

## DIOXIN AND PCB LEVELS IN HERRING AND SALMON FROM THE BALTIC REGION 2010

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### Introduction

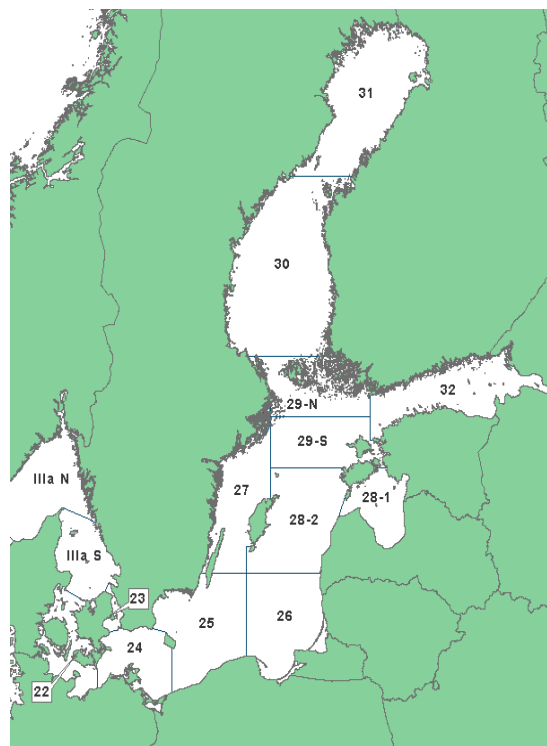
Food and fish in particular, is the major source of dioxins (PCDD/Fs) and polychlorinated biphenyls (PCBs) for humans. Although the levels of PCBs and PCDD/Fs have declined in food during the last decades, their concentrations are still high in some fish from the Baltic region. Monitoring programs show that the concentrations of PCBs in herring from the Baltic Sea have decreased since the 1970s by approximately 5-10% per year, while the decrease of PCDD/Fs seems to have ceased during the 1990s<sup>1</sup>. The PCDD/F levels in fatty fish from the Baltic region often exceed the established maximum level set by the European Commission. However, Sweden and Finland have an exemption from the regulation (1881/2006/EC) and are allowed to sell fish that exceed the maximum level on the domestic market. In order to protect identified vulnerable groups of the population, the Swedish National Food Administration, NFA, has established dietary recommendations for consumption of fish from this area.

During 2010, NFA has performed a survey to update data regarding PCDD/F and PCB levels in fish from the Baltic region. This study presents a part of the results from the survey and includes levels for herring and salmon taken from the Baltic Sea and salmon from the biggest lake in Sweden, Lake Vänern.

### Materials and methods

Herring (*Clupea harengus*) for human consumption was caught during 2010 at several locations in the Baltic Sea, ICES 24-31 (Figure 1). A total of 83 pooled herring samples were analysed. Each pooled sample consisted of 6 to 56 individuals depending on the herring weight. Wild caught salmon (*Salmo salar*) that was intended for human consumption was collected during 2010 from four different locations, Baltic Proper ICES 24-29, Bothnian Sea ICES 30, Bothnian Bay ICES 31 and from Lake Vänern. A total of 18 pooled salmon samples were analysed and each pooled sample consisted of five individuals. Analyses were carried out on herring muscle including skin and salmon muscle with scraped subcutaneous lipids but without skin. The sampling design covered locations and fishing seasons in which fish is usually caught for commercial purposes and followed the requirements laid down by the European Commission<sup>2</sup>.

Extraction, clean-up and analysis of PCDD/Fs and PCBs were done according to validated methods at the National Institute for Health and Welfare in Kuopio, Finland<sup>3</sup>. The pooled samples were analysed for the seventeen toxic chloro-substituted PCDD/Fs, twelve dioxin-like PCBs (PCB 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, 189) and six non dioxin-like PCBs (PCB 28, 52, 101, 138, 153, 180). The PCDD/F and dioxin-like PCB levels are presented as toxic equivalents (TEQ) using both the toxic equivalency factors (TEF) set by WHO in 1998 and the



**Figure 1. Division of the Baltic Sea fishing grounds in sub-divisions 24-32 by the International Council for the Exploration of the Sea (ICES). Herring was collected from ICES 24-31.**

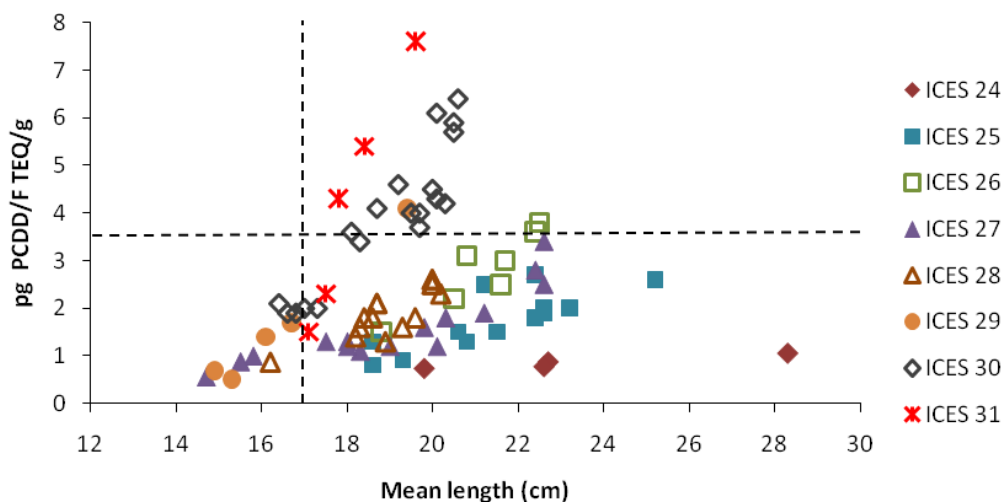
new reevaluated TEFs from 2005 and are summarised in Tables 1-2. Results are presented as median values with min-max values in brackets and levels of PCDD/Fs and PCBs are given as upper bound concentrations.

### Results and discussion

The current maximum level (ML) for PCDD/Fs in fish and fishery products set by the European Commission is 4 pg WHO TEQ<sup>1998</sup>/g fresh weight (f.w.) and 8 pg WHO TEQ<sup>1998</sup>/g f.w. for the sum of PCDD/Fs and dioxin-like PCBs (PCDD/F-PCB). The European Commission has suggested new lower MLs calculated with toxic equivalency factors (TEFs) reevaluated in 2005 to 3.5 pg PCDD/F WHO TEQ<sup>2005</sup> and 6.5 pg PCDD/F-PCB WHO TEQ<sup>2005</sup>/g f.w.. The new revision includes also MLs for non dioxin-like PCBs to 75 ng/g f.w. for sea fish and 125 ng/g f.w. for fresh water fish. Results are evaluated considering the new suggested MLs.

In general, herring shows increasing levels of PCDD/Fs and PCBs with increasing fish size but the increase varies depending of the fishing location. Earlier studies have shown that PCDD/F levels vary with age, herring stocks (location), and between years and seasons<sup>1,4,5</sup>. It has also been shown that PCDD/F and PCB levels in herring and salmon can differ depending on the matrix analysed, since lipophilic substances accumulate mainly in adipose tissue<sup>6</sup>.

In figure 2, correlation between concentrations of PCDD/F TEQ<sup>2005</sup> and mean length in pooled samples of herring from the Baltic Sea are shown. The majority of the herring samples collected in the Baltic Proper (ICES 24-29) in 2010 were below the new suggested ML for PCDD/Fs. The PCDD/F levels were between 0.5 and 4.1 pg TEQ<sup>2005</sup>/g f.w. However, few pooled samples from ICES 29 were analysed and most of the herring collected were small, < 17cm. Only one pooled sample from ICES 29 consisted of larger herring, mean length of 19 cm, and this sample exceeded the suggested ML for PCDD/Fs. Herring samples from the Gulf of Bothnia (ICES 30-31) showed much higher levels of PCDD/F compared to those from the Baltic Proper and most of the pooled samples exceeded the suggested ML. This observation is in agreement with earlier studies<sup>4</sup>. The PCDD/F levels in herring from ICES 30-31 varied between 1.5 and 7.6 pg TEQ<sup>2005</sup>/g f.w. Only samples consisting of herring with an average length below 17 cm showed PCDD/F levels below suggested ML (Figure 2). The non dioxin-like PCB levels were below the new suggested ML in all the herring samples (Table 1).



**Figure 2. PCDD/F levels (pg TEQ<sup>2005</sup>/g f.w.) in pooled samples of herring from the Baltic Sea caught in 2010. Muscle with skin was analysed. The new suggested ML for PCDD/F, 3.5 pg TEQ<sup>2005</sup>/g f.w. and the mean length 17 cm are marked.**

The ratio of PCDD/F and PCB in herring seems to vary depending of the fishing location. In the southern part of the Baltic Sea (ICES 24-25) the contribution of PCDD/Fs to the sum TEQ of PCDD/Fs and PCBs in herring was about 45-50% compared to 65% in the Bothnian Sea.

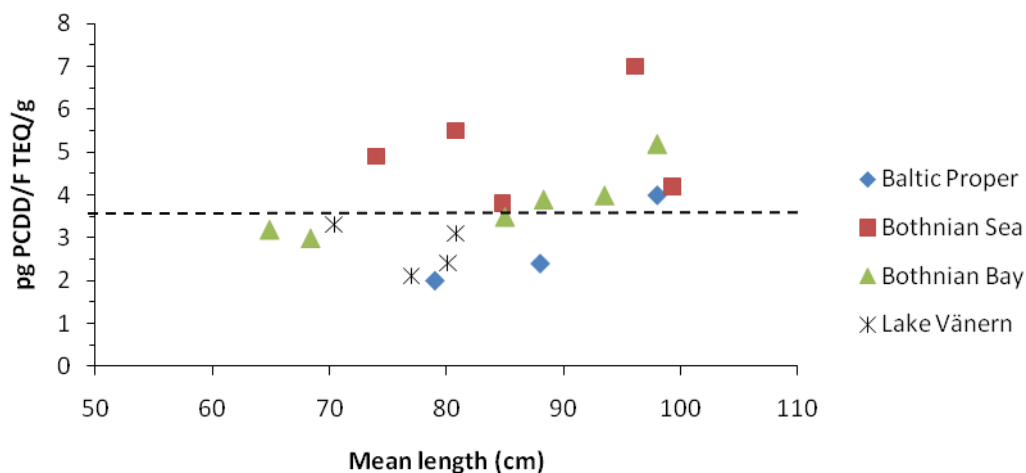


Figure 3. PCDD/F levels (pg TEQ<sup>2005</sup>/g f.w.) in pooled samples of salmon from the Baltic Sea and Lake Vänern caught in 2010. Muscle with subcutaneous lipids was analysed. The new suggested ML for PCDD/F, 3.5 pg TEQ<sup>2005</sup>/g f.w., is marked.

Table 1. Median (min-max) levels of PCDD/F and PCB in pooled samples of herring from the Baltic Sea (2010). N indicates the number of pooled samples analysed per ICES sub-division. Herring muscle with skin was analysed and the fat content of each pooled sample varied between 2 and 14 %.

Location	N	Mean length (cm)	Mean weight (g)	PCDD/F TEQ <sup>1998</sup> (pg/g)	PCDD/F TEQ <sup>2005</sup> (pg/g)	PCDD/F- PCB	PCDD/F- PCB	NDL- PCB <sup>1</sup> (ng/g)
						TEQ <sup>1998</sup> (pg/g)	TEQ <sup>2005</sup> (pg/g)	
ICES 24	4	23	77	1.0	0.8	2.0	1.6	12
		(20-28)	(50-180)	(0.1-1.3)	(0.7-1.0)	(2.0-2.7)	(1.6-2.2)	(9.7-15)
ICES 25	13	21	60	2.5	1.8	4.4	3.3	16
		(19-25)	(37-110)	(1.1-3.6)	(0.8-2.7)	(2.0-6.4)	(1.5-4.9)	(7.0-27)
ICES 26	7	22	67	4.1	3.0	6.9	5.2	21
		(19-22)	(41-77)	(2.0-5.1)	(1.5-3.8)	(3.4-9.0)	(2.7-6.8)	(8.3-29)
ICES 27	15	19	39	1.8	1.3	2.9	2.2	11
		(15-23)	(18-79)	(0.8-4.6)	(0.6-3.4)	(1.2-8.4)	(0.9-6.4)	(3.4-32)
ICES 28	15	19	42	2.5	1.8	4.3	3.3	12
		(16-20)	(26-52)	(1.2-3.4)	(0.8-2.6)	(1.9-6.4)	(1.4-5.0)	(6.3-20)
ICES 29	5	16	24	1.9	1.4	2.9	2.2	6.2
		(15-19)	(19-46)	(0.7-5.8)	(0.5-4.1)	(1.2-8.4)	(0.9-6.3)	(5.3-20)
ICES 30	19	19	46	5.7	4.0	8.2	6.0	24
		(16-21)	(27-56)	(2.6-9.0)	(1.9-6.4)	(3.8-13)	(2.9-9.4)	(11-45)
ICES 31	5	18	38	6.0	4.3	8.0	6.0	20
		(17-20)	(35-44)	(2.1-11)	(1.5-7.6)	(3.1-15)	(2.3-11)	(12-59)

The PCDD/F levels in salmon from the Baltic Sea varied between 2 and 7 pg TEQ<sup>2005</sup>/g f.w., ten of fourteen pooled samples exceeded the suggested ML. Salmon caught in the Bothnian Sea showed the highest levels (Figure 3). PCB levels in salmon from the Baltic Sea are high and the contribution of the dioxin-like PCBs to the sum TEQ of PCDD/Fs and PCBs is 60% which leads to exceeded ML for the PCDD/F-PCB sum in the majority of the samples from the Baltic Sea (Table 2).

<sup>1</sup> Sum of PCB 28, 52, 101, 138, 153 and 180.

All the pooled samples from Lake Vänern were below suggested ML for PCDD/Fs, the concentrations were between 2.1 and 3.3 pg TEQ<sup>2005</sup>/g f.w. Lake Vänern is also contaminated with PCBs and the contribution of dioxin-like PCBs to the sum TEQ of PCDD/Fs and PCBs in salmon from this area is about 50%. Two of four pooled samples exceeded the suggested ML for PCDD/F-PCB, these two samples are from the more contaminated northern part of the lake. The levels of the non dioxin-like PCBs were below suggested ML in all the analysed samples of salmon (Table 2).

**Table 2. Median (min-max) levels of PCDD/F and PCB in pooled samples of salmon from the Baltic Sea and Lake Vänern in Sweden caught in 2010. N indicates the number of pooled samples analysed per location. Salmon muscle with subcutaneous lipid scraped from the skin was analysed and the fat content of each pooled sample varied between 4 and 12 %.**

Location	N	Mean length (cm)	Mean weight (kg)	PCDD/F TEQ <sup>1998</sup> (pg/g)	PCDD/F TEQ <sup>2005</sup> (pg/g)	PCDD/F-PCB TEQ <sup>1998</sup> (pg/g)	PCDD/F-PCB TEQ <sup>2005</sup> (pg/g)	NDL-PCB <sup>2</sup> (ng/g)
Baltic Proper	3	88 (79-98)	5.5 (4.1-8.6)	3.1 (2.6-5.3)	2.4 (2.0-4.0)	8.4 (6.9-11)	6.7 (5.6-8.6)	36 (28-56)
Bothnian Sea	5	85 (74-99)	6.6 (4.3-11)	6.7 (5.1-9.8)	4.9 (3.8-7.0)	13 (11-17)	9.5 (8.0-12)	66 (48-107)
Bothnian Bay	6	87 (65-98)	6.8 (2.9-9.6)	4.9 (4.1-6.7)	3.7 (3.0-5.2)	11 (9.7-16)	8.7 (7.8-13)	51 (39-86)
Lake Vänern	4	78 (70-81)	5.4 (3.9-6.4)	3.1 (2.4-3.8)	2.7 (2.1-3.3)	7.1 (5.9-8.0)	5.9 (4.8-6.8)	43 (42-50)

Herring and salmon from the Baltic region show rather high concentrations of PCDD/Fs and dioxin-like PCBs, and particularly in fish caught in the Gulf of Bothnia where most of the analysed samples exceeded the current and new suggested MLs. The results confirm that the dietary recommendations set by the NFA to protect vulnerable groups from exceeding the daily intake of PCDD/Fs and PCBs are still important.

#### Acknowledgements:

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<sup>2</sup> Sum of PCB 28, 52, 101, 138, 153 and 180.