Aquatic laboratory toxicity tests and the Tier-2 effect assessment procedure

(SSD, Geomean)

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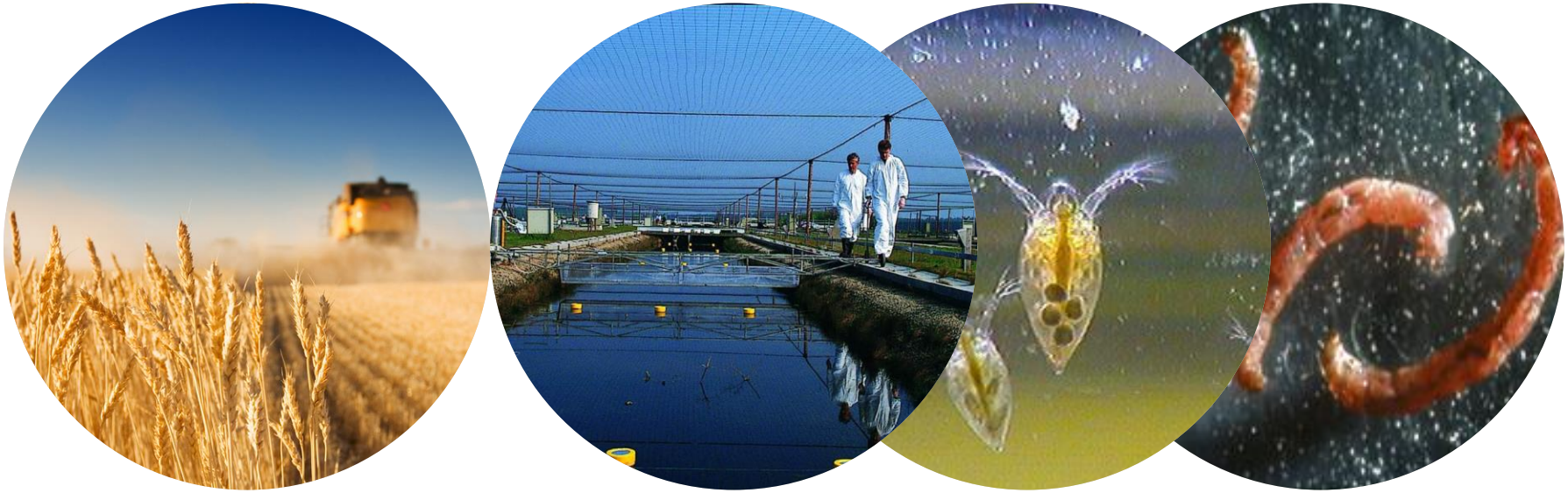

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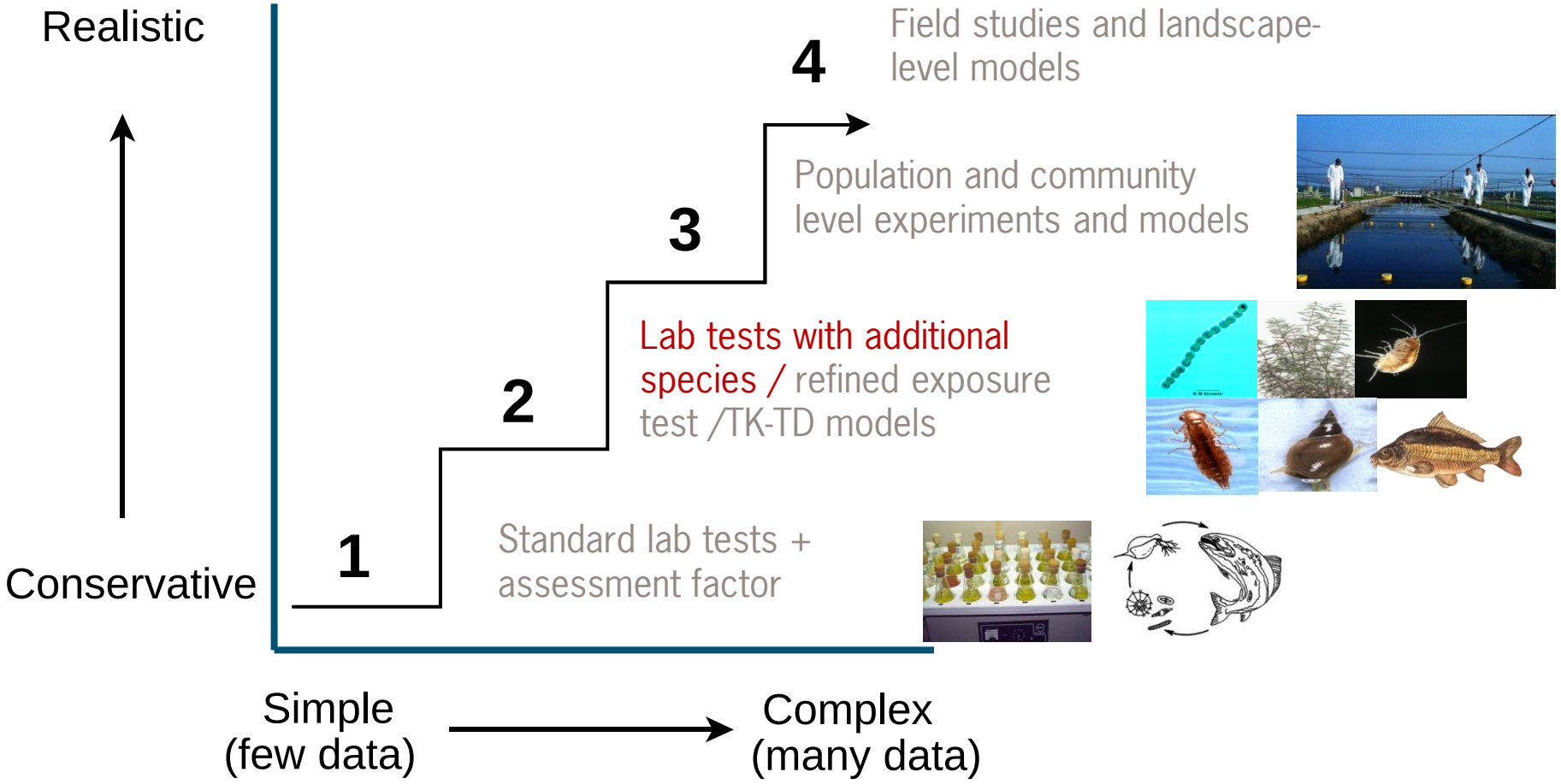
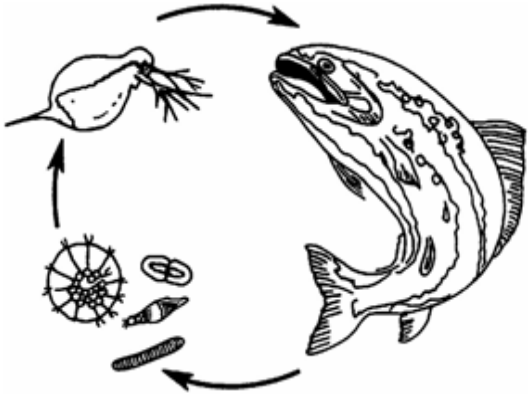
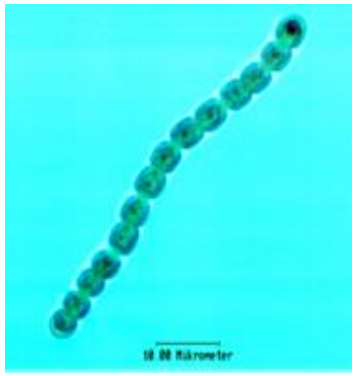
Tiered approach in effect assessment



Tests with additional species

- How representative are the standard test species ?





RAC derivation based on of laboratory toxicity tests with standard and additional species

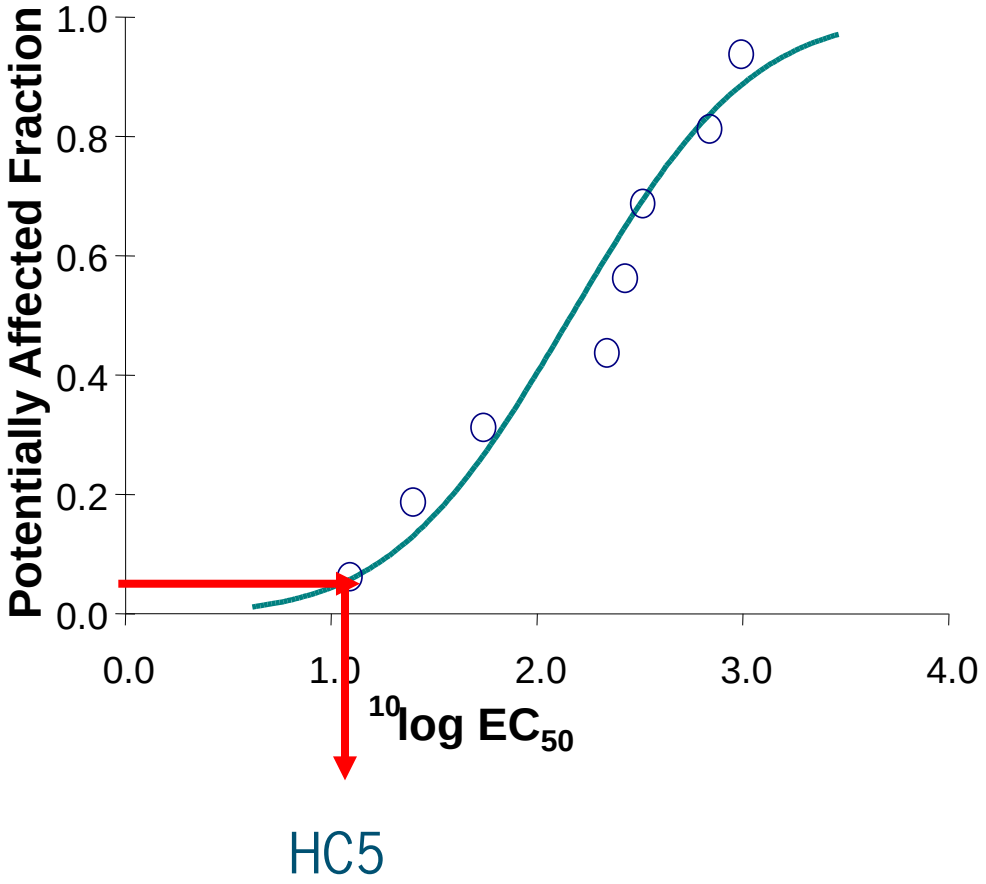
The Species Sensitivity Distribution approach (SSD-RAC)

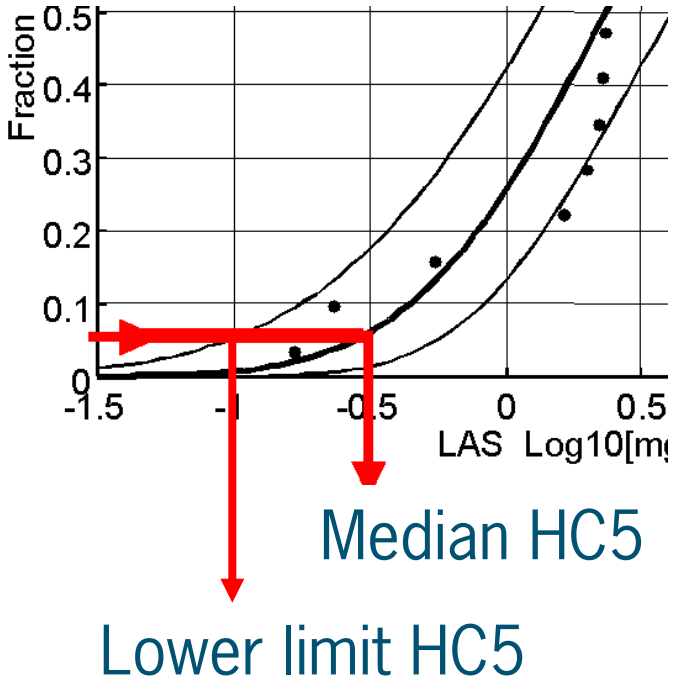
- *For ≥ 8 plant/invertebrates species laboratory toxicity data available*
- *For ≥ 5 fish/vertebrate species laboratory toxicity data available*

Geometric mean – AF approach (Geom-RAC)

- *For < 8 plant/invertebrate species laboratory toxicity data available*
- *For < 5 fish/vertebrate species laboratory toxicity data available*

Species Sensitivity Distribution (SSD) method





HC5 = Hazardous Concentration to 5 % of the species tested

Species Sensitivity Distributions: Some assumptions

1. the laboratory sensitivity of a species approximates its field sensitivity
2. the distribution is well modelled by the selected statistical procedure
3. the sample of the species on which the SSD is based is a random one
4. the protection of the prescribed percentile of species ensures an appropriate protection of field ecosystems

Questions

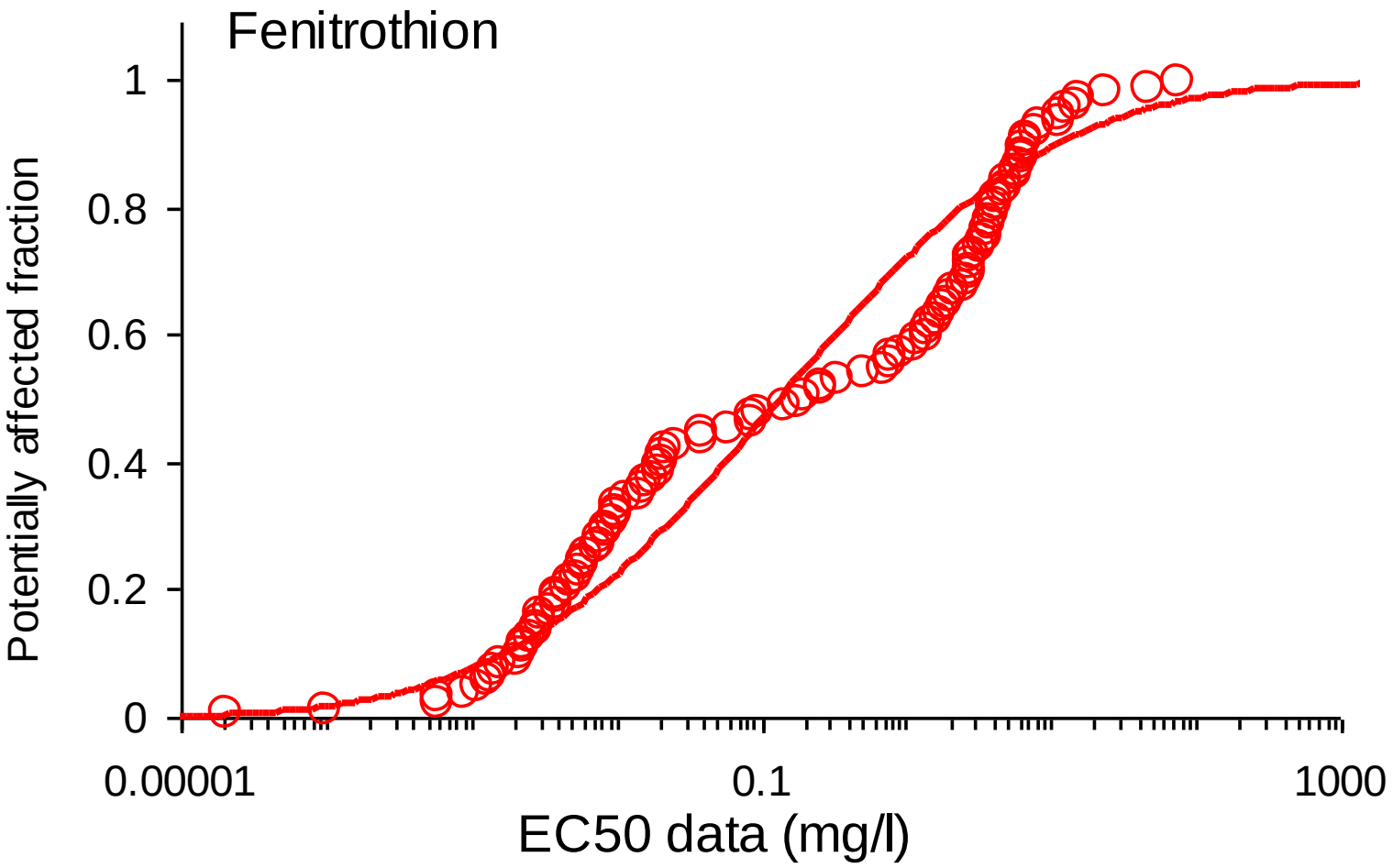
- Which model is most appropriate for describing SSDs? (example insecticides)
- To what extent does the choice of species used in SSDs influence effect assessment?
- How do SSDs generated using laboratory toxicity data compare to the responses of organisms in communities?
- Which effect percentage should be used to protect ecosystems?

Approach

- Collated laboratory single-species toxicity data for taxa exposed to 16 insecticides
- Generated SSDs and assessed importance of model and species selection
- Compared SSDs and HC5 estimates to results from micro/mesocosm studies to assess ecological relevance.

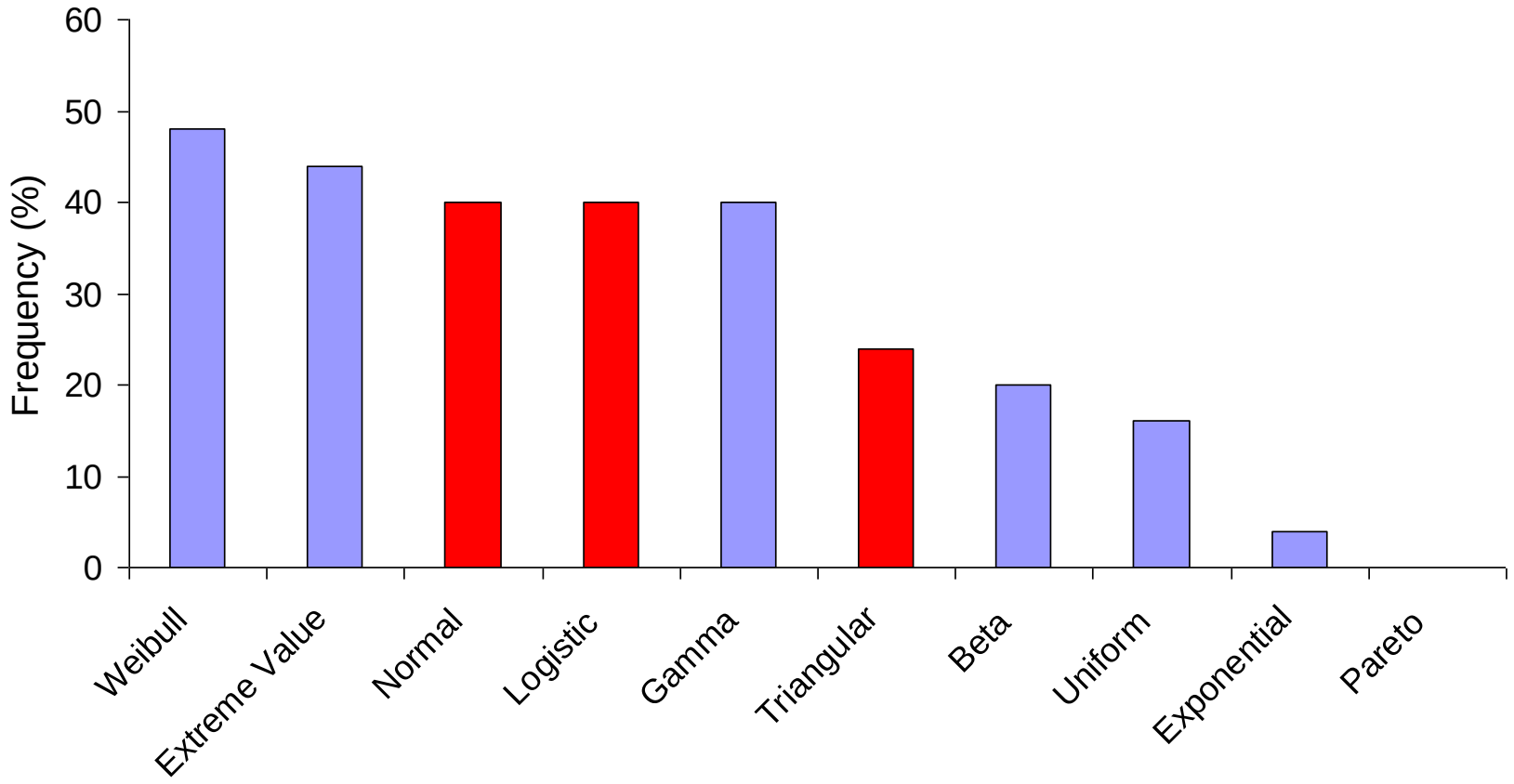
SSD: Model choice en data selection

Often polynomal distribution if all toxicity data are used

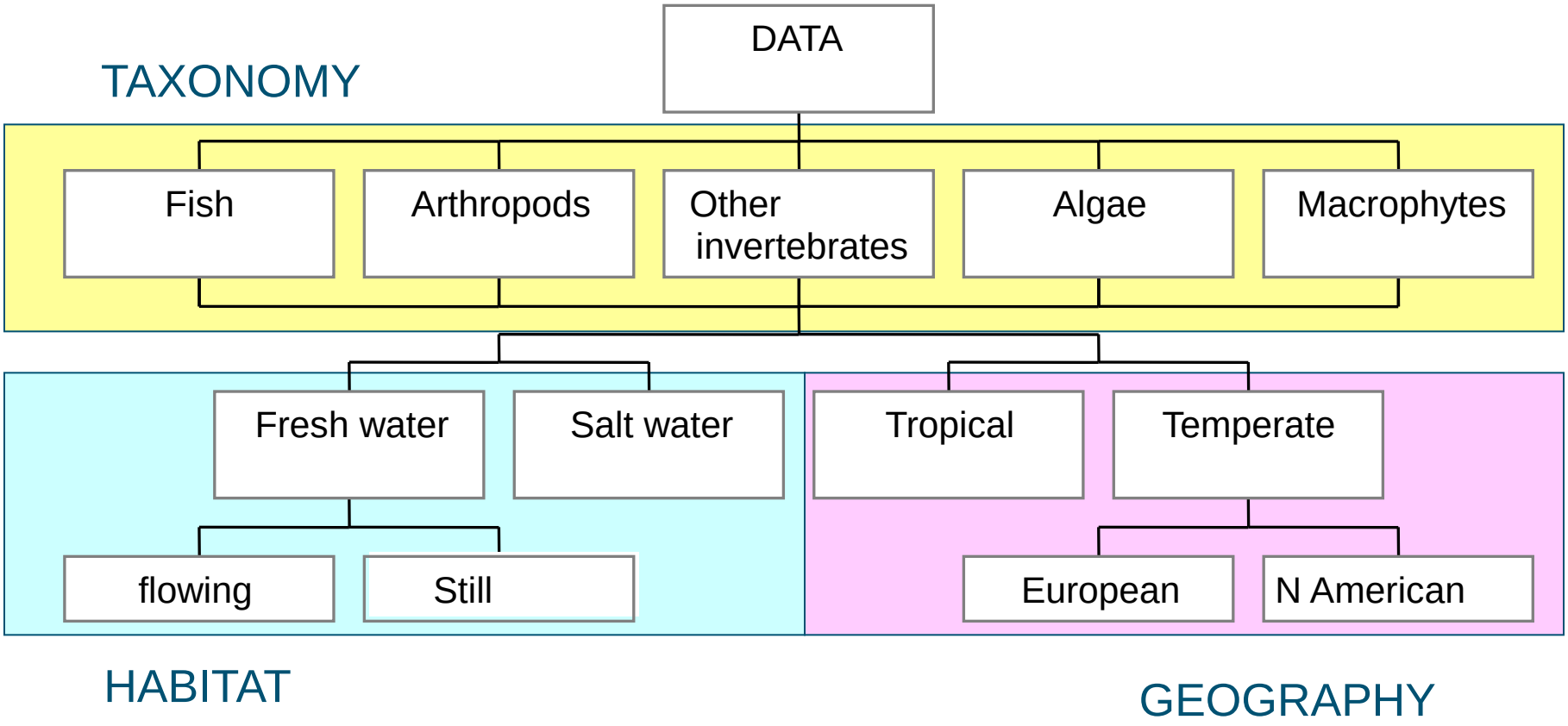


Model choice: all acute toxicity data insecticides

- 10 models fitted to all log EC50 data using Crystal Ball.
- Anderson-Darling test used to assess model fit.
- When using all acute toxicity data the selected models show a poor fit

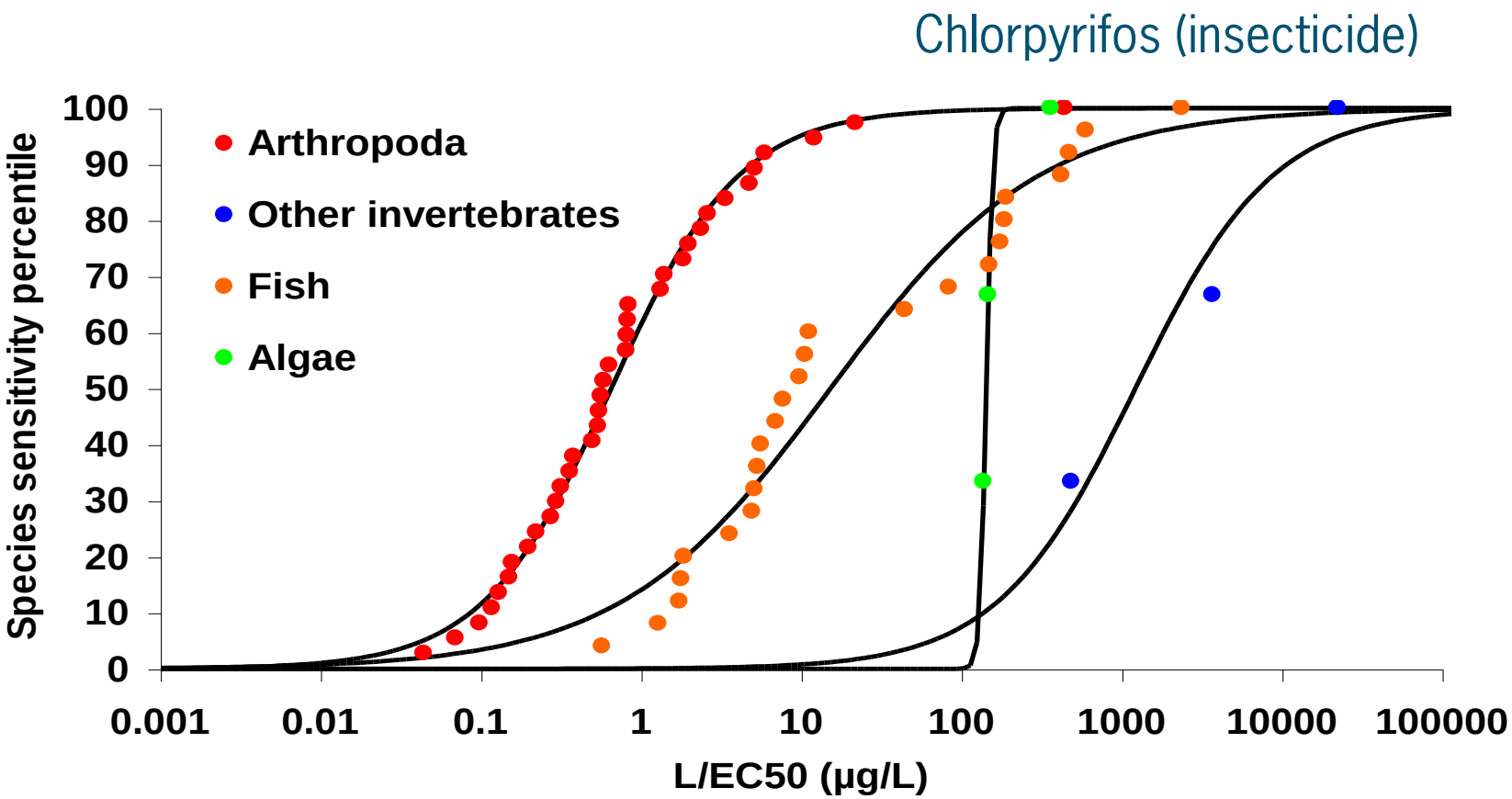


Toxic mode-of-action and sensitivity distribution



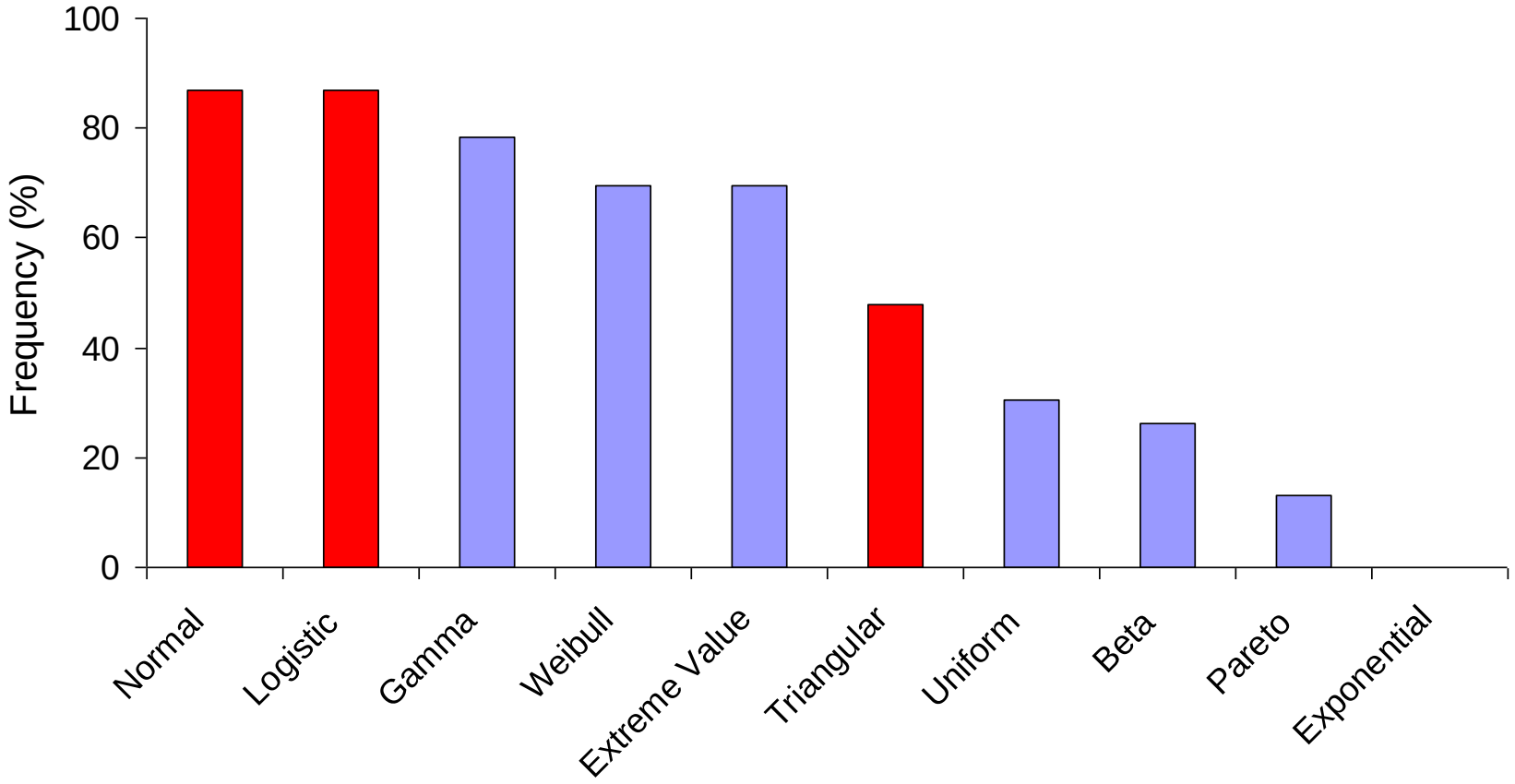
Maltby et al. 2005

SSD: influence of taxonomy



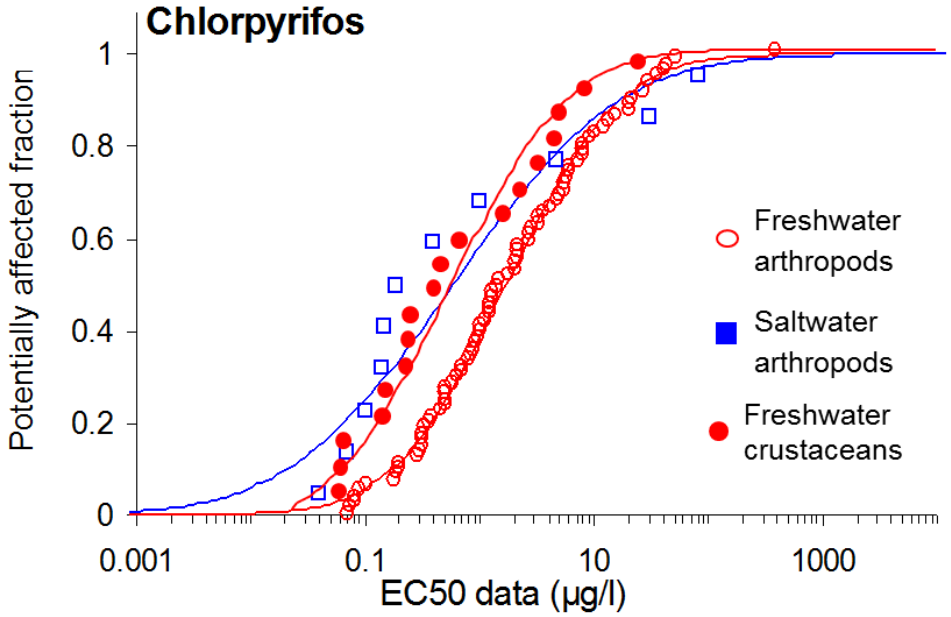
Toxic mode-of-action of the pesticide plays an important role

Model choice: acute toxicity data most sensitive taxonomic group

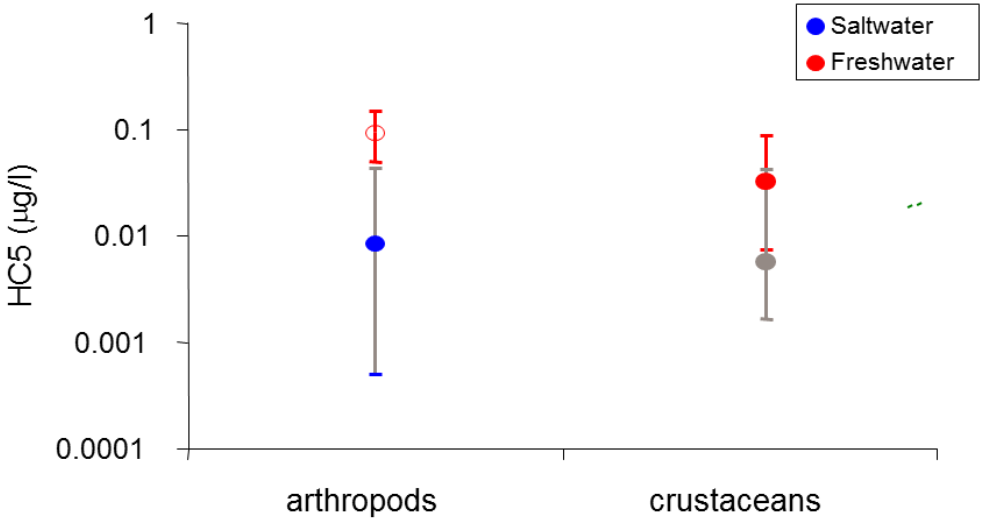


For sensitive taxonomic groups, normal and logistic model are the most appropriate

Sensitivity distribution and habitat (insecticides)



- SW arthropods are principally crustaceans.
- FW arthropods are insects and crustaceans.

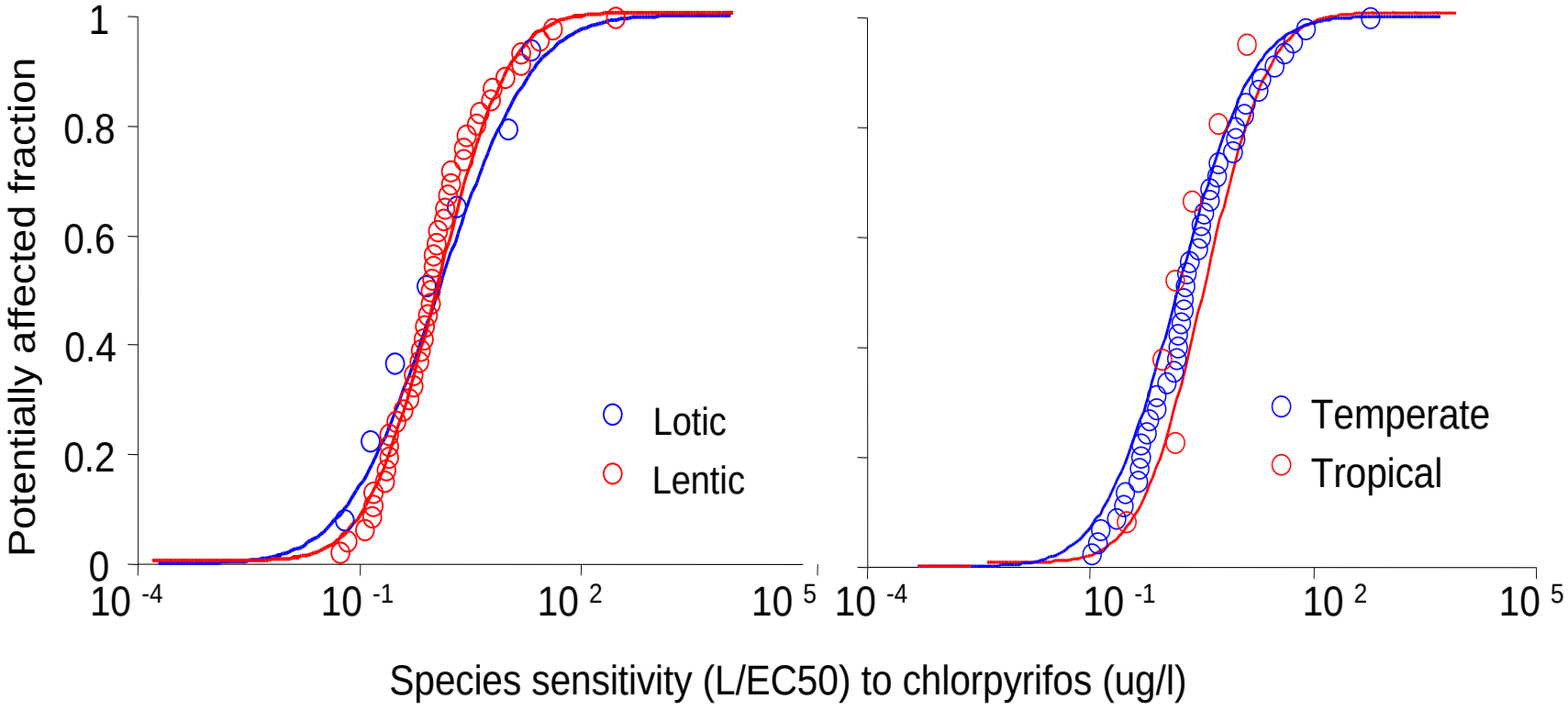


Correcting for taxonomy removes habitat differences.

Maltby et al. 2005

SSD: Influence of habitat and geographical region

Chlorpyrifos and toxicity data for arthropods

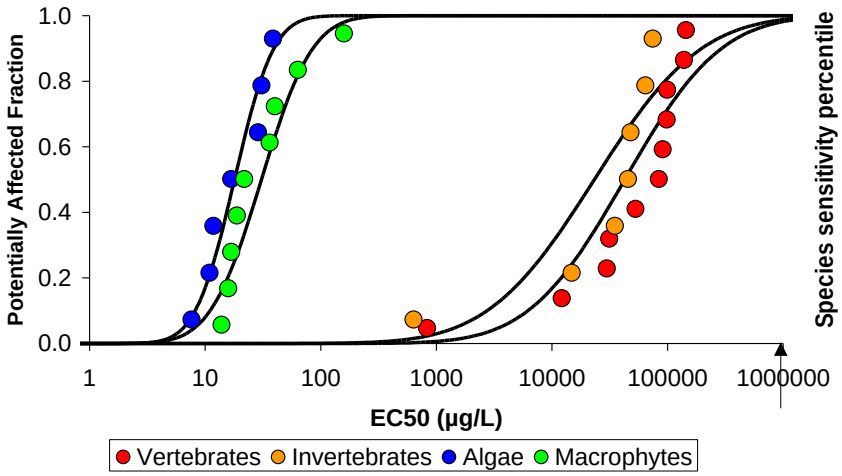


Insecticide SSD and species selection

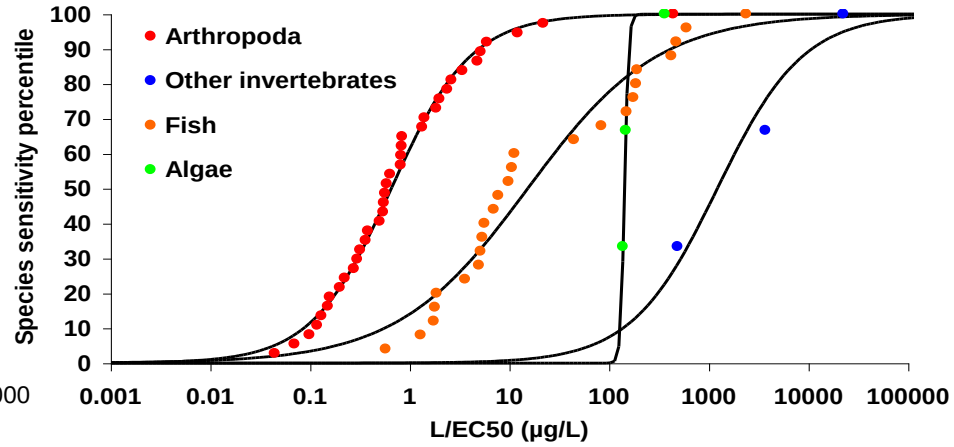
- Taxonomy has greater influence than habitat and geography
- Focus on sensitive taxonomic groups: Usually arthropods for insecticides
- Toxicity data of species from different freshwater-habitats and from different geographical regions can be combined

Specific toxic mode-of-action

Metribuzin (herbicide)

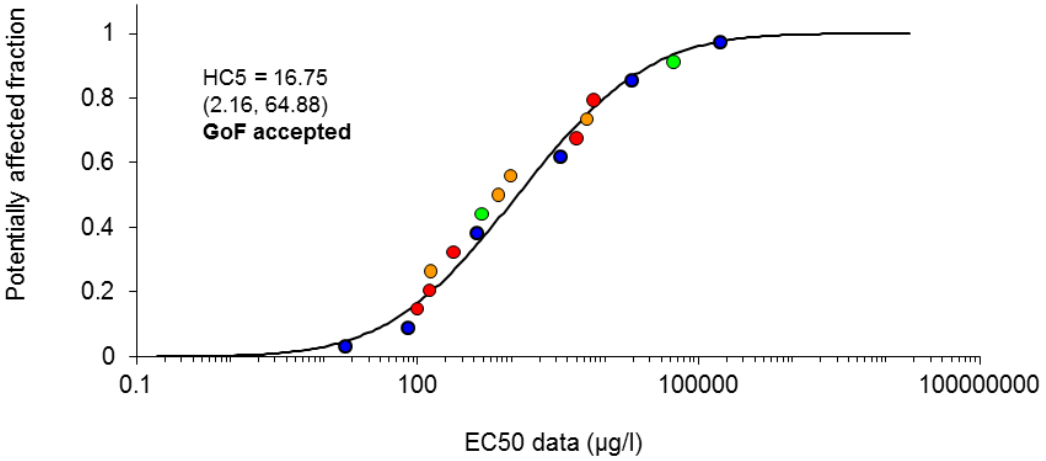


Chlorpyrifos (insecticide)

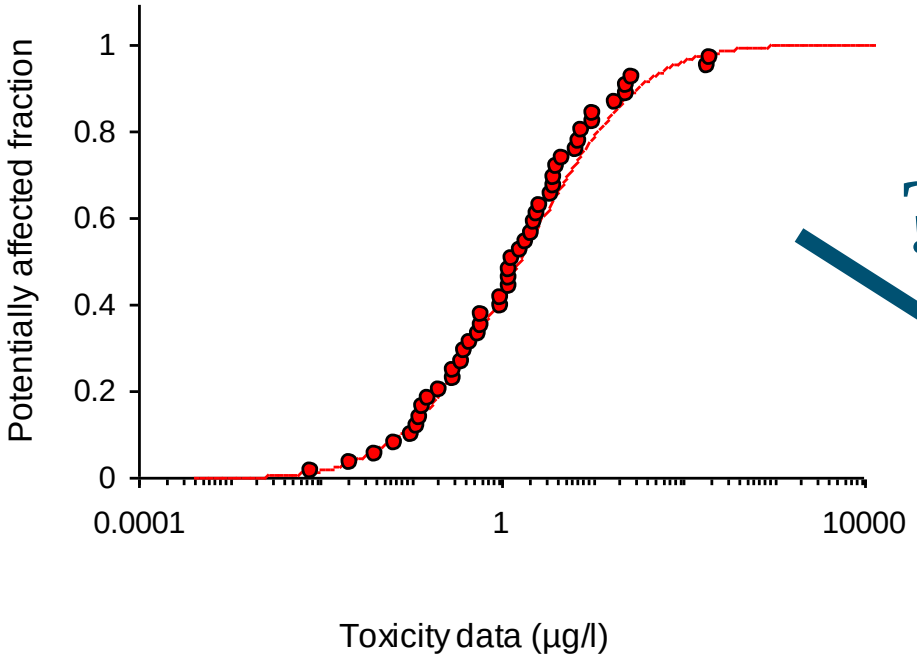


Toxic mode-of-action of the chemical plays an important role

Carbendazim (fungicide)



So what?



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Comparing SSD with model ecosystems

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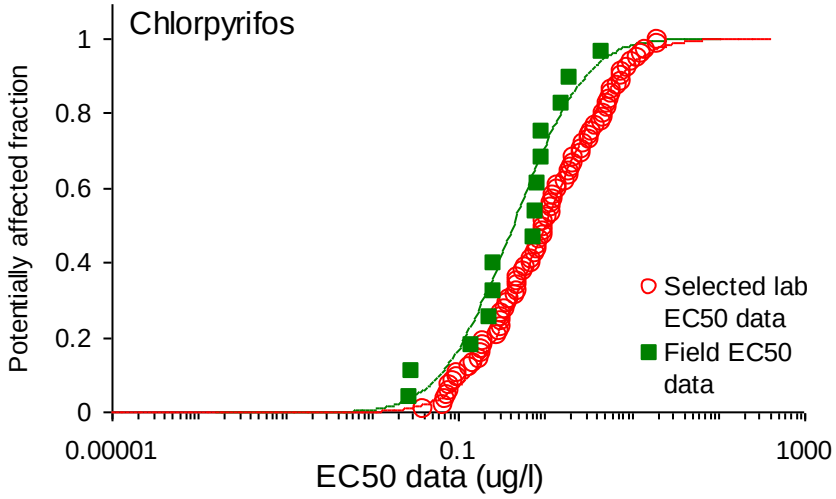
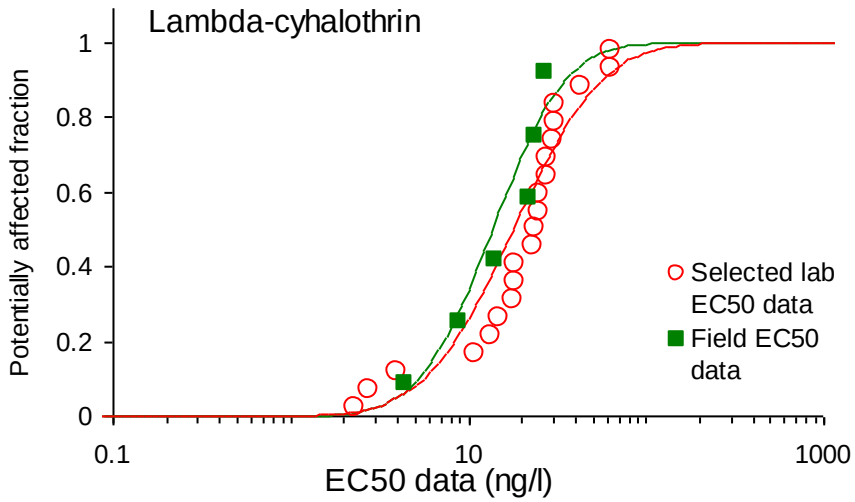
Ecological relevance of SSDs

- Assume: toxicity data used to generate SSD reflects sensitivity of species in natural communities.
- Compare SSDs for lab. data and mesocosm data





SSDs of freshwater arthropods are similar for field and laboratory exposures to insecticides, but field SSD tends to be on the left of the lab SSD.

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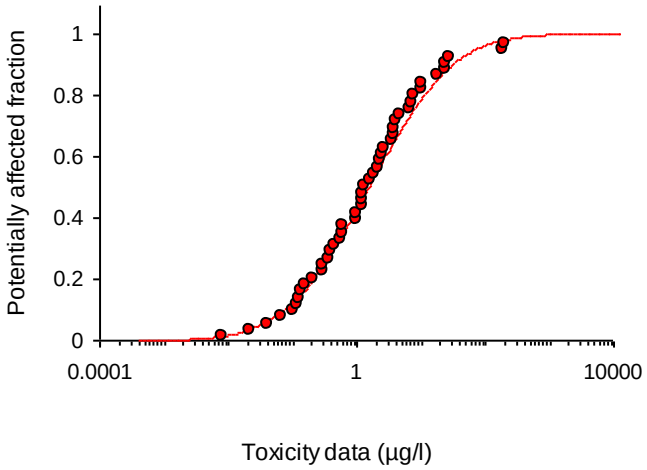
SSD-RAC derivation according to EFSA PPR (3013)

SSD constructed with toxicity data of sensitive taxonomic group(s)

Exposure regime	Relevant PEC	Hazardous conc.	AF to derive RAC
Single or repeated pulse exposures	PEC_{max}	Median HC5 (based on ≥ 8 acute EC50 values)	3-6 (invertebrates)
Single or repeated pulse exposures	PEC_{max}	Median HC5 (based on ≥ 5 acute LC50 values)	9 (fish)
Chronic, long-term exposure	PEC_{max} or PEC_{twa}	Median chronic HC5 (based on ≥ 8 chronic NOEC/EC10 values)	3 (invertebrates)
Chronic, long-term exposure	PEC_{max} or PEC_{twa}	Median chronic HC5 (based on ≥ 5 chronic NOEC/EC10 values)	3 (fish)
Chronic, long-term exposure	PEC_{max} or PEC_{twa}	Median chronic HC5 (based on ≥ 8 chronic EC50 values)	3 (algae; macrophytes)

Calibration of Tier-2 RAC for insecticides



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field

Tier-2 SSD-RAC_{sw}

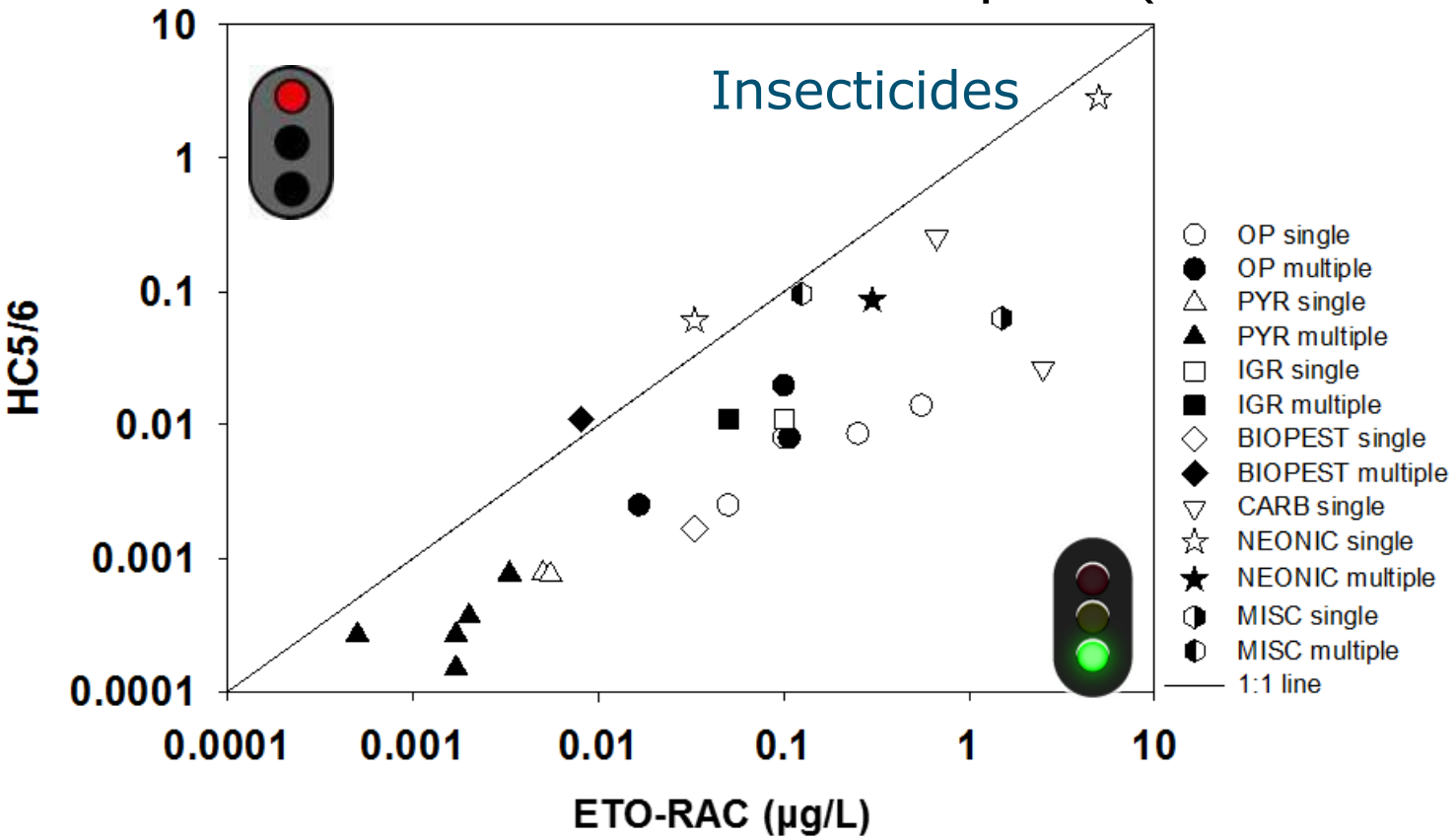
Tier-3 RAC_{sw} =
Threshold concentration most sensitive endpoint in mesocosms

- Effect class 1 divided by 2
- Effect class 2 divided by 3

Effect class 1 = no treatment-related effect on sensitive endpoints
Effect class 2 = slight effect (isolated sampling) on most sensitive endpoint

SSD-RAC calibration with micro-/mesocosm RACs (ecological threshold option)

Assessment on basis of SSDs for arthropods (acute HC5/6)



In 25 out of the 27 insecticide cases the SSD approach is protective, but two borderline cases within a factor of 2 (thiacloprid and abamectin)

Van Wijngaarden, Maltby & Brock (2014)

Geomean approach

- What to do if more toxicity data are available than the core data set but too few to apply the SSD approach?
- PPR Panel of EFSA suggested the Geomean approach
- Principle
  - Calculate the geomean L(E)C50 or NOEC value for the same sensitive taxonomic group
  - Apply the standard Assessment Factor that is also used in Tier-1

Geomean approach

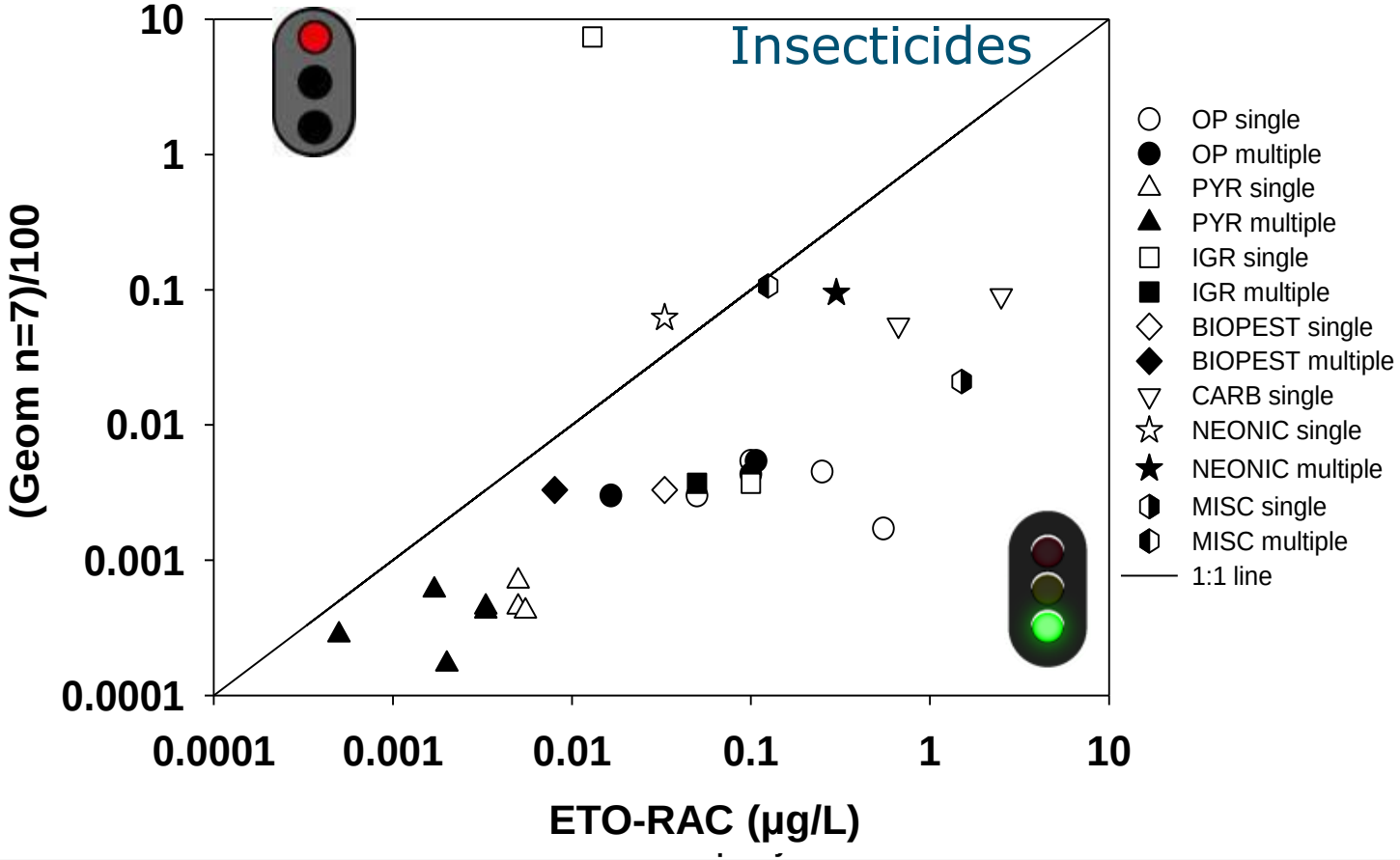
Example data set for an insecticide

Species	EC50 µg/L	Geomean µg/L	Geom-RAC µg/L
Crustaceans *Daphnia magna* *Americamysis bahia* *Gammarus pulex*	 15 8 23	14.0	14.0/100 = **0.140**
Insects *Chironomus riparius* *Cloeon dipterum*	 35 21	27.1	27.1/100 = **0.271**
All arthropods		18.3	18.3/100 = **0.183**

The default approach is to select the Geomean value of the most sensitive taxonomic group and to apply the same AF as in Tier 1 for RAC derivation

Geom-RAC calibration with micro-/mesocosm RACs (ecological threshold option)

Lowest acute Geomean/100 value for insects and crustaceans



In 28 out of the 30 insecticide cases the Geomean approach (AF of 100) is protective (IGR fenoxicarb is clear exception; thiacloprid within a factor of 2) Van Wijngaarden, Maltby & Brock (submitted)

Thank you for your attention
Questions ?

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