BOOKS: ECOLOGY

Beyond the Null Hypothesis

Thomas E. Miller and Gretchen LeBuhn

It is a curious fact that scientists have yet to agree upon an appropriate "scientific method" that is accepted across, or even within, disciplines. We generate hypotheses that are frequently stated as mathematical "models" and then test these models using data collected in the field or laboratory. Such models are simply mathematical representations of the hypotheses. But testing and interpreting these models and, in particular, distinguishing among several alternative models, can be problematic and controversial. One can argue that the current diversity of approaches to testing models in basic science has strengthened rather than restricted our advancement. The variety has, however, created particular difficulties for applied science, where a set of common approaches may be more important for developing and implementing policy.

The Ecological Detective
Confronting Models with Data
by Ray Hilborn and Marc Mangel

Princeton University Press, Princeton, NJ, 1997. 334 pp., $39.50, £30. ISBN 0-691-03496-6. Paper, $19.95, £16.95. ISBN 0-691-03497-4.

Ray Hilborn and Marc Mangel's recent contribution to the "Monographs in Population Biology" series, *The Ecological Detective*, is intended as a primer on connecting models and data. The authors (professors in the University of Washington School of Fisheries, and the University of California Santa Cruz Department of Environmental Studies, respectively) address scientists who "work on practical and important problems … because real answers are needed." This interesting book is indeed a primer—not only on testing mathematical models, but also on the methods for developing and comparing alternative models. Among such methods, Hilborn and Mangel focus on likelihood and Bayesian approaches. The latter allow the probability of events to be modified on the basis of preexisting information. Although the literatures of ecology and statistics are filled with information on model testing, the use of multiple alternative models is, unfortunately, not general practice. The general concepts in this book are applicable not only to applied biologists, but to virtually any scientist who attempts to compare models to data.

The book is effectively organized; the authors paired chapters that are separate primers on techniques for constructing and interpreting models with chapters that demonstrate the application of these techniques to real-world data and problems. A chapter on probability theory is matched with one on determining how best to use observers to estimate the incidental catch of albatross in squid trawls. A chapter describing the sum of squares technique for quantifying the fit of models is joined with one using this method to distinguish among different models of oviposition behavior in parasitoid wasps. Other pairs demonstrate the application of maximum likelihood to predicting wildebeest population dynamics and of Bayesian analysis to fisheries management in southwest Africa. Following a final chapter on computer methods for determining goodness of fit, the book ends with an appendix reprinting an 1890 paper by T. C. Chamberlain on the value of multiple working hypotheses (a perspective strongly emphasized by Hilborn and Mangel).

BRUCE DAVIDSON/ANIMALS ANIMALS

Serengeti gnus. Using likelihood methods, Hilborn and Mangel explore the effects of rainfall and poaching on the population size of these wildebeest (*Conochaetes taurinus*).

Although most of the approaches addressed in *The Ecological Detective* are covered in more detail and with greater balance in other texts, the book is valuable because it presents them in a well integrated fashion. The methods are described and applied to real data and questions, and a logical and useful hierarchy of techniques for evaluating models is developed throughout the book. We were particularly pleased to see the emphasis on the use of goodness of fit to compare and evaluate the fit of models to data.

Some chapters are especially well written, but the authors' writing style is uneven. The chapters on sums of squares and on fisheries examples are clear and concise. The one on probability theory, however, attempts to cover too much and the result is a dense thicket of equations and concepts. Readers already familiar with the topic might appreciate the long review, but a novice would be lost. There are also additions that would have improved the book. Throughout the text, the reader is challenged to work out problems alone; some means for confirming the results of these exercises would be helpful. In response to comments of prepublication reviewers, the authors present only pseudocodes (outline versions of the algorithms) for computer programs that can be used in the analyses. These are useful, but a World-Wide Web address or diskette with the programs that were removed from the text would have been appreciated.

Hilborn and Magnel present a biased view of some approaches. Their example on incidental catch leaves the impression that huge, perhaps impossible, observer numbers are required for adequate estimates of the numbers of albatross caught in hauls. Yet the confidence intervals around the mean estimated catch are actually quite small (<5% of the mean), which suggests that a sufficient estimate has already been made. Furthermore, the disadvantages of some of the more elaborate methods—in particular, Bayesian inference—are not discussed.

Despite our criticisms, we feel *The Ecological Detective* is a significant contribution to ecology. For some readers, this book may change their philosophical and operational framework. For others, it will simply serve as a reminder of the importance of considering and testing alternative models. But no scientist should ignore Hilborn and Mangel's attempt to provide a general approach for exploring a complex world.

The authors are in the Department of Biological Science, Florida State University, Tallahassee, FL 32306–1100, USA. E-mail: miller@bio.fsu.edu