PLANT RECOVERY: A MESOCOSM PERSPECTIVE

CAMBRIDGE ENVIRONMENTAL ASSESSMENTS

Experiences of demonstrating recovery to herbicide exposure in sloped mesocosms

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INTRODUCTION

Recovery is important when considering short term exposure of aquatic non-target plants to herbicides in edge of field water bodies. Unlike indoor laboratory studies, where test item concentrations are artificially maintained, mesocosm studies allow for a more realistic application and dissipation of test item. Therefore, mesocosm studies can assess both direct and indirect effects whilst a test item is present, and also monitor the period after dissipation has occurred to assess possible recovery.

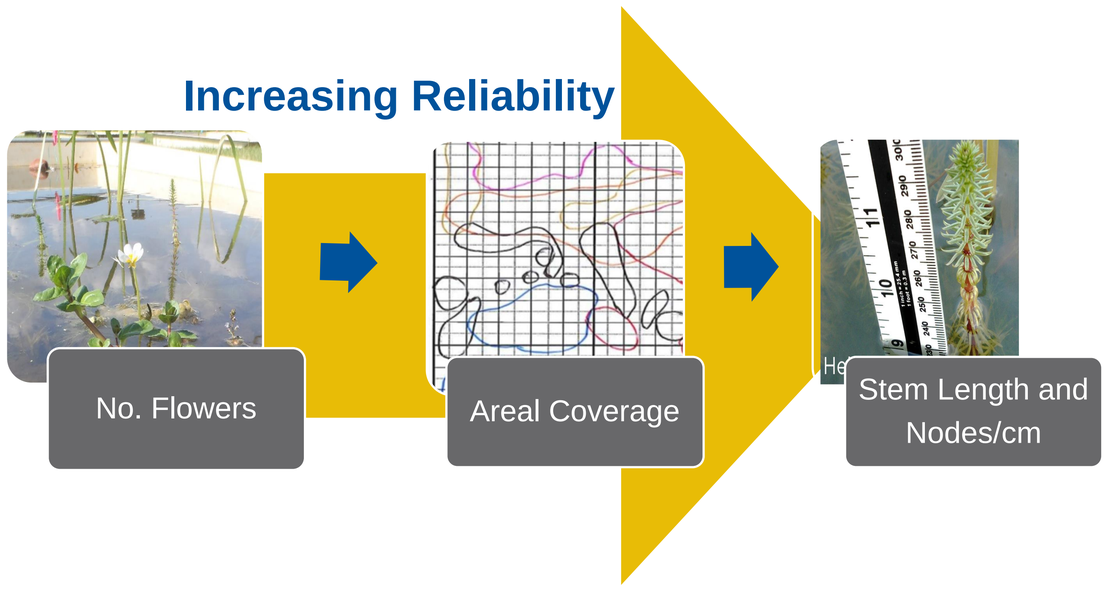
Here we have collated results from previous studies using specially designed sloped mesocosms to share experiences of assessing plant health. We will summarise which endpoints are the most sensitive and reliable and therefore most suitable for determining effects on each plant species. Finally we will discuss which of these measurements are most relevant to assess recovery.

METHODS

At CEA a mesocosm for herbicide exposure typically tests eight macrophyte species, of varying morphological traits (*Ceratophyllum demersum, Elodea canadensis, Glyceria maxima, Hippuris vulgaris*, *Myriophyllum spicatum*, *Ranunculus aquatilis*, *Sagittaria sagittifolia, and Veronica beccabunga*). Macrophyte health is assessed by measuring the total stem length per replicate, numbers of stems, flowers, leaves, nodes over 10 cm, and areal coverage. Finally on completion of the test period (approximately 84 days), portions of macrophytes are removed from the mesocosms and the wet and dry weight of each species is determined.

Reliability

For the testing of pesticides, all data must be assessed for reliability by calculating minimum detectable differences (%MDD) as per the EFSA guidance[1]. On review of our past studies, the following parameters are ranked most reliable (i.e. most occasions where MDD class IV was observed).



Wet and dry weight measurements (final biomass) endpoints are more variable and largely dependant on species dominance. In general, more abundant species (e.g. *Elodea candensis*) have increased reliability.

Sensitivity

Sensitivity of endpoints varies between species, and in some instances between studies. This is thought to be due to the mode of action of the herbicide. However the following generalisations can be made:

Elodea canadensis: Nodes and biomass > Coverage

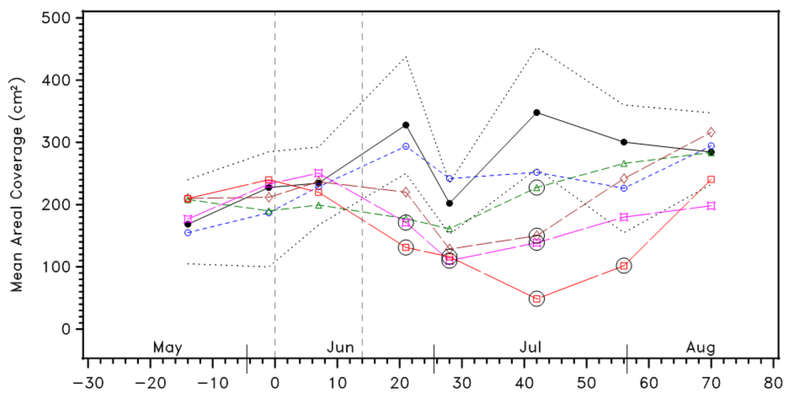
Myriophyllum spicatum: Coverage and Biomass > Nodes

Hippuris vulgaris: Stem length > Stem number> coverage

For the other five species used in our mesocosm studies, the sensitivity of each parameter was found to be similar.

But is it possible to demonstrate recovery?

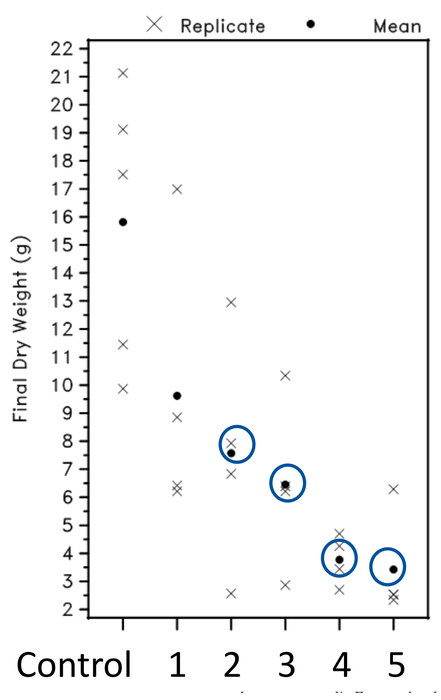
- Stem length/ number (as growth rate) ✓
- Areal Coverage ✓
- Nodes ✓
- Final wet and dry weight biomass ?



Day	-14	-1	7	21	28	42	56	70
NOEC	5	5	5	3	3	1	4	5
%MDD	57	46	48	47	38	33	59	42

The Biomass Conundrum

Stem length and number (as growth rate), areal coverage and nodes measurements can all be used show that plants are recovering and growing following herbicide exposure. However, it is rare that biomass is not statistically different at the end of the study, even if only a transient effect is observed in alternative parameters. Affected mesocosms often never "catch up". This is thought to be due to the relatively slow and exponential growth of macrophytes. For submerged species, recovery may be seen in areal coverage, however, the density of plant material (which is based on side shoot growth) may not be achieved. Alternative parameters can be as reliable and just as sensitive as final biomass, but allow for the demonstration of recovery.



CONCLUSION AND RECOMMENDATIONS

- The sloped mesocosm design can reliably determine effects for >8 species with varying physiological traits
- A combination of measuring techniques is most effective to determine the most sensitive endpoints
- Wet and dry weight biomass is a single endpoint and therefore does not always reflect whether recovery has been observed due to growth. The addition of parameters such as no. stems, nodes, or coverage enable a more accurate determination of growth rates.
- Mesocosms provide a more realistic recovery, whereby inter species competition can be observed.

References:
1 EFSA PPR Panel (EFSA Panel on Plant Protection Products and their Residues) (2013). Scientific Opinion - Guidance on tiered risk assessment for plant protection products for aquatic organisms in edge-of-field surface waters. EFSA Journal 2013; 11(7): 3290.