EXPLORING THE SPATIAL DISTRIBUTION OF ZOOPLANKTON IN MESOCOSMS: INFORMING SAMPLING STRATEGIES FOR AQUATIC TOXICITY TESTING

Katie Smith[1#], Nadine Taylor[1], Hanna Schuster[1]
[1]Cambridge Environmental Assessments, Boxworth, UK; [#]Corresponding author: katie.smith@cea-res.co.uk

CAMBRIDGE ENVIRONMENTAL ASSESSMENTS

Background

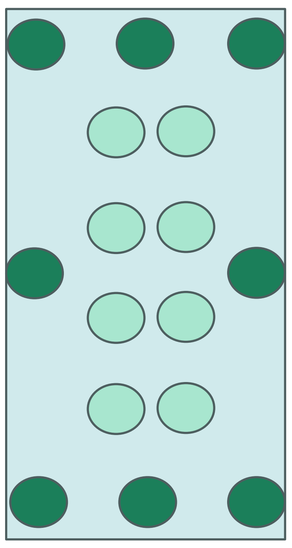
Zoplankton are a key component of freshwater ecosystems, forming an essential link between primary producers and higher trophic levels. Mesocosm studies are commonly used to assess the ecological effects of plant protection products, and other chemicals, under semi-natural conditions[1]. However, the spatial distribution of zooplankton within these systems is not well characterised, which may increase the variability of study data. Understanding whether zooplankton communities occupy distinct spatial zones[2] within mesocosms could allow for more targeted sampling strategies, improving consistency, data robustness and ecological relevance in regulatory studies.

Methods

The study was conducted at the CEA facility using isolated pond mesocosms, standardized in terms of plant configuration and water mixing, allowing for true replication. Depth-Integrated Water Samplers (DIWS) were used to collect zooplankton samples from defined depths within each mesocosm. Samples of 750 ml were collected at 22.5 cm depth (short) and 1.5 L at 45 cm depth (long, edge and middle), proportional to the sampled water column. Accounting for the difference in volume collected, the results are presented as organisms/L

Objectives

- Does proximity to the mesocosm boundary influence zooplankton community composition and abundance?
- Does vertical stratification influence zooplankton abundance depending on sampling depth?



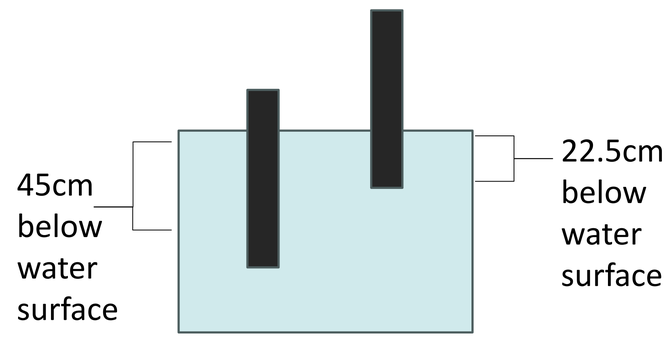
Sample sites within a mesocosm for the horizontal distribution

Horizontal distribution

- Samples collected from edge and center positions within each mesocosm
- Three individual mesocosms sampled per position

Vertical distribution

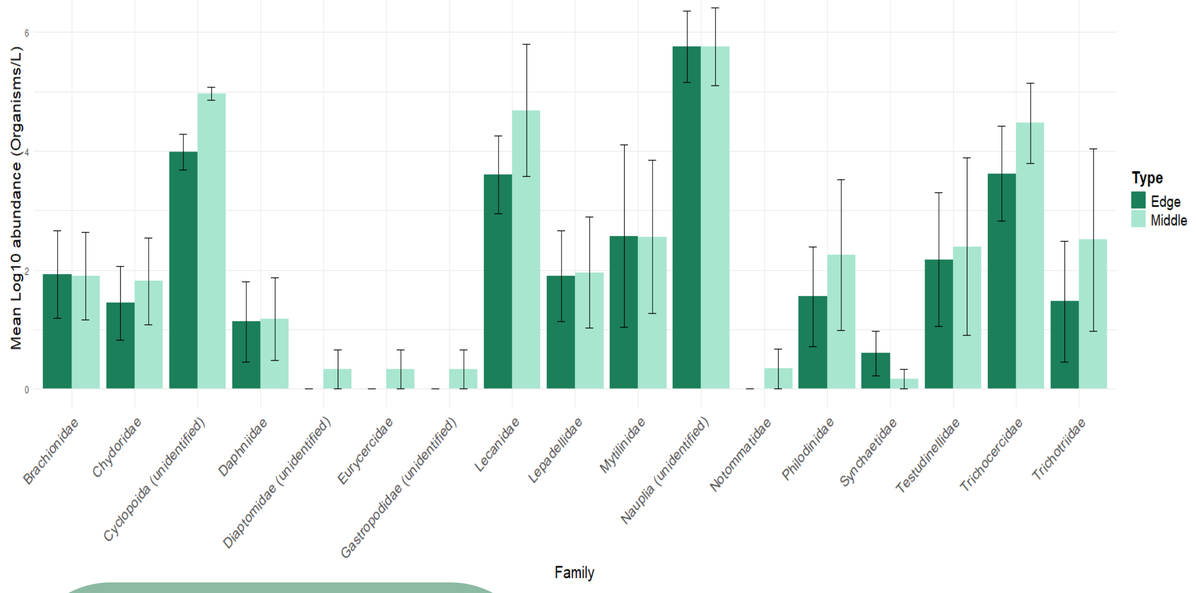
- Two DIWS depths deployed per mesocosm: shallow (22.5 cm) and deep (45 cm) below the water surface
- Sample volumes proportional to water column depth — 750 ml at shallow, 1.5 L at deep.
- To ensure comparability, organisms per L were calculated



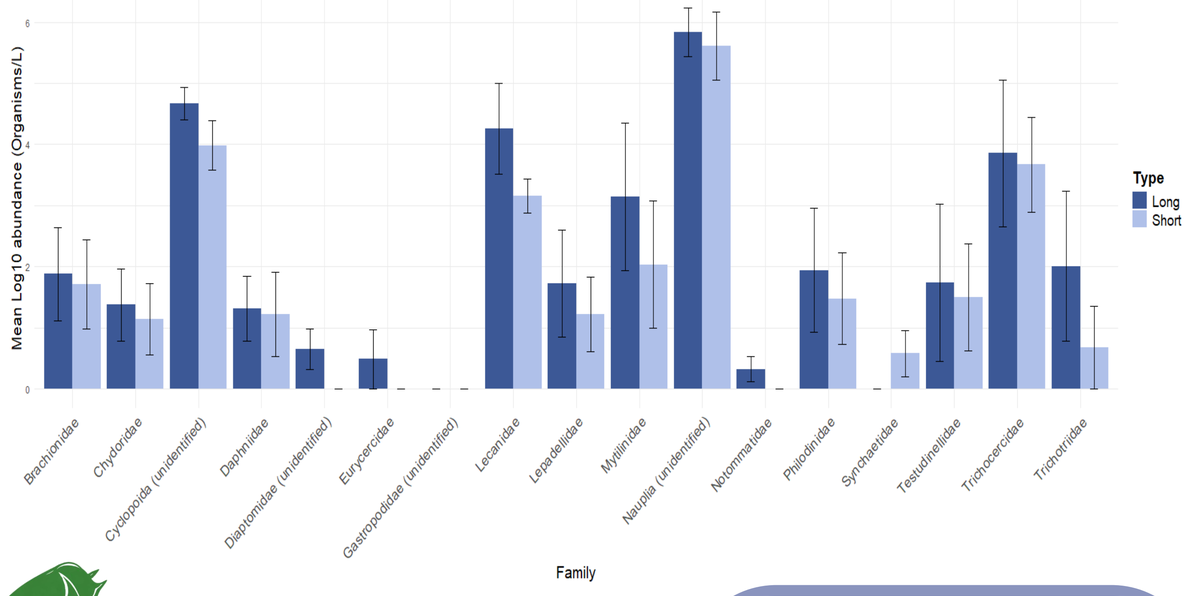
Sample depths for vertical distribution, 750ml per shallow DIWS and 1.5L in deep DIWS

Results

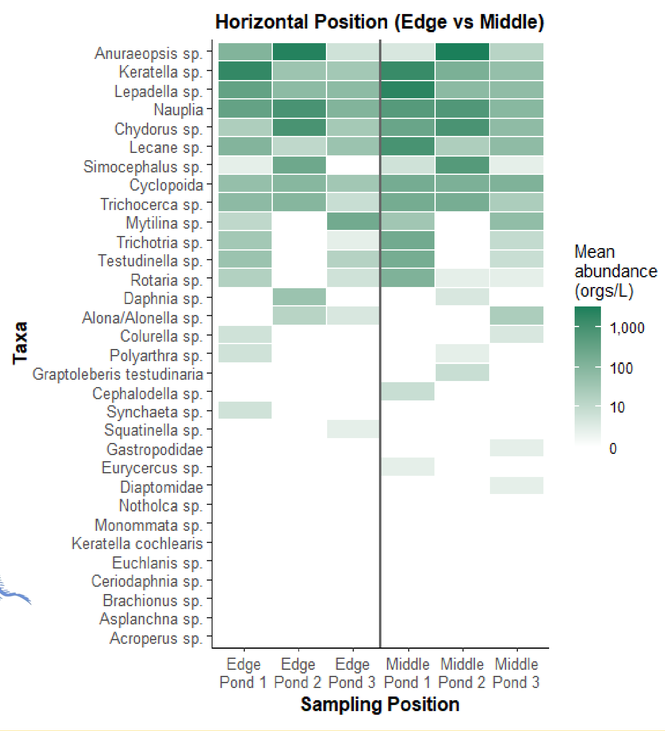
Logged Zooplankton Abundance by Space

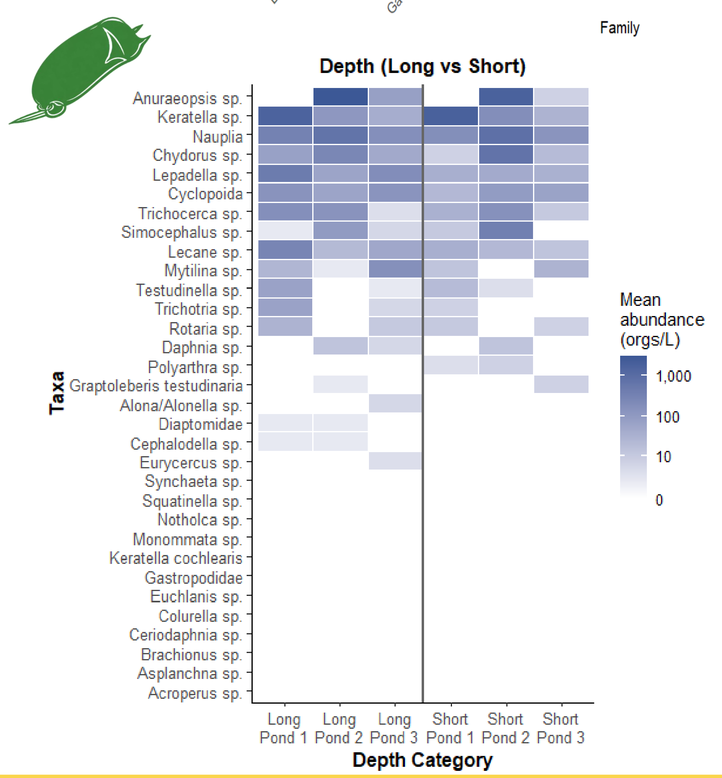


Logged Zooplankton Abundance by Depth



No statistically significant differences in abundance were detected between edge and middle positions (Wilcoxon signed-rank, $p > 0.05$). Visually, Cyclopoida and Lecanidae showed higher abundances in middle samples, whilst families such as Diaptomidae, Euryceridae, Gastropodidae and Notommatidae appeared only in middle positions





No statistically significant differences in abundance were detected between the shallow and deep samples (Wilcoxon signed-rank, $p > 0.05$). Deeper samples consistently showed higher zooplankton abundances across multiple taxa, including Cyclopoida, Lecanidae and Mytilinidae. Notommatidae were exclusively recorded in deep samples.

Analysis

Data were $\log_{10}(x+1)$ transformed prior to analysis to meet assumptions of normality, with absent taxa assigned a value of zero. Differences between spatial positions were assessed using a Wilcoxon signed-rank test (paired by mesocosm). P-values were corrected for multiple comparisons using the Benjamini-Hochberg procedure. This study found no statistically significant differences in zooplankton abundance between edge and middle positions or between depth categories, likely reflecting the low replication available (n = 3). However, visual trends suggest that both depth and spatial distribution were indicative of some difference in spatial heterogeneity in particular family groups.

- The ongoing analysis will contribute to understanding how spatial heterogeneity within mesocosms affects community assessment and exposure characterisation. Ultimately, the findings will inform best practices for mesocosm design and sampling in regulatory ecotoxicology, supporting the development of more representative and reproducible studies for environmental risk assessment
- Future work aims to increase mesocosm replication to improve statistical power, and focus on taxa showing consistent distributional patterns, particularly Cyclopoda and Lecanidae. These findings contribute to developing more targeted and reproducible sampling strategies for regulatory mesocosm studies.

QR code placeholder

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.
2 Pinel-Alloul, P. Spatial heterogeneity as a multiscale characteristic of zooplankton community. *Hydrobiologia* **300**, 17–42 (1995).