

## The Role of SageSTEP in Carbon and Climate Science

Many public land management agencies including the Bureau of Land Management (BLM) and US Forest Service are required to manage for multiple resource uses, to consider the conflicting desires of stakeholder groups, and adhere to government policies, including emerging policies related to carbon, climate and the economy. Land managers need high-quality information to help guide their decisions, information that comes from study areas that encompass the variation in the landscapes they work in.

The SageSTEP soils and biogeochemistry research provides information about carbon (C) cycling in sagebrush-steppe rangelands that can be used by land managers in the Great Basin and surrounding areas. The SageSTEP network spans a wide range of climatic variability and is well positioned to provide critical information on changes in climate, species diversity and nutrient cycling in arid environments threatened by exotic annual grass invasion and woodland encroachment. Additionally, researchers are looking at the impacts of fuel treatments, including prescribed fire, on nutrient cycling in the short- and long-term.

### Effects of annual grass invasion on ecosystem C and N

Invasion by the exotic annual grass, cheatgrass (*Bromus tectorum*) into sagebrush-steppe ecosystems replaces deep-rooted perennial grasses and shrubs with shallow-rooted

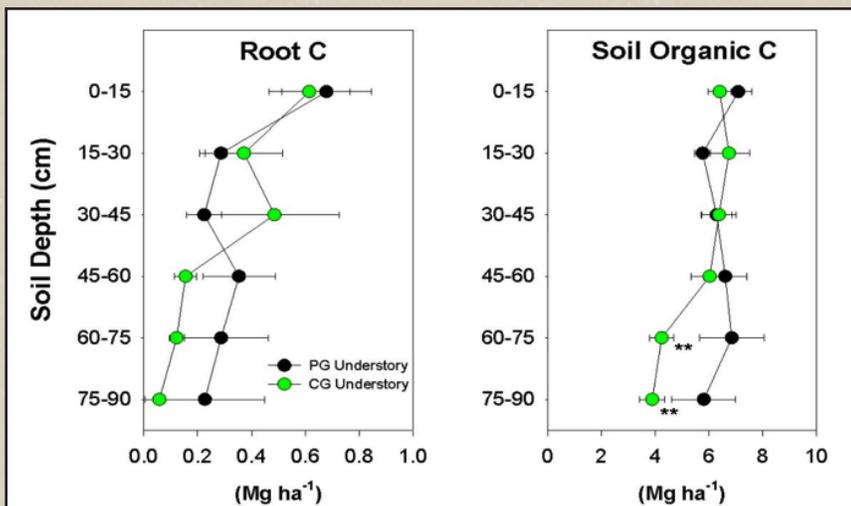


Figure 1. Root C and soil organic C in sagebrush-steppe systems with understory dominated by perennial grasses (black dots) and cheatgrass (green dots). Systems with understory dominated by cheatgrass have lower levels of C in the deeper soil horizons.

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annuals that are susceptible to wildfire and burn more frequently than native systems. Our results suggest that decreases in root biomass associated with cheatgrass invasion results in decreased belowground organic C storage (figure 1). Furthermore, more frequent fire facilitates transition of the ecosystem to exotic annual grass dominance, which dramatically reduces standing aboveground C stocks. Increased fire frequency could lead to further C loss through repeated oxidation of nitrogen (N), which is critical for C sequestration. Our current estimates indicate that the loss of soil organic C due to cheatgrass invasion can be two to three times greater than the loss of aboveground C.

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### Effects of woodland encroachment on ecosystem C and N

It comes as no surprise that woodland expansion rapidly increases biomass on sagebrush landscapes and, as a result, the amount of C stored in the system increases (figure 2a). The majority of this increase comes in the form of aboveground C storage. Belowground C storage increases only slightly and is a function of increased root production and incorporation of tree litter into surface soil horizons (figure 3). This is an important distinction because aboveground C storage is typically transient because much of it is eliminated in severe wildfires. Furthermore, the risk of severe stand-replacing fire increases with increasing tree cover, and fire easily carries through stands with tree cover exceeding 50%. Stands with tree cover exceeding 50% also have reduced understory vegetation cover and are at risk of exotic annual grass invasion following wildfire. This could further exacerbate C emissions.

Belowground C, especially soil organic C, is more stable and is often considered a long-term form of C storage due to the formation of stable organo-mineral complexes and incorporation into aggregates that shelter organic C from oxidation.

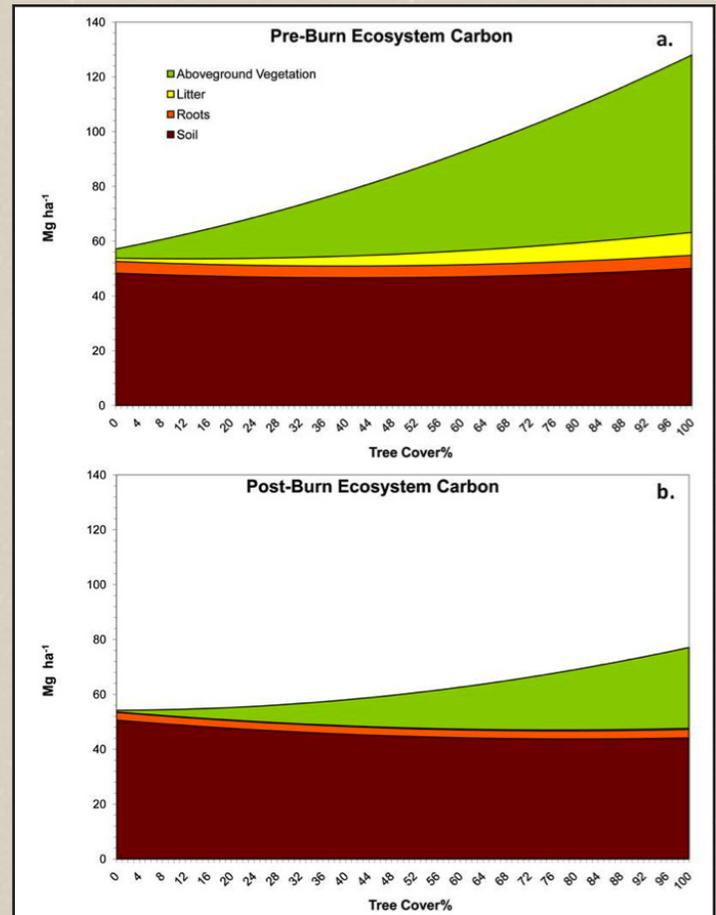


Figure 2. Empirical model from a JFSP study in Underdown Canyon, NV for carbon stored in a pinyon-juniper woodland in relation to tree cover. These graphs show the amount of C stored in a pinyon-juniper woodland before (a) and after a prescribed fire (b).

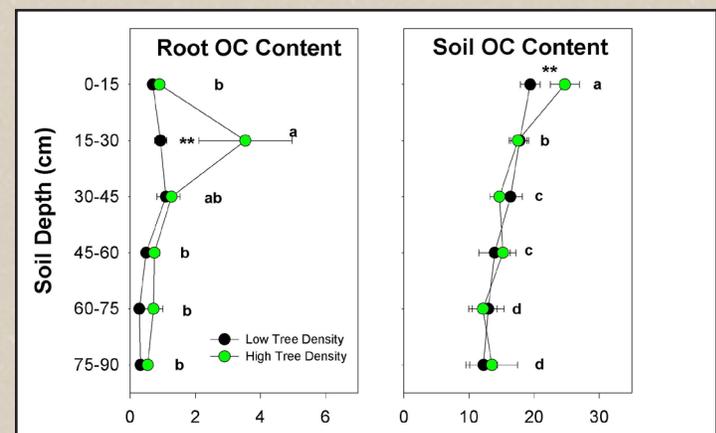


Figure 3. Root C and soil organic C in pinyon and juniper woodlands with low tree cover (black dots) and high tree cover (green dots). Increasing tree cover results in higher root C and incorporation of litter into surface soil horizons.

A variety of factors influence a system's ability to store C belowground including precipitation, temperature, soil texture, vegetation, and litter chemistry because all of these affect decomposition rates and nutrient cycling. However, the limiting

factor for belowground C storage in pinyon and juniper woodlands is most often N. Belowground C retention is highly dependent on the availability of N, so environments with high densities of leguminous species or high rates of atmospheric N deposition have a much higher likelihood of increasing soil organic carbon.

### Short-term impacts of prescribed burning on ecosystem C and N

SageSTEP and other JFSP data show that prescribed fire in pinyon and juniper woodlands significantly reduces aboveground carbon by burning vegetation, but it has relatively minor effects on belowground carbon (figure 2b). In some cases, prescribed burning in areas with low levels of tree cover actually increases soil carbon in the form of ash and organic distillates that have been incorporated into near surface soils.

Chemical decomposition that occurs during a fire (where oxygen is absent) creates products that can be very resistant to breakdown in soils and add to long-term soil organic C pools. Burning at higher levels of tree cover may actually oxidize soil organic C due to the intensity and severity of the fire. Figure 4 shows a hypothetical model in which prescribed burning could be used as a management tool to maintain or even increase carbon storage in areas where native plant communities are able to recover.

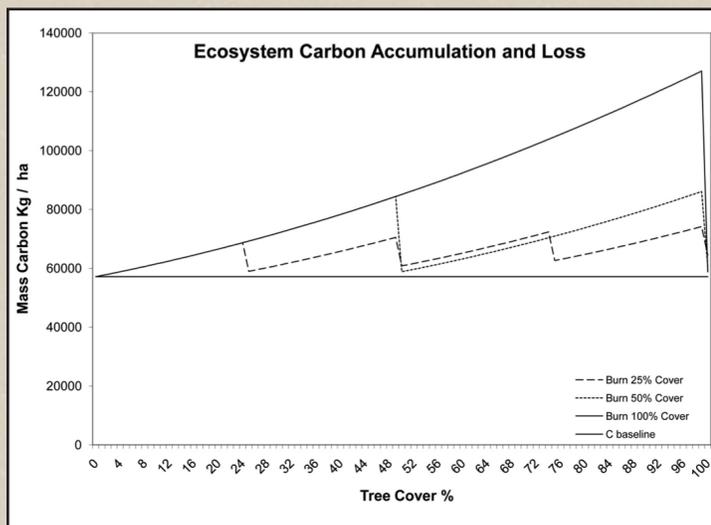


Figure 4. This empirical model developed from a JFSP funded project in Underdown Canyon, NV shows potential carbon accumulation and loss over time in a pinyon-juniper woodland managed with prescribed fire. Aboveground carbon accumulates as tree cover increases, and then decreases when a burn is implemented. Burns implemented when tree cover is lower are likely to be more effective management tools in the long-term.

Results presented in this article only touch on the relationships that exist between C cycles and vegetation composition and the impact that management decisions can have. The initial phase of the SageSTEP research has allowed us to evaluate our sites for 2–3 years following treatment, and we plan to continue monitoring these sites to better predict longer-term impacts. As we move forward, we will be able to provide additional information related to C storage and climate science in sagebrush rangelands and juniper woodlands including:

- Changes in climate and associated changes in species composition and nutrient cycles;
- Rates and magnitude of change associated with biological invasions;
- Effectiveness and longevity of management treatments in balancing objectives of carbon sequestration with other land uses;
- Data that may be incorporated into management tools and models.

For additional information about this research see the references below, or contact Ben Rau ([brau02@fs.fed.us](mailto:brau02@fs.fed.us)).

### References

Rau, B.M., R. Tausch, A. Reiner, D.W. Johnson, J.C. Chambers, R.R. Blank and A. Lucchesi. 2010. Influence of Prescribed Fire on Ecosystem Biomass, Carbon, and Nitrogen in a Pinyon Juniper Woodland. *Rangeland Ecology and Management* 63(2):197-202.

Rau, B.M., D.W. Johnson, R.R. Blank, A. Lucchesi, T.G. Caldwell and E.W. Schupp. 2011. Transition from sagebrush steppe to annual grass (*Bromus tectorum*): Influence on belowground carbon and nitrogen. *Rangeland Ecology and Management* 64:139–147.

Rau, B.M., Tausch, R., Reiner, A.L., Johnson, D.W., Chambers, J.C., and R.R. Blank. 2011. Developing a model framework for predicting effects of woody expansion and fire on ecosystem carbon and nitrogen in a pinyon-juniper woodland. *Journal of Arid Environments*. In Press.

Rau, B.M., Johnson, D.W., Blank, R.R., Lucchesi, A., Caldwell, T.G., Tausch, R.J., Roundy, B.A., and R.F. Miller. 2011. Woodland Expansion's Influence on Belowground Carbon and Nitrogen in the Great Basin U.S. *Journal of Arid Environments*. In Press.

# Public Priorities for Rangeland Management: Five Years of Data from the Great Basin

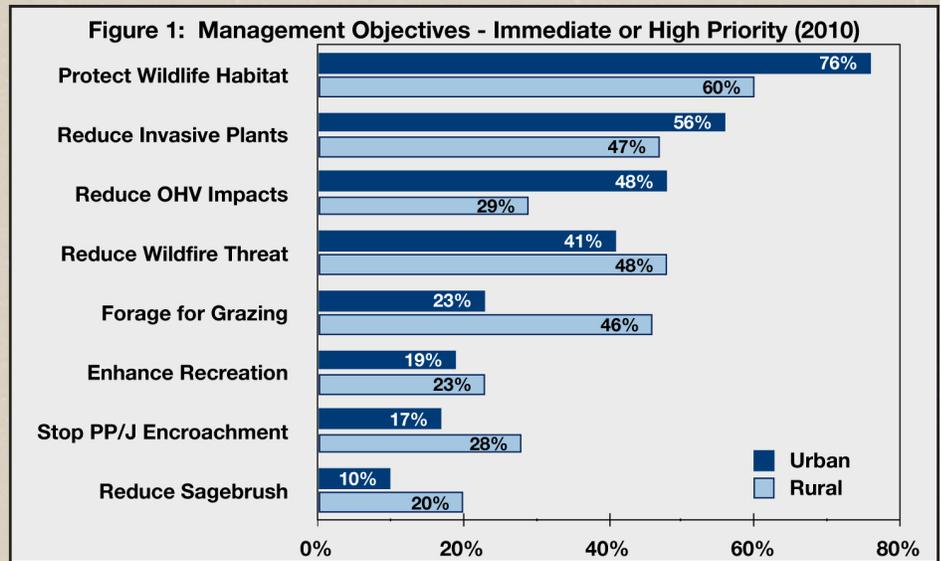
Ryan Gordon & Bruce Shindler, Oregon State University  
Mark Brunson, Utah State University

As SageSTEP social scientists studying public priorities for rangeland management, we've been following citizens' opinions and acceptance of management options and their trust in agencies to manage effectively. Our efforts began in 2006 with a mail-back questionnaire sent to residents in three urban areas (Boise, Reno, and Salt Lake City) and three rural areas (Elko and White Pine Counties, Nevada; Lake and Harney Counties, Oregon; and Millard and Beaver Counties, Utah) near where SageSTEP experimental treatment sites are located. In the summer of 2010 we sent a follow-up questionnaire to the original respondents seeking their input on some of the same issues, along with a few refinements.

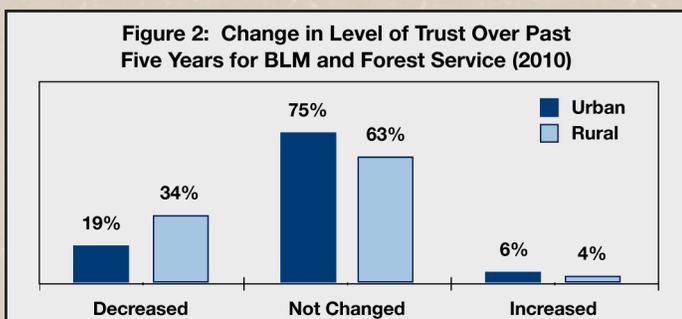
In our conversations with managers throughout the Great Basin, many expressed interest in knowing how citizens would prioritize rangeland management objectives. We asked the question directly in the 2010 survey (figure 1). While differences in rural and urban responses aren't all that surprising, it may be interesting to note that protecting wildlife habitat topped the list among both groups.

Another common—and more difficult—question relates to citizens' evaluation of agency efforts. We often look at this question in terms of trust: How much do citizens trust agencies to develop and implement effective land management strategies? Results from the 2010 survey show decreasing levels of trust, particularly among rural respondents (figure 2). We also asked respondents to rate the acceptability of different management strategies

and their trust in agencies to implement those strategies. In both the 2006 and 2010 surveys, respondents expressed relatively high levels of acceptance for many common practices, but lower levels of trust in agencies to implement them (figure 3, next page).



*Understanding citizen concerns and their priorities for management activities is a critical step in engaging the community and helping participants identify common goals.*



For insight on the trust issue, we examined answers to several open-ended questions where respondents noted factors contributing to decreased trust. These include perceived influence of outside groups (environmental as well as industry-based) that contribute to gridlock in the decision-making process, too much federal control over local decisions, management actions that are too restrictive (e.g. closed roads), and managers who are not in touch with local communities. On the positive side, among those who said their trust had *increased*, many indicated that agencies are now communicating more effectively with the public.



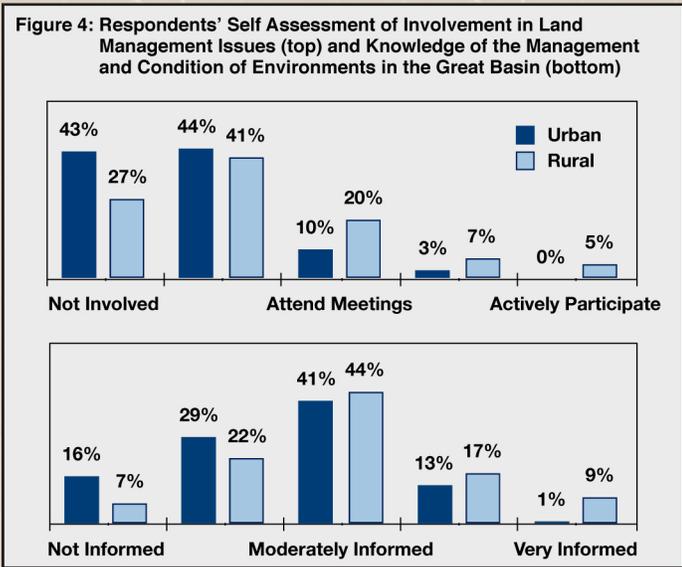
juniper encroachment and reducing sagebrush. These findings highlight key differences in the way urban audiences understand and define range management problems.

While they also put high value on protecting wildlife habitat, rural residents were generally less critical of human activities. They were much less concerned about impacts from grazing, mining, and OHV use; they also felt rangelands were overall healthier than urban respondents. They placed greater priority on reducing the threat of wildfire and protecting forage for grazing. They expressed higher levels of trust in

There are some opportunities to make positive progress, especially among urbanites who reported substantially less agency contact and understanding of key management issues (figure 4). The urban audience tends to be less engaged and informed because the issues are not as salient. This dynamic is changing as urban communities expand into the WUI, which indicates an opportunity for agencies to engage a new audience. Working with the urban audience will require an approach that considers the different levels of knowledge and interest, as well as the different concerns found among this group. It is a clear opportunity to begin building positive relationships and trust.

managers to use prescribed fire, but also indicated decreasing levels of trust in management agencies over the past five years.

When asked specifically about prescribed fire, loss of control and habitat loss topped the list of concerns reported by both urban and rural residents. Urban residents expressed significantly more concern about smoke impacts, while rural respondents were much more concerned about the loss of forage—underscoring another important difference between these two groups.



Over time (2006-2010), respondents generally expressed a high level of support for management practices to restore natural conditions. Acceptance remained strong for prescribed fire, grazing, felling, and mowing, but was lower for herbicide treatments and chaining (figure 3). These results are largely consistent with our research in other western states. That said, trust in agencies to use these practices in the Great Basin was much lower. Our research has also shown greater trust levels in communities where collaborative efforts among stakeholders are becoming successful. There is much less evidence of citizen-agency collaboration in the Great Basin, indicating an opportunity for agencies to place a priority on such efforts. Collaborative efforts build relationships and trust, which could help overcome some of the barriers to restoration activities in the Great Basin.

Among other key urban and rural differences, urban residents were generally more critical of human activities on rangelands. Overgrazing, mining, OHV use, and development were all high on their list of concerns. They also placed higher priority on managing for overall ecosystem health, particularly wildlife and invasive species. At the same time, they were less concerned about stopping pinyon pine and

Understanding citizen concerns and their priorities for management activities is a critical step in engaging the community and helping participants identify common goals. Such efforts often form the foundation of successful collaborative initiatives. For additional information about this study, contact Ryan Gordon in the Department of Forest Ecosystems and Society at Oregon State University: [ryan.gordon@oregonstate.edu](mailto:ryan.gordon@oregonstate.edu).

# New Online Resource for Rangeland Managers

A new online resource, *Guide to Legal and Institutional Resources for Restoration and Management of Great Basin Rangelands*, has recently been developed by the SageSTEP outreach team. The guide is available at [http://www.sagestep.org/pubs/leg\\_inst\\_res/index.html](http://www.sagestep.org/pubs/leg_inst_res/index.html) and provides links to information about policies and practices associated with the implementation of vegetation treatments.

Prescribed burning, herbicide application, and mechanical removal of vegetation are important tools for land owners and managers in the Great Basin. However, their use can be complicated by the wide range of political, economic, social and ecological considerations that come into play each time one of these tools is used. Various rules and regulations have been enacted to ensure that vegetation treatments are used responsibly, and guidelines and best management practices have been developed to help land managers make good decisions. The *Guide to Legal and Institutional Resources* provides access to this information from one convenient location.

The guide includes both national and state resources. We focus on common vegetation treatments such as prescribed burning, mechanical removal of vegetation, and the application of herbicides, as well as one of the most common land uses in the region—grazing. Additionally, information relevant to the Endangered Species Act is included in the National section and a General Land Management section provides additional resources not specific to the other categories.

These resources are intended to provide an introduction to the legal, institutional, and ecological factors relevant to the successful implementation of land management treatments and are not intended to be all-inclusive. A list of the guide contents is provided below:

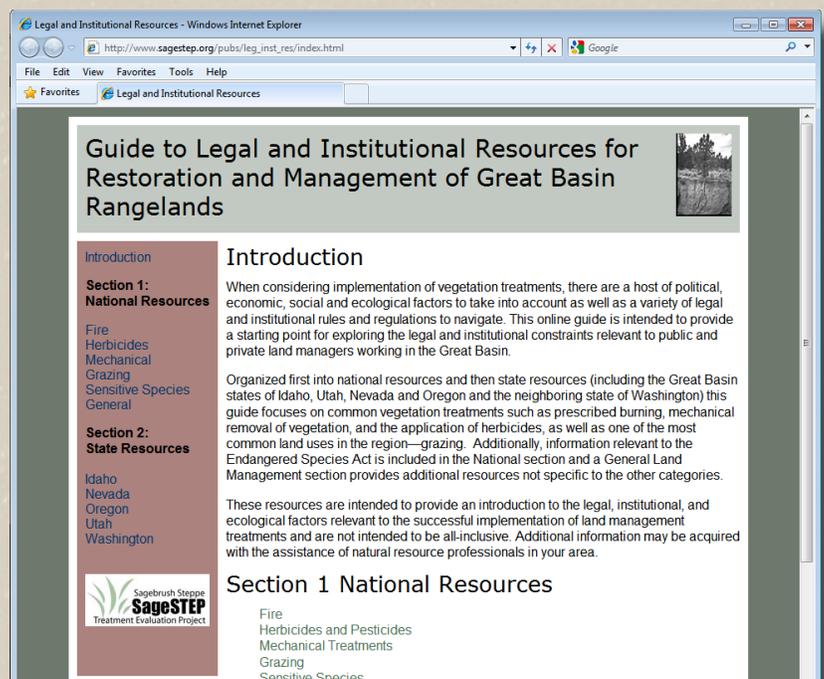
## Section 1 National Resources

- Fire
- Herbicides and Pesticides
- Mechanical Treatments
- Grazing
- Sensitive Species
- General Land Management

## Section 2 State Resources

- Idaho
- Nevada
- Oregon
- Utah
- Washington

If you are aware of additional resources that would fit with the objectives of this guide we would love to hear from you. Just send a message to [summer.c.olsen@usu.edu](mailto:summer.c.olsen@usu.edu) with the URL and an explanation of which section you think the information would best fit with.



SageSTEP's new online guide provides links to legal and institutional resources with information related to the implementation of vegetation treatments. The guide can be accessed at [http://www.sagestep.org/pubs/leg\\_inst\\_res/index.html](http://www.sagestep.org/pubs/leg_inst_res/index.html).

# SageSTEP Land Manager Workshop

## May 17-18, 2011 ~ Boise, Idaho

The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) received funding from the Joint Fire Science Program (JFSP) in 2005, to evaluate various fuels treatments at study sites throughout the Great Basin. Since 2007, we have held annual workshops to bring land managers and researchers together to discuss the progress of the project and to learn from each other. Our 2011 workshop will be held in Boise, Idaho, and will focus on results of 5 years of data collection and the application of this information to management decisions.

### Tuesday, May 17

We will meet at the Boise Hotel and Conference Center for presentations given by SageSTEP researchers as well as land managers from some of our partner offices. Research is being conducted in various disciplines including vegetation, fuels, wildlife, climate, soils, hydrology, economics and social science. We will also hear about the involvement of land managers in the research process and how they plan to incorporate study results into management activities. Presentations will be followed by a group discussion about application of research to land management.

### **NEW! Webinar Access Now Available for Indoor Session**

We understand that travel is currently restricted for many government employees due to budget cuts. With the help of the Great Basin Science Delivery Project, we are now able to provide webinar access to the indoor session of the workshop on May 17 for those who are unable to travel during this time and would still like to participate. Webinar participants will be able to view presentations, submit questions and comments throughout the day and be actively involved in the process of sharing information. If you are interested in signing up for the webinar, send an email to [summer.c.olsen@usu.edu](mailto:summer.c.olsen@usu.edu).

### Wednesday, May 18

We will travel to field sites where fuels treatments have been applied and discuss the impacts of treatments on a variety of ecosystem components. Additionally, we will discuss some of the SageSTEP field publications, including the Western Juniper Field Guide and Guide to Fuel Loading and their applicability to decision-making on the ground.

### Accommodation Information

The Boise Hotel and Conference Center  
3300 S. Vista Ave.  
Boise, ID 83705

For reservations call 1-855-611-1199 and **tell them you are part of the "SageSTEP Workshop" group.**



Prescribed fire in the Reynolds Creek area that we will be visiting on Wednesday, May 18 as part of our field day.

For additional information about the workshop, including the agenda, visit our website: <http://www.sagestep.org/events/2011workshop.html>.

# Upcoming Events

## **2011 SageSTEP Land Manager Workshop**

May 17-18, 2011

Boise, Idaho

<http://www.sagestep.org/events/2011workshop.html>

## **Great Basin Science Delivery Project Vegetation Resilience, the Role of the Perennial Herbaceous Understory, and Intact Sagebrush**

May 24-25, 2011

Winnemucca, Nevada

[http://greatbasin.wr.usgs.gov/GBRMP/docs/SD/11.01.06\\_Veg%20Resilience%20Workshop%20Flyer.pdf](http://greatbasin.wr.usgs.gov/GBRMP/docs/SD/11.01.06_Veg%20Resilience%20Workshop%20Flyer.pdf)

## **Ecological Society of America 96th Annual Meeting: Preserving and Enhancing the Earth's Life-Support Systems**

August 7-12, 2011

Austin, TX

<http://www.esa.org/austin/>

## **Association for Fire Ecology Interior West Fire Ecology Conference: Challenges and Opportunities in a Changing World**

November 14-17, 2011

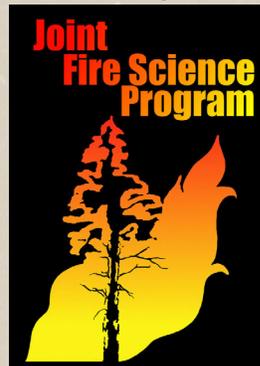
Snowbird Resort, Utah

<http://humboldt.edu/iwfire/>

## **SageSTEP is a collaborative effort among the following organizations:**

- Brigham Young University
- Oregon State University
- University of Idaho
- University of Nevada, Reno
- Utah State University
- Bureau of Land Management
- Bureau of Reclamation
- USDA Forest Service
- USDA Agricultural Research Service
- US Geological Survey
- US Fish & Wildlife Service
- The Nature Conservancy

Funded by:



For more information visit our website:

**[www.sagestep.org](http://www.sagestep.org)**

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