

PPP case study: Increasing the ecological relevance of chemical risk assessments using geospatial approaches

Christopher M. Holmes (Applied Analysis Solutions, USA), Lorraine Maltby (Sheffield University, UK), Stuart Marshall (Consultant, UK), Jens C. Otte (BASF SE, Germany), Paul Sweeney (Syngenta, UK), Pernille Thorbek (BASF SE, Germany)

BACKGROUND

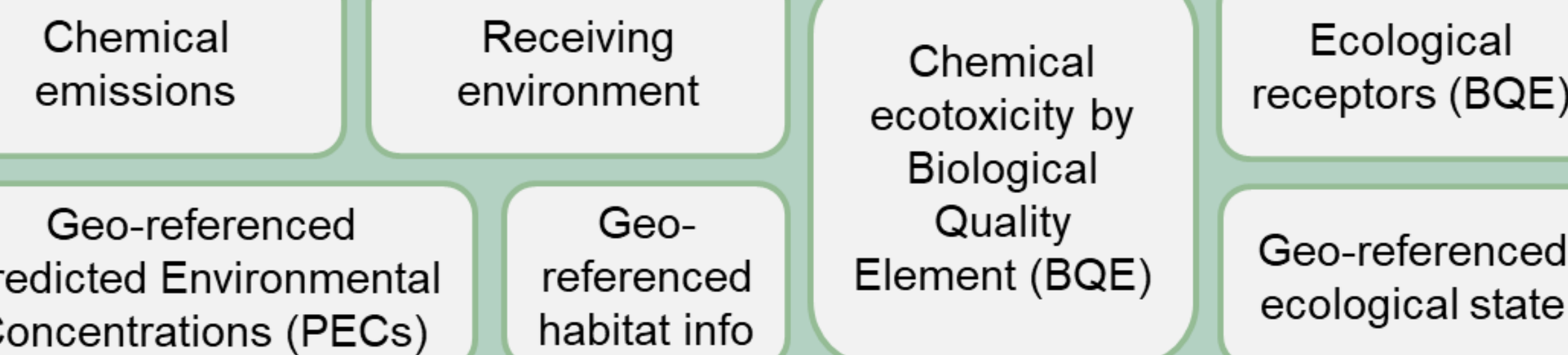
Environmental heterogeneity influences the risks of chemicals in landscapes

- Current chemical risk assessment frameworks do not directly address the landscape-scale heterogeneity of exposure and ecological receptors
- In order to achieve high levels of protection, generic frameworks assume that reasonably worst-case chemical exposure concentrations co-occur in space and time with species assemblages that are most sensitive to the chemical's toxicity
- At locations in the environment where these metrics do not co-occur, mitigation and conservation practices might be deployed where they are not needed and conventional risk assessment may be over-protective
- An ECETOC Task Force was established to assess the utility of geo-referenced chemical exposure and ecological data for making prospective ecological risk assessment over large spatial scales

Overview of Task Force approach

Data needs:

Geo-spatial information research and acquisition



Spatial analysis:

Compute risk (Exposure Toxicity Ratio, ETR) by spatially relating exposure, habitat and effects for each location

Analysis:

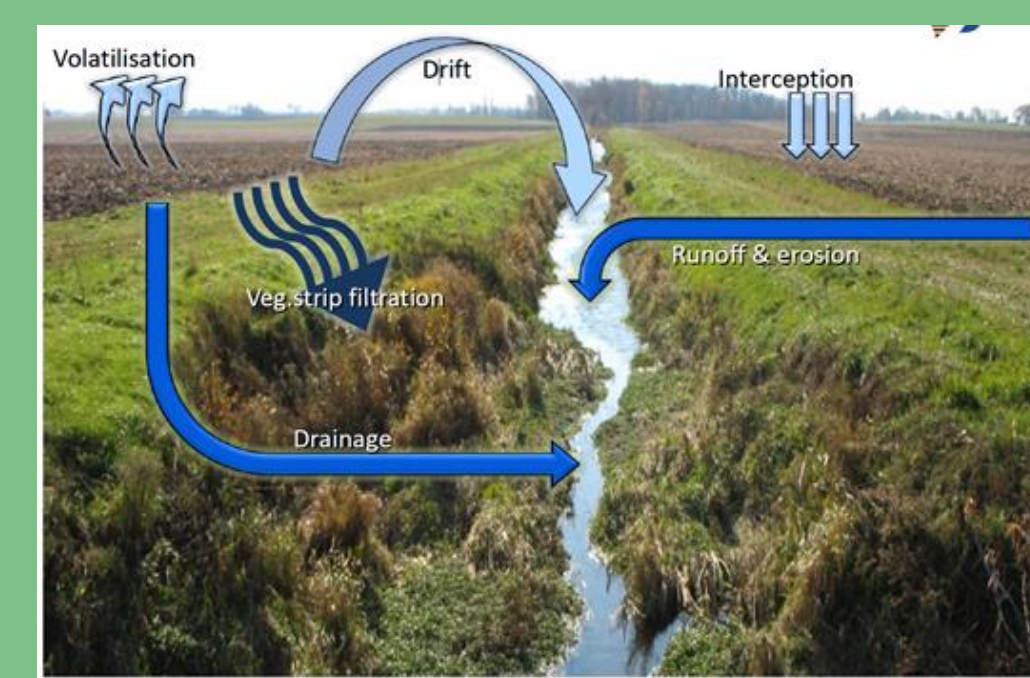
Assess relationship between calculated ETR and ecological status Taking into account spatial & temporal co-occurrence

Results:

Trends of risk (ETR) and ecological status across sites and BQEs

Plant Protection Product (PPP) Case Study

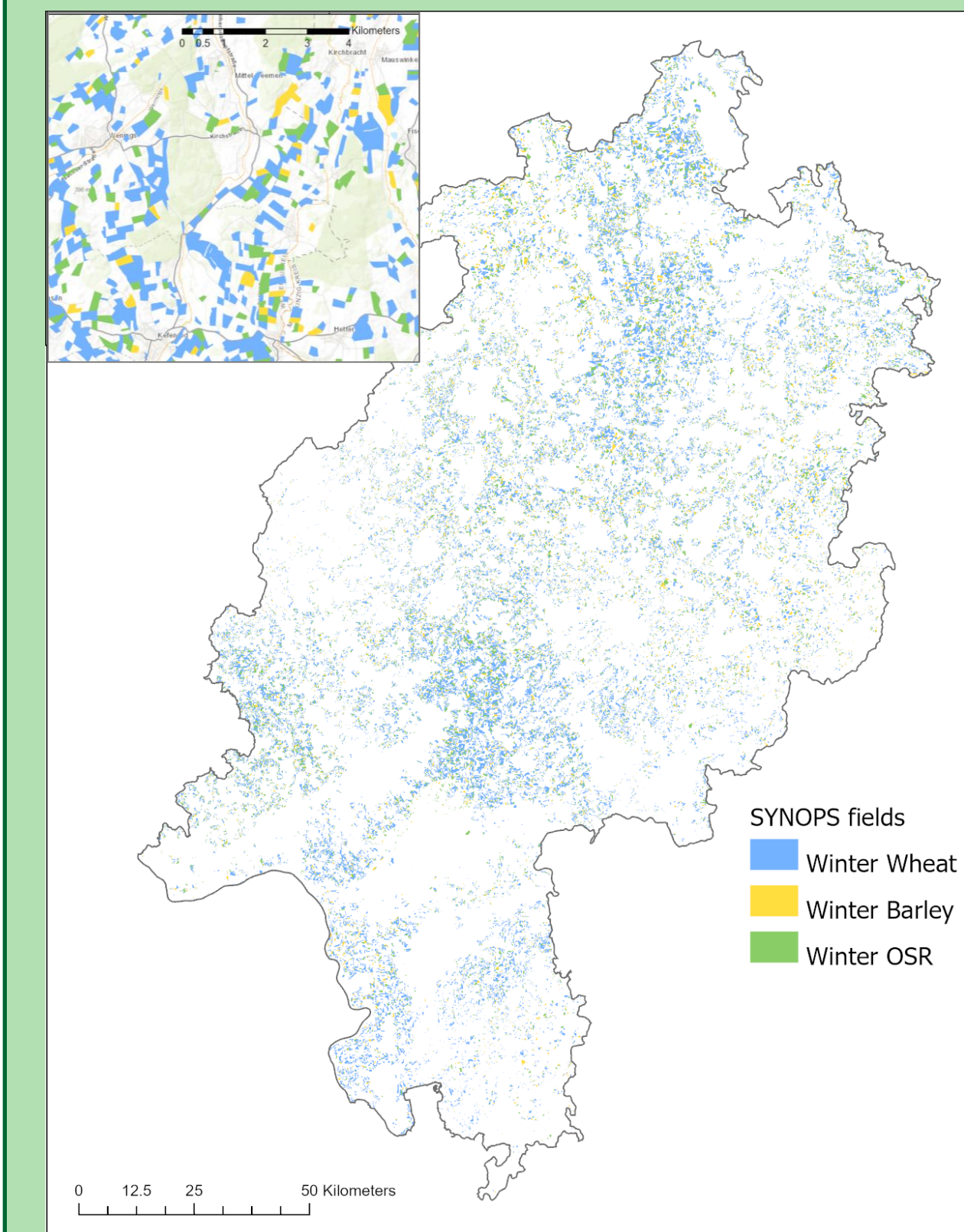
Insecticide, herbicide and fungicide
Winter wheat, barley and oilseed rape
Runoff, erosion and drift (no drainage)



METHODS

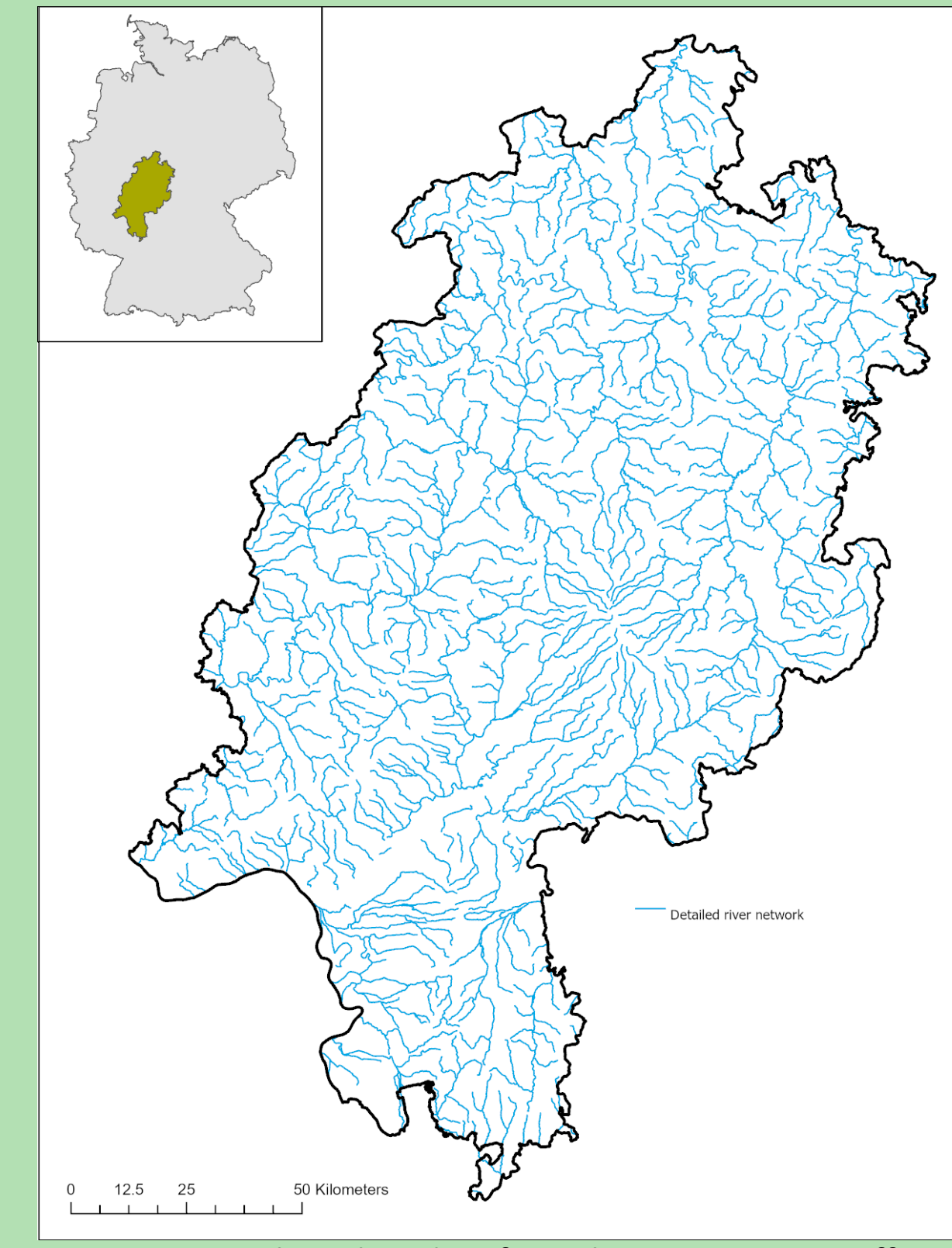
PPP Emission

Winter wheat, barley and OSR
Daily PEC_{sw} for insecticide, herbicide and fungicide



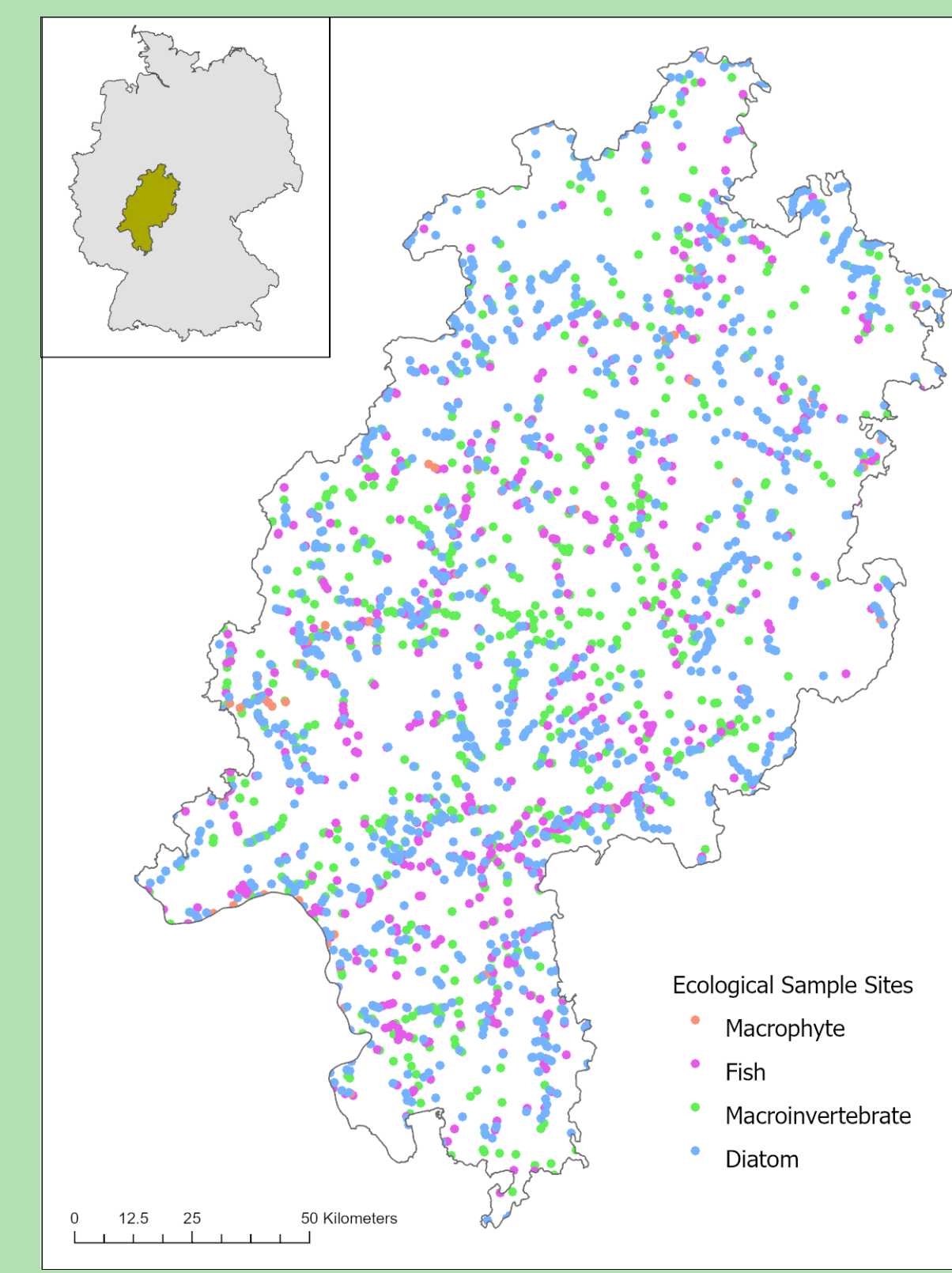
Aquatic Environment

Stream locations (Gewässerstruktur) comprising >77,000 segments



Ecological Receptors

Biological Quality Elements
Ecological Status
3970 locations in Hesse



Predicted Environmental Concentrations

- Based on SYNOPSIS model (JKI, 2019)
- 134,000 applications made to 81,800 fields
- Regulatory models for PPP transport and fate
- 90th percentile of daily 1- and 7- day PEC_{sw}

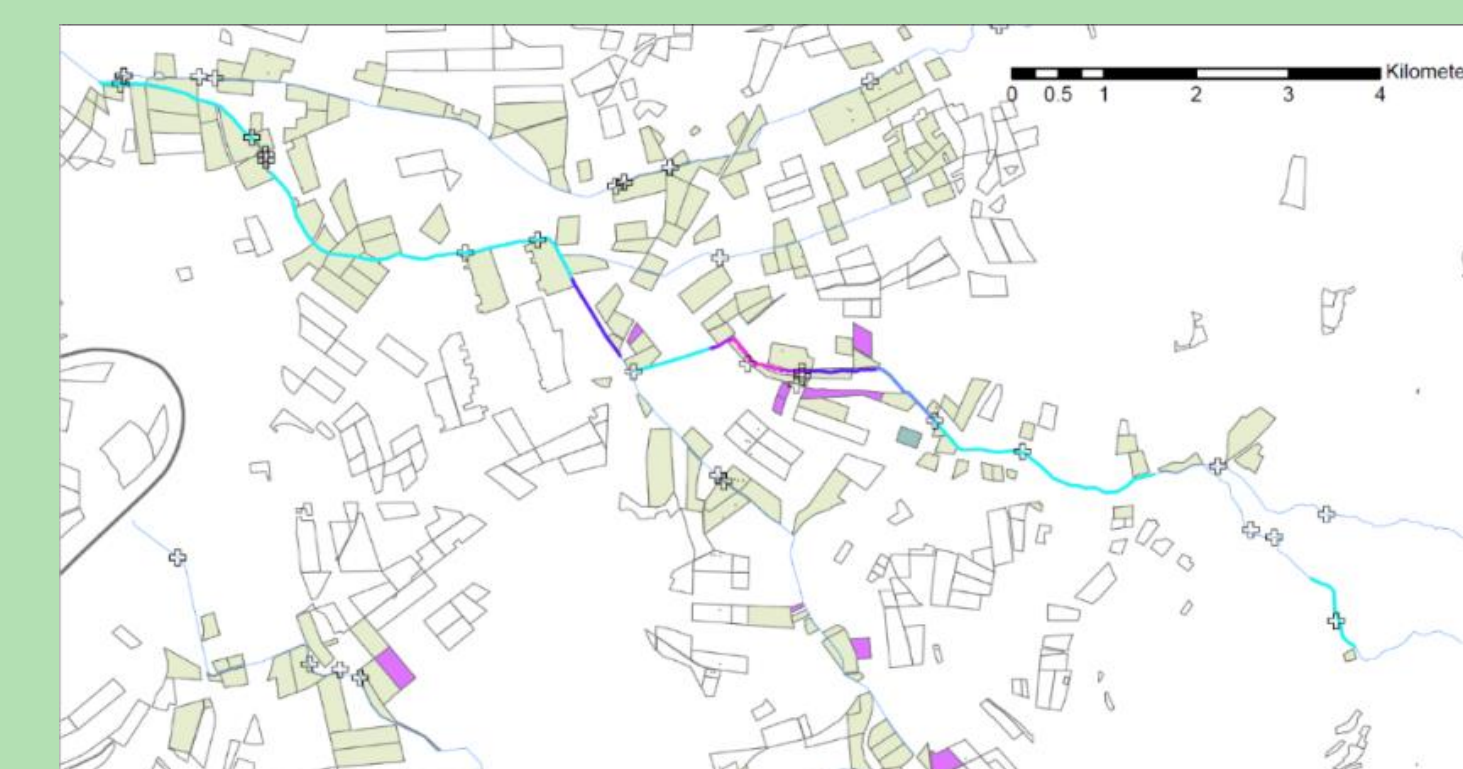
Exposure Toxicity Ratio (ETR)

Annual mean PEC
Acute $EC50$ fish or *Daphnia* (EFSA 2008, 2014)
Annual mean PEC
Chronic $NOEC$ fish; *Daphnia*; algae; *Limnaea* (EFSA 2008, 2014)

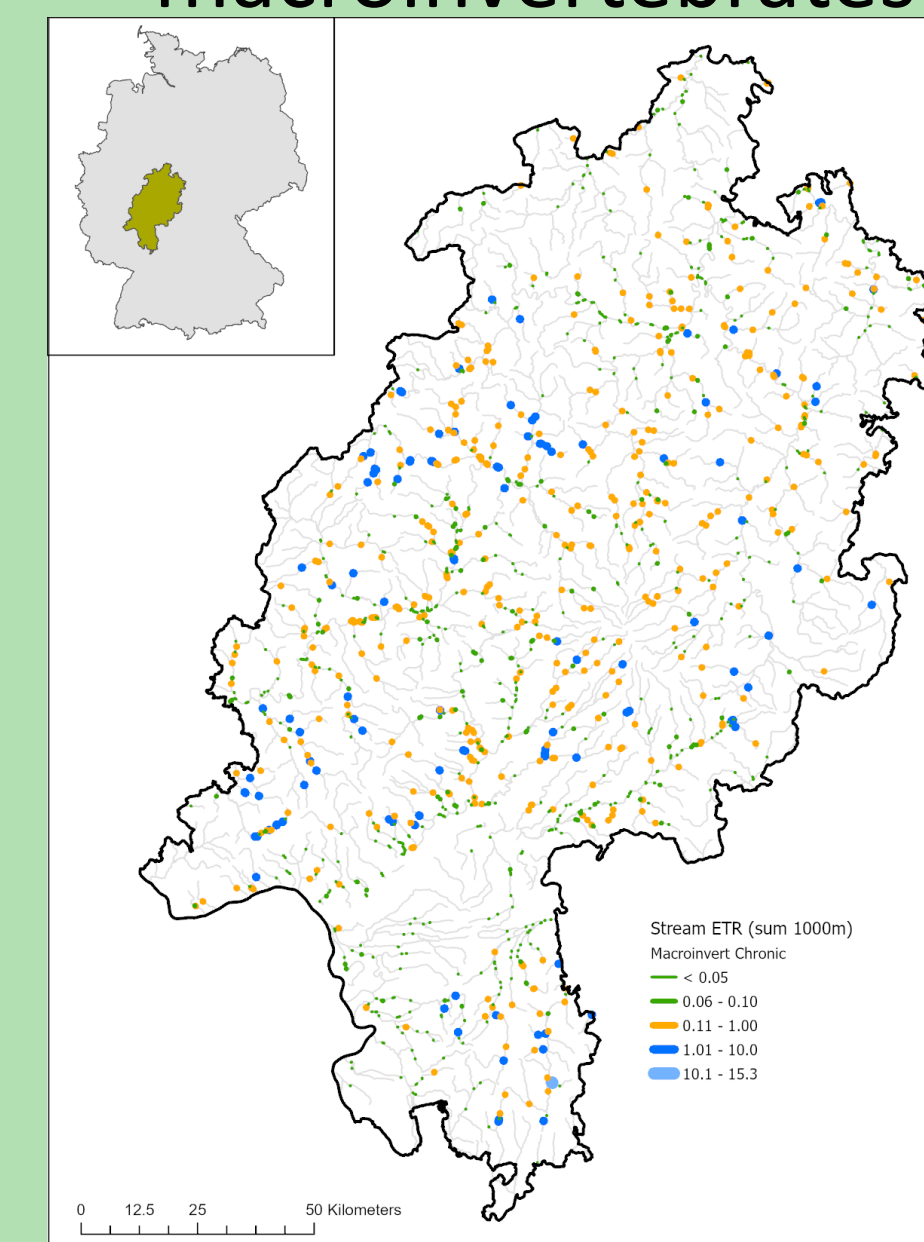
Spatial Processing

- \sum ETR of all actives per field
- Link field ETR to closest stream (300m)
- \sum stream ETRs for 1000m upstream

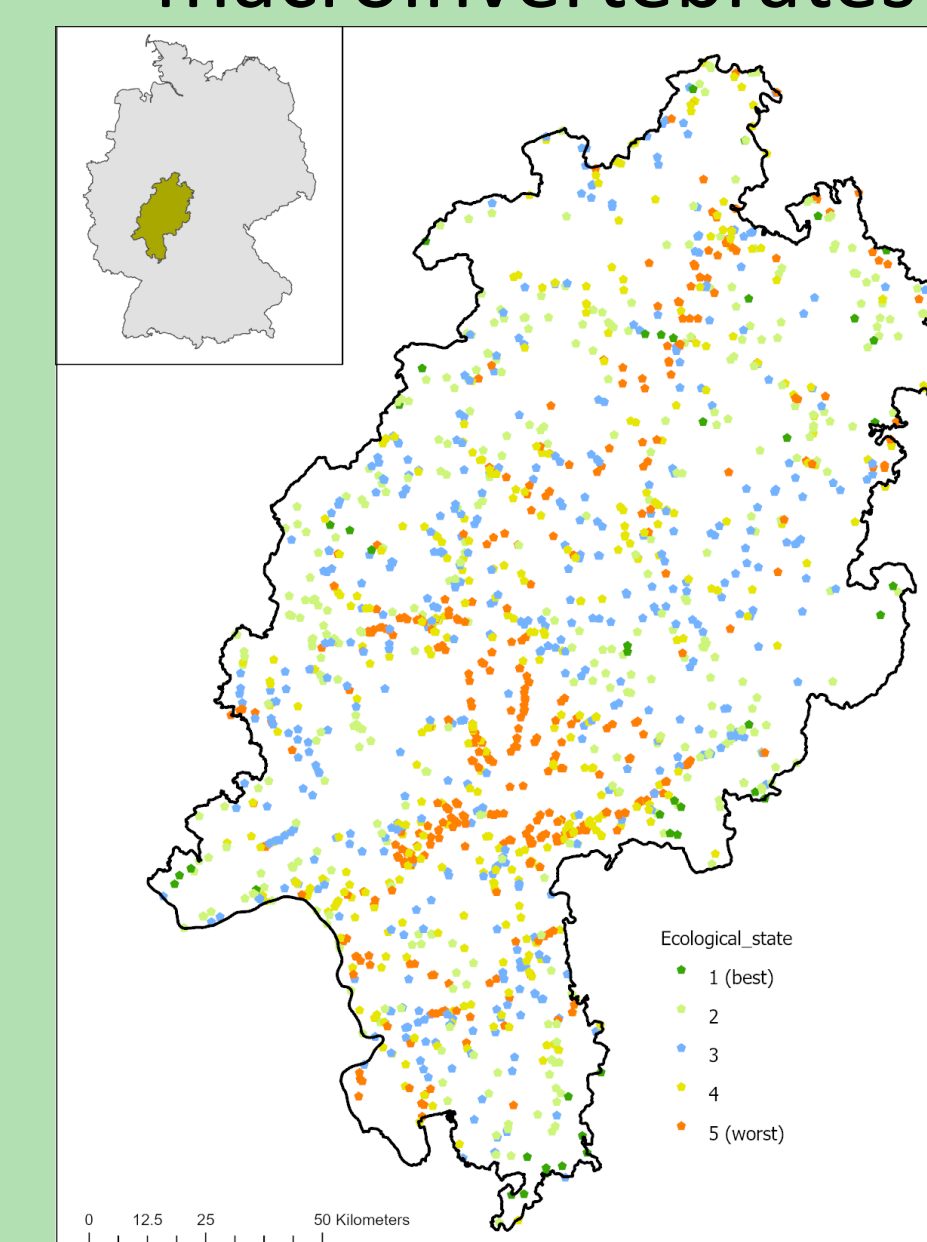
PPPs per field	% of fields
One	42%
Two	52%
Three	6%



Chronic risk (ETR) for macroinvertebrates



Ecological status for macroinvertebrates

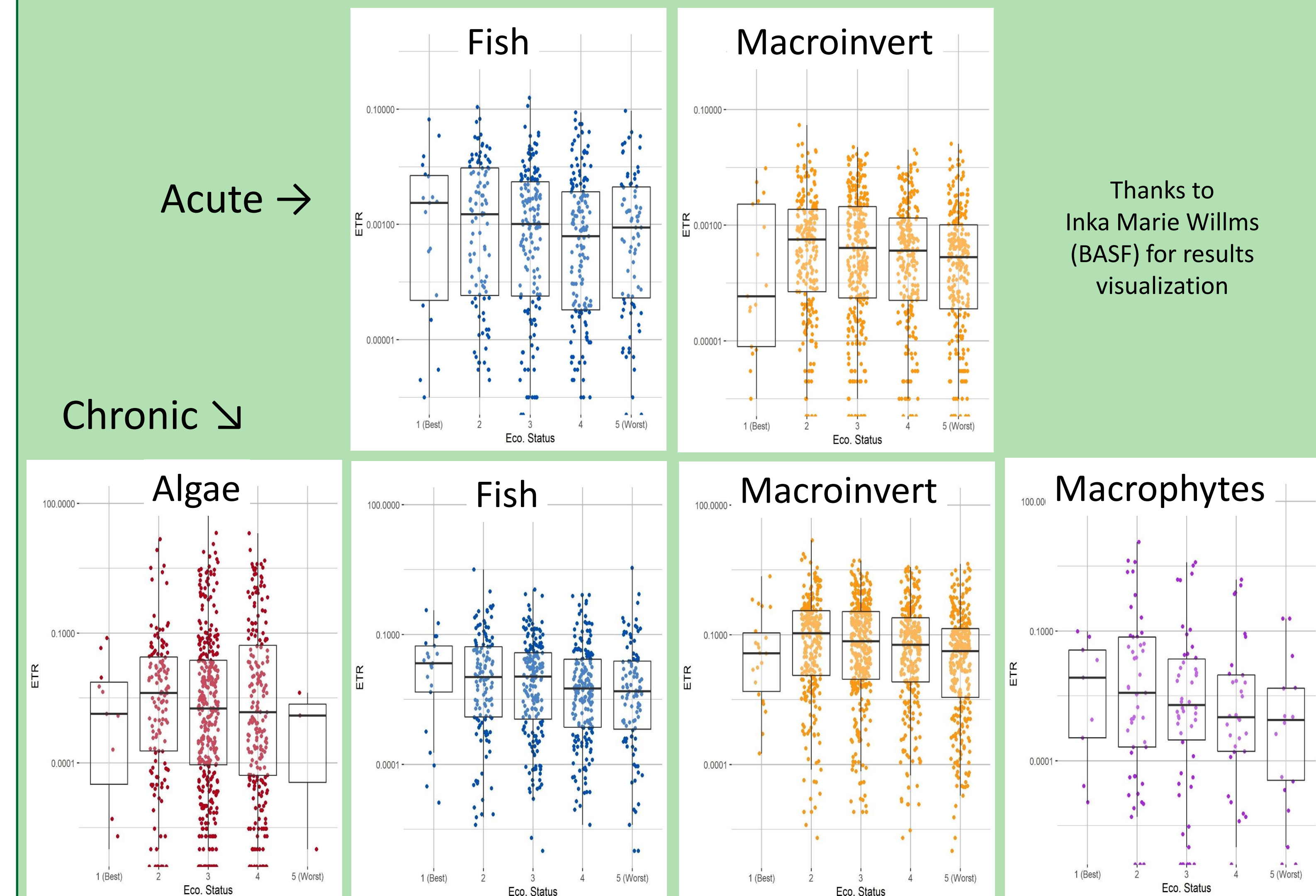


Analysis of ETR and Ecological Status

- Spatially relate final stream ETR with Ecological Status for each Biological Quality Element

RESULTS

Risk and Ecological Status by Biological Quality Element (BQE)



Thanks to Inka Marie Willms (BASF) for results visualization

- Algal risk values related to herbicide sensitivity and macroinvertebrate values due to insecticide sensitivity
- No relationship observed between acute or chronic risk and ecological status for any of the Water Framework Directive Biological Quality Elements

CONCLUSIONS

- Demonstrated capability for feasible geo-spatial analysis of the relationships between ecological status and chemical risk
- The refined approach for PPPs (compared to surfactant case study) allows for examination of multiple stressors that occur in space and time
- Results highlight variation in exposure and risk in the landscape which can be used to inform discussion around "what is acceptable risk?"
- Framing of landscape-scale risk assessment requires clear statement of the question to be addressed and must consider data handling, required resolution, and methods for integrating data layers

Also see poster 4.05.09 for the surfactant Case Study

www.ecetoc.org
Contact: info@ecetoc.org

ecetoc
WE ARE THE CENTRE FOR CHEMICAL SAFETY ASSESSMENT