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Book Review: Research Techniques in Animal Ecology: Controversies and Consequences

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Research Techniques in Animal Ecology: Controversies and Consequences. Edited by Luigi Boitani and Todd K. Fuller. Columbia University Press, New York, USA. 2000. xxxii + 442 pp., index. $75.00, ISBN 0231113404 (cloth); $32.00, ISBN 0231113412 (paper).

This edited volume covers a number of techniques widely used in animal ecology. It is intended not so much as a handbook, though, as a critique. Authors of each chapter present an overview of the techniques pertinent to the topic of that chapter, then point out weaknesses and strengths of those techniques. This book is the result of a workshop held in Sicily in late 1996, which involved a small group of scientists and a limited audience of 75. The authors, noted European and North American scientists, have clearly expended the effort to synthesize a lot of information for the reader.

In Chapter 1, Charles Krebs addresses hypothesis testing in ecology and gives 7 recommendations. While some are so basic as to seem almost trite ("Articulate a clear hypothesis"), others are refreshing, such as to postulate multiple working hypotheses. He concludes with an admonition for scientists to address significant problems and not waste one's career on trivial issues.

The second chapter, by Dennis L. Murray and Mark R. Fuller, reviews the effects of marking on the biology of vertebrates. The organization is by taxon, so that someone interested in, birds, for example, can find the relevant material in close proximity. The authors note several weaknesses characteristic of many evaluations of marker effects. Among these are the lack of suitable controls to contrast with marked animals, small sample sizes, and subjective assessments of effects. The extensive bibliography will be valuable to readers interested in further details.

Roger A. Powell discusses territories, home ranges, and estimators of home range in Chapter 3. The comparison of various estimators of home ranges is valuable, as is the author's recommendation of kernel estimators. The statement (p. 91) that the mean equals the variance of a uniform random distribution, is incorrect (R. A. Powell, personal communication). I suspect Powell meant that if use of an area was totally at random and homogeneous, a Poisson distribution of counts might ensue, for which the mean equals the variance. But that distribution is not uniform, and a uniform distribution would likely have a smaller variance than mean.

Chapter 4, by David Garshelis, treats use, selection, and importance of habitat. Garshelis is careful in defining terms, which sets the stage for a clear exposition. He distinguishes 3 kinds of designs for inferring habitat quality: (1) use-availability designs, which compare the proportion of time spent in a habitat type to the relative area of that type; (2) site-attribute designs, which contrast features of sites used by an animal from

those of random or unused sites; and (3) demographic designs, which attempt to compare the density, survival, and reproduction of animals in different habitat types. He reviews many of the methods used for each kind of design. Further, he outlines a couple of fatal flaws of assessing habitat selection. The first flaw is the assumption that the more a habitat is used, the more important it is to the animal. The second flaw is that habitat selection may not reflect the true quality of that habitat as it influences the animal's fitness. These are important considerations indeed.

John Litvaitis reviews methods of studying food habits of terrestrial vertebrates in Chapter 5. He presents the advantages and disadvantages associated with standard methods, including direct observation of feeding animals, either wild animals or tame, hand-reared animals; surveys of feeding sites; use of exclosures; and fecal or gastrointestinal samples. He also reviews some issues dealing with use, selection, and preference, analogous to what Garshelis does for habitats. Litvaitis suggests that food habits are better understood in the context of foraging theory. He emphasizes mammalian species, which I suspect is not so much the author's personal bias as a reflection of the work that has been done.

In Chapter 6, Joseph Elkinton discusses how the dynamics of population systems can be understood from information on densities of animals. Stability of populations and causes of population change are major topics here. Elkinton presents many of the statistical tests that have been employed to determine whether populations are density-dependent. Likewise, he discusses key-factor analysis and its limitations.

In Chapter 7, James Gibbs presents a perspective on monitoring populations, certainly a key current issue. He identifies the 2 basic questions about monitoring programs. First, do indices of population abundance truly track changes in the actual population? Second, do monitoring designs have sufficient statistical power to reliably detect real change? Too often the answers to both question are No. Sometimes Gibbs concludes that relations between indices and animal populations differed by area, based on visual comparisons that I found unpersuasive (e.g., Fig. 7.2a versus 7.2b). He argues that indices should have a 1:1 correspondence with abundance to be most reliable, but I wonder why; a *consistent* relation is important, and could be put into a 1:1 relation by a suitable transformation. Wisely, Gibbs notes that survey programs are often initiated at sites with abundant populations where any cyclicity in counts will tend to result in an evident population decline (see also Johnson and Larson 1994). He also points out that software used to determine adequate sample sizes for monitoring programs is critically dependent on the assumption that any trends in population are fixed and linear. Since most population fluctuations are irregular, the routine application of such software seems ill-advised. A long appendix provides coefficients of variation of counts for a large number of time series of numerous taxa.

Mark Boyce attempts in Chapter 8 to cover predator–prey systems, clearly a topic too large for a single chapter. Nonetheless, Boyce presents several approaches, providing the reader with both recent entry into the vast literature and the insight of a seasoned practitioner. He briefly describes a number of models, noting that none actually can be correct, but any can be useful as an aid to understanding. His notion that components of a model should not be eliminated simply because statistical tests of those components are not "significant" is thought-provoking. Field data are nearly always too meager to support the complex models that likely reflect the true situation. He suggests that such model simplification is done at the behest of statisticians, but as a statistician myself, I disagree. I suspect that a Bayesian approach, with a prior belief that a particular component truly belongs in a model, would yield results more compatible with his thinking.

Gary White follows with an excellent presentation on population viability analysis, a technique that endeavors to estimate the probability that a particular population will persist for a certain period, such as 100 years. He notes that virtually all such efforts to date are nearly useless, due to any of several problems. Insufficient data are a common and obvious deficiency. Another problem is confusion between process variation (variation in a true parameter, such as survival rate) and sampling variation (variance associated with statistical estimation from a sample). Other problems arise because estimates of temporal variation in parameters and individual heterogeneity are usually lacking. White succinctly explains different kinds of variation, such as stochastic, demographic, temporal, spatial, individual, and sampling. He has little use for population projection matrices (Leslie matrices) for conducting population viability analysis; making such matrices realistic enough to be useful all but eradicates their analytic charm. White notes

(p. 324) that population viability analysis "can be viewed as a heuristic tool to explore the dynamics of an endangered population but not as a predictive tool." He offers the intriguing suggestion to use well-known species, possibly game species, as surrogates for species too uncommon to provide useful estimates of critical parameters. He does not recommend using actual *rates* of survival and recruitment as surrogates, but rather the temporal and spatial *patterns of variation* in those rates. As with some other chapters, lessons here apply beyond just the topic of the chapter.

In Chapter 10, David W. Macdonald, Paul D. Stewart, Pavel Stopka, and Nobuyuki Yamaguchi describe how dynamics of mammalian societies can be measured. Here "dynamics" refers to social life, not populations. The authors define a social dynamic to be "the change in social interaction or relationship under the influence of extrinsic or intrinsic factors." I found their discussion of various methods for sampling and measuring behavior to be a useful introduction to that topic. I could not agree with their comment on page 375 that if events in a sequence occur independently, then the distribution of bout lengths will be exponential. That statement is correct, however, if the events are random and have a Poisson distribution.

The final chapter, by Fabio Corsi, Jan de Leeuw, and Andrew Skidmore, discusses the use of geographical information systems for modeling species distributions. In contrast with many of the other chapters that deal with population dynamics, this one argues that conservation is concerned mostly with the fragmentation and reduction of distributions of organisms. My impression is that the authors are on shaky ground when they present statistical concepts. For example, the variety of topics encompassed by ANOVA, rank correlation, and Bonferroni are all termed "univariate statistics." The authors mention one statistic that ranges in value from 0 to 1, but note that it can also be negative. And they seem to view the ability of GIS to handle large numbers of variables as an unmitigated blessing, failing to consider the possibility of spurious results arising from attempts to relate large numbers of variables (e.g., Armstrong 1967, Rexstad et al. 1998). Despite these shortcomings, the chapter provides good insight to some of the issues associated with modeling distributions of plants and animals—a very timely topic.

This book does an excellent job of gathering and synthesizing a huge amount of information about several important techniques in animal ecology. It generally provides a more conceptual treatment of topics, in contrast to the wildlife techniques manual (Bookhout 1994), which treats many of the same techniques but in a more "how-to" fashion. As in any edited volume, some chapters in Boitani and Fuller are better than others. Some minor inconsistencies in style exist among the chapters; for example, lists of references are arranged alphabetically in some chapters and by date in others. The editors and authors are to be commended for the effort they have put forth and for the valuable product they have provided. I would encourage anyone planning to use any technique presented in this volume to read the pertinent chapter.

LITERATURE CITED

ARMSTRONG, J. S. 1967. Derivation of theory by means of factor analysis, or Tom Swift and his electric factor analysis machine. American Statistician 21:17–21.

BOOKHOUT, T. A., editor. 1994. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, Maryland, USA.

JOHNSON, D. H., AND D. L. LARSON. 1994. Amphibian declines: real or perceived? Proceedings of the North Dakota Academy of Science 48:15.

REXSTAD, E. A., D. D. MILLER, C. H. FLATHER, E. M. ANDERSON, J. W. HUPP, AND D. R. ANDERSON. 1988. Questionable multivariate statistical inference in wildlife habitat and community studies. Journal of Wildlife Management 52:794–798.

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