Non-additive species interactions affect ecosystem response to eutrophication

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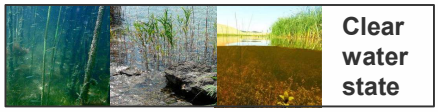
Background

Eutrophication is a threat to aquatic ecosystems worldwide. Excessive nutrient loading can push ecosystems from a clear to a turbid, phytoplankton dominated state.



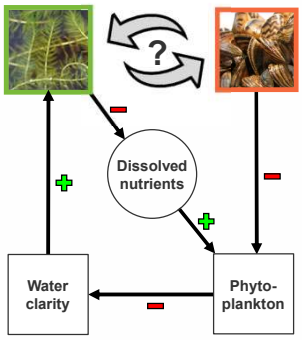
Nutrient loading

Foundation species

Foundation species are hypothesized to make aquatic ecosystems more resilient to nutrient perturbation:

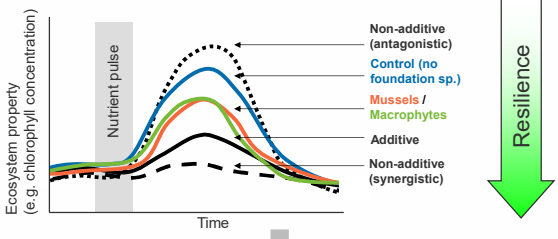
Macrophytes compete with with phytoplankton for nutrients; **mussels**, remove phytoplankton from the water - both alone can reduce turbidity.

However, we don't know how interactions between foundation species affect resilience of lakes.



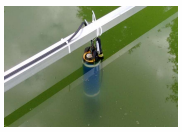
Hypothesis

We hypothesize that the combined single effects of foundation species on the ecosystem results in an additive response, and thus may increase resilience in the presence of a disturbance.

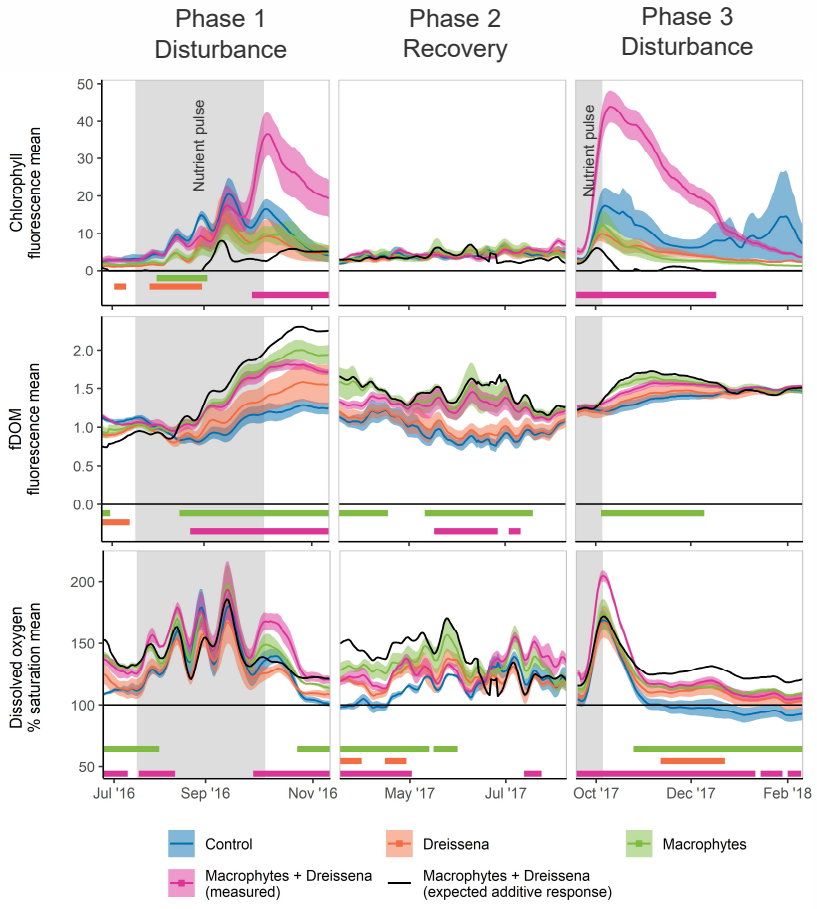


Methods and setup

Using 16 ponds (15000L) of the new Eawag experimental pond facility, we manipulated the presence of two foundation species (***Myriophyllum spicatum*** **macrophytes** and ***Dreissena polymorpha*** **mussels**) in a fully factorial design.



We then disturbed all ecosystems with nutrients and measured the response using a multiparameter sonde platform (EXO-2; WTW/YSI), which measured 6 water parameters continuously at 15 min resolution for 2 years in each of the 16 ponds.



Results and conclusions

We found that each foundation species had strong individual effects on multiple ecosystem properties, e.g. phytoplankton density (top), concentration of dissolved organic matter (mid), and dissolved oxygen concentration (bottom).
Largely in line with our expectations, **macrophytes** and **mussels** alone reduced chlorophyll concentration in comparison to the **control without foundation species**. However, when **both species were present**, we saw dramatic increases in algal biomass and other ecosystem parameters, indicating strong non-additive antagonistic effects. These patterns were highly repeatable across both nutrient pulses.

Overall, our results demonstrate how interactions between foundation species can cause surprisingly strong deviations from the expected responses of aquatic ecosystems to nutrient additions.

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