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Review of "Design and analysis of long-term ecological monitoring studies"

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How to monitor well

If you do monitoring, you need a copy of this book. It is that good. The editors have assembled 23 chapters covering all aspects of conceptualizing, designing, analyzing, and even terminating an ecological monitoring program. Many have lamented the sorry state of many monitoring efforts. Yet, there is a large body of technical expertise and experience that tells experts how to design a good monitoring program and then how to analyze the data appropriately. This book was written and edited to present that knowledge to a broad audience of ecologists.

The broad themes throughout the book are that you need to think really hard about why, what, and how before designing a monitoring program, you should use a probability-based sampling design if at all possible, and if you do, the data analysis should account for the survey design. These themes are covered in five sections. The first (“Overview”) has four very accessible chapters that provide overviews of different aspects of monitoring. The next two sections (“Survey design” and “Data analysis”) discuss design and then data analysis. The next section (“Advanced issues and applications”) contains six chapters on advanced issues, and the last section (“Conclusion”) has two chapters on practical issues: institutionalizing a monitoring program and deciding when to terminate a program. Most of the chapters are written for ecologists by statisticians with extensive experience in monitoring. Some are written by biologists or program managers.

The book provides a huge amount of practical advice. Some specific examples are (1) a large table listing “Common errors in natural resource surveys, with some potential remedies” in Reynolds’ chapter; (2) the pithy comments from Skalski that “Preliminary surveys should be an integrated component of every monitoring program which has as its objective more than simply long-term employment for those involved. In ecological studies, natural variation is typically too large and the sampling techniques too imprecise to leave study design to chance”; (3) the two examples of bias in a monitoring program described in Bart and Beyer’s chapter; and (4) MacKenzie’s description of the too-much (asking too many questions) and too-little (insufficient sample size) often seen in a monitoring program.

The editors have deliberately included features to increase the accessibility. Every chapter has a box with “Take-home messages for program managers” that summarizes that chapter for a nonstatistician. Most chapters have a second box describing common challenges. I found this material extremely informative because it highlights important issues and concerns when applying the methods in that chapter. Most chapters end with a summary of topics for future research and development.

As you would expect, the book describes lots of statistical methods. In general, the chapters organize and summarize previously published work. Some chapters, for example the one by Tony Olsen and colleagues on spatially balanced sampling, present new ideas, e.g., metrics to quantify the “spatial balanced-ness” of a particular choice of sample locations. Another example of new work is Converse and Royle’s random effects model to parsimoniously account for variation in detectability. Most chapters included a worked example or use a simulation study to compare methods. Data sets for two chapters and code for some simulations and some analyses are available on the publisher’s web site for the book.

One strength of the book is its diversity of perspectives. For example, there are chapters on design-based inference and chapters on model-based inference. There is also a chapter about a hybrid approach, in which a probability sample for regional-scale conclusions is combined with modeling to make local-scale conclusions. The survey world has traditionally used design-based inference. Results from a survey are appropriate when the survey units (e.g., locations or individuals) are selected using some form of probabilistic sampling and the analysis respects the survey design. If the survey design includes stratification or clustering, the data cannot be analyzed as if they were collected as a simple random sample. Many of the data analysis chapters show how to account for the survey design and frequently describe computer code (a mix of EXCEL, R, SAS, and WinBUGS).

The alternative to design-based inference is model-based inference, in which results are appropriate when the model is correctly specified. The book includes a diverse set of applications of model-based inference, including change-point models to estimate ecological thresholds, structural equation models, a random effects model for imperfect detection, and a hierarchical spatio-temporal model. Some models are fit by likelihood-methods, others by Bayesian methods. A minor critique is that few of the modeling chapters discuss how to assess model assumptions.

A second strength of the book is the emphasis placed on understanding the sources and magnitudes of variability. Two chapters in the design section describe variance components analysis in a much more general way than the typical additive normally distributed effects model. In this approach, the variance in an estimate is written using what Skalski calls the “variance in stages formula”: the sum of the variance of a conditional expectation and the expectation of a conditional variance. Although this might sound scary, it is very well explained. The advantage is that it can be used in situations where the typical additive effects model cannot. For example, Skalski uses it to evaluate spatial variability and binomial sampling variability in a multi-location monitoring of population size. Gray’s chapter complements this approach by describing generalized linear mixed models for categorical and count data. His extensive simulations show that precisely
estimating a variance component requires more than a few levels. For example, more than five years of data are required to get a good estimate of the between-year variance. Although estimates of variance components from pilot data will not be precise, Skalski argues strongly that using pilot data to design a monitoring program is very much better than using an ad-hoc design.

This book clearly explains what you need to know to plan and implement an effective monitoring program. It is a gem.

**Toward a new paradigm in conservation and restoration**


*Key words: active management; conservation; ecosystem services; restoration.*

Intact, undisturbed habitats have been the focus of conservation efforts and the public’s imagination since before the birth of the environmental movement. Whether as priorities for land preservation or references for management and restoration plans, such “wild” habitats have served as poster children for the notion of what nature is, or at least what it should be. The “other” habitats, even those not currently under plow or other direct human use, have tended to be classified in derogatory terms—“degraded,” “disturbed,” or even “trashed”—and have not been afforded the same level of protection, study, or appreciation.

What to do, then, as human influences extend to much, if not most, of the biosphere and we realize that pristine wilderness scarcely exists? Furthermore, as the limits of restoration science to successfully undo past human influences become clearer, it is apparent that the extent of such “wild” habitat can only decrease. In the face of these realities, do we (scientists, policymakers, and the public) continually shrink the size of the Earth that is considered worthy of protection and active management? Or, alternatively, do we readjust our notion of value to include a wider range of habitat?

*Novel ecosystems* explores the evidence for and implications of a new class of habitat to be recognized beyond the traditional “wild” vs. “degraded” dichotomy. It clearly advocates that scientists, stewards, and policy-makers expand their sense of value to include habitats that exhibit a strong legacy of human influence. While there are many points where pains are taken to reassure the reader that elevation of the value of novel ecosystems should not diminish the value of “protecting places and ecosystems that retain their original biota and historical character” (Chapter 1), some modestly dissenting viewpoints are also presented (e.g., Chapters 29, 41). It makes for a lively debate within a single volume.

Surprisingly, the book does not present a clear description of the novel ecosystem concept, in spite of a cooperatively written “working definition” (Chapter 6). This definition maintains the essential components of previous publications— “[A] system of abiotic, biotic and social components . . . that, by virtue of human influence, differ from those that prevailed historical-ly”—but also adds enough clauses as to make the outcome rather unwieldy. Other chapters early in the book present the idea of thresholds beyond which a return to a historical state is no longer possible (Chapter 3), and the relationship of the concept in the context of ecological theory (Chapter 5). Still, the book would have benefited from a single chapter that could serve as a stand-alone conceptual introduction.

This criticism aside, various chapters throughout the book make clear that novel ecosystems are neither rare across the landscape nor a recent phenomenon. As Chapter 5 argues, the work of Arthur Tansley, Henry Gleason, and Margaret Davis, among others, has made clear that species composition responds individualistically to environmental changes, and that ecosystem change is, in fact, the norm when viewed in a longer temporal context. When viewed this way, fealty to historical species combinations can be seen as running counter to well-accepted ecological theory. In some conditions, such as islands (Chapter 4), novelty may in fact be the norm rather than the exception. The book also presents numerous case studies that qualitatively describe a variety of novel ecosystems, including some in which species invasions or land-use changes have caused essentially permanent shifts in species composition (e.g., montane forests in the Seychelles, Chapter 27), as well as others in which a unique mixture of species has colonized areas of intense human activity (e.g., the “Hole-in-the-Donut” in the Everglades, Chapter 2).

Individual chapters present theoretical reviews of the role that drivers such as land use (Chapters 8 and 9), climate change (Chapter 10), and invasive species (Chapter 11) play in creating and maintaining novel ecosystems. Patterns of disease (Chapter 12), plant-soil feedbacks (Chapter 13), and fauna (Chapters 14 and 15) within novel ecosystems are also considered. There are also well-written considerations of novel ecosystems within prevailing environmental ethical frameworks (Chapter 31) and implications for policy (Chapter 33). Finally, one of the strongest aspects of the book is the occasional 1–2 page narrative of authors’ personal journeys towards recognizing the existence and value of novel ecosystems in their own personal or professional lives.

Perhaps the key practical question is when and how to intervene in the management of a novel ecosystem. Chapter 18