and PCB in mussels and cod from the north-east Atlantic, herring from the Baltic Sea and mussels from the Mediterranean. Contributions for the Mediterranean were mainly from France and Italy. Generally low concentrations were found and hence the finding of no-trends or decreasing trends was consider a positive sign. The predominance of moderate concentrations of lead in herring from the Baltic Sea and of PCB in mussels from the Mediterranean Sea should be of concern. PCB should be more of a concern than the other five hazardous substances when evaluating concentrations in mussels and fish from north-east Atlantic. High concentrations of cadmium, lead, DDT and lindane in mussels at the 1-3 Romanian stations which were the only ones from the Black Sea and hence not considered representative.
**Sub-indicator**

**Summary assessment: overview of cadmium concentrations**

**Key message**

😊 Generally low concentrations of cadmium for 1996-2002 were found in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean.

**Figure 3. Proportion of measurement stations in three categories of concentrations of cadmium in biota in European Seas. Station count in brackets.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Category</th>
<th>Station Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E. Atlantic - Fish</td>
<td>Low</td>
<td>37</td>
</tr>
<tr>
<td>N.E. Atlantic - Mussels</td>
<td>Low</td>
<td>150</td>
</tr>
<tr>
<td>Baltic Sea - Fish</td>
<td>Low</td>
<td>17</td>
</tr>
<tr>
<td>Baltic Sea - Mussels</td>
<td>Low</td>
<td>26</td>
</tr>
<tr>
<td>Mediterranean - Fish</td>
<td>Low</td>
<td>0</td>
</tr>
<tr>
<td>Mediterranean - Mussels</td>
<td>Low</td>
<td>317</td>
</tr>
<tr>
<td>Black Sea - Fish</td>
<td>Low</td>
<td>0</td>
</tr>
<tr>
<td>Black Sea - Mussels</td>
<td>Low</td>
<td>3</td>
</tr>
</tbody>
</table>

**Notes.** Moderate concentration ranges are (mg/kg wet wt.): 0.4-1.0 for mussels, 0.3-0.5 for cod liver and 0.01-0.05 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

The station-by-station overview of 1996-2002 concentrations of cadmium for mussels (both *Mytilus edulis* and *M. galloprovincialis*) indicated that concentrations were generally low (Figure 3). Elevated concentrations were found in the estuaries for large rivers, in areas with point discharges (e.g. Sørfjord, western Norway) and in some harbours (Map 1). The areas from which mussels did not appear to be suitable for human consumption were: Sørfjord, Norway, Calabria region of south-eastern Italy, two areas of Sardinia and along the Romanian coast in the Black Sea. The high level of cadmium in mussels from the Sørfjord was largely due to industrial activity (zinc smelter) in Sørfjord. In fish, the 1996-2002 concentrations exceeded suggested High concentration only for two stations in Iceland, where cod liver was measured (Map 2). The fish data show that cadmium concentrations were elsewhere generally low.
**Sub-indicator**

**Summary assessment: overview of cadmium trends**

**Key message**

😊 Generally no trends were found for cadmium in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean, which is a positive indication considering that concentrations are generally low.

**Figure 4.** Proportion of measurement stations in three categories of trends in concentrations of cadmium in biota in European Seas. Station count in brackets.

<table>
<thead>
<tr>
<th>Region</th>
<th>Category</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E. Atlantic - Fish</td>
<td>Decreasing</td>
<td>26</td>
</tr>
<tr>
<td>N.E. Atlantic - Mussels</td>
<td>No trend</td>
<td>78</td>
</tr>
<tr>
<td>Baltic Sea - Fish</td>
<td>Increasing</td>
<td>10</td>
</tr>
<tr>
<td>Baltic Sea - Mussels</td>
<td>No trend</td>
<td>1</td>
</tr>
<tr>
<td>Mediterranean - Fish</td>
<td>No trend</td>
<td>0</td>
</tr>
<tr>
<td>Mediterranean - Mussels</td>
<td>No trend</td>
<td>71</td>
</tr>
<tr>
<td>Black Sea - Fish</td>
<td>No trend</td>
<td>0</td>
</tr>
<tr>
<td>Black Sea - Mussels</td>
<td>No trend</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes.**

Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Of the 186 temporal trends statistically analysed on station-by-station basis (150 for mussels, 36 for fish) only 39 were significant, 27 down and 12 up (Figure 4, Maps 3 and 4). Inputs have been decreasing in the north-east Atlantic (cf. EEA 2003c). This does not correspond well with the regional trend for mussels (Figure 1) or fish (Figure 2). However, a station-by-station analysis revealed a certain dominance of decreasing trends over increasing trends. Concentrations in some contaminated areas, e.g. the Seine and Po estuaries and Sørfjord, appeared to be decreasing. There also appeared to be a general decreasing trend of cadmium in mussels from the French Mediterranean coast. Increasing trends were mostly found in Norway (4) and the Mediterranean (6). Only three trends were found for cadmium concentrations in fish, all decreasing, two in Norway and one in the inner German Bight. Regional (aggregated) concentrations in cod for the north-east Atlantic region indicated an increase during the recent period (1998-2002, Figure 2). That this does not correspond well with the station-by-station studies shows how aggregated values can be misleading. The results from the Rhine estuary (Belgian-Dutch border) and the inner Oslofjord illustrated that stations in close proximity may have conflicting results. Considering that concentrations are generally low, the abundance of no trends and decreasing trends is a positive signal.
Sub-indicator

Summary assessment: overview of mercury concentrations

Key message

☺ Generally low concentrations of mercury for 1996-2002 were found in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean.

Figure 5. Proportion of measurement stations in three categories of concentrations of mercury in biota in European Seas. Station count in brackets.

Notes. Moderate concentration ranges are (mg/kg wet wt.): 0.04-0.5 for mussels, 0.05-0.5 for cod liver and also for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2).
Sources: Data from Helcom, Ospar and EEA member countries.

Assessment of sub-indicator:
The station-by-station overview of 1996-2002 concentrations of mercury for mussels (both Mytilus edulis and M. galloprovincialis) indicated that concentrations were generally low (Figure 5). High concentrations, i.e. concentrations which are not suitable for human consumption, were found on the Napoli region and south-west Sardinia (Map 5). Moderate concentrations were associated with large rivers, in areas with point discharges (e.g. Sør fjord, western Norway) and in some harbours. No high concentrations and only a few moderate concentrations were found for fish for the period 1996-2002 (Map 6).
Sub-indicator

Summary assessment: overview of mercury trends

Key message

😊 Generally no trends were found for mercury in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean, which is a positive indication considering that concentrations are generally low.

Figure 6. Proportion of measurement stations in three categories of trends in concentrations of mercury in biota in European Seas. Station count in brackets.

Notes.
Sources: Data from Helcom, Ospar and EEA member countries.

Assessment of sub-indicator:
Of the 189 temporal trends statistically analysed on station-by-station basis (138 for mussels, 51 for fish) only 31 were significant, 21 down and 10 up (Figure 6, Maps 7 and 8). Inputs to the NE Atlantic has remained about 57% of the 1990-1992 average since 1993 (cf. EEA 2003c). The regional trend has also remained nearly constant around 40-50% of the 1990-1992 average since 1993 for mussels (Figure 1) and fish (Figure 2). Concentrations in some contaminated areas, e.g. the Seine estuary and German Bight region, appeared to be decreasing. There also appeared to be a general decreasing trend of cadmium in mussels from the French Mediterranean coast. Increasing trends were mostly found in Italy (4 of 8). Two of the seven trends for mercury concentrations in fish were increasing, both in the Sørfjord in Norway. Considering that concentrations are generally low, the abundance of no trends and decreasing trends is a positive signal.
**Sub-indicator**

Summary assessment: overview of lead concentrations

**Key message**

Generally low concentrations of lead for 1996-2002 were found in mussels and fish of the north-east Atlantic, and mussels in the Mediterranean, but a predominance of moderate values were found in fish from the Baltic Sea.

**Figure 7.** Proportion of measurement stations in three categories of concentrations of lead in biota in European Seas. Station count in brackets.

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<th>Type</th>
<th>Count</th>
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</thead>
<tbody>
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<td>Fish</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>148</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>Fish</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>26</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>Fish</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>183</td>
</tr>
<tr>
<td>Black Sea</td>
<td>Fish</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>3</td>
</tr>
</tbody>
</table>

**Notes.** Moderate concentration ranges are (mg/kg wet wt.): 0.6-1.5 for mussels, 0.1-1.0 for cod liver and 0.01-0.2 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2).

Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

The station-by-station overview of 1996-2002 concentrations of lead for mussels (both *Mytilus edulis* and *M. galloprovincialis*) indicated that concentrations were generally low (Figure 7). High concentrations, i.e. concentrations which are not suitable for human consumption, were found mainly at point discharges (e.g. Sørfjord, western Norway), and the Napoli region and Calabria region of south-eastern Italy (Map 9). High concentrations were also found at all three Romanian sites in the Black Sea. The only case of high concentrations for fish for the period 1996-2002 was found in the Faeroe Islands (Map 10). Moderate concentrations were generally found in herring from the Baltic Sea.
**Sub-indicator**

**Summary assessment: overview of lead trends**

**Key message**

😊 Generally no trends were found for lead in mussels and fish of the north-east Atlantic and mussels in the Mediterranean, which is a positive indication considering that concentrations are generally low in these regions. However, the large number of no trends in fish in the Baltic Sea where many concentrations are moderate should be a warning sign.

**Figure 8. Proportion of measurement stations in three categories of trends in concentrations of lead in biota in European Seas. Station count in brackets.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E. Atlantic - Fish</td>
<td>Decreasing</td>
<td>20</td>
</tr>
<tr>
<td>N.E. Atlantic - Mussels</td>
<td>No trend</td>
<td>75</td>
</tr>
<tr>
<td>Baltic Sea - Fish</td>
<td>No trend</td>
<td>9</td>
</tr>
<tr>
<td>Baltic Sea - Mussels</td>
<td>Increasing</td>
<td>1</td>
</tr>
<tr>
<td>Mediterranean - Fish</td>
<td>No trend</td>
<td>0</td>
</tr>
<tr>
<td>Mediterranean - Mussels</td>
<td>Decreasing</td>
<td>49</td>
</tr>
<tr>
<td>Black Sea - Fish</td>
<td>No trend</td>
<td>0</td>
</tr>
<tr>
<td>Black Sea - Mussels</td>
<td>No trend</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
</tr>
</tbody>
</table>

**Notes.**
Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Of the 154 temporal trends statistically analysed on station-by-station basis (125 for mussels, 29 for fish) 44 were significant, 34 down and 10 up (Figure 8, Maps 11 and 12). Inputs have been decreasing in the north-east Atlantic (cf. EEA 2003c) and so has the regional trend been for mussels (Figure 1). This correspondence was not so evident for fish (Figure 2). A station-by-station analysis revealed no increasing trends. Concentrations in some contaminated areas, e.g. the Seine estuary and Sørfjord, appeared to be decreasing. There also appeared to be a general decreasing trend of lead in mussels from the French Mediterranean coast. The exceptions include one station in the Marseilles area, possibly with influence from the river Rhône, one the Calabria regional of south-eastern Italy, and at some stations of the Aegean Sea. Increasing concentrations elsewhere in Europe appeared to be associated with harbour areas. In general, lead concentrations in fish appeared to decrease. The only increasing trend for fish was found at one station in the Baltic.
**Sub-indicator**

**Summary assessment: overview of DDT concentrations**

**Key message**

😊 Generally low concentrations of DDT for 1996-2002 were found in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean.

**Figure 9. Proportion of measurement stations in three categories of concentrations of DDT in biota in European Seas. Station count in brackets.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Category</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E. Atlantic - Fish</td>
<td>Low</td>
<td>40</td>
</tr>
<tr>
<td>N.E. Atlantic - Mussels</td>
<td>Low</td>
<td>132</td>
</tr>
<tr>
<td>Baltic Sea - Fish</td>
<td>Low</td>
<td>26</td>
</tr>
<tr>
<td>Baltic Sea - Mussels</td>
<td>Low</td>
<td>24</td>
</tr>
<tr>
<td>Mediterranean - Fish</td>
<td>Low</td>
<td>0</td>
</tr>
<tr>
<td>Mediterranean - Mussels</td>
<td>Low</td>
<td>65</td>
</tr>
<tr>
<td>Black Sea - Fish</td>
<td>Low</td>
<td>0</td>
</tr>
<tr>
<td>Black Sea - Mussels</td>
<td>Low</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes. DDT = ppDDE+ppDDD. Moderate concentration ranges are (mg/kg wet wt.): 0.001-0.01 for mussels, 0.5-5.0 for cod liver and 0.05-0.5 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2).

Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

The station-by-station overview of 1996-2002 concentrations of DDT (ppDDE+ppDDD) for mussels (both *Mytilus edulis* and *M. galloprovincialis*) indicated that concentrations were generally low (Figure 9). Elevated concentrations were found in the estuaries for large rivers, in areas where DDT has been known to have been used (e.g. Sørjford, western Norway) and in some harbours (Map 13). The areas with high concentrations in mussels were: Sørjford, Norway, and isolated incidences (German coast, Seine estuary, Genova and Venice harbour regions, Romanian coast in the Black Sea). In fish, the 1996-2002 concentrations exceeded suggested High concentration at only one stations which was located on the Polish coast (Map 14). The fish data show that DDT concentrations were elsewhere generally low.
**Sub-indicator**

**Summary assessment: overview of DDT trends**

**Key message**

😊 Generally no trends or only decreasing trends were found for DDT in mussels and fish of the north-east Atlantic and Baltic Sea, which is a positive indication considering that concentrations are generally low in these regions.

**Figure 10.** Proportion of measurement stations in three categories of trends in concentrations of DDT in biota in European Seas. Station count in brackets.

- N.E. Atlantic - Fish (27)
- N.E. Atlantic - Mussels (51)
- Baltic Sea - Fish (20)
- Baltic Sea - Mussels (1)
- Mediterranean - Fish (0)
- Mediterranean - Mussels (0)
- Black Sea - Fish (0)
- Black Sea - Mussels (0)

% of stations

Notes.
Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Of the 99 temporal trends statistically analysed on station-by-station basis (52 for mussels, 47 for fish) only 15 were significant, all down (Figure 10, Maps 15 and 16). No regional trend for mussels from the north-east Atlantic could be distinguished for the last two periods (1993-1997 and 1998-2002, Figure 1), however the concentration in cod dropped discernibly (Figure 2). Concentrations in mussels for some areas, one station in Dutch-German border region and one in the southern Norway area, were decreasing. Decreasing trends in fish were only found in southern Norway, and Baltic Sea.
Sub-indicator

Summary assessment: overview of lindane concentrations

Key message

😊 Generally low concentrations of lindane for 1996-2002 were found in mussels and fish of the north-east Atlantic, fish in the Baltic Sea, and mussels in the Mediterranean.

Figure 11. Proportion of measurement stations in three categories of concentrations of lindane in biota in European Seas. Station count in brackets.

Notes. Lindane = gamma hexachlorocyclohexane (γHCH). Moderate concentration ranges are (mg/kg wet wt.): 0.001-0.01 for mussels, 0.03-0.3 for cod liver and 0.005-0.05 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2).
Sources: Data from Helcom, Ospar and EEA member countries.

Assessment of sub-indicator:

The station-by-station overview of 1996-2002 concentrations of lindane (gamma HCH) for mussels (both *Mytilus edulis* and *M. galloprovincialis*) indicated that concentrations were predominantly low (Figure 11). Only two mussel stations, one on the coast of Poland and on the Romanian coast of the Black Sea, had High concentrations (Map 17). Moderate concentrations were mostly found in the inner German Bight in the vicinity of river estuaries. In fish, the 1996-2002 concentrations exceeded suggested High concentration at only one station which was located on the Polish coast (Map 18). The fish data show that lindane concentrations were elsewhere predominantly low.
**Sub-indicator**

**Summary assessment: overview of lindane trends**

**Key message**

😊 No trends or only decreasing trends were found for lindane in mussels and fish of the north-east Atlantic and Mediterranean and Baltic Seas, which is a positive indication considering that concentrations are generally low in these regions.

**Figure 12. Proportion of measurement stations in three categories of trends in concentrations of lindane in biota in European Seas. Station count in brackets.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Fish (Stations)</th>
<th>Mussels (Stations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.E. Atlantic</td>
<td>27</td>
<td>50</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Black Sea</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes.**
Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Of the 118 temporal trends statistically analysed on station-by-station basis (71 for mussels, 47 for fish) 28 were significant, all down (Figure 12, Maps 19 and 20). Inputs have been decreasing in the north-east Atlantic (cf. EEA 2003c) and so has the regional trends for mussels (Figure 1) and fish, mostly due to fish from southern Norway, (Figure 2). Decreases in mussels are generally located in the Seine estuary, the estuaries of the German Bight and the Oslofjord area in southern Norway. Regional trends analysis indicated a decrease in lindane in herring from the Baltic Sea the last period (1998-2002, Figure 1).
**Sub-indicator**

**Summary assessment: overview of PCB concentrations**

**Key message**

😊 Generally low concentrations of PCB for 1996-2002 were found in mussels and fish of the north-east Atlantic, and the Baltic Sea, but generally moderate values were found in mussels from the Mediterranean Sea.

---

**Notes.** PCB = sum of polychlorinated biphenyl (PCB) congeners 28, 52, 101, 118, 138, 153 and 180. Moderate concentration ranges are (mg/kg wet wt.): 0.003-0.03 for mussels, 0.1-2.5 for cod liver and 0.1-1.0 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2).

**Sources:** Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

The station-by-station overview of 1996-2002 concentrations of PCB (sum of congeners 28, 52, 101, 118, 138, 153 and 180) for mussels (both *Mytilus edulis* and *M. galloprovincialis*) indicated that concentrations were generally low (Figure 13). High concentrations were found in the estuaries for large rivers (e.g. Seine, Rhine) and harbours (e.g. Genova (Map 21). Moderate concentrations were found in the estuary regions of the German Bight, the south-west coast of Bretagne and along much of the southern coast of Italy. In fish, the 1996-2002 concentrations exceeded suggested High concentration at one station on the Polish coast and two in the inner Oslofjord, southern Norway (Map 22). The high concentrations in fish from Oslofjord concerned cod, and exceeded a Nordic limit for fish that is suitable for human consumption The fish data show that PCB concentrations were elsewhere generally low.
**Sub-indicator**

**Summary assessment: overview of PCB trends**

**Key message**

😊 Generally no trends or only decreasing trends were found for PCB in mussels and fish of the north-east Atlantic and Baltic Seas, which is a positive indication considering that concentrations are generally low in these regions.

**Figure 14. Proportion of measurement stations in three categories of trends in concentrations of PCB in biota in European Seas. Station count in brackets.**

![Bar chart showing proportions of stations with decreasing, no trend, and increasing concentrations of PCB in biota across different seas and species.](chart)

**Notes.**

Sources: Data from Helcom, Ospar and EEA member countries.

**Assessment of sub-indicator:**

Of the 114 temporal trends statistically analysed on station-by-station basis (61 for mussels, 53 for fish) 22 were significant, all down (Figure 14, Maps 23 and 24). Inputs have been decreasing in the north-east Atlantic (cf. EEA 2003c) and so has the regional trends for mussels (Figure 1) and flounder (Figure 2). Decreases in mussels are generally located in the Vigo and Bilbao harbour regions of Spain, Seine estuary, the estuaries of the German Bight and the Oslofjord area in southern Norway. Regional trends analysis indicated a decrease PCB in herring from the Baltic Sea (Figure 1).
## Data

Spreadsheet files:
- WHS6_Region-180903-conc.xls
- WHS6_Region-180903-conc-station.xls
- WHS6_Cd-180903-conc.xls
- WHS6_Cd-180903-trend.xls
- WHS6_Hg-180903-conc.xls
- WHS6_Hg-180903-trend.xls
- WHS6_Pb-180903-conc.xls
- WHS6_Pb-180903-trend.xls
- WHS6_DDT-180903-conc.xls
- WHS6_DDT-180903-trend.xls
- WHS6_Lin-180903-conc.xls
- WHS6_Lin-180903-trend.xls
- WHS6_PCB-180903-conc.xls
- WHS6_PCB-180903-trend.xls

### Table 2 Limit concentration used for classification in figures and maps: Low/High concentration limits for spatial assessment which delimits the classes Low, Moderate and High. EU foodstuff limits are highlighted in grey shade. Except for EU legislation the limits have no legal application.

Notes. * indicates where limits have been revised (cf. EEA 2003). Limits for lindane in fish have also been added.

<table>
<thead>
<tr>
<th>Name and tissue</th>
<th>Latin name</th>
<th>Low/High</th>
<th>mg/kg wet wt.</th>
<th>Reference</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CADMIUM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mussels</td>
<td>Mytilus sp.'</td>
<td>Low</td>
<td>0.4*</td>
<td>Green &amp; Knutzen 2003</td>
<td>A BRC of 0.11 mg/kg wet weight is suggested by Ospar (1999)</td>
</tr>
<tr>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>High</td>
<td>1.0</td>
<td>EU 2001</td>
<td>Foodstuffs limit for &quot;bivalve molluscs&quot; Regulation (EC) No. 466/2001</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td>Gadus morhua</td>
<td>Low</td>
<td>0.3</td>
<td>Green &amp; Knutzen, 2003</td>
<td>Based on 90 percentile of 1184 individuals from reference areas</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td>Gadus morhua</td>
<td>High</td>
<td>0.5</td>
<td>TemaNord 1994</td>
<td>Danish limit for &quot;fish liver&quot;</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td>Clupea harengus</td>
<td>Low</td>
<td>0.01</td>
<td>Knutzen 1987</td>
<td>Upper limit to proposed range in background level</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td>Clupea harengus</td>
<td>High</td>
<td>0.05</td>
<td>EU 2002</td>
<td>Foodstuffs limit for fish muscle Regulation (EC) No. 221/2002</td>
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<tr>
<td><strong>MERCURY</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mussels</td>
<td>Mytilus sp.'</td>
<td>Low</td>
<td>0.04*</td>
<td>Green &amp; Knutzen 2003</td>
<td>A BRC of 0.01 mg/kg wet weight is suggested by Ospar (1999)</td>
</tr>
<tr>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>High</td>
<td>0.50</td>
<td>EU 2001</td>
<td>Foodstuffs limit for &quot;bivalve molluscs&quot; Regulation (EC) No.466/2001</td>
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<tr>
<td>Atlantic cod, muscle</td>
<td>Gadus morhua</td>
<td>Low</td>
<td>0.05</td>
<td>Ospar 1999</td>
<td>BRC limit. A BRC of 0.1 mg/kg wet weight has been suggested (Green &amp; Knutzen, 2003)</td>
</tr>
<tr>
<td>Atlantic cod, muscle</td>
<td>Gadus morhua</td>
<td>High</td>
<td>0.50</td>
<td>EU 2001</td>
<td>Foodstuffs limit for fish muscle Regulation (EC) No. 466/2001</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td>Clupea harengus</td>
<td>Low</td>
<td>0.05</td>
<td>Knutzen 1987</td>
<td>Upper limit to proposed range in background level</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td>Clupea harengus</td>
<td>High</td>
<td>0.50</td>
<td>EU 2001</td>
<td>Foodstuffs limit for fish muscle Regulation (EC) No. 466/2001</td>
</tr>
<tr>
<td><strong>LEAD</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mussels</td>
<td>Mytilus sp.'</td>
<td>Low</td>
<td>0.6*</td>
<td>Green &amp; Knutzen 2003</td>
<td>A BRC of 0.19 mg/kg wet weight is suggested by Ospar (1999)</td>
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<tr>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>High</td>
<td>1.5</td>
<td>EU 2002</td>
<td>Foodstuffs limit for &quot;bivalve molluscs&quot;</td>
</tr>
<tr>
<td>Name and tissue</td>
<td>Latin name</td>
<td>Low/High</td>
<td>mg/kg wet wt.</td>
<td>Reference</td>
<td>Comment</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>----------</td>
<td>---------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>Low</td>
<td>0.1</td>
<td>Green &amp; Knutzen, 2003</td>
<td>Based on 90 percentile of 1162 fish from reference areas</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>High</td>
<td>1.0</td>
<td></td>
<td>Taken and 10 times LOW value</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>Low</td>
<td>0.01</td>
<td>Knutzen 1987</td>
<td>Upper limit to proposed range in background level</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>High</td>
<td>0.20</td>
<td>EU 2002</td>
<td>Foodstuffs limit for fish muscle</td>
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<tr>
<td>DDT</td>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>Low</td>
<td>0.001*</td>
<td>Green &amp; Knutzen 2003</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>High</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>Low</td>
<td>0.5</td>
<td>Ospar 1999</td>
<td>EAC limit for DDE. A BRC of 0.2 ppm wet weight has been suggested (Green &amp; Knutzen, 2003)</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>High</td>
<td>5.0</td>
<td></td>
<td>Taken as 10 times LOW</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>Low</td>
<td>0.05</td>
<td>Ospar 1999</td>
<td>EAC limit for flatfish</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>High</td>
<td>0.50</td>
<td></td>
<td>Taken as 10 times LOW</td>
</tr>
<tr>
<td>LINDANE</td>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>Low</td>
<td>0.001*</td>
<td>Green &amp; Knutzen 2003</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>Mytilus sp.</td>
<td>High</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>Low</td>
<td>0.03</td>
<td>Green &amp; Knutzen 2003</td>
<td>An EAC of 0.05 mg/kg wet weight is suggested by Ospar (1999)</td>
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<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>High</td>
<td>0.30</td>
<td></td>
<td>Taken as 10 times LOW</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>Low</td>
<td>0.005</td>
<td>Ospar 1999</td>
<td>EAC limit for flatfish</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>High</td>
<td>0.050</td>
<td></td>
<td>Taken as 10 times LOW</td>
</tr>
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<td>PCB</td>
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<td>Low</td>
<td>0.003*</td>
<td>Green &amp; Knutzen 2003</td>
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<td>High</td>
<td>0.030</td>
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<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>Low</td>
<td>0.10</td>
<td>MON 2001</td>
<td>EAC limit. A BRC of 0.5 ppm wet weight has been suggested (Green &amp; Knutzen, 2003)</td>
</tr>
<tr>
<td>Atlantic cod, liver</td>
<td><em>Gadus morhua</em></td>
<td>High</td>
<td>2.5</td>
<td>PNUN 1987</td>
<td>Swedish PCB [total] limit for &quot;fish liver* times 0.5</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>Low</td>
<td>0.10*</td>
<td>Ospar 1999</td>
<td>EAC limit for flatfish</td>
</tr>
<tr>
<td>Herring, muscle</td>
<td><em>Clupea harengus</em></td>
<td>High</td>
<td>1.0*</td>
<td></td>
<td>Taken as 10 times LOW</td>
</tr>
</tbody>
</table>

1) Blue mussel (*Mytilus edulis*) for the north-east Atlantic, Mediterranean mussel (*M. galloprovincialis*) for the Mediterranean
2) Background Reference Concentration

References


90/642/EC Council Directive 90/642/EEC of 27 November 1990 on the fixing of maximum levels for pesticide residues in and on certain products of plant origin, including fruit and vegetables


EU, 2001. [See 466/2001/EC]

EU, 2002. [See 221/2002/EC]


Helcom 1992. 1992 Helsinki Convention, Annex 1, Part 2.2, Substances banned for all uses, except in existing closed system equipment until the end of service life or for research, development and analytical purposes.


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**Meta data**

**Web presentation information**

1. **Abstract / description / teaser:**
   Gives concentrations of hazardous substances (heavy metals and chemicals) measured in marine biota (fish and mussels) in European seas.

2. **Policy issue / question:**
   Is pollution of marine waters with hazardous substances decreasing?

3. **EEA dissemination themes:**
   Coasts and seas

4. **DPSIR:**
Technical information

5. Data source.
Concentrations in organisms. Data was collected from Marine Conventions and National Reference Centres (NRC). Most of the data was from Ospar and Helcom supplied via the ICES data centre. Ospar provided data for the north-east Atlantic and Helcom provide data for the Baltic. France, Italy and Greece provided cadmium, mercury and lead data for the Mediterranean Sea. France provided lindane data and Italy provided DDT data in mussels for the Mediterranean Sea. France provided lindane data and Italy provided DDT data in mussels for the Mediterranean Sea. Received data from the Programme for the Assessment and Control of Pollution in the Mediterranean Region (MEDPOL) concerned Albania, Greece, Italy, Morocco, Spain, Turkey and Yugoslavia, but most of these data were from before 1991 and were regarded as too old to represent current concentrations and trends. It was apparent that MEDPOL member countries applied different guidelines for sampling which impaired comparison of data.

6. Description of data:
Concentrations in biota included: blue mussel from north-east Atlantic (from 11 countries), Mediterranean mussels from the Mediterranean (3) Black Sea (1), Atlantic cod from north-east Atlantic (7), herring from the Baltic Sea (5) and flounder the north-east Atlantic (6). Table 3 gives the number of stations per country and year, which were included in the indicator calculations (median and/or trend) of concentrations of the hazardous substance in mussels (blue mussel - *Mytilus edulis*, Mediterranean mussel - *M. galloprovincialis*) and fish (*Atlantic cod - Gadus morhua*, herring - *Clupea harengus* or flounder - *Platichthys flesus*).

7. Geographical coverage:
Generally good coverage for concentrations in the north-east Atlantic except for areas around England, Scotland and Wales and in the Baltic, but the Mediterranean Sea was only represented by three countries (France, Italy and Greece) and only one country represented the Black Sea (Romania).

8. Temporal coverage:
Concentrations in biota were measured during the period from 1985 to 2002. However most series were far from complete (Table 3). The number of stations monitored for each country and year varied from 0 to 189 annually.

9. Methodology and frequency of data collection:
Methods have been reported in more detail (EEA 2003a). Generally the unaggregated submitted data were based on annual measurements.

10. Methodology of data manipulation:
Methods have been reported in more detail (EEA 2003a). Time series were identified by station code where available, otherwise by location coordinates. Because of this, some data that constitute parts of the same time series may have been separated into different data series in the analysis because coordinates may vary for a station. Annual concentrations in biota were used converted to dry or wet weight basis, which ever is appropriate. The average concentration for the period 1996-2002 are classified into three groups (cf. Table 2). Monotone time trends were tested using Mann-Kendall statistics (ICES, 1999). Only series with data for at least 4 years and with data at least up to 1996 were used for the station-by-station trend analysis. Time trends are based on all available data from 1985 to 2002 for each time series - the time coverage is very variable between series. However, some of the trends shown may be based on mainly older data. Significance of trends is based on two-sided test with a nominal 5 % significance level, separately for each time series, without regard to serial correlation. Assessments of 'No trend' (i.e. no statistically significant trend) may be due both to actual lack of trend and to insufficient data.

The general changes in concentrations for each sea are based on the yearly aggregate values (averages) for each combination of location, year, species and tissue. Details of the calculation of these yearly averages are given in the text above. The overall time trends have been extracted from these aggregates for each species, tissue and region. Only series with data for at least 3 years in a
five year interval, and with data at least up to 1995 have been used. To diminish the effect on apparent time trends of changing geographical coverage between years, overall yearly average values have been extracted by variance analysis (general linear model - GLM) with location and year as factors. The aim of this is to separate the variation due to stations from the change over time, and achieve yearly averages that are adjusted for differences in geographical coverage between years. Some apparent changes in time may still be due to changes in geographical coverage between years. The analysis has been done using scaled values with the average value of each series, to get a representative average of relative variation over time, regardless of absolute levels at each station. The regional apparent changes in time may not be confirm the significant trends found in for at the stations (cf. cadmium in cod in Figure 2 and Figure 4 and Map 4).

Quality of information

See also a more detailed evaluation by EEA (2003a).

11. Strength and weakness (at data level):
   There is a general need for consistent or reliable data to enhance adequate assessment concentrations and trends. Data from the north-east Atlantic and Baltic Sea are relatively better than data from the Mediterranean and Black Seas.

12. Reliability, accuracy, robustness, uncertainty (at data level):
   Measurement of concentrations in biota are not co-ordinated with measurements of . There are also large spatial and temporal gaps.

13. Overall scoring (from 1-3: 1= no major problems, 3 = major reservations):
   Relevancy: 1
   Accuracy: 2
   Comparability over time: 2
   Comparability over space: 3

Further work required

Updating the EEA/ETC-WTR WATERBASE-Transitional/Coastal/Marine with long-term, consistent and reliable data that is spatially and temporally representative will greatly improve assessments of the concentrations and trends of hazardous substances in European Seas. It should be noted that the lack of consistent or reliable data from the marine conventions or EEA counties inhibits adequate assessment of concentrations and trends of hazardous substances in European marine water. Aggregated data do not necessarily convey the uncertainty these problems cause. Knowledge of local conditions will help determine how representative a measurement station is.

The assessment of concentration levels can be improved by using agreed European classification schemes. At the moment EU-legislation provides only limits for cadmium, mercury and lead in some foodstuffs. A classification system in line with the water framework directive implementation ought to be developed.

See also a more detailed evaluation by EEA (2003a).
ANNEX


Notes. Moderate concentration ranges is (mg/kg wet wt.): 0.4-1.0 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuffs *bivalve molluscs is 1 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.

Notes. Moderate concentration ranges are (mg/kg wet wt.): 0.3-0.5 for cod liver and 0.01-0.05 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuff muscle of fish is 0.05 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).

**Notes.** To be included requires four years of monitoring where the most recent year is 1996 or later

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.

**Notes.** To be included requires four years of monitoring where the most recent year is 1996 or later

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean).

Notes. Moderate concentration ranges is (mg/kg wet wt.): 0.04-0.5 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuffs bivalve molluscs is 0.5 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).
Map 6. Mercury (Hg) in muscle of cod (Gadus morhua) and muscle of herring (Clupea harrenagus), median concentration 1996-2002.

Notes. Moderate concentration ranges are (mg/kg wet wt.): 0.05-0.5 for cod liver and herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuff muscle of fish is 0.5 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).

Notes. To be included requires four years of monitoring where the most recent year is 1996 or later

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).
Map 8. Mercury (Hg) time trend in liver of cod (Gadus morhua) and liver/muscle of herring (Clupea harengus) and liver of flounder (Platichthys flesus), 1985-2002.

Notes. To be included requires four years of monitoring where the most recent year is 1996 or later

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.

Notes. Moderate concentration ranges is (mg/kg wet wt.): 0.6-1.5 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuffs *bivalve molluscs is 1.5 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.
Map 10. Lead (Pb) in liver of cod (Gadus morhua) and muscle of herring (Clupea harangus), median concentration 1996-2002.

Notes. Moderate concentration ranges are (mg/kg wet wt.): 0.1-1.0 for cod liver and 0.01-0.20 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). EU-legislation limit for cadmium in foodstuff muscle of fish is 0.2 mg/kg wet weight (EU, 2001b). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).
Map 11. Lead (Pb) time trend in mussels (Mytilus edulis - north-east Atlantic, M. galloprovincialis - Mediterranean and Black Sea) 1985-2002

Notes. To be included requires four years of monitoring where the most recent year is 1996 or later
Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.

**Notes.** To be included requires four years of monitoring where the most recent year is 1996 or later

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean).

Notes. DDT = ppDDE+ppDDD. Moderate concentration ranges is (mg/kg wet wt.): 0.001-0.01 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.
Map 14. DDT in liver of cod (Gadus morhua) and muscle of herring (Clupea harengus), median concentration 1996-2002.

Notes. DDT = ppDDE+ppDDD. Moderate concentration ranges are (mg/kg wet wt.): 0.5-5.0 for cod liver and 0.05-0.5 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).

**Notes.** DDT = ppDDE+ppDDD. To be included requires four years of monitoring where the most recent year is 1996 or later. 

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.
Map 16. DDT time trend in liver of cod (Gadus morhua) and liver/muscle of herring (Clupea harangus) and liver of flounder (Platichthys flesus), 1985-2002.

Notes. DDT = ppDDE+ppDDD. To be included requires four years of monitoring where the most recent year is 1996 or later

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).

Notes. Lindane = gamma hexachlorocyclohexane (γ-HCH). Moderate concentration ranges is (mg/kg wet wt.): 0.001-0.01.0 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.
Map 18. Lindane in liver of cod (Gadus morhua) and muscle of herring (Clupea harrenus), median concentration 1996-2002.

Notes. Lindane = gamma hexachlorocyclohexane (γ-HCH). Moderate concentration ranges are (mg/kg wet wt.): 0.03-0.3 for cod liver and 0.005-0.05 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).

Notes. Lindane = gamma hexachlorocyclohexane (γHCH). To be included requires four years of monitoring where the most recent year is 1996 or later.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean), and data reported by Romania.

**Notes.** Lindane = gamma hexachlorocyclohexane (*γ*HCH). To be included requires four years of monitoring where the most recent year is 1996 or later.

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean).

**Notes.** PCB = sum of polychlorinated biphenyl (PCB) congeners 28, 52, 101, 118, 138, 153 and 180. Moderate concentration ranges is (mg/kg wet wt.): 0.003-0.03 for mussels. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean).

**Notes.** PCB = sum of polychlorinated biphenyl (PCB) congeners 28, 52, 101, 118, 138, 153 and 180. Moderate concentration ranges are (mg/kg wet wt.): 0.1-2.5 for cod liver and 0.1-1.0 for herring muscle. Low concentrations are below this range and High concentrations are above (cf. table 2). NB: larger symbols may obscure other symbols.

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean).

**Notes.** PCB = sum of polychlorinated biphenyl (PCB) congeners 28, 52, 101, 118, 138, 153 and 180. To be included requires four years of monitoring where the most recent year is 1996 or later

**Data source.** Based on data from Ospar and EEA-member countries (Mediterranean)
Map 24. PCB time trend in liver of cod (Gadus morhua) and liver/muscle of herring (Clupea harangus) and liver of flounder (Platichthys flesus), 1986-2002.

Notes. PCB = sum of polychlorinated biphenyl (PCB) congeners 28, 52, 101, 118, 138, 153 and 180. To be included requires four years of monitoring where the most recent year is 1996 or later.

Data source. Based on data from Ospar and EEA-member countries (Mediterranean).