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Source: Rangeland Ecology & Management, 67(6):603-613.
Published By: Society for Range Management
DOI: http://dx.doi.org/10.2111/REM-D-13-00102.1
URL: http://www.bioone.org/doi/full/10.2111/REM-D-13-00102.1

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Rangeland Ecol Manage 67:603–613 | November 2014 | DOI: 10.2111/REM-D-13-00102.1

Incorporating Plant Mortality and Recruitment Into Rangeland Management and Assessment

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Abstract

Rangeland management is largely focused on managing vegetation change. Objectives may include managing against change if the desired vegetation is in place, or attempting to create a shift in vegetation if the desired plant community is not present. There is a rich body of research documenting influences of disturbance and management on rangeland vegetation. However, in many cases the information is largely observational and does not identify mechanisms driving change. We propose using the regeneration niche concept to more effectively predict when vegetation change is possible and to suggest successional direction. Simply stated, as plants die and leave gaps in the community, recruitment of new individuals will dictate successional direction. Recruitment requires that propagules are present, that the propagules find safe sites in which to establish, and that the seedlings and young plants are able to compete with existing vegetation and survive. In many rangeland communities, perennial bunchgrasses are a key to stability and invasion resistance. Existing literature shows that most rangeland bunchgrasses have average life spans of 10 yr or less, so periodic recruitment is necessary to maintain communities in which they are a major component. Disturbance can influence plant population dynamics, and we suggest classifying disturbances based on how they influence mortality and recruitment. We also suggest that more emphasis be placed on the concept of critical transitions and less on the degree of disturbance per se. In other words, a small disturbance at the wrong point in community composition (low plant density and high gap size for example) can cause a transition, whereas major disturbance in a high condition community may yield little risk of transition. We suggest that a focus on mortality and recruitment will provide a mechanistic approach for predicting vegetation change and making management decisions. We refer to this approach as recruitment-based management.

Key Words: disturbance, plant succession, recruitment, state-and-transition models, thresholds

INTRODUCTION

A substantial portion of rangeland management is focused on vegetation change. Many biotic and abiotic factors influence this process, and the complex nature of rangeland management can create a large array of management options, potential vegetation outcomes, and modifying factors. Much of the research on vegetation change involves measurements of plant community composition over time, after a disturbance or application of a management treatment. Most management knowledge is similarly acquired by observing changes, but often without data collection. In both research and management contexts, the conclusions apply to the specific conditions under which the observations were made. A disadvantage of using this type of knowledge is the lack of a mechanistic basis and thus limited predictive ability (Svejcar and Sheley 1995). Without a mechanistic understanding, it will be difficult to assess how a slight shift in driving factors might impact vegetation dynamics. The lack of predictive ability is a major shortcoming of vegetation management in general.

One approach to improving our ability to predict vegetation change revolves around population dynamics and life history analysis. Although we have limited information on the life span of perennial rangeland plant species, it is clear that many herbaceous species do not live more than a couple of decades (Wright and Van Dyne 1976; West et al. 1979; Lauenroth and Adler 2008). When plants die, they create gaps in communities which can be filled by existing dominant species or by new or rare species. This relatively simple concept was termed the "regeneration niche" by Grubb (1977), and is a critical phase from the standpoint of plant community change or resilience. There is mortality associated with a species' life span, but there is also mortality associated with both natural and human-caused disturbance. These disturbances can be relatively short duration (e.g., fires, insect and disease outbreaks, seasonal drought), or long duration (e.g., climatic shifts, chronic heavy grazing, alien species invasions). We are much more effective at evaluating the impacts of short-term disturbances on vegetation change than those of long-term disturbances. Vegetation shifts associated with the more subtle and long-term disturbances can be difficult to detect, especially in the early stages.

In a stable plant community, recruitment of new individuals is roughly equal to mortality, whereas replacement by other species indicates a community shift. Plant species have a variety of reproductive strategies associated with different life histories (e.g., Grime 2002). Many of the strategies are a result of ecological trade-offs—where allocation to one function results in a corresponding decrease to other functions (Fenner and Thompson 2005). For example, some plants have very rapid growth rates, but do not compete well for soil resources (Grime

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Manuscript received 24 June 2013; manuscript accepted 31 May 2014.

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