Book Reviews

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Back to basics on the cutting edge: building statistical models from the bottom up

Bolker, Benjamin M. 2008. **Ecological models and data in R.** Princeton University Press, Princeton, New Jersey. vii + 396 p. $55.00, ISBN: 978-0-691-12522-0 (alk. paper).

Key words: Bayesian analysis; deterministic models; ecological models; maximum likelihood; optimization; R; statistics

Ecological models and data in R, by Benjamin Bolker, is not your typical applied statistics book. Bolker does something quite magical. He sets out to empower ecologists to develop statistical models from the ground up, from first principles. At first blush this would suggest that the reader will spend more time on statistics than on ecology. Instead, by enabling us to build models from scratch, Bolker enables us to focus on the ecology, fitting *ecological* models using modern statistical tools, rather than spending our time cajoling our data into a form suitable for traditional parametric statistics. The end result is that, through a deep understanding of modern statistics and the power and flexibility that come from these modern methods, ecologists can focus on ecology rather than statistics.

Bolker begins with an introduction that covers modeling, statistical inference, and computing, and then proceeds to exploratory data analysis (Chapter 2). This second chapter offers the reader a nice introduction to R, a "language and environment for statistical computing and graphics." R has emerged as a powerful statistical tool, largely due to its open source framework and thus the ability for statisticians and applied users alike to write "packages" that extend R functionality into additional domains. The ecological community is one of many that has strongly embraced R.

Chapters 3–7 are the core of the book. Bolker introduces a variety of deterministic models with which to model ecological processes in Chapter 3, and then covers probability and stochastic distributions in Chapter 4. Chapter 5 introduces the reader to stochastic simulation and power analysis. Chapter 6 explains likelihood, or the probability of observing a particular model or parameter given your observed data, while Chapter 7 covers optimization, including explicit applied methods to find maximum likelihood estimates.

Throughout the text, Bolker frames his presentation through contrasts between frequentist, likelihood, and Bayesian approaches to statistical inference. In this manner Bolker provides the reader with ample opportunity to discern the advantages and disadvantages of each of these three approaches, and also the key similarities and contrasts between them. While Bolker clearly sees less utility in frequentist approaches, and the uninformative falsification of null hypotheses in particular, he successfully demonstrates the value of hypothesis testing and the added value of parameter estimation. He routinely expands the discussion to the Bayesian perspective, while highlighting the concomitant complications and potential pitfalls.

Chapter 8 brings it all together, analyzing three datasets from start to finish. Bolker's use of ecological examples definitely makes the entire approach more accessible to ecologists. However I wonder, somewhat selfishly, if perhaps examples could be drawn more widely from across the biological sciences. I intend to use *Ecological models and data in R* for a graduate class in the near future, but my audience will span the biological sciences. One of the first comments on my course proposal was that I cannot center such a class on a book with "ecology" in the title as it will put off a large segment of our graduate student body. While Bolker's methods may be honed on ecological problems, they are not inherently ecological and indeed could be applied more widely.

One aspect of *Ecological models and data in R* that I really like is that it does encourage the reader to carry out the example analyses themselves, but it does not always do all the work for them. Bolker offers snippets of code throughout the text and within R supplements at the end of the chapters. Offering the code in bite-sized chunks encourages the reader to examine the code to understand what it does, whereas longer blocks may tend to cause one's eyes to glaze over. While Bolker does offer most of the R code online (see below), the layout does not encourage students to run the scripts blindly.

One opportunity that Bolker misses in this otherwise great volume is a more careful treatment of data presentation. While Bolker does show some of the power and flexibility of R to graphically present complex data, some of the figures are difficult to interpret and should be reconceived from scratch. Other figures are simply not clear, either from too much clutter or grey lines that are indistinguishable from black. Still others lack keys or sufficient figure legends for the figures to stand on their own without digging into the text for clarification. This is a shame, as this volume is quite focused on scientific clarity, and the pursuit of clear and realistic models of ecological phenomena. To present the results with these flaws diminishes the volume and does a disservice to the considerable power of R's graphics capabilities. I am sure that these minor flaws will be addressed in future volumes.

Bolker wraps it up with a review of traditional parametric statistics (Chapter 9), an introduction to incorporating multiple sources of variability, including mixed and hierarchical models analyzed with both likelihood and Bayesian methods (Chapter 10), and a short introduction to modeling dynamic processes (Chapter 11).

These three final chapters go a long way towards offering the reader further guidance for dealing with more complicated ecological processes, data, and models. However, Chapter 10 must leave both the author and the reader wanting more. Multilevel data are ubiquitous in ecology, and Bolker himself states that they are "clearly the wave of the future in ecological statistics." If multilevel models and Bayesian analysis are truly the future for applied statistics in ecology, Bolker may well want to tailor his text further with this goal in mind. Resources do exist for readers to dig deeper into multilevel models, including Clark (Clark, James. 2007. Models for ecological data: an introduction. Princeton University Press, Princeton, New Jersey) and Gelman and Hill (Gelman, Andrew, and Jennifer Hill. 2006. Data analysis using regression and multilevel hierarchical models. Cambridge University Press, New York). Clark is explicitly ecological, while Gelman and Hill is not. Ultimately I wonder whether Bolker's effort here will serve as an introduction for ecologists to these more advanced texts, or whether Bolker will take the reader there himself in future editions.

In any case, Bolker will have his work cut out for himself. This volume taps into the cutting edge of applied statistics and as such we can expect that *Ecological models and data in R* will quickly become out-dated and obsolete. And I have to say this is a good thing, as it means that our statistical toolkit will continue to grow and become more powerful. Fortunately, *Ecological models and data in R* is supported by a webpage ⟨http://www.zoology.ufl.edu/bolker/emdbook/⟩ and a wiki ⟨http://emdbolker.wikidot.com/⟩. As such, this is clearly a living and evolving work, and the reader will benefit from a familiarization with these additional resources. Bolker will have much to do to keep the new editions flowing, and I am sure that he will do so. Statistics is an evolving science, and ecologists will benefit greatly from a book that can evolve with it, enabling more ecologists to build their own statistical models with the freshest statistical ideas around.

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Serengeti: people as part of ecology

Sinclair, A. R. E., Craig Packer, Simon A. R. Mduma, and John M. Fryxell, editors. 2008. **Serengeti III: human impacts on ecosystem dynamics.** The University of Chicago Press, Chicago, Illinois. x + 522 p. $125.00 (cloth), ISBN: 978-0-226-76033-9 (alk. paper); $45.00 (paper), ISBN: 978-0-226-76034-6 (alk. paper).

Key words: community-based conservation; human–wildlife conflict; Serengeti; wildebeest migration.

The thought of the Serengeti calls forth images of endless plains, broken only by the occasional *Acacia* or the large migratory herd of wildebeest. This land captures the imagination, and those who have seen the vast expanse and the unending abundance can never forget it. Perhaps this is why few ecosystems have been studied as comprehensively as the Serengeti–Mara System. However, as much as our imagination might desire it to be, we are beginning to realize that the land does not go on forever and that even this vast ecosystem is limited. Conservation, especially in developing countries, must enhance human welfare and reduce poverty. Conservation and ecological integrity are no longer enough; protected areas must provide economic and social benefits.

This book is not the standard compilation of research on a given ecosystem. General knowledge of the ecosystem was covered in *Serengeti* and *Serengeti II*. Nor is this book merely an update on the research being done. Instead, this book takes on a whole new direction, focusing on human impacts. If you want to know how grazing affects plant community composition or how fire affects herbivore distributions, read books one and two of the series. Book three will challenge the way you think of ecology and change the context in which you place natural ecosystems. This book is about humans. The fate of the Serengeti rests largely in the hands of humankind. The authors recognize this fact and develop a fully integrated research program that links socioeconomic research on human activities and human decision making with ecological research.

The early chapters serve as an introduction to the system by summarizing the climatic and ecological factors that dominate the area and by providing an ecological history. The book details the major phases of human activity in the Serengeti system, tracing the development of early humans as foragers when humans were still subordinate carnivores, through the development of pastoralism and agriculture, to commercialization and urbanization where humans are more decoupled from ecological events than ever before. The authors note that trends in rainfall and soil fertility not only affect wildlife distributions but affect the distribution of people and their land use choices.

The middle chapters focus on key ecological research topics of the last decade. Chapter 5 explores the patterns of heterogeneity in the Serengeti system and identifies processes that maintain this heterogeneity. Chapter 6 deals with climate change and how elevated CO_2, changes in rainfall and temperature, and increased nitrogen deposition will affect plant communities and food web structure as well as human welfare. Chapters 7, 8, and 9 touch on infectious disease, how food webs vary in structure through space and time, and why the grazer community is so exceptionally species rich. Although these chapters focus on changes to the natural system, every chapter considers human impacts, human responses, or effects of ecosystem changes on human welfare. Rarely a section goes by that we are not reminded of the sea of humanity in which this ecological island resides.

Chapter 10 introduces a model that integrates the consequences of human decision making on ecosystem processes. This model is then used throughout the next three chapters to predict possible futures for the Serengeti system under different climatic and socioeconomic scenarios. Chapter 11 looks in detail at human welfare and how it will change under two scenarios: increased climatic variability or altered market conditions in terms of prices of bush meat and crops. Chapter 12 examines how national and international policy and economics affect the Serengeti, while Chapter 13 looks at land use economics. The final chapters seem a hodgepodge of topics, discussing the usefulness of current ecological theories for predicting complex ecosystem dynamics (14), the financing of the Serengeti system (15), and community-based conservation (16).

Overall, the chapters relate well to each other and the book flows easily. The authors integrate the chapters well and yet the information is not repetitive. The chapters dealing with the models are laden with equations, making the read a bit more difficult, but the authors do an excellent job of walking the reader through the model-building process and making it clear what parameters are being used. The model introduced in Chapter 10, which integrates human decision-making and ecosystem processes, is an interesting exercise; however, I wonder at its applicability. The authors themselves admit that they lack the socioeconomic data needed to parameterize the model. Therefore, the conclusions drawn from the model simulations must not be taken too seriously.

Ecologists interested in conservation will find this book to be a good addition to their library, useful primarily for its focus on the integration of humans into ecosystem dynamics. The authors rightfully point out that human history has shaped and has been shaped by the natural system. We are not separate from the system but instead play an integral role. Humans, all of us—scientists, tourists, poachers, and farmers—control the fate of the Serengeti system, and it's time we integrate humans into ecological thought, development, and theory. Conservation areas do not exist in a vacuum, but are set within a social, economic, environmental, and political framework. Yet for most of the 20th century, conserved areas were managed as distinct units, completely separate from the surrounding landscapes. This book challenges the paradigm of fortress conservation, and uses the Serengeti system as an experiment in community-based conservation. The conservation of biological diversity depends not on keeping people out, but on getting people involved. The Serengeti system and the authors of this book serve as models for protected areas and scientists world wide, for we all must integrate human welfare into our work if we desire to make a positive sustainable impact.

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Learning R the practical way

Soetaert, Karline, and Peter M. J. Herman. 2009. **A practical guide to ecological modelling: using R as a simulation platform.** Springer, New York. xv + 372 p. $109.00, ISBN: 978-1-4020-8623-6 (acid-free paper).

Key words: advection-diffusion; ecological modelling; ordinary differential equations; population dynamics; R statistical software.

When I started graduate school, a young faculty member in my department strongly encouraged me to start working with R. Seven years later, I can say this was one of the best pieces of advice I have ever received, as in the meantime R has become perhaps the most popular software for ecological analysis. R was launched in 1997 as a statistical scripting language, but soon became a much larger project. R is in fact an easily extensible programming language, and users can contribute to it through packages that are freely available for anyone to download and use (there are currently more than 1700 packages, twenty of which are explicitly ecological). Also, users can write code in C and FORTRAN and easily wrap it in an R package. Finally, R is free software, and can be installed on virtually any architecture and operating system. Thanks to these characteristics, there are now many R packages for analyzing ecological data and more and more ecologists use R for research and teaching. Teaching with R can be a little challenging, as students in ecology are usually not familiar with the command-line style used by the program. A good teacher would therefore use R as a tool rather than a goal, and use R capabilities for simulations and statistics on ecological data.

This is what Soetaert and Herman do in their book, which covers basic ecological modelling using R as a simulation platform. The book is aimed at advanced undergraduates and early graduate students, starting from the definition of a model and moving to the implementation of models for aquatic ecosystems, model selection, and refined numerical simulations.

The book can be a valuable path to learning R while studying ecological modelling, as it contains excellent and extremely well-explained R code in all the chapters. Another excellent feature of the book is that all of the 125 (and mostly beautiful) figures have been provided as an R package. This means that interested students and teachers can readily reproduce, modify and experiment with all the examples in the book. The associated website (on www.springer.com) also contains an introduction to R written by Soetaert and the code presented in the book. The strength of the book lies in the straightforward approach to mathematical modelling and theoretical ecology: the mathematics are kept to a bare minimum, each concept is immediately applied to real-world problems, and each chapter contains several "projects" that students can pursue to get a deeper understanding and experience a "hands-on" approach to ecological models. Also, the necessary code is basically reproduced verbatim, making it easier for the students to move from equations to simulations and back.

The book tries to cover a lot of ground, and necessarily the choice of topics reflects the interests of the authors more than a general trend in the discipline. The focus is definitely on simple models for aquatic systems (chemical, physical, phytoplankton-zooplankton, and advection-diffusion are the most fully explored models). Most of the modelling is based on ordinary differential equations and their numerical solution, while little space is dedicated to the vast literature that makes use of different techniques. Two further chapters are dedicated to simple discrete time models and dynamic programming, and one final chapter explains how to validate and test alternative models.

The weak points of the book are the flip side of its strengths: because the mathematics are kept as simple as possible, some passages may be obscure to students as some intermediate passages are lacking, or the authors make a verbal argument rather than offering an analytical derivation. The "practical" approach constrains the authors to introducing only techniques that have immediate applications (for example chaos, which generated thousands of papers in ecology, is relegated to one paragraph showing the Lorenz butterfly). The analytical side of each problem is largely left out, so I would not suggest this book for a theoretical ecology course.

The book can be compared with Bolker's recent book (Bolker, Benjamin M. 2008. Ecological models and data in R. Princeton University Press, Princeton, New Jersey), which is much longer, more complete and definitely oriented toward learning R, and Roughgarden's book (Roughgarden, Jonathan. 1998. Primer of ecological theory. Prentice Hall, Upper Saddle River, New Jersey), which is a more rigorous introduction to theoretical ecology using MATLAB.

In summary, I praise the combination of book plus freely available code, and I think that freely available figures, data, and examples should be standard for all textbooks (the ideal being to have books freely available for individual users). The book does not cover all of ecological modelling (an impossible task), and is targeted at the application of simple models for aquatic systems. I would recommend the use of the book especially for an introductory modeling class for early graduate students in ecology and other disciplines (chemistry, physics, etc.) that share a common boundary with ecology.

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Ecological models of mutualism, exemplified by interactions between ants and myrmecophiles

Stadler, Bernhard, and Anthony F. G. Dixon. 2008. **Mutualism: ants and their insect partners.** Cambridge University Press, New York. viii + 219 p. $110.00, ISBN: 978-0-521-86035-2.

Key words: ants; aphids; mutualism; myrmecophiles; species interactions.

Don't let the book's title fool you: this book is much more about mutualism theory than it is about interactions between ants and myrmecophilous (i.e., "ant-loving") insects. The goal of *Mutualism: ants and their insect partners* is not really to review the natural history of ant-myrmecophile associations, but instead to explore current ideas about the ecology of mutualism and to illustrate these ideas with examples drawn from the literature on ants and myrmecophilous insects (i.e., aphids, treehoppers, scale insects, and lycaenid butterflies).

The book begins by discussing some of the major conceptual issues associated with mutualistic interactions among species (in Chapters 1 to 3). Like others before them, the authors argue that in comparison to competitive and trophic interactions, the study of mutualism has been neglected by ecologists. However, they also recognize that many important advances have been made in this area in the last few decades. In particular, it has become increasingly evident that mutualisms are common and integral parts of all natural communities and, as such, that we stand to gain considerable insight from ecological models that incorporate mutualisms. Stadler and Dixon take the view that all interactions among species fall somewhere along a continuum between mutualism and antagonism, and that this outcome varies in space and time and depends on the community in which the interactions are embedded. Many of the core arguments of this book are presented in Chapter 3, in which the authors first review the main theories relating to the evolution of mutualism and then discuss life history, population dynamic, and metapopulation models that deal with mutualisms. In this chapter, Stadler and Dixon emphasize density-dependent processes at work in mutualistic interactions; I share their view that more research is needed to understand how population density affects the costs and benefits of mutualism and consequently the population dynamics of mutualistic species.

In Chapters 4 and 5, which represent the middle section of the book, the authors draw on empirical studies of mutualisms between ants and myrmecophilous insects to exemplify the general arguments put forward in the previous conceptual chapters. Ants form mutualistic associations with the larval and/or adult stages of many Hemiptera and Lepidoptera, including species of aphids, membracids, coccids, and lycaenids. These are "food-for-protection" mutualisms, in which the hemipterans or lepidopterans provide the ants with nutritious rewards (i.e., honeydew) and, in return, the ants protect them against their natural enemies. The second author of this volume, Tony Dixon, has spent a career studying the biology of aphids, and brings to this review a mature and exhaustively thorough perspective on associations between aphids and ants. Generally speaking, relationships between ants and myrmecophilous insects have been well studied since they are typically systems that can be easily manipulated in experiments that tease apart costs and benefits. Moreover, many features of ant-myrmecophile mutualisms are common to most mutualisms; for example, they vary from facultative to obligate, they may be generalized or highly species-specific, and they are affected by local abiotic and biotic conditions. The authors' goal in describing in detail empirical studies of the costs and benefits, population dynamics, and conditionality of ant-myrmecophile mutualisms is to extrapolate from these systems to mutualisms in general.

One of this book's strengths is that Stadler and Dixon discuss not only the life history and population-level consequences of mutualism, but also the effects of mutualism at metapopulation, community, and metacommunity scales. They begin Chapter 6 by asking the question: how are ant-myrmecophile mutualisms influenced by top-down and bottom-up forces in the local community? Clearly, predation pressure and other top-down effects have an impact on ant-myrmecophile interactions, because when predators and other enemies of hemipterans and lepidopterans are scarce, these insects have little need for ants. Similarly, ant-myrmecophile mutualisms can be influenced by many bottom-up forces, including the nutritional quality, spatial distribution, and defenses of plants fed on by myrmecophilous insects. Stadler and Dixon also introduce the concept of "metamutualism" in this chapter, and although, oddly, they never define the term explicitly, I took it to mean a set of populations interacting as mutualists at the local scale and linked via dispersal at the regional scale. As the authors themselves point out, their metamutualism concept has much in common with Thompson's idea of a "geographic mosaic" (Thompson, John N. 2005. *The geographic mosaic of coevolution*. The University of Chicago Press, Chicago, Illinois), except that the latter also applies to antagonistic interactions. While the idea may not be entirely new, the authors have captured the emphasis and direction of current research into mutualism, as ecologists work to remedy the "clear shortage of studies that address the community- [and higher] level effects of mutualistic associations."

The scope of this book is extremely broad, but the book itself is only a slim 183 pages of text. For a review of its size, it is packed with information, including scores of bibliographic citations and numerous figures reproduced from the primary literature. Inevitably, however, the authors sacrifice depth for breadth, and thus some topics, like the connection between metamutualism and geographic mosaic theory, are discussed only cursorily. Perhaps as a means of being more efficient, the authors rely quite heavily on ecological jargon and write in a condensed and occasionally convoluted manner. (Take for example the following sentence: "Now, considering the ant-plant defence system via EFNs and the ant-homopteran-lycaenid/nectar production system gives an interesting meta-mutualism configuration in which two separate mutualistic interactions meet and might change the strategies and affect the evolution of the partners of ants.") Given the book's astonishingly high price ($110 and not a single color photo or figure), students are unlikely to be able to afford to purchase this book. But for researchers who are active in this area, a new book on the ecology of mutualism has been long overdue. The last comprehensive treatment of the subject was published over twenty years ago in an edited volume (Boucher, Douglas H., editor. 1985. *The biology of mutualism: ecology and evolution*. Oxford University Press, New York). So even though *Mutualism: ants and their insect partners* is more of a sketch than a masterpiece, it is nonetheless a timely and relevant contribution to the field.

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Spotlight

Recent Publications of Particular Interest

Brodowsky, Pamela K. 2009. **Destination wildlife: an international site-by-site guide to the best places to experience endangered, rare, and fascinating animals and their habitats.** Penguin Group, New York. xiv + 384 p. $20.00, ISBN: 978-0-399-53486-7. All readers of *Ecology* are likely to love seeing rarely encountered wildlife. This book describes more than 200 sites with interesting wildlife from North and South America, Africa, Europe, Asia, and Australia. Each site description is about two pages long and contains details such as hours of operation, contact information, best times to visit, and tips to make your visit comfortable.

Heinrich, Bernd. 2009. **Summer world: a season of bounty.** HarperCollins, New York. 253 p. $26.99, ISBN: 978-0-06-074217-1. Another Heinrich book is always worth investigating. This one provides tales of adaptations of animals to surviving and reproducing in spring and summer, including wood frogs, bald-faced hornets, hummingbirds, and mosses and lichens.

Books and Monographs Received Through March 2009

Angilletta, Michael J., Jr. 2009. **Thermal adaptation: a theoretical and empirical synthesis.** Oxford University Press, New York. xii + 289 p. $135.00 (cloth), ISBN: 978-0-19-857087-5 (acid-free paper); $65.00 (paper), ISBN: 978-0-19-857088-2 (acid-free paper).

Brodowsky, Pamela K. 2009. **Destination wildlife: an international site-by-site guide to the best places to experience endangered, rare, and fascinating animals and their habitats.** Penguin Group, New York. xiv + 384 p. $20.00, ISBN: 978-0-399-53486-7.

Butlin, Roger K., Jon Bridle, and Dolph Schluter, editors. 2009. **Speciation and patterns of diversity.** Cambridge University Press, New York. x + 333 p. $140.00 (cloth), ISBN: 978-0-521-88318-4; $65.00 (paper), ISBN: 978-0-521-70963-7.

Culver, David C., and Tanja Pipan. 2009. **The biology of caves and other subterranean habitats.** The Biology of Habitats Series. Oxford University Press, New York. xv + 254 p. $120.00 (cloth), ISBN: 978-0-19-921992-6 (acid-free paper); $60.00 (paper), ISBN: 978-0-19-921993-3 (acid-free paper).

Davis, Mark A. 2009. **Invasion biology.** Oxford University Press, New York. xiv + 243 p. $120.00 (cloth), ISBN: 978-0-19-921875-2 (acid-free paper); $55.00 (paper), ISBN: 978-0-19-921876-9 (acid-free paper).

Faldet, David S. 2009. **Oneota flow: the Upper Iowa River and its people.** American Land and Life Series. University of Iowa Press, Iowa City, Iowa. xi + 238 p. $27.50, ISBN: 978-1-58729-780-9 (acid-free paper).

Garrott, Robert A., P. J. White, and Fred G. R. Watson, editors. 2009. **The ecology of large mammals in central Yellowstone: sixteen years of integrated field studies.** Terrestrial Ecology Series. Volume 3. Elsevier, Burlington, Massachusetts. xvii + 693 p. $99.95, ISBN: 978-0-12-374174-5.

Heinrich, Bernd. 2009. **Summer world: a season of bounty.** HarperCollins, New York. 253 p. $26.99, ISBN: 978-0-06-074217-1.

Heintzenberg, Jost, and Robert J. Charlson, editors. 2009. **Clouds in the perturbed climate system: their relationship to energy balance, atmospheric dynamics, and precipitation.** The MIT Press, Cambridge, Massachusetts. xv + 597 p. $40.00, ISBN: 978-0-262-01287-4 (alk. paper).

König, Claus, and Friedhelm Weick. 2008. **Owls of the world.** Second edition. Yale University Press, New Haven, Connecticut. 528 p. $75.00, ISBN: 978-0-300-14227-3 (alk. paper).

Nemerow, Nelson L., Franklin J. Agardy, Patrick Sullivan, and Joseph A. Salvato. 2009. **Environmental health and safety for municipal infrastructure, land use and planning, and industry.** Environmental Engineering. Sixth edition. Wiley and Sons, Hoboken, New Jersey. xix + 556 p. $125.00, ISBN: 978-0-470-08305-5.

Sherratt, Thomas N., and David M. Wilkinson. 2009. **Big questions in ecology and evolution.** Oxford University Press, New York. xi + 297 p. $99.00 (cloth), ISBN: 978-0-19-954860-6 (acid-free paper); $45.00 (paper), ISBN: 978-0-19-954861-3 (acid-free paper).

Turvey, Samuel. 2008. **Witness to extinction: how we failed to save the Yangtze River dolphin.** Oxford University Press, New York. xii + 234 p. $29.95, ISBN: 978-0-19-954947-4 (acid-free paper).

Villard, Marc-André, and Bengt Gunnar Jonsson, editors. 2009. **Setting conservation targets for managed forest landscapes.** Conservation Biology 16. Cambridge University Press, New York. xii + 411 p. $140.00 (cloth), ISBN: 978-0-521-87709-1; $70.00 (paper), ISBN: 978-0-521-70072-6.

Zonn, Igor S., Michael H. Glantz, Andrey G. Kostianoy, and Aleksey N. Kosarev. 2009. **The Aral Sea encyclopedia.** Springer, New York. viii + 290 p. $159.00, ISBN: 978-3-540-85086-1 (acid-free paper).

Zuur, Alain F., Elena N. Ieno, Neil J. Walker, Anatoly A. Saveliev, and Graham M. Smith. 2009. **Mixed effects models and extensions in ecology with R.** Statistics for Biology and Health. Springer, New York. xxii + 574 p. $84.95, ISBN: 978-0-387-87457-9 (acid-free paper).