

Assessment of the effects of non-aqueous phase liquid (NAPL) pollution on aquatic macroinvertebrates survivorship

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HS 10.7 Groundwater - Surface Water Interactions: Physical, Biogeochemical and Ecological processes

Macroinvertebrates species selected for the experiment

Gammarus Pulex (Shrimp)



Baetis Rhodani (Mayfly)



NAPL used for the experiment: **Mineral Oil**

Sigma-Aldrich (CAS No.: 8042-47-5)

Specific gravity: 0.818- 0.880

Objective

A range of pollutants including non-aqueous phase liquids (NAPLs) disturb the physiological, behavioural, and breeding performance of macroinvertebrates; and may also affect their survival. Such responses, if observed and recorded carefully, can be a good indicator of ecological pollution. Macroinvertebrates like *Gammarus pulex* residing in the hyporheic zone are representatives of both surface and ground water pollution. This study was thus aimed at observing the response of two species to increasing levels of NAPL in the water under laboratory conditions. The study results provide the basis for detailed experiment to be conducted (on field) depending on the type of recorded response.

Experimental design

Step I : Collection of macroinvertebrates from river Brook inside the Loughborough University campus using a pond net. The species were kept overnight in a bucket to let them acclimatize to the system's conditions.



Step II : Preparation of mineral oil-water emulsion using hot-plate magnetic stirrer and then adding the measured quantity of sand to it.



Experimental design

Step III : Preparation of oil-water emulsions of different volume ratios and addition of the macroinvertebrates (5 nos to each mixture).

Step IV : The required observations (swimming and survival behaviour) were done in addition to measuring physico-chemical parameters like DO, temp etc. at regular intervals.



Experimental design

Treatment 1: 0 % Oil, 100 % Water

Treatment 2: 2.5 % Oil, 97.5 % Water

Treatment 3: 5 % Oil, 95 % Water

Treatment 4: 10 % Oil, 90 % Water

Treatment 5: 15 % Oil, 85 % Water

Treatment 6: 20 % Oil, 80 % Water

Treatment 7: 25 % Oil, 75 % Water

*(4 replicates of each treatment, making
total 28 treatment units for each species)*

Sand Properties

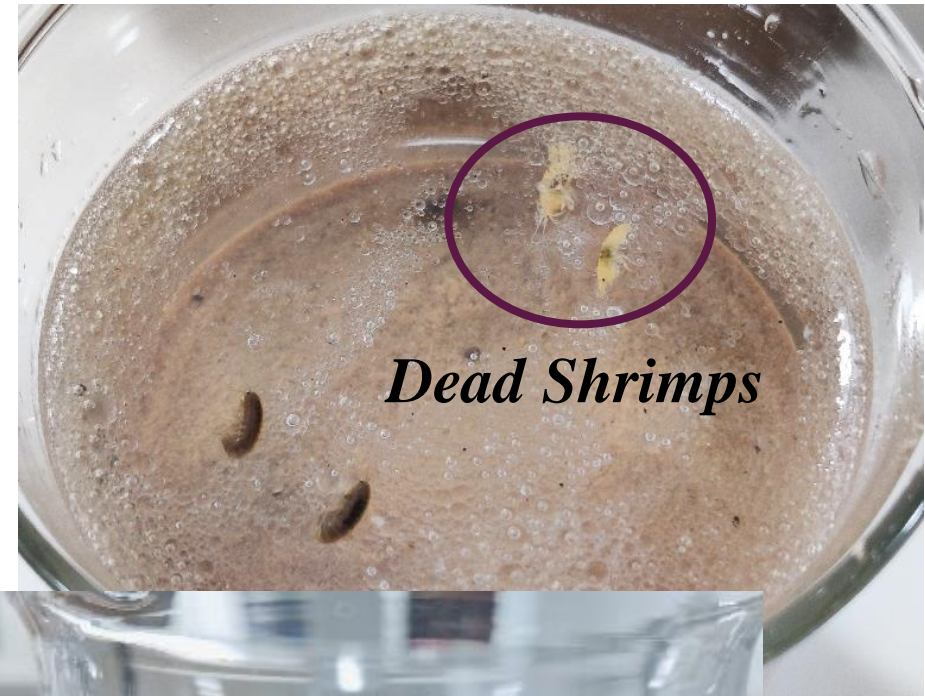
Porosity: 0.25

Hydraulic conductivity: 0.023 cm/s

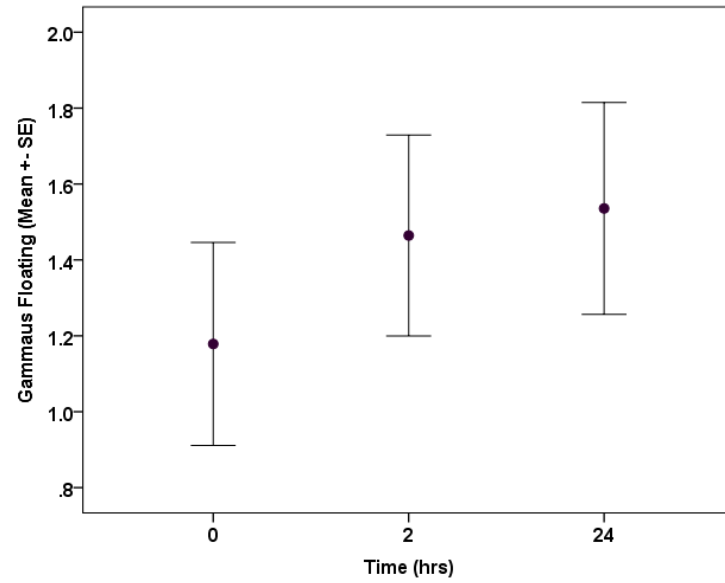
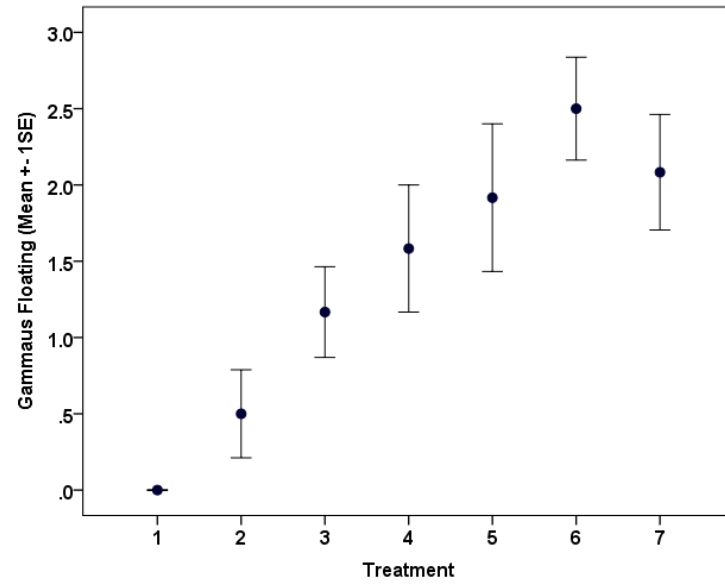
Grain Size: $\leq 250 \mu\text{m}$

Bulk density: 1.59 g/mL

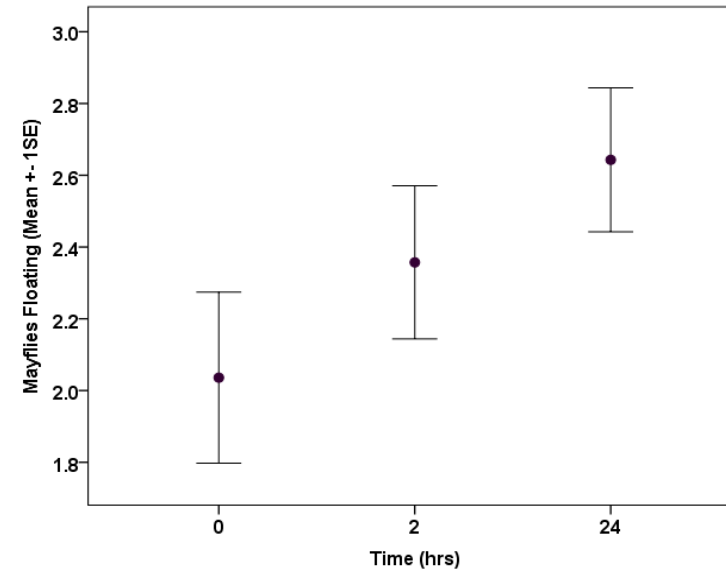
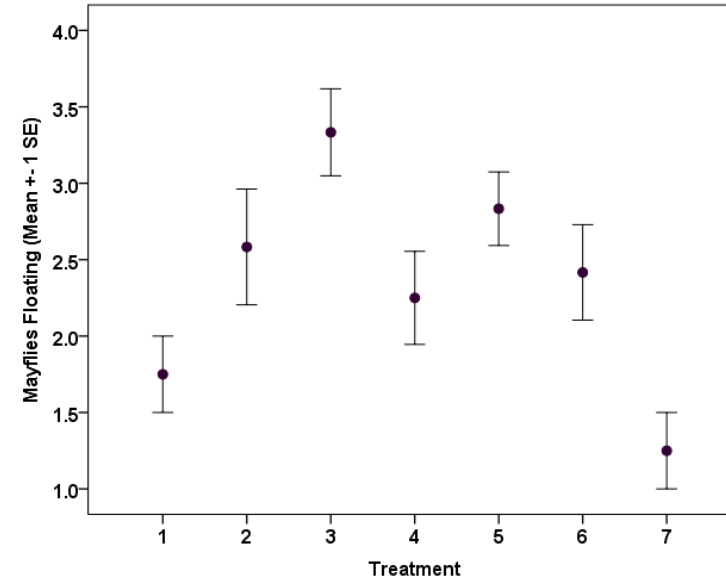
Results



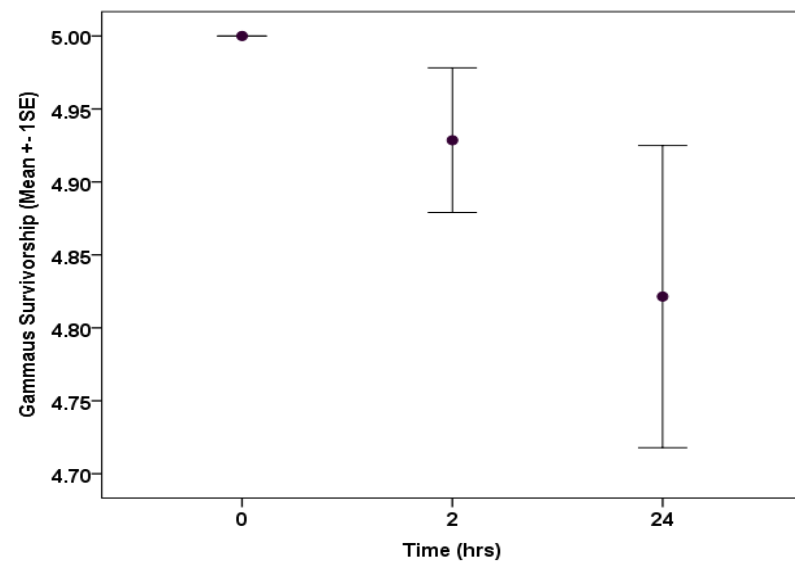
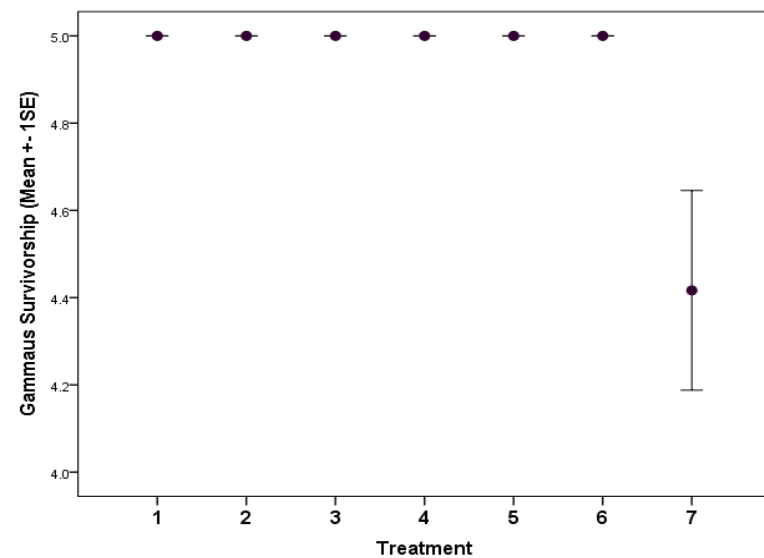
Gammarus pulex



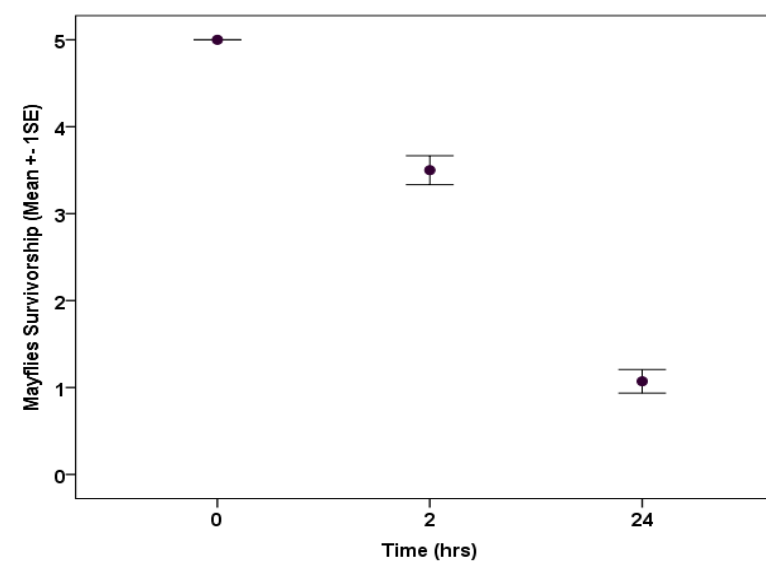
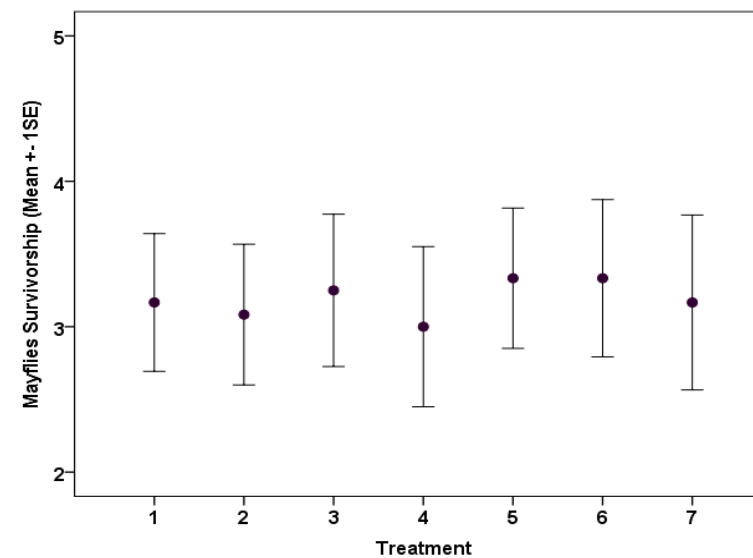
Baetis rhodani



Gammarus pulex



Baetis rhodani



Conclusion

- Macroinvertebrates *Gammarus* and *Baetis* display effects from NAPL pollution at different concentration levels.
- *Baetis* seems more sensitive as deaths occurred at very low concentrations of mineral oil, while *Gammarus* survived in most treatments except for the highest concentration.
- *Gammarus* is a good bio-indicator of pollution as the organisms responded very quickly through their restricted locomotion and arrival at the surface of water-oil mixture. Having present in an aquatic system with higher level organisms, they are most likely to be eaten up by them.
- Thus mineral oil affects the survival of both species, but through different response.
- The representative NAPL pollutant in this experiment was mineral oil which is very mild and non-toxic in nature. However, most NAPLs are chemically active and toxic in nature and thus, need more attention for their underlying effects on aquatic and the associated natural resources.

Thank you