DIOXIN AND PCB LEVELS IN EEL FROM LARGE RIVERS IN THE NETHERLANDS, THE IMPACT OF THE 2006 TEF VALUES, AND THE RISK FOR THE CONSUMER

Hoogenboom LAP[1], Kotterman MJJ[2], Zeilmaker MJ[3], Hoek-van Nieuwenhuizen M[2], van der Lee MK[1], Traag WA[1]
[1] RIKILT Institute of Food Safety, Bornsesteeg 45, 6708PD Wageningen, The Netherlands, [2] IMARES, Haringkade 1, 1976 CP IJmuiden, The Netherlands, [3] RIVM National Institute of Public Health and the Environment, P.O.Box 1, 3720 BA, Bilthoven, The Netherlands

Abstract
Eel from polluted rivers was shown to contain dioxin and dl-PCB levels above the new EU-limits. Application of the new TEF-values resulted in a 40% reduction of the levels. Nevertheless, consumption of one portion of this eel resulted in a 5-fold exceeding of the pTWI and the monthly consumption in an increase in body burdens above levels considered as safe. This applies to fisherman and consumers buying from a particular source. The general consumer has only a small chance of consuming this eel frequently.

Introduction
Past studies have shown that eel from Dutch rivers are often contaminated with high levels of dioxins and in particular dioxin-like PCBs[1,2]. Because of the recent inclusion of dl-PCBs in the EU-limits, a new survey was carried out, focussing on eel from the most polluted rivers. The impact of the new TEF_{2006} values on the levels was studied. Based on the corrected data a risk assessment was made for consumers of this type of eel, like fisherman and people buying eel from one source. It should be stressed that most of the eel produced in the Netherlands is derived from fish farming and complies with the new EU-limits for dioxins and total TEQ of respectively 4 and 12 pg TEQ/g eel.

Materials and methods
Eel were caught by electrical fishing in a number of selected spots, primarily in the rivers Rhine, Meuse and Waal with a special focus on the area around the Biesbosch. Eels were distributed in the length classes <30, 30-40 and >40 cm. In most cases 15-25 eels were pooled per sample. Fat was extracted with the method of Bligh and Dyer and dioxins and PCBs purified using a Powerprep System. Levels were quantified by GC/HRMS. Levels were expressed per gram of eel.

Results and Discussion

Dioxin and dl-PCB levels in eel
As shown in Table 1 many samples exceeded the EU-limits for dioxins and in particular the sum of dioxins and dl-PCBs. Levels increased with fish length (data not shown!) and fat content, as shown in Figure 1. In practice, eel shorter than 30 cm are too short and not fit for consumption.

Table 1. Dioxin and total TEQ levels in different length classes.

Length	Fat content (%)	Dioxins mean	Dioxins (range)	Dioxins positive (%)	Sum dioxins and dl-PCBs mean	Sum dioxins and dl-PCBs (range)	Sum dioxins and dl-PCBs positive (%)
< 30 cm	6,0	1.8	(0.3- 5.4)	6	17.1	(2.9-33.2)	67
30-40 cm	11,1	3.2	(0.3-12.9)	14	27.0	(2.0-70.5)	68
>40 cm	21,4	5.9	(0.5-15.8)	64	48.1	(6.7-74.5)	91

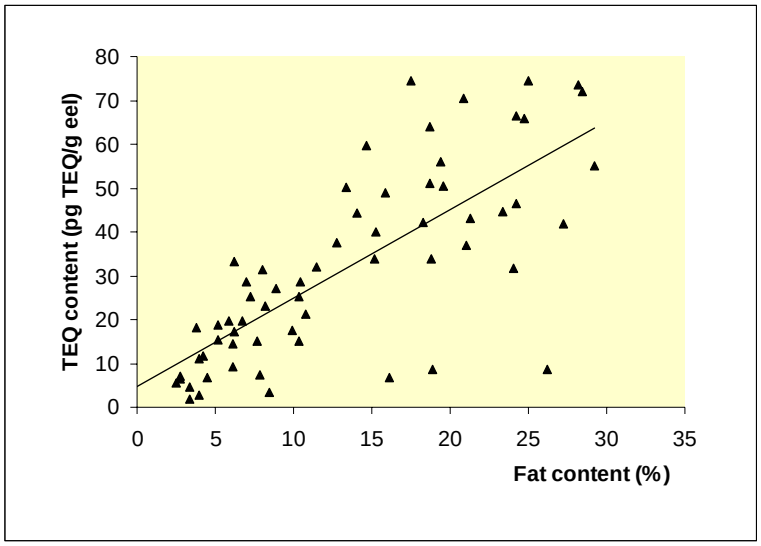


Figure 1. Relation between fat content and total TEQ levels.

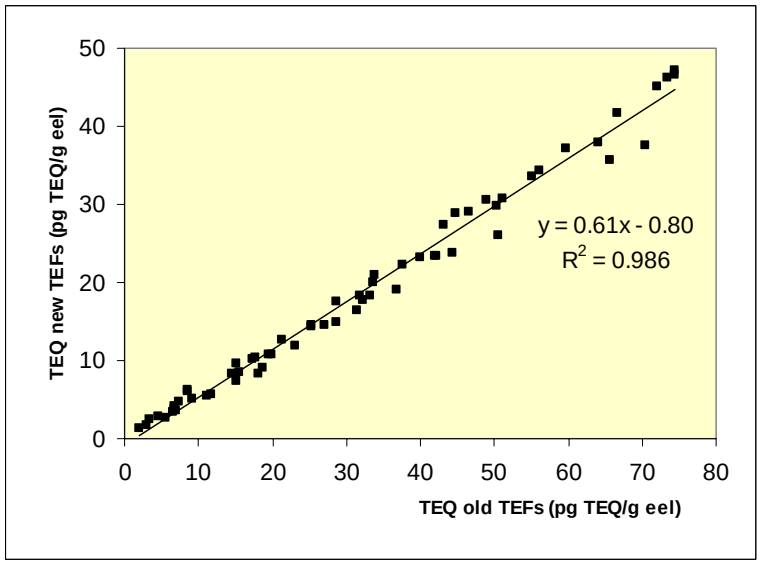


Figure 2. Relation between levels calculated with the TEFs from 1998 and 2006.

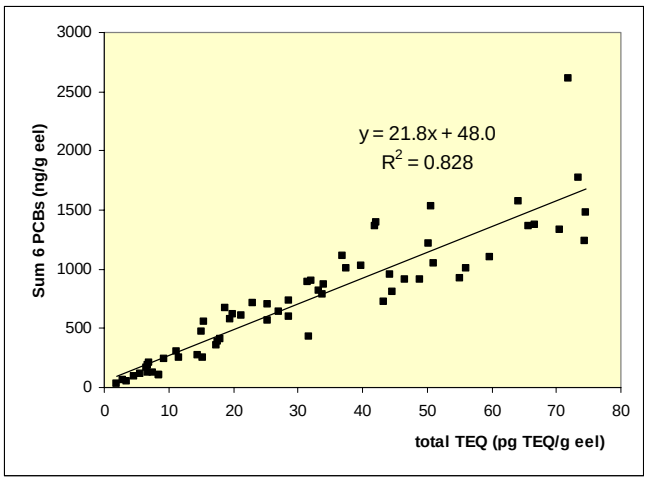
Influence of TEF-values on total-TEQ levels

Figure 2 shows a comparison between the levels calculated with the TEFs from 1998 and 2006. From the relationship it is clear that levels determined with the new TEF-values were 40% lower, being much lower than the general 15% estimated by van den Berg *et al.*[3]. This is primarily due to the much lower TEF-values for the mono-ortho PCBs and the high contribution of these PCBs to the TEQ-levels in wild eel.

Relation between total-TEQ and indicator PCBs

As shown before, the eel samples also contained high levels of the 6 indicator PCBs 28, 52, 101, 138, 153 and 180. Figure 3A shows a comparison between total TEQ and indicator PCB levels, showing a very good relationship. This relationship was similar when the TEQ-levels were based on the new TEF-values (Figure 3B),

showing that it is not based on the mono-ortho PCBs. In principle, a level of 300 ng/g would correspond with a total TEQ-level of 12 pg TEQ/g eel. Many European countries have limits on these compounds and at present a harmonized European limit is under discussion. For eel a limit of 200 ng/g eel has been proposed. In the current data set the number of samples exceeding this limit would be similar to that exceeding the total-TEQ level.



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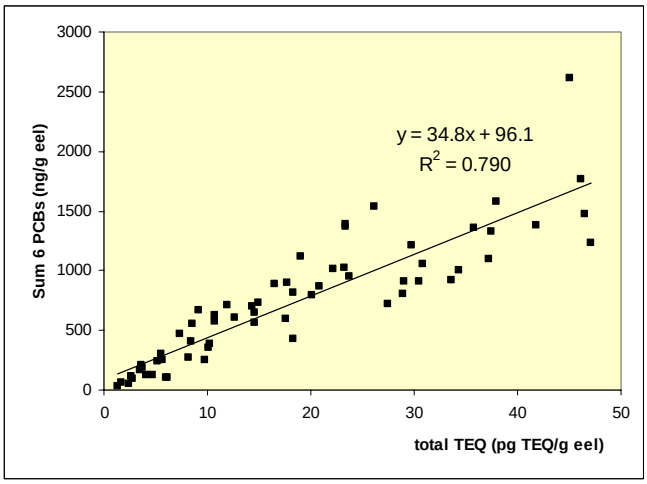

B

Figure 3. Relation between the sum of dioxins and dl-PCBs, and the sum of the 6 indicator PCBs, based on either $TEFs_{1998}$ (A) or $TEFs_{2006}$ (B).

Risk assessment of wild eel consumption

The general Dutch population will have a very small chance of eating wild eel from the more polluted areas, since most of the eel originates from aquaculture. However, wild eel is caught by sport fishermen and a number of professional fishermen selling their eel at local stores and markets. As a result a small number of consumers may eat this eel frequently, resulting in an elevated exposure. Based on interviews it was estimated that the maximum consumption frequency is once a month with a portion size of 150 g[4]. The average total TEQ-level in eel >30 cm from the Biesbosch area was 29 pg TEQ/g eel, based on new TEFs. As a result the intake per portion would be 4.3 ng TEQ or 66 pg TEQ/kg bw. Since fish eaters in the Netherlands have already a higher than average intake of dioxins and dl-PCBs, the overall intake was estimated to be 79 pg TEQ/kg bw. This is about 5

times the pTWI of 14 pg TEQ/kg bw as set by the SCF. However, as mentioned before, eel is unlikely to be eaten every week. Therefore, the estimated intake was used to estimate the effect of this eel consumption on the body burden (Figure 4). Body burdens were estimated from the levels in mother's milk. The starting level for fish consumers was based on the 95th percentile of the levels in mother's milk, again based on the higher TEQ intake by fish consumers. The body burden levels were compared to a NOAEL based on the effect of TCDD on sperm count in male rats exposed intrauterine, divided by an uncertainty factor of 3.
Due to the decreasing levels in food, the body burden of the average fish consumer is expected to decrease gradually to below the expected NOAEL. When eating eel from lake IJssel with elevated but much lower levels (6.9 pg TEQ/g eel, $TEFs_{2006}$), body burdens will decrease slightly less rapid and eventually approach the NOAEL. However, regular consumption of eel from the Biesbosch will result in a clear increase in the levels up to almost twice the NOAEL.

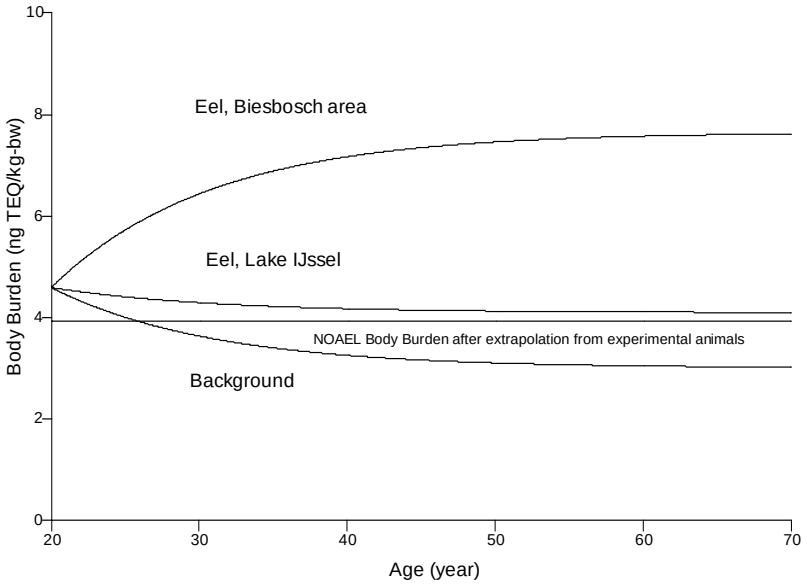

Figure 4. Body burden levels of dioxins and dl-PCBs in average fish consumers and fish consumers eating frequently eel from lake IJssel and the Biesbosch area. It was assumed that the intake started at 20 years of age.

Omega-3 fatty acids
An interesting discussion concerns the potential beneficial effects of fish due to the levels of omega-3 fatty acids. A selection of 13 eel samples were analysed, containing an average fat level of 22%. The fat consisted of 3.6% EPA and 4.3% DHA. Combined this results in EPA+DHA levels of 7.9 g EPA and 9.4 g DHA per kg eel or 17.3 g/kg (range 9.2-23.9). This means that consumption of 25 g of this eel per day would result in the amount of 400 mg/day currently recommended in the Netherlands. It should be mentioned that farmed eel contains at least as much of these fatty acids and much lower contaminant levels.

References
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