COMPARISON OF ENDPOINTS FROM LABORATORY TEST AND MESOCOSM STUDIES FOR RISK ASSESSMENT OF PESTICIDES

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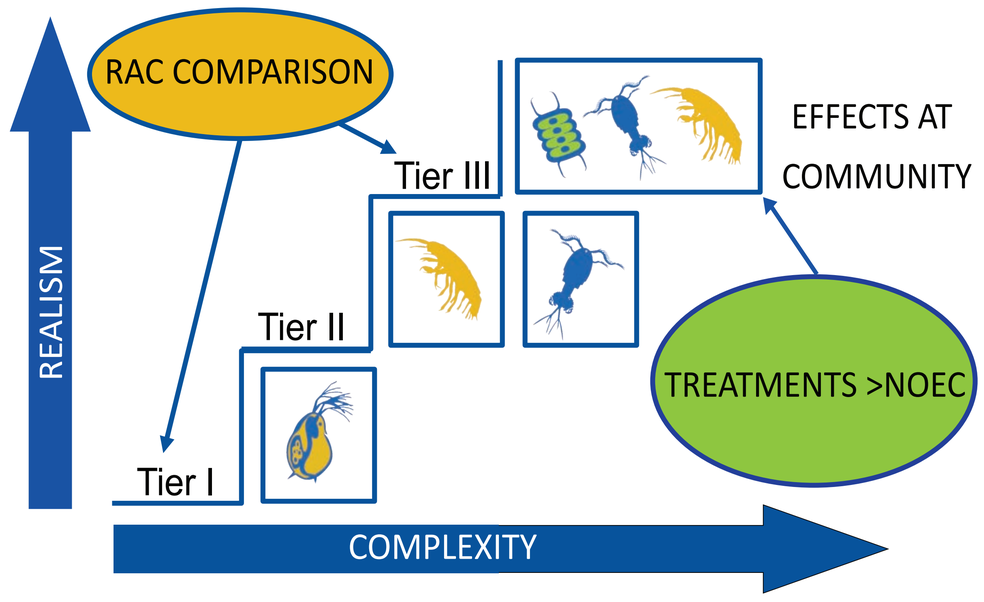
Introduction:

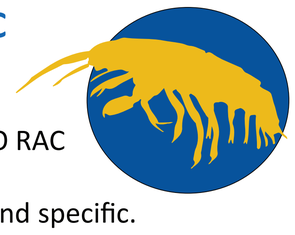
- Lower tiers: controlled laboratory systems.
- Higher tiers: less controlled, but more realistic environments.
- Designed so lower tiers are protective of higher tiers [1,2].
- Often criticised as unrealistic at lower tiers and accompanied by high uncertainty at higher tiers; therefore as either overprotective or not protective enough for certain species, scenarios and landscapes [4].
- To support future decision making, here we compare the Tier I (standard laboratory) and Tier III (mesocosm studies) RACs derived for the same compounds.
- Additionally, we explore the effects of a representative insecticide on the abundance and interactions within the zooplankton community.



Tier I studies: Core acute/chronic data (standard species and exposure)
Tier II studies: Acute/chronic data from additional species or refined exposure
Tier III studies: Population and community level experiments (e.g. mesocosms) [1]

PPP type	Factor ETO RAC/Tier I RAC	Most sensitive organism	
		Tier I	Tier III
Insecticide 1	4.6x	*Daphnia magna*	Copepoda, Asellidae
Insecticide 2	7.1x	*Daphnia magna*	Crangonyctidae
Insecticide 3	560x	*Gammarus pseudolimnaeus*	*Daphnia* sp.
Insecticide 4	724x	*Gammarus pulex*	*Daphnia* sp.
Fungicide 1	28x	*Daphnia* sp.	Diaptomidae
Fungicide 2	8.0x	*Chironomus riparius*	Diaptomidae, Nauplia
Herbicide 1	37x	*Pseudokirchneriella subcapitata*	Zygnematophyceae, *Daphnia longispina*
Herbicide 2	0.5x	*Lemna gibba*	*Myriophyllum spicatum*
Herbicide 3	3409x	*Pseudokirchneriella subcapitata*	*Hippuris vulgaris*
Herbicide 4	13x	*Pseudokirchneriella subcapitata*	*Elodea canadensis, Myriophyllum spicatum, Sagittaria sagittifolia*

Comparison between Tier I RAC and Tier III ETO RAC



Insecticides and fungicides

- In all cases, Tier I RAC was lower in comparison to the Tier III ETO RAC (mesocosms).
- The margin between Tier I RAC and ETO RAC was highly compound specific.
- For all insecticides, **crustaceans** (as part of zooplankton or macro-invertebrate communities) were the **most sensitive organisms group.**
- The most sensitive taxon in the laboratory was not the most sensitive organisms in the mesocosm study; this is often a non-standard test organism.

Herbicides

- The ETO RACs of three of the four herbicides (1, 3 and 4) investigated were higher compared to the corresponding RAC.
- For 3 out of 4 herbicides (2,3 and 4) **macrophytes** are the group **most sensitive** to exposure.
- The Tier I RAC of one herbicide (2) was not protective of the effects on *Myriophyllum spicatum.*
- The sensitivity of *M. spicatum* may have been overlooked without a mesocosm study [1,3].

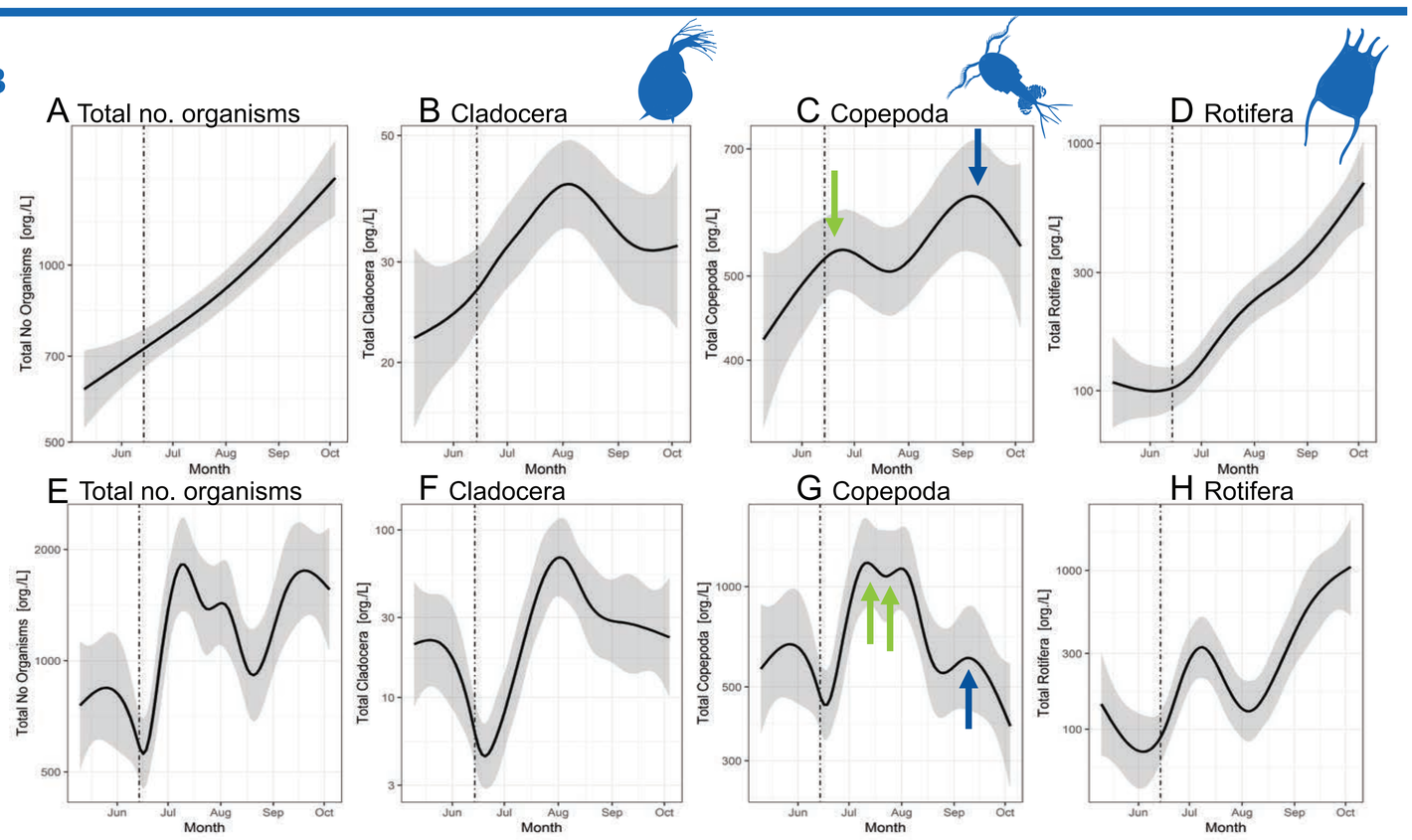
Zooplankton community changes in response to Insecticide 3

ETO RACs from mesocosm studies are typically higher than those for Tier I studies, and such studies also offer a greater understanding of both the direct and indirect effects of exposure, including species interactions within a community:

- Sharp decrease of Cladocera and Copepoda at concentrations above the NOEC following test item application, followed by steep increase in abundance.
- The most sensitive taxon in the mesocosm study for insecticide 3 was *Daphnia* sp. (the most dominant taxon within the Cladocera).
- Subsequent early peak in Rotifera abundance following the decrease in Cladocera and Copepoda.
- Within the Copepoda: there was a prolonged and higher abundance of Nauplia (green arrows) at high insecticide concentrations with a lower (but not delayed) abundance of adult Copepoda (blue arrows).
- Potential shift of the zooplankton community towards smaller organisms.

Potential effects for other communities:

Macroinvertebrates:
→ may aggravate effects on predators feeding on larger zooplankton
→ may compensate effects for predators feeding on smaller zooplankton
Phytoplankton:
→ Shift in the community towards larger algae that cannot be consumed by smaller zooplankton



A – D: Abundance of the main zooplankton groups throughout a mesocosm study for concentration below or equal to the NOEC.
E – F: Abundance of the main zooplankton groups throughout a mesocosm study for concentrations above the NOEC. Dashed vertical line: application date. Arrows in C and G: green – abundance peak due to Nauplia, blue – abundance peak due to adult Copepoda. Solid black line = fit from generalised additive model (GAM); grey shading indicates 95% confidence interval.

FUTURE STEPS: TOWARDS A MORE HOLISTIC APPROACH IN AQUATIC RISK ASSESSMENT

- Tier III data generally derives more realistic RAC and has the ability of capturing community changes in response to PPP exposure, despite the complexity of the studies.
- Analysing the large amounts of data produced in PPP risk assessment in new ways can support assessing risks for the aquatic environments, particularly in mesocosm studies.
- This new data analysis could include the size shifts as observed in the community analysis, including relating effects between different types of communities (e.g. phytoplankton, periphyton, macrophytes, zooplankton and macroinvertebrates) and traits that are not captured by taxonomic differences.

References:
[1] EFSA. 2013. Guidance on tiered risk assessment for plant protection products for aquatic organisms in edge of field water bodies. EFSA Panel on Plant Protection Products and their Residues (PPR). [2] Brock TC, Bhatta R, van Wijngaarden RP, & Rico A. (2016). Is the chronic Tier-1 effect assessment approach for insecticides protective for aquatic ecosystems?. Integrated environmental assessment and management, 12(4), 747-758. [3] Maltby L, Arnold D, Arts G, Davies J, Heimbach F, Pickl C, Poulsen V. 2010. Aquatic macrophyte risk assessment for pesticides. In Guidance from the SETAC Europe workshop AMRAP. [4] Vighi, M., & Villa, S. (2013). Ecotoxicology: The challenges for the 21st century. Toxics, 1(1), 18-35.