Does laboratory based probabilistic effect assessment protect field communities?

A theoretical exercise for divalent metals

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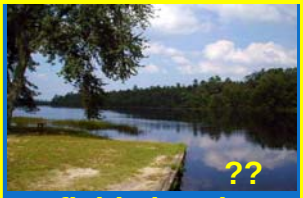
Introduction

Toxicity testing: lab sample of species sensitivities

extrapolation (e.g. SSD): derivation of Hazardous Concentration for 5% of tested species (HC_5)

associated hypothesis: "the lab sample of species sensitivities is representative of that in the field"

all possible species sensitivities



A field situation: site-specific sample of species sensitivities

Research question: which field situations are not protected by the lab samples?

A case study for divalent metals

Methodology

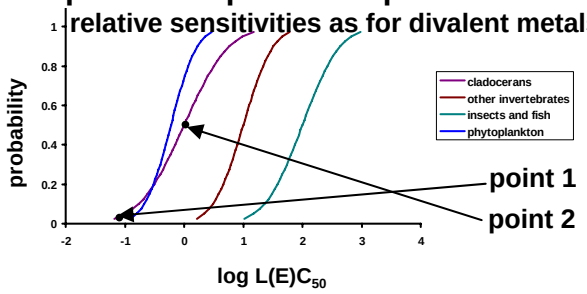
1 set of random samples representing lab species sensitivities

conversion $L(E)C_{50}$ to EC_{10} using slope[1] and acute to chronic data[3]

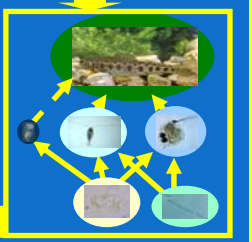
HC_5

pool of all possible species sensitivities

relative sensitivities as for divalent metals[2]



1 set random samples representing field species sensitivities



mechanistic ecosystem model simulates community dynamics exposed to HC_5

comparison with unexposed community biomass dynamics: % biomass change?

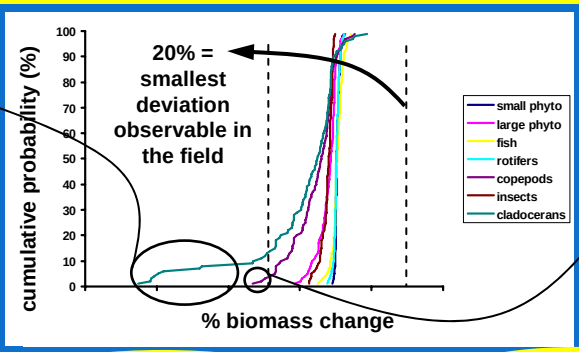
when this procedure is repeated 100 times: how many affected cases ?

Results

Affected cladocerans in 10 cases

reason

in these 10 cases:
- site-specific cladoceran LC_{50} originated from lower tail of distribution: point 1
- cladoceran LC_{50} in SSD: point 2



Affected copepods in 2 cases

reason

in these 2 cases, site-specific phytoplankton had an EC_{50} 5 times higher than phytoplankton EC_{50} in SSD

thus..

Affected phytoplankton

thus..

Affected copepods through trophic cascading

- Only if cladoceran LC_{50} samples in SSD are not representative of the corresponding field taxa, clearly observable effects on these populations can occur.
- In rare instances, non-representative phytoplankton EC_{50} samples in the SSD can lead to affected copepod dynamics.

Cited literature:
[1]Smit, M. G. D.; Hendriks, A. J.; Schobben, J. H. M.; Karman, C. C. and Schobben, H. P. M. The variation in slope of concentration-effect relationships. Ecotox. Environ. Safe. 2001, 48, 43-50.
[2]Brix,K.V.; DeForest, D.K.; Burger, M. and Adams, W.J. Assessing the Relative Sensitivity of Aquatic Organisms to Divalent Metals and Their Representation in Toxicity Datasets Compared to Natural Aquatic Communities. Human and Ecol. Risk Assess. 2005, 11, 1139–1156.
[3]Brix, K.V.; DeForest, D.K.; Adams, W.J. Assessing acute and chronic copper risks to freshwater aquatic life using species sensitivity distributions for different taxonomic groups. Environ.Toxicol. and Chem. 2001, 20, 1846-1856.

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