Cambridge Environmental Assessments

PS2339
Do Aquatic Mesocosms Represent Real Edge-of-field Water Bodies in the UK?

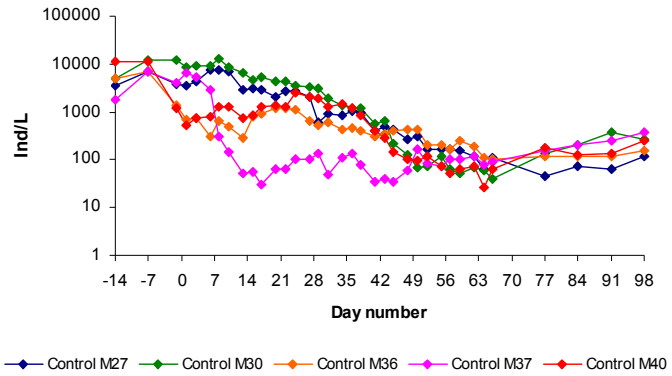
Seamus Taylor, Alan Lawrence
Naomi Blake, Greg Hughes

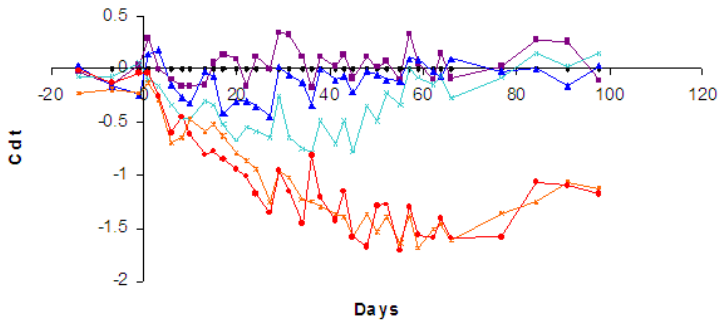
Outline

- Introduction to project
- Key questions
- Selection of landscape classes and water body types
- Macro-invertebrate data
  - Similarity indices
  - Variability in the sensitivity of different waterbodies to pesticides using SPEARpesticide
  - Inter-mesocosm variability and trends in sensitivity using SPEARpesticide
- What does it mean?
- Limitations
- Future work

Introduction

- Data from *protected* waterbodies have been demonstrated to contain diverse and abundant aquatic communities
  - Mesocosms have been demonstrated to be less diverse than these waterbodies (e.g. Williams *et al*, 2002)
- Limited information on some edge-of-field water bodies e.g. ponds and ditches
- Uncertainty exists with regards to representivity of mesocosms
  - How do the ecological communities in mesocosms relate to those in real edge of field water bodies?
  - Data would allow contextualisation of mesocosm results





Key questions

- Are mesocosms sufficiently ecologically representative of water bodies in the UK 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?

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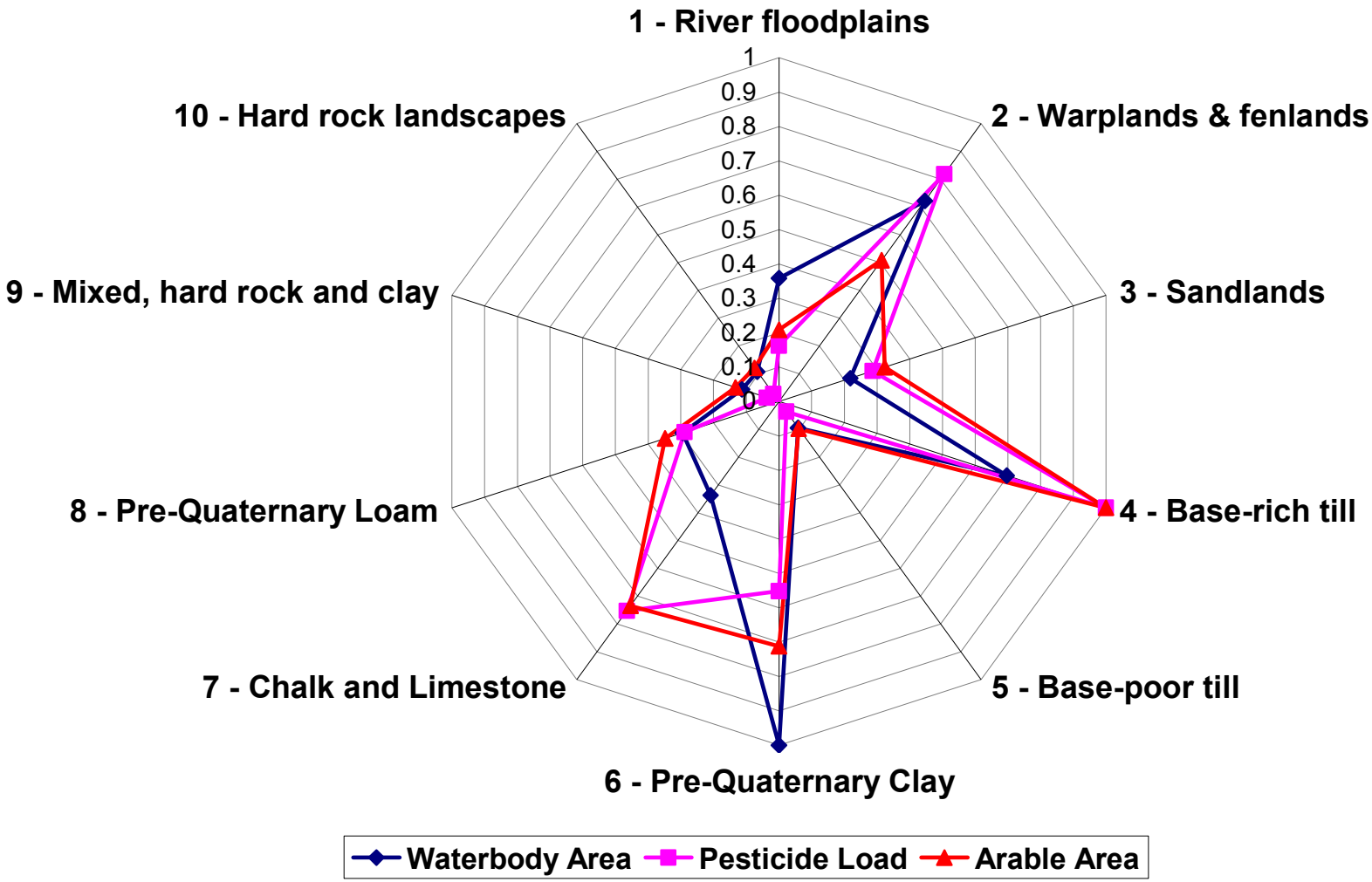
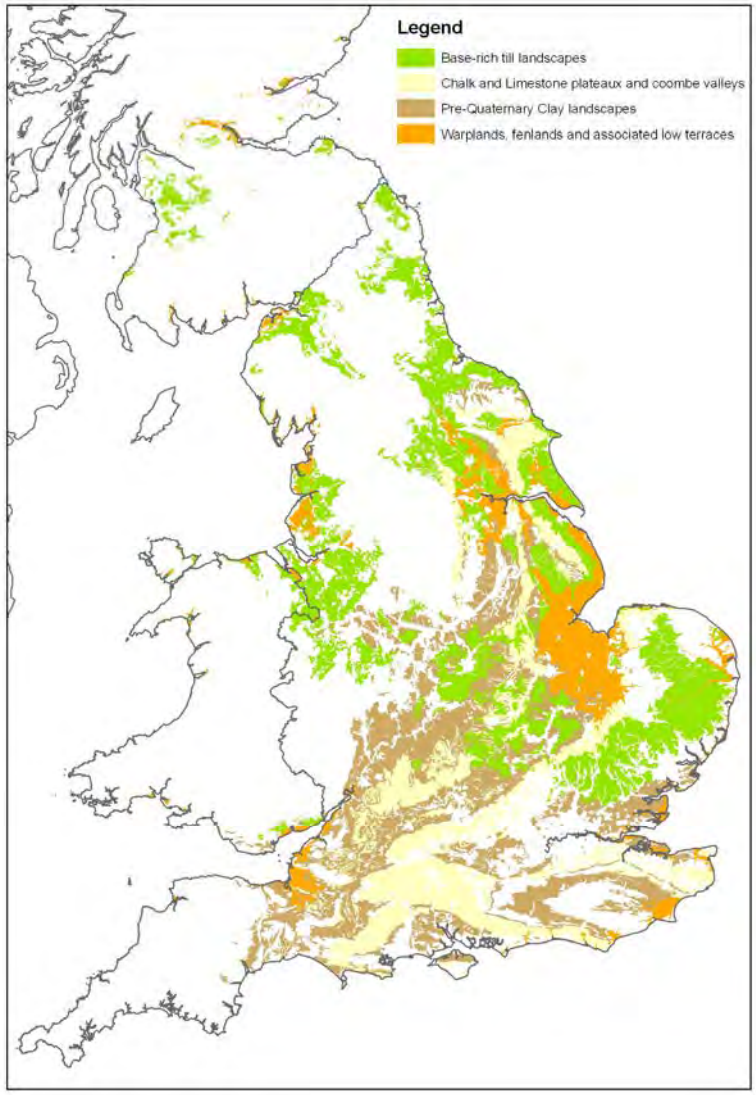
Landscape selection



Landscape selection

- Final landscapes selected
  - Eutrophic tills (Cambs, Suffolk)
  - Chalk and limestone (various locations)
  - Pre-quaternary clays (Oxfordshire)
  - Warplands and fens (Lincolnshire)



Site selection

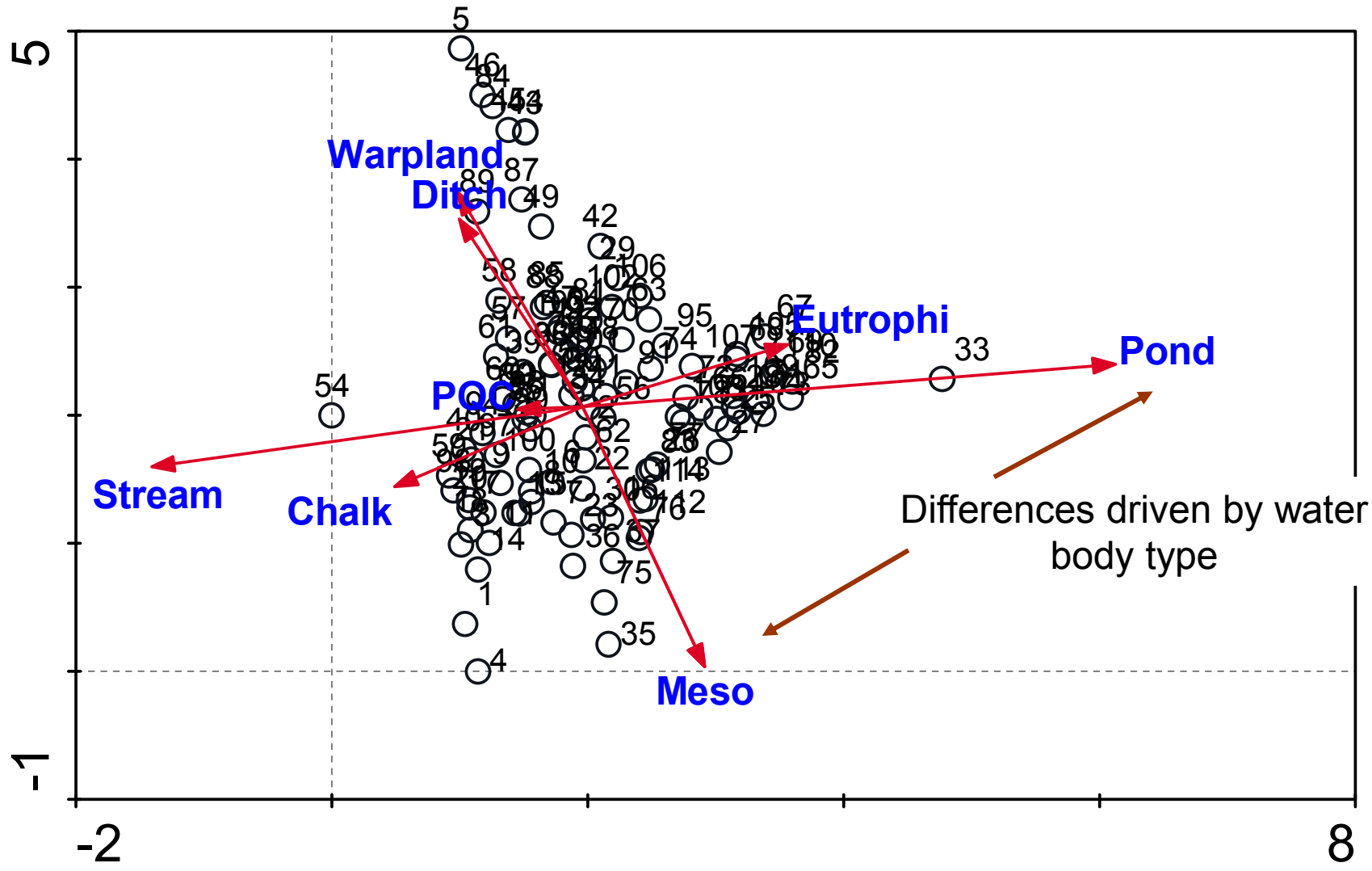
- Aerial photography and GIS used to identify potential sites
- Short list of suitable sites (>100 sites) were visited to assess representivity and suitability
- Sites selected to be representative of water bodies in arable landscapes in the UK

Landscape	Ponds	Ditches	Streams	**Total**
Warplands	0	6	0	**6**
Eutrophic tills	7	0	6	**13**
Pre-quarternary clays	5	4	4	**13**
Chalk & limestone	0	0	4	**4**
Total	**12**	**10**	**14**	**36**

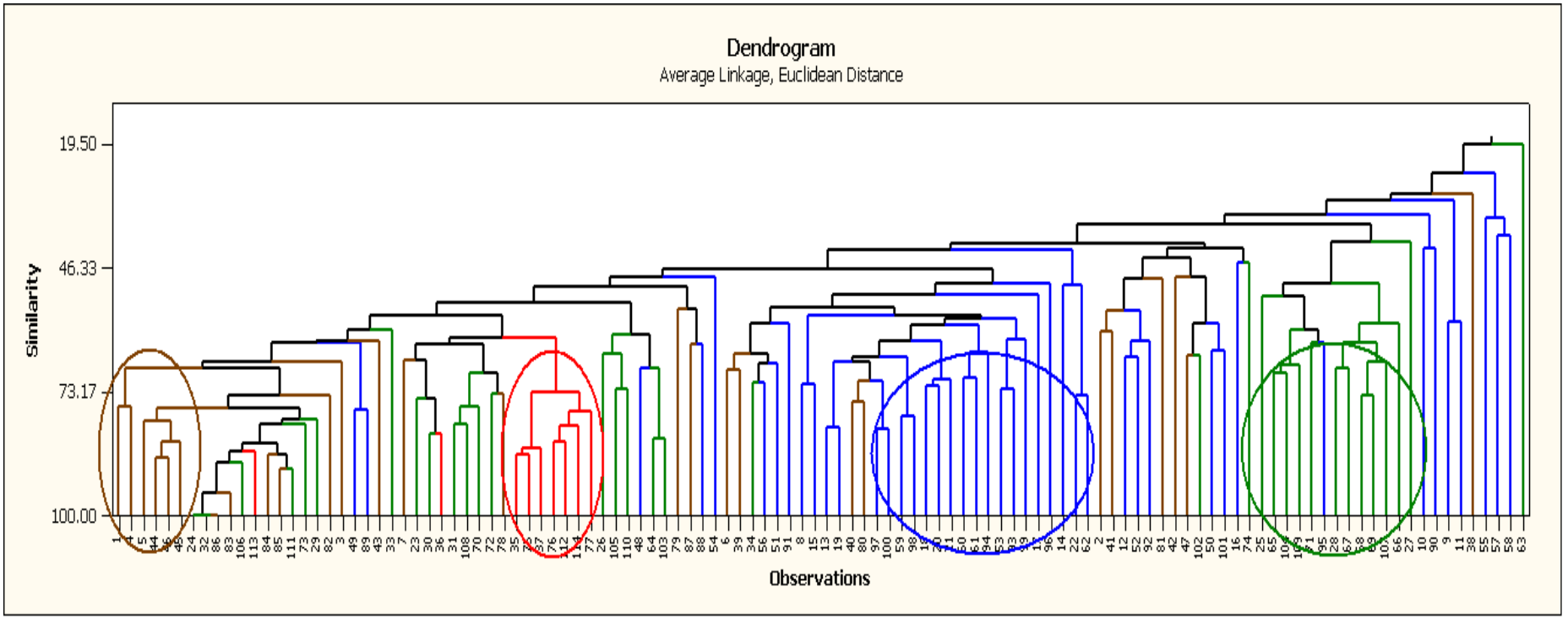
Sampling of sites

- Monthly sampling from May 2008 to April 2010
- Sampling natural water bodies and three (2008-2010) or four (2009-2010) independent mesocosm facilities
  - Macro-invertebrates
  - Zooplankton
  - Phytoplankton
  - Macrophytes
  - Physico-chemical
  - Land use assessment
  - General observations

Macroinvertebrates: indirect DCA



Macroinvertebrates: similarity indices



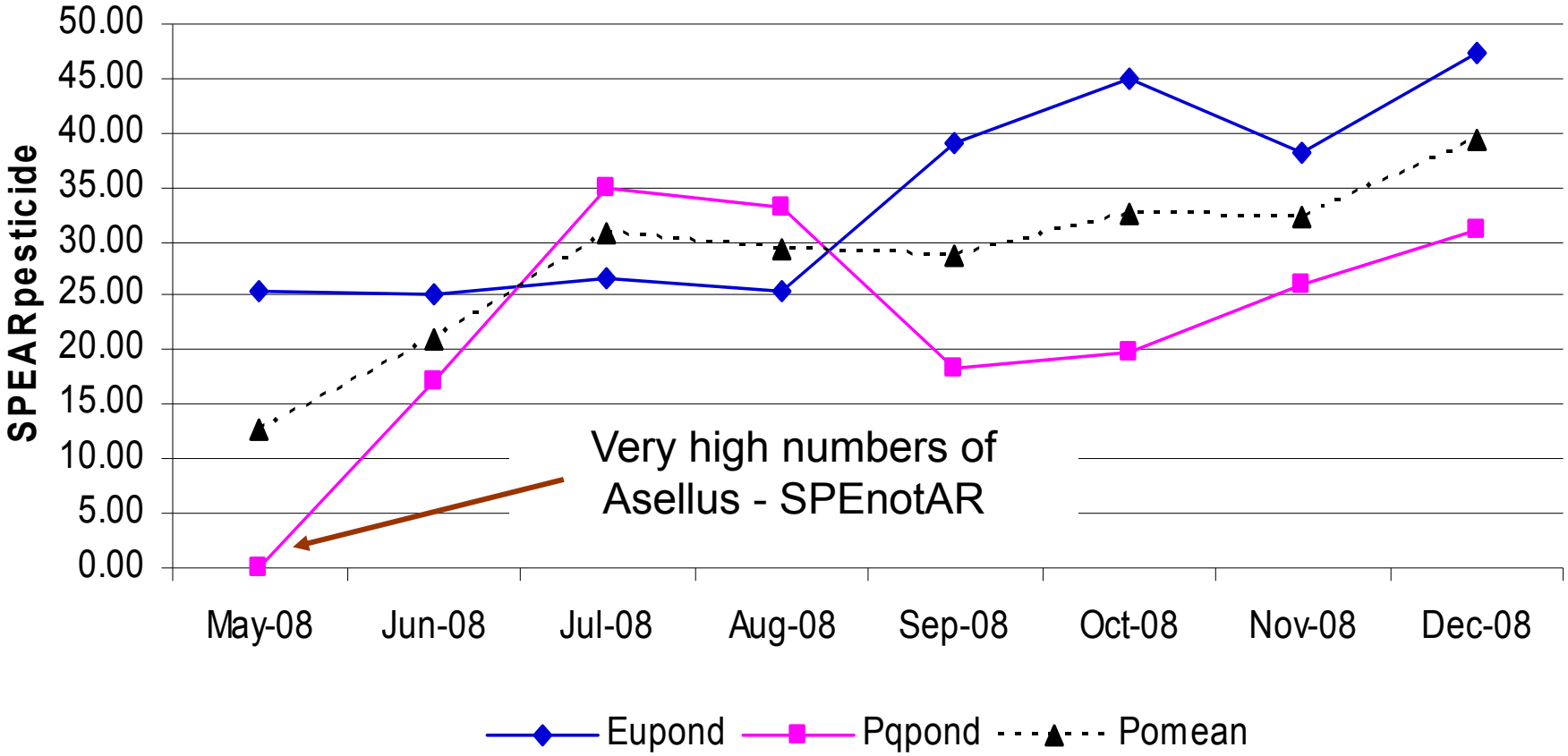
ditches streams

ponds mesocosm

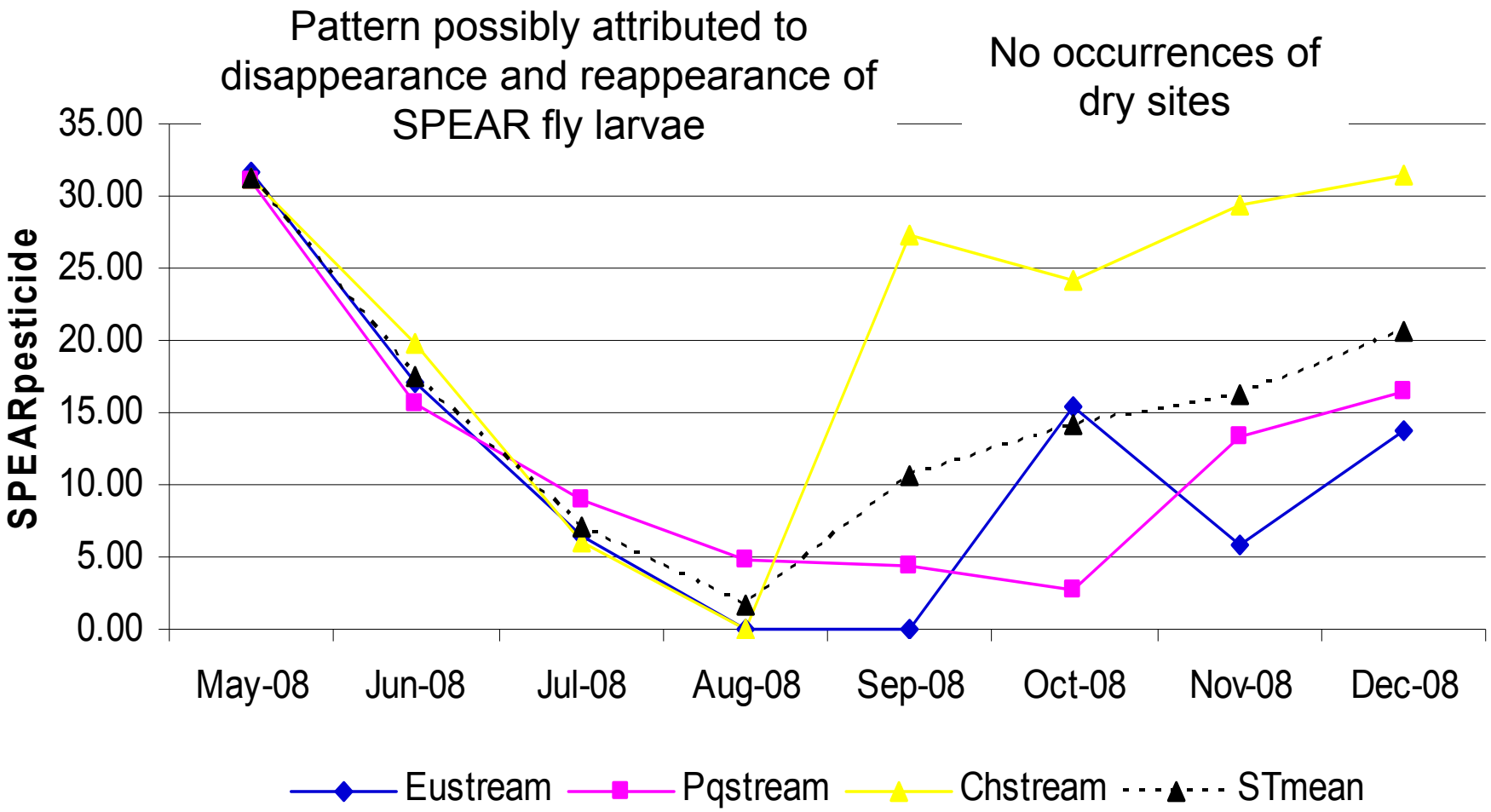
Overview of SPEAR$_{pesticide}$ to evaluate community sensitivity

- Pesticide-specific bioindicator system linking pesticide exposure and effects (Liess *et al.*)
- Taxa are ranked according to biological traits that influence sensitivity to pesticide exposure and known sensitivity to pesticides
  - Dispersal/avoidance ability
  - Re-colonisation potential
- Sensitivity of community is calculated from the relative abundance of each taxa
- Water bodies ranked as: bad, poor, moderate, good and high
- Information on SPEAR can be found at http://systemecology.eu/SPEAR/Start.html

SPEARpesticide (ponds)



SPEARpesticide (Streams)



SPEARpesticide (Streams)

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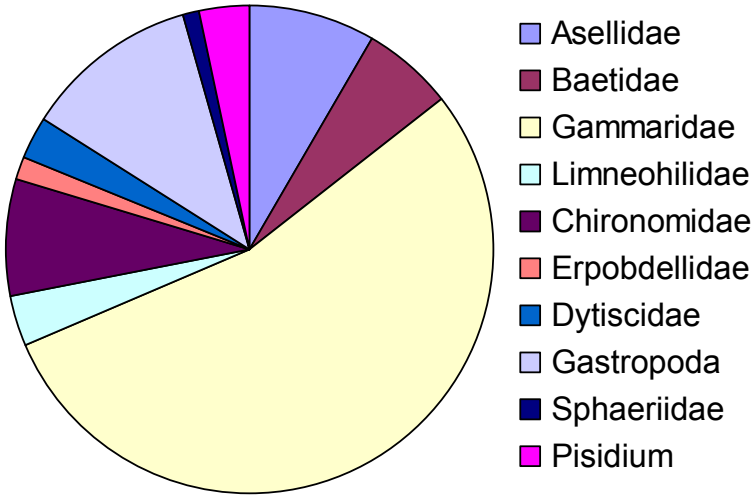
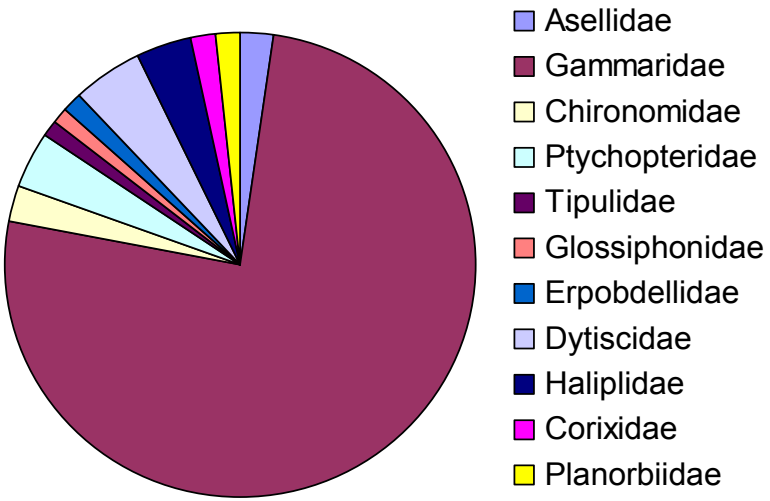
May 08



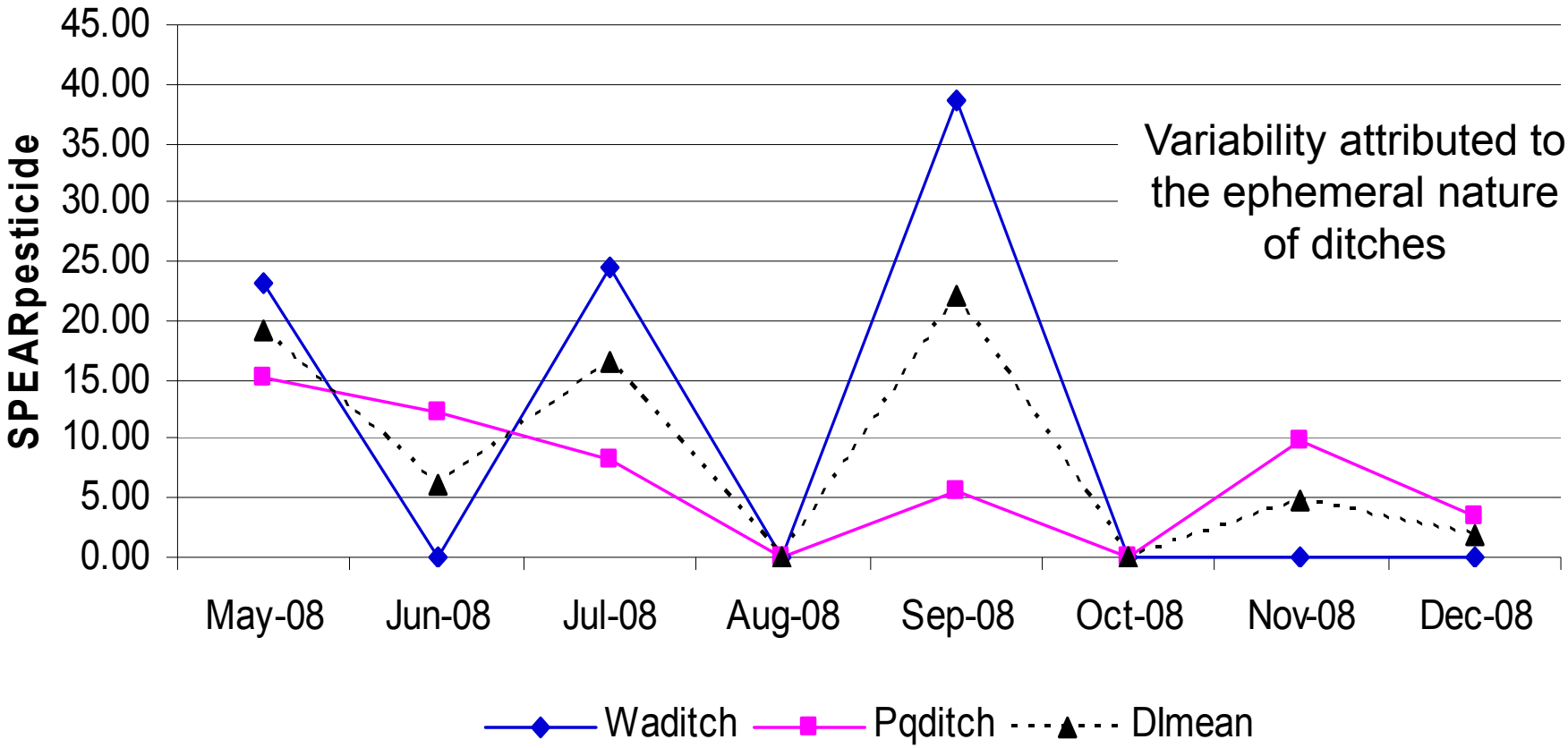
SPEAR	6 Taxa
SPEnotAR	17 Taxa

August 08



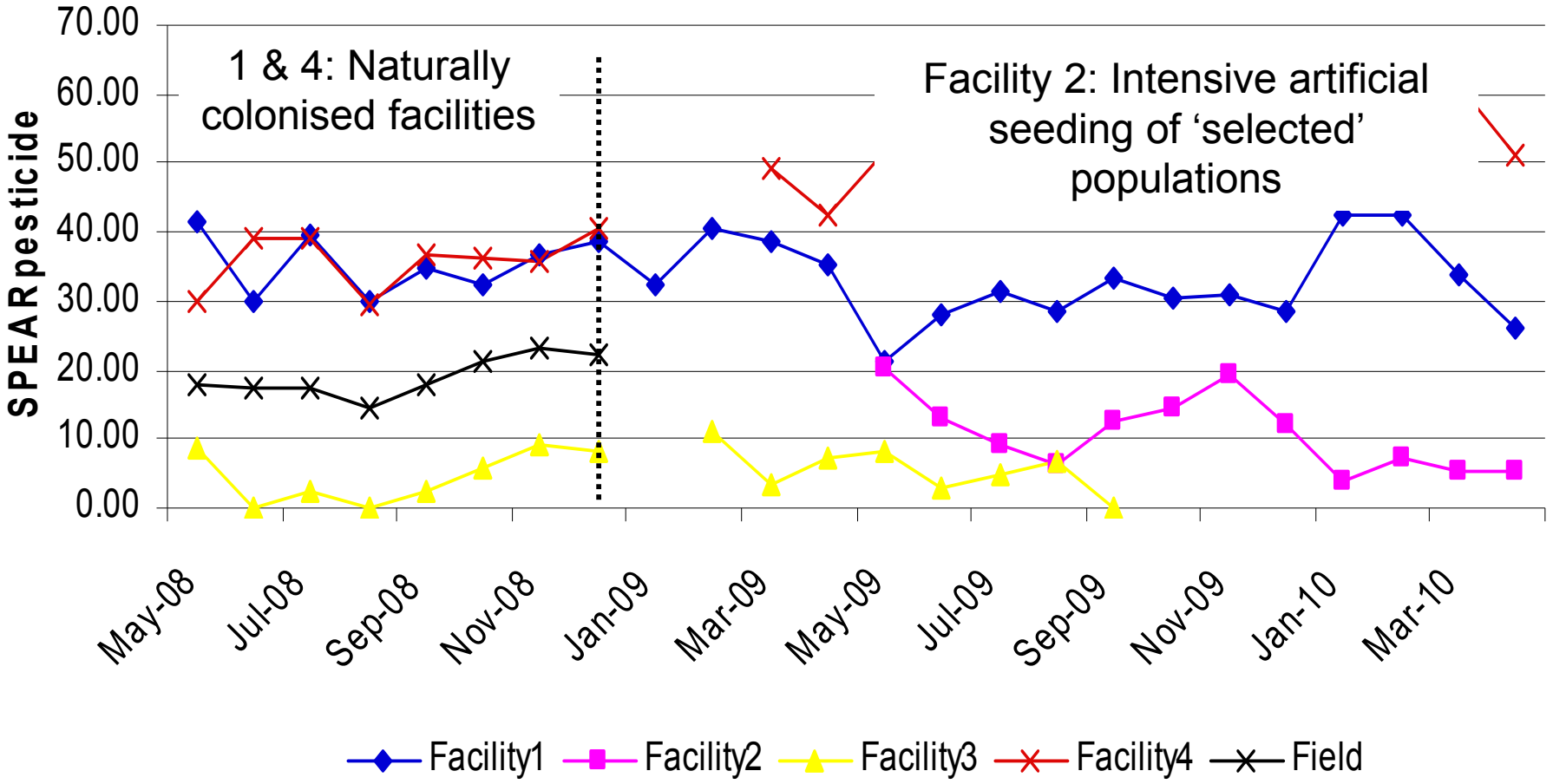
SPEAR	3 Taxa
SPEnotAR	14 Taxa

SPEARpesticide (Ditches)

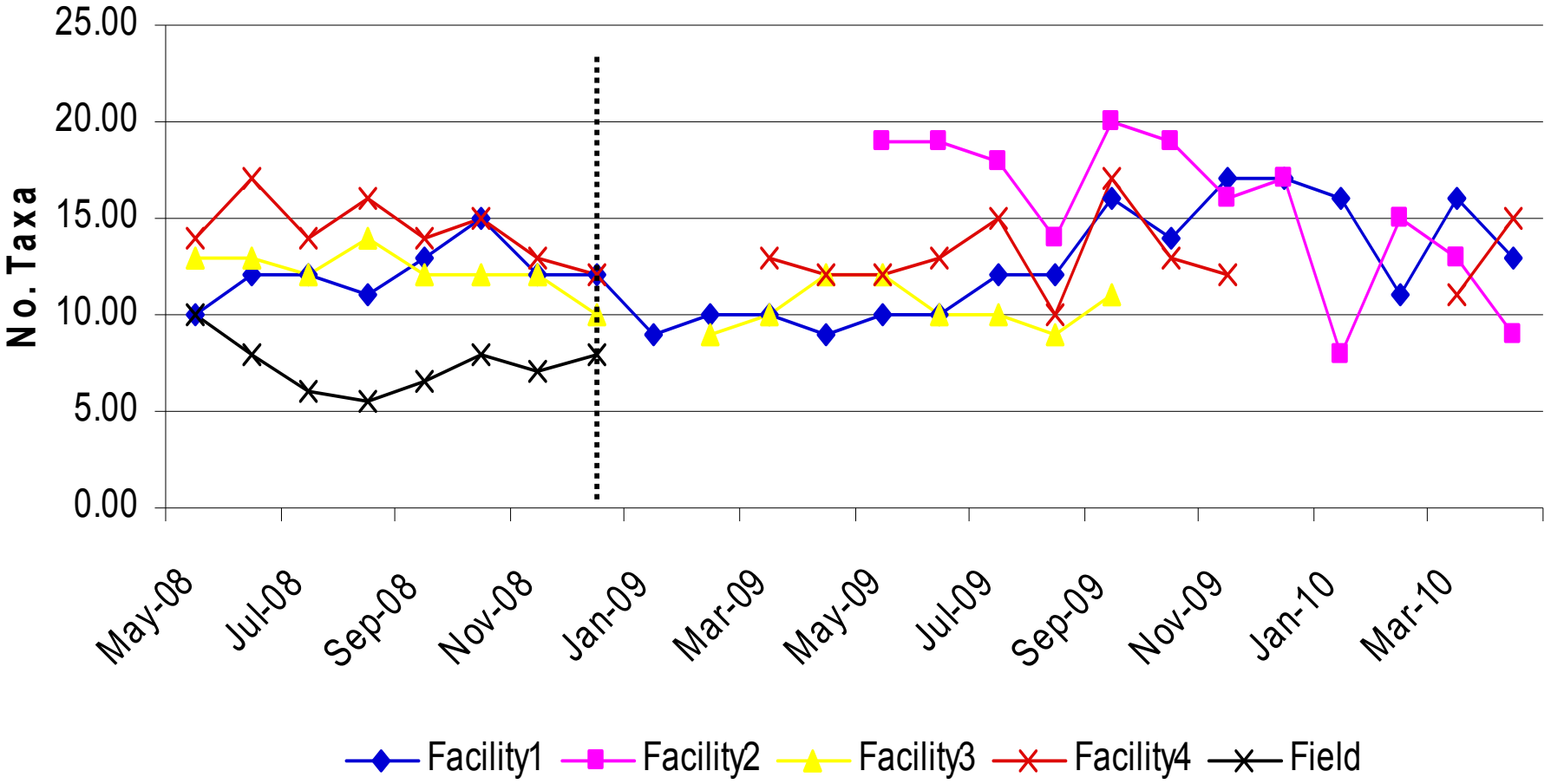


SPEARpesticide (mesocosms)

Variability attributed to different ‘seed’ population



Mean number of taxa (mesocosms)



What does it mean?

- SPEAR may be low for some facilities it does not detract from the derivation of robust data for individual species at risk
  - Numbers of SPEAR are generally comparable for all facilities
  - Community structure is driving differences
  - Statistical analysis sufficiently robust
  - Experimental objectives?
- SPEARmesocosms less variable and generally higher than SPEARedge-of-field
  - Mesocosms can be considered as being generally protective of edge-of-field water bodies when using this approach

What does it mean?

- Are mesocosms sufficiently ecologically representative of UK water bodies in the UK agricultural landscape?
  - Species composition is different
  - Mesocosms contain key SPEAR but less representative of streams
- Do mesocosm studies with spring/summer applications represent the ‘worst-case’ scenario?
  - Mesocosm in spring/summer include SPEAR taxa of representative sensitivity for edge-of-field water bodies
  - Spring/summer applications allow effects on different life stages to be evaluated
- Do seasonal changes in community structure increase the uncertainty associated with mesocosm endpoints when applied to autumn pesticide applications?
  - Difficult to answer at this stage; results based on SPEAR approach suggest uncertainties unlikely to be attributed to biology

Limitations & Future

- Limitations
  - Sample size; only 36 sites monitored
  - SPEAR for some species and families derived from extrapolation of existing data sets i.e. not necessarily based on data for species x
  - SPEAR calculated from pooled data for chemicals with different modes of action
  - Correlation with co-variables not yet investigated
- Future investigations
  - Development of sensitivity indices to specific modes of action to support more reliable endpoints e.g. SPEARpyrethroid
  - Knowledge sharing of innovative sampling techniques and experimental designs (specific techniques required to monitor some SPEAR orgs)
  - Re-visit guidance documents

The big question

The microcosms used in this test are considered to be representative of naturally occurring aquatic freshwater ecosystems in that they contained assemblages comprising a variety of macrophyte species, phytoplankton, multi- and uni-voltine invertebrates from wide ranging taxonomic groups and the physiological conditions were generally in line with guideline criteria. In addition, the number and type of sampling techniques, along with the sampling frequency, highly replicated design and the clear dose response observed are considered to contribute to a robust and reliable study

Thank you for your attention

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Seamus.Taylor@cea-res.co.uk