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Big Changes in the Great Basin

JFSP-funded researchers are exploring the ecological functioning of sagebrush-steppe communities in the Great Basin and other places in the dry Intermountain West. Their work is helping managers effectively use tools such as tree mastication and prescribed fire to help these communities become more resilient in the face of invasive weeds. Other research is finding ways to reestablish native vegetation on sites where weedy invaders have pushed the community past the point where it can recover on its own.

When it comes to endangered ecosystems, the arid Intermountain West has more than its share. The most urgent problem is invasive plants, both native and exotic, that are muscling into lands formerly dominated by native shrubs and grasses. In particular, cheatgrass, in combination with wildfires and other disturbances, is turning formerly diverse sagebrush communities into highly flammable monocultures. The resulting disruption of the plant communities is exposing the rangelands of the Great Basin and other arid and semi-arid western lands to more frequent and more extensive wildfires.

A warming climate is making matters worse by favoring the invading plants and by altering the amount and timing of the region's precious precipitation. As a result, water availability, always uncertain from year to year, is becoming even less predictable. Finally, all this is happening as a human population boom is putting pressure on an ecosystem that is on the edge at the best of times.

The proliferation of invasive weeds signifies a profound environmental change in the Great Basin and across the Intermountain West. Like the fruiting bodies of a fungus whose biomass is mostly underground, the weeds are the most visible thread in a complex tangle of issues that signify the unraveling of an ecosystem: impaired watershed function, decreased biodiversity, degraded habitat for sensitive wildlife, diminished forage for both cattle and wild herbivores, and more-intense outbreaks of insects and diseases.

When human aspects are considered, the problems extend to drinking-water shortages, potentially explosive conflicts over water rights, economic losses to ranching and farming communities, degraded recreational areas, wildfire risks to homes and communities, impaired air quality, and spiraling costs of fire suppression.

"Sometimes I lie awake thinking about this," says Aden Seidlitz, chief of the Bureau of Land Management's (BLM's) fire planning and fuels management division. He is headquartered in Boise, at the edge of the Great Basin, one of the fastest-growing metro areas in the nation. "It really hit home last summer with the big fires," Seidlitz says. "It appalls me that thousands of acres of good sagebrush land can just burn up."

The most urgent problem is invasive plants…that are muscling into lands formerly dominated by native shrubs and grasses.

Last summer's Murphy Complex fire in Idaho and Nevada, which burned 1,015 square miles, was the biggest rangeland fire in United States history. The Milford Flat fire, which burned 567 square miles, was the largest fire Utah had ever seen.

In all, about 2.7 million acres in the Great Basin burned in 2007, according to Mike Pellant, coordinator of the BLM's Great Basin Restoration Initiative. Since 1990, about 16.2 million acres have burned—an area larger than the state of West Virginia and about 12 percent of the Great Basin's land area. About one-eighth of those acres burned more than once within that period, says Pellant. Many scientists are saying a warming climate, coupled with increased plant production that may come with increased atmospheric carbon dioxide, will bring bigger and more frequent fires.

The Great Basin is a large arid and semi-arid area between the Rocky Mountains and the Sierra Nevada-Cascade range. It covers nearly 211,000 square miles, an area almost four-fifths the size of Texas. It takes in most of Nevada, about half of Utah and Idaho, the southeastern quarter of Oregon, and the sliver of California lying east of the Sierra Nevada.

The Great Basin takes in parts of five states. Map by Kurt Fesenmyer.

Its topography consists of mountains and lowlands and everything in between—a pattern known as basin and range. Moisture is sparse; over half the land in the Great Basin receives less than 12 inches of precipitation a year. Precipitation falls as winter snow, which provides water for rivers, streams, and reservoirs during spring and summer, and also as occasional rains from May through September. The amount of precipitation varies widely from season to season—a couple of wet years can be followed by a multi-year drought.

The native vegetation of the Great Basin is arrayed in a complex mosaic across the rugged landscape. Plant communities are keyed to elevation, although there is much intermixing of communities at the edges. The highest slopes and ridges feature alpine meadows and forests dominated by pines. Intermixed with these forests in moister environments are groves of aspen, one of the few broad-leaved trees to be found in the West's intermountain forests. Slightly lower down are mountain big sagebrush communities and associated pinyon pine and juniper woodlands.

More than 20 species and varieties of sagebrush dominate the Great Basin's sagebrush steppe lands.

The lowest-lying vegetated lands in the Great Basin are salt-desert shrublands. These are sparsely vegetated desert areas dominated by woody plants such as bud sage, shadscale, rabbitbrush, greasewood, and winterfat; and grasses such as Indian ricegrass and bottlebrush squirreltail. Globemallows are among the diverse native forbs. Many basins have barren playas at their valley bottoms.

Between the salt-desert shrublands and the higher-elevation shrublands and woodlands lies a wide band of vegetation known as sagebrush steppe. Its overstory is a shrub community dominated by sagebrush—more than 20 species and varieties—together with an understory of native perennial grasses and forbs, with species varying according to latitude and elevation. The grasses include wheatgrass, ricegrass, needlegrass, bluegrass, fescue, and squirreltail.

…the sagebrush-steppe vegetation communities had adapted to their challenging and changing climate over thousands of years.

Forbs include aster, lupine, penstemon, lomatium, buckwheat, balsamroot, and hawskbeard—some of which produce a dazzling array of flowers in moist springs. Beneath the understory is often a crust of lichens, mosses, algae, and other small organisms that covers and stabilizes the soil surface.

In its northerly reaches, the sagebrush steppe is moister and has more understory grass. In the sagebrush semi-desert that occupies lower-elevation and more southerly areas, conditions are drier and the understory vegetation sparser.

Before European-American pioneers arrived in the 1800s, the sagebrush-steppe vegetation communities had adapted to their challenging and changing climate over thousands of years. The deep-rooted sagebrush and other shrubs pull water from varying depths in the soil, and they anchor the soil and inhibit erosion. The tough bunchgrasses can withstand extended drought as well.

The understory of intact sagebrush steppe contains native bunch-grasses, forbs, and sometimes a crust of lichens on the soil.

The sagebrush steppe is home to a rich diversity of wildlife, from big game, including elk and mule deer, to smaller mammals, such as pygmy rabbits, many bird species including the sage-grouse, and several species of reptiles and amphibians. Historically, fire occurred about every 30 to 110 years. It occurred less frequently (every 60–200 years) in the pinyon-juniper zone in the southern reaches of the Great Basin and more frequently (every 8–20 years) in the more mesic western juniper communities in the northern Great Basin. In all these zones, fire touched the land relatively lightly because fuels were scattered and patchy.

Starting with early settlers, human activities have systematically altered those adaptive mechanisms. Many years of grazing by cattle and sheep gradually depleted the native bunchgrasses and perennial forbs and opened the way for invasive annual weeds such as cheatgrass, along with other non-native plants such as knapweeds, rush skeletonweed, and yellow starthistle. As a result, the sagebrush-steppe lands of the Great Basin are losing their capacity to provide vital ecosystem services—wildlife habitat and diversity, pollination, watershed function, rangeland productivity, and soil resources, among others. They have also become more susceptible to larger, more frequent fires.

"It's important to note that fire by itself is a natural phenomenon," says Jeanne Chambers, a Forest Service research ecologist based in Reno, Nevada, who has studied Great Basin ecosystems extensively. "We saw a long period in which low numbers of acres burned. Now, with increases in both fine and woody fuels, we're seeing much larger fires."

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What exactly is an "invasive" species? Especially since European-American settlement, many species of non-native plants have made themselves at home across the continent. Only a few are considered invasive—meaning they establish themselves, persist, and spread in a way that causes harm to desirable ecosystems, habitats, or species.

The judgment of "harm" is admittedly ambiguous. When one species takes over a natural system so thoroughly that it causes significant undesirable changes in ecosystem composition, structure, or function, its effects are generally understood as harmful. More pragmatically from a management standpoint, an invasive plant is "harmful" when it interferes with management goals like maintaining biodiversity, protecting wildlife habitat, restoring ecological processes, or enhancing human economic and aesthetic values such as grazing and recreation.

The sagebrush steppe is highly vulnerable to both the pressures of invasive non-native plants like cheatgrass, and the encroachment of native conifers like pinyon pine and juniper.

Cheatgrass, the poster villain of exotic invasive plants, is ubiquitous across the West. It is present on about 100 million acres of sagebrush steppe and has come to dominate about one-quarter of it. Introduced from Eurasia more than a century ago, probably in the course of European immigration, cheatgrass quickly grabbed hold in the Great Basin, settling mostly in the low and mid-elevation sagebrush steppes. Today, stimulated by a warming climate and adaptation to different climatic zones, it is expanding into new environments.

Cheatgrass is the poster villain of invasive species in the Great Basin.

True to its name, cheatgrass competes aggressively with the native shrubs, forbs, and grasses, cheating them of the water and nutrients they need and eventually spreading in a flammable blanket across the range. An annual plant, cheatgrass matures earlier than the native perennials. It comes up in fall or early spring and rapidly depletes the water needed by the later-appearing native grasses and shrubs. Then it dies back as the season enters its hottest, driest period. Its thin stalks and leaves are easily ignited, and its dense foliage makes a continuous layer of fine fuels that carries fire rapidly.

Cheatgrass thrives in a landscape with frequent, low-intensity wildfires. The cheatgrass-wildfire cycle is often initiated by wildfire in a sagebrush-steppe community that has some cheatgrass in the understory. After the fire, cheatgrass often out-competes the remaining native plants, and after a couple of wildfires, it can form a near-monoculture.

A cheatgrass-dominated landscape may burn every 3 to 5 years. "The fires are actually so cool that you can walk right through the advancing fire line," says Jim McIver, range ecologist at Oregon State University. "But they are more extensive [than presettlement fires] in the sense that they burn many acres very quickly."

As cheatgrass takes over a landscape, it gradually converts it into an environment more favorable to itself. Its seeds survive the fires to initiate many new plants, which rapidly occupy a site. Thus, it provides fuel for more fires, which then initiate a new flush of cheatgrass—a positive feedback, in scientific terms, or a vicious cycle, as managers prefer to call it. The fires progressively consume the remnants of the original sagebrush-grass-forb community, paving the way for cheatgrass to extend its domain.

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To crown its competitive prowess, cheatgrass may be getting a boost from higher levels of CO_2 in the atmosphere. Increases in atmospheric CO_2 have been hypothesized as a factor for more frequent rangeland wildfires. The extra CO_2 increases the plant's water use efficiency, which increases growth and thus biomass. It also increases the amount of lignin—the coarse, woody part of the stem—which makes the plant less palatable to livestock and also slower to decompose, which again results in higher levels of flammable biomass.

At the same time as cheatgrass is generally increasing, pinyon and juniper trees are expanding into mid-elevation mountain big sagebrush communities. Many of these trees became established during a period of favorable climate around the turn of the last century, says Chambers, and heavy grazing by livestock contributed to decreased competition from herbaceous species and allowed tree communities to expand downslope. Fire exclusion over the past 80 years may also have played a role.

While cheatgrass is expanding in the low- to mid-elevation sagebrush steppe, resulting in an increase in fine fuels, pinyon-juniper is expanding in the middle to higher elevation sagebrush steppe, causing an increase in woody fuels. "So sagebrush is being squeezed from both sides," says McIver, who also leads a JFSP-funded research effort called the Sagebrush Steppe Treatment Evaluation Project (SageSTEP). A cousin of cheatgrass, red brome, is also on the move, spreading into the lower-elevation salt-desert shrublands of the Great Basin and the Mojave and Sonoran deserts and increasing the fire frequency in these lands, which historically rarely experienced fire.

The Great Basin's problems loom high on the radar of scientists like Chambers and McIver, as well as program managers like Seidlitz and Pellant. About 70 percent of the Great Basin is federally managed, most of it by the BLM. Several BLM managers and university and agency scientists are taking part in

Pyrenophora semeniperda spores may help control the spread of cheatgrass. Photos by Julie Beckstead.

"Black Fingers of Death" May Help Stem Cheatgrass Spread

A fungus with a dramatic nickname may prove useful in controlling the spread of cheatgrass. *Pyrenophora semeniperda* infects cheatgrass seeds in the soil. Those that germinate soon after infection can survive, but virtually all those that fail to germinate quickly, die. The fungus sends out black, spore-laden tendrils, which led researchers to dub it "the black fingers of death."

Forest Service scientist Susan Meyer, Gonzaga University biologist Julie Beckstead, and Brigham Young University biologist Phil Allen are leading a 3-year study of the efficacy of the fungus against cheatgrass spread. The researchers will conduct both field experiments and molecular genetics research to see whether the fungus can help control cheatgrass without damaging native plants. The project is one of five studies funded in 2007 as part of a JFSP research initiative on revegetation of arid lands following fires.

Cheatgrass's Cousin Is Invading Deserts

Just as cheatgrass is altering fire regimes at the lower edges of the sage-steppe band, a relative called red brome, along with another exotic species, Mediterranean grass, is having similar effects on the lower-lying desert shrublands of the Mojave Desert.

Until recently, fire has been an infrequent visitor to these sparsely vegetated lands. Now they are starting to experience more fire as the invasive annual grasses gain a toehold.

Matt Brooks, a research botanist with the U.S. Geological Survey based in Las Vegas, has written extensively on management of non-native species in the Mojave Desert and elsewhere in the Intermountain West. Currently, he is looking at the relationship between fire in the Mojave Desert and variations in annual rainfall.

Grasses respond rapidly to yearly fluctuations in rainfall, Brooks says. A wet growing season produces more grassy biomass than a dry one, and thus, in a grass-dominated landscape, there is a tie between higher than normal rainfall in one season and the occurrence of fires in the next.

Red brome, a cousin of cheatgrass, is invading the shrub-lands of the Mojave Desert. Photo © Patrick J. Alexander.

the $13 million, JFSP-sponsored SageSTEP project. Their goal is to develop reliable techniques for treating vegetation communities, including using fire, to slow the spread of cheatgrass and pinyon-juniper woodlands and restore native vegetation.

A major goal of the SageSTEP work is to determine the critical thresholds of recovery. What are the key elements of a functioning sagebrush community—specifically, what plant composition and soil characteristics provide for resilience (the capacity to recover after disturbance) and for resistance to invasion? What disturbances or management treatments, and at what levels, allow a community to retain a high degree of resilience and resistance? At what point will intervention do some good? At what point does it become ineffective?

The SageSTEP strategy is two-pronged: to determine the ecological conditions (the degree of dominance of cheatgrass or pinyon-juniper and the environmental regimes) under which intervention will allow these ecosystems to recover without revegetation; and to determine the most effective treatment or combination of treatments for restoring functioning ecosystems that are resilient to disturbance and resistant to cheatgrass. The specific treatments are designed to reinstate natural disturbance regimes, decrease the competitive edge of cheatgrass, and restore the native vegetation before the site passes the point beyond which it can no longer recover on its own. The treatments include prescribed fire and tree cutting or mastication to control pinyon and juniper trees, herbicides to control cheatgrass, and mechanical treatments to revitalize sagebrush stands.

SageSTEP is "the flagship," in Pellant's words, of the arid-lands research funded by the JFSP. The project has about 20 large (300- to 800-acre) study sites spread across the Great Basin in areas where the sage-steppe ecosystem is threatened by cheatgrass and woody species. Three dozen university and agency scientists make up the research team, which began in 2005 to look at the effects of various types and levels of management treatments on plants, wildfire potential, soils and nutrients, water runoff and erosion, and wildlife.

For example, in mid-elevation (4,600–5,400 feet) sage-steppe lands in Modoc County, California, juniper encroachment and an increase in fuel loads is shifting the fire regime from low-intensity fires that occur every 30 to 70 years to less-frequent, higher-

Encroaching juniper is shifting the fire regimes in higher-elevation steppe lands.

Mechanical Hog Roots Out Juniper

On SageSTEP's Onaqui sagebrush-juniper site in Utah, the juniper foliage loomed thick and dark across miles and miles of silvery sagebrush range. On the side of a lonely hill, a yellow tractor called a Bull Hog™ toppled the junipers and ingested their foliage into its red masticator, then spat out and trampled the resulting tangle of fragrant needles and twigs. One tree, then another, then another, until no trees were left standing on the 50-acre plot.

On another plot, researchers cut the junipers down with a chainsaw, and they conducted a prescribed burn on a third. A fourth was left untreated as a control.

The Onaqui juniper site looks much like several million acres of rangeland in western Utah, northeastern Nevada, and southern Idaho. The fire return interval in these lands historically ranged from 20 to more than 100 years. The invasion of junipers at Onaqui suggests that the land has not burned since the late 1800s. As the woodlands gain in dominance, the fire regime shifts to less-frequent, higher-intensity fires.

A companion study site at Onaqui is focused on cheatgrass-invaded sagebrush steppe. Its four 75-acre plots received burning, mechanical, and herbicide treatments; one plot was left untreated as a control. This site is representative of several million acres of rangeland in western and central Utah, southern Idaho, northern Nevada, and eastern Oregon. Fire historically visited this land once every several decades. After settlement, extensive livestock grazing, and the encroachment of cheatgrass, fires have been coming more frequently.

severity fires. SageSTEP researchers are looking at both prescribed fire and mechanical removal of the juniper trees to see if these landscapes will recover on their own, without expensive reseeding projects.

Cheatgrass is shifting the fire regime on the Owyhee site in north-central Nevada, which historically experienced infrequent fires. Here, researchers are using prescribed fire and mechanical treatment in the form of mowing to decrease competition from sagebrush and allow the residual native forbs and grasses to increase. Some of the Owyhee trials also call for herbicides, both to thin the sagebrush and to decrease competition from cheatgrass. Again, the objective is to determine the conditions under which a desirable plant community will emerge after treatment.

While it is too early for detailed results, researchers have gleaned a few general findings that may help land managers cope until more information is in. For example, prescribed fire or some level of mechanical removal can be effective in slowing the spread of juniper. However, the outcome depends largely on the perennial grasses and forbs in the community before treatment: with a healthy understory, fire can work well; without one, fire can make things worse. Herbicides aimed at annual grasses like cheatgrass also appear to have favorable short-term effects, especially if there is a reasonably healthy community of native perennial bunchgrasses on the site.

These are tentative, qualified findings, McIver hastens to add—specific results are influenced by a host of variables such as latitude, elevation, time of year, character of the plant community, and land use and fire history. "Managers know generally what they need to do," he says, "but they don't know precisely when and where to do it. The object of our experiments is to fine-tune our understanding of when and where."

Whatever treatment is chosen, researchers agree it's essential to monitor treated sites for a few years, protect them from unnecessary disturbance (such as grazing), and sometimes reapply the treatment. SageSTEP has released a manager's guide on western juniper; additional guides for pinyon- juniper and sagebrush systems invaded by cheatgrass are planned for later this year.

Most of the SageSTEP study sites are located on grazing lands, with livestock excluded for the term of the study. None of the studies is looking specifically at the effects of post-treatment grazing on these ecosystems, although the potential exists for longer-term monitoring to discover those effects.

Some ranchers' organizations have suggested that grazing might be used to help reduce fuels. Cattle grazing is a flash point in an already difficult conversation with many of the Great Basin's citizens and groups about the best way to handle the region's invasive-species crisis. There are other BLM-supported studies looking at livestock, fuel, and wildfires, says Pellant. A team of scientists and land managers is assessing how livestock grazing might have affected fuels in the 2007 Murphy Complex fire, and how it might be used in the future to reduce catastrophic fire. A study being initiated on the BLM's Winnemucca District will examine the effects of post-fire grazing on ecosystem resistance to cheatgrass and the longer-term effects on fine fuels and fire frequency.

> ***"Our effort is active restoration… We're working on how to establish native plant communities with multiple species."***

However, recent research led by Jeanne Chambers demonstrates that using grazing to reduce fuels may have significant unintended consequences. Her results indicate that when grazing reduces the abundance of native perennial grasses or forbs, the susceptibility of sagebrush communities to invasion by cheatgrass may increase, especially after fire. This, in turn, can lead to an increase in fine fuels and even larger or more severe fires. However, in areas that are already dominated by cheatgrass and where livestock can be closely controlled, it may be possible to use livestock grazing to reduce fuels without significant risk of further exacerbating future fires or increasing cheatgrass dominance.

Cattle grazing is a flash point in an already difficult conversation among Great Basin citizens and land managers. Photo by Todd Black.

In places where invaders have pushed the site past the recovery threshold, more drastic treatments are needed. Another large research effort, the BLM-funded Great Basin Native Plant Selection and Increase Project, is finding ways to restore the original vegetation community on such sites.

"Our effort is active restoration," says Nancy Shaw, a Forest Service research botanist and collaborating scientist. "We're working on how to establish native plant communities with multiple species." Shaw and fellow scientists, land managers, and seed experts from more than 20 cooperating agencies and companies are exploring the best methods for seeding and cultivating native sagebrush-steppe plants.

Carefully selecting the mix of native plants to reseed an area can make a big difference in resiliency of the resulting plant community. The plants must be adapted to the latitude and elevation in question, of course, but other bases need to be covered as well. For example, the plant mix should represent a range in growth timing, or phenology, so that plants are growing, flowering, and seeding in succession throughout the season. The mix should also constitute a variety of growth habits and rooting depths to take the best advantage of the site's nutrients and water. And, there should be some fire-tolerant plants in the mix to make the newly established community more resilient to wildfire.

To arrive at the optimum mix of plants for various sites, Shaw and her colleagues are probing the basic biology of native rangeland plants—how they become established, what their cultural requirements are, how they're pollinated, and how they interact with other plants in their community. The project also includes trials of seed drills and other implements and techniques for planting seeds and improving conditions for germination and seedling emergence and establishment.

Researchers at the Great Basin Native Plant Selection and Increase Project raise native forbs and grasses in planting boxes (top). At bottom, seed production of *Phlox longifolis*.

These two projects—SageSTEP and the Great Basin Native Plant Selection and Increase Project—

More seedlings of native plants being propagated by the GBNP project. Left - *Penstemon, Eriogonum, Erigeron* polystrips, Middle Left - *Hedysarum boreale, Achillea millefolium, Eriogonum heracleoides*, Middle Right - *Eriogonum heracleoides, Potentilla gladulosa, Penstemon attenuatus*, Far Right - Squirreltail grass seed field.

are "the bookends" of the research on endangered Great Basin ecosystems, says Pellant, who is involved with both as a liaison between scientists and land managers. "SageSTEP is looking at ways to maintain areas that haven't already lost their functionality, to push them back into a healthier condition," he says. "The Great Basin Native Plant project is aimed at restoring areas that have crossed that threshold" and likely won't recover without heroic measures.

That threshold is easier to conceptualize than it is to define. The question of what to restore these ecosystems to is at best a judgment call based on incomplete information. In addition, the term "natural" implies "a value judgment that can be interpreted in different ways," wrote Matt Brooks, research botanist with the U.S. Geological Survey, in a recent report on non-native plants and fire.

What managers can do is to identify clearly what ecosystem characteristics they want to achieve—a specified-percent cover of native forbs and shrubs? Reduced likelihood of severe fire? A measurable improvement in wildlife habitat characteristics?—and then use science-based techniques, such as these research projects are developing, to achieve them.

Even with such techniques, it is not at all clear that land manipulation alone can halt the spread of invasive species in the Great Basin or elsewhere in the dry West. The huge size and ecological variability of the area make it hard to study comprehensively. And, as in any landscape-level research, it is not easy to pin down cause-effect relationships with confidence.

Land managers must contend with large realities—for example, the legacy of past environmental damage, current human settlement patterns and economic activities, controversy about public land management, declining budgets, and climate change.

It is a high-stakes situation, says McIver, to which considerable human effort and skill are being applied. "We're all concerned about the productivity of the land," he says. "Sure, plant ecologists and botanists prefer native bunchgrasses. But ranchers like bunchgrass too, especially compared to cheat. And other species love bunchgrasses and native forbs—birds, pygmy rabbits. When you remove [the habitat], these species decline. We're seeing it in sage-grouse and in smaller species like sage sparrow, sage thrasher, Brewer's sparrow, sage flycatcher."

These species are not listed under the Endangered Species Act, but some are distinctly at risk. A listing, McIver says, would have serious consequences for the

The Human Element

People who live in and care about the Great Basin tend to have passionate views about what should be done to solve its ecological problems. Arguments about land management policy can burn as hot as a juniper fire. To help managers better understand the human context in which they are operating, SageSTEP researchers are looking at the social and economic ramifications of the various land management treatments being tried.

Researchers are interviewing ranchers and other stakeholders to learn how people gauge whether a prescribed burn or an herbicide treatment is acceptable, and how these judgments affect managers' decisions. How do people weigh tradeoffs? How do they determine which course of action will be most effective? Which methods of communication work best and which ones turn people off? In what ways do people reconsider their opinions after seeing the outcome of a treatment? Those are the sorts of questions the researchers hope to answer.

In preliminary survey findings, the social research team identified "high recognition among the stakeholder groups of threats to sagebrush ecosystems and solid support for the concept of sagebrush steppe restoration in principle." However, some interviewees were skeptical that the land management agencies had the capacity to make it happen.

status quo in the Great Basin. It would make life hard for ranchers, recreationists, residents, and anyone who lives in or loves the land.

"Nobody wants to see wildlife species listed," he says, least of all the managers of the Great Basin's public lands. "It would tie their hands, even for management actions that are beneficial for the species," such as the habitat-restoration measures now under study.

"The processes in place and the great wheels in motion are pretty overwhelming," says McIver. "But you know what? We have to try. That's what our research is about, an honest attempt at trying. I don't think any of us is so naïve as to think that we're going to solve everybody's problems in one project. But, we will have a much better understanding of these systems five, six years down the road."

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Web Resources

Great Basin Native Plant Selection and Increase Project: ***http://www.fs.fed.us/rm/boise/research/shrub/greatbasin.shtml***.

Great Basin Restoration Initiative: ***http://www.blm.gov/nifc/st/en/prog/fire/more/gbri/briefing.html***.

Sagebrush-Steppe Treatment Evaluation Project (SageSTEP): ***http://www.sagestep.org***.

SageSTEP Educational Resources: Animated map showing wildfires in the Great Basin from 1990-2007: ***http://www.sagestep.org/educational_resources/fire_maps/Animation-PPT2-GB-Wildfires2.html***.

SageSTEP Western Juniper Field Guide: ***http://www.sagestep.org/pubs/userguides.html***.

Cover photos clockwise from left to right: Bull Hog™; map of Great Basin; sagebrush landscape; blue flax (photo by Travis Miller); prescribed burn at SageSTEP Onaqui study side near Tooele, Utah; cheatgrass.

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Credits

Writer – Gail Wells
Gail Wells Communications

Managing Editor – Kathy Rohling
Kathy_Rohling@blm.gov

Design and Layout – Jennifer Kapus
Jennifer_Kapus@blm.gov

Tim Swedberg
Communication Director
Timothy_Swedberg@nifc.blm.gov
208-387-5865

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John Cissel, Program Manager
208-387-5349
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