

Proof of concept case study on zinc (retrospective ERA)

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Introduction

The aim of this study was to apply an ecosystem services (ES)-based approach to conduct a retrospective environmental risk assessment for zinc, in order to evaluate:

- Effects on locally important ES in a lowland UK river, currently failing to achieve Good Ecological Status under the Water Framework Directive (WFD; 2000/60/EC).
- The potential of an ES-based risk assessment to add value to risk management decisions.

The assessment included the following steps:

- Identify ES of interest at the study site
- Map ES on to WFD biological quality elements
- Assess evidence that biological elements are impacted at the study site
- Assess potential risk of chemical (zinc) to biological elements; use laboratory toxicity data
- Assess impact on delivery of prioritized ES, based on observed and predicted biological quality

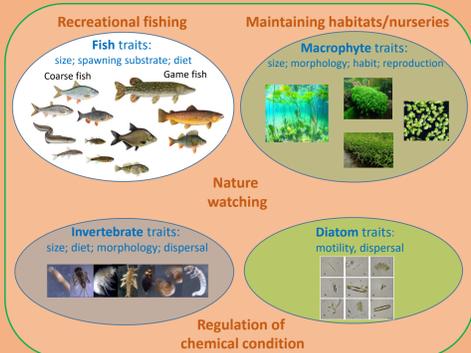
1) Identify ES of interest and their local importance

Ecosystem services (ES)	ES provided by rivers	Locally important ES
Provisioning services		
Food production	++	
Fibre and other material	+	
Genetic material	+++	
Plant-based or animal-based energy	+	
Regulatory services		
Pollination and seed dispersal	+	
Maintaining nursery pops and habitats	+++	X
Pest and disease regulation	++	
Climate regulation	++	
Air quality regulation	++	
Water quantity regulation	+++	
Regulation of chemical condition of FW	+++	X
Erosion regulation	++	
Mediation of waste and toxics	+++	X
Cultural services		
Recreation - (passive) nature watching / ecotourism - (active) fishing	+++	X
Spiritual and religious values	++	
Education and inspiration	++	
Cultural diversity and heritage	++	
Existence, option or bequest value	+++	

2) Map ecosystem services onto WFD biological quality elements

Ecosystem service	Diatoms	Macrophytes	Invertebrates	Fish
Maintaining nursery populations and habitats		Submerged & emergent species (plant architecture)		
Regulation of chemical condition, mediation of waste/ toxics	All species (nutrient uptake, photosynthesis, sequestration, detoxification)	All species (nutrient uptake, photosynthesis, sequestration, detoxification)	Esp. filter feeders, collector-gatherers (sequestration, detoxification, particulates)	All species (sequestration, detoxification)
Recreation - nature watching		Visible and attractive (e.g. flowering) species	Attractive insects, especially odonates (damselflies and dragonflies)	All species
Recreation - fishing				Gamefish species

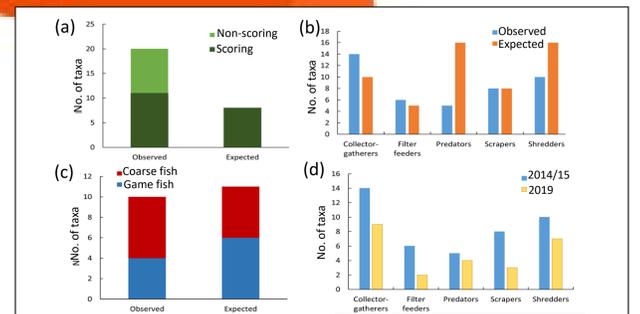
ES delivery by WFD biological quality elements (quantified via functional traits)



5) Assess risk to delivery of priority ES

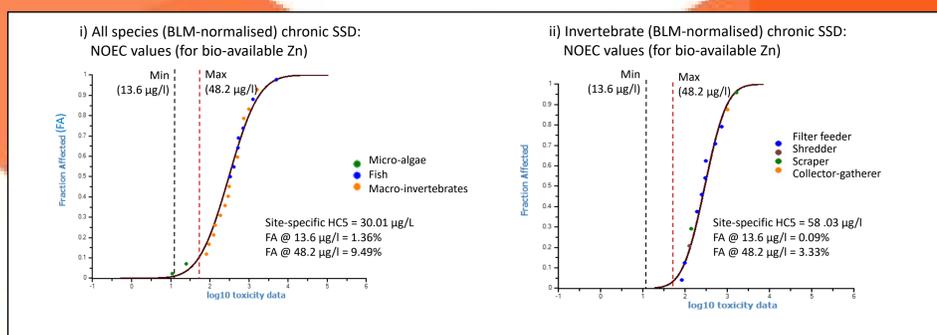
	Ecosystem service			
	Regulate chemical condition	Maintain habitats	Recreational fishing	Nature watching
At risk	🚫	🟡	🟡	🚫
...from zinc	🟡	🟡	🟢	🟡

3) Assess impact on WFD biological quality elements



Comparison between observed and expected number of (a) macrophytes, (b) macroinvertebrates (c) fish taxa at the study site in 2014/2015, (d) macroinvertebrates observed in 2014/15 and 2019.

4) Assess risk of zinc to (i) all biological elements, (ii) macro-invertebrates according to SSDs based on site-specific chronic NOECs (for bioavailable zinc)



Evaluation of the case study via a multi-stakeholder workshop

In the context of the WFD, when would an ES-based assessment be advantageous?

- Adopting an ES approach can enhance the retrospective environmental risk assessment of chemicals, including 'specific pollutants' such as zinc, under the WFD.
- The approach adds significantly to the taxonomic approach currently used under the WFD to define ecological status (or potential) versus type-specific reference conditions by:
 - Focusing on key functional taxa or service providing units (SPUs), which provide ES that are prioritised as being most important for specific water bodies.
 - Providing a 'unifying approach' in which chemical impacts in water and on land can be evaluated concurrently (including evaluation of trade-offs or synergies).
 - Providing a common currency for the valuation of chemical impacts versus the costs of remediation.

Comparison of ES approach with WFD risk assessment

- Under the WFD, ecological status is defined by the lowest common denominator i.e. the biological quality element which has lowest ecological status.
- In contrast, the ES approach aims to protect prioritised ecosystems services, taking into account ecological heterogeneity in the landscape and therefore spatial variation in ES delivery. This facilitates trade-offs in the functional status of biological quality elements or components thereof (i.e. prioritisation of some elements or SPUs above others).

Development needs

- More case studies are needed to demonstrate the utility of ES in retrospective chemical risk assessment, in comparison with conventional taxonomic approaches used under the WFD.
- The ES approach could be introduced as an additional step after taxonomic classification of ecological status, in order to prioritise action to remediate services which are highly valued.