Modeling Population Dynamics:

Estimating Demographic Parameters for Wildlife Conservation

Lecturer: Dr. Brett K. Sandercock

Norwegian Institute for Nature Research

Workshop 13–19 January 2020

University of Debrecen, Hungary

Registration: https://forms.gle/mb98dWbckDjJMdGw7

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Registration deadline: 10 November 2019

Workshop / course venue: DAB building, Thomas Mann street 49, Debrecen, Hungary

Capacity: 25 course participants (everybody needs to bring own laptop) + organizers
To assure the fairest possible selection process, every applicant will send a short letter of interest (up to 200 words) including: Why they are the most suitable participants, benefiting from the course the most? * How they are going to use the acquired knowledge? * What is their knowledge of R statistical software? * Which topics they would like to cover during the two last days of the course?
Workshop organizers (Dr. Brett Sandercock, Dr. Vojtěch Kubelka and Dr. Zsolt Végvári) will select 25 qualified participants with research interests in demography from a range of different institutions.
All applicants will be notified about the outcome until 17 November 2019.

Course fee: 50 EUR includes the course venue and coffee breaks for the whole week. See the registration form for more details. **Contact for workshop organizers**: demographicws.debrecen2020@gmail.com

Course Dates	**Tentative Hours**
Week 3: January 13–19, 2020 Morning and afternoon sessions	Two sessions per day, each 1 hour lecture and 2 hour lab with R

Instructor	**Contact**
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Schedule: Modeling Population Dynamics is a graduate workshop that will be taught at the University of Debrecen, Hungary. The course is scheduled for the week of January 13–19, 2020 (week 3). For the first five days, two topics will be presented each day. Each topic will have a one hour lecture and a two hour practical exercise using example scripts in Program R. For the last two days, participants will receive assistance on quantitative analyses for individual projects and will prepare a short presentation on their research project. Participants (students) enrolling in the course should have some background in population biology and have completed upper-level undergraduate courses in wildlife management or similar courses. Course materials and lectures will be held in English.

Workshop description: In this workshop, we will explore applications of demographic methods for conservation and management of plant, fish, and wildlife populations. Quantitative methods for demographic analyses are currently used in three arenas of modern ecology. In evolutionary ecology, researchers use demographic methods to investigate patterns of variation in the life-history traits of organisms. In conservation biology, biologists use demographic tools to devise conservation strategies for threatened species, and to reduce population declines. In wildlife management, the same techniques are applied to questions in developing strategies for control and sustainable harvest. The course will cover the quantitative techniques commonly used for modeling population dynamics, including occupancy models, count-based models, and structured models based on demographic rates. We will consider some of the common drivers of population dynamics including density-dependence, trophic interactions, and sustainable harvest. The course will cover basic concepts and theory of wildlife demography, and will introduce useful packages in Program R that can be used to estimate demographic parameters and model population dynamics.

Learning outcomes: Participants will gain the skills needed to address the following questions:
1. What are the main types of demographic data used for conservation and management of wildlife populations? What are the main statistical paradigms commonly used to analyse population data?

2. What are the different types of mark-recapture models used to estimate demographic parameters or occupancy rates for wildlife populations? How are count-based models and structured models used to determine population status and predict population change (λ)?
3. What are the relationships among life tables, life cycle diagrams, and projection matrices? How can sensitivity and elasticity analyses be used to identify the demographic parameters with the greatest effects on population dynamics that would suitable targets for management?
4. How do negative and positive density-dependence affect population dynamics and what is the role of Allee effects in small populations?
5. How do predation and harvest affect compensatory and additive mortality? What are the main anthropogenic stressors that affect viability of wildlife populations? What are the best harvest strategies to ensure a long-term sustainable harvest?
6. What are the best options for modeling variance in demographic rates? What are the fundamental differences among life-table response experiments (LTRE), life-stage simulation analyses (LSA), and other types of stochastic models?
7. What are the packages in Program R and other open source software that can be used to model the population dynamics of wildlife species for conservation and management?
8. Develop preliminary plans for a research project that would include methods from quantitative ecology and present it as a short oral presentation to the group.

Workshop expectations:

1. Class readings. Preparation for daily classes will require some background reading on review articles and the empirical papers used as model datasets for class exercises.
2. Class lectures. Regular attendance and participation in class discussions.
3. Working with daily problem sets. Population modeling often involves use of unfamiliar computer software and hands-on learning is the best way to learn the steps in different analyses. Problem sets will give students an actual example to try and work through. Participants are encouraged to work in groups to solve the problem sets.
4. Individual projects. Each participant should come prepared with a possible topic that would be suitable for an analysis that is related to wildlife demography. Participants will be asked to give a short presentation that outlines their research question, describes the sources of data that are available, and concludes with the type of population model that could be used for an analysis. All participants and organizers will then discuss and suggest the best approach for the given issue.

Workshop evaluation:

Certificate of the successful participation at the end of the course. To receive the certificate, a participant will attend the class, complete the class exercises, and give a short presentation on an aspect of their research project where quantitative methods could be applied.

Workshop materials:

Students will need to bring a personal laptop computer to participate in the course exercises. It would be helpful to download and install two free software packages beforehand:

1. Program R. R is a programming environment for data processing, statistical analyses, and graphics. The most current versions are available at the CRAN website (`https://cran.r-project.org/`).

2. R packages. The base version of Program R can be extended with tools and custom functions in different optional R packages. The main packages that we will use in the workshop include `unmarked` for occupancy models, `survival` for time-to-event models, `gss` for hazard rate functions, `RMark` as an interface to Program Mark for mark-recapture models, and `popbio` for matrix population models.

3. Program Mark. Mark is a dedicated software program for estimation of demographic parameters from different kinds of mark-recapture data. It is available for download from the phidot website (`http://www.phidot.org/software/mark`).

WORKSHOP / COURSE SYLLABUS – JANUARY 2020

Day	Session	Topic
Jan 13	**AM**	Lec. Introduction to population ecology and statistical paradigms Lab. Introduction to Program R and statistical analyses
	PM	Lec. Occupancy models for determining population status and trends Lab. Estimation of occupancy rates from detection-nondetection data for unmarked individuals
Jan 14	**AM**	Lec. Count-based models for population dynamics, with negative density-dependence and Allee effects Lab. Exponential and logistical population growth, population viability analysis and extinction thresholds, effects of harvest
	PM	Lec. Closed population models for estimation of abundance Lab. Closed population models with marked individuals
Jan 15	**AM**	Lec. Time-to-event models for estimating survival and hazard rates Lab. Kaplan-Meier, Cox proportional hazards and hazard rate models for radio-telemetry data and sessile organisms
	PM	Lec. Open population models for estimating apparent survival and other transition rates Lab. Closed population models with marked individuals
Jan 16	**AM**	Lec. Basics of life-tables for demographic data Lab. Estimation of life table statistics such as population growth rate, net reproductive rate, generation time, and life expectancy
	PM	Lec. Projection matrices and life-cycle diagrams Lab. Demographic analysis of projection matrices: lambda, reproductive value, stable age distributions, sensitivity and elasticity values
Jan 17	**AM**	Lec. Life-table response experiments (LTRE) Lab. Fixed and random effect LTRE models for estimating the variance of the finite rate of population change (λ)
	PM	Lec. Stochastic population models, estimation of variance components, life-stage simulation analyses (LSA) Lab. Analytical solutions based on the delta method, numerical solutions based on bootstrapping.
Jan 18	**AM/PM**	Consultation and development of participants projects
Jan 19	**AM/PM**	Consultation and development of participants projects