Looking for an appropriate monitoring design for Water Framework Directive priority substances targeting biota

Marc BABUT[1], Caroline SIMONNET-LAPRADE[2], Mathilde LAUZENT[2], Pierre LABADIE[2], Benoit J.D. FERRARI[3], Hélène BUDZINSKI[2] and Olivier PERCEVAL[4]

[1] Irstea, UR MALY, BP 32108, 69616 Villeurbanne Cedex, France Phone: +33-(0)4 72 20 87 28

[2] Université de Bordeaux, Environnements et Paléoenvironnements Océaniques et Continentaux (EPOC), UMR 5805 CNRS, Laboratoire de Physico- et Toxico-Chimie de l'environnement (LPTC), 351 cours de la Libération, 33405 Talence, France E-mail: marc.babut@irstea.fr

[3] Swiss Centre for Applied Ecotoxicology, Eawag/EPFL, EPFL ENAC IIE-GE, Station 2, CH-1015 Lausanne, Switzerland

[4] French Agency for Biodiversity/DREC, 5 Square Félix Nadar, 94300 Vincennes France

Introduction: With the adoption of the European directive 2013/39/EU, following the directives 2000/60/EC and 2008/105/EC, fifteen chemicals were added to the priority substance (PS) list, and the corresponding environmental quality standards (EQSs) were set as well. For eleven of these PSs, the EQSs target biota, in particular fish. This new orientation raises numerous questions relating to the monitoring strategy and compliance assessment. One possible option could be to implement a tiered approach, consisting at the first tier to screen the water bodies using water, sediment or caged invertebrates, so as to focus at the second tier on fish sampling in the water bodies at risk of exceeding the EQSs. Such an approach involves the use of predictive models allowing estimating the probability of exceeding the EQSs at the first tier. We studied the possibility of using trophic magnification factors (TMFs) [1] for this purpose, for two PSs, namely perfluorooctane sulfonate (PFOS) and polybromodiphényl ethers (PBDEs; congeners 28, 47, 99, 100, 153 and 154).

Methods: Benthic invertebrates and two fish species (barbel – *Barbus barbus*; chub - *Squalius cephalus*) were collected at five river sites, representing various conditions in terms of river width or flow and contamination level. All the organisms were analyzed for PBDEs, PFOS, and isotopic ratios ($\delta^{13}C$ and $\delta^{15}N$). Some of the fish individuals were also dissected in three fractions (muscle, liver and a fraction regrouping the skin, the viscera and the carcass), which were analyzed for PBDEs or PFOS. Regression models were derived from the results, so as to estimate whole-body concentrations from measurements in fillets (muscle). In parallel, caged organisms (namely *Chironomus riparius* larvae and *Gammarus* spp.) were exposed for one week at the same sites, and analyzed for PFOS, PBDEs and isotopic ratios.
Several regression approaches were tested for determining TMFs: simple linear regression, Kendall regression, and a linear mixed effect model.

Results: TMFs could not be determined at all sites with all approaches; the method performing best was the linear mixed effect model, but when the comparison was possible (e.g., for PBDEs) the differences with the Kendall's regression were not significant.

The TMFs resulting from the mixed effect model ranged from 1.27 ± 0.15 to 4.09 ± 1.34 for PFOS and from 1.71 ± 0.31 to 5.71 ± 2.62 for PBDEs. Based on these TMFs and on the concentrations measured in caged organisms, PBDE or PFOS concentrations in barbels or chubs were estimated. For PFOS, the predicted concentrations remained below the measured ones at all sites but one, but exceedance of the EQS (or not) was correctly predicted in all cases. The predicted PBDE concentrations in fish were similar to the observed concentrations at two sites out of four. The prediction of EQS compliance could not be assessed, because all sites exceeded the EQS for PBDEs.

Discussion: There are numerous sources of uncertainty, as well as methodological difficulties affecting the determination of TMFs [1], making it tricky to use such models for the targeted purpose. Moreover, the use of caged organisms still needs technical improvements such as exposure duration or the estimation of food intake, Nevertheless this approach seems promising, and could be helpful for the first tier (screening) of the future monitoring strategy.

Acknowledgements: This study was funded by ONEMA, the French National Agency for Water and Aquatic Environments, through the 2010-2013 partnership agreement with IRSTEA, action n°38.

References: [1] Borgå, K., Kidd, K.A., et al. (2012) *Integr. Environ. Assess. Manag.* **8**: 64-84