EVALUATION OF STATISTICAL METHODS FOR ESTIMATING LONG-TERM POPULATION CHANGE FROM EXTENSIVE WILDLIFE SURVEYS

by

Len Thomas

B.Sc., The University of Sheffield, U.K., 1990
M.Sc., The University of York, U.K., 1991

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Abstract

Monitoring long-term changes in population abundance is an integral part of conservation-oriented research and management. Many extensive monitoring programs are based on annual counts at a large number of permanent survey sites. However, estimating population change from the resulting data is challenging and controversial. At least eight statistical methods have been proposed and used, and in this thesis I evaluated these methods using data from the North American Breeding Bird Survey (BBS).

I began by demonstrating the importance of analysis method for the inferences drawn about species trends. I compared the results when three methods of trend analysis were applied to BBS data for 115 species in British Columbia, and found differences in the direction, magnitude and statistical significance of the estimates.

I then explored the issues surrounding the analysis of these data. I showed that even under ideal survey conditions subjective decisions must be made about whether to estimate annual indices or population trends and, for trend methods, which model to use for trend. In reality the analysis is further complicated by measurement error and missing data. I suggested the use of simulation studies to determine the accuracy of the methods, and provided a simple example using three geographic scenarios of population decline.

I next made a preliminary assessment of the reliability of eight candidate analysis methods by applying them to continental data for four case study species (Cerulean Warbler, Carolina Wren, Chestnut-collared Longspur, and Belted Kingfisher). All methods except one (Mountford moving windows) produced seemingly plausible results in most cases. However each method demonstrated obvious flaws in some cases, and I used these to suggest potential areas of further methodological development.

I concluded that loglinear modeling is currently the best method for estimating annual indices. For trend analysis, I could not determine whether route regression or direct estimation (based on generalized modeling) is generally superior. Large, long-term population changes in well-surveyed species are almost certain to be detected by any of these methods. However, their accuracy and robustness remains uncertain, and further research is required both to develop the methods and to evaluate them through comprehensive simulation studies.

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List of Abbreviations

AIC	Akaike's Information Criterion
BBS	Breeding Bird Survey
CI	Confidence interval
CWS	Canadian Wildlife Service
GAM	Generalized additive modeling
GLM	Generalized linear modeling
NNRR	Nonlinear nonparametric route regression
NSRR	Nonlinear semiparametric route regression
QAIC	Quasi-likelihood Akaike's Information Criterion
RR	Route regression
SE	Standard error
TRIM	Trends and indices for monitoring data (a computer program for loglinear modeling)
USNBS	U.S. National Biological Service

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Foreword

Parts of this thesis have previously been published. A version of Chapter 2 was published as

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and a version of chapter 3 was published as

Thomas, L. 1996. Monitoring long-term population change: why are there so many analysis methods? Ecology **77**: 49-58.

The first paper was co-authored with my research supervisor, Dr. Kathy Martin, who played an important part in the early development of the work and provided substantial editorial input. I initiated the work, performed the analysis and drafted the manuscript.

I agree that the contributions of the candidate to our co-authored paper are as stated.

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(Dr. K. Martin)