Complex Population Dynamics: A Theoretical/Empirical Synthesis. PETER TURCHIN. Princeton Monographs in Population Biology, Princeton, NJ, 2003, xvii + 450 pp. (ISBN 0-691-09021-1 pbk, $29.95).

If you asked ecologists about the state-of-the-art in population ecology, I suspect that many would have a difficult time telling you what it is, and what the major advances have been during the last decade. A reason for this difficulty is that the contributions lie in several sprawling fields, such as mathematics, statistics and empirical ecology, and few of us follow all of these literatures. However, these fields have been slowly converging to yield significant new insights into population dynamic mechanisms and population ecology. In this remarkable book, Peter Turchin suggests a brave new synthesis for temporal population dynamics. The author argues that a combination of these three approaches, mathematical modeling, time series analysis and empirical evaluation are essential to making progress in understanding temporal population dynamics. The book comes as a breath of fresh air on a topic that has (in my opinion) remained stagnant for too long. The volume merits attention because of the clarity it brings to a difficult subject and the broad audience to which it will be accessible. The author's enthusiasm for his subject is evident in the writing throughout the book.

In this volume, ''complex population dynamics'' are those temporal population changes that are bounded and result from something other than a monotonic approach to a stable equilibrium (which could be termed simple dynamics). Typically such dynamics include oscillations and chaos that are produced by some combination of exogenous and endogenous stochastic and/or deterministic factors. The book includes an excellent general review of population dynamics because we cannot reasonably consider complex dynamics without building on simple dynamics. The book does not consider spatial dynamics, only temporal dynamics, which keeps it tightly focused. Throughout the book, terms are carefully defined and a helpful glossary is also provided.

The book is arranged into three major sections: theory, data and case studies. The theory section provides an overview of modeling philosophy, model formalisms and the parallels between different classes of population model, spanning single species, two- or three-species, and considering a broad range of types of species interactions. The parallels drawn are both in structure of the models, and hence population dynamic mechanisms, and in the emergent dynamics, which are grouped by order of the processes that produce them. In the context of this book, ''order'' is the number of lags required to reproduce a given set of dynamics. The section ends with a discussion of chaos and stochasticity. The theory section is notable because it discusses far more kinds of models and ecological situations than standard ecology texts. For example, the section on trophic interaction models evaluates and discusses eleven different forms of predator functional response, and includes models of various kinds of plants and grazers, where partial organisms are consumed, having large effects on plant population growth. We are kept amused and made to question our own views during the journey by discussions, such as whether there are any laws in population ecology, and by the author drawing parallels between population biology and the Newtonian laws of mechanics.

The ''data'' section of the book provides an overview of modern techniques for fitting models to data, including a chapter on time series tools, and information on model selection and forecasting techniques. This is the shortest section of the book and provides a well thought-out summary of these topics. The third section, ''case studies'' provides six detailed evaluations of the nature of the complex dynamics in empirical systems, the gains in understanding about the causes of complex dynamics, and refreshingly open evaluations of the limits of the model-fitting approach. The examples chosen represent a mixture of classic complex population dynamic systems, such as hare and lynx, larch budmoths, and other well-studied systems, such as the southern pine beetle. The examples are notable in the thoroughness with which they have been evaluated, a marked contrast with some other books on population dynamics within the last 15 years.

So what is this new synthesis alluded to above and what does this book conclude? In my view the book makes three major academic contributions: Turchin demonstrates that complex dynamics can be caused by rather simple mechanisms by reviewing a wide range of models and applying these to selected empirical examples; the precise application of these models to natural systems provides empirical evidence for likely dynamical mechanisms that is missing from earlier modeling work, such as the seminal work of Robert May. Secondly, he shows that models with trophic interactions are often the best fitting models in empirical cases studies, suggesting that endogenous dynamics might be rejected as causes of complex dynamics in most cases. Thirdly, the book clarifies ways in which stochastic exogenous variation and endogenous dynamics can interact to blur the distinction between different kinds of complex dynamics. These are, in my opinion, the highlights, but the book offers a great deal of other insights along the way, making it a good read for any ecologist.

The book is aimed at researchers and graduate students. I think the book is particularly appropriate for those who have a basic understanding of common one- and two-species models, and who want either a more in-depth understanding, or an update on what has been achieved within the last decade. The explanations are generally excellent, with only some of the case studies and the discussion of the concepts behind chaos and stochasticity (Chapter 5) being more challenging. This is a remarkable achievement for a topic that has the potential to appear so difficult.

The book is well placed among other volumes in the Monographs in Population Biology series and, in my mind, belongs on a bookshelf alongside population dynamics volumes such as those of Robert May and Mike Hassell. Turchin will guide us in taking a new look at apparently complex dynamics and in using the modern tools available to us to demystify them.

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