Sage-Grouse Habitat Management Guidelines for Wyoming

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ABSTRACT: This set of guidelines provides recommendations to land mangers to maintain and enhance sagebrush habitats used by sage-grouse in Wyoming. It recognizes that sagebrush habitats are part of a dynamic ecosystem that has been altered by natural and human-caused perturbations, and the maintenance of those plant communities is dependent, to varying degrees, on the continuation of those natural disturbance regimes. The sage-grouse, as a sagebrush obligate, is a landscape species requiring broad expanses of diverse habitats associated with sagebrush steppe communities. This paper attempts to apply the sage-grouse habitat management guidelines in Connelly et al. (2000*a*) to Wyoming using data collected from research conducted in Wyoming where possible. These guidelines are tiered to management recommendations in *Wyoming Guidelines for Managing Sagebrush Communities with an Emphasis on Fire* (Wyoming Interagency Vegetation Committee 2002). The guidelines are intended to assist land managers developing habitat management objectives and projects in occupied sage-grouse habitat. Given the declines in sage-grouse populations in Wyoming over the last 30 years, it is necessary and prudent to manage these sagebrush habitats to maintain and enhance existing populations of sage-grouse (Connelly et al. 2004) using the best science available to achieve the desired results.

INTRODUCTION

This document provides guidelines to land managers interested in management of sagebrush (*Artemisia* spp.) communities used by greater sage-grouse (*Centrocercus urophasianus*) in Wyoming. The goal of these guidelines is to provide information and recommendations for land managers to consider when planning and implementing rangeland management and improvement projects to ensure that sage-grouse habitat needs are adequately addressed. These guidelines attempt to address the recommendations of the Wyoming Greater Sage-grouse Conservation Plan (Wyoming Game and Fish Commission 2003) and adapt the Guidelines to Manage Sage-grouse Populations and Their Habitats by Connelly et al. (2000*a*) for use in Wyoming. This document also tiers its guidelines to the Wyoming Guidelines for Management of Sagebrush Communities with an Emphasis on Fire Management (Wyoming Interagency Vegetation Committee 2002). We recommend these guidelines be implemented to maintain and enhance sage-grouse populations in areas where sage-grouse habitat is a priority. These guidelines may be subject to interpretation and modification in their application as the local situation and land and wildlife management goals dictate. Habitat monitoring techniques discussed in this document should follow the recommendations found in Monitoring of Greater Sage-grouse Populations and Habitat by Connelly et al. (2003). The reader is further directed to consider the body of work reported in Restoring Western Ranges and Wildlands (Monsen et al. 2004) as an excellent resource when addressing management of sagebrush habitats, among other vegetation types, found on western rangelands.

The art and science of managing sagebrush and sage-grouse habitats is an evolving process. This effort to develop sage-grouse habitat management guidelines is anticipated to be a living document. This document will be updated periodically with new information and technology that results from ongoing and new research, monitoring of habitat projects, and advances in technology of sagebrush habitat restoration and management. As an example, there is an effort underway to develop recommended grazing practices for sage-grouse habitats in the Wyoming Basins and Southern Rockies Ecoregions. This effort is sponsored by the Wyoming Game and Fish Department (representing the Western Association of Fish and Wildlife Agencies), the Bureau of Land Management, and the Wyoming Department of Agriculture. When completed, this set of recommended grazing practices will be added to this document.

There is widespread interest in actively managing sagebrush stands to meet various resource objectives, including sage-grouse habitat. Dense sagebrush stands can affect the water table in a drainage and reduce the flow of water from springs and streams in the sagebrush steppe communities, affecting hydrologic functions and populations of trout and other aquatic species (Wyoming Interagency Vegetation Committee 2002). From a livestock perspective, many of the sagebrush communities that provide adequate sage-grouse habitat (mid- to late-seral stands) may be less than optimal for livestock forage production. The question for land managers and biologists is how to manage sagebrush communities for other resource values while maintaining adequate habitat over time for sagebrush obligates such as sage-grouse and other sagebrush dependent species such as mule deer, pronghorn, and sage sparrows, both at the project and landscape level.

Big sagebrush dominated landscapes are a climax or late seral component of the intermountain steppe environments of Wyoming. Likewise, big sagebrush can be a mid- to late-seral component of at least some of the fringe mixed-grass prairie of the Northern Great Plains Steppe Ecoregion in eastern Wyoming. Natural disturbances or habitat factors less conducive to the establishment of big sagebrush may limit or keep it naturally fragmented on the prairie fringes. Generally, the grass and forb components increase or dominate following some disturbance. These early seral stages may dominate for long periods in the near prairie-suited environments, moderate periods in xeric steppe environments, and relatively short periods of time in mesic steppe or mountain-foothill environments. Herbivory affects these interactions as well (Winward 1991, Miller et al. 1994).

Fire has played a role in shaping the sagebrush communities in Wyoming since the last ice age. There are competing theories on how often fire historically burned these ecosystems (Winward 1991, Welch and Criddle 2003). Sage-grouse have evolved with fire that has impacted sagebrush stands with variable return intervals, depending on moisture regimes, topography, soils, and plant communities (Bunting et al. 1987). The natural disturbance elements are varied in these environments. Fires are inevitable wherever sufficient fuels accumulate. Ignitions and conditions suitable for ignition may or may not be limiting factors. Pre-settlement fires may have occurred every 100 to 200 years in low sagebrush community types (Young and Evans 1981, Miller and Rose 1999) and 50 to 100 years in more arid sagebrush types (Wright and Bailey 1982). However, in more mesic sagebrush types characterized by mountain big sagebrush, fire return intervals have been reported to occur between 12 and 25 years (Houston 1973, Burkhardt and Tisdale 1976, Miller and Rose 1999).

However, wildfires are believed by some scientists to have been a relatively uncommon event in xeric sagebrush environments, including many Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis*) communities (Connelly et al. 2000*a*). Baker (2006) provides an analysis of fire frequency in sagebrush communities, which suggests fire rotation may be much longer than previously reported. He indicates that fire rotation in low sagebrush (*A. arbuscula*) may be a minimum of 325-450 years, 100-240 years in Wyoming big sagebrush and 70-200 years or more in mountain big sagebrush (*A. tridentata* ssp. *vaseyana*). Some of these plant communities can maintain themselves over time in the absence of disturbances such as fire (Lommasson 1948, Welch and Criddle 2003). Most sagebrush species have features that are poorly adapted to fire. Exposure to fire generally results in the death of the plants and these shrubs have poor seed dispersing mechanisms, which limits reestablishment of seedlings following large fires (Welch and Criddle 2003). Silver sagebrush (*A. cana*), one of several exceptions, readily resprouts from the roots when the crown is killed by fire and apparently evolved in areas where frequent fires shaped ecological processes (Adams et al. 2004).

Miller and Eddleman (2001) provide a perspective on pre-settlement plant community structure in the sagebrush biome where variable disturbance and recovery rates in various sagebrush cover types produce a mosaic of multiple seral stages across the landscape. In addition, fire patterns were patchy, leaving unburned islands, particularly in Wyoming big sagebrush because of limited and discontinuous fuels. As a result, plant composition ranges from dominant stands of sagebrush to grasslands. The authors offer evidence to suggest that a large portion of the sagebrush steppe ecosystem was composed of open stands of shrubs with a developed understory of long-lived perennial grasses and forbs. The composition of sagebrush communities is a function of the amount and season of precipitation and soil characteristics that influence availability and distribution of soil water (Conquist et al. 1972). Current sagebrush habitats are the result of modified disturbance regimes and climate changes through time (Miller and Eddleman 2001).

Sage-grouse depend on sagebrush communities for their entire life cycle (Patterson 1952). The species cannot exist in an area over time without sagebrush. Current research suggests that landscape-scale fires are detrimental to sage-grouse populations in the short term (Fischer et al. 1996*a*, Connelly et al. 2000*a*, Nelle et al. 2000). Large, hot fires remove most of the valuable sagebrush habitat used by sage-grouse as nesting, early brood-rearing, and possibly winter habitat (relatively dense sagebrush with at least 12% canopy cover and a nominal herbaceous understory component). The residual shrub vegetation remaining after a fire is often in areas that would not burn because of the lack of fuels. These areas are often not the most valuable sagebrush habitats from a sage-grouse perspective because of the low density of sagebrush and/or the short shrub height typical of these xeric sites (Connelly et al. 2000*b*).

Historically, natural fires occurred most often on a small scale in Wyoming big sagebrush. Occasional large fires occurred when weather conditions and fuel loads were optimal. The small fires created a mosaic of open areas interspersed with mature sagebrush stands of varying density and canopy cover, which can provide productive nesting and early brood-rearing habitats in close juxtaposition. On the drier sites, these fires probably occurred at a much smaller scale and more infrequently because of the lack of adequate fuels to carry the fire in most years. In this scenario, numerous small wildfires created a fine-grained mosaic of patches of vegetation in early to mid-seral stages interspersed within a landscape of late seral stages in the xeric Wyoming big sagebrush communities. The mosaic created by small fires likely had some influence on fuel loading and may have precluded some larger fires. In areas where the dominant, pre-burn vegetation was mature sagebrush, the mosaic likely produced good sage-grouse habitat (Dorn 1986, Miller and Eddleman 2001). However, Baker (2006) counters this idea and suggests that pre-Euro American fires in sagebrush landscapes may have left less unburned area in a mosaic than is likely with prescribed fires today due to higher fine fuels loads, greater fuel continuity, and drier burning conditions.

Large-scale fires resulting from natural ignitions occurred at a much less frequent interval in the more xeric Wyoming big sagebrush communities. These large, landscape-altering fires converted extensive areas of sagebrush stands into a landscape dominated by grasses and forbs with small patches of residual sagebrush and sparse sagebrush cover on drier sites that did not burn. The result was marginal or unsuitable habitat for sage-grouse over extensive areas, depending on the amount of sagebrush removed and the pattern of the burns. In these situations, natural fires may have reduced or temporarily eliminated local sage-grouse populations due to the extent of loss of suitable nesting and early brood-rearing habitat and/or winter habitat. Recovery of the shrub canopy after these large fires may have taken many years due to the loss of seed sources where virtually all the sagebrush was removed over large areas (Bunting et al. 1987, Miller and Eddleman 2001, Welch and Criddle 2003, Baker 2006).

Historically, landscape-scale fires were likely more routine in mountain big sagebrush steppe environments and in more mesic Wyoming big sagebrush communities at higher elevations or on the fringe of the prairie. Patch sizes of these burned areas were probably larger and the residual patches of sagebrush smaller, resulting in a coarse-grained mosaic of burned and unburned patches (Miller and Eddleman 2001). In these situations, large burned patches with early seral plant communities and small residual mature sagebrush stands dominated the landscape and likely provided marginal nesting and early brood-rearing habitat but still provided late brood-rearing habitat. Sage-grouse were probably able to persist in this environment at a reduced population level in the short term. Sagebrush recovery to relatively dense stands on these mesic sites occurs at a much shorter interval than on the drier sites, and presumably sage-grouse populations responded accordingly. In areas with limited and/or naturally fragmented patches of suitable sage-grouse habitats, the loss of adequate nesting habitat and possibly winter habitat could have resulted in bottlenecks in the annual life cycle that may have resulted in the extirpation of these small, local populations.

Current research on sage-grouse suggests that hens have a high fidelity to nesting territories (Fischer et al. 1993, Holloran 2005). Apparently, sage-grouse hens do not move to suitable habitat and resume a productive life cycle following a fire or other perturbation resulting in the loss or removal of extensive areas of sagebrush. Often these hens do not attempt to nest, or they may select marginal nesting habitat within these fire-modified habitats and are subject to higher mortality rates and lower nest success than hens using unburned habitat (Fischer 1994).

Bennett (1991:61-73) provides a case history of the impacts of sagebrush control on a sage-grouse lek complex south of Lander, Wyoming on the Beaver Rim. The Granite Mountain Spray Project treated acreage around the Longs Creek lek complex with the herbicide 2-4-D in 1960 and 1961 with a reported 95% kill rate. Based on lek counts, grouse numbers declined to zero four years following treatment (1965), but the numbers of males on leks recovered to pretreatment levels nine years later (1969). Lek counts increased on the Hudson lek complex concurrent with the decline of the Longs Creek complex, but returned to near average levels as the sagebrush adjacent to Long Creek complex recovered. The author attributes the recovery of the grouse population to sagebrush reversion in the treated areas providing adequate breeding habitat in a relatively short period of time and the proximity of adequate habitat adjacent to the project area, allowing the birds to shift to alternative seasonal ranges to find suitable nesting and brood-rearing habitat. Subsequent research with radio-marked birds by Kuipers (2004) indicates the grouse in this area are a migratory population with considerable interchange of birds on seasonal ranges.

Bennett (1992:40) summarizes the history and impacts of sagebrush treatments in Wyoming. He reports that 2,667,138 acres of sagebrush were chemically treated in Wyoming from 1952 to 1991. This acreage is about 7% of the 37 million acres where all species of sagebrush are the dominant cover plant (Beetle and Johnson 1982) and 13% of the more than 20 million acres where big sagebrush is the dominant species. By his calculation, much of the treated acreage (73%) has reverted to sagebrush cover in various stages of succession. More recently, shrub management has shifted to the use of prescribed fires to treat sagebrush to produce more herbaceous vegetation for a variety of reasons, such as reducing fire hazards or to restore natural ecological function. Based on 1991 data, about 25,300 acres of sagebrush were planned for treatment on BLM lands: 6,900 acres (27%) by chemical treatment, 15,300 acres (60%) by prescribed fires, 2,400 acres (9%) by mechanical treatment, and 700 acres (4%) by other means (USDI-BLM 1991 *in* Bennett, 1992). From 1985 through July 2002, an average of 10,819 acres of non-forested areas were treated annually with prescribed fires (184,000 acres total) compared to about 330,000 acres burned by wildfires in the same vegetation types over the same time period. Much of this acreage was sagebrush or mixed shrub plant communities (USDI-BLM 2002).

Human-caused events and human interference in natural events through fire suppression have altered sagebrush ecosystems. As a result of 100 years of fire suppression, wildfires in recent years have had uncharacteristic behavior. These landscape-altering fires have resulted in the loss of sagebrush habitats on a local basis. On a more widespread basis in Wyoming, sagebrush habitats have been altered, fragmented, or lost through prescribed fire, mechanical or herbicide treatments, livestock grazing, conversion to farmland and non-native grass pastures, and other human developments such as oil and gas development, mining, and subdivisions. These impacts are further compounded by infrastructure development such as roads, pipelines, electric transmission lines, support facilities, water impoundments, and fences related to these activities. Cumulatively, these developments have substantially altered landscapes in the West, including Wyoming (Bennett 1992, Knick et al. 2003, Naugle et al. 2006*a*, Naugle et al. 2006*b*).

Existing habitat conditions have been affected by livestock grazing regimes, which are far different than those of wild herbivores that evolved with the sagebrush grasslands in occupied sage-grouse range. Crawford et al. (1992) states that domestic grazing is the most common and widespread use of rangelands and has the greatest potential to impact sagebrush habitats because it is the principle land management practice that affects herbaceous composition, cover, and height. Proper livestock grazing management can maintain healthy rangeland conditions and provides functional habitat for sage-grouse (Crawford et al. 2004). However, poor livestock grazing practices can have long-term, negative impacts on sage-grouse habitat by degrading sagebrush, meadow, and riparian communities (Miller and Eddleman 2001). Generally, as utilization of the herbaceous understory increases, sagebrush cover increases in the overstory (Laycock 1967). Historic grazing practices have resulted in reduced herbaceous understory over relatively large areas and increased sagebrush density in some areas in the Intermountain West (Vale 1975, Tisdale and Hironaka 1981). Bennett (1992) indicates historic drought conditions in Wyoming often did not result in reduced numbers of livestock on rangelands and overgrazing was most likely to occur when livestock numbers were maintained on deteriorating ranges during drought. In some situations where sagebrush cover has become very dense, vegetation trends have not been reversed in spite of changes in grazing management, including complete rest from grazing (Wambolt and Payne 1986). Beck and Mitchell (2000) indicate excessive livestock grazing has adversely impacted sage-grouse by creating seral conditions that favor annual grass dominance and by reducing perennial grasses used as nesting and escape cover for broods. In a synthesis paper, Crawford et al. (2004) provide a critique of available scientific literature examining impacts of livestock grazing on sage-grouse habitat and provide examples of grazing practices that have been reported to enhance sage-grouse habitat.

In a few areas in Wyoming, large wildfires have resulted in habitat loss or fragmentation. However, this situation is most common in the Great Basin where cheatgrass (*Bromus tectorum*) infestations have caused a significant change in fire regimes and have resulted in the conversion of sagebrush steppe to annual grass/forb plant communities with a very short fire return interval (Whisenant 1990). Conversely, in Wyoming, fire suppression and historic grazing patterns have caused extensive areas of mature sagebrush stands with dense canopies and depleted herbaceous understory vegetation (Winward 1991, Bennett 1992). If the herbaceous understory is depleted and the seed source no longer exists, fire alone will not rejuvenate perennial grasses and forbs. A steppe landscape dominated by large expanses of dense sagebrush with volatile woody fuel loads may result in large, hot fires covering significant portions of the landscape and resulting in undesirable fire effects on plants (Young and Evans 1973, Whisenant 1990, Swetnam et al. 1999, Tausch 1999).

Miller and Eddleman (2001:23-24) indicate there are four factors that determine the negative or positive impacts of fire on sage-grouse habitat: (1) site potential, (2) site condition, (3) functional plant group(s), and (4) pattern or size of the burn. They suggest that goals for managing sage-grouse habitat to achieve an optimal balance of shrubs, forbs, and grasses at community or landscape levels are similar to sagebrush restoration efforts designed to restore or maintain form, function, and process in sagebrush steppe habitats. Fire, primarily in mountain big sagebrush communities, can enhance native perennial grasses and forbs in areas where sagebrush is abundant and there is good native forb composition and few exotic weeds. In these more mesic sagebrush habitats, fire can increase nutrient content of forbs (McDowell 2000) and lengthen the growing season of forbs important in the sage-grouse diet (Wrobleski 1999). These burns may attract sage-grouse (Klebenow and Beall 1977, Martin 1990, Slater 2003). Fire may produce short-term increases in insect populations (*Hymenoptera*) (Pyle and Crawford 1996), but these may not be sustained in the long term (Nelle et al. 2000). In one study of 20 different-aged wild and prescribed fires on the Snake River Plains in Idaho, Nelle et al. (2000) reported fire had long-term, negative impacts on sage-grouse nesting and brood-rearing habitats in mountain big sagebrush stands. In that study, fires removed nesting and early brood-rearing habitat due to the loss of sagebrush cover. Forb production was not enhanced in the various aged burns up to 15 years old and only short term increases in insect populations were detected (one year post burn), but then returned to background levels in subsequent years. This evaluation occurred during a drought, which may have affected plant regeneration.

Miller and Eddleman (2001) summarized negative impacts of fire on sage-grouse, including loss of winter and nesting habitat due to the removal of sagebrush canopy. They indicate there is no evidence to suggest fire will enhance sage-grouse habitat in Wyoming big sagebrush dominated communities where there already is a balance of native shrubs, perennial grasses, and forbs. Fischer et al. (1996*a*) found that forb cover was similar in burned and unburned Wyoming big sagebrush habitats, but the abundance of Hymenoptera was lower in burned areas. Connelly et al. (2000*b*) indicated prescribed burning in Wyoming and three–tip sagebrush (*A. tripartita*) communities during a drought resulted in a large decline of the sage-grouse breeding population. Bryne (2002) documented avoidance of burned low sagebrush and Wyoming big sagebrush by nesting and brood-rearing hens in Oregon. Slater (2003) found variable responses in the use of burned areas by sage-grouse in his study areas in southwest Wyoming. Miller and Eddleman (2001) indicate fire should not be used where sagebrush cover is a limiting factor for sage-grouse, where the understory lacks perennial forbs and grasses and introduced annuals are present, or where high amounts of less palatable shrubs such as rabbitbrush (*Chrysothamnus* spp.), horsebrush (*Tetradymia canescens*), or snakeweed (*Gutierrezia sarothrae*) are present. These species resprout following fire and, when present in high densities, are indicators of depleted herbaceous plant composition in the understory. Baker (2006) recommended that fire should not be introduced into sagebrush ecosystems until native understory plants have been restored, particularly in situations where there is the potential for replacement by cheatgrass. In these situations, he recommended that fire suppression is an appropriate management action to preclude further cheatgrass conversions.

Wyoming is faced with both declining sagebrush acreages in some areas and declining sagebrush habitat quality and rangeland health issues in other areas. In some areas, sagebrush habitats are fragmented and in poor condition with decadent shrubs and poor understory components. However, these low-quality sagebrush stands may be the only significant habitat left to support remnant sage-grouse populations. In other areas, there are extensive stands of mature or late seral stands sagebrush with understories of herbaceous vegetation in variable condition. Some of these sagebrush communities appear to provide good sage-grouse habitat. Others are clearly less than optimal (over-mature or decadent stands with dense overstory and depleted herbaceous understory components). In some situations, restoring historic fire regimes on a landscape-scale may be one of our best tools to maintain suitable habitat for a number of sagebrush associated species, address the long-term needs of an array of wildlife species, and restore watershed function. Fire can be an effective tool to eliminate juniper (*Juniperus* spp.) and other conifer invasions of mesic sagebrush sites or to rejuvenate mixed shrub communities (Miller and Tausch 2001).

Late seral or zootic subclimax conditions in some big sagebrush steppe-dominated collection basins of some watersheds have resulted in depressed herbaceous understories that lack productivity. This situation, if not identified and mitigated, can negatively affect watershed functions. For example, reduced herbaceous ground cover can reduce infiltration and subsurface flow to streams for late season base flows. Conversely, overland flow is encouraged, which quickly funnels precipitation through the collection basin, increases erosion and sedimentation, and promotes conversion of perennial streams to intermittent or ephemeral streams (desertification). The impaired water cycle fragments stream habitats for endemic non-game fish and native cutthroat trout whose habitat requirements for spawning, juvenile rearing, and over-wintering are no longer consistently met due to the seasonal flow depletion or the loss of connectivity between larger streams and their tributaries. Much of our ability to restore stream habitat quality and connectivity depends on opportunities to manage steppe communities to promote a mosaic of early-, mid-, and late-seral stages across collection basins (Kevin Spence Wyoming Game and Fish Department, personal communication, Winward 2001).

Optimal conditions for watershed health are about 12-15% and 20% big sagebrush canopy coverage for Wyoming and mountain big sagebrush steppe ecotypes, respectively, with good perennial forb and grass understories (Winward 2001).

Issues such as scale of analysis, natural fire frequency, patch size for treated and untreated areas (or burned versus unburned areas resulting from wildfires), herbaceous understory management goals, grazing practices, drought impacts, and habitat loss or fragmentation from development activities all weigh heavily into any land and wildlife management plans that address sage-grouse habitat needs. The approach taken can have profound effects on local sage-grouse populations and other sagebrush dependent species. The biological and ecological questions posed by management of sagebrush communities on the periphery of core sage-grouse habitats (the fringe of the mixed grass prairie) are perhaps more complex than in the more uniform sagebrush steppe environments. Research on sage-grouse habitat utilization and selection is mostly lacking in these areas, however.

The basis for sage-grouse persistence over time appears to be maintaining a mosaic of quality habitats over the landscape. It is important to remember that there are considerable variations in site potential in an analysis area and vegetation characteristics and responses to management may vary accordingly. Management of sage-grouse habitats is ultimately constrained by the potential of those sites to produce suitable habitats and actions must be adapted to function within those limitations. Habitat quality relates to the amount, height, and canopy cover of sagebrush stands, size of sagebrush stands and natural openings, presence of adequate herbaceous understory vegetation replete with food forbs, and residual cover from the previous growing season (Holloran et al. 2005).

ASSUMPTIONS

- Important sage-grouse habitat is defined as areas of seasonal and yearlong habitat sustaining a significant sage-grouse population or subpopulation associated with a lek or group of leks. Management of the habitat is considered to be a high priority for maintenance of the population or subpopulation.

- Sage-grouse may be a good indicator of sagebrush habitat quality for a number of other sagebrush obligate or dependent species (umbrella or indicator species), although this assumption needs further scrutiny. It appears that sage-grouse occupy a broad niche, while some other obligates require very specific habitat components and occupy very narrow niches (Rich and Altman 2002). Management directed to maintain sage-grouse habitat may have substantial benefits for conservation of some sagebrush obligates and near obligates, but many species of concern with very narrow niches may not benefit from these conservation actions (Rowland et al. 2006).

- To date, very few acres of sagebrush in Wyoming have been actively managed with sage-grouse as the priority management objective. The Wyoming Game and Fish Department has identified the sage-grouse as one of the key species for the focus of habitat management programs. The BLM has identified the sage-grouse as a sensitive species in Wyoming and has focused management efforts for this species.

- Habitat treatments (prescribed fire, chemical, and mechanical) may result in some short-term habitat losses, but should eventually produce better quality habitat for the sage-grouse and other sagebrush obligate species. Vegetative communities respond to successional changes at different rates depending on pre-disturbance site potential, soils, precipitation, size and type of treatment, and post-treatment management. As a result of plant succession, treatments may eventually lose their value over time and may require additional treatments in later years.

- There is a temporal component to any discussion of the impacts of habitat alteration on sage-grouse. Short-term is defined as impacts lasting 1-14 years, mid-term is defined as impacts lasting from 15-30 years, and long-term refers to impacts lasting more than 30 years.

- Habitat treatments (prescribed fire, chemical, and mechanical) may result in some short-term sage-grouse population declines, the extent of which may be difficult to quantify. However, any proposed vegetation management plan should attempt to quantify those adverse impacts. Some decline in grouse numbers in the short term may be acceptable if long-term increases in productive sage-grouse habitat will likely occur. The extirpation of local populations of sage-grouse because of habitat enhancement projects (including cumulative impacts from other land management actions) is not acceptable. Any action that reduces the population below 300 effective breeders (i.e., fewer than 100 males counted on leks) in small, discrete populations or demes may be considered as unacceptable. In this case, a "population" refers to an aggregate of leks where interchange is likely. Unless telemetry data suggests otherwise, leks within approximately 6.2 miles (10 km) of each other should be considered a population (J. W. Connelly, Idaho Department of Fish and Game, personal communication). Defining the boundaries of a population for management and analysis purposes is a judgment call left to the local biologists.

- Habitat treatments (prescribed fire, chemical, and mechanical) in sage-grouse habitats should include post-treatment grazing practices designed to enhance vegetative recovery and sage-grouse habitat. If post-treatment grazing management is not consistent with the goals of the proposed habitat enhancement, then the value of the proposed habitat project may be questioned and the project should be reconsidered, modified, or terminated. Monitoring the post-treatment response of the vegetation to habitat manipulations is essential. A concerted effort should also be made to monitor the sage-grouse population response to large treatments. Post-treatment trends in lek attendance and productivity for the affected population should be monitored and compared to trends from similar, adjacent, but presumably unaffected, populations. Monitoring plans require a commitment of manpower and resources. Effective monitoring plans should be developed to make the best use of the available resources.

- Projects proposed in areas of fragmented habitats and in areas with substantial existing habitat loss should be constrained to a much greater degree than projects in vast areas of relatively undisturbed late-seral sagebrush habitat. Treatment options will vary between areas and circumstances, but the goals of any vegetation project should be to promote healthy ecosystem functions, maintain existing populations of sage-grouse, and enhance habitat to promote population recovery or expansion, where possible.

- The Wyoming Greater Sage-Grouse Conservation Plan (Wyoming Game and Fish Commission 2003) states that the vegetative composition of an area depends on its site potential, seral stage, and past management. This statement recognizes that not all sites can be managed as optimal seasonal habitat for sage-grouse.

SAGE-GROUSE LIFE HISTORY

Overview of life history

Sage-grouse breeding begins in mid-March, when the males start to congregate on leks. Leks are the breeding or strutting grounds. Females come to the leks to mate and generally nest in the vicinity. In Wyoming, 64% of nests were located within three miles (5 km) of the lek where the hen was bred (Holloran and Anderson 2005). However, some studies have shown that sage-grouse hens nest as far as 12 miles (19.3 km) or more away from the lek (Autenrieth 1981, Wakkinen et al. 1992, Lyon 2000). After hatching her young, a hen keeps her brood in the general vicinity of the nest for one or more weeks. For the first three to four weeks after hatching, chicks feed primarily on insects (ants and beetles), which provide the high protein diet needed for rapid growth (Patterson 1952, Klebenow and Gray 1968, Johnson and Boyce 1990, Fischer et al. 1996*b*). As the season and plant phenology progresses, hens move their broods to higher elevation habitats or to more moist habitats, such as meadows, where high-quality foods remain available.

Herbaceous plants other than grass, called forbs, are important foods to sage-grouse. Sage-grouse (particularly chicks) eat forbs until early fall. As forbs mature and dry out in upland habitats, sage-grouse utilize riparian habitats and irrigated hay or alfalfa fields with an abundance of forbs. With the advance of fall, their diet includes more sagebrush leaves and buds as forbs and insects become less available. During late fall, sage-grouse feed almost exclusively on sagebrush. They continue to forage on sagebrush throughout the winter until forbs reappear the following spring. Because of their dependence on sagebrush, the birds are commonly referred to as "sagebrush obligates." For this reason, there is much concern about the condition and distribution of sagebrush habitats (Connelly et al. 2000a).

Population Biology

A stable sage-grouse population largely depends on the level of production of young (clutch size, nest successs, and brood size), chick survival, and hen survival.

The sage-grouse generally has lower reproductive rates and higher annual survival rates than other species of upland game birds, such as quail and partridge (Connelly and Braun 1997). It also lives longer than most upland game bird species; individual birds four to five years old are common. Annual reproductive success varies throughout the species' range (Wallestad and Pyrah 1974, Gregg 1991, Connelly et al. 2004).

Nesting rates vary from year to year and from area to area (Bergerud 1988, Gregg 1991, Connelly et al. 1993, Schroeder 1997, Coggins 1998). This variation is most likely a result of the quality of available nutrition and the general health of pre-laying females (Barnett and Crawford 1994). At least 70% of the females in a population will initiate a nest each year, with higher nest initiation rates recorded during years of higher precipitation in comparison to periods of drought (Coggins 1998). However, research on follicular development indicates that 91-98% of hens breed annually (Braun 1979). Renesting rates of females who have lost their first clutch are typically less than 25%, which is far lower than other upland game birds (Patterson 1952, Eng 1963, Petersen 1980, Bergerud 1988, Connelly et al. 1993). Renesting may do little to increase overall population numbers.

Sage-grouse nest success also varies by year and area. Of all the birds that nest, 10-86% produce chicks, but typically range between 40-60% percent (Trueblood 1954, Gregg 1991, Connelly et al. 1993, Schroeder 1997, Holloran 1999, Lyon 2000). Adult females normally have higher success rates than yearling females (Wallestad and Pyrah 1974, Heath et al. 1998, Holloran 1999), a characteristic that may be related to past nesting experience.

Sage-grouse clutch size is variable and relatively low compared to other species of game birds (Edminster 1954, Schroeder 1997). Clutch size per nest normally ranges from six to ten eggs (Wakkinen 1990, Connelly et al. 1993, Schroeder 1997). These differences may be related to habitat quality and overall condition of pre-laying females (Coggins 1998).

Among western states, long-term juvenile to hen ratios have varied from 1.40-2.96 in the fall. In recent years, this ratio has declined to 1.21-2.19 juveniles per hen. Research suggests that at least 2.25 juveniles per hen should be present in the fall population to allow for stable to increasing sage-grouse populations (Connelly and Braun 1997, Edelmann et al. 1998, Compton and Connelly, Idaho Department of Fish and Game, unpublished data). However, this may vary depending on local conditions. Unpublished production and lek data from Wyoming suggested 2.00 chicks per hen in the fall resulted in increased lek counts the following spring.

Annual survival rates for yearling and adult sage-grouse vary from 35-85% for females and from 38-54% for males (Wallestad 1975, Zablan 1993, Connelly et al. 1994, Heath et al. 1998). Lower survival rates for males may be related to the higher predation rates on males during the lekking season and increased physiological demands due to sexual dimorphism (Swenson 1986).

HABITAT REQUIREMENTS

Seasonal movements and home range

Sage-grouse populations can be migratory or non-migratory (Beck 1975, Wallestad 1975, Berry and Eng 1985, Connelly et al. 1988, Wakkinen 1990, Fischer 1994), depending on location and associated landform. The annual habitat components of non-migratory populations are located in relatively close juxtaposition, so long distance seasonal movements (greater than 6.2 miles or 10 km) are not necessary to meet seasonal habitat needs (Connelly et al. 2000). Where topographic relief allows, sage-grouse generally move from lower to higher elevations as the summer progresses to take advantage of succulent herbaceous vegetation as plant growth advances. Non-migratory populations may spend the entire year within an area of 39 mi^2 (101 km^2) or less in size. In migratory populations, seasonal movements may exceed 47 miles (75 km) (Dalke et al. 1963, Connelly et al. 1988), and home ranges may exceed 1042 mi^2 (2700 km^2) (Leonard et al. 2000). There may be two or more seasonal ranges in such cases. For example, there may be a breeding range, a brood-rearing range, and a winter range, indicating that migratory sage-grouse populations depend on large expanses of habitat. Suitable habitat may be needed to allow for connectivity among the different resident populations.

Sage-grouse movements are likely influenced by site fidelity (Keister and Willis 1986, Fischer et al. 1993, Fischer et al. 1997, Holloran 2005). Juvenile birds follow hens during their first summer and fall and generally return to these seasonal ranges in subsequent years (Schroeder et al. 1999). Adult females return to the same area to nest each year (Fischer et al. 1993, Holloran 2005) and may nest within 660 feet (200 m) of her previous year's nest (Gates 1993, Lyon 2000). There is reduced fidelity to winter habitats, but this appears to be related to the availability of sagebrush under a variety of snow depths (Robertson 1991).

Breeding habitats (leks/nesting)

Sage-grouse breed on sites called leks or strutting grounds that are traditional courtship display and mating areas in or adjacent to nesting habitat in sagebrush. The same lek sites tend to be used year after year. They are established in open areas surrounded by sagebrush, which is used for escape and protection from predators (Patterson 1952, Gill 1965). Examples of lek sites include landing strips, old lake beds or playas, low sagebrush flats, openings on ridges, roads, crop land, and burned areas (Connelly et al. 1981, Gates 1985). As grouse populations decline, the number of males attending leks may decline, or the use of some leks may be discontinued. Likewise, as populations increase, male attendance on leks increases, old leks may be reoccupied, or new leks may be established (Holloran and Anderson 2005).

The lek is considered the center of year-round activity for resident grouse populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974). However, habitats that are located large distances from the leks are used by migratory populations of sage-grouse and are essential to their survival (Connelly et al. 1988, Wakkinen et al. 1992). On average, most nests are located within 3.9 miles (6.2 km) of the lek. However, some females or hens may nest more than 12.4 miles (20 km) away from the lek (Autenrieth 1981, Fischer 1994, Hanf et al. 1994, Wakkinen et al. 1992, Lyon 2000, Holloran and Anderson 2005). Mean distance from lek-of-capture to selected nest sites was 2.9 miles (4.6 km) in southeastern Idaho (Wakkinen et al. 1992) and 5.3 miles (8.6 km) in the Pinedale study area in west-central Wyoming (Holloran and Anderson 2005). The Pinedale study had a lek-of-capture to nest site range of 0.25-39.4 miles (0.4-63.8 km). Slater (2003) found between 75% and 87% of nests were located within 3.2 miles (5 km) of the lek-of-capture in his two study areas in southwest Wyoming.

In an analysis of sage-grouse studies conducted in seven areas in Wyoming since the mid-1990s, Holloran and Anderson (2005) found that 45% of nests were located within two miles (3 km) of the lek where the hen was bred, and 64% of the nests were within three miles (5 km) of the lek. Nests closer to leks were more likely to be predated than nests further from leks. Nests greater than 8.5 km from a lek had an average nest success of 61% compared to 44% success for nests less than 8.5 km from a lek (Holloran and Anderson 2005).

Habitats used by pre-laying hens are also part of the general breeding habitat. These areas provide forbs that are high in calcium, phosphorus, and protein, all of which are necessary for egg production. The condition and availability of these areas are thought to have a significant effect on reproductive success (Barnett and Crawford 1994, J. A. Crawford, Oregon State University retired, personal communication, Holloran and Anderson 2003).

Most sage-grouse nests are located under sagebrush plants (Patterson 1952, Gill 1965, Gray 1967, Wallestad and Pyrah 1974, Schroeder et al. 1999). However, nests have been found under other plant species (Connelly et al. 1991, Gregg 1991). Sage-grouse that nest under sagebrush experienced higher nest success (53%) than those nesting under other plant species (22%) (Connelly et al. 1991). The average height of sagebrush most commonly used by nesting sage-grouse ranges from 11-32 inches (28-81 cm), and sagebrush canopy cover within sagebrush stands used for nesting generally ranges from 15-25% (Connelly et al. 2000). Studies on sage-grouse nesting habitat have documented that sage-grouse tend to select nest sites under sagebrush plants that have large canopies. In Wyoming, higher shrub canopy cover and taller live sagebrush occurred in nest areas compared to random sites (Holloran et al. 2005). Holloran (1999) found mean height of nest shrubs of 18.2 inches (46.4 cm) was greater than the mean height of shrubs in the surrounding area.

The canopies of sagebrush and occasionally other species provide overhead cover and often correlate with an herbaceous (primarily grasses) understory, which provides lateral cover and assists birds in hiding from predators (Patterson 1952, Gray 1967, Klebenow 1969, Wallestad and Pyrah 1974, Fischer 1994, Gregg et al. 1994, Wakkinen 1990, Gregg 1991, Delong et al. 1995). In Wyoming, vegetation plots at nest sites had taller residual grass height (Holloran 1999), more live and residual grass cover (Lyon 2000), more total herbaceous and total forb cover (Lyon 2000), and less bare ground (Lyon 2000, Slater 2003) compared to random plots. An analysis of sage-grouse nest site selection from seven study areas in Wyoming indicates that residual grass height should be a minimum of 3.9 inches (10 cm) in Wyoming big sagebrush dominated sites (Holloran et al. 2005) compared to the 7 inches (18 cm) minimum live perennial herbaceous vegetation height recommended by Connelly et al. (2000) in breeding habitats. Hens nesting in these cover conditions experience higher nest success rates than those nesting under inferior cover conditions (Wallestad and Pyrah 1974, Delong et al. 1995, Holloran et al. 2005).

Grass and forb cover at nest sites may provide scent, visual, and physical barriers to predators (DeLong et al. 1995). Average live grass heights at nests range from 6-13 inches (15-33 cm) and average grass cover at nests ranges from 3-51% (Wakkinen 1990, Gregg 1991, Schroeder 1995, Apa 1998, Connelly et al. 2000*a*), based on vegetation measured at nest sites immediately after hatching. In addition to providing cover for concealment, succulent forbs in the diet of sage-grouse hens provide protein and other nutrients necessary for successful reproduction (Barnett and Crawford 1994).

Hagen et al. (2007) conducted a meta-analysis of vegetation characteristics recorded at nest sites in 24 studies to determine if there was an overall effect of habitat selection and to estimate average canopy cover of sagebrush, grass and forbs, and height of grass at nest sites. Shrub cover and grass height were greater at nest sites than at random locations in these studies. The results of these studies indicate there is considerable variation in habitat parameters at nest sites between studies but values generally fell within the nesting habitat guidelines by Connelly et al (2000*a*).

Brood-rearing Habitat

Early brood-rearing generally occurs relatively close to nest sites. Sage-grouse use the denser patches of sagebrush for nesting and the smaller openings and patches of sagebrush with a relatively sparse canopy and a good herbaceous understory as feeding sites in early brood-rearing habitat. However, movements of individual broods may be highly variable (Connelly 1982, Gates 1983). Optimum early brood habitat, similar to that of breeding, consists of sagebrush stands that are 11-32 inches (30-80 cm) tall with a canopy cover of 10-25% and an herbaceous understory of 15% grass canopy and 10% forb canopy. For brood-rearing, however, this type of habitat need only be found on at least 40% of the area. Hens with broods may use relatively open sagebrush habitats with less canopy cover (about 14%) than optimum nesting habitat (Martin 1970, Wallestad 1971), but they need an understory canopy cover of at least 15% of grasses and forbs (Sveum et al. 1998). Chick diets include forbs and invertebrates (Drut et al. 1994). Insects, especially ants and beetles, are an important component of early brood-rearing habitat (Drut et al. 1994, Fischer et al. 1996*a*). Brood-rearing habitats having a wide diversity of plant species tend to provide an equivalent diversity of insects that are important chick foods. Hens with broods tend to select these types of areas. A combination of more residual grass and total forb cover and shorter effective vegetation height were the best predictors of early brood-rearing use compared to available habitat in the Bates Hole area in central Wyoming (Holloran 1999). In the Pinedale study area in west-central Wyoming, early brood-rearing locations had less live sagebrush density, live sagebrush and total shrub canopy cover, and bare ground compared to available habitat (Lyon 2000). Total herbaceous cover was 24.8% at early brood locations compared to 9.1% at random locations (Lyon 2000).

In late June or July, as sagebrush habitats dry and herbaceous plants mature, hens usually move their broods to more moist sites where more succulent vegetation remains available (Gill 1965, Klebenow 1969, Savage 1969, Connelly and Markham 1983, Gates 1983, Connelly et al. 1988, Fischer et al. 1996*b*). Examples of such habitats include low sagebrush types (such as *A. nova* and *A. arbuscula*), riparian habitats along streams and wet meadows, and hay and alfalfa fields adjacent to sagebrush habitats (Savage 1969, Martin 1970, Connelly and Markham 1983, Gates 1983, Connelly et al. 1988). Where available, hens may move their broods to higher elevations to take advantage of more succulent vegetation in the mountain sagebrush communities and the abundant wet meadows and riparian habitats in the foothill zones. However, in years with good summer precipitation, hens with broods tend to remain dispersed in the sagebrush communities where succulent forbs are available until late summer when plant desiccation and maturation occurs (Martin 1970, Wallestad 1971, Fischer et al. 1996*b*, Holloran 1999). Groups of adult males and barren hens tend to congregate in these more mesic habitats in late June to July in most years. Diet of sage-grouse chicks changes from insects to forbs during this shift to summer brood-rearing habitats (Patterson 1952, Klebenow 1969, Peterson 1970, Drut et al. 1994).

Hagen et al. (2007) conducted a meta-analysis of vegetation characteristics recorded at brood habitats in eight studies to determine if there was an overall effect of habitat selection and to estimate average canopy cover of sagebrush, grass and forbs, and height of grass in brood habitats. Shrub cover was lower, grass height was significantly taller, and both forb and grass cover were greater in brood-rearing habitat than at random locations in these studies. The results of these studies indicate there is considerable variation in brood habitat parameters between studies but generally the values fell within the brood-rearing habitat guidelines by Connelly et al. (2000*a*).

Winter habitats

As fall progresses, sage-grouse move toward their winter ranges and shift their diet primarily to sagebrush leaves and buds (Patterson 1952, Wallestad 1975, Connelly and Markham 1983, Connelly et al. 1988). The exact timing of this movement varies depending on the sage-grouse population, geographic area, overall weather conditions, and snow depth.

Sage-grouse winter habitats are relatively similar throughout most of their range. Because their winter diet consists almost exclusively of sagebrush, winter habitats must provide adequate amounts of sagebrush available above the snow. Sagebrush canopy can be highly variable (Patterson 1952, Eng and Schladweiler 1972, Wallestad et al. 1975, Beck 1977, Robertson 1991). Sage-grouse tend to select areas with both high canopy and taller Wyoming big sagebrush and feed on plants highest in protein content (Remington and Braun 1985, Robertson 1991). It is critical that sagebrush be exposed at least 10-12 inches (25-35 cm) above snow level to provide food and cover for wintering sage-grouse (Hupp and Braun 1989). If snow covers the sagebrush, the birds move to areas where sagebrush is exposed. Sage-grouse winter habitats should allow access to sagebrush under all snow conditions when considered at a landscape scale (Connelly et al. 2000*a*).

Naugle et al. (2006*b*) identified landscape-scale habitat features that influence sage-grouse habitat selection in the Powder River Basin and developed a conservation planning tool by spatially depicting winter habitat quality in a Geographic Information System (GIS). Sage-grouse selected for large expanses of intact sagebrush in relatively flat terrain and avoided areas with conifer habitat and more rugged terrain. Sage-grouse also avoided areas with coal-bed natural gas development in otherwise suitable habitat.

METHODOLOGY

Habitat Assessment and Project Design

These guidelines include an approach to identifying sage-grouse issues in landscape-scale assessments, planning and implementation of proposed habitat projects, and building a safety net into the process to maintain or enhance sage-grouse populations. This is an approach that can be used to identify sage-grouse habitat issues and resolve conflicts in the development of vegetative treatment prescriptions, and it should be an integral part of the National Environmental Policy Act (NEPA) process where appropriate. The Wyoming Guidelines for Managing Sagebrush Communities with an Emphasis on Fire Management (Wyoming Interagency Vegetation Committee 2002:12) provides a list of nine decision elements that should be considered when evaluating a potential sagebrush treatment. In addition to those nine elements, assessing the need for a vegetation treatment involves a general assessment of the landscape and its use by sage-grouse. The following evaluation criteria should also be considered when developing vegetation treatments in occupied sage-grouse habitat:

1) Determine if sage-grouse (or other species of interest) seasonal habitats are present, the condition of these habitats, and the relative level of importance of these habitats. In the case of

sage-grouse, it is important to know whether the population is resident or migratory when evaluating potential habitats affected by proposed actions;
2) Identify how much of the sage-grouse habitat in the area has been previously impacted by fire (prescribed or wild), other habitat conversions, habitat losses, or fragmentation, preferably using a GIS based analysis;
3) Determine how much of the area is likely to burn in future wildfire and at what scale (a risk assessment);
4) Identify the short-term (1-14 years) effects and the mid-term effects (15-30 years) of prescribed fires or other treatments on vegetation and key wildlife species;
5) Assess the presence of undesirable plant species (e.g., cheatgrass, invasive noxious weeds, rabbitbrush, juniper, and other conifer invasion) and the risk of these species increasing under current management and/or as a result of the proposed treatment;
6) Determine the likely response of desirable species of vegetation that are present to the type and intensity of treatment being proposed;
7) Provide a clear statement of the intended objectives of the prescribed treatment, provide a rational for the treatment, and identify impacts to sage-grouse and other species of interest as part of the management prescription and environmental assessment;
8) Establish overall goals along with measurable objectives and an adequate monitoring plan (adequate in terms of funding as well as quantifying the effects of treatment);
9) Identify mitigation measures (if any) needed to offset potential adverse impacts on sage-grouse habitat; and
10) Develop a post treatment management plan that will ensure desired vegetative responses can be achieved and maintained.

This assessment will assist in the preparation of a prescribed vegetation treatment plan. If the need to modify the vegetation has been identified through a habitat evaluation process, impacts to sage-grouse should be considered and appropriate mitigation should be developed, if needed. If the area does not provide adequate sage-grouse habitat, but is within historic sage-grouse range, an objective could be to restore degraded rangelands to a condition that again provides suitable habitat for sage-grouse.

Early in the planning process for both landscape-scale assessments and project-level analysis, the area should be identified as occupied, unoccupied, or historic sage-grouse habitat based on existing information in the sage-grouse lek database and the Wildlife Observation System maintained by the Wyoming Game and Fish Department, distribution maps of sage-grouse habitat and sagebrush in Wyoming maintained by the Wyoming Game and Fish Department, and federal land management agencies, as well as any other reliable source. The focal point for sage-grouse habitat analysis is the lek, or strutting ground, because lek locations and activity are probably the best information that has been collected on most sage-grouse populations (Connelly et al. 2000*a*). All active and historic leks in the analysis area should be identified and a determination made whether it is likely there are other leks in the area. The area should be surveyed in late March through April using standard protocols to search for new leks (Connelly et al. 2003). This assumes the planning process should be at least one year in advance of the implementation phase to allow for adequate lek surveys. For planning purposes on public lands, BLM requires a two-year planning and budget process.

Based on research conducted in Wyoming, on average 45% of hens nest within a two-mile (3 km) radius of the lek at which they were captured, 64% of hens nest within a three-mile (5 km) radius, and 75% of hens nest within a four-mile (6.5 km) radius (Holloran and Anderson 2005). However, Slater (2003) found between 75-87% of nests were located within 3.2 miles (5 km) of the lek of capture in the population he studied in southwest Wyoming. Some birds or populations are migratory and hens regularly move up to 12 miles (20 km) from the lek to the nest site (Connelly 2000*a*). One hen in the Pinedale area moved 37 miles (60 km) to nest (Lyon 2000). Nesting habitat is not uniformly distributed throughout the area around the lek but is dependent on the topography, soils, vegetation, and other factors (Connelly 2000*a*). A migratory population can also be characterized by movements from breeding habitats to summer habitats and from summer habitats to distinct winter habitats (Connelly 2000*a*). We recommend that seasonal habitats for sage-grouse be mapped for the analysis area, particularly if the population or a portion of the population appears to be migratory. However, if time and manpower is limited, at a minimum, seasonal habitats within three miles (5 km) of the lek or leks affected by the project should be identified through habitat inventories.

Once an area has been inventoried for sage-grouse habitats (leks, nesting and early brood-rearing, late brood-rearing, and winter habitats), the quality of that sage-grouse habitat should be assessed. The amount and quality of the shrub overstory and the herbaceous understory should be evaluated using techniques described by Connelly et al. (2003). At a minimum, habitats should be mapped to show areas with 0%-14% canopy cover, 15%-30% canopy cover, and over 30% canopy cover. Shrub height should also be quantified. The BLM is developing specific guidelines to identify and evaluate sage-grouse habitats in a range of sagebrush communities based on current research, in collaboration with state wildlife agencies and other cooperators. These assessment and monitoring guidelines address sage-grouse habitats at multiple scales. This attempt to standardize sage-grouse habitat evaluation techniques within the federal agency responsible for managing much of the remaining sage-grouse habitat will be an important contribution to the effort to improve vegetation monitoring and habitat evaluation on a range-wide basis and could have applications to lands under other jurisdictions or ownership. However, the protocols were not available at the time this document was prepared.

The sage-grouse guidelines by Connelly et al. (2000*a*) recommend protecting all suitable nesting and brood-rearing habitat within 2-3 miles (3.2 km-5 km) of a lek, depending on whether the potential nesting habitat around the lek is relatively uniform or relatively patchy or fragmented. In addition, the BLM in Wyoming has Controlled Surface Use or No Surface Occupancy stipulations for oil and gas development that restrict human activity seasonally and generally allow no habitat disturbance or structures within 0.25 miles (0.4 km) of a lek. Timing stipulations for oil and gas development are also placed on nesting habitat within a two-mile (3.2 km) radius of a lek on BLM lands or lands with federal mineral leases. Some BLM Field Offices also place restrictions on habitat disturbances with two miles of a lek for other resource activities. Another factor to consider is whether the population is migratory, nonmigratory, or both. It is not realistic to attempt to protect every acre of potential nesting habitat on the landscape. However, it is possible some of the best nesting and brood-rearing habitat lies outside the two-mile (3.2 km) radius and may be important to the maintenance of the population (Holloran and Anderson 2005). These stands of sagebrush should be identified and mapped in the analysis area. The Wyoming Greater Sage-grouse Conservation Plan calls for protecting nesting and early brood-rearing habitat within a two-mile (3.2 km) radius of a lek, at a minimum, but recommends all nesting habitat associated with the lek be identified through surveys and protected, if possible (Wyoming Game and Fish Commission 2003). It is important to remember that, on average in Wyoming, the two-mile (3.2 km) radius around a lek includes only 45% of the nest sites and therefore any decision to avoid impacts to that habitat is only a limited protective measure.

Most nesting habitat can be identified as patches of sagebrush with 15-30% canopy cover. Productive nesting habitats in Wyoming big sagebrush have an understory with an herbaceous canopy cover of at least 15%. Productive nesting habitat in mountain big sagebrush stands and mesic Wyoming big sagebrush should have at least 25% canopy cover for herbaceous vegetation.

Suitable habitat is defined as sagebrush stands with at least 15% canopy cover of grasses and at least 10% canopy cover of a diversity of forbs. The average height of current year's growth should be at least 7 inches (18 cm) by early June. Residual grasses from the previous year provide cover for nesting at the time of nest site selection by the hen and should be at least 3.9 inches (10 cm) in height in potential nesting habitat in these two vegetation types (Heath et al. 1987, Holloran 1999, Lyon 2000, Slater 2003, Holloran et al. 2005).

The sage-grouse guidelines by Connelly et al. (2000*a*) recognize that degraded sagebrush habitat may need treatment to restore its productivity and value for wildlife. Nesting and early brood-rearing habitats have been identified as critical to nest success and chick survival (Holloran, 1999, Lyon 2000) and may be bottlenecks for many sage-grouse populations (J. W. Connelly, Idaho Department of Fish and Game, personal communication). Sagebrush stands should be evaluated for habitat characteristics that indicate a declining vegetative condition. The age of the stand, percent shrub canopy cover, the amount of decadence, and the amount and composition of the understory vegetation are good indicators of habitat quality. Braun et al. (1997) recommended that no sagebrush control work should occur where live sagebrush cover is less than 20%. Sagebrush canopy cover is important for sage-grouse, but the understory vegetation is also a key habitat component for sage-grouse.

If the understory conditions fall within the guidelines described above, the stand of sagebrush likely is adequate sage-grouse habitat, and the need to treat the stand should be carefully weighed against the need to maintain effective sage-grouse habitat. However, if the herbaceous understory is depleted (reduced number of grass and forb species present), providing limited or inadequate cover, and the shrub canopy is too dense, then some vegetative treatment may be needed to restore the stand to its potential productivity and value for sage-grouse and other wildlife species. In this situation, the guidelines recommend treating no more than 20% of nesting and early brood-rearing habitat.

Treatments should be designed to thin the sagebrush canopy, remove patches of sagebrush to provide a mosaic of early seral vegetation within mature sagebrush stands, reduce the competition between mature sagebrush and the herbaceous understory, and increase the vigor, productivity, and diversity of herbaceous species (Connelly et al. 2000*a*). Possible tools to achieve these objectives include prescribed fire, mechanical treatments, interseeding with grasses and forbs, herbicides, changes in grazing management, or some combination of these treatments (Miller and Eddleman 2000). Stevens (2004*a*) provides an overview of habitat improvement techniques that can be used to enhance sage-grouse habitat in rangeland restoration and rehabilitation projects.

The guidelines by Connelly et al. (2000*a*) indicate that no more than 20% of the area providing nesting and early brood-rearing habitat within a two-mile (3.2 km) radius of an active lek should be treated unless inventories are conducted to determine the habitat likely to be used for nesting and early brood-rearing (breeding habitat) for a population or lek complex. In the latter case, no more than 20% of the identified potential nesting and early brood-rearing (breeding) habitat for a sage-grouse population or subpopulation based on an aggregate of related leks should be treated at any one time. Preference should be given to the protection of nesting and early brood-rearing habitat within two miles (3.2 km) of a lek. In Wyoming big sagebrush communities, additional treatments in the analysis area should be deferred until treated sagebrush stands have again recovered to at least 12% canopy cover (possibly in excess of 30 years). In mountain big sagebrush communities, the return interval for treatments could be as short as 15 years, but canopy cover of sagebrush should be at least 15% in the initial treatment areas before another treatment is conducted.

The guideline to limit vegetation treatments to 20% of sage-grouse nesting and early brood-rearing habitat is a constraint recommended in areas where sage-grouse habitat management is a priority. From a biological perspective, this limitation is conservative, particularly in mountain big sagebrush steppe types, which likely burned quite extensively in the past. This recommendation may constrain efforts to manage portions of sagebrush communities for a mosaic of early to late seral stages necessary to address some watershed health issues, fisheries objectives, or maximum forage production for livestock grazing if managing for sage-grouse habitat is the priority. The trade-off is the short-term needs of sage-grouse versus other vegetation treatment goals. Land management decisions will have to weigh competing interests in the allocation of resources at both the landscape and project level.

Sagebrush restoration techniques should be considered in areas where sagebrush has been removed or severely fragmented by past management practices. If 40% or more of the breeding habitat of a population or subpopulation has been lost, the guidelines by Connelly et al. (2000*a*) recommend that the remaining habitat should be protected from additional loss or degradation. In these situations, sagebrush restoration should be the priority land treatment to restore suitable shrub densities and understory vegetation to provide effective sage-grouse habitat.

Late brood-rearing habitat (areas typically used by grouse in July, August, and early September) is important for sage-grouse production and survival. However, the species' requirements can usually be met by a diverse array of habitats that provide cover and foraging areas in close juxtaposition. Cover patches can be smaller, and open areas can be larger in a coarse-grained vegetative mosaic, compared to what is required for good nesting and early brood-rearing habitat. Often, wet meadows, riparian areas along streams and rivers, irrigated hayfields, and alfalfa croplands are the most productive feeding areas. Dense sagebrush patches within 0.5-1.0 miles (0.8-1.6 km) of the feeding areas are important for roosting and loafing areas. Treatments should be designed to maintain stands of sagebrush or mixed shrubs to provide adequate cover adjacent to feeding areas. Treatments are recommended if total shrub cover exceeds 30% or sagebrush cover exceeds 25%. Adequate shrub cover in late summer brood-rearing habitats is reported to be 10-20% sagebrush canopy cover and up to 25% total shrub cover (Connelly et al. 2000*a*). Up to 40% of this habitat type could be treated in a coarse-grained mosaic (J. W. Connelly, Idaho Department of Fish and Game, personal communication).

In Wyoming, some of this late brood-rearing habitat is found in mixed shrub communities at higher elevations. Treatment of these stands should consider the effects of the proposed treatment on all shrub species. Occupied sage-grouse habitat in Wyoming that consists of Wyoming big sagebrush or mountain big sagebrush stands that are mesic, are at higher elevations (typically greater than 7,500 feet (2286 m) in elevation), or receive annual precipitation greater than 14 inches (36 cm), generally do not provide core winter, breeding, nesting, and early brood-rearing habitat due to persistent snow-pack during the winter and spring periods. These higher elevation sagebrush basins, foothill ridges, and cold desert mountains are not generally considered to be important sage-grouse winter or breeding habitats essential for maintaining viable grouse populations in Wyoming. In these areas, managers have more flexibility to design vegetation treatments to promote the short- and long-term ecological integrity and diversity of sagebrush-grassland communities without causing short-term adverse impacts to sage-grouse. If the proposed treatment areas do not provide significant nesting and early brood-rearing habitat or winter habitat, the project design can be more flexible. Sagebrush treatment goals for sage-grouse call for a mosaic of irregular shaped treatment patches interspersed with untreated patches to create a mix of early, mid, and late seral plant communities. However, treatment mosaics in late brood-rearing habitat could include prescriptions which allow for 40-60% of the sagebrush to be treated within each delineated treatment polygon as long as the total acreage of identified late brood-rearing habitat that is treated does not exceed 40% of the available late brood-rearing habitat for a sage-grouse population or subpopulation.

These recommendations on the treatment of sage-grouse habitats are not intended to apply to areas where fire suppression and advanced vegetative succession have allowed sagebrush to encroach into aspen (*Populus tremuloides*) or mountain shrub stands, which generally lie outside important sage-grouse breeding and winter habitat. Prescribed treatments designed to restore and maintain healthy aspen and mountain shrub communities on the landscape generally do not pose a significant threat to most important sage-grouse habitats. But, pretreatment analysis should indicate the value of the proposed treatment areas for sage-grouse as well as other wildlife species, and the project should be designed accordingly.

Treatments that prevent the conversion of sagebrush-grassland sites to juniper communities or woodlands dominated by Douglas fir (*Pseudotsuga menziesii*) or limber pine (*Pinus flexilis*) are encouraged because the encroachment of conifers eventually results in the loss of useable sage-grouse habitat. In some situations, juniper encroachment is occurring in mid-elevation sagebrush communities in Wyoming that provide breeding and winter habitat. The availability of the remaining suitable habitat and the use of current habitat with juniper encroachment should be carefully evaluated so the best remaining sage-grouse habitat can be retained while up to 40% of the potential breeding and winter sage-grouse habitat is treated in areas with juniper encroachment. In many areas of Wyoming, juniper encroachment is a fine scale to site scale habitat feature, and treatment of these sites may or may not be a priority. In areas where juniper encroachment is more widespread, the design of the project to protect useable sage-grouse habitat is more critical. The potential for cheatgrass invasion should be considered when evaluating potential treatments for juniper encroachment. At higher elevations, conifer encroachment may be impacting late brood-rearing habitat along the interface between the sagebrush steppe, mixed shrub communities, and the low elevation tree line. Prescribed fire treatments may benefit sage-grouse by removing conifers, improving hydrologic function, restoring wet meadow complexes, and enhancing forb production in mesic sagebrush communities. Aspen regeneration to enhance habitat diversity for an array of other wildlife species may also be an objective of these treatments.

Winter habitat may also be a limiting factor for sage-grouse and can be variable in nature. Winter habitats may be windblown ridges with low sagebrush, steep, exposed south and west facing slopes with patches of taller sagebrush mixed with low sagebrush, swales or draws with tall sagebrush species such as basin big sagebrush, or sagebrush flats dominated by Wyoming big sagebrush where shrubs are available during severe winters and provide both forage and cover for sage-grouse. Winter habitat is generally defined as sagebrush stands with 10-30% canopy cover and heights of 10-14 inches (25-35 cm) above the snow cover (Connelly et al. 2000*a*). Large expanses of intact mature sagebrush in relatively flat terrain appear to be important in some areas of Wyoming (Naugle et al. 2006), but windblown ridges with exposed low sagebrush may also be important. In some areas it may be difficult to identify potential winter habitat without extensive surveys. It is possible to identify potentially available winter habitat from high resolution imagery that shows areas of available sagebrush exposed above the snow in normal and severe snow years. Professional judgment may be required to delineate potential winter habitats. It is possible to identify landscape features that influence sage-grouse winter habitat selection at various scales and conduct spatially explicit mapping of winter habitat quality in GIS (Naugle et al. 2006). An effort to inventory wintering areas will be needed to validate the maps of potential sage-grouse winter habitat indicated by vegetation and snow deposition patterns developed from aerial or satellite imagery.

The guidelines by Connelly et al. (2000*a*) recommend treating no more than 20% of the winter habitat within a 20-30 year period (or until the treated area again provides suitable winter habitat) if the habitat is degraded; burn patches should not exceed 123.6 acres (50 ha). The use of spring prescribed burns, which usually result in more fine-scale mosaics, or fire prescriptions that avoid every other draw or swale may be practical ways to achieve the desired vegetation patterns on the landscape. However, the recommended smaller burns may result in the "ice cream effect." This strong attraction to and over-utilization of these sites can occur in spite of grazing management regimes unless the burns are well distributed across the landscape.

In areas with severely fragmented habitat due to habitat loss, additional sagebrush treatment is not recommended if more than 20% of the original winter habitat has been lost. It is important to retain residual sagebrush patches within treated areas or wildfire boundaries because they may represent the last of the best remaining winter habitat and provide seed sources for sagebrush recovery. In these degraded winter habitats, sagebrush restoration should be a priority (Connelly et al. 2000*a*).

<u>Grazing Management</u>

The use of appropriate grazing systems and periodic rest may be the most effective tool available to manage the extensive low elevation xeric sagebrush-grassland habitat in Wyoming for the benefit of sage-grouse and other wildlife species (Crawford et al. 1992).

Wyoming Game and Fish Department Grazing Guidelines

The Wyoming Game and Fish Department (WGFD) developed livestock grazing guidelines to help employees work with private landowners and public land managers to develop and implement grazing programs that benefit wildlife habitat. Several WGFD programs such as the Landowner Incentive Program (LIP), habitat grant program, and Sage Grouse Working Group programs have grazing management as a major component or practice. There are numerous grazing systems available for land managers that can be tailored to meet landowner and wildlife management objectives. While these grazing guidelines were not specifically developed for management of sage-grouse habitats, they do provide some pertinent recommendations for land managers to consider. A one-size-fits-all grazing system does not fit the needs or provide the flexibility necessary for livestock operators or for meeting all wildlife habitat objectives. Different species of wildlife require different types and seral states of habitat across the landscape. These guidelines are developed to suggest some minimum requirements, provide flexibility, and promote consistency in grazing management to benefit most wildlife habitats.

The guidelines should help meet most wildlife habitat goals by achieving the following vegetation goals:

1) Provide a healthy sustainable under-story of native grasses and forbs;
2) Provide healthy, vigorous, and sustainable native shrubs and trees;
3) Provide adequate residual vegetation and litter to sustain plant and soil health and vigor, sediment capture, energy dissipation, groundwater recharge, and cover for ground nesting birds and small mammals;
4) Provide a healthy biotic community by ensuring that the appropriate kinds and amounts of soil organisms, plants, and animals to support the hydrologic cycle, nutrient cycle, and energy flow are maintained or enhanced;
5) Provide healthy sustainable vegetation, soils, hydrology, and water cycling to sustain health, free-ranging populations of fish and wildlife.

Some minimum suggested elements for livestock grazing systems to meet the above goals are:

1) Avoid continuous season-long grazing or other grazing management practices that hinder the completion of plants' life-sustaining reproductive and/or nutrient cycling processes by ensuring adequate periods of rest at the appropriate times;
2) Provide rest from grazing and rotation of grazing to ensure seedling establishment or other necessary processes at levels sufficient to move the ecological site condition toward the desired habitat objectives;
3) Maintain an appropriate and sustainable stocking rate with guidance from acceptable sources such as the Natural Resource Conservation Service;
4) In addition to providing periodic rest for pastures within a grazing system, provide opportunity for re-growth during the growing season, where possible, in pastures that are grazed. If this is not possible, then efforts should be made to ensure some level of growing season rest (early rest to ensure seed set or after use rest to allow re-growth) in the subsequent year or years;
5) Utilization of the herbaceous component by livestock should not exceed 30-35% by weight for rangelands that need improvement and 45-50% for rangelands in good condition;
6) Utilization of shrubs by livestock should not exceed 20% of current annual growth;
7) Monitor to determine if vegetation/habitat objectives are being met;
8) Adjustment of grazing elements should be made if current grazing system is not meeting objectives; and
9) Provide a minimum of two growing seasons of rest following range treatments or wild fires to allow vegetation to recover its vigor and productivity, allow production of seed heads, and create litter to lessen soil erosion and for seedling establishment.

Additional elements in the grazing system that should be considered are:

1) Yearlong rest of a pasture or more than one pasture in some pasture rotation system; and
2) Short duration grazing (fewer than 14 days) to avoid regrazing plants and to allow vegetation regrowth and recovery.

The major focus of these guidelines is to promote healthy and vigorous grass, forbs, shrubs, and trees in plant communities, which provide habitat to sustain healthy wildlife populations over time. The guidelines do not address specific vegetation requirements that may be necessary to sustain some species or assemblages of wildlife. It is important to keep in mind that plant communities are dynamic systems and a mosaic of different seral stages of vegetation across the landscape is needed to provide vegetation and wildlife diversity over time. That is why a "one-size-fits-all grazing program" cannot meet all vegetation or wildlife objective needs on any given parcel of land. Well-defined wildlife habitat objectives and grazing management plans with provisions for monitoring and adjustments are necessary for any grazing allotment or system. WGFD habitat biologists and personnel from other agencies and groups with grazing management expertise should be consulted for assistance with grazing systems or plans.

Other Grazing Considerations

Water development may be valuable to enhance late brood-rearing habitat. Existing livestock water developments may not be useful to sage-grouse and should be modified to restore springs and other water sources to provide natural free-flowing water, wet meadow habitat, or at least overflow pits where birds can drink (Connelly et al. 2000*a*). In addition, attempts should be made to minimize raptor perches at water sources and provide bird escape ladders in all troughs and tanks. Improving livestock distribution and forage use in upland areas though water developments is often a recommended practice to deal with adverse impacts of grazing on riparian areas in the pasture or to deal with over utilization in livestock concentration areas. Locating new water sources in critical sage-grouse habitat can cause conflicts if the water source is near a lek and livestock use is planned between March 1 and May 15 or if livestock are concentrated near water in good nesting and brood-rearing habitat and forage utilization results in reduced levels of residual cover or excessive trampling. Livestock grazing should be managed to reduce conflicts with sage-grouse where possible and location of water sources should be evaluated before they are developed.

Fences are necessary to control livestock distribution and to achieve grazing management objectives, but may cause additional sources of sage-grouse mortality due to collisions or predation resulting from fences providing increased perches for raptors. Construction of fences within 1.2 miles (2 km) of leks or in areas where grouse frequently move between loafing areas and feeding areas (Braun 2006) should be avoided. If problem fences that result in significant sage-grouse mortalities are documented, options such as modifying the fences, marking the top strand with permanent markers visible in low light, or removing or relocating the fences to reduce sage-grouse mortalities should be considered. An example of fence modification would be to replace a standard barbed wire fence with a let down fences near leks. The fence would be put up to control grazing in late May and then let down again after grazing the pasture or before the onset of winter to eliminate the fence problem during the breeding season from March 1 through mid-May when grouse are present on and adjacent to the lek.

Braun (2006) recommended that range fences in sage-grouse habitat be only three strands and the top and bottom strands be smooth wire. He also suggested metal fence posts are preferable to wooden posts because they are less likely to be used as raptor perches. Fences no longer needed to control livestock distribution should be removed.

Project Implementation

Proposals for vegetation management within sage-grouse habitats should identify the limiting vegetation factor(s) for the population, evaluate the proposed treatment to determine if the desired vegetative response can likely be achieved, and determine if post-treatment land uses can be managed to ensure that vegetation objectives are met (Connelly et al. 2000*a*). A negative evaluation for any of these criteria may suggest the project should be modified or deferred until the criteria can be achieved.

Montana Department of Fish, Wildlife, and Parks has developed a vegetation management standard for sage-grouse habitats on lands managed under its Upland Game Bird Habitat Enhancement Program. We recommend that any proposal to treat sagebrush habitats should consider the three guiding objectives of this program to improve management of grazing on lands providing sage-grouse habitat.

1) Maintain or improve integrity of native range (vegetation species composition, ground cover, plant vigor, and soil building process).

2) Maintain or improve habitat function, serving to meet habitat needs of sage-grouse on a year-round basis (vegetation structure and species composition).

3) Maintain large tracts of intact native landscapes through sustainable livestock grazing management (Montana Fish Wildlife and Parks 2004).

Vegetation treatments should be conducted in a manner that achieves a mosaic of shrub patches and small open areas, providing a mix of early and late seral plant communities over the landscape (Nelle et al. 2000). Generally in breeding habitats, small openings in the shrub community are desirable. Research in southwest Wyoming suggests that sage-grouse broods do not use the interior of large openings or the interior of large patches of dense sagebrush (Slater 2003). Hens with broods used open areas within 197 feet (60 m) of the edge of shrub patches for foraging areas. The study also found that sage-grouse tended to use that portion of shrub patches within 197 feet (60 m) of the edge for cover (Slater 2003). In mature sagebrush stands, birds nest in dense patches of sagebrush and use adjacent small openings or micro-sites for foraging for the first two weeks of the chicks lives (Holloran 1999). In much area, these sites occur naturally and are the result of soil types and different species or subspecies of sagebrush.

Treatment areas should be designed to achieve this fine-grained mosaic of small open areas surrounded by cover patches to safeguard nesting and early brood-rearing habitats. Klott and Lindsey (1990) recommended that treated areas should not be wider than 100 feet (30.5 m). Shrub cover treatments should create open patches less than 247 acres (100 ha) in size in nesting and brood-rearing habitat in mountain big sage communities (Nelle et al. 2000). In Wyoming big sagebrush communities, patch size should be smaller in nesting habitat and early brood-rearing habitats. The result should be a "Dalmatian" effect of a fine-grained mosaic of small burn patches (small black spots) on the landscape (A. H. Winward, Forest Service retired, personal communication). Klebenow (1973) recommended using small fires to create 1-10 acre (0.4-4 ha) openings in homogeneous sagebrush to enhance breeding habitat. Autenreith et al. (1982) recommended small fires be used to create patches of a few acres in size in sagebrush stands to increase forb production and enhance brood-rearing habitat. They also recommended using small fires on the edges of meadows to remove encroaching sagebrush to enhance brood-rearing areas. However, they recommended leaving some sagebrush on the meadow perimeter to provide cover. Holloran and Anderson (*In press*) recommend that prescribed treatments within potential nesting habitat should be relatively small - 21.9 acres (54 ha) to 69.6 acres (172 ha) in size. Braun (2006) recommended prescribed fires should not exceed 49 acres (20 ha) in size and no more that 40% of a section should be burned over a 15-year period.

Klebenow (1973) recommended that winter habitat should not be burned. Autenreith et al. (1982) recommended that the use of prescribed fire to treat winter habitat should be done with extreme caution and that winter sage-grouse distribution should be mapped during peak snowfall conditions to determine and protect key wintering grounds. Patch size should not exceed 123.6 acres (50 ha) in winter habitat (Connelly et al. 2000*a*). Braun (2006) recommended mechanical treatments should be designed in strips that usually are 33-66 feet (10-20 m) in width, not to exceed 25% of the width of untreated strips. Such strips should be perpendicular to the wind to facilitate seed dispersal and conform to the terrain. Klott and Lindsey (1990) recommended that untreated areas should be at least as wide as the treated areas. The treatment prescription should try to achieve this mosaic over the landscape in nesting areas, early brood-rearing habitats, and winter habitats that are fairly extensive in nature if the existing sagebrush community does not provide adequate habitat conditions for sage-grouse (or to meet other resource objectives). In areas where sagebrush habitats are fragmented, treatment patch sizes should be smaller. Retention of small patches of residual sagebrush within the treatment blocks is important to facilitate sagebrush reestablishment from seed sources and to provide cover patches for sage-grouse feeding within the treatment areas. These residual patches provide some diversity within larger treatment areas and may provide nesting habitat for sage-grouse and other birds if the patches are large enough.

In late brood-rearing habitats, the treated areas can be larger, and the residual sagebrush patches can be smaller compared to treatments in breeding habitat. A coarse-grained mosaic within the treatment unit perimeter, with created openings equal to the areas with residual shrub cover, may be adequate. Treated areas can range up to 40% of the available summer habitat and patch sizes can range up to 250 acres (100 ha) in size. This mosaic can be achieved by developing a fire prescription for the designated treatment units that burns some but not all of the potential treatment area within the perimeter (e.g., treat every other draw) and leaves most of the areas outside the burn unit as residual cover. When the treated areas recover to the point where they achieve a minimum of 15% canopy cover of sagebrush, another treatment can be scheduled to turn over more of the late seral sagebrush stands.

In areas that have been already fragmented from past land uses or wildfires, residual sagebrush stands should be protected if more than 40% of the breeding habitat or winter habitat has been lost over the last 30 years and has not returned to sagebrush stands with adequate canopy cover. If the loss of sage-grouse habitat (sagebrush) falls within the 20-40% range and the residual shrub stands are in poor condition with inadequate understory vegetation, then careful evaluation is needed to determine if treatments will improve or degrade the habitat in the short term, and if the population can withstand the effects of the treatment. Some proactive habitat treatment may be needed, but the goal should be to retain most of the nesting and early brood-rearing habitat within a two-mile (3.2 km) radius of an active lek. It may be appropriate to consider the presence of good habitat outside the two-mile (3.2 km) radius as a mitigation factor for a proposed treatment if it can be demonstrated that the habitat is important to nesting sage-grouse and it is superior habitat compared to the breeding habitat closer to the lek. Such a decision will likely have to be based on radio telemetry data or intense field inventories, which may not be available for most projects.

If using prescribed fire to achieve the desired mosaic, the use of natural or man-made fuel breaks will be required. Spring burns can achieve the best fine-grained mosaic, but the burning window is so narrow that it is difficult to achieve the desired objectives. There is the added drawback of using prescribed fire during the nesting period of sage-grouse and other avian species. In most areas, prescribed fire should not be used in nesting habitat after April 10 to avoid nest destruction in the treated areas and displacement of hens in the adjacent untreated areas. This restriction is consistent with timing restrictions used by BLM to protect nesting sage-grouse from other resource development activities.

Strategies such as burning every second or third draw in areas of discontinuous fuel loads may allow for the control of the prescribed fire to achieve the objective. We recommend that no more than 50% of the linear sagebrush cover along the edge of wet meadows, riparian habitats along streams, irrigated hayfields, and other key feeding areas in brood-rearing habitats be treated. The sage-grouse guidelines by Connelly et al. (2000*a*) call for leaving a 984 foot (300 m) buffer of sagebrush around the perimeter of these areas unless it is necessary to achieve other management objectives. Since these areas are good treatment boundaries and fuel breaks, it is desirable to map and manage to retain these habitat features. Total retention or total removal of the cover next to key sage-grouse foraging areas is probably not warranted.

It is important to note that these guidelines are written to maintain and enhance sage-grouse habitat. As such, they could constrain important habitat restoration goals for other species. Managers should take into consideration the ecological processes that shape the landscape and, in turn, maintain habitats in space and time for all species. Spatially, vegetation analysis and treatment proposals need to be assessed from a 5^{th} order Hydrological Unit level to address the above concerns. Temporally, proposed treatments should be assessed relative to the range of known natural variability and disturbance regimes.

The following is an example that can be used to illustrate this point. Many sage-grouse leks are located in or near the higher elevation sagebrush steppe environments of western Wyoming where mountain big sagebrush *(A. t.* ssp. *v.* var. *pauciflora*), Wyoming big sagebrush, or their hybrids occur. Annual precipitation, usually accumulated as snow in these locations, is greater than 13-14 inches (33-36 cm). Deep rooting zones with greater water holding capacity are common. Plant succession is more rapid than in more xeric, lower elevation Wyoming big sagebrush steppe environments. These higher elevation areas are often the headwater zones of collection basins surrounding first and second order streams. Because they are ecologically diverse with great overlap between aspen, mixed mountain shrub, big sagebrush, and riparian communities, these areas are extremely important habitat for a host of native fish and wildlife species, including sage-grouse. Some of these areas tend to be primarily late summer brood-rearing habitat for sage-grouse, although they may also be important and highly productive nesting and early brood-rearing habitat. More frequent and larger scale treatments may be desirable and necessary, depending on habitat goals for the area. In some situations, recommendations such as "do not treat more than 20% of the breeding habitat (including areas burned by wildfire) within a 30-year period" (Connelly et al. 2000*a*) may conflict with other habitat restoration goals. In these cases, guidelines meant to protect or manage sage-grouse habitat may constrain opportunities to restore habitat diversity for other associated wildlife in the more productive, higher elevation steppe environments of Wyoming. Here it is important to recognize that not every acre of occupied sage-grouse habitat will be managed for sage-grouse, and other resource considerations may limit management options for sage-grouse in some situations. Habitat needs of some species will conflict with those of sage-grouse. Managers must decide how best to allocate the resource, and some trade-offs can be expected. These guidelines provide recommendations to manage sagebrush habitat for sage-grouse, are based on the current knowledge and best research available from sage-grouse experts, and are viewed as essential to the successful management of the species. If the guidelines cannot be met because of other resource considerations, then the environmental assessment should describe the consequences for sage-grouse and identify mitigation measures.

Post-Treatment Management and Monitoring

The post-treatment land use practice that most often needs to be considered is livestock grazing (Bunting et al. 1987). Post-treatment grazing practices should include adequate rest after the treatment to allow the range to recover (Blaisdell et al. 1982). At a minimum, treated areas should generally be rested for two growing seasons from livestock grazing (BLM Policy on Rest Period after Vegetative Treatment 2005). Stevens (2004*b*), in Monsen et al. (2004), Restoring Western Ranges and Wildlands, provides an excellent discussion of the management of restored and revegetated sites. Particularly instructive are Tables 1 and 2 on page 195, which provide recommendations for minimum years rest from grazing following revegetation for different vegetative types. These recommendations vary according to treatments, site conditions, and special circumstances that may require additional periods of nonuse (growing seasons). For example**,** Stevens (2004*b*) recommends three-four growing seasons rest from grazing in Wyoming big sagebrush types, depending on whether the site is in an annual precipitation zone below or above 12 inches (30.5 cm), respectively.

The success of the treatment and the restoration of sage-grouse habitat will depend on the grazing system and utilization levels that follow the vegetation treatment. To quote Stevens (2004*a*:155), "Productive livestock ranges can, with proper planning and management, be productive wildlife ranges; however, many livestock range improvement projects have been detrimental to wildlife, particularly big game and sage-grouse."

It is also important to monitor post-treatment forage use by all large herbivores, including livestock. Other activities that could affect vegetative recovery of the treated areas, such as offroad recreational vehicle use, should also be monitored and managed. It is essential to determine if the vegetation treatments have received the prescribed amount of rest, the post-treatment forage utilization is within allowable parameters for the grazing allotment, and that other land use activities are compatible with the vegetation goals for the project area. One of the biggest failures of habitat projects is that gains achieved by vegetative treatments are lost through poor post-treatment grazing practices (Bunting et al. 1987). During periods of drought, similar to what Wyoming has experienced in recent years, the damage to rangeland from excessive grazing can be significant (Bennett 1992). Vegetative recovery can be delayed or compromised if utilization levels are excessive on newly treated areas. It is essential land managers consider, and where appropriate, implement the protective measures for the management of restored and revegetated sites discussed by Stevens (2004*b*:193-198). These protective measures may need to be retained for as many as 10 years following treatment if full recovery to the potential of the site is to be achieved.

Following completion of vegetation projects, the treatment areas should be monitored as discussed in the Wyoming Guidelines for Managing Sagebrush Communities with Emphasis on Fire Management (Wyoming Interagency Vegetation Committee 2002). Monitoring objectives should include habitat objectives needed to achieve sage-grouse habitat goals. A pre-treatment and post-treatment evaluation should be required. The vegetative response to the treatment should be monitored to determine if sagebrush is regenerating, if forbs increased, and if there is an increase in desired grasses. The post-treatment evaluation should also document residual sagebrush canopy cover and cover patch size, treatment patch size, and provide a GPS generated map of the treatment perimeter. It would be useful if a standardized protocol for pre-treatment evaluations and post-treatment monitoring of sage-grouse habitat on all federally owned lands could be adopted to assure the data is collected and analyzed consistently. Private landowners and state land management agencies should be encouraged to use similar protocols to evaluate and monitor projects on lands under their jurisdiction or ownership.

It is important to monitor lek attendance of males in the analysis area (which includes all the leks in the lek complex or population associated with the treatment) over time to attempt to determine the sage-grouse population response to the treatments. Following standard sage-grouse lek count protocols found in Appendix 1 of the Wyoming Greater Sage-grouse Conservation Plan (Wyoming Game and Fish Commission 2003), the grouse population should be monitored for at least 10 years post-treatment and the information should be reported annually. It is recommended that, for the purposes of evaluating vegetation manipulations, annual male attendance should be reported based on a three-year moving average. Intensive population monitoring using radio telemetry would be useful, but is not practical for most projects. For the purposes of this analysis, sage-grouse population trends should be compared between leks affected by the treatment (lek complex) and a reasonably comparable lek complex that has not been affected by the treatment, which would act as a control in an experimental design. This type of an evaluation is less than perfect, but changes in bird numbers and distribution should be monitored to determine if the expected response by the target population was achieved and to determine if changes in management direction are needed to maintain sage-grouse populations.

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