Sakrapport till Naturvårdsverkets Miljöövervakning:

Persistenta organiska miljöföroreningar i fisk från Östersjöregionen 2000-2002

Avtalsnr:	**1) 219 0216**	**2) 219 0308**
Utförare:	**Livsmedelsverket**	
Programområde:	**Miljögiftssamordning**	
Delprogram:	**1) Miljögifter i urban miljö**	**2) Screening**
Undersökningar/uppdrag:	**1) Mätningar av organiska miljögifter i fisk – analyser**	
	2) Mätningar av organiska miljögifter i fisk – utvärdering av resultaten	
	1. PCB:er (20 kongener, ej plana)	
	2. Plana PCB:er (non-orto, 4 kongener)	
	4. Klorerade pesticider (12 st)	
	5. PBDE (9 kongener) och HBCD	

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Report to the Swedish Environmental Protection Agency, 2004-01-23
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Persistent organic pollutants (POPs) in fish from the Baltic Sea, Sweden, 2000-2002.

Background

Polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/DFs) are still an environmental problem in Sweden, although the use and production of PCBs have been banned for decades and the release of PCDD/DFs have decreased significantly. In general, the concentrations in food have declined since the 1970s. However, in fish from some parts of the Baltic Sea, the decline of PCBs and PCDD/DFs appears to have ceased in the 1990s (Bignert, 2002).

For risk assessment purposes, the Swedish National Food Administration has conducted a fish survey 2000-2002 of levels of selected persistent organic pollutants (POPs), PCBs, PCDD/DFs and persistent pesticides, in fish from the Baltic Sea region. Also polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCD), ubiquitously used flame retardants, have been added to this list because of results suggesting the PBDE group as candidate for a new environmental hazard. The aim is to get relevant data to be used in the continuous evaluation of the dietary recommendations and to follow changes in the levels of these environmental contaminants in fish. The ambition is to use the data as a basis for intake estimations for human body burdens and compare with internationally established tolerable weekly intakes (TWI).

In addition, in November 2001, the European Commission (EC) published legislation aimed at achieving a reduction in human exposure to PCDD/DFs and PCBs (Council Regulation 2375/01/EC). One of the strategies to reduce the human exposure for PCDD/DFs and dioxin-like PCBs has been to set maximum levels for PCDD/DFs in foodstuffs. Sweden and Finland currently have a derogation from the Council regulation that allows national marketing of fish that exceed the maximum level for PCDD/DF. The legislation came into force from 1 July 2002. The Council Regulation also carries with it an obligation for Member States to monitor the levels of dioxin-like PCBs and PCDD/DFs in foodstuffs and to report the levels to the EC. These data will ultimately be used to both review the maximum limits and measure the effectiveness of the reduction strategy and set new maximum limits. For example, during 2004 the Commission is planning to set maximum levels for dioxin-like PCBs based on reported background levels from the member states.

The following report includes results from parts of the sampling carried out in the Baltic Sea area in 2000-2002. Only results of PCBs, persistent pesticides, PBDEs and HBCD are reported here. The corresponding PCDD/DF levels are reported on www.slv.se in three interim reports.

Methods and materials
The study contains results from analyses of eel (*Anguilla anguilla*; silver and yellow eel), brown trout (*Salmo trutta*), salmon (*Salmo salar*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*), whitefish (*Coregonus lavaretus*), vendace (*Coregonus albula*) and cod (*Gadus morhua*) from several locations in the Baltic Sea (Figure 1). All fish were caught in the autumn of 2000, 2001 or 2002. The sampling design was intended to cover areas in Sweden where fatty fish are caught on commercial basis as well as in areas where the public perform recreational fishing. Generally, analyses were carried out on muscle tissue except for herring and sprat where the muscle including fish skin was analysed, and for vendace where only the roe was examined. The analyses were carried out on pooled samples (see Table 1 for details). From all individuals were taken equal amounts of tissue (in weight) from the area around the dorsal fin. The tissue was pooled and thoroughly homogenised. All POP values are expressed in fresh weight.

Chemical analysis
Non-ortho PCBs
The non-ortho PBCs (PCB congeners 77, 81, 126 and 169) were analysed according to a validated method at Umeå University, Sweden. In brief, the samples were homogenised with acitvated sodium sulphate and extracted with mixtures of actone/n-hexane and n-hexane/diethyl ether. The lipids were removed by treatment with sulphuric acid and the extract was then fractionated on a carbon column. The samples were quantified by isotope dilution technique using gas chromatography (GC) coupled with high resolution mass spectroscopy (MS).

Chlorinated pesticides and ortho-PCBs. The analyses of the chlorinated pesticides hexachlorobenzene (HCB), hexachlorocyclohexane (α-, β-, and γ-HCHs), chlordane (oxychlordane, transnonchlor, α- and β-chlordane) and DDTs (*o,p'*-DDT, *p,p'*-DDT, *p,p'*-DDD and *p,p'*-DDE) as well as the ortho PCBs (PCB congeners 28, 31, 52, 66, 74, 101, 105, 110, 114, 118, 128, 138, 149, 153, 156, 157, 158, 167, 170 and 180) were performed according to a validated method at NFA, Uppsala, Sweden (Atuma et al 1996, Atuma et al 1999). The samples were extracted with mixtures of acetone/n-hexane and n-hexane/diethyl ether. After evaporation the lipid content was determined gravimetrically and the lipids were then removed by treatment with sulphuric acid. The PCBs were separated from most of the chlorinated pesticides by fractionation on a silica gel column. Finally, the samples were quantified on a GC equipped with dual capillary columns and dual electron capture detectors (ECD).

PBDEs and HBCD. The analyses of the PBDEs (PBDE congeners 28, 47, 66, 99, 100, 138, 153, 154 and 183) and HBCD were performed at NFA, Uppsala, Sweden. The same extraction and clean-up procedures as for the pesticides and ortho-PCBs were used except for a different fractionation on the silica gel column (Atuma et al 2000). The samples were quantified using GC-MS with negative chemical ionization (NCI).

Quality assurance. Both laboratories regularly participate in international inter-laboratory trials of measurements of the compounds of interest. In-house control samples were analysed together with the samples and blank analyses were performed carrying out the entire analytical procedure omitting only the sample. Internal standards were added to the samples before extraction and for the non-ortho PCB congeners ^{13}C-labelled standards were used.

Calculations and statistical analysis

67 samples were analysed for PCBs and pesticides and 61 for PBDEs and HBCD. The vendace roe and cod samples are only included in the tables but not in any further statistical evaluation of the material (the cod because of its much lower fat content and the roe because of not being muscle tissue). Results below the LOD (<LOD) were set equal to LOD in all calculations if not otherwise mentioned. The dioxin-like PCBs are expressed in pg WHO-TEQ/g fresh weight according to the WHO's toxicity equivalent factors (TEFs) for human risk assessment (van den Berg et al. 1998).

Spearman's rank correlation coefficients were calculated for the correlations between individual congeners, and between individual congeners and sum of congeners. The results from the correlation analysis were used to identify congeners that co-varied in the very heterogeneous fish material and to select single congeners in search for marker substances for concentrations of different POPs. When the correlation was higher than $r>0.80$, simple linear regression was performed to describe the strength of the regression (r^2-value). The regression equation was used to estimate the proportion between the substances in question. The level of significance was in all tests set to $P<0.001$.

Figure 1. Map over catching locations

Results and discussion

Table 1 gives a summary of basic data for the fish species in the study, i.e. gender, location caught, year caught, number of individuals in pooled sample, fat content in analysed tissue, age, weight and length. For brown trout and salmon, the reported age corresponds to the number of years spent in the sea (after two-three years as parr-smolt in the river). It is important to note that the concentration of environmental organic contaminants can vary considerably in individuals from the same location, depending on factors such as age, fat content, size, etc (e.g. Kiviranta et al., 2003). Earlier investigations have shown that POP levels in fish from a single location can vary from year to year and season to season (Bignert et al. 1994). The results presented in the report can therefore only be seen as representative of the sampling occasion in question.

The fat content of fatty fish can vary greatly from individual to individual, within the same species, 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 POP levels are expressed in e.g. pg WHO-TEQ/g fat, a 50% reduction of the fat content result in a doubling of the dioxin concentration in the fat. When POP levels are instead given on fresh weight basis, dioxin levels do not vary greatly, despite a 50% reduction in fat, since the persistent compounds will be accumulated in the remaining part of the fish fat. The levels of POPs in this report are expressed in fresh weight if not otherwise mentioned.

Table 3 shows the results from the analysis of 24 PCBs (N=67) in the pooled fish samples. The sum concentration (µg/kg fresh weight) of the congeners representing non-ortho PCBs (4), mono-ortho PCBs (10) and di-ortho PCBs (10) are given. See Table 2 for individual congeners. Also a sum for the 7 indicator PCBs (PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 and PCB 180) is given (ICES). Values below the limit of detection (LOD) were set equal to LOD in the calculations. LOD varied between the different congeners and species of fish (0.02-0.25 µg/kg fresh weight). In the analyses of the mono-ortho PCB congeners 105, 114, 156, 157 and 167, the samples were below LOD for 1.5, 75, 4.5, 25 and 1.5 % of the fish samples, respectively. Of the 67 analysed samples, 50 had one or more mono-ortho PCB congener that were below LOD. For mono-ortho PCBs, the median percentage increase after adjusting values below LOD from 0 to equal to LOD was 2,2 % (min=0.6%; max=363%, sample 25 - low levels in herring from Piteå archipelago). Eleven samples had an increase constituting of more than 10 % of the mono-ortho PCB. The corresponding values for sum PCBs was 0.4 % (min=0.1%; max 45.9%) of which seven samples had an increase constituting of more than 2 % of the sum PCB. The 7 indicator PCBs constitutes about 50 % of the sum PCB-levels. The group di-ortho PCBs constitutes with 62 % of the sum PCB-levels.

The Swedish maximum limit (ML) for PCB in foodstuffs of animal origin is expressed as the concentration of the congener PCB 153 (for fish, the ML in Sweden is set to 100 µg/kg fresh weight; SLV FS 1993:36, revised 1998:40). The reported PCB 153 levels in this study were all below the ML (min = 0.7 µg/kg fresh weight in a 3.4 year old pooled cod sample from the Baltic proper and max=53.6 µg/kg fresh weight in a 12 years old pooled male herring sample from Gotland). It is interesting to compare the concentration of PCB 153 with the concentration of sum PCB in the fish samples. Figure 2a shows that the dominating PCB congener 153 is highly and significantly correlated with sum PCB in the analysed fish samples ($r = 0.985$, Spearman, $p>0.001$) with an average contribution of 25 % (min 17 % and max 36 %) to sum PCB. Some European countries have set their national ML for PCBs based on the sum of 7 indicator PCBs. Also this correlation is highly significantly correlated with PCB 153 ($r = 0.994$, Spearman, $p>0.001$) (Figure 2b).

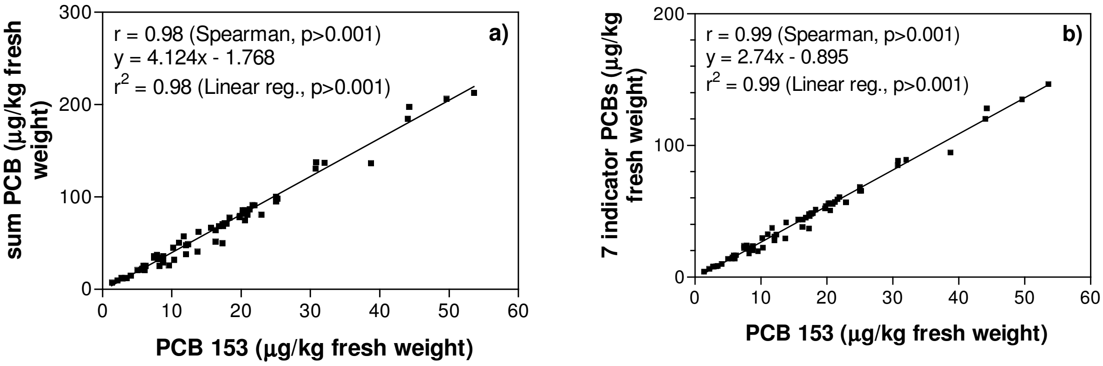


Figure 2a, b. Relationship between concentration of a) sum PCBs (sum of all 24 analysed congeners) and b) indicator PCBs (seven PCB congeners) in the fish samples and the concentration of PCB 153 (N = 65). The vendace roe and cod samples are not included in the correlation

Table 4 shows the results from the analysis of the 10 dioxin-like PCBs in the pooled fish samples (N=67). According to the WHO evaluations of TEF for human risk assessment, the 10 dioxin-like PCBs analysed were given individual TEF values and the TEQ were calculated (Table 2). The sum concentration (pg WHO-TEQ/g fresh weight) of the PCB-congeners analysed, representing non-ortho PCBs (4) and mono-ortho PCBs (6) is given in table 4. In the WHO evaluation, also dioxin-like PCBs 123 and 189 were given TEF values (0.0001) but these congeners were not analysed in the present study. Values below the LOD were set to equal LOD in the calculations. In the analyses of mono-ortho PCB congeners 105, 114, 156, 157 and 167, the samples were below LOD for 1.5, 75, 4.5, 25 and 1.5 % of the fish samples, respectively. Of the 67 samples analysed, 50 had one or more mono-ortho PCB congener that was below LOD. For mono-ortho PCB TEQs, the median percentage increase after adjusting values below LOD from 0 to equal to LOD was 7.6 % (min=3.1%; max=647%, sample 25 - herring Piteå). 21 samples had an increase constituting of more than 10 % to the mono-ortho PCB TEQ value. The corresponding values for sum PCB TEQs was 2.0 % (min=0.7; max =64.2) of which eight samples had an increase constituting of more than 10 % to the sum PCB TEQ.

The major contributing dioxin-like PCB congener to the sum dioxin-like PCBs is PCB 126. The contribution is on average 71 % (min 53 % and max 81 %) and the correlation is highly significantly correlated with the sum dioxin-like PCBs in the analysed fish samples (r = 0.99, Spearman, p>0.001) (Fig. 3a). Thus, despite the large variation in age, location caught and species in the fish material, the PCB126-TEQ vs. sum PCB-TEQ ratio is very consistent. A correlation analysis of sum dioxin-like PCB-TEQ (expressed in pg/g fresh weight) and the dominating non-dioxin like PCB 153 (expressed in µg/kg fresh weight) reveals a relatively strong correlation coefficient of r = 0.94 (Spearman, p>0.001) (Fig. 3b) with a ratio of

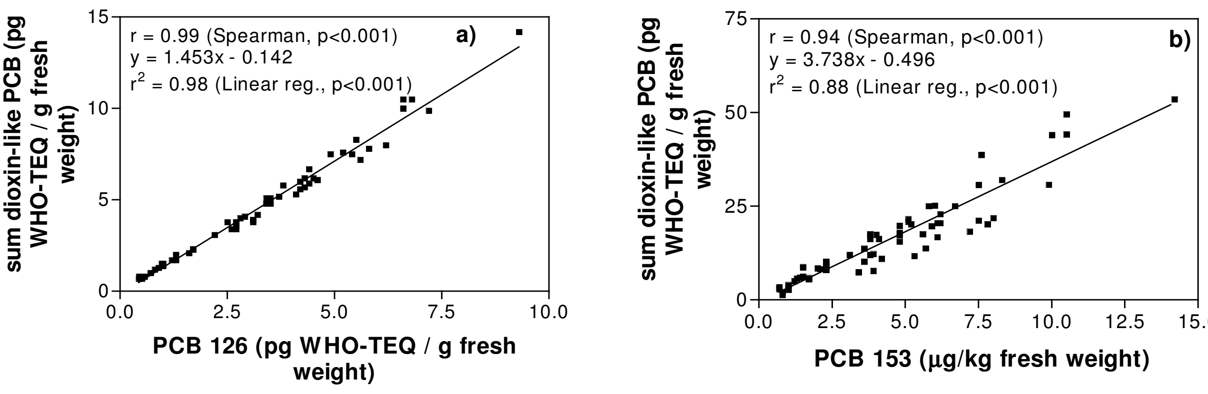
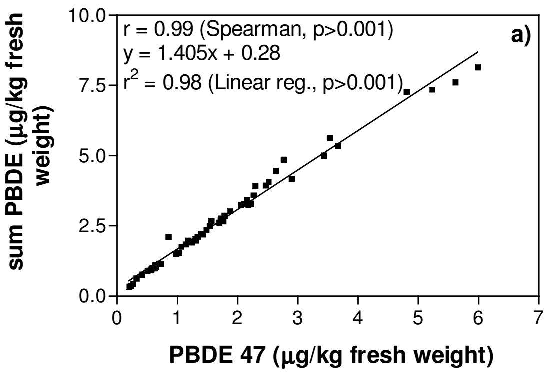


Figure 3a, b. Relationship between concentration of sum dioxin-like PCBs (sum of the 10 analysed dioxin-like PCB congeners) in the fish samples and the concentration of a) dioxin-like PCB 126 WHO-TEQ pg/g fresh weight and b) PCB 153 (N = 65). The vendace roe and cod samples are not included in the correlation

approximately ¼ (y = 3.738x – 0.496; please note the different labels on the axis).
The contribution of the dioxin-like PCBs to the total TEQ (i.e. including PCDD/DFs) is significant but shows also a large intra-species variation (data not shown). For example, for the 16 year old silver eel caught at the Västervik location (no. 5) the contribution from the dioxin-like PCBs to the total TEQ will be as high as 80 % while the corresponding contribution from the 4-6 year old herring caught at Piteå archipelago (no. 28) is only 34 % (PCDD/DF values taken from interim reports 2 and 3 on www.slv.se). A complete analysis and comparison of the dioxin-like PCB with PCDD/DFs will be reported elsewhere.

Table 5 shows the results from the analysis of brominated flame-retardants in fish muscle, fish muscle + skin and fish roe (µg/kg fresh weight) from 61 pooled fish samples. 9 PBDE congeners and HBCD were analysed. See Table 1 about details of the analysed fish samples and Table 2 for congener information. Values below the LOD were set equal to LOD in the calculations of mean PBDEs 47, 99 and 100, sum PBDE and HBCD. In the analyses of PBDE for congeners 28, 66, 99, 138, 153, 154 and 183, the percentage of samples below LOD were 26, 20, 3, 100, 15, 2 and 98 %, respectively. For sum PBDE, the median percentage increase after adjusting values below LOD from 0 to equal to LOD was 2.3 % (min = 0.6%; max = 44.1%). Eight samples had an increase constituting to more than 10 % of sum PBDE. For sum PBDEs, results are also presented as 1/2 LOD and 0 when <LOD. Sum PBDE, PBDE 47, PBDE 100 and HBCD are also expressed in µg/kg lipid weight. Please note that there are large differences in age within the species reported.

PBDE 47 is the major contributing congener to sum PBDE. The contribution is on average 62 % (min 40 % and max 74 %) and the correlation is highly and significantly correlated with the sum PBDEs in the analysed fish samples (r = 0.99, Spearman, p>0.001) (Figure 4a). In accordance with the analysis of the PCBs and the dioxin-like PCBs ratios, the PBDE 47 vs. sum PBDE ratio is very consistent, despite the documented large variation in age, location caught and species in the fish material. Further, a correlation analysis of PBDE 47 and the major PCB congener 153, reveals a relatively strong correlation coefficient of r = 0.90 (Spearman, p>0.001) (Figure 4b). The linear regression equation for PBDE 47 vs. PCB 153 (y = 8.382x + 2.201) indicate that the dominating flame-retardant congener level is approximately 10-fold lower compared to the dominating PCB congener, in the analysed fish samples. The corresponding ratio for sum PBDEs and sum PCBs is 1/25 (y = 25.339x – 0.7003; r^2 = 0.91; p<0.001). The PCB congener with the highest correlation coefficient to PBDE 47 was PCB 149 (r = 0.94, Spearman, p>0.001) with an approximate concentration ratio of 1/4 (y = 3.874x + 0.2887).



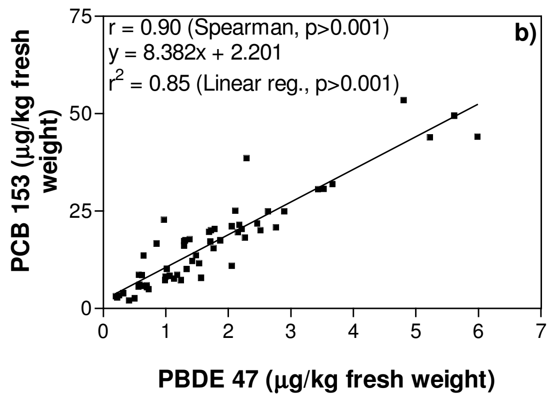


Figure 4a, b. Relationship between concentration of a) sum PBDEs (sum of all 9 analysed congeners) and b) PCB 153 in the fish samples and the concentration of PBDE 47 (N = 59). The vendace roe and cod samples are not included in the correlation. See Table 2 for congener information and Table 5 for sample information

The correlation of HBCD to the major flame retardant congener PBDE 47 is significant but only 60 % of the regression can be explained by PBDE 47 concentration (Figure 5a; average ratio = 0.75, min = 0.26, max = 1.79). The corresponding degree of explanation of HBCD regression by PCB 153 concentration is 40 % (Figure 5b; average ratio = 0.09, min = 0.02, max = 0.28).

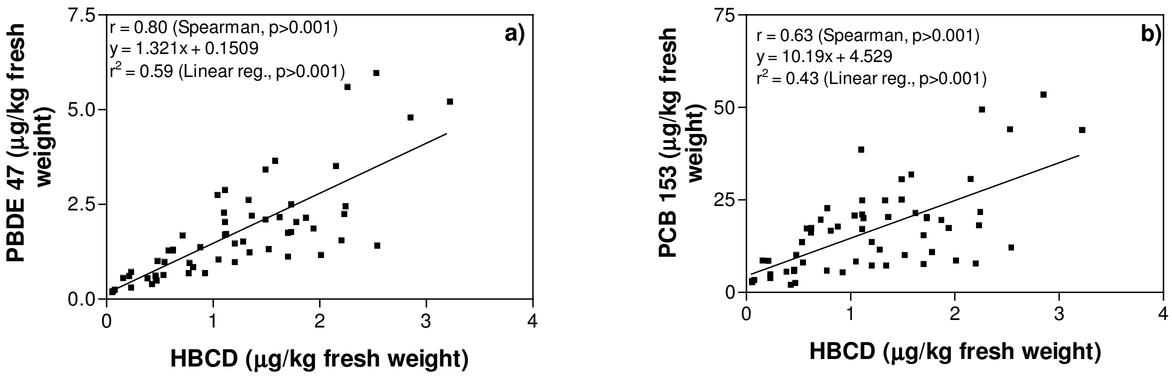


Figure 5a, b. Relationship between concentration of a) PBDE 47 and b) PCB 153 in the fish samples and the concentration of HBCD (N = 59). The cod and vendace roe samples are not included in the correlation. See Table 2 for congener information and Table 5 for sample information

Interestingly, HBCD was shown to have the highest correlation to PBDE 28 and PCB 28 (r = 0.89 and r = 0.86, respectively). The associations accounted for 76 and 74 % of the variation in HBCD concentration, respectively (r^2 = 0.76 and 0.74, respectively). We have no explanation to why the levels of PCB 28, or PBDE 28, may be especially good correlated to HBCD. It should however be noted that 26% of the PBDE 28 levels were below LOD which makes the PBDE 28 – HBCD correlation less reliable.

Table 6 shows the concentrations of chlorinated pesticides as HCB, sum HCHs, sum chlordanes and sumDDTs. The individual isomers included in the summed values are given in Table 2. Values below the LOD were set equal to LOD in the calculations. In the calculation of sum HCHs, 17 of 67 samples had one or more congener that were below LOD. For sum HCHs, the median percentage increase for these samples after adjusting values below LOD from 0 to equal to LOD was 112 % (min=33 %; max=168 %). For samples no. 7, 8 and 62 all HCH congeners were below LOD. β-HCH contributed with an average of 46 % to sum HCHs.

In the calculation of sum chlordanes, 50 of 67 samples had one or more isomer that were below LOD. For sum chlordanes, the median percentage increase for these samples after adjusting values below LOD from 0 to equal to LOD was 4.4 % (min=0.7 %; max=287 %). Six samples had an increase constituting of more than 10 % of the sum chlordanes. Trans nonachlor contributed with an average of 59 % to sum chlordanes.

In the calculation of sum DDTs, 53 of 67 samples had one or more isomers that were below LOD. For sum DDTs, the median percentage increase for these samples after adjusting values below LOD 0 to equal to LOD was 1.6 % (min=0.3 %; max=196 %). Four samples had an increase constituting of more than 10 % of the sum DDTs. p,p'-DDE contributed with an average of 69 % to sum DDTs.

Figure 6a shows that the dominating DDT metabolite, p,p'-DDE, is correlated with the dominating PCB congener 153 in the analysed fish samples ($r = 0.93$, Spearman, $p>0.001$). p,p'-DDE is approximately twice as high as PCB 153 ($y = 0.4212x + 2.802$, $p<0.001$). In contrast, the correlation of p,p'-DDE with β-HCH was low ($r = 0.38$) and only 14 % of the regression was explained by the β-HCH levels ($r^2 = 0.14$, linear regression; Fig. 6b).

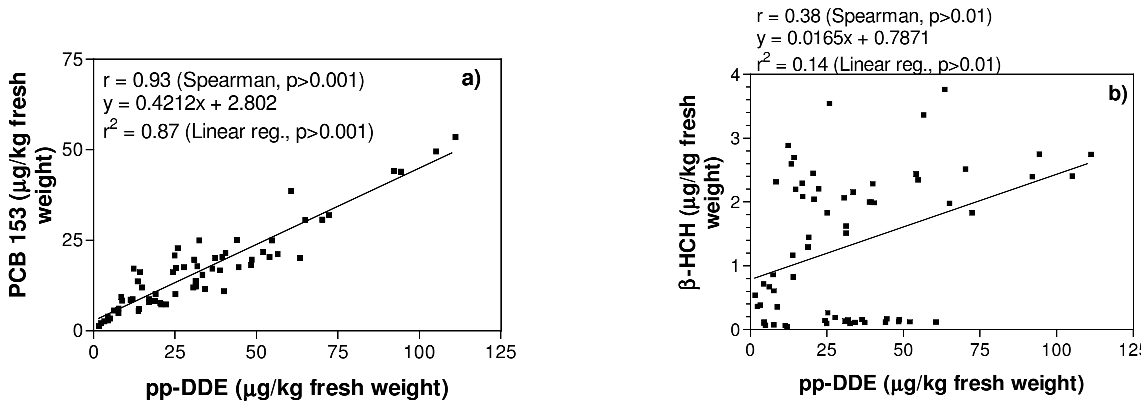


Figure 6a, b. Relationship between concentration of a) PCB 153 and b) β-HCH in the fish samples and the concentration of p,p'-DDE (N = 65). The vendace roe and cod samples are not included in the correlation. See Table 5 for sample information.

Conclusions

Among the presented POP levels, sum PCBs and sum DDTs are generally found in highest amount. The maximal sum PCB levels were found in herring from Västra Banken and from the waters SE of Gotland (above 200 µg/kg fresh weight), and regarding sum DDTs the highest levels were also observed in the Gotland herring, about 180 µg/kg fresh weight. In case of PCB there is a national maximum limit for PCB 153 in fish and fish products, specified to 100 µg/kg fresh weight. The PCB 153 levels in the fish in this report are at highest ca. 50 µg/kg fresh weight (herring from Västra Banken), thus half of the actual ML. However, PCB levels may vary considerably in different herring samples and levels as low as 1-2 µg/kg fresh weight could be found in e.g. Bothnian Bay herring. Second to herring, the highest PCB levels were found in Baltic salmon (max 50 µg/kg fresh weight).

Also in the case of dioxin-like PCBs (PCB TEQ), the levels in herring are the highest among the samples studied (10-15 pg/g fresh weight in herring from Bålsön, Västra Banken and SE of Gotland). Also in other fatty fish analysed, the PCB TEQ levels were considerably higher (max 6-8 pg/g fresh wt.) compared to the lean cod (one pooled sample; 0.3 pg/g fresh wt.). Regarding the brominated flame retardants the absolute levels are considerably lower than those found for sum PCB and sum DDT. Maximum levels of sum PBDEs and HCBD are found in herring from the same spots as previous mentioned, i.e. Västra Banken, Bålsön and

SE of Gotland. In many cases, the levels of sum PBDEs are 2-3 times those of HBCD in the same sample.

Despite the large variation in age, location caught and species in the fish material, the major POPs analysed and statistically evaluated in this fish material seem to correlate with each other to a large extent. It is indicated by the generally high correlation coefficients revealed in the statistical analysis. This in turn indicate that the exposure pattern for the POPs analysed, generally spoken, is relatively similar in this study. However, as illustrated in fig 6b with β-HCH and pp-DDE and to some extent valid also for HBCD, there are POPs that do not to correlate as well as others.

It should be pointed out that the simple statistical methods used in this report, do not necessarily detect and evaluate all existing differences in the material. A more thorough analysis, using e.g. multivariate statistical methods, of the material will be performed when complementary analysis have been done and the number of individuals are increased. When this analysis is performed, we hope to be able to explain more in detail similarities and discrepancies in the material.

The present report contain relatively detailed information about the samples analysed. However, it is therefore difficult to compare the present results with previous results, since the latter often are pooled samples with limited background information on including individuals.

Acknowledgements

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Table 1. Background data for the fish analysed. See also Figure 1 regarding location caught. NA = not analysed; f = female; m= male, Y = yellow eel; S = silver eel

No.	Species (gender)	Location caught (year caught)	Number of ind. in pool	Fat content (%)	Age (year)				Weight (g)				Length (mm)			
					mean	median	min	max	mean	median	min	max	mean	median	min	max
1	Eel, Y (f)	Kvädöfjärden (2000)	19	13,5	NA	NA	NA	NA	339	322	220	641	572	570	490	730
2	Eel, Y (f)	Marsö (2000)	21	17,1	NA	NA	NA	NA	369	352	208	527	571	560	490	670
3	Eel, Y (f)	Sturkö (2000)	20	14,1	NA	NA	NA	NA	360	348	250	538	576	575	520	630
4	Eel, Y (f)	Valjeviken (2000)	20	18,7	NA	NA	NA	NA	391	373	290	636	569	565	500	640
5	Eel, S (f)	Västervik (2001)	20	24,0	16,1	16,5	11	22	1088	1023	885	1500	792	790	715	870
6	Eel, S (f)	Karlshamn (2001)	10	19,6	10,3	9	7	20	661	646	526	823	654	658	580	730
7	B. trout (m)	R. Luleälven (2001)	5	2,7	3	3	2	4	3642	3960	1952	4697	684	705	580	745
8	B. trout (f)	R. Luleälven (2001)	5	2,9	3,8	3	3	6	2890	2870	1996	4036	722	750	610	795
9	B. trout (m)	R. Ång.älven (2001)	5	3,9	2,5	2,5	2	3	4100	4176	3617	4432	710	710	700	720
10	B. trout (f)	R. Ång.älven (2001)	5	4,4	2,2	2	2	3	3067	3010	2000	3593	671	685	20	700
11	B. trout (m)	R. Dalälven (2001)	4	4,1	1,25	1	1	2	3525	2500	1600	7500	645	613	550	805
12	B. trout (f)	R. Dalälven (2001)	4	3,3	1,75	1,5	1	3	2950	3000	2100	3700	635	635	580	690
13	B. trout (m)	R. Mörrumsån (2001)	5	3,0	2,6	2	2	4	7620	6700	4800	10500	865	840	760	985
14	B. trout (f)	R. Mörrumsån (2001)	5	3,3	2,2	2	2	3	5880	5800	4600	7200	785	780	730	850
15	Salmon (m)	R. Luleälven (2001)	5	2,9	1,2	1	1	2	3426	3437	2632	4666	706	690	655	780
16	Salmon (f)	R. Luleälven (2001)	5	3,4	1,8	2	1	2	6462	6364	4663	7956	868	885	755	920
17	Salmon (m)	R. Ång.älven (2001)	5	2,5	1,4	1	1	2	4547	4374	3733	5569	791	770	750	860
18	Salmon (f)	R. Ång.älven (2001)	5	3,3	2	2	2	2	6039	6249	5493	6645	854	865	830	870
19	Salmon (m)	R. Dalälven (2001)	5	4,0	1,6	1	1	3	4760	4000	1900	9800	762	720	610	995
20	Salmon (f)	R. Dalälven (2001)	5	3,9	1,4	1	1	2	3800	3700	2000	5700	724	700	600	855
21	Salmon (f)	N. of Gotland (2000)	5	9,5	1	1	1	1	3950	4188	3328	4503	705	715	660	720
22	Salmon (m)	N. of Gotland (2000)	5	11,5	1	1	1	1	3840	3871	2945	4561	698	700	620	760
23	Salmon (m)	R. Mörrumsån (2001)	5	3,2	2	2	2	2	8060	9100	2000	11400	952	1015	625	1090
24	Salmon (f)	R. Mörrumsån (2001)	5	2,7	2,2	2	2	3	8500	7800	7200	11400	961	940	920	1050
25	Herring (mix)	Piteå archipelago (2001)	7	5,9	1	1	1	1	18	17	15	25	141	136	133	162
26	Herring (m)	Piteå archipelago (2001)	14	5,5	2,5	2,5	2	3	25	25	20	31	157	156	145	168
27	Herring (f)	Piteå archipelago (2001)	14	5,0	2,5	2,5	2	3	24	24	21	27	156	156	150	164
28	Herring (mix)	Piteå archipelago (2001)	6	4,6	5	5	4	6	32	31	28	37	175	176	167	182
29	Herring (m)	Ångermanälven (2001)	15	4,5	2,5	3,00	2,00	3,00	27	27	18	38	162	167	143	186
30	Herring (f)	Ångermanälven (2001)	15	4,7	2,5	3,00	2,00	3,00	25	24	15	37	159	163	135	177
31	Herring (m)	Ångermanälven (2001)	10	5,7	4,5	4,50	4,00	5,00	33	33	27	41	175	175	164	183
32	Herring (f)	Ångermanälven (2001)	10	3,7	4,5	4,50	4,00	5,00	35	35	29	41	182	185	174	188
33	Herring (m)	Bålsön (2001)	9	10,9	5	5	4,0	6,0	55	44	29	124	201	193	172	264
34	Herring (f)	Bålsön (2001)	9	11,1	5	5	4,0	6,0	62	43	29	109	209	193	169	256
35	Herring (m)	Bålsön (2001)	6	15,5	8	8	7,0	9,0	98	105	60	118	245	249	218	257
36	Herring (f)	Bålsön (2001)	6	14,3	8	8	7,0	9,0	98	101	74	117	246	249	222	270
37	Herring (m)	Västra Banken (2001)	10	14,2	5,5	5,5	5	6	92	92	74	124	240	238	226	270
38	Herring (f)	Västra Banken (2001)	8	10,9	5,5	5,5	5	6	86	86	70	96	239	243	215	252
39	Herring (m)	Västra Banken (2001)	9	13,3	8	8	7	9	93	87	74	125	245	240	226	273

40	Herring (f)	Västra Banken (2001)	9	11,5	8	8	7	9	87	86	73	105	238	234	224	265
41	Herring (m)	Landsort (2000)	9	9,0	5	5	4,0	6,0	40	40	32	46	179	180	170	200
42	Herring (f)	Landsort (2000)	9	7,8	5	5	4,0	6,0	40	39	35	43	183	180	175	195
43	Herring (m)	Landsort (2000)	8	11,0	7,9	8,0	7,0	9,0	114	115	85	158	241	240	215	270
44	Herring (f)	Landsort (2000)	6	9,6	7,8	8,0	7,0	9,0	86	88	61	107	223	225	200	240
45	Herring (m)	SE Gotland (2000)	9	7,3	5	5	4	6	32	34	27	38	170	175	160	180
46	Herring (f)	SE Gotland (2000)	9	8,0	5	5	4	6	33	32	27	45	175	170	165	195
47	Herring (m)	SE Gotland (2000)	8	13,3	7,9	8,0	7,0	9,0	111	108	95	134	234	230	220	260
48	Herring (f)	SE Gotland (2000)	8	15,4	8	8	7,0	9,0	119	110	81	201	243	238	220	285
49	Herring (m)	SE Gotland (2000)	4	11,5	12,3	12,0	12,0	13,0	234	212	147	365	300	303	255	340
50	Herring (f)	SE Gotland (2000)	4	11,1	12,3	12,0	12,0	13,0	175	157	126	260	281	278	265	305
51	Herring (m)	Utlängan (2000)	9	3,8	5	5	4,0	6,0	41	42	33	47	184	185	170	200
52	Herring (f)	Utlängan (2000)	9	5,3	5	5	4,0	6,0	41	36	33	57	181	180	165	205
53	Herring (m)	Utlängan (2000)	6	6,5	7,3	7,0	7	9	89	90	68	107	225	225	215	235
54	Herring (f)	Utlängan (2000)	5	5,8	7,6	7,0	7	9	98	95	74	140	236	235	74	140
55	Herring (m)	W Bornholm (2002)	10	11,2	3,5	3,5	3	4	103	101	83	125	238	241	220	252
56	Herring (f)	W Bornholm (2002)	10	9,5	3,5	3,5	3	4	88	87	73	103	231	231	220	242
57	Sprat (mix)	W Bornholm (2002)	14	7,1	4,9	5	4	7	21	21	16	26	146	146	133	154
58	Sprat (mix)	W Bornholm (2002)	16	10,6	2,5	2,5	2	3	18	18	13	24	138	137	124	150
59	Sprat (mix)	E Gotland (2002)	22	9,1	5,0	5	2	8	9	9	8	11	118	118	110	125
60	Whitefish (m)	R. Luleälven (2001)	5	1,4	5,2	5	4	6	409	422	305	468	358	370	320	370
61	Whitefish (f)	R. Luleälven (2001)	5	1,7	4,6	4	4	7	509	557	400	610	375	390	335	395
62	Whitefish (m)	R. Ång.älven (2001)	10	1,0	4,3	4	3	5	290	289	258	328	349	350	320	375
63	Whitefish (f)	R. Ång.älven (2001)	7	1,2	4,9	5	3	6	379	271	255	730	373	365	330	440
64	Whitefish (m)	Öregrundsgrepen (2001)	7	1,2	4,3	4	3	6	314	278	261	391	339	330	305	370
65	Whitefish (f)	Öregrundsgrepen (2001)	10	1,2	4,3	4	3	6	358	304	223	782	346	338	300	420
66	Vendace (f) (1	Luleå archipelago (2001)	74	12,2	NA	NA	NA	NA	22	22	14	35,7	146	146	125	173
67	Cod (mix)	Baltic proper (2002)	11	0,6	3,4	3	3	5	1224	1016	786	2640	450	430	395	620

[1] Only roe analysed from vendace

Table 2. Congeners of different POPs analysed in the fish samples. For the dioxin-like PCBs analysed in this study, the WHO-TEF values for human risk assessment is given.

PCBs			**Flame retardants**	**Sum DDTs**	**Sum HCHs**	**Sum Chlordanes**
Non-ortho PCBs	***TEF value***	***Di/tri-ortho PCBs***	***Sum PBDEs***	o,p'-DDE	α-HCH	Oxy-chlordan
				p,p'-DDD	β-HCH	α -chlordan
				o,p'-DDT	γ-HCH	γ -chlordan
PCB 77	0.0001	PCB 52	PBDE 28	p,p'-DDT		Trans-nonachlor
PCB 81	0.0001	PCB 101	PBDE 47			
PCB 126	0.1	PCB 110	PBDE 66			
PCB 169	0.01	PCB 128	PBDE 99			
		PCB 138	PBDE 100			
Mono-ortho PCBs[1]		PCB 149	PBDE 138			
PCB 28	-	PCB 153	PBDE 153			
PCB 31	-	PCB 158	PBDE 154			
PCB 66	-	PCB 170	PBDE 183			
PCB 74	-	PCB 180				
PCB 105	0.0001		***HBCD***			
PCB 114	0.0005					
PCB 118	0.0001					
PCB 156	0.0005					
PCB 157	0.0005					
PCB 167	0.00001					

[1] The congeners PCB 123 and 189 have TEF factors but are not analysed

Table 3. Concentrations of PCB congeners in fish muscle, fish muscle + skin and fish roe (µg/g fresh weight) from 67 pooled fish samples caught along the Swedish east and south coast. Values below LOD were set equal to LOD in all calculations. Please note that there are large differences in age within the species reported. See Table 1 about details for the analysed fish samples and Table 2 for congener information. f = female; m= male, Y = yellow eel; S = silver eel.

No.	Species (gender)	Location caught	Non-ortho PCBs (µg/kg fw)	Mono-ortho PCBs (µg/kg fw)	Di-ortho PCBs (µg/kg fw)	Sum PCBs (µg/kg fw)	PCB 153 (µg/kg fw)	7 indicator PCBs (µg/kg fw)	% di-ortho PCBs of sum PCBs
1	Eel, Y (f)	Kvädöfjärden (2000)	0,027	7,9	30,2	38,2	12,0	27,9	79
2	Eel, Y (f)	Marsö (2000)	0,036	11,5	40,3	51,8	16,3	38,3	78
3	Eel, Y (f)	Sturkö (2000)	0,021	5,2	21,0	26,2	9,6	19,7	80
4	Eel, Y (f)	Valjeviken (2000)	0,032	9,4	40,7	50,2	17,3	37,0	81
5	Eel, S (f)	Västervik (2001)	0,055	19,5	61,6	81,2	22,9	56,9	76
6	Eel, S (f)	Karlshamn (2001)	0,034	8,1	33,0	41,2	13,7	29,4	80
7	B. trout (m)	R. Luleälven (2001)	0,072	13,5	67,5	81,1	20,9	55,5	83
8	B. trout (f)	R. Luleälven (2001)	0,079	16,4	84,3	100,7	25,0	68,6	84
9	B. trout (m)	R. Ång.älven (2001)	0,071	10,3	53,9	64,3	16,3	43,7	84
10	B. trout (f)	R. Ång.älven (2001)	0,089	13,1	66,8	79,9	19,8	54,0	84
11	B. trout (m)	R. Dalälven (2001)	0,071	11,1	57,7	68,9	17,4	46,6	84
12	B. trout (f)	R. Dalälven (2001)	0,061	11,9	59,7	71,7	17,6	48,5	83
13	B. trout (m)	R. Mörrumsån (2001)	0,137	14,9	63,4	78,4	19,7	52,2	81
14	B. trout (f)	R. Mörrumsån (2001)	0,134	14,0	57,7	71,8	17,6	48,0	80
15	Salmon (m)	R. Luleälven (2001)	0,139	11,6	45,8	57,5	11,7	37,6	80
16	Salmon (f)	R. Luleälven (2001)	0,148	21,6	115,1	136,8	38,7	94,7	84
17	Salmon (m)	R. Ång.älven (2001)	0,104	13,7	68,2	82,0	20,2	55,6	83
18	Salmon (f)	R. Ång.älven (2001)	0,122	17,4	80,8	98,4	25,2	65,5	82
19	Salmon (m)	R. Dalälven (2001)	0,117	12,8	57,8	70,7	17,3	48,0	82
20	Salmon (f)	R. Dalälven (2001)	0,108	12,6	58,6	71,3	17,9	48,5	82
21	Salmon (f)	N. of Gotland (2000)	0,152	13,3	49,0	62,4	13,8	41,5	78
22	Salmon (m)	N. of Gotland (2000)	0,157	13,8	54,6	68,6	16,8	45,2	80
23	Salmon (m)	R. Mörrumsån (2001)	0,188	16,2	61,6	77,9	18,3	51,4	79
24	Salmon (f)	R. Mörrumsån (2001)	0,195	18,2	72,8	91,2	21,9	60,9	80
25	Herring (mix)	Piteå archipelago (2001)	0,016	2,3	5,3	7,7	1,3	4,2	70
26	Herring (m)	Piteå archipelago (2001)	0,021	2,4	10,1	12,5	2,7	8,1	81
27	Herring (f)	Piteå archipelago (2001)	0,017	2,0	8,0	9,9	2,1	6,4	80
28	Herring (mix)	Piteå archipelago (2001)	0,036	6,1	28,5	34,6	8,5	22,6	82
29	Herring (m)	Ångermanälven (2001)	0,024	3,7	19,0	22,7	5,7	15,0	84
30	Herring (f)	Ångermanälven (2001)	0,021	2,5	12,6	15,1	4,0	10,1	83
31	Herring (m)	Ångermanälven (2001)	0,034	4,5	21,0	25,5	5,9	16,6	82
32	Herring (f)	Ångermanälven (2001)	0,026	4,5	21,2	25,7	6,2	16,8	82
33	Herring (m)	Bålsön (2001)	0,091	16,9	74,3	91,3	21,6	59,3	81
34	Herring (f)	Bålsön (2001)	0,111	16,5	69,3	86,0	20,5	56,2	81
35	Herring (m)	Bålsön (2001)	0,169	33,7	151,2	185,1	44,0	120,2	82
36	Herring (f)	Bålsön (2001)	0,173	26,9	110,8	137,9	30,8	88,6	80
37	Herring (m)	Västra Banken (2001)	0,163	37,3	160,5	197,9	44,2	128,2	81
38	Herring (f)	Västra Banken (2001)	0,127	26,9	110,3	137,4	32,0	89,2	80
39	Herring (m)	Västra Banken (2001)	0,159	37,4	168,9	206,5	49,6	135,1	82
40	Herring (f)	Västra Banken (2001)	0,120	25,3	105,6	131,1	30,7	85,1	81
41	Herring (m)	Landsort (2000)	0,100	13,1	53,6	66,8	15,6	43,9	80
42	Herring (f)	Landsort (2000)	0,089	9,2	36,1	45,3	10,2	29,8	80
43	Herring (m)	Landsort (2000)	0,112	15,0	59,9	75,0	20,5	50,7	80
44	Herring (f)	Landsort (2000)	0,097	10,2	40,2	50,5	11,0	32,8	80
45	Herring (m)	SE Gotland (2000)	0,086	7,0	27,4	34,5	7,4	22,3	79
46	Herring (f)	SE Gotland (2000)	0,084	8,2	27,9	36,1	7,4	23,9	77
47	Herring (m)	SE Gotland (2000)	0,124	19,4	67,2	86,8	21,2	57,2	77
48	Herring (f)	SE Gotland (2000)	0,149	19,3	66,5	85,9	20,2	56,3	77
49	Herring (m)	SE Gotland (2000)	0,193	42,0	170,8	213,0	53,6	146,7	80
50	Herring (f)	SE Gotland (2000)	0,098	19,9	75,5	95,4	25,0	65,8	79
51	Herring (m)	Utlängan (2000)	0,030	3,6	17,6	21,1	6,1	14,1	83
52	Herring (f)	Utlängan (2000)	0,040	4,0	17,5	21,4	5,6	14,1	81
53	Herring (m)	Utlängan (2000)	0,040	5,1	27,1	32,2	10,3	22,4	84
54	Herring (f)	Utlängan (2000)	0,041	4,3	21,3	25,7	8,2	18,0	83
55	Herring (m)	W Bornholm (2002)	0,069	6,4	26,7	33,2	8,0	21,6	81
56	Herring (f)	W Bornholm (2002)	0,069	6,6	29,5	36,2	8,8	23,6	82
57	Sprat (mix)	W Bornholm (2002)	0,127	8,3	40,5	49,0	12,3	32,4	83
58	Sprat (mix)	W Bornholm (2002)	0,138	8,3	39,5	48,0	12,0	31,1	82

59	Sprat (mix)	E Gotland (2002)	0,117	8,0	29,5	37,6	7,8	24,3	78
60	Whitefish (m)	R. Luleälven (2001)	0,011	2,1	10,3	12,3	3,4	8,5	83
61	Whitefish (f)	R. Luleälven (2001)	0,022	3,7	17,4	21,1	5,0	14,1	82
62	Whitefish (m)	R. Ång.älven (2001)	0,021	4,8	24,5	29,3	8,8	20,5	84
63	Whitefish (f)	R. Ång.älven (2001)	0,022	4,9	25,2	30,2	8,7	21,1	84
64	Whitefish m)	Öregrundsgrepen (2001)	0,013	2,1	9,9	12,1	2,9	8,0	82
65	Whitefish (f)	Öregrundsgrepen (2001)	0,011	2,1	10,4	12,5	3,2	8,4	83
66	Vendace roe	Luleå archipelago (2001)	0,040	2,9	12,8	15,8	3,6	10,2	81
67	Cod (mix)	Baltic proper (2002)	0,005	0,6	2,1	2,8	0,7	1,8	77

Table 4. Concentrations of dioxin-like PCB congeners (pg/g fresh weight) in fish muscle, fish muscle + skin and fish roe from 67 pooled fish samples caught along the Swedish east and south coast. Values below LOD were set equal to LOD in all calculations. Please note that there are large differences in age within the species reported. See Table 1 about details for the analysed fish samples and Table 2 for congener information. f = female; m= male, Y = yellow eel; S = silver eel.

No.	Species (gender)	Location caught	Non-ortho PCB-TEQ (pg/g fw)	Mono-ortho PCB-TEQ (pg/g fw)	Sum PCB-TEQ (pg/g fw)	PCB 126 TEQ (pg/g fw)	PCB 118 TEQ (pg/g fw)	% non ortho-TEQ of sum PCB-TEQ
1	Eel, Y (f)	Kvädöfjärden (2000)	2,2	0,9	3,1	2,2	0,4	72
2	Eel, Y (f)	Marsö (2000)	2,9	1,2	4,1	2,9	0,6	71
3	Eel, Y (f)	Sturkö (2000)	1,7	0,6	2,3	1,7	0,3	74
4	Eel, Y (f)	Valjeviken (2000)	2,7	1,0	3,8	2,7	0,5	73
5	Eel, S (f)	Västervik (2001)	4,4	1,8	6,2	4,3	0,9	71
6	Eel, S (f)	Karlshamn (2001)	2,7	0,8	3,6	2,7	0,4	76
7	B. trout (m)	R. Luleälven (2001)	3,6	1,5	5,1	3,5	0,7	71
8	B. trout (f)	R. Luleälven (2001)	4,0	1,8	5,8	3,8	0,8	69
9	B. trout (m)	R. Ång.älven (2001)	2,8	1,0	3,8	2,7	0,5	73
10	B. trout (f)	R. Ång.älven (2001)	3,5	1,3	4,8	3,4	0,6	73
11	B. trout (m)	R. Dalälven (2001)	2,9	1,1	4,0	2,8	0,5	72
12	B. trout (f)	R. Dalälven (2001)	2,6	1,2	3,8	2,5	0,6	69
13	B. trout (m)	R. Mörrumsån (2001)	4,5	1,4	5,9	4,4	0,7	76
14	B. trout (f)	R. Mörrumsån (2001)	4,3	1,3	5,6	4,2	0,6	76
15	Salmon (m)	R. Luleälven (2001)	4,2	1,1	5,3	4,1	0,6	79
16	Salmon (f)	R. Luleälven (2001)	5,4	2,2	7,6	5,2	1,0	71
17	Salmon (m)	R. Ång.älven (2001)	3,8	1,4	5,2	3,7	0,7	74
18	Salmon (f)	R. Ång.älven (2001)	4,3	1,7	6,0	4,2	0,8	72
19	Salmon (m)	R. Dalälven (2001)	3,6	1,2	4,8	3,5	0,6	74
20	Salmon (f)	R. Dalälven (2001)	3,6	1,2	4,8	3,5	0,6	75
21	Salmon (f)	N. of Gotland (2000)	4,4	1,3	5,7	4,3	0,6	77
22	Salmon (m)	N. of Gotland (2000)	4,7	1,4	6,1	4,6	0,6	77
23	Salmon (m)	R. Mörrumsån (2001)	5,7	1,5	7,2	5,6	0,7	79
24	Salmon (f)	R. Mörrumsån (2001)	6,3	1,7	8,0	6,2	0,8	79
25	Herring mix)	Piteå archipelago (2001)	0,5	0,4	0,8	0,44	0,0	55
26	Herring (m)	Piteå archipelago (2001)	0,7	0,3	1,0	0,71	0,1	72
27	Herring (f)	Piteå archipelago (2001)	0,6	0,2	0,8	0,57	0,1	70
28	Herring mix)	Piteå archipelago (2001)	1,4	0,6	2,0	1,3	0,3	68
29	Herring (m)	Ångermanälven (2001)	0,9	0,4	1,3	0,9	0,2	70
30	Herring (f)	Ångermanälven (2001)	0,7	0,3	1,0	0,71	0,1	71
31	Herring (m)	Ångermanälven (2001)	1,2	0,5	1,7	1,2	0,2	73
32	Herring (f)	Ångermanälven (2001)	1,0	0,5	1,5	0,97	0,2	68
33	Herring (m)	Bålsön (2001)	3,5	1,6	5,1	3,4	0,8	69

34	Herring (f)	Bålsön (2001)	4,6	1,5	6,2	4,5	0,8	75
35	Herring (m)	Bålsön (2001)	6,9	3,2	10,0	6,6	1,5	68
36	Herring (f)	Bålsön (2001)	7,5	2,4	9,9	7,2	1,2	75
37	Herring (m)	Västra Banken (2001)	7,1	3,5	10,5	6,8	1,7	67
38	Herring (f)	Västra Banken (2001)	5,8	2,5	8,3	5,5	1,2	70
39	Herring (m)	Västra Banken (2001)	6,9	3,6	10,5	6,6	1,7	66
40	Herring (f)	Västra Banken (2001)	5,1	2,3	7,5	4,9	1,1	69
41	Herring (m)	Landsort (2000)	3,5	1,3	4,8	3,4	0,6	74
42	Herring (f)	Landsort (2000)	2,8	0,8	3,6	2,7	0,4	77
43	Herring (m)	Landsort (2000)	4,7	1,4	6,1	4,6	0,7	77
44	Herring (f)	Landsort (2000)	3,3	0,9	4,2	3,2	0,5	78
45	Herring (m)	SE Gotland (2000)	2,8	0,6	3,4	2,7	0,3	81
46	Herring (f)	SE Gotland (2000)	2,7	0,8	3,4	2,6	0,4	78
47	Herring (m)	SE Gotland (2000)	5,6	1,9	7,5	5,4	1,0	74
48	Herring (f)	SE Gotland (2000)	6,0	1,9	7,8	5,8	1,0	76
49	Herring (m)	SE Gotland (2000)	9,7	4,5	14,2	9,3	2,2	68
50	Herring (f)	SE Gotland (2000)	4,6	2,1	6,7	4,4	1,0	69
51	Herring (m)	Utlängan (2000)	1,0	0,4	1,4	1	0,2	74
52	Herring (f)	Utlängan (2000)	1,3	0,4	1,7	1,3	0,2	78
53	Herring (m)	Utlängan (2000)	1,8	0,6	2,3	1,7	0,2	76
54	Herring (f)	Utlängan (2000)	1,7	0,5	2,1	1,6	0,2	78
55	Herring (m)	W Bornholm (2002)	1,7	0,5	2,3	1,7	0,3	77
56	Herring (f)	W Bornholm (2002)	1,7	0,5	2,3	1,7	0,3	76
57	Sprat (mix)	W Bornholm (2002)	3,2	0,7	3,9	3,1	0,4	81
58	Sprat (mix)	W Bornholm (2002)	3,2	0,7	3,8	3,1	0,4	82
59	Sprat (mix)	E Gotland (2002)	3,2	0,7	3,9	3,1	0,4	81
60	Whitefish m)	R. Luleälven (2001)	0,4	0,2	0,7	0,4	0,1	66
61	Whitefish (f)	R. Luleälven (2001)	0,8	0,4	1,2	0,8	0,2	68
62	Whitefish m)	R. Ång.älven (2001)	1,0	0,5	1,5	1,0	0,2	67
63	Whitefish (f)	R. Ång.älven (2001)	1,0	0,5	1,5	1,0	0,2	67
64	Whitefish(m	Öregrundsgrepen (2001)	0,5	0,2	0,7	0,5	0,1	70
65	Whitefish (f)	Öregrundsgrepen (2001)	0,5	0,2	0,7	0,4	0,1	68
66	Vendace roe	Luleå archipelago (2001)	1,1	0,3	1,4	1,1	0,12	79
67	Cod (mix)	Baltic proper (2002)	0,2	0,1	0,3	0,21	0,03	75

Table 5. Concentrations of 9 PBDE congeners and HBCD in fish muscle, fish muscle + skin and fish roe (µg/kg fresh weight) from 61 pooled fish samples caught along the Swedish east and south coast. Values below LOD were set equal to LOD in the calculations of mean and sum PBDE. For sum PBDEs, the results is also presented when <LOD were set to 1/2 LOD and 0. For sum PBDEs, PBDE 47, PBDE 100 and HBCD the results are also expressed in µg/kg lipid weight. Please note that there are large differences in age within the species reported. See Table 1 for details of the analysed fish samples and Table 2 for congener information. f = female; m= male. NA= Not Analysed

			FRESH EIGHT (µg/ kg)							**LIPID WEIGHT (µg/ kg)**			
			<LOD = LOD					**<LOD = 1/2 LOD**	**<LOD = 0**	**<LOD = LOD**			
No.	Species (gender)	Location caught (year caught)	Sum PBDEs	PBDE 47	PBDE 99	PBDE 100	HBCD	Sum PBDEs	Sum PBDEs	Sum PBDEs	PBDE 47	PBDE 100	HBCD
1	Eel, Y (f)	Kvädöfjärden (2000)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	Eel, Y (f)	Marsö (2000)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	Eel, Y (f)	Sturkö (2000)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Eel, Y (f)	Valjeviken (2000)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	Eel, S (f)	Västervik (2001)	1,52	0,966	0,025	0,3	0,78	1,47	1,42	6,3	4,0	1,3	3,2
6	Eel, S (f)	Karlshamn (2001)	1,05	0,645	0,056	0,172	0,53	1,00	0,95	5,3	3,2	0,9	2,7
7	B. trout (m)	R. Luleälven (2001)	4,87	2,76	0,878	0,669	1,04	4,85	4,82	185,2	104,9	25,4	39,5
8	B. trout (f)	R. Luleälven (2001)	4,47	2,63	0,638	0,698	1,33	4,45	4,42	158,5	93,3	24,8	47,2
9	B. trout (m)	R. Ång.älven (2001)	2,04	1,29	0,164	0,341	0,62	2,01	1,99	52,3	33,2	8,8	15,9
10	B. trout (f)	R. Ång.älven (2001)	2,63	1,69	0,224	0,432	0,71	2,61	2,58	59,6	38,2	9,8	16,1
11	B. trout (m)	R. Dalälven (2001)	2,05	1,29	0,201	0,322	0,58	2,02	2,00	50,9	32,1	8,0	14,4
12	B. trout (f)	R. Dalälven (2001)	1,99	1,31	0,140	0,311	0,62	1,96	1,94	60,8	40,1	9,5	19,0
13	B. trout (m)	R. Mörrumsån (2001)	3,43	2,15	0,422	0,459	1,87	3,41	3,38	117,2	73,4	15,7	63,8
14	B. trout (f)	R. Mörrumsån (2001)	3,04	1,87	0,388	0,411	1,94	3,01	2,99	95,0	58,4	12,8	60,6
15	Salmon (m)	R. Luleälven (2001)	2,51	1,53	0,298	0,341	1,28	2,49	2,46	84,8	51,7	11,5	43,2
16	Salmon (f)	R. Luleälven (2001)	3,93	2,29	0,364	0,798	1,10	3,91	3,88	117,0	68,2	23,8	32,7
17	Salmon (m)	R. Ång.älven (2001)	2,77	1,72	0,220	0,504	1,12	2,74	2,72	110,7	68,8	20,2	44,8
18	Salmon (f)	R. Ång.älven (2001)	3,30	2,11	0,267	0,535	1,49	3,27	3,25	97,9	62,6	15,9	44,2
19	Salmon (m)	R. Dalälven (2001)	2,70	1,71	0,274	0,391	1,11	2,68	2,65	68,7	43,5	9,9	28,2
20	Salmon (f)	R. Dalälven (2001)	2,23	1,38	0,200	0,359	0,88	2,20	2,18	57,2	35,4	9,2	22,5
21	Salmon (f)	N. of Gotland (2000)	2,37	1,48	0,252	0,319	1,20	2,34	2,32	24,7	15,4	3,3	12,5
22	Salmon (m)	N. of Gotland (2000)	2,12	0,85	0,274	0,293	0,81	2,09	2,07	18,3	7,3	2,5	7,0
23	Salmon (m)	R. Mörrumsån (2001)	3,60	2,26	0,416	0,454	2,23	3,57	3,55	113,1	71,1	14,3	70,1
24	Salmon (f)	R. Mörrumsån (2001)	3,94	2,46	0,477	0,522	2,24	3,92	3,89	147,2	91,8	19,5	83,6
25	Herring (mix)	Piteå archipelago (2001)	NA	NA	NA	NA-	NA	NA	NA	NA	NA	NA	NA
26	Herring (m)	Piteå archipelago (2001)	0,92	0,499	0,158	0,114	0,47	0,88	0,85	17,3	9,4	2,1	8,8
27	Herring (f)	Piteå archipelago (2001)	0,78	0,409	0,141	0,089	0,43	0,73	0,68	16,3	8,5	1,9	8,9
28	Herring (mix)	Piteå archipelago (2001)	1,76	1,06	0,206	0,289	1,05	1,73	1,69	39,4	23,7	6,5	23,4
29	Herring (m)	Ångermanälven (2001)	0,96	0,560	0,106	0,137	0,38	0,90	0,84	21,9	12,8	3,1	8,7
30	Herring (f)	Ångermanälven (2001)	0,64	0,317	0,084	0,084	0,23	0,57	0,51	13,9	6,9	1,8	5,0
31	Herring (m)	Ångermanälven (2001)	1,11	0,630	0,128	0,178	0,46	1,06	1,01	19,9	11,3	3,2	8,2
32	Herring (f)	Ångermanälven (2001)	1,02	0,577	0,094	0,181	0,46	0,95	0,89	27,6	15,6	4,9	12,4

33	Herring (m)	Bålsön (2001)	3,26	2,17	0,255	0,521	1,62	3,24	3,21	30,8	20,5	4,9	15,3
34	Herring (f)	Bålsön (2001)	2,87	1,78	0,284	0,467	1,73	2,84	2,82	25,4	15,8	4,1	15,3
35	Herring (m)	Bålsön (2001)	7,35	5,22	0,468	1,07	3,22	7,33	7,30	47,4	33,7	6,9	20,8
36	Herring (f)	Bålsön (2001)	5,65	3,52	0,452	1,10	2,15	5,62	5,60	40,6	25,3	7,9	15,5
37	Herring (m)	Västra Banken (2001)	8,15	5,98	0,394	1,16	2,53	8,13	8,10	56,6	41,5	8,1	17,6
38	Herring (f)	Västra Banken (2001)	5,35	3,66	0,308	0,904	1,58	5,32	5,30	47,7	32,7	8,1	14,1
39	Herring (m)	Västra Banken (2001)	7,62	5,61	0,270	1,21	2,26	7,60	7,57	57,3	42,2	9,1	17,0
40	Herring (f)	Västra Banken (2001)	5,01	3,43	0,288	0,857	1,49	4,99	4,96	44,4	30,4	7,6	13,2
41	Herring (m)	Landsort (2000)	2,67	1,76	0,297	0,325	1,70	2,65	2,62	29,8	19,6	3,6	19,0
42	Herring (f)	Landsort (2000)	2,11	1,33	0,273	0,247	1,52	2,09	2,06	27,6	17,4	3,2	19,8
43	Herring (m)	Landsort (2000)	3,30	2,21	0,274	0,462	1,36	3,28	3,25	29,5	19,7	4,1	12,1
44	Herring (f)	Landsort (2000)	3,26	2,05	0,410	0,408	1,78	3,24	3,21	33,5	21,1	4,2	18,3
45	Herring (m)	SE Gotland (2000)	1,54	0,986	0,166	0,172	1,20	1,52	1,49	20,5	13,1	2,3	15,9
46	Herring (f)	SE Gotland (2000)	1,92	1,24	0,231	0,206	1,34	1,90	1,87	23,8	15,4	2,6	16,6
47	Herring (m)	SE Gotland (2000)	3,26	2,05	0,312	0,541	1,11	3,24	3,21	24,0	15,1	4,0	8,2
48	Herring (f)	SE Gotland (2000)	4,08	2,51	0,507	0,623	1,73	4,05	4,03	26,3	16,2	4,0	11,2
49	Herring (m)	SE Gotland (2000)	7,27	4,80	0,628	1,16	2,85	7,25	7,22	63,8	42,1	10,2	25,0
50	Herring (f)	SE Gotland (2000)	4,19	2,89	0,282	0,684	1,11	4,16	4,14	38,1	26,3	6,2	10,1
51	Herring (m)	Utlängan (2000)	1,14	0,689	0,135	0,148	0,77	1,09	1,04	29,3	17,7	3,8	19,7
52	Herring (f)	Utlängan (2000)	1,17	0,693	0,165	0,127	0,92	1,14	1,12	20,5	12,2	2,2	16,2
53	Herring (m)	Utlängan (2000)	1,56	1,014	0,118	0,257	0,48	1,51	1,46	23,8	15,5	3,9	7,3
54	Herring (f)	Utlängan (2000)	1,54	0,989	0,144	0,238	0,54	1,50	1,47	25,7	16,5	4,0	9,0
55	Herring (m)	W Bornholm (2002)	2,69	1,56	0,382	0,347	2,20	2,65	2,61	23,6	13,7	3,0	19,3
56	Herring (f)	W Bornholm (2002)	1,99	1,18	0,274	0,245	2,01	1,96	1,92	20,9	12,4	2,6	21,1
57	Sprat (mix)	W Bornholm (2002)	2,22	1,42	0,237	0,292	2,54	2,19	2,17	30,1	19,3	4,0	34,5
58	Sprat (mix)	W Bornholm (2002)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
59	Sprat (mix)	E Gotland (2002)	1,85	1,13	0,216	0,237	1,70	1,81	1,78	21,7	13,3	2,8	20,0
60	Whitefish (m)	R. Luleälven (2001)	0,44	0,254	0,042	0,077	0,08	0,42	0,40	31,9	18,3	5,5	5,4
61	Whitefish (f)	R. Luleälven (2001)	1,14	0,726	0,117	0,180	0,23	1,12	1,10	67,2	42,7	10,6	13,4
62	Whitefish (m)	R. Ång.älven (2001)	0,94	0,566	0,093	0,177	0,15	0,93	0,93	90,8	55,0	17,2	15,0
63	Whitefish (f)	R. Ång.älven (2001)	1,01	0,615	0,098	0,186	0,21	0,99	0,98	85,9	52,6	15,9	17,9
64	Whitefish m)	Öregrundsgrepen (2001)	0,38	0,219	0,033	0,061	0,06	0,36	0,34	33,1	19,0	5,3	4,9
65	Whitefish (f)	Öregrundsgrepen (2001)	0,34	0,197	0,026	0,052	0,05	0,32	0,30	30,4	17,4	4,6	4,6
66	Vendace roe	Luleå archipelago (2001)	1,44	0,635	0,408	0,168	0,49	1,40	1,36	11,5	5,1	1,3	3,9
67	Cod (mix)	Baltic proper (2002)	0,18	0,109	0,008	0,018	0,04	0,16	0,13	31,0	18,5	3,1	7,3

Table 6. Concentration of analysed organohalogen pesticides (µg/kg fresh weight) in fish from different locations along the Swedish east and south coast. Please note that there are large differences in age within the species reported. See Table 1 for details of the analysed fish samples, and Table 2 for specification on individual substances included in the sum values. < LOD are set equal to LOD. f = female; m= male, Y = yellow eel; S = silver eel.

No.	Species (gender)	Location caught (year caught)	HCB (µg/kg fw)	sum HCHs (µg/kg fw)	% β-HCH of sum HCHs (%)	sum chlordanes (µg/kg fw)	% nonaklor of sum chlordanes (%)	sum DDTs (µg/kg fw)	% pp-DDE of Sum DDTs (%)
1	Eel, Y (f)	Kvädöfjärden (2000)	2,1	4,6	48	3,4	54	22,7	65
2	Eel, Y (f)	Marsö (2000)	2,3	5,7	48	3,8	53	23,1	61
3	Eel, Y (f)	Sturkö (2000)	1,4	4,8	48	1,8	54	12,8	65
4	Eel, Y (f)	Valjeviken (2000)	1,2	5,8	50	1,8	53	18,1	67
5	Eel, S (f)	Västervik (2001)	3,5	7,4	48	5,7	53	41,6	62
6	Eel, S (f)	Karlshamn (2001)	1,6	5,3	49	2,3	54	21,3	63
7	B. trout (m)	R. Luleälven (2001)	1,4	0,3	33	3,7	72	28,8	86
8	B. trout (f)	R. Luleälven (2001)	1,5	0,3	33	5,1	77	36,7	88
9	B. trout (m)	R. Ång.älven (2001)	2,1	0,4	39	3,9	69	31,4	77
10	B. trout (f)	R. Ång.älven (2001)	3,0	0,4	37	5,1	68	40,2	77
11	B. trout (m)	R. Dalälven (2001)	2,1	0,5	55	4,1	70	31,9	79
12	B. trout (f)	R. Dalälven (2001)	2,0	0,4	49	4,4	70	34,5	80
13	B. trout (m)	R. Mörrumsån (2001)	2,3	0,4	42	3,5	68	71,9	67
14	B. trout (f)	R. Mörrumsån (2001)	2,5	0,4	44	3,2	67	68,5	65
15	Salmon (m)	R. Luleälven (2001)	2,3	0,3	38	3,4	59	56,4	61
16	Salmon (f)	R. Luleälven (2001)	3,8	0,3	38	9,0	68	80,5	75
17	Salmon (m)	R. Ång.älven (2001)	2,5	0,3	37	5,8	64	50,7	73
18	Salmon (f)	R. Ång.älven (2001)	3,1	0,3	38	6,3	63	60,8	72
19	Salmon (m)	R. Dalälven (2001)	2,7	0,4	45	4,6	61	54,4	67
20	Salmon (f)	R. Dalälven (2001)	2,5	0,4	44	4,5	62	45,7	70
21	Salmon (f)	N. of Gotland (2000)	2,8	3,8	43	3,4	55	54,9	57
22	Salmon (m)	N. of Gotland (2000)	3,4	4,6	44	4,4	57	65,1	60
23	Salmon (m)	R. Mörrumsån (2001)	2,8	0,4	36	4,6	56	80,4	60
24	Salmon (f)	R. Mörrumsån (2001)	2,9	0,3	38	5,0	58	83,2	62
25	Herring (mix)	Piteå archipelago (2001)	0,7	1,3	43	0,9	26	4,5	34
26	Herring (m)	Piteå archipelago (2001)	0,9	1,0	37	1,3	55	5,1	63
27	Herring (f)	Piteå archipelago (2001)	0,8	1,0	38	1,0	52	4,0	57
28	Herring (mix)	Piteå archipelago (2001)	1,2	0,9	40	2,7	64	11,7	75
29	Herring (m)	Ångermanälven (2001)	1,7	1,6	43	1,8	57	9,2	67
30	Herring (f)	Ångermanälven (2001)	1,7	1,7	43	1,1	52	6,5	66
31	Herring (m)	Ångermanälven (2001)	2,6	2,1	42	2,1	56	10,6	69
32	Herring (f)	Ångermanälven (2001)	1,3	1,3	47	2,0	59	10,6	72
33	Herring (m)	Bålsön (2001)	4,2	4,1	49	9,7	62	52,8	76
34	Herring (f)	Bålsön (2001)	4,4	4,1	48	10,2	62	52,9	75
35	Herring (m)	Bålsön (2001)	6,2	5,3	52	22,5	63	120,2	78
36	Herring (f)	Bålsön (2001)	5,5	4,9	51	17,5	62	93,2	75
37	Herring (m)	Västra Banken (2001)	6,8	4,9	49	21,7	63	118,5	78
38	Herring (f)	Västra Banken (2001)	4,1	3,6	50	13,6	64	90,2	80
39	Herring (m)	Västra Banken (2001)	5,5	4,8	50	21,6	64	130,6	80
40	Herring (f)	Västra Banken (2001)	4,2	3,9	50	12,1	63	80,3	81
41	Herring (m)	Landsort (2000)	4,1	4,7	46	4,7	52	54,7	61
42	Herring (f)	Landsort (2000)	4,0	4,1	45	3,8	52	43,0	58
43	Herring (m)	Landsort (2000)	2,3	5,3	46	4,0	54	74,2	73
44	Herring (f)	Landsort (2000)	3,0	5,1	45	3,6	54	61,5	65
45	Herring (m)	SE Gotland (2000)	3,6	5,0	41	3,3	50	38,0	55
46	Herring (f)	SE Gotland (2000)	3,9	5,5	40	3,2	49	41,3	54
47	Herring (m)	SE Gotland (2000)	3,2	7,9	43	4,2	55	82,2	69
48	Herring (f)	SE Gotland (2000)	4,6	8,7	43	4,8	52	94,7	67
49	Herring (m)	SE Gotland (2000)	4,2	5,8	47	8,9	66	178,5	62
50	Herring (f)	SE Gotland (2000)	2,8	5,3	45	4,1	60	78,2	70
51	Herring (m)	Utlängan (2000)	1,1	1,8	46	1,4	51	20,9	67
52	Herring (f)	Utlängan (2000)	2,0	2,6	46	1,9	49	23,3	59
53	Herring (m)	Utlängan (2000)	1,3	3,1	47	1,3	59	23,5	81
54	Herring (f)	Utlängan (2000)	0,9	2,8	46	1,2	53	24,8	76
55	Herring (m)	W Bornholm (2002)	1,8	4,7	49	2,5	47	26,4	64
56	Herring (f)	W Bornholm (2002)	1,8	4,3	49	2,0	48	26,3	65
57	Sprat (mix)	W Bornholm (2002)	1,5	3,1	49	2,3	61	49,7	63
58	Sprat (mix)	W Bornholm (2002)	2,2	4,3	48	2,4	53	51,0	60

59	Sprat (mix)	E Gotland (2002)	2,4	5,4	45	3,2	54	39,1	52
60	Whitefish (m)	R. Luleälven (2001)	0,6	0,2	42	0,7	68	6,0	80
61	Whitefish (f)	R. Luleälven (2001)	0,9	0,2	41	1,2	67	10,0	75
62	Whitefish (m)	R. Ång.älven (2001)	0,8	0,2	33	1,2	70	14,1	84
63	Whitefish (f)	R. Ång.älven (2001)	0,9	0,2	40	1,4	69	13,9	81
64	Whitefish (m)	Öregrundsgrepen (2001)	0,8	0,3	50	0,6	66	5,6	80
65	Whitefish (f)	Öregrundsgrepen (2001)	0,8	0,2	48	0,6	65	5,5	79
66	Vendace roe	Luleå archipelago (2001)	1,6	1,6	29	1,3	56	4,9	55
67	Cod (mix)	Baltic proper (2002)	0,2	0,1	48	0,2	53	2,1	62