

Scientific Challenges in Shrubland Ecosystems

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Abstract—A primary goal in land management is to sustain the health, diversity, and productivity of the country's rangelands and shrublands for future generations. This type of sustainable management is to assure the availability and appropriate use of scientific information for decisionmaking. Some of most challenging scientific problems of shrubland ecosystem management are non-native invasive species, probable effects of global climate change, detrimental effects due to land use change, restoration of degraded environments, and maintaining the quality and quantity of water.

Introduction

One of the primary goals of land managers and landowners in the Western United States is to sustain the health, diversity, and productivity of our Nation's rangelands and shrublands to meet the needs of present and future generations. Effectively meeting this goal requires current information about the land and its resources, an understanding of the public's wishes, and actions that support the environment, the economy, and the local community. Key to attaining this goal is the availability of scientific information and the appropriate use of that information in informing decisionmaking. Sustainable management provides research the context and purpose to address some of our most difficult scientific challenges in shrubland ecosystems. These challenges include the: (1) biological invasion by nonnative invasive species, (2) probable effects of global climate change, (3) detrimental effects due to land use change, (4) restoration of degraded environments, and (5) maintaining the quality and quantity of water.

Nonnative Invasive Species

These species are one of the greatest threats to rangeland health, even though they might be considered both a cause and consequence of ecosystem degradation. Invasive species can compromise an ecosystem's ability to maintain its structure or function and can dramatically increase fire frequency and intensity, reduce property values, and increase management costs. In the future, it is likely that these impacts will be exacerbated by global climate change because scenarios suggest more favorable conditions for the introduction and spread of invasive species.

In: McArthur, E. Durant; Fairbanks, Daniel J., comps. 2001. Shrubland ecosystem genetics and biodiversity: proceedings; 2000 June 13–15; Provo, UT. Proc. RMRS-P-21. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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Scientific information is critically needed to prevent and mitigate the extensive invasive species damage on our rangelands. It is crucial that more emphasis be placed on pathway analyses, risk assessments, and predictive models. Further research and development is also needed on the biology and ecology of invasive species, their host-site relationships, and monitoring protocols.

Probable Effects of Global Climate Change

Our current natural ecosystems are threatened by the probable effects of global climate change. Future scenarios suggest that the rate of global climate change will increase and the magnitude and frequency of ecological processes will likely be greater in the next 100 years. This means there may be many scientific uncertainties. Science and technology opportunities need to focus on reducing the risks of climate change and adapting to the inevitable changes. Additional efforts are needed in assessing potential thresholds and breakpoints, improving long-term data sets and baseline indicators to measure environmental conditions, assessing the impacts of multiple stresses, and focusing on future changes in severe weather and extreme events.

Detrimental Effects Due to Land Use Changes

Shrublands play a key role in sequestration and greenhouse gas emissions. However, their location, composition, and health are noticeably changing because of land use changes. These land use changes have the potential to alter the balance between emissions and absorption and negatively impact ecological conditions. We need to understand the physical, biological, and social interactions within a fragmented landscape. Land use change research should include remote sensing, modeling techniques, and spatial analysis products to improve this understanding.

Many of our Nation's watersheds are deteriorating at alarming rates. Degraded, poorly functioning ecosystems limit our management options and increase the expense and frequency of our management activities. This degradation and disturbance can include a loss of ecosystem resilience and productivity, accelerated erosion and impaired soil development; accumulations of nutrients and chemicals, alterations in the biogeochemical cycles and hydrologic pathways, artificial and simplified structure and composition, modification of interactions and dynamics, reductions in biological diversity; and deterioration of water quality.

Restoration of Degraded Environments

Whether the cause is an influx of invasive species or harmful environmental effects due to land use change, there are an increasing number of acres needing restoration, an increasing number of conflicts over treatment options, and rising restoration costs. These trends indicate that lagging ecological restoration represents a major impediment to sustainable management of ecosystems at individual sites and at landscape scales. Clearly, there is a major need for additional investments in restoration science. Additional efforts are needed to study economic costs, benefits, risks, and efficacy of restoration options, prioritization methods for restoration actions, postrestoration prediction models, and performance monitoring. Areas for restoration emphasis should include ecosystems impacted by nonnative invasive species, degraded high-priority watersheds, and fire damaged lands.

The urgency of the restoration challenge facing resource managers and users is increasing. The demands of expanding human populations and development are making it progressively more difficult to conserve native flora and fauna, and to sustain the delivery of ecosystem goods and services from increasingly degraded public lands and waters. Degraded, poorly functioning ecosystems significantly limit management options. Nevertheless, public land and resource management agencies are mandated to protect and restore the health and productivity of the ecosystems entrusted to their stewardship. Unfortunately, management policies and practices are inadequate and in some cases inappropriate for restoring ecosystems to fully functioning condition. This management inadequacy is largely because the scientific basis for restoration based on understanding of the structure, composition, and function of ecosystems and their resilience to human and natural disturbance is inadequate.

Maintaining the Quality and Quantity of Water

Healthy watersheds play a vital role in maintaining the integrity of our water systems to supply people with drinking water, recreation, and commodities. Reducing erosion and contaminated runoff, maintaining soil quality and productivity, and safeguarding water quality and quantity will help maintain healthy watersheds. Research focusing on stream corridors and riparian areas, abandoned minelands, and headwaters is needed to perpetuate healthy watersheds. Basic and applied research on the effects of land management on the functioning of watershed and riparian landscape features and long-term process studies on fire and grazing continue to be of important in providing a scientific basis for restoring sensitive watersheds.

Our research can provide insight into long-term trends in the health and productivity and provide critical data to identify or predict potential changes caused by these scientific challenges.

In closing I would like to stress the importance of accountability. We need to do a better job documenting the impact of these scientific challenges and highlighting the value of the shrubland resource. This documentation requires consistent, comprehensive information. The Montreal Process Criteria and Indicator framework (figure 1) is an operational framework that provides reliable and accurate resource condition information about the extent, condition, and trend of sustainability across the landscape. This common language can communicate to a wide array of audiences across multiple scales, climatic zones, regions, agencies, and ownership boundaries while the consistent methodology provides a foundation for effectiveness and warning of critical issues. The Montreal Process, as it pertains to rangelands, is described in a special issue (volume 7 number 2) of "The International Journal of Sustainable Development and World Ecology" (Flather and Sieg 2000; Joyce 2000; Joyce and others 2000; McArthur and others 2000; Mitchell and Joyce 2000; Neary and others 2000).

Thank you for the invitation to give this presentation. I look forward to hearing more about the exiting new knowledge and technologies that are developing to help us sustain the health, productivity, and diversity of our private and public shrublands.

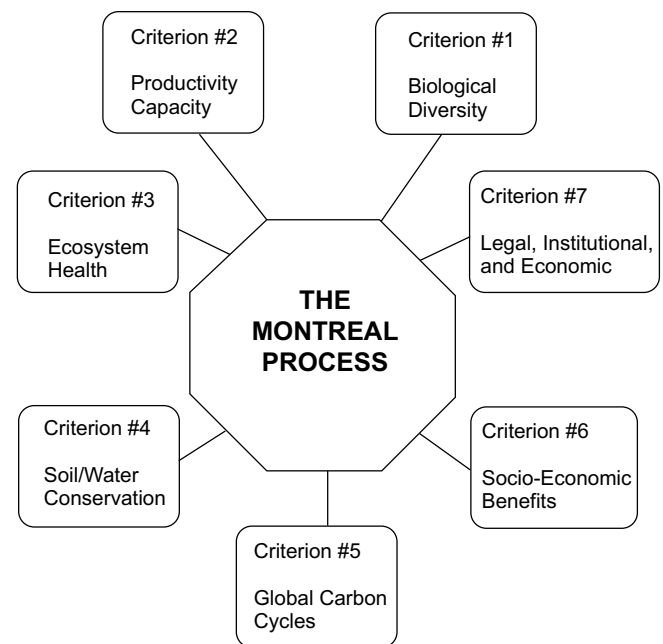


Figure 1 — Seven criteria (shown here) and 67 criteria make up the Montreal Process.

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