

USGS—Providing Scientific Understanding of the Sagebrush Biome

Early explorers wrote about the vast sea of sagebrush that stretched in front of them. Today, the consequences of land-use practices, invasion by exotic plants, and altered disturbance regimes have touched virtually all of these seemingly endless expanses. Increasing human populations in the western United States, the infrastructure necessary to support these populations, and a growing demand for natural resources exert a large influence. Changes within the biome have resulted in its designation as one of the most endangered ecosystems in North America.

The relatively simple structure of the sagebrush biome masks a complex ecosystem. Historical events, plants, animals, climate, weather, soils, elevation, and hydrology interact in the biome's response to disturbance or land use. Providing the unbiased scientific understanding needed by agencies responsible for stewardship of this biome is a tremendous challenge.

The most comprehensive documentation of range-wide population trends, habitat conditions, and potential threats to the sagebrush biome is found in a recent report—Range-wide Conservation Assessment for Greater Sage-grouse and Sagebrush Habitats¹. This assessment, sponsored by the Western Association of Fish and Wildlife Agencies, was written by a team of scientists from the U.S. Geological Survey (USGS), Idaho Department of Fish and Game, Washington Department of Fish and Wildlife, and others. Aptly named, the assessment

¹ Available at <http://sagemap.wr.usgs.gov/>.

provides a large-scale, ecological perspective of the sagebrush biome. The information helps us understand the condition and dynamics of the biome, can guide conservation management activities, and can focus future research efforts. The greater sage-grouse is the focus of the report because it is a sagebrush-obligate, dependent on sagebrush for all or part of its life cycle, and as such, is assumed to function as an indicator of the condition and trend of the biome. Many questions about sage grouse and habitats were not answered in the assessment, nor did the report assess conditions of other sagebrush-obligate species. In addition, the daunting challenges of stabilizing sage grouse populations, improving or restoring habitats, and implementing appropriate monitoring strategies remain.

Ecological Science Framework and Research Examples

The complex natural resource and societal issues in the sagebrush biome require that federal and state agencies, universities, and nongovernmental organizations collaborate if we are to succeed in conserving the sagebrush biome. The science framework presented here is a basic conceptual structure for helping to understand sagebrush ecosystems.

Quick Facts about Sagebrush Biome

- About 480,000 km² (120 million acres) across 14 western states and 3 Canadian provinces
- Largest semi-arid ecosystem in the West
- Mostly situated between Sierra Nevada and Cascade Mountain ranges and the Rocky Mountains
- Typically cold, wet winters and hot, dry summers
- In native condition, botanically characterized by shrubs interspersed with grasses and forbs
- Sagebrush often dominates where snow and rainfall exceed 18 cm (7 in) per year
- More than 70 percent public ownership; public land primarily managed by the Department of the Interior
- Major land uses include agriculture, mining, energy development, livestock grazing, and urbanization
- Primary stressors include the land uses listed above plus invasion of exotic plants, competition for water, soil erosion, altered fire cycles, and wildlife diseases

The goal underlying the framework is to integrate emerging scientific understanding into future management in order to restore and maintain long-term ecosystem health and ecological integrity, emphasize adaptive management over the long term, provide consistent management direction over broad spatial and temporal scales, and restore and maintain habitats for plant and animal species.

As we strive to achieve this goal, ecological research needs to be designed and accomplished to 1. synthesize and build on existing information, 2. delineate and interpret regional indicators of habitat conditions and wildlife population trends, 3. identify the effects of land use on habitats and wildlife, 4. develop restoration strategies, and 5. implement feedback

Who is the USGS?

The USGS serves as an independent research agency that collects, monitors, and analyzes data to provide scientific understanding about natural resource conditions, issues, and problems. It has no regulatory or management mandate but serves to provide impartial science. As a federal science agency, the USGS has the added responsibility and capability to conduct studies at multiple spatial (local, regional, and national) and temporal (days to decades) scales. Furthermore, the diversity of scientific expertise available within the agency, including biologists, hydrologists, geographers, and geologists, enables the USGS to carry out large-scale, multi-disciplinary investigations. Some of these investigations integrate information to make inferences about phenomena that are too broad to be explained by single scientific disciplines.

in an objective evaluation of management actions. Specifically we are integrating our science disciplines to focus on four areas:

- Understand the effects of habitat change on sagebrush-obligate species
- Develop cost-effective methods for restoring functioning sagebrush ecosystems
- Implement quantitative monitoring strategies as part of an adaptive program to detect changes resulting from management actions or habitat disturbances
- Manage spatial and nonspatial data to provide the information needed by researchers, resource specialists, managers, and the public

The USGS is working with other federal, state, university, and nongovernmental partners to conduct research that will improve our understanding of ecological conditions in the sagebrush biome and to provide information needed to manage and restore sagebrush ecosystems and the species that depend on them. The following

Wildlife Sentinels in the Sagebrush Biome

Warnings began appearing over a quarter of a century ago about loss of native sagebrush habitats and the consequences for wildlife. Greater sage-grouse (*Centrocercus urophasianus*), Gunnison sage-grouse (*Centrocercus minimus*), Brewer's sparrow (*Spizella breweri*), and pygmy rabbit (*Brachylagus idahoensis*) all rely heavily on sagebrush habitat, and are only some of the wildlife impacted by changes in the sagebrush biome. The range of greater sage-grouse today is approximately 56 percent of its historical distribution, and abundance is greatly reduced from historic levels. Gunnison sage-grouse, a close western relative of the greater sage-grouse, occupies only 11 percent of its historic range, and the species is a candidate for listing under the Endangered Species Act. The number of Brewer's sparrows has declined on breeding bird surveys conducted over the past 30 years. The smallest rabbit in North America, the pygmy rabbit, is classified by the federal government as a species of concern because of its specialized habitat requirements and evidence of declining populations, and one distinct population in the Columbia Basin is listed as endangered under the Endangered Species Act.



examples demonstrate the capabilities of USGS science to inform management decisions in the sagebrush biome.

Effects of Habitat Change on Sagebrush-Obligate Species

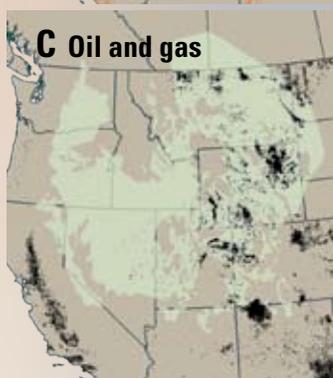
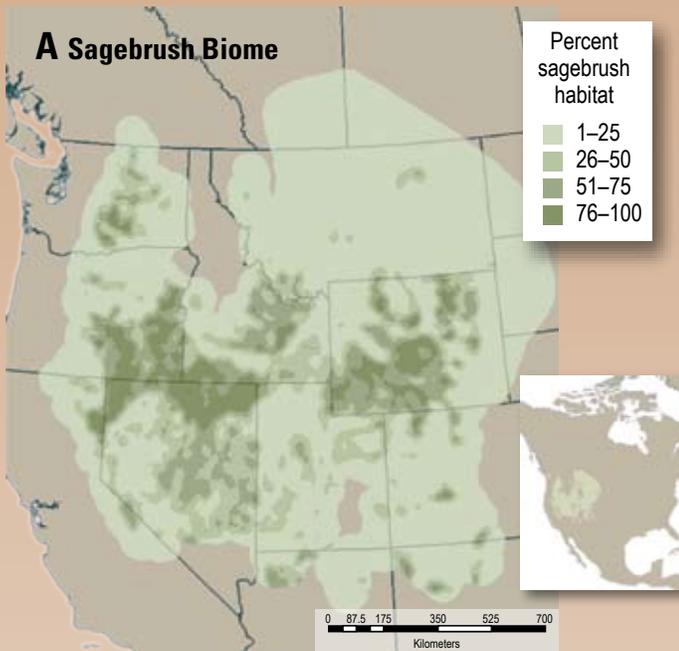
Environmental Correlates of Greater Sage-grouse Distribution and Population Trends

Patterns of distribution of greater sage-grouse populations and sagebrush habitats are well documented, but the underlying causes for population trends or habitat changes are poorly understood. To address this critical information need, the USGS and state and university partners are correlating long-term trends in greater sage-grouse populations with habitat changes. We also are describing the effects of roads, power lines, and other infrastructures on greater sage-grouse populations, and testing the assumption that the greater sage-grouse is an appropriate umbrella species for managing sagebrush habitats.

National Oil and Gas Assessments

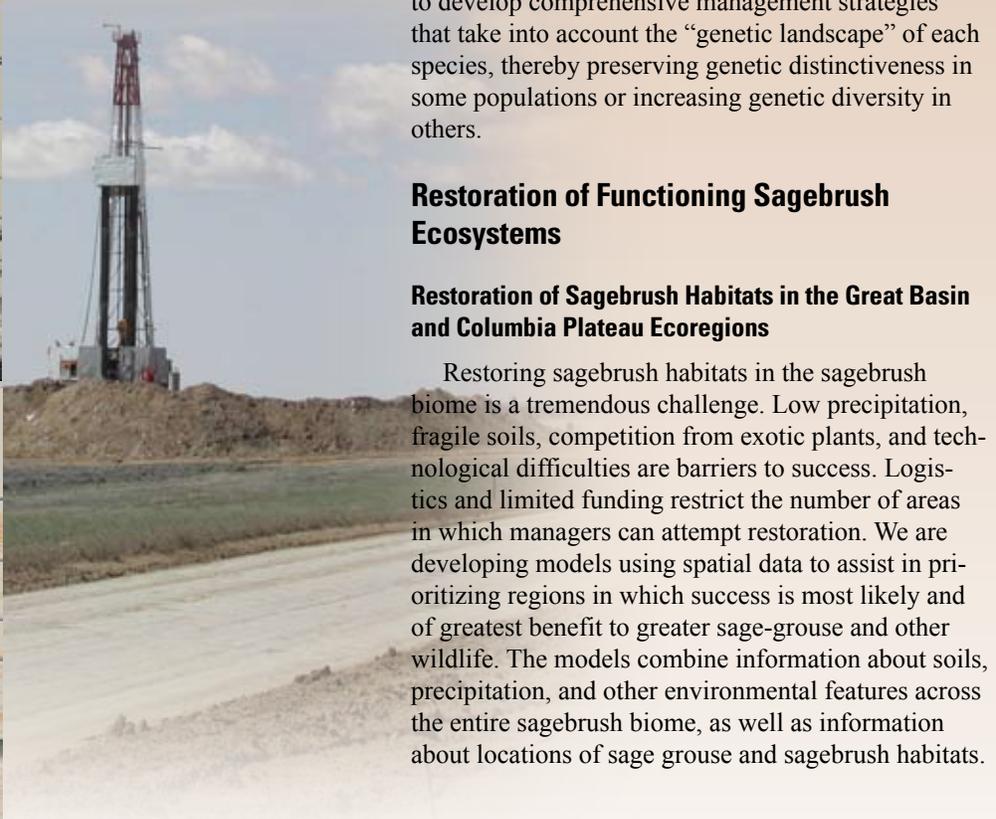
Oil and natural gas resources have been developed in the sagebrush biome for over a century, but recently, exploration and development have increased dramatically because of high demand for energy resources. A requirement for predicting ecological consequences of development is knowledge of where developments have and will occur. We conducted energy resource assessments of basins with petroleum and coalbed-methane-production potential throughout the Rocky Mountain Region and used this assessment to describe areas of current and potential future developments. We also are conducting an ecological





A. Sagebrush biome (shades of green) based on historic range of greater sage-grouse.

B–D. Examples of infrastructure and disturbances in sagebrush biome.



analysis of one basin, the Wyoming Basin, to estimate the amount of habitat influenced by activities associated with energy developments. In addition, we are using geographic information systems and remote sensing to quantify the indirect effects that potentially result from increased presence of exotic plants and from additional predators that affect wildlife populations.

West Nile Virus in Greater Sage-grouse

West Nile virus is a known cause of death for wild greater sage-grouse, and laboratory experiments show that this species is highly susceptible to the virus. Our research associated with this virus is designed to develop a disease monitoring and research strategy. In addition to evaluating the prevalence of exposure to West Nile virus and other avian pathogens in greater sage-grouse, we are sampling other vertebrates in sagebrush habitats to determine if they are affected by the virus and what role they may play in disease transmission. Early laboratory studies indicate that chukar partridge may serve as an amplifying host for West Nile virus and may be a useful sentinel for the virus.

Birds of a Different Feather

Genetic analyses have led to a host of discoveries associated with sage grouse, including recognition of the Gunnison sage-grouse as a distinct species, confirmation of geographically and genetically isolated populations of both Gunnison and greater sage-grouse, and understanding of gene flow, population connectivity, and gene pool diversity. We are continuing with these types of studies to help determine the effective size of populations and, inverse to this, the minimum size of a viable population. We also are testing if we can effectively monitor sage grouse using an individual bird's unique DNA and thereby estimate population abundance, survival, and movements. Information from such gene-based research can be used to develop comprehensive management strategies that take into account the "genetic landscape" of each species, thereby preserving genetic distinctiveness in some populations or increasing genetic diversity in others.



Restoration of Functioning Sagebrush Ecosystems

Restoration of Sagebrush Habitats in the Great Basin and Columbia Plateau Ecoregions

Restoring sagebrush habitats in the sagebrush biome is a tremendous challenge. Low precipitation, fragile soils, competition from exotic plants, and technological difficulties are barriers to success. Logistics and limited funding restrict the number of areas in which managers can attempt restoration. We are developing models using spatial data to assist in prioritizing regions in which success is most likely and of greatest benefit to greater sage-grouse and other wildlife. The models combine information about soils, precipitation, and other environmental features across the entire sagebrush biome, as well as information about locations of sage grouse and sagebrush habitats.



Coordinated Intermountain Restoration Program

The Coordinated Intermountain Restoration Program provides research and technical assistance needed to understand the effects of disturbance and invasive plants on the structure and function of Wyoming big sagebrush ecosystems and how to restore native plants where cheatgrass dominates. The program promotes the understanding of disturbance dynamics but, at a more applied level, it also provides guidance with selecting plant materials, site preparation techniques, methods of weed control, seeding equipment, management methods, and monitoring techniques for restoration projects. Additionally it provides research and technical assistance associated with fuels management to reduce the impacts of wildfires on semi-arid rangelands where exotic annual grasses provide the fuel. This is a major collaboration, involving the USGS, the Bureau of Land Management (BLM), universities, and many other partners.

Monitoring as Part of Adaptive Management

Evaluation of Fire Effects and Fire-Surrogate Treatments in the Sagebrush Biome

Federal agencies use a variety of management methods on western rangelands to alleviate the potential for fire, restore native plant communities, and create habitat for wildlife. We and other collaborators are studying these treatments (prescribed fire, herbicides, cutting and removal of woody species, and brush beating) to determine the conditions under which sagebrush communities recover on their own following treatment versus conditions that require active restoration. The program specifically considers how treatments influence the primary ecosystem processes that contribute to recovery. This information is important for understanding the characteristics of these systems that facilitate or resist the spread of invasive plants or the encroachment of pinyon-juniper woodlands. This research also will determine the habitat components that influence the distribution and abundance of wildlife species.

Evaluation of Habitat Treatments

Recovery of greater sage-grouse and other sagebrush-obligate species depends on preserving and restoring sagebrush habitats at landscape scales. Prescribed fire, and mechanical and chemical treatment of vegetation contribute to the loss and fragmentation of sagebrush communities but, if used appropriately, these techniques may aid restoration. Furthermore, the National Fire Plan mandates reductions in hazardous fuels to decrease the likelihood of large rangeland fires and to restore these areas to historic structure and function. We are evaluating changes in vegetation and in greater sage-grouse food items after fuels management treatments that were carried out at sites in Idaho, Nevada, and Wyoming between 1997 and 2004. We also are

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developing and testing assessment protocols for determining the extent and dominance of cheatgrass, a major contributor to wild-fire, in the sagebrush biome. This research will help determine which lands require restoration and which are resilient enough to recover on their own after the treatments.

Information Management and Technical Support

Integration of Sound Science and Adaptive Strategies in Sage Grouse Conservation Planning

We continuously strive to bridge the gap between the information decision makers require and the information generated through research. Demonstrating this, the USGS is part of a particularly effective collaboration with a local working group in Nevada and eastern California (the Bi-State Work Group), where we helped develop a conservation plan for greater sage-grouse. Ongoing work with this group and other partners includes development of models that integrate policy and economic choices, sage grouse habitat maps, and plans for monitoring sage grouse populations.

Role of Information Portals and Data Management

Huge amounts of biological information are compiled about the sagebrush biome every year. Effective access to this information by management agencies, policy makers, the general public, and researchers is crucial. In 2001, the BLM and the USGS launched a web portal called SAGEMAP, designed to deliver spatial data and other information about sagebrush ecosystems to researchers and managers in a concise and easily searchable format. Several other information portals provide biological and spatial data for the sagebrush biome (see box), all managed under the auspices of the National Biological Information Infrastructure. One aspect of the Great Basin Information Project is a science locator system, aimed at providing brief descriptions of all research in the Great Basin, cross referenced to locations where the research occurs and to the investigators involved.

Web Portals for the Sagebrush Biome

- SAGEMAP <http://sagemap.wr.usgs.gov/>
- Great Basin Information Project <http://greatbasin.nbii.gov/> includes links to Science Locator
- Wildlife Disease Information Node <http://wildlifedisease.nbii.gov/>
- Mountain Prairie Information Node <http://nrin.nbii.gov/>

USGS Science Centers Involved in Research

Forest and Rangeland Ecosystem Science Center
<http://fresc.usgs.gov/> • 541-750-1030

Fort Collins Science Center
<http://www.fort.usgs.gov/> • 970-226-9100

National Wildlife Health Center
<http://www.nwhc.usgs.gov/> • 608-270-2400

Western Ecological Research Center
<http://www.werc.usgs.gov/> • 916-278-9485

Southwest Biological Science Center
<http://sbsc.wr.usgs.gov/> • 928-556-7094