The Lead Biotic Ligand Model: a tool for the protection of aquatic life

- **One of the most important environmental research projects conducted by the lead industry in recent years has been the development of a method, the Biotic Ligand Model (see box below for definition of BLM), to predict more accurately the toxicity of lead to freshwater species under different environmental conditions.**
- **The BLM helps regulators and industry ensure the protection of rivers, lakes and streams from potential risks of metals such as lead.**
- **Managed by the International Lead Zinc Research Organization (ILZRO) the project[1] has advanced our understanding of how lead affects species living in freshwater environments.**
- **The results of close to $1.5 million of BLM research on lead are now used by regulatory agencies around the world when setting water quality standards.**

Field research for the BLM project in US wetlands.

What is a biotic ligand model?

The biotic ligand model (BLM) is a computer model that can predict how the toxic effects of metals on aquatic freshwater species, such as fish, crustaceans and algae, vary with changing water conditions. BLMs use the concept of 'bioavailability', which is a measure of how much of the metal in a body of water is available to cause a toxic effect.

Why was the research needed?

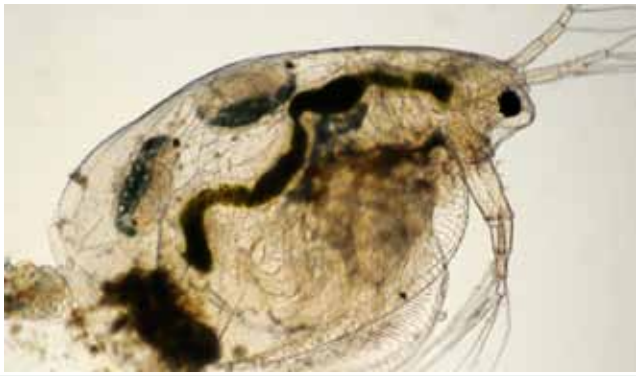
The toxic effect of any given concentration of metal in water can vary widely in different rivers or lakes because of the influence of 'water chemistry' (e.g. the hardness or pH of the water). In the past this resulted in regulators facing a great deal of uncertainty when setting water quality standards to protect aquatic species. The lead industry therefore recognised the need for a robust tool, based on sound science, that could assess the impacts of local water conditions on toxicity and allow for a more accurate risk assessment at specific freshwater locations.

What did the research reveal?

- Confirmation that the bioavailability and toxicity of lead to species such as fish, plants and invertebrates (such as snails) are not the same in all freshwater ecosystems due to chemical differences in the waters.
- The BLM can predict the bioavailability and acute (short term) and chronic (long-term) toxicity of lead over a wide range of water quality conditions observed in Europe, North America and other parts of the world.
- The amount of organic matter in the water in the form of 'dissolved organic carbon' (DOC) strongly affects lead toxicity. In fact DOC can be more important than water hardness, despite the fact that some existing water quality standards around the world currently account for the effects of hardness and not DOC.

[1] All research projects aiming at BLM development were commissioned in independent laboratories in Europe (University of Ghent, Belgium; ARCHE, Belgium, and Wageningen Agricultural University, the Netherlands) and North America (University of Miami, Florida; Parametrix Inc, Oregon; HydroQual Inc, New York, and Aquatox Inc., Canada).

CASE STUDY continued...



Daphnia: one of the standard species for which all BLMs are developed

Dr. Jasim Chowdhury, of ILZRO, said:

"Our findings show that the BLM represents a significant scientific advancement in ecological risk assessment for lead. Eventually we expect that BLM models will replace the approaches currently adopted by regulators, thereby improving environmental protection of waters around the world."

How is the research being used?

- **The BLM for lead will help protect the environment** - BLM's have already been developed for several other metals, such as copper, zinc and nickel, and are is recognised in many regions of the world as a state-of-the-art tool for assessing metal toxicity to aquatic organisms. The development of a BLM for lead is a significant scientific development that will help scientists and regulators protect our freshwater environment.

- **The basis for a new EU environmental quality standard for lead** - Europe is leading the way in applying the BLM model for regulatory compliance for several metals. The lead industry's sponsorship of independent BLM research has been the basis for the new EU environmental quality standard for lead as it showed that DOC was a more important predictor of toxicity than either total dissolved metal or metal concentrations corrected for water hardness.

- **Used extensively for regulatory risk assessment** - The BLM research has also been used extensively to underpin environmental risk assessments submitted by the lead industry to support the EU Registration, Evaluation & Authorisation of Chemicals (REACH) Regulation for lead metal and inorganic lead compounds.

- **Helping set standards in North America** - The US Environmental Protection Agency (EPA) has also recently initiated a revision of the national ambient water quality criteria (AWQC) for lead and it is hoped that this could be the first time that the lead BLM will be used in deriving water quality standards in the USA.

  In Canada, lead BLM data is currently being assessed by regulators for use in deriving the Canadian national water quality criteria for lead.

What happens next?

The ILA continues to work with regulators around the world to introduce lead BLM concepts into legislation. At the same time, the lead industry will continue to invest in research to further refine the model and to improve the ease with which it can be used by industry and regulators through a simple user-friendly software interface.

Fathead minnow: the BLM predicts the toxicity of lead to fish such as minnow