PhD Course: Modeling in Ecology & Evolution (5 credits)

When & Where

The course takes place between 17:00 and 20:00 at ten dates in January to March 2020.

Tuesdays: 21.1.; 28.1.; 4.2.; 11.2.; 18.2; 25.2; 3.3.; 10.3.; 17.3.; Thursdays: 23.01.

The course takes place at Lärosal 2, Norbyvägen 14, EBC, Uppsala.

Course set-up

Each meeting consists of a two-hour lecture and a one-hour tutorial. Additionally, each week participants obtain a problem set which they have to solve at home and whose solutions have to be handed in. Most problems have to be solved with paper and pencil but some involve computer modelling in R. The solutions will be corrected by the course leader and discussed in the tutorials. Participants are also expected to read some sections in the course book:

Otto, S.P. & Day, T. (2007). A biologist's guide to Mathematical Modelling in Ecology and Evolution. Princeton University Press.

Grading

This course is graded on a Pass/Fail basis. To receive a Pass, you must hand in solutions for the problem sets and obtain at least 50% of the points. Furthermore, you must participate actively in the tutorials.

Recommended Background

The course is intended for PhD-students working in ecology and evolution. There are no special requirements but a good knowledge of high-school level calculus and algebra is expected. The course is held jointly for master and PhD students.

Registration

To register please send an Email to Claus Rüffler (`claus.rueffler@ebc.uu.se`).

Deadline for registration is December 15, 2019.

If you need further information please contact me by Email or at the Department of Ecology and Genetics, Animal Ecology, EBC, Uppsala University. Tel.: 018-471 2639.

Course Description

A brief look in any of the leading journals in ecology and evolution quickly reveals that mathematical models are ubiquitous in these fields. However, mathematical models are not only an integral part of fundamental research but also important in applied fields such as nature conservation, fisheries management and epidemiology. There is a clear trend for biology to become a more exact science and the increased use of mathematical models is the signature of this development.

Many questions in ecology and evolution can be phrased in the language of dynamical systems: How does the number of individuals in a population change over time and how is this change affected by the presence of predators or by human activities such as conservation measures or harvesting? To what extent can we expect that the egg laying date of a migrating bird species evolves under climate change? Under what conditions can an allele providing increased resistance to antibiotics increase in frequency? Mathematics is the obvious tool to answer questions that are formulated in this manner.

Models can serve different purposes. They can be used to make exact quantitative predictions (What is the maximum amount of fish we can harvest before a fish stock collapses?) or they can be used as thinking tools that help us to understand biological concepts (Which factors favour speciation?) or let us create hypotheses that can subsequently be tested experimentally (Do changes in adult mortality affect the evolution of maturation age?).

In this course, you will learn the necessary steps to build, analyse and interpret mathematical models that are motivated by questions from ecology and evolution. Furthermore, you will acquire an in-depth understanding of some of the classical models in these fields. The course consists of lectures, home assignments and tutorials. Home assignments are a crucial part of the course because one can learn modelling only by doing it.

Course Contents

- The modelling cycle: (i) translating a verbal model into mathematics, (ii) analysing the model with the tools of mathematics, (ii) translating the mathematical results back to biology.
- Analysing models: equilibria and stability analysis of discrete and continuous time models, functions and approximations, matrix algebra.
- Models in ecology: population growth, density-dependence, species interactions, structured population models.
- Models in evolutionary biology: one- and two-locus population genetics models, basics of invasion analysis.

We touch on material from the first 12 chapters in the course book by Otto & Day.