Sage-grouse
(*Centrocercus spp.*)

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Introduction/ General Information

Sage-grouse, as their name indicates, are intricately linked to western sagebrush habitats. Sagebrush ecosystems historically covered a large geographic area in western North America. However, only about half of the suitable habitat once present in the historical range of sage-grouse remains (BLM 2003).

This leaflet provides information on the life history and habitat needs of the sage-grouse. In addition, it provides recommendations on how land users can address the factors responsible for habitat loss and the decline of sage-grouse populations. These factors include alteration of fire regimes, conversion of sagebrush to farming or intensive livestock forage production, mining and energy development, recreation, suburban expansion, sagebrush control, and the introduction of non-native species [Connelly et al. 2000, BLM (WY) 2002, Cannings 2001].

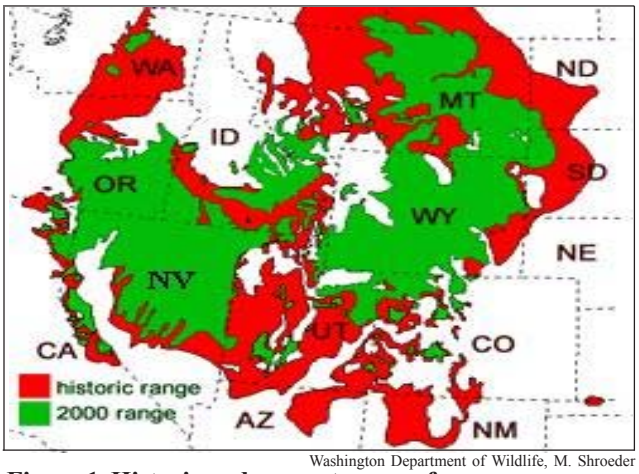
Breeding populations of sage-grouse have decreased by 17–47% since the early 1900s (Connelly and Braun 1997), and populations of sage-grouse continue to decline throughout the region (Braun 1998). With over 30% of the remaining sagebrush habitat located on private land, ranchers and private landowners can play a key role in providing suitable habitat for the sage-grouse and stabilizing and increasing local populations. Understanding how sage-grouse habitat quality can be improved on working lands, and becoming familiar with current management efforts aimed at sage-grouse conservation on both public and private lands, will help secure the future survival of this and other sagebrush-dependent species.

U.S. Fish and Wildlife Service, Dave Menke

Sage-grouse populations have declined due to the loss of quality sagebrush habitat.

Distribution and Status

Sage-grouse comprise two recognized taxa: the greater sage-grouse (*Centrocercus urophasianus)* and the Gunnison sage-grouse (*C. minimus)*. The greater sage-grouse is widely distributed across sagebrush-dominated habitats of the western United States and Canada, and can be found in Washington, Idaho, Montana, Alberta, Saskatchewan, North Dakota, South Dakota, California, Nevada, Utah, Wyoming and Colorado. The smaller Gunnison sage-grouse, formerly grouped with the greater sage-grouse, was recently recognized as a distinct species based on genetic differences (Kahn et al. 1999) and differences in size (Hupp and Braun 1991), courtship behavior (Young et al. 1994), and plumage (Young et al. 2000). Gunnison sage-grouse are restricted to southwestern Colorado and southeastern Utah. Table 1 contains information about the two recognized taxa of sage-grouse. Life history and habitat requirements of the two taxa are very similar. Hereafter, the term sage-grouse will refer to both taxa unless otherwise specified.



Washington Department of Wildlife, M. Shroeder

Figure 1. Historic and current range of sage-grouse.

Sage-grouse are dependent on the presence of sagebrush for survival (sagebrush obligates). Therefore, their geographic range is closely aligned with the distribution of sagebrush-dominated ecosystems in North America. Figure 1 depicts the historic and current range of sage-grouse in North America. The quality and quantity of remaining sagebrush habitat has declined over the last 50 years (Connelly et al. 2000) to the extent that very little pristine sagebrush habitat, undisturbed by human activity, remains (Braun 1998). Similarly, sage-grouse populations have declined throughout North America by 33% over the past 30 to 40 years, and have been extirpated in five states (Arizona, Kansas, Nebraska, New Mexico, Oklahoma and British Columbia) (BLM 2003). Canadian populations of sage-grouse (C. urophasianus urophasianus) have been listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Loss of sagebrush habitat and associated population declines of sage-grouse have prompted petitions to the U.S. Fish and Wildlife Service to list both the greater and Gunnison sage-grouse taxa under the Endangered Species Act (ESA) (Connelly et al. 2004).

Although the greater sage-grouse has not been awarded protection across its entire range, Distinct Population Segments of greater sage-grouse in the state of Washington have received Candidate for listing status under the ESA (USFWS 2004, Pat Deibert, USFWS-WY pers. comm. 2004). The Gunnison sage-grouse taxon, which occupies a much smaller geographic range, has been awarded Candidate for federal listing status under the ESA (USFWS 2004).

Official listings of the Washington population of greater sage-grouse and Gunnison sage-grouse have been precluded by species of higher conservation priority (Pat Deibert, WY-USFWS pers. comm. 2004). Six of 11 western states and all Canadian provinces have completed state or provincial strategic plans to manage greater sage-grouse. The remaining five states will complete strategic plans by July 2005 (Connelly et al. 2004).

Table 1. Sage-grouse distribution and population sizes in North America.[1]

Common name	**Greater sage-grouse**	**Gunnison sage-grouse**
Scientific name	*Centrocercus urophasianus*	*Centrocercus minimus*
Distribution	Central Washington, southern Idaho, Montana, southeastern Alberta, southwestern Saskatchewan, southwestern North Dakota, and western South Dakota south to eastern California, south-central Nevada, southern Utah, western Colorado	Gunnison basin and southwestern Colorado, southeastern Utah east of the Colorado River, Navajo Nation
Overall population size	fewer than 142,000 individuals	3,000-10,000 individuals
Breeding population size	unknown	fewer than 4,000 individuals

[1]Nature Serve 2004.

Description

Sage-grouse are large (21–31 in), ground dwelling birds, defined by their pectinate toes, which have comb-like projections, and their feathered nostrils and legs. The male sage-grouse is larger than the female and has yellow eye combs, a black throat and bib, and a large white ruff on the breast. Males use their brightly-colored yellow combs, olive-green air sacs, and elongated tails in courtship displays. Both sexes have cryptically colored brown/gray plumage and black bellies. Grouse (subfamily Tetraoninae) are grouped in the family Phasianidae, along with pheasants and partridges (subfamily Phasianinae), turkeys (subfamily Meleagridinae), and guineafowl (subfamily Numidinae).

Life History and Behavior

Breeding Behavior

During the breeding season, male sage-grouse gather in groups where they perform elaborate visual and auditory courtship displays. These courtship assembly areas, called leks, are located on relatively open sites adjacent to potential nesting and brood-rearing habitat where female sage-grouse are abundant (Schroeder et al. 1999, Connelly et al. 2000). Male sage-grouse establish individual display territories within the lek and solicit matings from March to May. Female sage-grouse choose their mates based on the spatial location of a male's territory within the lek. Territory location is related to the extent of a male's secondary sex characteristics (combs, air sacs, plumage, etc.); males with the most extensive physical traits attain preferred positions within the lek's interior. Sage-grouse do not form pair-bonds and a female may mate with more than one male during the breeding season (promiscuity). Sage-grouse exhibit low reproductive rates, producing clutches that are variable in size yet small relative to other Galliformes (Schroeder 1997, Schroeder et al. 1999). Following mating, female sage-grouse lay approximately 6–8 eggs, which are incubated for 25–27 days. Young exhibit independent activity from birth (precocial) and fly when 7–14 days old. Females that lose a clutch may renest during the same breeding season, although renesting rates are highly variable among sage-grouse populations (Connelly et al. 2000). Populations that exhibit a ratio of approximately 2.25 juveniles/hen in the fall should remain stable or increase over time (Connelly and Braun 1997, Edelmann et al. 1998).

U.S. Fish and Wildlife Service, Gary Kramer

Male greater sage-grouse are distinguished from females by their yellow eye combs, white neck plumage, and air sacs.

Seasonal Movement

Sage-grouse populations are defined by their spatial and temporal distribution (Connelly et al. 1988). Populations are either nonmigratory, or undertake one-stage or two-stage migrations when year-round habitat requirements cannot be met at a single location (Fischer et al. 1997). Nonmigratory sage-grouse often move 5–6 mi. between seasonal habitats and use home ranges no more than 40 mi^2 in size (BLM 2003). One-stage migrants move between distinct summer and winter ranges that are often 9–30 mi. apart. In some areas, sage-grouse make local elevational migrations between summer and winter habitats (Cannings 2001).

Two-stage migrants move between breeding habitat, summer range, and winter range, and their annual movements can exceed 50–60 mi. (Connelly 1999). Fall movements to winter range can span several months, from late August to December (Connelly et al. 1988). Populations that migrate make annual movements of 45 mi. or more and may have home ranges that exceed 580 mi^2 (BLM 2003). Males and females flock separately, and breeding females move independently with their young during the summer months. Sage-grouse exhibit high site-fidelity, returning to the same nesting areas annually (Connelly et al. 2004).

U.S. Fish and Wildlife Service, T.A. Blake

Grassland habitat maintained at the Clear Lake National Wildlife Refuge in California, where management objectives include sage-grouse conservation.

Habitat Requirements

General

Sage-grouse are sagebrush obligates, meaning they are dependent on large, interconnected expanses of sagebrush for food and protective cover throughout the year (Connelly et al. 2004). Sage-grouse inhabit foothills, plains, and mountain slopes where sagebrush is present and make seasonal use of riparian areas, upland meadows and sagebrush grasslands. Although sagebrush habitat and the specific habitat components used by sage-grouse can vary considerably across the species' range, large, woody species of sagebrush including big sagebrush, silver sagebrush, and threetip sagebrush are used by sage-grouse in all seasonal habitats (Dalke et al. 1963). Low sagebrush, black sagebrush, rabbitbrush, antelope bitterbrush, and horsebrush also provide vital habitat components for sage-grouse (Connelly et al. 2004).

Sage-grouse habitat requirements are summarized in Table 2. Sage-grouse require an extensive mosaic of sagebrush of varying densities and heights, high levels of native grass cover for nesting, and areas rich in high-protein forbs and insects during nesting and brood-rearing (Cannings 2001). Managing sagebrush habitat to include native grasses and forbs in the understory is extremely important because these vegetation types provide cover, food, and a productive insect fauna needed to support sage-grouse populations (Connelly 1999).

In general, managing land for moderate levels of sagebrush cover (15–20%) and high levels of forb (broad-leaved, herbaceous plant) production will likely increase sage-grouse reproduction and survival (Johnson and Braun 1999). Maintaining food-rich areas such as seeps, wet meadows, and riparian areas is important in the summer, while ensuring a 10–30% canopy cover of sagebrush that is tall enough to remain exposed above median snowfall depth provides sage-grouse with critical roosting and foraging sites in the winter (Connelly et al. 2004). Sagebrush control should be avoided in all seasonal habitats, unless it is being done to restore a sagebrush/steppe mosaic. Table 3 and Appendix B provide a summary of programs and organizations that can assist landowners in managing for a mosaic of native sagebrush that will benefit sage-grouse populations.

Food

A list of plant species used by sage-grouse is provided in Appendix A. Sagebrush and forbs (broad-leaved, herbaceous plants) serve as a critically important food sources for sage-grouse at all life stages, while native warm-season grasses provide nesting habitat and protective cover for hens and chicks during early brood-rearing. In addition, an abundance of insects,

USDA NRCS PLANTS National Database, J.L., Reveal

Sagebrush provides nesting and escape cover for sage-grouse, and its leaves are an important food source.

Table 2. Sage-grouse habitat requirements summary table.

Habitat Component	Sage-grouse Requirements
General	An extensive mosaic of sagebrush of varying densities and heights, high levels of native grass cover for nesting, and areas rich in high-protein forbs and insects during nesting and brood-rearing.
Food	Sagebrush, particularly big sagebrush, silver sagebrush, and threetip sagebrush, low sagebrush, and black sagebrush. Forbs including prairie dandelion, milkvetch, prickly lettuce, microsteris, and evening primrose. Insects including ants, bees, wasps, grasshoppers, and beetles.
Cover - lek	Leks are located on relatively open land with low sagebrush density. Males may choose sod-forming grasses or bare ground for display. Leks are usually surrounded by well-vegetated nesting habitat, and may be established on dry lakebeds, ridge clearings, or low sagebrush flats. Lek sites are highly variable and encompass both natural openings and disturbed sites. Sites appear to be chosen opportunistically based on the proximity of suitable nesting habitat.
Cover - nesting	Preferred nesting habitat is characterized by an overstory of sagebrush that varies in horizontal and vertical structure, and an understory of native grasses and forbs. Sage-grouse nests are small depressions in the ground, built beneath sagebrush or another shrub, usually in areas with good cover and abundant leaf litter. Sage-grouse use native grass cover for nesting, and prefer understory grasses with a height of approximately 6-8 in. or more. Hens require abundant forbs that contain high levels of calcium, phosphorus, and protein prior to egg laying.
Cover - brood rearing	Early brood-rearing habitat is used during spring and early summer after chicks have hatched. Hens select sagebrush areas rich in forbs and insects (the two main food sources for chicks). Later in the summer, as the weather becomes drier, hens move their broods to wetter (mesic) areas. This time period is known as late brood-rearing. During the late brood-rearing period sage-grouse may use a variety of additional habitats including sagebrush, wet meadows, and irrigated farmland adjacent to sagebrush habitats. Nonbreeding females and males will move into upland meadows and grasslands. During fall, sage-grouse move into mixed sagebrush/grassland habitats and increase their consumption of sagebrush relative to forbs.
Cover - winter	In winter, access to sagebrush is critical as it is used almost exclusively for food and cover in the snow. Preferred winter habitat is characterized by sagebrush cover that exceeds 20%. The timing of winter migration is dependent on the arrival of snow. Winter ranges may vary from year to year in some areas depending on snow cover and depth.
Minimum Habitat Size	Conclusive data are unavailable on minimum patch sizes of sagebrush needed to support viable populations of sage-grouse. Populations that migrate make annual movements of 45 mi. or more and may have home ranges that exceed 575 mi^2 (BLM 2003).

including ants, bees, wasps, grasshoppers, and beetles contribute to the diet of sage-grouse chicks.

Seasonal Requirements

Seasonal habits of sage-grouse are categorized into three distinct periods: breeding (March–May); late brood-rearing (June–October); and wintering (November–February) (BLM 2003). Specific habitat requirements are associated with each of these periods.

Breeding habitat encompasses areas used by sage-grouse for lekking, nesting, and early brood-rearing (Connelly et al. 2000). Leks may occur on dry lakebeds, ridge clearings, or low sagebrush flats that have less forb and shrub cover than surrounding nesting habitat (BLM 2003). Displaying males use the dense sagebrush stands associated with adjacent nesting habitat for escape, shelter, and feeding. Preferred nesting habitat is characterized by an overstory of sagebrush that varies in horizontal and vertical structure, and an understory of native grasses and forbs (Connelly et al. 2003). These habitat components provide a food source of insects, cover for nests, and herbaceous forage for reproductive hens.

Most nests are located under tall, large sagebrush plants that provide protective cover. The area used by hen and chicks for up to 3 weeks after hatch constitutes early brood-rearing habitat (Connelly et al. 2000). The selection of food items by chicks influences the habitat used during early brood-rearing. Sagebrush areas rich in forbs and insects are commonly used, as these food items are critical to chick survival (Drut et al. 1994, Fischer 1994).

When herbaceous vegetation found in the early brood-rearing habitat dries out during the summer months, sage-grouse move to areas characterized by sparser sagebrush canopy and a greater abundance of grasses and forbs. These areas are known as late brood-rearing habitat and may be selected based on the available moisture content of vegetation (Fischer et al. 1996). Sage-grouse may migrate to higher elevations that receive greater concentrations of moisture throughout the summer (BLM 2003). During the late brood-rearing period sage-grouse may also use a variety of additional habitats including sagebrush, wet meadows, and irrigated farmland adjacent to sagebrush habitats (Gates 1983, Connelly et al. 1998). The move to late-brood-rearing habitat marks a change in chick diet from predominantly insects to forbs (Drut et al. 1994). A second dietary transition occurs as autumn approaches and sage-grouse shift to a predominantly sagebrush-based diet. During early autumn, sage-grouse may use upland meadows, riparian areas, and alfalfa fields in addition to sagebrush habitat.

Throughout winter sage-grouse feed almost exclusively on sagebrush (BLM 2003). Winter habitats are usually dominated by big sagebrush although low and silver sagebrush communities are also used (Schroeder et al. 1999). Transition from late brood-rearing to winter habitat is often dependent on weather conditions and snow cover. Snow depth affects the spatial distribution of sage-grouse as birds search for areas where sagebrush remains exposed above the snow, available for roosting and foraging.

Factors Affecting Habitat Quality

The destruction and fragmentation of sagebrush habitat represents the largest threat to remaining sage-grouse populations. Factors contributing to habitat degradation include alteration of historical fire regimes, conversion of land to farming or intensive livestock forage production, water developments, use of herbicides and pesticides, establishment of invasive species, urbanization, energy development,

USDA NRCS, J. Vanuga

Conversion of land to produce forage for livestock can reduce sagebrush habitat.

mineral extraction, and recreation (BLM 2003, Connelly et al. 2004). The combined effects of these factors have greatly impacted the spatial and temporal capacity of sagebrush landscapes to support sage-grouse. An overall reduction in available habitat has led to smaller, more isolated populations of sage-grouse that may exhibit reduced genetic variability and low rates of juvenile survival and adult reproduction. Although historical land-management practices such as replacing large expanses of sagebrush with livestock forage plants are no longer practiced, it is not yet known how remaining sage-grouse populations will respond to the cumulative effects of intensive, historical land-use coupled with new activities such as energy development and recreation (BLM 2003). The following section provides a summary of the key land-management practices affecting sage-grouse populations.

Altered Fire Regimes

Fire ecology of sagebrush ecosystems was dramatically impacted by European settlement of western North America. Today, altered wildfire regimes are believed to be the greatest detriment to sage-grouse habitat in the western portion of the species' range (BLM 2003). At high elevation, fire return intervals have increased from 12–24 years to greater than 50 years in sagebrush habitat. As a result, juniper (*Juniperus* spp.) and pinyon (*Pinus* spp.) have invaded sagebrush stands, leading to a loss of herbaceous understory and shrub canopy cover preferred by sage-grouse (Crawford et al. 2001). In lower elevations, conversion of land for livestock grazing and the associated introduction of some non-native forage plants have fueled frequent wildfires and shortened the historical fire interval from 50-100 years to less than 10 years (Connelly et al. 2004). Native sagebrush communities may not naturally reestablish under altered fire regimes and the lack of prompt and appropriate habitat rehabilitation following wildfires can present additional threats to sage-grouse habitat.

Grazing

Historically, widespread sagebrush control methods were implemented to manage for landscape characteristics that favored livestock production. The effects of overgrazing combined with drought on plant communities in the late 1880s and early 1900s still influence current sagebrush habitats. While large-scale treatments to replace sagebrush with preferred livestock forage plants are no longer conducted (Connelly et al. 2004), sagebrush control methods including burning, plowing or mechanical removal, and herbicide application are still used to benefit production. In general, control methods and grazing management that favor increased livestock production make habitat less suitable for sage-grouse by limiting the food plants, nesting sites, and cover that sage-grouse require.

Agriculture

In regions with soils suitable for agricultural use, complete loss of sage-grouse habitat has been pervasive (BLM 2003). Habitat conversion to agriculture fragments the landscape, impacting the ability of sage-grouse to access critical resources, and facilitating the movement of sage-grouse predators such as common ravens (Connelly et al. 2004). Agricultural seeding practices can increase dominance of non-native species within sagebrush stands, reducing the value of remaining sagebrush habitat to sage-grouse. Mechanical sagebrush control to enhance land for agriculture is also detrimental. Small increases in tilled land have been linked to a large decline in the number of lekking males in south-central Montana (Swenson et al. 1987). Long-term management for cultivated crops may be more detrimental to sage-grouse than removal of sagebrush for grazing because regeneration of sagebrush, forbs, or native grasses cannot occur while crops are in place. By contrast, native sagebrush plants may regenerate to some extent on properly managed grazing lands.

Development of Water Sources

Development of water sources for livestock management, crop irrigation, or human consumption may negatively impact springs and associated riparian habitats that provide important watering and foraging areas for sage-grouse. Widespread water developments throughout sagebrush ecosystems have increased the amount of area that can be grazed. They also modify human and livestock land-use patterns,

Sage-grouse & Hunting

At the time of publication, some states and provinces had eliminated hunting altogether. In states that do allow hunting, sage-grouse seasons are short and possession limits are only a few birds per season. Often, a special permit to hunt sage-grouse is required, and hunting is only permitted in designated locations. Currently, hunting seasons are set to avoid breeding, nesting, and young rearing seasons to decrease the take of brood-rearing hens. Population viability analysis may be useful to estimate the effects of hunting on a particular population. Careful monitoring of population sizes through the use of lek counts, harvest surveys, and other techniques will help to ensure that sage-grouse are not overhunted and retain their game-species status. Hunters are encouraged to contact their state or provincial game agencies regarding current sage-grouse hunting regulations and opportunities.

exerting a new mosaic of disturbance across remaining sagebrush landscapes (Connelly et al. 2004).

Herbicides and Pesticides

The use of herbicides and pesticides can have negative effects on sage-grouse. These effects vary greatly depending on the timing, location and spatial extent of application. Treating large tracts of sagebrush with herbicides in order to encourage the growth of non-native forage plants preferred by livestock was a common practice prior to the 1980s. Herbicide application (primarily 2,4-D) to large blocks of sagebrush rangeland resulted in major declines of sage-grouse breeding populations (Peterson 1970, Wallestad 1975, BLM 2003). Although many modern pesticides are shown to have a low toxicity to birds, the timing of their application overlaps the early and late brood-rearing period when chicks are highly dependent on insects for survival and most vulnerable to starvation. In addition to depleting food supplies, pesticide residues can be detrimental to grouse survival and reproduction (BLM 2003).

Invasive Species

Invasive species affect the long-term productivity of sagebrush habitats by altering their natural composition and replacing native species essential for sage-grouse survival (BLM 2003). Cheatgrass (*Bromus tectorum*) and other non-native plant species that burn readily have invaded lower elevation sagebrush habitats across much of the western part of the sagebrush biome, further exacerbating the role of fire in these systems (Connelly et al. 2003). Introduced annual grasses from Eurasia, cheatgrass and medusahead (*Taeniatherum caput-medusae*), now either dominate or have a significant presence (estimated greater than 10% composition based on biomass) on over 27,000 mi^2 of public land in Washington, Oregon, Idaho, Nevada and Utah (Connelly et al. 2004). Although cheatgrass and medusahead proliferation is widespread, increases in other invasive plants and noxious weeds are also adversely affecting sagebrush habitats. For example, non-native wheatgrasses are often used in post-fire rehabilitation because of their forage value for livestock, fast establishment and low cost. Reseeding with wheatgrass may limit the natural regeneration of native grasses and forbs that provide critical habitat components for sage-grouse (BLM 2003). However, wheatgrass has also been successfully used to restore more natural fire regimes. Therefore, land users must carefully consider the costs and benefits of introducing wheatgrass on their properties. Other non-native species that compete with sagebrush include knapweed (*Centaurea* spp.), leafy spurge (*Euphorbia esula*), and Japanese brome (*Bromus japonicus*).

Urbanization

Urban expansion associated with population growth in western North America poses one of the largest threats to remaining sage-grouse populations. Commercial and residential development destroys and fragments sagebrush habitat via the construction of buildings, roads, powerlines, railroads, and communications towers. The development of roads

and other urban corridors may increase both legal and illegal harvest of grouse, facilitate predator movements, and provide corridors for spread of invasive species across the entire sagebrush biome. Mortality of sage-grouse through collisions with fences, power lines and other structures has been documented. Birds that do not die immediately from collisions become prey for predators (BLM 2003).

Energy Development

Extraction of oil and gas requires the construction of well pads, roads, and pipelines resulting in the physical destruction of sagebrush habitat. Indirect effects of energy development include habitat fragmentation and soil disturbance along roads, spread of invasive plants, and increased predation from raptors that have access to new perches for nesting and hunting. Noise disturbance associated with construction activities and vehicles also can disrupt sage-grouse breeding and nesting. High demand for oil and gas resources and advanced extraction technologies will continue to drive the development of sagebrush habitat for energy reserves well into the future (Connelly et al. 2004).

Mineral Extraction

Potential impacts to sage-grouse, from mineral extraction activities, include habitat loss from mine and well construction, increased human activity including noise disturbances, and mortality associated with evaporation ponds (BLM 2003). Mineral development activities also lower water tables, which results in loss or reduction of herbaceous riparian vegetation used by sage-grouse in late summer and fall. The roads, power lines, and increased dust and noise associated with mineral development can also be disruptive to sage-grouse populations. Roads fragment habitat and create an avenue for the establishment of invasive species, powerlines attract sage-grouse predators, and noise disturbances impede aural communication between males and females during the lekking season. Degradation of sagebrush habitat by mining activities usually occurs incrementally. The results are cumulative and, if severe enough, will result in abandonment of the areas impacted by mining activities.

Recreation

Recreational activities such as camping, hiking, mountain biking, or driving off-road vehicles increase dust, noise, and traffic, and can create avenues for the establishment of non-native plants that degrade and further fragment sage-grouse habitats (BLM 2003). Recreational observation of lek sites may have a negative effect on sage-grouse breeding behavior as the presence of humans may disturb courtship rituals.

Helping Remaining Sage-grouse Populations

Addressing land-management practices associated with sage-grouse decline will require unprecedented cooperation among wildlife biologists, range scientists, and private landowners (Crawford et al. 2001). Long-term conservation management plans for sage-grouse should include strategies that 1) identify and map remaining sage-grouse populations and sagebrush habitat, and 2) enhance key areas of high ecological integrity and restore habitat adjacent to these areas, while maintaining no net loss of sage-grouse habitat (BLM 2000). In order to ensure a future for sage-grouse, land managers must work to provide a landscape-scale mosaic of native plant communities such that viable populations of sage-grouse can exist throughout their range (Paige and Ritter 1999).

The ability of landowners and resource managers to address sage-grouse habitat concerns at large scales is aided greatly by geographic information systems (GIS) technology and advances in landscape ecology. These tools allow unprecedented linkage and analysis of habitat and population dynamics data over space and time (Crawford et al. 2001). Treatments to restore sagebrush that are derived from such technologies are becoming a major emphasis of land management agencies. Many western states and Canada have developed management plans that outline specific recommendations for sage-grouse conservation, and will provide copies of the plan upon request. Plans are available for Nevada (Bureau of Land Management), Wyoming (Wyoming Department of Fish and Game), Canada (Canadian Sage-grouse Recovery Team), Colorado (BLM), Oregon/Washington (BLM), Idaho (Idaho Department of Fish and Game), Utah (Utah Division of Wildlife Resources), and Montana

Table 3. Landowner assistance programs.

Program	Description	Land Eligibility	Contact Organization
Conservation Reserve Program (CRP)	Provides cost share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15-year contracts.	All privately owned grazing land.	Natural Resources Conservation Service (NRCS) or Farm Service Agency (FSA)
Conservation of Private Grazing Lands Initiative (CPGL)	Provides technical assistance on managing grazing lands for natural resource protection and economic and community benefits.	Highly erodible land, wetland and certain other lands with cropping history, streamside areas	Local NRCS or conservation district office
Environmental Quality Incentives Program (EQIP)	Provides up to 75% cost-share for conservation practices in accordance with 1 to 10-year contracts, and incentive payments for certain management practices.	Cropland, range, grazing land and other agricultural land in need of treatment.	Local NRCS or conservation district office
Partners for Fish and Wildlife Program (PFW)	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements.	Most degraded fish and/or wildlife habitat.	Local office of the U.S. Fish and Wildlife Service (USFWS)
Wildlife Habitat Incentives Program (WHIP)	Provides up to 75% cost-share for conservation practices under 5 to 10-year contracts.	High priority fish and wildlife habitats.	Local NRCS or conservation district office
Grassland Easement Program (GEP)	Protects grasslands with high wetland densities and native prairies or soils most likely to be converted to cropland through USFWS conservation easements. Grazing is permitted anytime on GEP easements, but haying and mowing are allowed only after 15 July each year to provide brood-rearing habitat for sage-grouse and other wildlife.	Grasslands with high wetland densities and native prairie soils.	Local office of the USFWS
Grassland Reserve Program (GRP)	Landowners may receive technical assistance and up to 90% of the cost to restore grassland or shrubland that has never been cultivated, or 75% of the cost if the land has a history of cultivation. Once the land is restored, landowners must enter into rental agreements with the USDA to conserve the restored land for 10, 15, 20, or 30 years.	Private lands	Local NRCS or conservation district office
Private Stewardship Grants Program (PSGP)	Provides grants or other federal assistance to individuals and groups engaged in private conservation efforts that benefit species that are threatened or endangered, candidates for listing, or other at-risk species on private lands within the U.S.	Private lands	Local office of the USFWS

(Montana Fish, Wildlife and Parks). Private land managers are encouraged to obtain copies of their state or provincial plan, and to implement the management recommendations outlined below in order to monitor local sage-grouse populations and enhance sagebrush habitat.

Population Monitoring and Analysis

Sage-grouse populations occupy large geographic areas and cross multiple jurisdictional boundaries on a year-round basis. Therefore, natural resource agencies and private landowners must work cooperatively to accurately assess sage-grouse population trends (Connelly et al. 2000). Identifying migration routes and seasonal habitats is one of the first steps that land-managers should take when establishing criteria for effective management of sage-grouse populations. Breeding populations should be assessed annually via lek counts (count the number of males on each known lek), or lek surveys (classify each known lek as active or inactive) (Autenrieth et al. 1982). In areas where hunting of sage-grouse is permitted, wing collection and hunter harvest data can be used to estimate production (population growth) or recruitment (age-structure) within sage-grouse populations (Connelly et al. 2000). Demographic variables collected using such techniques can be used in computer models that analyze current and project future population trends.

Two modeling tools that can be used to assess the condition of sage-grouse populations and their habitat are population viability analysis (PVA) and GIS. PVA is "a type of risk assessment designed to project the likelihood of a population's persistence" (Johnson and Braun 1999). This model estimates for particular conditions, using a range of demographic information such as population size, survivorship, reproductive ability and sex ratios. It can be used to assess the vulnerability of specific populations of sage-grouse, particularly those that are small and/or at high risk. The likely effectiveness of proposed management strategies can then be evaluated theoretically before they are enacted. GIS technology can be used to map sage-grouse populations and land-use in order to identify priority areas for conservation activities. Private landowners can participate in these efforts by sharing information with agencies and scientists who are using these technologies to develop population management strategies for sage-grouse.

Washington Department of Fish and Wildlife

Like the sage-grouse, the pygmy rabbit has suffered significant population declines due to the loss of sagebrush habitat. Land management practices that help to conserve sagebrush systems will benefit a suite of sagebrush-dependent species.

Modifying Land-Management Practices to Conserve & Enhance Sagebrush Habitat

The effective management of sagebrush is an essential part of any sage-grouse conservation plan. Remaining sagebrush habitat should be conserved, and degraded sagebrush habitat should be restored if practical. Nest and lek sites should be given priority as they are crucial to breeding success and population persistence. In addition to sagebrush habitat, springs, wet meadows, and riparian areas used by sage-grouse should also be carefully managed. A summary of recommended conservation actions to address land management activities that impact sage-grouse and sagebrush habitat is provided in Table 4. Protecting and restoring sage-grouse habitat will benefit many other species that use sagebrush during all or part of their life cycle. Other sagebrush fauna that would also benefit from conservation and restoration of sagebrush habitat can be found on the list in Appendix C.

Managing wildfire and prescribed burns

Burning over large areas to eradicate sagebrush for the benefit of livestock forage is detrimental to sage-grouse because it removes protective shrub cover and promotes conversion to invasive plants, such as cheatgrass, that have little to no habitat value for sage-grouse (Paige and Ritter 1999). In general, wildfire suppression is recommended to prevent further loss

Sage-grouse & West Nile Virus

Recent studies done in Alberta, Wyoming, and Montana indicated West Nile virus (WNV) resulted in a 25% decline in survival in four populations of radiomarked greater sage-grouse (Walker et al. 2004). Male and female lek attendance rates dropped dramatically the spring following a WNV outbreak, indicating that the disease may threaten local populations of sage-grouse with local extinction. WNV outbreaks may work synergistically with other (land-use) risk factors to further threaten the species' presence throughout western North America. At present, biologists are working to identify vectors and reservoir hosts that spread WNV throughout this region, and a full understanding of how WNV will impact sage-grouse populations will require a rapid, coordinated monitoring strategy among researchers and land managers (Walker et al. 2004). Symptoms of WNV in sage-grouse include lack of mobility, tilted or drooping head, drooping wings when roosting, or weak flight when flushed. Birds exhibiting these behaviors should be reported to state or provincial wildlife authorities. Sage-grouse carcasses should be similarly reported. Handling of dead birds or field necropsies are not recommended due to health risks to untrained personnel and potential loss or improper preservation of critical samples (Walker et al. 2004). State or provincial wildlife veterinary laboratories may be contacted for information on where to send sage-grouse carcasses for WNV testing.

of sagebrush habitat. However, prescribed burning can be a useful management tool if applied on a small scale at historical fire intervals (25–100 years). The response of sagebrush to fire depends on many factors that include but are not limited to: sage type, soil type, soil moisture, vegetation moisture, winds, humidity, season of burning, nature of the understory vegetation, degree of occupancy by invasive plants, management of livestock grazing, post-fire livestock management, and post-fire reseeding efforts. Securing the knowledge and expertise of local natural resource professionals who have experience balancing all of these factors is an essential step in planning a successful prescribed burn.

Areas dominated by continuous or dense sagebrush can be burned on a small scale with the goal of opening up the sagebrush canopy to encourage the growth of native grasses and forbs. Such efforts should be designed to allow natural regeneration of sagebrush from the soil seedbank or upwind stands. This will produce a sagebrush mosaic that varies in age over space and time, creating a landscape preferred by sage-grouse (Paige and Ritter 1999). When using prescribed burns to thin habitats dominated by mountain big sagebrush and Wyoming big sagebrush, no more than 20% of known sage-grouse breeding habitat should be treated within a 20- to 30-year period (Connelly et al. 2000). Where natural regeneration is insufficient, post-burn land-management practices should incorporate reseeding with native bunchgrass and forb species to prevent invasion by non-native species, and exclusion of cattle for 1–4 growing seasons to prevent damage to soil and new vegetation growth (Paige and Ritter 1999).

Grazing strategies

Grazing in sage-grouse habitat should be limited and closely monitored to ensure that it does not cause irreversible ecological damage to the sagebrush system. While no single grazing strategy is appropriate for all types of sagebrush and grazing management should be tailored to the condition and potential of each grazing unit, certain general land management practices may help buffer the effects of grazing on sagebrush habitat. Grazing plans that promote a mosaic of different amounts of shrub cover, perennial grass and forb cover, and openings of bare ground will benefit sage-grouse (Paige and Ritter 1999).

Rotational grazing practices that minimize the presence of cattle in sagebrush during the nesting season (late spring and summer) will help to ensure adequate nesting cover, and deter the loss of nests and chicks to trampling

Table 4. Summary of recommended land management practices for sage-grouse.

Land Management Component	Sage-grouse Conservation Goal	Recommended Management Practices
Fire	Prevent destruction of high-quality sagebrush habitat.	Suppress large-scale wildfires.
		Limit prescribed burning of mountain and Wyoming big sagebrush to less than 20% of the habitat with in a 20 to 30-year period.
		Use strips of fire resistant vegetation (green-stripping) in areas dominated by cheatgrass.
		Burn in early spring to discourage cheatgrass.
		Prescribed burn activity should be limited to those areas where forbs have been excluded from the system due to an overabundance of sagebrush cover. Under these circumstances, limit prescribed burns to small, patch areas to encourage regrowth of forbs.
		Design prescribed burns to allow natural regeneration from upwind stands and soil-banked seeds.
	Limit the invasion of aggressive invasive plants	Reseed burned areas with appropriate vegetation, if possible from local native seed that provides desired sagebrush habitat.
	Allow regeneration of native sagebrush, grasses, and forbs	Exclude cattle from burned areas for 1-4 years.
	Minimize disturbance to sage-grouse	Develop a burn plan that avoids nesting season mortality.
Grazing	Restore degraded sagebrush habitat	Control livestock access to the area to be restored and reseed in native vegetation.
		After establishment, manage grazing to develop the desired habitat.
		Livestock allocations should only be increased if it can be demonstrated that there are not detrimental effects on sage-grouse habitat quality.
	Encourage the growth of native sagebrush, grasses, and forbs	Use proper stocking levels and grazing management that produces the desired plant community.
	Avoid trampling of ground nests	Time grazing and rotate pastures to avoid the nesting season.
		Manage locations of salt or mineral supplements, and water.
	Maintain herbaceous nesting cover	Protect current season's growth through the nesting season, and manage livestock to consider affects of wild grazers such that atleast 50% of the annual vegetation growth is conserved.
	Ensure winter habitat availability	Locate supplemental winter feeding of livestock in areas that will limit livestock access to known sage-grouse habitat.
Agriculture	Maintain vegetative cover throughout the non breeding season	Use minimum-till or no-till systems.
	Maintain protective cover	Protect riparian buffer zones and unplowed field borders and edges.
	Reduce bird mortality	Delay haying and mowing until after birds have fledged (late July).
		Practice Integrated Pest Management (IPM).

Table 4. ***(cont)*** **Summary of recommended land management practices for sage-grouse.**

Land Management Component	Sage-grouse Conservation Goal	Recommended Management Practices
Water Resources	Maintain water quality and native vegetation in springs, seeps, and riprian areas	Engineer to retain natural water flow.
	Reduce bird mortality	Where priority and funding permit, retrofit existing springs to restore free-flowing nature of streams.
		Protect and enhance the growth of native forbs.
		Control livestock access to riparian areas.
		Develop new livestock watering facilities away from sensitive areas.
		Provide escape ramps or floats.
Herbicides & Pesticides	Provide insect food resources for sage-grouse	Practice Integrated Pest Management (IPM).
		Limit use to ground applications in key problem areas; use minimum application rates to achieve objectives.
	Minimize bird mortality	Minimize use during sage-grouse nesting and brood-rearing seasons.
		Use insecticide baits and natural pathogens instead of broad-spectrum insecticides.
Invasive Species	Make existing sagebrush habitat more resistant to invasive species	Minimize habitat fragmentation.
		Maintain and enhance the health of native sagebrush species.
		Avoid large-scale disturbance.
		Manage grazing activities to minimize habitat disturbance.
	Remove known invasive species	Employ appropriate physical, mechanical, and/ or chemical control methods.
	Restore native sagebrush vegetation	Reseed areas with appropriate local, native sagebrush, grasses, and forbs.
		Use heavy spring grazing to reduce cheatgrass, and then reseed with native perennial grasses.
Urbanization	Maintain large areas of sagebrush habitat	Manage for no net loss of sagebrush habitat.
		Use conservation easements and tax incentives to retain sagebrush habitat.
		Retain native vegetation in open spaces.
	Limit fragmentation of sagebrush habitat	Avoid development designs that fragment remaining sagebrush habitat.
		Utilize existing roads, powerlines, and associated infrastructure where possible.
		Use native plants in residential landscaping.
		Do not develop known lekking, nesting, or brood-rearing habitat.
	Minimize construction disturbances	Restrict construction activities to the immediate construction area.
		Reseed disturbed areas using native sagebrush species.
	Minimize bird mortality	Keep cats indoors and discourage other predators by covering garbage.

Table 4. ***(cont)*** **Summary of recommended land management practices for sage-grouse.**

Land Management Component	Sage-grouse Conservation Goal	Recommended Management Practices
Energy Development & Mineral Extraction	Maintain large area of sagebrush habitat	Manage for no net loss of sagebrush habitat.
		Use conservation easements and tax incentives to retain sagebrush habitat.
		Retain native vegetation in open spaces.
	Limit fragmentation of sagebrush habitat	Avoid development designs that fragment remaining sagebrush habitat.
		Utilize existing roads, powerlines, and associated infrastructure where possible.
	Minimize habitat disturbance over space and time	Initiate land reclamation concurrently with energy development and mining activities.
		Reseed disturbed areas using native sagebrush species.
	Minimize bird mortality	Limit the construction of structures that raptors can use.
		Place netting over ponds containing minimg water.
		Do not develop known lekking, nesting, or brood-rearing habitat.
Recreation	Minimize habitat disturbance, soil erosion, and contamination of water resources	Limit recreational use to low-impact activities in sagebrush habitat.
		Restrict biking and motor-vehicle access to designated roads and trails.
	Minimize disturbance to sage-grouse	Restrict target practice to designated shooting and archery ranges.
		Avoid placing recreation sites near known lekking, nesting, or brood-rearing habitat.
		Restrict bird-watching activities during the lekking season.
		Invoke emergency seasonal or area closures as needed.

(Paige and Ritter 1999). Cattle should be excluded from areas that have experienced extensive grazing damage and these areas should be reseeded in native sagebrush vegetation. Cattle should also be prevented from degrading riparian habitats. In upland areas grazing of bunch grasses should not occur during crucial growth periods.

In both riparian and upland habitats, early season light to moderate grazing can promote forb abundance and availability. In areas where cheatgrass and native perennials are mixed, grazing during the dormant period may favor perennial species, thereby improving habitat for sage-grouse. Finally, supplemental feeding of livestock in known sage-grouse habitat is strongly discouraged (Paige and Ritter 1999).

Agriculture strategies

Several practices can be adopted to reduce the impact of agriculture on sage-grouse. Farmers using minimum till and no-till systems can provide cover for sage-grouse throughout the non-breeding (winter) season. A 100-ft buffer of native vegetation should be maintained around springs, seeps, wetlands, and riparian habitats that occur within agricultural land (Paige and Ritter 1999). Areas comprised of unsuitable soils or steep slopes should be maintained in native vegetation to provide habitat stepping stones for sage-grouse using the area. Herbicide and pesticide use should be kept to a minimum to prevent poisoning of sage-grouse. Pesticide use should be limited to minimum application rates, ground applications, baits, and natural pathogens in order to prevent substantial loss of insect prey.

Water strategies

New livestock water developments should be constructed outside known sage-grouse nesting and early brood-rearing habitat unless it can be demonstrated that the development will not adversely affect habitat quality. New spring developments should be constructed to maintain their free-flowing nature and wet meadow characteristics (BLM 2000). Sage-grouse are attracted to wet areas due to the succulent forbs and insects found there. Management practices that protect and enhance the growth of native forbs around water developments are highly encouraged (Paige and Ritter 1999). Wildlife escape ramps or floats should be installed on all water troughs to prevent drowning. (BLM 2000). Water developments should be located at least 0.6 mi from leks to minimize concentration of livestock in sage-grouse mating areas. Construction should be done such that structures that provide avian predator perches are limited (BLM 2000).

Application of pesticides and herbicides

Land managers concerned with maintaining productive sage-grouse populations should reduce applications of pesticides and herbicides wherever possible. Use should be limited to ground applications in key problem areas using minimum application rates (Paige and Ritter 1999). Pesticides should not be applied to sage-grouse breeding habitat during the brood-rearing season (mid-May–mid-July) to limit the loss of insect prey and avoid secondary poisoning of chicks (Ulliman et al. 1998). Direct toxic effects of insecticides on sage-grouse can be further minimized through the use of insecticide baits and natural pathogens (such as *Nosema locustae* for grasshoppers) rather than broad-spectrum insecticides (Paige and Ritter 1999).

Invasive species management

Invasive plants that compete with native species should be monitored and controlled in sage-grouse habitat. Land managers can work to prevent non-native species from invading sagebrush by minimizing habitat fragmentation, limiting soil disturbance activities, and managing livestock to maintain the integrity of the plant community (Paige and Ritter 1999). Non-native species should be removed using an appropriate combination of physical, mechanical, and/ or chemical techniques. These areas should then be reseeded with native grasses and forbs to prevent reinvasion by non-natives (Larson et al. 1994). In areas dominated by cheatgrass, heavy spring grazing before spring production may help to prepare a unit for conversion to native perennial grasses (Vallentine and Stevens 1994). In areas where medusahead has invaded, herbicidal sprays may prove more effective than mechanical removal. Land managers are encouraged to consult local natural resource professionals for help in determining which plants are invasive and how they can best be controlled or eradicated.

Urbanization

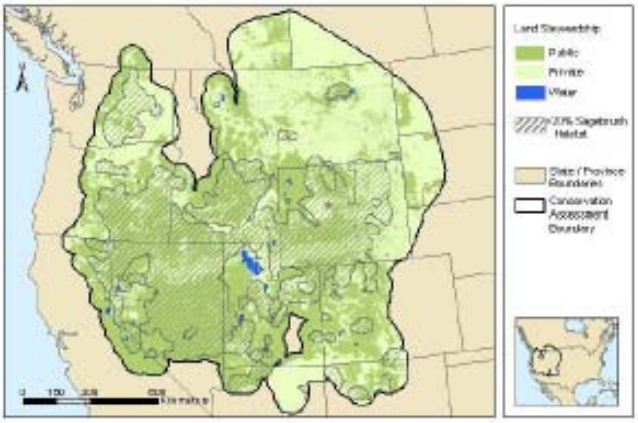
The impact of urban expansion on sage-grouse and sagebrush habitats can be buffered through careful development planning. Large-scale planning should discourage habitat destruction and fragmentation by preserving large, interconnected areas of native sagebrush habitat. Community planners are encouraged to explore conservation easements and tax incentives as a means to preserve open space in sagebrush habitat (Paige and Ritter 1999). On a local scale, commercial and residential plans should be designed so that homes and buildings are grouped in clusters on areas peripheral to interior portions of preserved sagebrush stands. Construction-related disturbance should be confined to immediate construction areas to avoid destruction of adjacent sagebrush habitat. Areas disturbed during construction should be restored using species native to sagebrush communities (Paige and Ritter 1999). New powerlines should be installed within existing utility corridors and rights-of-way where practical (BLM 2000). Homeowners should avoid using insecticides, herbicides, and fertilizers on their lawns, and can further protect sage-grouse by keeping their cats and dogs indoors.

Mining and energy development

Land reclamation techniques should be initiated concurrently with mining and energy development activities in attempt to minimize habitat disturbance over space and time. Infrastructure associated with mining and energy development should not be placed in or adjacent to leks, breeding and early brood-rearing habitat, or wintering habitat. Construction of structures that may serve as perches for predatory raptors should not occur. Ponds containing mining waters should be netted to exclude sage-grouse. Land reclamation using a variety of native shrub, forb and grass species may encourage sage-grouse to repopulate the area.

Recreation

Recreation sites and recreational activities should be limited such that impacts on native vegetation, and contribution to erosion and water contamination are minimal. Recreational land use should be low-impact. Biking, horseback riding and motor-vehicle use should be restricted to designated roads and trails. Target practice should be restricted to designated shooting and archery ranges. Land managers should avoid releasing the locations of all known lek sites to minimize human disturbance (bird watching) during the breeding season. If substantial public interest in lek viewing exists, managers might consider building observation blinds at selected sites. The impacts of recreational activities on sage-grouse populations should be closely monitored. Activities found to have detrimental effects on sage-grouse or sagebrush habitat should be prohibited by invoking emergency seasonal or areas closures as needed (Paige and Ritter 1999, BLM 2000).



Source: Connelly et al. 2004

Figure 2. Distribution of public and private lands within the sagebrush biome. Land ownership information compiled from state GAP analysis programs, the USGS National Land Cover Database, U.S. Bureau of Land Management, and individual state sources.

Landowner assistance

In Canada, 90% of the sagebrush area in Saskatchewan and 28% of the sagebrush area in Alberta are privately owned. In the United States, approximately 30% of remaining sagebrush habitat is privately owned with private land holdings are considered a major constituent of sagebrush landscapes in eastern Montana, eastern Wyoming, Washington, and Colorado (Connelly et al. 2004; see also Figure 2). Reversing the decline of sage-grouse throughout its range will require large-scale habitat restoration and conservation efforts on privately held land. Proactive land-management and conservation efforts aimed at preventing the listing of sage-grouse are highly encouraged. Federal conservation programs represent a key management tool that can be used in restoring the amount, condition, and extent of habitat necessary to impact sage-grouse on private land (Riley 2004).

A variety of federal conservation programs are available to assist landowners with sage-grouse conservation efforts. A listing of relevant programs is provided in Table 3. Federal conservation programs assist private landowners in implementing perpetual conservation easements, cost-share agreements, and term contracts, as well as provide technical land-management assistance. (Riley 2004). Contact information for organizations that provide assistance with federal conservation programs for sage-grouse and critical sagebrush habitat can be found in Appendix B.

Conclusion

To be truly effective, sage-grouse conservation measures must be enacted at regional landscape levels with cooperation from public and private landowners, government agencies, conservation organizations and academic institutions. Preserving and enhancing sagebrush habitat, which is the primary objective for sage-grouse conservation, will help to protect many other sagebrush species as well. Sustainable use of sagebrush habitat by both humans and animal species such as the sage-grouse should be the ultimate goal.

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Appendix A. Plant species associated with sage-grouse

Type	Common name	Scientific name
Grass	blue grama	*Bouteloua* spp.
	buffalo grass	*Buchloe* spp.
	giant wildrye	*Elymus cinereus*
	western wheatgrass	*Elymus smithii*
	bluebunch wheatgrass	*Pseudoroegneria spicata*
	Idaho fescue	*Festuca idahoensis*
	prairie junegrass	*Koeleria macrantha*
	Indian ricegrass	*Oryzopsis hymenoides*
	steppe bluegrass	*Poa secunda*
Forb	western yarrow[2]	*Achillea millefolium var. occidentalis*
	mountain-dandelion[2]	*Agoseris* spp.
	wild onion	*Allium* spp.
	evening primrose	*Oenothera* spp.
	everlasting	*Antennaria* spp.
	milkvetch[3]	*Astragalus* spp.
	sego lily[2]	*Calochortus* spp.
	hawksbeard[2]	*Crepis* spp.
	fleabane	*Erigeron* spp.
	buckwheat	*Eriogonum* spp.
	western marsh cudweed	*Gnaphalium palustre*
	curly cup gumweed	*Grindelia squarrosa*
	prickly lettuce[1,2]	*Lactuca serriola*
	prairie starflower	*Lithophragma* spp.
	desert parsley[3]	*Lomatium* spp.
	lupine	*Lupinus* spp.
	alfalfa[1]	*Medicago sativa*
	sweetclover[1]	*Melilotus officinalis*
	microsteris[3]	*Microsteris gracilis*
	prickly pear	*Opuntia polyacantha*
	phlox	*Phlox* spp.
	common dandelion[1,2]	*Taraxacum officinale*
	western salsify[1,2]	*Tragopogon dubius*
	clover	*Trifolium* spp.
	death camas	*Zygadenus venenosus*
	broom snakeweed	*Gutierrezia sarothrae*

Appendix A *(cont.)*. Plant species associated with sage-grouse

Shrub	low sagebrush	*Artemisia arbuscula*
	silver sagebrush	*Artemisia cana*
	prairie sagewort	*Artemisia frigida*
	black sagebrush	*Artemisia nova*
	big sagebrush	*Artemisia tridentata*
	threetip sagebrush	*Artemisia tripartita*
	rabbitbrush	*Chrysothamnus* spp.
	winterfat	*Eurotia lanata*
	antelope bitterbrush	*Purshia tridentata*
	horsebrush	*Tetradymia canescens*
Shrub/tree	juniper	*Juniperus* spp.
	scrub willow	*Salix* spp.
Tree	ponderosa pine	*Pinus ponderosa*
	quaking aspen	*Populus tremuloides*

[1] introduced species

[2] especially important sage grouse food species

[3] important sage grouse chick food species

Appendix B. Organizations that may assist with sage-grouse management

Program/Organization	Address	What they do
Canadian Wildlife Service (CWS)	Inquiry Centre 70 Crémazie St. Gatineau, Quebec K1A 0H3 819-997-2800 or 1-800-668-6767 http://www.cws-scf.ec.gc.ca	CWS handles wildlife matters that are the responsibility of the federal government: protection and management of migratory birds, nationally significant habitat and endangered species, as well as work on other wildlife issues of national and international importance.
National Wildlife Federation, Northern Rockies Project Office	240 N. Higgins, Suite 2 Missoula, MT 59802 http://www.nwf.org	Landscape-level focus on protecting particular endangered species (including sage-grouse) as a key to protecting other species and systems.
Native Seed Network	Institute for Applied Ecology 227 SW 6th St. Corvallis, OR 97333 http://www.nativeseednetwork.org	A collaborative effort to bring information, researchers, and restoration workers together to expand the use of native plants from local sources.
USDA Natural Resources Conservation Service (NRCS)	NRCS 14th and Independence Ave., SW Washington, DC 20250 http://www.nrcs.usda.gov	Delivers technical conservation assistance to private landowners, local, state, and federal organizations and policy makers based on sound science; financial and cost-share incentives are available.
North American Grouse Partnership	c/o Sutton Avian Research Center PO Box 2007 Bartlesville, OK 74005	Promotes the conservation of grouse and the habitats necessary for their survival and reproduction.
Society for Range Management	445 Union Blvd. Suite 230 Lakewood, CO 80228 http://www.rangelands.org	A non-profit professional society that promotes and publishes information about rangeland ecosystems and their management.
US Bureau of Land Management (BLM)	Office of Public Affairs 1849 C Street, Room 406-LS Washington, DC 20240 Phone: (202) 452-5125 Fax: (202) 452-5124 http://www.blm.gov	The BLM administers 261 million surface acres of America's public lands, located in 12 western states. The BLM sustains the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.
USDA Farm Service Agency (FSA)	1400 Independence Ave., S.W. STOP 0506 Washington, DC 20250-0506 http://www.fsa.usda.gov	The FSA works to stabilize farm income, help farmers conserve land and water resources, provide credit to new or disadvantaged farmers and ranchers, and help farm operations recover from natural disasters.
US Fish and Wildlife Service (USFWS)	1-800-344-WILD http://www.fws.gov	The USFWS mission is to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. Provides federal grants to assist with endangered/threatened species conservation and wildlife habitat expansion.
Wildlife Habitat Council (WHC)	8737 Colesville Road, Suite 800, Silver Spring, MD 20910 http://www.wildlifehc.org	WHC is a nonprofit group dedicated to increasing the amount of quality habitat on public and private lands. WHC helps large landowners manage their unused lands for the benefit of wildlife.
The Wildlife Society (TWS)	5410 Grosvenor Lane Suite 200 Bethesda, MD 20814-2144 http://www.wildlife.org	TWS is an international nonprofit scientific and educational organization serving professionals in all areas of wildlife ecology, conservation, and management.

Appendix C. Wildlife associated with sagebrush ecosystems.

Common name	Scientific name	Range overlap with sage grouse
Reptiles		
horned lizard	*Phrynosoma* spp.	AB, SK, CA, CO, ID, MT, ND, NV, OR, SD, UT, WA
rattlesnake	*Crotalus* spp.	AB, SK, CA, CO, ID, NV, SC, UT, WA, WY
Birds		
sage sparrow[1,3]	*Amphispiza belli*	CA, CO, ID, MT, NN, NV, OR, UT, WA, WY
golden eagle	*Aquila chrysaetos*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
ferruginous hawk	*Buteo regalis*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
common nighthawk	*Chordeiles minor*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
horned lark	*Eremophila alpestris*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
Brewer's blackbird	*Euphagus cyanocephalus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
prairie falcon	*Falco mexicanus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
ash-throated flycatcher	*Myiarchus cinerascens*	CA, CO, ID, NN, NV, OR, UT, WA, WY
sage thrasher[1,3]	*Oreoscoptes montanus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
green-tailed towhee[2,3]	*Pipilo chlorurus*	SK, CA, CO, ID, MT, NN, NV, OR, UT, WA, WY
vesper sparrow	*Pooecetes gramineus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
burrowing owl	*Speotyto cunicularia*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
Brewer's sparrow[1,3]	*Spizella breweri*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
western meadowlark	*Sturnella neglecta*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
sharp-tailed grouse[3,4]	*Tympanuchus phasianellus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
prairie chicken[3,4]	*Tympanuchus* spp.	AB, SK, CO, MT, ND, SD, WY
mourning dove[4]	*Zenaida macroura*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
Mammals		
pronghorn[4]	*Antilocapra americana*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
pygmy rabbit	*Brachylagus idahoensis*	CA, ID, MT, NV, OR, UT, WA, WY
coyote	*Canis latrans*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
prairie dog	*Cynomys* spp.	SK, CO, MT, ND, NN, UT, WY
jackrabbit[4]	*Lepus* spp.	AB, SK, CA, CO, ID, MT, ND, NV, OR, SD, UT, WA, WY
black-footed ferret	*Mustela nigripes*	AB, SK, CO, MT, ND, NN, SD, UT, WY
mule deer[4]	*Odocoileus hemionus*	AB, SK, CA, CO, ID, MT, ND, NN, NV, OR, SD, UT, WA, WY
ground squirrel	*Spermophilus* spp.	AB, SK, CA, CO, ID, MT, ND, NV, OR, SD, UT, WA, WY

1 obligate sagebrush species
2 near-obligate sagebrush species
3 Partners in Flight high priority species at the continental scale
4 game species

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www.nrcs.usda.gov

Wildlife Habitat Council

8737 Colesville Road, Suite 800
Silver Spring, Maryland 20910
301-588-8994

The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

www.wildlifehc.org

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