META ANALYSIS OF TRENDS OF CHLORINATED DIBENZO-P-DIOXINS, DIBENZOFURANS (CDDF) AND PLANAR POLYCHLORINATED BIPHENYLS (PPCB) IN BALTIC HERRING

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Introduction

This paper summarizes the results of four monitoring programs[1-5] which include the herring year classes from 1979 until 2002 (Tab.1).

Table 1 Monitored herring year classes. FS3 to BL9 are pools of 1993 and 1999 small (S), large (L) herring from Gulf of Finland (F), and 1999 small and large herring from Gulf of Bothnia (B, Table 3[1]).

	[1]	[2]	[3]	[4]	[5]	FS3	FS9	FL9	BS9	BL9
2003					X					
2002					X					
2001					X					
2000		X	X	X	X					
1999		X	X	X	X					
1998		X	X	X	X					
1997		X	X	X						
1996		X	X	X						
1995		X	X	X			X		X	
1994		X				X	X		X	
1993		X				X	X			X
1992	X	X								X
1991	X									X
1990	X							X		X
1989	X							X		
1988	X									
""""""	X									
1979	X									

The references present data on herring landed throughout the eastern part of Gulf of Bothnia, Bothnian Sea, and the northern part of Gulf of Finland[1], the eastern part of Bothnian Sea[2] , and along the Estonian coast [4] The data are medians of 4-20 pools [1], of 4-14 individually analyzed fish[2], and single analyses of pools of 4-17 fish[4] , and from five regions of the Baltic Sea: Bornholm Basin in the southern Baltic Proper (also known as the Main Basin of the Baltic Sea), eastern and western Gulf of Finland, Archipelago Sea, southern and eastern Bothnian Sea and Bothnian Bay[5]. (a= autumn, s=spring)

Results and Discussion

The weight and length *vs* age relations are, with a few exceptions, the same in all the data (Figs.1&2). On the other hand, the lipid *vs* age relation does not show a trend (Fig. 3).

The concentration of lipids varies with the maturity of the fish, time of the year and, possibly, with other factors. These variations introduce bias in the comparisons of data sets when the concentrations are expressed on a lipid basis. Differences in the weights of the fish may also complicate the comparisons. Consequently, we propose the expression of concentrations on a fish basis for comparisons of data sets. On this basis, the concentrations of CDDF in Baltic herring have not changed between 1979 and 2000 (Fig.4).

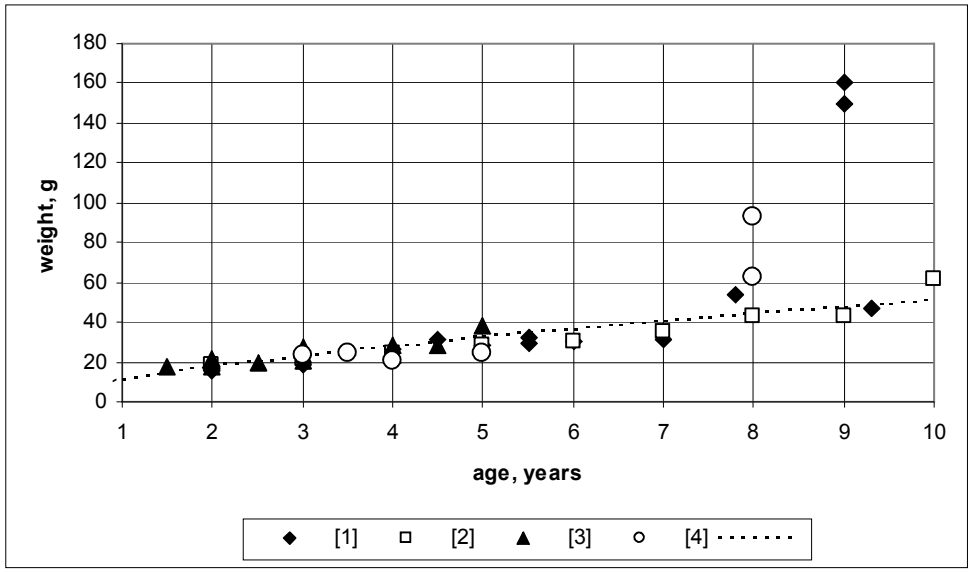

Fig. 1. Weight of herring as a function of age. Fitted line is weight = $10.81*age^{0.673}$. The two '9-years-old' pools of Gulf of Bothnia herring, ranging in age from 8 to 15 years[1] were not used in the calculation.

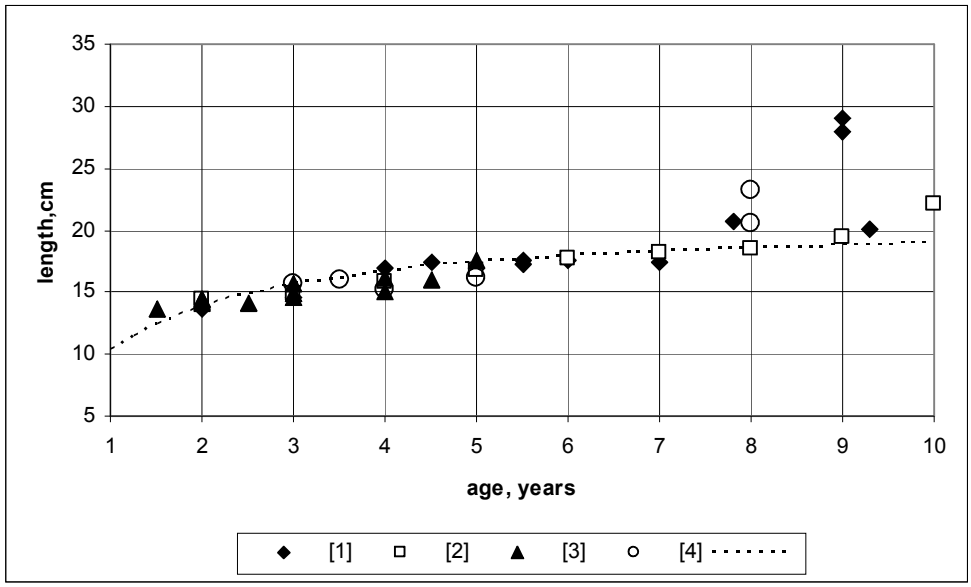

Fig. 2 Length of herring as a function of age. Fitted line is length = age/(0.0489+0.0478*age), The two Gulf of Bothnia pools (see Fig. 1) were not used in the calculation.

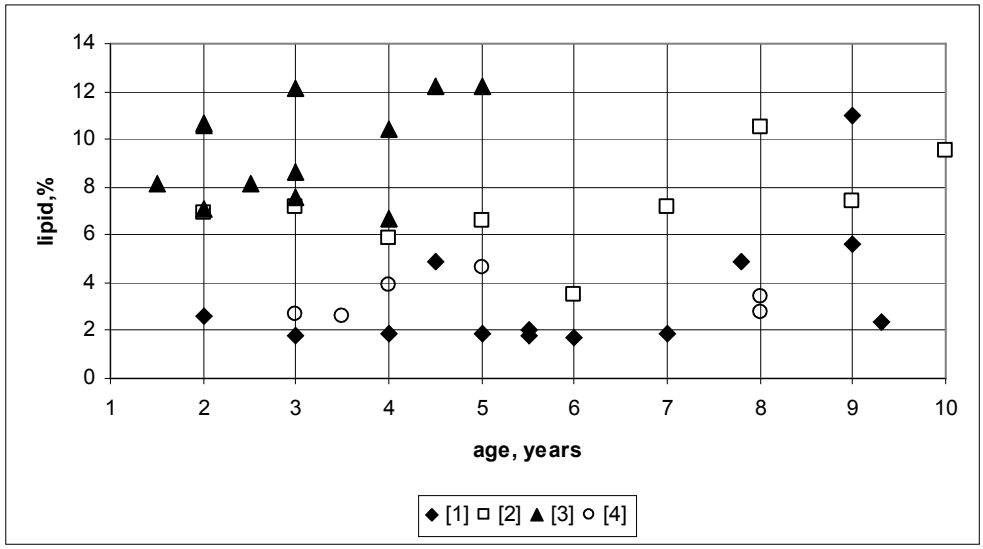

Fig. 3. Lipids concentration as a function of age.

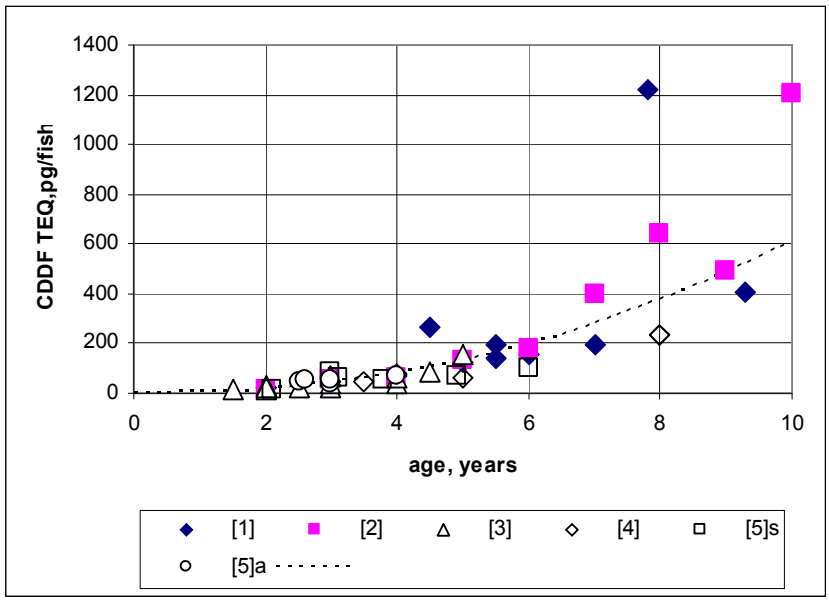

Fig. 4. Concentration of CDDFTEQ in pg/fish as a function of age. The outliers are: BL9 (diamond[1]) and fish ≥ 10 years old (square[2]). The fitted line is concentration = 4.01*age$^{2.18}$.

Interestingly, the concentration of PPCB (the sum of the concentrations of the chlorobiphenyls 77, 126, and 169, for which data are available in references[1,2,4]) has increased considerably after 1992 (Fig. 5).

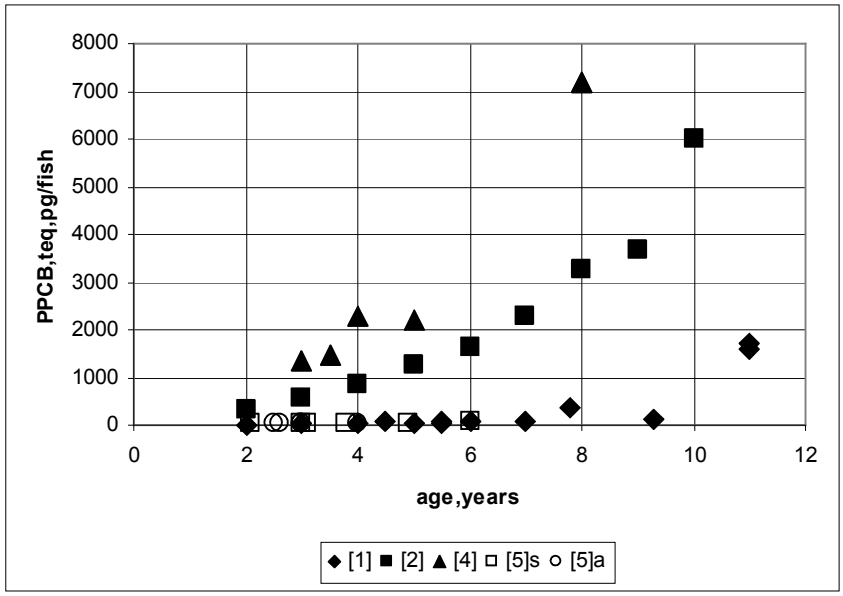

Fig. 5. Concentration of PPCB (77+126+169), TEQ pg/fish as a function of age.

The age of the fish is an important factor in the determination of trends of the concentrations of CDDF and PPCB. Since weight and length of the fish are closely related to their age, they could be used as surrogates for the prediction of probable concentrations of CDDF and PPCB. An examination of Fig.2[2] shows that on average, one half of the samples contains CDDF concentrations (TEQ pg/g fw) higher than predicted, with actual to predicted ratios 1.20 on the average and a maximum ratio of 2.18.

The data also show that, because of the power dependence of concentration on age, predators feeding on larger fish ingest disproportionately larger amounts of these compounds.

References

1. Kiviranta H, Vartiainen T, Parmanne R, Hallikainen A, Koistinen J. *Chemosphere* 2003; 50:1201.
2. Parmanne R, Hallikainen A, Isosaari P, Kiviranta H, Koistinen J, Laine O, Rantakokko P, Vuorinen PJ, Vartianen T. *Marine Pollution Bulletin* 2006;52: 149.
3. Roots O, Zitko V. *Environmental Science & Pollution Research* 2004;11:186
4. Roots O, Zitko V. *Fresenius Environmental Bulletin* 2006;15:207.
5. Isosaari P, Hallikainen A, Kiviranta H, Vuorinen PJ, Parmanne R, Koistinen J, Vartiainen T. *Environmental Pollution* 141:213(2006).