PS2339: Assessing the temporal / seasonal changes in the ecology of untreated mesocosms and natural water bodies to inform the uncertainty associated with aquatic risk assessments of plant protection products

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Introduction

- Key questions & objectives
- Findings
- Recommendations
- Conclusions
- Questions

Key questions

- Are mesocosms sufficiently ecologically representative of UK water bodies in the agricultural landscape?
- Do mesocosm studies with spring/summer applications represent the ‘worst-case’ scenario?
- Do seasonal changes in community structure increase the uncertainty associated with mesocosm endpoints when applied to autumn pesticide applications?

Objectives

1. Improve our knowledge of the temporal variations of aquatic communities of edge-of-field water bodies in the UK
2. Determine the extent to which mesocosms realistically represent these systems

Assess the level of uncertainty associated with different seasonal pesticide applications used in mesocosm studies and the relevance of derived ecological endpoints to risk assessments

Findings

- Environmental parameters
- Macro-invertebrates
- Zooplankton
- Phytoplankton
- Macrophytes
- Seasonal sensitivity

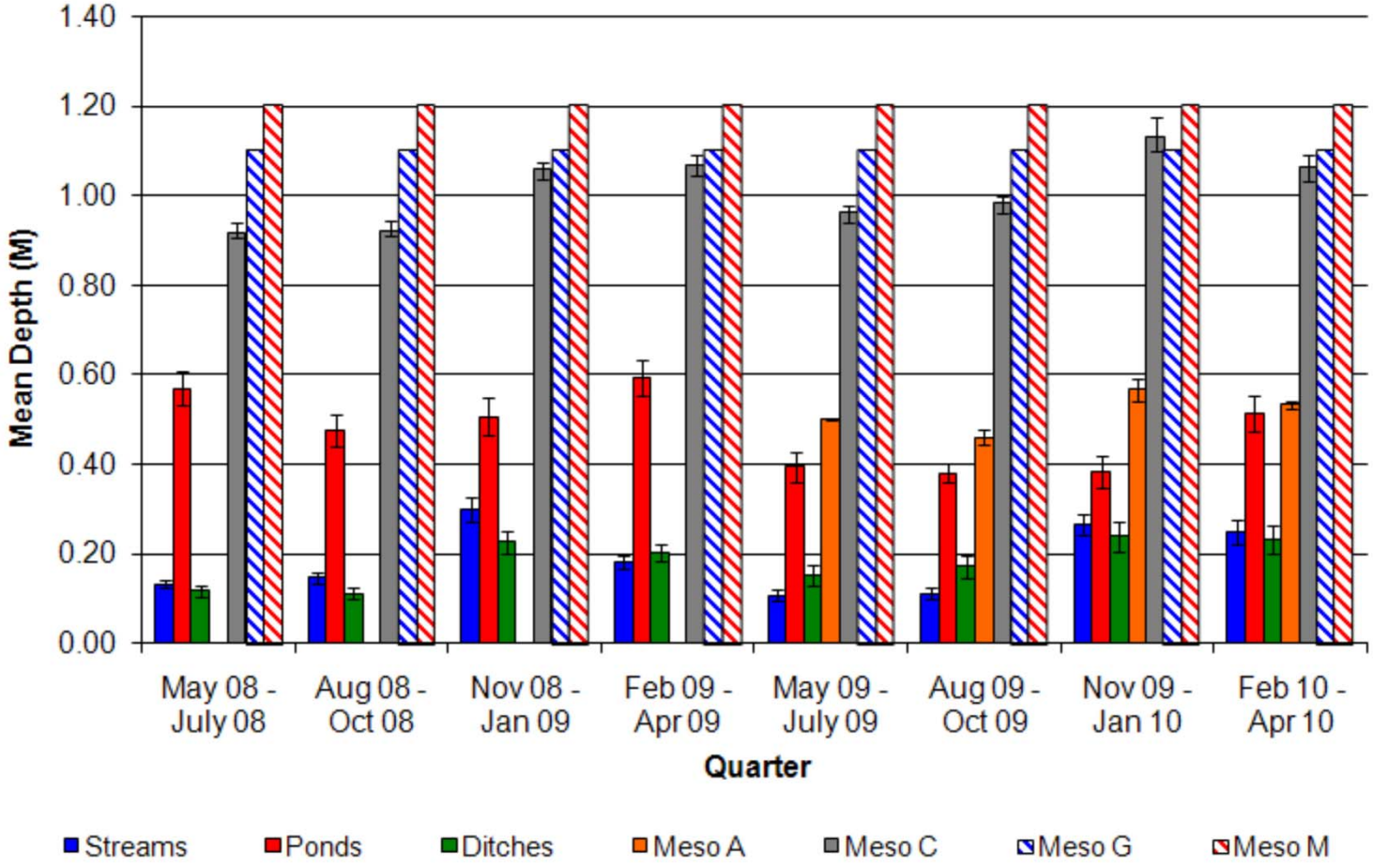
Environmental parameters

- Environmental parameters in mesocosms and edge of field water bodies generally comparable for most parameters
- Mesocosms could be considered to be worst case as there are less dissolved solids which could limit exposure of strongly adsorbing substances

Environmental parameters

- Depth of water is much higher in most mesocosms but the effects of this are less well known
- This can have a direct effect on the taxonomic composition and some environmental parameters due to the gradients found i.e. high D.O. at surface layers and low at bottom

Water depth


1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Mean Depth (M)
May 08 - July 08
Aug 08 - Oct 08
Nov 08 - Jan 09
Feb 09 - Apr 09
May 09 - July 09
Aug 09 - Oct 09
Nov 09 - Jan 10
Feb 10 - Apr 10
Quarter
Streams
Ponds
Ditches
Meso A
Meso C
Meso G
Meso M

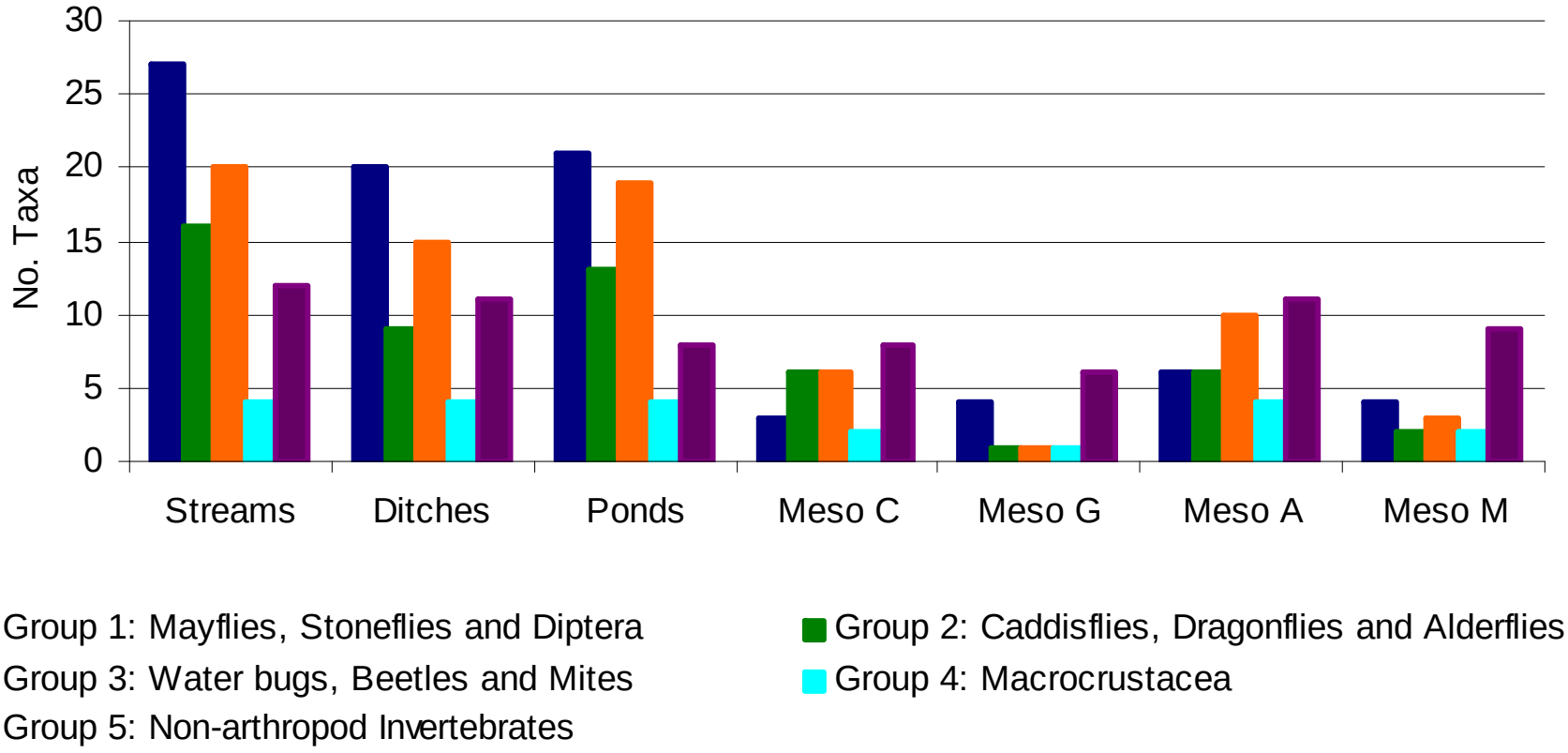
Macro-invertebrates

- Mesocosms can contain taxa representative of all functional groups of organisms so they could be considered to be representative and protective
- It should be accepted that diversity in mesocosms will be lower and as a result representative taxa should be fewer but more abundant; this is necessary for robust statistical evaluations

Macro-invertebrates

- Taxonomic richness is generally higher in edge of field water bodies
- The comparative sensitivity of some taxa is unknown therefore uncertainties remain regarding the representivity of the assemblages present in mesocosms

Macro-invertebrates: Taxonomic richness Yr2



Zooplankton

- Communities in mesocosms are highly representative and protective of all ecosystems
- Some taxa e.g. Bosminidae were not represented in this study but it is unlikely to be a concern as numerous other cladocera are present in mesocosms

Zooplankton: Number of taxa

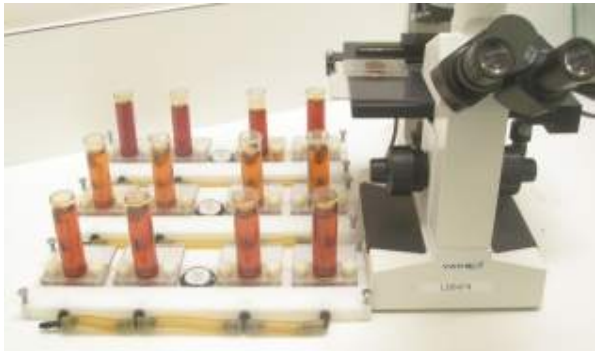
Functional group	Water body type / Mean No. taxa per quarter						
	Streams	Ponds	Ditches	Meso A	Meso C	Meso G	Meso M
Cyclopoida	1.8	2.0	2.0	2.0	2.0	2.0	1.9
Calanoida	0.0	0.1	0.1	1.0	0.5	0.5	0.9
Insects	0.8	1.9	0.8	1.8	1.1	1.0	0.9
Fish lice	0.1	0.4	0.3	0.0	0.4	0.1	1.0
Chydoridae	0.4	1.5	0.8	1.0	2.3	2.1	1.7
Daphniidae	0.8	2.1	0.5	1.8	1.9	1.9	1.7
Bosminidae	0.1	0.6	0.0	0.3	0.0	0.0	0.0
Totals	3.9	8.6	4.5	7.8	8.1	7.6	8.0

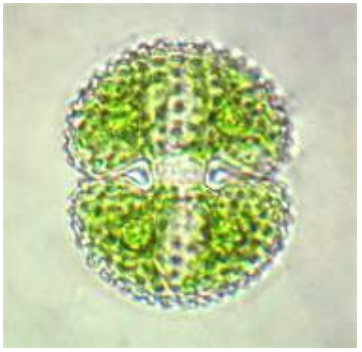
Zooplankton: Number of taxa

Rotifera family	Water body type / Mean No. taxa per quarter						
	Streams	Ponds	Ditches	Meso A	Meso C	Meso G	Meso M
Asplanchnidae	0.0	0.4	0.0	0.0	0.0	1.3	0.1
Brachionidae	2.0	3.3	2.1	1.1	2.5	3.3	2.4
Epiphanidae	0.0	0.3	0.0	0.1	0.1	0.0	0.0
Euchlanidae	0.1	0.3	0.3	0.0	0.4	0.6	0.4
Filniidae	0.1	0.9	0.0	0.0	0.4	0.1	0.7
Gastropodidae	0.6	0.6	0.6	0.5	0.8	0.0	0.1
Habrotrochidae	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Hexarthridae	0.0	0.1	0.0	0.0	0.0	0.4	0.7
Lecanidae	0.6	0.9	0.5	0.4	0.8	0.8	1.1
Lepadellidae	0.4	1.3	0.6	0.8	1.1	1.1	1.7
Mytilinidae	0.3	0.6	0.0	0.3	0.6	1.0	0.9
Notomatidae	0.0	0.1	0.0	0.1	0.0	0.0	0.0
Proalidae	0.0	0.0	0.0	0.0	0.0	0.1	0.9
Synchaetidae	0.6	1.1	0.4	0.5	1.5	2.0	1.6
Testudinellidae	0.4	1.0	0.6	0.3	0.8	0.5	0.4
Trichoceridae	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Trichotriidae	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Totals	5.1	10.8	5.1	4.0	8.9	11.1	11.6

Phytoplankton

- The mesocosms surveyed contained all the taxonomic classes found in edge of field water bodies
- The variability of the data makes it difficult to understand and interpret the results





Phytoplankton

- Effects on the phytoplankton community should be evaluated at the class level
- Mesocosm endpoints should be supported by statistical analysis of key functional parameters e.g. dissolved oxygen as indicators of toxic stress to improve the statistical reliability of the results

Phytoplankton: Taxonomic richness

Phytoplankton class	Water body type / Mean number of taxa						
	Streams	Ponds	Ditches	Meso A	Meso C	Meso G	Meso M
Bacillariophyceae	8.1	7.0	8.4	1.6	5.8	3.3	4.9
Chlorophyceae	12.5	14.3	14.4	3.0	8.0	3.5	12.1
Chrysophyceae	5.8	7.5	7.1	1.3	4.6	2.0	7.0
Craspedophyceae	2.0	2.5	2.6	0.8	1.4	1.0	2.3
Cryptophyceae	3.6	3.6	3.5	1.0	1.9	0.6	3.9
Cyanophyceae	0.5	1.0	1.3	0.1	0.4	0.4	1.5
Dinophyceae	2.0	2.0	1.8	0.8	1.6	1.0	1.1
Euglenophyceae	0.1	0.4	0.4	0.3	0.4	0.0	0.8
Hormogoneae	0.8	0.5	0.4	0.1	0.1	0.3	0.3
Pedinophyceae	0.1	0.5	0.4	0.0	0.3	0.0	0.8
Xanthophyceae	0.8	0.5	1.0	0.0	0.1	0.6	0.1
Zygnematophyceae	0.5	0.6	0.9	0.0	0.5	0.0	0.1
Totals	36.8	40.4	42.2	9.0	25.1	12.7	34.8
Sample size	98	86	53	9	24	84	66

Macrophytes

- Mesocosms are generally unrepresentative of edge of field water bodies
- The facilities employed in this study were established for use with an insecticide
- Mesocosms can be seeded with appropriate assemblages however the depth of some systems makes this difficult

Macrophytes

- The macrophyte assemblages could represent a more or less worst case scenario dependant on properties and mode of action of the chemical i.e. mesocosms with lower macrophyte biomass could be worst case for a strongly adsorbing insecticide
- If the objective is to improve the ecological realism then new guidance is required

Macrophytes: Prevalence of functional groups in water bodies

Macrophyte functional group	Water body type / mean occurrence (%) of macrophyte class					
	Streams	Ponds	Ditches	Meso A	Meso C	Meso G
Liverworts and mosses	0.3	0.4	0.0	0.0	0.0	0.0
Emergent broad leaved	8.1	4.0	6.5	41.8	0.0	0.0
Emergent monocots	27.3	32.0	28.4	66.8	0.0	0.0
Floating rooted	1.4	2.1	0.0	0.0	38.9	0.0
Floating un-rooted	0.0	29.4	0.9	0.0	0.0	0.0
Submerged broad leaved	7.8	8.1	2.4	2.8	0.0	70.9
Submerged linear leaved	3.6	5.6	0.0	0.3	84.9	88.6
Filamentous algae	6.6	16.5	8.8	64.0	0.0	0.0

Seasonal sensitivity

- From a taxonomic perspective spring/summer applications represent the worst case
- However, this does not take life history characteristics and exposure into account e.g. exposure occurring at a time when reproduction is reduced could lead to more pronounced effects
- This should be evaluated on a case by case basis

Key recommendations

- Sampling
  - Mesocosms should employ an appropriate number and type of sampling techniques
- Sensitivity indices
  - Pre-validation of the communities present against known toxicity data for the target chemical and species traits
  - Ensures the sensitivity of the test system to detect effects and thus to be protective of water bodies
  - Incorporation into PRCs would provide more robust evaluations

Key recommendations

- Macrophytes
  - Mesocosms should be seeded with representative macrophytes
  - Careful selection of test species is required for studies with herbicides
  - Mesocosm designs need updating i.e. depth
- Phytoplankton
  - Endpoints based on taxonomic class to facilitate the identification of clear dose responses rather than coincidental natural variability

Key recommendations

- Unrepresented species
  - Relative sensitivity compared to more abundant taxa
- Anomalous species
  - Endpoints driven by taxa that are not present in edge of field water bodies but are generally highly sensitive could be considered to be conservative
- Lotic vs. lentic taxa
  - Mesocosms should include taxa closely related to organisms adapted to lotic ecosystems

Conclusion

- Differences between mesocosms and edge of field water bodies do exist
- Mesocosms can be made to be representative or tailored to answer specific regulatory questions
- They remain a very important tool for evaluating the risk of PPPs to aquatic ecosystems
- Updated guidance is essential to achieving confidence

Thank You for your attention

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