Book Reviews

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The Wondering-land of Ecological Modeling

Canham, Charles D., Jonathan J. Cole, and William K. Lauenroth, editors. 2003. **Models in ecosystem science.** Princeton University Press, Princeton, New Jersey. xv + 476 p. $79.50, £52.95 (cloth), ISBN: 0-691-09288-5 (alk. paper); $35.00, £22.95 (paper), ISBN: 0-691-09289-3 (alk. paper).

After about two years into my Ph.D. program at the University of California, Davis, I began wondering what exactly an ecological model does, how useful it is for advancing science, how complex a model should be, and whether it would be possible for me to make a career with the training of simulation modeling. I was assigned to work alone on a highly complex, physiologically based, plant growth model for my Ph.D. degree–a daunting task for a graduate student–for four and an half years. Since then, I have wondered about those questions and had never found satisfactory answers. The book ''Models in ecosystem science'' edited by Charles Canham, Jonathan Cole, and William Lauenroth, adeptly scrutinizes those questions. If you ever wondered about them, too, you need to read this book. In the book, a group of excellent ecologists share with you their experience of working with ecological models, their insights into various modeling issues, and their visions of future directions.

This book evolved from the ''ninth Cary Conference, held in May 2001 at the Institute of Ecosystem Studies, Millbrook, N.Y.'' It is composed of 27 contributed chapters, which are divided into five parts. The first part is six chapters long and addresses general topics of quantitative modeling in regard to its role in: science and policy making; simplicity vs. complexity; and the general attitude of and practice by ecologists. The second part of the book, consisting of eight chapters, focuses on the methods of evaluating and testing models such as traditional validation, Bayesian analysis, model intercomparison, and uncertainty analysis. Six chapters in the third part of the book discuss applications of ecosystem models to research on environmental policy and management. Of the six chapters, one gives overviewed general issues regarding the applications and the other five chapters offer case studies on N deposition, coastal eutrophication, ecological toxicology, plant invasion, and climate change. The fourth part of the book attempts to answer the question: what is the future of modeling in ecosystem science? Two chapters in this part offer practical recommendations on how to incorporate quantitative modeling into undergraduate education and how to advance modeling skills for professional ecologists. One chapter identifies bottlenecks for model development and limitations of model applications. The fifth part of the book consists of three commentaries on the fast-and-frugal ecosystem models to accelerate learning and progress in ecology, the uses of modeling and scenario building to promote communications between scientists and policy-makers, and the community-wide investment in modeling.

Many chapters in the book make a consensual point that a model is an abstraction of reality. How much abstraction should be made during development of a model, however, is a point where viewpoints diverge. Simple models are easy to build and manipulate, in general. ''[T]hrough the process of manipulation, we learn about the abstraction, the model, and relevant aspects of the world.'' Simple models have been widely used in ecosystem science for generating questions, depicting ideas, creating alternate models, evaluating patterns, describing mechanisms, making predictions, and facilitating communications to public and decision-makers (Chapter 4). However, simplicity alone should not guide modeling in ecology as argued by DeAngelis and Mooij in Chapter 5. Models must be question driven. That cannot be overstated (Chapter 6). There are successful examples of mechanistically rich models that address specific questions (Chapters 13–15, 17–21). The challenges inherent in such models are their transparency and their amenability to analysis. No matter how comprehensive a model is, it is not possible for a model to address all questions over all scales. The key step in developing an effective model is the question identification and selection.

Model evaluation and testing is still a topic of perplexity. Traditional approaches to model validation and testing against data are still essential (Chapter 10) and should be well documented in publications (Chapter 11). Other approaches that have emerged or been frequently used in the past decade or so are Bayesian analysis (Chapter 9), intercomparison of models (Chapter 12 and 13), and uncertainty analysis (Chapter 8). Multiple constraints (Chapter 14) and some physical and biological principles, such as the mass balance of nutrients (Chapter 15), are also effective in model evaluation and testing. Nonetheless, it is always a challenge for modelers to enhance our confidence in model output.

The data-model fusion has been recently applied to model evaluation and testing in ecology. Unfortunately, this technique is not included in the book. The data-model fusion is an approach that makes use of both process thinking and information contained in data towards a comprehensive synthesis of ecosystem processes. It sometimes is a synonym of inverse analysis, data assimilation, parameter estimation, and multiple constraints for synthetic research. It offers the capability of (1) estimation of model parameters or state variables, (2) uncertainty analysis on parameters and model output, (3) rejection of a model, and (4) quantitative evaluation of sampling strategies. This technique has recently been applied to ecosystem and population ecology. The data-model fusion will be an active, growing point of research in ecology in coming decades.

The book also discusses the role of models in science and decision making. Scientifically, models have been used for synthesis and integration of data (Chapter 6) and predicting the future behavior of ecosystems (Chapter 1). Our confidence in model predictions, however, is a matter of scale and spec-

ificity (Chapter 2). Modeling can productively interact with observation and experimentation. It is highly recommended by several chapters that models be used at the beginning of a research project to infer the logical outcomes that follow from the premises (Chapters 1, 6, 12, and 24). In addition, ecosystem management is a wide spread practice for almost all kinds of ecosystems and models become an effective tool in management. To be effective, the management-oriented models should be built upon the fundamental science bases, make predictions that matter, and quantify uncertainty of the forecasts as recommended by Chapter 16.

Very intriguing is the report in Chapter 3 on the general attitudes of ecologists toward and the extent of application of quantitative models. Ninety-eight percent of ecologists surveyed considered ''simulation modeling an important tool'' whereas only 15% of papers in *Ecology* and 23% in *Ecological Applications* in 1996, 1998, and 2000 ''contained some use of dynamic quantitative modeling.'' This disparity partially results from the lack of training opportunities for quantitative modeling. It is important to incorporate quantitative modeling into undergraduate education in science (Chapter 22) and develop various programs and strategies to advance quantitative modeling skills among professional ecologists (Chapter 23). The key to resolving this disparity probably hinges on changes of the current attitude of reluctance that the research community has toward funding research on the tools and techniques of modeling (Chapter 27).

Overall, this book expertly critiques various aspects of ecological modeling. Experienced modelers or experimentalists with strong interests in modeling can learn a great deal from this book. The book could provide a platform from which to begin a quest for innovation in model development, testing techniques, and applications.

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BAT MAN IN THE TROPICS: STORIES OF ONE MAN'S CAREER IN FIELD STUDIES OF BATS

Fleming, Theodore H. 2003. **A bat man in the tropics: chasing El Duende.** Organisms and Environments, 7. University of California Press, Berkeley, California. xx + 311 p. $50.00, £32.95, ISBN: 0-520-23606-8 (alk. paper).

Those of us who study bats as part of our professional careers in science are truly lucky for two reasons. First, we often travel to unique and remote locations, to spend our time catching, observing, and studying one of the most unique groups of mammals on the planet today. As a result we see and experience things that most people can just read about. Second, we are lucky because it is fun.

In his new book, *A bat man in the tropics: chasing El Duende,* Ted Fleming illustrates these points in a unique and entertaining way. This book is a collection of field experiences and stories, told by the author, over his 30-plus year career as a bat biologist. It begins in 1966 with his first exposure to bat field research on a trip to Panama and takes us through the next 30 years of work in Central America, Australia, and into Mexico, Texas, and Arizona.

In his preface, Fleming identifies the underlying themes that run throughout the book; he calls these themes ''*El Duende.*'' Translated from the Spanish, *el duende* means ''hobgoblin'' or ''ghost,'' in reference to bats, the central theme of this book. Most people know bats only as mysterious creatures of the night. As one of the most misunderstood of all animals, bats are often feared and despised. The stories that the author relates about his research subjects go a long way in dispelling these myths and demonstrate the value and role bats play in ecosystems all around the world.

But *El Duende* also refers to ''will o' the wisp'' things that delude or mislead by luring on—the author's metaphor for scientific discovery. Ted Fleming's contributions to bat biology are well known. He has published numerous papers and books on bats and has emerged as one of the best-known bat biologists in the world. This book is unique in his efforts, an autobiography of sorts. Where it offers little in the way of experiments or data, it instead gives the readers a first hand thrill of scientific discovery, and the wonders of the often hidden lives of bats.

The book is well written and entertaining. It is designed to be of interest to the student, field biologist, and lay person alike. In it Fleming does a superb job of communicating the excitement for field work and love for the creatures he studies, something all of us in the field have experienced during the course of our own careers. Most of us have experienced the euphoria of field work but we seldom get the opportunity to express it in our scientific writing. While reading the stories in this book, I often found myself reflecting back on my own field experiences, with some relish and satisfaction. Over the years many of us have heard Fleming tell one or two of these stories at conferences, often to the delight of graduate and undergraduate students. It is all the more satisfying to see them laid down in print to be shared by all.

Each of the 11 chapters introduces readers to a new location where they become acquainted with tropical nature and scientific field work. We explore the excitement and trials of living and conducting research in the field and learn a great deal about the biology of bats as keystone species. Fleming's work over the years revealed much about the role that bats play in an ecosystem and demonstrated their critical contri-