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Review: Quantitative ecology: spatial and temporal scaling

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Scaling Ecological Quantities

Schneider, David C. 1994. **Quantitative ecology: spatial and temporal scaling.** Academic Press, San Diego, California. xv + 395 p. $49.95, ISBN: 12-627860-1.

This book takes a very different approach to quantitative ecology than is customary. Unlike other books with titles containing "quantitative ecology" or "statistical ecology," this is not a book of statistical techniques for species diversity measures, ordination, or spatial analysis. Quantitative ecology is defined here as "the use of scaled quantities in understanding ecological patterns and processes." The thesis of this book is that the units (e.g., number/km) used to describe ecological quantities are important, because the choice of units implies a specific spatial and temporal scaling. This concept is explored in fourteen chapters. Two chapters introduce scaled quantities and their use in multi-scale analysis. Four chapters then define different aspects of scaled quantities, including converting between spatial or temporal scales. The concept of scope is introduced as a description of the scale of either a set of measurements or a theory. Six chapters then discuss various operations on scaled quantities, including rates of change, fluxes, averages, and deviances. Two concluding chapters discuss allometric and spatial rescaling. Throughout the book, the author emphasizes the need for consistent notation, explicit units, and biological interpretation of quantities.

The book is written for upper-level undergraduate and first year graduate students, but the concepts in it should be of interest to all ecologists. The mathematics are deliberately kept simple, with an emphasis on concepts and understanding, not formalism.

This book suggests some intriguing new approaches to quantitative reasoning. I especially liked the discussions of fractal scaling and spectral densities, which are explained using simple mathematics. There is a strong emphasis on analysis at multiple spatial or temporal scales, including a comparison of methods to transfer results between scales. However, wavelets, a new technique for multi-scale analysis, are not mentioned. There is a very useful discussion of formal (i.e., mathematical equations), verbal, and graphical models.

There is also a good presentation of dimensional analysis, a tool that should be used more frequently in ecological thinking. Range expansion of sea otters, is presented as an example of dimensional reasoning. Dimensional analysis is used to reparameterize population sizes, birth rates, death rates, spacing among individuals, and length of occupied coastline into new quantities of otter lifetimes, departure rates, death rates, occupancy, and coastline length. Unfortunately, the example stops after deriving the new units. It is hard to evaluate their merits because they were not used in a model of range expansion.

There are a number of inconsistencies in the book, which is especially surprising for a book that emphasizes using consistent and precise notation. For example, the author makes a distinction between sums by superposition and sums by juxtaposition. These are two different ways of combining information from multiple samples. Operationally, one is the usual sum and the other is the mean, but the author uses the same symbol, Σ, for both. Another example is the discussion of proportional changes and per-capita rates. An equation that is given violates the author's rules for operations on units. The problem is that an equation that is correct for $\Delta t = 1$ is used for $\Delta t = 19$, 345, and 364 days.

Sometimes Schneider's recommendations conflict with traditional statistical understanding. The discussion of surveys and their uncertainty emphasizes the magnification factor, the size of the entire population divided by the total size of samples. However, in most cases, the size of the entire population has no influence on the uncertainty of sample estimates. Another example is the claim that the "calculator formula" to compute a variance is more accurate and less subject to round-off error than other formulas. The numerical example is extremely misleading.

I was very excited as I started to read this book, because it presents quantitative thinking about ecological problems in a novel way. There are some very useful concepts here, but I suggest that you evaluate the details carefully.

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Ecology of Reptiles

Vitt, Laurie J., and Eric R. Pianka (eds.). 1994. **Lizard ecology: historical and experimental perspectives.** Princeton University Press, Princeton, New Jersey. xii + 403 p. $39.50, ISBN: 0-691-03649-7.

This book is the third in a series of published symposia on the topic of lizard ecology, and it continues the traditions of timeliness, breadth of subjects covered (by leading researchers in each subject), ideas for future research, and high quality of the writing, organization, editing, and printing. Its four sections include 14 chapters by 20 authors and cover the currently popular and active subjects of reproductive ecology, behavioral ecology, evolutionary ecology, and population and community ecology. Each section is introduced by a "major player" in that area, but unlike the two preceding books, no participant discussion or concluding sections are included, and indices for authors and species but not for subjects are given.

Exciting concepts in the area of reproductive ecology in-