Do we have to incorporate ecological interactions in the sensitivity assessment of ecosystems?

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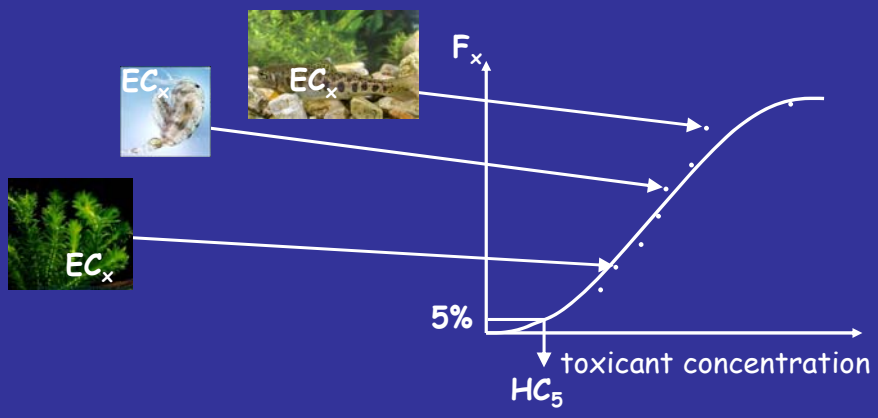
Sensitivity assessment of ecosystems

- ✓ Currently: based on single species toxicity test results…
- ✓ …extrapolated using species sensitivity distribution (SSD)



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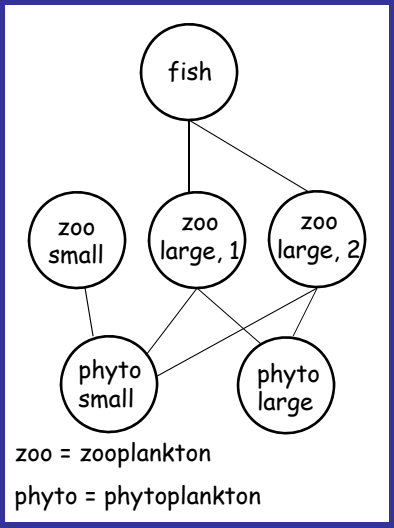
Problems with current approaches

- ✓ Assumptions underlying SSD-models
- ✓ Forbes and Calow, 2002, Hum. Ecol. Risk Assess. (8), 473-492
  - ✓assumptions related with **underlying theory**: T-assumptions
  - ✓assumptions related with their **application**: P-assumptions

T 1: "Ecological interactions do not influence the sensitivity distribution"

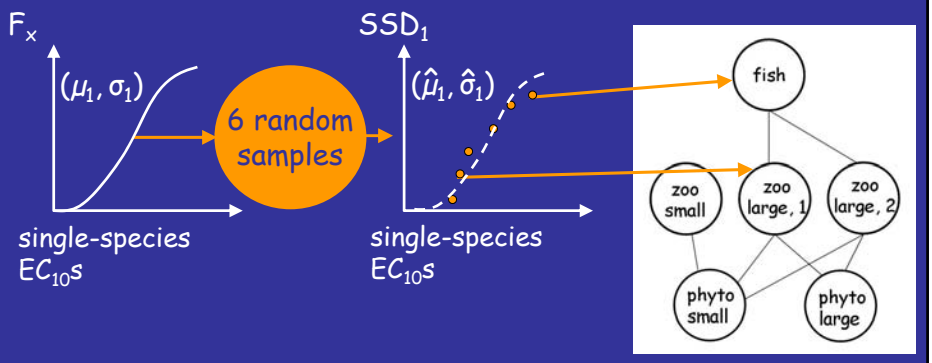
Methodology

- ✓ theoretical exercise
- ✓ for a simple ecosystem
- ✓ consisting of 6 species
- ✓ for 1000 hypothetical toxicants:
  "toxicant 1 to toxicant 1000"



Methodology – toxicant 1

- ✓ chronic single-species EC_{10}s of all possible species ~ lognormal (μ_1, σ_1)
- ✓ single-species toxicity testing of the 6 species → SSD_1



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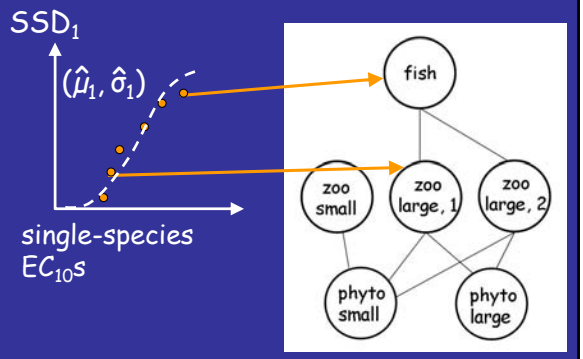

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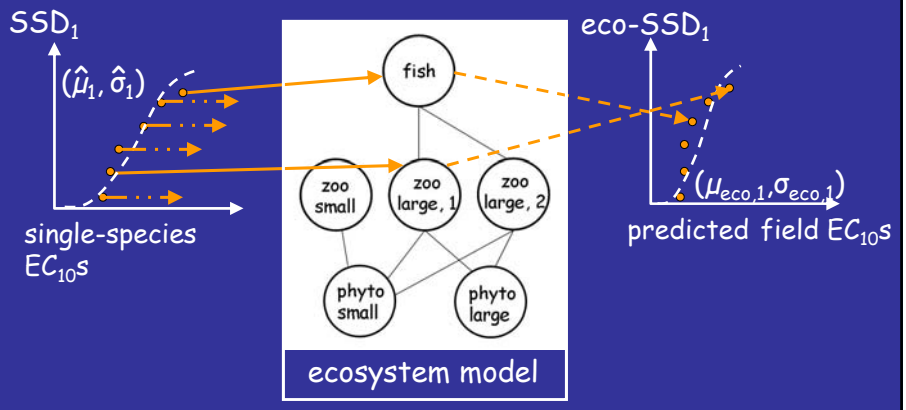
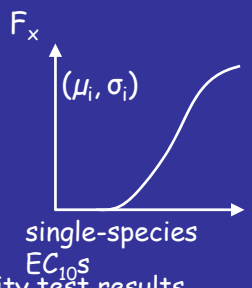


✓T1: parameters of SSD_1 ≈ parameters of eco-SSD_1

Methodology – 1000 toxicants

- ✓ run this methodology 1000 times
- ✓ ~ a different toxicant for every run



- ✓ use T and F-tests to compare mean and standard deviation of
  - ✓SSD → based on single-species toxicity test results
  - ✓eco-SSD → based on predicted field-EC_{10}s
- ✓ if parameters are not significantly different → T1 valid

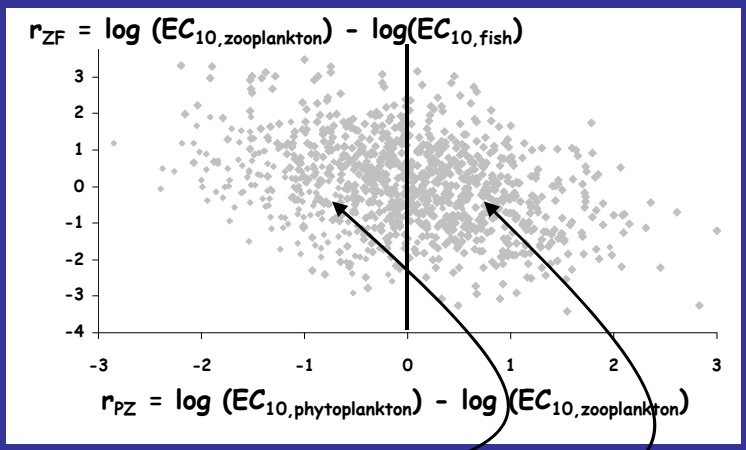
Results

- ✓ for 254 of the 1000 toxicants:
  → T1 invalid
- ✓ for 190 of the 1000 toxicants:
  mean SSD > mean eco-SSD
- ✓ characterize these 190 toxicants
  - ✓random cases?
  - ✓special cases?
- ✓ use relative sensitivities to characterize toxicants:

$$r_{PZ} = \log (EC_{10,phytoplankton}) - \log (EC_{10,zooplankton})$$

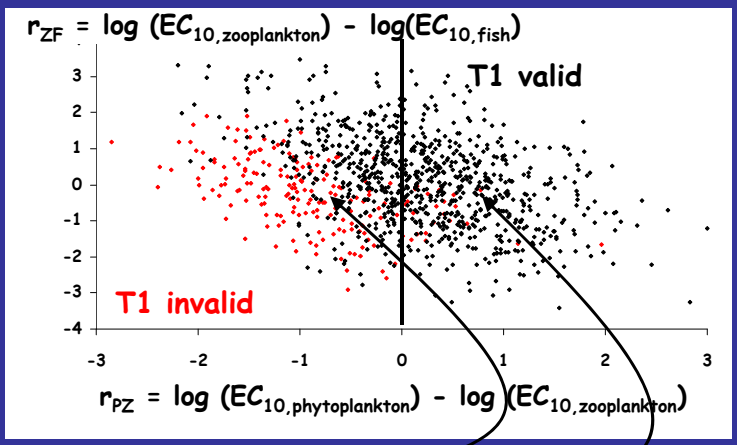
$$r_{ZF} = \log (EC_{10,zooplankton}) - \log(EC_{10,fish})$$

Results



- ✓ $EC_{10,phytoplankton} < EC_{10,zooplankton}$
- ✓ $EC_{10,phytoplankton} > EC_{10,zooplankton}$

Results



- ✓ $EC_{10,phytoplankton} < EC_{10,zooplankton}$
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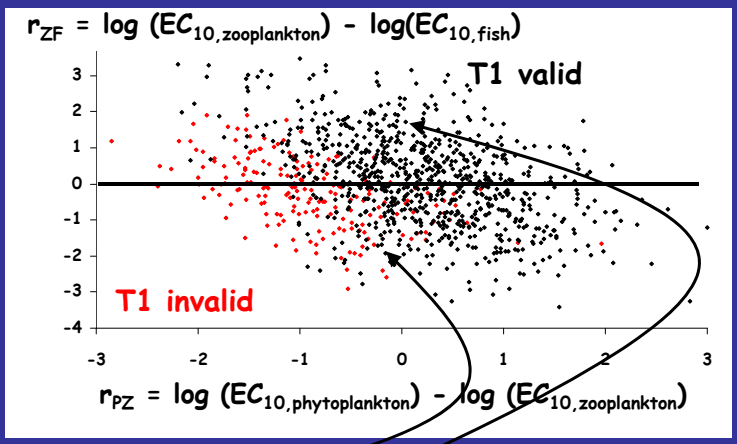

- ✓ $EC_{10,zooplankton} < EC_{10,fish}$
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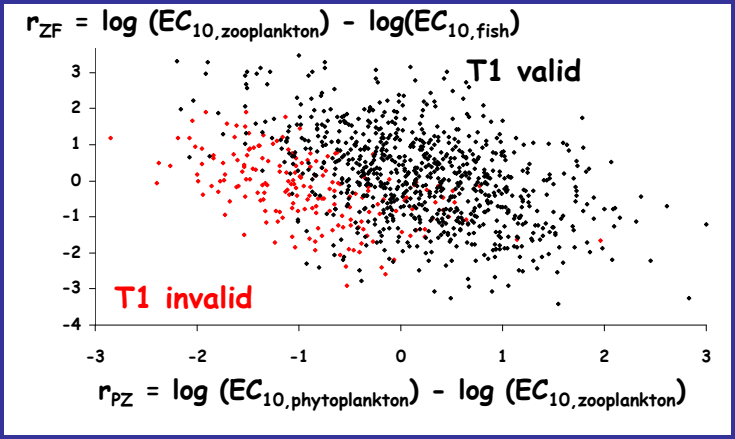
Results



- ✓ examine relationship with classification tree approach
- ✓ independent variables: r_{PZ} and r_{ZF}
- ✓ dependent variable: T1 valid / T1 invalid

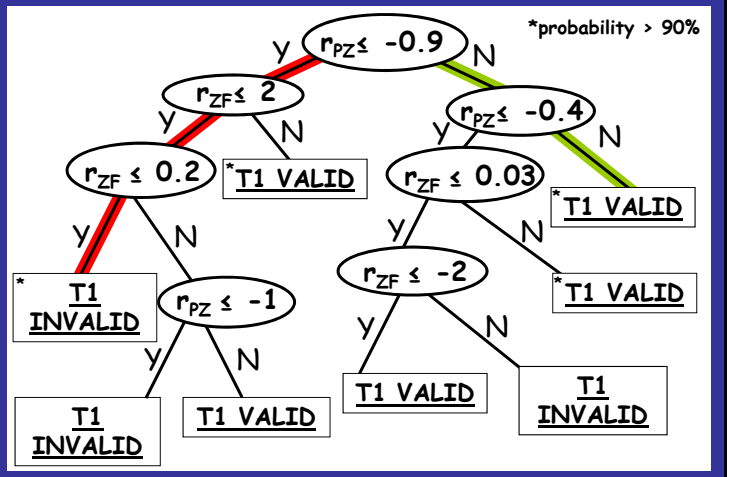
Results – classification tree

split rules

end nodes

- ✓ insecticide
- ✓ r_{PZ} ≈ 2
- ✓ r_{ZF} ≈ 0

- ✓ herbicide
- ✓ r_{PZ} ≈ -2
- ✓ r_{ZF} ≈ 0



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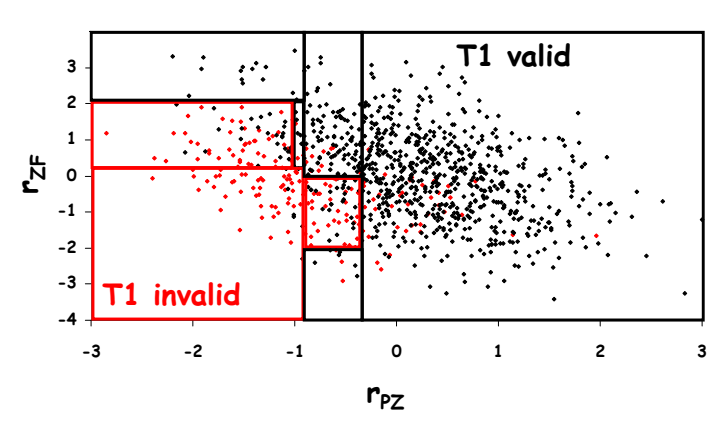
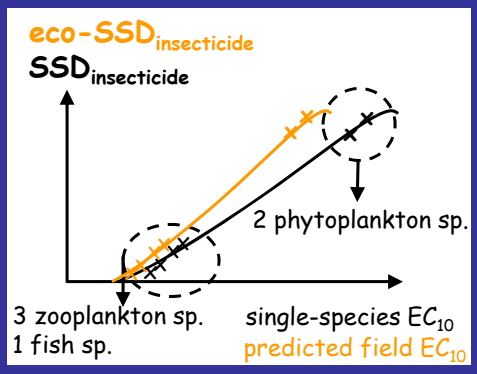


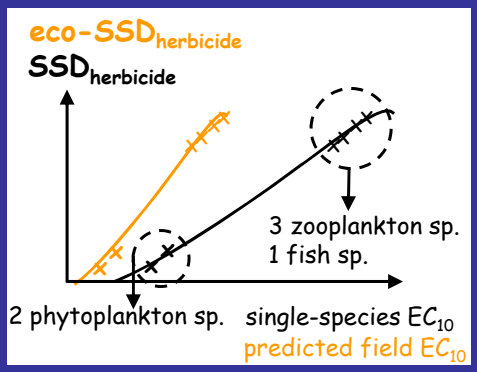
Discussion – insecticide case

- ✓ insecticide
- ✓ $r_{PZ} \approx 2$
- ✓ $r_{ZF} \approx 0$
- ✓ difference between single-species / field EC_{10}:
- ✓ zooplankton and fish
  < factor 2
- ✓ phytoplankton
  > factor 2
- ✓ mean (SSD) ≈ mean (eco-SSD)



Discussion – herbicide case

- ✓ herbicide
- ✓ $r_{PZ} \approx -2$
- ✓ $r_{ZF} \approx 0$
- ✓ difference between single-species / field EC_{10}:
- ✓ zooplankton and fish
  >> factor 2
- ✓ phytoplankton
  > factor 2
- ✓ mean (eco-SSD) < mean (SSD)



Conclusions

- ✓ Do we have to incorporate ecological interactions in the sensitivity assessment of ecosystems?
  → for 25% of the considered toxicants: yes
- ✓ Are these 25% random cases amongst the 1000 toxicants?
  → no
- ✓ Toxicants targeting **phytoplankton**:
  we **have to** incorporate ecological interactions in the sensitivity assessment of ecosystems
- ✓ Toxicants targeting zooplankton and fish:
  we do not have to incorporate ecological interactions in the sensitivity assessment of ecosystems

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