A Blueprint for Sage-grouse Conservation and Recovery

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Abstract: The distribution of greater sage-grouse (*Centrocercus urophasianus*) has declined by at least 44% while overall abundance has decreased by up to 93% from presumed historic levels. These decreases are the result of habitat loss, fragmentation, and degradation. Federal and state public land management agencies currently are responsible for about 70% of the remaining sagebrush (*Artemisia* spp.) steppe, with the Bureau of Land Management and U.S. Forest Service managing most of these lands for multiple uses. The goals of strategies outlined here are to improve sagebrush habitats to increase greater sage-grouse abundance by at least 33% by 2015, and overall distribution of greater sage-grouse by at least 20% by 2030. The abundance goal is achievable following recommendations presented in this document while the distribution goal will be more difficult to obtain. Federal land management agencies are key to achieving both goals, as they are responsible for managing public lands, which support most of the remaining populations of greater sage-grouse. Improved vegetation management to restore degraded habitat (from domestic livestock grazing and development, such as from mining and gas/oil extraction) followed by reduction of habitat fragmentation has the greatest potential for maintaining and enhancing viable populations of greater sage-grouse. While the habitat management strategies and recommendations in this report focus on greater sage-grouse, they are also applicable to Gunnison sage-grouse (*Centrocercus minimus*).

Introduction

Sage-grouse (*Centrocercus urophasianus, C. minimus)* are dependent upon sagebrush (*Artemisia* spp.) and were historically widespread and at least locally abundant (Patterson 1952, Schroeder et al. 2004). Concern about the decrease in the abundance of sage-grouse is not only recent (Connelly and Braun 1997, Braun 1998, Connelly et al. 2004) but also long-term (Hornaday 1916, Patterson 1952). Sagebrush was also historically widely distributed in western North America (Küchler 1964, Vale 1975, Miller and Eddleman 2001, Schroeder et al. 2004). In the United States, about 70% of the remaining sagebrush steppe and distribution of sage-grouse is on public land, with most (~50% of all publicly owned sagebrush steppe) managed by the U. S. Department of Interior, Bureau of Land Management (BLM) (Connelly et al. 2004). Thus, the BLM and the U.S. Forest Service (USFS) (U.S. Department of Agriculture) have the greatest potential to positively impact sage-grouse abundance and distribution provided effective policies and conservation actions are implemented that will benefit sagebrush steppe habitats. Overall, the "responsibility for maintaining sagebrush habitats and [sage-grouse] populations rests squarely on public land management agencies because most [of the] species' [home] range [is] owned publicly and managed by state or federal agencies" (Knick et al. 2003:627, Connelly et al. 2004).

Statement of Problem

The abundance and distribution of greater sage-grouse (*Centrocercus urophasianus*) have declined. Sage-grouse historically occupied at least 1,247,004 km² in western North America of which at least 1,200,483 km² were occupied by greater sage-grouse (Schroeder et al. 2004). Greater sage-grouse now occupy about 668,412 km² of

their estimated historical distribution and have been extirpated from 1 state (Nebraska) and 1 Canadian province (British Columbia) (Braun 1998). There are no data on historical numbers (pre-European settlement) but estimates range from at least 2 to 10 million birds (C. E. Braun, illustrated presentation to the Western Association of Fish and Wildlife Agencies, Jackson Hole, Wyoming, July 1998). Braun (1998) further presented estimated breeding population levels by state and province based on counts of male sage-grouse in spring 1998 as reported by state and provincial biologists. The total was presented as ~142,000 sage grouse (Braun 1998:141). This suggests a decrease of ~93% in overall abundance if the minimum historical estimate of 2 million sage grouse is used. Braun (1998) generally classified reasons for the apparent decrease in sage-grouse abundance as the result of habitat loss, habitat fragmentation, and habitat degradation. More recently, Connelly et al. (2004:13-4) indicated that of 41 populations defined for their analysis, 5 populations have been extirpated or have numbers too small to monitor, and 14 additional populations face a high risk of extinction. The vast majority of remaining sage-grouse are in only 8 populations. Additionally, Connelly et al. (2004: 6-67) reported that an examination of all trend data from the 1940s to 2003 "suggest a substantial decline in the overall sage-grouse population in North America." Sage-grouse populations declined at an overall rate of 2.0% per year from 1965 to 2003 (Connelly et al. 2004). These authors (2004:6-71) concluded, "Continued loss and degradation of habitat and other factors…do not provide causes for optimism."

Goals

With respect to conservation of sage-grouse and the species' habitats as well as other sagebrush obligate species, the overall goal of management of public lands should be to (1) maintain the present abundance and distribution of greater sage-grouse and (2) enhance the population viability of the species through habitat management that results in increased abundance and distribution. While it is necessary to understand past changes in abundance and distribution of greater sage-grouse, it is also important to understand the present status of the species and to work towards a goal of no net loss of sagebrush steppe presently or potentially useful to sage-grouse, no further loss of populations or subpopulations, and enhancement of sage-grouse numbers by one-third (33%) and overall distribution by one-fifth (20%) (from ~668,412 km² to 835,000 km²). The abundance goal can likely be achieved by 2015 while the enhanced distribution goal is longer term (2030). Both desired increases (33% in abundance, 20% in distribution) were selected (by C. E. Braun) because they should be achievable, detectable, and measurable using current technology. A 20% increase in distribution was selected, as it should be detectable. Smaller increases in distribution are not likely to be detectable or measurable.

Habitat Needs Overview

The habitat needs of greater sage-grouse are reasonably well understood based on knowledge of what has been described as "used" by sage-grouse (extensive literature summarized in Braun et al. 1977, Connelly et al. 2000*b*, Braun et al. 2005). The basic seasonal periods relating to sage-grouse habitat needs have been described as winter (early to mid-December to early to mid-March), spring (early to mid-March to early to

mid-June), summer (early to mid-June to late September), and fall (late September to early to mid-December) depending upon elevation and weather conditions (Braun et al. 2005). A summary (Braun et al. 2005) of the existing literature is attached as an appendix.

Management of Development

Development of sagebrush steppe could include agricultural uses (usually permanent loss), which includes converting sagebrush habitats to cropland, placement of ranch/farm buildings, or the replacement of native sagebrush habitats with seeded pasture lands. Development may also refer to permanent conversion of sagebrush habitats to urban, suburban, and exurban uses (housing), and related infrastructure. "Development" as used in this section refers primarily to energy development, which includes mining (coal, gold, trona, and other mineral deposits) and extraction of natural gas (including coal bed methane) and oil. The following are minimum recommendations for development in sage-grouse habitats as it has been documented that some populations of greater sage-grouse require larger areas for breeding, brood-rearing, winter-use, and security depending upon whether they are migratory or non-migratory (Connelly et al. 2000*b*).

Noise

Sage-grouse are known to select display sites (leks) that are highly visible and which have good acoustic properties (Patterson 1952, Connelly et al. 2000*b*, Lyon 2000, Braun et al. 2002). Sage-grouse numbers on leks within 1.6 km (1 mile) of coal bed methane (CBM) compressor stations in Campbell County, Wyoming, were consistently lower than on leks not affected by this disturbance (Braun et al. 2002). Holloran and Anderson (2005) reported that lek activity by sage-grouse decreased downwind of drilling activities, suggesting that noise had measurable negative impacts on sage-grouse. Roads also generate noise and Connelly et al. (2004) indicated there were no active sage-grouse leks within 2 km of Interstate 80 (I-80) across southern Wyoming and only 9 leks were known to occur between 2 and 4 km of I-80. Lyon and Anderson (2003) reported that oil and gas development influenced the rate of nest initiation of sage-grouse in excess of 3 km of construction activities. Clearly, the amount and (likely) frequency of noise associated with development has major negative effects on greater sage-grouse.

Consequently, all drilling activities for gas and oil development should be prohibited within 5.5 km (3.3 miles) of active leks and their associated nesting areas (Holloran 2005). Further, all existing and new compressor stations should add noise abatement devices (mufflers) to reduce audible noise within 5.5 km of active leks. The actual level of noise (measured in decibels) that would not negatively affect greater sage-grouse breeding and nesting activities is presently unknown.

Physical Disturbance

Greater sage-grouse are known to be negatively impacted by activities associated with mining, and oil and gas development (Remington and Braun 1991, Aldridge 1998, Lyon and Anderson 2003, Holloran and Anderson 2005). Besides the actual physical disturbance to the landscape caused by mining and oil and gas development activities, the

impacts of roads are also negative for sage-grouse (Connelly et al. 2004). There are numerous examples of active leks being abandoned once road use associated with mining and gas/oil development increased in close proximity (< 1 km) to leks and nesting habitat (Braun 1986).

All surface activity should be prohibited within 5.5 km (Holloran and Anderson 2004, 2005) of active sage-grouse leks. No surface occupancy is preferred to simply limiting use of areas to specific periods, as the latter does not appear to benefit sage-grouse. Roads should not be placed within 5.5 km (3.3 miles) of active leks. If roads are present, they should be seasonally closed during the sage-grouse breeding season from 1 March to 20 June.

Management of Fire

Prescribed Fire

Fire has been demonstrated to be negative for greater sage-grouse (Hulet 1983; Connelly et al. 2000*a*, *b*; Nelle et al. 2000) as it destroys winter and nesting habitats. Use of fire has been promoted by public land management agencies (both BLM and USFS) to reduce sagebrush cover and increase forbs. However, the only presumed value of this practice is to improve brood-use areas or remove encroaching conifers. The problems with use of prescribed fire relate to control of the fire (escapement is frequent), what is actually burned versus what was desired to be burned, and size of the planned burn. Too often, what is burned is nesting or winter-use areas and burned areas are too large (> 20 ha).

Prescribed fire should not be used in areas where invasion of cheatgrass (*Bromus tectorum*) or other exotic species is likely. Burned areas should be smaller than 20 ha in size and no more than 20% of the landscape (128 ac per section [640 ac]) should be burned over a 30-year interval in taller sagebrush types. Burning should not be permitted in low sagebrush habitat types (i.e., *Artemisia arbuscula, A. longiloba, A. nova*). Burning that benefits sage-grouse will most likely be that which affects brood habitat. There should be a demonstrated need for additional brood habitat before use of prescribed fire is considered. The goal is to not exceed 20% fire coverage (128 ac per section [640 ac]) over a 30-year period regardless of the total area planned to be burned. Reseeding should not be necessary for prescribed burns, as areas should be sufficiently small so that surrounding sagebrush habitat can reseed the areas naturally.

Wild Fire

All wild fires should be vigorously suppressed except in areas where juniper (*Juniperus* spp.) or pinyon pine (*Pinus edulis*) has invaded (>20 trees/ha). Most wild fires are negative for sage-grouse in the short-term. If wild fires occur, grazing by domestic livestock should be immediately suspended and should not be reinstated for a minimum of 3 years. The present 2-year rest period from grazing that is often prescribed on public lands following wild fires is not based on data. Replicated studies are needed across the gradient of moisture regimes and habitat types to learn if 3 years or more are adequate for ecosystem renewal following wild fire. Most areas burned by wild fire do not require reseeding, as disking and other forms of site preparation can be harmful to site restoration. These are practices that promote livestock grazing, not habitat restoration. If

reseeding must be done to reduce soil erosion, it should occur in linear strips perpendicular to the prevailing wind except on steeper (>30%) slopes. Strips should be planted with dryland alfalfa, biennial sweet clover, native bunch grasses, and sagebrush seed in a ratio of 1 strip (10 m width) per 50 m. Areas closest to a potential fire source (roads or railroads) should be planted with a 20-m wide strip of fire resistant vegetation.

Management of Grazing

Sound grazing management in sagebrush steppe should promote light use of herbaceous forage while having a neutral or positive impact on plant vigor. Further, proper livestock grazing should maintain or enhance desirable plant communities, improve vegetation palatability, increase native plant diversity, and promote residual vegetative cover. Extreme caution should be exercised in grazing sagebrush steppe until scientific evidence is obtained through replicated studies that demonstrate grazing improves, restores, or maintains the ecosystem. It is questionable if grazing of sagebrush-dominated rangelands that produce less than 448 kg per ha (400 lbs/ac) per year of herbaceous forage should be permitted. Domestic livestock grazing should not be permitted of any sagebrush steppe habitats that produce less than 224 kg per ha (200 lbs/ac) of herbaceous vegetation per year if successful sage-grouse nesting and brood rearing is an objective. Unfortunately, there are no replicated long-term studies of the effects of stocking rates for cattle in sagebrush grasslands (Holechek et al. 1999:12).

Livestock

Grazing by domestic cattle can negatively impact nesting success of ground-nesting birds (Walsberg 2005). Several studies have demonstrated that greater sage-grouse nest success is higher where grass height and density is greater than at random sites (Wakkinen 1990, Gregg 1991). Thus, livestock grazing that reduces herbaceous cover in sagebrush steppe may negatively affect nest success of sage-grouse. Sites used by sage-grouse broods are characterized by higher plant species richness (Dunn and Braun 1986, Klott and Lindzey 1990, and others) with strong grass and forb components (Sveum et al. 1998). Excessive livestock use may damage these important areas.

Livestock stocking rates are most important in affecting forage use and residual herbaceous cover followed by timing of grazing and length of the grazing season. The most common prescription used by public land management agencies on public lands is that of ‘moderate use’. Holechek et al. (1999:12) equated ‘moderate use’ to removal of an average of 43% (their Table 2) of the primary forage species. These authors found that moderate use resulted in rangeland deterioration in semi-arid grasslands. Holechek et al. (1999:15) recommended that no more than 30-35% use of annual herbaceous production would be necessary for improvement in rangeland vegetation versus the common recommendation of 50% use by the Natural Resources Conservation Service.

My recommendation, if livestock grazing is permitted on public rangelands, is to not exceed 25-30% utilization of herbaceous forage each year. Grazing should not be allowed until after 20 June and all livestock should be removed by 1 August with a goal of leaving at least 70% of the herbaceous production each year to form residual cover to benefit sage-grouse nesting the following spring. Twice-over grazing systems, where livestock pass through an area twice in a grazing season, should be avoided, and full

rotation of each subdivision of an allotment or at least on a pasture basis should occur once every 4 years. Winter grazing is generally less negative for herbaceous vegetation and sage-grouse than grazing during the growing season. Care should be used in calculating stocking rates to ensure that no more than 25-30% forage utilization is achieved. Winter grazing should not be initiated until plant growth has ceased for the year and should generally occur in the 15 November to 1 March interval. Larger pastures with fewer fences are better than smaller pastures. Water and salt should be placed near fences or fence corners, as these areas (fences and fence corners) tend to 'naturally' attract livestock. The goal should be to reduce livestock impacts in the centers of pastures or allotments. Because fences are generally negative for sage-grouse (Connelly et al. 2004), placement of water and salt near fences can be used to concentrate livestock impacts in areas removed from the more valuable habitats for sage-grouse.

Wildlife

Native wildlife, primarily elk (*Cervus elaphus*), but also deer (*Odocoileus* spp.), pronghorn (*Antilocapra americana*), and hares (*Lepus* spp.), graze sagebrush steppe. Except in limited situations, such as within fenced pastures (to benefit domestic sheep which may prevent pronghorn movement), severe winter conditions, or unique situations (especially with hares), grazing by native wildlife species of particular sites is non-repetitive (unlike with domestic livestock). Hunting regulations by state and provincial agencies should keep populations of game animals within herd objectives. Management of elk can be difficult in achieving adequate harvests. State and provincial wildlife agencies should rigorously seek to manage elk within stated herd objectives or to reduce their numbers when sage-grouse habitat objectives are at risk. In areas where herd objectives cannot be met through legal hunting, reintroduction of native large predators should be considered.

'Wild' horses and burros also occupy some public lands and can cause habitat deterioration in areas important to sage-grouse. Efforts should be made to reduce or eliminate undocumented or permitted horses and burros on public lands important to sage-grouse where habitat deterioration is occurring.

Management of Habitat Fragmentation

Fragmentation of habitats useful for greater sage-grouse is not of recent origin, but only recently has it been accorded proper recognition (Braun 1998, Connelly et al. 2004). There are many factors that can fragment habitats from conversion of habitat type (agriculture adjacent to sagebrush steppe), to fences, power lines, roads, reservoirs, wild fire, and prescribed burns. Essentially, any land use, development, or treatment that subdivides blocks of intact sagebrush causes fragmentation. Management of sagebrush steppe should focus on maintaining large (>1 cadastral section [2.59 km^2 or 1 mi^2]) blocks of sagebrush steppe and preferably in excess of 20 cadastral sections [51.8 km^2 or 20 mi^2] in size. These blocks should conserve habitat at the landscape scale with at least 1 large block per Township (36 cadastral sections [93.2 km^2 or 36 mi^2]) throughout the sagebrush steppe. This recommendation is based on personal observations as well on published literature (Toepfer et al. 1990).

Continuity among habitat patches is desirable. Dispersal corridors should be preserved between and among blocks of habitats useful to greater sage-grouse. These corridors should be at least 1.6 km (1 mi) in width to reduce predator concentrations. Corridors should not contain roads, power lines, oil and gas developments, fences, or buildings.

Management of Invasive Plant Species

Invasive plant species are becoming more widespread throughout public lands as a result of disturbance from livestock grazing, livestock feeding operations, roads, development, and other land uses. While there are numerous invasive species that may occur across the sagebrush steppe, those most important over large areas include cheatgrass, juniper and pinyon pine (both native species), as well as other exotic species. Control or elimination of exotic species should have the highest priority.

Cheatgrass

Livestock management practices, fire, plowing/chaining, various types of development, and other practices have facilitated the spread of cheatgrass. Cheatgrass is palatable to livestock for only a short period during early growth in spring. It is a highly proficient seed producer and cannot be easily controlled by disking, plowing, grazing, or herbicides during the growing period or when mature. However, several pre-emergent herbicides have been demonstrated to reduce germination of cheatgrass (Connelly et al. 2000*b*). Reseeding cheatgrass-dominated areas with dryland alfalfa and native bunch grasses in strips (20 m width with every other strip being alfalfa/bunch grasses/biennial sweet clover/sagebrush) would appear to be effective in reducing cheatgrass abundance and may be more economical than use of herbicides.

Pinyon/Juniper

Management of pinyon pine or juniper invasion can be achieved through cutting and burning (either or both) individual trees as well as use of prescribed fire over larger landscapes. Treatment of individual trees is most effective (but more expensive), as the live sagebrush and grass/forb understory is not burned (Commons et al. 1999).

Management of Rangeland Seedings

Hundreds of thousands of hectares of former sagebrush steppe have been seeded with non-native forage species following plowing (to benefit livestock) or wild fire. Much of this area was reseeded with crested wheatgrass (*Agropyron cristatum*). Unfortunately, crested wheatgrass is of little use to sage-grouse as it provides poor cover and no food value. Sage-grouse seasonally consume forbs, insects, and sagebrush and do not eat grass seeds or leaves. Further, crested wheatgrass is a prolific seed producer with the ability to remain dominant on the landscape for periods exceeding 40 years. Crested wheatgrass is preferred forage for livestock and wild ungulates, especially during the growing period. It is capable of withstanding substantial grazing pressure and, once established, crested wheatgrass is difficult to replace with native bunchgrasses and sagebrush (due to competition and lack of seed sources).

Benign neglect has allowed portions (primarily the edges) of many seedings on public lands to revert in part to sage-grouse habitat. This is the result of sagebrush regeneration from seeds of live sagebrush in adjacent areas. Sage-grouse use these areas as density of sagebrush seedlings and canopy cover increases. Unfortunately, forb abundance in most crested wheatgrass seedings is very low (<3-5% cover) and sage-grouse use is mostly confined to foraging on young sagebrush plants. Crested wheatgrass seedings with less than 5% sagebrush canopy cover should be disked and reseeded in strips perpendicular to the prevailing wind to aid restoration of native habitats. Strips should be no more than 20 m in width in a ratio of 1 strip every 100 m. Strips should be planted with a mixture of dryland alfalfa, biennial sweet clover, native bunch grasses, and taller sagebrush (either mountain big sagebrush [*Artemisia tridentata vaseyana*] or Wyoming big sagebrush [*A. t. wyomingensis*] depending upon the site).

Biological control of crested wheatgrass seedings through manipulation of grazing intensity is possible but is negative to overall rangeland health as it results in severe overgrazing of all areas including adjacent native sagebrush steppe. This practice should not be promoted, as it will fail to control or eliminate crested wheatgrass. Chemical control of crested wheatgrass seedings also has little chance of success because of the abundant but dormant seed in the upper levels of the soil profile that are not affected by herbicides. Mechanical control through plowing or disking of the entire seeding followed by reseeding with desirable plant species also has little merit as it is expensive and exposes large expanses to wind erosion and exotic weeds. Plowing or disking (with or without reseeding) also has little chance of success because of the abundant amount of crested wheatgrass seed in the upper soil profile. Thus, the best scenario is to disk strips into crested wheatgrass seedings horizontal to the prevailing wind and replant desired vegetation (in strips) while protecting all larger sagebrush plants that may be present to serve as seed sources. Additional strips should be disked and reseeded at 3-5 year intervals depending upon site and results from the initial strips (adaptive management).

Management of Roads

Roads are known to reduce the value of potential breeding habitats for greater sage-grouse (Connelly et al. 2004), cause lek abandonment (Braun 1986), and lead to death (from collisions). Road densities are increasing within occupied sage-grouse habitats. A recent study in the Upper Green River Valley, Wyoming found that all remaining greater sage-grouse leks were within 5 km (3.1 miles) of a road and that 95% of the Jonah gas field had road densities greater than 3.2 km per 2.59 km² (2 miles/mile²) (Thomson et al. 2005). Distinction should be made among primary roads (usually paved), secondary roads (mostly gravel), and trails (usually dirt, commonly expressed as 2-tracks). Primary roads are most negative for greater sage-grouse because of vehicle frequency, speed, and noise. Secondary roads can also be very negative depending again upon vehicle frequency, speed, and noise. Generally, trails are used seasonally and receive light vehicle use. Consequently, they are least problematic for sage-grouse.

Public land management agencies should have transportation plans for each forest, district, and resource area. Both permanent and seasonal road/trail closures are appropriate to reduce disturbance to sage-grouse during breeding activities and winter.

Most trails within occupied sage-grouse habitat should be closed during the breeding period and winter. Some secondary roads within 5 km of active leks should be closed during the 1 March-20 June period as well as during winter (December-February). All secondary roads and trails that traverse important sage-grouse areas should be reviewed and considered for permanent closure and revegetation.

Off-road vehicles (ORVs) should be prohibited except on designated trails and roads where sage-grouse use does not occur.

Management of Structures

Greater sage-grouse did not evolve with structures. Sage-grouse commonly collide with fences, and power lines have been demonstrated to be negative as they may result in collisions resulting in injury to or death of birds (Connelly et al. 2004). Structures can also provide perch locations for raptors, especially golden eagles (*Aquila chrysaetos*), which prey upon sage-grouse during all seasons of the year, and corvids that prey on nests. Prior to the advent of human-made structures, raptors and corvids in sagebrush steppe used elevated natural sites from which to hunt. The addition of power line poles, fences, hay equipment and stacks, and abandoned buildings have greatly expanded the number of suitable perches for raptors in a landscape that is mostly devoid of trees (Connelly et al. 2004). Historically, there were large expanses of suitable habitat for sage-grouse with few elevated perch sites.

Utility companies should be required to fit all potential perch sites (poles, towers) for golden eagles with devices to deter perching (including power poles associated with oil and gas development). All unused power poles (and towers) should be removed and consideration should be given to elimination (and removal) of unnecessary power lines that traverse sage-grouse habitats. Existing power lines should be placed in corridors that follow road systems, especially those that are paved, to minimize impacts on the landscape. First priority for fitting power poles with raptor guards and or for removal of power lines should be given to areas within 5.5 km (3.3 miles) of active leks (at least line of sight). Second priority should be given to known sage-grouse winter-use areas, especially along windswept ridges and near large expanses of sagebrush that are not typically covered by snow in winter. Raptor predation during summer and early fall is usually a local problem and more a product of habitat quality (i.e., sage-grouse are limited to few areas of suitable habitat) than at other times of the year.

Metal fence posts are preferable to wooden posts for fencing as the former better discourage raptors from using them as perches. Fencing within 2 km of active leks should be discouraged as sage-grouse are more likely to collide with them as they fly to and from leks, frequently at low levels and in low light. Fences designed to prevent domestic sheep from escaping pastures should be eliminated as walking sage-grouse frequently will follow and not readily fly over them. Fences in sage-grouse areas should be of no more than 3-strands of wire with both the top and bottom wires being barbless. All unnecessary fences should be removed (wire and posts). If fences known to result in sage-grouse mortality cannot be removed, the top wire should be marked with permanent visual flagging.

Management of Vegetation

Native sagebrush steppe vegetation should be given highest priority for management. Management should revolve around proper livestock grazing practices and not use of chemical or mechanical treatments. Grazing should be managed to ensure that sagebrush-dominated rangelands have the opportunity to recover from past management practices. The goal is to have healthy, self-sustaining native vegetation in which sagebrush comprises 10 to 25% of the vegetative canopy cover, grasses comprise 30-40%, and forbs comprise 15 to 20% of the ground cover. Holechek et al. (1999:15) indicate that livestock grazing, if the intent is to improve rangeland vegetative condition, should remove no more than 30-35% of the annual herbaceous growth. Some areas may require complete removal of livestock grazing for 3-5 years before grazing at lower stocking rates can resume. Improved management of grazing is the least expensive practice to restore degraded sagebrush steppe and should have the highest priority.

Chemicals such as 2,4-D and tebuthiuron have been widely used in attempts to eliminate or reduce sagebrush to increase livestock forage on public rangelands (Braun 1987, 1998). Use of 2,4-D has mostly been phased out for a variety of human health and environmental reasons (Braun 1998). Tebuthiuron is now favored for controlling sagebrush, especially to 'thin' sagebrush stands. Unfortunately, the effectiveness of this chemical is site dependent and is greatly affected by soil characteristics (Braun 1998) and continued livestock grazing. Application rates are critical and use of high rates or any chemical use on inappropriate soils can lead to total kill of sagebrush and forbs. For this reason, use of chemicals to 'thin' or control sagebrush is usually inappropriate for winter and breeding habitat.

Mechanical methods to manage sagebrush date to the 1930's and have involved brush beating, disking, chaining, and railing (Pechanic et al. 1954). These methods are relatively expensive and have mostly been used on small scales. They have the advantage of being able to be tailored to specific sites and will not 'escape' or 'drift' when compared to fire or use of chemicals. Of the available mechanical methods, use of brush beating is most appropriate as the desired results in terms of vegetation can reasonably be predicted. Brush beating or any other type of mechanical method to manage sagebrush should only be considered for 'better' range sites where vegetation response can be expected. These are normally areas where sagebrush canopy cover is >30%. Brush beating should be done in strips (usually 10-20 m in width) not to exceed one-quarter (25%) of the width of untreated strips. Strips should conform to the terrain and should not be straight lines but should be perpendicular to the prevailing wind. The design should result in a mosaic of sagebrush types with no more than 20-30% of the area being treated every 10-15 years (depending upon site). The goal is to set back sagebrush height (causing resprouting) and not death of all sagebrush plants. This can be accomplished by adjustment of the height of the mower blades. More recent advances such as the 'Dixie Harrow' and 'Lawson Aerator' may have merit but more scientific analysis of the results of using these devices is needed. Management of livestock grazing (reduction in or elimination of use for at least 2 years) is normally needed following brush beating or any mechanical treatment.

Use of fire to manage sagebrush steppe vegetation is usually inappropriate as it is difficult to control and frequently burns primarily winter and nesting habitats (Connelly et al. 2000*a*). Fire should generally be avoided or, at the least, restricted to small (<20 ha) sites where a lack of brood habitat has been documented to limit increases in sage-grouse populations.

Management of Water

Greater sage-grouse have been documented to use open water, especially during dry seasons. They readily eat snow in winter and forage during summer and fall on succulent vegetation in mesic sites. This vegetation may be adjacent to agricultural areas, riparian habitats, or where water is allowed to flow over land at springs and ponds. The need for so-called wildlife "guzzlers" is questionable, as studies have failed to demonstrate increases in sage-grouse density in areas with guzzlers (Connelly and Doughty 1989). Surface water flow in summer is important as it promotes growth of succulent forbs, which are attractive to greater sage-grouse. Pipes and tanks (for livestock) have no value for sage-grouse unless water is available at ground level or is allowed to spill onto the ground. There should be no emphasis placed on improving water distribution for livestock as this negatively affects sage-grouse habitats in most cases outside of ponds. All seeps and springs, and associated mesic sites should be fenced to exclude large grazing animals including domestic sheep, cattle, horses, and burros.

Livestock grazing has also impacted water tables by increasing sagebrush density and increasing soil erosion by reducing surface litter that slows runoff. Techniques useful to increasing water table levels include reduction of livestock grazing, sagebrush mowing, filling eroded drainages with (certified weed-free) straw bales, and creating check dams. These techniques are also useful in creating brood habitat for sage-grouse.

Where Should Management Focus Be Placed?

Areas with existing sage-grouse populations should have the highest priority for conservation. The best scenario for improved sage-grouse abundance and distribution is to conserve habitats with existing populations and then work outward from those core areas to improve habitats in more peripheral areas. GIS (Geographic Information Systems) derived maps of present vegetation and soil potential should be used with overlays of past and planned treatments to prevent too much area from being treated in a 10-15+ year period. The goal should be to increase sage-grouse abundance and distribution. Increases in abundance will be easier to achieve.

Areas contiguous to existing populations which do not presently have sage-grouse or which have very small populations (100-300 birds) should have second priority for management. Review of GIS maps of vegetation and soil potential will frequently identify factors that are depressing sage-grouse populations when compared to similar maps where sage-grouse still persist in some number. Treatments to improve abundance and distribution of populations will vary from area to area. Grazing practices and development are the most obvious factors depressing sage-grouse populations followed by fragmentation caused by vegetation treatments, including fire.

How Should Success Be Measured?

Changes in abundance of greater sage-grouse are best measured by monitoring the number of active leks in a discrete area (leks/10 km²) over a 3-5 year period. Total number of males counted in a given area over a 3-5 year period can also be used. Changes in estimated nest success and percent young based on wing surveys of hunter-harvested birds (where appropriate) may also provide useful data (Autenrieth et al. 1982, Connelly et al. 2003). Changes in the proportion of young to adult (and yearling) hens in the harvest can also be used to detect improvement in sage-grouse production.

Changes in distribution of greater sage-grouse can be derived from intensive searches for active leks in areas (based on GIS derived maps of potential habitat) where sage-grouse were not present in the previous 3-5 years. Random transects to assess seasonal changes in distribution of sage-grouse fecal pellets can also be used to assess changes in distribution. Even presence or absence line transect counts of either sage-grouse or their sign (pellets) can be useful. These surveys should be made at 3-5 year intervals.

Changes in vegetation such as % bare ground, % forb coverage, % grass coverage, % sagebrush cover, as well as height of residual herbaceous material can be used to assess changes in vegetative composition and quality of habitats. However, vegetation surveys are labor intensive, costly, and may be affected by weather conditions, rodents, insects, and grazing animals. It is highly unlikely that short-term changes can be detected without standardized plots, which are marked and uniformly evaluated. This is not likely to be done on a consistent basis over large areas of western North America. It will be difficult to measure success in vegetation improvement except over time in very localized sites.

Conclusions

Habitat conservation strategies to improve the abundance and distribution of greater sage-grouse have not been scientifically tested because of the reluctance of public land management agencies to invest in replicated management experiments over sufficiently large areas to be able to detect responses. However, sufficient information is available to make management recommendations given that negative responses of sage-grouse (decreases in abundance and distribution) are measurable. Habitat loss is certainly measurable as are fragmentation and degradation of habitats. The most notable changes in the sagebrush steppe since European settlement are associated with repetitive grazing by domestic livestock and developments (no matter how ‘development’ is defined). It is logical to expect improvement in sage-grouse abundance, at the least, with changes in policies, regulations, and practices involving grazing of domestic livestock and development. Both of these factors are managed by the key public land management agencies (BLM and USFS) that together control in excess of 60% of the remaining sagebrush steppe occupied by greater sage-grouse. Improvement in distribution will be more difficult as restoration of useful sagebrush habitats in areas that have been burned or plowed and seeded to exotic grasses will be exceedingly slow.

Management practices that significantly reduce wild fire, reduce grazing intensity and forage utilization, and reduce or eliminate the spread of introduced annuals have the

best chance to positively impact abundance of greater sage-grouse. They will be the least expensive to implement. Development practices such as gas and oil exploration and production including surface infrastructure, which are obviously negatively affecting sage-grouse abundance and distribution, will be more expensive to change, but collectively changes in these practices could equal the gains expected to result from changes in livestock grazing practices.

Sufficient knowledge is available to begin implementing recommended practices that will positively affect greater sage-grouse. The key is to develop public support and the resolve within federal agencies to make the necessary changes.

Recommendations

-First priority for habitat management should be areas where larger sage-grouse populations are still present. Management practices chosen should maintain the present abundance and distribution of sage-grouse.
-The second priority for habitat management is for areas where sage-grouse populations are small (<300 birds or 100 males counted on a 3-year moving average). Management practices should enhance sage-grouse abundance and distribution.
-A third priority should be to improve habitats in areas adjacent to existing populations.
-Sagebrush steppe management should focus on maintaining large (>1 cadastral section and preferably >20 cadastral sections in size) blocks of sagebrush habitat per Township (36 cadastral sections).
-No surface occupancy should be allowed within 5.5 km of all active sage-grouse leks.
-No roads should be constructed within 5.5 km of active sage-grouse leks.
-Existing roads within 5.5 km of active sage-grouse leks should have seasonal closures (1 March-20 June).
-Prescribed fires should be no larger than 20 ha with no more that 40% of each cadastral section being burned over a 15-year period.
-Wild fires in sagebrush steppe should be vigorously suppressed except in areas with >20 invasive conifer trees per ha.
-Livestock grazing should be deferred for 3 years following fires for recovery of herbaceous native vegetation.
-Livestock grazing should not remove more than 25-30% of the annual growth of herbaceous vegetation with grazing delayed until after 20 June. True rest rotation systems should be used and winter grazing is preferred.
-Where wildlife (deer and elk) herd objectives cannot be achieved through legal hunting, reintroduction and expansion of populations of large predators should be encouraged.
-Rangeland seedings of exotic grasses should be converted using reseeded strips of native bunchgrasses, adapted subspecies or species of sagebrush, and dryland alfalfa.

-Power lines should be placed only into existing road/utility corridors.
-Power poles and other existing human structures should either be removed, if not used, or fitted with raptor-deterrence devices.
-Fences in sage-grouse use areas should be no more than 3 strands with the top and bottom wires being barbless. Unused fences should be removed.
-Use of chemicals to 'manage' sagebrush should not be permitted. If sagebrush is to be managed to reduce density or to enhance vigor, mechanical methods are preferred.
-Sage-grouse have not been shown to need open water. However, water should be allowed to flow (seep) over the ground to encourage growth of succulent forbs.
-Active leks per unit of area and total number of male sage-grouse counted at proscribed (4 counts per breeding period spaced at 7-10 day intervals) should be used as the measure of success of management treatments followed by changes in % bare ground, % forb coverage, % grass cover, % sagebrush canopy cover, and height of residual herbaceous vegetation.
-Sage-grouse pellet transects should be used to measure expansion of birds into vacant or former habitat.

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Clait E. Braun has worked with sage-grouse as a researcher (1973-99) and consultant (2000-06), and has been a leader in publishing research and management articles on sage-grouse. Dr. Braun is a Certified Wildlife Biologist and has either worked in or extensively visited all states and provinces with current populations of sage-grouse. He retired from the Colorado Division of Wildlife where he was responsible for sage-grouse research from 1973 into 1999 and now operates Grouse Inc. providing professional guidance and reviews on sage-grouse and their habitats. This 'Blueprint' represents his professional experience and selected literature based on 30+ years of work with sage-grouse.

Appendix

Seasonal Habitat Requirements for Sage-grouse:

Spring, Summer, Fall, and Winter[1]

(Citation: Braun, C. E., J. W. Connelly, and M. A. Schroeder. 2005. Pages 38-42 *in* N. L. Shaw, M. Pellant, and S. B. Monsen, compilers. Sage-grouse habitat restoration symposium proceedings, 4-7 June 2001, Boise, Idaho, USA. U. S. Department of Agriculture, Forest Service, RMRS-P-38.)

[1]The contents of this 'Blueprint' document have not been reviewed or approved by either of the 2 coauthors of the published paper referenced in the Appendix.

Seasonal Habitat Requirements for Sage-Grouse: Spring, Summer, Fall, and Winter

Clait E. Braun
John W. Connelly
Michael A. Schroeder

Abstract—Sage-grouse (*Centrocercus minimus, C. urophasianus*) are dependent upon live sagebrush (*Artemisia* spp.) for all life processes across their entire range. This paper describes habitats used by sage-grouse as documented in the scientific literature. The leaves of sagebrush are eaten by sage-grouse throughout the entire year and comprise 99 percent of their winter diets. Spring (late March through May) habitats are those with intermixed areas of taller (40 to 80 cm) sagebrush with canopy cover of 15 to 25 percent and taller (>18 cm) grass/forb cover of at least 15 percent. Sites used for display have shorter vegetation, frequently few or only short sagebrush plants, but with taller, more robust sagebrush within 100 to 200 m that is used for escape cover. Nesting cover mimics that used overall during spring but with clumps of tall (>50 cm), dense (about 25 percent) live sagebrush and abundant forbs (>10 to 12 percent cover). Early brood rearing areas are those within 200 m (initial 3 to 7 days posthatch) to 1 km (up to 3 to 4 weeks posthatch) of nest sites. Forbs and taller (>18 cm) grasses are important for broods; forbs provide succulent foods, grasses provide hiding cover, and the grass/forb mixture supports insects used by chicks. Summer use areas are those with abundant succulent forbs with live, taller (>40 cm), and robust (10 to 25 percent canopy cover) sagebrush useful for cover. These areas continue to be used into fall when sage-grouse move to higher benches/ridges where they forage on remaining succulent forbs such as buckwheat (*Eriogonum* spp.) and switch to more use of sagebrush leaves. Winter (early December to mid-March) use areas are often on windswept ridges, and south to southwest aspect slopes as well as draws with tall, robust live sagebrush. Height (25 to 35 cm) of sagebrush above the surface of the snow in areas used in winter is important, as is canopy cover (10 to 30 percent). Management of habitats used by sage-grouse should initially focus on maintaining all present use areas. Practices to enhance sagebrush habitats to benefit sage-grouse are reviewed, as is the need to annually monitor sage-grouse numbers along with systematic monitoring of the health of sagebrush ecosystems.

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Introduction

Sage-grouse (*Centrocercus minimus, C. urophasianus*) historically occurred in at least 16 States and three Canadian Provinces (Aldrich 1963; American Ornithologists' Union 1957; Johnsgard 1973). They have been extirpated in five States and one Canadian Province (Braun 1998; Connelly and Braun 1997) and their overall distribution has become discontinuous (fig. 1). The changes in sage-grouse distribution have been attributed to loss, fragmentation, and degradation of habitats (Braun 1995, 1998; Connelly and Braun 1997), and it is probable that at least one-half of the original occupied area can no longer support sage-grouse (Braun 1998). Because of the reduced amount of available habitat, sage-grouse abundance has also markedly decreased with reported declines of 10 to 51 percent (Connelly and Braun 1997) and as much as 45 to 82 percent since 1980 (Braun 1998). The known decreases in distribution and abundance have led to concern about stability of sage-grouse populations and the health of sagebrush ecosystems upon which they depend. Petitions to list sage-grouse under the Federal Endangered Species Act have been filed for northern sage-grouse (*C. urophasianus*) and for Gunnison sage-grouse (*C. minimus*).

Sage-grouse are dependent upon ecosystems with vast and relatively continuous expanses of live, robust, taller sagebrushes (*Artemisia* spp.) with a strong grass and forb component. This dependency upon sagebrush, especially the subspecies of big sagebrush (*A. tridentata vaseyana, A. t. wyomingensis, A. t. tridentata*), low sagebrush (*A. arbuscula*), black sagebrush (A. *nova*), silver sagebrush (*A. cana*), and three-tip sagebrush (*A. tripartita*), as well as a variety of less apparent and abundant species, has been well documented (Patterson 1952; reviews by Braun and others 1977 and Connelly and others 2000a). Since the early 1960s, the sage-grouse/sagebrush relationship has focused attention by Western States and Provinces on the need to maintain healthy sagebrush-steppe communities over large expanses. Guidelines for maintenance of sage-grouse habitats were developed from the scientific literature (Braun and others 1977, completely revised by Connelly and others 2000a) and promoted by the Western States Sage-Grouse Technical Committee. The purpose of this paper is to present an overview of the habitat needs of sage-grouse based on the scientific literature, identify the issues that affect maintainance of useful habitats for sage-grouse, and discuss management strategies to maintain, enhance, and restore habitats

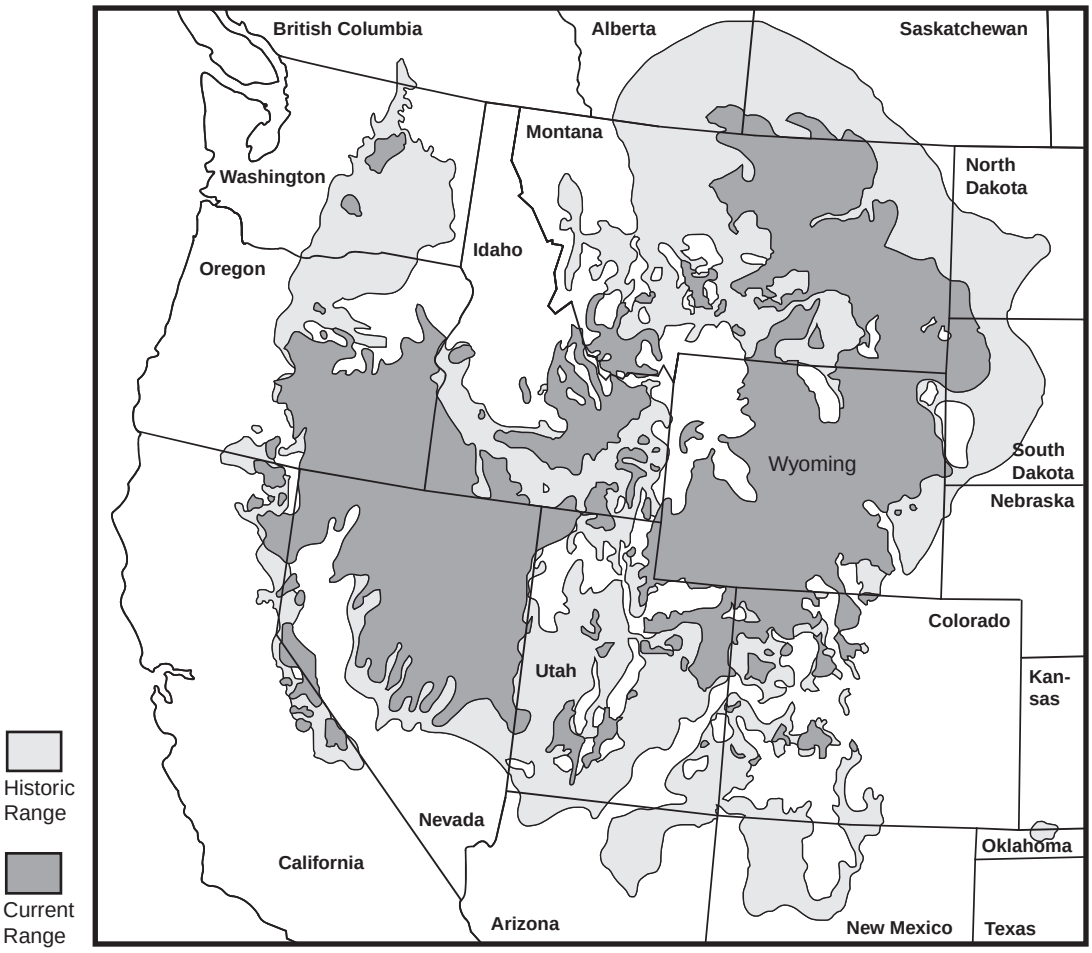

Figure 1—Historic and current distribution of sage-grouse (map prepared by M. A. Schroeder).

for sage-grouse. This paper draws extensively on the published *Guidelines to Manage Sage Grouse Populations and Their Habitats* (Connelly and others 2000a).

Habitat Overview

Spring

Timing of spring breeding activities of sage-grouse is dependent on elevation and amount of persistent snow cover. Attendance at leks may start in early to mid-March or, at higher elevations, in early April. Males may attend and display at leks until late May but most display and mating activities are greatly reduced by mid-May. Amount and depth of snow cover greatly influence sage-grouse breeding activities; thus, snow-free areas are important components of spring habitat. Habitats used by sage-grouse during the breeding period are those associated with foraging, leks, escape, and nesting. Depending upon moisture regimes, height of sagebrush in used habitats varies from 30 to 80 cm with canopy cover from 15 to 25 percent (Connelly and others 2000a). Lek sites typically have low amounts of sagebrush and appear relatively bare, but they may have extensive cover of low grasses and forbs. Taller, robust live sagebrush used as escape cover is normally within 100 to 200 m of active leks. The average distance from a nest to the nearest lek varies from 1.1 to 6.2 km, and the actual size of the breeding habitat appears largely dependent on the migratory characteristics of the sage-grouse population as well as distribution of sagebrush cover with respect to lek location (Connelly and others 2000a). Habitats selected for nesting are those with abundant (15 to 30 percent canopy cover) live, taller (30 to 80 cm) sagebrush plants within a community with >15 percent ground cover of taller (40 to 80 cm) grasses and forbs (Connelly and others 2000a). Early brood-rearing habitats (fig. 2) are normally those within 100 m to 1 km of nesting sites, especially areas with high plant species richness, moisture, and taller grasses and forbs (Connelly and others 2000a). Adult sage-grouse, while still foraging extensively on leaves of live sagebrush, eat leaves and flower parts of forbs during spring, as do chicks (Apa 1998; Drut and others 1994; Dunn and Braun 1986; Klott and Lindzey 1990).

Summer

Habitats used by sage-grouse in summer (early to mid-June to mid to late September) are those that provide

Figure 2—Sage-grouse brood hen in good quality Wyoming big sagebrush habitat, North Park, Colorado (photograph by C. E. Braun).

adequate forage, especially succulent forbs, and cover useful for escape. These habitats may include those used for agriculture, especially for native and cultivated hay production, edges of bean and potato fields, as well as more typical sagebrush uplands and moist drainages. Taller (>40 cm) and robust (10 to 25 percent canopy cover) sagebrush is needed for loafing and escape cover as well as a source of food. Grass and forb ground cover can exceed 60 percent (hayfields). Provided moisture is available through water catchments or from succulent foliage, sage-grouse may be widely dispersed over a variety of habitats during this period (Connelly and others 2000a). As late summer approaches, there is movement from lower sites to benches and ridges (fig. 3) where sage-grouse forage extensively on leaves of sagebrush.

Fall

Fall (late September into early December) is a time of change for sage-grouse from being in groups of hens with chicks or males and unsuccessful brood hens to separation into larger flocks frequently segregated by gender. Some birds may continue to use lower riparian or hayfield habitats, but there is movement onto higher, frequently north-aspect slopes where succulent native forbs, such as buckwheats, provide green forage. Use of sagebrush leaves for food becomes more common as does use of extensive stands (>20 percent canopy cover) of taller (>25 cm), live sagebrush (Connelly and others 2000a). Movements can be slow but there is a general shift toward traditional winter use areas (Connelly and others 1988).

Winter

Flocks of sage-grouse are somewhat nomadic in early winter but may remain within chosen areas for periods of several weeks or more depending upon extent of snow cover and depth (Beck 1977; Hupp and Braun 1989b). Sagebrush height (>20 cm, but usually >30 cm, above the surface of the snow) is important as is the robust (>10 to 30 percent canopy cover) structure of live sagebrush (Connelly and others 2000a). Sage-grouse use a variety of sites in winter including windswept ridges with open (10 to 20 percent canopy cover) (fig. 4) stands of sagebrush to draws with dense (>25 percent canopy cover) stands. Quality of the snow can be important because sage-grouse are known to use snow roosts and burrows (Back and others 1987). Aspect is also important with south and southwest slopes most used in hilly terrain (Hupp and Braun 1989b). Leaves of live, vigorous sagebrush plants provide >99 percent of the foods eaten during the winter period (early December until early to mid-March) (Patterson 1952; Remington and Braun 1985; Wallestad and others 1975). Generally, winter is a time of body mass gain (Beck and Braun 1978), although severe winter conditions over prolonged intervals can reduce the amount of area available for foraging and cover (Beck 1977) and thus affect body condition (Hupp and Braun 1989a). Overall movement during winter may be extensive and home ranges can be large (Connelly and others 2000a). As winter wanes, flocks of sage-grouse move toward breeding areas that may be immediately adjacent to or far distant from winter use areas (Connelly and others 2000a).

Figure 3—Radio-tracking sage-grouse in high-elevation summer range with a stand of mountain big sagebrush in the background (photograph by J. W. Connelly).

Figure 4—Sage-grouse winter range in Wyoming big sagebrush habitat in North Park, Colorado (photograph by C. E. Braun).

Issues

Decreases in distribution and abundance of sage-grouse have been ascribed to a complexity of factors (Braun 1987, 1998; Connelly and Braun 1997). The three major causes, (1) habitat loss (mostly permanent), (2) fragmentation (frequently permanent but reversible at times), and (3) degradation (usually can be corrected), are generally accepted but the latter two are poorly recognized and understood. Examples of permanent habitat loss include conversion of sagebrush rangelands to agricultural crops, town and subdivision developments, placement of power plants or surface mines, and reservoir construction. Fragmentation of habitats occurs with power lines, paved and other high-speed road development (including maintenance and improvement of farm roads), habitat-type conversion projects, fire, or any permanent development that reduces the size of existing habitat patches. Less understood are the impacts of fences, seasonal use trails, oil and gas wells with surface pipelines, noise, and so on. Some of these impacts can be resolved and sage-grouse will reoccupy some formerly disturbed areas (Braun 1987).

Distribution of habitat types useful to sage-grouse is also important, as these species are habitat specialists using a variety of areas within a larger landscape mosaic. Thus, not only is the quantity of sagebrush habitats important, but also the juxtaposition and quality of those habitats. All sagebrush habitats are not equal in their acceptability to sage-grouse, and location of areas used may affect sage-grouse distribution. Size of habitat patches is important and larger (>30 km^2) is better than smaller, although the spatial relationships of habitats for sage-grouse are not well understood. Sage-grouse use a mosaic of habitats that is normally present in sagebrush-steppe because of differences in soils, moisture, topography, aspect, insect defoliation, wildfires, and other factors. Sagebrush naturally regenerates as overmature plants die and seedlings become established. Use of the term "decadent" for sagebrush is generally inappropriate because it implies that sagebrush communities are not dynamic with a variety of age classes from seedlings to overmature. Since most sagebrush communities are resilient and represent a continuum of age classes within a mosaic of habitats, creation of "edge" to benefit sage-grouse is rarely needed. Because of human activities, the presence of too much edge (especially in straight lines) is more common than too little edge and results in degradation of sage-grouse habitats.

Sagebrush ecosystems have been managed through a variety of treatments from domestic livestock grazing, mechanical and chemical clearing or thinning, to use of prescribed fire (Braun 1998). Fire was a natural event in more mesic sagebrush communities but was infrequent as demonstrated by the lack of resprouting of big sagebrush, black sagebrush, and low sagebrush. Fire was more common in areas with three-tip sagebrush and silver sagebrush because both species resprout. Recent research suggests there is little gain in forage production of grasses and forbs after fire, because it can take longer than 30 years to return to preburn conditions (Wambolt and others 2001).

Treatments of sagebrush communities have primarily been conducted to benefit another treatment (livestock grazing). Use of some treatments has led to plantings of exotic grasses, invasion of areas by exotic plants, conifer invasion of sagebrush habitats, and increased fire frequency. Many, if not most, of these treatments have been applied to improve rangelands for domestic livestock but have had negative impacts on sagebrush communities and animals dependent on them (Braun and others 1976). Further, successive treatments have been applied to landscapes with little understanding of the cumulative effects that may impact both sagebrush-dependent animals, such as sage-grouse, and the overall health of the plant community. The impacts of natural events such as periodic drought are further exacerbated by human treatments of sagebrush communities. All of these issues emphasize the need for active protection of habitats presently used by sage-grouse as well as restoration of habitats that formerly supported sage-grouse populations.

Sage-Grouse Habitat Management Strategies

The objectives of habitat management to benefit sage-grouse, in order of importance, should be (1) to protect and maintain existing occupied habitats, (2) enhance existing occupied habitats, (3) restore degraded habitats that still receive some sage-grouse use, and (4) rehabilitate significantly altered habitats that no longer support sage-grouse. Strategies to accomplish these objectives should include:

- Vigorous suppression of wildfire.
- Reconsideration of any use of prescribed fire.
- Proper livestock management (including reconsideration of time of grazing, stocking rates, season of use, and frequency of use).
- Use of nitrogen fertilizer, except in areas infested by annual weeds.
- Mechanical chopping of sagebrush.
- Fence type and placement.
- Water management.
- Rehabilitation and restoration techniques discussed in these proceedings.

At times, manipulation of some occupied sage-grouse habitat may be necessary to enhance the overall quality of a seasonal range. An example would be removing or reducing some sagebrush canopy cover in known breeding habitat to enhance a depleted understory. Removal of 57 percent of sagebrush cover resulted in a significant decline in a sage-grouse breeding population (Connelly and others 2000b) and degradation of early brood-rearing habitat (Fischer and others 1996). More recently, a wildfire that removed about 30 percent of the sagebrush cover in a breeding habitat resulted in a 60 percent decline in sage-grouse nest success (Connelly, unpublished data, 1998). Because of this information and the fact that wildfires, drought, and insect infestations cannot be predicted, any sagebrush removal efforts should affect a relatively small portion of the occupied habitat. Connelly and others (2000a) suggested that >80 percent of breeding and winter habitat with vegetative characteristics necessary for productive sage-grouse habitat should remain intact to adequately provide for the needs of sage-grouse. However, an even greater percentage should be protected if sage-grouse populations are declining or the population status is unknown. All proposed habitat

manipulations should carefully consider the current condition of habitat, status of the sage-grouse population, and likely outcome of the vegetation treatment, including recovery time necessary for the area to again provide adequate habitat for sage-grouse nesting and early brood rearing.

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