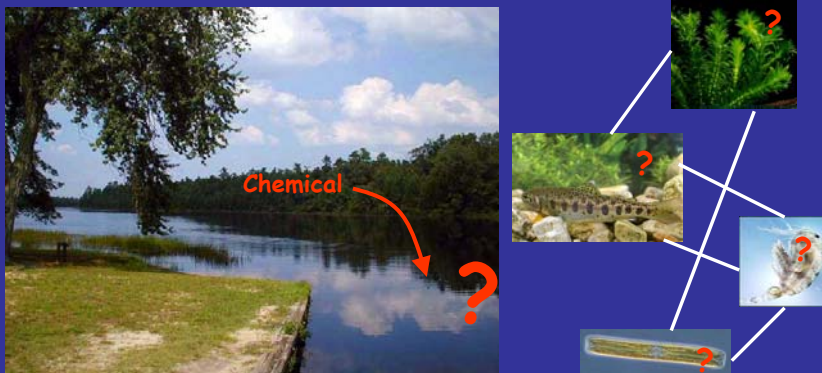# Validation of ecosystem modelling as a tool for ecological effect assessments

Frederik De Laender, Karel De Schamphelaere,
Peter Vanrolleghem and Colin Janssen

Ecological Effects Assessment (EEA)

✓ Ecological Effects Assessment: what is the effect on the ecosystem of a given chemical concentration?
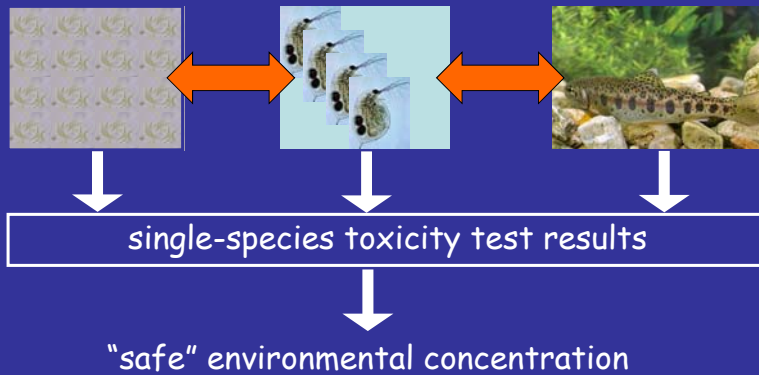

→ derivation of water quality criteria

EEA: current solutions

✓ extrapolation of single species toxicity test results
✓ ..which are only function of inherent species sensitivities

single-species toxicity test results

"safe" environmental concentration

SETAC Europe, Annual meeting. 21/5/2007, Porto, Portugal – frederik.delaender@ugent.be

EEA: alternative solution

✓ ecosystem modelling
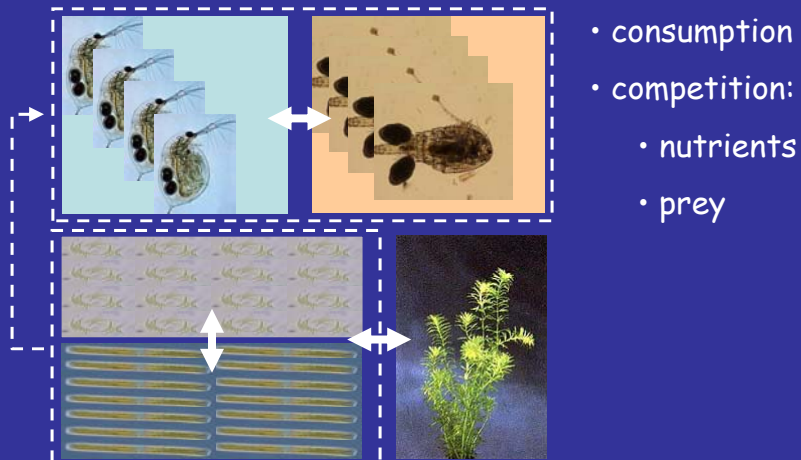
• consumption
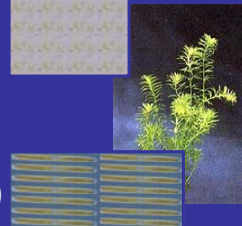• competition:
  • nutrients
  • prey

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EEA: alternative solution

✓ dynamic ecosystem modelling in ecotoxicology

$$\frac{dBio_{phyto}}{dt} = \boxed{photosynthesis} \quad f\ (toxicant)$$

- sinking
– consumption by zooplankton
– other losses (e.g., respiration)

$$\frac{dBio_{zoo}}{dt} = consumption \quad f\ (toxicant)$$

– $\boxed{mortality}$
– other losses (e.g., excretion)

Research goal

How accurate are model predictions?

→ comparison with experimentally observed effects

3

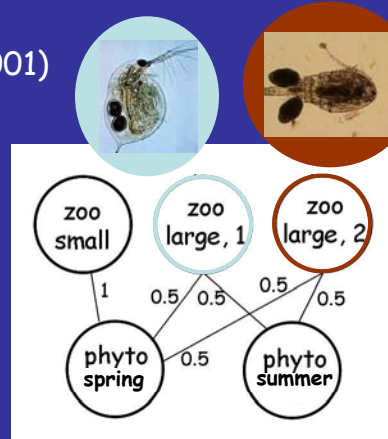# Case study: copper in microcosms

1. Study report by Schaeffers (2001)
2. Species grouping:
   - ✓ growth kinetics / body size
   - ✓ sensitivity for copper
   - ✓ cladocerans and copepods
   - ✓ macrophyte
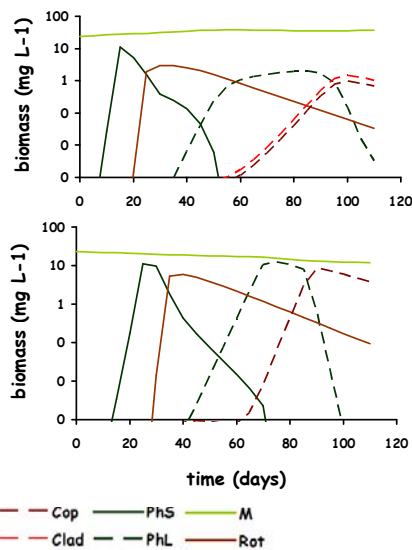3. Single-species toxicity data:
   - ✓ mortality – $EC_{50}s$
   - ✓ growth – $EC_{50}s$

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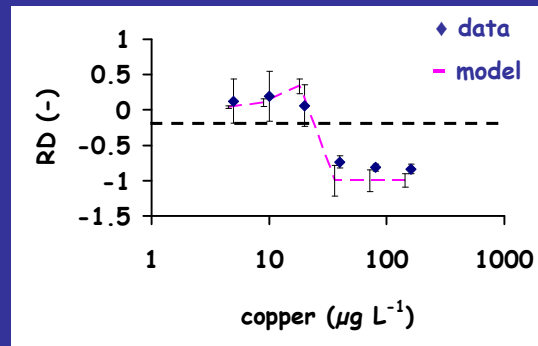# Case study: copper in microcosms

dynamics: control vs. treatment

Quantification of effects:

- average biomass in time
- for each population
- at different chemical concentrations
- → relative difference (RD)

$$RD_c = \frac{\overline{bio}_c - \overline{bio}_{control}}{\overline{bio}_{control}}$$

- assumption: |RD| > 0.2 is observable
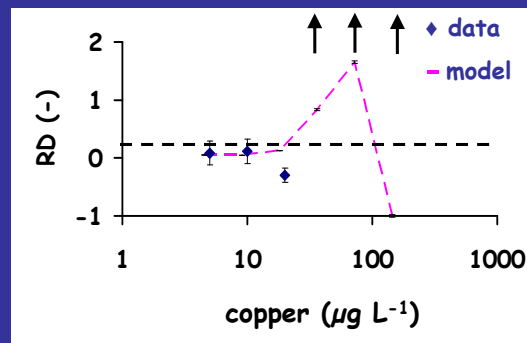- used for NOEC derivation

4

Data vs predictions: cladocerans

- ✓ good predictions of RD-values
- ✓ trend: decrease of biomass with increasing Cu
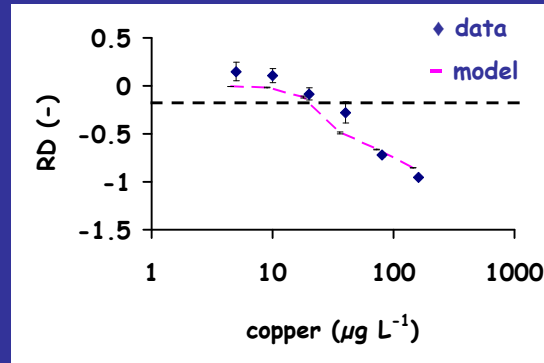- ✓ observed = predicted population-NOEC = 20 μg L^{-1}
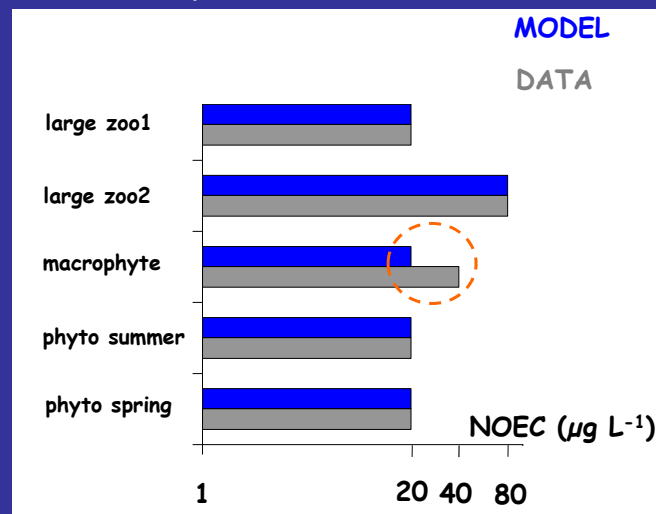
Data vs predictions: spring phyto

- ✓ inaccurate RD-predictions at higher concentrations
- ✓ trend: increase of biomass with increasing Cu
- ✓ observed = predicted population-NOEC for increase = 20 μg L^{-1}

Data vs predictions: macrophyte

✓ effect slightly over-predicted by model

✓ observed population-NOEC = 40 μg L^{-1}

✓ predicted population-NOEC = 20 μg L^{-1}

Data vs predictions: NOECs

✓ ecosystem-NOEC = min (population-NOECs) = 20 μg L^{-1}

Data vs predictions: other chemicals

- ✓ **11 additional large-scale studies**
    - ✓ **diflubenzuron**
    - ✓ **atrazine (3)**
    - ✓ **linorun**
    - ✓ **esfenvalerate (2)**
    - ✓ **metribuzin**
    - ✓ **azinphos-methyl (2)**
    - ✓ **fenthion**

- ✓ **with a duration of ≥ 40 days**

Data vs predictions: other chemicals

- ✓ e.g. study by Denoyelles et al. (1982), Ecology, 63, 1285-1293
- ✓ atrazine
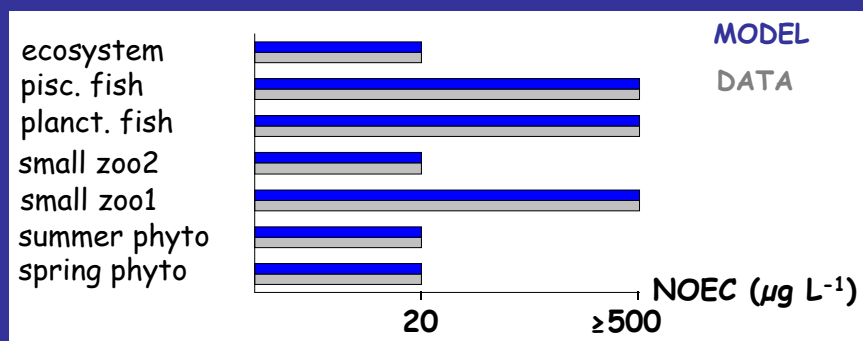
- ✓ all NOECs accurate

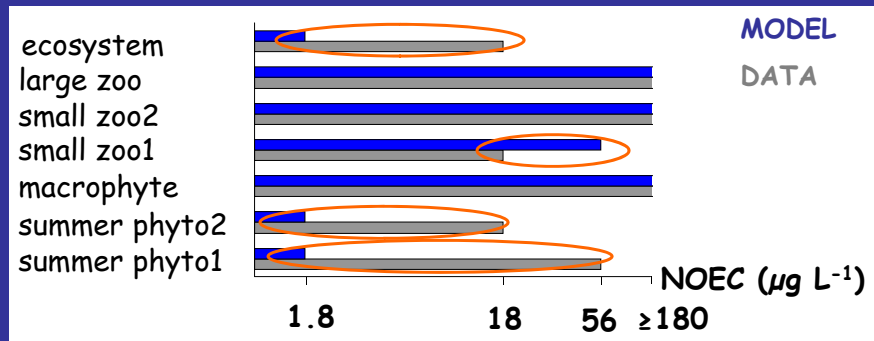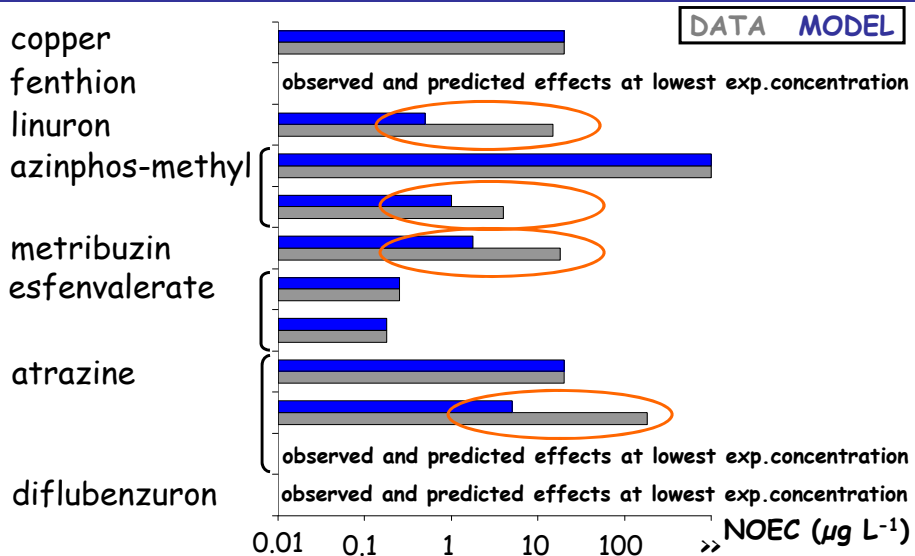## Data vs predictions: other chemicals

✓ e.g. study by Brock et al. (2004) Environ. Poll., 130, 403-426

✓ metribuzin

✓ predicted ecosystem-NOEC a factor 10 conservative

ecosystem-NOECs: overview

Conclusions

- ✓ Methodology relies on :
  - ✓ single-species toxicity test results
  - ✓ default feeding relationships
- ✓ Accurate predictions of copper effects in microcosms
- ✓ Inaccurate NOEC predictions tend to be more conservative

  ...especially at ecosystem-level

Acknowledgements