Statistical challenges in ecotoxicology

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Faced with the always-growing threat due to massive discharges of xenobiotics within ecosystems, relevant decision tools are needed to quantitatively assess the environmental risk. In particular, both the stressors' mode of action on individual characteristics and the emergence of effects across levels of biological organization should be better understood. In this perspective, ecotoxicology must today take up the challenge of developing mathematical and statistical models for explanatory and predictive purposes. Some authors develop complex mechanistic models in order to better understand the mode of action of a contaminant at each level of biological organization. In parallel, others develop simple metrics to summarize biological observations and to predict the impact of xenobiotics on ecosystems. Whatever the chosen approach, scientists have to tackle a variety of statistical issues:

- How to properly estimate parameters of complex models from experimental data? Which statistical approach (frequentist or Bayesian) and which algorithm should be used? How to account for correlation between measurements while modeling longitudinal data?
- How to take into account the nature of data (quantal data, count data, continuous data) and what to do with disparate data (mixture of data of different natures)?
- How to account for censored data or incomplete data due to mortality during a reproduction bioassay for example?
- How to take into account inter-individual or inter-replicate variability?
- How to model inter-species variability taking into account all of the available biological information?
- How to estimate uncertainty on model parameters and how to transfer it within the risk assessment framework? How much uncertainty is too much? I.e., when is uncertainty so large as to render results meaningless for risk assessment?
- How computer simulation studies can help to explore how well models reflect reality? This is an important component in capturing the uncertainty in modeling.
- To what extend do we need to complicate the statistical methods used to fit models to data? What are the impacts of some common simplifications?
- Presumably, the size effect, e.g., ECx, is of interest, for risk assessment, but what size effect (x) should/can be estimated meaningfully for each response?
- Are there ecological data for which no useful models currently exist?
- Are some responses or datasets inherently poorly modeled by regression-type models and should be analyzed by alternative methods (e.g. hypothesis tests)?
- What are the implications for experimental design imposed by different modeling methods? Can testing laboratories accommodate these designs?
- What type of tools and statistical training should we provide to ecotoxicologists for better statistical handling of data in ecotoxicology?

This list of questions is not exhaustive and any communication presenting modern methods to deal with statistical challenges in ecotoxicology will be welcome.

SESSION TYPE: Platform and Poster