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Life Cycle Impact Assessment of pesticides on aquatic ecosystems The AMI method (Assessment of Mean Impact)

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Objectives

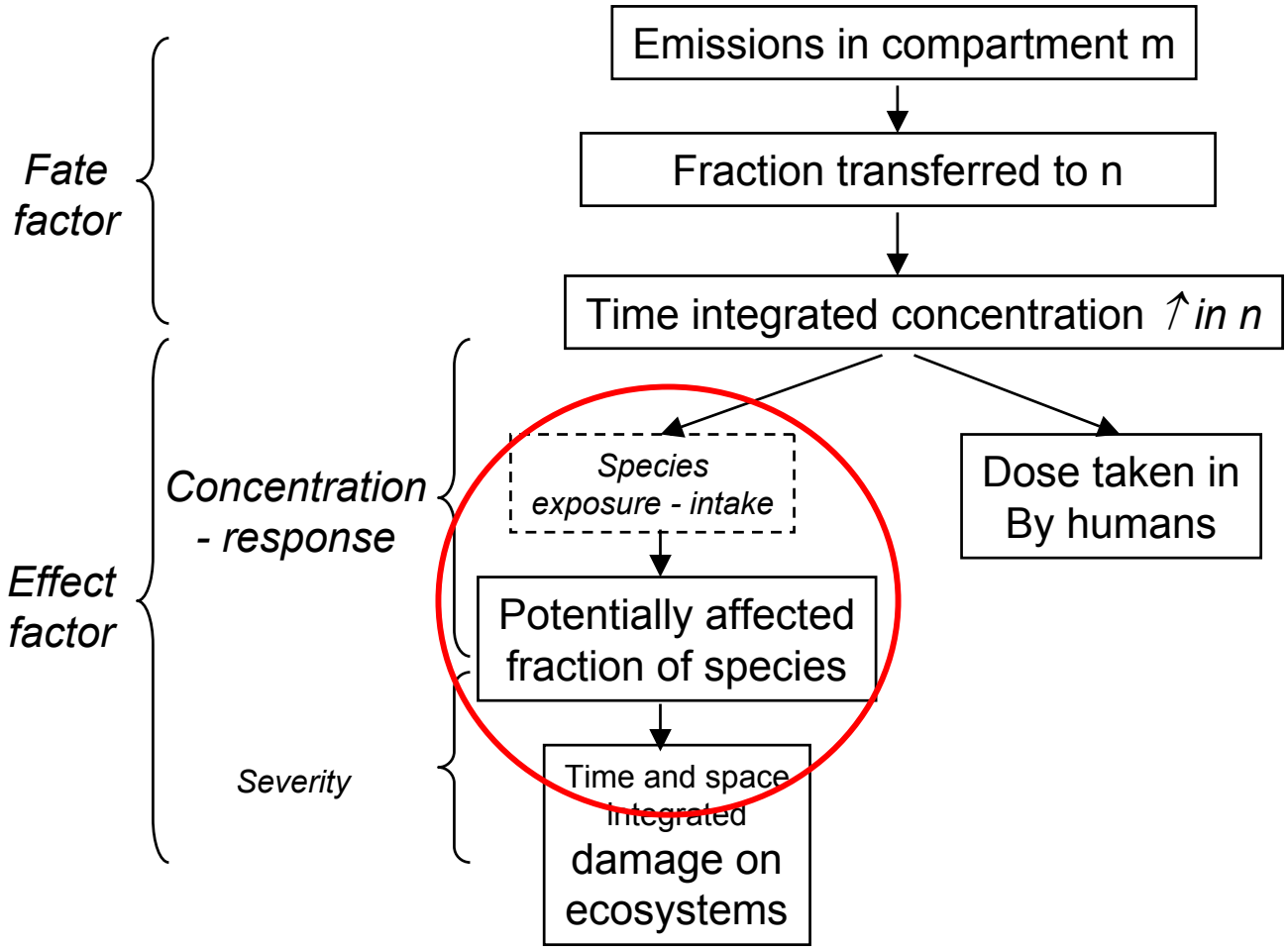
Compare the impact on aquatic ecosystems of three substituables fungicides use in for a wheat crop :

- **Benomyl**
- **Chlorothalonil**
- **Propiconazole**

Impact are quantified using the AMI method [Assessment of the Mean Impact];

--> compare with PEC/PNEC approach based on No Effect Concentration for most sensitive species

Emission to damage
b) Ecotox



Assessment of the Mean Impact [AMI]

- Use the geometric mean of the species response (HC50) instead of extrapolate from the most sensitive species;

- Calculate the confidence interval on the geometric mean based on student test;

- Express the results in term of biodiversity.

From PEC/PNEC to PEC/P**M**EC

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Comparison of sensitivity of 63 species regarding 315 pesticides

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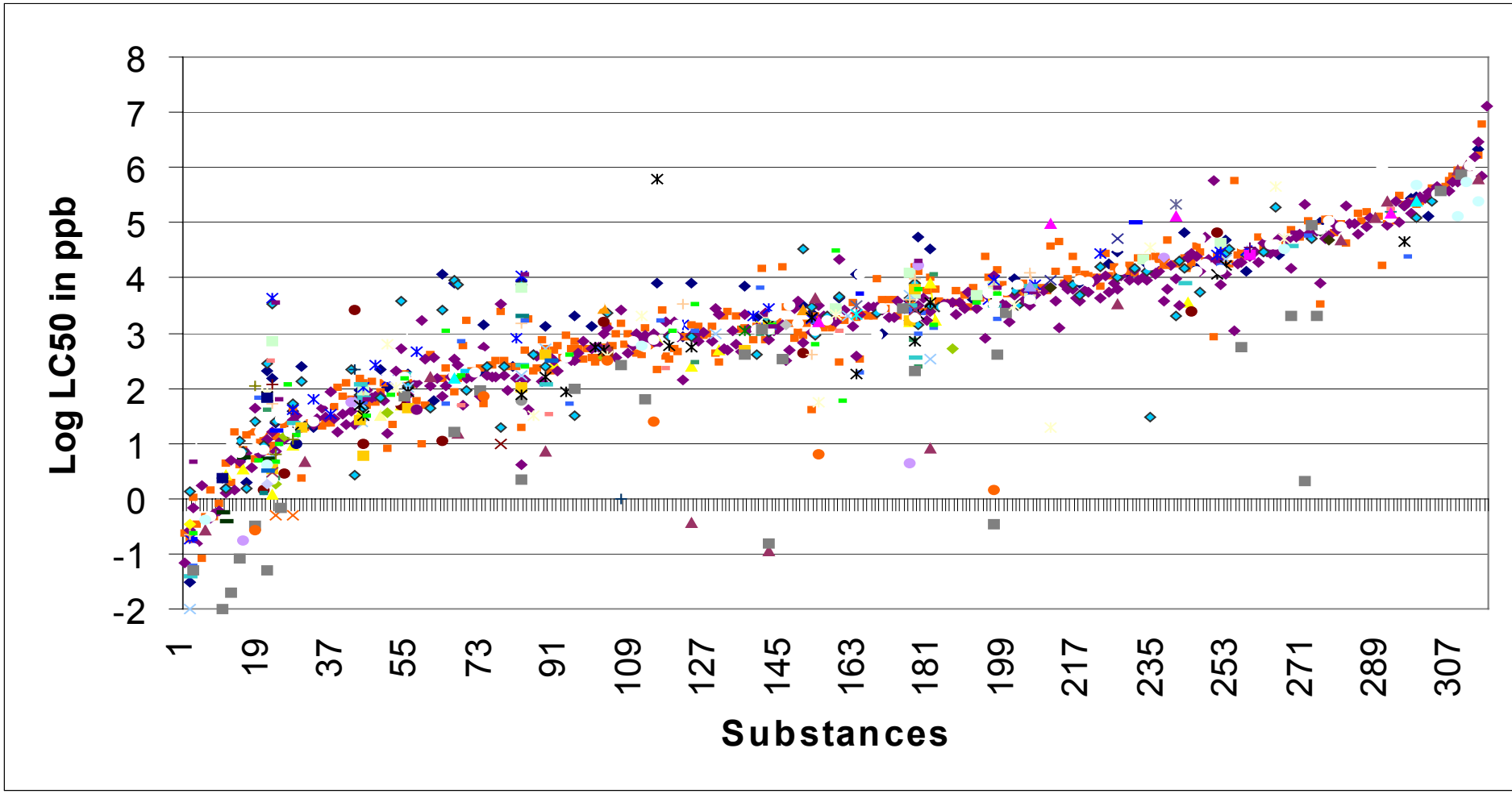

Variability between species for a given chemical is high
--> more consistent to use the median instead of the most sensitive

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Comparison of species responses

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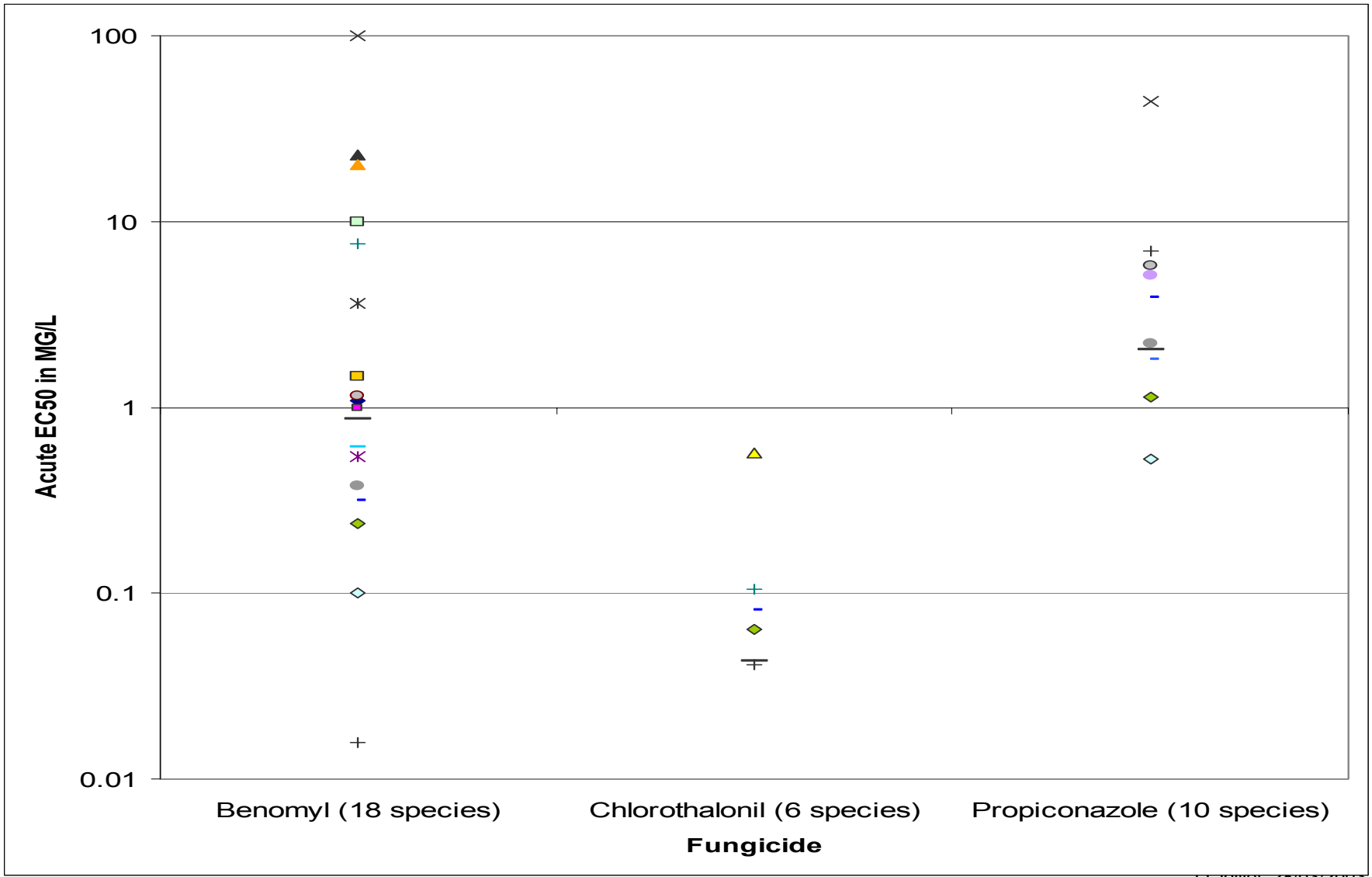

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Comparison between the PNEC and geometric mean toxicity of fungicides

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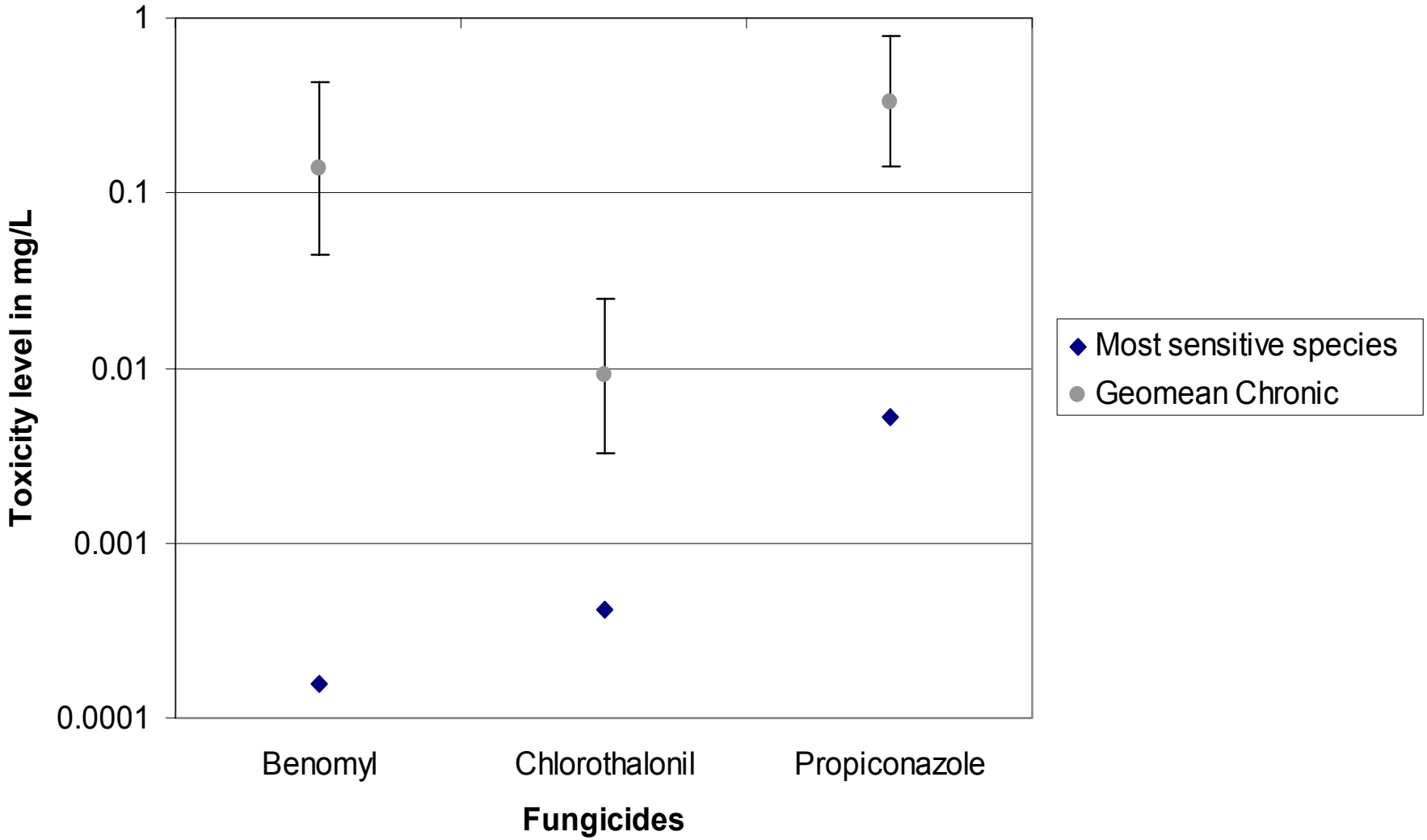

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Indicator stability regarding species (Ictalurus punctatus removed)

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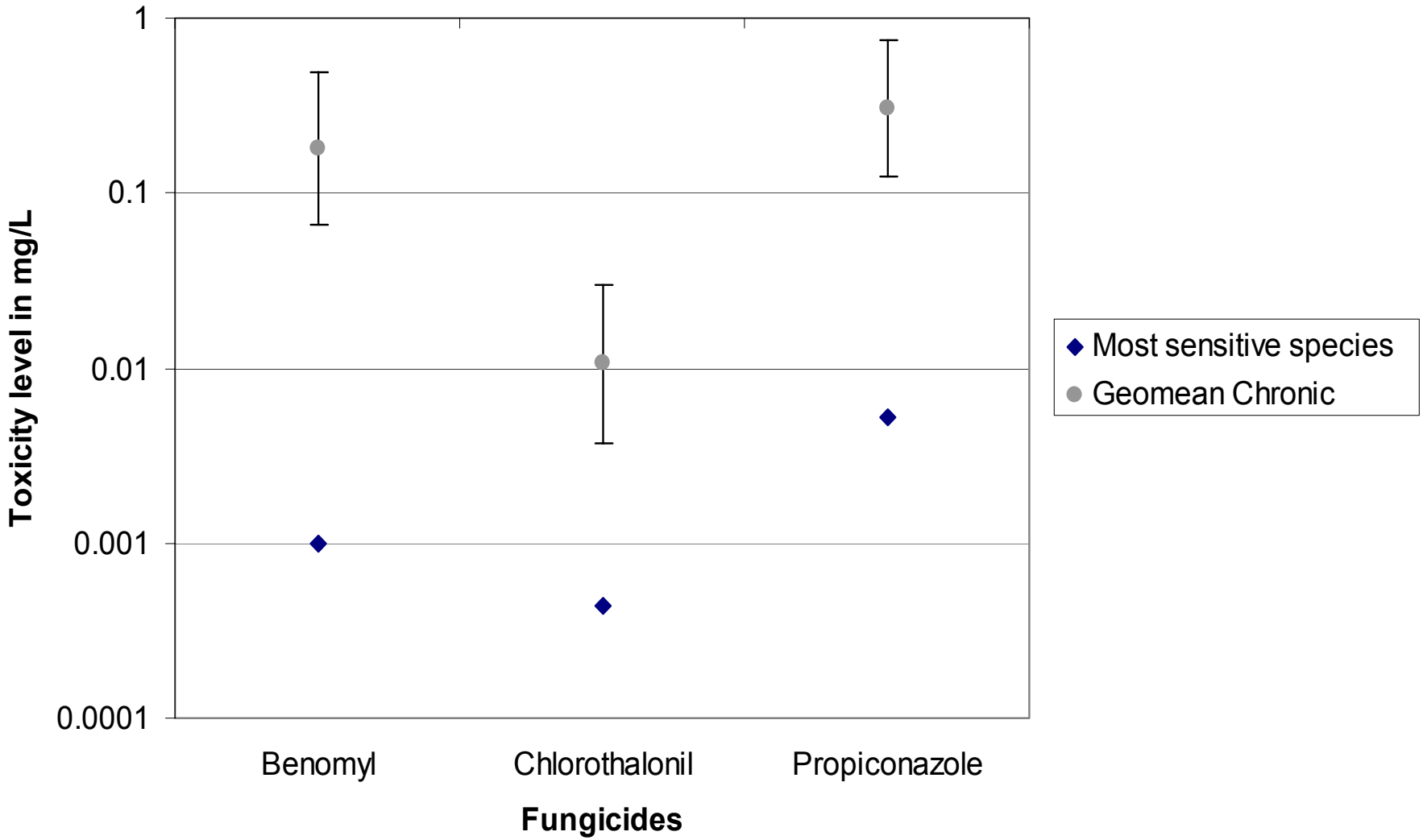

Description of Impact Modelling

Impact = Source x Fate x Effect

Effect model = 0,5 / HC50

PEC proportional to $F_{pest.\ water}$ x 1/ $K_{tot\ water}$

$$I_{pest} = S_{pest} \times F_{pest.\ water} \times 1/K_{tot\ water}. \times 0{,}5/HC50$$

I_{pest} = Impact of pesticide

S_{pest} = Quantity of pesticide applied

$F_{pest.\ water}$ = Fraction of pesticide transferred in the aquatic ecosytesm

$K_{tot\ water}$..= Residence time time in water

0,5/HC50 = Fraction of affected species per increasing unit of concentration

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Transport modelling
progression in levels of complexity

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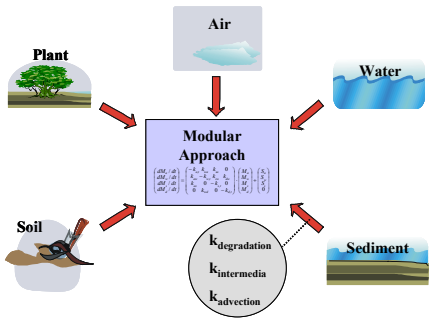
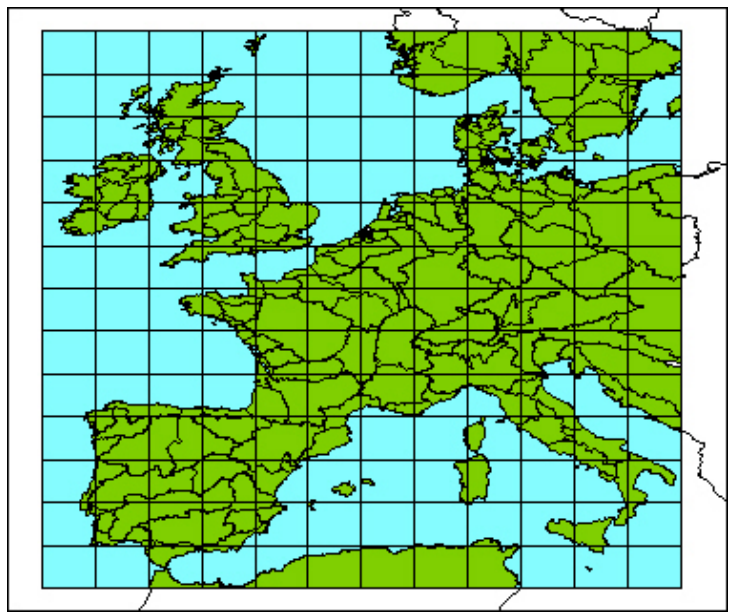
Tier 1: Steady state model available: "Impact 2002"



Tier 2: Spatially differentiated model available



Tier 3: Dynamic modelling (e.g plants)

$$M(t) = P \cdot diag(\exp \lambda_1 t, \ldots, \exp \lambda_n t) \cdot P^{-1} \cdot (M(0) + A^{-1}S) - A^{-1}S$$

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Environmental parameters for fungicides

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		Benomyl	Chlorothalonil	Propiconazole
		17804-35-2	**1897-45-6**	**60207-90-1**
Environmental data	Kow	1.42	1.64	1.8
	Henry's cste	5.00E-03	3.40E-01	1.92E-03
	1/2 air	2.999990547	59386.43118	14.15720789
	1/2 water	146	50	5.5
	1/2 soil	4380	1460	115
Source	emission in air(kg/h)	0.15	0.15	0.15
	emission in soil(kg/h)	0.85	0.85	0.85
Fraction transfer	*Faw*	*0.7%*	*0.7%*	*0.6%*
	Fsw	*25.8%*	*5.0%*	*1.0%*
Tot. Mass in Water	*Mw*	*46.11*	*3.16*	*0.07*

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Comparison of Impact based on HC50 and PNEC

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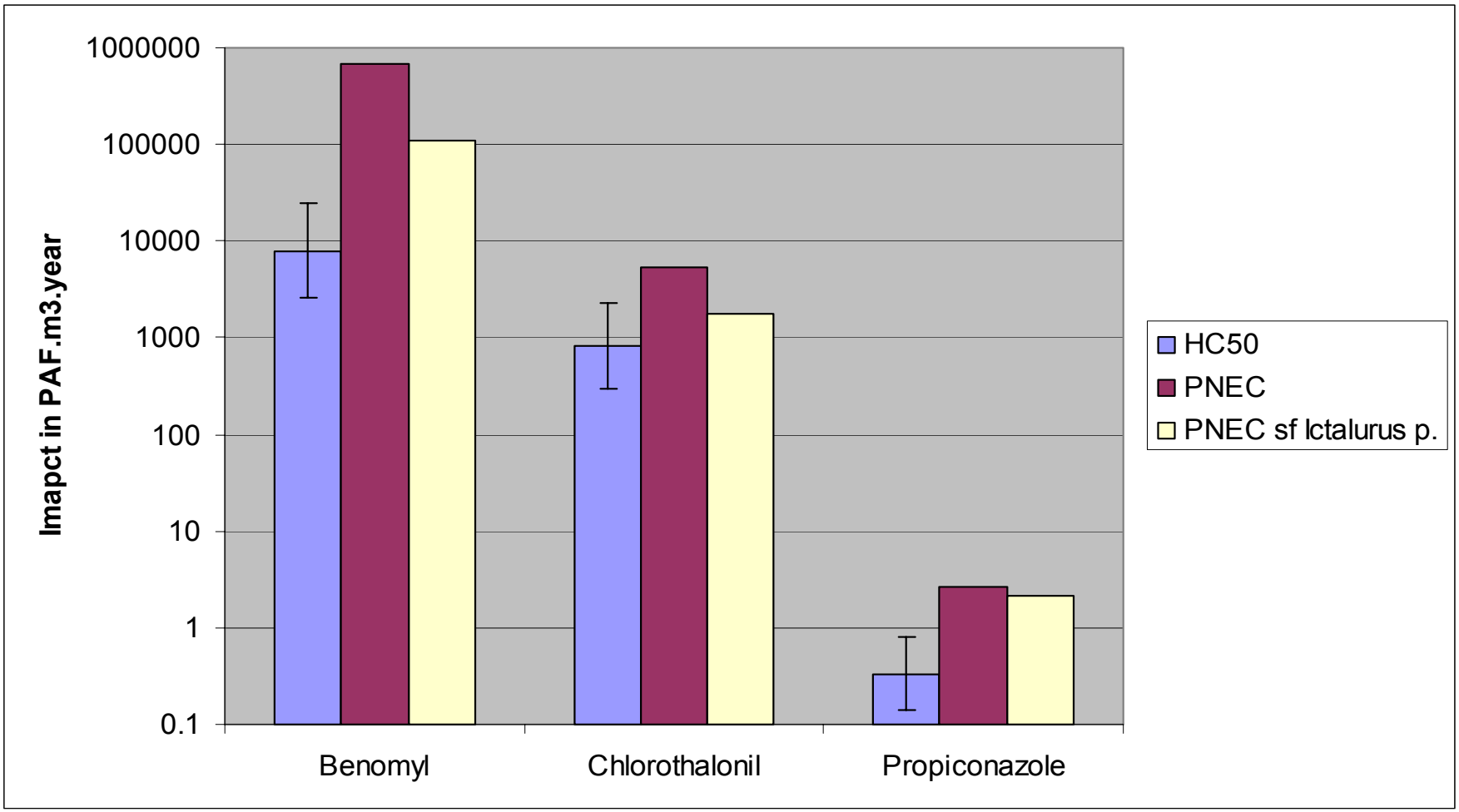

Conclusion

Indicator : fraction of affected species over volume during a certain time, in PAF · m^3 · Year

For comparative assessment geometric mean more stable to species tested

Indentification of key factors, Faw, 1/ktot, HC50

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Comparison of toxicity based on HC50 and PNEC

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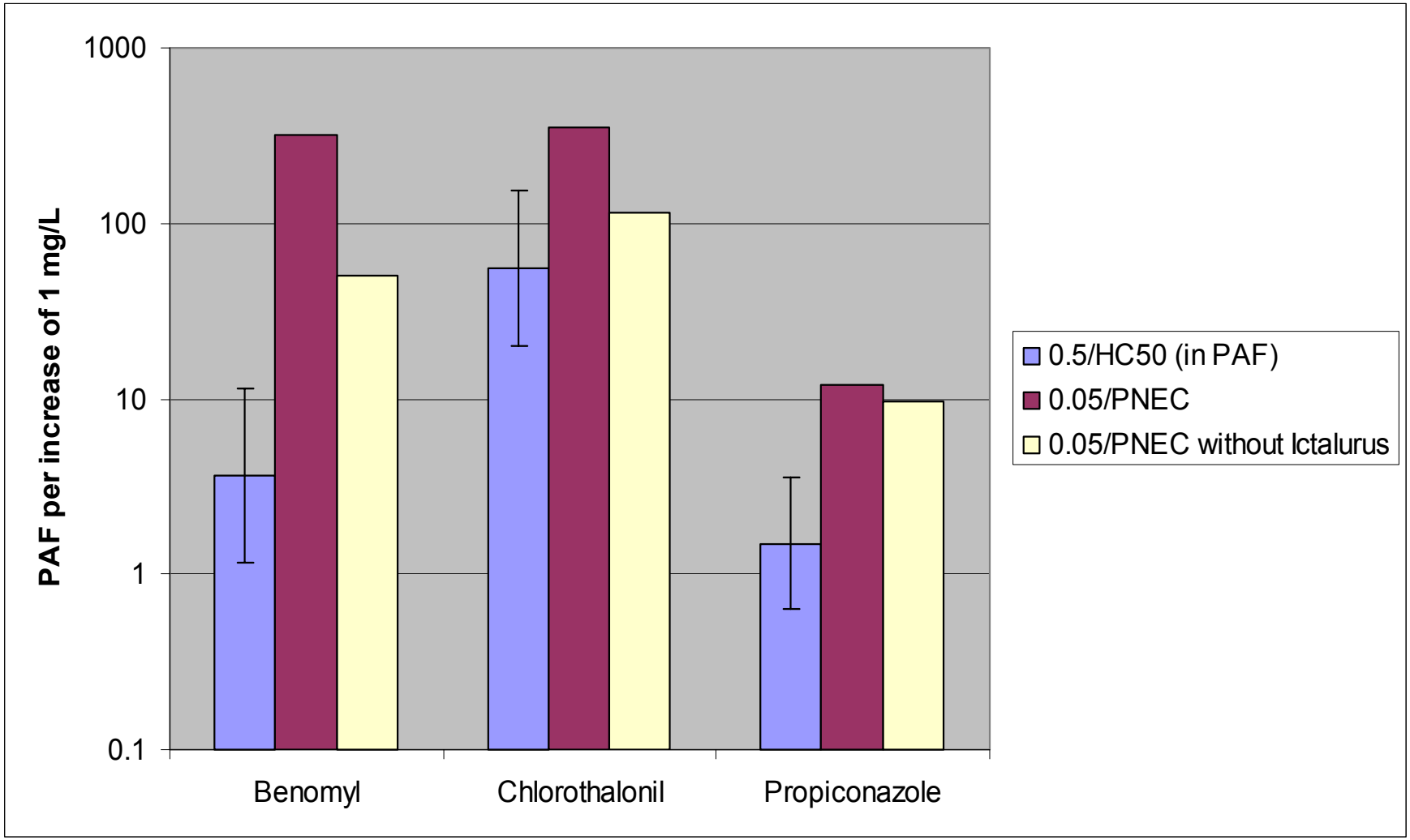

Effect Model

Impact = Source x Fate x Effect

Effect model = 0,5 / HC50

Indicator : fraction of affected species (PAF) over the chronic HC 50 expressed in PAF · M^3 · year

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Comparison of the median toxicity of 82 chemicals regarding 217 species

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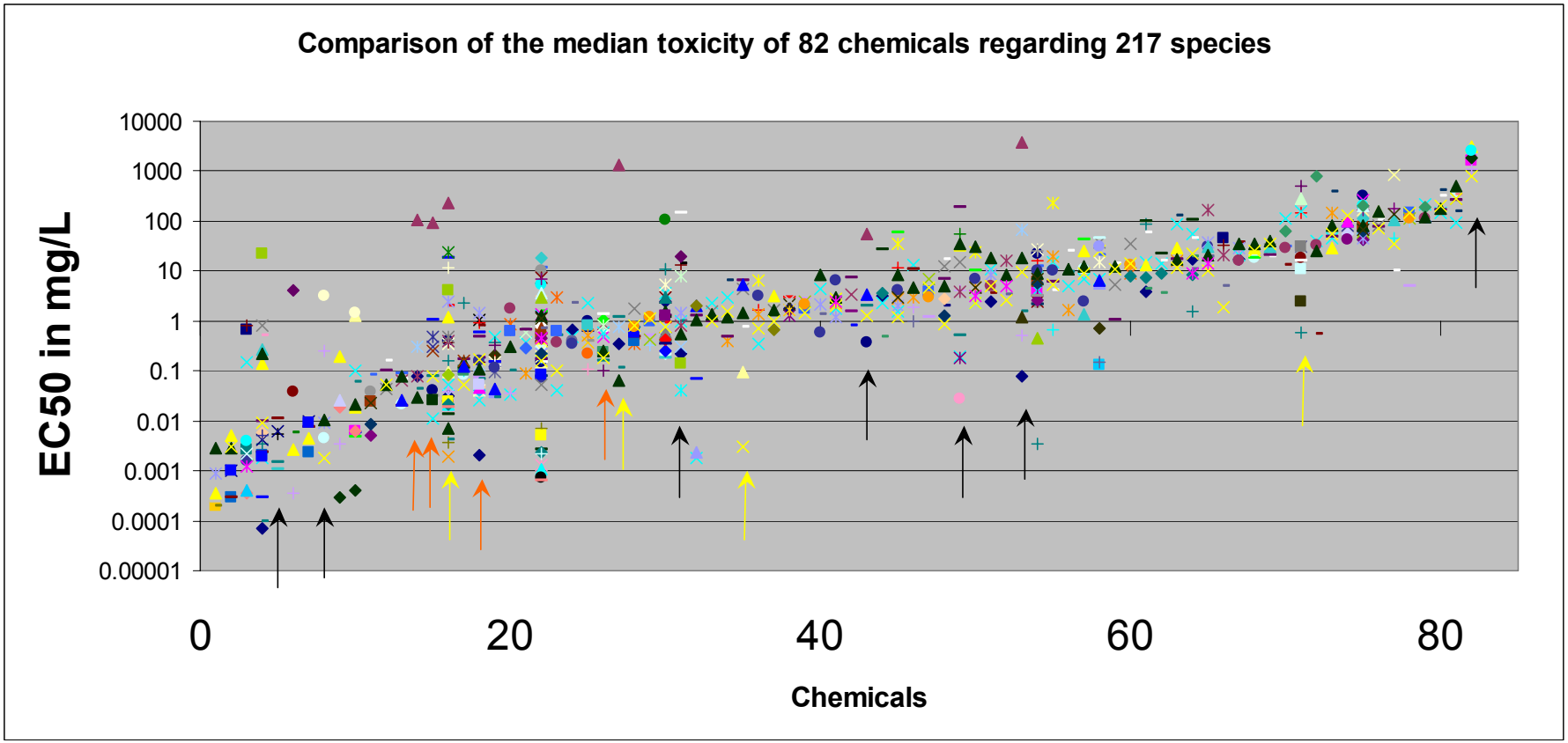

Variability between species for a given chemical is high --> more consistent to use the median instead of the most sensitive

Median toxicity and corresponding uncertainty of 82 chemicals organics (67) and metals (15)

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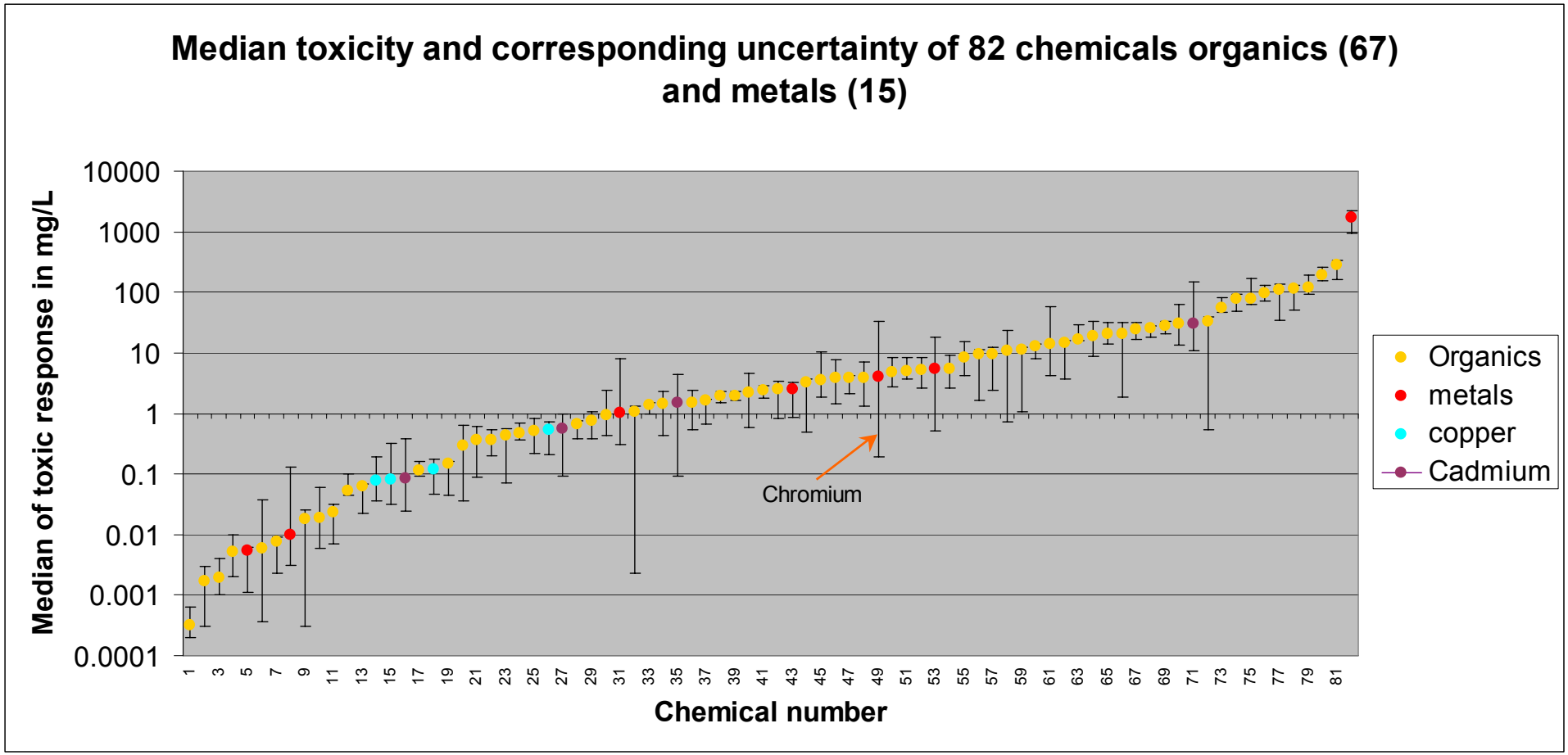

Available for 500 substances (metals, inorganics, pesticides)

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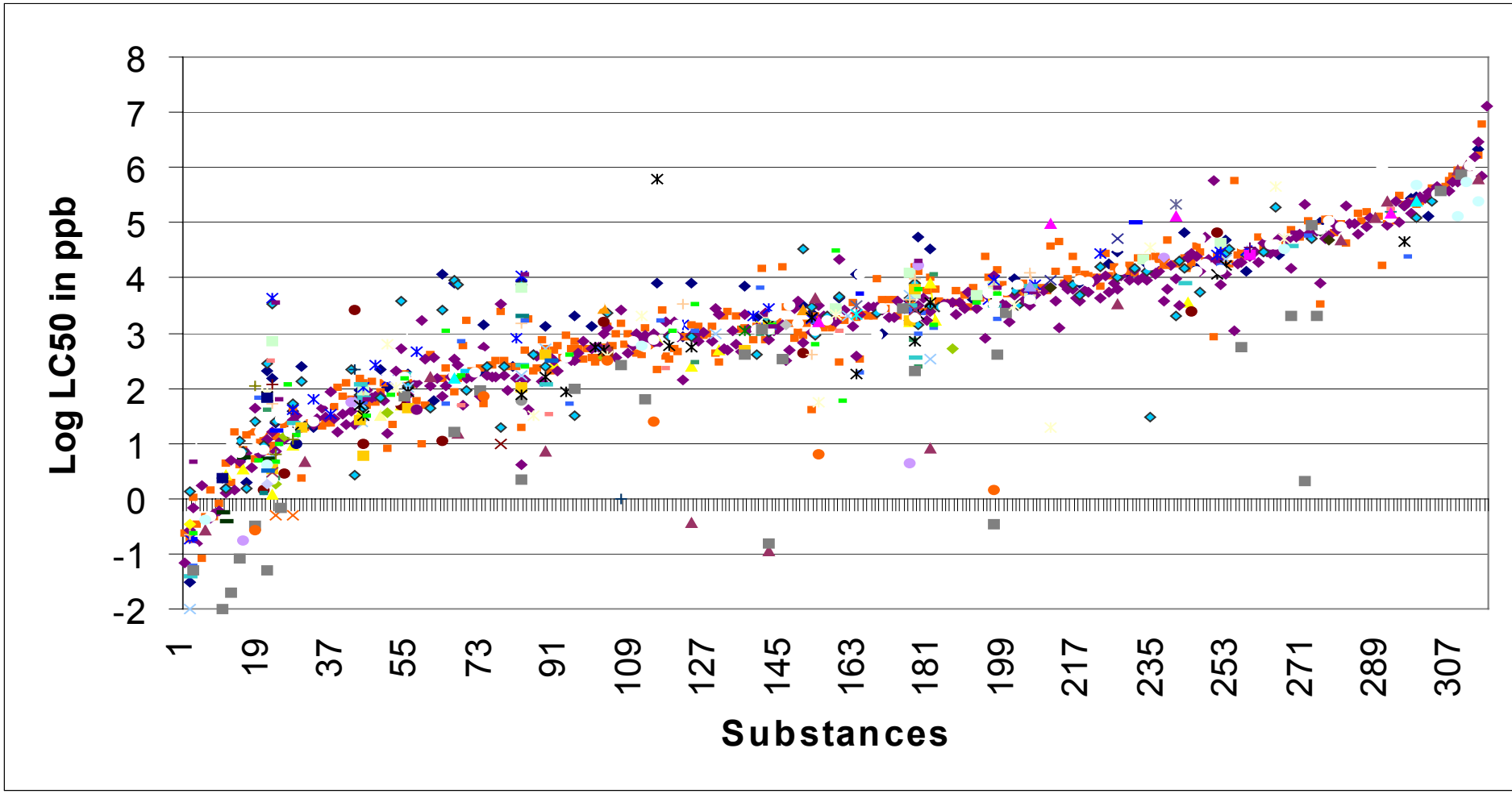

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95% confidence interval on the median at least 3 species per substance

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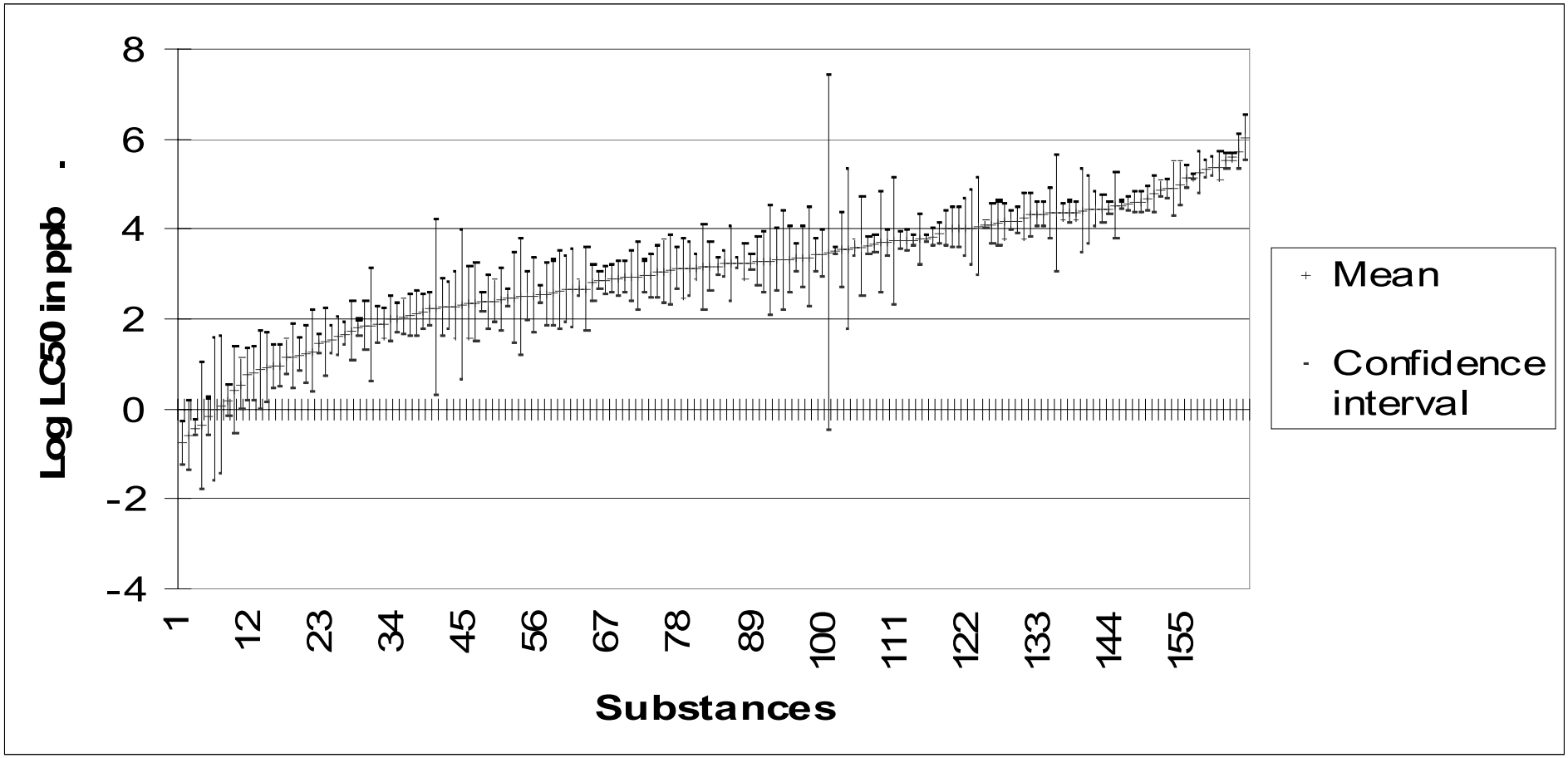

Substances are differentiated if uncertainty on the medians do not overlap.

Uncertainty tends to decrease with the number of species tested !