Science to Solutions

Sage Grouse Initiative

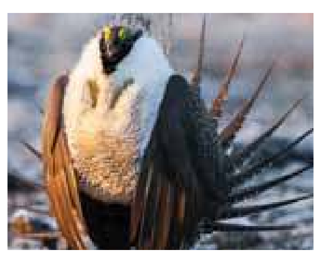
Wildfire and Cheatgrass: New Science Helps Reduce Threats to Sage Grouse

In Brief: A new strategy helps land managers reduce impacts from two of the most daunting challenges facing sage grouse: the threat of large-scale wildfires and invasion of exotic annual grasses like cheatgrass (*Bromus tectorum* L.) that can transform large expanses of sagebrush habitat into nonnative grasslands. This strategy serves as a powerful decision tool to address wildfire and cheatgrass threats at local sites or large landscape scales. Using existing data to map soil temperature and moisture regimes along with the amount of sagebrush cover across landscapes, managers can predict a sagebrush ecosystem's ***resilience*** to disturbance and ***resistance*** to invasive species, as well as where sage grouse are most likely to persist. This tool helps prioritize and pinpoint management tactics across sagebrush landscapes, from fire and fuels management to restoration, and partners have already quickly engaged in implementation of this new strategic approach.

A New Strategic Framework to Tackle a Double Threat

Large scale wildfire and exotic annual grasses pose a formidable threat to sage grouse habitats, particularly across the Great Basin where invasion of annual grasses, especially cheatgrass, is altering natural fire regimes and converting large expanses of the sagebrush sea to an ocean of nonnative annual grass. This broad scale conversion of habitat creates an enormous challenge for sage grouse conservation. Recently, an inter-agency team of plant ecologists, wildlife biologists, fire specialists, and land managers was convened by the Western Association of Fish and Wildlife Agencies to develop a new strategy to help managers tackle this seemingly intractable threat to sage grouse habitats.

The strategy combines new science on sage grouse habitat requirements with factors that determine sagebrush ecosystem **resilience and resistance** (known as R&R to ecologists). **Resilience** is the ability of an ecosystem to bounce back after fire, and **resistance** is an ecosystem's



Large wildfires remove vast areas of sagebrush required by sage grouse. Bottom right photo: Cheatgrass (the brown grass on left) is an exotic invasive grass that cures earlier than desirable perennial grasses (green grass on right) and easily carries fire, promoting larger and more frequent fires that convert sagebrush habitats into vast nonnative annual grasslands. Photo credits: top - Douglas J. Shinneman; bottom left - Rick McEwan; bottom right - Jeremy Maestas.

Resilience: the capacity of an ecosystem to ***regain or recover*** its fundamental structure, processes and functioning when altered by stresses like drought and disturbances like wildfire.

Resistance: the capacity of an ecosystem to ***retain*** its fundamental structure, processes and functioning (or remain largely unchanged) despite stresses, disturbances or invasive species.

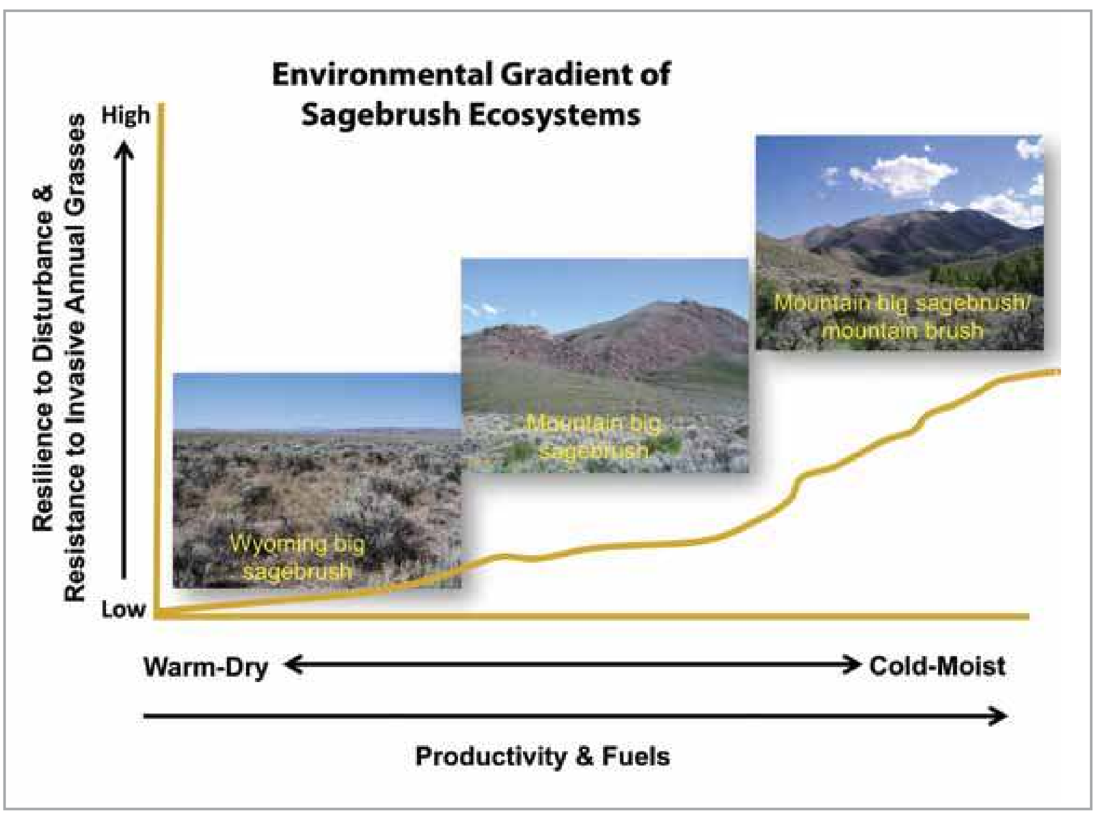
Resistance to Invasion: the abiotic and biotic attributes and ecological processes of an ecosystem that limit the population growth of an invading species.

natural ability to keep out invading plant species—somewhat like a healthy person's immunity to disease. These characteristics can be mapped at multiple scales—across large regions or at specific sites—using existing data. The result gives managers a powerful decision tool to identify priority areas, plan treatments, and target investments: in essence, a spatial game plan to reduce the impacts of fire and invasive grasses in sage grouse habitat long term.

Resistance and Resilience in Sagebrush Ecosystems

"Sagebrush ecosystems occur across strong environmental gradients, and ecosystem resilience and resistance differ greatly depending on environmental characteristics. These concepts are equally applicable across broad landscapes and at local scales." ~Jeanne Chambers, U.S. Forest Service, Rocky Mountain Research Station

Sagebrush ecosystems across the west are remarkably diverse and respond differently to environmental disturbance. Sagebrush occurs from low elevation semi-desert to mid- and high-elevation shrub-steppe. The inherent resilience and resistance of these sagebrush ecosystems are tightly linked to productivity: the greater the cover of native shrubs, perennial grasses and forbs, the greater the resistance to invasive plants and resilience in the face of disturbance.



Sagebrush ecosystem resilience to disturbance and resistance to annual grass invasion is closely linked to soil moisture and temperature. Warm, dry sites with low productivity typically occur at lower elevations and are more vulnerable than cold, moist sites with greater productivity that occur at higher elevations. Chart courtesy of Jeanne Chambers, USFS RMRS.

"The relative abundance and spatial distribution of perennial grasses are particularly important for resilience and resistance," explains Dr. Jeanne Chambers, lead author and scientist with the U.S. Forest Service, Rocky Mountain Research Station.

Vegetation productivity is directly tied to soil temperature and moisture regimes: warm dry sites are less productive, and cool moist sites are more so. Also, invasive annual grasses, like cheatgrass, grow more slowly and produce fewer seeds in cooler and moister environments. In a key breakthrough, the science team showed how soil temperature and moisture regimes can be used as indicators of ecosystem resilience and resistance, and how the R&R gradient can be mapped across broad landscapes. By compiling existing data from soils surveys, the team mapped soil moisture and temperature regimes to illustrate potential ecosystem R&R across the entire range of sage grouse.

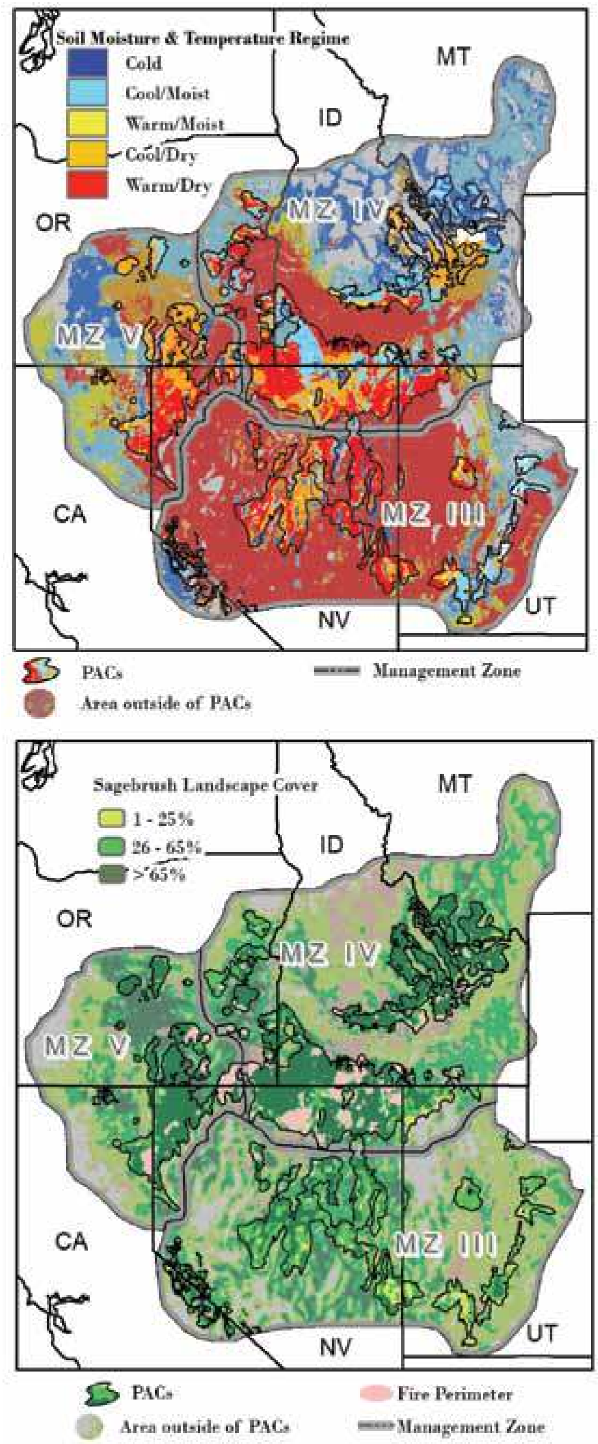
Building a Decision Tool: the Sage Grouse Habitat Matrix

Understanding R&R of sagebrush ecosystems provides an ecological foundation for prioritizing management. The next step is to superimpose R&R with a key habitat characteristic important to sage grouse: the amount of landscape covered by sagebrush.

Sagebrush landscape cover, measured at large scales using remote sensing, should not be confused with sagebrush canopy cover, which is measured at a local site level. "Think of landscape cover as the amount of gray sagebrush area you see looking down from an airplane rather than what you see across a site from a pickup window," explains coauthor Jeremy Maestas, Sage Grouse Initiative Technical Lead.

Sage grouse lek sites, or breeding grounds, are often used to evaluate sage grouse population viability. Most active sage grouse lek sites are located where the majority of the surrounding area is in sagebrush cover. Sage grouse populations usually do best where more than 65% of the landscape is in sagebrush because these areas provide essential habitat needs such as nesting areas, sources of food, and cover from predators. Sage grouse populations have difficulty surviving in areas with too little sagebrush cover (<25%) where these habitat needs cannot be not met.

By superimposing existing GIS map layers of R&R (based on soil temperature and moisture) and sagebrush landscape cover (derived from Landsat satellite imagery) managers can now map the potential for restoration and recovery at multiple scales. All of this data is available for download.



Soil temperature and moisture regimes (at top) and sagebrush landscape cover (bottom) can be mapped to help inform management decisions. While the study area included the entire range of sage grouse, the emphasis was on the Great Basin where fire and invasive risks are greatest. Priority Areas for Conservation (PACs) are overlaid to illustrate those habitats expected to be critical for long-term viability of sage grouse and to aid managers with initial identification of focal areas for management. Figures adapted from Chambers et al. 2014 by Amarina Wuenschel.

By overlapping sagebrush landscape cover and R&R, the science team created a 9-cell **Sage Grouse Habitat Matrix** that provides a decision tool for minimizing fire and cheatgrass risks. Each cell represents an intersection between low to high sagebrush cover and low to high R&R and ***predicts the potential of a site for recovery, likelihood of annual grass invasion, and possible need for intervention after disturbance.*** The cell where a site falls within the matrix can help managers quickly assess risks and decide on appropriate actions.

Sage Grouse Habitat Matrix

Amount of Sagebrush Shrubland in Landscape

Resilience & Resistance of Sagebrush Community	*Low* < 25% Sagebrush	*Medium* 25-65% Sagebrush	*High* > 65% Sagebrush
High	RESTORATION/RECOVERY POTENTIAL HIGH *Native grasses and forbs sufficient for recovery* *Annual invasive risk low*		
	Requires longer timeframe.	Minimal intervention, enhance connectivity.	Little to no intervention needed.
Moderate	RESTORATION/RECOVERY POTENTIAL VARIABLE *Native grasses and forbs usually adequate for recovery* *Annual invasive risk moderate* *Seeding/transplanting success depends on site characteristics*		
	Requires longer timeframe with intervention likely.	Minimize invasive risks, enhance connectivity.	Little intervention needed, minimize invasive risks.
Low	RESTORATION/RECOVERY POTENTIAL LOW *Native grasses and forbs inadequate for recovery* *Annual invasive risk is high* *Restoration may require multiple interventions*		
	Recovery unlikely	High amount of intervention, long timeframe for recovery.	Moderate-to-high amount of intervention, moderate timeframe for recovery.

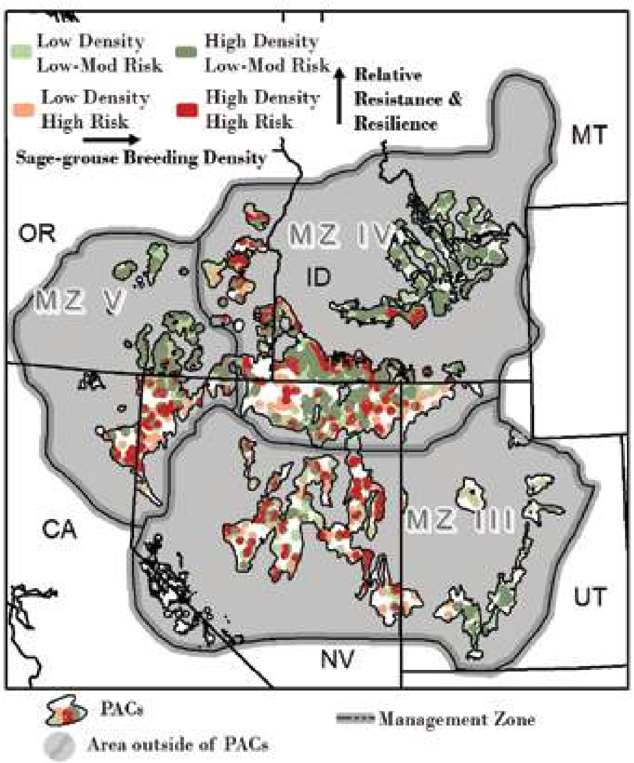
The potential for sagebrush habitat recovery after disturbance is linked to site characteristics. Recovery potential is high where community resilience and resistance are high and where the native perennial understory is intact. Management intervention is often needed to assist recovery of sagebrush habitat on sites with low to moderate resilience, moderate to high risk of invasives, depleted perennial understory, and <65% sagebrush cover. Sites with little sagebrush cover or low resistance and resilience often require long timeframes for sagebrush and sagebrush habitat recovery. Recovery success across the matrix depends on appropriate grazing management. Chart adapted from Chambers et al. 2014.

Right Strategy, Right Place

Matching appropriate management responses with the right scenario on the ground is critical for addressing fire and invasive threats over vast landscapes. "We combined what we know about grouse and sagebrush ecosystems to empower land managers with information and tools to more consistently make good decisions about how to invest limited resources," says Maestas.

In the Sage Grouse Habitat Matrix, along the gradient from high to low R&R, management strategies vary with the potential for restoration and recovery, risk of invasive annual grasses, amount of sagebrush cover left on the landscape, and the landscape context. Areas with a high amount of sagebrush cover and high R&R are likely to recover in a relatively short time period after disturbance and are a low priority for intervention. In contrast, areas with low R&R that have few native grasses and forbs and high risk of invasive annual grass dominance are unlikely to recover within a desirable time frame and these areas require more proactive and intensive management. In low R&R areas, priorities should focus on minimizing stress and disturbance and maintaining intact sagebrush cover. Intensive management and repeated interventions may be needed to protect and restore warm dry sagebrush ecosystems that still support sage grouse populations, but that are highly threatened by wildfire and cheatgrass invasion.

The science team took it a step farther and prioritized management strategies commonly used by the agencies for each cell in the Sage Grouse Habitat Matrix. These strategies include fire operations, fuels management, post-fire rehabilitation, habitat restoration and recovery and cover everything from fire suppression to fuel breaks to seeding. ***However, no matter your management focus, the overarching goal should be to maintain or increase ecosystem resilience and resistance.***



Combining soil temperature and moisture regimes with breeding bird densities within PACs illustrates the relative risks of fire and cheatgrass impacts in relation to grouse concentrations. High density areas represent sage grouse population centers containing 75% of breeding population; low density contains the remaining 25%. Priority landscapes are high risk areas with low R&R and high bird densities. Figure adapted from Chambers et al. 2014 by Amarina Wuenschel.

Putting It All Together

This information can be combined with other data to guide sage grouse habitat management from rangewide scales to local management units to project site levels. Overlaying available data in GIS, such as sage grouse Priority Areas for Conservation (PACs), breeding bird density maps, and land cover maps of cheatgrass, piñon and juniper, and fire history, can help target projects.

For example, coupling the maps for R&R with PACs and breeding density provides a snapshot of sage grouse population centers that may be most at risk of negative impacts of fire and invasives (see figure at left). This type of information helps managers determine where to emphasize more intensive planning and invest management projects or fire suppression efforts.

Within focal areas, R&R concepts can also be used to determine the most appropriate treatment technique at the project scale. The strategic approach steps all the way down to ecological sites where local practitioners craft management prescriptions.

The R&R strategy is rapidly being adopted into agency policy and implementation. For example, the Bureau of Land Management's interagency Fire and Invasive Assessment Teams (FIAT) are using it as the basis for how to strategically address fire and invasives in their Resource Management Plan amendments across the Great Basin. Once those plans are completed, partners stand ready to implement targeted conservation actions benefiting millions of acres of habitat. Using natural ecosystem resilience and resistance in the battle against cheatgrass invasion can help managers stem the tide of grassland conversion, and conserve sage grouse habitats into the future.

Conifer removal is a key strategy for reducing fuels and maintaining resilience and resistance. Photo credit: Jeremy Roberts, Conservation Media.

Where Do I Go From Here?

For full detail on potential applications of resistance and resilience concepts to fire, annual grass invasion, and vegetation management, see the primary source for this article, cited below: Chambers et al. 2014, **http://www.fs.fed.us/rm/pubs/rmrs_gtr326.html.**

To download GIS data layers of soil temperature-moisture regimes and sagebrush landscape cover across the range of sage grouse, visit: **https://www.sciencebase.gov/catalog/folder/537f8bf8e4b021317a872f1d.**

To learn more about how to work with soil temperature and moisture data, see the fact sheet cited in Additional Resources below: Maestas and Campbell 2014, **http://www.sagegrouseinitiative.com/wp-content/uploads/2014/08/Soil-Temp-Moist-Data-Fact-Sheet.pdf.**

Use the field guides cited in the Additional Resources below to help assess the potential for post-fire sagebrush recovery (Miller et al. in press) and address treatment options (Miller et al. 2014).

To learn more about sage grouse conservation and the Sage Grouse Initiative, visit **http://www.sagegrouseinitiative.com.**

Suggested Citation

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Source

Chambers, J.C.; Pyke, D.A.; Maestas, J.D.; Pellant, M.; Boyd, C.S.; Campbell, S.B.; Espinosa, S.; Havlina, D.W.; Mayer, K.E.; Wuenschel, A. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: A strategic multi-scale approach. Gen. Tech. Rep. RMRS-GTR-326. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 73pp. **http://www.fs.fed.us/rm/pubs/rmrs_gtr326.html.**

Additional Resources

Chambers, J.C., B.A. Bradley, C.S. Brown, C. D'Antonio, M.J. Germino, J.B. Grace, S.P. Hardegree, R.F. Miller and D.A. Pyke. 2013. Resilience to stress and disturbance to *Bromus tectorum* L. invasion in cold desert shrublands of western North America. Ecosystems 17:360-375. DOI: 10.1007/s10021-013-9725-5.

Knick, S. T.; Hanser, S. E.; Preston, K. L. 2013. Modeling ecological minimum requirements for distribution of greater sage-grouse leks: Implications for population connectivity across their western range, U.S.A. Ecology and Evolution 3(6):1539–1551.

Maestas, J.D., and S.B. Campbell. 2014. Mapping potential ecosystem resilience and resistance across sage grouse range using soil temperature and moisture regimes. Fact Sheet. Sage Grouse Initiative. 4pp. **http://www.sagegrouseinitiative.com/wp-content/uploads/2014/08/Soil-Temp-Moist-Data-Fact-Sheet.pdf.**

Miller R. F., Chambers, J. C., Pellant, M. 2014. A field guide to selecting the most appropriate treatments in sagebrush and pinyon-juniper ecosystems in the Great Basin: Evaluating resilience to disturbance and resistance to invasive annual grasses and predicting vegetation response. Gen. Tech. Rep. RMRS-GTR-322. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72pp. **http://www.fs.fed.us/rm/pubs/rmrs_gtr322.html.**

Miller, Richard F.; Chambers, Jeanne C.; Pellant, Mike. In press. A field guide for rapid assessment of post-wildfire recovery potential in sagebrush and piñon-juniper ecosystems in the Great Basin: Evaluating resilience to disturbance and resistance to invasive annual grasses and predicting vegetation response. Gen. Tech. Rep. RMRS-GTR-###. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. ### p.