Key Concepts to Improve the Utility of Ecological Site Descriptions

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ABSTRACT
Ecological Site Descriptions (ESDs) represent a major change in the format and conceptual basis for interpreting observed changes on range, pasture and forest lands and for providing technical and financial support for the application of land management practices. With the acceptance of the possibility of multiple stable states and multiple pathways among those states, basic relationships between plants and soils should become an important organizing factor in determining how fundamental soil units are grouped together and interpreted for management. In this paper, we propose that changes to soil plant interactions, especially feedbacks, should be considered as important organizing factors in determining which soil properties are the basis of ESD organization. Although there are few accepted guidelines for making these decisions, realistic hypotheses and rigorous testing is possible to resolve many of the uncertainties.

1. INTRODUCTION
Introduction and implementation of Ecological Site Descriptions (ESDs) represent a substantial change to the basic concepts underlying the NRCS approach to providing technical assistance for land management. While ESDs are most often thought of as replacements for existing range site descriptions, ESDs are intended to be applied to all types of land, not just rangeland[1]. The inclusion of multiple land uses and management options, including simultaneous and shifting use patterns means that technical assistance must acknowledge a greater variety of management objectives and approaches.

Another important change to the conceptual basis for land inventory, monitoring and assistance for decision-making is the adoption of state and transition models as the primary means of describing and communicating site dynamics. Previously, range site descriptions classified and described dynamics based on the assumed 'climax plant community'. The new approach places a greater emphasis on site dynamics rather than the endpoint.

One constant remains, however. Ecological sites (and their predecessors: range sites, pasture and woodland suitability groups and forest sites) are based on groupings of soils with similar properties. Those groupings reflect the way soil attributes influence vegetation. In the fifty-plus years since the concepts underlying range sites were implemented, there have been major changes in the way we view soils and their interactions with plants. The purpose of this paper is to examine some of those changes and propose how they might affect our concepts for the development and implementation of ESDs.

2. Three Important Concepts
Aboveground and belowground components are inextricably linked and disturbances in one often initiate changes in the other[2]. Although we have long acknowledged these interactive relationships in the form of soil nutrients and crop growth and altered soil profiles (e.g. eroded surface horizons due to cultivation), we have only recently recognized the importance of more subtle and complex relationships in determining community dynamics. For example, our understanding of the importance of vegetation in providing inputs of organic matter to the soil system and the effect of that carbon on a variety of physical, chemical and biological processes that govern nutrient availability, moisture status and subsequently, plant growth has become the basis for an increased emphasis on the management of soil quality. For many years, we tended to look at these relationships as agronomic in nature, as processes that could be managed via cultural inputs. However, if ESDs are to be representative of ecological dynamics in response to land management, many types of land uses that do not rely on substantial cultural inputs must be accommodated.

Those soil plant relationships affected by feedback mechanisms are especially important to site dynamics. Many of these feedbacks possess breakpoints, or thresholds, where soil plant relationships change dramatically in response to relatively small changes in either component. These nonlinear relationships represent critical points for land management decisions, that once missed, are no longer viable decision points[3]. For example, numerous recent studies have shown that shrub invasion may alter soil attributes to the point that the removal of shrubs via mechanical or chemical means is insufficient to reestablish previously existing soil plant relationships. In extreme cases, wind and water may redistribute surface soil, irreversibly altering the soil plant relationships[4].

Based on the previous two premises, it follows that a system of ESDs designed to assist land managers in making critical decisions, whether it be in planning, implementation or monitoring, should incorporate critical soil plant relationships as a primary element. *Thus, groupings of soils into ESDs should be based on the soil plant interactions that govern site behavior, rather than an assumed endpoint.* This approach places the focus squarely on the need to improve understanding and quantification of 'transitions', those practically irreversible changes between distinct states. Initiating or avoiding these changes, depending on goals and objectives, are the essence of management. Because there may be multiple and changing pathways to achieve similar objectives based on any of several driving variables such as climate, invasive organisms or management, the fundamental links between soils and vegetation form the basis for an ESD system with widespread utility.

3. Implications for practical applications

Using an assumed endpoint as a means of grouping soils into sites, even though it has a shaky theoretical underpinning, had an advantage in that if the endpoint was defined loosely enough, general agreement was possible. Using dynamic properties and processes that result from complex interactions of soils and plants presents challenges that can only be resolved by application, systematic testing and subsequent refinement of the approach.

Because many soil map units are associations of distinct soils, several important questions must be addressed. Should soils be grouped into sites according to the most vulnerable soil in the association? Or according to the soil with the greatest extent? Which particular process or transition should site descriptions be organized around? Should alteration of soil physical structure or changes in soil biogeochemistry govern the organization of soil map units into sites? How does soil spatial pattern and landscape context influence dynamics?

Are temporal or spatial relationships more important? Should the emphasis be on increasing the resolution of delineating map units or on describing the transfer of matter and energy among interacting patches of soil and vegetation?

There are certainly no ready-made answers to these and many other questions. Given the nascent nature of the implementation of ESDs across regions, we suggest that it would be unwise to attempt to develop inflexible rules for grouping soil map units into ESDs. As always, these types of decisions are best made closest to where information is used. However, guidance and general rules to aid in making these organizational decisions can certainly improve the utility of ESDs for policy, program and management decisions. We suggest that all ESDs be considered hypotheses and a part of every site description is a discussion of uncertainties associated with using that site information and a formal set of recommendations for critical tests that can be used to resolve important questions about organization and interpretation of site data.

Thus, ESDs and the ESD system becomes a valuable tool not only for making decisions about managing plant communities, but also to guide research and development on land management.

4. REFERENCES

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