

Freshwater fish contamination by PCBs and other persistent contaminants in the basin Rhône-Méditerranée

Determination of biota-sediment accumulation factors (BSAFs) for fish and of a sediment quality guideline (SQG)

Marc BABUT¹, Annie ROY¹, Christelle LOPES¹ & Sébastien PRADELLE^{1,2}

¹ Cemagref, UR MALY, 3 bis Quai Chauveau – CP220, F-69336 LYON, France

² DREAL Rhône-Alpes, Délégation de bassin, F-69509 LYON Cedex 03, France

Adopted in 2007, the action plan on polychlorobiphenyls (PCB) in the Rhone river basin for 2008-2010 aims to improve our understanding of the origins of this pollution in the catchment, its extent and the factors controlling it. Bottom sediments are acknowledged to play a key role in biota contamination process, including fish. This role for sediments covers various implications, in particular a PCB concentration level in sediment acceptable in the perspective of fish consumption. Answering this question entails to understand the relationships between sediment and fish PCB contamination at a large spatial scale.

This study was set up so as to exploit the database developed in the context of this action plan, in order to achieve the following objectives: (i) to determine a sediment quality threshold for indicator PCBs (iPCB) corresponding to the regulatory threshold for fish, based on dioxin toxic equivalent (TEQ); (ii) to study the factors influencing the accumulation of mercury in fish, and (iii) to study the accumulation of polybromodiphenyl-ethers (PBDE) and perfluorinated compounds (PFC).

We showed that eel, giant catfish, barbel, bream and common carp display highly variable TEQ concentrations, opposite to tench, roach, chub, pike and pike-perch. The two latter species are the least contaminated ones. The species, weight and lipid content are well correlated to total TEQ when all species are accounted for.

A bootstrapping approach is presented, allowing to describe the #153 biota-to-sediment accumulation factors (BSAF) for 10 species throughout the Rhone river basin. Eels and barbels display the highest BSAFs, while chubs and common carps display the lowest ones. Indicator PCBs concentrations in sediments, as well as BSAFs, are higher in sites where fish exceed the fish advisory level (based on TEQ).

A sediment concentration threshold equal to 27 ng.g⁻¹ dry weight (15.6 – 39.3), corresponding to the fish advisory level of 8 pg TEQ.g⁻¹ fresh weight, was derived on the basis of the barbel's BSAF distribution. The overall efficiency of this value is nonetheless limited to 60%.

The species most contaminated by mercury are the barbel and the tench, and to a lesser extent the eel, the pike-perch and the pike. Most samples lay between the environmental quality standard (EQS) for biota implemented according to the Water Framework directive, and the European fish advisory level targeting fish consumption.

Among the 9 PBDE congeners measured, the congener #47 is dominant, followed by the congener #209. The contamination patterns are somewhat different between species: while eels and chubs accumulate congeners #47, #100 and #209, barbels and nose-carps accumulate mainly #47 and #209. Trouts accumulate #47, #99, #100 and #209. These interspecies differences could be explained either by sources (e.g. atmospheric transport) or differences in hepatic metabolism.

The most frequently detected PFCs are octanoates (PFOS, PFOSA), nonanoate (PFNA), decanoate (PFDA), and undecanoate (PFUnA). When considering the sum of concentrations of 17 PFC, the species most prone to accumulate are the gudgeon, the roach, and to a lesser extent the European eel and the barbel. Except the PFOS, 1 to 7

different PFCs are encountered at each site, suggesting both diffuse sources, when few compounds are detected, and direct releases from industries when more compounds are present. Several areas where such releases could be suspected have been identified.

EQS are being prepared in the context of WFD implementation for penta- and octa-PBDE, as well as for PFOS. It could therefore be interesting to study the incidence of EQS exceedence in the Rhône-Méditerranée dataset.

Chub appears as the most common species throughout the basin, and also a kind of "median species", according to most variables including contamination by PCB or mercury. These observations sustain the use of this species as a bio-monitor. However, it does not accumulate PCBs nor mercury very much. The barbel, though less widespread than the chub, accumulates much PCBs, PBDEs and mercury, and to a lesser extent PFCs. This species seems essential for the study of long-term contamination trends, in particular for PCBs. Anyway, a reduction of the number of species sampled and analyzed for persistent contaminants should be considered. The most common species in the Rhône-Méditerranée basin database are the chub, the barbel, the eel, the roach, the nose-carp, and the river trout. These species are also those which are most prone to accumulate the whole range of contaminants studied until now (PCBs, PBDEs, PFCs and mercury).