NOVEL APPROACHES FOR STATIC MESOCOSM STUDIES WITH HERBICIDES: LINKING MODELLED EXPOSURE WITH THE REALITY OF FLOWING WATER AND OTHER CHALLENGES

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Abstract

A great deal of advance thought and planning is required for many substances before initiating a mesocosm study otherwise there is a risk of conducting a study that is of limited regulatory use. Here we will give advice and considerations for mesocosm studies with herbicides with long aquatic half-lifes. This will be illustrated using example state-of-the-art mesocosm studies. It is hoped that this information will advance mesocosm study design and offer advice to those considering a mesocosm study.

Introduction

Each study required special consideration of the exposure profile in the static mesocosm system versus the reality of flowing water, and a novel design following the principles of E-Link was used. Along with providing conservative exposure estimates, a number of other technical challenges were faced regarding the experimental design and practical conduct of the studies. The key issues faced are presented to drive discussion on alternative approaches for mesocosm testing.

Mesocosm design considerations

The tested compounds have a long DT50 in water, based on standard fate studies, and low Koc's so do not move to sediment to any great extent. This means that when put into a static mesocosm system, they will remain there for the duration of a study. However, the main exposure issue being considered in the risk assessment in each case was moving water. Therefore, static mesocosm studies would be unrealistic and overly conservative. The compounds are also used only once per season, and are toxic to algae and plants in laboratory studies. Therefore it was decided to conduct mesocosm studies in which the compound would be put in the mesocosms and then gradually be diluted out so that the study exposure profile covered the PEC profiles (Figure 1) in a conservative way, using the principles of E-link (Brock et al. 2007).

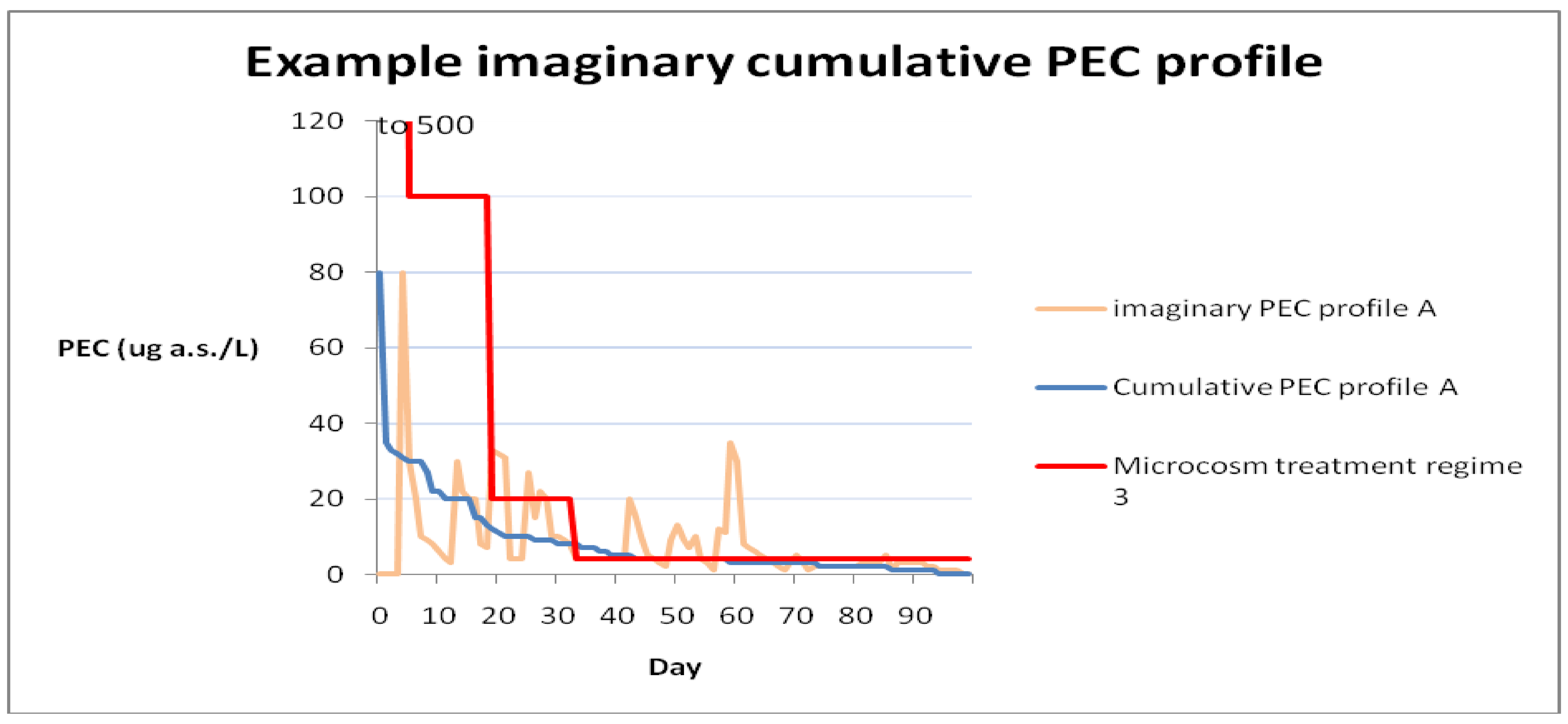


Figure 1. Example cumulative PEC profile.

In each case, three treatments were used, with dilution (Figure 2) occurring in the same way in each, in an attempt to ensure the exposure profiles covered conservative PEC profiles generated from higher-tier modelling with varying safety factors. One of the challenges of this approach was matching exposure within a typical mesocosm study period to modelled exposures where the PEC profile suggested peaks and troughs of exposure over a longer time period than is practical during a mesocosm study due to seasonality. To overcome this problem, the 'cumulative PEC profile' (all peaks compressed together) was calculated for each compound and the microcosm treatment regime was designed to be conservative by including worst case initial exposure levels incorporating safety factors, and also ensuring the area under the curve of the cumulative PEC profile was smaller than the area under the curve of the microcosm treatment regime.

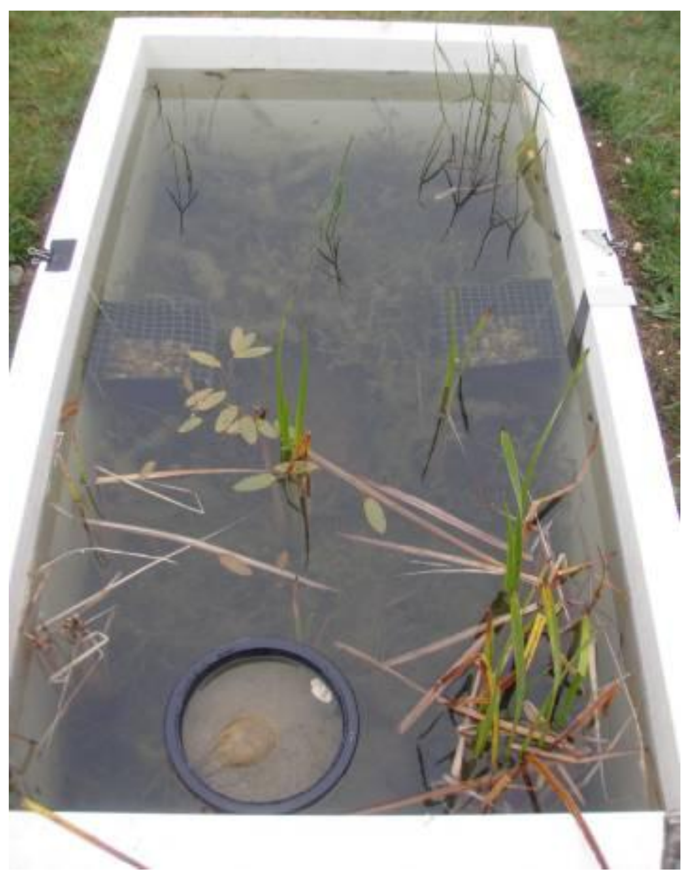
Figure 2. Water dilution

Technical challenges

The main consideration in the design of the studies was to remove the compound over time in such a way as to conservatively cover PEC profiles for moving water (slow and fast). In addition, a small amount of the compound was left in the system so there was also an element of static design to cover PEC profiles for static ponds, which tend to be lower. The analytical chemistry demonstrated that the dilution method was very successful and concentrations over the dilution phase can closely match the nominal design. However, in one study there was unexpectedly fast degradation/dissipation of the compound in the mesocosms, which may be attributed to the plant community.

Effects followed by recovery were demonstrated. However, in some cases the standard recovery period should be reconsidered when more realistic application timings are employed. In addition, the life history characteristics of some taxa within the macrophyte community means that the accepted approach to demonstrating recovery should be reconsidered for studies which include slow growing species. In addition, careful consideration of the relevant level of taxonomic detail is required for interpretation of effects on naturally fluctuating algal communities.

Mesocosm on Day 0



Mesocosm on Day 112

In addition, as the exposure profiles in the mesocosm studies included levels where effects on autotrophs and in one case zooplankton were expected, we were required to evaluate the possibility of effects on invertebrates.

Conclusions

Careful consideration must be made before conducting a mesocosm study. Aspects such as: compound DT50, entry mode to surface water, type of water body being considered, PEC profile over time, feasibility and cost must be considered. Due to the increasing complexity of exposure calculation and risk assessment, mesocosm studies must also increase in their design complexity in order to stay relevant to the regulatory risk assessment. It will be necessary for both laboratories and regulators to be open to novel designs which do not necessarily fit with recent standards for mesocosm assessment.

Reference

Brock T, *et al*. 2007. Linking Aquatic exposure and effects in the registration procedure of plant protection products (E-link). SETAC Press.