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BOOK REVIEW

Lindenmayer DB and Likens GE (eds): Effective ecological monitoring

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Long-term ecological monitoring is becoming increasingly important but more challenging to fund. Lindenmayer and Likens describe the common characteristics of successful monitoring programs and of those that fail. They draw upon their monitoring experiences together, independently, and from a variety of other long-term monitoring programs around the world. They then use these characteristics to "present a new paradigm—Adaptive Monitoring" by putting the characteristics into a logical framework. The target audience is broad, including researchers, resource managers, and policy-makers. As a result, the book is easy to read and provides numerous examples while avoiding technical jargon.

Chapter 1 describes three types of monitoring: curiosity-driven or passive monitoring, mandated monitoring, and question-driven monitoring—stressing the importance of the latter and its ability to be adaptive. They then review the value of long-term monitoring, including slow response times, use for simulation modeling, testing of ecological theory, and ability to monitor surprises, such as natural disturbances. They close by elaborating on their motivation for writing the book: high-quality monitoring systems are needed for detecting impacts of climate change and other environmental changes. Much has been written about monitoring, but overall guidance is lacking. Often monitoring starts with identifying lists of variables to observe, rather than identifying the objectives and questions that should drive the monitoring.

Chapter 2 describes why monitoring systems can, and often do, fail. Often monitoring systems lead to being "data-rich and information-poor" by focusing on collecting data rather than on answering questions. Measuring long lists of variables reduces the sample size. This problem grows with the number of scientists and disciplines involved. Not involving statisticians initially can lead to poor experimental designs. Applying the same approach everywhere is likely to be inappropriate as the resources and questions differ. While electronic monitoring equipment can result in an excellent time series, the expense of the equipment limits the sample size (number of observational units). Scientists can become disengaged with resource managers and policy-makers. Poor data management can lead to lost or underutilized data. "Improving" monitoring methods can lead to loss of integrity of data over time (broken time series). Study champions leave. Bureaucracy can become excessive. Short funding cycles make long-term monitoring challenging.

Chapter 3 is the heart of the book. It provides an excellent description of characteristics of effective long-term monitoring systems and the adaptive monitoring framework. Largely they are the flip side of the failures described in Chapter 2. Good characteristics

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include: (1) good questions that evolve as conditions change over time, (2) using a conceptual model to inform research direction, (3) selecting appropriate variables to measure, (4) good experimental design, (5) well-developed partnerships with resource managers and policy-makers, (6) strong and dedicated leadership (a "champion"), (7) ongoing funding, (8) frequent examination and use of data, (9) scientific productivity released in a variety of outlets, and (10) maintenance of data integrity and calibration of measurements. They also mention several logistical issues of maintaining monitoring sites that are important. Building on these characteristics, they describe the adaptive monitoring framework. The key addition is a feedback loop. Monitoring programs must evolve as questions change or new ones are added and as new protocols or new technologies arise. These can then influence what is measured and how frequently, thus affecting all the remaining monitoring steps.

Chapter 4 presents a variety of case studies which reinforce the negative (Chapter 2) and positive (Chapter 3) points previously made. Some of their concerns with the problematic case studies are debatable. Acknowledging this, the authors provide several rejoinders. The most common problems involve a lack of well-defined questions, lack of a useful conceptual model, poor experimental design, and the costs of a laundry list of attributes to observe. They also provide a number of effective case studies, but also list some of their challenges. Much can be learned from the experiences given in these examples.

Chapter 5 closes the book with some general conclusions. Long-term ecological monitoring is essential to evidence-based environmental decision-making and to demonstrating the effectiveness of those decisions. Many challenges remain. The authors list several cultural changes that they believe are needed for monitoring programs to thrive. Many researchers do not embrace long-term monitoring for a variety of reasons, including the lack of academic rewards, slow time to first publication, short-term funding, and a shift away from teaching field courses. These constraints have led to a spatial versus temporal bias (resulting in attempting to substitute space for time) and a focus on modeling, especially simulation modeling. They also describe organizational, funding, intellectual property, and societal culture issues. They finish with the challenge of integrating different kinds of monitoring. Several efforts to integrate results across monitoring systems to provide a comprehensive understanding of environmental health have demonstrated the difficulties of spanning spatial and temporal scales to provide a consistent assessment. Managers of site-based monitoring systems need to understand their broader context in order to enable an eventual linkage with extensive monitoring systems. This linkage may involve adjustments to both systems, thus enhancing the ability to deal with pressing issues, such as climate change.

I found the book to be very readable and interesting. Each chapter is well referenced. The many case studies provided concrete examples with which the reader can relate. I have certainly witnessed many of the problems that they identify. The list of characteristics for successful monitoring is very valuable and should be heeded by those involved in long-term monitoring. Most of them are applicable to short-term monitoring as well. The adaptive monitoring framework is similarly widely applicable and fits well in an adaptive management framework where resource managers monitor their management actions to provide feedback on the ecosystem responses.

While I agree with all the components listed, I would add a few and change the order slightly since it is almost a "checklist" of monitoring steps. I agree that monitoring should be driven by questions; however, I have found that resource managers often have trouble articulating the questions. I believe that the questions come from a stated need or resource objective, such as ecosystem restoration, adaptation, or mitigation. The researchers can then work with the resource managers and policy-makers to articulate clear questions to drive the monitoring. Finally, as I moved from chapter to chapter, the discussion of the list of characteristics became a bit repetitive; however, this served to drive home the importance of addressing each of them. I highly recommend this book for any researcher, resource manager or policy-maker who is involved in new or existing resource monitoring programs.