What methods do we need to identify hazardous substances in the environment?

Marine Theme Objective: Human Pressures and the impacts on the marine environment

What's the problem?

Methods are required to assess the risk posed by chemical pollutants in the marine environment. Existing approaches assess the risk posed by known contaminants with established ecotoxicological effects. This process is not flawless since little or no relevant data are available for the majority of the 120,000 synthetic chemicals listed by EINECS (European Inventory of Existing Commercial Substances). Consequently a 'priority pollutants' approach is very much dependent on quantitative structure activity relationships (QSARs), where the structure of a chemical is modelled to give an estimated toxicity. This process also does not take into account factors such as the formation of breakdown products as chemicals degrade. A 'priority pollutants' approach to assessing inputs and directing monitoring programmes may therefore severely underestimate the real risks that chemicals pose to the marine environment.

What are the aims of the project?

The purpose of this project is to develop a standardised toolbox of techniques that can be used on a case-by-case basis to inform risk assessment processes. These techniques will then be applied to inform existing procedures.

Biological effects monitoring provides a 'broad-spectrum' approach to an area historically dominated by the targeted chemical analysis of priority pollutants. The type of information provided by these techniques offer the environmental manager a better understanding of the stresses placed on ecosystems; however for effective ecosystem management it is necessary to identify the substances causing the observed effects.

Previous Defra funded R&D has shown that unexplained ecotoxicological effects are a recurrent feature when evaluating environmental data. The best available, and most successful, approach to identifying the causes of the observed effects is to employ toxicity identification evaluation (TIE) procedures. These procedures use the response of bioassays to direct the simplification of complex environmental cause-effect relationships in order to isolate and identify the compounds responsible for the observed effect.

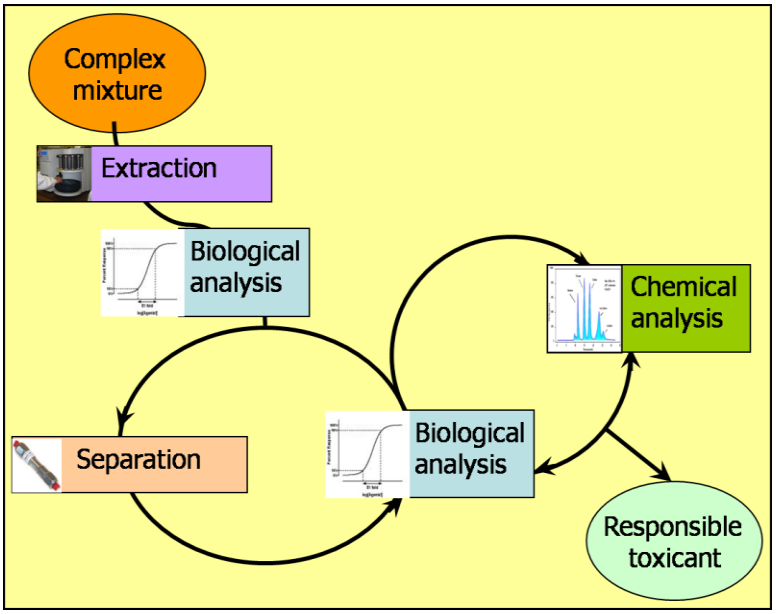

Figure 1: Toxicity Identification evaluation (TIE) procedure for identifying hazardous substances

Which policy areas will the research inform?

Defra's commitments to the clean and safe seas environment monitoring programme (CSSEMP), Food and Environment Protection Act (FEPA), the Oslo and Paris Commission (OSPAR), the Marine Strategy Framework Directive (MSFD) and the EU Water Framework Directive (WFD) requires its environmental managers to have a good understanding of the contaminant stresses that are placed on marine ecosystems.

defra
Department for Environment Food and Rural Affairs

What are the results from the project and how will they be used?

The main output from this project is a toolbox of techniques used to identify hazardous compounds in the marine environment using TIE. The techniques cover all aspects of TIE from sampling and extraction, toxicity testing, separation of complex mixtures, and identification of hazardous substances. For example: Passive sampling methods have been tested and calibrated. This method offers a cost effective way of acquiring time integrated samples with limited labour requirements. Passive samplers can simply be left in the water column to take up contaminants over a period of time. The advantages of this over traditional sampling methods (where a bottle or other vessel is filled with water and returned to the laboratory for processing) are that (a) a large part of the processing is done in the field unaided (b) the sample is much more representative of 'average conditions' and (c) the results can be directly related to 'what organisms (e.g. fish) in the local environment are exposed to'.

Since developing this expertise, these sampling methods are already being used in other programmes, including a UK wide survey, to inform the MSFD.

Sediments licensed for disposal under FEPA currently undergo chemical analysis in order to determine the hazard associated with them. This method does not account for toxic compounds which are not measured routinely. We have developed an approach in which the toxicity is measured before and after being exposed to a passive extraction medium (usually a powder). This allows us to determine how much toxicity is actually available to the organisms in the sediment, and which chemicals contributed to the toxicity.

We have developed a new toxicity test (known as a bioassay), which tests specifically for antibiotic activity. There is increasing concern that the levels of antibiotics in the environment may be sufficient to cause some bugs to become resistance to antibiotic treatment, as has already been the case in treatment works are in danger of failing. There are many different types of antibiotic, and in order to test the levels occurring in the environment, we can use this assay as a screen.

Where activity is found, further chemical analysis can be carried out to determine which types of antibiotic are present. This work has benefits for the urban wastewater treatment directive, as well as the WFD and MSFD.

These methods and others developed will allow us to identify hazardous substances and assess their risk to the marine environment.

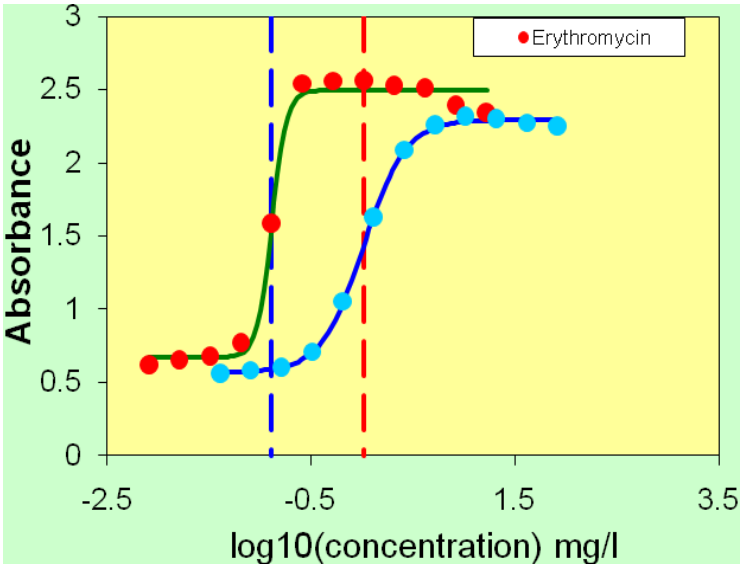

Figure 2: Response of erythromycin and Sulfamethoxazole in Antiobiotic Challenge Bioassay

This research is being carried out be Cefas. For more information see www.cefas.co.uk or contact the project manager directly jan.balam@cefas.co.uk

Alternatively, please contact Defra's Marine and Fisheries Science Unit: marinescience@defra.gsi.gov.uk