Ecosystem management in pasture communities: tools from restoration ecology

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Introduction Pasture systems have the potential to improve both economic and environmental sustainability in agricultural communities worldwide. To achieve maximum benefits, pasture plant communities must be tailored to the climate, the site type and the goals of the producer. Little is known about how to accomplish this, beyond very broad recommendations. We approached the problem by adapting a three-step conceptual framework from restoration ecology for use in managed pasture communities of the northeastern United States. The three steps, inventory, assessment and remediation, were designed for managers interested in restoring degraded native ecosystems, but can be applied equally well in managed ecosystems.

The first step, inventory, involves a detailed examination of what is present in pasture plant communities, and how community composition relates to soil factors, climate and management. Assessment is the comparison of the existing ecosystem to a target system. For restoring degraded systems, the appropriate target is usually obvious, but in managed ecosystems, the choice of target condition is much more problematic. The target must be appropriate for the climate, topography and soils, be sustainable both economically and ecologically, and satisfy the requirements of the producer. Potential requirements for pasture systems include total production, growing season length, invasion resistance and drought tolerance. Remediation is the process of moving from the existing state to the target by altering management to produce and maintain the desired state. We present here the results from regional inventory and initial assessment phases.

Methods The inventory phase was begun in 1998 with detailed sampling of plant community composition and soil properties on farms across the northeastern United States. Plant sampling was conducted using the multiscale modified Whittaker plot, which has subplots of 1 m^2, 10 m^2, 100 m^2 and 1000 m^2 (Stohlgren *et al*., 1995). Soil properties were measured using a standard soil test pooled across the pasture. As part of developing appropriate reference conditions for various objectives, we have been using the Pasture Condition Score, a ten-element semi-quantitative index, as a general assessment tool (Cosgrove *et al*., 2001). Additional management information has been collected from producers whenever possible. Relationships between plant community composition and environmental factors were assessed using the Mantel test (Mantel, 1967).

Results We have sampled 126 pastures on 42 farms over the past seven years. Many of these pastures have been sampled repeatedly, for a total of 227 modified Whittaker plots. We have found 286 plant species. Most of these were rare: 181 were found in less than 5% of the plots, and only 14 were found in more than half. Two species, white clover and dandelion, were nearly ubiquitous, found in 98% of the plots. Plant community composition was strongly related to latitude and related to the topographic factors elevation and aspect. Phosphorus, pH, organic matter and texture were the soil properties most closely related to vegetation. Although the overall Pasture Condition Score was not strongly related to plant community composition, the relationships with certain individual elements - percentage cover, uniformity of use, standing dead and plant vigour – were highly significant.

Discussion We found far more species in pastures than were expected. Although most were rare, a few were nearly ubiquitous. Any management plan for pasture vegetation should assume that some of these species will be present, whether planted or not. The strong significant relationships between location, topographic factors, soil properties and plant community composition illustrate clearly the importance of including environmental information when choosing the management goals for a pasture system. While the survey results presented here are a valuable first step, additional information on plant species function alone and in mixtures is required to develop appropriate target communities. This is being addressed by ongoing greenhouse and small-plot studies. The results of these experiments will allow us to evaluate the ecosystem function of existing pastures based on inventory data, and to design pasture plant communities to meet economic and environmental goals. Restoration ecology, which deals with creating and maintaining particular ecosystem types, can provide valuable lessons for the management of pasture ecosystems.

References

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