Environment Agency

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# Bioaccumulation of chemicals in fish: correcting for growth and parameterising depuration rate constant

This report considers two new approaches to interpreting how chemicals build up in fish (bioaccumulation), specifically correcting for fish growth and the rate at which chemicals levels fall after exposure (depuration). The study follows on from an earlier Environment Agency report: "Estimation of fish bioconcentration factor (BCF) from depuration data" (Environment Agency Evidence Report SCHO0811BUCE-E-E)

Bioaccumulation is an important piece of information in assessing the risk of chemicals and for regulatory regimes such as the EU chemicals regulation REACH (the Registration, Evaluation and Authorisation of Chemicals). When means of getting information on bioaccumulation potential are not viable, fish are generally used as the key indicator for bioaccumulation in laboratory studies. Studies investigate how a chemical is taken up into fish in an exposure phase, and how the chemical is lost from the fish when exposure is ceased (so-called depuration). Our understanding of the effect of different processes in such tests is constantly improving and so we need to update the way in which we interpret the information that is measured.

This report looks at two aspects related to interpretation of fish bioaccumulation data:

**Fish growth**

How fish grow during a study can have a marked influence on the study's results. To date, one method has commonly been used to account for fish growth in such research, but this method has shortcomings. This report proposes and investigates a different method for correcting study results for fish growth that may be used when the current method does not work well.

This alternative method is based on calculating the amount of substance per fish rather than the mass concentration of substance per unit mass of fish.

The report describes the theory behind the approach and presents several examples from studies using both rapidly growing and slowly growing fish combined with faster and more slowly depurating chemicals. Overall, the analysis shows that the method is a viable and appropriate alternative which is also useful when there are uncertainties over whether fish growth is following a predictable rate.

**Parameterising depuration rate constant**

A new laboratory method for measuring bioaccumulation in fish has been proposed which is recommended for poorly water-soluble chemicals that cannot be tested by exposure via water (this is the method that has been used until now).

The new method involves exposing fish to the test chemical via the diet. This different route of exposure means that the study results in a dietary biomagnification factor (BMF) – the ratio of the concentration of the chemical in the fish's body to the concentration in the food. The laboratory method that has been used to date results in a bioconcentration factor (BCF; the ratio of the chemical concentration in the fish to the chemical concentration in water). The two measures of bioaccumulation potential, BCF and BMF, are not directly comparable.

This difference in bioaccumulation measure is important because in several regulatory regimes, the criteria for a chemical being categorised as bioaccumulative (B) or very bioaccumulative (vB) are based on BCF and not BMF. In addition, risk assessment requires a BCF (and in some cases also a BMF) to estimate concentrations in prey for the investigation of risks from secondary poisoning. BMFs obtained from the new dietary study could be used to demonstrate qualitatively that a chemical is not taken up (and so is unlikely to meet the criteria for B or vB) or, in other cases, indicate that a chemical would be likely to meet the B or vB criteria.

However, as many of the chemicals that will be tested with the new method are likely to be B or vB candidates, being able to estimate a BCF from the data generated in the dietary study would be a great advantage and meet an accepted regulatory need. Therefore this report also investigates the use of the depuration rate constant, $K_2$, (or the elimination half-life) as a direct measure of bioaccumulation potential and an alternative parameter for indirect comparison against regulatory PBT (persistent, bioaccumulative and toxic) and vPvB (very persistent and very bioaccumulative) criteria based on BCF. This part of the report follows on from the approach to estimating a BCF from dietary fish bioaccumulation study data that was investigated in the previous report.

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**Project manager:** Daniel Merckel, Evidence Directorate

**Research Contractor:** Building Research Establishment Ltd (BRE), Bucknalls Lane, Garston, Watford WD25 9XX
Tel: 01923 664000

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