PhD course in Mathematical and Statistical Modeling of Ecological Data

The theme of the course is "mathematical and statistical models in the analysis of survival and dynamics of species inhabiting fragmented landscapes". While the methods and models are of general nature, they are discussed especially in the context of the EBFB project.

Below, the numbers in brackets indicate for each topic the number of sessions of type (A,B,C). Here A refers to lectures, B to computer exercises, and C to group work. Each session lasts for 100 minutes (2 x 50 minutes). In group work, the students are split into 5 groups, each tutored by one teacher. The group picks a topic of its own interest (among topics covered by the lecture, computer exercise or background reading papers), and discuss that for 50 minutes (covering issues that remained unclear, possible relations to their own work, etc.). In the second 50 minute session a representative from each group briefly summarizes the group discussion, followed by a brief overall discussion. Those groups with Russian speaking students and tutors may have their discussion in Russian, thus also clarifying issues that may have remained unclear due to language issues.

Otherwise it is indicated in Schedule, sessions are to take place at:

A – Dep-t of Geobotany, Sredniy pr. 41
B – computer class, Sredniy pr. 41
C – computer class, Sredniy pr, 41

Brief introduction to Biodiversity [1,0,0]

Basic introduction to the Biodiversity issues: literature, terminology and leading concepts in BD, structure and levels of BD: genetic polymorphism, high level taxonomy, ecosystem's structure and typology. The analysis is given to the interaction of BD and society: economy, ethics, aesthetics, public participation, etc. At the centre there are the following topics: threats to BD (habitat destruction, climate change, environmental pollution, and biological invasions), BD conservation (methodology, expertise, monitoring, bioindication, etc.).

Background reading: A Global Species Assessment. 2004 IUCN Red List of Threatened Species – IUCN Red List Programme Office, Gland, Switzerland and Cambridge, UK, 2004. Global Biodiversity Assessment – Cambridge: United Nations Environment Programme, 1995.

Modeling methods in ecology and evolutionary biology [1,1,1]

The important general principles of modeling are described at the beginning of the course. The main attention is devoted to mathematical modeling and computer imitation (so called "simulation") of real biological processes in terrestrial ecosystems. Besides, important ecological and evolutionary regularities have to be discussed in lectures. The aim of that is to explain what is the difference between succession processes in the forest ecosystems and evolutionary ones. Several computer demonstrations are given along the course in order to simplify the understanding of typical ecological and evolutionary tasks. The practical work studies with using of computer simulation are planed.

Background reading: F.Capra. The Web of Life. Anchor/Doubleday, New York, 1996; Ф.Капра. Паутина жизни . «София», 2002; Odum E.P. Fundamentals of Ecology.

Philadelphia & London: W.B. Saunders Co, 1959. 574 p.; А.К. Бродский Общая экология. М., издательский центр «Академия». 2006. 254 с.

Teachers: prof. Otso Ovaskainen, Dr. Eliezer Gurarie, Dr. Daniel Simpson, Dr. Juri Kurhinen, MSc. Jussi Jousimo.

The EBFB project: data and questions (1,0,0)

This lecture gives an introduction to the EBFB project (probably just 45 minutes is enough for this).

Background reading: The www-page http://www.helsinki.fi/science/metapop/EBFB/index.html, including the linked material, especially the scientific plan and the description of the EBFB database. These materials are available also in Russian.

Introduction to population dynamics in fragmented landscapes (1,0,1)

We give an introduction to spatial population dynamics, covering processes that shape ecological, genetic and evolutionary dynamics of species inhabiting heterogeneous or fragmented landscapes. The group work session related to this lecture will be in the end of the course, and it is aimed as a more broad discussion summarizing the entire course.

Background reading: [to be added]

Modeling animal movement (1,1,1)

We give an introduction to modelling animal movement, with a special emphasis on models that apply to heterogeneous landscapes. The theoretical part covers random walk and diffusion based movement models. The statistical part covers the parameterization of movement models from e.g. mark-recapture data and the analysis of habitat use and movement scales from GPS data.

Background reading: (Patterson et al. 2008, Gurarie et al. 2011).

Mathematically advanced background reading: (Ovaskainen et al. 2008, Ovaskainen and Crone 2010)

Modeling (meta)population dynamics (1,1,1)

We give an introduction to population modelling covering both deterministic and stochastic approaches, and modelling approaches that link individual-level behaviour to population dynamics.

Background reading: (Ovaskainen and Hanski 2004b). Morales at al. 2010 review (add to endnote).

Mathematically advanced background reading: (Ovaskainen and Hanski 2004a, Ovaskainen and Meerson 2010).

Data analysis with linear models (1,1,1)

We give an introduction to linear models. The first lecture covers the basics (analysis of variance and regression) and the second lecture more advanced topics: spatial and spatio-temporal models and hierarchical modelling approaches.

Background reading: The following site: https://sites.google.com/site/ecologywithrporusski/ gives background lectures and labs (in Russian) on linear modelling using R with ecological applications.

Mathematically advanced background reading: (Ovaskainen and Soininen 2011) [a paper about spatial models is to be added]

Gurarie, E., J. Suutarinen, I. Kojola, and O. Ovaskainen. 2011. Summer movements, predation and habitat use of wolves in human modified boreal forests. Oecologia **165**:891-903.

Ovaskainen, O. and E. E. Crone. 2010. Modeling animal movement with diffusion.*in* S. Cantrell, C. Cosner, and S. Ruan, editors. Spatial Ecology. Chapman and Hall/CRC.

Ovaskainen, O. and I. Hanski. 2004a. From individual behavior to metapopulation dynamics: Unifying the patchy population and classic metapopulation models. American Naturalist **164**:364-377.

Ovaskainen, O. and I. Hanski. 2004b. Metapopulation dynamics in highly fragmented landscapes. Pages 73-103 *in* I. Hanski and O. Gaggiotti, editors. Ecology, Genetics, and Evolution in Metapopulations. Academic Press.

Ovaskainen, O. and B. Meerson. 2010. Stochastic models of population extinction. Trends in Ecology & Evolution **25**:643-652.

Ovaskainen, O., H. Rekola, E. Meyke, and E. Arjas. 2008. Bayesian methods for analyzing movements in heterogeneous landscapes from mark-recapture data. Ecology **89**:542-554.

Ovaskainen, O. and J. Soininen. 2011. Making more out of sparse data: hierarchical modeling of species communities. Ecology **92**: 289-295.

Patterson, T. A., L. Thomas, C. Wilcox, O. Ovaskainen, and J. Matthiopoulos. 2008. State-space models of individual animal movement. Trends in Ecology & Evolution **23**:87-94.

Schedule

Monday, April 23	**Dep-t of Botany, main Building**
10.00-10.30	**Registration**
10.30-11.50	**Welcome to the Course – Andrei Brodsky**
12.00-12.50	**The EBFB project: data and questions [A] – Otso Ovaskainen**
12.50-13.50	**Lunch (**not provided**)**
13.50-15.20	**Brief introduction to Biodiversity [A] – Andrei Brodsky**
15.30-17.20	**Population dynamics in fragmented landscapes [A] – Otso Ovaskainen**

Tuesday, April 24	**Computer class & Dep-t of Geobotany**
09.00-10.50	**Modeling methods in ecology and evolutionary biology [A] – Vladimir Levchenko**
11.00-12.50	**Modeling animal movement [A] – Otso Ovaskainen**
12.50-13.30	**Lunch (**not provided**)**

13.30-15.20 **Modeling animal movement [B]**

15.30-17.20 **Modeling animal movement [C]**

Wednesday, April 25 **Computer class & Dep-t of Geobotany**

09.00-10.50 **Modeling methods in ecology and evolutionary biology [B]**

11.00-12.50 **Modeling (meta) population dynamics [A] – Otso Ovaskainen**

12.50-13.30 **Lunch (**not provided**)**

13.30-15.20 **Modeling (meta)population dynamics [B]**

15.30-17.20 **Modeling (meta)population dynamics [C]**

Thursday, April 26 **Computer class & Dep-t of Geobotany**

09.00-10.50 **Modeling methods in ecology and evolutionary biology [B]**

11.00-12.50 **Data analysis with linear models [A] – Otso Ovaskainen**

12.50-13.30 **Lunch (**not provided**)**

13.30-15.20 **Data analysis with linear models [B]**

15.30-17.20 **Data analysis with linear models [C]**

Friday, April 27 **Computer class & Dep-t of Geobotany**

09.00-10.50 **Modeling methods in ecology and evolutionary biology [C]**

11.00-12.50 **Population dynamics in fragmented landscape [C]**

12.50-13.30 **Lunch (**not provided**)**

13.30-17.20 **Main results, Discussion – Otso Ovaskainen, Andrei Brodsky & others**