FACULTY OF BIOSCIENCE ENGINEERING

POPULATION LEVEL RISK ASSESSMENT OF COPPER TOXICITY TO RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)

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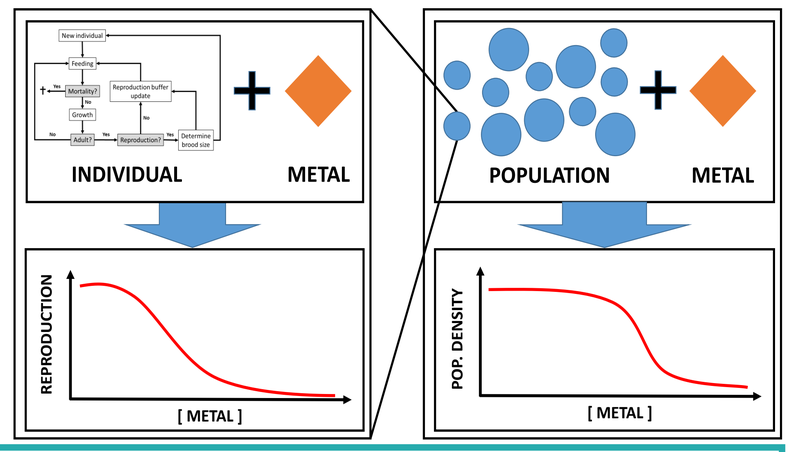
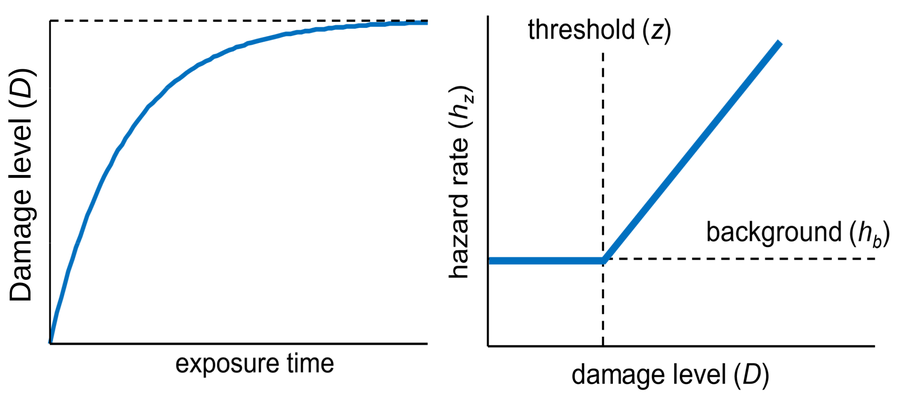
- Currently, risk assessment of metals is based on **species sensitivity distributions (SSD)** compiled with laboratory toxicity data on **individual-level endpoints**
- However, individual-level endpoints do **not** necessarily translate directly to a **similar effect at population level**
- Therefore, there is a need for a **population level approach** which can integrate effects on various vital rates

Goal of the study:

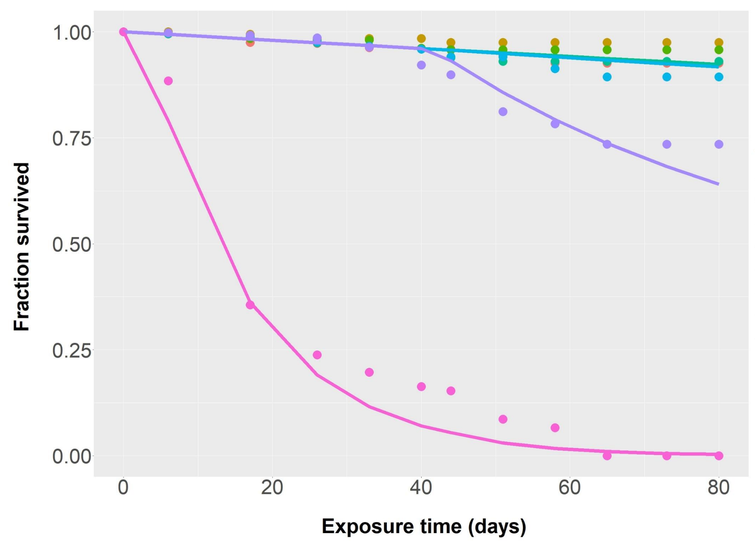
- **Derive population level EC10 values** for the effect of copper toxicity on rainbow trout (*Oncorhynchus mykiss*) and compare those with individual level EC10 values



1 Toxicokinetic-Toxicodynamic modelling



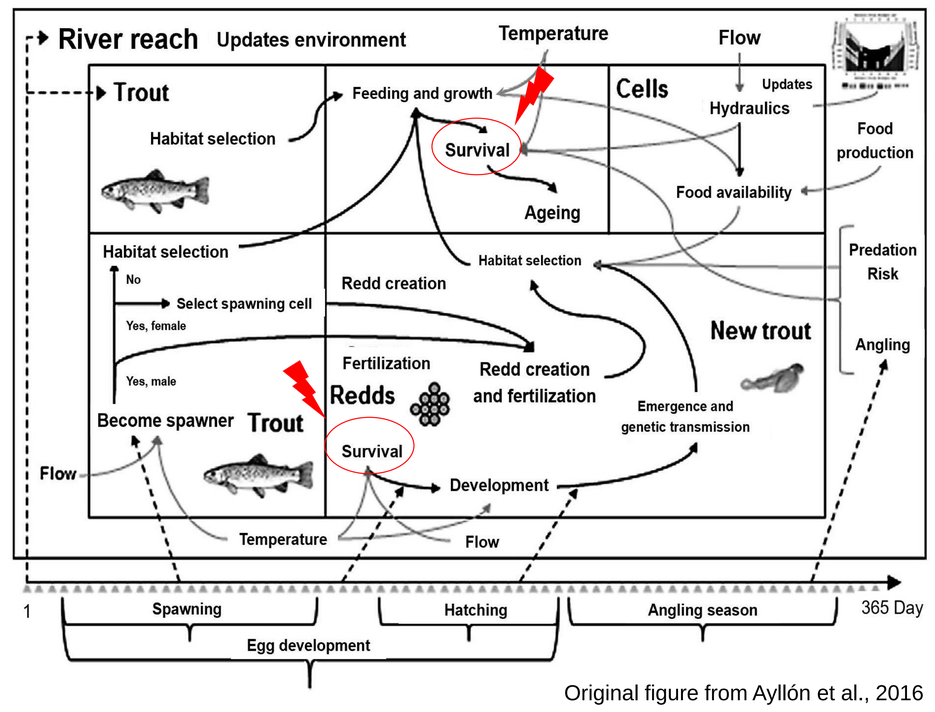
Modified, original figure of Jager and Ashauer, 2018



- **Toxicity experiment: early life stages** of *O. mykiss* are most sensitive for copper toxicity
- Effect of copper on survival rates of early life stages was modelled using the **General Unified Threshold Model (GUTS)** (Jager and Ashauer, 2018)
- Data of early life stages (Seim et al., 1978) showed **two phases of mortality,** before and after day 40 (corresponding with 46 dph)
- This corresponds with the **switch from the yolk sac stage** to **swim-up fry stage**
- **Two GUTS models** were fitted to the data:
  - Yolk sac: GUTS-reduced-SD
  - Swim-up fry: GUTS-reduced

2 inSTREAM-Gen

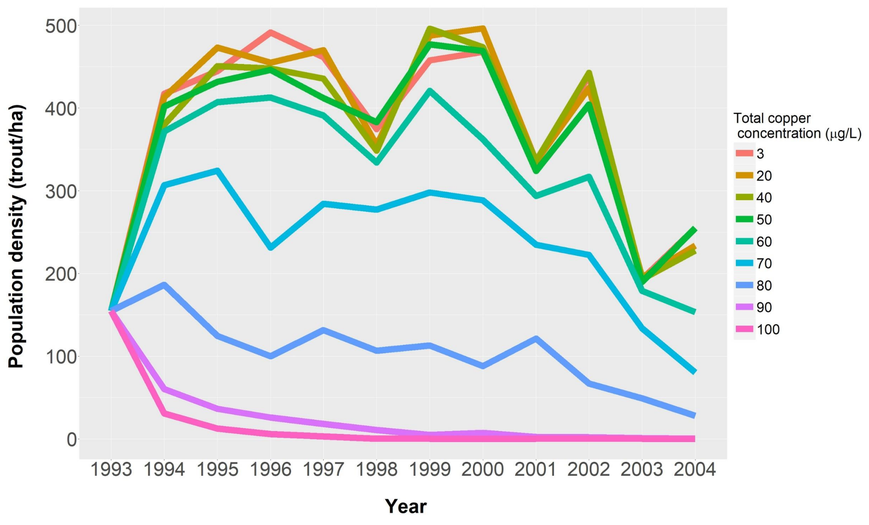
- For extrapolation to population level, the individual based model **inSTREAM-Gen** was used (Ayllón et al., 2016)
- Several parameters were adjusted to *O. mykiss* specific parameters
- **Effects on survival were incorporated** in the yolk-sac phase in the redd survival function and in the swim-up fry phase of the 0-year old survival function



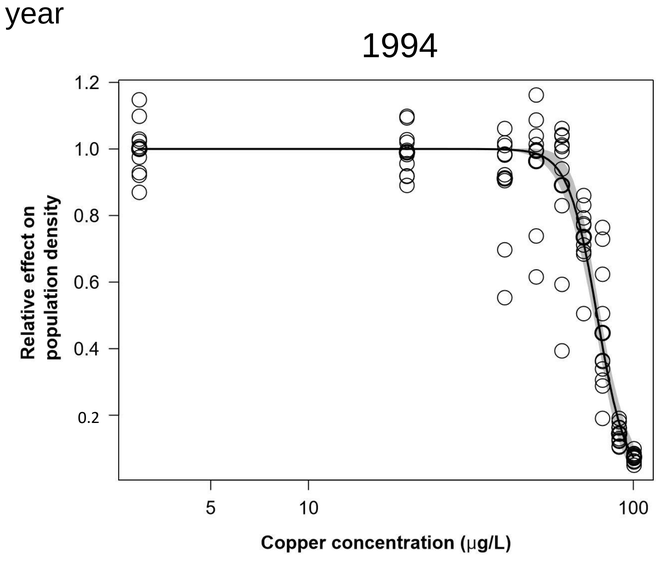
Original figure from Ayllón et al., 2016

3 Population level response

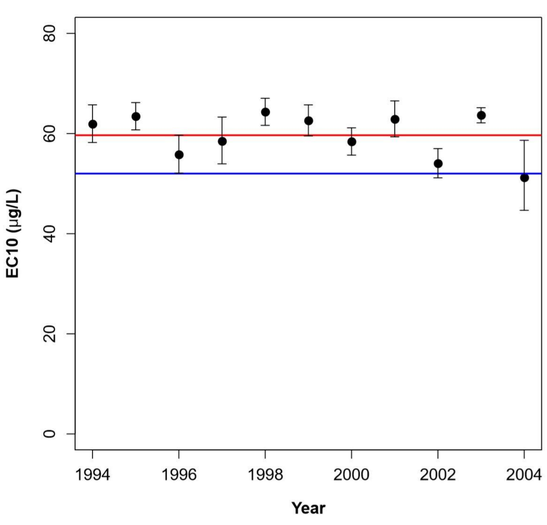
- A decrease in survival rates due to an increase in total copper, led to a **decrease in population size** over time
- Mean of 10 simulations



- A **log-logistic concentration-response model** was fitted for the relative population size in each year



- Individual level LC10 (78-day survival): **52 µg/L**
- Population level EC10 (modelled), average over 10 years: **60 µg/L**



Conclusion & future development

- The EC10 value on population level was about 15% higher compared to the standard approach
- Incorporating effects of copper toxicity on other vital rates
- Correct for copper bioavailability

Acknowledgements: This research is supported by the European Copper Institute (ECI) and the International Zinc Association (IZA)

References: Ayllón et al. 2016, Ecological Modelling 326: 36-53. Jager and Ashauer 2018, version 1.0 leanpub: https://leanpub.com/ guts_book.%0A. Seim et al. 1984, Canadian Journal of Fisheries and Aquatic Sciences 41 (3): 433–438.

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