



FIRESCIENCE **DIGEST** *Research Supporting Sound Decisions*

ISSUE 23

OCTOBER 2016

Secretarial Order 3336 Science Priorities: The Role of Science Past, Present, and Future

Within sagebrush (*Artemisia* spp.) ecosystems, which are home to more than 350 species of plants and animals, potentially more frequent and severe fires are causing an increased threat to human safety, property, rural economies, and wildlife habitat. In particular, the habitat of the greater sage-grouse (*Centrocercus urophasianus*), an iconic sagebrush-dependent species, is at risk. In response to this reality, on January 15, 2015, Secretary Sally Jewell signed Secretarial Order 3336 (S.O. 3336), titled “Rangeland Fire Prevention, Management, and Restoration.” The main purpose of the order is to implement enhanced policies and strategies for managing rangeland fire and restoring sagebrush landscapes impacted by fire across the West. S.O. 3336 established the Rangeland Fire Task Force, which, guided by the order, is designed to ensure that land managers and other interested parties have access to the best available science and tools to conserve sagebrush ecosystems, protect greater sage-grouse habitat, reduce the threat of wildfire, and restore degraded areas. To meet the science and tool needs, the task force directed the development of an actionable science plan. The

Joint Fire Science Program not only participated in the development of this plan, but it also played a pivotal role in both the establishment of S.O. 3336 and subsequent strategic planning by the Rangeland Fire Task Force through previous and ongoing research it has funded relative to sagebrush ecosystems and fire.



Sagebrush (*Artemisia* spp.) ecosystems encompass many of the interior West's rangelands—and are among the most imperiled landscapes in the U.S. today (Chambers et al. 2008). Over the past 150 years, the proliferation of nonnative invasive annual grasses, altered fire regimes, and other factors have seriously degraded many areas (Chambers et al. 2014). For example, encroachment by nonnative cheatgrass (*Bromus tectorum*) has overwhelmed many Great Basin landscapes that were dominated by sagebrush and associated herbaceous species. In other areas, fire exclusion, overgrazing, and climate change have promoted conifer tree encroachment into sagebrush ecosystems (Miller and Tausch 2001).

With increasing fuel loads and a warming climate, “megafires” are becoming more frequent in sagebrush ecosystems (Chambers et al. 2014). In landscapes where blackened sagebrush remnants now stand as mute testament to the past, post-fire regeneration of vegetation is often dominated by cheatgrass and other invasives. These flashy fuels—or “grassoline” in firefighter parlance—increase the fire risk even more, thus creating an invasive species-fire cycle that can promote long-term conversion to nonnative grasslands in the absence of management intervention (Figure 1).

In addition to the growing threat to human safety, property, and rural economies, the possibility of increased frequency and severity of fires caused by invasive plants can lead to negative ecological impacts on wildlife habitat. Consider the case of the iconic greater sage-grouse (*Centrocercus urophasianus*), which has lost as much as 50 percent of its habitat since the mid-1800s (Schroeder et al. 2004). Since 2006, the U.S. Fish and Wildlife Service has responded

three separate times to petitions to list the bird under the Endangered Species Act.

A Call to Action: Secretarial Order 3336

Many rangeland stakeholders have long recognized the threats to the sagebrush ecosystem. Protecting, conserving, and restoring the health of the sagebrush ecosystem is now recognized as a critical fire management priority by the U.S. Department of the Interior (DOI) in coordination with the U.S. Department of Agriculture (specifically, the U.S. Forest Service and the Natural Resources Conservation Service) (see the sidebar by the Assistant Secretary for Land and Minerals Management). On January 5, 2015, Interior Secretary Sally Jewell signed Secretarial Order 3336 on “Rangeland Fire Prevention, Management, and Restoration” (S.O. 3336). This order provides enhanced policies and strategies, including the development of new science-based strategies, for managing rangeland fire and restoring sagebrush landscapes across the West. It focuses primarily on sagebrush rangelands and greater sage-grouse habitat while also addressing human safety, economic, cultural, and social concerns (see the Purpose and Need sidebar). In addition, S.O. 3336 specifies that an actionable science plan be developed that builds on past research and prioritizes future research that is needed to support sagebrush ecosystem management. Clearly, the Secretary's order reflects the Obama administration's oft-stated goal of supporting sustainable, science-based management of the nation's natural resources.

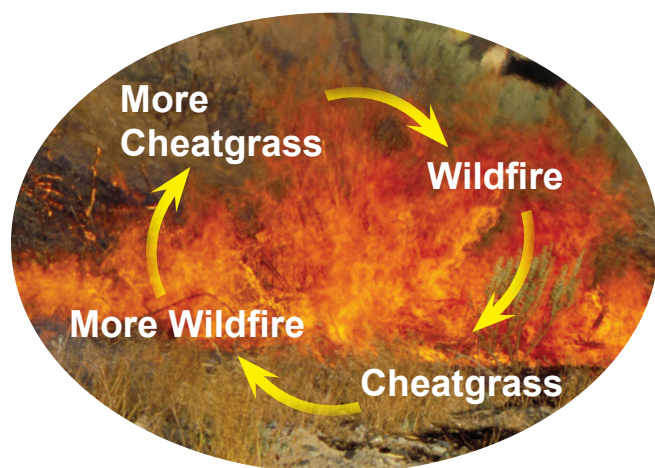


Figure 1. The invasive species-fire cycle: An intractable feedback loop of increasingly frequent wildfires in which invasive annual grasses, such as cheatgrass, continue to expand onto landscapes that previously were dominated by native sagebrush (DOI 2015).

Purpose and Need for Secretarial Order 3336

The S.O. 3336 background section highlights the impetus of the order by summarizing the significant rangeland issues to be addressed by the Bureau of Land Management (BLM), other DOI agencies, and partnering entities. The overarching purpose of the order is stated in the supporting graphic.

ORDER NO. 3336

Subject: Rangeland Fire Prevention, Management and Restoration

Sec. 1 Purpose. This Order sets forth enhanced policies and strategies for preventing and suppressing rangeland fire and for restoring sagebrush landscapes impacted by fire across the West. These actions are essential for conserving habitat for the greater sage-grouse as well as other wildlife species and economic activity, such as ranching and recreation, associated with the sagebrush-steppe ecosystem in the Great Basin region. This effort will build upon the experience and success of addressing rangeland fire, and broader wildland fire prevention, suppression and restoration efforts to date, including the National Cohesive Wildland Fire Management Strategy, and ensure improved coordination with local, state, tribal, and regional efforts to address the threat of rangeland fire at a landscape-level.

Assistant Secretary for Land and Minerals Management Janice M. Schneider on S.O. 3336

The increasing frequency and severity of rangeland fires and the conversion of sagebrush ecosystems to invasive annual grasses pose a major threat to those who depend on these lands and resources to sustain their livelihoods and quality of life. This includes individual ranchers, more than 1,000 communities, and others who live, work, and recreate on these iconic landscapes. On several trips to the Great Basin region, I've seen first-hand the harm that dangerous and destructive rangeland fires cause, including on my recent visit to the Soda Fire rehabilitation site near the Idaho/Oregon border.

This unique American landscape supports energy development, ranching, and outdoor recreation such as hunting, hiking, and camping. Today's rangeland "megafires" also pose an increased threat to the more than 350 species of plants and animals, including the greater sage-grouse, that rely on this critically important ecosystem. In addition, many of the nation's treasured cultural and archaeological sites dot the sagebrush rangelands.

We are committed at all levels of the Department to comprehensively address these threats to our communities, to our businesses, and to fish and wildlife—in short, to protect our livelihood and values in the West. Our land and resource management plans must be grounded in the best available science to help us understand and address the threat and impacts of wildfire on western rangelands; find new strategies to prevent and suppress rangeland fire; reduce the spread of invasive annual grasses, like cheatgrass; and restore rangelands for the benefit of local communities and economies, outdoor enthusiasts, and the hundreds of wildlife species that call this area home.

This is why, in 2015, Secretary of the Interior Sally Jewell signed Secretarial Order 3336, titled "Rangeland Fire Prevention, Management, and Restoration", a comprehensive science-based strategy to address the ecological problems that are damaging vital sagebrush ecosystems and productive rangelands in the American West. Through the order, we are improving our efforts to work at a landscape level and to make better use of science and technology—including development of an actionable science plan—in preventing and suppressing



Department of the Interior Secretary Sally Jewell and associates on a 2016 field tour of the Soda Fire rehabilitation landscape in Idaho. From left to right, Secretary Sally Jewell, Interior Assistant Secretary for Land and Minerals Management Janice Schneider, and Bureau of Land Management natural resource specialist Cindy Fritz (foreground).

fire and restoring fire-impacted landscapes. The success of this effort relies on robust collaboration that brings together a wide array of partners, including federal and state agencies, tribes, ranchers, industries, and nongovernmental organizations. Combining our resources and expertise will enable us to more effectively address the most important science priorities and answer critical management questions that will improve our collective ability to manage and restore western rangelands, as well as target our limited resources to the places where our impact can be most successful.

For geographic perspective, the sagebrush ecosystem is the dominant vegetation type in the Great Basin (Figure 2), totaling roughly 165 million acres. Note, however, that the S.O. 3336 directive applies to the entire range of the ecotype and associated sage-grouse habitat, which extends well beyond the Great Basin (Figure 3). As the main federal



Figure 2. The Great Basin as defined by similar climatic and floristic relationships (Chambers et al. 2008). Although the region is the main focal point of Secretarial Order 3336, sagebrush ecosystems in other areas of the West will also benefit.

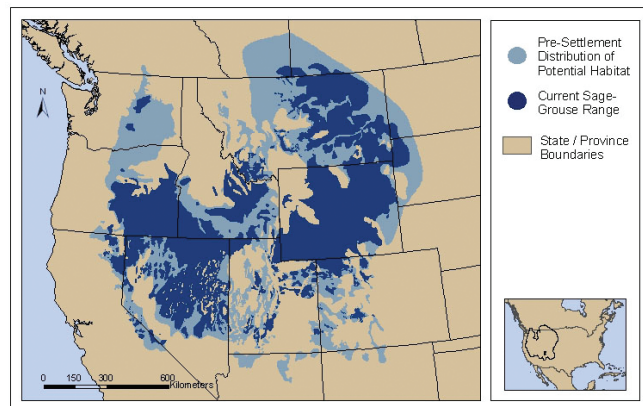


Figure 3. Combined light and dark blue shading represents the historical extent of potential sage-grouse habitat in western North America; dark blue shading represents the present-day sage-grouse range (www.greatbasin.wr.usgs.gov/lwg/maps.asp).

agency responsible for managing the nation's public rangelands, the BLM oversees about 65 million acres of sagebrush ecosystem. Also note that the BLM and U.S. Forest Service (USFS) together manage about two-thirds of the sagebrush lands in the U.S.

To underscore the importance of the sagebrush/greater sage-grouse conservation issue, in May 2016, Secretary Jewell toured areas burned by the 2015 Soda Fire that occurred in southwestern Idaho and southeastern Oregon. The fire burned about 280,000 acres of the area's sagebrush ecosystem, quickly overwhelming firefighting resources and spurring home evacuations. In talking with rangeland managers, local ranchers, and political leaders, Jewell emphasized the need for science-based conservation while highlighting the human component of ecosystem management. She pointed out that, in addition to several hundred animal species, several dozen grazing permittees depend on the success of post-fire restoration efforts in the area.

Implementing S.O. 3336

Phase one of the implementation of S.O. 3336 included the establishment of a Rangeland Fire Task Force. The order assigned specific objectives to the task force, including to: review existing policies and programs, identify opportunities for interagency and stakeholder collaboration (see sidebar titled A Multitude of Collaborators), and develop a science-based strategy to reduce the threat of significant wildfires. In May 2015, the task force published "An Integrated Rangeland Fire Management Strategy" (DOI 2015). The following excerpt illustrates some of the challenges and potential solutions facing today's rangeland managers, scientists, firefighters, and other stakeholders concerned with the sagebrush ecosystem:



Through application of "All Hands, All Lands" management, increased collaboration among Federal, state, tribal, and local officials, natural resource managers, and the fire community can improve the efficiency and effectiveness of the overall rangeland fire management effort (DOI 2015).



A Multitude of Collaborators

The Rangeland Fire Task Force's strategy highlights the need for robust collaboration to bring diverse perspectives, ideas, and levels of expertise to the conservation table. The strategy lists numerous potential partners who will be invited to join the BLM and other federal agencies in implementing S.O. 3336:

- Western Governors' Association
- Western Association of Fish and Wildlife Agencies
- State wildland fire, wildlife, and agricultural agencies
- Intermountain West Joint Venture
- Great Basin Fire Science Exchange
- Great Basin Landscape Conservation Cooperative
- Scientists and researchers
- Indian tribes
- Rangeland Fire Protection Associations
- Local/rural fire departments
- Weed collaboratives
- Native seed production organizations
- Soil and water conservation districts
- Various nonprofit groups

A key objective of the Rangeland Fire Task Force is to promote science-based management of sagebrush ecosystems and associated greater sage-grouse habitat based on an actionable science plan. Toward that end, a science team composed of agency and nonagency experts subsequently worked to develop a plan to promote restoration and conservation using: (1) effective rangeland management, including the use of sustainable livestock grazing; (2) fire prevention and suppression tactics; and (3) landscape-scale post-fire rehabilitation.

In summary, S.O. 3336 and the Rangeland Fire Task Force are designed to ensure that land managers and other interested parties have access to the best available science and tools to conserve sagebrush ecosystems, protect greater sage-grouse habitat, reduce the threat of wildfire, and restore degraded areas—while protecting human safety, property, and

rural economies. That's a pretty tall order. But the call for science-based management is where the Joint Fire Science Program (JFSP) and various regional partners enter the picture.

JFSP Research: A Pivotal Role

In addition to contributing to the expanding knowledge base regarding the sagebrush ecosystem, JFSP-funded research served to inform the establishment of S.O. 3336 and subsequent Rangeland Fire Task Force strategic planning. That is, JFSP-funded science and associated outreach efforts informed regional stakeholders and helped raise the national profile of this imperiled ecosystem.

Many examples of JFSP-funded research helped form the scientific basis of S.O. 3336 and the task force strategy that serves as the roadmap for future management. Consider, for example, the large body of work produced by USFS research ecologist Jeanne Chambers of the Rocky Mountain Research Station in Reno, Nevada, and various associates. The JFSP database (www.firescience.gov/JFSP_research.cfm) reveals 12 research projects completed by principal investigator Chambers and associates between 2001 and 2009, covering such topics as fire ecology; fire effects on plants and wildlife; technology transfer methods and tools; ecosystem restoration, rehabilitation, and stabilization; wildlife; and more. Such studies helped form the underpinnings of S.O. 3336 because they not only documented the current ecological status of sagebrush ecosystems but also helped inform stakeholders about future science needs.

Another example of a seminal body of JFSP-funded research that started before the onset of S.O. 3336 is the Sagebrush Steppe Treatment Evaluation Project, or more commonly known as SageSTEP (www.sagestep.org). In 2005, multiple SageSTEP researchers began both short- and long-term experiments in many areas of the Great Basin to help inform land managers about the efficacy of various restoration treatments. For example, research within a regional network of study sites between 2005 and 2014 evaluated short-term treatment effects on plants, wildfire potential, soils, water runoff and erosion, and birds and insects. The researchers also conducted sociopolitical and economics research during that same period.

Importantly, SageSTEP research continues to this day, and the researchers involved hope to continue remeasurement efforts for up to 25 years posttreatment. Doing so will satisfy the critical

need for long-term data on treatment effects and effectiveness, which is one of the key directives of S.O. 3336 and the subsequent Rangeland Fire Task Force strategy.

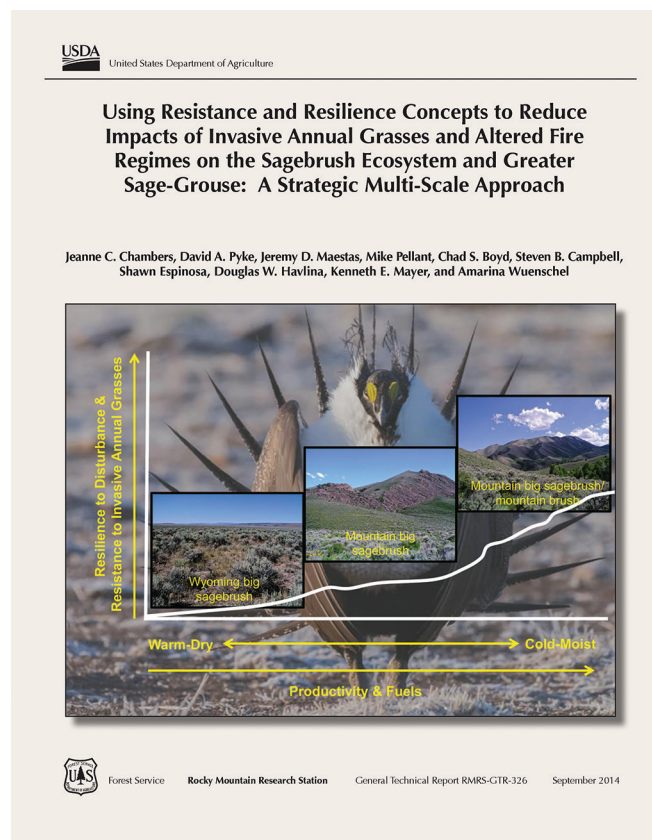
One can readily find other examples of research funded by the JFSP before the onset of S.O. 3336. In addition to the searchable database on the JFSP website, published compendiums like USFS general technical reports contain many articles highlighting JFSP-funded science. Rangeland managers in many areas of the Great Basin and beyond commonly use the following two reports: “Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action” (Chambers et al. 2008) and “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” (Chambers et al. 2014). The second publication was a collaborative effort among the USFS, U.S. Geological Survey, Natural Resources Conservation Service, BLM, Agricultural Research Service, Nevada Department of Wildlife, Western Association of Fish and Wildlife Agencies, and Great Basin Landscape Conservation Cooperative.

Role of Great Basin Fire Science Exchange and Partners

A key action item for implementation of the Rangeland Fire Task Force’s strategy is to: “Develop or identify a primary online science delivery system to allow easier access to published science products and other science information.” Primary responsibility for this task is assigned to two co-leads, the JFSP-funded Great Basin Fire Science Exchange (GBFSE; www.greatbasinfirescience.org/) and the Great Basin Landscape Conservation Cooperative (GBLCC; www.greatbasinlcc.org/). These two entities serve as coordinators among more than 20 federal and nonfederal partners and represent clearinghouses for a vast array of scientific and other information contributing to knowledge and management of Great Basin ecosystems. Both entities also are members of the Great Basin Consortium and interact closely with other consortium organizations to host annual symposia and workshops for reporting the best available science in the Great Basin and beyond. In the words of the GBLCC mission statement: “The [cooperative] supports landscape scale conservation, promotes science, and enables management based on traditional knowledge and science so human and ecological communities can respond and adapt to climate and land use change.”

According to U.S. Geological Survey research ecologist Matt Germino, many of the cooperative’s outreach efforts, in terms of meetings and presentations, focus on emerging topics that are central to S.O. 3336. Examples include leading the Great Basin Consortium conference series (www.greatbasinresearch.com/consortium/index.html), forming or arranging science-management partnerships, and supporting research and conservation projects that are selected through a collaborative, peer-reviewed process. Recently, GBLCC staff also worked in association with the Great Basin Research and Management Partnership, coeditors Jeanne Chambers, Cynthia Brown (Colorado State University), and other partners to produce a book (Germino et al. 2016) detailing the ecology and management of nonnative brome grasses in the Great Basin and Western U.S. In fact, that effort represents a synthesis of information from nearly 30 agency, university, and nongovernmental organization participants.

S.O. 3336 science team co-lead and USFS Grassland, Shrubland, and Desert Ecosystems Science Program Manager Deborah Finch recently indicated that another regional cooperative—the



Great Northern Landscape Conservation Cooperative (GNLCC)—provided valuable assistance during the development of the S.O. 3336 science plan (discussed later). Specifically, GNLCC staff helped set up web conferencing sessions for several virtual town hall discussions held during the team's research prioritization process.

Not surprisingly, the internet serves as the major conduit for disseminating information and resources relative to S.O. 3336. Upon visiting the GBFSE web portal, for instance, users encounter a vast array of resources available to anyone concerned with managing and restoring sagebrush ecosystems (Figure 4). The website is a user friendly, comprehensive collection of up-to-date scientific information and tools that are accessible with the click of a mouse. Visitors can explore pages of events and

webinars, research and publications, maps and tools, funding, and community conversations, or visitors can open the Secretarial Order Science Support Center portlet and read the S.O. 3336 document itself. On the research and publications page, for instance, visitors have access to portable document files, abstracts, videos, bibliographies, and more. The left sidebar on the main webpage allows visitors to search for resource products organized by topic or type. There are more than 20 searchable topics, such as fire regimes, fire behavior, firefighter safety, fuels and fuel treatments, post-fire environment and management, restoration, sage-grouse, and more (Figure 5). As for product types, the menu includes published and unpublished papers, fact sheets, webinars, field workshops, conference announcements and proceedings, and so on.

GREAT BASIN FIRE SCIENCE EXCHANGE AND SECRETARIAL ORDER 3336 SCIENCE SUPPORT CENTER

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JFSP FIRE SCIENCE EXCHANGE NETWORK

Events & Webinars | Research & Publications | Maps & Tools | Funding | Community | About

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SECRETARIAL ORDER 3336 SCIENCE SUPPORT CENTER

Our mission at the Great Basin Fire Exchange (GBFSE) is to provide access to scientific information that meets the needs of sagebrush ecosystem management. Because of our mission focus, this website serves as the Science Support Center for Secretarial Order 3336.

The May 19, 2015 Department of the Interior report titled, "**An Integrated Rangeland Fire Management Strategy**" named the Great Basin Fire Science Exchange and the Great Basin Landscape Conservation Cooperative (GBLCC) as co-leads on Appendix A, Section 7(b) viii - Science & Research, Action Item #4:

"Develop or identify a primary online science delivery system to allow easier access to published science products and other science information."

Search this website to find scientific research about sagebrush ecosystem management.

Topics

- Fuels & Fuel Treatments (137)
- Fire Ecology & Effects (125)
- Restoration (99)
- Invasive Species (75)
- Climate & Fire & Adaptation (64)
- Post-Fire Environment & Management (44)
- Decision Support (40)
- Sagebrush (33)
- Sagebrush (22)
- Fire Communication & Education (20)

Figure 4. The Great Basin Fire Science Exchange is part of the Joint Fire Science Program Fire Science Exchange Network and serves as the Science Support Center for Secretarial Order 3336. A link to the support center portlet (www.greatbasinfirescience.org/secretarial-order-3336) and associated resources are displayed prominently on the home page.



Topics

Fuels & Fuel Treatment (123)
 Fire Ecology & Effects (116)
 Restoration (69)
 Invasive Species (51)
 Climate & Fire & Adaptation (46)
 Decision Support (38)
 Post-fire Environment & Management (33)
 Sagebrush (29)
 Fire Communication & Education (16)
 Human Dimensions of Fire (14)
 Landscape Analysis (12)

Types of Resources

Article/Book (66)
 Synthesis/Tech Report (45)
 Fact Sheet/Brief (43)
 Field Guide (14)
 Training (9)
 Database (8)
 Photo/Video/Audio (8)
 Tool (6)
 Abstracts (6)
 Newsletter/Digest (5)
 Webinar (5)
 App (4)
 Bibliography (3)
 Field Guide/Manual (1)
 Workshop (1)

Figure 5. The Great Basin Fire Science Exchange and Secretarial Order Science Support Center website contains numerous hyperlinked topics and resource types classified and tallied for user convenience (menu view as of July 2016).

In addition to the partners' respective websites, GBFSE and GBLCC conduct many other activities that foster fire and fuels science exchange including webinars, conferences, field workshops, and in-person and online training sessions. According to GBFSE coordinator Génie MontBlanc, rangeland practitioners, researchers, and others interested in the sagebrush ecosystem have been enthusiastic about such events to date. For instance, during May and June 2016, more than 150 managers, researchers, and others attended a field workshop series titled "How to Quickly Evaluate the Resilience and Resistance to Invasive Annuals Following Wildfire or Vegetation Treatments in Sagebrush and Pinyon-Juniper Ecosystems," where participants learned about and discussed new land treatment assessment and prioritization methods.

Twice per year, the GBLCC and Desert Research Institute co-lead a series of climate forum workshops at various locations that focus on climate adaptation in relation to rangeland and resource management issues. In addition, GBLCC staff co-organized a conference on native plant restoration that included a post-Soda Fire field trip attended by more than 60 researchers and managers. That field trip was particularly important because the area represents the first landscape-scale restoration project to benefit from the evolving implementation of S.O. 3336.

In addition to field workshops, various Great Basin Consortium partners, the Western Association of Fish and Wildlife Agencies, and federal agencies have hosted numerous webinars focused on sagebrush ecosystems and associated greater sage-grouse habitat. The webinars are available to online visitors who are interested in learning about—and in some cases participating in live-streamed discussions about—relevant issues, research, and practical tools. For example, individuals can review a popular discussion series on the GBFSE website titled "Rangeland Fire Management Priority Science Needs" (www.greatbasinfirescience.org/events-webinars/). Participants in that series share knowledge and ideas about such topics as greater sage-grouse, climate, restoration, fire management, and invasive species.

The Great Basin Consortium and its supporting organizations also cohosted symposia that played a major role in disseminating and promoting the latest science and management concepts and tools. For instance, participation during the February 2016 conference titled "Sagebrush Ecosystems Conservation: All Lands, All Hands" (www.sagebrushconference2016.org/) in Salt Lake City, Utah, included more than 500 conference attendees

and about 300 online viewers. DOI Assistant Secretary for Land and Minerals Management Janice M. Schneider, who led efforts to develop S.O. 3336 and the rangeland fire strategy, gave plenary remarks at the conference that emphasized the important role of science-based, collaborative management of the sagebrush ecosystem. The next Great Basin Consortium conference is scheduled for February 21–23, 2017, at the University of Nevada-Reno and will focus on the implementation of “An Integrated Rangeland Fire Management Strategy.” According to Great Basin Consortium chair/GBLCC coordinator Rick Kearney, the conference will highlight the upcoming S.O. 3336 science plan and will bring together researchers, resource managers, and other regional stakeholders to discuss high-priority science needs and promote collaboration across organizational and political boundaries.

Social media opportunities represent yet another useful and popular component of the co-leads’ mission of providing science-based support for implementation of S.O. 3336. GBFSE website visitors can sign up for periodic newsletters and announcements by clicking on the subscribe link from the home page. Interested users can also subscribe to the GBFSE accounts on Facebook, Twitter, and YouTube.

The large body of scientific resources and outreach efforts to date by the Great Basin Consortium, GBFSE, GBLCC, and other partners constitutes a well-organized collaboration that has contributed greatly to regional conservation efforts. Although the current knowledge base goes a long way toward supporting S.O. 3336, questions remain about current and future science needs. Given the many scientific resources becoming available to land managers, it’s logical to ask whether knowledge gaps remain that might need to be addressed by future research. To answer this question, a key provision of the order called for the development of a science action plan to guide future research in support of sagebrush ecosystem management. Following is a brief description of that effort and what it might mean for future landscape restoration and conservation.

The S.O. 3336 Science Plan

A major element of the Rangeland Fire Task Force strategy was its directive to establish a coordinated, integrated, and, above all, actionable science action plan for successful implementation of S.O. 3336. Consider this excerpt from the task force’s strategy:

“In the past two years, Federal and state agencies have made considerable strides in identifying and prioritizing science needs for suppressing unwanted rangeland fire, controlling invasive plants, and restoring sagebrush-steppe...A review of [previous agency] reports, and a multi-agency analysis of the gaps in our understanding of invasive species, wildland fire impacts, and management techniques will determine the highest priority science and research needs related to sagebrush-steppe ecosystems. This analysis will guide new actions aimed at filling the greatest knowledge gaps, define implementation needs, and direct science information delivery to practitioners on the ground.” (DOI 2015)

In response to the strategy, leading scientists and other experts from nearly 20 key federal agencies and other regional stakeholders recently joined in a collaborative effort to produce the actionable science plan. The science team is co-led by U.S. Geological Survey Forest and Rangeland Ecosystem Director Ken Berg and USFS Grassland, Shrubland, and Desert Ecosystems Science Program Manager Deborah Finch and is being developed by participants from the U.S. Geological Survey, USFS, U.S. Fish and Wildlife Service, JFSP, Great Basin and Great Northern Landscape Conservation Cooperatives, Agricultural Research Service, BLM, Western Association of Fish and Wildlife Agencies, U.S. Department of Agriculture Southwest Climate Hub, and DOI Northwest Climate Science Center.

The critical science needs identified in the plan will be organized within five themes: fire, invasive species, sagebrush/greater sage-grouse, restoration, and climate. Research priorities have been defined through input from federal and state agencies, nongovernmental organizations, universities, and other groups.

One question raised by rangeland managers and others is whether S.O. 3336 and the subsequent science plan will apply only to Great Basin landscapes or throughout the entire geographic range of the sagebrush ecosystems. Science team co-lead Deborah Finch recently verified that, although the Great Basin is the main focal point of S.O. 3336, many aspects of the science plan will also be applicable to other sagebrush-dominated areas. And although uncharacteristic wildfires and the need for state-of-the-art fire research clearly are major themes to be addressed by the plan, fire-related issues are not the

only impetus. Such factors as invasive plant species prevention and control, restoration effectiveness, climate change adaptation, and greater sage-grouse habitat issues likewise will be major components. In short, the science team's goal is to create an integrated science plan that addresses potential science needs and opportunities for the multitude of ecological and socioeconomic issues that pertain to today's sagebrush ecosystems.

Another goal of the science plan team is to identify and prioritize major science needs—that is, contemporary needs as well as projected needs into the foreseeable future. A specific objective includes identifying opportunities, knowledge gaps, and future needs for practical, science-based information and tools for conservation of sagebrush rangelands. Various sources of information have greatly helped the team's assessment to date. For example, discussions and informal contacts with rangeland managers and other stakeholders have helped the team identify research needs in relation to various sagebrush ecosystem management issues. The coined “gap statements” prepared by JFSP science advisor Molly Hunter and others have also helped identify potential research needs in relation to the strategy's directive for restoration and conservation. According to science plan co-leads Berg and Finch, the team started with more than 500 science questions culled from numerous sources and published reports and then whittled the list down to less than 50 indepth, high-priority questions. Examples of management issues to date include preventing and mitigating against wildfires, fighting the spread of invasive plants, restoring sagebrush ecosystems, protecting greater sage-grouse habitat, and improving grazing management.

Once the needs assessment and prioritization have been completed, the science plan will be a road map to guide sagebrush-related research and associated technology transfer activities for at least the next 5 years. Mike Haske, implementation manager for “An Integrated Rangeland Fire Management Strategy,” recently emphasized that the plan not only needs to be actionable, but also a “living document.” In other words, it must be continuously adaptable because science needs in support of management will undoubtedly change over time, partly as a result of coordinated monitoring and adaptive management. Currently, the S.O. 3336 science plan is slated for completion by late 2016—so stay tuned for an announcement on the GBFSE website!

A New Era of Hope

Back in the 1940s, the iconic conservationist Aldo Leopold expressed these thoughts about the rapidly expanding cheatgrass problem:

“I listened carefully for clues whether the West has accepted cheat as a necessary evil, to be lived with until kingdom come, or whether it regards cheat as a challenge to rectify its past errors in land-use. I found the hopeless attitude almost universal. There is, as yet, no sense of pride in the husbandry of wild plants and animals, no sense of shame in the proprietorship of a sick landscape.”
(Leopold 1949)

Fortunately, thanks in part to Secretarial Order 3336, most rangeland managers and their partners today are anything but hopeless about sagebrush ecosystems. Instead, landscape restoration has become the modern clarion call.

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Suggested Reading: Ongoing JFSP Research Supporting S.O. 3336

A major objective from S.O. 3336 that was discussed in the Rangeland Fire Task Force strategy is to build upon the large body of research pertaining to sagebrush ecosystems and associated greater sage-grouse habitat. With that in mind, the following are some applicable research projects (completed and ongoing) funded by the JFSP (www.firescience.gov/JFSP_research.cfm).

Project Title (Identification Number)	Principal Investigator
Long-term effects of restoration treatments in a Wyoming big sagebrush community invaded by annual exotic grasses (16-1-03-25)	Becky K. Kerns, U.S. Forest Service
An integrated approach to identifying and leveraging factors that enhance sagebrush restoration success in the Great Basin (16-1-03-13)	Matthew J. Germino, U.S. Geological Survey
Post-fire recruitment of Great Basin big sagebrush species: spatial and temporal controls along regional gradients of soil temperature and moisture (16-2-01-27)	Peter J. Weisberg, University Nevada-Reno
Applied nucleation as a restoration strategy in cheatgrass-invaded sagebrush ecosystems (16-1-03-19)	Karen A. Haubensak, Northern Arizona University
Long-term SUCCESS: SUCcession and Ecosystem dynamics in the Sagebrush Steppe following wildfires (15-1-07-2)	Jonathan D. Bakker, University of Washington
Long-term impacts of wildfire on fuel loads, vegetation composition, and potential fire behavior and management in sagebrush-dominated ecosystems (14-1-02-5)	Lisa M. Ellsworth, Oregon State University
Learning Together: Great Basin Science Delivery (09-S-04-8)	Mark W. Brunson, Utah State University
Relations among cheatgrass-driven fire, climate, and sensitive-status birds across the Great Basin (15-1-03-6)	Erica Fleishman, University of California-Davis
Modeling long-term effects of fuel treatments on fuel loads and fire regimes in the Great Basin (15-1-03-23)	Nancy F. Glenn, Boise State University
Do post-fire fuel treatments and annual grasses interact to affect fire regimes in the Great Basin? (14-1-01-7)	Beth A. Newingham, Agricultural Research Service
Restoring Sage-Grouse Habitat After Fire: Success of Different Restoration Methods Across an Elevation Gradient (13-1-06-1)	Kirk W. Davies, Agricultural Research Service

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Credits

Writer – Steve Barrett

Managing Editor – Tammie Adams

Design and Layout – Jennifer Kapus

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