MT5751 - Estimating Animal Abundance

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The module will introduce students to the most widely-used survey methods for wildlife populations and give students experience of using state-of-the-art estimation software for each of the methods. After a brief overview of likelihood theory relevant to wildlife surveys, distance sampling, mark-recapture, including spatially explicit mark-recapture, and occupancy estimation methods will be dealt with in turn. The course focuses on methods for closed populations (populations that do not change during the survey period). Some open population methods will be mentioned but will not, for lack of time, be addressed in detail.

Learning objectives

By the end of the course, you should be able to

a) identify an appropriate assessment method for a given population,
b) design a survey to assess the population and
c) conduct analyses of survey data and interpret the results appropriately.

Location & Times (also see schedule below)

Lectures: Observatory/ CREEM Seminar room, Mon (odd weeks), Wed, Fri 12-1pm.
Practicals: Observatory/CREEM PC classroom, (tentatively) Wed 1-2pm

OUTLINE OF CONTENT

Statistical foundations

Introduction of the problem and motivation of the need for statistical methods in wildlife population assessment. Overview of the concept of likelihood and maximum likelihood estimation. The sampling distribution of an estimator and estimator properties.

Measures of precision; confidence intervals; bootstrapping; model selection. General statistical framework for wildlife population assessment methods.

Plot sampling and Distance sampling

Derivation of likelihood function, and maximum likelihood estimator. Assumptions and the effect of violating them.

Distance sampling as a generalisation of plot sampling. Formulation of the distance sampling likelihood function, and maximum likelihood estimator. Assumptions and the effect of violating them.

Introduction to software for distance sampling estimation. Use of software to analyse distance sampling data.

Assessed Project 1: Estimate density from selected distance sampling survey dataset(s).

Mark recapture methods

Lincoln-Petersen estimator, likelihood function and maximum likelihood estimator. Mark recapture models M_0, M_t, M_b, M_h and more complex mark recapture estimators. Assumptions and the effect of violating them.

Brief coverage of mark-recapture distance sampling methods.
Introduction to capture-recapture estimation using RMark. Use of RMark to analyse capture-recapture data.

Assessed Project 2: Analysis of selected Capture-recapture survey dataset(s).

Spatial capture-recapture

Spatial capture-recapture (SCR) methods. Location as an individual random effect and the associated marginal likelihood function. Varieties of SCR models, with illustrative examples. Introduction to the R package secr for SCR estimation. Use of the package to analyse SCR data.

Assessed Project 3: Analysis of selected SECR survey dataset(s).

Occupancy modelling

Overview of occupancy models, likelihood function and maximum likelihood estimators. Varieties of occupancy model. Assumptions and the effect of violating them.

Introduction to occupancy estimation using RMark. Use of RMark to analyse occupancy data.

Assessed Project 4: Analysis of selected occupancy survey dataset(s).

Summary and Overview

Overview of modelling framework for wildlife population assessment. Summary of estimators and their properties; which method is appropriate under given circumstances; relationships between the methods. Summary of issues and methods not covered in this course.

Recommended Reading: see library reading list with link via MMS

ASSESSMENT

Continuous assessment (50% of final grade)

- ✓ Four projects (details above)

Final Exam (50% of final grade)

- ✓ Duration: 2 hours
- ✓ May diet

Week	Day	Presenter	Lecture	Tutorial	Practical Class	Projects
1	M	Steve	Stat Fundamentals & Sampling distributions			
1	W	Steve	Plot sampling to Line & Point Transects			
1	W	Eric			R and Stats basics	
1	F	Steve	DS likelihoods, MLE			
2	W	Steve	DS: detection functions, GoF, Model Selection			
2	W	Eric			Distance	DS handed out
2	F	Steve	DS: variance & CIs			
3	M	Steve		Distance		
3	W	Steve	DS: PT, mcds, mrds			
3	W	Eric			Distance	
3	F	Steve	DS: mrds (ctd); CR: MT, M0, MLEs			
4	M					DS due
4	W	Steve	CR: Mb, Mh & CIs			
4	W	Eric			CR	CR handed out
4	F	Steve	Covariates, Huggins, Delta Method			
5	M	Steve		CR		
5	W	Steve	Design matrices & link functions			
5	W	Eric			CR	
5	F		No lecture: Hons talks			
6	M					CR due; DS feedback due (Steve)
6	W	David	SCR with known location			
6	W	Eric			SCR	SCR handed out
6	F	David	SCR marginal, conditional, full likelihood			
7	M	David		SCR		
7	W	David	SCR detector and response types			
7	W	Eric			SCR	
7	F	David	SCR Density models, covariates, model selection			
			Easter Break			
8	M					SCR due; CR feedback due (Eric)
8	W	David	SCR Advanced topics			
8	W	Eric			Occupancy	Occupancy handed out
8	F	David	Occupancy			
9	M	David		Occupancy		
9	W	David	Occupancy			
9	W	Eric			Occupancy	
9	F	David	Occupancy			
10	M					Occupancy due; SCR feedback due (David)
10	W	David	N-mixture			
10	F	David	Overview & some info on open pops			
12	M					Occupancy feedback due (Eric)