The eel pollutant monitoring network in Flanders, Belgium. Results of 10 years monitoring.

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Introduction

Since 1994 the Institute for Forestry and Game Management (IBW) has build out a pollutant monitoring network for public water bodies in Flanders (Belgium) using eel (*Anguilla anguilla*) as a biomonitor.
The results presented here come from 2000 individually analysed eels originating from 260 different localities in Flanders, including rivers, canals, polder waters and closed water bodies. The sampling took place from 1994 to 2002.
Eel is used for biomonitoring because it is a very fatty (strong lipophylic character of a.o. pesticides and PCB's), benthic, sedentary (during the yellow eel phase), long-living and widespread fish (in non-polluted as well as in polluted waters) and because of the absence of a seasonal effect through reproduction and its place on the trophic ladder.
Some results represented are: 1) on 80 % of all sampled localities the Belgian PCB-standard for fish (75ng/g BW) is exceeded; 2) in the north-western part of Flanders is a severe lindane-contamination; 3) many long time prohibited pesticides are still found in considerable amounts in our food-chain; 4) several locations contain high to very high concentrations of brominated flame retardants.
For several contaminants a comparison is made between the Flemish values and other values found in literature.
The results of the Flemish eel pollutant monitoring network have initiated a catch-and-release obligation for eel in Flanders and for all fish on the 5 most polluted waters in Flanders.

Materials and Methods

The fish were collected by elecrofishing, fykenets or a combination of both.
Fish fillets were wrapped in aluminum paper (cleaned with hexane 99 %) and stored at –20 °C. All fish were analysed individually and per locality usually 10 individual eels were used to constitute an average. For this paper only the eels with a length between 30 and 50 cm are considered because of standardisation and comparison reasons.
Chemical analyses were carried out by the Sea Fisheries Department in Ostend.
10 grams of fish fillet was extracted using the Bligh & Dyer method[1]. The extract is evaporated (Rotavapor) and at the most 100 mg lipid is dissolved in hexane and applied on an aluminum oxide

chromatography column. After elution with hexane, the lipid free eluate is evaporated and applied on a silica gel chromatography column. Ten PCB's (CB 28, 31, 52, 101, 105, 118, 138, 153, 156 and 180), p,p'-DDE and HCB are isolated after elution with hexane. After elution with diethylether/hexane (10/90) the remaining organochlorine pesticides (dieldrin, endrin, aldrin, trans-nonachlor, alfa- and gamma-HCH, p,p'-DDT and p,p'-DDD) are isolated.
Both fractions are evaporated to 1 ml, after addition of an internal standard (tetrachloronaphtalene) and separated by GC using a Rtx-5ms capillary column (60 m x 0.25 mm x 0.25 µm), with helium as a carrier gas and an electron capture detector (ECD).

Results and Discussion

Concentrations of several organic pollutants encountered in 'Flemish' eel-tissue are among the highest worldwide. These high concentrations are mainly due to the densely populated area that Flanders is (443 inh./km²), being almost 4 times higher than the average population density in the (former) European 15 (115 inh./km²), the second highest are The Netherlands with a density of 373 inh./km².
For the Flemish eel pollutant monitoring network there are about 300 sampling sites on an area of only 12,500 square kilometers, this means there is one sampling site on every 40 square kilometers. This intensive monitoring may attribute for some of the high values encountered.

PCB

On 80 % of all sampled localities in Flanders the Belgian consumption standard in fish for the 7 indicator PCB's (75 ng/g BW) is exceeded. Figure 1 shows us that average peak values of almost 7,000 ng/g BW were measured.

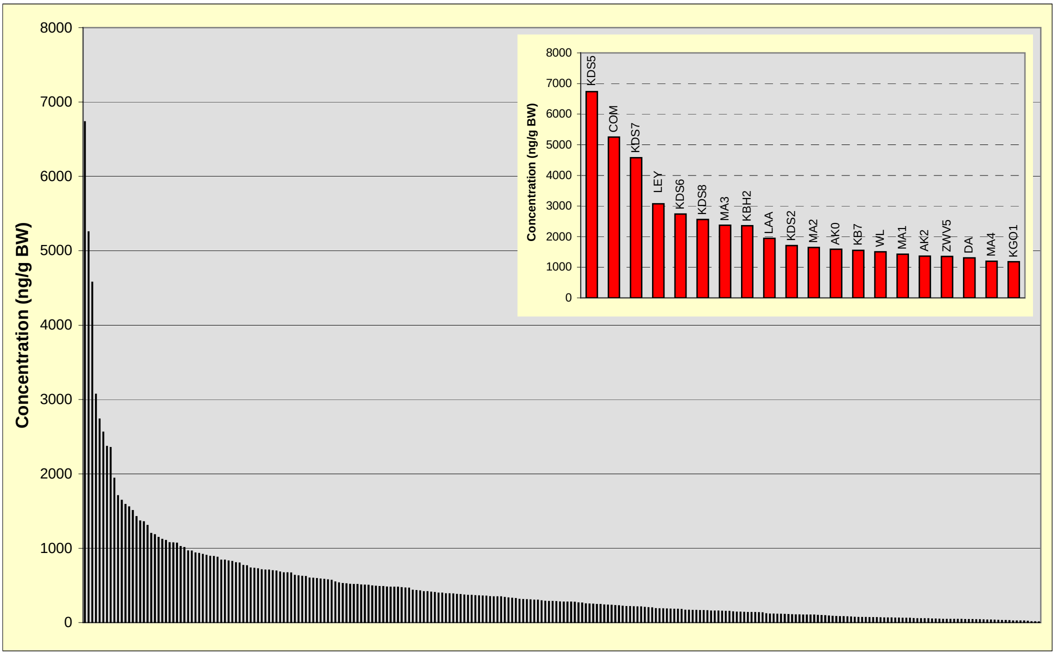

Figure 1: Sum of the 7 indicator-PCB's, mean concentrations (ng/g BW) in eel muscle-tissue from Flanders (260 localities, 1994-2001)(From Goemans *et al.*[2])

These high PCB-values together with high heavy metal loads have led to a global catch-and-release obligation for eel in Flanders by ministerial decree. On the 5 most polluted waters (PCB > 2,000 ng/g BW or Cd > 100 ng/g BW or Pb > 400 ng/g BW) there is a catch-and-release obligation for all fish (figure 2).

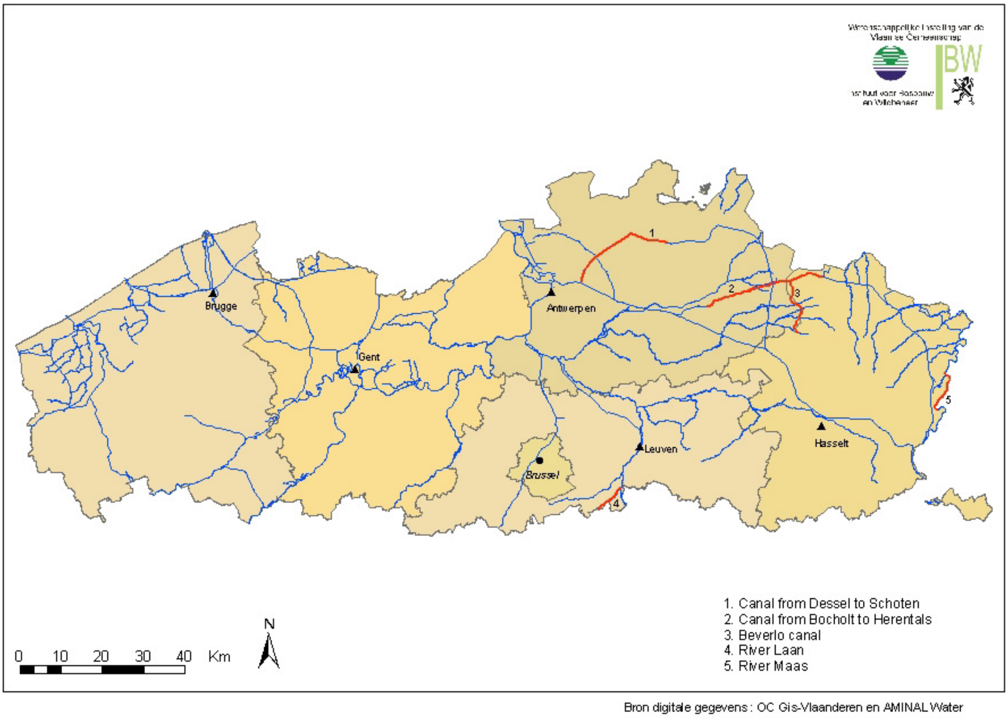

Figure 2: Five most polluted waters in Flanders where a catch-and-release obligation for all fish is in force until 2005 (From Goemans et al.[2]).

Comparing the measured PCB-values in eel from Flanders with the RfD-values as stated by the US EPA[3], it should be concluded that on 77 % of all Flemish water bodies not more than one fish meal every 2 months may be consumed without a possible health risk. The overall average concentration for the 7 indicator PCB's in eel from Flanders is 493 ng/g BW, if one recalculates this with the RfD-value, it points out that on average even less than 1 kg of fish per year can be consumed safely[2].

Lindane

In eel originating from Flemish water bodies lindane concentrations were found ranging from detection limit to more than 2,000 ng/g BW. These extreme (average) values are more than tenfold the highest values found in literature, namely 171 ng/g BW in eel originating from the rivers Taw and Mole[4]. As a reference, the highest average value found in eel from The Netherlands over the period 1995 – 2001 was 98 ng/g BW[5,6,7,8,9,10]. The main reason for these extreme high values in eel is that until 2002 lindane was still very common as a pesticide in Belgian agriculture (mainly for beet and corn). Only as from june 2002 the use of lindane is prohibited by law. In most other countries lindane has since long been banned. Following this prohibition, the concentrations of lindane in eel are expected to decrease significantly in Flanders starting from 2003. The continuation of the Flemish eel pollutant monitoring network will point out if this indeed will be the case.

Other pesticides

As in most of the other ‘developed’ countries pesticides like DDT, dieldrin, HCB, … have been banned in Belgium, since the beginning of the 1970’s. Although banned, they are still being found in quite high concentrations in our environment. This points out the extreme persistence of these pollutants or, that illegal stocks are still being used. A third explanation for some regions might be the import of material from countries which still use these pesticides, e.g. cotton coming from Africa contains DDT residues which might be washed out in the importing country and in this way end up in the environment. All localities in Flanders with high DDT concentrations are clearly located in the same regions.
The highest total-DDT concentration found in eel from Flanders (680 ng/g BW[2]) is similar to the extreme values found in literature (eel from the Bay of Puck in Poland, 720 ng/g BW[11]).
The highest values for dieldrin in Flanders are high but not extremely high compared to literature concentrations. Concentrations on 260 localities vary from detection limit to 235 ng/g BW[2]. On four locations in Flanders an average concentration of more than 100 ng/g BW was encountered, this concentration is considered as a consumption standard in a.o. The Netherlands.
HCB concentrations in Flanders[2] and The Netherlands[5,6,7,8,9,10] are similar (max. 73 and 110 ng/g BW respectively), compared to other literature concentrations these values are relatively high.

Brominated flame retardants (BFR’s)

On 18 locations in Flanders, eels were analysed for the brominated flame retardants HBCD, TBBP-A and PBDE[12]. TBBP-A levels were low at all stations. The concentrations of HBCD and PBDE however varied considerably between stations and in some cases extremely high values for both groups were recorded (maximum of 33,000 ng/g lipid weight; 5,500 ng/g BW for HBCD and 32,000 ng/g lipid weight; 5,300 ng/g BW for PBDE’s). Such high concentrations in fish were never found elsewhere, except for one single carp (*Cyprinus carpio*) from Virginia Hyco River in the US[13]. Other concentrations found in literature are at least 10 times less than the concentrations found in eel from Flanders.

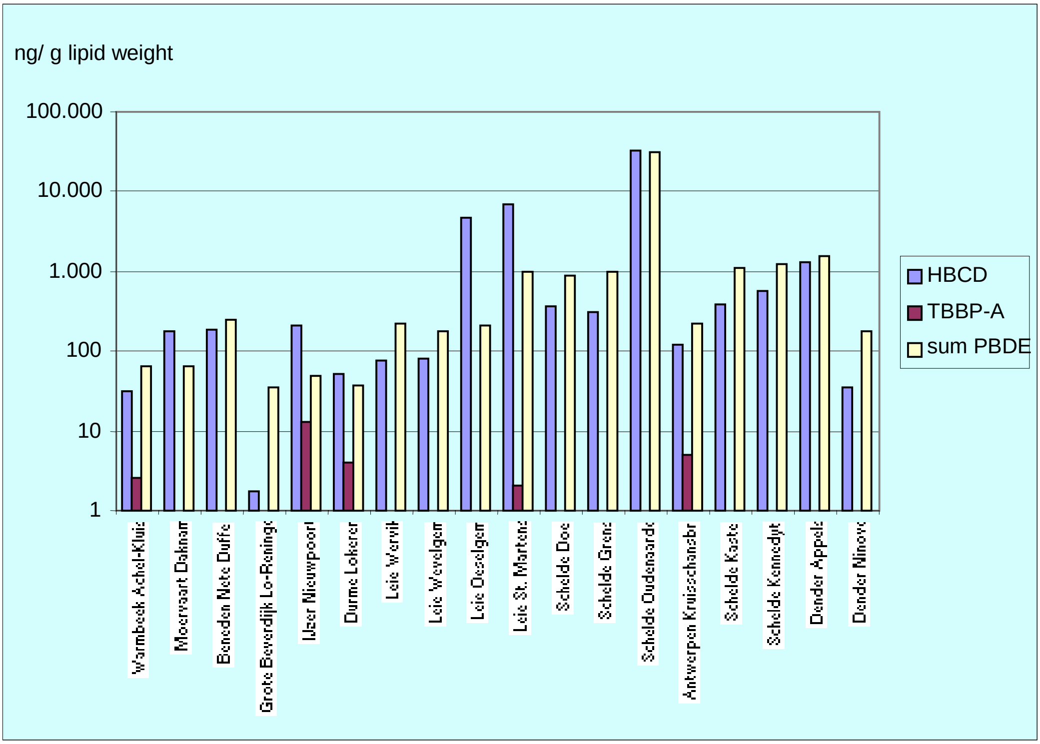

Figure 3: BFR-concentrations in eel lipid tissue from Flanders, 2002 (From Belpaire *et al*[14]).

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