Viewpoint: Lessons from the Past for Managing Tomorrow's Range Ecosystems

Robin J. Tausch, J. Wayne Burkhardt, Cheryl L. Nowak, and Peter E. Wigand

Editor's Note:
This paper is a condensed version of the paper "Viewpoint: Plant Community Thresholds, Multiple Steady States, and Multiple Successional Pathways; Legacy of the Quaternary" published in the September 1993 issue of the Journal of Range Management.

Range ecosystems have seen dramatic changes over the last century and a half (Young et al. 1978, West 1983). Many studies have shown that the changes in the affected communities have not followed traditional concepts of plant succession (Johnston and Mayeux 1992). These traditional concepts were based on assumptions of environmental stability and eventual equilibrium conditions. What managers have been observing has been much more complex and without much evidence of environmental stability or long-term equilibrium (Westoby et al. 1989, Kaufmann 1993). Evidence from the past provided by paleoecological research is indicating that such complex and dynamic situations are more the norm than the exception.

Lessons from the Past

Paleoecological research provides information on both past variations in climate and the associated changes in plant communities. Records of temperature (Eddy and Bradley 1991, Webb 1991, Winograd et al. 1992, Taylor et al. 1993) and lake level fluctuations over the last 2 million years (Smiley et al. 1991) indicate that climatic variations in the past were highly complex (Tausch et al. 1993). Over the last 850,000 years, for example, there have been approximately 10 major glacial-interglacial cycles (Fig. 1). During this period temperatures have fluctuated by as much as 8°C. Average temperatures that are equivalent to those of today totaled only 10 to 15 percent of the period. On a geologic time scale this represents periods of drought in an otherwise glacial climate. The effects of these temperature variations on climate is evident, such as in the changes in pluvial Lake Lahontan in western Nevada (Fig. 2), which has had several fluctuations in lake level in only the last 35,000 years (Thompson et al. 1986, Benson 1991).

First and third authors are project leader and paleobiologist, Intermountain Research Station, USDA Forest Service, 920 Valley Road, Reno, Nev. 89512. Second author is associate professor, Department of Environmental and Resource Sciences, University of Nevada, Reno, Reno 89512, and the last author is associate research professor, Desert Research Institute, University of Nevada System, Reno 89506.

Fig. 1. Reconstruction of the history of surface temperature deviations for the last 850,000 years. Mean annual temperature deviations are for the mean value of the present century of about 15°C. Figure adapted from Eddy and Bradley, Earthquest, Spring 1991, Vol. 15, No. 1, Office for Interdisciplinary Earth Studies.

Fig. 2. Reconstructed pluvial Lake Lahontan levels for the past 35,000 years. Redrawn from Thompson et al. (1986) and Benson (1991).

Vegetation data for the last 45,000 years collected from woodrat middens (Betancourt et al. 1990) and for the last 200,000+ years from the analysis of pollen from lakes, bogs, and ocean sediments (Schoonmaker and Foster 1989, 1991) shows that vegetation responses to climate variations have been equally complex. At each point in space and time the combination of species and environment has been in some way unique (Tausch et al. 1993).
Throughout the period in Figure 1, with the exception of about the last 10,000 years, southwestern plant communities supported many different species of large grazing or browsing animals (Grayson 1991).

Today's plant communities are the result of their constituent species surviving over 2 million years of continual climate and other environmental variation (Schoonmaker and Foster 1991). These environmental variations have had a major influence in the on-going evolution of plants in response to their environment (Conklin 1992). Each plant species has responded individually to the climatic changes (Nowak 1991, Tausch et al. 1993). Many species have migrated hundreds of miles in the last 12,000 years, but the rates and directions have differed among species. The species present in a particular plant community today often arrived at different times, came from different locations, and had to cope with different adversities during migration (Davis 1986, Huntley 1991). The result has been continual changes in community composition and many modern communities that have no analog in the past (Webb 1987, Anderson et al. 1989). Many southwestern communities have dramatically changed in just the last century and a half. Some of these communities may have been relics from a previous climate that were sensitive to recent environmental changes and to the impacts of western settlement (Neilson 1986, 1987; Tausch et al. 1993).

The legacy of this past climate change is that plant communities are far less stable than they appear to be from our generally short-term historic perspective (Davis 1986). Models of ecosystem dynamics based on long-term equilibrium conditions have limited applicability. Such models are based on observations from too narrow a time base (Tausch et al. 1993). The principles and concepts of ecosystem management, and the ecosystem paradigms or models from which they are developed, need to incorporate the past, as well as the present conditions, to successfully project long-term future variation over both space and time (Johnson and Mayeux 1992, Tausch et al. 1993).

Experience from the Present

Additional evidence for dynamic communities is accumulating from management experience. We are finding that communities have multiple possible steady states, each with different species composition (Westoby et al. 1989, Friedel 1991, Laycock 1991). Between the different steady states are thresholds representing various levels of sensitivity to physical and biological disturbance. Once disturbance pushes the community across a threshold, the community composition changes. After the composition has changed, it often does not reverse when the disturbance is removed. These dynamics, plus the presence of similar patterns throughout the paleoecological record (Tausch et al. 1993), are affecting how we can define long-term management goals by defining the communities that are possible in the future.

Climatic variations of the past have continued to the present, including the last 150 years (Neilson 1986, 1987). The present 30 percent increase in CO₂ over pre-industrial levels is already changing the productivity patterns of plants (Polley et al. 1993) and this is altering the competitive interactions between plant species (Johnson et al. 1993). The future outcome of these competitive changes on community composition is mostly unknown. Research is needed to measure and understand these changes.

Combining Past and Present

Several important concepts can be developed by combining current ecological research results and management experience with the extended time-line and perspective provided by paleoecological information. These concepts need to be considered in the development of the longer-term aspects of the management of range ecosystems. Although effects vary between locations, no community or ecosystem is now without some level of human impact (West 1993). Communities of the future can never be exactly what they were in the past (Box 1992). Because our knowledge is still insufficient to fully grasp or to accurately predict the outcome of future vegetation-climate interactions (Mooney 1991), these interactions need to be a priority of research.

The many influences we have discussed are global in nature and represent various aspects of what is called global change. All communities on the earth are in some way managed systems, intended or not. Because we are indirectly as well as directly affecting the future of all ecosystems, a hands off approach is also management (Kaufman 1993, Tausch et al. 1993). Although we can't eliminate our influence, we can control and direct our actions to minimize undesirable results or accentuate desirable changes.

As recent paleoecological and ecological research results have shown, continual variation in ecosystems is not new. Only our awareness of the changes and their potential magnitude is new because the timescales at which we have been observing ecosystem variation have not matched the timescales at which the changes are occurring (Scholes 1990). Short-term information makes it difficult to recognize and estimate the magnitude of changes that take decades or longer to occur. Time lags, common in ecological systems, can conceal evidence of mismanagement and the links between cause and effect, further confusing our interpretation (Scholes 1990). The management of range ecosystems needs to consider the many global change problems and the perspective provided by paleoecological information in the development of long-term planning.

The paleoecological record and the history of the last two centuries of land use are clear. If we manage for the future by trying to recreate communities of the past, most of our efforts will not succeed because the conditions that made those past communities possible no longer exist. The resulting community may resemble a community present on the site at some past time, but it also may not. To determine a desired future condition for a site will require an understanding of the future capabilities or
possibilities of that site along with its potential uses. (Tausch et al. 1993). These decisions also need to be based on an increased understanding and sustainment of ecosystem function and biodiversity so as not to foreclose on future options. Often there is more than one community that can achieve the same management goals (Johnson and Mayeux 1992). Knowledge of past climate variation and the associated changes in environments and communities is equal in importance to knowledge of present conditions for understanding the management implications of such complex ecosystem dynamics (Tausch et al. 1993).

While it is one thing to recognize the need for new methods and models, it is another to produce them (Keddy 1992). The hardest part of management for sustaining ecosystem function will be the extrapolation of the trajectories of change from the past, through the present, and into the future (Mooney 1991, Tausch et al. 1993). A promising way to accomplish this is to gather information in a way that facilitates the verification of general predictive hypotheses that can be assembled into general models applicable to landscapes. This requires sufficiently large numbers of sampled species to (1) statistically test correlations between specific traits representing basic functions of organisms and environmental parameters; and (2) determine whether the observed patterns represent widespread responses or are specific to only a few species (Keddy 1992). Examples of efforts beginning the movement in this direction include Bosch and Booyse (1992), George et al. (1992), and Leonard et al. (1992).

References


Frasier's Philosophy

In recent months I have had several people express concern about the costs associated with the Society's two journals, the Journal of Range Management and Rangelands. The concerns are from both sides of the issue—how much it costs an author to publish an article, primarily with respect to the Journal of Range Management, and should the membership dues be used to "subsidize" the publications, especially Rangelands.

With respect to page charges, specifically in the Journal of Range Management, there are several scientific publications that do not assess the authors page charges for publication. They use other sources—dues, subscriptions, etc.—to pay the costs of their publications. Some people have used this criterion as the reason to publish their material elsewhere. It is the authors' prerogative to select the outlet for their material. At the same time we (the Journal of Range Management) have developed a scientific credibility to a point that some authors are stating that the JRM audience is the one they wish to address. In the current economic times when a research project frequently costs tens of thousands of dollars to conduct, the few hundred dollars to publish in the Journal of Range Management may be a minor component of the total cost.

There is also the statement that "I wish I didn't have to receive the Journal of Range Management. It is too technical and I don't read it." We must remember that the Society for Range Management was formed to provide a professional organization to "...insure the best management of our range resources." (Our Range Society' by Joseph F. Pechanec, Journal of Range Management, Vol. 1, No. 1, Oct. 1948; Rangelands Vol 15, No. 3, Jun 1993).

Our respect as professionals is entirely based on the scientific credibility of the information we use to make our management decisions. Today, the Journal of Range Management is a scientifically credible journal. When our Society officers make a statement about proper resource management, the validity for the statements is frequently based on information published in the Journal of Range Management. Without a scientific background, the statements are opinions. When you receive the Journal of Range Management as a part of your membership, you have in your possession the scientific proof with which "you" can provide information to others on proper resource management.

With respect to the question "Should membership dues be used to support the publications?", it all depends upon what you want out of the Society. If we had no publications, many members would get nothing for their "bucks." Rangelands is a means for getting technical information to the readers who "do not understand" the Journal of Range Management. Rangelands provides information on the history of our great rangeland resources and the people who made it what it is (good or bad). Rangelands is a forum for expressing ideas and thoughts on the past, current, and future management of the rangeland resources.

Is all of this worth a portion of your dues? This is for everyone to decide for themselves.

When you are making a success of something, it's not work. It's a way of life. You enjoy yourself because you are making your contribution to the world—Andy Granatelli