Safety & Environmental Assurance Centre

Bringing an ecosystems perspective into ERA: Indicators of chemical stress on freshwater ecosystem functions

Laura Harrison[1], Claudia Rivetti[2], Christopher Wheatley[3], Duncan Lister[1], Lucy Speirs[2], Julia Chatterton[2], Geoff Hodges[2], Jane Hill[3] & Piran White[1].

[1] Dept. of Environment and Geography, Univ. of York. [2] Safety & Environmental Assurance Centre, Unilever. [3] Dept. of Biology, Univ. of York.

laura.harrison@york.ac.uk

WHY INDICATORS OF FUNCTIONS?

Conventional Ecological Risk Assessment (ERA) relies on identifying the most sensitive species to a chemical stressor as a proxy for protecting whole ecosystem structure and functions. There is a call for ERA to enhance this approach, moving towards understanding vulnerability at population, community and ecosystem levels.

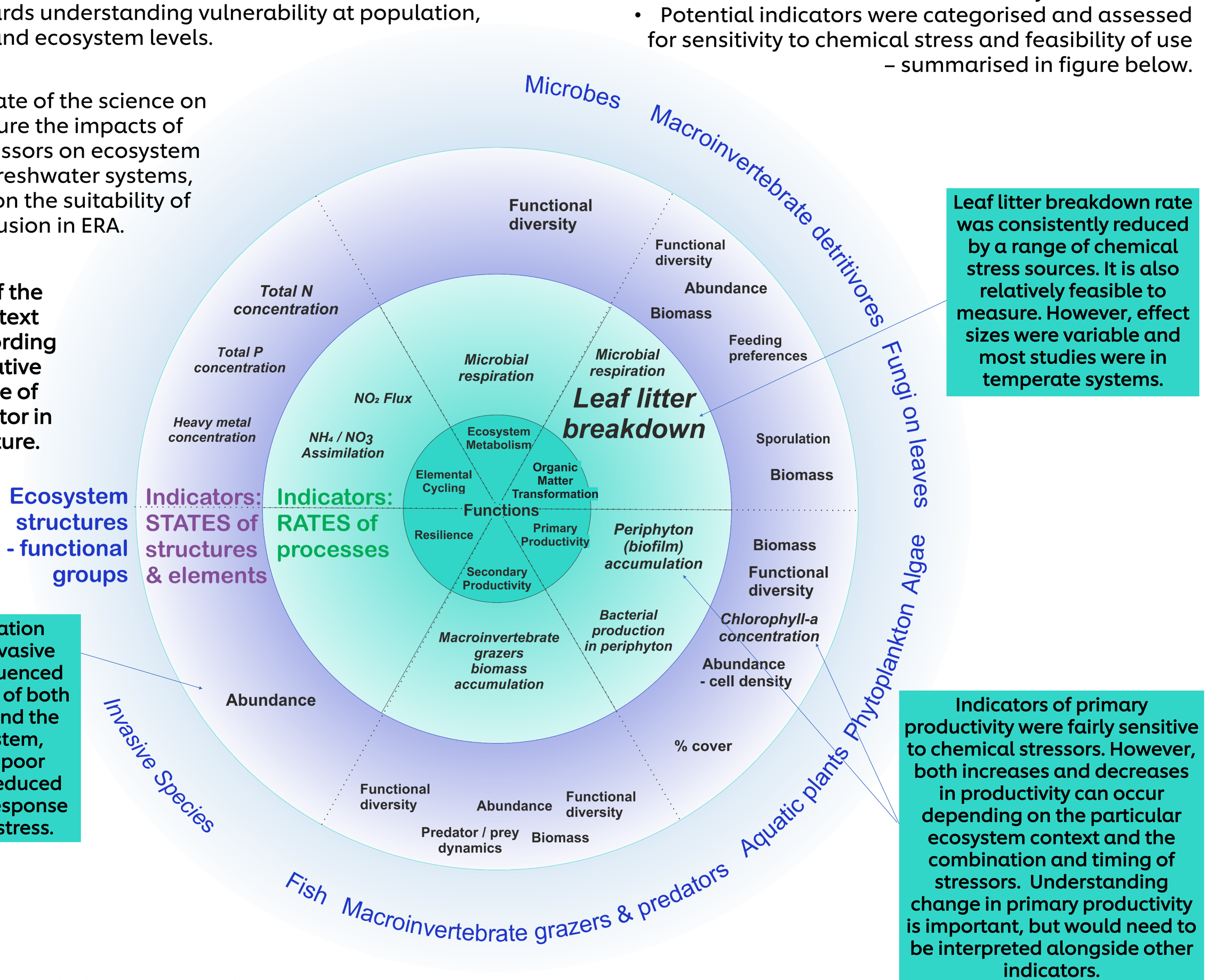
AIM

Assess the state of the science on how to measure the impacts of chemical stressors on ecosystem functions in freshwater systems, with a focus on the suitability of these for inclusion in ERA.

METHODOLOGY

- We considered 143 papers which included a source of chemical stress AND quantification of an ecosystem component or process with the potential to be a direct or indirect indicator of ecosystem function.
- Potential indicators were categorised and assessed for sensitivity to chemical stress and feasibility of use – summarised in figure below.

The size of the indicator text scales according to the relative recurrence of that indicator in the literature.



Leaf litter breakdown rate was consistently reduced by a range of chemical stress sources. It is also relatively feasible to measure. However, effect sizes were variable and most studies were in temperate systems.

The colonisation success of invasive species is influenced by many traits of both the invader and the invaded system, making it a poor indicator of reduced resilience in response to chemical stress.

Indicators of primary productivity were fairly sensitive to chemical stressors. However, both increases and decreases in productivity can occur depending on the particular ecosystem context and the combination and timing of stressors. Understanding change in primary productivity is important, but would need to be interpreted alongside other indicators.

EVIDENCE

- Most functional indicators are indirect, measuring ecosystem structures that underpin processes, rather than the processes themselves.
- Functional indicators can provide added value, as they sometimes show higher sensitivity to chemical stress than taxonomic indicators.
- There is a focus on single functions, although all functions are expected to be inter-dependent.
- There have been few studies in which the relative impacts of different chemical stressors are considered.
- There is evidence of both positive and negative interactions between chemical stress and other stressors, such as temperature, hydrology and change in the land use of the surrounding catchment.

TAKE-HOME MESSAGES

- There is a risk of applying indicators that are “easy” rather than those that are best suited to detecting early changes in freshwater systems.
- The responses of indicators to stress vary between different aquatic systems, and can also be moderated by the presence of other stressors.
- Several taxonomic and functional indicators used together will provide the best evidence of changes in ecosystem structure and functioning.