

## Fact Sheet

# Mapping Potential Ecosystem Resilience and Resistance across Sage-Grouse Range using Soil Temperature and Moisture Regimes



*A cool and moist (frigid/xeric) mountain big sagebrush site in Nevada (left) compared to a warm and dry (mesic/aridic) Wyoming big sagebrush site in Oregon (right) illustrates the natural variability in site potential across sagebrush ecosystems. Mapping soil temperature and moisture regimes can help depict this gradient and indicate potential ecosystem resilience and resistance. Photos: Jeremy Maestas*

## Background

Our ability to address threats to sage-grouse and the sagebrush steppe can be greatly enhanced by understanding ecosystem resilience to disturbance and resistance to invasive species (Chambers et al. 2014a,b). A recent breakthrough in the practical application of resilience and resistance concepts has been linking *soil temperature and moisture regimes* to sagebrush ecosystem responses to disturbance and annual grass invasion.

Potential resilience and resistance to invasive annual grasses reflect the biophysical conditions of an area, and soil temperature and moisture regimes provide a useful indicator of these conditions at multiple scales. Resilience

to disturbance typically increases with higher resource availability and more favorable environmental conditions for plant growth and reproduction. Thus areas with warm (*mesic*) soil temperature and dry (*aridic*) soil moisture regimes typically have low potential resilience, while those with cool (*frigid*) to moderately cold (*cryic*) soil temperature and relatively moist (*xeric* to *ustic*) soil moisture regimes have high potential resilience. Resistance to exotic annual grasses, like cheatgrass, is strongly influenced by climate suitability for establishment and persistence. Cheatgrass germination, growth and reproduction appear to be optimal under relatively warm and dry to moist regimes (*mesic/aridic* or *xeric*), limited by low and sporadic precipitation under dry regimes (*aridic*), and generally constrained by colder regimes (*frigid* to *cryic*). These relationships are modified

by effects of: (1) elevation, landform, slope, aspect, soil characteristics, and resulting vegetation composition and structure, and (2) the ecological condition of an area (Figure 1. Chambers et al. 2014a,b)

Soil climate data (temperature and moisture) are fundamentally important in classifying and mapping soils, and as such, are widely collected as part of the National Cooperative Soil Survey program. This provides us with the ability to map temperature and moisture regimes across the range of sage-grouse to better understand potential resilience and resistance along a diverse environmental gradient.

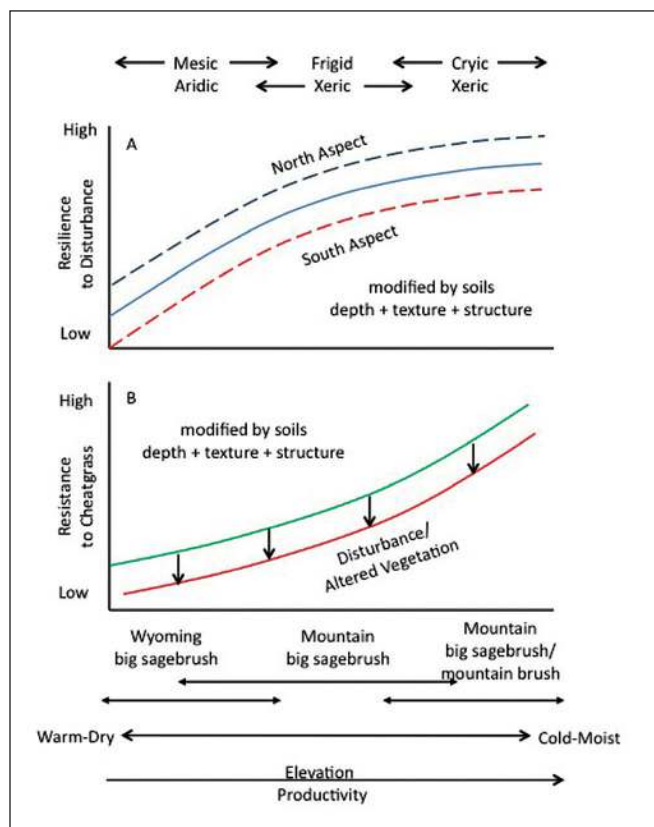


Figure 1. Example of resilience to disturbance (A) and resistance to cheatgrass (B) over a soil temperature and moisture regime gradient in the western portion of the sagebrush ecosystem. Dominant ecological types occur along a continuum from Wyoming big sagebrush communities on warm and dry sites to mountain big sagebrush/mountain brush communities on cold and moist sites (modified from Chambers et al. 2014a,b).

**Resilience** is the capacity of an ecosystem to regain its fundamental structure, processes and functioning when altered by stressors like drought, and disturbances like altered fire regimes. It is a measure of the ability of an ecosystem to *recover* after stress or disturbance.

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

**Resistance to invasion** is the capacity of an ecosystem to limit the establishment and population growth of an invading species.

## New product assembles available data for rangewide use

While soil temperature and moisture regimes can be found in published soil surveys, a single dataset aggregating all available data was compiled to facilitate broad scale analyses and to provide a simple decision support tool for field practitioners. Available soils data from across Sage-Grouse Management Zones (Stiver et al. 2006) were compiled from two primary sources: 1) completed and interim soil surveys (SSURGO), and 2) state soils geographic databases (STATSGO2).

### SSURGO – Soil Survey Geographic Database

SSURGO is the most detailed soil survey product produced by the National Cooperative Soil Survey. Information was collected through field inventory and interpretation at scales ranging from 1:12,000 to 1:63,360, with 1:24,000 being the most common. SSURGO datasets consist of spatial data, tabular data, and information about how the data were created. Soil survey maps are linked in the database to information about the component soils and properties for each soil map unit.

For this rangewide product, Gridded Soil Survey Geographic (gSSURGO) file geodatabases were used to display a 10-meter raster dataset. State gSSURGO datasets were then clipped to the extent of the Sage-Grouse Management Zones and merged.

## STATSGO2 – State Soil Geographic Database

The Digital General Soil Map of the United States or STATSGO2 is a broad-based inventory of soils and non-soil areas that occur in a repeatable pattern on the landscape and that can be cartographically shown at a scale of 1:250,000. The dataset was created by generalizing more detailed soil survey maps. Where more detailed soil survey maps were not available, data on geology, topography, vegetation, and climate were assembled and related to Land Remote Sensing Satellite (LANDSAT) images. Soils of similar areas were studied, and the probable classification and extent of the soils were determined. STATSGO2 was used in areas of the Sage-Grouse Management Zones where more detailed SSURGO was currently not available.

## Where can I access the product?

The aggregated soils data product can be downloaded free-of-charge on the Landscape Conservation Management and Analysis Portal (LCMAP):

<https://www.sciencebase.gov/catalog/folder/538e5aa9e4b09202b547e56c>

## How to work with the files in a Geographic Information System (GIS)

### Rangewide layer for rapid application

The data product includes a file geodatabase named *SoilMoistureTemperatureRegimes.gdb* that contains a single raster dataset merging best available SSURGO and STATSGO2 across Sage-Grouse Management Zones. The attribute table includes the temperature and moisture regime for the map unit dominant condition. A layer file named *SoilMoistTempLayer.lyr* can be used to quickly create a fully symbolized map with a legend of the predominant temperature and moisture regimes across sagebrush ecosystems (Figure 2).

### Detailed data for more in-depth analyses

Separate geodatabases providing more detailed information are also available for both SSURGO and STATSGO2 data. These products allow users to explore the data in more depth at finer scales. An example of how to work with one of the geodatabases is provided here.

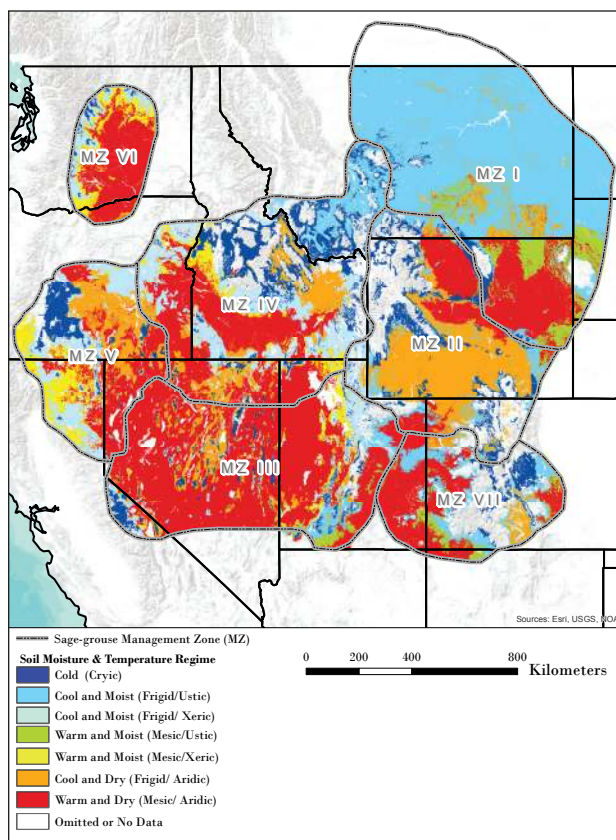


Figure 2. New soils product provides ability to depict potential ecosystem resilience and resistance across the range of sage-grouse using soil temperature and moisture regimes. For more information on interpretation, see Chambers et al. 2014b.

The file geodatabase named *SGMZ\_SSURGO\_temp\_moist\_regimes\_v2.gdb* contains a raster dataset with all the SSURGO spatial data that is currently available in the Sage-Grouse Management Zones. There are two tables in this file geodatabase that can be joined to the raster dataset using the common mukey field. The table named *SSURGO\_SGMZ\_temp\_moist\_dom\_cond\_v2* contains the temperature and moisture regime and moisture subclass for the dominant condition in each map unit. The table named *SSURGO\_SGMZ\_temp\_moist\_components\_v2* has data for each major component, including things like soil type, precipitation range, temperature-moisture regimes and subclasses, and ecological sites. When this table is joined to the raster dataset, the data for the dominant component will be in the attribute table. The *Identify* tool in ArcGIS can be used to display many attributes of the dominant component.

For an even finer grain look, the *SSURGO\_SGMZ\_temp\_moist\_components\_v2* table can be opened to determine the ecological site and temperature and moisture regimes that are associated with each component in a map unit, rather than just the dominant component.



## For More Information

### Data Contact

Steve Campbell, USDA-NRCS Soil Scientist, 503-273-2421,  
steve.campbell@por.usda.gov



Background on SSURGO and STATSGO data: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/geo/>

Access to soil surveys: <http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

### Acknowledgements

We thank the Western Association of Fish and Wildlife Agencies, Fire and Invasives Working Group, for laying the foundation for development of this product. Special thanks to Amarina Wuenschel and Jeanne Chambers for their contributions to this product and to the many USDA Natural Resources Conservation Service specialists who contributed soil survey program data.

### Suggested Citation

Maestas, J. D., and S. B. Campbell. Mapping Potential Ecosystem Resilience and Resistance across Sage-Grouse Range using Soil Temperature and Moisture Regimes. Fact Sheet. Sage Grouse Initiative, [www.sagegrouseinitiative.com](http://www.sagegrouseinitiative.com).

### References

Chambers, J. C.; Bradley, B.A.; Brown, C.A.; D'Antonio, C.; Germino, M. J.; Hardegree, S. P.; Grace, J. B.; Miller, R. F.; Pyke, D. A. 2014a. Resilience to stress and disturbance, and resistance to *Bromus tectorum* L. invasion in the cold desert shrublands of western North America. *Ecosystems* 17: 360-375

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. 2014b. 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. 73 p.

Stiver, S. J.; Apa, A. D.; Bohne, J. R.; Bunnell, S. D.; Deibert, P. A.; Gardner, S. C.; Hilliard, M. A.; McCarthy, C. W.; Schroeder, M. A. 2006. Greater Sage-grouse Comprehensive Conservation Strategy. Unpublished report on file at: Western Association of Fish and Wildlife Agencies, Cheyenne, WY.

## Displaying Dominant Condition Vs. Dominant Component

It is important to understand some fundamental concepts in how soils are mapped in order to properly interpret information provided. Soils and their properties change over a continuous gradient but soils are described in map units. Soil map units commonly contain more than one "component" (soil types or miscellaneous areas such as rock outcrops) with unique data associated with each component. When spatially displaying soil survey information, a decision has to be made as to how to aggregate the component data to the map unit. The two most common aggregation methods are to display either *dominant component* or *dominant condition*. The example below illustrates the difference between these two methods:

### Soil map unit: Alpha-Beta-Gamma complex, 8 to 30 percent slopes

Component Name	% of Map unit	Temperature/Moisture Regime	Aggregation Method
Alpha	45	Warm and Dry (Mesic/Aridic)	Dominant Component
Beta	30	Cool and Dry (Frigid/Aridic)	Dominant Condition
Gamma	25	Cool and Dry (Frigid/Aridic)	

This map unit is on highly dissected hill slopes with a complex pattern of northerly and southerly aspects. The Alpha component is on southerly aspects and the Beta and Gamma components are on cooler northerly aspects. The temperature and moisture regime for the dominant component is Warm and Dry (mesic/aridic) since the Alpha component comprises the highest percentage of the map unit. The dominant condition is Cool and Dry (frigid/aridic) since the Beta and Gamma components cumulatively comprise 55 percent of the map unit, exceeding the 45 percent of the Alpha component. For the majority of soil map units, but not all, the dominant component and dominant condition results are identical. This product provides aggregated data in both dominant condition and component tables to allow users access to advantages of each approach.