# Interim Report 3 – Study of dioxin levels in fatty fish from Sweden 2001-2002

## Contents



The aim of the study is to update basic data regarding the concentration of non-readily biodegradable environmental organic contaminants (dioxins and dioxin-like PCBs) in fatty fish from Sweden used as food or in animal feed. The data relates to a representative sampling of various areas of the Baltic Sea, lakes Vänern and Vättern, as well as the waters along Sweden's west coast. The study's goal is to provide Sweden with:

- a current base of supporting material for discussion of the threshold values for dioxins and furans in the EU member states.
- current data for review of National Food Administration dietary recommendations concerning fatty fish.
- current data on the concentration of these contaminants for coming control programs.

The study deals primarily with fish for which the National Food Administration has issued dietary recommendations due to elevated levels of organic environmental contaminants. This report of dioxin studies does not include dioxin-like PCBs which are at present not affected by the maximum levels. Analysis of these compounds is not yet complete and will be presente$ at a later date.

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## About Interim Report 3

Interim Report 3 contains results from studies done on salmon, brown trout, Arctic char, whitefish, herring, sprat and vendace roe from several locations in the Baltic Sea, and lakes Vänern and Vättern. The report also aontains results from analysis of crabs from Sweden's west coast.

To determine differences in concentrations between different locations and fish species requires more extended time-trend studies. The current ongoing study can be seen as a basis for such future studies.

The results presented here, together with those of interim reports 1 and 2, represent the bulk of the testing th`T will be performed within the framework of the "Study of dioxin levels in fatty fish from Sweden" project. The remaining results (7 analyses) will be presented on the website (www.slv.se) in the fall of 2002. The final report is estimated to be complete in the first half of 2003.

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## Points to note when reading the table

The results presented below in the "Table of results on dioxin levels in fatty fish from Sweden" are from analysis of salmon, brown trout, Arctic char, whitefish, herring, sprat and vendace roe from several locations in the Baltic Sea, and lakes Vänern and Vättern. The table also contains results from analysis of crabs from Sweden's west coast.

For all fish species included in Interim Report 3, the tests were carried out on muscle tissue (fish meat). For herring, the muscle including skin was analysed.

The fish were caught in fall 2001 or winter 2002 (see link to "Detailed information…").

All of the results presented in Interim Report 3 are from analysis of pooled samples. (Pooled sample = equivalent amounts of muscle tissue from several fish is mixed and used for analysis). This is a practice used, among other reasons, to secure representation of a somewhat larger number of fish from the locations sampled.

Because dioxins accumulate mainly in the fat of the edible parts of fish, the fat content of the individual fish is of great significance to the dioxin levels.

The levels of dioxins found in the fish studied can be compared to the maximum level for fish that the EU takes effect 1 July 2002, i.e., 4 pg WHO-TEQ/g fresh weight.

Earlier investigations have shown that dioxin levels in fish from a single location can vary from year to year and season to season (Bignert et al. 1994). It is also important to note that the concentration of environmental organic contaminants can vary considerably in individuals from the same location, depending on factors such as fat content, size (age), gender, etc. The results presented in the table below can therefore only be seen as representative of the sampling occasion in question.

The variation in the fat content of fish classified as fatty fish can vary greatly from individual to individual depending on what time of year they are caught. Variations may be due to the fish having spawned (lower fat levels), or to the fish having been caught during a foraging period (higher fat levels). When dioxin levels are expressed in pg WHO-TEQ/g fat, a 50% reduction of the fat content means a doubling of the dioxin concentration in the fat. When dioxin levels are instead given in pg WHO-TEQ/g fresh weight, dioxin levels do not vary greatly, despite a 50% reduction in fat, since the fat in the muscle tissue (the edible part of the fish) usually accounts for only a small part of the total muscle weight (fresh weight).

Because the variation in the fat content of fish can be so great, dioxin levels are expressed in pg WHO-TEQ/g fresh weight. The dioxins levels for fish muscle reported here show the actual amount of dioxins present in this food, independent of fat content. The results presented are those for 17 toxic chlorinated dibenzodioxins and dibenzofurans (PCDD/PCDF). TEQ (toxic equivalent) is a corrected value that takes into consideration the combined toxicity of the substances studied in relation to one of the two the most toxic of all dioxin compounds (2,3,7,8-TCDD). In calculating the WHO-TEQ values, the upper-bound level (1 x detection limit) has been used for non-detectable levels.

The study is also designed to examine how age, size and gender can affect dioxin levels in fish. A more detailed analysis of these variables will be carried out when the National Food Administration has access to the complete data.

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## Breakdown of dioxin analysis results by species of fish and location caught

**Salmon (Salmo salar) from Lake Vänern:**

The mean dioxin level for pooled samples of salmon from north (Alfhildsgrund) and south (Dalbosjön) parts of the lake is 2.4 pg WHO-TEQ/g fresh weight. Results from earlier dioxin studies from Lake Vänern 1990 comprise two pooled samples of 10 fish each from the south (Dalbosjön) and the north (Värmlandssjön) of the lake (3.2 and 2.8 pg N-TEQ/g fresh weight, respectively) (Olsson 1992).

**Salmon (Salmo salar) from Lake Vättern:**

The level for the pooled salmon sample from northern Lake Vättern was 0.83 pg WHO-TEQ/g fresh weight. The mean value for salmon from southern- (Interim Report 2, 1.6 pg) and northern Lake Vättern is 1.2 pg WHO-TEQ/g fresh weight. Comparison with previous results was not possible.

**Brown trout (Salmo trutta) from Lake Vänern:**

The level in the pooled sample from brown trout from southern Lake Vänern was 1.3 pg WHO-TEQ/g fresh weight. The mean value for brown trout from the northern- (Interim Report 2, 3.2 pg) and southern parts of the lake is 2.2 pg WHO-TEQ/g fresh weight. Results from earlier dioxin studies from Lake Vänern, 1990 and 1996, comprise two pooled samples of 10 fish each from the south (Dalbosjön) and north (Värmlandssjön) of the lake (2.0 and 3.3 pg N-TEQ/g fresh weight, and 2.4 and 4.7 pg N-TEQ/g fresh weight, respectively) (Olsson 1992; Lindeström and Grotell, 1998).

**Brown trout (Salmo trutta) from Lake Vättern:**

The level in the pooled sample from brown trout from northern Lake Vättern was 0.65 pg WHO-TEQ/g fresh weight. The mean value for brown trout from the southern- (Interim Report 2, www.slv.se, 2.2 pg) and northern parts of the lake is 1.4 pg WHO-TEQ/g fresh weight. Comparison with previous results was not possible.

**Arctic char (Salvelinus alpinus) from Lake Vättern:**

The mean dioxin level for the pooled samples of Arctic char from northern and southern Lake Vättern was 3.8 pg WHO-TEQ/g fresh weight. Results from earlier dioxin studies from Lake Vättern 1991 comprise analysis of 5 individual chars with extremely high fat contents (14.9%) that showed a mean value of 5.4 pg TEQ/g fresh weight (min=4; max=6.7) (Andersson et al., 1997).

**Herring (Clupea harengus) from Piteå archipelago:**

The dioxin level in pooled samples of herring from Piteå archipelago was 1.8 pg WHO-TEQ/g fresh weight. For this sampling and location, a difference in dioxin level was indicated based on the age of the fish, where 1 year-old herring showed a concentration of 0.86 pg WHO-TEQ/g fresh weight, 2-3 year-olds a mean concentration of 1.2 pg WHO-TEQ/g fresh weight, and the 4-6 year-old fish a mean concentration of 3.8 pg WHO-TEQ/g fresh weight. Note that for this sampling location no fish older than 4-6 years were analysed, meaning that direct comparison with the dioxin levels of herring from other locations representing other age groups is not possible (other locations often include a 7-9 age group).

**Herring (Clupea harengus) from the waters around the Ångermanälven estuary (Omnefjärden):**

The mean dioxin level in pooled samples of herring from Omnefjärden was 3.0 pg WHO-TEQ/g fresh weight. Also for this sampling and location, a difference in dioxin level was indicated based on age of the fish, where 2-3 year-old herring showed a mean of 2.2 pg WHO-TEQ/g fresh weight and 4-5 year-olds a mean of 3.6 pg WHO-TEQ/g fresh weight. Note that for this sampling location no fish older than 4-5 years were analysed, meaning that direct comparison with the dioxin levels of herring from other locations representing other age groups is not possible (other locations often include age groups for 4-6 years and 7-9 years).

**Herring (Clupea harengus) from Bålsen:**

The mean dioxin level for pooled samples of herring from Bålsen was 14 pg WHO-TEQ/g fresh weight. For this sampling and location, a marked difference was indicated for dioxin levels based on age of the fish, where 4-6 year-old herring showed a mean concentration of 10 pg WHO-TEQ/g fresh weight and 7-9 year-old herring a mean concentration of 18 pg WHO-TEQ/g fresh weight.

**Herring (Clupea harengus) from Västra Banken:**

The mean dioxin level for pooled samples of herring from Västra Banken was 20 pg WHO-TEQ/g fresh weight. This sampling and location showed no indication of age-related differences corresponding to the above. It should however be noted that, in the case of Västra Banken, the younger age group (4-6 year-olds for most other areas) consisted of 5-6 year-old herring, since the fish collected contained no 4 year-olds, and that direct comparison with herring from other locations representing other age groups is not possible.

**Herring (Clupea harengus) from west of the island of Bornholm:**

The mean dioxin level for pooled samples of herring caught in the area to the west of Bornholm (exact position unavailable) was 2.0 pg WHO-TEQ/g fresh weight. It should be noted that the herring from this location comprise only 3-4 year-olds (other locations often include age groups for 4-6 years and 7-9 years) and that the fish were caught in January 2002 (other herring were caught in fall 2000 and fall 2001), meaning that direct comparison with herring from other locations representing other age groups and caught in other seasons is not possible. Despite its relatively low age, however, this herring stock is comparable in size and fat content to the 7-9 age group from locations such as Landsort, Gotland and Utlängan in this study (Interim Report 1).

**Sprat (Sprattus sprattus) from west of the island of Bornholm:**

The dioxin level for the pooled sample of sprat caught in the area to the west of Bornholm (exact position unavailable) was 2.7 pg WHO-TEQ/g fresh weight. An additional sample of sprat from this location will be analysed in August 2002. Comparison with previous results was not possible.

**Whitefish (Coregonus lavaretus) from Luleå archipelago:**

The mean dioxin level for pooled samples of whitefish from Luleå archipelago was 0.90 pg WHO-TEQ/g fresh weight. This fish is probably a migratory whitefish and caught while in these coastal waters to spawn. The foraging grounds of the migratory whitefish include large areas of the Bothnian Bay and Bothnian Sea, where it spends most of the year. Results from earlier dioxin studies from Luleå comprise a pooled sample from 15 whitefish, 1987, showing a dioxin concentration of 2.3 pg TEQ/g fresh weight (Andersson et al., 1997).

**Whitefish (Coregonus lavaretus) from the waters north of the Ångermanälven river estuary:**

The mean dioxin level for pooled samples of whitefish from the waters to the north of the mouth of the Ångermanälven river was 1.8 pg WHO-TEQ/g fresh weight. This fish is likely also a migratory whitefish and caught while in these coastal waters to spawn. The foraging grounds of the migratory whitefish include large areas of the Gulf of Bothnia and Bothnian Sea, where it spends most of the year. There are no results from earlier dioxin studies on whitefish in this region.

**Whitefish (Coregonus lavaretus) from Öregrundsgrepen:**

The mean dioxin level for pooled samples of whitefish from Öregrundsgrepen was 0.90 pg WHO-TEQ/g fresh weight. In contrast to the two fish stocks listed above, these fish are probably a non-migratory population, meaning that they live in the waters where they were caught year-round. Results from earlier dioxin studies from an area north of Öregrundsgrepen (Limön, Gävle Bay), comprise a pooled sample from 15 whitefish, 1987, showing a dioxin concentration of 8.4 pg TEQ/g fresh weight (Andersson et al., 1997).

**Vendace roe (from Coregonus albula) from archipelagos of Luleå/Råneå:**

The dioxin level for the pooled sample of roe caught in the archipelagos of Luleå/Råneå was 2.1 pg WHO-TEQ/g fresh weight. An additional sample of vendace roe from Lake Vänern will be analysed in August 2002. Comparison with previous results was not possible.

**Crab from the west coast of Sweden (Skagerrak Strait):**

The dioxin level in muscle tissue (white meat) in the pooled sample of Swedish crab was low (0.85 pg WHO-TEQ/g fresh weight), while the fatter gray-green ‘butter’ (hepatopancreas) from the same crabs showed a considerably higher level of 13 pg WHO-TEQ/g fresh weight. The crabs collected had little or no red-orange roe making analysis of this part impossible. Interim Report 2 presents corresponding results from Irish crabs, indicating a dioxin level in the roe of about twice that of the hepatopancreas (2.5 and 4.5 pg WHO-TEQ/g fresh weight, respectively).

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Comments of the National Food Administration on the results in relation to dietary recommendations concerning fatty fish from the Baltic Sea

The National Food Administration’s dietary recommendation concerning fatty fish from the Baltic Sea remain at present unchanged.

Conclusions based on comparison of the results from this third part of the study and earlier reported studies on fish (not included in interim reports 1, 2 or 3) should be made with care owing to differences in size, season and location caught, etc. When statistical analysis of the results is complete and the quality of the results has been substantiated, the National Food Administration will take them into consideration in the continual follow-up of its dietary recommendations.

A preliminary evaluation has been done of the results for herring and indicates that the dioxin level is in general lower the smaller the herring, since the size of the fish within a particular area is often associated with the age of the fish. Thus, it follows that those who eat herring should choose smaller fish if they want to reduce their dioxin intake during herring season.

Another tip that can help to reduce the intake of these environmental contaminants (dioxins and polychlorinated biphenyls, PCBs) is to remove the skin (and the fat directly under the skin) before preparation and consumption of the herring. The reason for this is that the skin has a high fat content, in which dioxins and PCBs are concentrated. Another precautionary measure, when heating (frying) herring products, is to drain off the fat that runs off the fish during preparation. This tip is also passable for other fatty fish species.

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## Participants in the study

This investigation is being conducted by the National Food Administration in cooperation with the National Board of Fisheries, Umeå University (Environmental Chemistry, Dept. of Chemistry), the Swedish Museum of Natural History, the Swedish Board of Agriculture, Uppsala University (Dept. of Environmental Toxicology), and the societies for water conservation for lakes Vänern and Vättern. Government has allocated special funding for the study.

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## Table of results on dioxin levels in fatty fish from Sweden, Interim Report 3

Mean value for 17 dioxins and furans (PCDD/F) measured in fish from different locations in Sweden from fall 2001 – February 2002.

Dioxin levels are given in picogram (pg) WHO-TEQ/g fresh weight. (1 picogram = 0.000000000001 g) The dioxin levels measured in the fish in the study can be compared to the maximum level for the EU (4 pg WHO-TEQ/g fresh weight).

The fish analysed were caught in the Baltic Sea, lakes Vänern and Vättern, and in the waters along Sweden's west coast. More detailed information on individual fish samples

| No. | Species | Gender | Mean age, years (range) | Mean weight (g) | Fat content (%) | Location caught | Year caught | No. of analyses (indiv.) | Dioxin content |
|---|---|---|---|---|---|---|---|---|---|
| 59 | Salmon | Mixed | *1.4 (1-2) | 2955 | 3.7 | N.Vättern | 2001 | 1(10) | 0.83 |
| 60 | Salmon | Mixed | *1.6 (1-3) | 3516 | 6.0 | N.Vänern | 2002 | 1(10) | 2.7 |
| 61 | Salmon | Female | *1.4 (1-2) | 3215 | 4.9 | S.Vänern | 2001-2002 | 1(7) | 2.1 |
| 62 | Brown trout | Female | *1.4 (0-3) | 1168 | 1.6 | N.Vättern | 2001-2002 | 1(9) | 0.65 |
| 63 | Brown trout | Female | *3.0 (2-3.5) | 4013 | 2.2 | S.Vänern | 2001-2002 | 1(10) | 1.3 |
| 64 | Arctic char | Mixed | Not available | 707 | 3.5 | N.Vättern | 2001 | 1(10) | 2.7 |
| 65 | Arctic char | Female | Not available | 1014 | 3.3 | S.Vättern | 2001 | 1(10) | 4.8 |
| 66 | Herring | Female | 2.5(2-3) | 23.9 | 5.6 | Piteå archipelago | 2001 | 1(14) | 1.1 |
| 67 | Herring | Male | 2.5(2-3) | 25.2 | 6.1 | Piteå archipelago | 2001 | 1(14) | 1.4 |
| 68 | Herring | Mixed | 5.0(4-6) | 31.6 | 5.1 | Piteå archipelago | 2001 | 1(6) | 3.8 |

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|---|---|---|---|---|---|---|---|---|---|
| 69 | Herring | Mixed | 1.0(1) | 18.4 | 6.9 | Piteå archipelago | 2001 | 1(7) | 0.86 |
| 70 | Herring | Female | 2.5(2-3) | 25.5 | 5.1 | Ångerman river, Omnefjärden | 2001 | 1(15) | 2.0 |
| 71 | Herring | Male | 2.5(2-3) | 27.4 | 5.0 | Ångerman river, Omnefjärden | 2001 | 1(15) | 2.5 |
| 72 | Herring | Female | 4.5(4-5) | 34.8 | 4.1 | Ångerman river, Omnefjärden | 2001 | 1(10) | 3.5 |
| 73 | Herring | Male | 4.5(4-5) | 33.2 | 6.2 | Ångerman river, Omnefjärden | 2001 | 1(10) | 3.8 |
| 74 | Herring | Female | 5.0(4-6) | 62.0 | 11.4 | Bålsen | 2001 | 1(9) | 10 |
| 75 | Herring | Male | 5.0(4-6) | 54.7 | 11.0 | Bålsen | 2001 | 1(6) | 10 |
| 76 | Herring | Female | 8.0(7-9) | 98.0 | 15.0 | Bålsen | 2001 | 1(9) | 17 |
| 77 | Herring | Male | 8.0(7-9) | 98.3 | 15.8 | Bålsen | 2001 | 1(6) | 20 |
| 78 | Herring | Female | 5.5(5-6) | 85.5 | 11.3 | V.Banken | 2001 | 1(8) | 19 |
| 79 | Herring | Male | 5.5(5-6) | 92.3 | 14.5 | V.Banken | 2001 | 1(10) | 21 |
| 80 | Herring | Female | 8.0(7-9) | 86.8 | 11.8 | V.Banken | 2001 | 1(9) | 17 |
| 81 | Herring | Male | 8.0(7-9) | 93.3 | 13.9 | V.Banken | 2001 | 1(9) | 23 |
| 82 | Herring | Female | 3.5(3-4) | 87.9 | 10.2 | W.Bornholm | 2002 | 1(10) | 1.9 |
| 83 | Herring | Male | 3.5(3-4) | 102.8 | 11.8 | W.Bornholm | 2002 | 1(10) | 2.0 |
| 84 | Sprat | Mixed | 4.9(4-7) | 21.4 | 8.3 | W.Bornholm | 2002 | 1(14) | 2.7 |
| 85 | Whitefish | Female | 4.5 (3-7) | 509 | 1.6 | Luleå archipelago | 2001 | 1(5) | 1.1 |
| 86 | Whitefish | Male | 5.2 (4-6) | 409 | 1.3 | Luleå archipelago | 2001 | 1(5) | 0.71 |
| 87 | Whitefish | Female | 4.9 (3-6) | 379 | 1.0 | Ångerman river | 2001 | 1(7) | 1.9 |
| 88 | Whitefish | Male | 4.5 (3-6) | 278 | 0.88 | Ångerman river | 2001 | 1(10) | 1.7 |
| 89 | Whitefish | Female | 4.3 (3-6) | 358 | 1.1 | Öregrunds-grepen | 2001 | 1(10) | 0.81 |
| 90 | Whitefish | Male | 4.3 (3-6) | 314 | 1.2 | Öregrunds-grepen | 2001 | 1(7) | 1.0 |
| 91 | Vendace roe** | Female | Unknown | 22.2 | 13.3 | Luleå/Råneå archipelago | 2001 | 1(74) | 2.2 |
| 92 | Crab (muscle) | Female | Unknown | 223.2*** | 0.87 | Skagerakk | 2001 | 1(10) | 0.85 |
| 93 | Crab (butter****) | Female | Unknown | 223.2*** | 13.0 | Skagerrak | 2001 | 1(10) | 13 |

*= Number of years fish have been in the sea/lake (after two-three years in the river).

** = Vendace roe sample comprises a pooled sample from 74 individuals with a mean roe weight of 3.9 g.

*** = Mean weight for 10 whole crabs comprising the pooled sample.

**** = By 'butter' here is meant the gray-green hepatopancreas.

Fish = For all fish species in this report, testing was carried out on muscle tissue (fish meat), for herring, the muscle including fish skin was analysed. All analyses in Interim Report 3 have been done on pooled samples (pooled sample = an equivalent amount of muscle from several fish is mixed and used for analysis).

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## Links

Dioxin in Swedish food
Council regulation no. 2375/2001 amending no. 466/2001 setting maximum levels for certain contaminants in foodstuffs

## Further information

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