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1. See: http://ec.europa.eu/environment/water/water-framework/index_en.html
2. See: http://chm.pops.int/default.aspx

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Science for Environment Policy

New tiered-approach to assessing hazardous substance levels in water

Debate exists as to whether environmental concentrations of the hazardous substance hexachlorobenzene (HCB) should be measured in water or in wildlife when assessing compliance with environmental quality standards (EQS). New research has proposed a method to calculate concentrations in water that best represent critical levels in wildlife, and a tiered approach to compliance assessment that minimises sampling of wildlife.

The EU Water Framework Directive (WFD)[1] defines EQS for certain polluting substances, which generally consist of concentration thresholds within water, sediment or wildlife. Hexachlorobenzene (HCB) is classified as a priority hazardous substance by the WFD and therefore needs to be monitored to determine whether the relevant EQS is met.

HCB was formerly used as a fungicide until it was banned by the Stockholm Convention[2], and has a high 'bioconcentration' potential, which means it accumulates in organisms to a higher concentration than in the surrounding water. The WFD therefore established an EQS in wildlife (at 10 micrograms (µg) per kg). However, in some countries, such as the Netherlands, there is a preference for measuring concentrations in water samples rather than in wildlife (typically mussels or fish).

The study investigated the feasibility of converting the wildlife-based EQS for HCB into an equivalent water-based QS, which could reduce the need for sampling of wildlife, bringing both welfare and efficiency benefits. This can be done by using a reliable bioaccumulation factor (BAF) which is the ratio of HCB concentration in wildlife to the concentration in the surrounding water.

As it is difficult to accurately measure the BAF in the natural environment, it is often estimated by multiplying the bioconcentration factor (BCF) by the biomagnification factor (BMF). In small fish, the BCF is essentially the same ratio as the BAF, and is usually determined in laboratory studies. The BMF is the ratio of the HCB concentration in a predator to the concentration in a prey organism, generally determined in the field.

From an extensive analysis of previous studies, the study's authors calculated a mean value of 12,800 litres/kg for the BCF. The mean value of the BAF was much greater at 238,000 litres/kg. However, these included a few values that were extremely high, for example, the worst-case BAF for 3-year-old *Coregonus autumnalis* (a freshwater whitefish) was 2,116,000 litres/kg. When ignoring extreme values such as this, it appeared that the BAF values were strongly related to a species' position within the food chain (or its 'trophic level'). The analysis of BMFs produced an average value of '3' per trophic level, i.e. the concentration is on average three times higher in the predator than in the prey.

The results demonstrated that the BAFs from field samples in a natural setting differed from the laboratory BCF measures by several orders of magnitude, and that even the estimate of the BAFs calculated by multiplying the BCF and BMF (3 x 12,800 = 38,400 litres/kg) underestimated the observed BAFs, which ranged from 48,000 to 885,600 litres/kg.

Based on the findings, the authors suggest a 'tiered approach' to assessing compliance with the EQS for HCB. They suggest first calculating a water EQS using a BAF for the fish that are most relevant for human consumption, which, in the case of HCB, is large fish. Large fish have an estimated BAF of 372,000 litres/kg which yields a water EQS of 0.026 nanogrammes per litre.

Then, if this water standard is exceeded in samples from surface water bodies, representative samples of fish from those waters could be tested to compare their concentrations to the wildlife-based EQS in order to decide, using a weight of evidence approach, whether the EQS is met or exceeded. The authors acknowledge the need to achieve the very low limit of detection required for measuring in water at levels corresponding to the water EQS.