Weather Variability and Adaptive Management for Rangeland Restoration

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The Ecologically Based Invasive Plant Management (EBIPM) model for restoration planning is based on a conceptual framework for understanding successional dynamics and trajectories, but with specific guidance and tools for practical implementation.[1] Weather variability impacts all aspects of the successional processes underlying the EBIPM model.[2] Recent reviews have discussed the interactions of weather and seedbed preparation treatments on site availability and seedbed microclimate.[2,3] In this paper we will discuss weather variability, and how local weather knowledge can be used in EBIPM planning, interpretation of monitoring data, and development of adaptive management strategies for rangeland restoration.

Weather is the real-time combination of atmospheric inputs that drives seedbed temperature and water relations. Most seedbed preparation and planting treatments are designed to optimize soil microclimate for plant establishment, but these treatments are generally prescriptive and cannot compensate for episodic drought and temperature stress that can occur at a given site and year.[3] Restoration planners have primarily used weather information for retrospective assessment of success and failure. A recent survey of the rangeland seeding literature observed that for studies reporting some level of successful establishment, the vast majority were conducted in years or establishment seasons with average or above average precipitation.[3] This implies that weather thresholds may exist below which any given restoration treatment may be unsuccessful.

Climate is the long-term average characterization of weather. Climate data have been shown to be correlated with the historical distribution of plant species and are primarily used to select appropriate plant materials for a given site.[3] Seeding guides commonly contain tables listing species suitability as a function of average precipitation and soil texture. Unfortunately, the microclimatic requirements for seedling establishment are much more restrictive than the climatological averages that explain the historical distribution of mature plant communities.[3]

Current successional models acknowledge that there is a restricted set of weather conditions under which successful recruitment and establishment can occur. Weather and climate data are increasingly available for remote rangeland locations, but few tools exist to exploit these data in planning and management.[2] It might be possible in the near future to use real-time weather forecasting to assist in restoration management decisions, which in the Intermountain western United States are often made in the fall, several months before the critical season for plant establishment.[2,3] Even with forecasting tools, however, weather constraints will require adaptive management for planning and implementation of restoration projects in highly variable rangeland systems. The EBIPM framework uses an adaptive management approach to understand and adjust to uncertainty in the planning process.[1] The purpose of this article is to outline how weather and climate information can be used to facilitate EBIPM and adaptive-management planning. We have structured the following discussion to follow the eight steps to adaptive management outlined in EBIPM management planning guides.[4,5]

Goal Setting

Realistic rangeland restoration goals need to take into account the high variability in rangeland weather. Rangelands are generally arid or semiarid, but are also highly variable from year to year. Annual climate indices might be insufficient to characterize expected variability in seedbed microclimate. For example, the correlation between annual and spring precipitation is only 32% for records in Boise, Idaho, and precipitation alone accounts for only 54% of the variability in predictions of microclimatic favorability for seed germination.[6] Boise weather records also show that the inherent variability in precipitation is approximately 25%, 40%, and 80% of the mean for annual, March–May, and monthly precipitation, respectively.[6] Increased variability in shorter time scales can have a relatively large impact on the periodicity of mortality events that cannot be predicted by analysis of long-term climate averages.[6,7] Inherent variability in rangeland weather