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Invited Feature

Uses and Limitations of Historical Variability Concepts in Managing Ecosystems[1]

Recognition of the importance of ecosystem change over decades, centuries, and millenia has come largely from the unique insights provided by historical reconstructions of past community structures and disturbance regimes. These reconstructions suggest that many current environmental problems are rooted in extreme and unsustainable human-caused deviations from historical, or so-called "natural" conditions. Thus, an increasingly recognized and debated concept in ecosystem management is that knowledge of historical patterns and processes as reference conditions is prerequisite to informed land management. Although the values of historical perspectives have long been recognized in wilderness and park management (e.g., fire history reconstructions to justify natural fire programs), recent applications of historical variability concepts to other managed lands have generated debate about their uses and limitations. Even so, it is common to find planning documents for ecosystem management explicitly calling for the acquisition and integration of data on past ecosystem conditions. Holling and Meffe (Holling, C. S., and G. K. Meffe. 1996. Command and control and the pathology of natural resource management. Conservation Biology **10**(2):328–337), for example, have gone so far as to define a "Golden Rule" of sustainable natural resource management: "management should strive to retain critical types and ranges of natural variation in resource systems in order to maintain their resiliency." Despite the potential management importance of knowledge about past variability, there are no clear prescriptions or frameworks for using or evaluating this knowledge in land management.

Challenges to the use of historical-ecological data in land management planning have led to some frustration and criticism. Managers, for example, have had difficulties in identifying and obtaining appropriate reference condition data, and they sometimes struggle to develop defensible frameworks for using this information for planning the management of different landscapes. Some argue that ecosystem variability is so strongly scale dependent, or affected by humans, that identification and application of meaningful and relevant historical data for management is essentially impossible (1996 review comment on a proposal by the authors for a workshop on natural variability to the National Center for Ecological Synthesis and Analysis). Others are concerned that naive scientists and managers will use reference conditions to define a misguided, impractical, or expensive template for the future.

In October 1996, a workshop was held at Georgetown Lake, Montana, to address the need for scientists and land managers to collaborate in the definition and clarification of critical terminology related to historical-ecological information, to identify the types and resolution of historical information that is most useful to land management decisions, to articulate the limitations of historical data in developing management goals or templates, and to evaluate the consequences and implications of potential management decisions. The workshop brought together 23 scientists (university, government, and private) and federal land managers. The interest generated led to a symposium on the same topic at the 1997 Ecological Society of America annual meeting in Albuquerque, New Mexico. The papers in this Invited Feature are based largely on papers presented at that symposium.

In the following papers we have asked scientists and land managers who have attempted to apply historical or natural variability concepts to land management issues to present their unique perspectives on how such concepts have been developed and applied in "real world" situations. Each of these papers was developed independently by its authors, but with the understanding that it would be presented in the context of this thematic collection. We believe this collection of papers provides an up-to-date understanding of some of the uses and limitations of historical data as it has been applied in actual land management situations.

[1] Reprints of this 101-page Invited Feature are available for $15.00 each. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 1707 H Street, N.W., Suite 400, Washington DC 20006.

P. B. Landres, P. Morgan, and F. J. Swanson set the stage by providing a review of the applications and limitations of natural variability concepts in managing ecological systems. They review problems associated with imprecise terminology as well as examples of how knowledge of spatial and temporal variation in ecosystems has provided insight into understanding ecological processes and the dynamics and implications of ecological change.

T. W. Swetnam, C. D. Allen, and J. L. Betancourt provide a summary of the scales and resolutions of data and methods used in environmental history reconstructions. Citing examples of packrat middens, fire-scar chronologies, and repeat aerial photographs from the southwestern United States, they describe the uses and limitations of these lines of research in understanding and managing ecosystems.

C. I. Millar and W. B. Woolfenden use examples of the effects of past climatic change on ecosystem conditions in the eastern Sierra Nevada to suggest limitations of using historical conditions to guide ecosystem restoration and management. They use data from ecosystem and water level studies in the Mono Lake basin as well as a recent U.S. Forest Service watershed landscape analysis to demonstrate the importance of understanding the context of climate change and vegetation response to that change.

J. H. Cissel, F. J. Swanson, and P. J. Weisberg describe a plan that utilizes understanding of historical landscape patterns and disturbance regimes as a guide for timber harvest prescriptions in western Oregon. They conclude that this approach results in conditions more closely resembling historical conditions, thus posing less risk to native species and ecosystems, than the approach found in the Northwest Forest Plan.

P. F. Hessburg, B. G. Smith, and R. B. Salter describe the use of aerial photography to compare historical and current vegetation to detect recent change in forest spatial patterns in the eastern Washington Cascade Mountains. They outline methods for using spatially extensive comparisons of early vs. late 20th century landscapes to identify ranges of ecological conditions, including how such information can be used to direct management strategies.

Mandates to restore giant sequoia ecosystems to more natural conditions have led scientists and managers to search for ways to use past conditions as references for restoration efforts. N. L. Stephenson reviews available information on sequoia ecology to evaluate the arguments of so-called "process" and "structure" restorationists. He concludes that the restoration of fire to giant sequoia ecosystems without mechanical modification of fuels can effectively restore pre-European forest structure.

M. M. Moore, W. W. Covington, and P. Z. Fulé apply the concepts of evolutionary environment and reference conditions to restoration projects in Southwestern ponderosa pine forests. Based on findings that, in many cases, increased tree density and fuel accumulation have moved these ecosystems from low-intensity to high-intensity fire regimes, they describe efforts to restore both structure and process to the forest.

Despite the wide diversity of approaches and opinions regarding the best ways to utilize historical data, it is clear that there is great value in considering historical-ecological information in natural resource planning and management. Although the application of such information may vary widely, depending on the quality and resolution of the available data and the goals and constraints of those applying the information, the value of historical perspectives in understanding factors influencing the structure and function of ecological systems is critical to almost all resource management decisions. We hope, and expect, that the discussion generated by these papers will stimulate increased dialogue between scientists and managers regarding the value and limitations of historical variability data in developing scientifically based land management programs.

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