

Case studies in developing rangeland sustainability indicators : scale matters

B.H. Allen-Diaz¹, L. Huntsinger², J.W. Bartolome², and L.D. Ford³

¹University of California, Office of the President, 1111 Franklin St., Oakland CA 94607, Barbara. E-mail: allen-diaz@ucop.edu; ²Environmental Science, Policy, and Management, 137 Mulford Hall MC 3110, University of California, Berkeley, California 94720-3114; Consultant in Rangeland Management and Conservation Scientist, Felton, CA 95018-9253, E-mail: fordld@sbcglobal.net.

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Introduction Several new monitoring systems that rely on "ecosystem sustainability indicators" are being developed and used in California. Indicators ideally are ecosystem attributes that can be measured over time to determine whether specific management goals and objectives are being achieved. We argue that attempting to apply one set of indicators to all cases repeats a long history of inappropriate generalization of ecological science. Instead, a tool box of broadly accepted indicators from which managers can select to meet specific needs better recognizes diverse ecological, social, and political contexts (Harris and Hobbs 2001). To be practical, indicators must fit the situation--in particular local capacity for consistent application, address the important questions (Ford and Huntsinger 2007), and provide meaningful data. Indicators should be based on what we know about how systems work, and should be dynamic as more data is collected and interpreted and understanding of system structure and function increases. One of the primary purposes of indicators is to challenge assumptions and identify knowledge gaps, replacing them with more reliable, data-driven information.

Goals for indicator monitoring systems often include terms such as sustainability, productivity, integrity, and health. These inter-related terms should be defined (*sensu* Battles (pers. comm) and Harris and Hobbs 2001) as demonstrations or tests of rangeland ecosystem:

- productive capacity
- desired biological community composition and structure
- ability to recover from stress (chronic and cumulative in its effect, e.g. heavy grazing) and from disturbance (sudden and often severe effect)
- production of economic, social, and aesthetic benefits to the owner, manager, and local communities, in order to maintain economic and social viability.

Methods We use case study analysis of three indicator development projects to discuss how indicators, to be effective, need to be scale-sensitive, temporally as well as spatially.

Results and discussion The first case study is a grassroots effort by ranchers on California's central coast to develop an indicator system with currency among the ranching community, ecological scientists, agency managers, and the public. A second case is California's statewide assessment of rangeland conditions and sustainability, conducted at the level of the state government and for the state legislature. A final case is the well-known Montreal Process, and the five criteria and 28 indicators developed as part of that process. For each of these initiatives, we examine the indicators in the light of their applicability at particular scales, their commonalities and differences, and issues of application and implementation. We will discuss criteria for appropriate selection of indicators for particular situations, and issues of application and relevance.

Conclusions We return to the underlying foundation of our understanding of basic factors driving rangeland ecosystems, and the link to sustainability indicators. Models of ecosystem function, for example, should be evaluated for their repeatability over time and space to determine whether they are generalizable or idiosyncratic, and based on experimentation should be explicitly linked to spatial and temporal scales and the identification and potential revision of indicators. Indicators, therefore, to be useful, must be explicitly tied to a spatial scale. A critical consideration is that processes that occur at one level of a system may not be indicative of dynamics at higher or lower levels (Allen and Starr 1982).

References

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