Quantitative EcoToxicology

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Course Description

This course is intended to deepen the skills and knowledge of ecotoxicological practitioners through quantitative methods. The motivation for the course is the translational nature of toxicological data. All data should lead to inference to improve decisions about chemical management and appropriate quantitative methods are key. This course will address types of data common to toxicity testing and exposure quantifications. This course will address types of statistical and modeling methods used to interpret testing outcomes and exposure quantification and estimates. The course will introduce population models, Bayesian methods, and hierarchical models. The course will be based in the R programming language and students will be expected to be familiar with common frequentist statistics.

Course Philosophy

The course will largely be example driven, but will require introductory components for the programming language. Daily/weekly examples will generally follow a 'pencil first, computer second' approach such that student's engagement with underlying mathematical concepts is equivalent to technical proficiency.

Course Purpose and Learning Outcomes

The purpose of the course is to gain proficiency in the quantitative techniques commonly used in the field of ecotoxicology to support ecological risk assessments.

Successful students of the course will be able to:

-Describe common toxicity testing designs and their matching statistical interpretation
-Describe common exposure and environmental chemistry statistical analysis and modeling methods
-Describe methods to translate ecotoxicological test results to organismal, population, and ecosystem inference
-Perform methods in R programming language

Suggested Reading:

The course will largely follow the layout of Newman's Quantitative Ecotoxicology but make references to other texts which will be made available as needed.

Newman, M.C. (2012). Quantitative ecotoxicology (2nd ed.). CRC press. https://doi.org/10.1201/b12498

Other relevant texts:

Ritz C, Jensen SM, Gerhard D, Streibig JC. 2021. Dose-response analysis using R. Boca Raton London New York: CRC Press (The R Series).

Hothorn LA. 2021. Statistics in toxicology using R. Boca Raton, FL: CRC Press (The R series).

Kéry MMM, Kellner KF. 2024. Applied statistical modelling for ecologists: a practical guide to Bayesian and likelihood inference using R, JAGS, NIMBLE, Stan and TMB. 1st edition. Amsterdam, Netherlands Cambridge, MA, United States: Elsevier.

Course Structure:

The course will largely be based on daily/weekly working of examples (i.e. labs). Material will be presented with a context or case study, the method will be described, an example worked 'by hand' and then in R programming language.

Student Performance Evaluation:

Students will be evaluated throughout the course by periodic reviews of a RMarkdown or Quarto document. This document will represent a 'portfolio' and will be the main graded output of the course.

{insert legalese sections specific to organization}

Course Schedule:

Week	Topic	Reading
1	Introduction to ecotox and ecorisk	Newman Chp 1
2	Distributions and measures	Newman Chp 2
3	Partitioning	Newman Chp 3
4	Quantal Responses 1	Newman Chp 4
5	Quantal Responses 2	Ritz and Hothorn
6	Continuous Responses 1	Newman Chp 5
7	Continuous Responses 2	Ritz and Hothorn
8	Nested Responses	Kery Chp 10 and Hothorn
9	Population Models 1	Newman Chp 6
10	Population Models 2	Newman Chp 6
11	Threshold Determination	Ritz
12	Kinetics	Newman Chp 3 and Ratier et al. 2022
13	Solving through simulation	EPA Handbook

Ratier A, Baudrot V, Kaag M, Siberchicot A, Lopes C, Charles S. 2022. rbioacc: An R-package to analyze toxicokinetic data. Ecotoxicology and Environmental Safety. 242:113875. doi:10.1016/j.ecoenv.2022.113875.

EPA US. 1993. Wildlife Exposure Factors Handbook. Report No.: EPA/600/R-93/187. https://assessments.epa.gov/risk/document/&deid=2799