A Framework for Sagebrush

A NEW RESILIENCE-BASED APPROACH HELPS MANAGERS ASSESS RISKS AND PRIORITIZE ACTIONS

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Credit: Jeremy Roberts, Conservation Media

▲ The vast sagebrush sea encompasses almost 182,000 square miles in the western United States and supports a large diversity of habitats and species.

An unprecedented conservation effort is underway across 11 western states to address risks to sagebrush ecosystems and the species that depend on them. The sagebrush biome — the largest biome in the Lower 48 states — provides a large diversity of habitats and supports more than 350 species of conservation concern. Since Euro-American settlement in the mid-1800s, this "sagebrush sea" has been reduced in area by nearly half and many of the remaining sagebrush ecosystems have been significantly altered.

The primary risks to sagebrush-dependent species vary over the vast sagebrush biome. In the west, invasion of highly flammable, exotic annual grasses is resulting in more frequent and larger fires. In recent years, these ecosystems reached the era of megafires. Between 2000 and 2018, over 15 million acres burned within sagebrush shrublands, mostly in Oregon, Idaho, Nevada and Utah – more area than burned in western forests during the same period. In Montana, Wyoming and Colorado oil and gas development coupled with conversion to cropland is resulting in progressive habitat fragmentation. The continued loss of sagebrush habitats has placed many species at risk, including greater sage-grouse (*Centrocercus urophasianus*), which has been considered for listing under the Endangered Species Act several times and whose status will be reevaluated this year.

Shared stewardship

Combating risks to sagebrush ecosystems requires effective shared stewardship — working together with partners to do the right work in the right place and at the right scale. Shared stewardship is about increasing our ability to manage multiple resources across land jurisdictions in an integrated and collaborative manner. It enables management focused on maintaining the necessary biological diversity, habitat connectivity and adaptive capacity to sustain ecosystems into the future. Shared stewardship is especially important in the sagebrush biome, where federally managed lands range from 29% in Montana to 80% in Nevada, and federal land management agencies, state agencies, tribes, private landowners and other partners all have a stake in management decisions.

Recently, a diverse group of partners came together to develop the Science Framework for Conservation and Restoration of the Sagebrush Biome, providing

a strategic, multiscale approach for managing risks that facilitates shared stewardship across the biome. The Science Framework provides the necessary scientific information and decision-support tools to enable managers to prioritize areas for conservation and restoration actions where they are likely to have the greatest benefits and to determine the most appropriate management strategies and actions for prioritized areas. Part 1 provides the science basis and overall approach (Chambers et al. 2017), while Part 2 provides the specific management applications (Crist et al. 2019).

The strategic, multiscale approach used throughout the Science Framework was developed by state and federal collaborators, including the U.S. Department of Agriculture, the Department of the Interior and the Western Association of Fish and Wildlife Agencies, with representatives from across the Intermountain West. Input into the management strategies provided in the Science Framework was obtained not only from state and federal partners, but also from university partners, NGOs, tribes and private landowners.

To ensure relevance to management agencies, the Science Framework includes scales that range from the national to the district or field office level and can be used in different aspects of the planning process. Prioritizations of areas for management actions are typically conducted for ecoregions or large planning areas with similarities in environmental characteristics, risks and management strategies. These assessments can be used to help with budget prioritization and ensure consistency in allocating funds for the sagebrush biome as a whole. At the district or field office, site-level data and expertise can be used to select project sites and determine appropriate management strategies and treatments within areas prioritized for management.

Resilience and resistance

The Science Framework uses a new approach that integrates information on the ecological resilience of ecosystems with species conservation. Traditional assessments of relative risk to habitats are based primarily on the likelihood of an area supporting species' populations and the potential effects of natural or human-caused disturbances, such as wildfire or energy development, on species' habitats. This new resilience-based approach incorporates information on environmental and ecosystem characteristics, such as climate, soils and plants, which allows managers to better assess how an area is likely to respond to disturbances and management actions. Specifically, will the species' habitat recover as desired or is there a risk of irreversible habitat change?

The new approach is based on recent research that provides the basis for characterizing sagebrush ecosystems according to their ecological resilience to disturbance and resistance to invasive annual grasses (Chambers et al. 2014, Chambers et al. 2019). In states farther to the west, sagebrush ecosystems are at high risk of developing invasive annual grass-fire cycles. On the eastern side, they are experiencing a high number of plant invasions due to human development activities. Consequently, understanding relative resistance to invasion by nonnative plants is as important as understanding resilience to fire and human-caused disturbance. Resilient ecosystems have environmental characteristics and ecological conditions that allow them to reorganize and regain their basic characteristics — to recover — when altered by disturbances, such as wildfire. Resistant ecosystems have characteristics that limit the establishment and expansion of invading plant species.

Resilience and resistance vary across the strong environmental gradients within the sagebrush biome. Cooler and wetter areas are typically more

Credit: Douglas Shinneman, U.S. Geological Survey, Department of the Interior

▼ **A major risk to sagebrush ecosystems and the species that depend on them is the spread of invasive annual grasses and increases in wildfire frequency and size.**

Credit: Emily Kachergis, Bureau of Land Management, Department of the Interior

▲ **Partners are working together across the sagebrush biome to assess habitat conditions and determine the best strategies for increasing habitat resilience to disturbances like wildfire.**

resilient and resistant than warmer and drier areas. Areas that receive most precipitation in winter and have dry summers are less resilient and resistant than those that receive a high proportion of their yearly rainfall in summer. Because plant species' composition and abundance are often dependent on soil temperature and moisture regimes, and these regimes differ across the sagebrush biome, they can be used as indicators of potential resilience and resistance (Maestas et al. 2016). These regimes are mapped as part of the National Cooperative Soil Survey and can be used to assess an area's resilience and resistance.

Credit: U.S. Fish and Wildlife Service, Department of the Interior

◀ **The iconic greater sage-grouse serves as an umbrella species for other sagebrush-dependent species because it requires large areas of intact sagebrush, and declines in its numbers can indicate changes in the condition of sagebrush landscapes that are likely to affect other species.**

A focus on sage-grouse

The resilience-based risk management approach in the Science Framework is based on three factors. What is the likely response of an area to disturbance or management actions — its resilience to disturbance and resistance to invasion by nonnative plants? What is the capacity of an area to support high-value resources? And what are the predominant risks to the ecosystem? A spatially explicit approach enables managers to quantify and visualize differences in resilience and resistance across the landscape in relation to species' habitat and the risks.

The framework's focus is sage-grouse. The largest grouse species in North America, it depends on sagebrush for protective cover and food from chick to adult. Sage-grouse are often managed as an umbrella species for sagebrush-dependent species because they require large intact areas of sagebrush, and declines in their populations often indicate changes in conditions that are likely to affect other species.

In the risk management approach, modeled breeding bird habitat probabilities are used to indicate the likelihood of an area supporting sage-grouse. Sage-grouse habitat probabilities are based on analysis of the relationships of breeding bird densities to general landscape characteristics, such as cover of sagebrush, climate, landform and disturbance (Doherty et al. 2016). For species that lack such explicit models, variables such as the type and extent of landscape cover can provide a viable alternative for assessing the probability of suitable resources and deciding on management actions.

Because risks to sagebrush ecosystems vary across the biome, the risks included in the assessment depend on the planning area. In fire-prone areas on the western side, the risk of large fires and cover of

annual grasses and forbs are most important. In the eastern part of the biome, the proportion of land tilled annually for agricultural crops or the number of active oil and gas wells per square mile may be of primary interest.

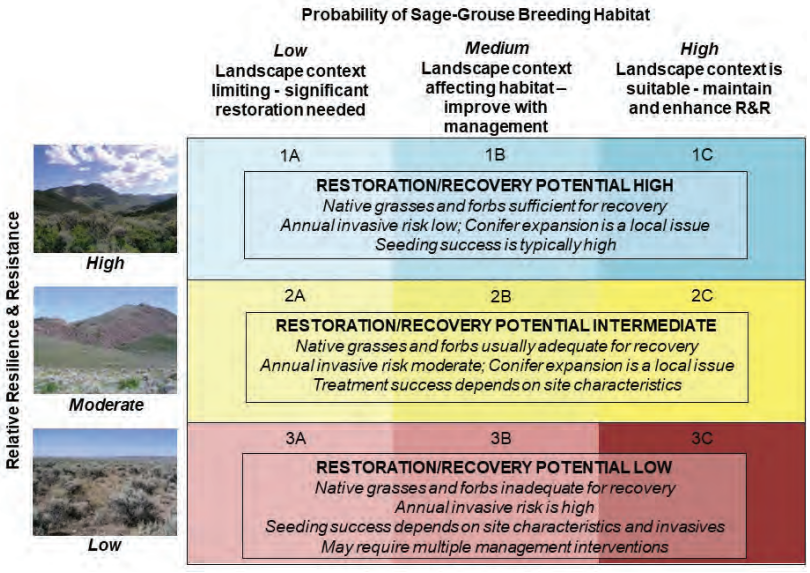
Strategies on the ground

A real strength of the Science Framework is the ability to link conservation and restoration strategies directly to mapped locations on the ground. The sage-grouse habitat resilience and resistance matrix provides a decision-support tool that allows managers to better evaluate risks and decide where to focus specific activities to promote desired species and habitat conditions. As resilience and resistance go from high to low, as indicated by the rows in the matrix, the amount of time required for the sagebrush community to regrow increasingly limits the capacity of sagebrush habitats to recover after disturbances without management assistance. The risk of invasive plants also increases, and the ability to successfully restore burned or otherwise disturbed areas decreases.

As the probability of sage-grouse breeding habitat goes from low to high within these same habitats, as indicated by the columns in the matrix, the capacity to sustain populations of sage-grouse increases. Management strategies can be developed for each cell in the matrix that incorporate both ecosystem recovery potential and species population information. Knowledge of the dominant natural and human-caused risks provides additional information for deciding on strategies.

Overlaying the resilience and resistance categories with the probability of sage-grouse breeding habitat on a map provides a clear picture of which areas should be prioritized for management. The different colors on the map can be related directly to the sage-grouse habitat resilience and resistance matrix and management strategies provided in the Science Framework.

Areas with high habitat suitability may be considered for protective management — establishing conservation easements, stepping up invasive species control efforts and, where appropriate, fire prevention and conifer removal to maintain or improve habitat connectivity. Areas with low resilience and resistance are at greatest risk following disturbances, and those with high habitat suitability are among the highest priorities for active management — fire suppression and fuels management, improved livestock grazing management and early detection and rapid response management of invasive plant species.



Credit: U.S. Forest Service, Rocky Mountain Research Station

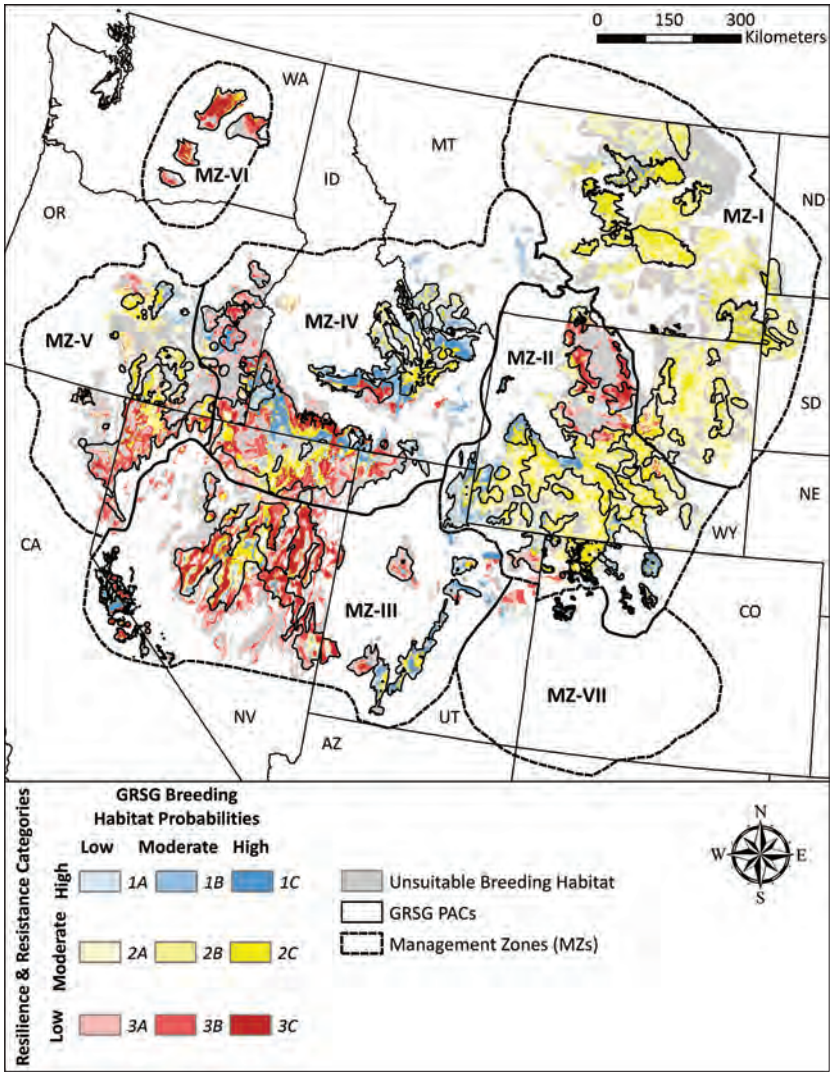
▲ A sage-grouse habitat resilience and resistance matrix helps managers evaluate an area's relative resilience and resistance — or recovery potential — and its capacity to support sage-grouse in order to prioritize areas on the landscape for management actions.

The local level

Once priority areas and overarching strategies are identified, specialists working at the district and field office level can identify project areas and determine appropriate management strategies. At this stage, local specialists often use higher resolution data, but the same factors — resilience and resistance, breeding habitat probabilities and primary risks — are still important considerations. To enhance their assessments, they can use additional data on habitat condition, which for sage-grouse may include information on brood-rearing habitat.

The Science Framework provides the necessary information and decision-support tools for managers to work with stakeholders to select the specific management actions and tools for improving prioritized habitat.

In Part 2, individual sections co-produced by land manager and research teams focus on key resource management topics in the sagebrush biome — monitoring and adaptive management, climate adaptation, wildfire and vegetation management, nonnative invasive plant management, application of National Seed Strategy concepts, livestock grazing management and wild horse and burro considerations.



Credit: U.S. Forest Service, Rocky Mountain Research Station

▲ **A map overlaying relative resilience and resistance with the probability of greater sage-grouse breeding habitat helps visualize the areas that should be prioritized for management and determine appropriate management strategies as described in the sage-grouse habitat resilience and resistance matrix.**

Each section includes the basis for identifying risks and prioritizing areas for management using the resilience-based risk management approach. The best available information on management options and effectiveness is included, as well as potential environmental consequences and administrative realities. Also discussed are the tradeoffs associated with managing diverse resources across large landscapes.

A model for management

The Science Framework is being widely used to inform emerging strategies to conserve sagebrush ecosystems, sagebrush-dependent species and human uses of these sagebrush systems. It is directly linked to the U.S. Department of the Interior's Integrated Rangeland Management Strategy and ongoing multi-partner conservation efforts, such as the Sagebrush Conservation Strategy led by the Western Association for Fish and Wildlife Agencies.

The Science Framework is also being used to assist managers in prioritizing and planning on-the-ground conservation and restoration actions. The concepts and approaches in the Science Framework have been used in a new fire risk assessment for the Intermountain Region of the Forest Service, which encompasses nearly 34 million acres and includes 12 national forests.

In the fire-prone Great Basin region of the sagebrush biome, the concepts and approaches have been used by the Bureau of Land Management to develop a multi-year program of work for BLM-managed lands that includes fuel reductions and restoration treatments. The best locations for management actions and the types of treatments are being decided by district and field office personnel using field guides (Miller et al. 2014, Miller et al. 2015) and workbooks (Pyke et al. 2015) that were developed to help apply the new resilience-based concepts.

The resilience-based, risk management approach used in the Science Framework serves as a model for other species conservation efforts. By applying ecological resilience concepts, it lets managers determine locations on the landscape where conservation and restoration activities are most likely to be effective and select the types of actions most likely to succeed. Shared stewardship involving collaboration among managers, scientists and stakeholders helps ensure that the appropriate management strategies are implemented to maintain or increase ecosystem resilience. ■

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