Alternative Approaches to Rangeland Management

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SUMMARY

Traditional range management is based on the ecological concept of the climax plant community, that is, the community which will dominate a site if disturbance is removed. Disturbance is viewed primarily as drought and/or livestock grazing. Under this approach, it is assumed that if overgrazing or drought caused a shift from the climax plant community, then simply removing grazing or returning to a normal precipitation pattern would allow the plant community to return to climax. This traditional ecological concept has been applied to agricultural fields with the intention of returning them to native vegetation. Theoretically, "go-back" fields and weed-infested sites should return to the climax plant community given enough time. However, there are many examples where this concept fails. For example, once western juniper gains dominance in a sagebrush community, only fire or mechanical removal will cause the community to return to the sagebrush/bunchgrass "climax". There are many examples of exotic weed invasions (e.g., cheatgrass, yellow starthistle) that have resulted in apparently permanent infestations. Ecologists generally agree that the ecological basis for traditional range management does not adequately explain the observed patterns of vegetative change. Ecological theories consistent with observations have been developed. We suggest that a new approach to range management, based on current ecological thinking, is required. One alternative is the "state-and-transition" approach, where potential plant communities (states) and observed factors allowing changes from one community to another (transitions), are catalogued for general types of rangelands. Managers refer to these historical catalogues to guide their decisions. If we include the primary ecological causes of vegetation change, that is, availability of suitable sites, availability of species, and the relative ability of individual species to survive and reproduce then it may be possible to combine scientifically based research information and management knowledge to predict the plant communities that will result from specific management actions.

INTRODUCTION

The ecological basis for traditional range management has been the climax plant community concept. This concept arose from ecological theories proposed by Frederick Clements during the early part of this century.

Clements spent 1913 and 1914 studying the vegetation of the western half of the United States. He came to the conclusion that vegetation was very orderly and viewed vegetation formations as complex organisms with characteristic development patterns (Clements 1916). Dyksterhuis (1949) refined the concept and placed it in a context that could be easily understood and applied. Basically stated, a given piece of rangeland will support a climax plant community if there are no major disturbances, and if a disturbance shifts the plant community it will gradually succeed back to climax. In this context, climax is viewed as a stable endpoint. For example, a heavily grazed sagebrush steppe community might be dominated by sagebrush and Sandberg's bluegrass. With reduced stocking rates the community might regain the perennial bunchgrasses, such as bluebunch wheatgrass, Idaho fescue, and Thurber's needlegrass that existed prior to overgrazing. The change from one plant community to another is called succession. This system defined the condition of rangeland by the departure from the climax plant community. A climax community is considered to be in excellent condition, good condition range is a minor shift away from climax, and poor condition would have a community of plant species very different from the climax. This approach provided a means of assessing range condition and resulted in major improvements in the rangelands of the world. The focus on vegetation and ecological principles allowed managers to assess the impacts of management. However, there were only limited attempts to explain why changes in plant communities occurred. There were examples of grazing systems where dramatic improvement in vegetation was observed, and many opinions as to why, yet few scientific studies of the ecological causes of plant community changes have been conducted. With the extensive use of this traditional approach came many examples where it was ineffective as a management tool.

Since the pioneering work of Clements, the field of plant ecology has made great strides. There has been recognition of the fact that disturbance (e.g., fire, drought, flooding, and grazing) is an important component of many ecosystems (White and Pickett 1985), that many plant communities are not at equilibrium with the environment, that climax may not be as constant as once assumed, and that some ecological changes occur more easily than others (there are thresholds). For example, climate has varied over time and some plant communities evolved under a previous climate. These communities may be able to persist because adults have a long life span (e.g., oaks), but they do not reproduce under the current climatic conditions. Thus, management aimed at restoring these relict communities will fail. Several alternatives to the traditional climax approach have been proposed (e.g., Westoby et al. 1989, Friedel 1991). State-and-transition models provide a way of organizing what is known about a particular type of rangeland. Laycock (1992) described such a model for the sagebrush steppe (Figure 1). The various types of plant communities are the potential states (boxes), and the transitions necessary to move from one community to another are defined by the arrows. Transitions are factors necessary to move a plant community in a particular direction, and are based on observation.

Another concept of importance in rangeland management is that of thresholds (Archer 1989, Friedel 1991). A threshold is a change that is difficult to reverse. In eastern Oregon the change from sagebrush/bunchgrass to juniper dominance might be considered a threshold, because returning to sagebrush/bunchgrass can be very difficult, depending on circumstances.

We have previously suggested that state-and-transition models provide a means of organizing information, but are limited in predictive capability (Svejcar and Sheley 1995). We feel that future approaches to range management should include the scientific mechanisms or explanations for why changes occur. Many management decisions are challenged and managers must be able to explain why they expect to see a particular response to a management decision. It appears there is a challenge to use "the best science" when making a management decision. What is lacking is a framework for combining science and management. We favor using the mechanisms of succession proposed by Pickett et al. (1987), i.e., availability of establishment sites, availability of species, and growth of individual species (or the ability to survive and reproduce) to help explain why changes might or might not be expected. For example, we are planning a prescribed fire in the sagebrush steppe and we wish to predict the outcome. We would need to ask the following questions: 1) Will burning open up establishment sites in the community? 2) If so, what species are available to occupy those sites? 3) Of the species available, which will perform or grow the best? If our goal is to increase native perennial bunchgrasses, we must make sure that opening up establishment sites does not result in a sea of the cheatgrass that out-competes the native bunchgrass seedlings. Also, if the appropriate native species are not present, we might want to provide the seed source (i.e., seed the site).

Combining what is currently known about a type of rangeland (summarized in a state-and-transition model) with the ecologically based mechanisms of succession (availability of sites, availability of species, and growth of species) might allow us to blend science and management in a manner that we can predict the outcome of management practices (Figure 2). There is a need for scientists to gain a better understanding of management, and for managers to gain a better understanding of science. We propose Figure 2 as a starting point in what we hope will be vigorous discussion of how to integrate science and management in the future. One advantage of Figure 2 is that economic and time estimates can be placed on each step. The potential communities can also be grouped according to management needs and/or sustainability. For example, potential plant communities 1 to 4 could be rated according to grazing potential during the four seasons. If a ranch lacked fall grazing opportunities, it might be worth considering the option of establishing a community that helps fill that void. The primary questions might be: 1) What type of communities are appropriate? 2) How long will they take to establish? 3) What are the costs and potential returns in the long run?

There are several limitations and concerns that we should mention in closing. First, we agree with Cairns (1990) that random events can influence succession, and therefore we must not assume that any ecological model will have rigorous predictive capability. There must be some flexibility in the predicted outcome. And second, the model must be viewed in a site-specific manner, with managers given the opportunity to develop predicted outcomes for their specific situations. There are no "cookbook" answers that can be applied across landscapes.

LITERATURE CITED

Archer, S. 1989. Have southern Texas savannas been converted to woodlands in recent history? Amer. Natr. 134:545-561.

Cairns, J., Jr. 1990. Lack of theoretical basis for predicting rate and pathways of recovery. Environ. Manage. 14:517-526.

Clements, F.E. 1916. Plant succession: an analysis of the development of vegetation. Carnegie Institute of Washington, Publication No. 242.

Dyksterhuis, E.J. 1949. Condition and management of rangeland based on quantitative ecology. J. Range Manage. 2:104-115.

Friedel, M.D. 1991. Range condition assessment and the concept of thresholds: A viewpoint. J. Range Manage. 4:422-426.

Laycock, W.A. 1991. Stable states and thresholds of range condition on North American rangelands: A viewpoint. J. Range Manage. 44:427-433.

Laycock, W.A. 1992. Alternative range condition concepts and models for sagebrush grass rangeland. *In*: T.J. Svejcar and J.R. Brown (eds) Proceedings of the Symposium: Is the Range Condition Concept Compatible with Ecosystem Dynamics? Annual Meeting, Society for Range Management. (Copies available from T.J. Svejcar).

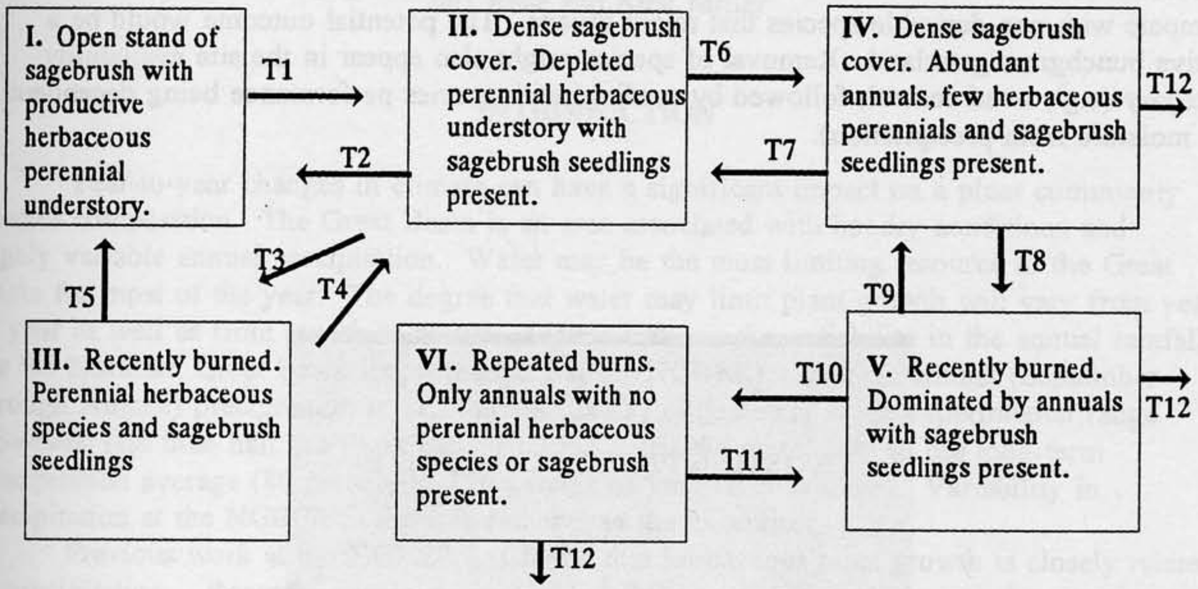
Pickett, S.T.A., S.L. Collins, and J.J. Armesto. 1987. Models, mechanisms, and pathways of succession. Bot. Review 53:335-371.

Svejcar, T.J. and R.L. Sheley. 1995. A Conceptual Framework for Integrating Natural Resource Management and Research. Proc. Inter. Rangeland Congress. (In press).

Westoby, M., B. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not a equilibrium. J. of Range Manage. 42:266-274.

White, P.S. and S.T.A. Pickett. 1985. The ecology of natural disturbance and patch dynamics. Academic Press.

Figure 1. State-and-transition model for a sagebrush grass ecosystem (from Laycock 1992). Notice that some transitions are difficult to cross and can be viewed as thresholds.



State-and-transition diagram for sagebrush-grass vegetation.

Catalogue of Transitions

Transition 1 - Heavy continued grazing. Rainfall conducive for sagebrush seedlings.
Transition 2 - Difficult threshold to cross. Transitions usually will go through T3 and T5.
Transition 3 - Fire kills sagebrush. Biological agents such as insects, disease, or continued heavy browsing of the sagebrush by ungulates could have the same effect over a longer period of time. Perennial herbaceous species regain vigor.
Transition 4 - Uncontrolled heavy grazing favors sagebrush and reduces perennial herbaceous vigor.
Transition 5 - Light grazing allows herbaceous perennials to compete with sagebrush and to increase.

If climate is favorable for annuals such as cheatgrass, the following transitions may occur:

Transition 6 - Continued heavy grazing favors annual grasses which replace perennials.
Transition 7 - Difficult threshold to cross. Highly unlikely if annuals are adapted to area.
Transition 8 - Burning removes adult sagebrush plants. Sagebrush in seed bank.
Transition 9 - In absence of repeated fires, sagebrush seedlings mature and again dominate community.
Transition 10 - Repeated burns kill sagebrush seedlings and remove seed source.
Transition 11 - Difficult threshold to cross if large areas affected. Requires sagebrush seed source.
Transition 12 - Intervention by man in form of seedlings of adapted perennials.

Figure 2. A schematic outline for using successional mechanisms to predict plant community changes. In the example from the text, we might define the current community as sagebrush dominated, choose burning to improve site availability, decide that existing vegetation can provide a seed source, and consider the life histories of the existing species adequate to compete with non-desirable species that might invade. The potential outcome would be a native bunchgrass grassland. Removal of species might also appear in the site availability category (e.g., weed control, followed by seeding, with species performance being dependent on moisture from precipitation).

EXISTING PLANT COMMUNITY

SUCCESSIONAL MECHANISM			
Site Availability	Burning	Protection	Grazing
Species Availability	Additions (seeding)	Existing	Removals (e.g., spraying, mechanical treatment)
Species Performance	Moisture	Nutrients	Life History

POTENTIAL PLANT COMMUNITIES

#1 #2 #3 #4