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GENT

BIOMATH

Department of Applied Mathematics,
Biometrics and Process Control

Accounting for hierarchical variability in species sensitivity distributions

Frederik Verdonck,
O. Thas, C. Janssen, J. Jaworska & P. Vanrolleghem

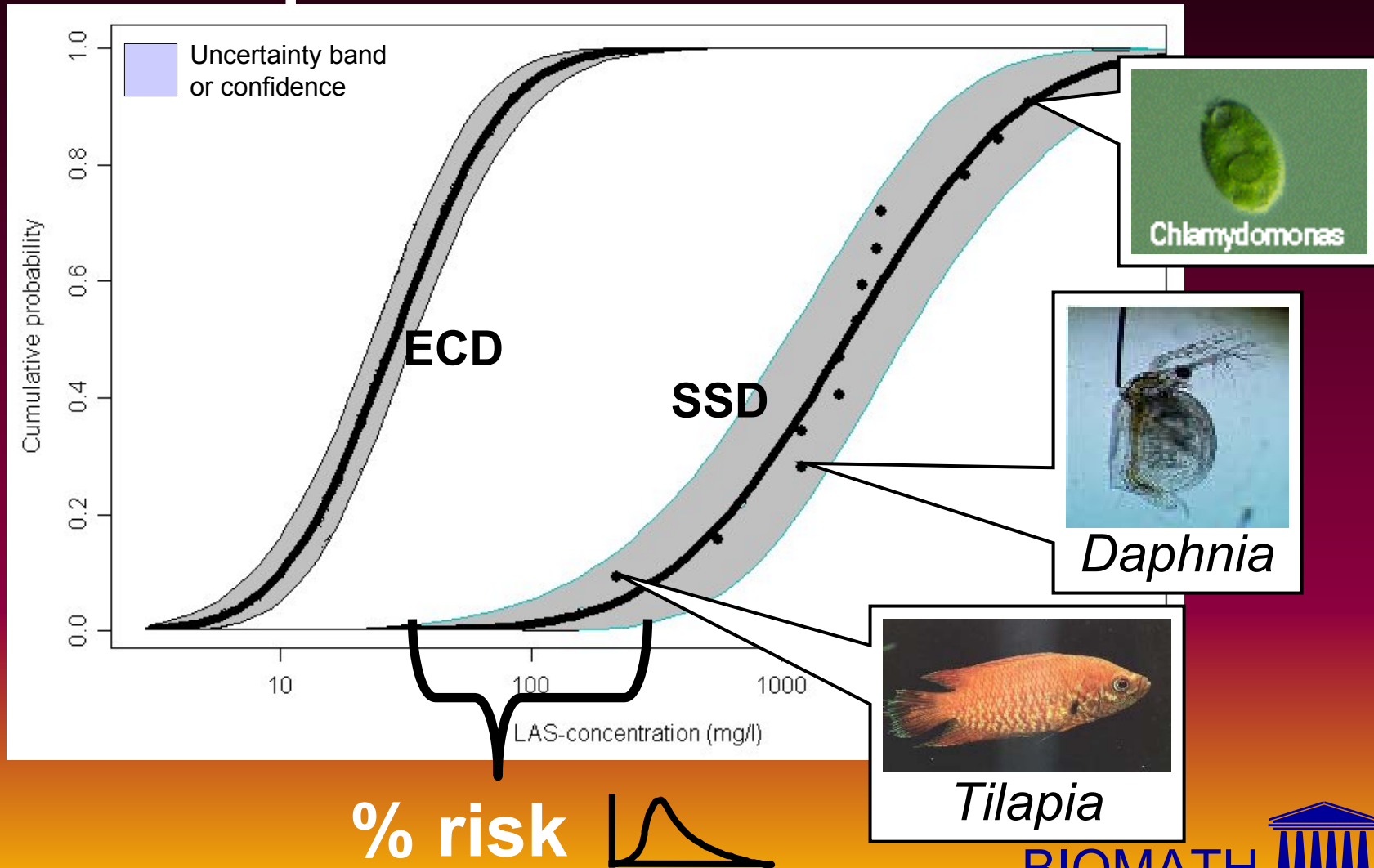
Outline

- Introduction
- Hierarchical structure of SSD
- Solutions:
 - weighted hierarchical (bootstrap) model
 - weighted non-hierarchical (bootstrap) model
- Discussion
- Conclusions

Probabilistic risk assessment

Exposure

Effects



Introduction

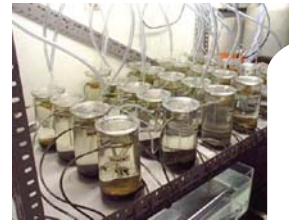
To protect communities from adverse effects:

- Toxicity data are hierarchical in structure:
 - NOEC: No Effect Concentration
 - EC_x: x % Effect Concentration
 - Averages for the same species of several laboratories
- **A lot of information is discarded/lost**
- Goal:
 - How to account for this extra info in a SSD?
 - Should a hierarchical or nonhierarchical model be used?

Hierarchical structure of toxicity data



1. Sampling uncertainty

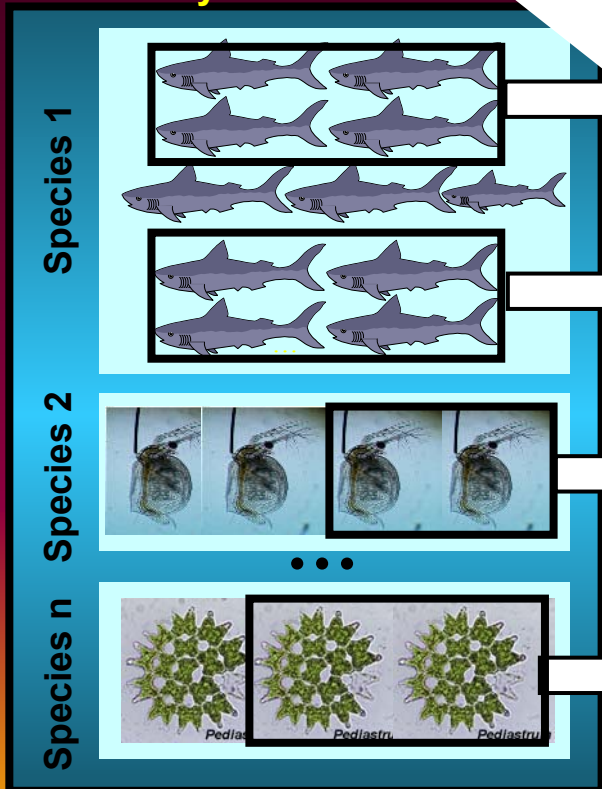


2. Intra-species dose-response curve

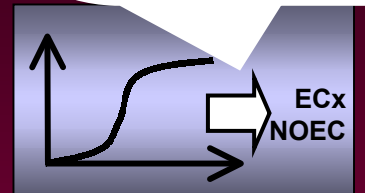


3. Sampling uncertainty

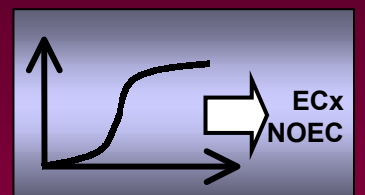
Community



Lab 1



Lab 2



...similar procedure...

...similar procedure...

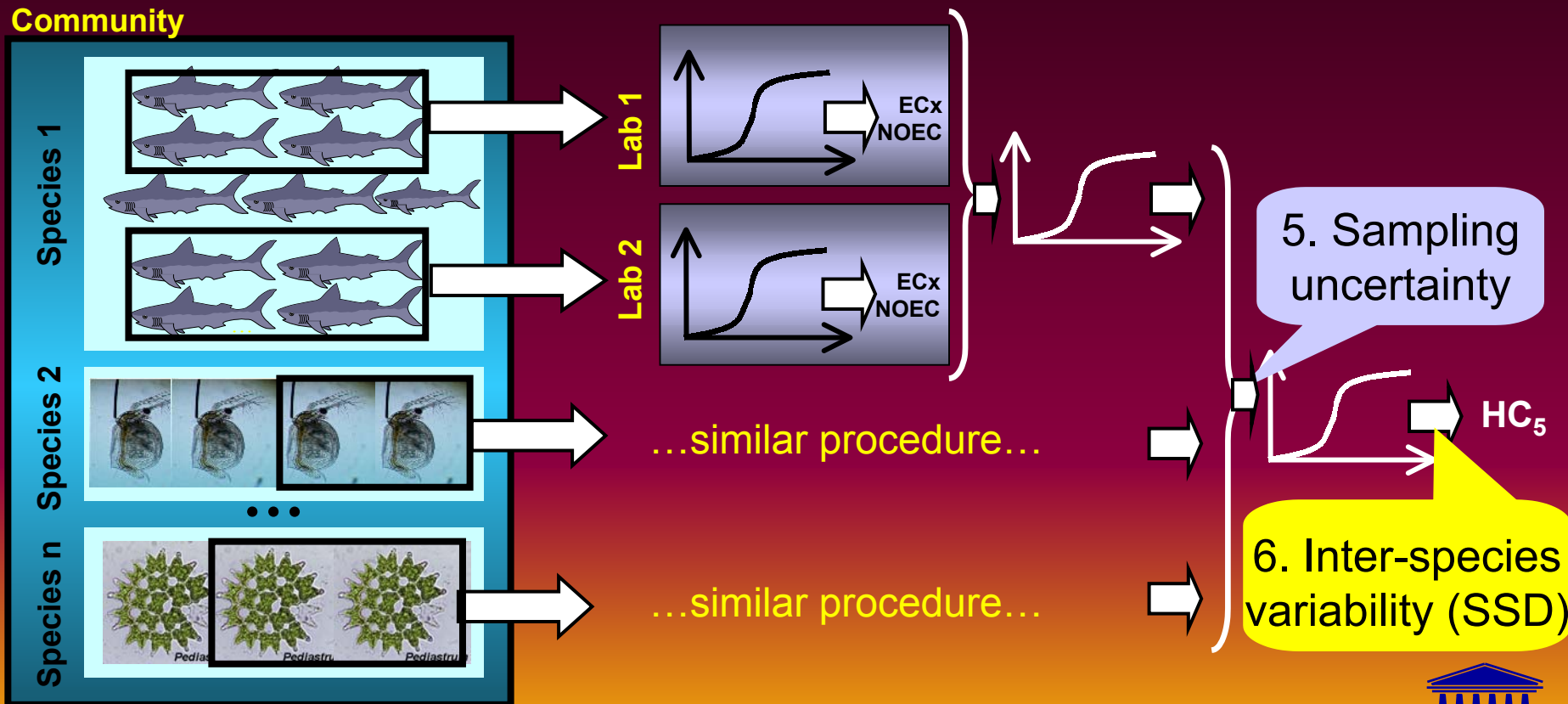
4. Inter-laboratory variability

5. Sampling uncertainty

6. Inter-species variability (SSD)

HC₅

'Usual' approach



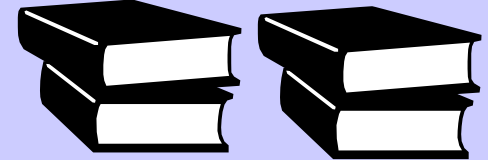
Goal



1. Sampling uncertainty

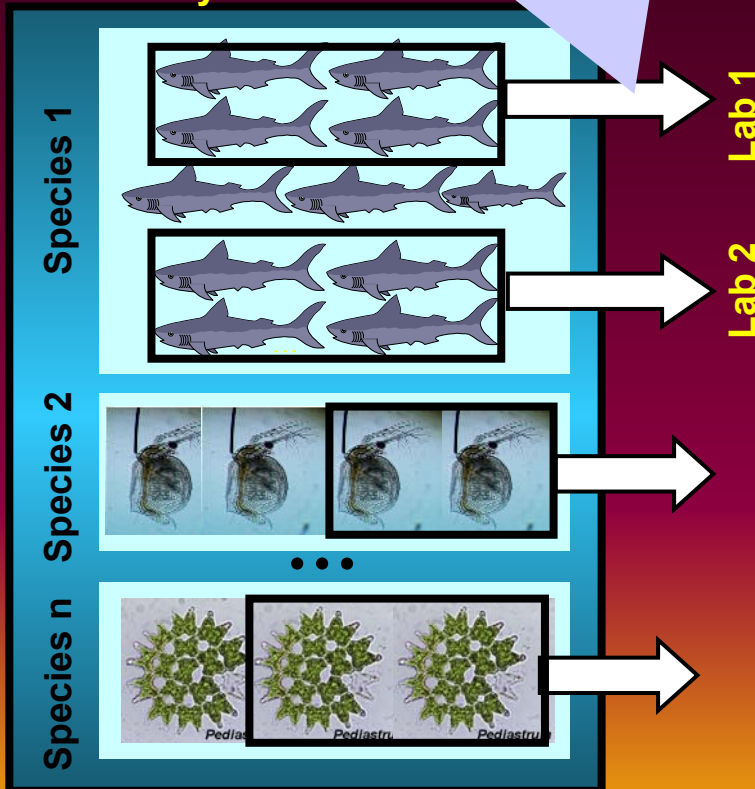


2. Intra-species dose-response curve

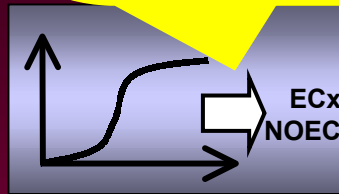


3. Sampling uncertainty

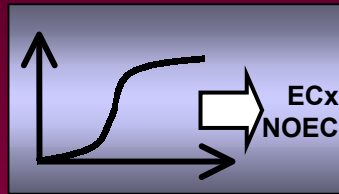
Community



Lab 1



Lab 2



...similar procedure...

...similar procedure...

4. Inter-laboratory variability

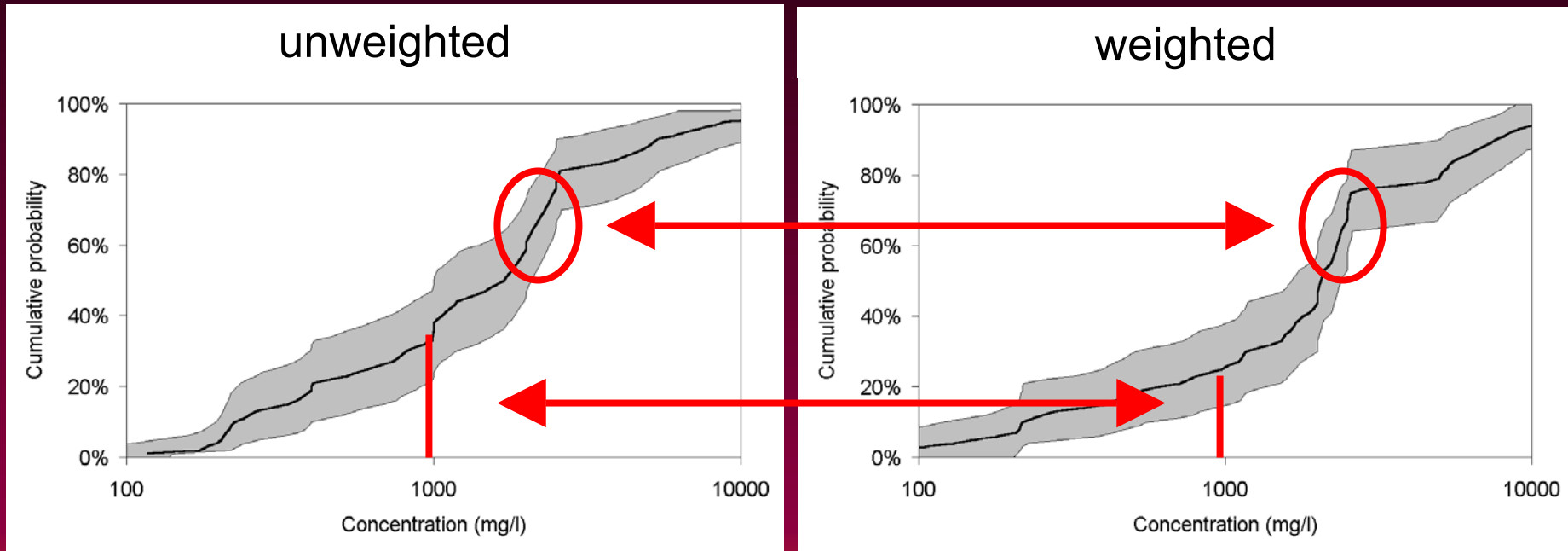
5. Sampling uncertainty

HC₅

6. Inter-species variability (SSD)

Weighting toxicity data

> To avoid over/under-representation of a species, laboratory, individual!



- Shape of the curve changes (shift)
- Uncertainty band changes in width

First solution: hierarchical models

Several types:

- Nonparametric <> parametric
- Bayesian <> frequentist
- Analytical <> Numerical

All these have their advantages and disadvantages.

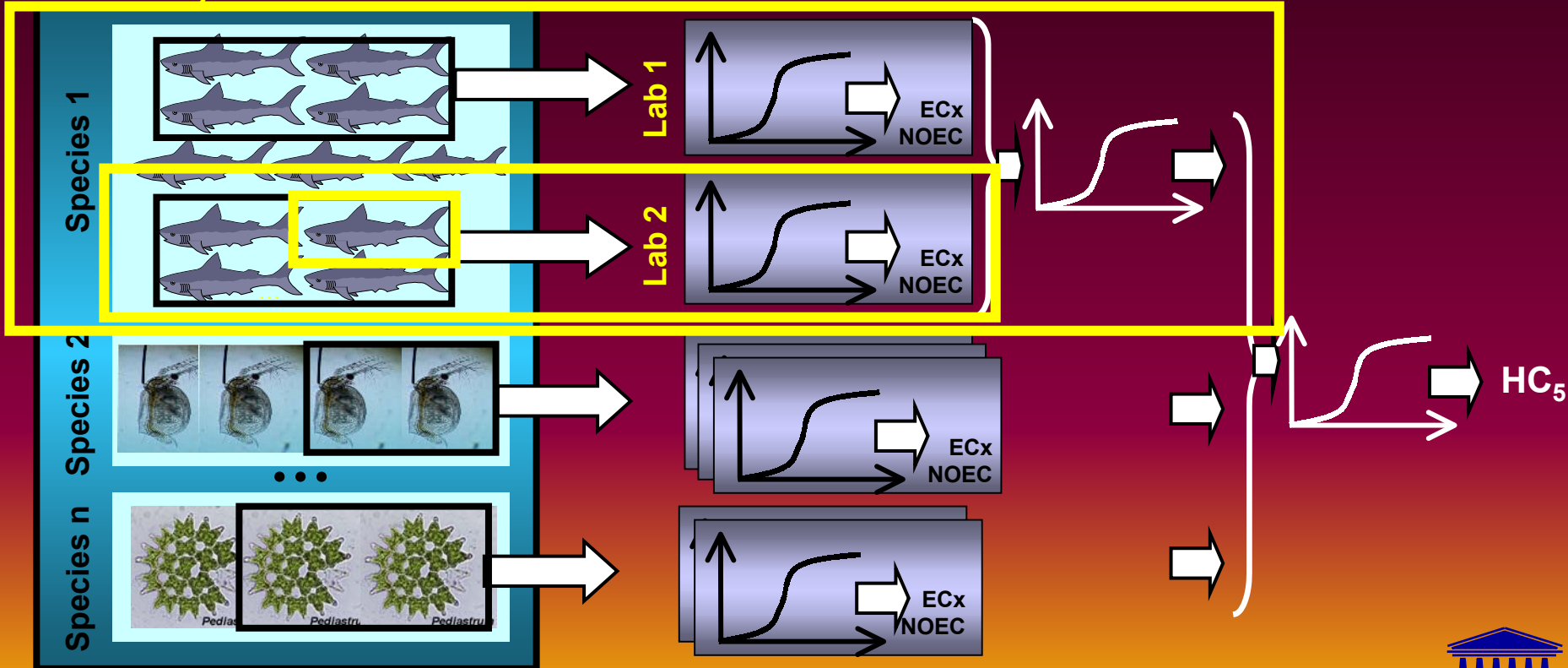
Main focus here is hierarchical or NOT?

Weighted hierarchical bootstrap

1. Sample the species
2. Sample the laboratories
3. Sample the individuals

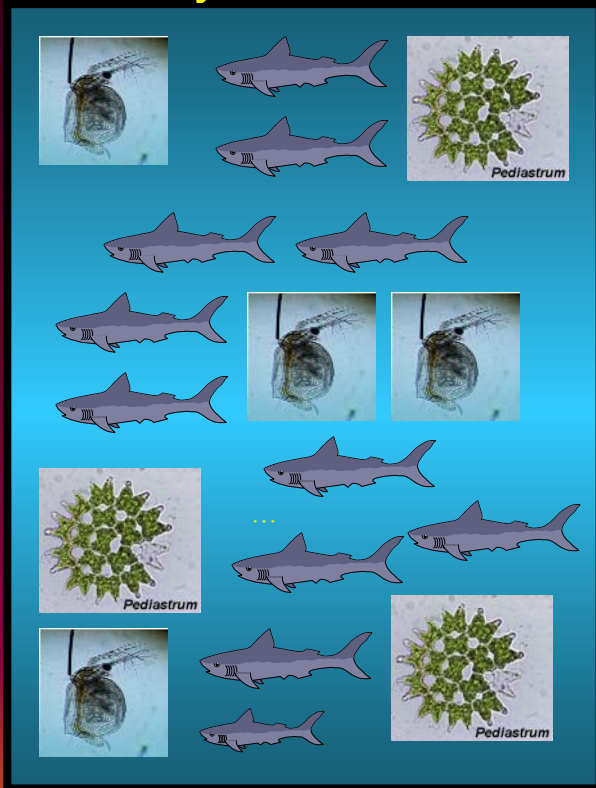


Community



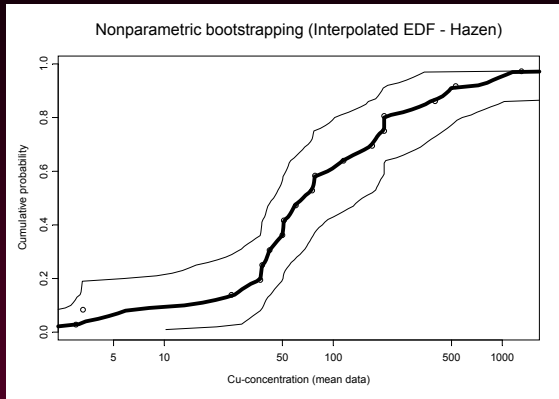
Second solution: non-hierarchical model

Community



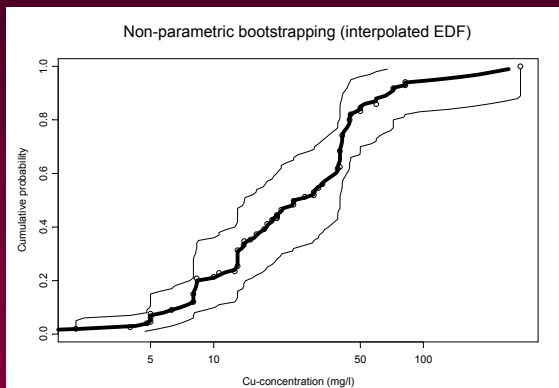
- Ignore hierarchical structure of variabilities and treat all raw data (no summary statistics!) on same level
- no hierarchical method but easier to understand

Example: Cu



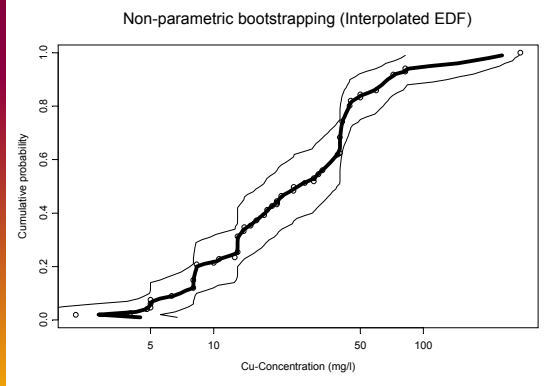
'Usual approach'

- Inter-species variability
- sampling uncertainty (only 5.)



Hierarchical Model

- Inter-species + inter-laboratory + intra-species variability
- 'Aggregated' sampling uncertainty



Non-hierarchical model

- Inter-species + inter-laboratory + intra-species variability
- Uncertainty difficult to interpret

Discussion

	Summary data	Raw/all data	
	'Usual' approach	Hierarchical Model	Non-hierarchical Model
HC ₅ result	+	+++	++
Practical Use	+++	+	+++
Interpretation of Confidence band	+	+++	-

Conclusions

- All raw data should be included in the effects analysis.
- To incorporate intra-species and inter-laboratory variability into a SSD, a weighted non-hierarchical bootstrap model is sufficiently accurate and easy-to-use.
- To incorporate several levels of sampling uncertainties, a weighted hierarchical model is more appropriate.