science summary

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Environmental Quality Standards for trace metals in the aquatic environment

Science Summary SC030194

Researchers at the Centre for Ecology and Hydrology have developed a new approach for setting Environmental Quality Standards (EQSs) for some important metals. The Toxicity Binding Model (TBM) calculates toxicity thresholds and quantifies the contributions of different metals to the overall toxicity.

EQSs are normally based on acute and chronic laboratory toxicity experiments on environmentally representative organisms. For metals, the organisms would usually be exposed to dissolved salts of the substance. However, this simple approach may not account for important factors, for example the amount of natural organic matter present in the environment, that may affect the toxicity of the metal.

The use of metal EQSs that do not account for the bioavailability of metals can lead to either the overprotection of waters or an underestimate of the risk of adverse impacts depending on the site specific conditions. The application of the TBM could help the Environment Agency set appropriate and site-specific EQSs.

In this study, the researchers targeted upland streams influenced by historic mining activity, allowing them to explore the relationship between stream water metals and ecological response with minimal other confounding chemical factors. Stream water was analysed for metals and other relevant chemical parameters together with field sampling of macro invertebrates and diatoms. The aim was to establish a quantitative relationship between measured metals concentrations and the observed impact on the ecology.

At the field sites selected, metals concentrations appeared to reduce the species numbers of both macro invertebrates and diatoms.

The macro invertebrate community provided an effective and sensitive tool for detecting metal toxicity. The researchers found that aluminium and zinc had a toxic effect on macro invertebrates; there was some evidence of toxic effects due to acidity and copper. Diatoms were less sensitive to elevated metals concentrations than macro invertebrates.

The report supports the use of Biotic Ligand Models (BLMs) as a mechanism for accounting for bioavailability when setting water quality standards. However, BLMs are metal specific and therefore consider the bioavailability and toxicity of each metal in isolation.

The TBM developed in this project takes BLMs to the next level, to quantify the contributions of different metals to the overall toxicity.
The report also describes emerging methodologies for the analysis of 'free' or uncomplexed metal ions in waters as a potential direct measurement of available metals. The research found that metals concentrations measured in the body burdens of macro invertebrates and bryophytes from the field sites correlated with the concentrations predicted by the TBM models.

This summary relates to information from Science Project SC030194, reported in detail in the following output:

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