Using Resilience and Resistance Concepts to Assess Threats to Sagebrush Ecosystems and Greater Sage-Grouse, Prioritize Conservation and Restoration Actions, and Inform Management Strategies

excerpted from Chambers et al. (2016)

Table 8. The sage-grouse habitat resilience and resistance matrix is based on resilience and resistance concepts and Greater Sage-Grouse breeding habitat probabilities. Rows show the ecosystem's relative resilience to disturbance and resistance to invasive annual grasses (1 = high resilience and resistance; 2 = moderate resilience and resistance; 3 = low resilience and resistance). Resilience and resistance categories were derived from soil temperature and moisture regimes (Maestas et al. 2016) and relate to sagebrush ecological types. Columns show the landscape-scale sage-grouse breeding habitat probability (A = 0.25 to < 0.5 probability; B = 0.5 to < 0.75 probability; C = ≥ 0.75 probability).

The matrix illustrates an area's relative resilience to disturbance and resistance to invasive annual grasses in relation to its probability of providing breeding habitat. As resilience and resistance go from high to low, as indicated by the rows in the matrix, the amount of time required for sagebrush regeneration and perennial grass and forb regrowth progressively limit the capacity of sagebrush ecosystems to recover after disturbances without management assistance. Also, the risk of invasive annual grasses increases and the ability to successfully restore burned or otherwise disturbed areas decreases. As the probability of breeding habitat goes from low to high within these same ecosystems, as indicated by the columns in the matrix, the capacity to sustain sage-grouse populations increases. Areas with breeding habitat probabilities of 0.25 to < 0.5 are unlikely to provide adequate breeding habitat. Areas with breeding habitat probabilities of 0.5 to < 0.75 can provide breeding habitat, but are at risk if sagebrush loss occurs without regeneration or if other factors negatively impact the area, such as conifer expansion, development, or infrastructure. Areas with breeding habitat probabilities ≥ 0.75 can provide the necessary breeding habitat conditions for sage-grouse persistence.

Management strategies can be determined by considering: (1) an area's resilience to disturbance and resistance to nonnative invasive plants, (2) breeding habitat probabilities, and (3) the predominant threats to both sagebrush ecosystems and their associated sage-grouse populations. Because management strategies often cross-cut multiple program areas for land management agencies, an integrated approach is typically used to address the predominant threats. For example, agency program areas such as invasive plant management, fuels management, range management, wildlife, and others may all contribute to vegetation management strategies designed to address persistent ecosystem and land use and development threats.

The matrix is a decision support tool that allows land managers to better evaluate risks at mid to local scales and decide where to focus specific activities to promote desired species and ecosystem conditions. Areas with high breeding habitat probabilities and high concentrations of birds are typically comprised of intact habitats and thus are high priorities for management (cells 1C, 2C, 3C). Protective management can be used in and adjacent to these areas to maintain habitat connectivity and ecosystem resilience and resistance. Protective management can include a diverse set of strategies such as reducing or eliminating disturbances from land uses and development, establishing conservation easements, utilizing an Early Detections and Rapid Response approach, or suppressing fires. Areas with high breeding habitat probabilities but lower resilience and resistance are slower to recover following fire and surface disturbances and are more susceptible to invasive plant species than areas with higher resilience and resistance. Consequently, these low resilience and resistance areas are at greater risk of habitat loss than areas with moderate to high resilience and resistance and are among the highest priorities for protective management (cell 3C).

Areas with moderate breeding habitat probabilities are comprised of habitat that supported a higher proportion of leks in the past than currently and that may be improved through various management strategies (cells 1B, 2B, 3B). Management objectives may include increasing resilience and resistance by promoting perennial grasses and forbs through conifer removal or improved livestock management, reducing or eliminating new infestations of invasive plants through EDDR approaches, or restoring sagebrush habitat through seeding or transplanting. Management strategies often have synergistic effects. Increasing native perennial grasses and forbs can decrease the probability of invasion or expansion of annual invasive grasses and, in turn, reduce the risk of altered fire regimes, transitions to undesired states, and decreased connectivity. Similarly, management strategies aimed at reducing the risk of wildfires outside of the historical range of variation, such as removing conifers in expansion areas, can increase the functional capacity of plant communities to resist invasive annual grasses as well as enhance habitat connectivity. The relative resilience and resistance of an area strongly influences its response to management strategies such as conifer removal or post-fire rehabilitation and the likelihood of nonnative annual grass invasion. Areas with lower resilience and resistance may still be among the highest priorities for management in areas with moderate breeding habitat probabilities, but they may require greater investment and repeated interventions to achieve management objectives (cell 3B).

Areas with low breeding habitat probabilities are characterized by habitat that supported active leks in the past, but that currently support few leks (cells 1A, 2A, 3A). If land use and development threats such as oil and gas development or cropland conversion are causing low breeding habitat probabilities, then habitat improvement may not be feasible. However, if the area has the capacity to respond to management treatments and if breeding populations are close enough for recolonization, improvement of these areas to increase breeding habitat probabilities may still be possible. Managers may decide to restore critical habitat in these types of areas, but the degree of difficulty and time-frame required for habitat restoration increase as resilience and resistance decrease. Consequently, substantial investment and repeated interventions may be required to achieve objectives.

Landscape-Scale Sage-Grouse Breeding Habitat Probability

	Low (0.25 to < 0.5 probability)	Moderate (0.5 to < 0.75 probability)	High (≥ 0.75 probability)
	Landscape context is likely limiting habitat suitability. If limiting factors are within management control, significant restoration may be needed. These landscapes may still be important for other seasonal habitat needs or connectivity.	Landscape context may be affecting habitat suitability and could be aided by restoration. These landscapes may be at higher risk of becoming unsuitable with additional disturbances that degrade habitat.	Landscape context is highly suitable to support breeding habitat. Management strategies to maintain and enhance these landscapes have a high likelihood of benefiting sage-grouse.

Ecosystem Resilience to Disturbance and Resistance to Invasion

Low------------------Moderate------------------High

High resilience and resistance: 1A | 1B | 1C

Potential for favorable perennial herbaceous species recovery after disturbance without seeding is typically high.

Risk of invasive annual grasses becoming dominant is relatively low. EDRR can be used to address problematic invasive plants.

Tree removal can increase habitat availability and connectivity in expansion areas.

Seeding/transplanting success is typically high.

Recovery following inappropriate livestock use is often possible given changes in management.

Moderate resilience and resistance: 2A | 2B | 2C

Potential for favorable perennial herbaceous species recovery after disturbance without seeding is usually moderately high, especially on cooler and moister sites

Risk of invasive annual grasses becoming dominant is moderate, especially on warmer sites. EDRR can be used to address problematic invasive plants in many areas.

Tree removal can increase habitat availability and connectivity in expansion areas.

Seeding-transplanting success depends on site characteristics, and more than one intervention may be required especially on warmer and drier sites.

Recovery following inappropriate livestock use depends on site characteristics and management.

Low resilience and resistance: 3A | 3B | 3C

Potential for favorable perennial herbaceous species recovery after disturbance without seeding is usually low.

Risk of invasive annual grasses becoming dominant is high. EDRR can be used to address problematic invasive plants in relatively intact areas.

Seeding/transplanting success depends on site characteristics, extent of annual invasive plants, and post-treatment precipitation, but is often low. More than one intervention likely will be required.

Recovery following inappropriate livestock use is unlikely without active restoration.