



Assessing chemical risk within an ecosystem services framework: a proof of concept studies

Lorraine Maltby, Paul van den Brink,
Jack Faber, Stuart Marshall, Ross Brown

- **ECOSYSTEM SERVICES**

- Direct and indirect contributions of ecosystems to human well-being

- **NATURAL CAPITAL**

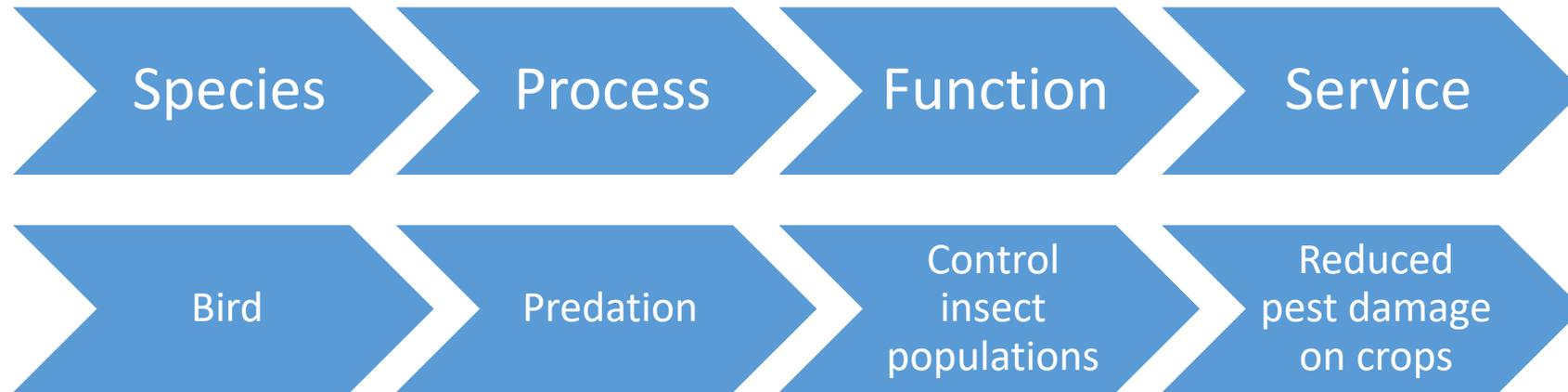
- Stocks of natural resources: rocks & minerals, soil, air, water, biodiversity

- **SERVICE PROVIDING UNITS (SPUs)**

- Species, populations, communities, habitats providing ecosystem services



Species to services



Key questions

- How to extrapolate data from toxicity test species to SPUs?
- How to link effects on service providers to effects on ecosystem service delivery?
- How to develop scenarios for modelling and ecosystem service assessment?
- What is the added value from evaluating chemical effects on ES for regulatory decision making?

*(Maltby et al 2018. STOTEN 621: 1342-1351;
Faber et al 2019. STOTEN 651: 1087-1077)*



Three proof of concept studies.

	Pesticide	Surfactant	Metal
Type of risk assessment	Prospective	Prospective	Retrospective
Environmental compartment	Terrestrial	Aquatic	Aquatic
Number of ecosystem services	4	5	4
Regulatory framework	Regulation 1107/2009	REACH	WFD
For more details see POSTERS	2.04P.10	2.04P.11	2.04P.9



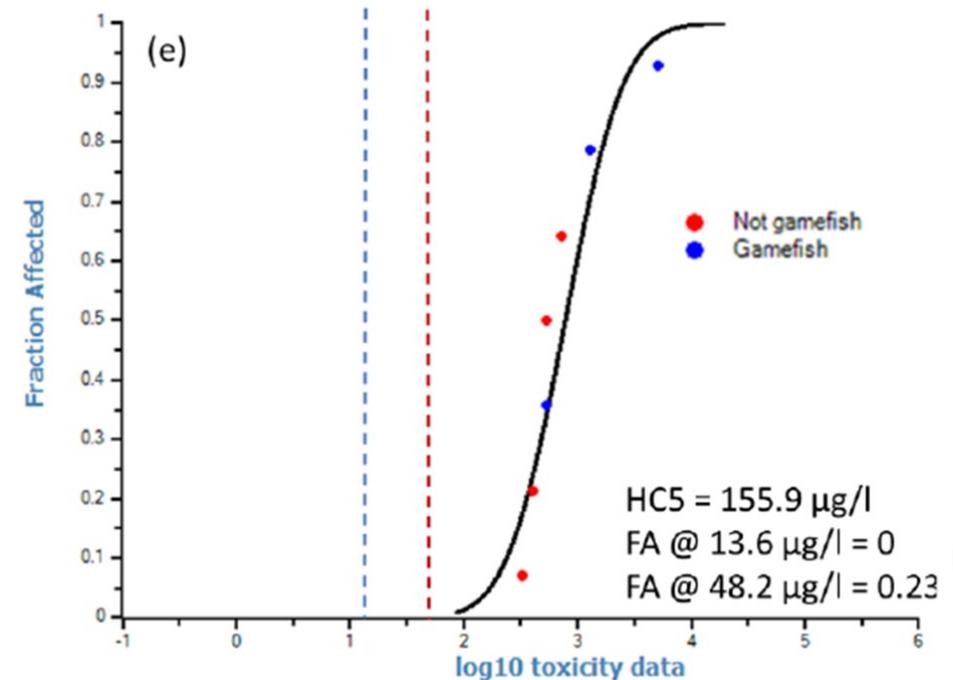
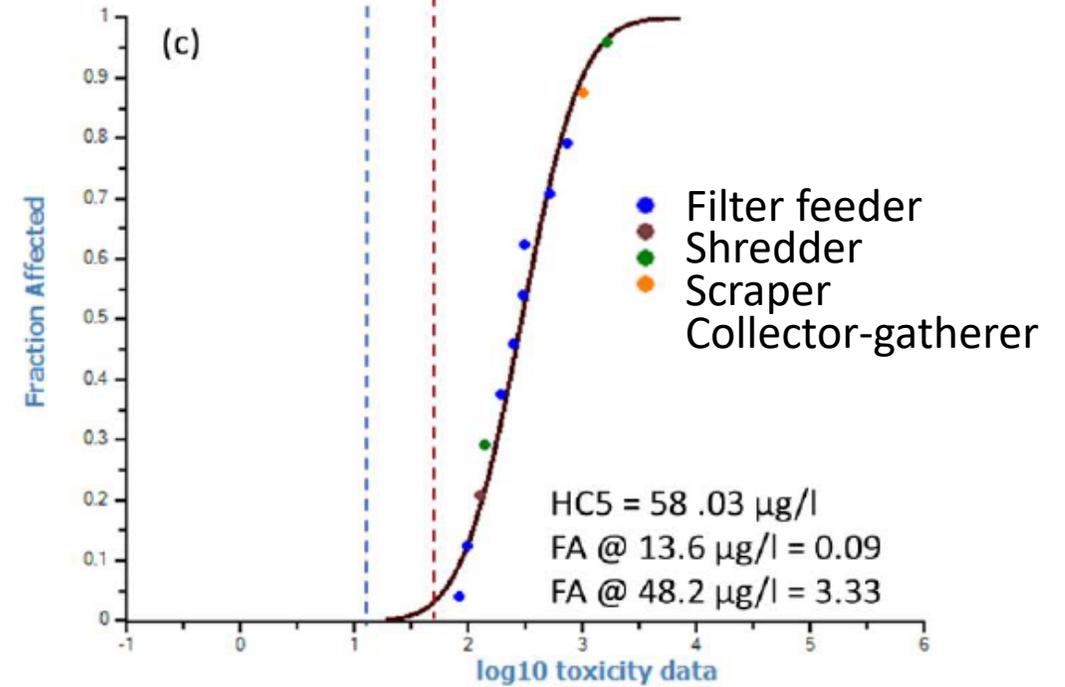
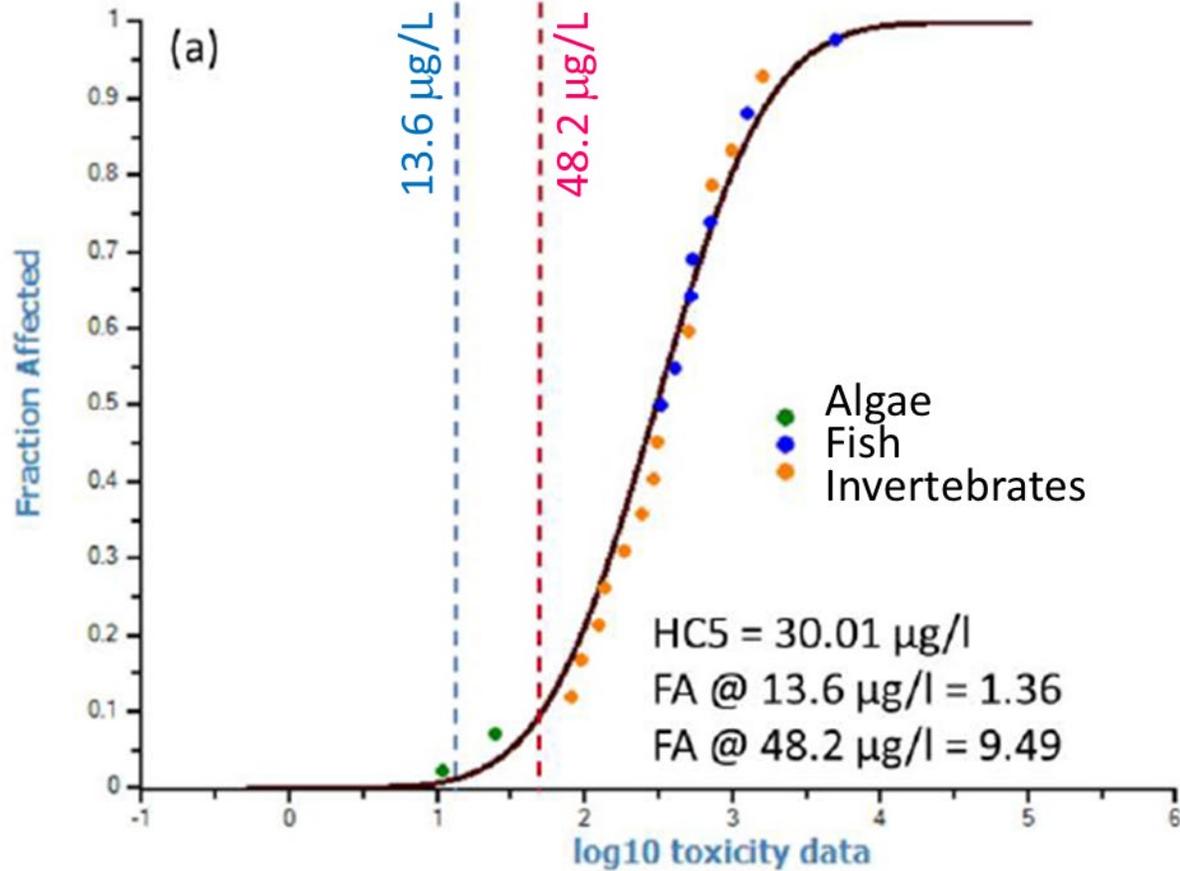
1: Extrapolating from toxicity test species to SPUUs

- Surrogate species approach
- Mechanistic approaches
 - Dynamic energy budget (DEB),
 - toxicokinetic-toxicodynamic (TKTD) models
- Interspecific extrapolation
 - Correlation approaches (e.g. WebICE)
 - Trait-based approaches
 - Taxonomic relatedness (e.g. hierarchical species sensitivity distribution (hSSD)),
 - Phylogenetic approaches (e.g. Sequence Alignment to predict across species susceptibility (SeqAPASS))

Importance of toxic mode of action



Example: Trait approach

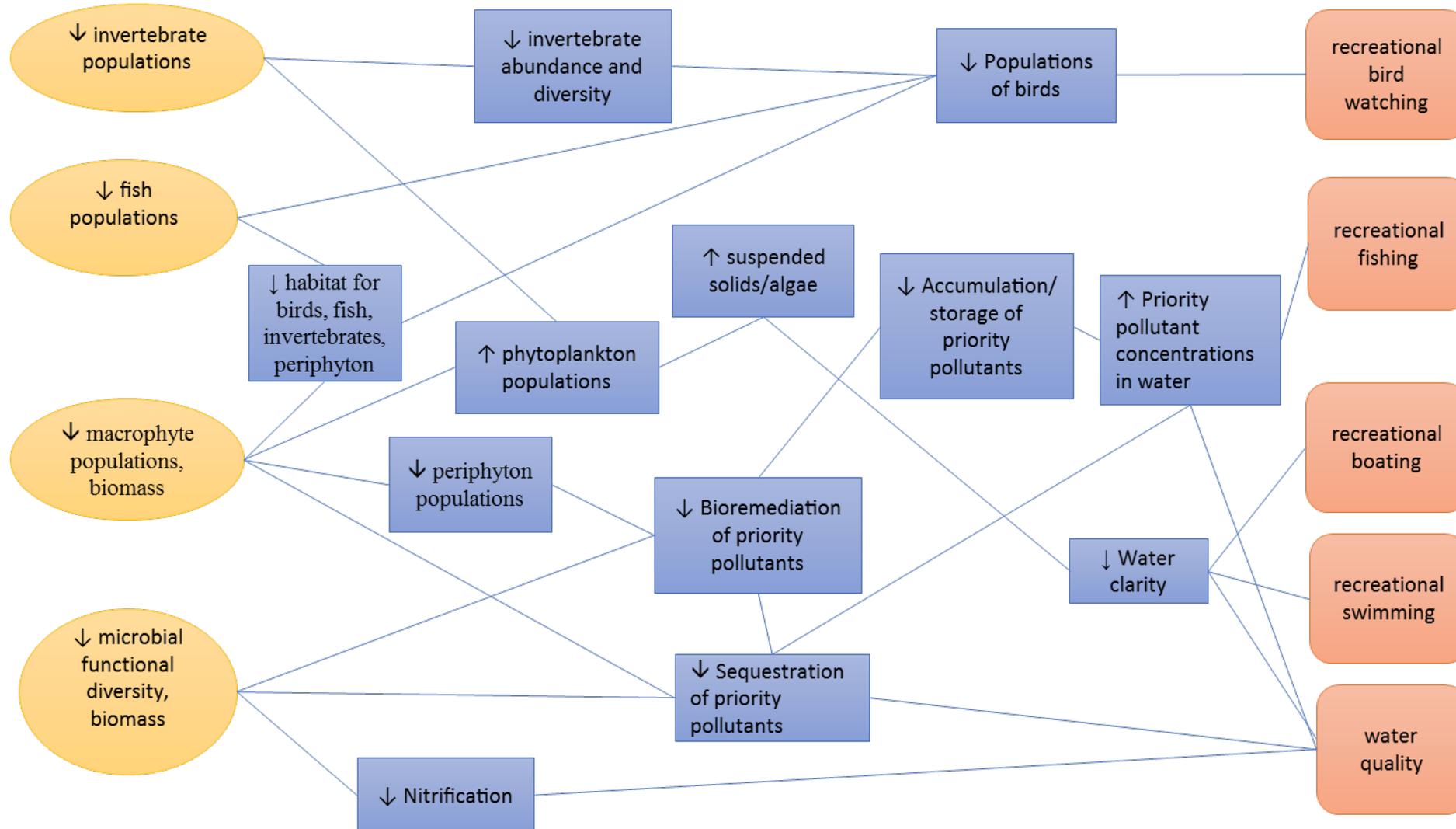


2: Linking effects on SPUs to effects on ecosystem service delivery.

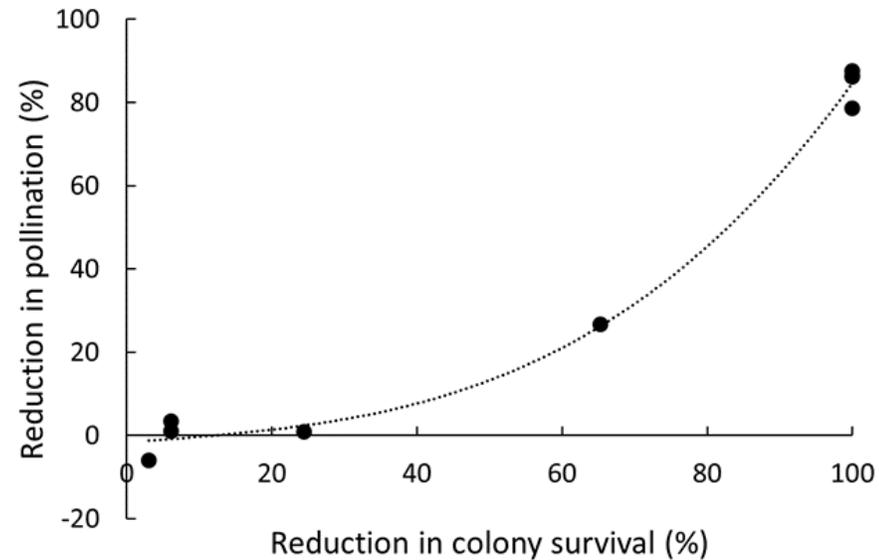
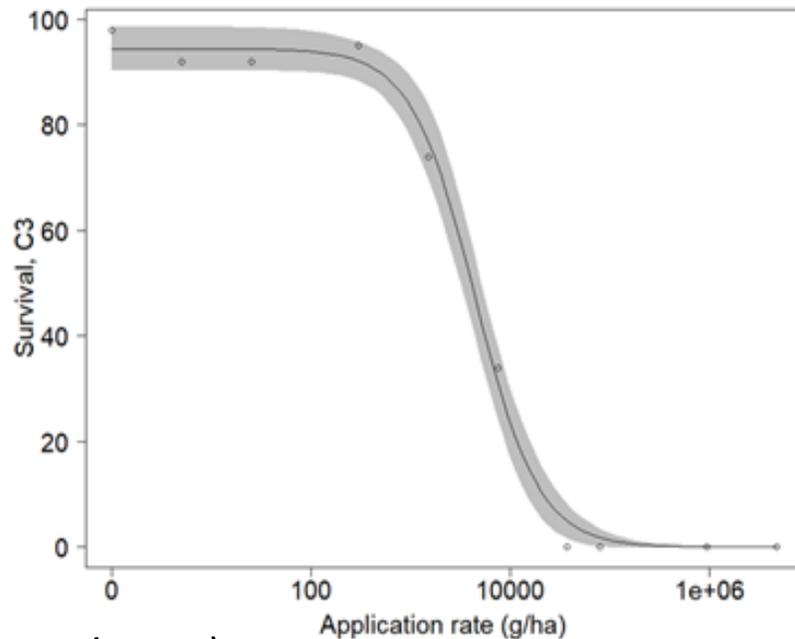
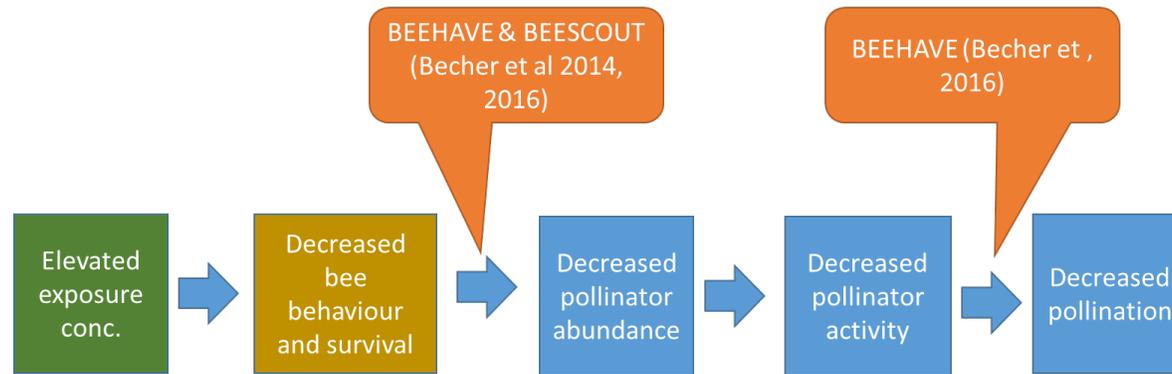
- Evidence-based logic chains (qualitative).
- Ecological production functions (quantitative) that link structure to function/process.
- Ecological models
 - linking effects on individuals to vulnerable populations using individual-based models, IBMs;
 - population to community using connected population models.
 - Food web effects e.g. AQUATOX



Example: Logic chain network



Example: Bee model and link to pollination

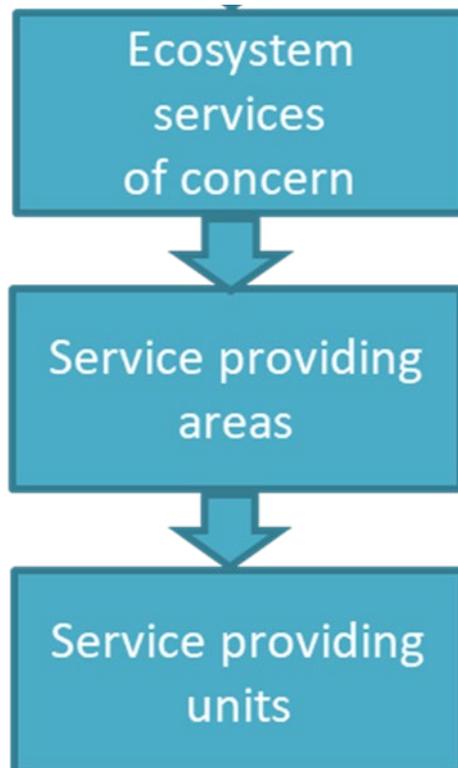


(Annika Agatz, Ibacon)



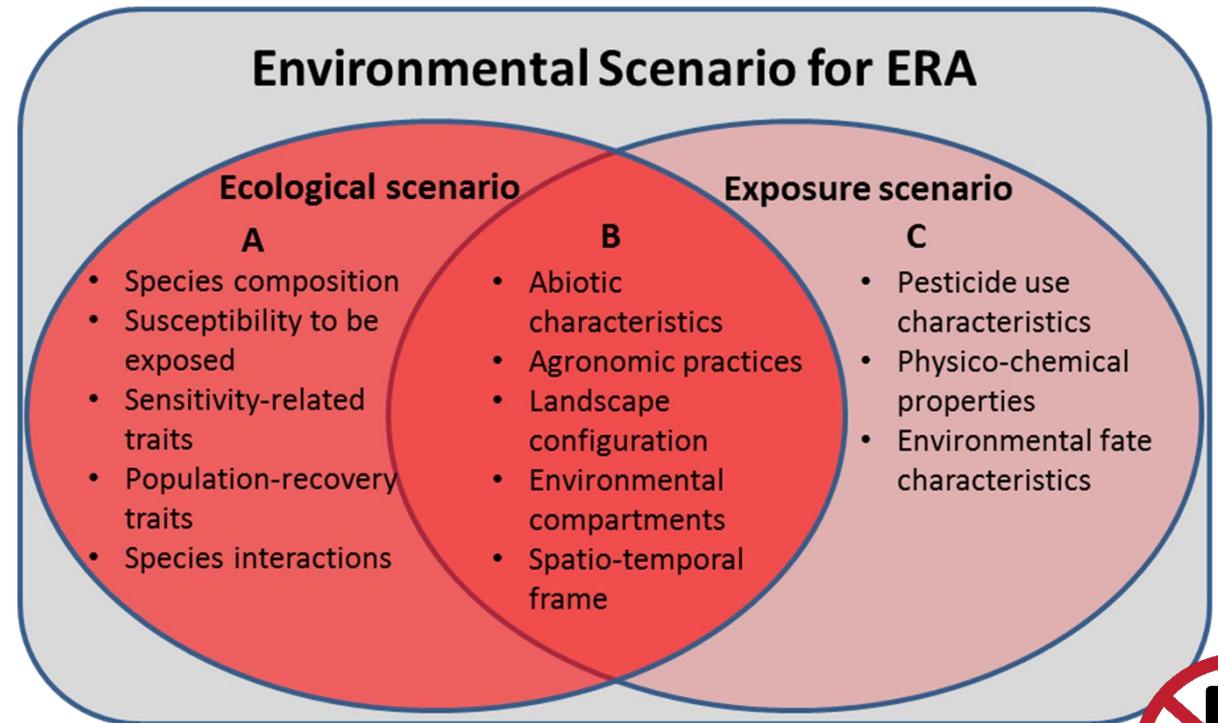
3: Developing scenarios for modelling and ecosystem service assessment

- Ecosystem services scenario



(Faber et al 2019. STOTEN 651: 1067-1077)

- Environmental scenario



(Rico et al 2016. IEAM 12: 510-521)



4: Added value from evaluating chemical effects on ES for regulatory decision making

- Provides a common currency and a 'unifying approach' across environmental compartments, stressors and regulatory frameworks.
- Aids the identification of what really matters for ERA, informing prioritisation of risk and remedial action and aiding risk communication and risk management.
- A more holistic assessment enables ES trade-offs to be compared across alternative solutions / management actions enabling comparative risk assessment.



Recommendations

- Engage relevant regulatory stakeholders to facilitate the development of an integrated systems-level approach.
- Develop and agree scenarios and specific protection goals for framing ERAs and acceptability criteria for interpreting ecosystem service impact.
- Further develop tools for extrapolating toxicity data between species, logic chains and ecological production functions to link what is measured in toxicity tests to what needs to be assessed (i.e. change in ecosystem service delivery).
- Start considering methods and metrics for ecosystem service valuation to be used in assessing trade-offs between services.



Summary

- Proof of concept studies were undertaken to evaluate the feasibility of adopting an ecosystem services approach to chemical risk assessment and discussed in a multi-stakeholder workshop.
- Workshop participants concluded that there was added value in adopting an ecosystem services-based approach for regulatory decision making.
- Key to realising the added value of an ecosystem services approach in regulatory decision is the development of an integrated systems-level approach across regulatory frameworks and agreement on protection goals and acceptability criteria.

