chapters give the reader a general but comprehensive introduction to each of these habitats and the ecosystem processes that are important in shaping them. Each chapter investigates both the common processes and differences (i.e., exposed vs. protected shorelines) within habitats. If students read the chapter on soft sediment beaches prior to visiting the shores of North Carolina or Georgia, they would have a firm understanding of both the physical and ecological interactions that make these communities work.

Each chapter contains a summary and a list of suggested readings. A few of the suggested readings have a one-sentence description that lets the reader know what to expect if they wish to do further reading, but most don't. Given that this text is aimed at undergraduates, an annotated list of suggested readings would be more helpful. The chapters are well organized and the differentiated chapter headings allow the reader to easily follow the organization of the book. I found the glossary useful and the literature cited extensive, containing a good mix of classic work in marine ecology as well as recent studies that have helped to elucidate our understanding of the Atlantic coast shorelines.

Throughout the book there are numerous figures, diagrams, and drawings. In fact it is rare for a page not to contain some sort of graphic. This is both a strength and a weakness of the book. The line diagrams of organisms are outstanding and students will gain much from these. The weakness lies in the figures. Many professors feel that students need to be able to interpret data and in my class I like to place a figure on an overhead and have students tell me what it means. Bertness, it appears, has tried to take figures from primary literature and simplify them for the book. But, by doing so, critical information is lost. I came across more than one figure in the text that could not be interpreted from Bertness's book alone. I needed to go back to the original papers to determine x-axes and/or scales.

I think the major strength of this book is Bertness' ability to present important concepts and ideas in a conversational text, one which should be engaging to students. I think he does an excellent job in pulling together many fields of study (geology, hydrology, and ecology) in a way that shows the interconnectedness of these fields on the Atlantic shorelines. The major weakness of the book, and it is not minor, is that one must have supplemental material from primary literature to help fully understand some of the figures in the book.

According to the book's preface and the publisher's WWW page, this book is intended for a mixed audience of both undergraduates and amateur naturalists. After reading the book, I would recommend that both the author and publisher rethink whether they want the latter audience. I feel the book is appropriate for undergraduates enrolled in marine ecology, biology, or a field-based course as long as it is supplemented with primary literature cited in the text.

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ABANDON ALL *P*-VALUES, YE WHO ENTER HERE!

Burnham, Kenneth P., and David Raymond Anderson. 1998. **Model selection and inference: a practical information-theoretic approach**. Springer-Verlag, New York. xix + 353 p. $69.95, ISBN 0-387-98504-2 (alk. paper).

As ecology matures as a scientific discipline, ecologists are more and more confronting the inadequacy of using classical hypothesis testing to draw biologically meaningful conclusions from their data. While this inadequacy is nowhere more apparent than at the interface between ''basic'' ecology and its applications to conservation, preservation, and management, the advancement of ecological theory itself is constrained by an overemphasis on *P*-values and a neglect of parameter estimation and statistical inference. Two recent books have illustrated this contrast. Tony Underwood's widely-cited book on analysis of variance in ecology (Underwood, Anthony. 1997. Experiments in ecology: their logical design and interpretation using analysis of variance. Cambridge University Press, Cambridge, United Kingdom) advocates a classical hypothesis testing approach, but ignores much ecological reality (for example, unbalanced designs, empty cells, and lack of replication caused by logistical constraints). Ray Hilborn and Marc Mangel's monograph (Hilborn, Ray, and Marc Mangel. 1997. The ecological detective: confronting models with data. Princeton University Press, Princeton, New Jersey) showed how likelihood and Bayesian methods could be used to draw stronger conclusions regarding fits or models to data than could hypothesis testing alone. In their book on model selection and inference, Burnham and Anderson take the logical next step: eschewing *P*-values completely and focusing entirely on how to decide when a model (or models) adequately fits the data. In essence, this is what ecologists want to know—do our predictive models work?

This simple categorization, however, belies the conceptual richness that Burnham and Anderson present in their book, and its importance. By asking the simple question: what model should be used to fit the data?, and answering it with an overt focus on parameter estimation and model choice using Akaike's Information Criterion (AIC), Burnham and Anderson advance a radical (for ecologists) approach to scientific progress. Burnham and Anderson assert that the key to successful research is to approach an exciting scientific question that has been carefully posed through sound experimental design and sampling that leads to the collection of relevant data. Although a similar approach is advocated by Underwood, Burnham and Anderson take a very different approach to the analysis of the data. Rather than working to reject a statistical null hypothesis, Burnham and Anderson argue that once in hand, data should be tested against a set of candidate models that were specified a priori through careful thought and consideration of existing biological information. In Burnham and Anderson's universe, the widely-taught, but uninformative null hypothesis-testing approach would be avoided and *P*-values would not be presented. Instead, investigators would present a set of possible, biologically realistic models, and illustrate which one (or ones) fit the data at hand. Such careful thinking and a priori model specification renders unnecessary data mining (and its pejorative cousin, data dredging), which is now widely advertised by purveyors of statistical software. It would also discourage the common (but rarely admitted) post-hoc hypothesis generation that occurs after ecologists measure all the variables they can think of, search for patterns in the data, and then publish statistically "significant" results with little regard to their biological meaning.

The opening chapter presents Burnham and Anderson's philosophy of data analysis and model inference, and should be read by every ecologically-minded graduate student, instructor, and researcher, as well as by applied ecologists of every stripe. The book is pitched at this audience, and is probably too advanced for most undergraduates. In spite of being wordy and modestly repetitive (a characterization that applies to all of the book except Chapter 6), this chapter alone convinced me to thoroughly revise the experimental and analytical methods of an about-to-be-submitted grant proposal.

Chapter 2 is a comprehensive review of information theory and log-likelihood models, and is a good complement to, and extension of, material presented by Hilborn and Mangel. Akaike's fundamental observation was to show a direct linkage between information theory (formally, the Kullback-Liebler distance) and the maximized log-likelihood. Burnham and Anderson emphasize the fact that the AIC "selects" from a set of candidate models that model for which the least "information" is lost when it is used to approximate the data. For practicing ecologists, AIC is easy to compute:

$$AIC = -2\log(L(\hat{\theta} \mid y)) + 2K \qquad (1)$$

where $L(\hat{\theta} \mid y)$ is the likelihood of the estimated model parameters $\hat{\theta}$ given the data y, and K is the number of estimable parameters in the model. While (1) is the general form of AIC based on maximum likelihood, it can also be calculated for the special, more familiar least-squares case (when errors are normally distributed) as:

$$AIC = n\log(\hat{\sigma}^2) + 2K \qquad (2)$$

where $\hat{\sigma}^2$ is the maximum likelihood estimator of σ^2 (not necessarily the σ^2 provided in statistical software output). The best fitting model is that whose AIC is lowest (least information lost); other candidate models with AICs "close to" (within 2) of the best fit model should also be explored. When sample size is small ([number of observations/K] < 40), a corrected AIC, AIC_c should be used (substitute $2K(K + 1)/(n - K - 1)$ for $2K$ in (1) or (2). Burnham and Anderson also illustrate why an analogous Bayesian method for model selection (the Bayesian Information Criterion) does not work as well, or as consistently, as AIC or AIC_c.

Chapters 3–5 present clear, detailed, (mostly) ecological examples of the use of AIC or AIC_c; any ecologist could see analogies to her data in these examples. Chapter 6 presents the statistical details of AIC. Whereas the first five chapters can be read with little quantitative background beyond basic statistics (Burnham and Anderson recommend three semesters worth, more than most graduate students take, but it is likely that one semester plus a thorough reading of Hilborn and Mangel would be adequate), Chapter 6 requires a very firm grounding in statistical theory and calculus. However, Chapter 6 can be skipped without loss of information content. The summary chapter (7) is essentially a recapitulation of the first chapter.

In *Model selection and inference,* Burnham and Anderson present ecologists with the opportunity and the tools to make a major leap forward in our understanding and interpretation of the systems that we study. Whereas most ecologists would agree that the hypothetico-deductive, scientific method of multiple working hypotheses is the best way to structure our research, hypothesis testing by itself does not allow one to choose among multiple, statistically significant, hypotheses. The information-theoretic approach advocated by Burnham and Anderson provides a method by which ecologists can decide which model best fits the data, and leads to direct linkages between questions that basic researchers address and answers that applied ecologists need. Statistical inference through model selection demands that more attention be paid to careful experimental design, that models be specified in advance of field or laboratory work, and that we abandon our blind obeisance to null hypothesis testing and *P*-values. The path opened by Burnham and Anderson should let us finally assess fundamental ecological mechanisms underlying patterns of distribution and abundance of organisms, and their roles in ecosystem functions.

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