Challenges in applying the ecosystem services framework to risk assessments of regulated stressors.

Valery E. Forbes
Department of Ecology, Evolution and Behavior
What we measure

What we care about

- Genome
- Transcriptome
- Proteome
- Metabolome

DNA

RNA

Proteins

Sugars
Nucleotides
Amino acids
Lipids (Lipidome)

Metabolites

Phenotype/Function

- University of Minnesota
- Driven to Discover
SCIENTIFIC OPINION

Scientific Opinion on the development of specific protection goal options for environmental risk assessment of pesticides, in particular in relation to the revision of the Guidance Documents on Aquatic and Terrestrial Ecotoxicology (SANCO/3268/2001 and SANCO/10329/2002)1

EFSA Panel on Plant Protection Products and their Residues (PPR)2,3

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

General protection goals are stated in European legislation but specific protection goals (SPGs) are not precisely defined. These are however crucial for designing appropriate risk assessment schemes. Here a process for defining SPG options is presented, which uses the ecosystem services approach as an overarching concept and could be used in consultation processes with risk managers and stakeholders. SPGs are defined in 6 dimensions: biological entity, attribute, magnitude of effect, temporal and geographical scale of the effect, and the degree of certainty that the specified level of effect will not be exceeded. SPG options are presented for 7 key drivers (microbes, algae, non target plants (aquatic and terrestrial), aquatic invertebrates, terrestrial non target arthropods including honeybees, terrestrial non-arthropod invertebrates, and vertebrates), covering all ecosystem services which could potentially be affected by the use of pesticides. To ensure ecosystem services, taxa representative for the key drivers identified need to be protected at the population level or higher. However, for aesthetic reasons (cultural ecosystem services) it may be decided to protect vertebrates at the individual level. To protect biodiversity, impacts at least need to be assessed at the scale of the watershed/landscape. The Panel also emphasizes the importance of a tiered approach for risk assessment, the essential linking of exposure and effect assessments in terms of spatial and temporal scales, and the relevance of ecological scenarios for appropriate pesticide risk assessments. It intends to use the presented concepts as input for the dialogue between risk managers and risk assessors during the next steps of the revision of the Ecotoxicology Guidance Documents.

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Development of a framework based on an ecosystem services approach for deriving specific protection goals for environmental risk assessment of pesticides

Karin M. Nienstedt a,1, Theo C.M. Brock b, Joke van Wensem c, Mark Montforts d, Andy Hart e, Alf Aagaard a,2, Anne Alix 1, Jos Boesten b, Stephanie K. Bopp a,3, Colin Brown g, Ettore Capri h, Valery Forbes i,j, Herbert Köpp j, Matthias Liese k, Robert Luttik d, Lorraine Maltby l, José P. Sousa m, Franz Streissl a, Anthony R. Hardy n

a European Food Safety Authority (EFSA), Largo N. Palti 5/A, 43121 Parma, Italy
b Alterra Wageningen University and Research Centre, Droevendaalsesteeg 3a, 6708PB Wageningen, The Netherlands
c Soil Protection Technical Committee, P.O. Box 30947, The Hague, The Netherlands
d National Institute for Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands
e Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ, UK
f General Directorate on Food, Ministry of Food, Agriculture, Fisheries and Rural Affairs, 251 rue de Vaugirard, 75732 Paris Cedex, France
 g Environment Department, University of York, Heslington, York, YO10 5DD, UK
h Istituto di Chimica Agraria ed Ambientale, Università Cattolica del Sacro Cuore, Via Emilia Parmense 86, 29100 Macenza, Italy
i Department of Environmental, Social and Spatial Change, Roskilde University, P.O. Box 260, 4600 Roskilde, Denmark
j Federal Office of Consumer Protection and Food Safety (BVL), Bundesallee 50, 38136 Braunschweig, Germany
k UFZ Helmholtz Centre for Environmental Research, Dept. System Ecotoxicology, Pernerstor Str. 15, 04318 Leipzig, Germany
l Department of Animal and Plant Sciences, The University Sheffield, Western Bank, Sheffield, S10 2TN, UK
m IMAR-CMA, Department of Life Sciences, University of Coimbra, 3001-401 Coimbra, Portugal
n Bishop’s Cottages, 2 Church Lane, Bishopthorpe, York, YO23 2OG, UK
How has this changed ERA?

- Facilitating the use of better extrapolation models and fate/effect integration
- Used to generate trigger values (e.g., bees)
- It has not changed which species are tested or what endpoints are measured
- Not making quantitative, mechanistic links between test endpoints and service delivery
Several challenges

- ERA endpoints are moving further away from protection goals
- Effects on SPUs are not simple or robust proxies for impacts on service delivery
- Standardized conceptual models to link test endpoints to ES are lacking
How to make ES more than nice words?

Step 1: Risk assessment data, e.g., toxicity tests

Step 2: Mechanistic effect model – Links toxicity test output to SPU attribute

Step 3: Ecological production function – Links SPU attribute to service delivery
Goals of NIMBioS WGs

- Macro-Molecular interactions
- Cellular responses
- Physiological responses
- Organism responses
- Population dynamics
- Community structure changes
- Ecosystem services

Diagram showing biological processes:
- Feeding
- Reserve
- Somatic maintenance
- Maturity maintenance
- Growth
- Maturation
- Reproduction
Overall Objectives of Orgs-ES WG

- Develop a general framework to mechanistically link ES to organismal toxicity endpoints
- Test framework using case study approach
- Identify key gaps in data and understanding
- Integrate with mols-to-orgs group
- Develop recommendations for research and implementation of framework
Case Study Approach:

Mountain Stream

- ES: catchable fish; presence of fish
- Stressor: Ethynyl estradiol (EE2)
- Model: inSTREAM IBM

Midwest Reservoir

- ES: clear water; catchable fish
- Stressor: Insecticide
- Model: AQUATOX multi-species ecosystem model
Predicting impacts of chemicals from organisms to ecosystem service delivery: A case study of endocrine disruptor effects on trout

Valery E. Forbes,1,2 Steve Railback,3 Chiara Accolla,4 Bjorn Birnir,5 Randall J.F. Bruins,6,7 Virginie Ducrot,8 Nika Galic,9 Kristina Garber,9 Brett C. Harvey,9 Henriette Jager,1 Andrew Kanarek,9 Robert Pastorok,1 Richard Rebarber,9 Pernille Thorbek,1 Chris J. Salice10

A Framework for Predicting Impacts on Ecosystem Services From (Sub)Organismal Responses to Chemicals

Valery E. Forbes,1,2 Chris J. Salice,1 Bjorn Birnir,5 Randy J.F. Bruins,6,7 Peter Calov,9 Virginie Ducrot,8 Nika Galic,9 Kristina Garber,9 Brett C. Harvey,9 Henriette Jager,1 Andrew Kanarek,9 Robert Pastorok,1 Steve F. Railback,3 Richard Rebarber,9 and Pernille Thorbek,1
Next Steps

• Need a standard protocol for model design that links test endpoints to ES delivery
• Implement as a multi-stakeholder collaboration
• Improve efficiency, consistency and transparency in model development and implementation

Schmolke et al 2017, STOTEN

Forbes, Schmolke, Accolla, Grimm. In preparation
Conclusions

• For the ES framework to measurably improve ERA, it has to be more than a descriptive framework.
• We need more/better models to predict ES delivery from impacts on SPUs and impacts on SPUs from standard ERA information.
• We need more consistency and transparency in the models and less expert judgment.