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BOOK REVIEWS

SAMPLING AND STATISTICAL METHODS FOR BEHAVIORAL ECOLOGISTS. By J. Bart, M. A. Fligner and W. I. Notz. xii 300pp. Published by Cambridge University Press, 1998. Price £17.95. ISBN 0-521-45705-X (paperback).

Many biologists have haphazardly accumulated expertise in statistics through the practical experience of analysing their own data. They will appreciate this reasonably priced book as providing a friendly, somewhat idiosyncratic, treatment to complement more traditional textbooks. However, it is insufficiently comprehensive to merit the publisher's claim that ' it will quickly become *the* statistical handbook for all field biologists '.

The book is not aimed at students new to statistics who are studying for an exam. Rather it provides another run through of the most standard techniques, incorporating some extra points that are often overlooked but of practical use (e.g. the statistical properties of ratios), and then introducing some specialist techniques relevant to the ecologist that are rarely included in standard texts (e.g. estimating survivorship). Most biologists who use non-trivial statistics will learn something of interest, and learn it rather painlessly because the book is well written in an accessible style. There is mostly little algebra; the concepts are explained verbally, sometimes quite briefly, but generally clearly. Appropriate examples from the ecological literature further illuminate. We are warned when to consider consulting a statistician, and given a moderate number of references to up-to-date work at a suitable mathematical level.

The first 255 pages are divided into 12 chapters. Quite refreshingly, chapters differ considerably in style and level of treatment. Early chapters tend to be long and thorough, later ones treat specialist techniques in increasing brevity (eventually just one-page per topic, but with some references). Further differences perhaps reflect authorship. One author is an ecologist, the other two statisticians, and the mix is complementary. Would a statistician have advised that fewer individuals mean longer continuous periods of behavioural observation, which facilitates gaining novel insights while collecting data? Chapters do depend on one another, so that I recommend to work through from the beginning. Unfortunately, another reason is that the index is so deficient. This considerably reduces the book's utility, especially because concepts are often not introduced in the orthodox sequence. On the other hand the end-of-chapter summaries are excellent at crystallizing the important points.

Following the main text is a 20-page key to statistical methods, together with explanations and formulae. This is clear and useful, except that it is restricted in scope. It provides the only justification for 31 pages of standard statistical tables that most users will already have to hand. Eight pages of more technical footnote material follow, then eight pages of references.

The authors aimed to describe the statistics most often used in behavioural ecology, behaviour, ecology, fisheries and wildlife biology. Accordingly they surveyed the statistics in a year's run of six journals in these fields, although none specialising in fisheries. Nevertheless, my most serious misgivings about this book are what they excluded. One deficient aspect is certain standard terms that are necessary to understand other books. For instance, type 1 and type 2 error, nested and crossed designs, and heteroscedasticity are not mentioned, even though the concepts themselves might be. Some aspects that are covered I felt deserved more prominence. For instance, transformations are mentioned only briefly, yet lack of an appropriate transformation is the commonest error that I notice in published statistical analyses. Some important issues associated with particular techniques are omitted altogether. For instance, no reference

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is made to autocorrelation in the chapter on how to sample behaviour. When discussing stepwise multiple regression analyses no warning is given about the dangers of ' data trawling ': if many variables are tested we expect some significant *P* values just by chance. Other very relevant techniques are not mentioned at all. For instance, surely ecologists use time-series analysis to examine population cycles. Behavioural ecologists routinely use comparative methods to eliminate the non-independence caused by phylogeny? All we get on multivariate techniques are some specific techniques named briefly in passing. The single suggestion of the existence of randomisation or simulation techniques was the totally unexplained phrase ' use a bootstrap '! Do not look to this book either for direct information on how to perform an analysis of variance.

On the other hand, what is included is often not dealt with as well elsewhere. The kind of many small points that I liked to see emphasized were these: *P* values do not measure how different two populations are; one should not argue from a non-significant result that populations are not different; non-parametric statistics do make assumptions about the shape of the distributions; the importance of a habitat to an animal is not measured by the time spent in it. Also, there are very practical hints, for instance about the level of bias that one can safely ignore, and about how misleading a graph's error bars can be in indicating whether differences are significant.

A more fundamental strength of this book is its treatment of sampling; it is fair that this appears first in the title. Ecologists often use complex hierarchical sampling designs. A long Chapter 4 carefully explains a classification of such designs, before considering how the design affects the tests that are appropriate (but I wish that they had related this approach to standard ANOVA techniques). The length of the chapter turns out to be vindicated by the repeated use of its concepts in later chapters. As an example, I see the glory of the book to be the chapter on pseudoreplication. This buzzword can become an unthinking knee-jerk criticism amongst behavioural ecologists. Using some classic examples from the literature (reactions of fish to unfamiliar fish, playback of bird song), this book clarifies what are statistical issues and what are issues over which biologists may legitimately disagree. Suppose that we experiment on 30 fish collected from three ponds. We then have a legitimate choice: either view the ponds as representing a wider population of ponds, and then the sample size is the number of ponds used; or view the chosen ponds as a condition of the experiment, in which case the sample size can be the number of individuals. Or do both analyses.

If you have ever had to think through whether your statistics are pseudoreplicated, there is probably much else in this book also of interest to you, but look elsewhere for a general statistics manual.

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FISH DISEASES AND DISORDERS VOL. 3. VIRAL, BACTERIAL AND FUNGAL INFECTIONS. Edited by P. T. K. Woo and D. W. Bruno. ix 874pp. Published by Cabi Publishing, Oxford, 1999. Price £99.50. ISBN 0-85199-194-7.

This is the third volume of the series, edited overall by Patrick Woo. Although a very large book, it is well presented and produced. It purports to cover the major viral, bacterial and fungal diseases of fin fishes and shellfishes. Given the breadth of such a spectrum, I believe this to be a mistake, since a much better justification can be made for restricting the content to fin fishes, just as applied to the first two volumes in this series. Shellfish microbial diseases have no priority over shellfish parasitic or other diseases and it seems illogical to include shellfish only in relation to their microbiology, and in this volume, which is already 722 pages long before any consideration of invertebrates. The invertebrate microbiology section is good, but would be much better placed alongside invertebrate parasitology and non-infectious diseases in a different text.