Nat. Hist. Bull. Siam Soc. 61(2): 135–137, 2016

Estimation of Parameters for Animal Populations: A primer for the rest of us by Larkin A. Powell and George A. Gale. Caught Napping Publications Lincoln, Nebraska USA. 2015. 239 pp. Paper cover. ISBN 978-1-329-06151-4.

Perhaps you have noticed, in reading scientific literature, that statements introducing statistical models are often preceded by the word "simple". As in: "We develop/present/use a simple model to…" Using Google Scholar just before I wrote this, I found that in fact there were at least 137,000 biology-related papers in which the phrase "simple model" has been used. Many of them stake out even higher intellectual ground by adding adverbs to create such comforting phrases as "very simple model" and even "remarkably simple model". This phrase, "simple model", can make one feel, shall we say, mentally challenged, since it is often difficult to understand a model's mathematical logic and functioning.

Certainly there is nothing simple about statistical models, even the simple ones. The authors of "Estimation of Parameters for Animal Populations: A primer for the rest of us" understand this, and have written a book for the rest of us who find statistical modeling complicated and difficult, but nonetheless need to use models and want to do so properly and skillfully. The title of this book tells us something about the current state of knowledge transmission in biostatistics: complex statistical approaches and techniques remain, for many people, impenetrable even after explanation. This book is for them. The authors state their goal to "…present information to beginning learners in the field of demographic parameter estimation in a manner that allows a firm foundation from which to expand…" The book succeeds admirably in achieving this goal.

The firm foundation that the authors seek to build starts with the logic underlying statistical models (indeed, even an explanation of what a model is in the first place). The authors present underlying ideas (and sometimes their genesis) and logic behind the models used to estimate essential population and demographic parameters, including abundance, density, survival, and emigration. This attention to opening the "black box" and dissecting the actual machinations employed in various methods of parameter estimation permeates every chapter and is the overarching strength of the book. The book employs succinct, often light-hearted prose combined with a generous amount of figures, diagrams, and other visual explanations. These diverse visual aids, which were obviously painstakingly designed, are a great feature and work very well to help convey complex ideas.

The book starts with the basics behind the basics, explaining what a model is and the purposes modeling can serve, and how models are put into practice in the context of wildlife management. One of these early chapters is about Maximum Likelihood Estimation (MLE), a fundamental and widely used method of parameter estimation. This is one of the best explanations and visual descriptions of the concept of maximum likelihood I have seen. The treatment of this important concept is both comprehensive and clear. I wished actually that the chapter had covered even more basic terrain than it did, in particular an explanation for the origin of the binomial coefficient, which is an integral part of the mathematical machinery of MLE. (How *was* it determined that $N!/[n!(N–n)!]$ tells us the number of combinations of n individuals that can occur in a group of N individuals?) The logic and process of MLE is explained nicely, but it would be better still to understand all of the pieces.

A chapter on Akaike's Information Criterion (AIC) and model selection is likewise very thorough and contains an excellent section on model set interpretation and model averaging. What to do when numerous models have similar statistical support is not straightforward, and the book draws on recent literature and author experience to present a number of approaches, along with reasoned opinions about which is best in different circumstances. This chapter is not just for beginners; experienced researchers will find excellent, up-to-date guidance in using AIC and multi-model inference.

Chapter 5 covers the delta method. Wait. A chapter on the delta method? Yes it is true, and it is clearly and slowly explained, complete with formulae and examples of calculations. This is a rare find. Estimating sampling variance of demographic parameters in population ecology research is often not straightforward when our questions require combining parameters to indirectly calculate another one, or extrapolating a parameter (such as survival rate) to a different time scale. Step-by-step details for using the delta method are frustratingly hard to find, and often scattered and incomplete. This chapter provides clear comprehensive instructions all in one place.

Next come chapters that illustrate and explain fundamental concepts of linear models and mark-recapture models, including the basics of writing probability statements for capture histories (an important aspect for understanding how mark-recapture models "think"). Following this are chapters on closed population mark-recapture, and known fate models to estimate survival (complete with how to do censoring). Next is a chapter on estimating apparent survival with Cormack-Jolly-Seber models. A particularly excellent feature in this chapter is a section on maximum "eye-klihood", in which the authors illustrate how to visually appraise capture histories (rows of 0s and 1s), interpret the sequences of detections and non-detections, and thereby discern, for example, whether one population has higher or lower survival probability or capture probability than another population. Too often researchers are happy to feed their data into software without understanding the logical basis for the quantitative output produced; this exercise illuminates the 'why' behind the numerical results.

A chapter on multi-state models provides a good introduction to this topic, complete with the book's characteristic visual explanations. This chapter seemed rushed though, failing to discuss one of the model's assumptions (others were covered), and leaving terms unexplained ("less deterministic transitions from juvenile to adult"- what does this mean?). Further chapters cover robust design, occupancy modeling, double-observer methods, removal sampling, N-mixture models, and finally distance sampling. The chapter on N-mixture models, which are relatively new additions to ecology, was particularly good. However, a beginner would be frustrated by the inconsistent use of key terms in this chapter. For example, probability density function was interchangeably referred to as f(x) and P(x); and sampling replicates were variously called "visits", "surveys", and "sampling sessions". However, instances like this are uncommon in the book.

It is important that wildlife biologists do not develop the mindset of data collection and statistical modeling as the ultimate goal; this does little to advance ecological understanding or wildlife management. I was therefore happy to see, in an early chapter, the presentation of data collection and modeling as one piece of a larger process of problem diagnosis, management response, and monitoring and evaluation. The book also wisely advises the use of conceptual models (basically hypotheses about cause and effect) and urges readers to think critically about what aspects of species biology to include in a model. Ecological theory and existing empirical

knowledge might also have been mentioned, as critical reference points before embarking on modeling. The authors identify four reasons for modeling. Two of these—visualizing complex situations for learning ecology, and predicting the future—would in most cases be enhanced if the modeling were set within a framework of hypothesis testing informed by ecological theory and existing knowledge. After all, models can be regarded as hypotheses, and hypotheses are often best developed with reference to established theory and knowledge.

This book is highly recommended, even essential, for any student in ecology or wildlife science that wants to work confidently with quantitative data. It will also be useful for established researchers (at least one, anyway): this book taught me new things about modeling approaches I was already familiar with, and instilled confidence—based on a solid grounding of underlying logic—to employ other approaches I haven't yet used.

Robert Steinmetz
World Wide Fund for Nature (WWF)–Thailand
92/2 Soi Phahonyothin 5
Phahonyothin Road, Samsen Nai
Phaya Thai, Bangkok 10400
Thailand