Chemicals: Assessment of Risks to Ecosystem Services (CARES II)

Proof of concept case study of a surfactant used in consumer products

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Introduction

The aim of the study was to make a targeted, ecosystem service, ES,-based assessment of a general industrial chemical, to evaluate:

(1) to what extent it is currently possible to assess chemical risks to ES;
(2) the potential of an ES-based risk assessment to add value to risk management decisions.

The study was on a surfactant emitted to a river via treated domestic sewage effluent. The assessment included the following steps:

- Identify ES of interest (Table 1)
- Identify potential for impacts using evidence-based logic chains (Figure 1)
- Explore the applicability of the food web model AQUATOX[2] for assessing impacts on ES (Table 2, Figure 2)
- Discuss results at a stakeholder workshop (Box 1)

Table 1 ES at risk from surfactant exposure.

Assessments mostly require data on population abundance and biomass, specific processes - often not determined in standard toxicity tests.

ES	Service providing unit, SPU	Entity	Attribute
Water quality: [suspended solids/clarity]	Submerged & emergent macrophytes	Meta-population	Abundance/biomass: Water flow moderating structures
Water quality: [suspended solids/clarity]	Phytoplankton (as suspended particulates)	Meta-population	Abundance
Bioremediation	Microbial biofilms	Functional group	Process: biotransformation.
Filtration, Sequestration, Storage, Accumulation	Phytoplankton, periphyton, macrophytes, microbes	Meta-population	Process: sequestration, storage, accumulation
	Zooplankton/ bivalves	metapopulation	Process: filtration, sequestration, storage, accumulation
Maintaining nursery populations/ habitats	macrophytes	Meta-population	Abundance/biomass: habitat abundance and structure
Recreational fishing	Fish (salmonid or coarse)	Meta-population	Abundance/biomass
Engaging with the environment: aesthetic experience	Littoral and riparian plants	Meta-population, landscape structure	Abundance/biomass, Landscape structure
Engaging with the environment: boating	Grazing birds, mammals, fish, invertebrates	Meta-population, landscape structure	Process: grazing
Engaging with the environment: observing birds	Birds	Meta-population, landscape structure	Behaviour, Abundance/biomass, Diversity.

Table 2. Direct and Indirect results from AQUATOX modelling

Most predicted effects due to direct toxicity (EC50s assigned to taxonomic groups using surrogate species).Indirect effects also expected at > or < EC50. No effects at realistic surfactant exposure concentrations.

Organism/Food web group	Response: surfactant toxicity	Response: indirect effects
Periphyton	None (expected)	Reducing biomass follows reducing surface area of colonisable surfaces
Phytoplankton	None (expected)	Increase in biomass at highest [surfactant] due to reduced herbivore biomass
Myriophyllum	Monotonic response, slightly more sensitive than expected	None
Polypedilum	Monotonic response in line with assigned EC50	None apparent
Chironomus	Monotonic response in line with assigned EC50	None apparent
Amphipod	Monotonic response in line with assigned EC50	None apparent
Mayfly	Monotonic response in line with assigned EC50	None apparent
Caddisfly	>10x less sensitive than expected	None apparent
Stonefly	2-3 times less sensitive than expected	None apparent
Trout YOY and Trout Large	>30x less sensitive than expected	Annual short-term inhibition coincides with reduction in food availability.

Figure 1. Logic-based evidence chains[1] developed from potential impacts on SPUs exposed to surfactant.

Most evidence is qualitative and directional. Evaluation influenced by feedback loops and hysteresis.

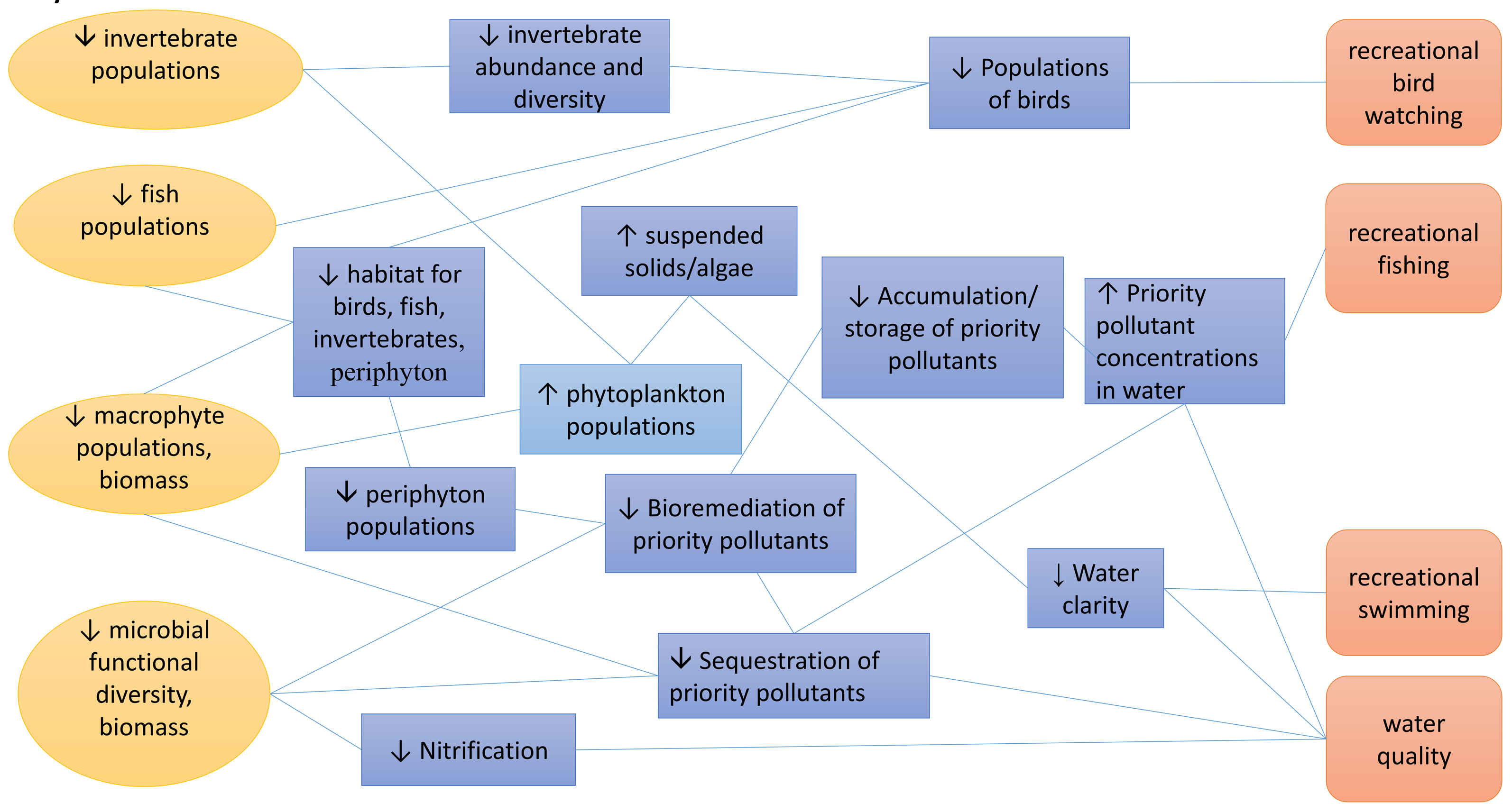
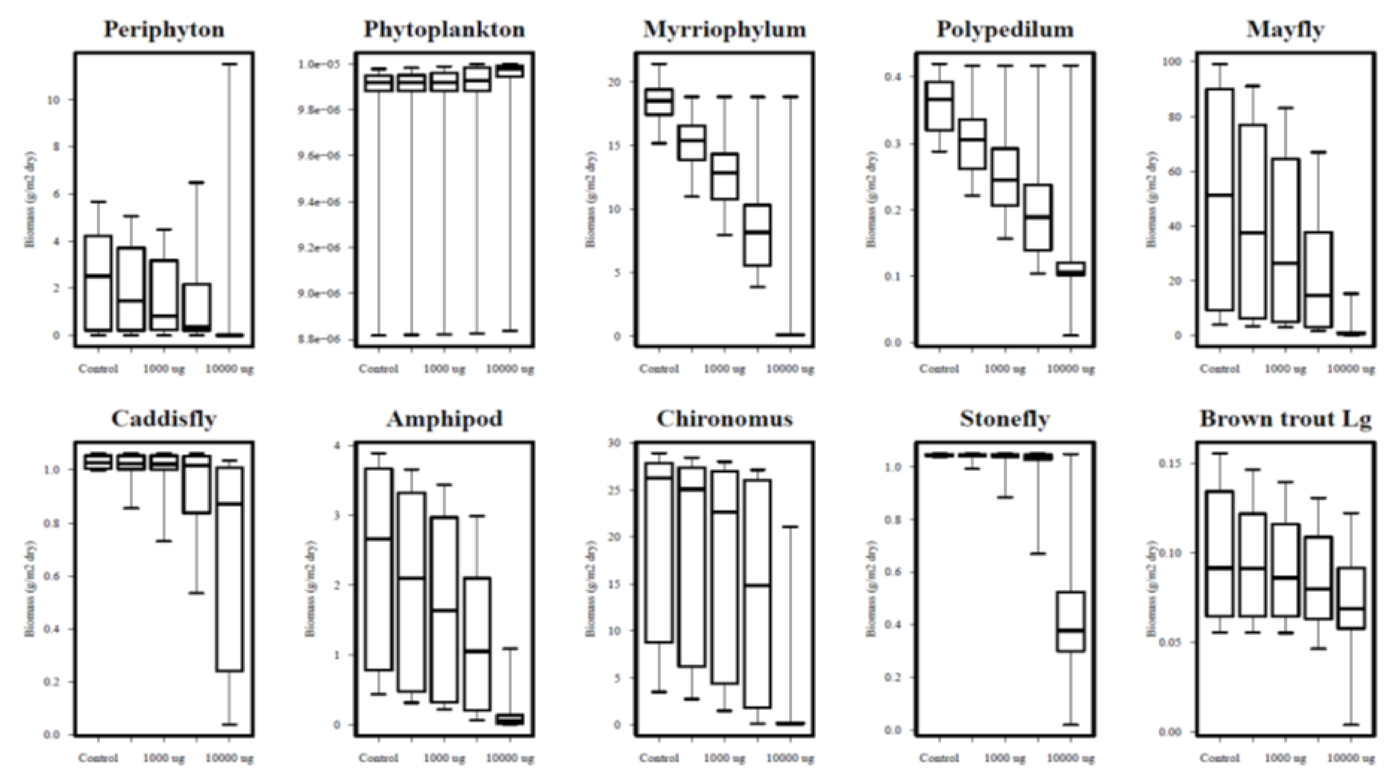


Figure 2. AQUATOX predicted impacts on biomass of SPUs exposed to several surfactant concentrations (ug/L).



Assessment of AQUATOX modelling

- Parameterising each taxon in a simulated food web will often require data from surrogate species.
- AQUATOX is a flexible modelling platform for representing SPUs and ES found in aquatic ecosystems; however, the initial investment in identifying and parameterizing essential taxa and their interactions is substantial and extensive analysis of its outputs is usually required

Box 1. Stakeholder workshop discussions

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

- ES could provide a basis for quantification and valuation of environmental impact in the assessment of substances of very high concern (SVHC) that require a socio-economic assessment, SEA - describing environmental benefits in terms of ES could make decisions on trade-offs more tractable.
- Assessment of chemicals with a specific mode of action which have potential to impact particular taxa/biological traits associated with a range of ES.
- Assessment of chemicals released with an intermittent exposure scenario, i.e., when there is potential for recovery of impacted SPUs.
- Impacts on ES can be readily associated with catchment management objectives, which enables better informed decision making.
- Voluntary assessment of chemicals as part of product stewardship initiatives to increase public and regulatory confidence in safe use, e.g. higher tier assessment.

Comparison of ES approach with REACH risk assessment

- For chemicals with a broad exposure scenario (widespread, dispersive use) and a non-specific MoA, a wide range of ES could be impacted. If management objectives are to protect all exposed ES, then the protective thresholds for an ES approach are likely to be similar to the REACH PNEC.

Development needs

- Extend capability to extrapolate from “standard” toxicity test species to ES providers
- Better understanding of linkages between effects on service providers and ES delivery – quantitative ecological models and ecological production functions for each service of interest need to be defined
- Environmental scenarios for modelling and ecosystem service assessment
- Valuation (monetary and non-monetary) methodology (e.g. SEA) to enable/allow trade-off analyses across services

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References

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