Sage-Grouse Habitat Assessment Framework

Multi-scale Habitat Assessment Tool

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The Sage-grouse Habitat Assessment Framework (HAF) has been organized into three volumes. The first volume is a conceptual overview of the HAF and how we envision its implementation. Volume II provides the life requisites, indicators and characteristics for sage-grouse at each scale of habitat selection. Volume II further provides discrete habitat description steps and methodology for completing data collection and assessments at each scale. Volume III contains the array of forms for data collection. The document is designed to be used as separate volumes or in combination, depending upon the needs of the reader.

Acknowledgements

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In 2004, following the release of the Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats (Connelly et al. 2004) it became apparent that assessing sage-grouse habitats at multiple scales was needed because the species used large landscapes and occurred over a large geographical range in western North America. In January 2005, the Western Association of Fish and Wildlife Agencies (WAFWA) Directors passed a resolution to coordinate with BLM on the development of a Sage-grouse Habitat Assessment Framework. Again Signe Sather-Blair brought together a team composed of BLM and Idaho Department of Fish and Game biologists (Michelle Commons-Kemner, Tom Rinkes, and Alexis Carroll) to address sage-grouse at multiple habitat scales. To assist this group in developing this document an informal working group composed of various disciplines, federal and state agencies, and universities was convened to assist in addressing these issues. The comments provided by the working group were invaluable in the development of the final product. This working group was composed of the following individuals:

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Sage-Grouse Habitat Assessment Framework

Volume I

Sage-grouse Multi-scale Habitat Assessment

Conceptual Overview

Sage-grouse Habitat Assessment Framework
A Multi-Scale Assessment
Volume I – Conceptual Overview

Preamble

This document provides policy makers, resource managers, and specialists with a comprehensive framework for landscape conservation in the sagebrush ecosystem. Success of this approach is founded on four pillars: science, effective conservation policy, implementation and adaptive management. Recent landscape evaluations indicate that conservation of sagebrush ecosystems have not been realized because large scale mapping was not available to inform site scale management actions. Advances in landscape ecology enable conservation planners to develop spatially-explicit decision support tools that link populations with habitats for effective conservation planning, implementation and evaluation at landscape scales. A shift from local to landscape conservation will empower decision-makers to maximize likelihood of achieving conservation by implementing site-scale actions within priority landscapes. Standardized methodologies provide consistency in terminology and techniques for site-scale assessments.

Introduction

Sage-grouse represent a focal species for sagebrush conservation because they select habitats at multiple scales. Conservation of sagebrush landscapes has been difficult because large scale mapping was not available or unused to inform site-scale management actions. Rather, cumulative impacts that reduce and degrade habitat continue to overwhelm systems and leave managers struggling to maintain viable populations. Conservation concerns will remain at the forefront until we demonstrate the ability and political will to manage habitats across scales that match the biological needs of focal species (Mills 2007) such as sage-grouse.

Sagebrush habitats

Conservation of the sagebrush ecosystem is dependent upon collaborative landscape planning and implementation of appropriate actions. Landscapes have to be prioritized for conservation because

threats to habitats are numerous and varied, and resources are limited (Bottrill et al. 2008). Implementing ecosystem conservation across landscapes represents a proactive and fundamental shift in management philosophy. This shift will provide the mechanism for efficient allocation of limited resources to maximize the biological return on conservation investments. Outcomes should yield a set of viable and connected populations and their associated habitats.

The vision of the Habitat Assessment Framework (HAF) is to proactively implement conservation in priority landscapes to provide the greatest benefit to sage-grouse populations. This approach will allow managers to integrate conservation actions at a project level that make sense at the population level. Broad-scale mapping that is linked to populations is the key to identifying priority landscapes for conservation. Spatial analyses provide decision-support tools to 1) identify landscapes with high biological value, 2) evaluate all risks to refine conservation strategies, and 3) simulate how proposed changes in policy would affect sage-grouse distribution and abundance. Lastly, this approach, grounded in science, provides the ability to assess management outcomes, a vital step in quantifying success of past actions, informing future actions, and garnering additional social and financial support for conservation (Naugle and Walker 2007).

The HAF challenges administrators, scientists, resource specialists and local working groups to make this collaborative vision a reality. The HAF provides a blueprint for landscape conservation but the actual mechanics of its implementation are still to be decided. The Bureau of Land Management will play a key role in successful implementation of the HAF because they manage >50% of sage-grouse habitat (Connelly et al. 2004). Other state and federal land ownerships account for an additional 20%. Private, tribal and other non-public lands comprise about 25% of the habitat. Sage-grouse transcend jurisdictional boundaries, and these lands are frequently intermixed with public lands and require coordinated management (Figure I-1). States also will be pivotal players because they hold ultimate responsibility for management of sage-grouse populations.

Hierarchy for Implementing Landscape Conservation

Landscape conservation begins with a policy vision for the management of the sagebrush ecosystem. Policy to facilitate landscape conservation must be developed at the highest levels of government in collaboration with major land users, state governments and the public. Policy originating from these high levels is analogous to first order habitat selection (Johnson 1980) for sage-grouse at the range-wide scale (Figure I-2).

Second order selection is a systematic appraisal of habitat availability and bird abundance (Figure I-1) within sage-grouse management zones (Figure I-3). Stakeholders provide input to decision-makers who in turn develop policy to balance conservation objectives with other demands on resources. Spatial analysts then link maps depicting populations and habitats with natural and anthropogenic constraints that limit populations to inform decision-makers of potential management scenarios. Decisions at this level are borne by State/Regional level federal land management officials in concert with State and Tribal governments.

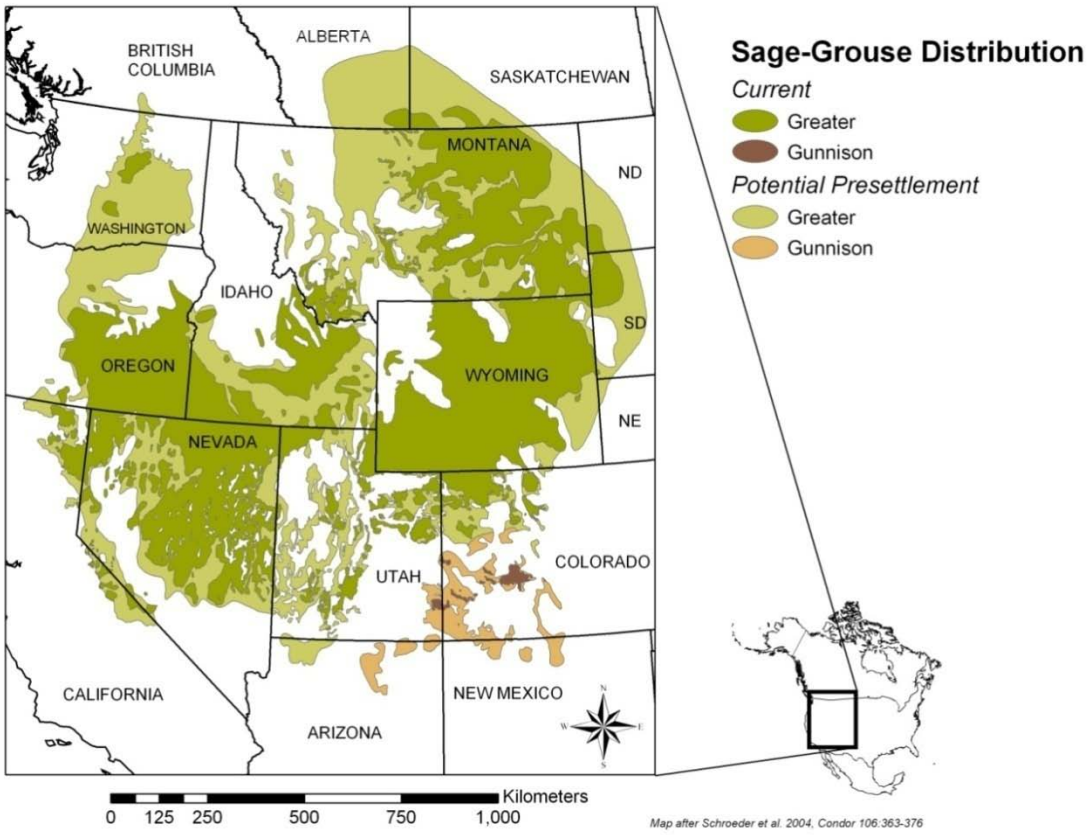

Figure I-1. Current distribution of sage-grouse and pre-settlement distribution of potential habitat in North America (After Schroeder et al. 2004).

Third order selection is at the project level where decision-makers select a management alternative using science, site-scale habitat assessments, public input, and evaluation of alternatives (Figure I-2). They allocate resources, and direct resource specialists to initiate conservation actions.

Fourth order selection (Figure I-1) is the actual implementation of conservation actions, monitoring of results and evaluation of outcomes by resource specialists. The HAF provides consistency in terminology and techniques for site-scale assessments (Volumes II and III). This enables resource specialists to use standardized methodologies in evaluations that inform decision-makers of ways to adapt and improve future management actions.

Sage-grouse as a Focal Species for Conservation

Sage-grouse provide resource managers with a unique impetus for conservation of the sagebrush ecosystem and species that depend upon this ecosystem. Although sage-grouse distribution has declined by nearly half (Schroeder et al. 2004), they are still distributed across approximately 668,412 km^2 of the sagebrush ecosystem (Figure I-2). The diversity of habitats used during each life stage make sage-grouse an appropriate focal species (Mills 2007) for managing the sagebrush ecosystem (Wisdom et. al 2005, Rowland et al. 2006, Hanser and Knick *In Press*).

Conservation of sage-grouse will be challenging. Previously widespread, the species has

undergone population declines of 45-80%, and local declines of 17-92% (Connelly and Braun 1997, Braun 1998, Connelly et al. 2000, Aldridge and Brigham 2003, Connelly et al. 2004). Loss and degradation of habitat from anthropogenic developments, fire, and invasive species are among the most important factors leading to isolation, reduction and extirpation of populations (Braun 1998, Connelly et al. 2000, Aldridge and Brigham 2002, Knick et al. 2003, Wisdom et al. 2005). These, combined with new constraints such as West Nile virus (Walker et al. 2004, Naugle et al. 2004, 2005), climate change (Nielson et al. 2005) and genetic isolation (Oyler-McCance et al. 2005) require an integrated approach to landscape conservation to assess and effectively conserve sage-grouse populations and associated habitats.

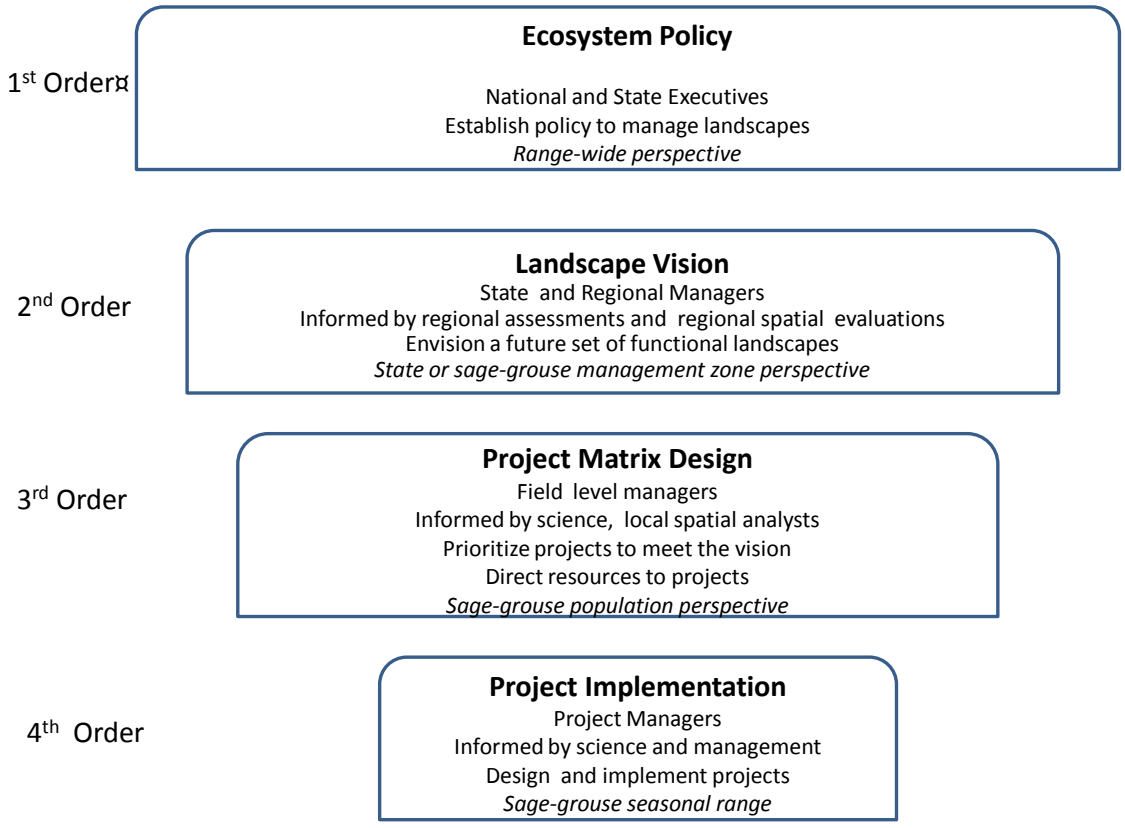

Figure I-2 Assessment decision making matrix.

Intended Application

The HAF was developed for use by resource managers working closely with specialists in range management, landscape ecology, GIS, botany, wildlife, and other associated disciplines. To be fully functional, the HAF will require input from policy and operational staff. Flexibility is part of the suggested procedures and professional judgment will be required in its application, hence the need for experience. An increased capacity to deliver conservation will need to be addressed regionally because actions necessary to enhance populations vary widely across management zones (Figure I-3). Quantity and quality of population and distribution data also vary widely for individual populations and across management zones (Figure I-3), and users of the HAF may be required to make certain assumptions concerning local populations. Shortcomings in existing datasets highlight the need to identify and subsequently collect additional datasets. Datasets may include population and habitat information on

seasonal use patterns, home ranges, migratory and dispersal movements and fitness to aid in identifying important habitat areas and features.

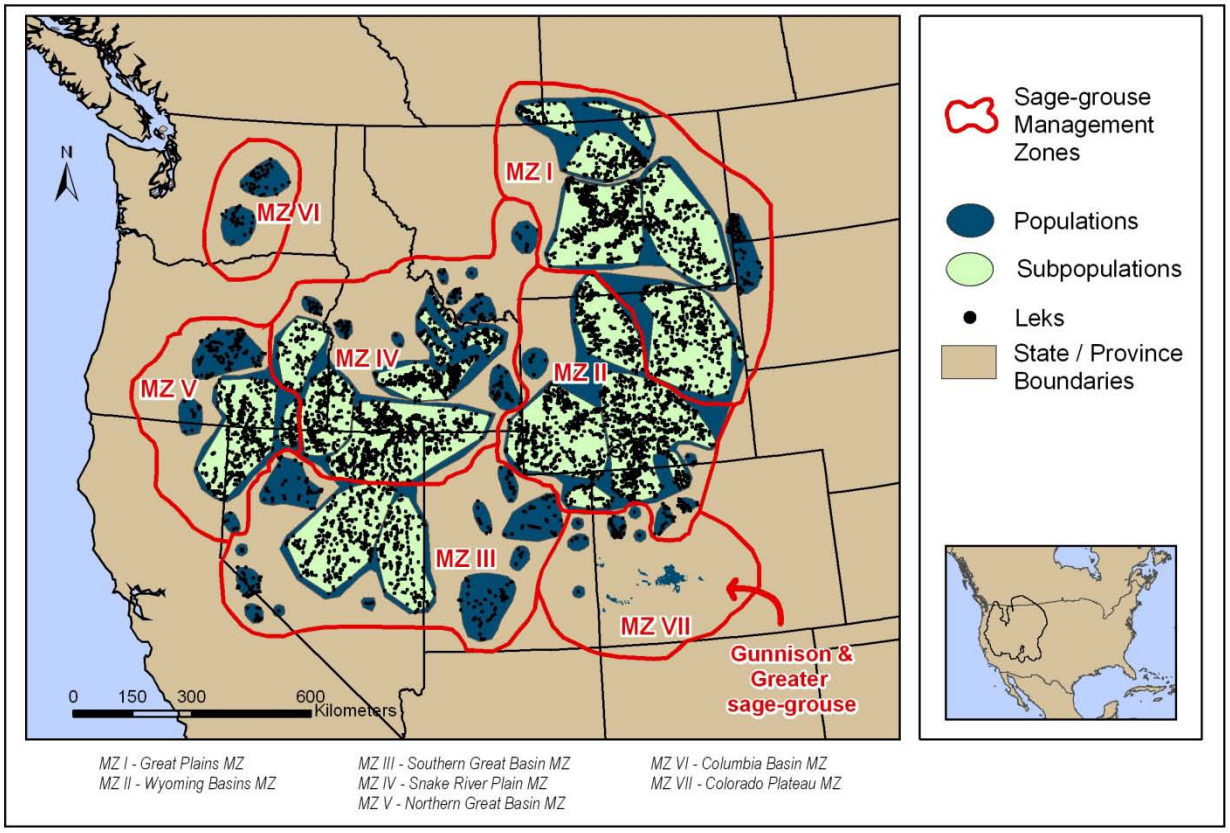

Figure I-3. Sage-grouse Management Zones (Stiver et al. 2006).

Inventory and Monitoring

Inventory and monitoring are integral components of the HAF. Inventory provides baseline data and may provide projections of future condition. Monitoring changes in the baseline provides a metric for determining the effectiveness of conservation actions. Inventory of habitat characteristics used in the HAF are synonymous with the wildlife habitat inventory described by Cooperrider et al. (1986). Monitoring is a primary tool for applying effective adaptive management strategies in conservation and fulfilling the commitments in the Greater Sage-grouse Comprehensive Conservation Strategy (Stiver et al. 2006) and the Gunnison Sage-Grouse Range-wide Conservation Plan (GSRSC 2005).

Ecological Scales and Associated Processes

Habitat Selection Processes

Landscape conservation is a scale-dependent process whereby priority landscapes are identified across the species range (broad-scale) and appropriate conservation actions are implemented within seasonal habitats to benefit populations (site-scale). The HAF has adopted the hierarchical orders of habitat selection as described by Johnson (1980). Johnson's orders of selection are widely accepted and provide the foundation for the HAF to discuss scale in common and consistent terms. Johnson (1980)

described four orders of habitat selection in which each latter order is dependent on the previous higher order (Figure I-4): a food item is nested within a feeding site, which is nested within a seasonal use area, which is nested within a home range, which is nested within a population area, which is part of the species range (Table I-1). For example, sage-grouse select nesting and feeding areas within their seasonal range and that seasonal range is nested within their home range. An ecological or anthropogenic disturbance that changes their home range can affect nest or feeding site selection.

First order selection (Figure I-4) is described as "the selection of physical or geographical range of a species" (Johnson 1980:69). By definition we have only one first order habitat, the range of the species (Figure I-2). For sage-grouse, this is defined by populations of sage-grouse associated with sagebrush landscapes (Connelly et al. 2003). Populations or subpopulations within those populations are the second order selection (Figure I-3). The second order selection habitats may include as many as 41 discreet populations (Connelly et al. 2004). Third order selection is the home range of an individual bird (Figure I-4). Location and size of a home range is in part determined by the quality and juxtaposition of resources within and between seasonal habitats. Fourth order selection (Figure I-4) is the use of a particular nesting, feeding or roosting site within one particular seasonal habitat. Spatial and temporal scales are evident throughout the selection process – becoming finer as orders of selection increase.

Orders of habitat selection provide a unifying framework in which to evaluate populations and their habitats. At the second order, state and regional planners and decision makers have the flexibility to design a "future" landscape and the location and types of actions necessary to achieve desired conditions. The resource manager is provided significant flexibility evaluating third and fourth order habitat selection. The manager must provide an accurate estimate of populations, sub-populations; seasonal-use habitats and ecological site potentials to effectively coordinate and design appropriate conservation actions.

Table I-1. Four orders of habitat selection by sage-grouse according to Johnson (1980).

Habitat Selection Processes	**Broad-Scale**	**Mid-Scale**	**Fine-Scale**	**Site-Scale**
Orders of Habitat Selection	**First-order:** Range-wide distribution of sage-grouse populations throughout the West.	**Second-order:** Physical and geographic range of populations and subpopulations: 1) Habitat characteristics within populations and sub-populations. 2) Dispersal between sub-populations.	**Third-order:** Physical and geographic area within home ranges: 1) Habitat characteristics within a home range (sagebrush and associated vegetation communities). 2) Movement between seasonal ranges (breeding to summer, summer to winter).	**Fourth-order:** Physical and geographic area within seasonal ranges to meet life requisite needs: 1) Habitat characteristics within a specific seasonal range (e.g., breeding, brood-rearing/summer, winter). 2) Movement between daily use sites (feeding to loafing, nesting to feeding).

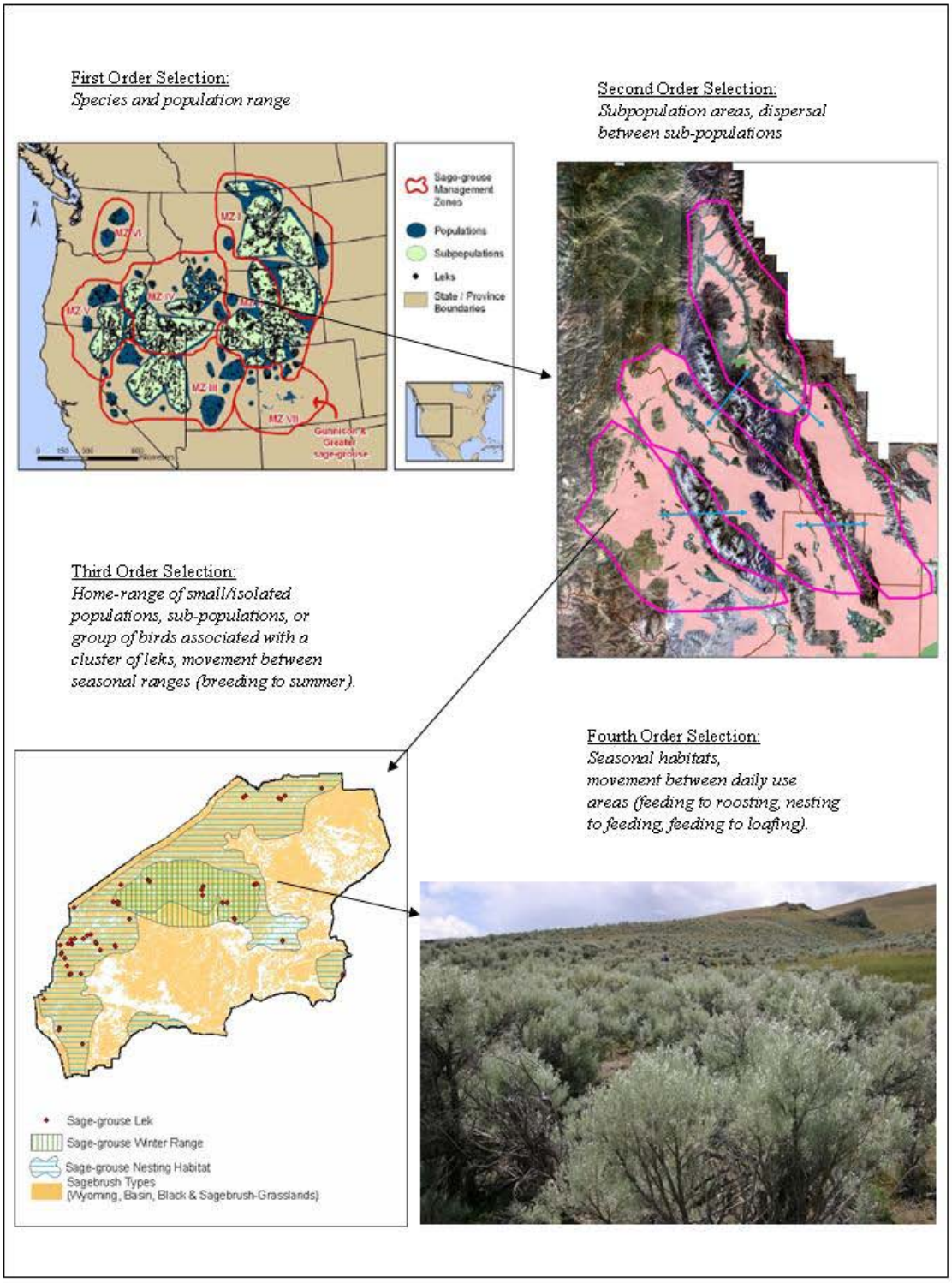

Figure I-4. Habitat selection process for sage-grouse based on Johnson (1980).

Organization of Three Volumes

The HAF has been organized into three volumes. The first volume (this document) is a conceptual overview of the HAF and how we envision its implementation. Volume II provides the life requisites, indicators and characteristics for sage-grouse at each scale of habitat selection. Volume II further provides discrete habitat description steps and methodology for completing data collection and assessments at each scale. Volume III contains the array of forms for data collection.

Scale Assessments

Implementation of the HAF requires practitioners at each scale to use their best analytical skills, resources and flexibility to identify priority landscapes and implement conservation actions that benefit populations. A hierarchical approach to landscape conservation requires executives to provide policy direction and resources to manage the landscape as a functional unit. Policy direction and resources facilitate conservation and empower managers at finer scales.

State and regional managers that design the future landscape, at the second order of selection, will develop policy direction to begin their task of evaluating sage-grouse habitat needs. These needs include protection, management and restoration of seasonal habitats and the maintenance of pathways that facilitate movement within and among populations (i.e., connectivity). State and regional decision makers will provide third order managers with the vision and the resources to meet the landscape vision.

Managers at the third order will use the landscape vision blueprint to design a matrix of conservation actions that meet the landscape vision. Managers at this level, informed by science and inputs from local spatial analysts and s, will develop actions and priorities of the matrix. Resources to conduct conservation actions will be estimated, acquired and allocated to the project matrix design. The matrix of conservation actions will guide managers with project implementation priorities.

Project managers at the fourth order of habitat selection will conduct site-specific habitat assessments, implement conservation actions, and install monitoring studies. These actions will be guided by science and management at the site level, prioritized by the third order assessment described by the second order assessment with executive conservation policy determined in the first order. If successfully implemented, the Habitat Assessment Framework will be utilized as the initiation of a new era in landscape conservation of the sagebrush ecosystem.

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Sage-Grouse Habitat Assessment Framework

Volume II

Sage-grouse Habitat Requirements

and

Data Descriptions

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A Multi-Scale Assessment

Volume II

Sage-grouse Habitat and Data Descriptions
Habitat Suitability – Life Requisites, Indicators and Characteristics

Introduction

Sage-grouse habitat suitability is described at different spatial scales to address the ecological processes and population dynamics that occur at each scale. Although, life requisites of space, food and shelter are not easily segmented into spatial scales, addressing these requisites is an imperative for description and conservation planning purposes. The life requisite of space is significant at all scales though in different contexts. Pathways for movement within and between populations are critical for maintaining population viability. Having access to well-connected sagebrush patches that provide dispersal and movement among subpopulations is essential for sage-grouse survival. A variety of natural or anthropogenic disturbances may interrupt or retard dispersal, which is essential for population viability. Similarly, at the fine-scale, habitat availability, security and connectivity within home ranges are important for securing seasonal movements to shelter and food needs. Shelter and food availability at the site-scale within the seasonal ranges directly affects individual fitness, survival, and reproductive potential. Thus, the suitability of habitat at each scale has significant conservation implications on population health.

Descriptions of measurable habitat characteristics, procedural steps and habitat models are necessary tools biologists use to standardize techniques for habitat descriptions that reflect life requisite needs (USDI 1980, Cooperrider et al. 1986, Gilbert and Dodds 1987, Morrison et al. 1998). Habitat indicators are often used to characterize the environment in terms of suitability for shelter, food, water and space. They must be sensitive to the ecological processes operating at the scale of interest. Indicators are based on scientific research findings and should be quantitatively repeatable for data summarization and to avoid bias. A single habitat indicator does not define habitat suitability for an area or particular scale. Once measured or described, indicators must be collectively reviewed and put into context for a habitat description. In many cases more than one scale with multiple indicators will be of interest. This section describes the important habitat indicators for each scale, and integrating information for within- and between-scale habitat descriptions.

The Habitat Assessment Framework (HAF) adopted Johnson's hierarchical description of scale. The first order selection is described as, "the selection of physical or geographical range of a species" (Johnson 1980:69, Hagen 1999). By definition, we have only one first order habitat, the range of the species. For sage-grouse, this is defined by populations of sage-grouse associated with sagebrush landscapes (Connelly et al. 2003). Populations or subpopulations within those populations are the second order selection. The second order selection habitats may include as many as 41 discreet populations (Connelly et al. 2004). Sagebrush patch

configuration within the landscape matrix of other vegetation types and land uses affects home range habitat selection and use. Within these home ranges, seasonal habitats are selected (third-order selection). The pattern and connectivity of sagebrush communities and other beneficial habitats such as riparian areas, wet meadows, and grasslands (within close proximity to sagebrush shrub communities) affect seasonal use and movement between seasonal ranges. Finally, within seasonal habitats sage-grouse select nesting, feeding, and roosting areas based on site-scale habitat availability (fourth order). Spatial and temporal scales are evident in this selection process – becoming finer as selection orders increase.

First Order (Broad-Scale) Habitat Suitability and Indicators

The first order (broad-scale) habitat selection is the range-wide potential pre-settlement habitat of both species of sage-grouse (Schroeder et al. 2004) (Figure II-2). Sage-grouse historically occupied up to 1,200,483 km^2 (~463,500 miles^2) Schroeder et al. (2004) estimate they have declined 44% to a current distribution of approximately 668,412 km^2 (~258,000 miles^2) Connelly et al. (2004) provided figures that demonstrate the extent of the first order. Habitat suitability was demonstrated in the Assessment by evaluating sage-grouse numbers at leks, distributed across the landscape (Figure II-2). This figure and underlying dataset provides decision makers and conservation planners with a baseline from which they may begin the broad process of "visioning" the configuration of the landscape.

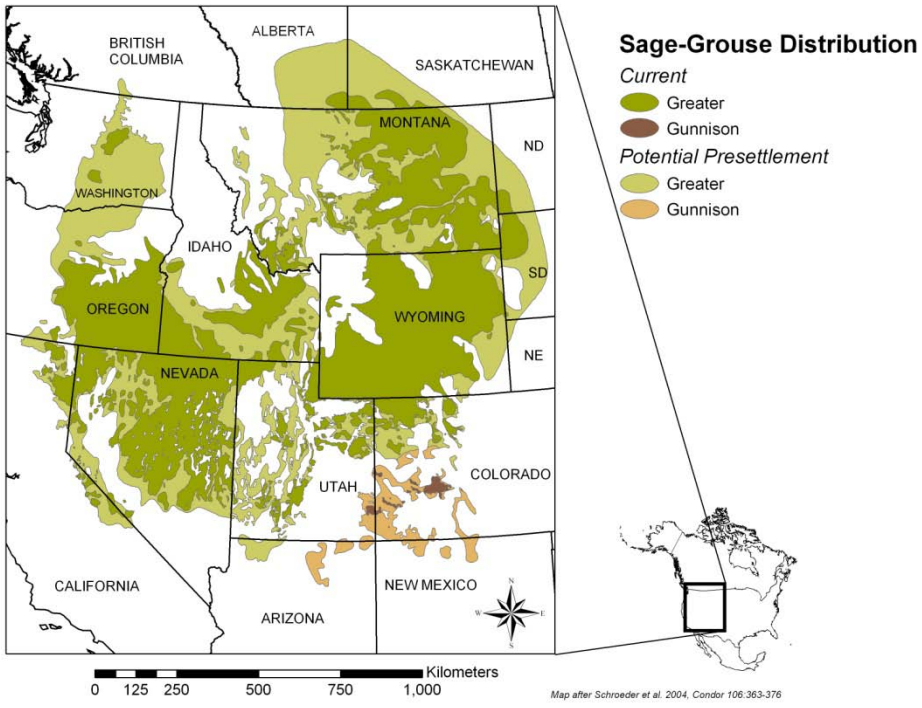


Figure II-4. First order sage-grouse habitat. The range of the species.

Connelly et al. (2004) discussed first order sage-grouse habitat suitability in terms of characteristics such as availability of large expanses of sagebrush or grass/sagebrush habitat, presence of migration corridors, and juxtaposition of other habitats and land uses within these large expanses.

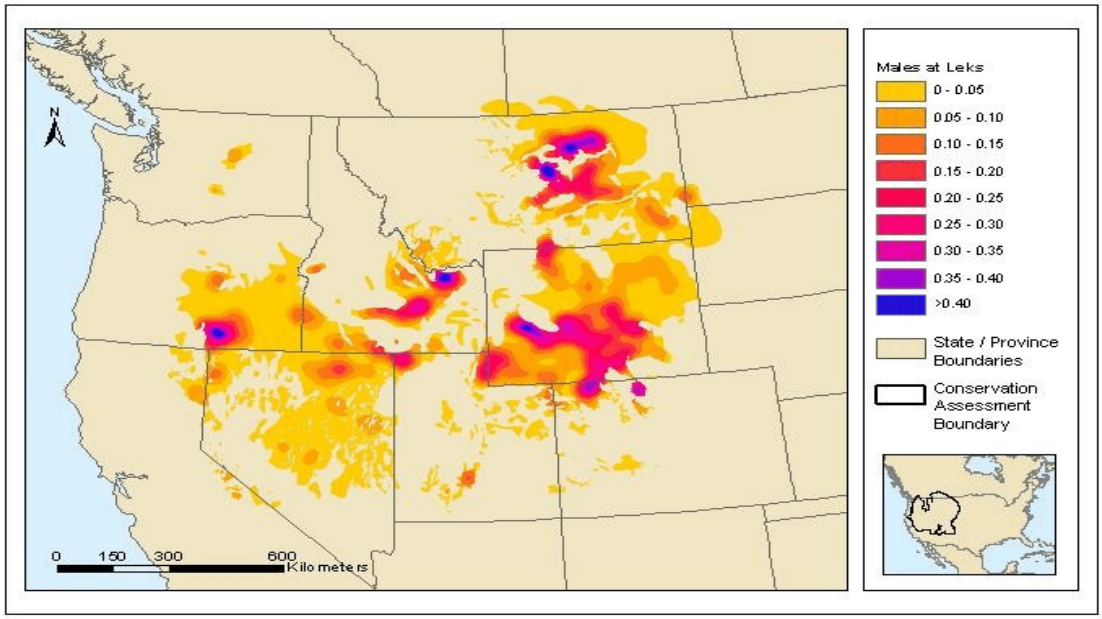


Figure II-5. Sage-grouse population strongholds. (From Connelly et al. 2004)

Second Order (Mid-Scale) Habitat Suitability and Indicators

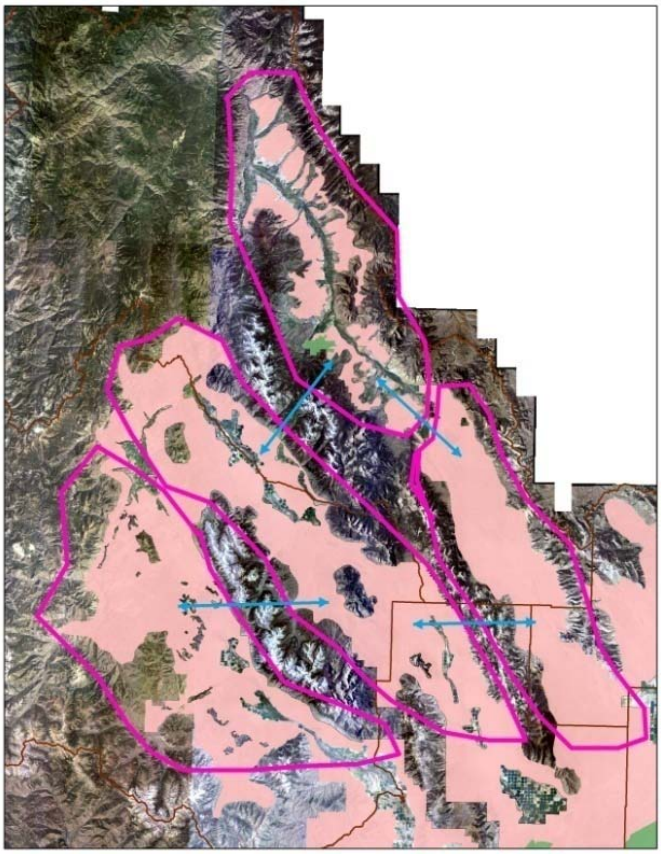
Second order habitat descriptions are linked to bird dispersal capabilities in population and subpopulation areas (Figure II-3). These population areas have been geographically described in a general manner for the Greater (Connelly et al. 2004; Figure 12) and for Gunnison Sage-grouse (GSRSC 2005; Figure 1). A detailed description of the distribution of Greater Sage-grouse populations and subpopulations is described in the Conservation Assessment (Connelly et al. 2004). Second order descriptions are generally appropriate for subpopulations. However, some isolated populations may warrant second or third order habitat descriptions.

The mix of sagebrush or grassland/sagebrush patches on the landscape at the second order also provides the life requisite of space for sage-grouse dispersal needs. The configuration of sagebrush or grassland/sagebrush habitat patches and the land cover or land use between the habitat patches within a subpopulation defines suitability. Landscape suitability at the mid-scale for subpopulations can generally be described by the following scenarios:

- Suitable habitats within landscapes have connected mosaics of sagebrush or grassland/sagebrush that allow for dispersal movements across subpopulations. Anthropogenic disturbances that can disrupt dispersal or cause mortality are generally not wide-spread or are absent.
- Marginal habitats within landscapes have patchy, fragmented or low quality sagebrush shrublands (cheatgrass (*Bromus tectorum*) or medusahead (*Taeniatherum caput-medusae*) in the understory) or grasslands/sagebrush that are not well connected for dispersal between portions of subpopulations.

Anthropogenic disturbances that disrupt dispersal or cause mortality are common throughout all or portions of the landscape.

- Unsuitable habitat within landscapes are formerly shrubland habitat dominated by shrubs and converted to primarily grass dominated shrubland or shrubland dominated by trees, or perennial grassland dominated with sagebrush converted to other uses. Resulting habitats are predominantly or nearly unoccupied. The area has potential to become occupied in the foreseeable future through succession or restoration.



At the second order, sage-grouse occupancy and dispersal are dependent on the extent and pattern of sagebrush shrublands within a landscape matrix of non-habitat and unsuitable habitat. Other habitats such as grasslands, wet meadows, and riparian areas provide important habitat for sage-grouse but only when they are in close proximity to sagebrush habitat (Connelly et al. 2004). The importance of these habitats is more appropriately addressed at the site-scale where seasonal habitat needs are addressed.

Figure II-6 Second order of habitat selection. The map demonstrates a series of interconnected sub-populations in mountain valleys.

There are three significant second order habitat indicators that influence habitat use, dispersal and movement across subpopulation areas (Table II-1):

1. Availability of sagebrush habitat.
    - Size and number of habitat patches.
2. Connectivity of habitat patches.
    - Vegetation structure characteristics of linkage areas between patches.
3. Landscape matrix in which patches are imbedded and resulting fragmentation.
    - Habitat fragmentation - scope of unsuitable and non-habitats and intensity of anthropogenic features between habitat patches.

The threshold metrics for these indicators are not completely known and it is likely that the

relationships among indicators confound thresholds. Consistently describing subpopulation areas using these indicators across the range of the species may provide insights important in conservation planning. Comparing changes in these second order indicators over time (e.g., between existing conditions and those of an earlier reference period) provides information on habitat trends. These indicators include A) reference period, B) habitat availability, patch size and connectivity, C) landscape matrix, linkage areas and patch edges, and D) anthropogenic disturbances.

Habitat suitability thresholds are poorly understood (Connelly et al. 2004) at the second order of habitat selection (Connelly et al. 2004). Quantifying existing habitat conditions using the four sets of indicators and population monitoring will help reveal habitat and population relationships and comparing existing conditions over time, or reference period, and could be helpful for describing habitat trends associated with second order indicators.

Habitat availability, patch size and connectivity are primary components of suitability in the second order. Generally, the larger and more contiguous the sagebrush patches of a (sub)population are, the greater the suitability for this indicator. The amount of occupied habitat within the landscape matrix of non-habitat and unsuitable habitat is important to describe (Table II-1, Indicator 1). In some areas, the ratio of suitable to marginal to unsuitable habitat would be an important conservation statistic for measuring habitat restoration progress. Whether the available habitat is contained in one large habitat patch or several patches (Indicator 2) could influence sage-grouse use and dispersal between subpopulations (Figure II-4). Dispersal could be uninterrupted in large habitat patches, whereas movement between patches may be disrupted, depending on the configuration of the patches and landscape matrix in which they are imbedded. The closer the suitable habitat patches are to each other, the more likely sage-grouse can freely move between them (Indicator 3).

Habitat linkage and patch edges forming a matrix on the landscape can greatly influence habitat use and dispersal within and between occupied areas. The landscape context in which

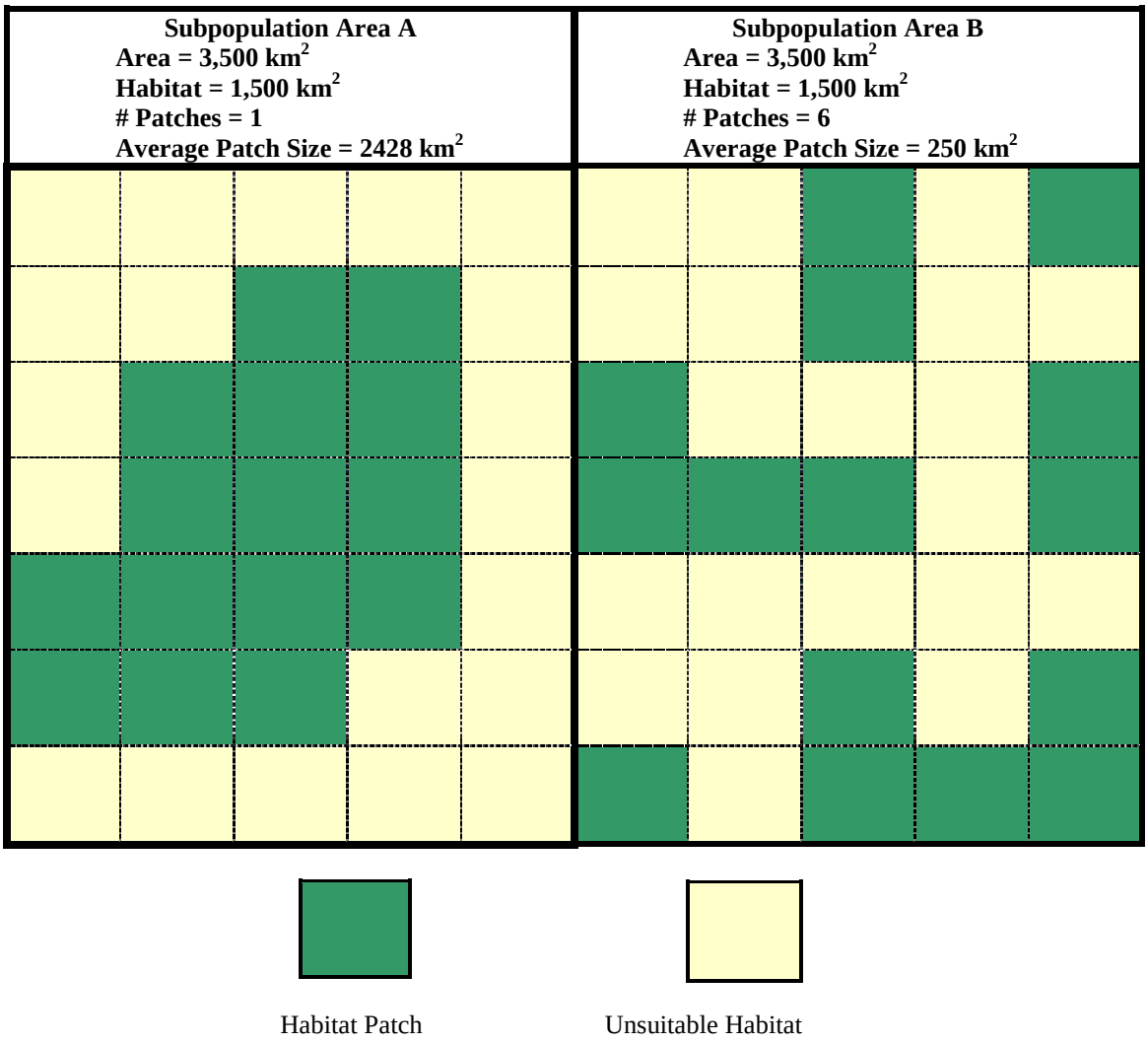


Figure II-4. Areas A and B have similar total area and habitat quality, but Area A has one large habitat patch while Area B has several smaller ones. In area A, sage-grouse can freely disperse. The distance between patches in Area B is great enough to limit sage-grouse movement between the patches, potentially affecting habitat suitability.

patches are located has a bearing not only on habitat suitability for dispersal between patches but also on the likelihood that the habitat patches will persist into the future (Morrison et al. 1998). Resource managers, planners and decision makers should evaluate existing or potential pathways from habitat patch to habitat patch. Barriers that compromise sage-grouse movements between habitat patches are not completely understood and are variable (Connelly et al. 1988, Beck et al. 2006, Leonard et al. 2000) It is believed that linkage area suitability improves as the percent of shrub cover (not necessarily sagebrush) increases relative to tree or grass cover in the areas between the habitat patches (Table II-1, Indicator 4). The cover type or land use immediately adjacent to a habitat patch can affect the quality of that patch suitable as sage-grouse habitat. As previously stated, when shrub cover increases and tree cover decreases in adjacent cover types, the likelihood that birds will disperse through those areas increases (Morrison et al. 1998). Adjacent land cover types also differ in: (1) mortality risks posed to birds occupying the habitat

patch, (2) influence on existing patch quality and (3) influence on patch and habitat persistence. As the proportion of suitable habitat in contact with adjacent land cover types increases, habitat patch suitability also increases (Figure II-5). This is termed positive edge. Edge effects associated with roads and

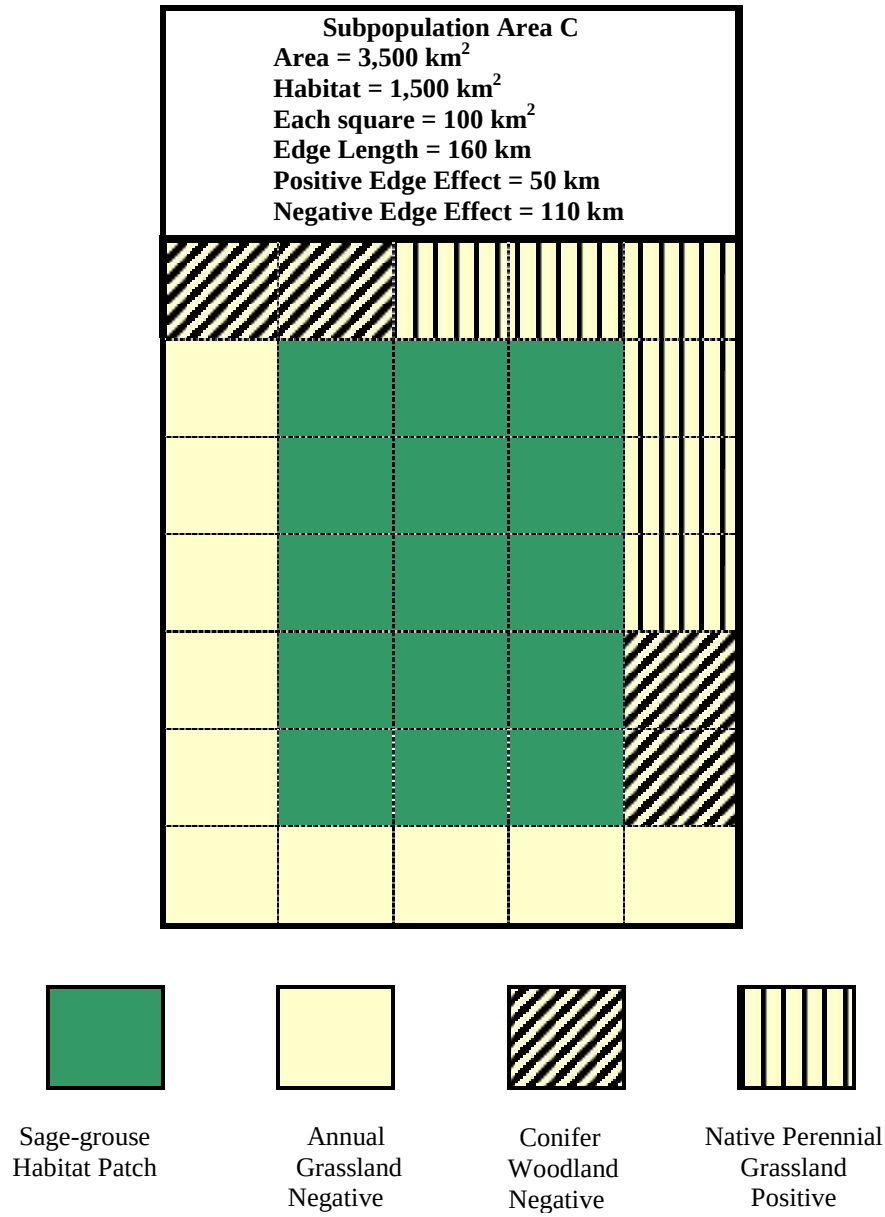


Figure II-5. The habitat patch in this figure is a function of contrast and (dis)similarity. These communities greatly affect future risks to sage-grouse populations and habitat suitability.

other linear anthropogenic features within habitat patches are discussed later as a component of fragmentation within the habitat patch.

Anthropogenic disturbances influence sage-grouse habitat, numbers and distribution at each order of habitat selection. Anthropogenic features can affect sage-grouse productivity in two significant ways:

- Anthropogenic features may directly and indirectly cause mortality, which can then affect the long-term sustainability of the subpopulation. The mortality significance of the features depends on their scope and intensity. However, an increase in anthropogenic features in otherwise suitable habitat increases the probability that the habitat will become a sink rather than a source habitat (Aldridge 2005). Effects of the human footprint may not be readily apparent in the immediate population response, but over time, and if the scope and intensity of these features increase, there will likely be a negative impact on population trend (Connelly et al 2004, Aldridge 2005, Holloran 2005, Wisdom et al. 2005).
- Sage-grouse eventually avoid areas with a high density of anthropogenic features even if site-scale conditions are suitable (Connelly et al. 2004). While there is still much to learn about dispersal and home range selection process, there is mounting evidence that sage-grouse are sensitive to human disturbances and will avoid areas they once used if those areas have been altered by anthropogenic features that exceed some threshold (Connelly et al. 2004, Aldridge 2005, Holloran 2005). The anthropogenic feature thresholds that affect these selection processes likely vary depending on type of use, seasons of use, intensity of use, topography, and other factors. However, if these changes occur quickly on the landscape, sage-grouse may not recognize the risks associated with these features and may not show an immediate avoidance response (Aldridge 2005, Aldridge and Boyce 2007).

Third Order (Fine-Scale) Habitat Suitability and Indicators

Sage-grouse select seasonal habitats (third order) within their home ranges: breeding, summer, fall and winter periods (Figure II-6; Johnson 1980, Connelly et al. 2004). For many wildlife species with large home ranges, including sage-grouse, seasonal life requisite needs differ and movement is required to meet seasonal shelter and food needs. Sage-grouse are generally traditional in their seasonal movement patterns (Schroeder et al. 1999, Connelly et al 2004, Holloran 2005). Some sage-grouse may move long distances (> 30 km) between breeding and summer and summer and winter habitats. Their diets shift from insects and forbs during breeding and summer to sagebrush during winter (Berry and Eng 1985, Schroeder et al. 1999, Connelly et al. 2004). The life requisite "space" is still a predominate need for sage-grouse to access their seasonal food and shelter needs at the fine-scale.

Third order habitat descriptions should address factors that affect sage-grouse use of, and movements between, seasonal use areas. Seasonal home ranges for sage-grouse associated with a lek, or lek group within a subpopulation area, should be the habitat focus. In some cases, small isolated populations or subpopulations may be the focus of fine-scale descriptions. Habitat suitability at the fine-scale can generally be described as follows:

- Suitable habitats within home range areas have contiguous mosaics of sagebrush shrublands or grassland/sagebrush connecting seasonal use areas. Anthropogenic features within home ranges that can disrupt seasonal movements or cause mortality are generally absent or at least not widespread.

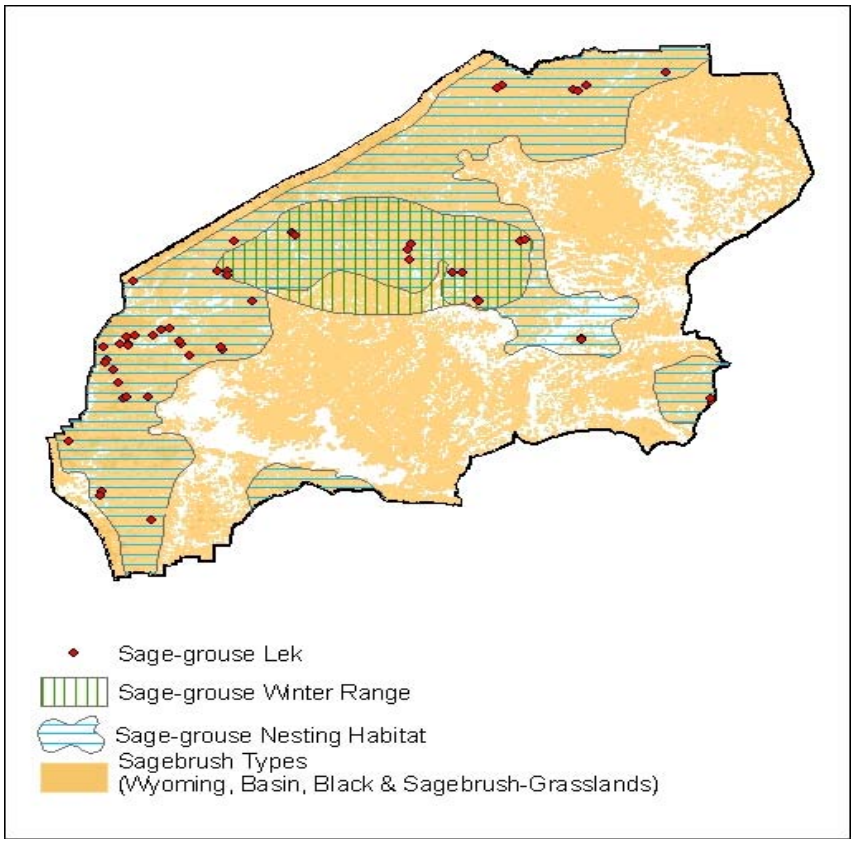


Figure II-6. Third order habitat selection.

- Marginal habitats within home range areas have disjunct sagebrush shrublands or grassland/sagebrush between seasonal use areas. Anthropogenic features that can disrupt seasonal movements or cause mortality may occur within the home range area.
- Unsuitable habitats within a home range area are potential shrublands currently dominated by grasses, annual grasses, invasive woodlands (e.g. western juniper) or incompatible land uses (some anthropogenic features) not conducive to sage-grouse seasonal movements or habitat use.
- Other unsuitable habitats include timber lands, severe topographical features, and landscape conversion to farmland, urban areas, reservoirs, etc.

At this scale, sage-grouse select seasonal ranges to meet their life requisite needs (Johnson 1980, Connelly et al 2003). There are two, third order (fine-scale) habitat indicators that influence sage-grouse use of and movements between seasonal use areas (Table II-2):

1. Habitat connectivity between seasonal ranges and,
2. Anthropogenic disturbances and habitat loss and fragmentation.

The availability and connectivity of sagebrush within seasonal use areas of sage-grouse home ranges can affect suitability. To address this, seasonal use areas need to be identified and mapped. Generally, the greater the amount of contiguous sagebrush shrublands within seasonal use areas, the greater the habitat availability and suitability (Table II-2, Indicator 1). The

availability of other forb-rich habitats in summer and fall areas is also important to describe at this scale, particularly if these are in close proximity to sagebrush dominated communities.

Sage-grouse may travel long distances between seasonal habitats. Following nesting, hens often move chicks to summer ranges for food. Connectivity between breeding and summer brood-rearing habitats is particularly important due to the restricted flight capability of chicks at this time. In general, the more contiguous the sagebrush cover between seasonal use areas, the more suitable the habitat. In some areas, other shrub communities may provide important connecting habitat between seasonal use areas similar to what was described for third order linkage areas (Table II-2).

There is increasing evidence that anthropogenic disturbances within a home range can cause local extirpations even if other habitat conditions appear suitable (Aldridge 2005, Holloran 2005, Aldridge et al. 2008). Anthropogenic features can affect sage-grouse in two significant ways at the fine-scale. Anthropogenic features directly and indirectly increase mortality or decrease recruitment, and sage-grouse may eventually avoid seasonal use areas with a high density of anthropogenic features even if site-scale conditions are suitable. Anthropogenic features can also allow the intrusion of exotic species that directly depredate sage-grouse (e.g. predators), or habitat features that alter the suitability of habitats (e.g. exotic plants such as cheatgrass) (Lyon 2000, Lyon and Anderson 2003, Holloran 2005, Aldridge 2005).

Fourth Order (Site-scale) Habitat Suitability and Indicators

Habitat suitability at the site-scale (Fourth order) describes the more detailed vegetation of seasonal habitat characteristics such as canopy cover and height of sagebrush (nesting and wintering) and the associated understory vegetation (nesting, early-brood-rearing), and vegetation associated with riparian areas, wet meadows, and other mesic habitats adjacent to sagebrush (late-brood-rearing/summering) (Figure II-7). Based on extensive research in many western states, Connelly et al. (2000) developed and Hagen et al. (2007) refined habitat criteria or indicators required by sage-grouse for specific seasonal needs (leks, breeding, summer/brood-rearing, and wintering). While general criteria were recommended, Connelly et al. (2000) recognized that ecological site potential should be considered at the site-scale. Hagen et al. 2007 provides a meta-analysis of existing research on nesting and brood-rearing habitats. Generalized seasonal habitats are characterized as 1) breeding habitat – habitat for pre-laying hens, leks, nesting habitat, and early brood-rearing habitat, 2) summer/late brood-rearing, 3) fall and 4) winter. Connelly et al. (2000) provides extensive treatment of each of these seasonal ranges.

Figure II-7. Fourth order habitat selection scale.

Table II-1. Second order (mid-scale) habitat indicators and relationship to habitat suitability characteristics for sage-grouse habitats.

Habitat Indicators	Metric Description	Relationship to Habitat Suitability
1. Habitat Availability	The amount of sagebrush habitat in the area.	The more sagebrush habitat relative to potential habitat the greater the area suitability.
2. Patch Size and Number	The average size of habitat patches and the number of patches within the area.	Generally, the larger and more contiguous the habitat patches relative to the area the greater the suitability of that area.
3. Patch Connectivity	The average distance from one habitat patch to the nearest similar patch within the area.	As the average distance between sage-grouse habitat patches in the area decreases, suitability increases.
4. Linkage Areas	Percent shrub cover in relation to tree or grass/forb cover of areas between habitat patches through which sage-grouse move.	As linkage areas between habitat patches increase in shrub cover rather than tree or grass/forb cover, habitat suitability increases. Presence of anthropogenic features between patches also decreases linkage area suitability.
5. Landscape Matrix and Edge Effect	The amount of edge in contact with plant communities or land uses with positive or negative influences on the habitat patch.	As the amount of sagebrush edge in contact with plant communities or land uses that positively influence shrub land patch habitat increases, the landscape matrix and edge suitability increase.
6. Anthropogenic Disturbances	The fragmentation of contiguous sagebrush patches in the area through land use changes and infrastructure development. Measured as the number, length, or area (or area of influence) of embedded anthropogenic features per unit patch area.	As the number and intensity of anthropogenic features within the habitat patches in the area decrease, suitability increases.

Table II-2. Third order (fine-scale) habitat indicators and characteristics for sage-grouse habitat seasonal use areas within home ranges. Think in terms of potential barriers to movement, reproduction, and survival.

Habitat Indicators	Metric Description	Habitat Suitability Characteristics
1. Seasonal Habitat Availability	The amount of sagebrush shrubland in seasonal use areas. The amount of other forb-rich habitats in summer / fall seasonal use areas.	The more sagebrush shrubland within seasonal use areas in the home range the greater the area suitability. Other forb-rich habitats in summer / fall seasonal use areas are available.
2. Seasonal Use Area Connectivity	The extent of sagebrush connectivity between seasonal use areas.	As areas between seasonal use areas increase in sagebrush cover, habitat suitability increases.
3. Anthropogenic Disturbances	The disruption of movement between or use of seasonal use areas within a home range due to land use changes and infrastructure development. Measured as the number, length, or area of anthropogenic features within a home range area.	As the number and significance of anthropogenic features within a home range decrease, suitability increases.

Table II-3. Habitat indicators and suitable habitat characteristics for lek sites (Connelly et al. 2000).

Habitat Indicators	Metric Description	Habitat Suitability Characteristics
1. Cover Availability	Lek has adjacent sagebrush cover in close proximity.	Adjacent sagebrush cover.
2. Proximity of detrimental land uses	The distance to land uses that have detrimental effects on lek use. Sonic and physical disturbances such as highways, railroads, and industrial parks are examples.	Detrimental land uses are not within 5 km of lek in Non-migratory and 18 km of lek for migratory populations.
3. Proximity of trees or other tall structures	The presence of trees or other tall structures within line of sight of leks.	Trees or other tall structures are not within line of sight of lek and absent or uncommon within 3 km of the lek.

Table II-4. Habitat indicators and suitable habitat characteristics for third order (fine-scale) nesting habitat (Connelly et al. 2000, Hagen et al. 2007). Fourth order (site-scale) measurements provides third order (fine-scale) information.

Habitat Indicators	Consider using variance (Range) rather than mean Metric Description	Habitat Suitability Characteristics	
		Arid Sites	**Mesic Sites**
1. Sagebrush Canopy Cover	Average percent canopy cover for land cover type.	15 – 25 %	15 – 25 %
2. Sagebrush Height	Average sagebrush height for land cover type.	30 - 80 cm (12 – 30 inches)	40 – 80 cm (15 – 30 inches)
3. Sagebrush Shape[1]	Most common sagebrush shape for land cover type.	Spreading	Spreading
4. Perennial Grass and Forb Heights	Average maximum heights in land cover type.	≥ 18 cm (≥ 7 inches)	≥ 18 cm (≥ 7 inches)
5. Perennial Grass Canopy Cover	Average percent canopy cover for land cover type.	≥ 10%	≥ 15%
6. Forb Canopy Cover	Average percent canopy cover for land cover type.	≥ 5%	≥ 10%
7. Forb Availability	Number of preferred forbs in land cover type.	Good abundance & availability relative to ecological site potential	

[1] Sagebrush plants that are more tree or columnar-shaped do not provide the protective cover of sagebrush with a spreading shape. Sagebrush communities with the more columnar shrub shape would require more herbaceous cover to provide good protection for nesting sage-grouse and young broods.

Table II-5. Habitat indicators and suitable habitat characteristics for fourth order (site-scale) summer habitat (Connelly et al. 2000).

		Habitat Suitability Characteristics	
Habitat Indicators	**Metric Description**	**Upland Sagebrush Communities[1]**	**Riparian and Wet Meadow Communities**
1. Sagebrush Canopy Cover	Average percent canopy cover for land cover type.	10 – 25%	
2. Sagebrush Height	Average sagebrush height for land cover type.	40 – 80 cm (15 – 30 inches)	
3. Sagebrush Proximity	Food site has sagebrush cover in close proximity		Sagebrush cover is within 100 m of riparian or wet meadow foraging area.
4. Grass / Forb Canopy Cover	Average percent canopy cover for land cover type.	>15%	
5. Riparian / Wetland Stability	Functioning condition		Wetland or riparian area is in proper functioning condition
6. Forb Availability	Number and density of preferred forbs in land cover type.	Good abundance, diversity & availability relative to ecological site potential	

[1] In areas where agricultural fields provide the food resources the habitat indicators for protective cover apply.

Table II-6. Habitat indicators and suitable habitat characteristics for fourth order (site-scale) winter habitat (Connelly et al. 2000).

Habitat Indicators	**Metric Description**	**Habitat Suitability Characteristics**
1. Sagebrush Canopy Cover	Average percent canopy cover exposed above snow in wintering area.	10 – 30% exposed above snow
2. Sagebrush Height	Average height above snow in wintering area.	25 -35 cm (10 - 14 inches) exposed above snow

Table II-7. Summary of suitability indicators and descriptions for each of the scales are listed. Suitability descriptions appropriate for each scale are based on the habitat indicator measurements for that scale.

Second order (mid-scale) Descriptions – Isolated/small population, subpopulation, or homerange of group of leks	
Habitat Indicators:	1. General habitat Availability 2. Patch Size and Number 3. Patch Connectivity 4. Linkage Area Characteristics 5. Landscape Matrix and Edge Effect 6. Anthropogenic Disturbances
General Suitability Descriptions:	**Suitable:** Landscapes have connected mosaic sagebrush shrublands that allow for bird dispersal and migration movements within the population or subpopulation area. Anthropogenic disturbances that can disrupt dispersal or cause mortality are generally not wide-spread or are absent. **Marginal:** Landscapes have patchy, fragmented sagebrush shrublands that are not well connected for dispersal and migration in portions of the population or subpopulation area. Anthropogenic disturbances that disrupt dispersal or cause mortality are present throughout all or portions of the landscape. Some lek groups or subpopulations are isolated or nearly isolated. **Unsuitable:** Landscapes were former shrubland habitat now converted to predominantly grassland or woodland land cover or other unsuitable land cover or use. Remaining sagebrush patches are predominantly unoccupied or have few remaining birds. Portions of the population or subpopulation area may become occupied in the foreseeable future through succession or restoration.

Third order (fine-scale) Descriptions – Seasonal habitats within home ranges	
Habitat Indicators	1. Seasonal Habitat Availability 2. Seasonal Use Area Connectivity 3. Anthropogenic Disturbances
General Suitability Descriptions	**Suitable:** Home ranges have connected seasonal use areas. Anthropogenic features that disrupt seasonal movements or cause mortality are generally absent or at least not widespread. **Marginal:** Home ranges have poorly connected or disjunct seasonal use areas. Anthropogenic features that disrupt seasonal movements or cause mortality are within the home range. **Unsuitable:** Home ranges have seasonal use areas with predominantly grassland, woodland or incompatible land uses (anthropogenic features) not conducive to sage-grouse seasonal movements or habitat use. Most leks have been abandoned or have few remaining birds.

Fourth order (site-scale) Descriptions – Use areas within seasonal habitats	
Habitat Indicators	1. Sagebrush Canopy Cover (all seasons) 2. Sagebrush Height (all seasons) 3. Sagebrush Shape (breeding only) 4. Perennial Grass and Forb Heights (breeding and summer) 5. Perennial Grass Canopy Cover (breeding and summer) 6. Forb Canopy Cover (breeding and summer) 7. Forb Availability (breeding and summer)
General Suitability Descriptions	**Suitable:** Seasonal habitat has preponderance of sagebrush cover types with sufficient shrub and herbaceous cover to protect sage-grouse from predators and weather and successfully raise young. Food resources are present or in close proximity to cover. **Marginal:** Seasonal habitat has preponderance sagebrush cover types with sparse shrub and/or herbaceous cover that do not provide the shelter needs for protection from predators and weather. Food resources are present but are either not at levels expected for ecological site potential or not in close proximity. **Unsuitable:** Seasonal habitat has preponderance of land cover types that do not provide sufficient cover or food resources to meet the life requisite needs though there is potential to meet them in the future.

Habitat Description Steps

Habitat description steps are identified for each scale. Descriptions for the first and second order are brief. Descriptions of habitat and the evaluation of habitat at these scales have been completed or are in the process of being completed by ecosystem-wide evaluations. These assessments have been tasked by agencies including the Bureau of Land Management, US Forest Service and US Geological Survey and non-governmental organizations including the Nature Conservancy. Policy level officials, scientists, spatial analysts and resource managers need to access these evaluation efforts to reach decision points for each scale.

First and Second Order Habitat Description Steps

Introduction

There is considerable broad-scale and mid-scale information for Greater Sage-Grouse range (Schroeder et al. 2004) and populations (Connelly et al. 2004), and for Gunnison Sage-Grouse (GSRSC 2005). Stiver et al. (2006) identified seven sage-grouse management zones scale that conform to seven clusters of habitat and populations described in Connelly et al. 2004 from Kuchler (1970) West (1983) and Miller and Eddleman (2001) (Figure II-8). The management zones provide a first and second order context for management purposes. There are also regional assessments describing shrub steppe habitat (Table II-8). These assessments provide critical information necessary for finer-scale habitat descriptions as they provide scale context to habitats and populations (Connelly et al 2004, Wisdom et al. 2005, Aldridge et al. 2008). In addition, these assessments describe and evaluate disturbances to landscapes and resulting habitat patterns operating at the population and species range scales. Large landscape features and disturbances influence the distribution and abundance of sage-grouse on the landscape.

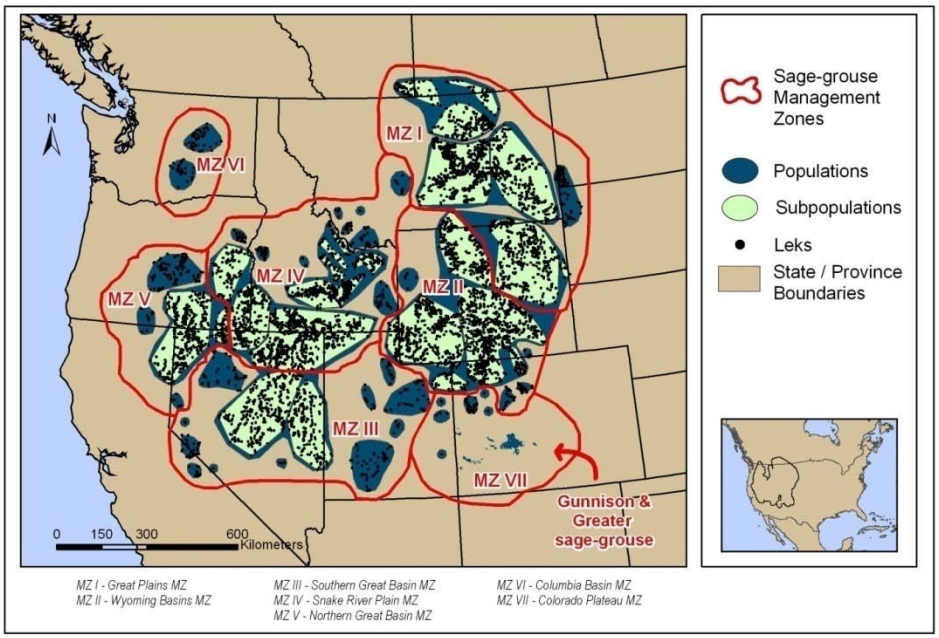


Figure II-8. Sage-grouse Management Zones and populations.

Management Description Steps

From a practical standpoint, the management of sagebrush/sage-grouse habitats at the first order habitat selection requires policy at the management zone that contributes to policy for the range of sage-grouse. Each management zone, evaluated by the various regional assessments provides policy makers with parameters to match policy to realistic outcomes.

Management and management direction for second order scales requires the use of existing broad-scale data and the application of GIS tools for analysis. These evaluations should include existing conditions, assess potential for habitat manipulation, and consider landscape constraints. Landscape scientists and spatial analysts may provide decision makers with a vision of the future landscape matrix.

Table II-8. Range-wide and regional assessments that have information on sage-grouse or their habitat.

Species	Assessment Area	Citations
Greater sage-grouse	Rangewide (OR, WA, CA, NV, ID, UT, MT, WY, CO, NM, AB, SK)	Connelly et al. 2000, Miller and Eddleman 2001, Connelly et al. 2004, Aldridge et al. 2008
Greater sage-grouse	Upper Columbia River Basin (OR, WA)	Hann et al. 1997, Wisdom et al. 2000
Greater sage-grouse	Great Basin (ID, NV, UT, CA)	Wisdom et al. 2005
Greater sage-grouse	Wyoming Basin (WY, CO, MT, UT, ID)	Rowland et al.2006
Gunnison sage-grouse	Rangewide (CO, UT)	GSRSC 2005

Third Order (Fine-scale) Habitat Description Steps

Introduction

Ecological processes of interest at the third order of habitat selection are those that may affect sage-grouse movements between seasonal habitats within a home range (Table II-9). Habitat needs and the indicators that describe life requisite needs vary by season. Third order habitat mapping takes into account seasonal use areas or home ranges of sage-grouse associated with a lek or group of leks. Seasonal habitat availability, connectivity and anthropogenic disturbances should be described at this scale (Table II-10). Third order habitat mapping uses the information gathered at the mid-scale and refines it to show seasonal habitat patterns for a home range of interest.

At this scale, it is important to identify seasonal habitat use areas (Table II-12). Habitat and wildlife resource specialists along with people with local knowledge should jointly evaluate sage-grouse seasonal distribution evidence to determine presence or absence. Wildlife biologists who understand sage-grouse habitat selection and needs can effectively predict how sage-grouse make seasonal use of their habitats. This section describes how to map sage-grouse habitat at the third order and how to use the information gathered at broader scales to help with a fine-scale assessment.

Steps to Describe Sage-Grouse Habitat at the Third Order

Step 1. Determine the extent and grain appropriate for a habitat description of the home range area. Develop vegetation map using appropriate third order land cover types.

Delineate the home range area of interest and document grain size for the analyses needed. Generally, a 30-m pixel size is desired for third order descriptions. We suggest collecting remote data at as fine a scale as available and affordable and aggregating those data at the 30-m pixel resolution. Third order habitat descriptions require more detailed vegetation information for an area. Identify natural vegetation cover types using information from the National Vegetation Classification System (see http://www.natureserve.org/explorer/). It is important to distinguish between sagebrush alliances (Reid et al. 2002) to help identify seasonal habitat availability and connectivity of different sagebrush communities (Table II-11). It is also important to distinguish certain non-habitat types such as salt desert shrub, forest/woodland, and agricultural lands. Pasture lands or conservation reserve program lands adjacent to sagebrush habitat may provide summer food resources with little risk from pesticides or mowing. Conversely, sage-grouse use of agriculture lands such as row crops adjacent to sagebrush may be hazardous.

Step 2. Map occupied seasonal habitats and identify potential habitat by seasonal use period.

Occupied and potential (currently unsuitable) seasonal habitats should be mapped in cooperation with the state wildlife agency. Historic and current data and knowledge by local sage-grouse experts should be used to help identify seasonal use areas and to determine the

migratory status of the population. In some areas, seasonal habitats will overlap (breeding and winter or brood-rearing and summer). In other areas, seasonal habitat may be separated by several miles. Three main sage-grouse seasonal habitats (breeding, summer-late brood, and fall-winter) should be identified (Table II-12). If seasonal use patterns are unknown, mapping the vegetation (Step 2) and elevations will help identify these areas. Predictive modeling as described by Yost et al. (2008) will also help identify seasonal habitats.

Breeding Habitat:

The breeding period typically occurs from 1 March through late June and includes the period when sage-grouse attend leks to breed, prepare nutritionally for nesting, nest, and raise young chicks (Connelly et al. 2000). Sage-grouse require a mixture of sagebrush, grasses, and forbs for adequate breeding habitat. Sagebrush cover types within 18 km (11 miles) of a lek for migratory populations and 5 km for non-migratory populations are considered breeding habitat and mapped as such unless this distance includes sagebrush communities sage-grouse would not use for nesting (e.g., canyon areas, snow-covered sagebrush areas). Mapping sagebrush habitats at this scale, including the exclusion of canyon areas etc. can be readily accomplished using routine GIS techniques and available landcover/digital elevation data. In addition, there may be some sagebrush cover types that do not provide breeding habitat due to plant structure characteristics, edaphic conditions, slope, aspect or other factors. Breeding habitat is not just nesting habitat, but includes all sagebrush habitat the birds may use from March through June. Map known nesting and early brood-rearing areas if there are telemetry data or other observational data.

Summer - Late Brood-rearing Habitat:

Summer is generally described as that period between 1 July and 30 September (Table II-12; Connelly et al. 2000). During summer, sage-grouse are found in areas with succulent forbs adjacent to or intermixed with sagebrush. Hens generally move their chicks to mesic sagebrush, mountain shrub communities, wet meadow complexes, agricultural fields, perennial lakes, streams, ponds, or lakebeds adjacent to sagebrush during the summer months. Riparian areas associated with steep drainages or canyons are not used by sage-grouse and should not be mapped as summer habitat. Several information sources are available to help identify summer habitats within the home range area:

1. Observations by local residents, field personnel
2. Historic observation in BLM or other agency files
3. Telemetry data
4. National Wetland Inventory (NWI) maps
5. Riparian Proper Functioning Condition (PFC) assessments and maps
6. Remote sensing data (NAIP Imagery, GAP)
7. Digital elevation models
8. Current and historic brood survey routes/area surveys conducted by wildlife agencies.

Mesic sagebrush communities adjacent to breeding habitats should be considered summer habitat (i.e., extending past the 18 km distance from leks), particularly higher elevation areas. In addition, within breeding and summer sagebrush habitat all riparian, wetland and other forb-rich habitat should be considered summer habitat. Historic brood routes should be ground-truthed to determine presence.

Fall and Winter Habitat:

Sage-grouse are entirely dependent on sagebrush for food and cover during winter. Sagebrush exposed above the snow or on wind-swept ridges is used by sage-grouse. Sage-grouse typically congregate in large groups during winter and are traditional in their use of wintering areas (Berry and Eng 1985, Schroeder and Robb 2003). Wintering areas are likely the most difficult habitats to map for sage-grouse. Wintering areas may be located in inaccessible regions, may vary based upon weather and may be found long distances from other known habitats. It is important to map known traditional winter use areas, particularly those that are crucial for large numbers of birds. Due to access constraints during winter, important areas may be identified any time during the year based on topography, sagebrush type, and evidence of roost sites. The area should be verified for winter use. During years of above average snow fall, document sage-grouse winter-use areas in order to identify the critical habitat areas during these periods. Additionally, managers should conduct directed searches during the winter based upon topography, slope and aspect, elevation, and vegetation. The state wildlife agency, local landowners, or other field personnel may have information regarding winter-use. Information sources that may be useful include:

1. Observations by local residents, Local Working Group's (LWG) or agency personnel
2. Telemetry data
3. Historic observations from land management and wildlife agency files
4. Aerial flights during winter

Step 3: Describe seasonal habitat availability

Using the information from Steps 1-2, describe occupied and potential seasonal habitats in the home range area. Breeding, summer, and winter habitats are important to describe. Calculate:

1. The estimated amounts of occupied breeding, summer and winter habitats.
2. The estimated amounts of potential breeding, summer and winter habitats.

The amount of existing sage-grouse seasonal habitat relative to potential habitat is important to document because it provides critical information for restoration planning.

Step 4. Describe and map anthropogenic features within and between seasonal habitats.

Overlay anthropogenic feature spatial data gathered at the second order (mid-scale; Step 6). For the home range area, document the following information:

1. The location and density of highways, major roads (km/km^2), railroads, transmission lines, or other large linear features.
2. The location, number and density (sites/km^2) of communication sites, energy pads, mineral sites, wind turbines, meteorological towers, geothermal sites, landfills, or other point landscape features.
3. If planning a habitat trend analysis, the estimated decade or year (the latter if within the last 10 years) when the anthropogenic feature occurred within the home range.
4. Overlay the spatial information and describe cumulative suitability of the home range based on anthropogenic features.

Step 5. Describe vegetation connectivity characteristics between seasonal use areas.

Home ranges with contiguous sagebrush cover between seasonal use areas are more suitable as habitat than those with discontinuous land cover. For home ranges with separated seasonal use areas, habitat suitability improves as the amount of shrub cover between seasonal use areas increases and tree or annual grass cover decreases. Shrub cover connectivity is particularly important for movements between breeding and summer when chicks are incapable of making long distance flights. Describe the vegetation between each seasonal use area: What natural (canyons, mountains) and anthropogenic (reservoirs, canals, major highways, intensive agriculture) barriers exist between each seasonal use area that may hinder the birds' ability to move between the areas?

1. Breeding to Summer, 2. Summer to Winter, 3. Winter to Breeding

Step 6. Summarize the information from Steps 3-5 to describe existing third order habitat suitability of the home range area of interest.

Organize and summarize the information for each third order indicator on Form G (Table II-13). Baseline third order habitat data can be used in the future for trend analyses. It is therefore very important to document the data sources and computer programs used to describe third order habitat conditions. It is also important to identify where the data for the assessment are stored and can be retrieved in the future. Good documentation of the data and analyses will help future biologists assess changes, causes and effects.

Once a habitat description summary has been completed for each indicator, describe the suitability of the seasonal-use area using theses descriptive criteria (Sather-Blair et al. 2000):

> **Suitable:** Seasonal use areas are well connected. Anthropogenic features that can disrupt seasonal movements or cause mortality are generally absent or at least not widespread.
>
> **Marginal:** Seasonal use areas are poorly connected or disjunct. Anthropogenic features that can disrupt seasonal movements or cause mortality are within the home range.
>
> **Unsuitable:** Seasonal use areas that were formerly shrubland dominated sites are predominantly grassland, woodland or incompatible land uses (certain agricultural areas, urban sites, other anthropogenic features) not conducive to sage-grouse seasonal movements or habitat use. Most leks have been abandoned or have few remaining birds.

Spatially depict the habitat suitability of the home range area on the map created in Steps 1-2.

Step 7. Optional – Repeating Steps 1-6, identify a reference period to assess habitat trends.

At the third order, it is useful to compare existing habitat suitability for all or selected third order indicators to some previous reference period for habitat trends. The reference period should have land cover type data available for the fine-scale indicators of interest as well as sage-grouse lek or other historical data. Identify the habitat indicators of interest, measure them with appropriate computer and GIS tools, and describe in terms of positive, neutral or negative trends. A summary of this description (Form III-G) for each time period should be completed.

Table II-9. Summary of scale-related ecological processes, mapping features and management levels for third order sage-grouse habitat descriptions (Johnson 1980). Selection of seasonal habitats within home ranges: sagebrush and adjacent other vegetation communities (e.g., wet meadows, riparian areas, perennial grassland or herbland).

Third Order (fine-scale) Ecological Processes	
Ecological Time Period	5 – 20 years in future
Climatic Processes	Local weather patterns: localized drought, rain shadow areas.
Landscape Disturbance	Local-scale processes that have long- and short-term consequences on home range use, seasonally and year-round: conversion of sagebrush habitat between seasonal ranges to non-habitat or unsuitable habitat; anthropogenic features that act as filters or barriers to seasonal movements.
Population Processes - Habitat Dynamics	Connectivity of sagebrush habitat and other adjacent habitats provide for effective use of seasonal habitats within a home range, seasonal migration corridors are maintained; collective fitness of birds within the home range is sufficient for long-term persistence.
Fine-scale Mapping Features	
Extent	Seasonal habitats within a home range
Grain	Fine grain (30-m pixel size)
Vegetation Cover Types	Associations or groups thereof
Geographic Extent Equivalents	Sub-basins or group of watersheds
Cartographic Scale Range	1:24,000 – 1:100,000
Fine-scale Management Levels	
Administrative Hierarchical Level	Local county governments; BLM field offices or sub-units
Planning & Assessment Documents	BLM activity plans (e.g., habitat management plans); watershed assessments and land use plans.

Table II-10. Third order habitat indicators and characteristics for sage-grouse habitat seasonal use areas within home ranges.

Habitat Indicators	**Metric Description**	**Habitat Suitability Characteristics**
1. Seasonal Habitat Availability	The amount of sagebrush shrubland in seasonal use areas. The amount of other forb-rich habitats in summer / fall seasonal use areas. (ha)	The more sagebrush shrubland within seasonal use areas in the home range the greater the area suitability. Other forb-rich habitats in summer / fall seasonal use areas are available.
2. Seasonal Use Area Connectivity	The extent of sagebrush connectivity between seasonal use areas. (km edge/sq.km of habitat)	As areas between seasonal use areas increase in sagebrush cover, habitat suitability increases.
3. Anthropogenic Disturbances	The disruption of movement between or use of seasonal use areas within a home range due to land use changes and infrastructure development. Measured as the number, length, or area of anthropogenic features within a home range area. (km/ha)	As the number and significance of anthropogenic features within a home range increase, suitability decreases.

Table II-11. Example of basic sagebrush land cover types needed for third order habitat descriptions. Third order cover types are generally shrubland alliances as described by Reid et al. (2002). NP = Native perennial grass, EP = Exotic perennial grass, EA = Exotic annual grass.

Second Order Cover Types (overstory / understory)	**Third Order Cover Types (overstory / understory)**
Sagebrush / Native Perennial Grass	Wyoming & basin big sagebrush/NP Black sagebrush/NP Low sagebrush/NP Low sagebrush-mountain big sagebrush/NP Low sagebrush-Wyoming big sagebrush/NP Mountain big sagebrush/NP Rigid sagebrush/NP Silver sagebrush/NP Threetip sagebrush/NP Wyoming big sagebrush – squawapple/NP Gambel Oak / Basin big sagebrush shrubland/NP
Sagebrush / Exotic Perennial Grass	Wyoming & basin big sagebrush/EP Black sagebrush/EP Low sagebrush/EP Low sagebrush-mountain big sagebrush/EP Low sagebrush-Wyoming big sagebrush/EP Mountain big sagebrush/EP Rigid sagebrush/EP Silver sagebrush/EP Threetip sagebrush/EP Wyoming big sagebrush – squawapple/EP
Sagebrush / Exotic Annual Grass	Wyoming & basin big sagebrush/EA Black sagebrush/EA Low sagebrush-mountain big sagebrush/EA Low sagebrush-Wyoming big sagebrush/EA Mountain big sagebrush/EA Rigid sagebrush/EA Silver sagebrush/EA Threetip sagebrush/EA Wyoming big sagebrush – squawapple/EA

Table II-12. General seasonal habitat descriptions modified from Connelly et al. (2000).

Habitats	**General Use Period**[1]	**General Description**[2]
Breeding Habitat	March 1 – June 30	Includes leks, pre-nesting, nesting and early brood-rearing habitats. A variety of sagebrush plant communities in close proximity to leks and big sagebrush communities
Summer / Early Fall	July 1 – September 30	Variety of mesic or moist habitats in close proximity to sagebrush communities.
Fall/Winter	December 1 – February 28 or 29	Variety of sagebrush communities that have sagebrush above the snow.

[1] Use periods may vary based on elevation and annual weather conditions.
[2] General descriptions for some areas: primary vegetation communities may vary based on local conditions and availability.

Table II-13

Form G: 3rd Order (Fine-Scale) Sage-Grouse Habitat Description Example

General Information		
Home Range Name: Lone Willow	Subpopulation: Montana Mountains	
Lek Group Name:	General Location: Lone Willow	
Description Year: 2008	State: NV	Counties: Humboldt
Recorder Name: Stiver	Agency: NDOW	
Data Sources and Computer Programs		
Land Cover Type Data Sources: GAP		
Anthropogenic Features Data Sources: Nevada Heritage		
Population Data Sources: NDOW		
Data Storage Location: ftp://ftp.ndow.org/sagegrouse/habitat/HU		
Computer Programs Used: ArcView 9.2		
Mapping Grain: 30 m pixel	Home range Area Extent (km^2): 240	
Habitat Indicator Descriptions		
1. Seasonal Habitat Availability	a. Area of occupied breeding habitat (km^2) = 80	
	a. Area of occupied summer habitat (km^2) = 120	
	a. Area of occupied winter habitat (km^2) = 140	
	b. Area of potential breeding habitat (km^2) = 100	
	b. Area of potential summer habitat (km^2) = 150	
	b. Area of potential winter habitat (km^2) = 200	
	c. Area of non-habitat (km^2) (optional) =	
	Discussion:	
2. Seasonal Use Area Connectivity	Breeding to Summer: Adjacent	
	Summer to Winter: Adjacent	
	Winter to Breeding: Adjacent	
3. Anthropogenic Features	a. Densities of linear features (km / km^2) = .75	
	b. Densities of point features (sites / km^2) = 1.45	
	c. Area of non-habitat or unsuitable habitat inclusions (km^2) =	
	Discussion:	

3rd Order Suitability Summary	
✓	**Check one of the below descriptions that best describe the home range:**
✓	**Suitable:** Home ranges have connected seasonal use areas. Anthropogenic features that can disrupt seasonal movements or cause mortality are generally absent or at least not widespread.
	Marginal: Home ranges have poorly connected or disjunct seasonal use areas. Anthropogenic features that can disrupt seasonal movements or cause mortality are within the home range.
	Unsuitable: Home ranges have seasonal use areas with predominantly grassland, woodland or incompatible land uses (anthropogenic features) not conducive to sage-grouse seasonal movements or habitat use. Most leks have been abandoned or have few remaining birds.

Discussion: Large intact habitat. Priorities are to protect winter range on the east side of the range and create winter range south of the main mountain.

Fourth Order (Site Scale) Habitat Description Steps

Introduction

Ecological processes that may affect individual sage-grouse selection of leks, nest sites, feeding locations and winter-use areas are important at the fourth order (Table II-13). Ecological processes of interest take into account seasonal habitat needs related to the life requisites of shelter and food for birds associated with a lek or lek group. Habitat needs and the indicators that describe life requisite needs vary by season. Seasonal habitat availability, connectivity and anthropogenic disturbances were described at the mid- and fine-scales. At the fourth order, availability of protective vegetation cover and food resources within seasonal habitats are described.

Suitable habitats provide the appropriate protective cover (sagebrush and herbaceous plants), food (forbs and sagebrush), and security (proximity of trees and tall structures for predators) needs for sage-grouse to survive and reproduce (Connelly et al 2000, Sather-Blair et al. 2000). Marginal habitats include habitat components to support sage-grouse but habitat conditions are lower in quality compared to suitable habitats. It is assumed that survival rates and reproduction are lower in marginal habitats compared to suitable habitats (Cooperrider et al. 1986, Morrison et al. 1998). Unsuitable habitats are currently missing one or more of the basic life requisites of food or shelter, though they may have the potential to provide these life requisites in the future.

Basic seasonal habitat suitability matrices were based primarily on Connelly et al. (2000) because they used data collected across the species range (Tables H-2 through H-6). For the purpose of standardizing habitat descriptions and improving communication, discrete ranges of numeric values or other measurements (e.g., visual site guides) are used to describe seasonal habitat indicators as suitable, marginal, or unsuitable (Sather-Blair et al. 2000). It is important to remember that the numeric values described for productive habitat by Connelly et al. (2000) are guidelines and are not intended to be used as strict prescriptions. There may not be much difference between a sagebrush community with 14 percent sagebrush canopy cover and one with 15 percent canopy cover. However, discrete ranges are needed to organize the field information for interpretation.

Individual indicator values cannot be used independently to describe habitat; site suitability[1] is described using all of the appropriate indicators. For example, the predominant shape of sagebrush plants in an area affects the herbaceous cover needs during the breeding season. A columnar-shaped (tree-shape) sagebrush plant does not provide the shelter that a spreading-shaped plant provides (Figure II-9). However, in an area of more columnar-shaped sagebrush plants, abundant grass, forb, other shrub species cover, or younger, more robust sagebrush shrubs may make the site suitable as nesting habitat. At another site, shrub and grass cover may be suitable, but the absence of forbs would affect overall site suitability. These examples illustrate that individual indicator values do not define site suitability and that overall

[1] Use of the term "site suitability" in this section refers to the suitability of a specific land cover type or other sampling unit in a seasonal use area based on field data collection.

site suitability descriptions require an interpretation of the relationships between the indicators and other factors. Professional expertise and judgment are required for these steps.

Steps to Describe Sage-Grouse Habitat at the Fourth Order

Step 1. Identify seasonal use areas and associated third order cover types of interest for third order descriptions. Determine the extent of these land cover types within the seasonal use area.

Refining fine-scale cover type maps of a home range area may be helpful for site-scale descriptions. For a home range area it may be important to describe all (for a small, mountain valley subpopulation) or some (for a larger, basin subpopulation) of the seasonal use areas. Depending on the scope and purpose of the habitat description, not all land cover types within a seasonal use area may need to be sampled at the project level. For long term monitoring, only one or two sagebrush cover types for breeding habitat descriptions or certain known wet meadow complexes for brood-rearing habitat descriptions may be needed.

Grasslands or other currently unsuitable cover types that have the potential to become habitat in the future should also be measured because the information collected may be useful for conservation planning. Fourth order information for these cover types can provide important information on shrub and forb recruitment, linkage area suitability, conifer encroachment or other aspects of habitat condition.

Step 2. Overlay soil or ecological site maps on land cover type maps to determine ecological site potential.

Ecological site potential, the potential vegetation community and the production of plant material of a site is based on soil, topography and climate. For sagebrush communities, site potential (in terms of shrub, grass and forb composition) is mostly determined by precipitation patterns and soil characteristics (Cronquist et al. 1972, Miller and Eddleman 2001). Ecological site descriptions and soil maps can be obtained from local Natural Resource Conservation Service (NRCS) offices or from the Internet (http://esis.sc.egov.usda.gov). Herrick et al. (2005) provide recommendations on types and numbers of samples as well as background information on ecological sites and site potential. This information is needed for interpreting habitat data for the suitability matrices (e.g., forb abundance related to site potential) and for predicting potential natural habitat changes (i.e. composition and rates of change in community composition relative to natural disturbances and succession) and alternative habitat changes (i.e. composition and rates of change to plant communities not anticipated for a site and from which it is more difficult to recover the natural community). . Site potential data would be particularly valuable for predicting future conditions of sagebrush shrubland areas that are now grasslands (native perennial vs. exotic annual) due to fire or anthropogenic disturbances.

Soils are mapped in units (e.g., soil mapping units) that can and often do include a mixture of soils that are correlated to a mixture of ecological sites. For example, a soil map unit may include two soils with two different ecological sites. One ecological site may result from small inclusions of soils that supports a mountain big sagebrush community, but the vast majority of

the soil map unit consists of a soil that supports a different ecological site with a low sagebrush community. These intermixed communities are valuable because big sagebrush is used by males and females for protective cover or nesting, while low sagebrush sites provide important forbs for pre-laying hens and broods, and loafing sites for adult birds. It is helpful to consult with other biologists, soil scientists, aridland ecologists or rangeland management specialists to develop a sampling design for seasonal use areas based on available soils and ecological site data. It is important to note that soil maps are not completed for the entire range of sage-grouse. However, NRCS State Soils Geographic (STATSGO) information is available and provides basic information at a course resolution. Data are available at http://www.soils.usda.gov/survey/geography/statsgo/ . The citation for this dataset is: Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. U.S. General Soil Map (STATSGO) for *State* [Online WWW] Available URL: "http://soildatamart.nrcs.usda.gov".

Step 3. If available, obtain Ecological Reference sheets for the ecological sites contained within the seasonal habitat area of interest.

Pellant et al. (2000) described Ecological Reference Areas (ERAs) as:

> "The reference sheet describes a range for each indicator based on expected spatial and temporal variability within each ecological site (or equivalent)."

Reference sheets provide important information about ecological site potential as it relates to vegetation conditions for sage-grouse habitat suitability. However, it is important to note that ecological site descriptions have not been completed in much of the sage-grouse range. If Ecological Reference Areas (ERA) (see Pellant 2000 for definitions and descriptions) for the important cover types in the seasonal use area are available then a visit may be valuable when the expected forb species composition for an ecological site is not well described in ecological site guides. It might be useful to collect fourth order data at an ERA for reference purposes.

Step 4. Design sampling approach.

Prior to sampling habitat at the fourth order, an appropriate design must be determined. Using the information from Steps 1-3, develop an appropriate sampling design and collect field data using one of the methods outlined in Volume III.

For most fourth order descriptions, stratified, random sampling of the seasonal habitat area based on land cover types and soils (ecological sites) will be appropriate. In some cases the seasonal use area may be further stratified by sagebrush canopy cover strata (e.g., 0-5%; 6-15; 16-25%; >25%) or anthropogenic disturbance strata (e.g., grazing pastures, density of anthropogenic features). Karl and Sadowski (2005) provided recommendations on sagebrush canopy cover classes and subclasses based on understory grass composition and conifer densities in eastern Oregon. Summer habitat, for example, can be stratified by type (riparian, wet meadow mesic uplands, springs, and others), or sampled together as a single stratum.

In many areas, patches of big sagebrush (or other tall-stature sagebrush) occur in expansive low or dwarf sagebrush areas. It is recommend that these are treated as two separate

cover types or strata. However, there are heterogeneous sagebrush communities that are not easily teased apart and may be better sampled as one stratum. There may be situations where only certain sagebrush areas are of interest due to steepness of slope, aspect or other reasons. In other cases, only the priority breeding habitat cover types may be sampled due to costs. The rationale for decisions concerning sampling design should always be clearly explained and documented.

The number of samples required for each cover type depends on the vegetation heterogeneity of the land cover type, degree of precision desired and size of the seasonal use area. Elzinga et al. (1998) and Herrick et al. (2005) provide guidance on sampling design.

Timing of sampling fourth order data depends on what is being measured (Table II-19). Generally, breeding habitat vegetation should be measured between 1 May and 30 June to assess forb and grass presence annual variation in precipitation should be evaluated to determine when samples should be measured. Late brood-rearing habitat should be measured between 1 July and 30 August depending on latitude and elevations. Autumn is a transitional time period when the birds are moving from summer to winter habitat. During September birds may still be concentrated on summer use areas where succulent forbs and insects can be found. As temperatures cool and their diet changes to sagebrush, sage-grouse begin moving from forb-rich areas to winter range. Winter habitat can be evaluated throughout the year as related to sagebrush species and subspecies diversity and general sagebrush distribution on the landscape, however the availability of sagebrush to sage-grouse in winter is contingent on local snow depths. In some cases, therefore, winter site visits are recommended.

Step 5. Collect field data.

Measuring vegetation at the fourth order generally involves field data collection on composition and structure of habitat within a seasonal use area (Table II-19). There are additional measurements (e.g., proximity to sagebrush) for some seasonal habitats as well. Connelly et al. (2003) describe methods to measure sage-grouse habitat at the fourth order. In addition, Elzinga et al. (1998) and Herrick et al. (2005) describe methods and provide examples of ways to measure vegetation for fourth order habitat indicators. Additional data collection techniques can be found in *Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1, Denver, CO.* Although two common measurement options are prescribed, we strongly advise the use of line-point intercept technique because of its application across scales.

Procedures for two data collection methods, including illustrations and data forms, are provided in Measurement Techniques and Data Forms document. These methods have been used for sage-grouse habitat descriptions and are referred to as line intercept – Daubenmire frame (LIDF) and point intercept (PI). Both methods will provide comparable results and their advantages and disadvantages are discussed in Elzinga et al. (1998), Connelly et al. (2003) and Herrick et al. (2005). We recommend that PI be used for rapid assessment, at the discretion of the field supervisors and technicians, when a significant number of potential projects are identified. We recommend that project level data be collected using LIDF for increased data and increased utility monitoring the effects of the treatments. Data should be collected along at least four 50-m transects per cover type. More transects may be needed based on heterogeneity or

specific local habitat description needs. The 50-m transects are also used to record preferred forb species / species group and abundance in a 50-m^2 belt.

This document (Volume II) and the data forms booklet (Volume III) provides illustrations and site guides (e.g. sagebrush shape) to aid in the technical aspects of these habitat measurements. Additional fourth order notes and measurements are included for some seasonal habitats to aid in interpreting overall site suitability. These include local drought conditions, presence of anthropogenic noise disturbance, other shrub canopy cover (besides sagebrush), annual grass canopy cover and noxious weed abundance. For example, sagebrush canopy cover is a crucial habitat indicator for fourth order descriptions. However, in some locations the composition and percent cover of other shrubs can affect site suitability. For instance, sagebrush may only provide 10 percent canopy cover for a particular cover type, but antelope bitterbrush is also present with a canopy cover of 5 percent. The density of bitterbrush may positively affect the overall site suitability.

Once field data are collected, summarize the data for the seasonal habitats of interest. A Seasonal Habitat Fourth Order Data Summary form (Form H-1, Management Techniques and Data Forms and an example of a hypothetical summary form are provided (Figure II-10).

Step 6. Transfer field data for land cover types of interest into suitability matrix categories associated with the seasonal habitat. Determine fourth order suitability.

Once the field data have been summarized for land cover types of interest (Seasonal Habitat Site Scale Summary - Form H-1), they can be transferred to the suitability worksheets for the appropriate seasonal use periods. Seasonal habitat suitability worksheets with detailed instructions are provided in Volume III (Forms H-2 through H-7). One worksheet should be completed for each cover type stratum sampled in the seasonal use area. Appropriate mean, mode or other measurement for each indicator is recorded on the worksheet and the corresponding suitability category is checked (✓). Overall site suitability descriptions will require some level of professional judgment because all indicators will rarely fall in the same suitability range. The rationale for suitability criteria must be explained, particularly if it is not obvious on the worksheet. A few examples are provided to illustrate suitability interpretation (Figures II-12 through II-14).

Leks (Sage-Grouse Habitat Suitability Worksheet – Lek Habitat - Form H-2): Suitability should be described for each lek regardless of status (occupied, unoccupied, or unknown status). Site suitability for leks is relatively easy to describe because there are only two indicators: 1) sagebrush cover (presence and amount of sagebrush in close proximity to the lek); and 2) sage-grouse security (proximity of tall structures such as trees and power poles). However, it may also be valuable to describe anthropogenic noise levels (from highways, oil and gas wells, and wind turbines) (Form H-2). It is important to identify opportunities that might improve the status of a lek (Figure II-11). For example, removal of perching structures (e.g., trees, fence posts) near the lek in the provided example would likely increase security. Habitat descriptions are intended to help with identifying conservation actions. In addition, the influence of anthropogenic disturbances on lek use and lekking behavior may be easiest to describe when third and fourth order data are integrated.

Breeding Habitat (Sage-Grouse Habitat Suitability Worksheet – Breeding Habitat - Form H-3): The breeding habitat suitability matrix is the most complicated of the suitability worksheets (Table 15). This reflects the importance of breeding habitat, its complexity, and the amount of scientific data available on fourth order habitat needs. There are different suitability ranges for some indicators depending on whether the breeding area is associated with mesic or xeric sagebrush sites. For much of the Greater Sage-grouse range, xeric sites will be those closely associated with Wyoming big sagebrush (*A. t. wyomingensis*) and mesic sites will be associated with mountain big sagebrush (*A. t. vaseyana pauciflora* and *A. t. vaseyana vaseyana*). Determine whether the land cover type of interest is mesic or xeric as defined by Connelly et al. (2000) before completing the suitability worksheet.

Where sagebrush cover types are highly interspersed (e.g., big sagebrush inclusions in low sagebrush) it may be appropriate to combine the results from the field data into one suitability description for the mixed community. The big sagebrush inclusions may provide suitable cover for nesting while the low sagebrush communities may provide a greater diversity of forbs for pre-laying hens and broods. Individually these cover types may lack a life requisite need but together they provide suitable habitat. One suitability worksheet can be completed combining the site field data for these intermixed cover types.

Three examples of completed breeding habitat suitability worksheets are provided using field data for a hypothetical breeding area (Figures II-12 through II-14). In the first example (Figure II-11), all indicators are in the suitable range other than sagebrush canopy cover, which is barely marginal. Overall suitability is recorded as suitable. In the second example, indicator measurements are in the marginal range for 4 out of the 7 indicators (Figure II-13). Sagebrush cover is adequate but understory cover conditions and food resources provide only marginal fourth order suitability. The last example of native perennial grassland is clearly unsuitable due to lack of sagebrush cover (Figure II-14). However, native perennial grassland in the breeding habitat area has the ecological potential and the habitat components (i.e., forb and sagebrush recruitment) needed to become suitable in the future.

Summer Sites (Sage-Grouse Habitat Suitability Worksheet – Upland Summer Habitat - Form H-4 and Sage-Grouse Habitat Suitability Worksheet – Riparian Summer Habitat Form H-5): Suitability is described differently for summer / late brood-rearing seasonal habitats depending on whether they are associated with upland sagebrush communities or riparian/wet meadow communities (Tables II-16 and II-17), in close proximity to sagebrush communities. The indicators for upland summer habitats are similar to those for breeding habitat but the ranges for the suitability categories differ. For riparian areas and wetlands, their functioning condition as defined by Prichard et al. (1998, 2003) is used to describe site stability, which impacts the likelihood that cover and food resources are provided annually (fourth order temporal scale). The definitions for functioning conditions differ slightly between lentic and lotic areas but the following are general definitions:

Proper Functioning Condition (PFC) An area is considered to be in PFC when adequate vegetation or other structure components are present to:

- Dissipate energy, reduce erosion and improve water quality;
- Filter sediment and aid in floodplain development;

- Improve flood-water retention and ground-water recharge;
- Stabilize streambanks and shorelines;
- Develop diverse ponding and channel characteristic for fish and wildlife habitat and other uses;
- Support greater biodiversity.

Functional – at risk (FAR): An area is considered to be FAR when it possesses some or most of the elements for PFC, but has at least one component/process that gives it a high probability of degradation.

Non-functioning (NF): An area is considered NF when it clearly lacks the elements listed for PFC.

PFC data are available for most perennial streams and some wet meadows located on federal public lands. There are training opportunities and detailed procedures available (Prichard et al. 1998, 2003). PFC data should be used whenever possible to help describe sage-grouse habitat. If PFC data cannot be obtained from other sources or collected directly, then the other two indicators should be used to assess habitat suitability.

Preferred forb abundance should be described for brood-rearing areas associated with sagebrush uplands including those adjacent to agricultural lands (e.g., alfalfa fields). With respect to the latter, are sage-grouse exposing themselves to unnecessary risks associated with agricultural fields when forbs are present in the uplands, or are they taking advantage of the only forbs available? Not all agricultural lands provide good brood-rearing habitat. Certain agricultural practices (e.g., herbicide and pesticide spraying, mowing, use of domestic animals considered to be sage-grouse predators) create risks to sage-grouse survival. Potential risks associated with agricultural fields should be noted (e.g., pesticides (Blus et al. 1989), direct mortality by mower, West Nile virus, etc.).

Proximity to taller sagebrush communities may be an important habitat indicator in some situations. For instance, some brood-rearing habitat occurs in forb-rich low sagebrush communities adjacent to big sagebrush. In other cases, the available forbs such as arrowleaf balsamroot (*Balsamorhiza sagitata*) may be providing adequate cover, especially for very young broods ($\leq$ 21 days old)

Winter Habitat (Form H-6): There are only two closely related indicators of concern for winter habitat (Table II-18). It is generally more important to identify all existing potential or likely winter areas rather than describe individual areas. However, evaluating wintering areas during years of above average snowfall could be helpful in identifying critical winter habitats that need protection.

Step 7. Describe fourth order habitat suitability for the seasonal habitats of interest.

Summarize the seasonal suitability descriptions for the home range area (Form H-7). If the same area provides for more than one seasonal habitat, data could be collected at one time (between March and June to ensure spring forb availability). Be sure to summarize only those seasonal habitats for which data have been collected during the appropriate season. Further, summarize habitat potential for each area based on the presence of habitat components (e.g., sagebrush and forb recruitment) and ecological site potential. An example for a hypothetical home range area is presented (Figure II-15) based in part on the field data for the land cover types previously discussed. This summary, with the associated field data, represents a fourth

order habitat description for the home range area. Spatially depict the habitat suitability of the seasonal use areas within the home range on the map created in Steps 1-2. Copies of completed fourth order summary descriptions should be provided to the sage-grouse data coordinator for each state.

Step 8. Review the seasonal habitat suitability matrices and determine whether regional adjustments to Connelly et al (2000) Management Guidelines are warranted.

In some cases, regional research or other appropriate data sources may suggest the need to adjust management guidelines or thresholds in the suitability matrices. However, these matrices are designed to organize field data into a useful format for communications, and changes should only be made after considerable scientific evidence warrants their adjustment. There is a tendency to review each indicator and its suitability category independently, but site suitability is determined by the relationship among indicator values. The suitability expectations for these matrices are based on range-wide productivity data and the term "suitable" is not synonymous with "optimum." Repeated observations of Sandberg's bluegrass (*Poa secunda*) that never reaches 18 cm tall on a range site is not sufficient cause to alter the suitability criteria for height in the breeding habitat matrix, if the site potential is for bluebunch wheatgrass (*Pseudoroegneria spicata*). This condition likely indicates a range health issue that should be addressed. Wyoming BLM in coordination with Wyoming Game and Fish Department made adjustments to the recommendations of Connelly et al. (2000) for breeding habitat, based on productivity research findings in that state (Soehn et al. 2001). Regional adjustments must be supported by regional productivity and habitat data.

Table II-14. Summary of scale-related ecological processes, mapping features and management levels for fourth order sage-grouse habitat descriptions.

Fourth Order Ecological Processes

Ecological Time Period	Current to 5 years; average life span of sage-grouse
Climatic Processes	Seasonal weather patterns that can affect individual fitness (e.g., excessive spring rains during nesting or early brood-rearing).
Landscape Processes	Fourth order processes that have short-term consequences on seasonal habitat selection and suitability: natural variation in potential of ecological sites to provide suitable seasonal habitats; herbivory effects on food and shelter habitat needs; human disturbance of birds during critical periods (lekking, nesting and wintering); anthropogenic features that increase predation potential during critical periods.
Population Processes Habitat Dynamics	Habitat provides for food and shelter needs of the birds for effective daily use within seasonal use areas; individual fitness is sufficient.

Fourth Order Mapping Features

Extent	Seasonal use areas
Grain	Sampling plots (transects or 1-m plots)
Vegetation Cover Types	Associations and ecological sites
Geographic Extent Equivalents	Cover type within an ecological site

Cartographic Scale Range (e.g., < 1:24,000)

Fourth Order Management Levels

Administrative Hierarchical Level	Local county governments; BLM field offices or sub-units; Forest Ranger districts; state regional government offices
Planning & Assessment Documents	Site evaluations; project-specific assessments and plans

Table II-14. Breeding (Lek) habitat life requisites, indicators and suitability categories for site-scale habitat descriptions.

Life Requisite	Habitat Indicator	Suitability Categories		
		Suitable	**Marginal**	**Unsuitable**
Cover	**Availability of Sagebrush Cover**	*Lek has adjacent sagebrush cover.*	*Sagebrush provides very little protective cover adjacent to the perimeter of the lek*	*Adjacent nesting habitat unavailable..*
Security	**Proximity of Trees or Other Tall Structures**	*Trees or other tall structures are not within line of sight of lek and none to uncommon within 3 km of lek.*	*Trees or other tall structures are within line of sight of lek though uncommon or scattered within 3 km of lek.*	*Trees or other tall structures are within the vicinity of the lek site.*

Table II-15. Breeding (pre-laying, nesting and early brood-rearing) habitat life requisites, indicators and suitability categories for site-scale habitat descriptions (adapted from Connelly et al. 2000, Sather-Blair et al. 2000, Hagen et al. 2007).

Life Requisite	Habitat Indicator	Suitability Categories		
		Suitable	**Marginal**	**Unsuitable**
Cover	**Sagebrush Canopy Cover (%)**	*15 to 25*	*5 to < 15 or > 25*	*< 5*
	Sagebrush Height (cm)			
	Mesic Site[2]	*40 to 80*	*20 to <40 or > 80*	*< 20*
	Arid Site	*30 to 80*	*20 to <30 or > 80*	*< 20*
	Sagebrush Shape	*Spreading*	*Mix of spreading and columnar*	*Columnar*
	Herbaceous Height (cm)	*≥ 18*	*10 – <18*	*< 10*
	Perennial Grass Cover (%)			
	Mesic[2]	*≥ 15*	*5 to < 15*	*< 5*
	Arid	*≥ 10*	*5 to < 10*	*< 5*
Cover & Food	**Forb Canopy Cover (%)**			
	Mesic[2]	*≥ 10*	*5 to < 10*	*< 5*
	Arid	*≥ 5*	*3 to < 5*	*< 3*
Food	**Preferred Forb Availability[1]**	*Preferred forbs are common with several species present*	*Preferred forbs are common but only a few preferred species are present*	*Preferred forbs are rare*

[1] Relative to ecological site potential.
[2] Mesic and arid sites should be defined on a local basis; annual precipitation, herbaceous understory, and soils should be considered (Connelly et al. 2000).

Table II-16. Late brood-rearing/summer habitat life requisites, indicators and suitability categories for upland sagebrush fourth order habitat descriptions (adapted from Connelly et al. 2000, Sather-Blair et al. 2000, Hagen et al. 2007).

Life Requisite Feature	Habitat Indicator	Suitability Categories		
		Suitable	**Marginal**	**Unsuitable**
Cover	**Sagebrush Canopy Cover (%)**	*10 to 25*	*5 to < 10 or > 25*	*< 5*
	Sagebrush Height (cm)	*40 – 80*	*20 – <40 or > 80*	*< 20*
Cover & Food	**Perennial Grass and Forb Canopy Cover (%)**	*≥ 15*	*5 to <15*	*< 5*
Food	**Preferred Forb Availability[1]**	*Preferred forbs are common with several species present*	*Preferred forbs are common but only a few preferred species are present*	*Preferred forbs are rare*

[1] Relative to ecological site potential.

Table II-17. Late brood-rearing/summer habitat life requisites, indicators and suitability categories for riparian or wet meadow fourth order habitat descriptions (adapted from Connelly et al. 2000, Sather-Blair et al. 2000, Hagen et al. 2007).

Life Requisite	Habitat Indicator	Suitability Categories		
		Suitable	**Marginal**	**Unsuitable**
Cover and Food	**Riparian and wet meadow stability**	*Majority of areas are in PFC*	*Majority of areas are FAR*	*Majority of areas are NF*
Food	**Preferred Forb Availability[1]**	*Preferred forbs are common with several species present*	*Preferred forbs are common but only a few preferred species are present*	*Preferred forbs are rare*
Cover	**Proximity of sagebrush cover**	*Sagebrush cover is adjacent to brood-rearing areas (< 90 m)*	*Sagebrush cover is in close proximity to brood-rearing areas (90-275 m)*	*Sagebrush cover is unavailable (> 275 m)*

[1] Relative to ecological site potential.

Table II-18. Winter habitat life requisites, indicators and suitability categories for fourth order habitat descriptions (adapted from Connelly et al. 2000, Sather-Blair et al. 2000, Hagen et al. 2007).

Life Requisite	Habitat Indicator	Suitability Categories		
		Suitable	**Marginal**	**Unsuitable**
Cover and Food	**Sagebrush Canopy Cover (%)**	*≥ 10*	*5 to < 10*	*< 5*
	Sagebrush Heights (cm)	*> 25*	*> 10 to < 25*	*≤ 10*

Table II-19. Seasonal timing of vegetation data collection associated with habitat indicators for fourth order descriptions.

Seasonal Habitat	Window for Vegetation Data Collection	Comments
Breeding (leks)	Anytime	Vegetation data can be collected at any time of year.
Breeding (nesting and early brood-rearing)	April – June	Data should be collected as soon as hens are off the nest. Timing within this window will vary based on latitude and elevation.
Summer / Late Brood-rearing	July – August	Data should be collected based on timing of seasonal movements. Data collection for higher elevation late brood-rearing habitat areas should occur later than for areas of lower elevation.
Fall	September – November	See comments under summer season for early fall use areas. As fall progresses, seasonal movements begin and diets shift.
Winter	November – March Historical and extreme snow depths should be assessed.	Data can be collected at any time in this window. Snow levels may dictate when data should be collected for wintering areas.

Table II-20. List of seasonal habitat measurements and associated data collection methods (PI=Point intercept; LIDF=Line intercept – Daubenmire frame). Additional information and guidance are provided in Volume III.

Life Requisite	**Habitat Measurements**	**Applicable Seasonal Habitat**	**Measurement Technique**
Security	Proximity of Trees or Other Tall Structures	Leks Winter	Line of sight distance – field measurement
	Proximity of Disturbance Factors		Proximity to measurement – field or remote sensing
Protective Cover	Proximity of Sagebrush Cover	Leks Summer (riparian / wet meadows)	Proximity to measurement – field or remote sensing
	Sagebrush and Other Shrub* Canopy Covers	Breeding Summer Winter (above snow)	PI: Number of pin hits of live sagebrush. LIDF: Line intercept of live sagebrush foliage.
	Sagebrush and Other Shrub* Heights		PI: Height of sagebrush plants with pin hits. LIDF: Height of nearest sagebrush plant from transect point.
	Sagebrush Shape	Breeding	PI: Description of each sagebrush plant pin hit using site guide. LIDF: Description of nearest sagebrush plant from intercept point using Figure II-9.
	Perennial Grass Height	Breeding Summer (sagebrush communities)	PI: Live or residual height of perennial grasses with pin hits. LIDF: Live or residual height of perennial grass plant nearest to intercept point for sample DF.
	Perennial Forb Height		PI: Live or residual height of perennial forb with pin hits. LIDF: Live or residual height of perennial forb nearest to transect point.
	Perennial Grass Canopy Cover	Breeding Summer (sagebrush communities)	PI: Number of pin hits of live or residual perennial grass. LIDF: Estimated canopy cover within DF.
	Annual Grass Canopy Cover*		
Protective Cover and Food	Perennial Forb Canopy Cover	Breeding Summer (upland sagebrush communities)	PI: Number of pin hits of live or residual perennial forb. LIDF: Estimated canopy cover within DF.
	Annual Forb Canopy Cover		
	Riparian and Wet Meadow Stability	Summer (riparian / wet meadow)	Proper Functioning Condition status
	Sagebrush Cover and Heights	Winter (above snow)	See above
	Invasive/exotic Species*	Breeding Summer	% cover and number of invasive/exotic species measured in 50-m^2 belt transect.
Food	Preferred Forb Availability	Breeding Summer	Number of Preferred forb species and abundance measured in 50-m^2 belt transect.

*Ancillary data that will be collected to assist in data interpretation for suitability.

SPREADING

COLUMNAR

Figure II-9. Sagebrush shape is an important habitat cover indicator. Sagebrush communities with more columnar-shaped plants need more herbaceous cover for shelter needs than communities with more spreading-shaped plants.

Form H-1: Seasonal Habitat Site-Scale Data Summary

Date: 6/23/06	**State:** ID	**County:** Blaine	**Subpopulation:** North Side Snake River
Recorder: Janet Hill		**General Location: T. R. Sections**	**Home Range Name:** Big Hill
Seasonal Habitat: Breeding			**Associated Leks:** RBO5; RBO2

Land Cover Type	Ecological Site	Area (ha) / Length (km)	Transects (#)	Measurements From Data Sheets (means in most cases)							
				Sage CC (%)	Sage Ht. (cm)	Sage Shape (# of S, M or C)	PG & PF Ht. (cm)	PG CC (%)	PF CC (%)	# Preferred Forb Species	Distance to Sage Cover (m)
Wyoming big sagebrush / Bluebunch wheatgrass	ARTRw / PSSP	2300	8	13	56	S=36 M=10 C=2	19	17	13	10	
Threetip sagebrush / Bluebunch wheatgrass	ARTR2 / PSSP	1400	5	19	66	S=7 M=25 C=14	15	9	5	3	
Bluebunch wheatgrass	ARTRw / PSSP	5600	4	4	20	-	23	24	16	13	
Bluebunch wheatgrass	ARTR2 / PSSP	2900	4	8	20	-	20	25.5	18	12	
Threetip sagebrush / Crested wheatgrass	ARTR2 / PSSP	2100	4	16	64	S=5 M=10 C=23	17	18	8	6	
Crested wheatgrass	ARTR2 / PSSP	700	4	3	23	-	21	23	4	3	

Figure II-10. Example of Seasonal Habitat Fourth Order Data Summary form completed with data from field measurements for the cover types of interest

Form H-2: Sage-Grouse Habitat Suitability Worksheet - Lek Habitat

Date: 4/3/06	State: ID	County: Owyhee	
Evaluator(s): Janet Hill		Subpopulation: SW ID	
Legal Description: T. R. Section , 1/4, 1/4		Home Range Name: Triangle	
Lek ID #: 20702		Lek Status (circle one): Active (Inactive)	
Land Cover Type: ARTRw/ARTRv/AGSP, JUOC		GPS File #:	UTM #:

Habitat Suitability Range

Habitat Indicator	Suitable	✓	Marginal	✓	Unsuitable	✓
Availability of Sagebrush Cover	*Lek has adjacent protective sagebrush cover (within 100 m)*	✓	*Sagebrush within 100 m provides very little protective cover*		*Adjacent sagebrush cover is > 100 m*	
Proximity of Trees or Other Tall Structures	*Trees or other tall structures are not within line of sight of lek and none to uncommon within 3 km of lek*		*Trees or other tall structures are within line of sight of lek and uncommon or scattered within 3 km of lek*		*Trees or other tall structures are within the vicinity of the lek site*	✓
SITE-SCALE SUITABILITY		☐		☑		☐

Anthropogenic Noise Description: N/A. Isolated from human presence. Some livestock can be heard in the lower valley.

Rationale for Overall Description:

Site is generally a good lek site. It is a natural opening in a patch of Wyoming and Mountain big sage, relatively short grasses and forbs and rocks. However, juniper has encroached to within 50 m of the lek, creating perch sites for raptors. Removal of all juniper within 100 m of lek would greatly improve the site. Also, surrounding habitat may be used for nesting if trees are removed. Mostly big sage/bluebunch wheatgrass community with balsamroot, phlox, buckwheat, and Tragopogon in understory.

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Figure II-11. Example of a completed lek suitability worksheet.

Form H-3: Sage-Grouse Habitat Suitability Worksheet - Breeding Habitat

Date: 5/15/06	State: ID	County: Blaine	Subpopulation: North Side Snake River
Evaluator(s): Janet Hill			Home Range Name: Big Hill
Legal Description: T. R. Sections			Associated Leks: RBO5; RBO2
Land Cover Type: Wyoming big sagebrush/bluebunch wheatgrass			Ecological Site: ARTRw / PSSP
Number of Transects: 8		Area Sampled (ha): 2300	Site Info. (circle one): (Arid Site) Mesic Site
List UTM Coordinates of All Transects: 542335E 4912479N; 542416E 4912418N; 542599E 4912520N; 542721E 4912540N; 542680E 4912357N; 542253E 4912296N; 541867E 4912235N; 541826E 4912418N			

Habitat Indicator Suitability Range

Habitat Indicator	$\bar{x}$	Suitable	✓	Marginal	✓	Unsuitable	✓
Sagebrush Canopy Cover (mean)	13	15 to 25%		5 to < 15% or > 25%	✓	< 5%	
Sagebrush Height							
Mesic Site (mean)		40 to 80 cm	✓	20 to <40 cm or >80		< 20 cm	
Arid Site (mean)	56	30 to 80 cm		20 to <30 cm or >80		< 20 cm	
Predominant Sagebrush Shape (mode)							
Spreading (*n*)	35	Spreading	✓	Mix of spreading and columnar		Columnar	
Mixed (*n*)	10						
Columnar (*n*)	2						
Perennial Grass and Forb Height (mean)	19	≥ 18 cm	✓	10 to < 18 cm		< 10 cm	
Perennial Grass Canopy Cover							
Mesic Site (mean)		≥ 15%	✓	5 to < 15%		< 5%	
Arid Site (mean)	17	≥ 10%		5 to < 10%		< 5%	
Perennial Forb Canopy Cover							
Mesic Site (mean)		≥ 10%	✓	5 to < 10%		< 5%	
Arid Site (mean)	13	≥ 5%		3 to < 5%		< 3%	
Preferred Forb Availability (relative to site potential)		Preferred forbs are common with several species present	✓	Preferred forbs are common but only a few species are present		Preferred forbs are rare	
Number of Preferred Forb Species (*n*)	10						

SITE-SCALE SUITABILITY ☑ ☐ ☐

Does ecological site potential limit suitability potential? (circle one) Yes (No)
Drought Condition (circle one): Extreme Drought Severe Drought (Moderate Drought) Mid-Range Moderately Moist Very Moist Extremely Moist
Rationale for Overall Description: Site is in suitable condition. Sagebrush canopy cover is not quite in the suitable range, but all of the other indicators are in the suitable range. Sagebrush plants are healthy and there are signs of recruitment. Herbaceous cover heights are barely suitable but are similar to ecological reference area. Poor winter and spring moisture may account for herbaceous heights.

Figure II-12. Example of a Wyoming big sagebrush / bluebunch wheatgrass (*Pseudoroegneria spicata*) cover type site with suitable breeding habitat conditions.

Form H-3: Sage-Grouse Habitat Suitability Worksheet - Breeding Habitat

Date: 5/27/06	State: ID	County: Blaine	Subpopulation: North Side Snake River
Evaluator(s): Janet Hill			Home Range Name: Big Hill
Legal Description: T. R. Sections			Associated Leks: RB05; RB02
Land Cover Type: Threetip sagebrush / bluebunch wheatgrass			Ecological Site: ARTR2 / PSSP
Number of Transects: 5		Area Sampled (ha): 1400	Site Info. (circle one): (Arid Site) Mesic Site
List UTM Coordinates of All Transects: 542335E 4912479N; 542416E 4912418N; 542599E 4912520N; 542721E 4912540N; 542680E 4912357N			

Habitat Indicator Suitability Range

Habitat Indicator	$\bar{x}$	Suitable	✓	Marginal	✓	Unsuitable	✓
Sagebrush Canopy Cover (mean)	19	15 to 25%	✓	5 to < 15% or > 25%		< 5%	
Sagebrush Height							
Mesic Site (mean)		40 to 80 cm		20 to <40 cm or >80		< 20 cm	
Arid Site (mean)	66	30 to 80 cm	✓	20 to <30 cm or >80		< 20 cm	
Predominant Sagebrush Shape (mode)							
Spreading (*n*)	7	Spreading		Mix of spreading and columnar	✓	Columnar	
Mixed (*n*)	25						
Columnar (*n*)	14						
Perennial Grass and Forb Height (mean)	15	≥ 18 cm		10 to < 18 cm	✓	< 10 cm	
Perennial Grass Canopy Cover							
Mesic Site (mean)		≥ 15%		5 to < 15%		< 5%	
Arid Site (mean)	9	≥ 10%		5 to < 10%	✓	< 5%	
Perennial Forb Canopy Cover							
Mesic Site (mean)		≥ 10%		5 to < 10%		< 5%	
Arid Site (mean)	6	≥ 5%	✓	3 to < 5%		< 3%	
Preferred Forb Availability (relative to site potential)		Preferred forbs are common with several species present		Preferred forbs are common but only a few species are present	✓	Preferred forbs are rare	
Number of Preferred Forb Species (*n*)	3						
SITE-SCALE SUITABILITY			☐		☑		☐

Does ecological site potential limit suitability potential? (circle one)	Yes (No)
Drought Condition (circle one):	Extreme Drought Severe Drought (Moderate Drought) Mid-Range Moderately Moist Very Moist Extremely Moist
Rationale for Overall Description:	Understory conditions are only marginal with forb canopy cover barely suitable. The predominance of columnar-shaped sagebrush plants, marginal herbaceous cover conditions, and lack of preferred forbs makes this site marginal as breeding habitat.

Figure II-13. Example of a threetip sagebrush / bluebunch wheatgrass cover type with marginal breeding habitat conditions.

Form H-3: Sage-Grouse Habitat Suitability Worksheet - Breeding Habitat

Date: 5/27/06	State: ID	County: Blaine	Subpopulation: North Side Snake River
Evaluator(s): Janet Hill			Home Range Name: Big Hill
Legal Description: T. R. Sections			Associated Leks: RBO5; RBO2
Land Cover Type: Bluebunch wheatgrass			Ecological Site: ARTRw / PSSP
Number of Transects: 4		Area Sampled (ha): 5600	Site Info. (circle one): (Arid Site) Mesic Site
List UTM Coordinates of All Transects: 542335E 4912479N; 542416E 4912418N; 542599E 491252ON; 542721E 491254ON			

Habitat Indicator Suitability Range

Habitat Indicator	$\bar{x}$	Suitable	✓	Marginal	✓	Unsuitable	✓
Sagebrush Canopy Cover (mean)	4	15 to 25%		5 to < 15% or > 25%		< 5%	✓
Sagebrush Height							
Mesic Site (mean)		40 to 80 cm		20 to <40 cm or >80	✓	< 20 cm	
Arid Site (mean)	20	30 to 80 cm		20 to <30 cm or >80		< 20 cm	
Predominant Sagebrush Shape (mode)							
Spreading (*n*)		Spreading		Mix of spreading and columnar		Columnar	NA
Mixed (*n*)							
Columnar (*n*)							
Perennial Grass and Forb Height (mean)	23	≥ 18 cm	✓	10 to < 18 cm		< 10 cm	
Perennial Grass Canopy Cover							
Mesic Site (mean)		≥ 15%	✓	5 to < 15%		< 5%	
Arid Site (mean)	24	≥ 10%		5 to < 10%		< 5%	
Perennial Forb Canopy Cover							
Mesic Site (mean)		≥ 10%	✓	5 to < 10%		< 5%	
Arid Site (mean)	16	≥ 5%		3 to < 5%		< 3%	
Preferred Forb Availability (relative to site potential)		Preferred forbs are common with several species present	✓	Preferred forbs are common but only a few species are present		Preferred forbs are rare	
Number of Preferred Forb Species (*n*)	13						
SITE-SCALE SUITABILITY		☐		☐		☑	

Does ecological site potential limit suitability potential? (circle one)			Yes	(No)	
Drought Condition (circle one):	Extreme Drought	Severe Drought	(Moderate Drought)	Mid-Range	
	Moderately Moist	Very Moist	Extremely Moist		
Rationale for Overall Description: Site is currently unsuitable due to lack of sagebrush cover. All habitat components (sagebrush, grasses, forbs) are present, therefore site has potential to become suitable habitat in the future.					

Figure II-14. Example of a bluebunch wheatgrass cover type with unsuitable breeding habitat conditions. Data indicate that cover type may provide suitable habitat in the future.

Forms H-4, H-5 and H-6 are self explanatory.

Form H-7: Seasonal Habitat Site-Scale Suitability Summary

Date: 6/23/06	**State:** ID	**County:** Blaine	**Subpopulation:** North Side Snake River
Recorder: Janet Hill			**Home Range Name:** Big Hill
General Location: T. **R.** **Sections**			**Associated Leks:** RB05; RB02

Seasonal Habitat Information						Suitability		
						Current	Future	
Seasonal Habitat	**Land Cover Type**	**Ecological Site**	**Area (ha)** ***(upland)***	**Length (km)** ***(riparian)***	**Number of Sites (#)** ***(leks, wet meadows, springs, etc.)***	**S, M, U**	**Site potential limiting?**	**Habitat components present?**
Breeding	Lek				4	S		
Breeding	Lek				2	M	No	Yes
Breeding	Wyoming big sagebrush / bluebunch wheatgrass	ARTRw / PSSP	6,400			S		
Breeding	Threetip sagebrush / bluebunch wheatgrass	ARTR2 / PSSP	1,400			M	No	Yes
Breeding	Bluebunch wheatgrass	ARTR / PSSP	5,600			U	No	Yes
Breeding	Crested wheatgrass	ARTR2 / PSSP	700			U	No	No
Breeding	Threetip sagebrush / crested wheatgrass	ARTR2 / PSSP	2,100			M	No	Yes
Summer	Riparian			10		S		
Summer	Riparian			2		M	No	Yes
Summer	Wet meadow				4	S		
Summer	Wet meadow				2	U	No	No
Winter	Not measured							

Figure II-15. Example of the Seasonal Habitat Fourth Order Suitability Summary form completed including information from the previous examples as seasonal habitats.

Glossary

Abundance: The total number of organisms in an area (Wisdom et al. 2003, Braun 2005).

Active Lek: 1) [*General*] A display area in or adjacent to sagebrush habitat where at least two male sage-grouse have attended in at least two of the previous five years. Connelly et al. (2003) defined active leks as "occupied"; 2) [*Gunnison sage-grouse*] An area used by displaying males in the previous five years (GSRSC 2005). *–See also Lek, Inactive Lek*

Adaptive Management: An approach to natural resource management that involves identifying areas of scientific uncertainty, devising field management activities as real-world experiments to test that uncertainty, learning from the outcome of such experiments, and revising management guidelines on the basis of the knowledge gained (Morrison et al. 1998).

Adult (sage-grouse): A sage-grouse that is greater than 17 months of age and has entered or is about to enter its second breeding season (Connelly et al. 2003).

Alliance (plant): A physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species, which as a rule are found in the uppermost strata of the vegetation. Dominant species are often emphasized in the absence of detailed floristic information (such as quantitative data), whereas diagnostic species (including characteristic species, dominant differential, and other species groupings based on constancy) and used where detailed floristic data are available (Reid et al. 2002).

Annual Plant: A plant that completes its life cycle and dies in 1 year or less (Pellant et al. 2005).

Anthropogenic Disturbance: The direct loss or fragmentation of habitat due to human development and increased human activity causing the displacement of individuals through avoidance behavior (Holloran 2005).

Anthropogenic Feature: Any human-caused disturbance on the landscape that results in the direct loss or fragmentation of habitat.

Assessment: The process of estimating or judging the functional status of ecosystem structures, functions, or processes within a specified geographic area at a specific time (USDI 2001).

Association (plant): A plant community of definite floristic composition, uniform habitat conditions, and uniform physiognomy. Differentiated from the alliance level by additional plant species, found in any stratum, which indicate finer-scale environmental patterns and disturbance regimes (Reid et al. 2002).

Breeding Habitat: Leks and the sagebrush habitat surrounding leks that are collectively used for pre-laying, breeding, nesting, and early brood-rearing, from approximately March through June (Connelly et al. 2003).

Brood (sage-grouse): A hen or group of hens with at least one chick.

Canopy Cover: The proportion of the soil surface covered by a vertical projection of a plant canopy; the area that is protected from raindrops and is in the shade when the sun is directly overhead (Herrick et al. 2005).

Chick (sage-grouse): A sage-grouse up to 10 weeks of age (Connelly et al. 2003).

Community: A set of two or more interacting species, such as members of a trophic web, that live in a particular habitat (Meffe and Carroll 1997).

Condition: The ability of a community or ecosystem to function naturally (Wisdom et al. 2005).

Connectivity: The degree to which habitats for a species are continuous or interrupted across a spatial extent, where habitats defined as continuous are within a prescribed distance over which a species can successfully conduct key activities (e.g., effective dispersal distances of seeds or juveniles, mean distances moved for foraging, nesting, and brood-rearing), and habitats defined as interrupted are outside the prescribed distance (Wisdom et al. 2003).

Cover: 1) [*General*] The proportion of the soil surface covered by a vertical projection of the cover class of interest (e.g. canopy cover, basal cover, litter cover), regardless of what is above or below the object (Herrick et al. 2005); 2) (*Sage-grouse*) An indication of the relative amount of shelter or protection provided by all vegetation at a given point, normally used to assess nesting habitat (Connelly et al. 2003).

Cover Type: A vegetation classification depicting genera, species, group of species, or life form of tree, shrub, grass, or sedge, or a dominant physical feature (e.g. water or rock) or land use (e.g. urban or road). When a genus or species name is given to the cover type at a broad-scale, it is typically representative of a complex of species or genera with similar characteristics (Wisdom et al. 2000).

Daubenmire Frame: A rectangular frame, 20 x 50 cm, used to estimate canopy cover class. The frame has a painted pattern that provides visual reference areas equal to 5, 25, 50, 75, and 95 percent of the plot area (Daubenmire 1959).

Dispersal: Movement of individuals to new living areas. Includes initial movements from place of birth to first attempted breeding area (natal dispersal), and subsequent movements from one breeding location to another (adult dispersal; Elphick et al. 2001).

Distribution: The spread or scatter of an organism within its range (Morrison and Hall 2001).

Disturbance: Any relatively discrete event in time that disrupts ecosystem, community, or population structure, and changes resources, substrate availability, or the physical environment (White and Pickett 1985). *–See also Anthropogenic Disturbance*

Droop Height: The height of a grass or forb measured from the ground to the point where the plant naturally bends. There may be no droop to some plants with relatively short stature (Connelly et al. 2003).

Early Brood-Rearing Habitat: Upland sagebrush sites relatively close to nest sites, typically characterized by high species richness with an abundance of forbs and insects, where sage-grouse hens raise young chicks (< 21 days old) (Connelly et al. 2003).

Ecological Reference Area (ERA): Land in which ecological processes are functioning within a normal range of variability and the plant community has adequate resistance to and resiliency from most disturbances. This area best represents the potential of a site in both physical function and biological health (Herrick et al. 2005).

Ecological Site: An area of land with a specific potential plant community and specific physical site characteristics, differing from other areas of land in its ability to produce vegetation and to respond to management (USDI 1996).

Ecological Site Description: Description of the soils, uses, and potential of a kind of land with specific physical characteristics to produce distinctive kinds and amounts of vegetation (Pellant et al. 2005).

Ecological Site Potential: The plant community that can be supported in an area given its edaphic and climatic potential (Habich 2001).

Ecoregion: A large area of similar climate where similar ecosystems occur on similar sites (those having the same landform, slope, parent material, and drainage characteristics; Wisdom et al. 2005).

Ecosystem: The totality of components of all kinds that make up a particular environment; the complex of a biotic community and its abiotic, physical environment (Wisdom et al. 2005).

Edge: The intersection of two vegetation types (Morrison et al. 1998).

Edge Effect: The influence of a habitat edge on interior conditions of a habitat, or on species that use interior habitat (Meffe and Carroll 1997).

Encroachment: Advancement beyond the usual or proper limits; often used to describe the advancement of pinyon pine or juniper woodlands into sagebrush communities (Wisdom et al. 2005).

Erosion: Detachment and movement of soil or rock fragments by water, wind, ice, or gravity (Habich 2001).

Exotic: Not native; an organism or species that has been introduced into an area, and is thus outside of its native range (Wisdom et al. 2005).

Extent: (1) *[General]* The area over which observations are made (e.g. study area, species range); (2) *[Spatial]* The geographic extent of a geographic data set specified by the minimum bounding area (Wisdom et al. 2005).

Extirpation: The loss or removal of a species from 1 or more specific areas but not from all areas (Wisdom et al. 2005).

Fall Habitat: The matrix of sagebrush habitat areas that sage-grouse slowly move through from September through November, transitioning from summer habitat to winter habitat, and shifting their diet from including large amounts of forbs to feeding exclusively on sagebrush (Connelly et al. 2000).

Forb: An herbaceous plant other than a grass, sedge, or rush, having little or no woody material (USDI 1996).

Geographic Information Systems (GIS): A collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (ESRI, http://www.gis.com/whatisgis/index.html, May 9, 2006).

Grain: 1) [*General*] The smallest resolvable unit of study (e.g., 1- x 1-m quadrant); generally determines the lower limit of what can be studied (Morrison and Hall 2001); 2) [*Spatial*] Mapping resolution at which spatial patterns are measured (Wisdom et al. 2000).

Grass: Any plant of the family Poaceae (USDI 1996).

Grassland: Vegetation dominated by grasses and grass-like plants, including sedges and rushes (Reid et al. 2002).

Habitat: An area with a combination of resources (such as food, cover, and water) and environmental conditions (temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species and allows those individuals to survive and reproduce (Morrison et al. 1998).

Habitat Connectivity: The arrangement of parts, specifically the patch size, fragmentation, and interrelatedness of habitats in relation to the requirements of a species (adapted from Wisdom et al. 2005).

Habitat Fragmentation: The process by which a species habitat is reduced and fragmented into pieces separated by areas of unsuitable or non-habitat. Habitat fragmentation has not occurred when habitat has been separated by unsuitable habitat but occupancy, reproduction or survival of the species has not been affected (Franklin et al. 2002).

Habitat Indicator: A component or attribute of habitat that can be observed and or measured in order to characterize suitability for shelter, food, water, and space.

Habitat Patch: A species habitat unit, appropriate for the scale of interest, surrounded by unsuitable habitat (adapted from Franklin et al. 2002).

Habitat Quality: Consists of 2 components: 1) a measure of habitat use (selection) by animals, and 2) a measure of fitness consequences associated with that habitat (Van Horne 1983, Aldridge 2005, Aldridge and Boyce 2007).

Habitat Selection: The process by which an animal chooses its habitat or habitat components (Johnson 1980).

> ***First Order Selection:*** Selection of physical or geographic range of a species
> ***Second Order Selection:*** Selection of physical or geographic home range for a subpopulation (e.g., for a sage-grouse lek or lek group)
> ***Third Order Selection:*** Selection of seasonal habitats (cover types) within a home range (e.g., sage-grouse seasonal habitat areas)
> ***Fourth Order Selection:*** Selection of habitat components (food items and shelter provisions for feeding, nesting, and roosting areas) within a seasonal use area (Johnson 1980)

Habitat Suitability: The relative appropriateness of a certain ecological area for meeting the life requirements of an organism (i.e., food, shelter, water, space).

> ***Suitable Habitat:*** Area provides environmental conditions necessary for successful survival and reproduction to sustain stable populations (Cooperrider et al. 1986; Morrison et al. 1998).
> ***Marginal Habitat:*** Area supports the species but survival rates and reproductive success are generally lower by comparison, and area may or may not have the potential to become suitable in the future (Cooperrider et al. 1986).
> ***Potential Habitat:*** Area is currently unoccupied but has the potential for occupancy in the foreseeable future (< 100 years), through succession or restoration.
> ***Unsuitable Habitat:*** Area does not currently provide one or more of the life requisites, and therefore does not provide habitat, but may provide habitat some time in the foreseeable future (<100 years), through succession or restoration.
> ***Non-habitat:*** Area within the historical distribution of sage-grouse that is unoccupied, does not currently provide habitat, and does not have the potential to provide habitat in the foreseeable future (100 years).

Herbaceous (vegetation): Plants that die back to the ground each year, normally with soft, non-woody stems (Connelly et al. 2003).

Home Range: The area traversed by an animal during its activities during a specified period of time (Morrison and Hall 2001).

Inactive Lek: *[Greater Sage-grouse]* A display area that has been attended by fewer than two males in fewer than two of the previous five years. Connelly et al. (2000) defined active leks as "occupied"; *[Gunnison sage-grouse]* A former display area that has been seasonally inactive for five consecutive years (GSRSC 2005). – *See also Active Lek, Lek*

Indicator: *– See Habitat Indicator*

Invasive (plant): A plant species that is not part of, or is a minor component of, a pre-disturbance plant community, and that has the potential to become a dominant or co-dominant species on the site if its future establishment and growth is not actively controlled by management interventions (Pellant et al. 2005).

Inventory: A point-in-time measurement of a resource to determine its location or condition (Elzinga et al. 1998).

Juvenile (sage-grouse): A sage-grouse that is more than 10 weeks of age but has not entered into its first breeding season (Connelly et al. 2003).

Land Cover Type: A classification of the observed biophysical cover on the surface of the earth (Wisdom et al. 2005).

Landscape: A mosaic of land forms, vegetation and land uses; a heterogeneous land area that is often hierarchically structured and varies in extent with the organism(s) being studied and the purpose for defining a landscape (Urban et al. 1987; Liu and Taylor 2002).

Landscape Matrix: A broad-scale pattern of varied vegetation classes and land uses throughout a region (Urban et al. 1987; Crow 2002).

Late Brood-Rearing Habitat: Variety of habitats used by sage grouse from July through September. Habitats used include, but not limited to, meadows, farmland, riparian areas, dry lakebeds, sagebrush areas (Connelly et al. 2003).

Lek: Open area surrounded by sagebrush, without trees or other tall structures in close proximity, where males traditionally display and breeding occurs (Connelly et al. 2003). *– See Active Lek, Inactive Lek*

Lek Group: A group of active leks with 5-km overlapping or contiguous buffers (Moynahan et al. 2007).

Life Form: Characteristic form or appearance of a species at maturity, such as a grass, forb, tree, or shrub (Habich 2001).

Life Requisites: Items an animal needs to survive; these include food, shelter or cover, water (Morrison et al. 1998), and space.

Line Intercept -- Daubenmire Frame (LIDF): A technique for measuring canopy cover that involves placing a tape between 2 points and measuring the amount of plant (crown, stems, leaves) that intersects a vertical projection of this line (Canfield 1941). Normally used for shrubs. Daubenmire Frame—Normally a 20 x 50 cm wooden, metal or PVC frame used to estimate canopy cover. The frame has a painted pattern that allows reference for visual estimates of 5, 25,

50, 75, and 95 percent of the frame (Daubenmire 1959). These methods have commonly been used to estimate shrub and herbaceous cover in sage-grouse research studies.

Linkage Area: A land cover type, other than occupied sagebrush shrubland, that sage-grouse frequently use and may move through to another habitat patch. If made into suitable habitat, this area will increase movement between populations and decrease the probability of extinction of the species by stabilizing population dynamics (GSRSC 2005).

Marginal Habitat: – *See Habitat Suitability*

Monitoring: The collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective (Elzinga et al. 1998).

Native: Indigenous to a given place (Wisdom et al. 2005).

Nesting Habitat: Area with protective grass and high lateral shrub cover where hens nest, typically under sagebrush shrubs (Connelly et al. 2000).

Non-habitat: – *See Habitat Suitability*

Noxious Weed: An unwanted plant specified by Federal or State laws as being especially undesirable, troublesome, and difficult to control. It grows and spreads in places where it interferes with the growth and production of desired species (Habich 2001).

Overstory: The upper canopy or canopies of plants, usually referring to trees, shrubs, and vines (USDI 1996).

Patch: *– See Habitat Patch*

Perennial Plant: A plant that has a life span of three or more years (Pellant et al. 2005).

Point Intercept (PI): Line-point intercept is a rapid, accurate method for quantifying soil cover, including vegetation, litter, rocks and biotic crusts as described in Herrick et al. (2005). The methodology uses a measuring tape and two pins for anchoring the tape and a straight small diameter rod to determine plant cover and composition.

Population: A collection of organisms of the same species that freely share genetic material (i.e., breed; Morrison et al. 1998, Braun 2005). *– See also Subpopulation*

Potential Habitat: – *See Habitat Suitability*

Precision: The closeness of repeated measurements of the same quantity (Elzinga et al. 1998, Braun 2005).

Productivity (sage-grouse): The number of juvenile birds recruited to the fall population, often reported as a ratio of juveniles to adult females (including yearlings) (Cooperrider et al. 1986; Connelly et al. 2003).

Proper Functioning Condition (PFC) Assessment: A consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas (Prichard et al. 2003).

> ***Proper Functioning Condition (PFC):*** A riparian-wetland area in which adequate vegetation or other structure components are present to dissipate energy, reduce erosion and improve water quality, filter sediment and aid in floodplain development, improve flood-water retention and ground-water recharge, stabilize streambanks and shorelines, develop diverse ponding and channel characteristic for fish and wildlife habitat among other things, and support greater biodiversity.
> ***Functional – At Risk (FAR):*** A riparian-wetland area which is in functional condition but has at least one attribute or process that makes it susceptible to degradation.
> ***Non-Functioning (NF):*** A riparian-wetland area which clearly does not provide adequate vegetation, landform, or large woody debris to dissipate energies associated with high flow, and thus does not reduce erosion, improve water quality, etc. (Prichard et al. 2003).

Quantitative: Data derived from measurements, such as counts, dimensions, weights, etc., and recorded numerically. Qualitative numerical estimates, such as ocular cover and production estimates, are often referred to as "semi-quantitative" (Pellant et al. 2005).

Range: The limits within which an organism lives or can be found (Morrison and Hall 2001).

Range Site: *See Ecological Site*

Recruitment: The addition of new individuals (typically only breeding individuals) to a population through reproduction (Dinsmore and Johnson 2005).

Reference Period: A period of time during which data were collected at an area that can be chosen to provide a basis or standard for evaluation or comparison of trend over time. *– See also Ecological Reference Area*

Restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. An ecosystem is recovered or restored when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy (SER 2004).

Riparian (habitat): An area that is saturated or inundated at a frequency and duration sufficient to produce vegetation typically adapted for life in saturated soil conditions (Prichard et al. 2003).

Risk: The potential or probability of an adverse event (Wisdom et al. 2005).

Road: A linear route declared a road by the owner, managed for use by low-clearance vehicles having four or more wheels, and maintained for regular and continuous use (USDI 2005).

Sagebrush Ecosystem: Arid and semi-arid, sagebrush-dominated lands in the western United States and Canada that encompass the approximate boundaries of the historical range of greater and Gunnison sage-grouse (Wisdom et al. 2005).

Scale: The resolution at which patterns are measured, perceived, or represented. Scale can be broken into several components, including grain and extent (Morrison and Hall 2001). For sage-grouse:

> ***Broad-Scale:*** Entire species range and populations (First Order Habitat Selection)
> ***Mid-Scale:*** Subpopulations (Second Order Habitat Selection)
> ***Fine-Scale:*** Seasonal use areas (Third Order Habitat Selection)
> ***Site-Scale:*** Seasonal foraging and shelter habitat (Fourth Order Habitat Selection)

Selection: – *See Habitat Selection*

Shrub: A plant that has persistent woody stems and a relatively low growth habit (less than 5 meters tall), and that generally produces several basal shoots instead of a single bole (Pellant et al. 2005).

Shrubland: Vegetation dominated by shrubs, generally greater than 0.5 m tall and less than 5 m tall, and generally forming greater than 25% cover, with trees forming less than 25% cover (Reid et al. 2002).

Shrubsteppe: Habitats characterized in western North America by woody, mid-height shrubs and perennial bunchgrasses; typically arid, with annual precipitation averaging <36cm over much of the region (Wisdom et al. 2000).

Sink Habitat: Habitat in which local mortality exceeds reproductive success, and therefore the number of individuals occupying the habitat is declining (Meffe and Carroll 1997).

Site: An area of uniform physical and biological properties and management status (Morrison and Hall 2001).

Source Habitat: Habitat in which local reproductive success exceeds local mortality thus producing an excess of individuals to emigrate to other areas (Meffe and Carroll 1997).

Species: Groups of populations which can potentially interbreed or are actually interbreeding, that can successfully produce viable, fertile offspring (Mayr 1969).

Species Composition (plant): The proportions of various plant species in relation to the total on a given area; it may be expressed in terms of relative cover, density, or weight. (Habich 2001).

Species Occupancy: The action of a species inhabiting a place at some time either currently or historically.

> ***Occupied Habitat (sage-grouse):*** All sagebrush and associated plant communities known to be used by sage-grouse within the last 10 years. Sagebrush areas contiguous with areas of known use, which do not have effective barriers to sage-grouse movement from known use areas, are considered occupied unless specific information exists that documents the lack of sage-grouse use.

Subpopulation: A portion of a population in a specific geographic location (Morrison et al. 1998). *– See also Population*

Succession: An orderly and predictable process in which vegetation change represents the life history of a plant community, developing to a distinct climax condition (Morrison et al. 1998).

Succulent: Juicy, watery, or pulpy, as the moist stems of cacti (Habich 2001).

Suitable Habitat: *– See Habitat Suitability*

Summer Habitat: The summer or late brood-rearing period from July through August, when hens and chicks use a variety of moist and mesic habitats where succulent forbs and insects are found in close proximity to sagebrush (Connelly et al. 2000).

Trend: The direction of change in ecological status or resource value rating observed over time (Herrick et al. 2005).

Understory: Plants growing beneath the canopy of other plants; usually refers to grasses, forbs, and low shrubs under a tree or shrub canopy (USDI 1996).

Unsuitable Habitat: *– See Habitat Suitability*

Upland (habitat): An area that is not inundated with water and typically supports vegetation types adapted to life in non-saturated soil conditions (Prichard et al. 2003).

Vegetation Type: A kind of plant community with distinguishable characteristics described in terms of the present vegetation that dominates the aspect or physiognomy of the area (Habich 2001).

Watershed: A group of streams that flow into a subbasin (Wisdom et al. 2000).

Wet Meadow: A meadow where the surface remains wet or moist throughout the summer, usually characterized by sedges and rushes (USDI 1996).

Winter Habitat: Sagebrush habitats that provide access to sagebrush above the snow for all food and cover requisite needs (Connelly et al. 2000).

Woodland: Vegetation dominated by open stands of trees with crowns not usually touching (generally forming 25-60% cover); canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover, respectively (Reid et al. 2002).

Yearling (sage-grouse): A sage-grouse that has entered its first breeding season but has not completed its second summer molt, usually between 10 and 17 months of age (Connelly et al. 2003).

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Sage-Grouse Habitat Assessment Framework

Volume III

Measurement Techniques

and

Data Forms

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Sage-grouse Habitat Assessment Framework
A Multi-Scale Assessment

Volume III

Management Techniques and Data Forms

Introduction:

This volume of the Sage-grouse Habitat Assessment Framework (HAF) contains the data forms and specific instructions for completing the forms. This volume is organized by scale and is intended to be used in the field or in the lab as appropriate for data collection. Volume II of the HAF provides the detailed habitat description steps and should be used as a companion document to guide data collection.

Assessments for the first order (broad-scale) habitat selection require range-wide coverage and a policy decisions at either the range-wide scale or the management zone scale. No structured data forms are required for a first order assessment. Policies direct the management effort and direction for sagebrush habitats and sage-grouse.

The assessment of second order (mid-scale) habitat selection requires a general delineation of sage-grouse populations, habitat, and habitat patterns such as patch connectivity, linkage, patch edges and fragmentation. Managers, scientists, and policy executives view the current landscape, its constraints and its attributes and project the future configuration and condition of the various habitats. Scientists employing advanced mapping technology will provide decision makers with existing land cover classification (e.g. urban, agriculture, and natural vegetation communities at the Alliance level), ecological potential for cover classes, and biotic risk factors across the landscape. Spatial analysts, specializing in anthropomorphic features will add sociological and political layers of constraints on the landscapes. This information will enable managers and decision-makers working in concert with scientists to develop priority conservation focus areas. A single form is required for the second order assessment. This form should be applied for each landscape at this scale.

Third order (fine-scale) habitat selection analysis allows managers to develop a project matrix that meets the objectives of the higher level decision and policy makers. Managers develop project priority lists based on science and spatial analytical information. Priority conservation focal areas are evaluated and prescribed for fourth order treatments. Following this evaluation, specific conservation projects are proposed.

The majority of data forms found in this volume are fourth order (site-scale) instruments, adequate to describe vegetation communities to the Association level. Managers and resource specialists will find systematic collection and analysis of these data helpful in prescribing appropriate treatments for fourth order projects.

Raw data forms are found on the accompanying CD.

Sage-Grouse Habitat Assessment Framework

Measurement Techniques

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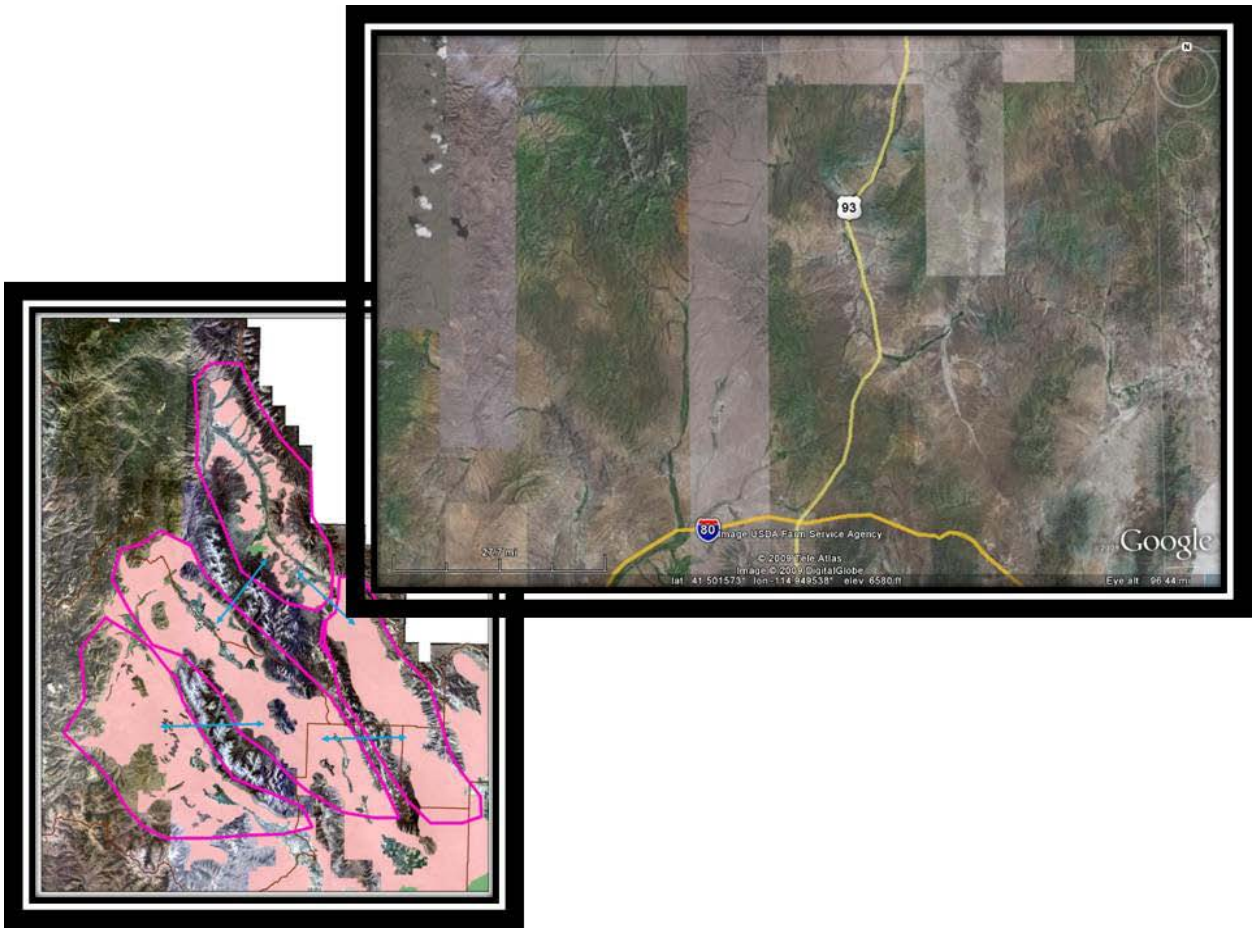
Data Forms

Second Order (Mid-Scale)



Form F – 2nd Order Sage-Grouse Habitat Description

Date:	State:	Counties:
Evaluators:		Populations:
General Location:		Map File Name:
Sage-Grouse Management Zone(s):		
Agencies:		

Data Sources and Software

Land Cover Type Data Sources:	Date:
Anthropogenic Features Data Sources:	
Population Data Sources:	
Data Storage Location:	
Software and version:	
Mapping Grain (spatial resolution):	Population Area Extent (km^2):

Habitat Indicator Descriptions

1. Habitat Availability	a. Area of occupied habitat (km^2) =
	b. Area of potential habitat (km^2) =
	c. Area of non-habitat (km^2) (optional) =
	Discussion:
2. Habitat Pattern	a. Mean size of occupied habitat patches (km^2) =
	b. # of occupied habitat patches =
	Discussion:
3. Patch Connectivity	Mean distance to nearest occupied habitat patch (km) =
	Discussion:
4. Linkage Areas	a. % suitable land cover types in linkage areas =
	b. % marginal land cover types in linkage areas =
	c. % unsuitable land cover types in linkage areas =
	Discussion:
5. Patch Edges	a. Mean % positive patch edges =
	b. Mean % negative patch edges =
	Discussion:
6. Internal Patch Fragmentation – Anthropogenic Features	a. Densities of linear features (km / km^2) =
	b. Densities of point features (sites / km^2) =
	c. Area of non-habitat or unsuitable habitat inclusions (km^2) =

2nd Order (Mid-scale) Suitability Summary

Population Description, **Check one of the descriptions below that best describe the subpopulation area:**	✓
Suitable: Subpopulation landscape has connected mosaic sagebrush shrublands that allow for bird dispersal movements. Anthropogenic disturbances that can disrupt dispersal or cause mortality are generally not wide-spread or are absent.	
Marginal: Subpopulation landscape has patchy, fragmented sagebrush shrublands that are not well connected for dispersal in portions of the area. Anthropogenic disturbances that disrupt dispersal or cause mortality are present throughout all or portions of the landscape. Some lek groups may be isolated or nearly isolated.	
Unsuitable: Subpopulation landscape was former shrubland habitat now converted to predominantly grassland or woodland land cover or other unsuitable land cover or use (e.g., high density of anthropogenic features). Remaining sagebrush patches are predominantly unoccupied or have few remaining birds. Portions of the area may become occupied in the foreseeable future through succession or restoration.	
Discussion:	

Measurement Techniques

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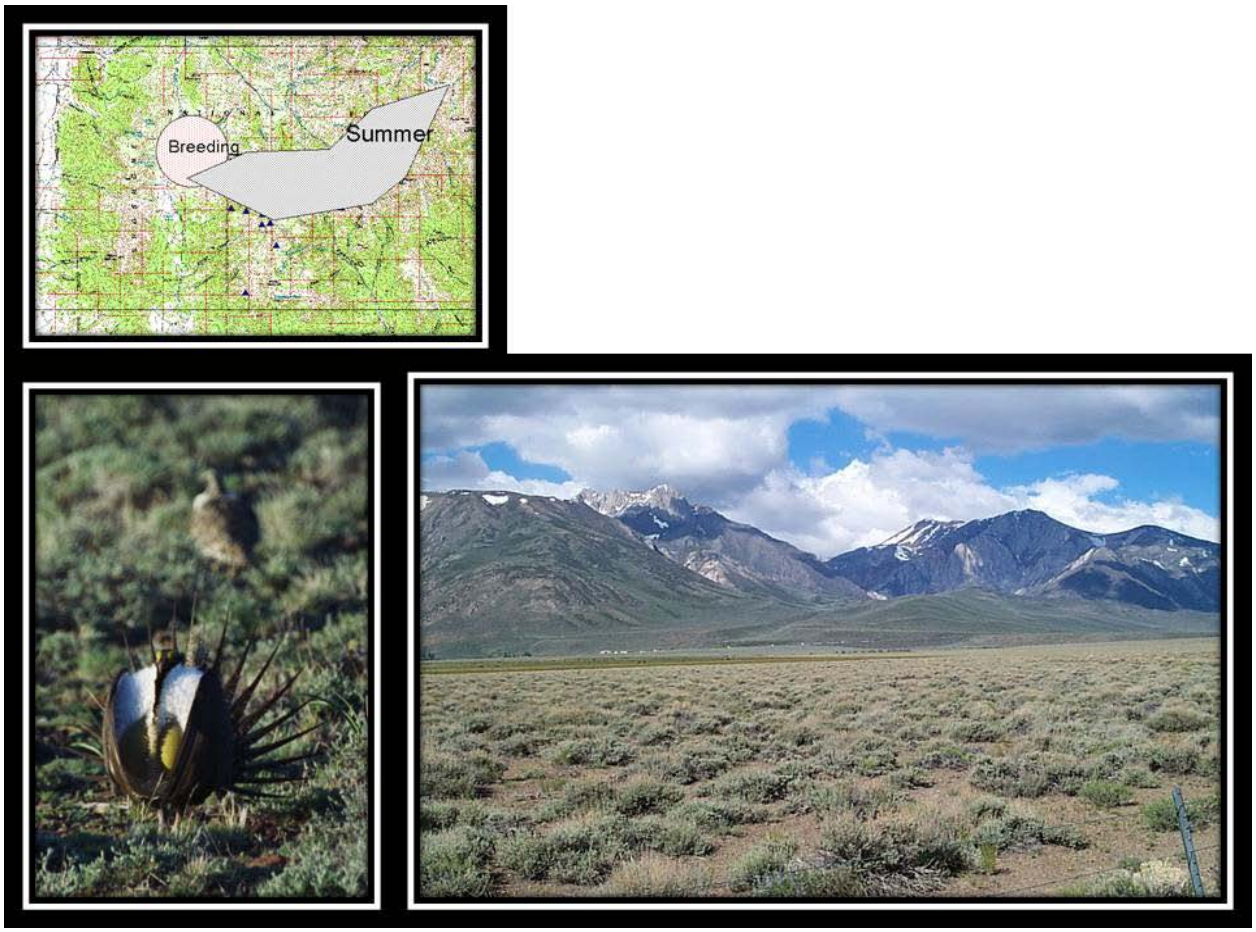
Third Order (Fine-Scale)



Form G: 3rd Order (Fine-Scale) Sage-Grouse Habitat Description

General Information			
Home Range Name:	Subpopulation:		
Lek Group Name:	General Location:		
Description Year:	State:	Counties:	
Recorder Name:	Agency:		

Data Sources and Computer Programs	
Land Cover Type Data Sources:	
Anthropogenic Features Data Sources:	
Population Data Sources:	
Data Storage Location:	
Computer Programs Used:	
Mapping Grain:	Home range Area Extent (km^2):

Habitat Indicator Descriptions	
1. Seasonal Habitat Availability	a. Area of occupied breeding habitat (km^2) =
	a. Area of occupied summer habitat (km^2) =
	a. Area of occupied winter habitat (km^2) =
	b. Area of potential breeding habitat (km^2) =
	b. Area of potential summer habitat (km^2) =
	b. Area of potential winter habitat (km^2) =
	c. Area of non-habitat (km^2) (optional) =
	Discussion:
2. Seasonal Use Area Connectivity	Breeding to Summer:
	Summer to Winter:
	Winter to Breeding:
3. Anthropogenic Features	a. Densities of linear features (km / km^2) =
	b. Densities of point features (sites / km^2) =
	c. Area of non-habitat or unsuitable habitat inclusions (km^2) =
	Discussion:

Fine-scale Suitability Summary	
✓	**Check one of the below descriptions that best describe the home range:**
	Suitable: Home ranges have connected seasonal use areas. Anthropogenic features that can disrupt seasonal movements or cause mortality are generally absent or at least not widespread.
	Marginal: Home ranges have poorly connected or disjunct seasonal use areas. Anthropogenic features that can disrupt seasonal movements or cause mortality are within the home range.
	Unsuitable: Home ranges have seasonal use areas with predominantly grassland, woodland or incompatible land uses (anthropogenic features) not conducive to sage-grouse seasonal movements or habitat use. Most leks have been abandoned or have few remaining birds.

Discussion:

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Data Collection Form

Fourth Order (Site-Scale)

Form H-1: Seasonal Habitat Forth Order (site-scale) Data Summary

Date:	State:	County:	Subpopulation:
Recorder:		General Location: T. R. Sections	Home Range Name:
Seasonal Habitat:			Associated Leks:

Land Cover Type	Ecological Site	Area (ha) or Length (km)	Transects (#)	Measurements From Data Sheets (means in most cases)							
				Sage CC (%)	Sage Ht. (cm)	Sage Shape (# of S, M or C)	PG & PF Ht. (cm)	Pg CC (%)	PF CC (%)	#Preferred Forb Species	Distance To Sage Cover (m)

Form H-1: Seasonal Habitat Site-Scale Data Summary Directions

1. Form is used to summarize seasonal habitat field data collected using methods outlined in this document.

2. Complete all site location information at top of sheet. Information should be consistent with information on the field data forms. Most of the information should be self explanatory except for the following:

Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

Seasonal Habitat: List one of the following: breeding, summer, or winter to which the data pertain. The same area may provide more than one seasonal habitat need but data must be collected at the appropriate time of year for descriptions.

Land Cover Type: Identify the land cover type of the data.

Upland communities: Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

Riparian or wetland communities: Use site type (riparian areas, wet meadows, springs) or more detailed classification using Cowardin et al. (1979), or riparian type (regional classification systems) to which the data pertain.

Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

Area or Length: Record the polygon area or linear length of the habitat sampled.

Transects: Record the number of 50-m transects or sites measured within the land cover type.

Indicator values (Sage CC, Sage Ht., etc.): Record the mean or total numbers as indicated for each measurement.

Sage Height: Sagebrush height above ground for most seasons and above snow for winter habitat.

Sage Shape: S=Spreading; M=Mixed; C=Columnar (see site guides in Figure III - 7)

Form H-2: Sage-Grouse Habitat Suitability Worksheet – Lek Habitat

Date:	State:	County	
Evaluators:		Subpopulation:	
Legal Description: T. R. Sections ¼ ¼		Home Range Name:	
Lek ID#:		Lek Status (circle one): Active Inactive Unknown	
Land Cover Type:		GPS file #:	UTM:

Habitat Suitability Range

Habitat Indicator	**Suitable**	✔	Marginal	✔	Unsuitable	✔
Availability of Sagebrush Cover	*Lek has adjacent protective sagebrush cover (within 100 m)*		*Sagebrush within 100 m provides very little protective cover*		*Adjacent sagebrush cover is > 100 m*	
Proximity of Trees or Other Tall Structures	*Trees or other tall structures are not within line of sight of lek and none to uncommon within 3 km of lek*		*Trees or other tall structures are within line of sight of lek and uncommon or scattered within 3 km of lek*		*Trees or other tall structures are within the vicinity of the lek site*	

Site-Scale Suitability ☐ ☐ ☐

Anthropogenic Noise Description:

Rationale for Overall Suitability Rating:

Form H-2: Sage-Grouse Habitat Suitability Worksheet – Lek Habitat Directions

1. Complete one form for each active or inactive lek in the home range or lek group, as needed.

2. Complete all location information at the top of the sheet. Most of the information should be self-explanatory except for the following:

Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

Lek ID #: Use the identification number or name that is used in the state-wide database.

Active lek: *[Greater sage-grouse]* A lek that has been attended by ≥ 2 males in ≥ 2 the previous 5 years; *[Gunnison sage-grouse]* A lek that has been attended by males in the previous 5 years.

Inactive lek: *[Greater sage-grouse]* A lek that has been attended by < 2 males in <2 of the previous 5 years; *[Gunnison sage-grouse]* A lek that has been inactive for 5 years.

Land Cover Type: Identify the plant community at the lek site. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).. Note if the lek is located in non-habitat (e.g., agriculture, urban, industrial). If the lek is located on a road, livestock watering area, or similar type of surface within a plant community, indicate this cover type in the following manner: ARTRw:road; ARTRw:trough area.

3. Indicator Measurement Directions:

Availability of Sagebrush Cover: Adjacent sagebrush distance is measured from the edge of the lekking area to the edge of the nearest stand of mature sagebrush of sufficient extent to provide protective cover.

Proximity of Trees or Other Tall Structures: Trees and tall structures are considered "within the vicinity" when these tall structures provide avian perch sites with a view of birds on the lek.

4. Each indicator must be marked as suitable, marginal, or unsuitable. Mark a ✓ in the appropriate suitability category.

5. **Site-Scale Suitability:** Overall suitability takes into consideration the relationship between the indicators and their relative importance. This evaluation is based on professional judgment using the indicators for guidance. Explain overall site suitability in the rationale section.

6. **Anthropogenic Noise Description:** Indicate the presence of and describe any anthropogenic noises observed during the lekking period. Identify the noise source (highway vehicles, generator, wind turbines, military over-flights, etc.) and describe the occurrence frequency (constant or periodic), volume (loud to soft), and pitch (high to low). Use a decibel meter, if available, to record data when anthropogenic noises are a concern for the lek.

7. Attach photographs of the lek site.

8. Provide a copy of this form to the state wildlife agency coordinator for sage-grouse conservation.

Form H-3: Sage-Grouse Habitat Suitability Worksheet – Breeding Habitat

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:
Land Cover Type:			Ecological Site:
Number of Transects:		Area Sampled (ha)	Site Info. (Circle one) Aird Site Mesic Site
List UTM Coordinates (Coordinates, Zone, Datum) of All Transect:			

Habitat Indicator Suitability Range

Habitat Indicator	x̄	Suitable	✔	Marginal	✔	Unsuitable	✔
Sagebrush Canopy Cover (mean)		15 to 25%		5 to < 15% or > 25%		< 5%	
Sagebrush Height Mesic Site (mean) Ari Site (mean)		 40 to 80 cm 30 to 80 cm		 20 to < 40 cm or > 80 20 to < 30 cm or > 80		 < 20 cm < 20 cm	
Predominant Sagebrush Shape (mode) Spreading (*n)* Mixed (*n*) Columnar (*n*)		Spreading		Mix of spreading and columnar		Columnar	
Perennial Grass and Forb Height (mean)		≥ 18 cm		10 to < 18 cm		< 10 cm	
Perennial Grass Canopy Cover Mesic Site (mean) Arid Site (mean		 ≥ 15% ≥ 10%		 5 to < 15% 5 to < 10%		 < 5% < 5%	
Perennial Forb Canopy Cover Mesic Site (mean) Arid Site (mean		 ≥ 10% ≥ 5%		 5 to < 10% 3 to < 5%		 < 5% < 5%	
Preferred Forb Availability (relative to site potential)		Preferred forbs are common with several species present		Preferred forbs are common but only a few species are present		Preferred forbs are rare	
Number of Preferred Forb Species (*n*)							
Site-Scale Suitability							

Does ecological site potential limit suitability potential? (circle one)	Yes	No		
Drought Condition (circle one):	Extreme Drought	Severe Drought	Moderate Drought	Mid-Range
	Moderately Moist	Very Moist	Extremely Moist	
Rationale for Overall Suitability Rating:				

Form H-3: Sage-Grouse Habitat Suitability Worksheet – Breeding Habitat Directions

1. This worksheet is used to interpret field data collected using methods outlined in the Supplemental Data Collection section (PI / LIDF and belt transect) and summarized in the Seasonal Habitat Site-Scale Data Summary (Form H-1).

2. Complete all site location information at the top of the sheet. Be sure to list all UTM coordinates or other identifying feature of all sites being summarized. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the plant cover type of the data. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Number of Sampling Transects: Record the number of 50-m transects completed within the land cover type.

   Area Sampled: Record the total area of the land cover type sampled.

   Arid Site: Term applies to sagebrush ecological sites generally in the 25-30 cm (9.8–11.8 in.) precipitation zone. *Artemisia tridentata wyomingensis* is a common big sagebrush sub-species for this type of site.

   Mesic Site: Term applies to sagebrush ecological sites generally in a >30 cm (11.8 in.) precipitation zone *Artemisia tridentata vaseyana* is a common big sagebrush sub-species for this type of site.

3. Transfer data from the Seasonal Habitat Site-Scale Data Summary (Form H-1) to this form. Enter the appropriate mean ($\bar{x}$) and number (n) values where appropriate for the indicators in the column under $\bar{x}$.

4. Each indicator must be marked as suitable, marginal, or unsuitable. Mark a ✓ in the appropriate suitability category.

Predominant Sagebrush Shape: Check the suitability category that describes the most common (mode) shape.

Preferred Forb Availability: Check the appropriate suitability category based on data derived using the Preferred Forb Availability Data Form. Suitability evaluation must be relative to ecological site potential.

Site-Scale Suitability: Overall suitability takes into consideration the relationship between the indicators and their relative importance. This evaluation is based on professional judgment using the indicators for guidance. Explain overall site suitability in the rationale section.

Site Potential: Indicate if site potential is a factor for a suitability description of marginal or unsuitable. Explain further in the rationale section.

Drought Condition: Indicate the current drought condition using local weather station data or as reported for the region of concern on the National Weather Service website: www.ncdc.noaa.gov/oa/climate/research/us-drought-monthly.html

5. Attach field data sheet(s) and photographs used for this site-scale description.

6. Provide a copy of this form to the state wildlife agency coordinator for sage-grouse conservation.

Form H-4: Sage-Grouse Habitat Suitability Worksheet – Upland Summer Habitat

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:
Land Cover Type:			Ecological Site:
Number of Transects:			Area Sampled (ha or acres)
List UTM Coordinates (Coordinates, Zone, Datum) of All Transect:			

Habitat Indicator Suitability Range

Habitat Indicator	x̄	**Suitable**	✔	Marginal	✔	Unsuitable	✔
Sagebrush Canopy Cover (mean)		10 to 25%		5 to < 10% or > 25%		< 5%	
Sagebrush Height (mean)		40 to 80 cm		20 to < 40 or > 80 cm		< 20cm	
Perennial Grass and Forb Canopy Cover (mean)		≥ 15 %		5 to < 15%		< 5%	
Preferred Forb Availability (relative to site potential) Number of Preferred Forb Species (*n*)		Forbs are common with several preferred species present		Forbs are common but only a few preferred species are present		Preferred forbs are rare	

Site-Scale Suitability ☐ ☐ ☐

Does site potential limit suitability? (circle one)	Yes	No		
Drought Condition (circle one):	Extreme Drought	Severe Drought	Moderate Drought	Mid-Range
	Moderately Moist	Very Moist	Extremely Moist	
Rationale for Overall Suitability Rating:				

Form H-4: Sage-Grouse Habitat Suitability Worksheet – Upland Summer Habitat Directions

1. This worksheet is used to interpret field data collected using methods outlined in the Supplemental Data Collection section (PI / LIDF and belt transect) and summarized in the Seasonal Habitat Site-Scale Data Summary (Form H-1).

2. Complete all site location information at the top of the sheet. Be sure to list all UTM coordinates or other identifying feature of all sites being summarized. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the plant cover type of the data. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Number of Transects: Record the number of 50-m transects completed within the land cover type.

   Area Sampled: Record the total area of the land cover type sampled.

3. Transfer data from the Seasonal Habitat Site-Scale Data Summary (Form H-1) to this form. Enter the appropriate mean ($\bar{x}$) and number (n) values where appropriate for the indicators in the column under $\bar{x}$.

4. Each indicator must be marked as suitable, marginal, or unsuitable. Mark a ✓ in the appropriate suitability category.

   Preferred Forb Availability: Check the appropriate suitability category based on data derived using the Preferred Forb Availability Data Form. Suitability evaluation must be relative to ecological site potential.

5. Site-Scale Suitability: Overall suitability takes into consideration the relationship between the indicators and their relative importance. This evaluation is based on professional judgment using the indicators for guidance. Explain overall site suitability in the rationale section.

6. Site Potential: Indicate if site potential is a factor for a suitability description of marginal or unsuitable. Explain further in the rationale section.

7. Drought Condition: Indicate the current drought condition using local weather station data or as reported for the region of concern on the National Weather Service website: www.ncdc.noaa.gov/oa/climate/research/us-drought-monthly.html

8. Attach field data sheet(s) and photographs used for this site-scale description.

9. Provide a copy of this form to the state wildlife agency coordinator for sage-grouse conservation.

Form H-5: Sage-Grouse Habitat Suitability Worksheet – Riparian Summer Habitat

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:
Land Cover Type:			Site Info. (circle one): Arid Site Mesic Site
Site Type (circle one) riparian areas, wetland/wet meadows, springs, lakebeds, all, other:			
Number of Transects:			Area (ha or acres) or Distance (km) Sampled:
List UTM Coordinates (Coordinates, Zone, Datum) of All Transect:			

Habitat Indicator Suitability Range

Habitat Indicator	x̄	**Suitable**	✔	Marginal	✔	Unsuitable	✔
Riparian and Wet Meadow Stability (mode) PFC (*n*) FAR (*n*) NF (*n*)		Majority of areas are in PFC		Majority of areas are FAR		Majority of areas are NF	
Preferred Forb Availability (relative to site potential) Number of Preferred Forb Species (*n*)		Preferred forbs are common with several species present		Preferred forbs are common but only a few species are present		Preferred forbs are rare	
Proximity of Sagebrush Cover (mean)		Sagebrush cover is adjacent to brood-rearing areas (< 90m)		Sagebrush cover is in close proximity to brood-rearing areas (90 to 275 m)		Sagebrush cover is unavailable (> 275 m)	

Site-Scale Suitability ☐ ☐ ☐

Drought Condition (circle one):	Extreme Drought	Severe Drought	Moderate Drought	Mid-Range
	Moderately Moist	Very Moist	Extremely Moist	
Rationale for Overall Suitability Rating:				

Form H-5: Sage-Grouse Habitat Suitability Worksheet – Riparian / Wet Meadow
Summer Habitat Directions

1. This worksheet is used to interpret field data collected using methods outlined in the Supplemental Data Collection section (PFC and belt transect) and summarized in the Seasonal Habitat Site-Scale Data Summary (Form H-1).

2. Complete all site location information at the top of the sheet. Be sure to list all UTM coordinates or other identifying feature of all sites being summarized. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: (Optional) Identify the wetland (Cowardin et al. 1979) or riparian type (regional classification systems) of the habitat sampled. This data may be important to record when more detailed descriptions of summer habitats are desired (i.e., with sites stratified by cover type).

   Arid Site: Term applies to sagebrush ecological sites generally in the 25-30 cm precipitation zone. *Artemisia tridentata wyomingensis* is a common big sagebrush sub-species for this type of site.

   Mesic Site: Term applies to sagebrush ecological sites generally in a >30 cm precipitation zone *Artemisia tridentata vaseyana* is a common big sagebrush sub-species for this type of site.

   Site Type: Identify the type of habitat sites sampled.

   Number of Sampling Transects: Record the number of 50-m transects or sites measured within the land cover type.

   Area or Distance Sampled: Record the total area or distance (for riparian areas) of the site type or land cover type sampled.

3. Transfer data from the Seasonal Habitat Site-Scale Data Summary (Form H-1) to this form. Enter the appropriate mean ($\bar{x}$) and number (n) values, and PFC data where appropriate for the indicators in the column under $\bar{x}$.

4. Each indicator must be marked as suitable, marginal, or unsuitable. Mark a ✓ in the appropriate suitability category.

   Riparian and Wet Meadow Stability: Record the number of sampling sites that were PFC, FAR, or NF (Pritchard et al. 1998, 2003). Current PFC data can be used, if available. If PFC data cannot be obtained from other sources or collected directly, then the other two indicators should be used to assess habitat suitability.

   Preferred Forb Availability: Check the appropriate suitability category based on data derived using the Preferred Forb Availability Data Form. Suitability evaluation must be relative to ecological site potential.

   Proximity of Sagebrush Cover: Distance is measured from the edge of the riparian or wetland area to the edge of the nearest stand of mature sagebrush of sufficient extent to provide protective cover.

5. **Site-Scale Suitability:** Overall suitability takes into consideration the relationship between the indicators and their relative importance. This evaluation is based on professional judgment using the indicators for guidance. Explain overall site suitability in the rationale section.

6. **Drought Condition:** Indicate the current drought condition using local weather station data or as reported for the region of concern on the National Weather Service website: www.ncdc.noaa.gov/oa/climate/research/us-drought-monthly.html

7. Attach field data sheet(s) and photographs used for this site-scale description.

8. Provide a copy of this form to the state wildlife agency coordinator for sage-grouse conservation.

Form H-6: Sage-Grouse Habitat Suitability Worksheet – Winter Habitat

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:
Land Cover Type:			Ecological Site:
Number of Transects:			Area Sampled (ha or acres):
List UTM Coordinates (Coordinates, Zone, Datum) of All Transect:			

Habitat Indicator Suitability Range

Habitat Indicator	x̄	**Suitable**	✔	**Marginal**	✔	**Unsuitable**	✔
Sagebrush Canopy Cover (mean)		≥ 10 %		5 to < 10%		< 5%	
Sagebrush Height above Snow (mean)		> 25 cm		> 10 to < 25 cm		< 10cm	

Site-Scale Suitability ☐ ☐ ☐

Rationale for Overall Suitability Rating:

Form H-6: Sage-Grouse Habitat Suitability Worksheet – Winter Habitat Directions

1. This worksheet is used to interpret field data collected using methods outlined in the Supplemental Data Collection section (PI / LIDF) and summarized in the Seasonal Habitat Site-Scale Data Summary (Form H-1).

2. Complete all site location information at the top of the sheet. Be sure to list all UTM coordinates or other identifying feature of all sites being summarized. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the plant cover type of the data. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Number of Transects: Record the number of 50-m transects completed within the land cover type.

   Area Sampled: Record the total area of the land cover type sampled.

3. Transfer data from the Seasonal Habitat Site-Scale Data Summary (Form H-1) to this form. Enter the mean ($\bar{x}$) for the indicators in the column under $\bar{x}$.

4. Each indicator must be marked as suitable, marginal, or unsuitable. Mark a ✓ in the appropriate suitability category.

5. Site-Scale Suitability: Overall suitability takes into consideration the relationship between the indicators and their relative importance. This evaluation is based on professional judgment using the indicators for guidance. Explain overall site suitability in the rationale section.

6. Attach field data sheet(s) and photographs used for this site-scale description.

7. Provide a copy of this form to the state wildlife agency coordinator for sage-grouse conservation.

Form H-7: Seasonal Habitat Site Suitability Summary

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:

Seasonal Habitat Information						Suitability		
						Current	Future	
Seasonal Habitat	**Land Cover Type**	**Ecological Site**	**Area (ha or acres)** ***(Upland)***	**Length (km)** ***(riparian)***	**Number of Sites (#)** ***(leks, wet meadows, springs, etc.)***	**S**uitable, **M**arginal, **U**nsuitable	**Site potential limiting?**	**Habitat components present?**

Form H-7: Seasonal Habitat Site-Scale Suitability Summary

1. This form is used to summarize site-scale seasonal habitat suitability descriptions (Forms H-2 through H-6) for land cover types within a home range area.

2. Complete all site location information at the top of the sheet. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

3. Transfer data from the seasonal habitat suitability worksheets (Forms H-2 through H-6) to this form.

   Seasonal Habitat: List one of the following: lek, breeding, summer, or winter, for each seasonal habitat summarized.

   Land Cover Type: Identify the land cover type of the data.

   Upland communities: Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Riparian or wetland communities: Use site type (riparian areas, wet meadows, springs) or more detailed classification using Cowardin et al. (1979), or riparian type (regional classification systems) to which the data pertain.

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Area / Length / Number of Sites: Record the area (upland habitat), linear length (riparian habitat), or number of sites (leks, wet meadows, springs, etc.) sampled.

   Current Suitability: Record the overall site-scale suitability: S = Suitable; M = Marginal; U = Unsuitable.

   Future Suitability: Record any site-scale ecological constraints for the cover type to provide habitat in the future. This information applies only to those sites that are currently providing marginal or unsuitable site-scale conditions.

   Site potential limiting?: If ecological site potential indicates that the site may provide suitable habitat in the future, record "No." If ecological site potential is limiting suitability, record "Yes."

   Habitat components present?: If there is sagebrush recruitment and forbs and perennial grasses are present in suitable amounts, record "Yes." If recruitment of these life forms is lacking, record "No."

Point Intercept Data Form

Date:	State:	County:	Subpopulation:
Examiner(s):			Home Range Name:
Legal Description T. R. Section ¼, ¼			Associated Leks:
Land Cover Type:			Ecological Site:
Seasonal Habitat:			Site Info. (circle one) Arid Site Mesic Site
Transect #	Area (ha) sampled:		UTM:

Transect Data Summary (see directions)

Shrub	Forbs	Grasses
Sagebrush Canopy Cover Hits#_____, %_____	Perennial Forb Canopy Cover PF Hits:# _____, %_____	Perennial Grass Canopy Cover PG Hits: #_____, %_____
Avg. Height (cm)	Annual Forb Canopy Cover	Annual Grass Canopy Cover
Sagebrush Shape Hits (%) S:_____, M:_____, C:_____	PF Hits:# _____, %_____	PG Hits: #_____, %_____
Shrub Canopy Cover Hits #_____, %_____	Total Forb Canopy Cover PF & AF Hits: _____, %_____	Total Grass Canopy Cover PG & AG Hits: _____, %_____
	Avg PF Height (cm):	Avg. PG Height (cm):

Pts.	Hits: Top Layer		Shape	Lower Canopy Hits				Soil	Pts.	Hits: Top Layer		Shape	Lower Canopy Hits				Soil
				Layer 2		Layer 3							Layer 2		Layer 3		
	Species	Ht.		Species	Ht.	Species	Ht.			Species	Ht.		Species	Ht	Species	Ht.	
1									26								
2									27								
3									28								
4									29								
5									30								
6									31								
7									32								
8									33								
9									34								
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22									47								
23									48								
24									49								
25									50								

Point Intercept Method

Equipment:

Tape, 50-m (optional)	Stakes for tape (at least two spikes; old, medium-large screwdrivers work well)
Pin flag or Pointer or other Point Intercept device: straight piece of wire or rod at least 1m long and less than 2.5mm in diameter	Meterstick (for measuring shrub and grass/forb heights)
Digital camera, extra camera battery	Photo cards and markers, or small dry-erase board and marker
Topographic map with project area, general cover types, and pasture boundaries delineated	Aerial photographs
Ecological Site Guides	GPS unit, compass
Forms and/or Data Logger with extra battery, Pencils	Calculator

Protocol:

- Seasonal habitat has been stratified by land cover types prior to field evaluation (see HAF Vol. II document for more directions).
- Repeat all steps for a minimum of 4 transects per land cover type.

1. Complete all site location information at the top of the sheet. Be sure to list UTM coordinates or other identifying feature of the site. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the land cover type of the data. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Seasonal Habitat: List one of the following: breeding, summer, or winter.

   Arid Site: Term applies to sagebrush ecological sites generally in the 25-30 cm precipitation zone. *Artemisia tridentata wyomingensis* is a common big sagebrush sub-species for this type of site.

   Mesic Site: Term applies to sagebrush ecological sites generally in a >30 cm precipitation zone *Artemisia tridentata vaseyana* is a common big sagebrush sub-species for this type of site.

   Transect #: Assign a unique transect identifier for each transect within the land cover type.

   Area Sampled: Record the total area or distance (for riparian areas) of the site type or land cover type sampled.

2. Anchor the tape with a steel pin and pull the tape out 50 meters. Keep the tape as taught and straight as possible. Anchor the tape on the far end.

3. Take photographs of the study site. At least one photograph must be taken at each transect/evaluation area. Photos will prove invaluable in locating evaluation areas in subsequent years. They will also be of substantial utility in the office when preparing evaluation documents and documenting habitat condition.
   a. Complete a photo card, showing, at a minimum, the date, location, allotment, and sagebrush canopy cover percentage.
   b. With the photo card near the zero end of the tape, take a general photo of the area, sighting down the tape from eye level, showing landmarks in the background, if possible. A cover board or meter stick should be in the picture for a frame of reference.
   c. In a representative location along or near the tape, place the photo card near the base of a sagebrush plant, and take a tangential close-up photo from near ground level (2-3 ft) toward the shrub/ground interface, to document herbaceous conditions and cover. A cover board or meter stick should be in the picture for a frame of reference.
   d. Optional: take one or more other close-ups or panoramic photos as needed.

4. Begin at the “0” end of the tape.

5. Every 1 meter place the pin in the ground so that it is angled precisely vertically and touches the near side of the tape at the correct interval point (every 1 m for 50 marks).

6. Measure canopy cover at each pin point:
   a. Record the plant with the highest leaf or stem touching the pin. Record only live canopies of shrubs and live or residual cover of herbaceous plants (remember that residual plant cover can be very important for sage-grouse nesting) under the Species column of Top Layer hits, using the species acronyms. See Monitoring of Greater Sage-grouse Habitats and Populations http://sagemap.wr.usgs.gov/docs/grouse_habitat_book.pdf and http://www.cnr.uidaho.edu/range357/notes/cover.pdf for discussions on canopy cover.
   b. Record the next different life form species with the highest leaf or stem touching the pin. Record these under the Species column within the Lower Canopies columns. Only one hit per life form can be recorded unless the 2nd hit is a basal hit. For example, do not record more than one shrub hit or one perennial grass hit per pin point.

7. Record soil surface type and life forms (tree, shrub, perennial grass and forb, annual grass and forb) by species:
   a. Record soil surface.
      - Use the following abbreviations for soil surface type: R = Rock Fragment (>5mm diameter); BR = Bedrock; M = Moss; LC = Visible Lichen Crust on soil; S = Soil, without any other soil surface code; EL = Embedded Litter; D = Duff.
   b. Record life form species when present.
      - When possible use the scientific name acronyms for plant cover species (e.g., *Artemisia tridentata wyomingensis* = ARTRw; Table III - 2). Make a list of those you will likely encounter in data collection before going to the field.
      - When species cannot be identified, record genus. If genus is unknown, use the following life form abbreviations: TR = Tree; SH = Shrub; PG = Perennial Grass; PF = Perennial Forb; AG = Annual Grass; AF = Annual Forb.

8. Measure plant heights:
   a. Shrubs:
      - Record the maximum height in cm of the shrub that is touched by the pin, excluding flower or seed stalks.
      - Record the shape of sagebrush only: S = Spreading; M = Mixed; C = Columnar (Figure III - 7).
   b. Perennial Grasses and Forbs:
      - Record the natural or droop height in cm of the perennial grass or perennial forb touched by the pin. [Natural = the highest point measured with no straightening by the observer, Figure III - 8]. This includes seed and flower stalks when they contribute to the body of the plant that provides screening cover. There will be instances (e.g., certain *Poa* spp.) when only a few, sparse seed stalks are present and extend well above the body of the plant that provides the cover. In these cases the droop height of the plant *exclusive of the seed stalks* should be measured. This will require some professional judgment on the part of the biologist (see illustration in).

9. Proceed to the next point or intercept and repeat for 50 total hits.

10. Summarize the data at the top of the form. Only one hit per lifeform (one shrub, forb, and grass each) per point can be used in the summary.

   a. Shrubs:
      - *Sagebrush Canopy Cover: Hits* = # of sagebrush hits, *% cover* = # of hits divided by the total number of transect points
      - *Avg. Height* = sum of all sagebrush recorded heights divided by total number of sagebrush plants measured
      - *Sagebrush Shape Hits* = total # of sagebrush plants of each shape (S, M, and C) divided by total number of sagebrush plants measured
      - *Shrub Canopy Cover: Hits* = # of total shrub hits, *% cover* = # of hits divided by the total number of transect points
   b. Forbs:
      - *Perennial Forb Canopy Cover: PF Hits* = # of perennial forb hits, *% cover* = # of hits divided by total number of transect points
      - *Annual Forb Canopy Cover: AF Hits* = # of annual forb hits, *% cover* = # of hits divided by total number of transect points
      - *Total Forb Canopy Cover: PF&AF Hits* = # of perennial and annual forb hits, *% cover* = # total forb hits divided by total number of transect points (There may be instances where a perennial and annual forb hit is recorded for one point. In these instances the upper layer hit is the only one that should be included for that point in calculating combined cover.)
      - *Avg. PF Height* = sum of all perennial forb recorded heights divided by total number of perennial forbs measured
   c. Grasses:
      - *Perennial Grass Canopy Cover: PG Hits* = # of perennial grass hits, *% cover* = # of hits divided by total number of transect points
      - *Annual Grass Canopy Cover: AG Hits* = # of annual grass hits, *% cover* = # of hits divided by total number of transect points
      - *Avg. PG Height* = sum of all perennial grass recorded heights divided by total number of perennial grass plants measured
      - *Avg. PG&PF Heights* = sum of all perennial grass and perennial forb recorded heights divided by total number measured

11. Complete the Sage-Grouse Preferred Forb Availability Data Form.

Line **Intercept and Daubenmire Frames Data Form**

Date:	State:	County:	Subpopulation:
Examiner(s):			Home Range Name:
Legal Description T. R. Section ¼, ¼			Associated Leks:
Land Cover Type:			Ecological Site:
Seasonal Habitat:			Site Info. (circle one) Arid Site Mesic Site
Transect #	Area (ha or Acres) sampled:		UTM: (Coordinates, Zone, Datum)

Transect Data Summary (see directions)

Shrub	Forbs	Grasses
Sagebrush Canopy Cover Hits#_____, %_____	Perennial Forb Canopy Cover PF Hits:# _____, %_____	Perennial Grass Canopy Cover PG Hits: #_____, %_____
Avg. Height (cm)	Annual Forb Canopy Cover	Annual Grass Canopy Cover
Sagebrush Shape Hits (%) S:_____, M:_____, C:_____	PF Hits:# _____, %_____	PG Hits: #_____, %_____
Shrub Canopy Cover Hits #_____, %_____	Total Forb Canopy Cover PF & AF Hits: _____, %_____	Total Grass Canopy Cover PG & AG Hits: _____, %_____
	Avg PF Height (cm):	Avg. PG Height (cm):

Line Intercept Shrub Canopy Cover

Shrub Species	Intercept	Total	% Cover
	All Shrubs		

Daubenmire Cover Class & Vegetation Height Data (recorded at 1 m intervals)

Cover Type	Estimated Cover Class for Each Plot																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Annual Forb																									
Perennial Forb																									
Annual Grass																									
Perennial Grass																									
*Cover Class 1=0-5%, 2=5-25%, 3=25-50%, 4=50-75%, 5=75-95%, 6=95-100%																									
Cover Type	Vegetation Height for Each Plot (record to nearest 3 cm)																								
Sagebrush Species																									
Sagebrush Shape**																									
Other Shrub spp.																									
Perennial Forb																									
Perennial Grass																									
*Cover Class 1=0-5%, 2=5-25%, 3=25-50%, 4=50-75%, 5=75-95%, 6=95-100%																									

Line Intercept and Daubenmire Frames Method

Equipment:

Tape, 50m	Stakes for tape (at least two spikes; old, medium-large screwdrivers work well)
Daubenmire frame 20 x 50 cm	Meterstick (for measuring shrub and grass/forb heights)
Digital camera, extra camera battery	Photo cards and markers, or small dry-erase board and marker
Topographic map with project area, general cover types, and pasture boundaries delineated	Aerial photographs
Ecological Site Guides	GPS unit, compass
Clipboard, Data Forms and/or Data Logger w/ extra battery, Pencils	Calculator

Protocol:

- Seasonal habitat has been stratified by land cover types prior to field evaluation (see HAF Vol. II document for more directions).

- Conduct an appropriate number of transects in each seasonal habitat by each land cover type. Repeat all steps for each transect.

1. Fill out all site location information at the top of the sheet. Be sure to list UTM coordinates or other identifying feature of the site. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the land cover type of the data. Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Seasonal Habitat: List one of the following: breeding, summer, or winter.

   Arid Site: Term applies to sagebrush ecological sites generally in the 25-30 cm (9.8-11.8 in.) precipitation zone. *Artemisia tridentata wyomingensis* is a common big sagebrush sub-species for this type of site.

   Mesic Site: Term applies to sagebrush ecological sites generally in a >30 cm (11.8 in.) precipitation zone *Artemisia tridentata vaseyana* is a common big sagebrush sub-species for this type of site.

   Transect #: Assign a unique identifier to each transect within the land cover type.

   Area Sampled: Record the total area or distance (for riparian areas) of the site type or land cover type sampled.

2. Anchor the tape with a steel pin and pull the tape out 50 meters. Keep the tape as taught and straight as possible. Anchor the tape on the far end.

3. Take photographs of the study site. At least one photograph must be taken at each transect/evaluation area. Photos will prove invaluable in locating evaluation areas in subsequent years. They will also be of substantial utility in the office when preparing evaluation documents and documenting habitat condition.
   a. Complete a photo card, showing, at a minimum, the date, location, allotment, and sagebrush canopy cover percentage.
   b. With the photo card near the zero end of the tape, take a general photo of the area, sighting down the tape from eye level, showing landmarks in the background, if possible. A cover board or meter stick should be in the picture for a frame of reference.
   c. In a representative location along or near the tape, place the photo card near the base of a sagebrush plant, and take a tangential close-up photo from near ground level (2-3 ft) toward the shrub/ground interface, to document herbaceous conditions and cover. A cover board or meter stick should be in the picture for a frame of reference.
   d. Optional: take one or more other close-ups or panoramic photos as needed

4. Begin at the "0" end of the tape.

5. On the data form, record **shrub canopy cover** by species, using the line intercept method.
   a. For the entire length of the line, determine the *intercept length* of any shrub species that touches the line. Intercept length is the portion of the transect length intercepted by the shrub, measured by a perpendicular projection of the shrub foliage over the line.
   b. List all cover increments for each species measured to the nearest 3 cm. Ignore spaces or gaps in the canopy *less than 5cm* across. Gaps in the live canopy in excess of 5 cm *will not* be included as canopy intercepts (Figure III - 6). Record only live (green) canopy cover.

6. Estimate **cover class** and **vegetation height** using the Daubenmire method at each 2 m increment (n = 25 plots per transect) along the tape:
   a. Place a 20 x 50 cm Daubenmire frame along the tape with the long axis perpendicular to the tape (Figure III - 1). For each plot, estimate and record cover class for annual forbs, perennial forbs, annual grasses, and perennial grasses (based on Connelly et al. 2003):

Cover classes:	1 = 0-5%,	midpoint of range 2.5%
	2 = >5-<25%,	midpoint of range 15%
	3 = >25-<50%,	midpoint of range 37.5%
	4 = >50-<75%,	midpoint of range 62.5%
	5 = >75-<95%,	midpoint of range 85%
	6 = >95-100%,	midpoint of range 97.5%

   b. Record the height in cm of the nearest sagebrush plant (or other shrub species if no sagebrush is present) within a semi-circle of radius 1-m measured from the lower corner of the plot touching the line, on the same side as the frame.
   c. Record the shape of the nearest sagebrush plant: S = Spreading; M = Mixed; C = Columnar (Figure III - 7).
   d. Record the maximum "natural" or "droop height" in cm of the nearest perennial grass or perennial forb within a 1m, 180^0 arc around the point that ends at the tape line. [Natural = the highest point of a leaf or seed stalk is measured with no straightening by the observer, Figure III - 8]. This includes seed stalks when they contribute to the body of the plant that provides screening cover. There will be instances (e.g., certain *Poa* spp.) when only a few, sparse seed stalks are present and extend well above the body of the plant that provides the cover. In these cases the bulk or droop height of the plant *exclusive of the seed stalks* should be measured. This will require some professional judgment on the part of the biologist. If no plants are within this arc then record a dash and move on to the next point.

7. Summarize the data under Line Intercept Shrub Canopy Cover.
   a. <u>Shrub Species:</u>
      - *Total* = sum of intercept lengths for each shrub species
      - *% Cover* = Total shrub intercept length divided by full transect length
   b. <u>All Shrubs:</u>
      - *Total* = sum of above Total intercept lengths
      - *% Cover* = sum of above % Cover calculations

8. Summarize the data at the top of the form.
   a. <u>Shrubs:</u>

- *Sagebrush Canopy Cover: % Cover* = sum of % covers of all sagebrush species listed under Shrub Species in the Canopy Cover section
- *Avg. Height* = sum of all sagebrush recorded heights divided by total number of sagebrush plants measured in the Vegetation Height section
- *Sagebrush Shape* = total # of sagebrush plants of each shape (S, M, and C) divided by total number of sagebrush plants measured in the Vegetation Height section
- *Shrub Canopy Cover: % Cover* = sum of % covers of all shrub species listed under All Shrubs in the Canopy Cover section

b. Forbs:
- *Perennial Forb Canopy Cover: PF % Cover* = number of plots with perennial forbs in each of the 6 cover classes, multiplied by the midpoint of each cover class, added together as sum of products for all cover classes, divided by total number of plots sampled on the transect (e.g., [15 (# plots in cover class 1) * 2.5 + 10 (cover class 2) * 15] / 25 = 7.5% canopy cover)
- *Annual Forb Canopy Cover: AF % Cover* = number of plots with annual forbs in each of the 6 cover classes, multiplied by the midpoint of each cover class, added together as sum of products for all cover classes, divided by total number of plots sampled on the transect (e.g., [15 (# plots in cover class 1) * 2.5 + 5 (cover class 2) * 15] / 25 = 7.5% canopy cover)
- *Total Forb Canopy Cover: PF&AF % Cover* = sum of *PF% Cover* and *AF% Cover* (e.g., 7.5 + 7.5 = 15% canopy cover)
- *Avg. PF Height* = sum of all perennial forb recorded heights divided by total number of perennial forbs measured

c. Grasses:
- *Perennial Grass Canopy Cover: PG % Cover* = number of plots with perennial grasses in each of the 6 cover classes, multiplied by the midpoint of each cover class, added together as sum of products for all cover classes, divided by total number of plots sampled on the transect
- *Annual Grass Canopy Cover: AG % Cover* = number of plots with annual grasses in each of the 6 cover classes, multiplied by the midpoint of each cover class, added together as sum of products for all cover classes, divided by total number of plots sampled on the transect
- *Avg. PG Height* = sum of all perennial grass recorded heights divided by total number of perennial grass plants measured
- *Avg. PG&PF Heights* = sum of all perennial grass and perennial forb recorded heights divided by total number measured

9. Complete the Sage-Grouse Preferred Forb Availability Data Form.

Sage-Grouse Preferred Forb Availability Data Form

Date:	County:	State:	Subpopulation:
Evaluators:			Home Range Name:
Legal Description: T. R. Sections			Associated Leks:
Land Cover Type:			Ecological Site:
Seasonal Habitat:			Site Info. (circle one) Arid Site Mesic Site
Transect #:	Area (ha) or Distance (km) Sampled:		UTM:
PFC Status (riparian areas only, circle one) PFC FAR NF			

Transect Data Summary (see directions)

Preferred Forb Species	**Noxious Weeds**	**Invasive Annual Forbs**	**Other Forbs**
Total Species (#): _____	Total Species (#) _____ List major species:	Total Species (#) _____ List major species:	Total Species (#) _____ List major species:

Preferred Forb Species		**Abundance**			
Species	# of Occurrences	Trace ≤ 2 plants	Sparse < 0.5%	Common 0.5 - < 1%	Abundant ≥ 1%
Composites					
Daisies (*Aster, Erigeron)(non-milky sap)*					
Dandelion, Common *(Taraxacum officinale)*					
Dandelion, Prairie *(Agoseris & Microseris*)					
Hawksbeard *(Crepis)*					
Prickly lettuce *(Lactuca serriola)*					
Pussytoes *(Antennaria)*					
Salsify *(Tragopogon)*					
Yarrow *(Achellea)*					
Legumes (other than *Lupinus*)					
Alfalfa, Clovers, & Vetches *(Medicago, Melilotus, Trigolium, Hedysaran)*					
Bird's-foot trefoil *(Lotus)*					
Milkvetch *(Astragalus)*					
Desertparsley *(Lomatium, Cymopterus, Perideridia)*					
Penstemons					
Indian Painbrush *(Castilleja)*					
Knotweed, Buckwheats *(Polygonum, Eriogonum, Rumex)*					
Blue Flax *(Linum)*					
Phlox *(Gilia, Linanthus, Microsteris, Phlox)*					
Lily *(Calochortus, Fritillaria)*					
Woodland-star *(Lithophragma)*					
Other (any preferred forbs not listed above, list major species)					

Comments (abundance, diversity, distribution, etc.)

Sage-Grouse Preferred Forb Availability Data Form
Belt Transect Method

Equipment:

Tape, 50-m (optional)	Stakes for tape (at least two spikes; old, medium-large screwdrivers work well)
Meterstick (for measuring width of belt transect)	GPS unit
Pencils	Calculator

Protocol:

- This worksheet should be used to collect preferred forb availability information at various breeding and summer habitat sites.
- Forb availability should be evaluated as close to the end of nesting as possible (May-June) to allow for easier identification of plant species, as well as more relevant application to the evaluation of breeding habitat. For low elevation areas this will be May; for higher elevation areas it will be June.
- Seasonal habitat has been stratified by land cover types prior to field evaluation (see HAF Vol. II document for more directions).
- Conduct an appropriate number of transects in each seasonal habitat by each land cover type. Repeat all steps for each transect.

1. Fill out all site location information at the top of the sheet (transfer information from the PI or LIDF data form if used on the same transect line). Be sure to list UTM coordinates or other identifying feature of the site. Most of the information should be self-explanatory except for the following:

   Subpopulation: Identify the subpopulation with which the habitat is associated. This definition also includes small populations.

   Home Range Name: Identify the home range area using a major drainage area or other distinguishing land feature (e.g., Little Lost River Home Range).

   Associated Leks: List the two largest active leks to which the breeding habitat is associated. Use identification numbers or names that are used in the state-wide database.

   Land Cover Type: Identify the land cover type of the data.

   Upland communities: Use plant alliances or associations (Reid et al. 2002) for sagebrush or grassland communities; www.natureserve.org/explorer (International Classification of Ecological Communities) or other sampling strata used to describe the habitat (e.g., % sagebrush categories). Use the species Symbol (Table III - 2) for dominant species in the overstory and understory (Examples: ARTRw (alliance level – Wyoming big sagebrush) or ARTRw/FEID (association level – Wyoming big sagebrush / Idaho fescue).

   Riparian or wetland communities: Use site type (riparian areas, wet meadows, springs) or more detailed classification using Cowardin et al. (1979), or riparian type (regional classification systems) to which the data pertain.

   Ecological Site: Refer to soil maps and range site guides and record the appropriate ecological site. Use the species Symbol for dominant species in the overstory and understory.

   Seasonal Habitat: List one of the following: breeding, summer, or winter.

Arid Site: Term applies to sagebrush ecological sites generally in the 25-30 cm precipitation zone. *Artemisia tridentata wyomingensis* is a common big sagebrush sub-species for this type of site.

Mesic Site: Term applies to sagebrush ecological sites generally in a >30 cm precipitation zone *Artemisia tridentata vaseyana* is a common big sagebrush sub-species for this type of site.

Transect #: Assign a unique number to each transect within the land cover type (use the same transect number as for the PI or LIDF data form).

Area or Distance Sampled: Record the total area or distance (for riparian areas) of the site type or land cover type sampled.

PFC Status: Record PFC status for riparian areas only (PFC = Proper Functioning Condition, FAR = Functional—At Risk, NF = Nonfunctional). Current PFC data are available for most perennial streams and some wet meadows located on federal public lands. If no current data are available, perform PFC assessments when possible. See Prichard et al. (1998, 2003) for guidance.

2. Using the same 50-m transect line as was used for the PI or LIDF method, walk down one side of the tape (if habitat was measured using the LIDF method, use the same side of the tape on which the Daubenmire frame was placed) with a meterstick held horizontally, perpendicular to the tape, creating a 1-m wide belt along the length of the 50-m transect.

3. Record in the "# of Occurrences" column the number of forb species observed within the belt in each species group listed. Estimate the % abundance (<0.5% = <0.25 m^2, 0.5-<1% = 0.25-0.5 m^2, >1% = >0.5 m^2) of each species group and mark a ✓ in the appropriate column under Abundance. Figure III - 9 can help estimate forb abundance.

4. Under Other, list any other preferred forbs (indicated as P in Table III - 2 under Most Likely Category) observed that were not listed on the data form. Indicate the total number of species observed in this category, and estimate their abundance.

5. List any exotic invasive species (indicated as W in Table III - 2) observed under Exotic Invasive Species in the Transect Data Summary. Indicate the total number of species observed. Please note that some species such as dandelions are desirable forbs for wildlife and therefore are not listed as noxious. Exotic invasive species are limited to listed state exotic invasive weeds.

6. List any invasive annual forbs (indicated as I in Table III - 2) observed under Invasive Annual Forbs in the Transect Data Summary. Indicate the total number of species observed. Invasive annual forbs are any forbs that are not considered exotic invasive species but that are of low palatability and considered ecologically undesirable.

7. List any other forbs (indicated as O in Table III - 2) observed under Other Forbs in the Transect Data Summary. Indicate the total number of species observed. Other forbs are any forbs that are not considered to be preferred, noxious, or invasive annual forbs (e.g., ecologically desirable but unpalatable forbs such as *Lupinus* spp.).

8. Sum the total number of preferred forb species and record under Preferred Forb Species in the Transect Data Summary.

9. Provide any additional pertinent information that describes the site in the Comments section.

10. Attach this form to the other field data sheet(s) (PI or LIDF) used for this transect.

Supplemental Data Collection Support

Introduction

Measuring vegetation at the site-scale generally involves field data collection on composition and structure of over-story and understory habitat within a seasonal use area (Table III - 1). There are a few other measurements (e.g., proximity to sagebrush) for some seasonal habitats as well. This appendix describes methods to measure vegetation at the site-scale and how to use habitat indicators to describe habitat. Sampling design including further stratification of fine-scale land cover types was described in Volume II.

Connelly et al. (2003) discussed methods to measure vegetation at the site-scale for describing sage-grouse habitat. In addition, Elzinga et al. (1998) and Herrick et al. (2005) provide background information and examples of ways to measure vegetation for site-scale habitat indicators. Connelly et al. (2003) preferred Canfield's (1941) line intercept method for sage-grouse habitat descriptions but determined that point intercept or quadrat sampling is faster than line intercept and yields the same results. Two data collection methods that have been used to describe sage-grouse habitat descriptions, point intercept (PI) and line intercept – Daubenmire frame (LIDF), are presented. Both methods provide comparable results and their advantages and disadvantages are discussed in Elzinga (1998), Connelly et al. (2003) and Herrick et al. (2005).

Specific measurements associated with each habitat indicator were outlined in Volume II and are presented again in Table III - 1. Additional site-scale notes and measurements are included for some seasonal habitats to aid in interpreting overall site suitability. These measurements are also listed in Table III - 1. For example, sagebrush canopy cover is a crucial habitat indicator for site-scale descriptions. However, in some locations the composition and percent cover of other shrubs can affect site suitability. While sagebrush may only provide 10 percent cover, the inclusion of antelope bitterbrush with a canopy cover of 5 percent could affect overall site suitability.

Illustrations for field measurements are provided below. In addition, data forms are provided with detailed procedures on the back of the forms.

Transect Set-up for the LIDF and PI Methods

Data should be collected along at least four 50-m transects within each cover type, and measurements should taken every 1-2 meters. For the PI method, at least 200 points per cover type should be sampled in order to increase the likelihood that sparsely distributed forbs are sampled (Elzinga et al. 1998). More transects may be needed based on vegetation heterogeneity or specific local habitat needs.

After the line transect has been laid out but before collecting data, take a picture of the transect line with transect identification information and the date clearly visible. Pictures are part of the data collected and may be extremely valuable in the future for detecting habitat change and ensuring repeatability in monitoring efforts.

The LIDF method uses the line intercept for sagebrush and other shrub canopy cover measurements, and Daubenmire plots for other canopy cover estimates along the same transect line. Collect data within the Daubenmire plots prior to the line intercept in order to avoid trampling of vegetation. Place Daubenmire frames along one side of the transect line at predetermined intervals along the measuring tape (Figure III - 1). Estimate percent cover of forbs, grasses, litter, and bare ground within each frame (Figure III - 2). Life form height measurements and sagebrush shape should be noted for the plants nearest the transect interval point on the same side of the transect as the Daubenmire plot (Figure III - 1). To avoid double measurement of plants, only measure plant heights or note sagebrush shape if plants fall within a semi-circle of radius equal to half the distance to the next transect point (e.g., radius 1 m from the lower corner of the plot touching the line, for measurements taken every 2 meters; Figure III - 1). If there are no plants within this radius, mark the datasheet with a slash.

The PI method provides canopy cover estimates by dropping a long ($\geq$ 1 m), small diameter (< 2.5 mm) pin at a specific intervals along a transect line (Figure III - 3). Four 50-m transects with measurements taken at 1-m intervals are recommended. When the pin is dropped, any plant or ground cover that touches the pin at that point is recorded as a "hit" (Figure III - 4). Starting at the top of the pin and working down, record only one hit per life form (shrub, perennial grass, perennial forb, annual grass, annual forb, litter or soil). Canopy cover by life form is determined by the number of hits along transects (e.g., 40 hits in 1-m intervals along a 200-m transect = 20% canopy cover). Life form heights and sagebrush shape should be noted as well.

Data Collection for Habitat Indicators

Shrub Canopy Cover:

LIDF: Measurements include all shrubs along the line intercept transect (Figure III - 5). The following specific protocols are needed for consistency in describing sage-grouse habitat:

1. Shrub intercept measurements should be documented by species whenever possible (Table III - 2). Document by genus if species is not known.
2. Only live canopy cover is measured (leaves, live stems, and shrub trunk).
3. Gaps in foliage canopy $\geq$ 5 cm denote a break in the measurement. If gaps are < 5 cm then include as part of the foliage measurement (Figure III - 6).

PI: Shrub cover is determined by the actual live shrub 'hits' on the transect line including leaves, live stems, and shrub trunk hits. PI technically measures foliar cover, not canopy cover. PI can be made equivalent to LIDF canopy cover measurements if the same gap criteria for LIDF are applied to PI. For example, if the pin ends up in a gap in the foliage that is less than 5 cm then it would be recorded as a hit to get a canopy cover reading.

Note dead shrubs (winter kill, aroga moth) or other unusual conditions that are observed.

Sagebrush Height: Measure the tallest point of the shrub excluding flower or seed stalks.

Sagebrush Shape: Describe the sagebrush plant as predominately columnar (C), spreading (S) or mixed (M) using the provided site guide as a reference (Figure III - 7).

Perennial Grass Height: Record maximum "natural" or droop (the highest point measured with no straightening by the observer) height of the perennial grass, residual or live plant parts (Figure III - 8) (both native and exotic). This measurement should include seed stalks when they contribute to the body of the plant that provides cover (e.g., *Pseudoroegneria spicata*). However, there are some cases where only a one or two seed stalks extend above the body of the plant and do not provide cover (e.g., *Poa secunda* that has been grazed). In these cases, measure the natural or droop height *exclusive* of the seed stalk.

Perennial Forb Height: Record "natural" or droop (the highest point measured with no straightening by the observer) height of the perennial forb, residual or live plant parts (Figure III - 8). The measurement includes flower stalks and heads when they contribute to the body of the plant that provides protective cover.

Annual Forb Cover: Same as above.

Forb Availability:
Perennial Grass and Forb Cover: Measure the live and residual foliar cover.
LIDF: Use a Daubenmire frame (Figure III - 2) to estimate cover class.

PI: Record a hit when the pin touches a live or residual herbaceous plant part (Figure III - 4). Record by species, or genus if species is unknown.

Belt Transect: Measure the density of preferred sage-grouse forbs (Table III - 2) by counting the number of species in each forb genus group listed, and estimating their abundance within a 50-m^2 area (Figure III - 9).

Table III - 1. List of seasonal habitat measurements and associated data collection methods.
PI = Point intercept, LIDF = Line intercept – Daubenmire frame, PFC = Proper Functioning Condition.

Seasonal Habitat	Habitat Indicator	Life Requisite(s)	Measurement Technique
Lek	Availability of Sagebrush Cover	Cover	Field or remote sensing measurement
	Proximity of Trees or Other Tall Structures	Cover	Field or remote sensing measurement
Breeding	Sagebrush Canopy Cover	Cover, Food	PI / LIDF
	Sagebrush Height	Cover	PI / LIDF
	Predominant Sagebrush Shape	Cover	PI / LIDF
	Perennial Grass and Forb Height	Cover	PI / LIDF
	Perennial Grass Canopy Cover	Cover	PI / LIDF
	Perennial Forb Canopy Cover	Cover	PI / LIDF
	Preferred Forb Availability	Food	Belt transect
Summer – Riparian	Riparian and Wet Meadow Stability	Cover, Food	PFC data, if available
	Preferred Forb Availability	Food	Belt transect
	Proximity of Sagebrush Cover	Cover	Field or remote sensing measurement
Summer – Upland	Sagebrush Canopy Cover	Cover, Food	PI / LIDF
	Sagebrush Height	Cover	PI / LIDF
	Perennial Grass and Forb Canopy Cover	Cover	PI / LIDF
	Preferred Forb Availability	Food	Belt transect
Winter	Sagebrush Canopy Cover	Cover, Food	PI / LI (part of LIDF)
	Sagebrush Height Above Snow	Cover	PI / Vegetation Height (part of LIDF)

Table III - 2. Sagebrush community vegetation species and preferred forbs for sage-grouse. To be used for PI, LIDF, and belt transect data collection. Space is provided for addition of local species.
* P = Preferred forb, W = (Noxious) weeds, I = Invasive annuals, O = Other forbs, N/A = Not applicable

Scientific Name	Common Name	Symbol	Most Likely Category*
SHRUBS			
Dwarf sagebrush			
Artemisia arbuscula	Low sagebrush	ARAR8	N/A
A. arbuscula ssp. *longicaulis*	Lahontan sagebrush	ARARl3	N/A
A. arbuscula ssp. *longiloba*	Early sagebrush	ARARl	N/A
A. bigelovii	Bigelow sage	ARBI3	N/A
A. nova	Black sagebrush	ARNO4	N/A
A. papposa	Fuzzy sage	ARPA16	N/A
A. pygmaea	Pygmy sagebrush	ARPY2	N/A
A. rigida	Stiff sagebrush	ARRI2	N/A
A. spinescens Syn = *Picrothamnus desertorum*	Bud sagebrush	ARSP5 / PIDE4	N/A
A. tripartita ssp. *rupicola*	Wyoming threetip sagebrush	ARTRr2	N/A
Tanacetum nuttallii Syn = *Sphaeromeria argentea*	Chicken sage	TANU2 / SPAR2	N/A
Tall sagebrush			
A. cana ssp. *bolanderi*	Bolander's silver sagebrush	ARCAb3	N/A
A. cana ssp. c*ana*	Plains silver sagebrush	ARCAc5	N/A
A. cana ssp. v*iscidula*	Mountain silver sagebrush	ARCAv2	N/A
A. tridentata ssp. *spiciformis*	Subalpine big sagebrush	ARTRs2	N/A
A. tridentata ssp. *tridentata*	Basin big sagebrush	ARTRt	N/A
A. tridentata ssp. *vaseyana*	Mountain big sagebrush	ARTRv	N/A
A. tridentata var. *pauciflora* Syn = *A. tridentata* ssp. *vaseyana*	Few-flowered mountain big sagebrush	ARTRp4 / ARTRv	N/A
A. tridentata ssp. *wyomingensis*	Wyoming big sagebrush	ARTRw8	N/A
A. tridentata ssp. *xericensis*	Xeric big sagebrush	ARTRx	N/A
A. tripartita ssp. *tripartita*	Threetip sagebrush	ARTRt2	N/A
Subshrub sagebrush			
A. frigida	Fringed sagewort	ARFR4	N/A
A. pedatifida	Birdfoot sagebrush	ARPE6	N/A
Other shrubs			
Amelanchier alnifolia	Saskatoon serviceberry	AMAL2	N/A
Amelanchier utahensis	Utah serviceberry	AMUT	N/A
Ceanothus velutinus	Snowbrush caenothus	CEVE	N/A
Chrysothamnus nauseosus Syn = *Ericameria nauseosa* ssp. *nauseosa* var. *nauseosa*	Rubber rabbitbrush	CHNA2 / ERNAn5	N/A
Chrysothamnus viscidiflorus	Green rabbitbrush	CHVI8	N/A
Gutierrezia sarothrae	Broom snakeweed	GUSA2	N/A
Juniperus occidentalis	Western juniper	JUOC	N/A

Scientific Name	Common Name	Symbol	Most Likely Category*
Juniperus osteosperma	Utah juniper	JUOS	N/A
Pachystima myrsinites	Pachystima	PAMY2	N/A
Purshia tridentata	Antelope bitterbrush	PUTR2	N/A
Rosa woodsii	Woods' rose	ROWO	N/A
Sarcobatus vermiculatus	Greasewood	SAVE4	N/A
Symphoricarpos albus	Common snowberry	SYAL	N/A
Symphoricarpos oreophilus	Mountain snowberry	SYOR2	N/A
Tetradymia canescens	Spineless horsebrush	TECA2	N/A
Atriplex confertifolia	4-wing saltbush	ATCO	
Ceratoides lanata	Winterfat	CELA	
Grayia spinosa		GRSP	
FORBS			
Annuals / Occasionally Biennials			
Alyssum desertorum	Desert alyssum	ALDE	I
Asperugo procumbens	German-madwort	ASPR	I
Camelina microcarpa	Littlepod false flax	CAMI2	I
Carthamus tinctorius	Safflower	CATI	W
Chenopodium album	Lambsquarters	CHAL7	P
Chenopodium fremontii	Fremont's goosefoot	CHFR3	P
Chenopodium leptophyllum	Narrowleaf goosefoot	CHLE4	P
Chorispora tenella	Purple mustard	CHTE2	W
Collinsia parviflora	Blue eyed Mary	COPA3	P
Collomia grandiflora	Grand collomia	COGR4	P
Collomia linearis	Tiny trumpet	COLI2	P
Cryptantha scoparia	Pinyon desert cryptantha	CRSC2	P
Descurainia pinnata	Western tansymustard	DEPI	I
Descurainia richardsonii Syn = *Descurainia incana* ssp. *incana*	Tansymustard	DERI2 / DEINi	I
Descurainia sophia	Herb sophia	DESO2	I
Epilobium minutum	Chaparral willowherb	EPMI	P
Epilobium paniculatum Syn = *Epilobium brachycarpum*	Tall annual willow-herb	EPPA2 / EPBR3	P
Eriastrum sparsiflorum	Great Basin woollystar	ERSP3	P
Eriogonum spp.	Buckwheat	ERIOG	P
Erodium cicutarium	Stork's bill	ERCI6	P
Galium aparine	Stickywilly	GAAP2	I
Halogeton glomeratus	Saltlover	HAGL	I
Helianthus annuus	Common sunflower	HEAN3	P
Kochia scoparia	Kochia	KOSC	W
Lactuca serriola	Prickly lettuce	LASE	P
Lappula texana Syn = *Lappula occidentalis* var. *cupulata*	Flatspine stickseed	LATE3 / LAOCc	I
Lepidium perfoliatum	Clasping pepperweed	LEPE2	I
Lepidium virginicum	Virginia pepperweed	LEVI3	I
Medicago hispida Syn = *Medicago polymorpha*	Burclover	MEHI / MEPO3	P

Scientific Name	Common Name	Symbol	Most Likely Category*
Medicago sativa	Alfalfa	MESA	P
Melilotus officinalis	Yellow sweetclover	MEOF	P
Microsteris gracilis Syn = *Phlox gracilis* ssp. *gracilis*	Mircrosteris	MIGR / PHGRg	P
Philox gracilis	Slender philox	PHGR16	P
Plantago patagonica	Woolly plantain	PLPA2	P
Plectritis macrocera	Plectritis	PLMA4	P
Polygonum aviculare	Prostrate knotweed	POAV	P
Ranunculus testiculatus Syn = *Ceratocephala testiculata*	Bur buttercup	RATE / CETE5	W
Salsola kali	Russian thistle	SAKA	W
Thlaspi arvense	Field pennycress	THAR5	I
Tragopogon dubius	Salsify	TRDU	P
Trifolium spp.	Clover	TRIFO	P
Veronica biloba	Speedwell	VEBI2	I
Biennials			
Cirsium spp.	Thistle	CIRSI	W
Cynoglossum officinale	Hounds tongue	CYOF	W
Gilia aggregata Syn = *Ipomopsis aggregata* ssp. *aggregata*	Scarlet gilia	GIAG / IPAGa3	P
Machaeranthera canescens	Hoary aster	MACA2	P
Perennials / Occasionally Biennials			
Achillea millefolium	Common yarrow	ACMI2	P
Agoseris glauca	Pale agoseris	AGGL	P
Allium acuminatum	Tapertip onion	ALAC4	P
Antennaria dimorpha	Low pussytoes	ANDI2	P
Antennaria spp.	Pussytoes	ANTEN	P
Arabis holboellii	Holboell's rockcress	ARHO2	P
Arenaria kingii	King's sandwort	ARKI	P
Artemisia dracunculus	Tarragon	ARDR4	P
Aster chilensis Syn = *Symphyotrichum chilense* var. *chilense*	Pacific aster	ASCH2 / SYCHc	P

Scientific Name	Common Name	Symbol	Most Likely Category*
Astragalus argophyllus	Silverleaf milkvetch	ASAR4	P
Astragalus beckwithii	Beckwith's milkvetch	ASBE3	P
Astragalus calycosus	Torrey's milkvetch	ASCA9	P
Astragalus convallarius	Lesser rushy milkvetch	ASCO12	P
Astragalus lentiginosus	Freckled milkvetch	ASLE8	P
Astragalus purshii	Woollypod milkvetch	ASPU9	P
Balsamorhiza hookeri	Hooker's balsamroot	BAHO	P
Balsamorhiza sagittata	Arrowleaf balsamroot	BASA3	P
Berberis repens	Creeping barberry	MARE11	P
Calochortus nuttallii	Sego lily	CANU3	P
Castilleja chromosa Syn = *Castilleja applegatei* ssp. *martinii*	Wavyleaf Indian paintbrush	CACH7 / CAAPm	P
Castilleja linariifolia	Wyoming Indian paintbrush	CALI4	P
Chaenactis douglasii	Douglas's dustymaiden	CHDO	P
Comandra umbellata	Bastard toadflax	COUM	P
Convolvulus arvensis	Field bindweed	COAR4	W
Crepis acuminata	Tapertip hawksbeard	CRAC2	P
Crepis spp.	Hawksbeard	CREPI	P
Cymopterus spp.	Springparsley	CYMOP2	P
Delphinium nuttallianum	Twolobe larkspur	DENU2	P
Erigeron corymbosus	Longleaf fleabane	ERCO5	P
Erigeron humilis	Arctic alpine fleabane	ERHU	P
Erigeron pumilus	Shaggy fleabane	ERPU2	P
Eriogonum microthecum	Slender buckwheat	ERMI4	P
Eriogonum ovalifolium	Cushion buckwheat	EROV	P
Eriogonum umbellatum	Sulfur-flower buckwheat	ERUM	P
Erysimum asperum Syn = *Erysimum capitatum* var. *capitatum*	Sanddune wallflower	ERAS2 / ERCAc	P
Fritillaria pudica	Yellow fritillary	FRPU2	P
Geranium viscosissimum	Sticky purple geranium	GEVI2	P
Geum macrophyllum	Largeleaf avens	GEMA4	P
Grindelia squarrosa	Curlycup gumweed	GRSQ	I
Hackelia patens	Spotted stickseed	HAPA	I
Haplopappus acaulis Syn = *Stenotus acaulis* var. *acaulis*	Stemless mock goldenweed	HAAC / STACa	P
Hedysarum spp.	Sweetvetch	HEDYS	P
Helianthella uniflora	Oneflower helianthella	HEUN	P
Hydrophyllum capitatum	Ballhead waterleaf	HYCA4	P
Iva axillaris	Povertyweed	IVAX	P
Lathyrus nevadensis	Sierra pea	LANE3	P
Leptodactylon pungens Syn = *Linanthus pungens*	Granite prickly phlox	LEPU / LIPU11	P
Linanthus spp.	Linanthus	LINAN2	P
Linum perenne	Blue flax	LIPE2	P
Lithophragma spp.	Woodland-star	LITHO2	P
Lithospermum ruderale	Western stoneseed	LIRU4	P

Scientific Name	Common Name	Symbol	Most Likely Category*
Lomatium grayi	Gray's biscuitroot	LOGR	P
Lomatium triternatum	Nineleaf biscuitroot	LOTR2	P
Lomatium spp.	Desertparsley	LOMAT	P
Lotus corniculatus	Bird's-foot trefoil	LOCO6	P
Lupinus argenteus	Silvery lupine	LUAR3	O
Lupinus leucophyllus	Velvet lupine	LULE3	O
Lupinus spp.	Lupine	LUPIN	O
Lygodesmia juncea	Rush skeletonplant	LYJU	P
Mentha piperita Syn = *Mentha aquatica*	Water mint	MEPI / MEAQ	I
Mertensia oblongifolia	Oblongleaf bluebells	MEOB	P
Microseris nigrescens Syn = *Nothocalais nigrescens*	Meadow prairie-dandelion	MINI3 / NONI	P
Microseris spp.	Silverpuffs	MICRO6	P
Oenothera pallida	Pale evening-primrose	OEPA	P
Opuntia polyacantha	Plains pricklypear	OPPO	N/A
Penstemon cyaneus	Blue penstemon	PECY3	P
Penstemon procerus	Littleflower penstemon	PEPR2	P
Penstemon spp.	Beardtongue	PENST	P
Perideridia spp.	Yampah	PERID	P
Phacelia hastata	Silverleaf phacelia	PHHA	P
Phlox hoodii	Spiny phlox	PHHO	P
Phlox longifolia	Longleaf phlox	PHLO2	P
Rumex salicifolius	Willow dock	RUSA	P
Sanguisorba minor	Small burnet	SAMI3	P
Sedum lanceolatum	Spearleaf stonecrop	SELA	P
Senecio dimorphophyllus Syn = *Packera dimorphophylla* ssp. *dimorphophylla*	Splitleaf groundsel	SEDI4 / PADId2	P
Senecio integerrimus	Lambstongue ragwort	SEIN2	P
Senecio streptanthifolius Syn = *Packera streptanthifolia*	Rocky Mountain groundsel	SEST3 / PAST10	P
Smilacina racemosa Syn = *Maianthemum racemosum* ssp. *racemosum*	Feathery false lily of the valley	SMRA / MARAr	P
Solidago missouriensis	Missouri goldenrod	SOMI2	P
Sphaeralcea munroana	Munro's globemallow	SPMU2	P
Sphaeralcea spp.	Globemallow	SPHAE	P
Taraxacum officinale	Common dandelion	TAOF	P
Viola nuttallii	Nuttall's violet	VINU2	P
Viola purpurea	Goosefoot violet	VIPU4	P
Wyethia amplexicaulis	Mule-ears	WYAM	P
Zigadenus paniculatus	Foothill deathcamus	ZIPA2	P

Scientific Name	Common Name	Symbol	Most Likely Category*
GRASSES			
Annuals			
Avena fatua	Wild oat	AVFA	N/A
Bromus commutatus Syn = *Bromus racemosus*	Bald brome	BRCO4 / BRRA2	N/A
Bromus japonicus	Japanese brome	BRJA	N/A
Bromus mollis Syn = *Bromus hordeaceus* ssp. *hordeaceus*	Soft brome	BRMO2 / BRHOh	N/A
Bromus tectorum	Cheatgrass	BRTE	N/A
Festuca octoflora	Sixweeks fescue	FEOC3	N/A
Triticum aestivum	Common wheat	TRAE	N/A
Perennials			
Agropyron cristatum	Crested wheatgrass	AGCR	N/A
Agropyron intermedium Syn = *Thinopyrum intermedium*	Intermediate wheatgrass	AGIN2 / THIN	N/A
Agropyron repens Syn = *Elymus repens*	Quackgrass	AGRE2 / ELRE4	N/A
Agropyron smithii Syn = *Pascopyrum smithii*	Western wheatgrass	AGSM / PASM	N/A
Agropyron spicatum Syn = *Pseudoroegneria spicata* ssp. *spicata*	Bluebunch wheatgrass	AGSP / PSSPs	N/A
Bromus inermis	Smooth brome	BRIN2	N/A
Carex douglasii	Douglas's sedge	CADO2	N/A
Elymus cinereus Syn = *Leymus cinereus*	Basin wildrye	ELCI2 / LECI4	N/A
Elymus junceus Syn = *Psathyrostachys juncea*	Russian wildrye	ELJU / PSJU3	N/A
Festuca idahoensis	Idaho fescue	FEID	N/A
Koeleria cristata Syn = *Koeleria macrantha*	Prairie junegrass	KOCR / KOMA	N/A
Melica bulbosa	Oniongrass	MEBU	N/A
Oryzopsis hymenoides Syn = *Achnatherum hymenoides*	Indian ricegrass	ORHY / ACHY	N/A
Poa bulbosa	Bulbous bluegrass	POBU	N/A
Poa juncifolia Syn = *Poa secunda*	Sandberg bluegrass	POJU / POSE	N/A
Poa sandbergii Syn = *Poa secunda*	Sandberg bluegrass	POSA12 / POSE	N/A
Poa scabrella Syn = *Poa secunda*	Sandberg bluegrass	POSC / POSE	N/A

Scientific Name	Common Name	Symbol	Most Likely Category*
Sitanion hystrix Syn = *Elymus elymoides* ssp. *elymoides*	Squirreltail	SIHY / ELELe	N/A
Stipa comata Syn = *Hesperostipa comata* ssp. *comata*	Needle and thread	STCO4 / HECOc8	N/A
Stipa occidentalis Syn = *Achnatherum occidentale* ssp. *occidentale*	Western needlegrass	STOC2 / ACOCo	N/A
SEDGES			
Typha spp.	Cattail	TYPHA	N/A

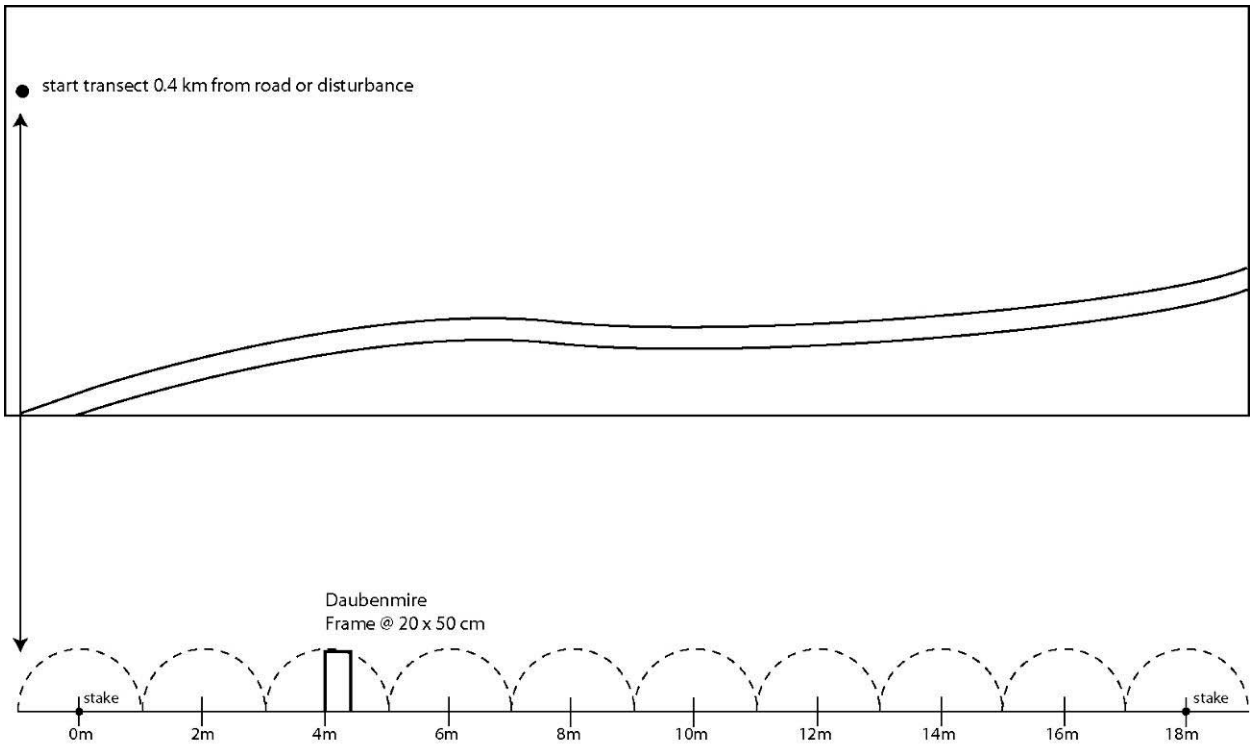

Figure III - 1. Line transect with Daubenmire frames positioned every 2 meters. Half circles represent area from where the nearest shrub, grass and forb plants are sampled for height measurements. Note distance and extent of disturbances.

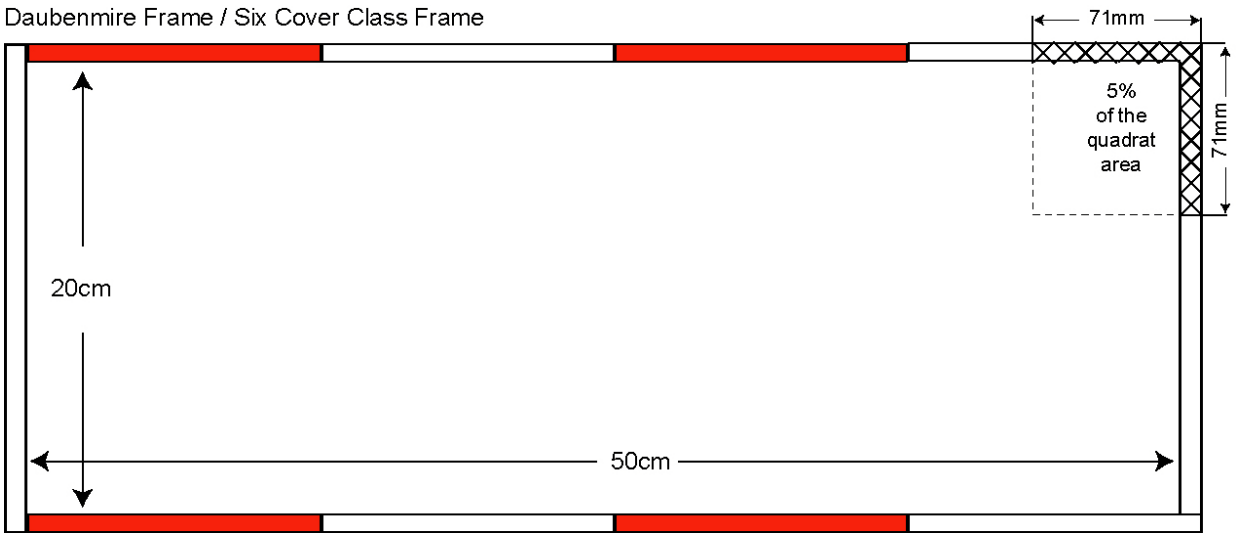

Figure III - 2. Daubenmire frame used for measuring grass and forb canopy covers. Estimate canopy cover of plants within frame using lines on frame as guides to estimate percent cover.

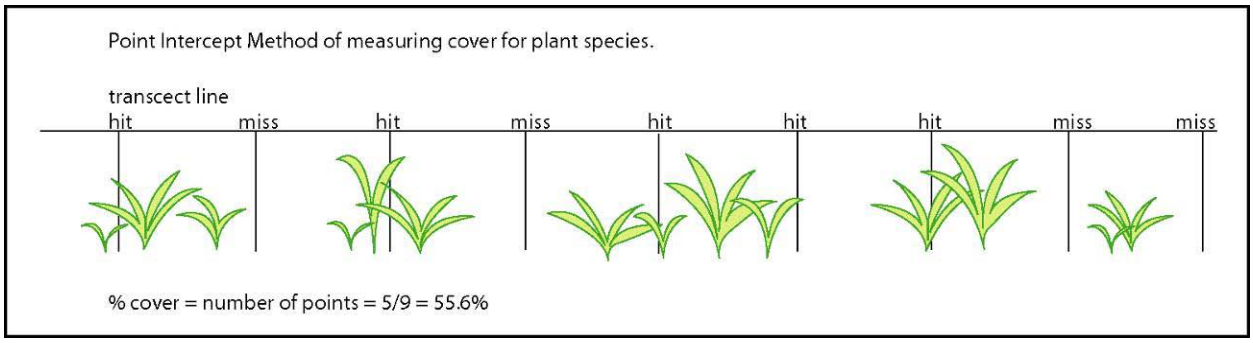

Figure III - 3. Point intercept method. Can be used to measure canopy cover and vegetation height of all grass, forb, and shrub species at a site, or canopy cover of a single lifeform (e.g., sagebrush cover for winter habitat areas).

Figure III - 4. Measuring plant species hits using point intercept technique (pin size exaggerated to emphasize method).

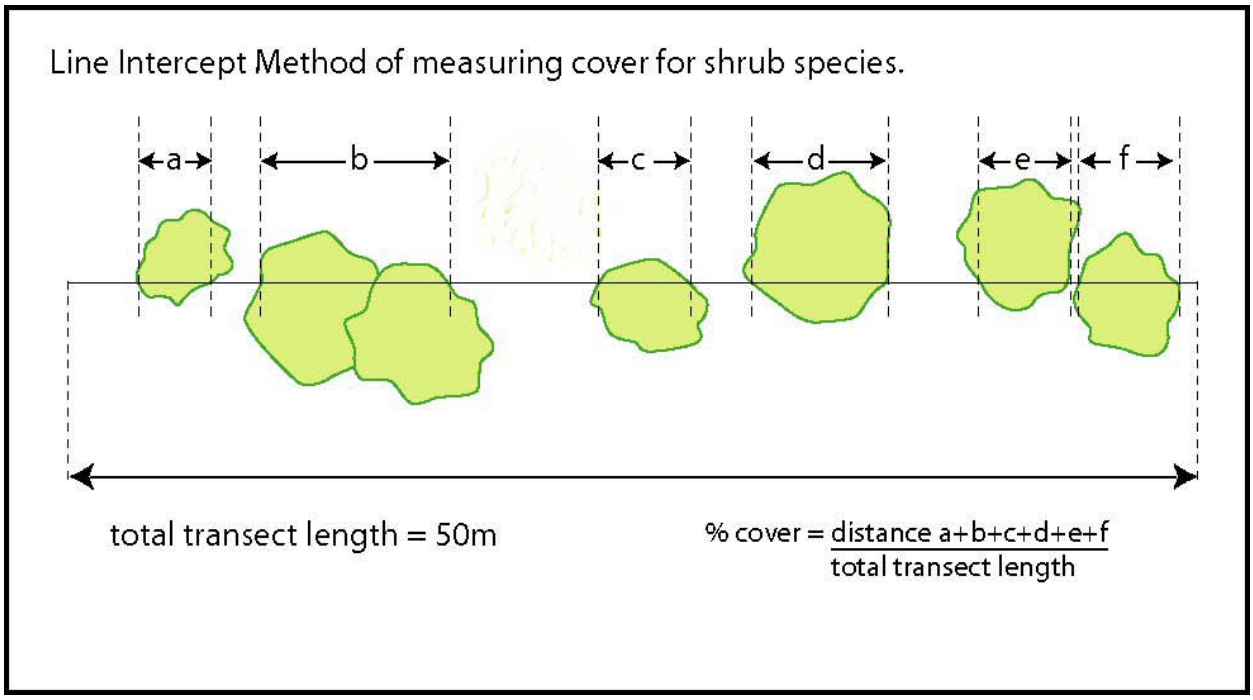

Figure III - 5. Line intercept method. Can be used to measure canopy cover of sagebrush species.

Figure III - 6. Measuring gaps in shrub canopy cover using line intercept method. Group sagebrush with gaps smaller than 5 cm. Record sections of sagebrush separated by greater than 5 cm as separate intercepts.

Figure III - 7. Site guide for sagebrush shapes: spreading, mixed, columnar. Sagebrush shape has an influence on herbaceous cover needs. Breeding areas with columnar-shaped sagebrush plants need more herbaceous cover for shelter needs than spreading-shaped plants.

Figure III - 8. Grass and forb height measurements. Record natural or "droop" height of grasses and forbs.

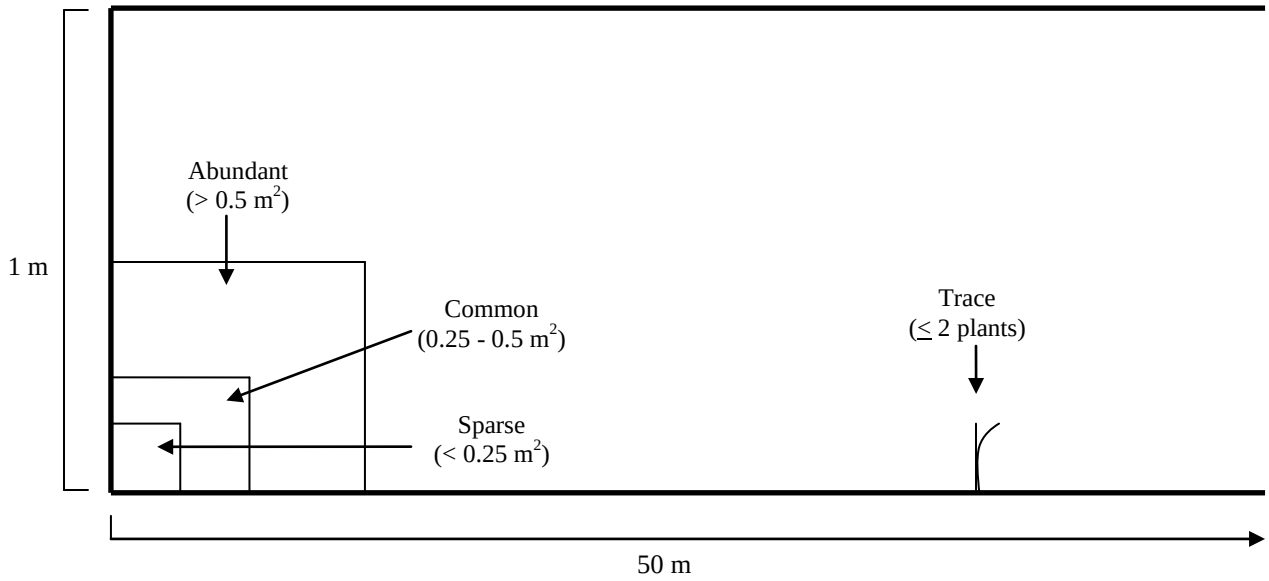

Figure III - 9. Belt transect method. The abundance of preferred forbs can be estimated by visualizing all of the forbs throughout a 50-m belt transect grouped into one corner. The amount of cover area can then be classified as trace, sparse, common, or abundant.