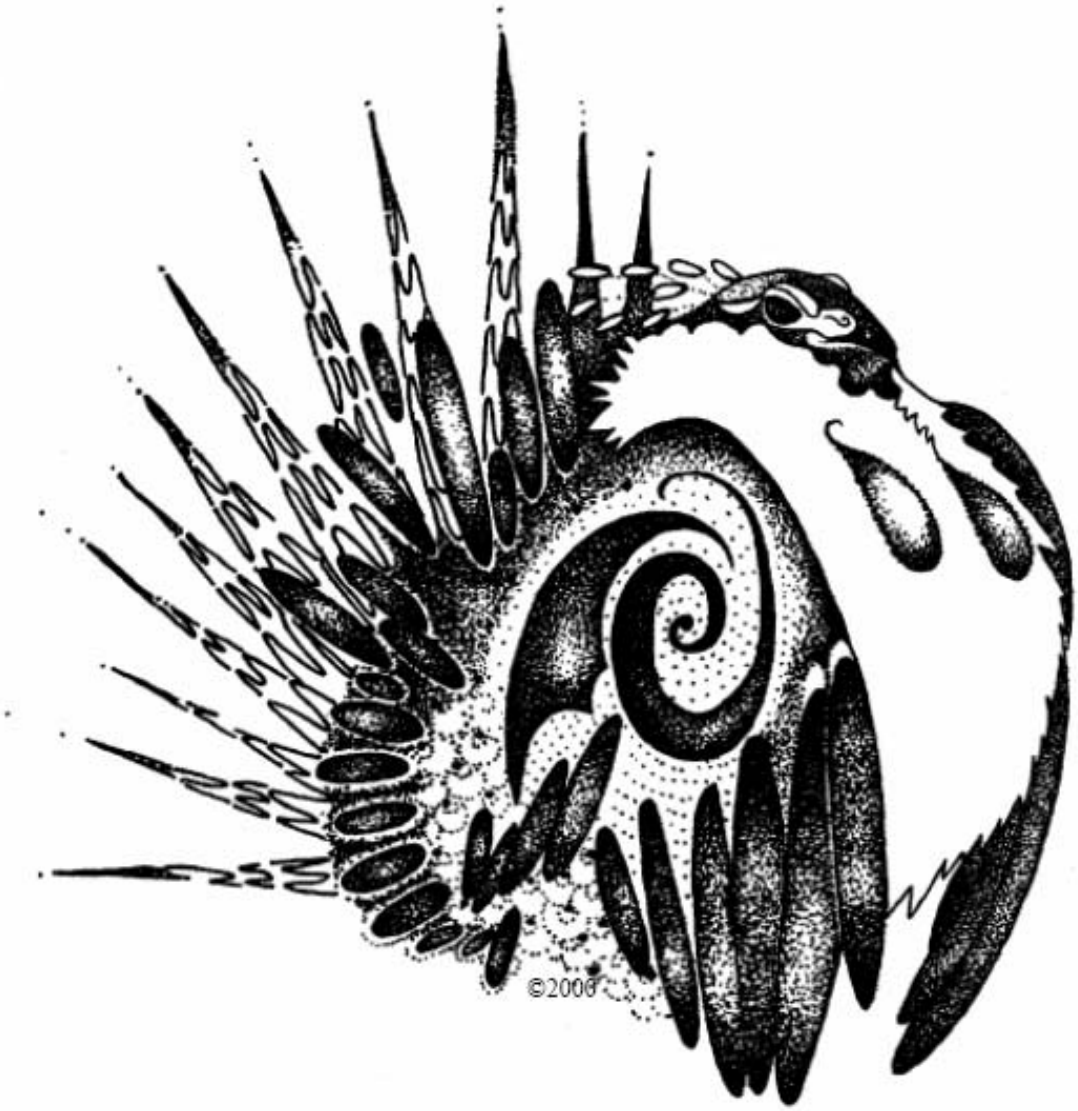
GREATER SAGE-GROUSE CONSERVATION ASSESSMENT AND STRATEGY FOR OREGON: A Plan to Maintain and Enhance Populations and Habitat

August 2005



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EXECUTIVE SUMMARY

Greater sage-grouse (*Centrocercus urophasianus*) were once found in most sagebrush (*Artemisia* spp.) habitats east of the Cascades in Oregon. European settlement and conversion of sagebrush steppe into agricultural production led to extirpation of the species in the Columbia Basin by the early part of the 1900s, but sagebrush rangelands have persisted, particularly in southeast Oregon. Populations have fluctuated markedly since the mid 1900s with notable declines in populations from the 1950s to early 1970s. These patterns in populations and habitat loss are similar to those observed for greater sage-grouse throughout its range. Population declines during the latter part of the 1900s led to considerable concern for the species and subsequent conservation planning in all western states where it occurs. This management strategy is a result of this larger conservation effort by the Western Association of Fish and Wildlife Agencies. This Plan describes Oregon Department of Fish and Wildlife's management of greater sage-grouse and provides guidance to public land management agencies and land managers for sage-grouse conservation. Conservation actions should be encouraged on private lands as these contain some of the more productive sites, but conservation on private land is voluntary.

This management strategy and the supporting background information is intended to promote the conservation of greater sage-grouse and intact functioning sagebrush communities in Oregon. The strategy is tied to the life history of greater sage-grouse and uses the best science available. Although this strategy focuses on conservation of greater sage-grouse, the intent is to benefit conservation needs of other sagebrush-steppe species. Oregon greater sage-grouse are important to the North American population and management actions in the state will have implications on a much larger scale.

This document is divided into 6 sections. Section I explains the background and philosophy of conservation approaches in this strategy. Section II provides an overview of sage-grouse biology and ecology throughout the species range. Sections III and IV provide an assessment of populations and habitat, respectively, upon which management objectives are developed and their underlying assumptions and rationale are stated. In Section V, conservation guidelines are outlined, that describe actions needed and methods for achieving habitat objectives. Section VI outlines components for Plan implementation, includes a description of the structure and role of local implementation groups, and implications for public (state and federal) land management agencies. There are 4 appendices that provide supporting information and detail for the assessment and strategy portions of the Plan. This Plan provides expanded summaries of Sections III to VI, because these sections are linked to the objectives and implementation of this Plan. However, first this Plan provides a rationale for physio-geographic units to base the assessments and objectives.

Populations and habitat were assessed by BLM district boundaries because; the availability of habitat measures by district, each district approximates an eco-region, and BLM is the primary land manager within most of the district boundaries. The 23 years 1980-2003 that are the relevant time period in which to assess sage-grouse populations and their habitats, because the factors of predator control methods (and take levels), grazing schedules, survey protocols, habitat treatments and harvest levels of sage-grouse were similar through this period.

Sections I&II. Introduction and General Ecology

These sections provide the justification for this effort and supporting background information on sage-grouse biology.

Section III. Populations

Oregon sage-grouse numbers apparently have declined over the long-term for which data are available (1957-2003). The reasons for these losses likely are the cumulative effects of habitat loss and degradation, changes in predator control methods, and increases in human disturbance. It is possible that these factors had the greatest effect on sage-grouse productivity (ratio of chicks per female) because this variable was correlated with spring population trends. Statewide spring population trend was relatively stable for the assessment period (1980-2003). Populations have been on the increase in most areas since the mid 1990s. The current statewide population size and trend provides a benchmark for maintaining and setting population objectives. However, the Prineville BLM District population has continually declined during the assessment period.

Management Direction

In accordance with *Wildlife Policy* (ORS 496.012) the primary goal of this Plan is to restore, maintain, and enhance populations of sage-grouse such that multiple uses of populations and their habitats can continue. Regional and state population goals should be identified based on the best information available since 1980. Population management objectives for statewide and regional populations are as follows:

Objective 1—Statewide: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 40,000 birds, until 2055.

Objective 2— Baker Resource Area: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 3,000 birds, until 2055.

Objective 3— Vale District (not including Baker): Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 16,000 birds, until 2055.

Objective 4— Burns District: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 6,500 birds, until 2055.

Objective 5— Lakeview District: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 12,000 birds, until 2055.

Objective 6— Prineville District: Restore sage-grouse numbers and distribution near the 1980 spring breeding population level, approximately 3,000 birds, until 2055.

Section IV. Habitat

The majority of habitat loss occurred in the Columbia Basin during the late 1800s and early 1900s as a direct result of sagebrush conversion to agricultural land. In the last 20-30 years 2 million ha (5 million acres) habitat of the current range has been diminished by fire, juniper encroachment, and other conversions. Currently there are >6 million ha (15 million acres) of sagebrush habitat much of it occurs in the Great Basin ecosystem. The connectivity mapping indicated that approximately 3.7 million ha (9.2 million acres) are connected blocks of habitat; however the understory condition of most of these acres is unknown. Compared to other sage-grouse states Oregon has large expanses of contiguous habitat with minimal threats of oil, gas, or coal-bed methane development. However, there is potential and interest to develop wind-energy grids in most sage-grouse regions in Oregon. The current status of sagebrush habitat is a landscape comprised of 70% sagebrush and 30% potential habitat that has supported sage-grouse populations over the last 23 years. Thus, to meet population objectives of this Plan it is paramount that the current distribution of sagebrush communities be maintained (minimum) or enhanced (optimum).

Management Direction

The overarching habitat goal is to maintain or enhance the current range and distribution of sagebrush habitats in Oregon. Attaining the population objectives is largely dependent upon achieving habitat objectives. To meet this statewide goal,through the year 2055, the conservation focus should be to retain ≥70% of sage-grouse range as sagebrush habitat in advanced structural stages, sagebrush class 3, 4 or 5, with an emphasis on classes 4 and 5. The remaining 30% could include areas of juniper encroachment, non-sagebrush shrubland, and grassland (either from natural or human-caused disturbance) that potentially can be enhanced. The "70/30" goal is based on a habitat assessment described in BLM Technical Bulletin 417 (U.S. Department of Interior 2005).

Maintenance of 70% sagebrush and 30% potential habitat approximates the current extent of intact to disturbed sagebrush habitat throughout Oregon. Maintaining this proportion overtime provides a conservation focus for sagebrush types, while providing land managers opportunities to inventory and assess structure and composition of sagebrush communities that are beneficial to sage-grouse. Such an approach is critical because of current knowledge gaps regarding sagebrush communities and sage-grouse habitat needs. Ultimately, a more specific habitat goal for sage-grouse that focuses on the sagebrush community types critical to the species is envisioned. In the interim, the 70/30 objective provides a conservation focus for multiple species associated with sagebrush communities. Understanding that there are natural fluctuations in sagebrush cover types, the 70/30 goal serves as an adaptive management strategy for sage-grouse habitat. Flexibility is needed in managing sagebrush habitats as a dynamic landscape where short-term losses of sagebrush can yield long-term benefits to sagebrush steppe community. However, for such "losses" to benefit sage-grouse in the long-term, treatments should be conducted such that the integrity and ability of sagebrush and native vegetation to reestablish is maximized.

Statewide and regional objectives are recommended as follows:

Objective 1— Statewide: retain ≥70% of sage-grouse range as sagebrush habitat in advanced structural stages, sagebrush class 3, 4 or 5, with an emphasis on classes 4 and 5. The remaining 30% will include areas of juniper encroachment, non-sagebrush shrubland, and grassland that potentially can be rehabilitated or enhanced.

Objective 2— Maintain 100% of existing sagebrush habitats and enhance potential habitats that have been disturbed in the following regions. Existing conditions are:

Baker Resource Area: 82% sagebrush and 18% disturbed habitats.

Vale District (not including Baker): 73% sagebrush and 27% disturbed habitats.

Burns District: 68% sagebrush and 32% disturbed habitats.

Lakeview District: 72% sagebrush and 28% disturbed habitats.

Prineville District: 47% sagebrush and 53% disturbed habitats.

Section V. Guidelines

The guidelines contained in this Plan are designed to maintain (at a minimum) or enhance the quality (optimum) of current habitats, and will assist resource managers in achieving population and habitat objectives of this Plan. Because populations and habitats have been maintained over a relatively consistent set of conditions for 20+ years maintaining or enhancing these habitats through these guidelines should provide sustainable populations into the future. The guidelines should be viewed as tools as needed in a region. Not all issues identified in the guidelines (e.g., juniper encroachment) are relevant to all regions of the state. Implementation of these conservation guidelines to meet population and habitat objectives will be guided by local groups comprised of land managers and land owners.

Section VI. Implementation and Monitoring

Implementation of conservation measures outlined in this Plan will be guided by local implementation groups comprised of land managers and land owners. Because these groups are not mutually exclusive and include a mix of public and private entities, local groups will be based on BLM District boundaries and in some cases Resource Areas (BLM is the primary land manager of sage-grouse habitat in Oregon). These technical groups will identify management priorities within a region and the actions to address them. These groups will also be responsible for establishing: appropriate timelines, overseeing treatments and monitoring, and facilitating the funding of projects.

This Plan provides specific guidance for public land management agencies to adopt conservation practices so that compliance can be measured and regulatory mechanisms will exist for management of sagebrush habitats. It is the intent of this Plan to provide private landowners

with options for land management. Voluntary conservation projects need to be identified that are mutually beneficial and can be funded with the assistance of ODFW, NRCS, BLM, SWCD, or USFWS. A goal of the Plan is to provide a foundation for conservation agencies and individuals to work cooperatively in sage-grouse and sagebrush management.

Monitoring populations and habitat are paramount. ODFW and BLM should continue surveys to delineate sage-grouse distribution in the state; this project likely will be completed by spring 2005 if appropriate funding is available. Once the distribution project is complete, surveys should be developed to estimate the number of active leks in a region. ODFW is developing a statistically valid sampling scheme for examining lek activity. Additionally, sampling schemes for evaluating trend and estimating population size are being considered for districts in which not all leks can be counted in a breeding season.

One primary criterion for sage-grouse conservation is inventorying the quantity and quality of habitat in a region (Connelly et al. 2000b). From that baseline, conservation actions can be identified, prioritized, and implemented. One of the cruxes to land management is developing a comprehensive framework in which habitats can be inventoried and management objectives defined. The approach of BLM Technical Manual 417 (2005) provides such a framework. Strengths of this approach enable rangeland inventories to occur at the pasture or ecological site level. When completed over a watershed or planning area these (pasture by pasture) inventories cumulatively provide an inventory of sagebrush habitat in various successional stages. Scales pertinent to this process and management include: state level (**broad**), geographic areas which might range from a BLM district, planning area, or watershed (**mid**), allotments or pastures (**fine**), and ecological sites (**site/local**).

Synopsis

Sage-grouse are sagebrush obligates requiring large areas with a variety of sagebrush communities to meet life-history needs. The primary objective of this Plan is to maintain large expanses of intact sagebrush habitat for the benefit of sage-grouse and other sagebrush associated species. Based on this assessment of habitat and populations, several core areas of habitat have sustained populations over the last 20+ years. Protecting large expanses of sagebrush communities from fragmentation and habitat degradation should ensure sustainable populations into the future. The conservation guidelines provided in this Plan will assist local implementation groups and land managers maintain and enhance sagebrush communities throughout Oregon; and ultimately enable Oregon to achieve population and habitat objectives provided.

Section I. INTRODUCTION

This management strategy and supporting background information is intended to promote effective management of greater sage-grouse (*Centrocercus urophasianus*) and intact functioning sagebrush (*Artemisia* spp.) communities in Oregon. The strategy is tied to the life history of greater sage-grouse (hereafter sage-grouse) and uses the best science available. Most of the current sagebrush habitat in Oregon occurs on public lands and much of this document focuses on public land management. Conservation actions on private lands should be encouraged as these are likely some of the more productive sites, but conservation on private land is voluntary. Although this strategy focuses on conservation of sage-grouse, the intent is to benefit conservation needs of other species associated with sagebrush-steppe (Wisdom et al. 2002). Oregon sage-grouse populations and sagebrush habitats likely comprise nearly 20% of the North American range wide distribution (Connelly et al. 2004). Thus, management actions in Oregon will have implications on a rangewide scale.

This Plan is the result of a multi-stakeholder effort to conserve sage-grouse and their habitats. Because Oregon Department of Fish and Wildlife (ODFW) has the legal authority and responsibility for Oregon wildlife, ODFW has taken a lead role in crafting this Plan. This document is not exclusively an ODFW plan; it is a strategy represented by multiple interests and users of sage-grouse and their habitats. The motive for development of this Plan is multifaceted ranging from national to local objectives and include:

First, ODFW signed a Memorandum of Understanding (MOU) with the Western Association of Fish and Wildlife Agencies (WAFWA) that commits the ODFW to development of a sage-grouse conservation strategy (1999). Additionally, WAFWA has signed a similar MOU with the primary federal land management agencies (U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service), which in summary directs signatories to maintain or enhance sage-grouse populations and their habitats into the future.

Second, development of this Plan facilitated a statewide assessment of sage-grouse populations and their habitats. This has enabled us to identify knowledge gaps (Rowland and Wisdom 2002) and guide ODFW and other resource agencies to strive for the collection of needed data. Information in this Plan will become a part of a range-wide strategy of sage-grouse and their habitats that is being developed by WAFWA.

Third, the purpose of this Plan is to provide a framework within which sage-grouse conservation efforts can occur into the future; establishing habitat and population goals. This Plan describes the habitat needs of sage-grouse, which relates to the management actions that land managers or working groups should consider to ensure that healthy sage-grouse populations and sagebrush habitats persist into the future.

Nature of this Guidance

The intent of this strategy is to ensure that sage-grouse and sagebrush habitats will be maintained or enhanced into the future. The management strategies listed herein, if followed, should increase the likelihood that this occurs. The Plan is meant to be a dynamic document so as new information

is learned it will be used in an adaptive management process to evaluate, maintain and enhance sage-grouse populations and sagebrush habitat.

The outcomes of each conservation action suggested in this document must be evaluated for their effectiveness. As such, many of the proposed actions should be implemented in an experimental context, and evaluated under the framework of adaptive resource management (ARM). ARM is learning by doing (Macnab 1983, Nudds 1999), and it is an iterative process that enables managers to evaluate the effectiveness of their management decisions (e.g., harvest quotas, habitat projects), and researchers gain information on system response (e.g., nesting success, recruitment) to the treatment (Lancia et al. 1993). In this context, management actions are not "failures," but may be an ineffective management tool, because ineffective actions can be learned from as easily as actions that are effective. The critical point is to learn and understand why an action was ineffective so that it is not repeated. It is the spirit of learning by doing that an unsuccessful experiment has the same merit as a successful experiment, and each management action herein should be treated as an experiment with controls, treatments, appropriate replication (where possible), and measurable response variables.

Single-species vs. Ecosystem Process Approaches

The sage-grouse is a wide ranging species that requires a variety of plant community types within sagebrush habitat to meet the needs of its annual life cycle: lekking habitat (areas used for communal breeding displays) often contains little to no shrub component, a strong perennial grass component is needed for nesting habitat, forb rich communities are needed for brood rearing, and relatively dense stands of sagebrush are required during winter months. This Plan, while it concentrates on the habitat needs of sage-grouse, is intended to focus on maintenance and enhancement of sagebrush habitats, which are important to a number of other species (Maser et al. 1984). The overarching objective of this Plan is to promote intact and functioning sagebrush landscapes. These landscapes should support more wildlife species than monotypic grasslands (Maser et al. 1984).

In addressing the conservation of sage-grouse, this Plan recognizes that its geographic range overlaps the ranges of many other species, some of which are federally listed as threatened or endangered, are candidates for listing, or are closely associated with sagebrush communities. Consequently, other species associated with sagebrush were considered in developing the conservation strategy for sage-grouse. Specifically, this Plan assessed the relative benefits to other species that might occur in developing the conservation plan for sage-grouse, because managers should take advantage of opportunities to benefit other species where possible and not impact them negatively. This was appropriate because the primary stated purpose of the Endangered Species Act is "------to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved--------(Endangered Species Act 1973: Section 2(b)).

Examples of such species that could benefit from the suggested approach include mule deer (*Odocoileus hemionus hemionus*), pronghorn (*Antilocarpa americana*), pygmy rabbit (*Brachylagus idahoensis*), black-tailed jackrabbit (*Lepus californicus*), sagebrush vole (*Lemmiscus curtatus*), Brewers sparrow (*Spizella breweri*), black-throated sparrow (*Amphispiza*

bilineata), sage thrasher (*Oreoscoptes motanus*), sage sparrow (*Amphispiza belli*), loggerhead shrike (*Lanius ludovicianus*), horned lark (*Chondestes grammacus*), western meadowlark (*Sturnella neglecta*), northern sagebrush lizard, and short-horned lizard. Maintenance of connectivity and reduction of fragmentation of sagebrush habitats is key to the long-term welfare of all these sagebrush associated species (Connelly et al. 2004).

How the Document will be updated

At the direction of the Oregon Sage-Grouse and Sagebrush Habitat Conservation Team, this document may be updated as new information is collected.

Relationship of Document to Federal Endangered Species Act Listing Criteria

The population and habitat assessments and management strategies provided in this Plan are intended to address the listing criteria used by the U.S. Fish and Wildlife Service (Service). The following criteria are used in the process of deciding whether or not a species warrants protection under the Act:

1. The present or threatened destruction, modification, or curtailment of the species' habitat or range;

2. Over-utilization for commercial, recreational, scientific, or educational purposes;

3. Diseases or predation;

4. The inadequacy of existing regulatory mechanisms; or'

5. Other natural or manmade factors affecting the species' survival.

Current Federal ESA Listing Status/Petitions

On 12 January 2005, the Service determined that actions from 3 petitions to protect sage-grouse range-wide were not warranted under the Endangered Species Act. The Columbian Basin Distinct Population Segment (DPS) which is currently "warranted but precluded" from protection under ESA has a historic distribution in north-central Oregon. However, populations have been extirpated from this region since early in the 20th century.

Oregon Endangered Species Act

The Oregon Revised Statute (ORS) 496.012 (also known as the *Wildlife Policy*) includes the statement that, "[i]t is the policy of the State of Oregon that wildlife should be managed to prevent serious depletion of any indigenous species and to provide the optimum recreational and aesthetic benefits for present and future generations…" To this end, inherent in this Plan is the overarching goal to manage sage-grouse populations, such that they are not listed as an Endangered Species at the State or Federal level. Consistent with the *Wildlife Policy* and the Oregon Fish and Wildlife

Commission's authority to adopt rules necessary to manage wildlife (ORS 496.138) this Plan provides a framework to maintain and enhance sage-grouse populations and their habitats.

Policy for Evaluating for Conservation Efforts (PECE), U.S. Fish Wildlife Service

The Service recently adopted the Policy for Evaluating for Conservation Efforts (PECE) which provides criteria for evaluating species conservation plans in lieu of federal protection (U.S. Fish and Wildlife Service 2002). The policy establishes 2 basic criteria 1) the certainty that the conservation efforts will be implemented, and 2) the certainty that the efforts will be effective. To determine the likelihood of *implementation* the Service evaluates whether or not the parties have the authority, resources, and schedule to complete the proposed efforts. To determine the likelihood of *effectiveness* the Service evaluates whether or not the Plan: describes the nature and extent of threats, establishes specific conservation objectives, identifies steps to reduce the threats, and provides quantifiable performance measures to monitor for both compliance and effectiveness. The intent of this Plan is to satisfy these criteria where possible, understanding that greatest likelihood of meeting PECE will occur at the local level.

Section II. OVERVIEW OF GREATER SAGE-GROUSE ECOLOGY

Description

Sage-grouse are sexually dimorphic gallinaceous birds (i.e., males are larger and have more conspicuous plumage than females) and are the largest North American grouse species. Adult males are typically 66-76 cm in length (beak to tail) and 2-3.5 kg. Adult females are typically 48-58 cm in length and 1-2 kg. Sexual dimorphism is also expressed by plumage. Males have a black throat and bib, white feathers along the sides of the neck, a large white ruff on the breast, green cervical apteria, and yellow superciliary combs; both enlarge during breeding displays. Although they have white-tipped upper tail coverts, females are more cryptically colored (Schroeder et al. 1999).

Taxonomy/Genetics

Sage-grouse belong to the order Galliformes, family Phasianidae, and subfamily Tetraoninae. There are 2 species of sage grouse: greater sage-grouse and Gunnison sage-grouse (*C. minimus*). The latter occurs only in Colorado and Utah and is not discussed further in this document. Two subspecies of greater sage-grouse were previously recognized: the eastern greater sage-grouse (*C. u. urophasianus*) and the western greater sage-grouse (*C. u. phaios*) (American Ornithological Union 1998) which occurs in Oregon. However, recent genetic analyses (Benedict et al. 2003) found little evidence to support this subspecies distinction, and this Plan refers to sage-grouse without reference to subspecies delineation in this document. Benedict et al. (2003) also described genetics for Beaty's, Steens, Wagontire, Warner, and Whitehorse (ODFW hunt management units), and found reasonable levels of genetic diversity.

Nesting Rates

The numbers of females nesting varies annually and regionally (Bergerud 1988, Gregg 1991, Connelly et al. 1993, Schroeder 1997, Coggins 1998). This variation is possibly a result of available nutrition quality and the general health of pre-laying females (Barnett and Crawford 1994). At least 70% of the females in a population will initiate a nest each year, with higher nest initiation rates recorded during years of higher precipitation in comparison to periods of drought (Coggins 1998). Renesting rates by females which have lost their first clutch are 10-40% (Patterson 1952, Eng 1963, Petersen 1980, Bergerud 1988, Connelly et al. 1993). The effect of renesting on overall population numbers can be highly variable and may be critical during some years (Schroeder 1997).

Nest Success

Nest success rates range from 10 to 86% (Trueblood 1954, Gregg 1991, Connelly et al. 1993, Schroeder 1997). Adult females may experience higher success rates than yearling females, but this pattern is not consistent across studies (Schroeder et al. 1999).

Clutch Size

Clutch size is variable and relatively low compared to other species of gallinaceous birds (Edminster 1954, Schroeder 1997) and within the grouse sub-family. Clutch size per nest normally ranges from 7-10 (Schroeder et al. 1999). These differences may be related to habitat quality and overall condition of pre-laying females (Coggins 1998). Females that renest usually have slightly smaller clutches.

Survival Rates

Annual survival rates for yearling and adult female sage-grouse vary from 35 to 85%; male survival rates vary from 38 to 54% (Wallestad 1975, Connelly et al. 1994, Zablan et al. 2003). Lower survival rates for males may be related to higher predation rates on males during the lekking season (Swenson 1986).

A stable sage-grouse population is largely dependent on the level of production of young (note: clutch size, nest success, and chick survival are subsets of production) and adult survival. Among the western states, the number of young in the fall population varies from 1.40 to 2.96 juveniles per female. In recent years, this ratio has declined to 1.21 to 2.19 juveniles per female. Research suggests that at least 2.25 juveniles per (successful) female should be present in the fall to allow for stable to increasing populations (Connelly and Braun 1997, Edelmann et al. 1998).

Historic and Current Range-Wide Distribution

Historically, an estimated 89 million ha (220 million acres) of sagebrush-steppe vegetation existed in North America (McArthur and Ott 1996) making it one of the most widespread habitats in the country. Much of this habitat, however, has been lost or degraded over the last 100 years.

Sage-grouse populations have exhibited long-term declines throughout North America, declining by an estimated 33% over the past 30 to 40 years (Connelly and Braun 1997, Braun 1998, Connelly et al. 2004). The species has been extirpated in five states--Arizona, New Mexico, Oklahoma, Kansas, Nebraska, and in the Canadian province of British Columbia (Schroeder et al. 2004). It is considered “at risk” in Washington, California, Utah, Colorado, North Dakota, South Dakota and in the Canadian provinces of Alberta and Saskatchewan. Even in Oregon, Nevada, Idaho, Wyoming, and Montana, where the species is considered to be “secure,” long-term population declines have averaged 30% (Connelly and Braun 1997). Many factors affect sage-grouse populations and occur at different temporal and spatial scales. No specific factor has been identified for these declines. Instead, an accumulation of factors described herein are responsible.

GENERAL HABITAT CHARACTERISTICS

In 1977, the Western Association of Fish and Wildlife Agencies’ (WAFWA) Sage Grouse Technical Committee published guidelines for the maintenance of sage-grouse habitats (Braun et al. 1977). These guidelines were recently updated (Connelly et al. 2000b) and provide a baseline of information for sage-grouse habitat and its management that should be adapted as local ecological conditions and knowledge dictates.

Sage-grouse are sagebrush obligate species and without sagebrush the species cannot persist (Patterson 1952). Sagebrush is important for cover and it is an important component in their diet throughout the year (Schroeder et al. 1999). Within the sagebrush landscape there are key habitat elements that sage-grouse need or use to be productive and survive.

Breeding Habitat

Sage-grouse breed on sites called leks (strutting grounds). The same lek sites tend to be used annually. They are established in open areas surrounded by sagebrush, which is used for escape and protection from predators (Patterson 1952, Gill 1965). Examples of lek sites include landing strips; old lake beds or playas; low sagebrush flats; openings on ridges, roads, crop land; and burned areas (Connelly et al. 1981, Gates 1985). As grouse populations decline, the number of males attending leks may decline or the use of some leks may be discontinued. Likewise, as populations increase, male attendance on leks increases, new leks may be established, or old leks may be reoccupied. Annual counts of males on leks are used to assess population trends (Connelly et al. 2003a).

The lek is considered to be the center of year-round activity for resident grouse populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974). However, habitats that are located substantial distances from leks are used by migratory populations of sage-grouse and are essential to their survival (Connelly et al. 1988, Wakkinen et al. 1992). On average, most nests are within 6.2 km (4 mi) of the lek; however, some females may nest more than 20 km (12 mi) from the lek on which they were captured (Autenrieth 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994).

Habitats used by females prior to nesting are also part of the general breeding habitat. These areas provide forbs that are high in calcium, phosphorus, and protein, all of which are necessary for egg production. The condition and availability of these areas may have a significant effect on reproductive success (Barnett and Crawford 1994). Females exhibit relatively strong fidelity to nesting areas (Fischer et al. 1993).

Optimum sage-grouse nesting habitat consists of a healthy sagebrush ecosystem complete with sagebrush (*A. tridentata tridentata, A. t. vaseyana, A. t. wyomingensis, A. arbuscula*) plants and an strong native herbaceous understory composed of grasses and forbs. Nesting and early brood-rearing periods are a critical time period for sage-grouse.

Most sage-grouse nests are under sagebrush plants (Patterson 1952, Gill 1965, Gray 1967, Wallestad and Pyrah 1974, Schroeder et al. 1999); however, nests have been found under other plant species (Connelly et al. 1991, Gregg 1991). Sage-grouse that nest under sagebrush experience higher nest success (53%) than those nesting under other plant species (22%) (Connelly et al. 1991). Studies of nesting habitat have documented that sage-grouse tend to select nest sites under sagebrush plants that have large canopies. The canopies provide overhead cover and often correlate with an herbaceous (primarily grasses) understory, which provides lateral cover and assists birds in hiding from predators (Patterson 1952, Gray 1967, Klebenow 1969, Wallestad and Pyrah 1974, Wakkinen 1990, Gregg 1991, Fischer 1994, Gregg et al. 1994, Delong et al. 1995).

Females nesting in these cover conditions experience higher nest success rates than those nesting under inferior cover conditions (Wallestad and Pyrah 1974, Delong et al. 1995).

Brood Rearing Habitat

Early brood-rearing generally occurs relatively close to nest sites; however, movements of individual broods may be highly variable (Connelly 1982, Gates 1983). Females with broods may use sagebrush habitats that have less canopy cover (about 14%) than that provided in optimum nesting habitat (Martin 1970, Wallestad 1971), but need a canopy cover of at least 15% of grasses and forbs (Sveum et al. 1998). Low sagebrush community types (e.g., *A. longiloba*, *A. nova* and *A. arbuscula*) are drier sites with shallow clay soils that green-up early and may provide a rich forb component during early-brood rearing (Savage 1968, Martin 1970, Connelly and Markham 1983, Gates 1983, Connelly et al. 1988). Chick diets include forbs and invertebrates (Drut et al. 1994). Insects, especially ants and beetles, are an important component of early brood-rearing habitat (Johnson and Boyce 1990, Drut et al. 1994, Fischer et al. 1996b). Brood-rearing habitats having a wide diversity of plant species tend to provide an equivalent diversity of insects that are important chick foods.

In June and July, as sagebrush habitats become dry and herbaceous plants mature, females usually move their broods to more moist sites where more succulent vegetation is available (Gill 1965, Klebenow 1969, Savage 1968, Gates 1983, Connelly and Markham 1983, Connelly et al. 1988, Fischer et al. 1996a). Where available, alfalfa fields and other farmlands or irrigated areas adjacent to sagebrush habitats are sometimes used by sage-grouse. These anthropogenic habitat types are not uniformly distributed throughout the range of sage-grouse in Oregon, nor do they provide forage during fall and winter months. In addition, pesticides, which are frequently applied to such fields, have had negative impacts on sage-grouse survival (Blus et al. 1989).

Winter Habitat

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

Sage-grouse winter habitats are relatively similar throughout most of their range. Because winter diet consists almost exclusively of sagebrush, winter habitats must provide adequate amounts of sagebrush. Sagebrush canopy can be highly variable (Patterson 1952, Eng and Schladweiler 1972, Wallestad et al. 1975, Beck 1977, Robertson 1991). Sage-grouse tend to select areas with both high canopy and taller Wyoming big sagebrush (*A. t. wyomingensis*), and they will feed on plants which are highest in protein content (Remington and Braun 1985, Robertson 1991). It is critical that sagebrush be exposed at least 25 to 30 cm (10 to 12 in) above snow level because this provides both food and cover for wintering sage-grouse (Hupp and Braun 1989). Sage-grouse are known to burrow in snow for thermoregulation and predator avoidance (Back et al. 1987). If snow covers the sagebrush, sage-grouse may move to areas where sagebrush is exposed. Alternatively, low sagebrush may provide adequate winter habitat where snow depths are low or wind swept slopes keep the sagebrush clear of snow (Hanf et al. 1994).

Movement Patterns

Sage-grouse populations can be migratory or non-migratory (resident) (Beck 1975, Wallestad 1975, Berry and Eng 1985, Connelly et al. 1988, Wakkinen 1990, Fischer 1994), depending on location and associated land form. Where topographic relief allows, sage-grouse will generally move upwards in elevation from spring through fall as snow melt and plant growth advances so that forbs are maintained in the diet as long a duration as possible. Resident populations may spend the entire year within an area of 100 km^2 (38.61 $mi.^2$) or less in size. In migratory populations, seasonal movements may exceed 75 km (46.5 mi.) and home ranges may exceed 1,500 km^2 (579 $mi.^2$) (Dalke et al. 1963, Connelly et al. 1988) . There may be 2 or more seasonal ranges in such cases. For example, a migratory population may have a breeding range, a brood-rearing range, and a winter range, indicating a dependence on large expanses of habitat.

To accommodate these habitat needs, it is important to identify sage-grouse movement patterns and seasonal ranges before management actions, such as vegetation treatment projects, are planned. Suitable habitat is needed to allow for connectivity between different resident populations. Connectivity promotes genetic exchange and reduces complications that may arise from inbreeding.

MORTALITY FACTORS

Weather

Weather can influence nesting success and survival of young chicks (Bergerud 1988). However, Wallestad and Watts (1972) found no correlation between sage-grouse productivity and rainfall or temperature in Montana. Similarly, Patterson (1952) found no nest failure resulting from low temperatures or snow but chicks survival was compromised by several consecutive days of precipitation accompanied by cold temperatures in Wyoming. The impacts of weather on brood survival depended on the availability of forbs and insects for broods immediately following hatch in Idaho (Dalke et al. 1963, Autenrieth 1981). Sage-grouse production was reasonable when mean average temperature in spring was > 7° C (45° F) and total precipitation was <5 cm (2 in) in Colorado (Gill 1966). Adult sage-grouse endure winter reasonably well, and actually can gain body mass during this period provided adequate wintering habitat is available (Patterson 1952).

Predation

Predation of grouse accounts for approximately 85% of reported non-hunting mortalities and 79% of nest failures (Bergerud 1988). Specifically, predation on nests and young chicks can be high and affect populations (Gregg et al. 1994, Aldridge and Brigham 2001, Schroeder and Baydack 2001). However, few studies have indicated that predation is a major limiting factor to sage-grouse. In Idaho predation was the most common cause of death for radio-marked sage-grouse (83% of males and 52% of females) in a hunted population (Connelly et al. 2000a). Predation is probably most frequent on adult males during or shortly after the breeding season and on females during incubation and brood rearing (Schroeder et al. 1999). Predation rates may depend in part on the availability of alternative prey for predators, such as cottontail rabbits (*Silvlagus* spp.) and jackrabbits (*Lepus* spp.) or other small mammals (Willis et al. 1993). Additionally, habitat quality

may influence the rates of predation on sage-grouse (Schroeder and Baydack 2001). However, relatively high rates of nest success and adult survival suggests that predation is not a limiting factor range-wide, but might be an issue with isolated or fragmented populations.

Hunting

The impacts of recreational hunting on sage-grouse populations are unclear. There are few experimental studies demonstrating an effect of harvest on populations the following year. However, Connelly et al. (2003b) demonstrated that rates of population growth were less in hunted than unhunted populations in Idaho. Twenty years of harvest data from Oregon did not indicate a correlation between harvest level and spring breeding population (Crawford 1982). Braun and Beck (1985) analyzed banded birds, harvest levels, and lek counts and concluded that the harvest rate of 7-11% in Colorado had no measurable effect on sage-grouse densities in spring. Because sage-grouse do not fit the 'high productivity-short life span' life history model common to other game bird species, the assumptions that harvest mortality replaces birds that would have died of other causese during the year (i.e., compensatory mortality) have been questioned (Johnson and Braun 1999). Connelly et al. (2000a, 2003b) suggested that hunting losses are likely in addition to winter mortality for adult females (i.e., additive mortality). Johnson and Braun (1999) modeled population dynamics for sage-grouse in North Park, Colorado and concluded that hunting mortality can be additive to other sources of mortality, especially in years of poor recruitment.

Parasites & Diseases

Local populations may occasionally be affected by parasites or disease. However, there is no evidence to suggest that annual fluctuations in sage-grouse numbers are linked to such pathogens. Batterson and Morse (1948) reported a sage-grouse population crash in Oregon in 1919-1920 when dead and dying grouse were common throughout the preferred portions of their range. Schroeder et al. (1999) list the various parasites that infect sage-grouse and coccidiosis is is the most commonly reported disease (i.e., diarrhea is the clinical sign) caused by protozoan organisms (*Eimeria* spp.).

In 2003, West Nile Virus caused mortalities of sage-grouse in Wyoming (n = 16), Montana (n = 2), and Alberta (n = 5) with at least 23 sage-grouse found dead (Naugle et al. 2004). This included 9 of 15 radio-marked birds and 7 other sage-grouse in northeastern Wyoming that died of the virus. West Nile mortalities have not been observed in southwestern Wyoming where >100 sage-grouse have been radio-tagged. At this time, sage-grouse show no resistance to WNV and mortality is assumed to be 100% (Naugle et al. 2004). Total mortality from WNV has been markedly reduced in 2004 (thought to be the result of cooler weather), but the disease has been confirmed in dead sage-grouse from Colorado (n = 1), and Mono Lake California (n = 3).

Human Influences

Insecticides. Organophosphorus insecticides (dimethoate or methamidophos) have been found to be directly responsible for death of sage-grouse in proximity of sprayed alfalfa or potato fields in southeastern Idaho (Blus et al. 1989).

Roads. Sage-grouse, particularly juveniles, are susceptible to being killed by vehicles. Mortalities from vehicle collisions were more frequent than collisions with wires and fences in Montana (Wallestad 1975), and in Idaho vehicles accounted for 4% of mortalities of 77 radio-marked females (Connelly et al. 2000a).

Wires and fences. Utility wires are known to cause mortality (Borell 1939), and collisions with power lines accounted for 2% of male and 0.9% of overall mortalities of radio-marked sage-grouse in Idaho (Connelly et al. 2000b). A barbed wire fence in winter habitat killed at least 36 sage-grouse the first winter after installation (Call and Maser 1985), and 21 mortalities were reported along a similar fence in Wyoming (Connelly et al. 2004).

Section III. SAGE-GROUSE POPULATIONS IN OREGON

The Decline of Oregon Sage-Grouse Populations

Sage-grouse were once found in most sagebrush habitats east of the Cascades (Figure 1). European settlement and conversion of sagebrush steppe into agricultural production led to extirpation of the species in the Columbia Basin by the early 1900s (Batterson and Morse 1948). Population monitoring did not begin until after this range contraction, thus estimating population size or density at the time of European settlement is difficult. Within the extant range of Oregon, spring population indices have demonstrated an overall decline since the 1940s. However, population indices over the last decade suggest stable or increasing populations. The early data, prior to 1980s, should be viewed with caution due to small sample sizes and the absence of survey protocols. Crawford and Lutz (1985) estimated substantial declines in spring populations during this period (1941-1983), and attributed these declines to an "unmeasured" habitat factor. Willis et al. (1993) summarized population information through 1992 and indicated a similar decline from the 1940s but a fluctuating and stable trend since the late 1950s. Connelly and Braun (1997) summarized the data of the previous studies and implicated poor production and cumulative effects of land use as contributing factors to declining population trends, but classified Oregon as a state with "secure" sage-grouse populations.

POPULATION MONITORING PROGRAM IN OREGON

Monitoring efforts for sage grouse began to increase since about 1980 with a resulting increase in sample sizes. In addition, since approximately 1996, ODFW has been following a population monitoring protocol so data quality is consistent and comparable from district to district (Appendix I). More than one type of data were used to assess population trend and status as described below.

Lek counts. Counts are based on the number of sage-grouse (primarily males) attending designated leks ("trend leks") each spring. Each trend lek or lek complex is counted at least 3 times at 7-10 day intervals during the breeding season. This survey provides a measure of population trend over time and serves as the basis for making annual population estimates.

Lek searches. Since the early 1990's, ODFW has cooperated with BLM to systematically search all potentially suitable habitats for active sage grouse leks. Since that time, many (>150) previously unknown leks have been discovered.

Brood routes. Brood production surveys are conducted to provide a measure of annual reproductive success and trend in sage-grouse productivity. Routes are conducted by vehicle between 15 July and 10 August, depending on spring plant growth and timing of the hatch. Routes are conducted in the same manner (time of day, method of transportation) each year. All birds observed are counted, and classified as male, female, juvenile, and unknown. Classification information is used to calculate chicks per brood, chicks per adult, and chicks per female.

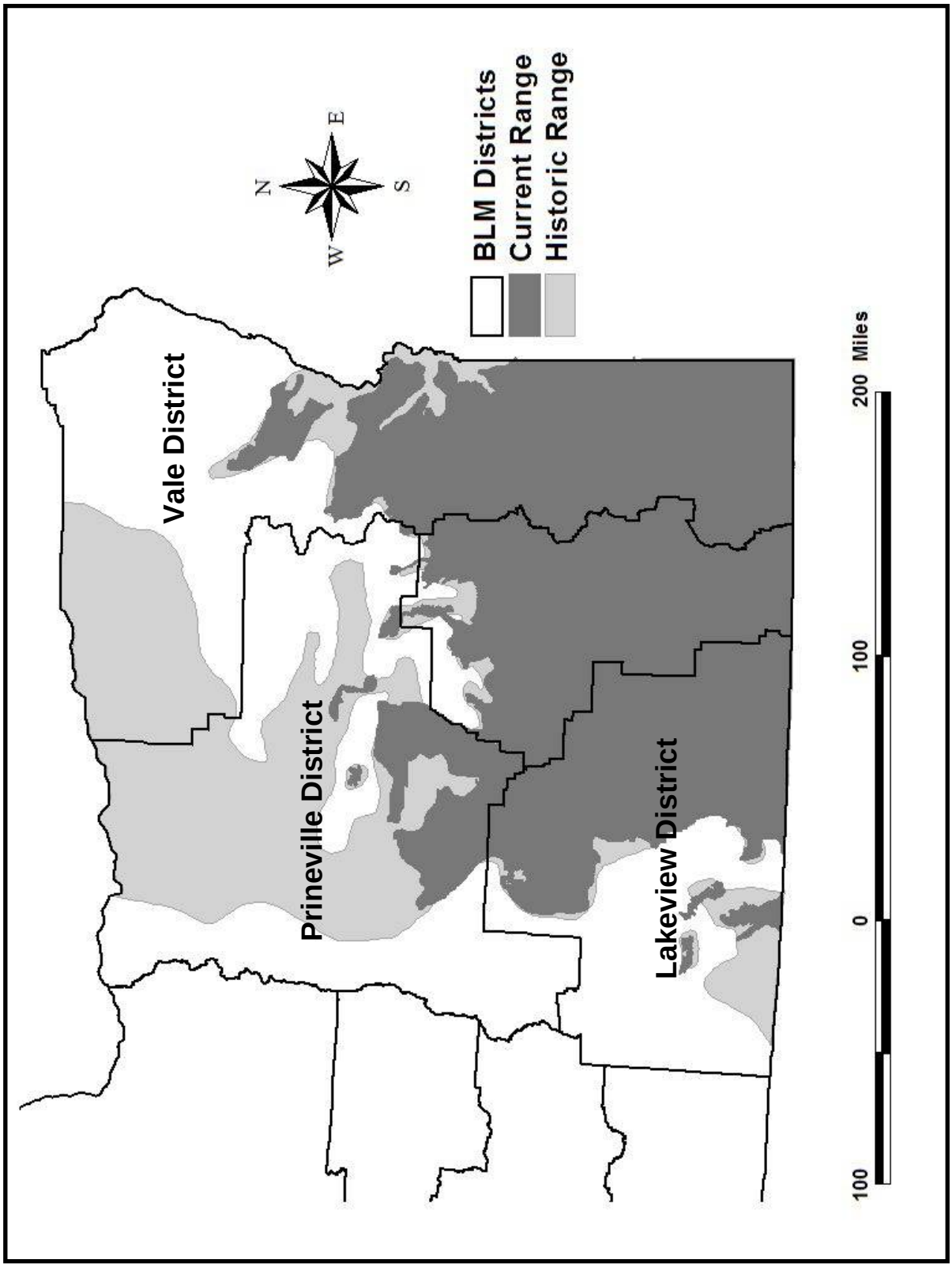

Figure 1. Historic and current range of greater sage-grouse in Oregon. The historic range is derived from Schroeder et al. (2004) and current range based on habitat map developed by Oregon BLM and Oregon Department of Fish and Wildlife.

Wing collections. Wings provide information on the proportion of adults/yearlings/juveniles, chicks/females, and the sex ratio in the population prior to winter. Sage-grouse seasons in Oregon are tightly regulated through limited entry hunting and are designed to collect additional information on population composition.

Population Trends. Trend is measured by the change in the average number of males per active lek, the number of active leks, and the annual rate of change (percent change) in total numbers of males counted on leks between consecutive years.

POPULATION ASSESSMENT

Historical Conditions

There is evidence that Oregon sage-grouse populations have diminished since the early part of the twentieth century (Crawford and Lutz 1985, Willis et al. 1993, Connelly and Braun 1997, Connelly et al. 2004); however, the magnitude of that decline is largely unknown. Moreover, one must consider the conditions that may have contributed to the apparent large populations. Before the assumption is made that population sizes of the 1940s and 1950s were "natural" and perhaps relevant to setting population or habitat objectives there are 4 important factors to consider.

1) The intensive predator control programs of that era in Oregon were removing an estimated 10,000 coyotes from the state and ~60% of the annual take was from sage-grouse counties (Animal Damage Control Records 1941-2003; Figure 2). Several other predator species were culled as well both directly and indirectly from predator control methods such as the use of Compound 1080.

2) This may have artificially elevated sage-grouse population sizes of sage-grouse despite the fact that grazing (Authorized AUMs) on public land was nearly 2 times that of current levels (Public Land Statistics, Figure 2).

3) There were several years in which >10,000 sage-grouse were harvested during regulated fall hunting seasons and may have had an additive effect on mortality (Figure 3) despite larger population sizes.

4) It was not until the 1980s that a reasonable sample (>20) of leks was monitored statewide (Figure 5), and monitoring protocols become more standardized. Thus the ability to monitor trends in the early period may be questionable.

There is little doubt that broad-scale sagebrush eradication programs of the 1960s (e.g., Vale Project; Willis et al. 1993) impacted populations. However, the cumulative effects of changes in predator control techniques, harvest levels, and habitat loss possibly contributed to these declines. The question remains, "Are the pre-decline conditions attainable?" If so, "Is it financially or socially realistic to achieve such conditions?" This Plan questions the relevance of the 1940-50s as a time period to base population or habitat objectives, and recommend that an era of predator control methods (and take levels), grazing schedules, survey protocols, habitat

treatments and harvest levels similar to or attainable in the near future be utilized for assessing sage-grouse populations in Oregon. Because of these factors, this Plan considered 1980-2003 as the relevant time period in which to assess sage-grouse populations and their habitats in Oregon. Data from the 1980-2003 period will also be used to set population and habitat objectives.

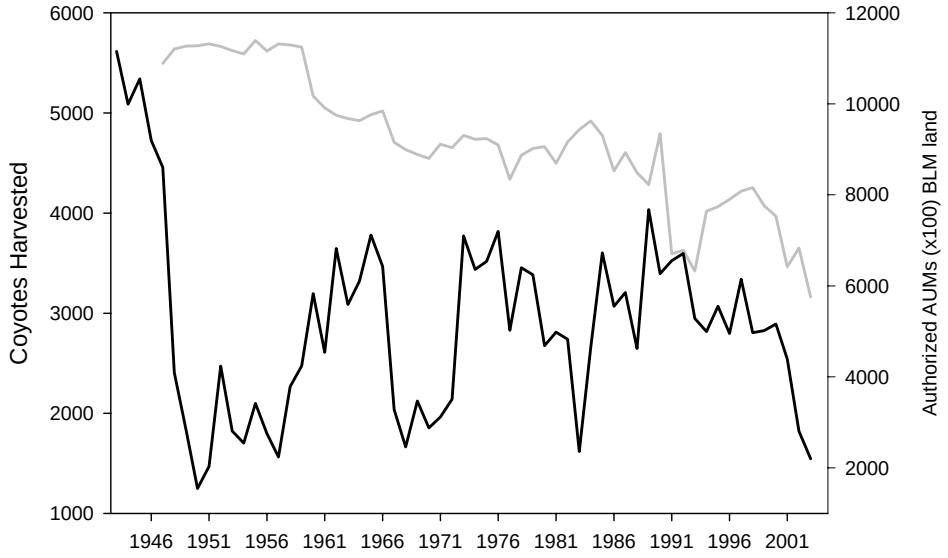

Figure 2. Authorized AUMs (gray line) on BLM lands and coyotes harvested and reported by Animal Damage Control and for sage-grouse counties (black line) in Oregon 1943-2003.

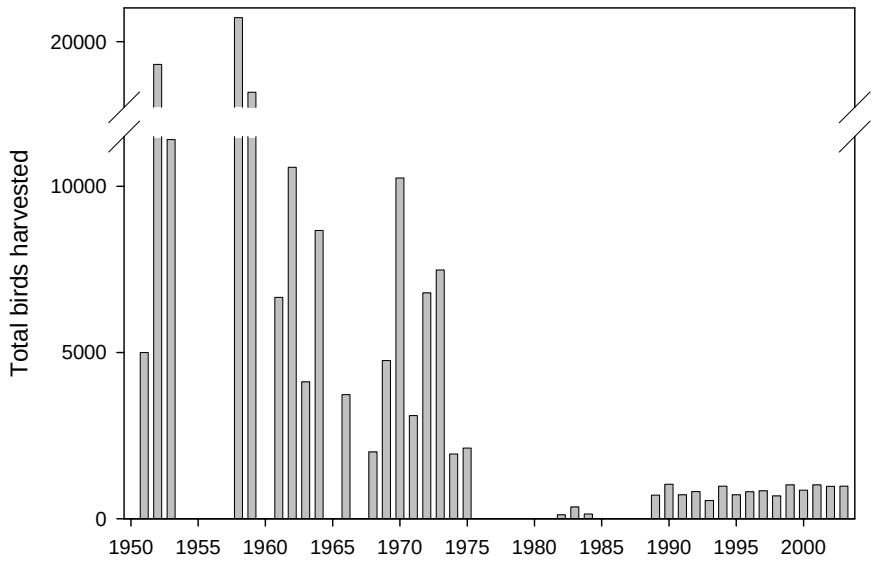

Figure 3. Total number of sage-grouse harvested in Oregon 1950-2003.

Assessment Period and Regional Units

The Bureau of Land Management (BLM) retains regulatory authority for 70% of the sage-grouse habitat in Oregon; therefore this Plan assessed populations based on the four BLM districts boundaries in which sage-grouse currently occur, Burns, Lakeview, Prineville, and Vale (Figure 1). The district boundaries approximate the following 4 ecoregion boundaries of the Great Basin (Connelly et al. 2004 and references therein): Lahontan, High Desert, John Day and Humboldt/Snake River, respectively. However, because of geographical separation of the Baker Resource Area within Vale District, this area was treated as its own population within the Snake River ecoregion. This Plan presents data from 1957 to 2003 to provide historical context. However, the assessment period varies for each district because of differences in monitoring effort.

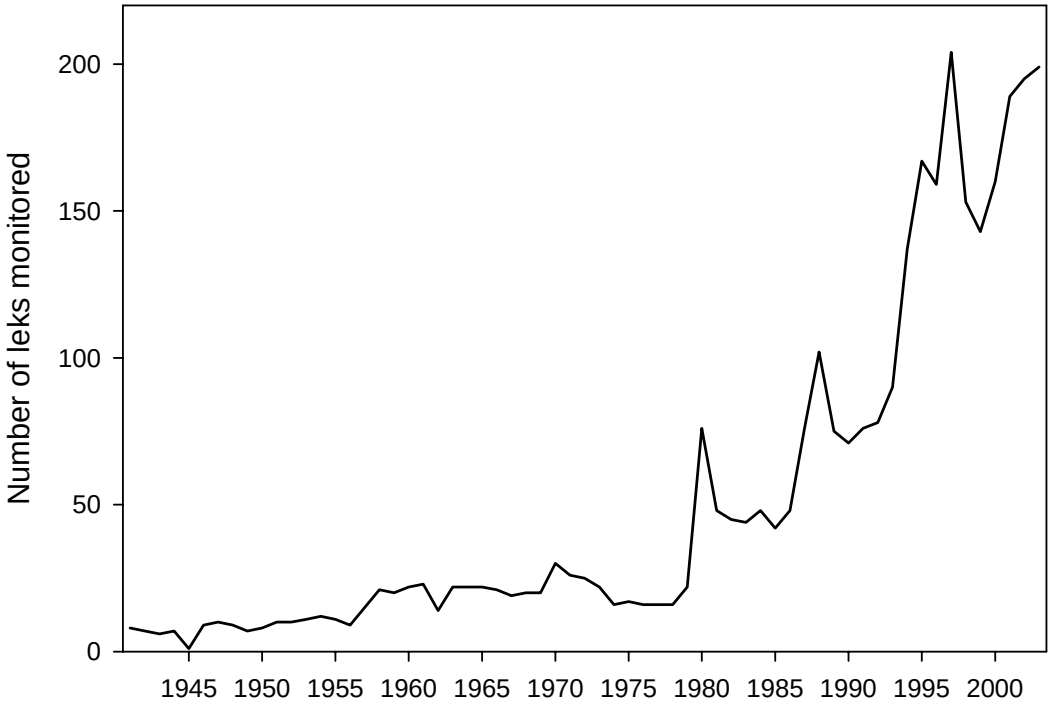

Figure 4. Total number of leks monitored by ODFW, USFWS, and BLM staff from 1941-2003.

Meta-populations and Geographic Sub-divisions

Connelly et al. (2004) examined spatial information on sage-grouse populations both within and among states and identified potential meta-population structuring (a meta-population is 1 large population comprised of numerous smaller but usually interconnected sub-populations). Seven subpopulations have been identified in Oregon (Figure 5) and 4 of these are managed by at least 2 states. At this time this Plan assumes these sub-populations are not continuous, because of natural and human-caused habitat fragmentation. Recognizing this population structure over a larger region will assist in local management decisions.

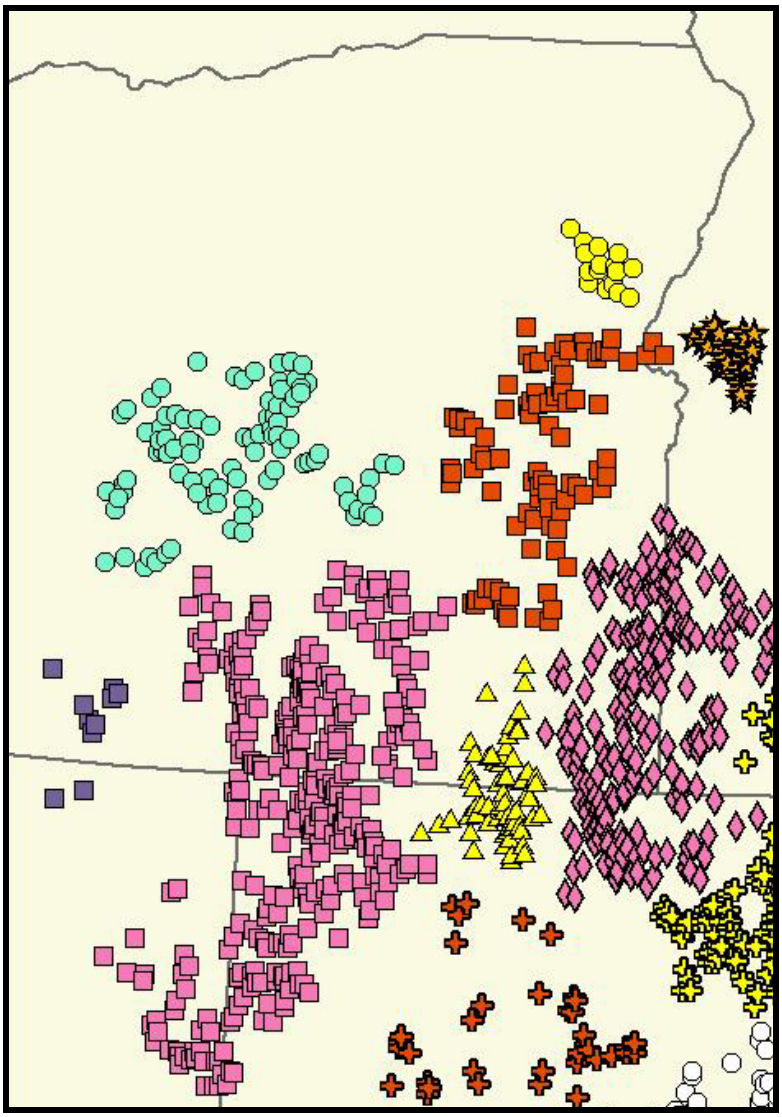

Figure 5. Geographic sub-division of sage-grouse populations in Oregon and shared populations among adjacent states as defined in Connelly et al. (2004): *purple squares* = Klamath OR/CA, *turquoise circles* = Central OR, *pink squares* = Lake Area, *yellow triangles* = S-Central OR/N-Central NV, *red squares* = E-Central OR, *pink diamonds* = N-Central NV/SE OR/SW ID, and *yellow circles* = Baker (Adapted from Connelly et al. (2004).

CURRENT TRENDS AND STATUS OF SPRING POPULATIONS

The number of strutting males was obtained from counts of birds attending leks during March and April. Historically, the number of times a lek was counted in a year was variable. As of 1996 ODFW, USFWS, and BLM field staff adopted and implemented protocols to count each trend lek at least 3 times during the breeding season between 0.5 before and 1.5 hours after sunrise. Trend leks are breeding sites that have been counted consistently over a number of years and generally are a sub-sample of all leks in a region. This Plan provides 3 measures of

population trends for sage-grouse populations in Oregon, changes in males per lek, annual rate of change (Schroeder et al. 2000), and changes in lek size or total number of male sage-grouse using the lek. The indices chosen and methods for data analyses are similar to those used in the *Conservation Assessment for Greater Sage-Grouse* (Connelly et al. 2004) and have been implemented for continuity and comparison.

A lek site is defined as an area with 2 or more males observed displaying in 2 or more of the 5 previous years. Generally sites with small numbers of males are associated with a larger lek site in the vicinity (≤ 1 mile) and are collectively referred to as a lek complex. A count of a lek complex generally includes censusing all displaying males in a series of leks where no 2 lek sites are more than 1 mile apart. This rule was flexible in some cases, based on field knowledge of District Biologists. Thus all summaries that refer to males per lek, are accounting for lek complexes. Data for males per lek are based solely on trend leks monitored annually as described above. These data were collected by ODFW, USFWS, and BLM biologist for nearly 65 years.

The annual rate of change (upward or downward) in the sage-grouse population was calculated based on the method described by Schroeder et al. (2000). Briefly, annual rates of change (up or down) were estimated by comparing the numbers of birds counted at leks in consecutive years. Thus, a lek must be counted at least 2 years consecutively to be included in the estimate of population change. A technical description of these techniques is in Appendix III.

Statewide

Monitoring effort. Males attending leks have been monitored since 1941 as a measure of population trend. To provide an historical context this Plan used data from 1957-2003 because starting in 1957, more than10 leks were monitored per year. In Oregon, over 900 leks have been identified and many of these have been found in the last 10-15 years with the use of helicopter surveys. The result has been a 12.3 times increase in monitoring effort of leks counted since the mid 1950s (Table 1). The proportion of all leks monitored that were active fluctuated between 59 and 89% and averaged 78% over 5 year periods. During the 1955-59 period 99% of monitored leks were estimated to be active, but sample sizes were small.

Table 1. Statewide monitoring effort and population trends summarized over 5 year periods from 1955 to 2003.

Variable	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Leks Counted	15.2	20.6	20.4	23.8	17.4	52.2	68.6	90.4	165.2	185.8
Leks Active	15.0	18.4	17.0	18.4	11.4	31.0	55.6	76.8	132.8	149.3
Males / lek	30.8	18.5	20.8	17.8	12.2	13.7	22.3	20.3	12.5	18.1
Males /active	31.0	20.7	24.7	23.3	18.7	21.3	27.1	24.3	15.5	22.6
Median / lek	29.0	17.5	12.5	8.8	8.5	8.0	14.5	13.2	8.8	11.4
Median /active	29.1	18.9	16.9	13.3	16.2	16.4	18.9	16.2	12.2	15.1

Table 2. Statewide changes in lek size classified as small (<20), medium (20-49), and large leks (≥50) reported as numbers (*n*) and percent of column total, average over 5 year periods.

Lek size	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Small (*n*)	34	49	54	54	37	95	152	287	452	291
%	40%	56%	59%	67%	57%	58%	49%	63%	69%	62%
Med (*n*)	45	33	28	19	27	58	109	139	171	133
%	53%	38%	30%	23%	42%	35%	35%	31%	26%	28%
Large (*n*)	6	6	10	8	1	12	50	28	31	49
%	7%	7%	11%	10%	2%	7%	16%	6%	5%	10%

Population trends. The annual average numbers of males per active lek has not changed significantly since 1957 (Figure 6A; Table A-1), but when summarized over 5 year periods there was a downward trend in the population (Table 1), and this pattern held true for all measures of lek activity. Statewide population trends for the assessment period (1980-2003;which incorporates 3 of 5 BLM areas) also indicated no significant change (Table A-1) but when summarized over 5 year periods, there was also a downward trend (Table 1). For 1993-2003 the data suggested a positive trend but again it was not a significant change in average number of males per lek. Size of leks (number of birds counted) varied over this period with no systematic trend (Table 2). Except for the 1955-59 interval, small leks comprised between 49-69%, medium leks 23-42%, and large leks were less than 16% of the leks counted over 5 year periods. The 1955-59 interval had the smallest and largest proportion of small (40%) and medium leks (53%), respectively. Annual rates of change based on lek data suggested large declines in populations during the late 1950s to early 1970s, and a fluctuating but stable trend from 1973 to 2003 (Figure 6B). These data also suggest that populations in Oregon during the late 1950s were possibly 2.5 times as large as they are today.

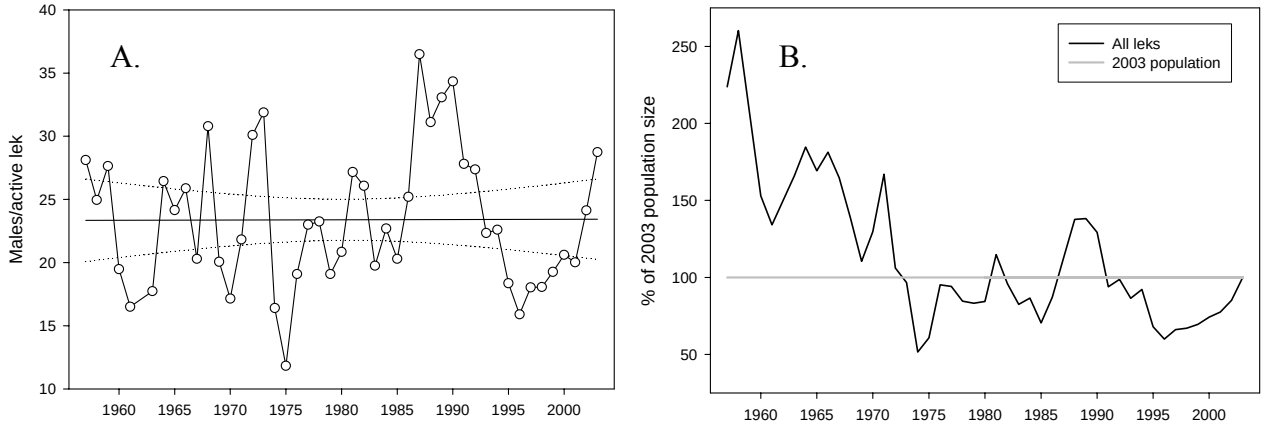

Figure 6. Statewide changes in lek size (males per active lek) (A), and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Oregon, 1957-2003.

Baker Resource Area

Monitoring efforts.—Baker County was the location of the first sage-grouse field study in Oregon (Batterson and Morse 1948) where 8 leks were monitored intensively between 1941-1948. However, systematic lek surveys were not initiated until 1993, and only 4 leks were counted until 1996 (Table 3). Fifty-one lek sites have been identified in this region and 80% were active, with 54-64% of leks classified as small, 34-46% as medium, and 0-1% as large (Table 4).

Table 3. Monitoring effort and population trends summarized over 5 year periods from 1995 to 2003 for Baker Resource Area and Vale District.

	Baker		Vale	
Variable	95-99	00-03	95-99	00-03[a]
Leks Counted	11.2	17.0	61.8	15.8
Leks Active	8.4	17.0	46.8	14.8
Males / lek	15.1	17.9	10.1	23.9
Males / active	21.6	17.9	12.9	25.5
Median / lek	13.1	15.0	5.8	17.8
Median / active	20.7	15.0	8.5	21.5

[a] The early years of monitoring effort in Vale were characterized by extensive helicopter searches. Once a set of trend leks was established the numbers of leks monitored decreased.

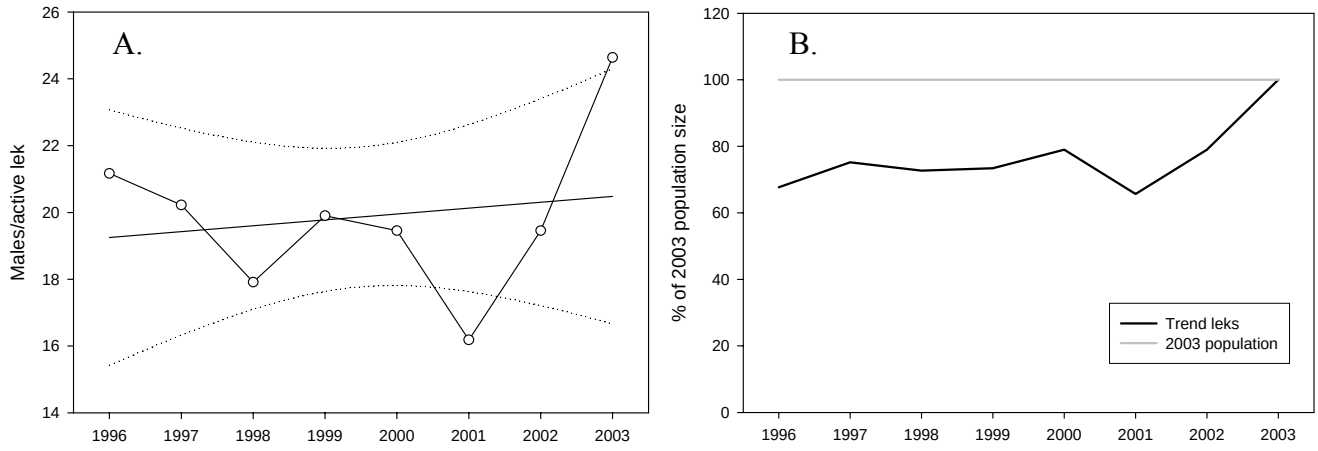

Figure 7. Changes in lek size (males per active lek) (A), and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Baker County Oregon, 1996-2003.

Population trends.—This Plan used the period from 1996-2003 as the assessment period, although it was difficult to draw many conclusions from this relatively short time period. The data suggested a positive trend but it a non-significant change in average number of males per lek (Figure 7A). Annual rates of change also indicated population increase over this period with previous populations an average of 73% of the 2003 population (Figure 7B).

Vale District

Monitoring effort.—Sage-grouse population monitoring has been sporadic in Vale district since the 1960s. Extensive helicopter surveys began in the late 1980s through the early 1990s and have identified over 250 lek sites. Status for many of these leks is currently unknown. Because systematic ground surveys began in 1993, this Plan used this as the beginning of the assessment period (Table 3). Fifteen leks were used to measure trend and 13 were currently active. Lek size varied over this period with small leks comprising 53-81%, medium leks 16-37%, and large leks 3-10% of counted leks (Table 4).

Table 4. Changes in lek size classified as small (<20), medium (20-49), and large leks (≥50) reported as numbers (*n*) and percent of column total, average over 5 year periods for Baker Resource Area, and Vale District.

	Baker		Vale	
Lek size	95-99	00-03	95-99	00-03
Small (*n*)	34	49	54	37
%	54%	64%	81%	53%
Medium (*n*)	45	33	19	27
%	46%	34%	16%	37%
Large (*n*)	6	6	8	1
%	0%	1%	3%	10%

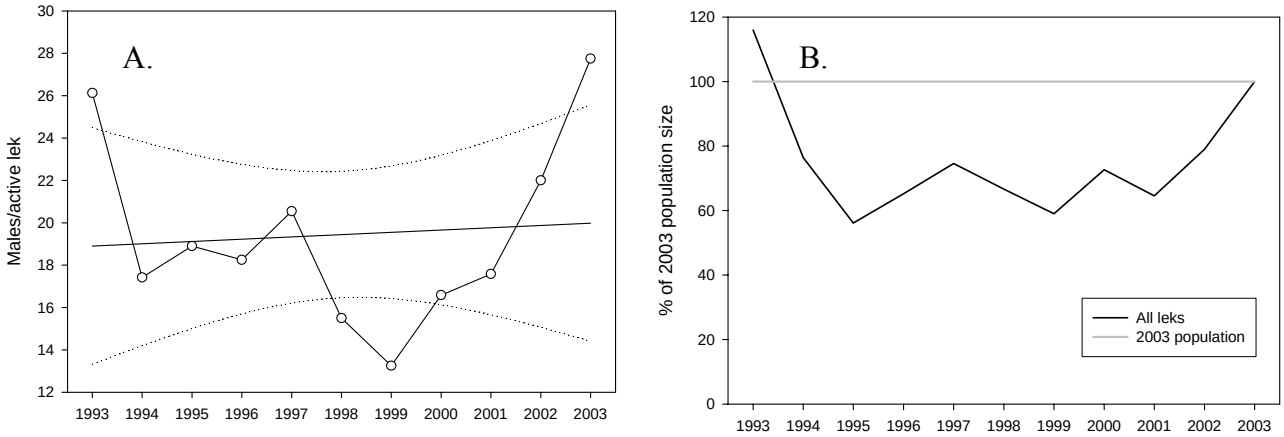

Figure 8. Changes in lek size (males per active lek) (A), and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Vale BLM District (Malheur County Oregon), 1993-2003.

Population trends.—Average males per lek declined from 1993-99 but has returned to pre-decline levels. The overall positive trend was not significant during the assessment period (Figure 8A). Annual rate of change suggested near recovery from the declines observed during the mid to late 1990s (Figure 8B), and was similar for both trend leks and all leks counted in successive years, although the former indicated a larger decline by 1999.

Burns District

Monitoring effort.— In the Burns District, ODFW has one of the longest running monitoring programs of sage-grouse leks. More than 100 leks have been identified, many of which are still active. Recent helicopter surveys have assisted in determining status of many remote leks as well as identifying new leks in sub-optimal habitats. Beginning in1981 ≥10 leks were monitored consistently, with 70% activity levels for those leks during the period (Table 5). The percentage of small leks has increased in recent years and was likely due to increased survey effort in peripheral habitat (Table 6). The percentage of medium size leks has decreased and large leks have fluctuated between 4-17% during this period.

Table 5. Monitoring effort and population trends summarized over 5 year periods from 1955 to 2003 for Burns District.

Variable	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Leks Counted	6.0	8.2	8.8	12.2	7.8	14.2	23.6	20.2	26	28.8
Leks Active	6.0	6.6	7.6	10.0	5.6	12.4	22.2	19.6	20.8	22.5
Males / lek	35.6	18.6	20.6	22.6	15.8	20.8	29.8	31.8	14.2	17.5
Males / active	35.6	23.0	23.3	28.1	22.0	23.7	31.8	32.8	16.5	21.9
Median / lek	38.6	17.1	11.7	12.4	11.5	15.5	23	22.9	9.8	10.6
Median/ active	38.6	26.3	14.4	15.2	21.9	18.3	24.2	23.2	12.2	14.3

Table 6. Changes in lek size classified as small (<20), medium (20-49), and large leks (≥50) reported as numbers (*n*) and percent of column total, average over 5 year periods for Burns District.

Lek size	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Small (*n*)	1	3	4	6	2.6	7	8	9	16	16
%	17%	39%	58%	64%	46%	52%	38%	47%	75%	72%
Med (*n*)	4	4	3	2	2.8	6	10	8	4	3
%	73%	61%	34%	22%	50%	41%	45%	42%	21%	13%
Large (*n*)	1	0	1	1	0.2	1	4	2	1	3
%	10%	0%	8%	14%	4%	7%	17%	11%	4%	14%

Population trends.—Males per lek fluctuated dramatically from 1981-2003 (Figure 9A). The peak of the population trend in the late 1980s and the decline of the mid 1990s were consistent with Lakeview (below), statewide trends, and to a lesser extent with Prineville (below). Populations in the Burns District have not recovered from the 1990s decline as overall trend was significantly down (Table A-1). However, it is likely that counts from 2004 will change this downward trend (ODFW unpublished data). Estimated population size from trend leks of the 1980s/early 1990s peak was 1.5-1.9 times of the 2003 population; however, the 2003 population has returned to pre-peak population sizes (Figure 9B). The general pattern in annual rates of change and males per lek were similar, the latter indicating how much of the population may have been lost due to the decline of the 1990s.

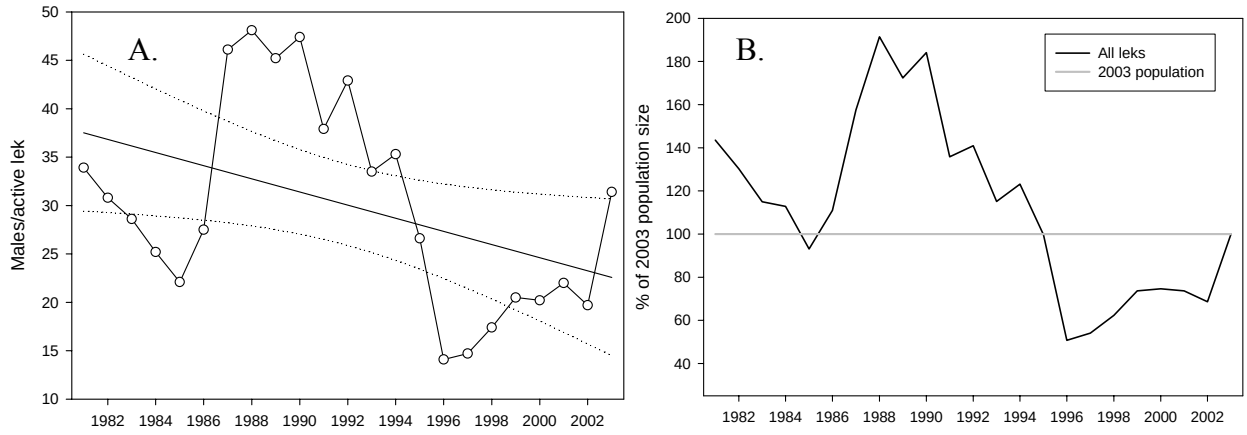

Figure 9. Changes in lek size (males per active lek) (A) and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Burns District, 1981-2003.

Lakeview District

Monitoring effort.— Hart Mountain National Antelope Refuge is within the Lakeview District and has had long term but inconsistent monitoring of sage-grouse leks. Over 150 leks have been identified in this region with most occurring in the southeastern portion of the District. Lek activity has been relatively high (74%) for those monitored during the assessment period (Table 7). Lek sizes have been relatively consistent during the 1981-2003 assessment period, with Lakeview having the largest average percentage (15%) of large leks. There were several large lek complexes in this region that contribute to this statistic (Table 8).

Table 7. Monitoring effort and population trends summarized over 5 year periods from 1955 to 2003 for Lakeview District.

Variable	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Leks Counted	2.6	7.0	6.2	5.0	2.8	23.2	20.0	19.8	28.8	73.5
Leks Active	2.6	6.8	4.2	3.8	1.4	11.2	14.2	16.8	25.0	56.5
Males / lek	--[a]	19.4	11.1	12.7	5.6	15.0	28.0	25.7	17.1	22.3
Males / active	--	19.8	14.3	--	--	21.6	38.1	31.0	19.8	29.2
Median / lek	--	17.0	6.0	6.6	5.2	8.8	14.6	15.0	13.2	12.13
Median / active	--	17.3	10.9	--	--	15.7	25.9	22.2	16.4	20.5

[a] Missing data or no counts made averaging over period not reliable.

Population trends.—As with Burns District, population trends have fluctuated markedly during the assessment period, with a peak in 1989 and lows in 1983 and 1996 (Figure 10A). As of 2003, the average males per lek (46.9) has recovered from the 1996 low and exceeded the 1988 pre-peak level (44.4 males per lek). The overall slightly negative trend was a non-significant for average number of males per lek during the assessment period. Previous population sizes were 1.2 to 1.4 times the 2003 estimate, most of which occurred during the late 1980s (Figure 10B). The Klamath Falls population had few birds at leks into the early 1990s and no sightings have been confirmed since 1993, despite annual survey efforts.

Table 8. Changes in lek size classified as small (<20), medium (20-49), and large leks (≥50) reported as numbers (*n*) and percent of column total, average over 5 year periods for Lakeview District.

Lek size	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Small (*n*)	1	4	3	3	1.0	7	6	9	14	27
%	46%	59%	76%	68%	71%	57%	41%	48%	58%	48%
Med (*n*)	1	2	1	1	0.4	4	4	7	9	19
%	46%	35%	14%	21%	29%	31%	31%	38%	37%	34%
Large (*n*)	0.2	0.4	0.4	0.4	0.0	1	4	3	1	10
%	8%	6%	10%	11%	0%	11%	28%	14%	6%	18%

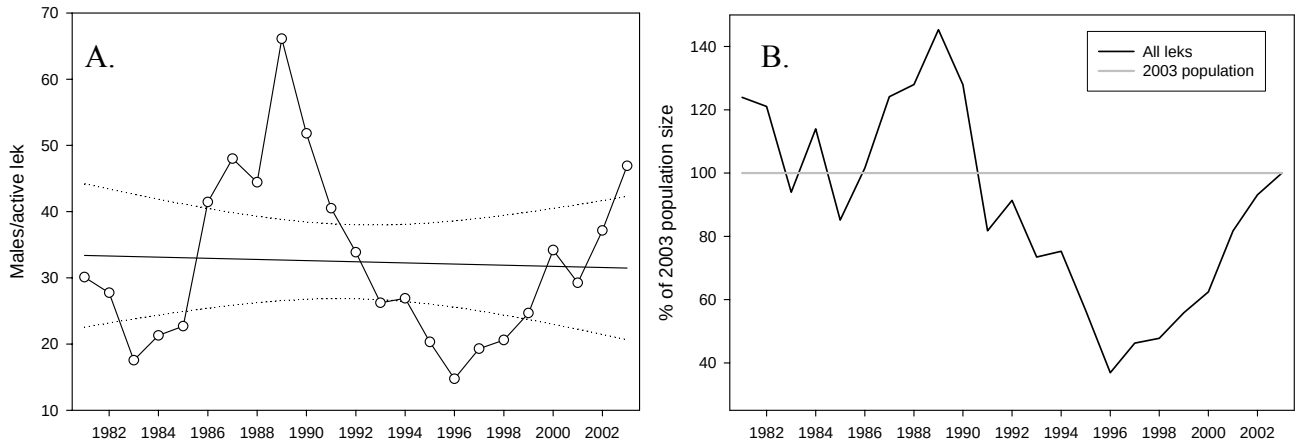

Figure 10. Changes in lek size (males per active lek) (A), and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Lakeview District, 1981-2003.

Prineville District

Monitoring effort.—Leks were first counted in 1949 in Prineville; however, <10 were monitored consistently during the 1950s and 1970s. Nearly 70 lek sites have been located in this region with approximately 50% of those active in 2003 (Table 9). The frequency of lek size classes has not changed appreciably over the assessment period (Table 10). Prineville consistently had the largest percentage (70%) of small leks.

Table 9. Monitoring effort and population trends summarized over 5 year periods from 1955 to 2003 for Prineville District.

Variable	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Leks Counted	6.6	5.2	5.4	5.4	6.6	11.0	17.6	25.8	37.4	50.75
Leks Active	6.4	4.8	5.2	4.4	4.2	7.0	14.6	21.4	31.8	38.5
Males / lek	26.1	--[a]	33.0	10.7	9.8	9.8	12.7	13.1	12.5	11.1
Males / active	26.7	--	34.4	12.8	15.7	15.6	15.7	15.7	14.7	14.6
Median / lek	25.2	--	27.8	6.8	8.1	6.1	8.7	10.4	11.1	7.5
Median / active	26.8	--	30.9	10.1	17.8	15.0	11.4	12.2	12.8	12.13

[a] Missing data or no counts made averaging over period not reliable.

Table 10. Changes in lek size classified as small (<20), medium (20-49), and large leks (≥50) reported as numbers (*n*) and percent of column total, average over 5 year periods for Prineville District.

Lek size	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	00-03
Small (*n*)	3	3	2	3	3.2	4	10	16	23	28
%	47%	63%	31%	73%	76%	67%	68%	69%	72%	73%
Medium (*n*)	2	1	2	1	1.0	2	4	7	9	10
%	34%	29%	46%	27%	24%	33%	30%	29%	27%	25%
Large (*n*)	1	0.4	1	0.0	0.0	0.0	0.2	0.4	0.2	1
%	19%	8%	23%	0%	0%	0%	1%	2%	1%	2%

Population trends.—There has been a negative but non-significant trend in males per lek during the assessment period (Figure 11A). The declining trend line is the most sustained of all districts. The Prineville population did not experience the peak of the late 1980s when compared to Burns or Lakeview and has steadily declined since that time. Although the data are not presented here, many of the declining leks in this region are located south of Highway 20, in Deschutes and northern Lake counties, while several leks north of Highway 20 in Crook County show stable trends during the assessment period. Annual rate of change (Figure 11B) analysis indicated a population in steady decline. However, since 2001 the population rate of change has remained fairly consistent. Populations of 1980 could have been 3.6 times as large as those of 2003. The change in population size since the peak of the late 1980s was similar to that of Lakeview and Burns districts, 1.5 to 1.7 times that of current the population size.

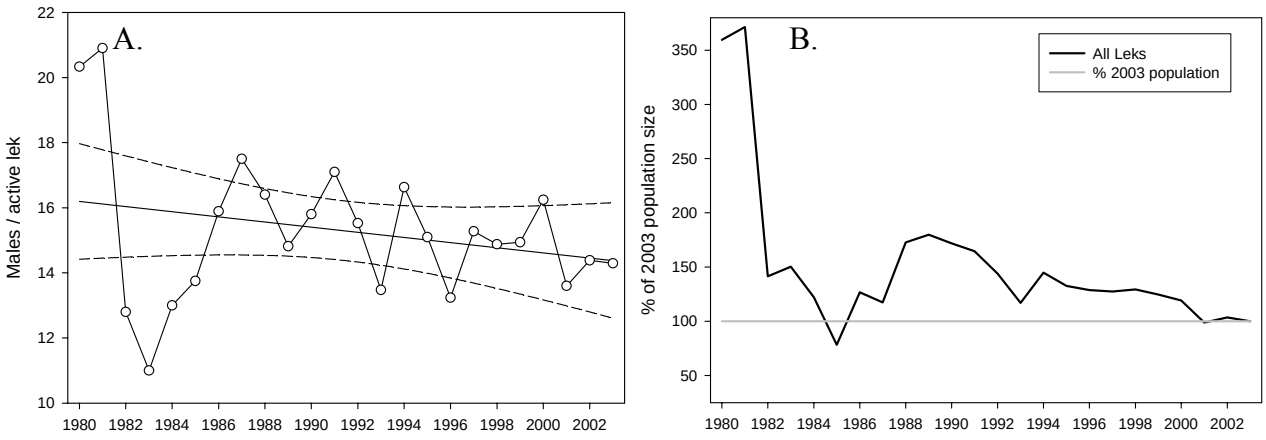

Figure 11. Changes in lek size (males per active lek) (A) and annual rates of change in population index (B) reported as a percentage of the 2003 sage-grouse population (gray line) for Prineville BLM District, 1980-2003.

2003 Estimated Population Size

The population estimate for Oregon sage-grouse was stratified by assessment areas, with the goal of minimizing variability that may occur relative to habitat condition and extraneous variables in these regions. Because only a sample of leks are monitored each year in Baker, Burns, Lakeview, Prineville, and Vale districts, assumptions were made about the number of leks currently active to estimate spring population size.

Based on the best available information, in spring of 2003 there were approximately 40,000 (34,393 to 45,268) sage-grouse in Oregon (Table 11; see Appendix III for calculations). Previous estimates of sage-grouse population size support these results (Willis et al. 1993, Braun 1998). Using 40,000 birds as baseline and the backwards projection from annual rates of change data (Figure 6A), the 2003 population estimate was compared with estimates from past. As of spring 1992, Willis et al. (1993) calculated 27,505 birds in Oregon; the annual rates of change indicated that 1992 was 98% of the 2003 baseline. Willis et al. (1993) was an underestimate, but >150 new leks have been identified since then and adjusting their estimate by total number of known leks provides an estimate of 40,269. Additionally, Braun (1998) estimated that Oregon had >20,000 sage-grouse in spring of 1998; the annual rates of change indicated that 1998 was 67% of the 2003 baseline, and likely within the range of this estimate (23,000-30,300) for that year. Some caution should be used when making inference from this estimate, because it is largely based on indices of population size, and the actual relationship between the indices and population size is unknown. Based on current knowledge of sage-grouse lek attendance and that not all leks have been identified in the state, it is likely that this estimate is conservative.

Table 11. Estimate of 2003 Oregon sage-grouse spring breeding population stratified by assessment area.

				Range of estimate	
District	Median males per lek	Mean males per lek	Active leks[a]	Low	High
Baker	19.0	24.6	40	2,706	3,503
Vale	30.0	32.6	141	15,059	16,364
Burns	16.5	27.3	84	4,934	8,164
Lakeview	20.5	31.1	135	9,852	14,947
Prineville	11.5	14.3	45	1,842	2,291
Total			445	34,393	45,268

[a] The proportion of active leks was determined differently for each district because of the variability in sampling and best available information on lek status. See text for calculations and assumptions.

CURRENT TREND AND STATUS IN PRODUCTION

Production is a critical stage in the life history of grouse and is often the population variable upon which harvest levels are established. Previous assessments of sage-grouse in Oregon indicated long-term declines in production (Crawford and Lutz 1985, Connelly and Braun 1997). Brood production surveys (brood routes) provide a measure of annual reproductive success and trend in sage-grouse productivity. However, Oregon is the only state that uses brood routes to estimate production and for setting harvest levels. Since 1951, brood routes were conducted yearly although continuity between regions within the state has varied. Generally, routes were conducted between mid-July and mid-August, depending on plant phenology and timing of the hatch. All birds observed were counted and data were summarized as birds per 16 km (10 miles). Birds were classified as male, female, juvenile, and unknown. Classification information was used to calculate chicks per female as well as other indices of population trend. Production routes were conducted in all BLM districts. However, there are no routes in Baker Resource Area, and Vale District estimates represent productivity primarily in Malheur County.

Wing-data from the harvest also can provide estimates of productivity through classification of hatch-year and adult birds. Oregon has used wing-data as an additional tool to assess productivity since 1982, however, without hunting seasons from 1985-1988 no wing data were collected in during these years. Moreover, improved methods for assessing age were implemented in 1993 making direct comparisons or trend analyses from the earlier period (1982-1992) problematic. Thus, all years (1982-2003) of wing-data were used qualitatively (Figure 12 A&B), and only 1993-2003 in were used in formal analyses.

Table 12. Summary of wildlife management units (MUs) incorporated into each assessment area for the purpose of analyzing sage-grouse productivity from wing-data in the harvests.

	BLM District Boundary		
Burns	Lakeview	Prineville	Vale
Juniper	Beatys Butte	Silvies	Beulah
Malheur River	Wagontire	Wagontire	Lookout Mountain
Silvies	Warner		Owyhee
Steens			Sumpter
			Whitehorse

Trends in productivity

An average of 1,006 km (629 miles) was traveled annually while conducting brood route surveys between 1957 and 2003. There was a significant decline in chicks per female over the long-term (Figure 12A). There was a 31% decline in the chick to female ratio from the long term average 2.02 to 1.39 for the 1980 to 2003 period. Despite, increasing productivity trends since 1983,

productivity has not reached 1977 levels. Wing-data from 1982 to 2003 also suggest an increasing trend (Figure 12B). Wing-data and brood route data were highly correlated from 1993 to 2003 and wing-data alone indicated significant (Appendix III: Table A-2) and increasing trend during this period (Table 13).

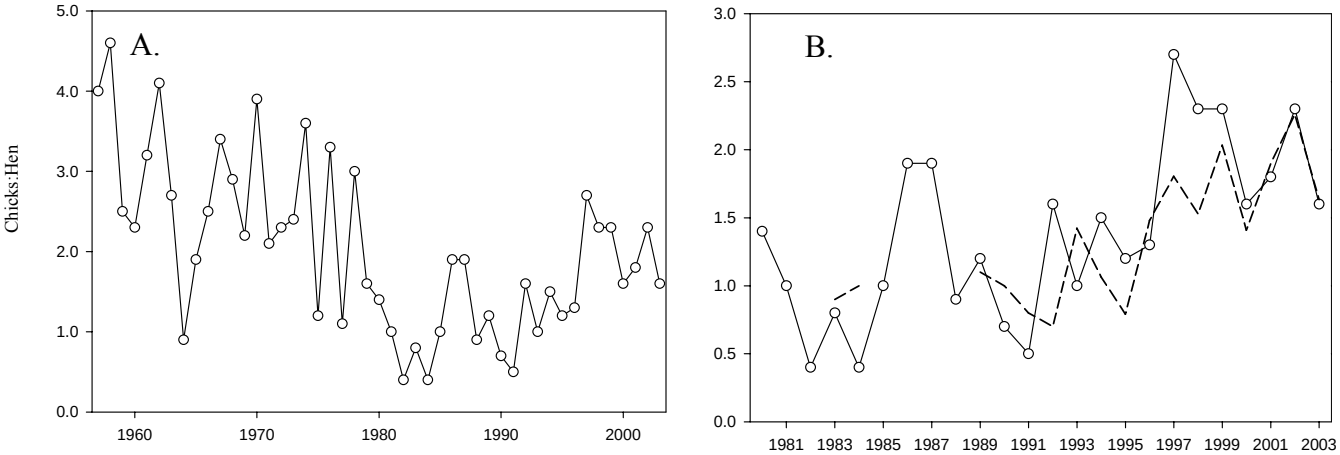

Figure 12. Sage-grouse productivity estimates (chicks per female) for the long-term (1957-2003) from brood routes (A) and for the assessment period (1980-2003) including brood routes (lines with open circles) and wing-data (dashed line) (B).

Wing-data indicated positive trends for all BLM districts but were significant only in Lakeview and nearly so for Vale (Table 13). Sample sizes were adequate for all districts and years except Prineville which generally had small sample sizes (<99) and should be viewed with caution. Statewide brood route data also supported the increasing trend in this district.

PRODUCTIVITY AND SPRING POPULATION SIZE

Monitoring trends in production and spring populations is an important aspect to regulating harvest in Oregon (Appendix I). However, surveys and statistics generated from those analyses also can provide methods for evaluating population response to management activities. The following paragraphs synthesize information from spring populations and productivity data and illustrate how these data might be used as response variables when measuring the impact of management actions on sage-grouse populations.

Productivity trends generally followed the annual rate of population change (Figure 13A), with an overall negative trend from 1957 to 1982, and steady increase from 1982 to 2003. The increasing trend is supported by the 2 independent measures of productivity (Figure 13B) and suggests that recent increases in production have contributed to the stable to increasing trend statewide. These data also are consistent with the hypothesis that declines through the 1980s was due in part to poor recruitment.

Table 13. Sage-grouse production index (chicks:hen ratio; C:H) and total number of wings (*n*) from fall harvest 1993 to 2003, and linear regression statistics (regressing C:H against year): coefficient of determination (r^2), *P-value*, and the slope parameter (β) and its standard error (SE). All regression analyses considered statistically significant at $P \leq 0.05$.

	Burns		Lakeview		Prineville		Vale		Statewide	
Year	*n*	C:H	*n*	C:H	*n*	C:H	*n*	C:H	*n*	C:H
1993	156	1.61	95	1.72	19	2.00	175	1.22	439	1.42
1994	272	0.90	199	0.81	47	0.90	262	1.46	764	1.07
1995	126	0.75	152	0.52	21	0.58	175	1.15	456	0.79
1996	156	1.25	133	1.63	33	1.67	204	1.59	493	1.48
1997	152	2.18	211	1.80	39	1.57	223	1.61	586	1.81
1998	117	0.78	163	2.51	56	1.45	186	1.48	466	1.53
1999	174	1.74	226	2.34	33	1.80	271	2.01	671	2.03
2000	142	1.76	182	1.30	53	1.11	260	1.35	592	1.41
2001	176	1.91	214	1.72	62	1.94	271	2.04	664	1.90
2002	185	1.92	203	3.00	39	2.18	260	2.08	648	2.26
2003	172	1.37	228	2.17	41	0.45	254	1.47	654	1.63
r^2		0.179		0.359		0.001		0.342		0.417
P-value		0.19		0.05		0.93		0.06		0.03
β (SE)	0.06 (0.05)		0.13 (0.06)		0.004 (0.06)		0.05 (0.03)		0.11 (0.04)	

Another important statistic from wing-data is the ratio of immature males to immature females in the harvest. This information can provide insight into habitat conditions relative to chick survival because the faster growth rates of male chicks requires a higher energy diet (Swenson 1986). Chick-male to chick-female ratios less than 1:1 may indicate relatively 'poor' habitat conditions in which male survival is compromised. Thus, the proportion of chick-males in fall harvest should indicate (predict) spring population trends.

Linear regression was used to examine the predictive capabilities of wing-data and brood route data of spring population trends. The scope of this analysis was limited to the 1993-2003 time period because survey and wing classification protocols were most consistent during this period. From the wing-data, chick-male:chick-female ratios (MF) and chicks:female (CF), and chicks:female from brood routes (BR) were examined as predictors of average males per lek in the following year.

Chick-male:chick-female ratio was the best predictor of males per lek in the following spring, chicks:female ratios from wing-data were the second best predictor of lek data (Table A-2). However, brood route data was a poor predictor of males per lek, despite a positive correlation between these variables. It was surmised that brood losses occurring between brood routes and harvest may weaken the correlation between brood route chicks:female and males the following spring.

These analyses indicate a strong relationship between the wing-data and males per lek. Thus, if wing-data are not available males per lek can provide an indirect measure of management actions on production.

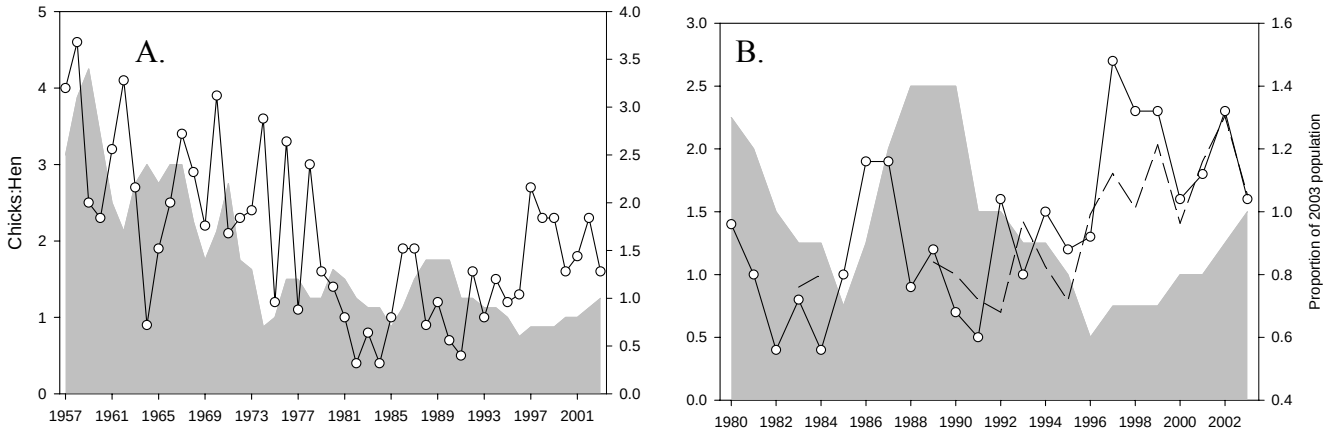

Figure 13. Changes in productivity from brood routes (line with open circles) with respect to annual rates of change in males counted at leks (gray filled area) for 1957-2003 (A). Chicks:hen ratios from brood routes (line with open circles) and wing-data (dashed black line) and annual rates of change in males counted at leks (gray filled area) for 1980-2003 (B).

POPULATION ASSESSMENT SUMMARY

Oregon sage-grouse numbers apparently have declined over the long-term (1957-2003). Reasons for these losses likely are the cumulative effects of habitat loss and degradation, changes in predator control methods, and increases in human disturbance. Because this variable was correlated with spring population trends, it is probable that these factors had the greatest effect on sage-grouse productivity. Statewide spring population trends were relatively stable for the assessment period (1980-2003) with population increases in most areas since the mid 1990s. There have been wide fluctuations in annual counts of males during the assessment period; such fluctuations may make it difficult to assess the impacts of future conservation actions. It is important that planning and evaluations account for this variation. A 5-year moving average of males per lek to assess population trends might be a practical guideline to use. The current population size and trend (1980-2003) provides a benchmark for maintaining and setting population objectives.

MANAGEMENT OBJECTIVES FOR POPULATIONS

POPULATION GOAL

In accordance with *Wildlife Policy* (ORS 496.012) the primary goal of this Plan is to restore, maintain, and enhance populations of sage-grouse such that multiple uses of populations and their habitats can continue. Regional and state population goals should be identified based on the best information available. Population management objectives for statewide and regional populations are as follows:

STATEWIDE POPULATION

Objective 1—Statewide: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 40,000 birds, until 2055.

Assumptions and Rationale

Since 1980 (and as early as 1974), statewide population size has fluctuated around the 2003 estimate. Therefore it is assumed that maintaining currently available habitat amounts and quality will sustain similar population size and distribution into the future.

Implementing the habitat enhancement and restoration guidelines in the Plan will contribute to the quality and total area of habitat over the long-term and will assist in maintaining or enhancing the abundance and distribution of sage-grouse in Oregon.

The annual percentage change was used in estimating population size relative to the 2003 population to establish thresholds for management actions.

Actions

1.1. Monitor population trends with both spring lek surveys and brood-routes, and in years with hunter harvests wing-data should also be summarized to evaluate productivity and population growth. See Appendix II for details on population monitoring.

1.2. Develop a more efficient method for estimating population size, especially for regions where only a sub-sample of leks can be monitored.

1.3. Until more refined methods can be established to estimate population size, a 5-year moving average of annual rates of change should be used to determine trend.

1.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

1.5. Because of natural fluctuations in populations it is anticipated for numbers to drop below the 2003 benchmark possibly by as much as 30%. If the statewide population estimate drops below 20,000 birds, federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population.

1.5a. Alternatively, populations have increased by nearly 30% and such growth (~50,000 birds) should not result in "no-action" management.

1.5b. Coordinate with land management entities to address land use issues that may be affecting populations.

1.5c. The Oregon Sage Grouse and Sagebrush Habitat Conservation Team will convene to address these issues and provide recommendations.

1.6. Monitor the geographic distribution of leks on a regional basis at 5 year intervals.

1.7. Develop methods for sub-sampling regions where not all leks can be counted during spring surveys to provide statistically valid trend and population estimates.

1.8. The primary goal of the Plan is to maintain or enhance current populations, however, efforts to restore populations to portions of historic range may be considered at some point in the future. Such actions will need to carefully consider long-term sustainability of a reintroduced sage-grouse population with respect to the connectivity and quality of sagebrush habitats (see Regional Conservation Measures Section).

REGIONAL POPULATIONS

Objective 2— Baker Resource Area: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 3,000 birds, until 2055.

Assumptions and Rationale

Lek count data is not continuous from 1941 to 2003, but the number of males counted on leks from 1941-48 ($n = 6$) has declined by 70% and of those ($n = 2$) that are still active today are down by 18%. Since systematic counts began in 1989, males/active lek have remained relatively constant.

Baker County supports smaller populations of sage-grouse than 20 years ago. Therefore it is assumed that maintaining currently available habitat amounts and quality will sustain a 2003 population size and distribution into the future.

It is unknown if there is movement (dispersal) of birds from sagebrush areas east of Interstate-84 to habitats in the southwest portion of the county. Without this knowledge it is difficult to determine if the Baker populations are "closed" to immigration from other populations. Immigration and emigration could have substantial impacts on population size and trend.

The population objective assumes the area east of Interstate-84 represents a closed population, and those near the Malheur County border are open populations (i.e., population size is regulated in part by immigration from populations North of Harper).

Actions

2.1. Monitor trends as described in Action 1.1.

2.2. Collect genetic and movement data to evaluate the potential for open or closed populations in this region.

2.3 Monitor distribution as described in Action 1.6.

2.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

2.5. Coordinate with land management entities to address land use issues that may be affecting populations.

Objective 3— Vale District (not including Baker): Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 16,000 birds, until 2055.

Assumptions and Rationale

Since 1993 population size has fluctuated around the 2003 estimate, however, because this region was the location for extensive sagebrush removal programs (1960s) it is likely that populations were significantly larger prior to those treatments. Because some of those treatments are returning to sagebrush habitat, they will assist in maintaining local populations.

Therefore it is assumed that maintaining currently available habitat amounts and quality will sustain a 2003 population size and distribution into the future.

Implementing the habitat enhancement and restoration guidelines in the Plan will contribute to the quality and total area of habitat over the long-term and will assist in maintaining or enhancing the abundance and distribution of sage-grouse in Vale District BLM.

There is potential for population trends to be influenced by management outside of Oregon. The extent to which management practices (i.e., population and habitat) influence shared populations with Idaho and Nevada is unknown.

Actions

3.1. Monitor trends as described in Action 1.1.

3.2. Collect movement data to evaluate connectivity with populations in Idaho and Nevada.

3.3 Monitor distribution as described in Action 1.6.

3.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

3.5. Coordinate with land management entities to address land use issues that may be affecting populations.

3.6. Identify lek complexes that could serve as source populations for intra- and interstate translocation projects.

Objective 4— Burns District: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 6,500 birds, until 2055.

Assumptions and Rationale

Since 1981 population size has fluctuated around the 2003 estimate. However, the 2003 population is likely smaller relative to earlier periods (1980 and earlier), but data are limited.

Therefore it is assumed that maintaining currently available habitat amounts and quality will sustain similar population size and distribution into the future.

Implementing the habitat enhancement and restoration guidelines in the Plan will contribute to the quality and total area of habitat over the long-term and will assist in maintaining or enhancing the abundance and distribution of sage-grouse in Burns District BLM.

There is potential for population trends to be influenced by management outside of Oregon. The extent to which management practices (i.e., population and habitat) influence shared populations with Nevada is unknown.

Actions

4.1. Monitor trends as described in Action 1.1.

4.2. Collect movement data to evaluate connectivity with populations in and Nevada.

4.3 Monitor distribution as described in Action 1.6.

4.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need

to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

4.5. Coordinate with land management entities to address land use issues that may be affecting populations.

4.6. Identify lek complexes that could serve as source populations for intra- and interstate translocation projects.

Objective 5— Lakeview District: Maintain or enhance sage-grouse numbers and distribution at the 2003 spring breeding population level, approximately 12,000 birds, until 2055.

Assumptions and Rationale

Since 1981 population size has fluctuated around the 2003 estimate. However, the 2003 population is likely smaller relative to earlier periods (1980 and earlier), but data are limited.

Therefore it is assumed that maintaining the amount of currently available habitat will sustain similar population size and distribution into the future.

Implementing the habitat enhancement and restoration guidelines in the Plan will contribute to the quality and total area of habitat over the long-term and will assist in maintaining or enhancing the abundance and distribution of sage-grouse in Lakeview District BLM.

There is potential for population trends to be influenced by management outside of Oregon. The extent to which management practices (i.e., population and habitat) influence shared populations with Nevada and California is unknown.

Actions

5.1. Monitor trends as described in Action 1.1.

5.2. Collect movement data to evaluate connectivity with populations in California and Nevada.

5.3 Monitor distribution as described in Action 1.6.

5.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

5.5. Coordinate with land management entities to address land use issues that may be affecting populations.

5.6. Identify lek complexes that could serve as source populations for intra- and interstate translocation projects.

5.7. Identify regions within the Klamath Basin that maybe suitable for reintroduction.

Objective 6— Prineville District: Restore sage-grouse numbers birds and distribution near the 1980 spring breeding population level, approximately 3,000 birds, until 2055.

Assumptions and Rationale

Since 1980, population size has declined steadily (average 2% annually). Identifying a sustainable population size based on historic populations is difficult, because of the declining trend. The population objective for this region is based on the apparent stability of Baker County birds (~3,000) and similar conditions in the Prineville region.

The causes for population declines in this region are unknown but could be related to genetic diversity, population isolation, land-use practices, recreation activities, and urban development.

Therefore this Plan assume that maintaining and/or increasing the amount of currently available habitat and increases in quality (enhancement and restoration) will assist in restoring populations and distributions in this region.

Implementing the habitat enhancement and restoration guidelines in the Plan will contribute to the quality and total area of habitat over the long-term and will assist in maintaining or enhancing the abundance and distribution of sage-grouse in Prineville District BLM.

Actions

6.1. Monitor trends as described in Action 1.1.

6.2. Collect genetic and movement data to evaluate the potential for open or closed populations in this region.

6.3 Monitor distribution as described in Action 1.6.

6.4. If the trend indicates an annual decline in a population of >7% for more than 3 consecutive years or a decline <7% for 5 or more consecutive years, then federal and state agencies will need to consider management actions to reverse the decline or at least stabilize the population, including, evaluating harvest levels on a unit by unit basis.

6.5. Coordinate with land management entities to address land-use issues that may be affecting populations.

6.6. Identify lek complexes that may require population augmentation through a translocation.

Section IV. SAGE-GROUSE HABITAT IN OREGON

Historical Distribution and Abundance

Pre-European settlement habitat of sage-grouse in Oregon encompassed 7.2 million ha (17.7 million acres) of sagebrush habitat throughout eastern Oregon (Figure 14). The conversion of sagebrush steppe to agricultural land in the Columbia Basin alone was responsible for an estimated 750,000 ha (1.5 million acre) loss of sage-grouse habitat, nearly all of which is currently in private ownership. It is highly unlikely that habitat or populations can be restored in the Columbia Basin given the ownership and land use practices of this region. Sage-grouse habitat has diminished by 21% compared to pre-settlement conditions. The current range (5.7-6.2 million ha or 14.0-15.0 million acres) is not contiguous because of natural and artificial factors. For example, Malheur National Wildlife Refuge is largely a wetland complex and contributes little to sage-grouse habitat, except the southeastern corner provides brood habitat. Similarly, the Alvord Desert region of Harney County is largely a salt-desert shrub community with large alkali flats that do not provide appropriate habitat. Additionally, wildfires and sagebrush conversion projects have reduced the amount of suitable habitat. The impacts of these disturbances will be discussed in greater detail in as they pertain to each BLM district. Although approximately 69,000 ha (171,000 acres) of potential habitat still exists in the Klamath Basin region and is included in the current range, there are no confirmed observations of sage-grouse since 1993.

Numerous activities have impacted and potentially continue to impact distribution and quality of sage-grouse habitat. Additionally, natural events and human response to these events may have a direct impact on both sage-grouse and their habitat. A discussion of these early impacts follows.

Agricultural conversion

Permanent conversion of sagebrush to agricultural lands is the single greatest cause of decline in sagebrush-steppe habitat in the Columbia Basin (Quigley and Arbelbide 1997). In the northern half of eastern Oregon, large areas of sagebrush-steppe habitat have been converted to agricultural lands (Wisdom et al. 2002). Although sage-grouse do use some agricultural lands (e.g., alfalfa) as late summer and late brood-rearing habitat, row crops and dryland cereal grains are generally not beneficial habitat (Swensen et al. 1987, Blus et al. 1989). In southeastern Oregon, most conversion occurred in the late 1800s to early 1900s, reached a threshold in the mid 1950s and has remained relatively unchanged since. However, the number of irrigated acres has increased slightly in some areas during this period (Figure 15).

Sagebrush Conversion

Prior to the 1980s, herbicide treatment of large tracts of land (primarily using 2,4-D) was a common method of reducing sagebrush (Braun 1987). In addition to the loss of sagebrush the use of 2,4-D resulted in the decline of forbs (Miller and Eddelman 2001). In many cases, broad herbicide treatment may have contributed to declines in sage-grouse breeding populations (Enyeart 1956, Higby 1969, Peterson 1970, Wallestad 1975). A Utah study suggests this adverse

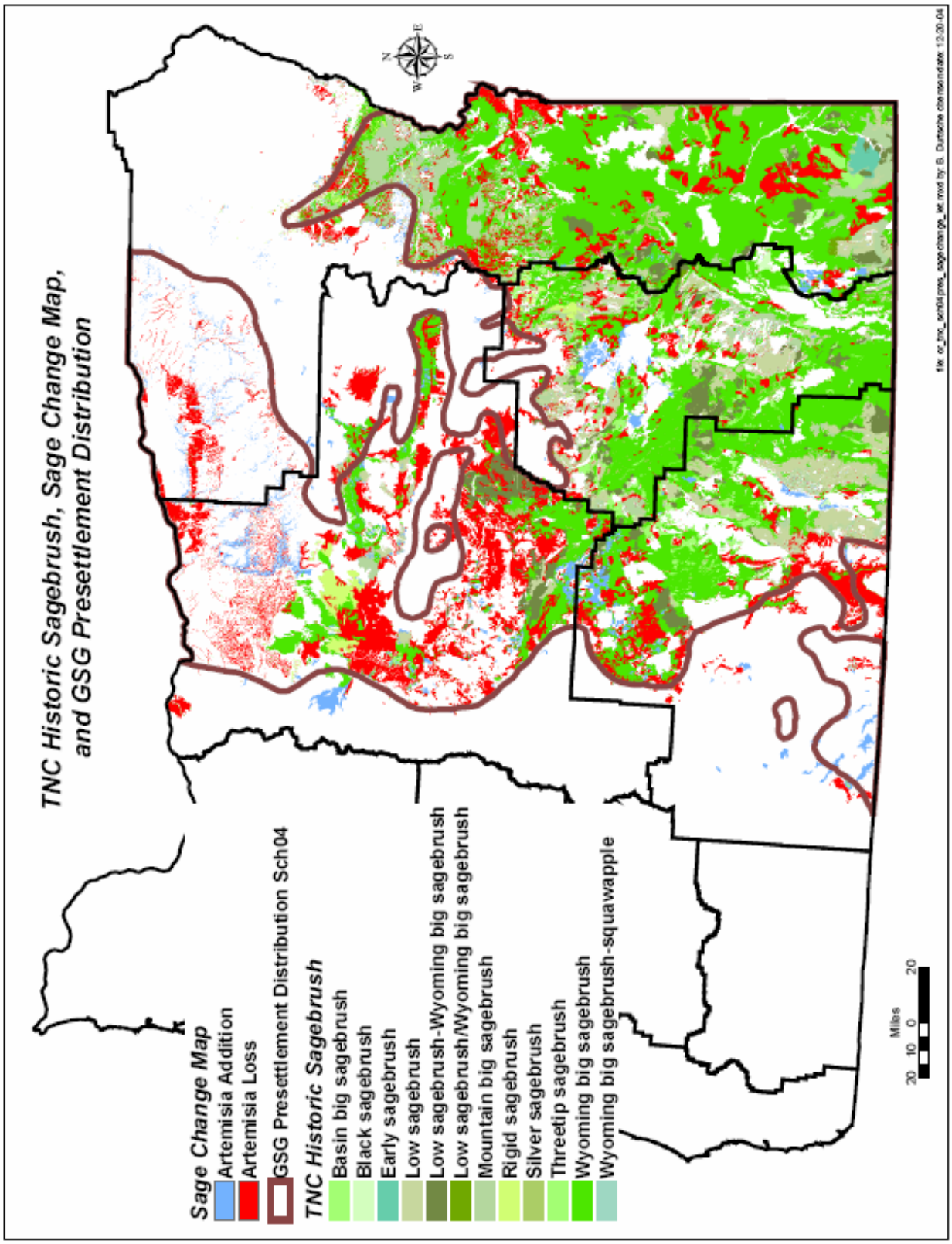

Figure 14. Changes in the distribution of sagebrush habitat in Oregon, where various shades of green indicate no change; red indicates loss, and light blue indicates gains of sagebrush (see website for color version).

impact on sage-grouse was compounded if the area was subsequently reseeded to crested wheatgrass (*Agropyron cristatum*) (Enyeart 1956). In Malheur County, for example, the Vale Project resulted in approximately 202,000 ha (500,000 ac) of sagebrush eradication projects for the benefit of livestock grazing (Willis et al. 1993). Approximately 50% of the treated area was reseeded with crested wheatgrass. Most of these treatments occurred on mild slopes in areas of deep soil which, based on current knowledge of sage-grouse, impacted breeding and winter habitats. While monocultures of crested wheatgrass may be detrimental to sage-grouse habitat use in the short-term, it can be highly effective in stabilizing an area and reducing the risk of invasive annuals (i.e., cheatgrass). Moreover, sagebrush has been documented to re-colonize some of these seedings and return to usable sage-grouse habitat over the past 30 years (B. Kindschy, BLM retired, personal communication).

Reduced application rates of some herbicides (e.g., Tebuthiuron) may result in a dramatic increase in forbs and perennial grasses while retaining some sagebrush cover (Olson and Whitson 2002). Such applications of Tebuthiuron have not been documented to benefit sage-grouse and need to be carefully planned such that they do not result in complete eradication of sagebrush.

Mechanical treatments (mowing, plowing, chaining) of sagebrush have generally been more "local" in nature, but these, too, have been known to adversely impact sage-grouse habitat if done on a broad scale (Swensen et al. 1987). Even small-scale projects to reduce sagebrush can be damaging if in the wrong location, for example, in winter habitat.

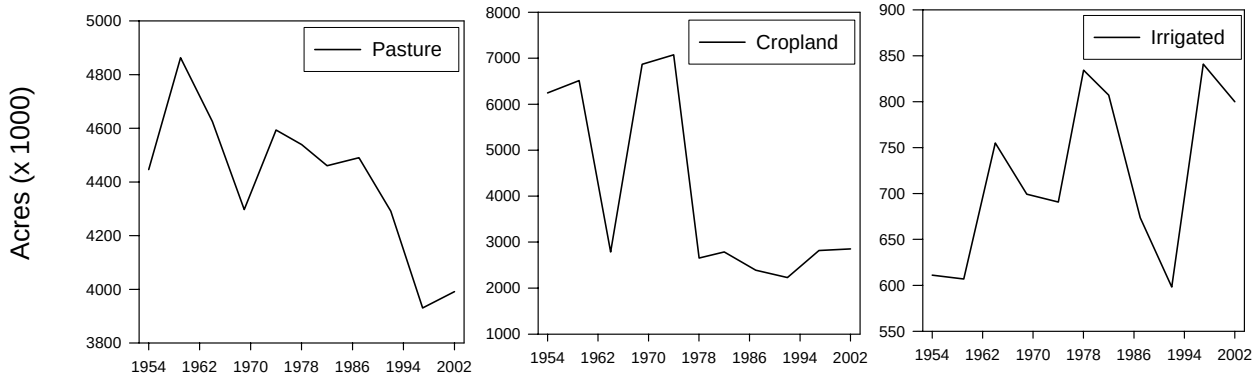

Figure 15. Changes in agricultural acreage for pasture land, cropland, and irrigated croplands, note the differences in scale on Acres (× 1000) axis. Change is calculated for sage-grouse counties in Oregon from 1954-2002 (USDA Agricultural Census data).

Grazing

A variety of livestock developments have altered sage-grouse habitat over the last century. Livestock facilities such as spring developments, water pipelines, and fencing have distributed livestock use over areas that were formerly only sporadically or lightly used. In many areas, excessive grazing has contributed to changes in plant community composition and structure and reduced certain habitat components which contribute to the health of sagebrush-steppe habitat (Mack and Thompson 1982, Wisdom et al. 2002).

Historical grazing practices.—Crawford et al. (2004: 10) provide a history of livestock grazing in sagebrush steppe, "Herbivory as a disturbance of sagebrush-dominated plant communities existed prior to the arrival of domestic livestock in sage-grouse habitat (Burkhardt 1996). However, the proliferation of domestic livestock in the latter 1800s represented a fundamental change in the diversity of dominant herbivores, and the timing, and selection pressures associated with herbivory (Miller et al. 1994). Historic grazing practices centered around season-long use with stocking rates far exceeding carrying capacity (Young and Sparks 1985). The net impact of these grazing practices on sagebrush-dominated plant communities was an increase in shrub abundance, a decrease in perennial grasses, and the proliferation of non-native annual grasses (Young et al. 1972, 1976). By 1900, cattle and sheep on western rangelands totaled over 30 million animals (Wagner 1978). Cattle and sheep AUM's on federal land have declined since the early 1900s (Council for Agricultural Science and Technology 1974, Laycock et al. 1996) and decreased more than 25% in the last 40 years (USDI-BLM 1990). Concurrent with reduced stocking of public rangelands has been measurable improvements in range condition during the latter half of the 1900s (Box 1990, Laycock et al. 1996)."

Recent grazing practices.—The effects of grazing on the structure and composition of sage-grouse habitat can be positive, negative, or neutral and will vary with timing and intensity of use and a host of environmental factors. A positive impact of livestock grazing on sage-grouse habitat might be increased brood use of moderately grazed areas – as opposed to non-grazed or heavily grazed areas. A neutral impact could be the maintenance of perennial bunchgrasses – i.e., as opposed to a reduction – with moderate levels of livestock utilization. A negative affect could be a reduction in residual perennial grass cover at nesting sites.

While moderate levels of livestock use (e.g., removal of 30% of current year's production by weight; Holocheck et al. 1999) are generally thought to be compatible with maintenance of perennial bunchgrass, the level of use which is sustainable varies strongly in accordance with a number of factors. Generally, cool season bunchgrasses present across much of the sage-grouse range are most vulnerable to the effects of defoliation in late spring and early summer. Excessive use during this time can reduce cover and vigor of perennial grasses and increase opportunity for invasion of undesirable species. Some grasses (e.g., Indian ricegrass [*Oryzopsis hymenoides*] or Sandberg blue grass [*Poa nevadensis sandbergii*]) tolerate high levels of use whereas other species are more sensitive to grazing (e.g., Idaho fescue [*Festuca idahoensis*] or Thurber needlegrass [*Stipa thurberiana*]). Drought can exacerbate adverse effects of livestock and wild horse grazing on vegetation and soils (Vallentine 1990). In some instances, failure to make timely adjustments in livestock use during drought has resulted in limited plant regrowth, overuse in wet meadows and riparian areas, and has negated gains in rangeland conditions made during higher-precipitation years (Thurow and Taylor 1999).

Few research efforts that have actually addressed the effects of livestock grazing on sage-grouse demography, and as a result, management and planning activities must rely on indirect evidence for guidance.

Riparian Areas/Wetlands

Riparian areas and wetlands (playas are included in wetland) within sage-grouse habitat have a long history of mismanagement. Stream channels and wetlands have been degraded, channelized, dredged and filled resulting in the loss of connectivity between the stream channels and the flood plains. This de-watering has led to site desiccation and a loss of associated riparian/wetland plant communities. Much of this mismanagement has been associated with commodity-driven land use (e.g., livestock grazing). Sage-grouse adults and chicks depend on high quality forage (e.g., forbs) in these riparian/wetland areas during the late growing season when upland communities have desiccated (Savage 1968, Oakleaf 1971, Crawford et al. 2004). Chick survival has been identified as one of the greatest limiting factors for sage-grouse populations. Research suggests that the earlier the transition to a fall/winter sagebrush diet (e.g., during drought years) the lower the survival of sage-grouse chicks (Drut et al. 1994). In effect, riparian/wetland areas help fill the dietary gap between a protein rich growing season diet of forbs and insects and winter diet dependent on sagebrush leaves.

Recreation

The impacts of recreational activity on sage-grouse habitat have been poorly documented in the literature. However, sage-grouse have been known to abandon lek sites frequented by birdwatchers and photographers who observe and photograph at distances not tolerated by displaying males or visiting females (Call 1979). Off highway vehicle (OHV) use may be detrimental to sage-grouse breeding or nesting activity if the timing and intensity of such use is inappropriate. Intensive off-trail OHV use may cause nest abandonment, if laying or incubating females are flushed from nesting locations. Previous work on sage-grouse indicates that it is one of the most sensitive grouse species with respect to abandoning a nest once disturbed (Patterson 1952).

Other Land Uses

Sagebrush habitats have been developed for renewable and non-renewable energy sources and associated infrastructure (e.g., powerlines, roads, transfer stations, etc,). Cause-effect relationships between sage-grouse and these features have not been documented with well designed experiments (Braun et al. 2002). However, observational studies of sage-grouse and related prairie grouse (*Tympanuchus* spp.) species provide a baseline indicating these types of human-caused change to landscapes can negatively impact habitat quality and ultimately productivity of local populations (Lyon and Anderson 2003, Connelly et al. 2004, Robel et al. 2004, Aldridge 2005, Pitman et al. 2005). Risk assessment models of nesting and brood rearing habitat indicated that set back distances (1-km radius) to anthropogenic features would protect <10% of these available habitat types (Aldridge 2005). Moreover, chick survival rates were lower for broods in closer proximity to these features but nest success was not impacted by this variable. Nest initiation rates were lower in areas classified as “disturbed” than “undisturbed” by oil and gas development (Lyon and Anderson 2003). Nest success was similar between these 2 groups, because fewer nests were available for producing young; recruitment was reduced as a consequence of these anthropogenic features. Interstate highways may also impact population growth rate (Connelly et al. 2004). The effects of distance to human-caused features (i.e., threshold models) have not been developed for

sage-grouse. However, appropriate reclamation of these disturbances can lead to suitable habitat in the future (Braun 1987). The initial effect may be large but not long lasting, and it is unclear if populations can reach pre-disturbance levels (Braun 1987).

DEFINING SAGE-GROUSE HABITAT USE

Sage-grouse use large landscapes often traveling over vast areas to fulfill various seasonal habitat requirements. They require specific vegetation types, and or structure to meet daily nutritional and protection needs. Sage-grouse are a multi-scale species that will require innovative approaches to management strategies and techniques. For the purposes of this document **broad-scale management** includes actions at the state or interstate level; BLM districts and/or planning areas within a district are considered **mid-scale;** pastures (allotments) are **fine scale**; and **site level** would include an ecological site (U.S. Department of Interior 2005). The integration of multi-scale management will be discussed, but the definitions of scale are pertinent to the material in the following paragraphs. This section describes some of the basic habitat requirements of Oregon sage-grouse and provides an assessment of habitat availability at the state (broad-scale) and BLM district scales (mid-scale).

Limitations to Vegetation Information

Vegetative characteristics of sage-grouse habitat have been described primarily from Hart Mountain National Antelope Refuge (HMNAR), Steens Mountain, and Beaty's Butte regions. However, additional work has been conducted by BLM in Deschutes and Crook counties (Hanf et al. 1994), and ODFW conducted a winter ecology study that included the areas of Jordan Valley, Jack Creek, and HMNAR (ODFW unpublished data). The following descriptions summarize vegetative characteristics of nesting, brood-rearing and winter habitats in Oregon. Lekking habitats were excluded primarily because lek sites are not limiting to populations and the descriptions in Section- II also pertain to Oregon. Most vegetation measurements and characterizations have been stratified by sagebrush community type, which is important when comparing to other states or to established guidelines (Connelly et al. 2000b).

Recently the Western Association of Fish and Wildlife Agencies guidelines (Connelly et al. 2000b) have garnered debate as to the appropriate scale at which they should be applied. It would appear that the guidelines were developed for patch scales but monitoring and evaluation techniques are often conducted at the community scale (Bates et al. 2004, Schultz 2004). There is a limitation: the sub-sampling scheme around nest sites (e.g., perpendicular 10 m [32.8 ft] transects centered over the nesting shrub) may reflect an accurate assessment of canopy cover at the nest site. The nest site scale (i.e., patch scale) may overestimate shrub cover relative to measurements at larger scales (e.g., community scale), making it difficult to use cover values generated at the nest site to imply appropriate cover values at larger scales (Hagen 1999, Bates et al. 2004). The implication is that allotment and pasture estimates would be similarly affected. Bates et al. (2004) also report highly variable estimates of shrub, forb, and grass cover in relatively non-disturbed Wyoming sagebrush communities, suggesting that managing for an average cover at a 10 m scale may be inherently difficult. In an attempt to alleviate some of these problems the data for Oregon studies are summarized by "nesting area" (as opposed to nest site or nest shrub) which is the vegetation <u>outside</u> a 3 m^2 (32.3 ft^2) area around the nesting shrub (Gregg 1991, Hanf et al. 1994).

This does not alleviate the problem of over-estimation by perpendicular transects entirely but, removes the core of redundant sampling at the nest site, and describes the vegetation at a slightly larger scale.

General Description

Call and Maser (1985) summarized characteristics of quality sage-grouse habitat in Oregon as sagebrush steppe at elevations of 1,220 to 2,438 m (4,000 to 8,000 ft) with annual precipitation of 25 to 38 cm (10 to16 in) and rolling topography with slopes generally less than 30%. Altitudinal migrations by sage-grouse have been documented in Oregon (Batterson and Morse 1948). Such movements occur as herbaceous plants of lower elevations desiccate in late spring and grouse move from the valleys and into the mountains. Call and Maser (1985) indicated that grouse likely occur in sagebrush areas outside of the documented elevation and precipitation gradients but sage-grouse numbers were lower in these sub-optimal conditions.

Nesting

Sage-grouse nest in a variety of cover types, but most nests are under big sagebrush. Other shrubs used for nesting cover include bitterbrush, greasewood (*Sarcobatus vermiculatus*), horsebrush (*Tetradymia* spp.), low sagebrush, mountain mahogany (*Cercocarpus* spp.), rabbitbrush, shadscale saltbush (*Atriplex confertifolia*), snowberry, and western juniper (*J. occidentalis*). Nests also have been found on bare ground devoid of cover under basin wildrye (*Elymus cinereus*). The most suitable nesting habitat includes a mosaic of sagebrush with horizontal and vertical structural diversity. A healthy understory of native grasses and forbs provides 1) cover for concealment of the nest and female from predators, 2) herbaceous forage for pre-laying and nesting females, and 3) insects as prey for chicks and females.

Nest area vegetation cover was comparable to other studies throughout sage-grouse range (Table 14) and mid-sized shrubs (40-80 cm) generally comprised >13% canopy cover with the exception of low sagebrush stands. Low sagebrush stands had shrub canopy cover >25% but was lower in stature (<40 cm). Combined grass and forb cover were >16% and in most cases >19%, however the vertical structure of herbaceous cover was not measured in most studies. Mountian big sagebrush (MBS) tended to have greater mid-shrub and herbaceous cover than low sage (LS) or Wyoming big sagebrush (WBS) stands.

Table 14. Summary of Oregon sage-grouse nest site vegetation stratified by study area and sagebrush stand type: LS = low sagebrush, MBS = mountain big sagebrush, mountain shrub, MXD = mixed shrubs, WBS = Wyoming big sagebrush, and ALL = stand types not differentiated in study. All values reported are canopy coverage estimates (%).

			Canopy Cover of Vegetation Type (%)			
Study Area[a]	Sage-type	*n* (# nests)	Low shrub (<40 cm)	Mid shrub (40-80 cm)[d]	Tall grass (>18cm)[e]	Key forbs[e]
Beatys	LS	8	26.4	2.9	8.1	3.6
	MBS	6	12.6	17.8	17.4	3.2
HMNAR	LS	7	16.0	5.0	17.0	7.0
	MBS	27	13.0	18.0	12.0	11.0
	MS	5	12.0	12.0	19.0	10.0
Jackass	LS	19	29.0	2.0	9.0	10.0
	MXD	12	19.0	7.0	11.0	6.0
	WBS	19	7.0	13.0[d]	14.0	11.0
Prineville	ALL	20	9.0	11.0	17.0	4.0
Pooled[b]	LS	34	25.7	2.8	10.7	9.0
	MBS	33	12.9	18.0	13.1	11.1
	OTH[c]	69	11.5	13.5	14.2	8.7

[a] The study areas statistics come from the following sites: Beatys = Crawford and Carver (2000), HMNAR (Hart Mt. National Antelope Refuge) and Jackass = Gregg (1991), and Prineville = Hanf et al. (1994).
[b] Pooled estimates are a weighted mean within a habitat type.
[c] OTH = a weighted mean across all habitats except for low sage.
[d] Tall shrub category was excluded because in most studies it was ≤4%, and was 4% at Jackass Creek.
[e] Canopy cover was only differentiated between grass stature and forb type in Crawford and Carver (2000), all other estimates are total canopy cover of grasses and forbs.

Brood-rearing

Female sage-grouse with broods seek out mesic sites for foraging especially later in the season as lower elevation sites begin to desiccate. Brood-rearing habitat in Oregon typically has >15% forb cover (Table 15). Studies have differentiated between "key forbs" and "non-key forbs" with the latter typically comprising most of the forb cover. Low and mid-shrub cover was slightly less in brood areas than in nesting areas (Tables 14&15), but typically was > 11%. However, there was less total shrub cover at brood areas (25%) than nest areas (33%) in mountain big sagebrush stands (Gregg 1991, Drut 1992, Hanf et al. 1994, Crawford and Carver 2000).

Table 15. Summary of canopy cover estimates for sage-grouse brood rearing habitats in Oregon. The data are stratified by study area, brood rearing stages early (≤6 weeks post hatch) and late (7 to 12 weeks post-hatch), and by sagebrush stand type: LSBB = low sage blue-bunch wheatgrass, LSBF = low sage fescue, LS = low sage, MXD =mixed shrubs, WBS = Wyoming big sage, and MBS = mountain big sage. All values reported are canopy coverage estimates (%).

			Canopy cover estimates (%)				
Brood stage / area[b]	Stand type	*n*	Key Forbs	Non-key Forbs	Short Grass[a]	Low shrub (<40 cm)	Mid shrub (40-80 cm)
Early							
HMNAR	LSBB	14	2.0	7.0	10.0	21.0	0.0
	LSBF	46	3.0	12.0	16.0	22.0	0.0
	MBS	27	3.0	14.0	15.0	18.0	9.0
Jackass	LSBB	44	7.0	14.0	8.0	25.0	1.0
	MXD	23	5.0	14.0	9.0	21.0	6.0
	WBS	16	1.0	10.0	10.0	5.0	15.0
Late							
HMNAR	LSBF	15	4.0	19.0	17.0	19.0	0.0
	MBS	21	4.0	19.0	16.0	17.0	14.0
Jackass	LSBB	7	1.0	3.0	3.0	36.0	0.0
	MXD	7	5.0	12.0	9.0	13.0	12.0
	WBS	18	3.0	9.0	11.0	5.0	14.0
All							
Beatys	LS	42	4.6	9.6	13.8	13.0	0.4
	MBS	42	4.6	8.2	11.1	3.2	17.7
Pooled[c]	LS	124	5.9	15.9	16.8	28.1	0.5
	MBS	90	4.0	12.5	13.4	10.9	14.2
	OTH	154	3.8	12.0	11.9	11.2	13.0

[a] Height of grass was differentiated only in the Beatys study area.
[b] HMNAR (Hart Mountian National Antelope Refuge) and Jackass data came from Drut (1992), and Beatys from Crawford and Carver (2000).
[c] Pooled estimates were calculated as a weighted mean within a stand type, OTH = all types except for low sage stands.

Winter

Shrub cover can be relatively sparse in winter habitats (Table 16). However, extreme winter habitat use has been documented with radiomarked birds only once in Oregon (1992-93), and winter use sites that year had the greatest shrub canopy cover (Hanf et al. 1994). Typically shrub cover and height is not limiting in winter habitat except for years of greater than average snowfall. Shrub cover values and heights in Oregon are similar to those found elsewhere, except perhaps for the usage of low sagebrush types with canopy cover <10%.

Table 16. Sagebrush canopy coverage (%) and height (cm) at sage-grouse winter use sites in Oregon. Data are stratified by sagebrush stand type: BSB = big sagebrush, SSB = silver sagebrush, LS = low sage, LSMX = low sage and mixed shrub, Mosaic = low sagebrush with inclusions of big sagebrush, CRWS = crested-wheatgrass seeding, and grassland = native grassland.

	Study Areas[a]						
	HMNR		Jackass		Jordan Valley		Prine-ville[b]
Stand type	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover
BSB	8.7	46	10.2	57.4	5.0	54.1	15.5
SSB	ND	ND	ND	ND	ND	ND	17.0[c]
LS	7.2	27.6	8.5	24.2	4.8	30	12.5
LSMX	7.1	24.3	6.2	27.1	3.5	33.5	ND
Mosiac	6.9	28.7	9.1	36.8	6.4	43.4	ND
CRWS	ND	ND	ND	ND	3.1	34.6	ND
Grassland	ND	ND	ND	ND	ND	ND	4.0[c]

[a] HMNR (Hart Mountain National Antelope Refuge), Jackass and Jordan Valley measurements were from Willis (1999), and Prineville data from Hanf et al. (1994).
[b] Shrub height was not recorded by Hanf et al. (1994).
[c] SSB and grassland were used only during the mild winter of 1991-92, BSB and LS were averaged across the 2 winters only differing by 1 percentage point.

BROAD AND MID-SCALE HABITAT ASSESSMENTS

The objectives of this assessment are 4-fold: 1) describe the change in sagebrush habitats from the late 1800s to present, 2) provide descriptive statistics as to the landcover types in sage-grouse habitat, 3) examine the cumulative effects of fire, seedings, juniper, agriculture, and natural variability that may compromise the continuity of sage-grouse habitat, 4) and evaluate the risks and opportunities for habitat conservation in Oregon based on land ownership and habitat type. Following the *Population Status* section these assessment units for habitat availability were based on BLM District boundaries.

Changes in Sage-Grouse Habitat

Historic and current sagebrush habitat maps were developed using geographic information system (GIS) data and analyses. Historic sagebrush habitats were determined from The Oregon Natural Heritage Program's Pre-settlement Vegetation Map (Tobalske 2002). This map was largely based on Land Surveyors notes from the mid- to late 1800s, and supplemented with current soils information. Any vegetation type that included an *Artemisia* spp. was considered as historic sage-grouse habitat. Current sagebrush habitat was from the USGS coverage referred to as SAGESTICH, which is a comprehensive GIS database covering most of the western states that have sage-grouse populations. The historic vegetation map was subtracted from the current map and the difference indicates changes in sagebrush habitat over time (Figure 14). Juniper expansion was estimated by comparing Tobalske's (2002) historic vegetation map and Oregon GAP land cover.

The assessment of current conditions for the state (broad-scale) and BLM districts (mid-scale) was conducted using a composite data set. This included combining the 1991 National Land Cover Data (NLCD) with the SAGESTICH coverage. Briefly, NLCD has finer resolution (30 m) than SAGESTICH (90 m), but the latter has greater detail with respect to vegetation types. For example, NLCD only identifies shrubland whereas SAGESTICH classifies the type of shrubland vegetation (e.g., sagebrush vs. rabbitbrush). The combination of the 2 resulted in a more detailed map. Additional layers were acquired from Oregon BLM that identified recent fires (>1980) and grass seedings (primarily crested wheatgrass) in Oregon. Based on this analysis current habitat status was delineated as follows:

1) Sagebrush,

2) Potential habitat,

3) Agriculture, and

4) Non-habitat.

Sagebrush includes all subspecies of *Artemisia* spp. that occur in Oregon. *Potential habitats* are recognized as sites that currently are *potentially* useful to sage-grouse but the extent of which is unknown, or sites that have been disturbed by various treatments (natural or artificial) and there is *potential* for a transition from its current state to sagebrush. While most *agriculture* is in private ownership and much of it might be considered "non-habitat" acres for this category were provided separately as there may be opportunities for partnerships with private landowners and NRCS (and Farm Bill funded projects) in the future. *Non-habitat* includes areas both naturally and artificially (and likely permanently) not suitable.

Potential habitats are sub-classified as *habitats* that are *potentially* useful to sage-grouse but the extent of which is unknown and include

- Sagebrush/wetland mix,
- Sagebrush/hay mix, and
- Other shrub

or *habitats* that have *potential* to transition from a disturbance (natural or human-caused) to sagebrush include,

- Grassland,
- Sage/juniper mix,
- Fire, and

- Seedings.

ANALYSIS OF CUMULATIVE EFFECTS

The long-term decline of sage-grouse is likely a result of the cumulative impact of several previously identified risks. The objective of this analysis is to quantify the amount of remaining habitat and the extent of connectedness (or fragmentation) with respect to cumulative impacts of disturbances. The approach uses a GIS to identify vulnerable and intact habitat regions, based on landscape level assessments (e.g., habitat patch size, connectivity) of cumulative effects of habitat modifications and human-caused disturbance (e.g., power lines, roads) and the resulting map is referred to as a connectivity model. In this context, the term "model" was used as a description of the sagebrush system that accounts for its known habitat characteristics. Thus, at this stage future status of habitats was not projected or predicted with these models, although that may be an appropriate use (e.g., land-use or fire planning). The maps generated from this model visually and quantitatively depict areas of vulnerable and intact habitats. These maps will be useful for developing population and habitat objectives at state and local levels, as well as the type(s) of management actions that may be appropriate for a given area.

It is important to understand that connectivity maps DO NOT describe the habitat condition with respect to understory structure and composition of habitat blocks. Identifying these factors will be of importance to management and implementation groups, and likely would be an identified need in monitoring habitat (Appendix II). The habitat monitoring described will facilitate and complement this need in local areas on public lands.

Methods

Development of the connectivity model (map) requires 3 basic steps: 1) develop a baseline of current habitat status (referred to as habitat capability model), 2) estimate the amount of disturbance on the landscape from human developments (referred to as disturbance model), and 3) combining the 2 layers yields a connectivity model. Model validation will be conducted in the field by recording the dominant cover type, using Global Positioning Systems (GPS) and photographs at random locations.

GIS and satellite imagery data was used from the *Changes in Sage-Grouse Habitat* (NLCD and SAGESTICH) and Oregon BLM fire maps as a baseline of current habitat capability (Appendix IV). Habitat capability was defined and ranked most to least capable of supporting sage-grouse from 1 to 4, respectively, based on 160 acre units. Within each 160 acre unit, the dominant cover type (>50%) determined the overall viability. For continuity the terms *sagebrush, potential and non-habitat* were used in conjunction with this analysis. *Sagebrush* habitats were ranked 1 (the highest), *potential habitat* was ranked 2, non-sagebrush shrublands and grasslands, all other native vegetation (comprised of both *potential* and *non-habitat*) were ranked 3, and *non-habitat*s (including bare rock, alkaline flats, and agriculture) were ranked 4, as least capable of supporting grouse. Each ranking was referred to as a level of *viability.*

- **High Viability** refers to areas of intact *sagebrush* habitat

- **Moderate Viability** refers to areas of *potential* sagebrush habitat

- **Low Viability** typically refers to native vegetation that is not likely sage-grouse habitat (e.g., forest types)

- **Negligible Viability** refers to habitat converted to agriculture or urban developments, and natural features such as bare ground or rock cliffs

The second step in this process is to delineate a disturbance model layer. This is comprised of roads, power lines, and urban or rural industrial developments; these disturbances downgraded otherwise viable habitat to negligible viability.

The synthesis of these two models reveals a broad- and mid-scale depiction of sagebrush and non-sagebrush areas throughout sage-grouse range in Oregon. A land status coverage was used to describe ownership and management of sage-grouse habitats in the state.

Products

The resulting maps identify sets of priority areas with respect to maintenance of high (rank of 1) or moderate viability (enhancement areas; ranked = 2 or 3) areas across the state (broad-scale) and for each BLM District boundary (mid-scale). This will facilitate management of core sagebrush areas that cross administrative boundaries. Tabular data for each map included amounts of landcover types within each habitat block and its ownership composition. Methods for maintaining or enhancing a particular region will be determined by the local implementation group, however, some ideas are provided as to how this might be achieved (Section V).

REGULATORY LIMITATIONS

Regulatory limitations and land acquisitions/disposals occurring within a district were described. Much of this information was derived from a data request from BLM by ODFW, where specific information regarding protection of sage-grouse habitats was requested. The basic question was: Does the land use plan, amendment, or other programmatic guidance (i.e., condition of approval or other mitigative measure) contain a stipulation or other provision that provides benefits to sage-grouse habitat? The specific stipulations referred to were a “no surface occupancy,” “controlled surface use,” “prohibited use or timing restriction” (with respect to nesting and wintering seasons), and “noise limitation.” These stipulations were reported as total area of occupied habitat, area around lek sites, and indicated to which programs they were applied. It is important to note that not all acres reported applied to all programs. Moreover these data were reported by Planning Areas within a district and the acreages are not necessarily distributed evenly among them.

CURRENT TRENDS AND STATUS OF SAGEBRUSH HABITAT

Statewide Ownership and Management

Sagebrush habitats have been reduced by 21% in Oregon from the late 1800s (Table 17) most of which occurred in the north-central region of the potential historic habitat range (Figure 14).

Because this estimate was based on vegetation type instead of a coarse-grained range map, it is somewhat lower than previous calculations of 50% and 33% by Crawford and Lutz (1985) and Willis et al. (1993), respectively, The BLM is the primary land manager and administers most of the currently occupied sage-grouse habitat (70%) followed by private ownership (21%). Oregon Department of State Lands (DSL), U.S. Forest Service, and U.S. Fish and Wildlife Service combined these agencies have jurisdiction for 8% of the current habitat (Table A-3). Other federal and state agencies land management comprised <1% of the current habitat. Clearly management activities on BLM land will have the largest impact on sage-grouse based on land area alone.

Table 17. Historic and current habitat (acres) of sage-grouse in Oregon as determined from The Nature Conservancy and Oregon Natural Heritage Program (2002) map of historic vegetation. Current sagebrush habitat was determined from the SAGESTICH map of Oregon.

Status	Assessment Area					
	Baker[a]	Burns	Lakeview	Prineville	Vale[b]	Total
Acres						
Historic	934,374	3,898,174	3,533,586	3,417,371	5,878,473	17,661,978
Current	771,134	3,554,844	2,935,542	1,798,738	4,917,529	13,977,787
Loss	163,240	343,330	598,044	1,618,633	960,944	3,684,191
% Change	–17.4	–8.8	–16.9	–47.4	–16.3	–20.9

[a] Includes sagebrush only within Baker County.
[b] Includes sagebrush in all areas of Vale District BLM Boundary except for Baker County.

Habitat Connectivity

There were 3.7 million ha (9.2 million acres) classified as high viability in Oregon (Table A-4), 2.6 milion ha (6.5 million acres) of which was administered by the BLM. An assessment of habitat connectivity using only those high viability habitat blocks that were >1,000 ha (2,500 acres) identified several "core areas" of contiguous habitat (Figure 16). The 2 largest areas depicted in this map encompass >2.4 million ha (6.0 million acres). Despite the vast area of sagebrush these regions cover, several areas within these remain contiguous only because of small and tenuous corridors. Both human-caused and natural barriers in Burns District BLM separate these 2 contiguous areas. From the statewide scale, it is evident that the Baker Resource Area birds are likely isolated from the population in northern Malheur County. A number of sagebrush areas >1,000 ha (2,500 acres) were identified in Jefferson and Wasco counties and Warm Springs Indian Reservation. These areas are currently isolated and sage-grouse have not been found in this region for many years (Crawford and Lutz 1985). Alternatively, most habitat blocks in the Klamath Falls region were ranked as moderate viability despite having active leks in early 1990s.

Natural and Anthropogenic Disturbances

Statewide, conversion from sagebrush to non-sagebrush types was due primarily to fire (259,201 ha [640,496 acres]) and non-native seedings (120,247 ha [297,135 acres]) (Table 18). Some of

these areas have not been lost ecologically but are in a transitory state and likely will return to sagebrush habitat. Many of these acres likely were converted to grassland as a result of recent fires, and it will be several years before they return to sage-grouse habitat. Low elevation sites burned by wild or prescribed fire are especially susceptible to invasive annual grasses or exotic weeds. Sage/juniper mix was ranked as the third largest disturbance (76,345 ha [188,651 acres]), but described only those areas where juniper and sagebrush habitats were adjacent to one another. Alternatively, juniper expansion has increased by nearly 2-fold in sage-grouse range (from 1.6 to 3.3 million acres), much of which has occurred in the Prineville region. To maintain connectivity efforts will be required to rehabilitate acres lost to conversion of exotic weeds and grasses, juniper encroachment, and seedings within the extant range of sage-grouse. Most sage-grouse habitat in public and private ownership is grazed annually, but some pastures are on rest-rotation systems. However, the number of authorized Animal Unit Months (AUMs) has been effectively reduced by 50% since 1940 from >1.1 million to 550,000 in 2003 (U.S. Department of Interior, Public Land Statistics 1941-2003). Duration, stocking rates, and various grazing systems that occur in this region have not yet been summarized.

Habitat Assessment Units

The current range of sage-grouse in Oregon occurs entirely within an area encompassed by 4 BLM District boundaries (Figure 1). The status of sage-grouse habitat was briefly summarized as the amount of remaining habitat, current ownership, risks, and types of habitat treatment or rehabilitation potential within each of the BLM District administrative boundaries. Because of its geographical separation, information within Baker County was summarized separately from that of Jordan and Malheur Resource Areas within the Vale District administrative boundary. These factors were assessed by BLM district administrative boundaries, because of the availability of habitat measures by district, each district approximates an eco-region, and BLM is a primary land manager within most of the district boundaries.

To describe the status of sagebrush these data were summarized at 2 levels for each assessment area 1) within the entire administrative boundary and 2) within the current range of sage-grouse within in an administrative boundary. Both summaries were provided to depict the total area of sagebrush habitat remaining in eastern Oregon using entire administrative boundaries, and the total area of habitat available for sage-grouse to occupy within their current range. The former provides insights to unoccupied areas of sagebrush that may be targeted for translocations at some point in the future. The analysis within the current range provides a management focus for maintaining or enhancing populations and their habitats.

Table 18. Current habitat acres in five assessment areas of eastern Oregon, 2003. These are total acres for each assessment area, and includes areas of non-habitat (e.g., forests) to provide a complete profile of the habitat in these regions.

	Assessment Area											
Habitat type	Baker	%[a]	Burns	%	Lakeview	%	Prineville	%	Vale	%	Total	%[a]
Sagebrush	595,948	62.1	3,109,217	67.1	2,920,710	60.0	2,906,517	42.7	5,869,863	60.6	15,402,255	56.9
Potential[b]												
Other shrub	257,900	26.9	889,298	19.2	1,384,876	28.5	3,234,631	47.5	2,686,001	27.7	8,558,172	31.5
Fire	-[c]	0.0	201,771	4.4	100,975	2.1	7[c]	0.0	337,750	3.5	640,496	2.4
Grassland	85,803	8.9	145,953	3.1	361,641	7.4	514,493	7.6	614,812	6.4	1,739,708	6.4
Seedings	-[c]	0.0	104,967	2.3	43,925	0.9	-[c]	0.0	139,186	1.4	297,135	1.1
Sage/juniper	1,484	0.2	79,364	1.7	13,487	0.3	93,431	1.4	1,998	0.0	188,651	0.7
Sage/wetland	820	0.1	29,079	0.6	10,322	0.2	2,599	0.0	9,241	0.1	51,309	0.2
Sage/hay	17,360	1.8	75,872	1.6	31,295	0.6	55,731	0.8	86,259	0.9	249,157	0.9
Subtotal	363,366	37.9	1,526,305	32.9	1,946,521	40.0	3,900,893	57.3	3,810,794	39.4	11,724,637	43.2
Agriculture	112,304		193,212		539,254		944,160		1,562,348		3,351,278	
Non-habitat	903,201		941,014		3,727,419		5,295,237		1,700,786		12,567,657	
Total[d]	1,974,817		5,769,747		9,133,904		13,046,807		13,120,551		43,045,827	

[a] Percent shown only of sagebrush and potential habitat total (i.e., what % of sagebrush and potential sagebrush is currently in a given condition).

[b]Potential habitat are those habitats that have some capability of transitioning to sagebrush or are potentially important to sage-grouse (e.g., interface of sagebrush and emergent herbaceous wetlands "sage/wetland"). In some cases this is not feasible, because the site has transitioned into a steady state and cannot return to sagebrush without considerable intervention (e.g., cheatgrass or mature juniper stands).

[c] Fire and seeding disturbance data were not available at the time of this report.

[d] Total acreage differs from Table 17 because the data in Tables 18 and 19 are a composite of SAGESTICH and NLCD, where Table 17 is based solely on SAGESTICH.

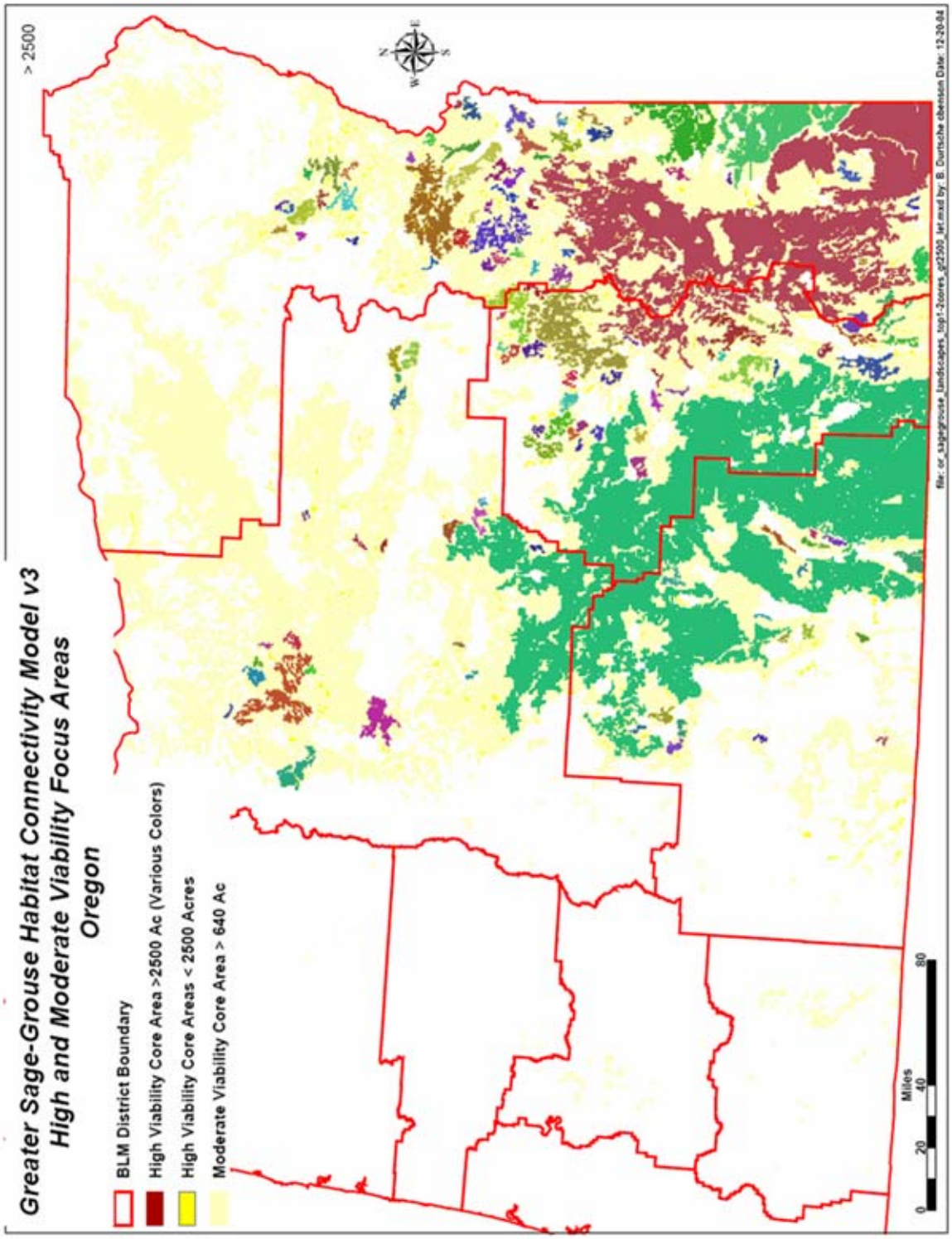

Figure 16. Connectivity model output showing contiguous sagebrush habitat patches >2,500 acres in Oregon. Areas depictied in light yellow indicate moderate viability habitats and all colored patches are high viability habitat patches >2,500 acres. The 2 largest patches occupy more 6 million acres.

Baker Resource Area

Because of conversions and land ownership status in much of the Baker Resource Area and a relatively small habitat area in Union County, habitat assessments were constrained to habitats and disturbances within Baker County.

Administrative boundary.—Sagebrush habitat has decreased by 17%, much of which was lost due to conversion to agriculture. Currently the BLM administers 31% of sage-grouse habitat and 68% is in private ownership (Table A-5). Contrary to other assessment areas in the state, steeper slopes (35% of the area) and rugged topography (13% of the area) reduced considerable amounts of sagebrush to moderate viability (potential habitat) in Baker County. Non-sagebrush shrubland impacted 22% of potential sagebrush habitat (Figure 17).

Current range.—Eighty two percent (225,667 ha or 557,633 acres) of this region was comprised of sagebrush habitat. However, only 56,352 ha (139,247 acres: 25%) were ranked as high viability and suggested that the area contained smaller and more fragmented habitats, than other regions of the state (Table 19). This was especially true east of Baker City, where agricultural practices, housing developments, and recreational activities, may limit habitat suitability. In general this region is one of the most isolated from other habitat blocks (Figure 16). Much of this isolation is due to rugged and steep sagebrush terrain. The area near I-84 may serve as migratory or dispersal corridor.

Burns District

Administrative boundary.—There has been an 8.8% decrease in sagebrush habitat in the Burns District from its historic distribution, much of which was conversion of private land to agriculture (Table 17). Currently the BLM administers 73% of sage-grouse habitat (Table A-6) and 22% is in private ownership. Similar to statewide patterns, potential habitat was largely a result of fire (9%), seedings (10%), and juniper encroachment (Table 18). Generally, sage-grouse habitat north of Highway 20 is most impacted by juniper encroachment, but higher elevation areas in the Steens Mountain region have also been impacted by juniper. Malheur National Wildlife Refuge is in the middle of this District, but it provides only a relatively small area of brood habitat along the eastern edge and southeast corner of the refuge.

Current range.—Sagebrush habitats comprise 68% of this region (1,231,238 ha or 3,042,442 acres) most of which (80%) was ranked as high viability (Table 19). This indicated reasonable habitat connectivity (Figure 18) as evidenced by the inclusion of significant portions of the two largest contiguous areas in the state (Figure 16). Sagebrush areas north of Highway 20 are impacted from juniper and ponderosa pine encroachment (7%) and likely contribute to the fragmentation in this portion of the district. Natural features (e.g., Malheur and Harney Lakes) and conversion to agriculture impact sagebrush connectivity between the town of Burns and Steens Mountain.

Approximately 30% of the sagebrush habitat within the boundary of Burns District BLM is closed to locatable, leasable and saleable minerals activities because it is within the Steens Mineral Withdrawal Area, WSAs, a USFWS refuge, or Wild & Scenic River designations. Approximately 0.5% to 1% of additional sagebrush habitat within the boundary of Burns District

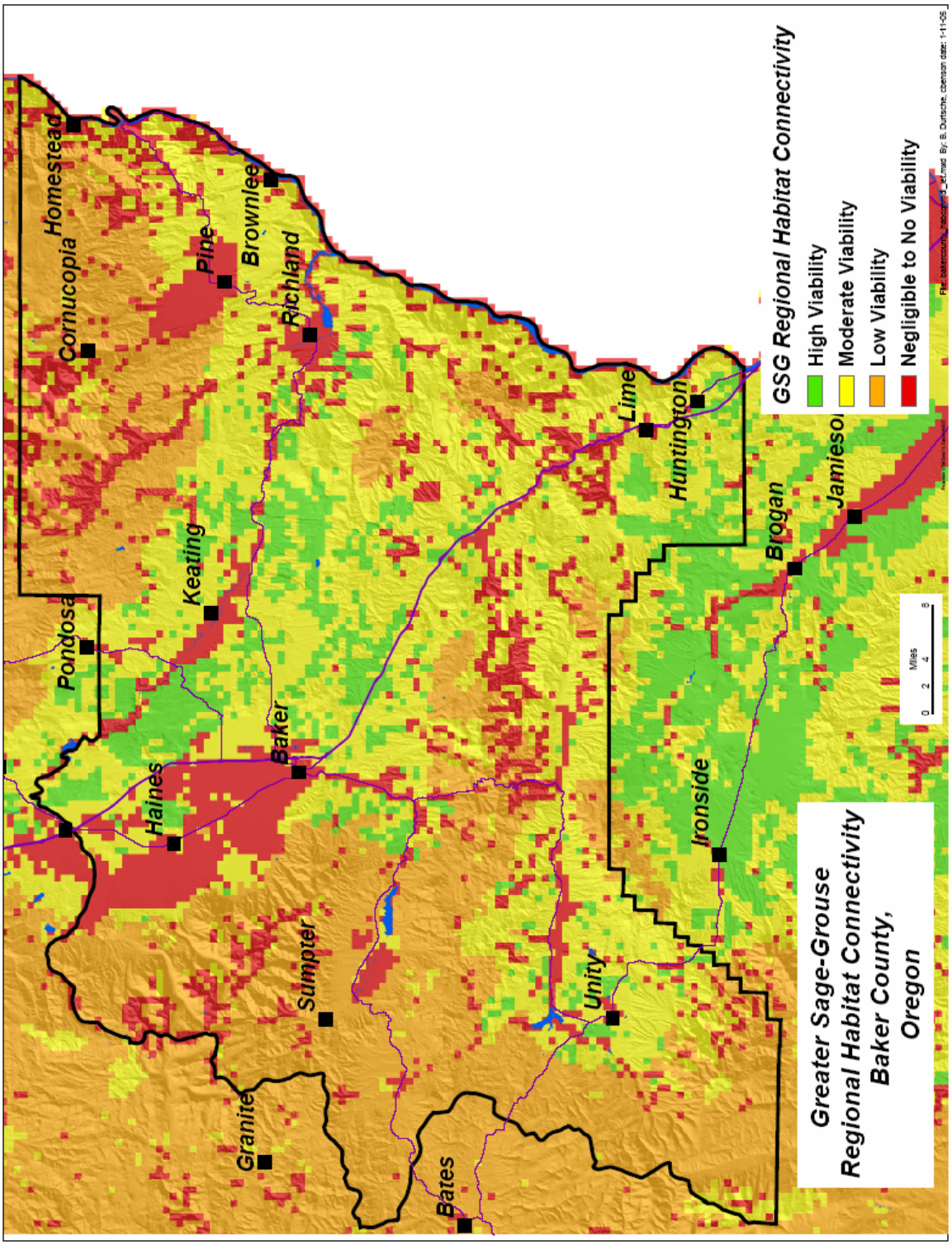

Figure 17. Connectivity model outputs for the Baker County shades of gray depict high, moderate, low, and negligible habitat viability categories.

Table 19. Current habitat acres within 5 sage-grouse assessment areas of eastern Oregon, 2003. These are acres within the current range of sage-grouse for each region to provide a profile of available habitat in occupied range.

	Assessment Area											
Habitat type	Baker	%[a]	Burns	%	Lakeview	%	Prineville	%	Vale	%	Total	%
Sagebrush	557,633	82.0	3,042,442	68.0	2,566,113	72.1	805,146	47.1	4,298,392	73.1	11,269,726	69.1
Potential[b]												
Other shrub	92,004	13.5	811,692	18.1	695,986	19.5	820,827	48.1	815,567	13.9	3,236,076	19.9
Fire	-[c]	0.0	201,372	4.5	99,738	2.8	7[c]	0.0	321,472	5.5	622,589	3.8
Grassland	17,185	2.5	132,059	3.0	118,166	3.3	43,512	2.5	233,202	4.0	544,124	3.3
Seedings	-[c]	0.0	103,286	2.3	43,925	1.2	-[c]	0.0	145,535	2.5	292,746	1.8
Sage/juniper	1,063	0.2	78,763	1.8	4,118	0.1	7,396	0.4	2	0.0	91,342	0.6
Sage/wetland	553	0.1	29,074	0.7	6,502	0.2	1,614	0.1	8,323	0.1	46,066	0.3
Sage/hay	10,662	1.6	73,545	1.6	26,592	0.7	29,468	1.7	57,856	1.0	198,123	1.2
Subtotal	121,465	18.0	1,429,791	32.0	995,025	27.9	902,824	52.9	1,581,957	26.9	5,031,062	30.9
Agriculture	40,106		188,224		105,526		62,993		185,459		582,308	
Non-habitat	45,056		669,666		352,917		398,854		131,721		1,598,214	
Total[d]	764,259		5,330,124		4,019,581		2,169,817		6,197,529		18,481,310	

[a] Percent shown only of sagebrush and potential habitat total (i.e., what % of sagebrush and potential sagebrush is currently in a given condition).

[b]Potential habitat are those habitats that have some capability of transitioning to sagebrush or are potentially important to sage-grouse (e.g., interface of sagebrush and emergent herbaceous wetlands "sage/wetland"). In some cases this is not possible, because the site has transitioned into a steady state and can return to sagebrush without considerable intervention (e.g., cheatgrass or mature juniper stands).

[c] Fire and seeding disturbance data were not available at the time of this report.

[d] Total acreage differs from Table 17 because the data in Tables 18 and 19 are a composite of SAGESTICH and NLCD, where Table 17 is based solely on SAGESTICH.

is closed to development of saleable minerals. That same 0.5 to 1% of additional sagebrush habitat within the boundary of Burns District BLM has a seasonal No Surface Occupancy (NSO) stipulation for leasable minerals. In Andrews Resource Area of Burns District BLM the seasonal NSO stipulation applies between March 1 to June 1 on land within 0.6 mile of leks (there are currently no leases). In Three Rivers Resource Area of Burns District BLM the seasonal NSO stipulation applies from March to June on land within 0.5 mile of leks (there are currently no leases) and year-round to any mineral leases on the leks themselves (Table A-10).

Lakeview District

Administrative boundary.—Approximately 17% of the sagebrush habitat has been lost in this district (Table 17). The Hart Mountain National Antelope Refuge is surrounded by the Lakeview BLM, and results in ~121,000 ha (300,000 acres) of US Fish and Wildlife Service land in this region (Table A-7). Sagebrush habitat in this region is administered primarily by BLM (78%) and secondarily by private land owners (11%). Conversions of sagebrush to irrigated fields occurred primarily in Christmas Valley. Non-sagebrush shrublands comprised the majority (52%) of current potential habitat, followed by seedings/grasslands (12%) and fire (5%). There are several large seedings in Lakeview District that may compromise future connectivity if further loss of sagebrush occurs.

Current range.—Sagebrush habitats comprised 72% (1,038, 474 ha or 2,566,113 acres) of this region and most (93%) of this habitat was ranked as high viability (Table 19). Connectivity was high in this region with the most contiguous patch of sagebrush in the state extending from the Nevada border to north of Hwy 20 (Figure 19). However, Christmas Valley and the area north of Summer Lake are highly susceptible to future isolation given the relatively narrow corridors of habitat connecting them to the larger habitat areas (Figure 16).

Nearly all of the BLM land in the Lakeview District is protected by either no surface occupancy or controlled surface use stipulation (Table A-11). These stipulations do not apply to most programs except for minerals and fluid minerals.

Prineville District

Administrative boundary.—Sage-grouse habitat in Prineville District sustained a 47% contraction from the pre-settlement era (Table 17). Most of which occurred in the Columbia Basin and was largely private land converted to agriculture. Current range and habitat is limited primarily by juniper encroachment (Table 18), however fire and seeding mapping was not complete for this District, and these impacts could not be assessed. BLM administered lands (41%) and private land ownership (48%) are nearly equal in this region (Table A-8) which will require additional efforts to identify willing land owners to participate in conservation projects. Although not quantified in the habitat map, extensive human disturbance (e.g., ATVs, mountain biking, horseback riding) from the urban areas of central Oregon impact habitat quality. Cumulative effects of power line corridors, juniper, and human disturbance are some of the factors limiting this population. Continued urbanization of private lands in sagebrush habitat will likely be detrimental to sage-grouse.

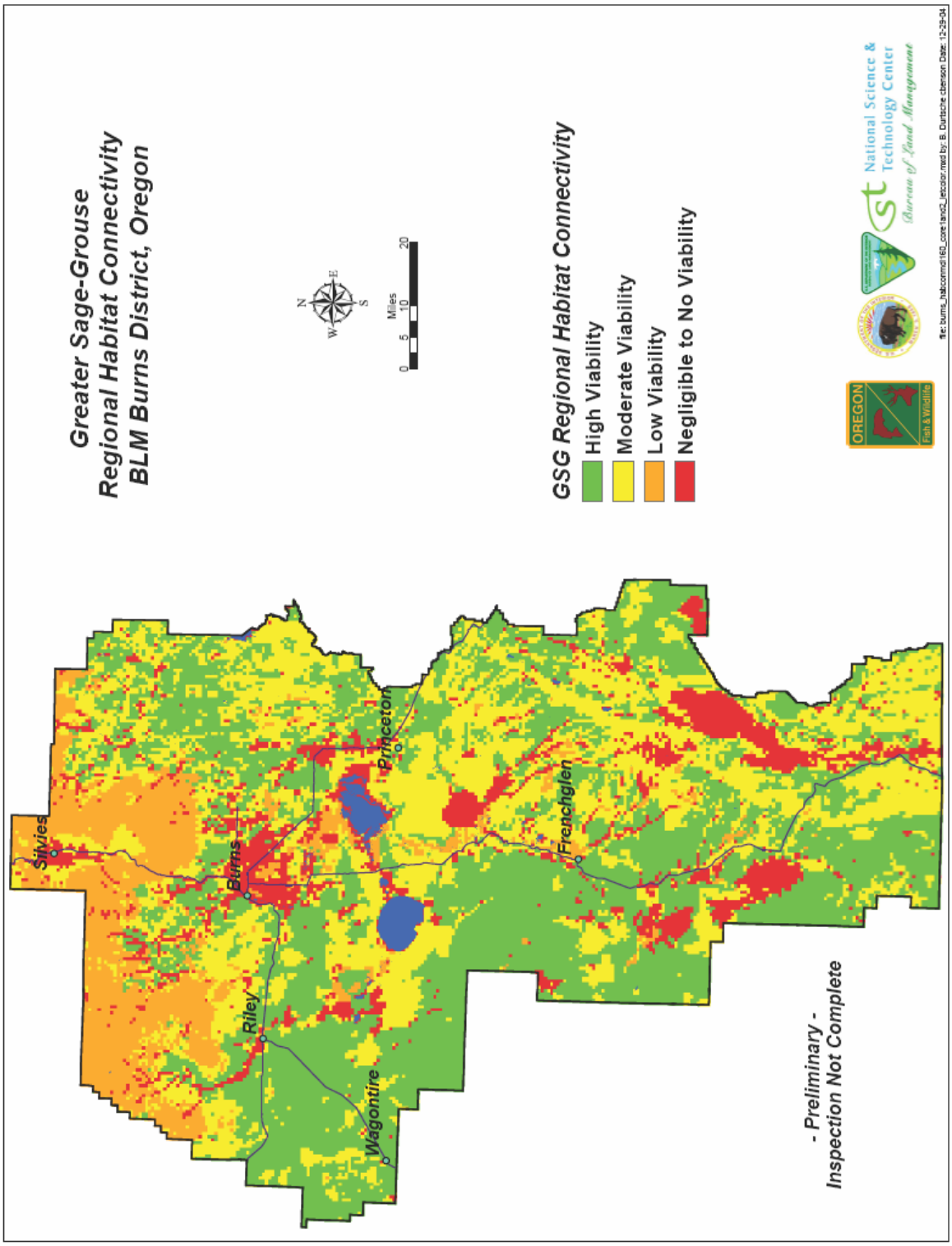

Figure 18. Connectivity model outputs for the Burns District Boundary shades of gray depict high, moderate, low, and negligible habitat viability categories.

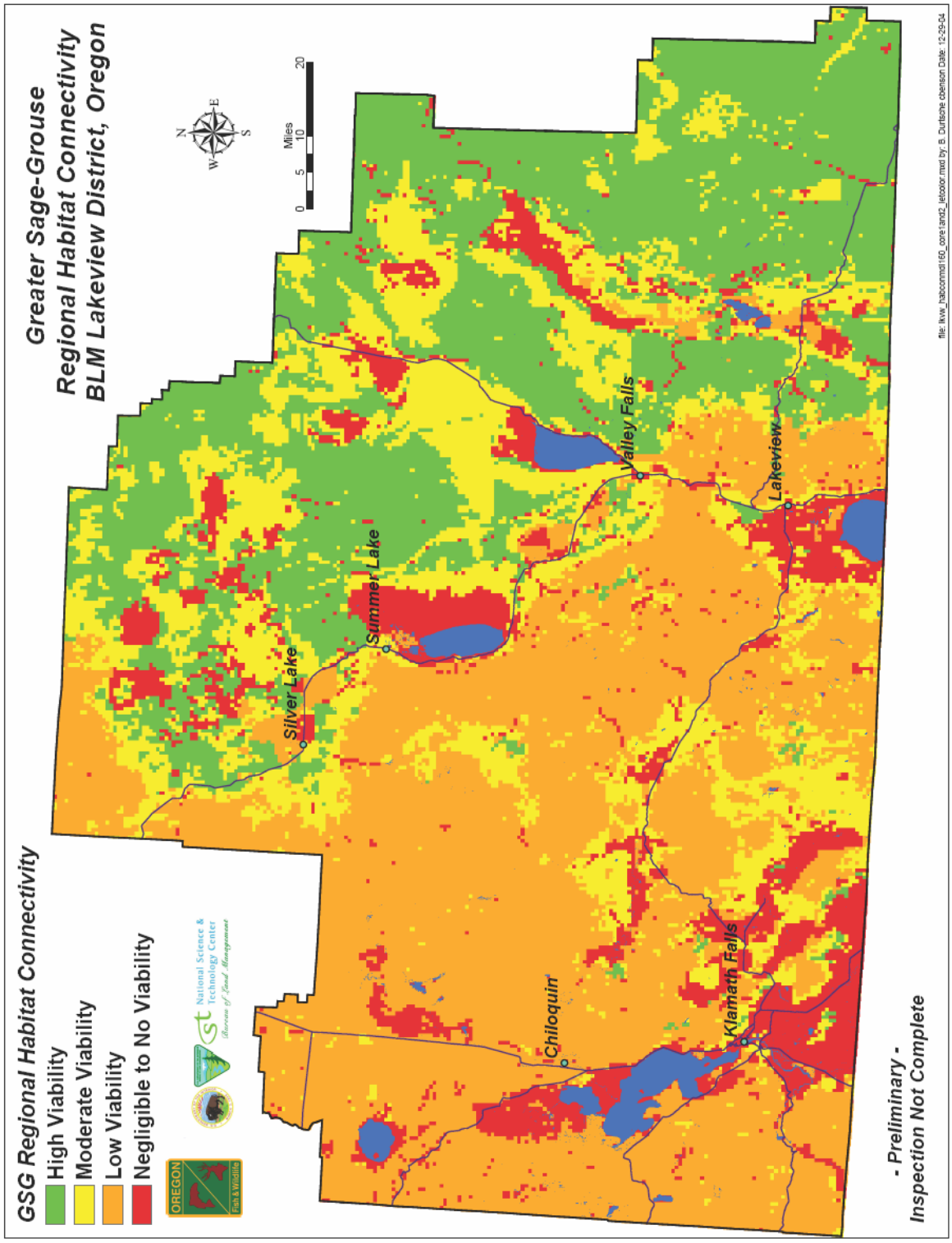

Figure 19. Connectivity model outputs for the Lakeview District Boundary shades of gray depict high, moderate, low, and negligible habitat viability categories.

Current range.—Only 47% (325,832 ha or 805,146 acres) of the region was in sagebrush, but the available habitat is relatively connected as 79% of it was ranked as high viability in the region (Table 19). Because the Prineville District is at the northern edge of sage-grouse range habitat, connectivity in this region is especially important (Figure 20). The primary habitat block (Figure 16) where sage-grouse occur is contiguous with the core area shared by Lakeview and Burns districts. The Crooked River area is largely marginalized by juniper and other disturbances. Disturbances south of Highway 20 threaten the connectivity of Prineville sagebrush habitats to other areas. Most sagebrush habitat outside of the current range of sage-grouse in Oregon occurred in this region. A total of 366,998 acres of habitat is scattered throughout the northern portion of the Prineville District boundary, much of which was near Madras and the Warm Springs Indian Reservation.

No sagebrush habitat was protected by stipulations in Prineville District Resource Management Plans.

Vale District

Administrative boundary.—Vale District has lost 17% of its historic sage-grouse range (Table 17). As in the case of Prineville, much of this loss occurred in the Columbia Basin and is largely private agricultural land today. Currently land ownership (Table A-9) is primarily BLM (73%), private (20%), and Oregon Department of State Lands (DSL; 7%). Some of the largest areas of state land occur in the Owyhee and Malheur River basins. Sagebrush areas lost to fire (136,683 ha [337,750 acres]) and seedings (59,992 ha [148,243 acres]) are the largest in Vale (Table 18). Lower elevations in the southern portion of the Vale District are susceptible to cheatgrass invasion following disturbances.

Current range.—Sagebrush comprised 1,739,505 ha (4,298,392 acres: 73%) of this region and most (71%) was ranked as high viability (Table 19). Overall habitat connectivity was reasonable in this region (Figure 18), however, the southern portion is comprised of a few large contiguous habitat patches and large disturbed areas. Several of these disturbed areas were the result of seeding projects in the 1960s. Nearly the entire sagebrush habitat in Malheur County portion Vale District was protected by most regulatory limitations (Table A-12). This reflects the Southeastern Oregon Resource Management Plan (SEORMP) that identified sage-grouse as a focal species for much of the conservation efforts.

Land Acquisitions

Except for the Burns District information on future acquisitions and disposal of sagebrush habitat was not available (Table 20). The specifics of land acquisitions can change as new opportunities arise, and efforts should be made such that there is a “no net loss” with respect to purchases and exchanges of sagebrush habitats. Special designations had relatively little impact on sage-grouse with the exception of Vale District, which those special designated lands protect > 1million acres (Table 20). It is unclear that such designations are or will be effective in sage-grouse conservation unless such areas were identified for wildfire suppression and containment.

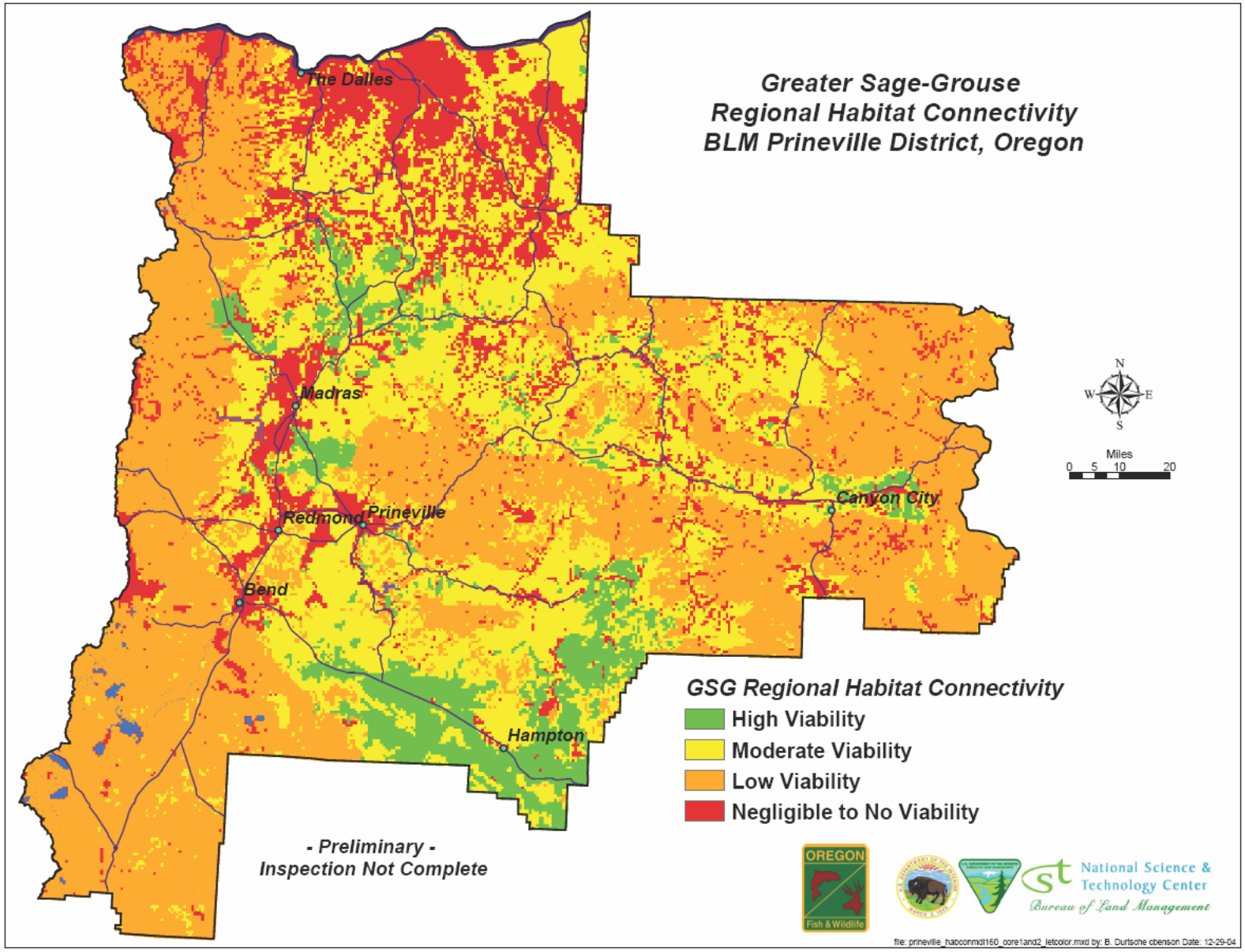

Figure 20. Connectivity model outputs for the Prineville BLM Boundary shades of gray depict high, moderate, low, and negligible habitat viability categories.

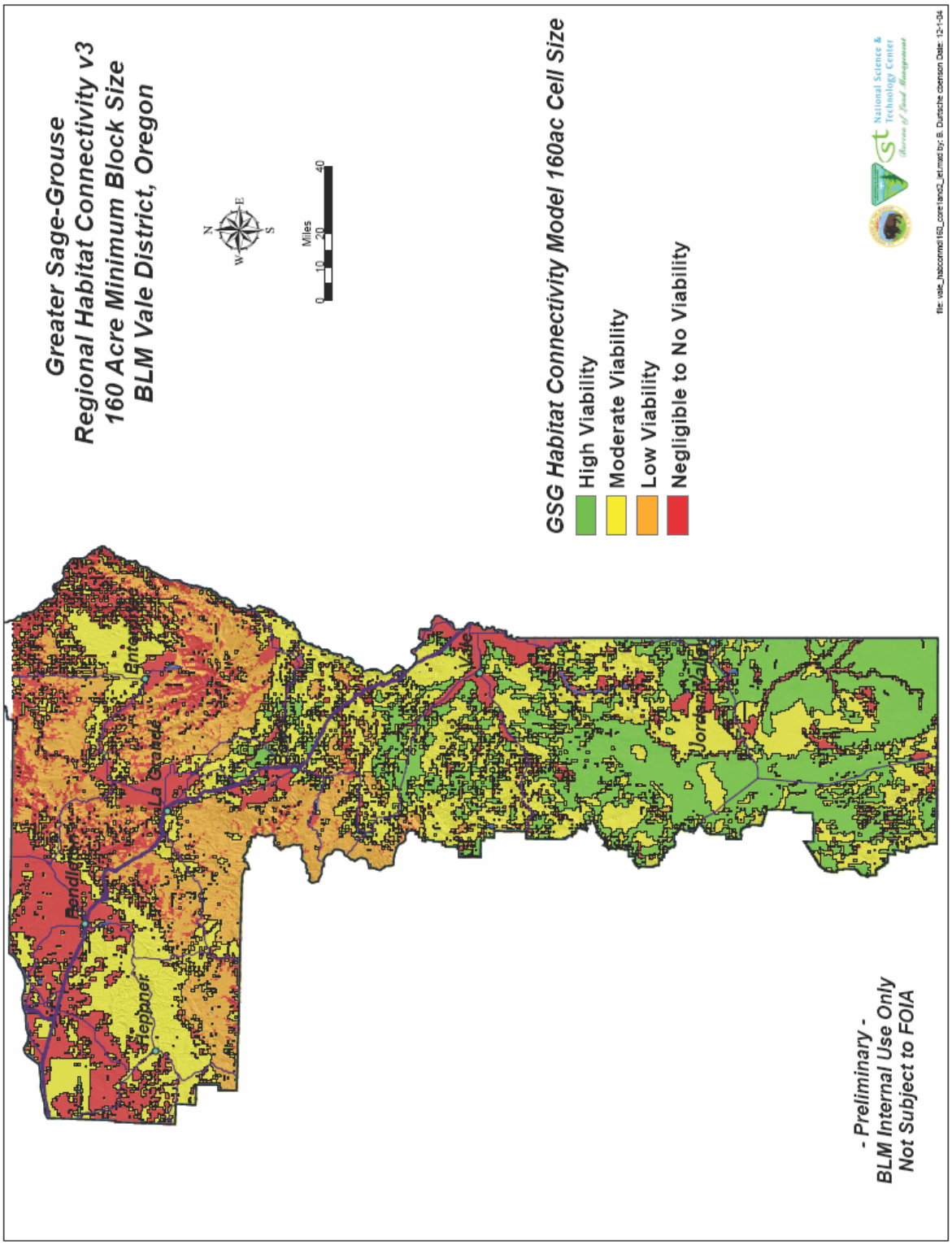

Figure 21. Connectivity model outputs for the Vale BLM District Boundary shades of gray depict high, moderate, low, and negligible habitat viability categories.

Table 20. Special designations (e.g., wilderness study areas) and land acquisitions/disposal of sage-grouse habitats by Oregon BLM Districts. Special designation acreage of sagebrush habitat is summarized as total acres and acres specifically designated to protect sage-grouse.

	Burns	Lakeview	Prineville	Vale
Special designation	1,502,400	1,237,700	119,693	1,664,809
Sage-grouse specific	825,382	101,300	640	1,664,809
% of designated	54.9	8.2	0.5	100.0
% of total BLM sagebrush	33.4	4.3	0.1	44.1
Acquisition 2000-04	13,635	800	-	-
Disposal 2000-04	77,650	-	-	-
Difference	(64,015)			
Acquisition 2005-09	3,000	-	-	-
Disposal 2005-09	8,500	-	-	-
Difference	(5,500)			
Totals	(69,515)			

SUMMARY OF HABITAT ASSESSMENT

The majority of habitat loss occurred in the Columbia Basin during the late 1800s and early 1900s as a direct result of sagebrush steppe conversion to agricultural land. In the last 20-30 years 2 million ha (5 million acres) of the current range has been marginalized by fire, juniper encroachment, and other conversions. Currently there are >6 million ha (15 million acres) of sagebrush habitat much of it in the Great Basin ecosystem. The connectivity mapping indicated that approximately 3.7 million ha (9.2 million acres) are largely connected blocks of habitat; however the understory condition of most of these acres is unknown. Compared to other sage-grouse states Oregon has large expanses of contiguous habitat with minimal threats of oil, gas, or coal-bed methane development. However, there is potential and interest to develop wind-energy grids in most sage-grouse regions in Oregon. The current status of sagebrush habitat is a landscape comprised of 70% sagebrush and 30% potential habitat that has supported sage-grouse populations over the last 24 years. Thus, to meet population objectives of this Plan the current distribution of sagebrush communities should be maintained (minimum) or enhanced (optimum). The current landscape configuration is consistent with the habitat assessment described by U.S. Department of Interior (2005), which identifies a goal of maintaining 70% of sagebrush rangelands in later structural stages (sagebrush classes 3,4, and 5) of sagebrush at broad- and mid-scales.

Sagebrush classes.—It is important to note that the following plant community structural classifications are considered useful for describing big sagebrush habitats and their ability to provide sage-grouse security cover, nesting cover, winter forage, migratory corridors, and

thermal relief which is provided by shrub cover alone. Class does not in describe sagebrush understory makeup. Forb and grass composition data for conservation planning are obtained

Class 1: **No sagebrush canopy cover**— Characteristic of rangelands that exhibit a grassland aspect and low vegetative structure. Generally common and widespread species of wildlife (e.g., pronghorn and horned larks) can be supported. Forage and insects are often abundant even for species that are dependent on sagebrush cover availability for nesting, hiding and so on. Class 1 rangelands do not necessarily pose a threat to wildlife diversity because they may in fact meet part or all of the habitat requirements of certain wildlife species. Native or nonnative Class 1 rangelands may be a wildlife issue of concern due to habitat fragmentation where they dominate large tracts of land within a GMA. Depending on rangeland condition and site potential, grass and forb values are highly variable.

Class 2: Trace to 5%— Characteristic of rangelands that exhibit a predominantly grassland aspect and low vegetative structure. Canopy cover in this range of values is often indicative of relatively recent fire or other treatment effects. They may indicate that recolonization of sagebrush is underway or a site that has transitioned into a steady state dominated by grasses. Generally common and widespread species of wildlife (e.g., pronghorn and horned larks) can be supported. Most of the complex shrub cover needs of sage-grouse and other sagebrush dependent wildlife (structure, forage, and cover) are very limited or absent altogether in Class 2 rangelands. Connelly et al. (2000b) refer to the cessation of sage-grouse nesting where live sagebrush canopy cover values go below 5%. Depending on rangeland condition and site potential, grass and forb values are highly variable

Class 3: >5%, up to 15%— Characteristic of rangelands that exhibit a shrub land aspect and desirable complex vegetative structure that is capable of supporting a variety of sagebrush-dependent wildlife (including many special status species), especially at the higher canopy values of 10 to 15%. Connelly et al. (2000b) suggest that sage-grouse are able to winter within habitats that support at least a 10% canopy cover of sage if the shrub cover is available 25 to 30 cm (10 to 12") above snow cover. Sage-grouse nesting habitat values are thought to be present at the upper (near 15%) sagebrush canopy cover values. Unpublished BLM surveys suggested sagebrush obligate songbirds began to reoccupy crested wheatgrass grasslands where the sagebrush canopy was more than 5%. Songbird studies in Nevada crested wheatgrass seedings showed that a balanced composition of grassland and shrub dependent species were present when shrub overstory recovery was around 10% line intercept values. Depending on rangeland condition and site potential, grass and forb values are highly variable.

Class 4 : >15%, up to 25%— Characteristic of rangelands that exhibit a shrubland aspect and desirable complex vegetative structure that is capable of supporting a wide variety of sagebrush-dependent wildlife (including many special status species). Sage-grouse breeding and wintering can both occur within habitats with Class 4 shrub cover. Depending on rangeland condition and site potential, grass and forb values are highly variable.

Class 5: >25%— Characteristic of rangelands that exhibit a shrubland aspect and complex vegetative structure that is capable of supporting sagebrush dependent species. Class 5 types may, though not always, support diminished herbaceous cover values. However, Class 5 cover values need to be present for some species such as the pygmy rabbit. Mule deer and elk use this type of habitat for hiding in rangelands where topographic cover is limited and/or tall structure provided by mountain shrubs is absent. Class 5 shrub cover does not necessarily imply poor or low value habitat conditions for wildlife.

from Ecological Site Inventories, Rangeland Health Assessments, or other available rangeland surveys normally possessed by land managing agencies. Sagebrush communities (1 to 5) can be further classified by type of understory composition (Appendix II).

After layering structural classes and ecological conditions in a geographic information system, a clear picture of sage-grouse habitat quality, composition, and resilience to disturbance can be determined. As described in the table below, classes 1 and 2 are grass/forb structural types that may be important to sage-grouse for their herbaceous forage values. However, classes 1 and 2 will not support nesting activity, they lack security cover for brood rearing, they cannot support winter use, and in large blocks they represent fragmented habitat. On the other hand, classes 3, 4, and 5 may each fulfill most of the yearlong habitat requirements of sage-grouse and other species because of the availability of shrubs, grasses, and forbs in combination.

MANAGEMENT OBJECTIVES FOR SAGE-GROUSE HABITAT

HABITAT GOALS

The overarching habitat goals are to 1) maintain or enhance the current range and distribution of sagebrush habitats in Oregon, and 2) manage those habitats in a range of structural stages to benefit sage-grouse. Attaining the population objectives is largely dependent upon achieving habitat goals. To meet this statewide goal through the year 2055, the conservation focus should be to retain ≥70% of sage-grouse range as sagebrush habitat in advanced structural stages, sagebrush class 3, 4 or 5, with an emphasis on classes 4 and 5. The remaining 30% will include areas of juniper encroachment, non-sagebrush shrubland, and grassland (either from natural or anthropogenic disturbance) that potentially can be rehabilitated or enhanced. The "70/30" goal is based on a habitat assessment described in BLM Technical Bulletin 417 (U.S. Department of Interior 2005).

Maintenance of 70% sagebrush and 30% potential habitat approximates the current status of intact and disturbances to sagebrush habitat, respectively, in Oregon. Maintaining this proportion over time provides a conservation focus for sagebrush types, while providing land managers opportunities to inventory and assess structure and composition of sagebrush communities that are beneficial to sage-grouse. Such an approach is critical because of current knowledge gaps regarding sagebrush communities and sage-grouse habitat needs. Ultimately a more specific habitat goal for sage-grouse is envisioned that focuses on the sagebrush community types critical to the species. In the interim, the 70/30 objective provides a conservation focus for multiple species associated with sagebrush communities. Understanding that there are natural fluctuations in sagebrush cover types, the 70/30 goal serves as an adaptive management strategy for sage-grouse habitat. Flexibility is needed in managing sagebrush habitats as a dynamic landscape where short-term losses of sagebrush can yield long-term benefits to sagebrush steppe community. However, for such "losses" to benefit sage-grouse in the long-term, treatments should be conducted such that the integrity and ability of sagebrush and native vegetation to reestablish is maximized. Decadal fluctuations in sagebrush cover type proportions are anticipated due to human and natural causes.

The current range of sage-grouse habitat in Oregon primarily includes sagebrush communities within the Great Basin. Thus, sagebrush or potential habitats in the Columbia Basin should not be considered a rehabilitation or management priority, because the vast majority of potential habitat is privately owned land and the funding required to restore sage-grouse habitats are not logistically practical at the present. The 70/30 goal is consistent with *The Wildlife Policy* (ORS 496.012[7]) which directs ODFW, "to make decisions that affect wildlife resources of the state for the benefit of the wildlife resources and to make decisions that allow for the best social, economic, and recreational utilization of wildlife resources by all user groups."

It is recommended that all Oregon BLM districts and Resource Management Plans (RMPs; it has already been adopted by the South East Oregon RMP) and other public land management agencies adopt the 70/30 framework as a comprehensive tool for maintaining and conserving sage-grouse habitat. Not only does this approach establish habitat goals, but it provides a comprehensive set of tools for inventory to ensure that goals are being met at both local and regional scales. The 70% level is based on currently available habitat and represents an attainable target of acres supporting later structural stages of sagebrush at any point in time. Retaining the 70% level provides a conservation focus for sagebrush vegetation across the sage-grouse range. To achieve the statewide goal of >70% sagebrush and ~30% disturbance, regional heterogeneity and proportions of habitat must be maintained. Stateswide and regional objectives are recommended as follows:

STATEWIDE HABITAT

Objective 1— Statewide: retain ≥70% of sage-grouse range as sagebrush habitat in advanced structural stages, sagebrush class 3, 4 or 5, with an emphasis on classes 4 and 5. The remaining 30% will include areas of juniper encroachment, non-sagebrush shrubland, and grassland that potentially can be rehabilitated or enhanced.

Objective 2—Maintain 100% of existing sagebrush habitats and enhance potential habitats that have been disturbed in the following regions. Existing conditions are:

Baker Resource Area: 82% sagebrush and 18% disturbed habitats.

Vale District (not including Baker): 73% sagebrush and 27% disturbed habitats.

Burns District: 68% sagebrush and 32% disturbed habitats.

Lakeview District: 72% sagebrush and 28% disturbed habitats.

Prineville District: 47% sagebrush and 53% disturbed habitats.

Assumptions and Rationale

Because statewide the sagebrush disturbance proportion is currently near objective (70/30) and most sage-grouse populations have persisted under this proportion for at least 20 years it is assumed that maintaining or enhancing the current level of habitat will sustain similar populations over the next 50 years.

Sagebrush classes (3, 4 and 5) provide the best habitat for sage-grouse as identified in the WAFWA guidelines (Connelly et al. 2000b). The range of canopy cover values in these classes encompasses the range of site potential for sagebrush communities in Oregon (Bates et al. 2004).

These objectives are meant to be advisory for private land holdings. As willing private landowners become involved in sage-grouse conservation the addition of their land to the 70/30 objective will allow for greater flexibility for public land management.

The 70/30 objective will need to be evaluated to determine if this ratio provides sustainable habitat over time for sage-grouse.

As a mid-scale objective, 70% of an area in sagebrush DOES NOT describe the condition or quality of sagebrush communities (i.e., vegetation composition and structure). Ideally the majority of the 70% should be of high quality habitat, however defining the appropriate proportion of quality habitat in a region is difficult at this time.

This adaptive management strategy for sagebrush habitat objectives will benefit sage-grouse and other sagebrush associated species.

Proper planning should facilitate sagebrush recruitment (e.g., juniper removal, seeding of sagebrush, specific livestock grazing treatments) and will likely exceed the 70% sagebrush objective. This will provide a buffer for unplanned disturbances that result in grassland type communities, and flexibility for other land use objectives. Alternatively, shrub canopy cover thinning treatments can still be implemented, but the timing and location of such treatments must be carefully considered to maintain the long-term 70% sagebrush goal.

Actions

Land Management

1.1. Advise public land management agencies to adopt the 70/30 framework as a comprehensive tool for maintaining and conserving sage-grouse habitat.

1.2. If the total area of grassland statewide approaches the 30% maximum, additional land treatments that would decrease sagebrush further would require substantial justification, and should be scrutinized carefully.

1.2a An exception might be a project where the objective of a treatment is to retain the overall sagebrush component, but enhance the understory of forbs and perennial grasses.

1.3. If the 30% maximum grassland type is exceeded, then land management will transition from maintaining to rehabilitation of sagebrush communities.

1.4. If 70% sagebrush objective is exceeded this will provide a buffer for unplanned disturbances or shrub canopy cover thinning treatments can still be implemented, but the timing and location of such treatments must be carefully considered so that long-term declines are not below 70%.

Monitoring

1.5. There is a need to adapt the long-term objective of 70/30 to account for habitat quality (e.g., habitat block size, vegetation structure and composition within different sagebrush communities). Initially this will require an inventory of vegetative communities within allotments and pastures. At the pasture level quality can be assessed under Rangeland Health Standard #5 on BLM lands.

1.6. Similar standards for rangeland health should be adopted by other land management entities for consistency in monitoring and assessing habitat. This could be conducted through a series of MOUs between BLM and other land management agencies.

1.6a. Inventories of pasture level sagebrush structure and herbaceous understory can be effective in evaluating allotments for habitat related Rangeland Health Standard.

1.6b. Pasture and allotment assessments should contribute to an inventory of sagebrush habitat by recording the presence or absence of sagebrush and if present quantify its class value (1-5).

1.7. Broad- and mid-scale assessments should be updated every 3-5 years to monitor the progress towards maintaining the long-term goal of 70/30 sagebrush/grassland mix.

1.8. Determine the ecological relevance of 70/30 objective from monitoring and inventories, and adjust if necessary and the appropriate goals will be adapted to the appropriate minimum.

1.9 Consider using more detailed habitat data on a regional basis.

Partnerships

1.11. Opportunities must be sought to include private and tribal lands into this planning framework of maintaining and enhancing 70% sagebrush habitat in a landscape context over the long term. The voluntary participation of tribes and private landowners will be sought through cost-share projects to add to this long-term goal.

1.12. Private lands may contain some of the higher quality habitats and any additions of these habitat types to overall goal should be encouraged.

HABITAT SECTION SUMMARY

Maintaining and enhancing habitat throughout sage-grouse range will ensure the sustainability of Oregon populations. It is important for land-use practices and habitat projects to be conducted such that there is a balance between the goal of the project and biological needs of sage-grouse and other sagebrush associated species. Following the guidelines provided in the Plan will assist in achieving habitat and population goals for sage-grouse.

Section V. SAGE-GROUSE CONSERVATION GUIDELINES

These guidelines are designed to maintain (at a minimum) or enhance the quality (optimum) of current habitats, and will assist resource managers in achieving population and habitat objectives of this Plan. Because populations and habitats have been maintained over a relatively consistent set of conditions for 20+ years maintaining or enhancing these habitats through these guidelines should provide sustainable populations into the future. The guidelines should be viewed as tools as needed in a region, not all issues identified in the guidelines (e.g., juniper encroachment) are relevant to all regions of the state. Implementation of these conservation guidelines will be guided by local implementation groups comprised of land managers and land owners. These groups will include a mix of public and private entities, and because BLM is the primary land manager, local groups initially will be based on BLM District boundaries. Part of the local implementation teams' responsibility will be to identify the appropriate tools to meet the objectives in their region.

STATEWIDE MANAGEMENT GUIDELINES

The Oregon office of the BLM adopted the "*Greater Sage-Grouse and Sagebrush Steppe Management Guidelines"* (2000; referred to as *Interim Guidelines*). This document encourages the BLM to continue to use the *Interim Guidelines* and expect them to include the conservation measures discussed in this section. These measures alone cannot replace the *Interim Guidelines* and implementation of both will be necessary for long-term conservation of sage-grouse and their habitats in Oregon. Other federal and state land management agencies are also expected to adopt the applicable conservation guidelines in this document as well as the *Interim Guidelines*. This document recognizes the limitation of "one size fits all" management whether it is grazing practices and herbaceous vegetation or set-back distances for construction of human-made features in sage-grouse habitat. However, these guidelines were derived from a baseline of knowledge that should be evaluated and compared to regional or local conditions. Moreover, they promote a management focus for the conservation of sage-grouse and sagebrush habitats in Oregon.

The remainder of this section will describe various risk factors for sage-grouse, and provide recommendations to minimize or alleviate these risks. Additionally, regional recommendations for management actions are identified.

WILDFIRE

Management of both wild and prescribed fires is considered one of the key issues in maintaining sagebrush systems (Crawford et al. 2004). Sage-grouse have co-evolved in this ecosystem where fire was a primary disturbance process, albeit at infrequent intervals. Impacts of fire on sagebrush communities are described with respect to elevational gradients, because elevation is an important environmental factor impacting post-fire succession of vegetation. The length of the fire cycle has changed with anthropogenic manipulations to the landscape; it has often shortened in the case of low elevation sites and increased at high elevation sites. The importance of fire in the sagebrush habitat is often generalized. However, fire regimes are temporally and spatially complex across the sagebrush region, due to factors such as site potential, plant community type, and season, size and pattern of fire (Crawford et al. 2004).

High elevation communities

Post-fire basin and mountain big sagebrush communities generally restock with sagebrush more quickly than Wyoming big sagebrush sites because these subspecies tend to occupy deeper soils and wetter sites. The absence of fire at higher elevations typically results in juniper expansion into sagebrush dominated communities (Figure 21). If fire is absent from a site long enough for juniper abundance to reach or approach stand closure, reduced fine fuel abundance may prevent return fire and necessitate mechanical cutting to restore degraded habitat.

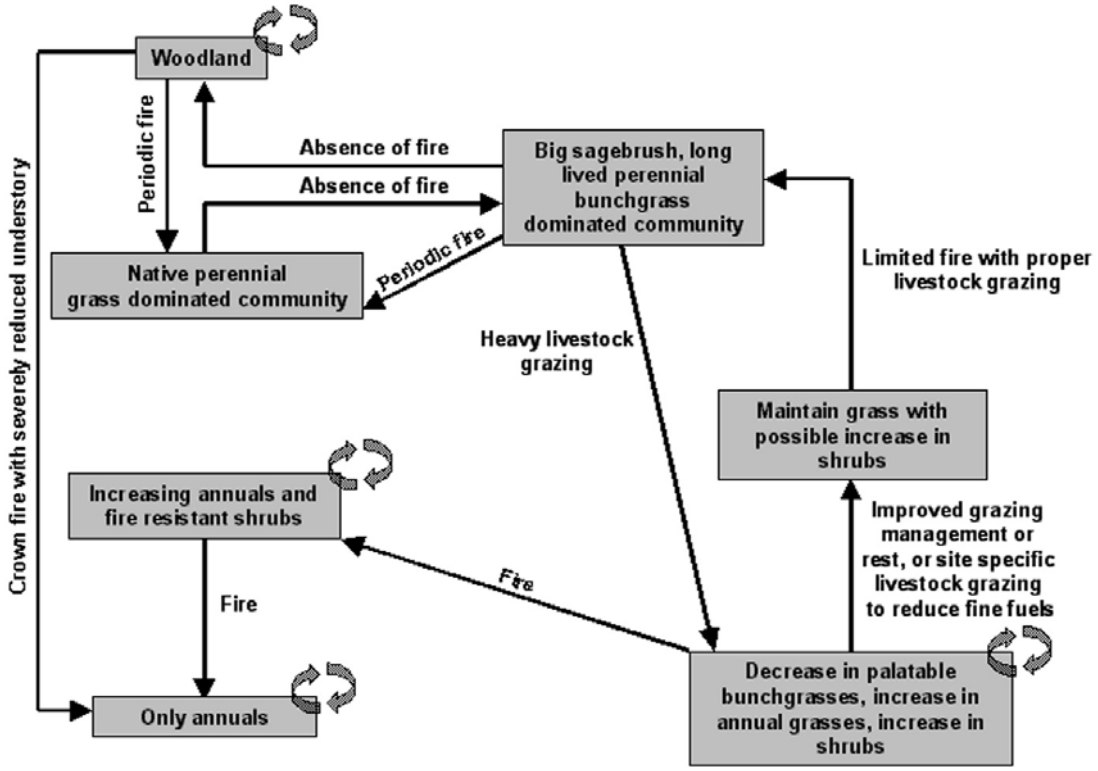

Figure 22. Hypothesized relationship of grazing and fire to successional dynamics in sagebrush communities. Curved arrows indicate "steady states" that will require significant management action to change the community type to a desired habitat condition for sage-grouse. In some cases it may not be economically or logistically feasible to manipulate areas that have become steady states. Movement towards annual dominated communities tends to occur in Wyoming big sagebrush communities and at elevations below 1500 m, but this will vary regionally (Adapted from Crawford et al. 2004).

Low elevation communities

Wildfires in low elevation sagebrush habitats may burn nearly all vegetation leaving the area unsuitable for sagebrush dependent species for a number of years. This is particularly true in Wyoming big sagebrush types, especially where there is an abundance of annual grasses in the understory. Repeated wildfires and the disturbance by historic livestock grazing have favored

invasion by cheatgrass and other exotic species (Valentine 1990, Pellant 1990). Conversion to cheatgrass alters the fire frequency from the historic 32-70 years in low elevation sagebrush communities to 1-5 years or less (Wright et al. 1979). This scenario is referred to as the cheatgrass-wildfire cycle (Pellant 1996), and is considered a steady state (Figure 22). Cheatgrass monocultures do not provide usable sage-grouse habitat. Wildfires in cheatgrass areas increase the threat in adjacent areas not yet dominated by cheatgrass. If there is an abundance of cheatgrass in the understory of a shrub community, this should alert managers to refrain from the use of prescribed fire in that and adjacent areas. Alternatively, understory cheatgrass provides a good indicator of a high priority protection area during wildfire. There are many more acres of non-cheatgrass communities, than areas dominated by that species; therefore, preventing invasion should be the management priority, as opposed to restoring invaded sites

Action: Reduce negative impacts of wildfire on sage-grouse through efficient fire suppression techniques	
Issue	**Conservation guidelines**
Fire management plans should identify sage-grouse habitat as a high priority for protection,. During multiple fire events prompt access to local resource specialists, and subsequently to their knowledge concerning areas with critical habitat may be limited.	1) The act of fire fighting has little impact on sage-grouse as compared to the loss of habitat from a fire. Retain unburned areas (including interior islands and patches between roads and the fire perimeter) of sage-grouse habitat unless there is a compelling safety, resource protection, or control objectives at risk. This may require additional suppression and resources for holding and mop-up. Fire managers should proactively plan for and anticipate these needs early in the incident. 2) Fire specialists and wildlife biologists should review District Fire Management Plans (Phase I) annually to incorporate new sage-grouse information in setting wildfire suppression priorities. Updates to Phase-I Fire Plans should be distributed to dispatchers for initial attack planning. 3) Train and use resource advisors to assist with prioritizing fires during suppression activities and work with Incident Commanders and Incident Management Teams as appropriate. 4) Give wildfire suppression priority to known sage-grouse habitat within the framework of the Federal Wildland Fire Policy (human life and safety as the first priority, with property and natural resources as second priorities, USDI and USDA 1995). 5) Use direct attack tactics when it is safe and effective at reducing amount of burned habitat. 6) Within 3 km (2 miles) of a lek as well as identified winter range, should be given top priority in fire suppression. Judiciously use heavy equipment and excessive brush removal at only the level necessary to expeditiously extinguish the fire. 7) Given the scale of the cheatgrass problem, and its ramifications to sage-grouse habitat it is important to re-iterate that preventing fire from entering at risk communities – e.g., cheatgrass in understory/overstory sagebrush – should be a high priority for protecting sage-grouse habitat.

Action: Reduce negative impacts of wildfire on sage-grouse through prompt and appropriate habitat reclamation or rehabilitation	
Issue	**Conservation guidelines**
The lack of prompt and appropriate rehabilitation following a wildfire can present additional threats to sage-grouse habitat.	1) Wildfires burning >10 acres of sage-grouse habitat should be evaluated to determine if seeding is necessary to recover ecological processes and achieve habitat objectives. a) If seeding is necessary, managers should use appropriate mixtures of sagebrush, native grasses, and forbs and appropriate non-native perennials, that will increase the probability of recovering ecological processes and habitat features of the site. b) Wyoming big sagebrush sites should be re-seeded with Wyoming big sagebrush when available. All wildfires burning >10 acres of habitat that is at high risk of cheatgrass invasion will be seeded with an appropriate mixture to reduce the probability of cheatgrass establishment. 2) Although planting shrub species is more common now than in the past, sagebrush should be included in fire rehabilitation seeding mixtures as often as possible. 3) The seed supply of native species is generally limited when large acreages burn. Land managers should encourage development of native seed banks (both in the private and government sectors). 4) If natives and sagebrush seed is unavailable crested wheatgrass can be planted in lieu of native species or as a mixture with native species, because it is readily available, can successfully compete with cheatgrass, and establishes itself more readily than natives. a) If crested wheatgrass is planted initially specific efforts or plans are needed to interseed native grasses, forbs and shrubs in the rehabilitation area. This might include an initial seed-mix of 1 to 2 lbs per acre of crested wheatgrass mixed with natives. 5) If cheatgrass or other exotic plant species are present before a fire occurs, they are likely to become more dominant post-fire if the area is not properly rehabilitated (but see suppression activities above). Rehabilitation techniques that decrease the probability of cheatgrass invasion are needed. 6) Drought can impact the success of a rehabilitation project. Post-treatment monitoring will be needed to determine if rehabilitation efforts need to be repeated if initial attempts fail.

PRESCRIBED FIRE

The *Federal Wildland Fire Management Policy and Program Review* (U.S. Department of Interior and U.S. Department of Agriculture 1995) indicates that, consistent with land and resource management plans, fire must be reintroduced into the ecosystem to rehabilitate and maintain ecosystem health and reduce wildfire risk. Recent budget increases in fuels management has allowed increased use of prescribed fire and other fuels management treatments. However, prescribed fire has contributed to the decrease in sage-grouse habitat (Connelly et al. 1994, Fischer et al. 1996a). This decrease may be associated with temporary loss of sagebrush cover, or long-term loss due to post-fire dominance of invasive plants.

Action: Reduce negative impacts of prescribed fire on sage-grouse through appropriate strategic planning and field techniques	
Issue	**Conservation guidelines**
If conducted correctly prescribed fires may be beneficial to sage-grouse habitat.	1) Burns should be conducted in such a way that there is a mosaic of sagebrush and burned areas. This will provide a seed source for sagebrush regeneration. These should occur at higher elevations near juniper encroachment areas. a) Remove juniper encroaching from mountain big sagebrush communities through cutting of juniper and burning piled trees and limbs ("jack-pot burning"). b) Prescribed fires at lower elevations generally should be avoided as a management tool. This tool should be used **only** when i) No other options are available ii) A pre-burn evaluation has determined that the risk of cheatgrass or other invasive weeds is minimal iii) There is a low risk of reducing critical features of sage-grouse habitat

LIVESTOCK GRAZING

Moderate levels of livestock use are generally considered compatible with maintenance of perennial bunchgrass, however level of sustainable use varies with a number of environmental factors. Generally cool season bunchgrasses present across much of the sage-grouse range are most vulnerable to the effects of defoliation in late spring and early summer. Grazing during this time can reduce cover and vigor of perennial grasses and increase opportunity for invasion of undesirable species (Crawford et al. 2004). Optimum sage-grouse nesting habitat consists of a healthy sagebrush ecosystem complete with an herbaceous understory composed of native perennial grasses and forbs. Nesting and early brood-rearing periods are critical for sage-grouse.

Action: Promote vegetation that supports nesting and brood-rearing habitats including maintenance or recovery of shrub and herbaceous (native grasses and forbs) cover. Retain residual cover adequate to conceal sage-grouse nests and broods from predation, and plant communities that provide a diversity of plant and insect food sources.	
Issue	**Conservation guidelines**
Appropriate livestock grazing regimes can be compatible with sage-grouse habitat needs.	1) Where livestock grazing management results in a level of forage use (use levels) that is consistent with Resource Management Plans, Allotment Management Plans, Terms and Conditions of Grazing Permits or Leases, other allotment specific direction, and regulations, no changes to use or management are required if habitat quality meets Rangeland Health Standard and Guidelines. 2) Where livestock grazing management results in a forage use level detrimental to habitat quality, changes in grazing management that will maintain or rehabilitate habitat quality will be made as soon as possible. Adjustments to grazing management will be conducted in accordance with responsible land management agency regulations. a) Adaptive management that should be considered include: i) changes in salting and/or watering locations, ii) change in the season, fencing, duration or intensity of use, iii) reducing grazing use levels, iv) temporary livestock non-use (rest), or v) extended livestock non-use until specific local objectives are met as identified by implementation group. 3) The timing and location of livestock turnout and trailing should not contribute to livestock concentrations on leks during the sage-grouse breeding season. 4) Measurement of grazing levels will be conducted on that portion of the pasture which is known to be sage-grouse habitat and will not be based on by "average use" throughout the entire pasture. 5) Reduce physical disturbance to sage-grouse leks by livestock through managing locations of salt or mineral supplements placed greater than 1 km (0.6 mi) of lek locations. 6) Avoid supplemental winter feeding of livestock in known/occupied habitat unless it is part of a plan to improve ecological health or to create

	mosaics in dense sagebrush stands that are needed for optimum grouse habitat. Although ecologically winter grazing may have a minimum impact on the plant community, the impacts to residual cover for sage-grouse nesting can be detrimental.
Livestock management facilities can promote balanced grazing distributions and compatibility with sage-grouse habitat needs.	1) Locate new and/or relocate livestock water developments within sage-grouse habitat to maintain or enhance habitat quality. 2) Spring developments both new and old should be constructed and/or modified to maintain their free-flowing natural and wet meadow characteristics. 3) Ensure wildlife accessibility to water and install escape ramps in all new and existing water troughs. 4) Construct new livestock facilities (livestock troughs, fences, corrals, handling facilities, "dusting bags," etc.) at least 1 km (0.6 mi.) from leks to avoid concentration of livestock, collision hazards to flying birds, or avian predator perches. 5) For playas, wetlands, and springs that have been hyrdologically modified for livestock water facilities, local working groups should identify water improvements that have population limiting implications. These should be rehabilitated and off-site livestock watering facilities developed and new water should be available before existing water is eliminated.
Wild Horses--*The management goals for wild horses are to manage them as components of the public lands in a manner that preserves and maintains a thriving natural ecological balance in a multiple use relationship. Wild horses are managed in twenty Herd Management Areas (HMAs) that involve 2.8 million acres of public land , primarily in southeastern OR..*	1) The cumulative Appropriate Management Level (AML) for horse numbers should be kept within current AML (**1,351** to **2,650)** in herd management areas. a) Management agencies are strongly encouraged to prioritize funding for wild horse round-ups in sage-grouse areas that are over AML, b) Evaluate the AML's for impacts on sagebrush habitat, c) Further measures may be warranted to conserve sage-grouse habitat even if horses are at, above, or below the appropriate AML for a herd management area.

JUNIPER EXPANSION

Before settlement by Euro-Americans, western juniper (*Juniperus occidentalis*) existed on fuel limited sites including open, savannah-like woodlands in low sagebrush (Miller and Rose 1995) rocky surfaces or ridges (Barney and Frishknecht 1974, Cottam and Stewart 1940, Miller and Rose 1995) and pumice influenced soils. These woodlands had an understory that included various sagebrush species. Since the 1880s, western juniper has increased in density and distribution in the northern Great Basin (Miller and Rose 1995, 1999; Miller and Tausch 2001). Western juniper has expanded into mountain big sagebrush, low sagebrush, quaking aspen (*Populus tremuloides*), and riparian communities. The extent of the juniper expansion has increased 10 fold (Miller and Tausch 2001). Increased livestock grazing in the late 1800s and early 1900s contributed to a reduction in fuels that could carry fire, thereby decreasing fire frequency (Miller and Rose 1999, Miller and Tausch 2001). In addition, fire suppression policies have generally lengthened fire-return intervals in juniper-dominated areas. Miller et al. (2005) recognize three stages of juniper succession:

- **Phase I**, trees are present but shrubs and herbs are the dominant vegetation that influence ecological processes (hydrologic, nutrient, and energy cycles) on the site;
- **Phase II**, trees are codominant with shrubs and herbs and all three vegetation layers influence ecological processes on the site;
- **Phase III**, trees are the dominant vegetation and the primary plant layer influencing ecological processes on the site.

Action: Juniper removal methods should promote the return sagebrush, native grasses, and forbs.	
Issue	**Conservation guidelines[a]**
If conducted correctly juniper removal can restore native vegetation communities to proper functioning condition	1) **Prescribed fire**: Please refer to cautions about this tool described above. *Advantages*: most economical; natural process; vegetation can respond positively under the right conditions; can treat large areas; some control over intensity of fire; and usually results in the longest time period before juniper returns to the site. *Disadvantages*: risk; liability; weed threat in some locations; reduction of shrubs (e.g., sagebrush, bitterbrush, mountain mahogany); tree selectivity limited; must have adequate fuels; potential nutrient losses with high intensity fires; limited climatic conditions under which prescribed fire can be used; smoke issues; urban interface. 2) Mechanical: Chainsaw *Advantages*: selective (trees removed); control the area that is treated; broad time period when treatment can be applied; minimal liability; friendly near urban interface, which may negate high costs; maintains shrubs with proper planning; little soil disturbance; not fuel limited; slash may be beneficial in restoring the site; broadcast seed beneath slash. *Disadvantages*: high cost/acre; limited amount of area treated; large amounts of woody debris remains following treatment in dense woodlands;

	potential liability in fire protection zones adjacent to pine forests. 3) Mechanical: Heavy machinery *Advantages*: control the area that is treated; broad time period when treatment can be applied; minimal liability; friendly near urban interface, which negate high costs; maintains shrubs with proper planning; not fuel limited; slash may be beneficial in restoring the site; broadcast seed beneath slash; soil surface disturbance may enhance germination of seed broadcast prior to treatment. *Disadvantages*: high cost/acre; limited amount of area treated; some mechanical equipment are limited by steepness of slope and rockiness; large amounts of woody debris remain following treatment in dense woodlands; soil disturbance or compaction. 4) Chemical *Advantages*: Can treat areas quickly; not limited by topography; effective on trees less than 2 m (6 ft) in height. *Disadvantages*: Use is highly restricted on Federal lands, at least in Oregon; effectiveness of control often limited; few effective products are currently labeled for this use.

[a] These guidelines were adapted from Miller et al. (2005)

Recognizing the transitory phase of a juniper encroachment identified for removal is critical to understanding methods required for removal as well as site rehabilitation to sagebrush steppe. While rehabilitation of lands dominated by western juniper may be beneficial to sage-grouse, lack of proper post-treatment management of these lands may limit rehabilitation towards native shrubs and deep-rooted perennial grasses.

Action: Post-treatment management of juniper removal areas should promote the return of native grasses and forbs to the treatment area.	
Issue	**Conservation guidelines**
If conducted correctly post-treatment management can return to native vegetation communities and reduce the risks of invasion of noxious weeds.	1) Seeding prior to treatment should be considered when current perennial grass community is in poor condition (<2 plants /10ft^2,<1 plant/10ft^2 on dry and wet sites) or if exotic annual grasses are present. a) Broadcast seeding prior to soil disturbance or under slash may increase the chances of establishment. 2) Length of rest from grazing following treatment will depend on understory composition at time of treatment and response of desirable vegetation following treatment. This typically varies from less than 1 to more than 3 years. 3) Juniper succession stage (Phase I, II, or III) and site conditions should be considered when selecting removal and post-treatment methods.

INVASIVE VEGETATION

Nonnative Invasive Plants

While cheatgrass proliferation has been widespread, increases in other exotic species such as medusahead (*Taeniatherum caput-medusae*), knapweed (*Centaurea* spp.) and yellow starthistle (*Centaurea solstitialis*) are also adversely impacting sagebrush-steppe habitat (Quigley and Arbelbide 1997). Many exotic plants are adapted to the Great Basin climate (Trewartha 1981 *in* Mack 1986, Young et al. 1972 *in* Mack 1986), and have the greatest potential for impact on the warmer, lower elevation sagebrush communities. They alter the structure and function of ecosystems they invade and threaten biological diversity (Randall 1996, Vitousek et al. 1996, Olson 1999). Invasive weeds have increased soil erosion, reduced infiltration (Lacey et al. 1989), and displaced native plant species (Belcher and Wilson 1989, Miller et al. 1994). The rapid rate of expansion is partly attributable to the life history of exotic plants. Exotic plants are often opportunists, and many are pioneering, colonizing species. They are frequently one of the first species to arrive and colonize areas that have experienced soil-surface disturbance or areas that lack plant cover. Their establishment and spread are aided by disturbance to the soil surface (Baker 1986, Bazzaz 1986). Spotted knapweed (*C. maculosa*), yellow starthistle, and leafy spurge (*Euphorbia esula*) have exhibited the ability to invade relatively undisturbed sites, including wilderness areas (Asher 1994, Tyser and Key 1988).

Other Limitations with Invasive Plants

In 1984, the BLM and U.S. Forest Service completed the *Western Oregon Program Management of Competing Vegetation Environmental Impact Statement*. Legal action was taken on this EIS and the result was a court-ordered injunction that prohibited the use of herbicides on all federally-administered lands in Oregon. The injunction was modified in 1987 and allowed federal land management agencies to use 4 herbicides to control noxious weeds only. Those four herbicides are glyphosate, 2,4-D, picloram, and dicamba, and are the only herbicides that can be used on BLM-administered lands.

Action: Minimize the impact of invasive noxious weeds on sage-grouse habitat.	
Issue	**Conservation guidelines**
Prevention of invasive plants moving into new areas underemphasized.	The most successful and efficient method for managing weeds is prevention of invasion. Weed Prevention Areas (WPA's) should be established in areas with limited infestation. Spread vector analysis should be used to determine the highest probability spread mechanisms. "Invasive Plant Prevention Guidelines" developed by the Center for Invasive Plant Management should be followed to reduce the risk of the exotics into sagebrush communities.
Newly arriving satellite weed patches are not detected before they become major infestations.	Systematic and strategic detection surveys should be developed and conducted in a manner maximizing the likelihood of finding new patches before they expand. Once patches are located, seed production should be stopped and the weeds should be eradicated. The most effective tools for eradication of many weeds are herbicides.

Invasive weeds continue to expand from borders of large infestations	Containment programs for large infestations should be maintained. Border spraying infestations, planting aggressive (even non-native species) plants as a barrier, establishing seed feeding biological control agents, and grazing weeds to minimize seed production are all methods that could help contain large infestations.
Repeated periodic largescale herbicide applications are not sustainable.	The goal of weed management should be to establish and maintain a healthy, functioning sagebrush plant community that has some degree of invasion resistance by maximizing niche occupation.
Many sagebrush steppe communities have not past a threshold after which they are no longer recoverable by weed control.	Areas with an adequate understory (> 20% composition) of desired vegetation should be identified and prioritized as high for control since they have higher likelihood of successful rehabilitation that areas where to desired species are completely displaced.
Many sagebrush steppe communities have past a threshold after which they are no longer recoverable by control.	A rehabilitation and/or restoration plan should be developed and implemented for areas with inadequate understory (< 15% composition) of desired vegetation. The species of choice should include these with similar niche as the invasive weeds. The goal should be to maximize niche occupation with desired species.
Herbicide injunction on public land limits land managers ability to treat various exotic weeds.	Work with various agencies and the courts to remove the injunction.

VEGETATION TREATMENTS

Large-scale sagebrush eradication programs of the mid-1900s resulted in the direct loss of sage-grouse habitat. There is a need (on a case by case basis) to reinvigorate some sagebrush communities that have transitioned into late seral stages. The use of such treatments need to be conducted judiciously, so that the needs of sagebrush associated species is not jeopardized. This section overlaps to some extent with juniper and prescribed fire, but focuses more so on sagebrush treatments.

Use of Crested Wheatgrass

This Plan recognizes the importance of native vegetation in functioning sagebrush systems; however, currently there is a limited supply of native seed, and current technologies and protocols for establishing native species following disturbance have had only limited success. This Plan encourages the development of native seed sources and the use of native seed by land management entities. However until that market is fully realized and technologies for establishing native species improve, this Plan supports the use of crested wheatgrass (seeded at low rates [1 to 2 lbs per acre]) in conjunction with native plants as an intermediate step in rehabilitating disturbances to sagebrush habitats. In the recent past, monocultures of crested wheatgrass were used in lieu of native vegetation as livestock forage at the expense of thousands of acres of sagebrush habitat. Despite past use of this plant species it has potential to stabilize an area that has been recently disturbed. It is competitive with cheatgrass and if planted at low rates it is compatible with native grass and forb species (Monsen et al. 2004).

Action: Maximize benefits of vegetation treatments for sage-grouse through best management practices	
Issue	**Conservation guidelines**
Vegetation manipulations should benefit the long-term health of sagebrush habitat.	1) Use brush beating (or other appropriate treatment) in strips (or a mosaic pattern) 4 to 8 meters (12 to 24 ft.) wide (with untreated interspaces 3 times the width of the treated strips) in areas and with relatively high shrub cover (>25%) to improve herbaceous understory for nesting and brood rearing habitats. Such treatments should not be conducted in known winter habitat. 2) Avoid vegetation treatments in sage-grouse habitat in areas that are highly susceptible to cheatgrass or other exotic species invasion. Any vegetation treatments conducted in cheatgrass-dominated communities will be accompanied by rehabilitation, and if necessary, reseeding to achieve re-establishment of native vegetation. 3) Minimize disturbance to sage-grouse populations, do not conduct any vegetation treatments during nesting and early-brood rearing periods when sage-grouse are present. 4) Aggressively treat noxious weeds and other invasive plants where they threaten quality of sage-grouse habitat, and apply best management practices to prevent infestations from occurring. 5) Crested wheatgrass can be planted (1 to 2 lbs per acre) but preferably in a mixture with native species, because it is readily available, can successfully compete with cheatgrass, and establishes itself more readily

	than natives. 6) The use of herbicides (primarily tebuthiuron) at low (0.1–0.3 kg ai/ha) application rates may effectively thin sagebrush cover while increasing herbaceous plant production (Olson and Whitson 2002). These treatments should be applied in strips or mosaic patterns. a) Site conditions must be critically evaluated prior to treatment (including fire rehabilitation, new seedings and seeding renovations) to increase likelihood of the desired vegetation response.

REALTY

Various human activities and structures decrease quality of sage-grouse habitat, and some can result in habitat loss. This sub-section addresses a variety of land-use issues and methods of minimizing their impacts on sagebrush habitats. Because direct effects of these risks (disturbances) have not been demonstrated in all cases, it is critical that land management agencies err on the side of sage-grouse needs, rather than assume no effect. Thus, many of the set-back distances are based on the known habitat needs of sage-grouse relative to the distance from lek sites and serves as minimum area that should be protected from development. However, the size, duration, and intensity of a development should be considered when assessing potential impacts and determining the set-back distance for a project.

Action: Minimize impacts of land-exchanges and the construction of anthropogenic features on sage-grouse habitat.	
Issue	**Conservation guidelines**
Land Exchanges/Disposals	1) Evaluate sage-grouse habitat values when federal or state lands are being considered for sale or exchange. This should apply to the quality of the habitat as well as the quantity (i.e., this should not be swapping high quality sagebrush for low quality sagebrush). 2) Maintain existing sage-grouse habitats, with particular attention to areas of intact habitat.
Energy & Minerals Development	1) Mineral and fossil fuel exploration and extraction sites should avoid surface occupancy within 3.2 km (2 mi) of known/occupied sage-grouse habitat. 2) Future developments of wind energy might have significant impacts on local breeding populations. Disturbances associated with construction and maintenance of turbines and subsequent power lines may displace nesting females. Wind energy grids (wind farms) should be constructed 8 km (5 miles) from known/occupied habitat. However, the placement of such a facility will require careful planning in sage-grouse range to minimize the potential impacts (Manville 2004). a) Appropriate set-back distances (thresholds) regarding density (# of units per area), size (total area disturbed), and noise levels of energy developments need examination to determine what the effects are on sage-grouse. Until better information is available, managers should err on the side of the birds' biology and use the greatest set-back distance where feasible and necessary.
Transmission Lines	1) Use existing utility corridors and rights-of-ways to consolidate activities to reduce habitat loss, degradation, and fragmentation by new construction. Except where topographically possible, install new power lines within existing powerline corridors or highway rights-of-way. a) In some cases power lines may be buried to minimize the disturbance. 2) If installation is not possible within existing corridors, seek to minimize disturbance to known breeding, nesting, and brood-rearing habitats by

	placing power line corridors >3.2 km from these areas.
Communication/Emitter Sites	Use existing communication/emitter sites to consolidate activities of new construction, except where topographically impossible, and install new communication sites in forested landscapes. However, off-site mitigation should be considered if the area of impact from new construction is ≤640 acres, disturbance of larger areas for communication sites should be critically evaluated.
Road Rights-of-Ways	Disturbance from high volume roads can lead to avoidance of otherwise suitable habitat or direct mortality of birds. Minimize the construction of new roads through occupied sage-grouse habitat, especially nesting and brood-rearing areas.
Agricultural Conversion	Sagebrush conversion on public lands (e.g., crested wheatgrass seedings) should be avoided if the sole purpose is to increase livestock forage. There may be instances of non-sagebrush types (e.g., rabbitbrush) that such activity might be considered. Alfalfa may provide foraging habitats for sage-grouse, but typically this occurs at the edge of extensive agricultural areas. There is potential for sage-grouse mortality if organophosphorus insectides are applied to agricultural fields to limit insect damage. A small number of alfalfa fields in an expanse of sagebrush may provide late-season brood habitat. Typically conversion to alfalfa is at the discretion of private landowner.
Urban Development	Urban developments should be clustered to limit the extent of disturbance to sage-grouse habitats. If clustering is not possible off-site mitigation should be considered (i.e., funding or cost-sharing a habitat project elsewhere). Typically these developments will occur on private land and such stipulations would need to be addressed through county planning.
Habitat Fragmentation	Habitat loss and fragmentation are probably the 2 leading causes for the long-term decline in sage-grouse. Current and future land management will need to examine landscape patterns of sagebrush habitat and seek strategies to ensure that large connected patches of sagebrush are present. The implementation of the connectivity model and habitat monitoring techniques suggested in the Plan will help minimize the impacts of habitat loss and fragmentation.

RECREATION

Human uses of the sagebrush steppe for recreational activity vary widely. The direct effects of these activities are unknown, but there are negative correlations with sage-grouse populations and increased human activity (Connelly et al. 2004).

Action: Minimize the impact of recreational activities on sage-grouse habitats while ensuring continued enjoyment of the sagebrush steppe ecosystem.	
Issue	**Conservation guidelines**
Viewing	1) Protect existing leks and provide secure sage-grouse breeding habitat with minimal disturbance and harassment. 2) Provide sage-grouse habitats secure from direct human disturbance during the winter and breeding seasons (when birds are concentrated and susceptible to harassment). 3) If alternative measures have not been successful in reducing disturbances initiate seasonal or area closures as necessary to protect key sage-grouse habitat. 4) Assist with developing public viewing areas of sage-grouse leks with oversight from ODFW and land management agencies to minimize disturbance.
Off-Highway-Vehicles-this includes ATVs, motorcycles, four-wheel-drive jeeps, pick-up trucks, or sport-utility vehicles.	1) Off-highway-vehicle (OHV) use should be restricted to areas >3.2 km (2 mi) from leks during the breeding season. 2) OHV should be restricted to on-trail or on-road use during the nesting season in areas known to be occupied by sage-grouse. Some playas serve as breeding display sites and could be impacted by off-road use. 3) The extent and intensity of OHV use should be monitored. Quantifying OHV use (e.g., daily and seasonal use) will assist in mitigating potential conflicts with sage-grouse habitat needs and recreational pursuits.
Developed or Improved Recreation Sites	1) Facilities (i.e., kiosks, toilets, signs, etc.) should be constructed at least 3.2 km (2 mi.) from leks to minimize disturbance during the breeding season. 2) Facilities (kiosks, toilets, signs, etc.) should be constructed to minimize disturbance in known/occupied sage-grouse nesting and early brood-rearing habitat. Avoid construction of facilities that provide avian predator perches unless they include mitigating features such as perch guards.
Hunting	1) Maintain current methods for establishing harvest rates (Appendix I). 2) Maintain data collection from hunter harvests for estimating productivity. 3) Regulations will be re-evaluated every 5-years consistent with ODFW Upland Gamebird Framework.

PREDATION

Sage-grouse have many predators, but there is little published information indicating that predation is a major limiting factor for the species (Connelly et al. 2004). A few studies have examined the effects of predator control on sage-grouse populations (Batterson and Morse 1948, Slater 2003 Coates and Delehanty 2004). Batterson and Morse (1948) and Coates and Delehanty (2004) removed ravens from their study areas and indicated increased nest success, however neither study had an appropriate control in their experiment. Slater (2003) examined the effects of coyote removal on nest and brood survival and found no measurable effects between the removal and non-removal area. However, there may be instances where small isolated populations are declining or are at risk of extirpation because of predation. A human-induced increased in abundance of red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), or other predators may negatively impact local populations. Similarly translocated birds may be unfamiliar with their new habitat and more susceptible to predation. In such instances, where populations are at a critical level the feasibility of short-term predator control program should be evaluated. Long-term intensive predator control programs are not cost-effective nor socially acceptable. Proper habitat management is the best long-term strategy to ensure predation does not threaten viability of populations (Schroeder and Baydack 2001).

Action: Minimize the effects of predation on isolated, translocated, or declining populations where predation has been identified as a limiting factor	
Issue	**Conservation guidelines**
Translocated populations have naïve birds and may be more susceptible to predation. *Isolated populations may be at increased risk level due to marginal or fragmented habitat* *Populations have reached critically low numbers*	1) Evaluate feasibility of short-term predator control programs. 2) Consider predator control program only when identified as a limiting factor and other management tools have not stabilized declining population. a) Predator control may include non-lethal controls such as: using perch deterrents on power poles or fence posts, modifications to power poles or other human-made structures that are used by corvids or raptors for nesting

WEST NILE VIRUS

The recent emergence of West Nile Virus (WNV) in the western U.S. and the lack of resistance in the sage-grouse immune system is a serious management concern. Outbreaks of the virus have been localized but sage-grouse have been documented with the disease in Alberta, California, Colorado, Montana, and Wyoming. At this point in time, monitoring for outbreaks is priority and development of response strategies is needed. Oregon Department of Human Services (ODHS) has added sage-grouse to the species watch list for monitoring the spread of WNV. ODHS has provided funding for testing of specimens and information and education.

Action: Minimize the effects of WNV (or other pathogens) on populations.	
Issue	**Conservation guidelines**
The effects of WNV to the statewide population is unknown	1) Investigate and record deaths that could be attributed to disease or parasites. 2) Develop and implement strategies to deal with disease outbreaks where appropriate 3) Continue to educate public about WNV and sage-grouse 4) Monitor radiomarked populations during WNV season (July – September) where applicable

REGIONAL CONSERVATION MEASURES

Baker Resource Area

Baker County has substantial human activity. Thus, there is a need to be cautious and evaluate recreational activities as it pertains to sage-grouse habitat use. In particular, the area near Virtue Flat contains several leks (Batterson and Morse 1948), and is under increasing pressure for OHV trail use. The preponderance of private land in this region will require additional efforts to identify willing landowners for participation in sage-grouse conservation. NRCS in Oregon (and throughout the west) has provided funding specifically for sage-grouse, and has identified this region as a priority for projects. Also, given the relatively small and isolated area of sagebrush habitat east of Baker City it is important for management to carefully consider the benefits/detriments to sage-grouse, as the population likely will be more sensitive to fragmentation or other disturbance. A wind energy test turbine has been proposed for the area near Virtue Flat extreme caution and planning is needed if a full scale wind farm is proposed.

A wind farm has recently been proposed in Union County, on the northern fringe of sage-grouse habitat. No leks were found within 5 km of the project site (J. Caldwell, ODFW unpublished report). This type of activity could have a negative effect on a peripheral population especially if the project site was determined to be in occupied habitat. Measures should be taken to retain birds of Union County so the present range is not compromised further.

Burns District

While there are large areas currently under special status in this region, the multi-scale approach to rangeland assessment has not been adopted in the Andrews RMP. The 3 Rivers RMP will be updated in the near future and the multi-scale approach should be included in the new document.

Management practices should maintain connectivity of core sagebrush areas between Burns, Lakeview and Prineville Districts to the west and Vale to the east. Several areas along Highway 20 corridor between Hines and Hampton are in need of juniper removal to maintain connectivity of this core area. There are at least 32,000 ha (79,000 acres) of juniper that need to be evaluated for potential treatment throughout the district. Fire has altered at least 81,000 ha (200,000 acres) within which opportunities for habitat rehabilitation and restoration need to be identified. Similarly acreages of grassland, seedings, and non-sagebrush shrublands need to be evaluated for conservation projects. Specific opportunities will be identified by Implementation Groups, but most of this work will need to be addressed by BLM.

The potential for wind-powered electricity generation on the Stinking Water Pass will be evaluated in the coming years with a test turbine (F. Taylor, BLM personal communication). Construction of that turbine and subsequent activity should be monitored for potential effects on sage-grouse habitat use. This may provide some insight to the effects of a full-scale wind power generation grid should it be constructed at this site. However, the small scale of the test turbine likely will not have the same impact as 100 or so turbines that could be constructed in this area.

Lakeview District

The recent Lakeview RMP provided significant consideration for sage-grouse in resource use and activities. There is a need to adopt the multi-scale rangeland and habitat assessment proposed in this document. Habitat management at Hart Mountain National Antelope Refuge also should include the multi-scale approach; this will assist in providing a more complete profile of habitat configuration with respect to the long-term landscape scale objectives for sagebrush cover.

At least 6,000 ha (14,000 acres) of juniper need to be evaluated for potential treatment (especially the area west of Warner Valley). This is likely a gross underestimate of juniper expansion on the district. Rehabilitation projects need to be identified for areas planted to crested wheatgrass, and trying to bring portions of those stands into sagebrush classes 3, 4, or 5. Most of these plantings occurred in the northern portion of the district. Rehabilitation of at least 40,000 ha (100,000 acres) in transition from fire needs to be assessed. There is a wind-farm test site proposal for the south Warner Rim. Construction of that turbine and subsequent activity should be monitored for potential effects on sage-grouse habitat use.

Sage-grouse have been absent from the Klamath Falls Resource Area since 1993. Habitat improvement projects continue in this region with respect to juniper encroachment treatments (T. Collom, ODFW personal communication). A reintroduction of sage-grouse to Klamath Falls region may have potential both from the stand point of habitat and population restoration. Such a project would need careful consideration and habitat evaluation to increase the likelihood of

success. Additionally, sage-grouse and sagebrush management in California should be considered when evaluating the potential translocation to this region.

Prineville District

Prineville RMPs are beginning the process of updates and renewal, the adoption and integration of the multi-scale approach described herein should be included in each new RMP. Because Prineville District includes a larger human population than most others in Oregon's sage-grouse range, there is an array of issues that likely will need action in the near future.

Juniper encroachment is a significant issue for this region (36,000 ha [90,000 acres]) as it may marginalize 10% of the habitat remaining in the district. Disturbances due to fire need to be clarified through more thorough inventories. Maintaining the connectivity of habitat between this region and Burns/Lakeview is critical to ensuring the long-term sustainability of the current population. Identifying partnerships to best maintain or rehabilitate these areas will be critical in this region where private land comprises a slight majority of sage-grouse habitat. Similar to Baker County the NRCS in Oregon has identified this region as a priority for projects. Because of declining population trends in this region aggressive management is needed to identify limiting factors and halt the decline.

Human impact is the greatest in this region, whether it be anthropogenic structures (power lines, OHV trails, potential housing developments) or activities (mountain biking, bird watching, horseback riding). These all occur in greater frequency on a relatively smaller area in comparison to the rest of sage-grouse range in the state. Thus, management and mitigation of such activities will be necessary to reduce the impacts on sage-grouse. There is lack of information indicating what the effects have been, and research is needed. Managing the human activity may be the primary conservation action to assist in stabilizing populations. Habitat improvements should be pursued in concert with managing human activity.

Given the continued negative trends in sage-grouse populations in Prineville District, it may be necessary to augment populations in the future through intrastate translocations. Such efforts should be pursued in conjunction with aggressive habitat management strategies to increase the likelihood that augmentations will succeed. Loss of populations in the Prineville District would not only reduce the range of the bird but, in effect, create a new peripheral range and the population susceptibility that often corresponds with populations at the fringe of the range. Several sagebrush areas > 1,000 ha (2,500 acre) were identified near Warm Springs Indian Reservation and further north into Wasco and Jefferson counties. These areas should be evaluated for their potential to support sage-grouse and future re-introductions considered if long-term sustainability is feasible. Thus an evaluation should consider the ability of birds from these isolated patches to disperse or migrate with populations further south into the district.

Vale District

The Southeast Oregon RMP is the most recent in Oregon, but does not include the Baker Resource Area. The Baker RMP is due for renewal and the multi-scale approach used in the other 2 resource areas should be adopted. Similar to Prineville, Baker City and the surrounding public land is

another urban interface that has potential for conflicts between human recreation and sage-grouse habitat.

Fire has altered > 121,000 ha (300,000 acres) of sagebrush in the Vale District in recent years and thousands of sagebrush hectares were converted to crested wheatgrass in the 1960s-70s. This has produced significant grasslands throughout the southern portion of the District. Some of these areas have been recolonized by sagebrush. Experimental work to rehabilitate those areas not in sagebrush should be conducted. Similarly much work is needed to identify the best methods for rehabilitating areas lost to fire, so that cheatgrass invasions are minimized. Contrary to other districts juniper does not pose as great a threat as fire and invasion of cheatgrass. Higher elevation sites especially in the Malheur watershed should be evaluated for areas of juniper which threaten the connectivity of sagebrush habitat. Much of this area is administered by BLM and these actions will need to be facilitated through this agency.

SECTION VI. IMPLEMENTATION AND MONITORING

IMPLEMENTATION

The guidance provided in the Plan in regards to habitat management and/or protection will require BLM to determine if the said guidance conforms to existing RMPs, and may need to amend current plans. For such guidance to be amended, this may require multiple Environmental Impact Statements (EIS) under the National Environmental Protection Act (NEPA). These processes will require additional public involvement and comment. Some of the guidance has already been subjected to this process and formally adopted (e.g., SEORMP), providing precedence that can be followed. Alternatively, this guidance can and should be included in revised or updated RMPs.

A schedule of RMP renewal is needed so that planning areas can decide whether or not to amend current plans if needed or to include these recommendations as policy in forthcoming updated plans.

Intergrating the State's Strategies and Local Conservation

This Plan provides specific guidance for public land management agencies to adopt conservation practices so that compliance can be measured and regulatory mechanisms will exist for management of sagebrush habitats. The Plan also provides private landowners with conservation actions and monitoring tools to measure the outcome of those actions. The Plan identifies most of the issues surrounding sage-grouse in Oregon. As local projects and working groups evolve to address them, other issues may arise and some may not apply to a specific region. It is the intent of this Plan to provide private landowners with options for land management. Voluntary conservation projects need to be identified that are mutually beneficial and can be funded with the assistance of ODFW, NRCS, BLM, SWCD, or USFWS. The goal of the Plan is to provide a foundation for conservation agencies and individuals to work cooperatively in sage-grouse and sagebrush management, and identify or define landscape mosaics that support stable populations of sage-grouse.

Plan Implementation

The Oregon Sage-grouse Conservation Plan will be implemented at the state and local level. It is anticipated that BLM, NRCS, DSL, U.S. FWS Refuges, USFS, and ODFW will formally adopt the Plan and implement its elements at the local level. Although there may be policies and conservation actions that occur at the state level, it is the intent of this Plan that most of the conservation actions occur under the direction of the local implementation groups.

Local Implementation Groups

Implementation of conservation guidelines outlined in this Plan will be guided by local implementation groups comprised of land managers and land owners. Because these groups are not mutually exclusive and include a mix of public and private entities, BLM is the primary land manager; local groups initially will be based on BLM District boundaries (and in some cases Resource Areas).

This Plan identifies 5 local implementation groups: one in each BLM district boundary and one in the Baker Resource Area within the Vale District boundary. These groups will facilitate and identify management priorities and actions to address them to achieve population and habitat objectives. This process will occur at the interface of public and private lands. Priorities and projects should first be identified based on the biological needs of sage-grouse or habitat rehabilitation. Ownership or administrative jurisdiction should be secondary in identifying priorities, but will be critical in identifying partners to implement a conservation action. As a result implementation of projects will require 2 parallel processes; one for public and the other for private lands. Plan implementation on private lands will occur primarily through the local SWCD offices. The public lands process will include extensive public involvement via the NEPA process through integration of plans of other federal land management agencies in the designated area. Regardless of ownership, local implementation groups will be responsible for establishing: appropriate timelines, parties conducting treatments and monitoring, and identifying funding sources for projects.

The federal land agencies will need to first identify conformance of the Plan with local land use plans and consider the need or lack thereof for a land use plan amendment. Lands administered by the state likely will require revision of resource plans. Membership to local implementation groups at a minimum will include: ODFW, DSL (where applicable), SWCD (2 private land owners), BLM (1 biologist and 1 rangeland conservationist), USFS (where applicable; 1 biologist and 1 rangeland conservationist), and US FWS Refuge (where applicable). Private landowners may be appointed to the local SWCD by the Board of Directors as existing elected Directors or as Associate Directors as recommended. There may be existing groups in counties or BLM districts that may serve as the implementation group, provided they include the representation from appropriate action agencies. The local implementation groups, and/or individuals (public and private) represent entities that are directly responsible for implementing on the ground actions identified in the Oregon Sage-Grouse Conservation Plan. The local implementation group may appoint additional members as needed. Technical experts/advisors may be consulted through Oregon State University, USDA Agricultural Research Service, US FWS (Ecological Services), or NRCS, as needed.

Local groups will implement conservation within the scope of existing policies. Such groups may influence agency policy, but they do not set policy, and cannot change policies, many of which are mandated by state and federal law.

Role of Local Groups

The primary directive for implementation groups is to ensure that sage-grouse and sagebrush habitat conservation (at a minimum those actions identified in the Plan) decisions occur at the local. It is the expectation that decisions will be made through consensus. Conflicts arising regarding projects or management actions could be elevated to the state conservation team for discussion and consultation.

The Oregon Sage Grouse and Sagebrush Habitat Conservation Planning Team will provide oversight and direction by providing workshops and training to regional teams.

Mission and Guidance

It is the intent of the Plan, and consistent with ORS 496.12(7), to promote local conservation in balance with social, cultural, and community values. The following principles provide a framework to guide the local efforts. Each group may find a need to develop additional principles or ground rules that meet local needs and improve its efficiency.

1) Conservation actions for sage-grouse will promote intact and functioning sagebrush steppe communities.

2) Conservation strategies identified in the Plan and additionally by local efforts will integrate local, regional, and national needs for sage-grouse and sagebrush habitat conservation.

3) Wildlife professionals, land managers, private landowners, and all others who have a vested interest in sagebrush communities will be tolerant, understanding and respectful of other perspectives and focus on areas of common interest.

4) The Plan is not intended to exclude any users or activities or infringe on legally defined private property rights; but serves to provide solutions to problems and issues that affect sage-grouse and the functionality of sagebrush communities.

Effectiveness and Validation of Conservation Measures

Sagebrush systems respond slowly to treatments and it may take several years of monitoring before effects are observable. Thus, when evaluating the impacts on sage-grouse populations or their habitats there must be a long-term commitment by all involved in the project in order to measure the outcome.

The criteria by which a management action is considered successful will vary by project. The crux will be to decide: how big of an effect is needed and can it be accurately measured? The conservation measures suggested will need to be evaluated in terms of population or vegetation response. Other response variables may warrant exploration depending upon the resource that may be impacted.

INFORMATION AND EDUCATION

Agencies adopting this strategy should provide public outreach that extends beyond public hearings and meetings that parallel the planning process. Such outreach might include opportunities to collaborate with various publics to provide sage-grouse workshops for observations of displaying birds or community volunteers to assist with habitat enhancement projects (e.g., removal of old fences, seedling planting). The goal is to provide the public with a basic understanding of sage-grouse and sagebrush steppe and the significance of these natural resources.

INVENTORY, MONITORING, AND RESEARCH NEEDS

Inventory and Monitoring of Sage-Grouse Distribution

ODFW and BLM should continue helicopter surveys to delineate sage-grouse distribution in the state; this project likely will be completed by spring 2005 if appropriate funding is available. Once the distribution project is complete, helicopter surveys could be used to estimate the number of active leks in a region. ODFW is developing a statistically valid sampling scheme for examining lek activity. Additionally, sampling schemes for evaluating trend and estimating population size are being considered for districts in which not all leks can be counted in a breeding season.

Inventory and Monitoring of Sage-Grouse Habitat Conditions

One primary criterion for sage-grouse conservation is inventorying the quantity and quality of habitat in a region (Connelly et al. 2000b). From that baseline, conservation actions can be identified, prioritized, and implemented. One of the cruxes to land management is developing a comprehensive framework in which habitats can be inventoried and management objectives defined. The multi-scale approach of U.S. Department of Interior (2005) provides such a framework that is currently integrated into the Southeastern Oregon RMP. Strengths of this approach enable rangeland assessments and inventories to occur at the pasture or ecological site level. When completed over a watershed or planning area these (pasture by pasture) assessments cumulatively provide an inventory of sagebrush habitat in various successional stages (Figure 23). The potential for this framework to unify sampling and management across various scales, may assist in Oregon's modification and implementation of the Western Association of Fish and Wildlife Agencies guidelines (Connelly et al. 2000b). Scales pertinent to this process and management include: state level (**broad**); geographic areas which might range from a BLM district, planning area, or watershed (**mid**); allotments or pastures (**fine**); and ecological sites (**site/local**). Much of what is discussed below is taken or modified from U.S. Department of Interior (2005).

Sagebrush Desired Conditions

Mid-scale.— The presence of shrub cover that supports the life history of sage-grouse and other wildlife species should occur at multiple scales, over a large area, and in a variety of spatial arrangements (U.S. Department of Interior 2005). The focus for sage-grouse should be the presence of large contiguous areas of viable habitat. However the spatial arrangement might include some islands, corridors, and mosaic patterns (Figure 14).

Wildlife objectives for sagebrush communities in individual pastures, allotments, or management areas (identified by the connectivity model) will consider factors such as: (1) presence of sage-grouse and their life history needs, (2) existing native shrub cover patterns and characteristics, (3) frequency and reasonable likelihood of fire, (4) locations of seedings and their shrub canopy cover conditions, and (5) locations of invasive juniper stands and their shrub understory.

Mixed age-class sagebrush stands (i.e., various structural characteristics) should occur throughout a geographic area with an emphasis on communities in classes 3, 4 and 5.

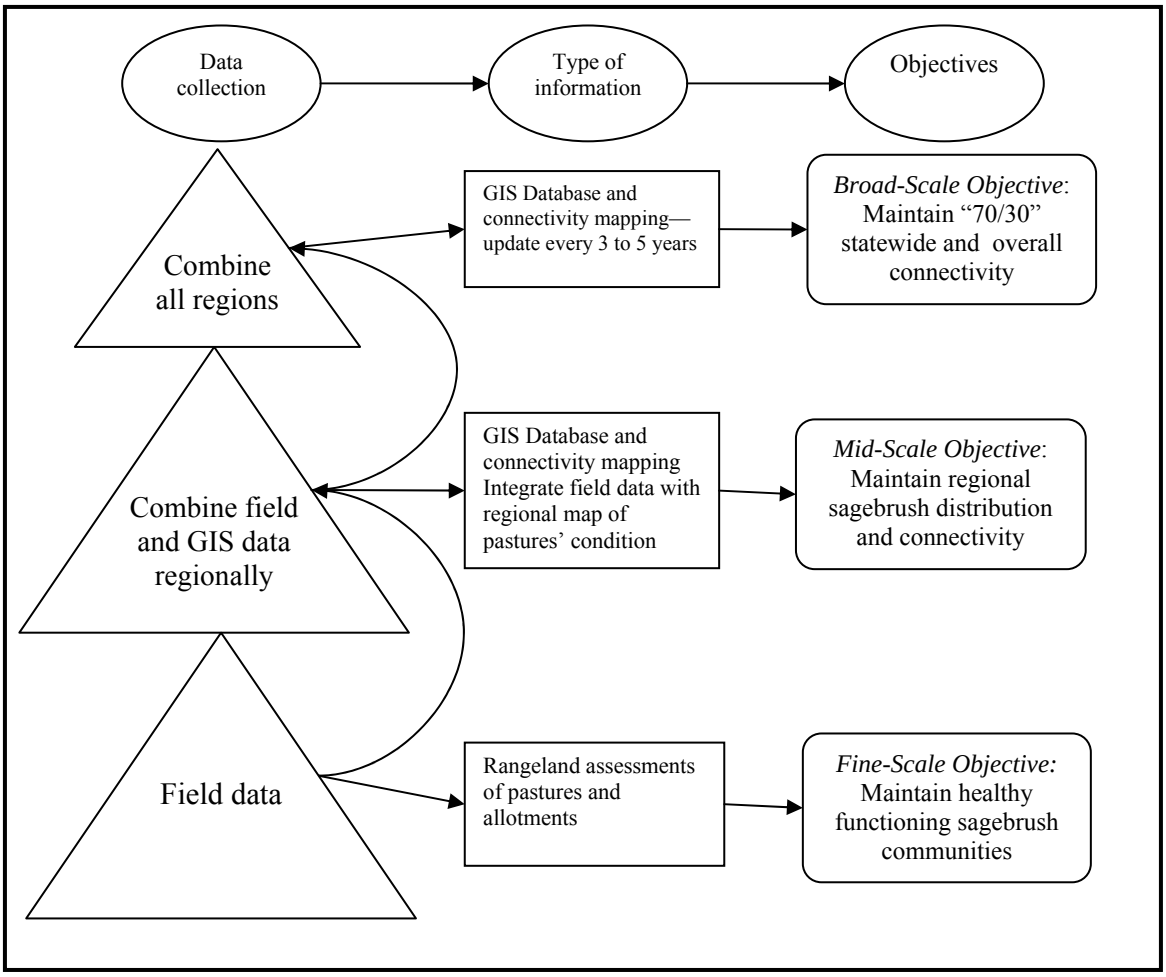

Figure 23. Data collection and information used to evaluate habitat objectives for sage-grouse at fine, mid and broad scales in Oregon.

Fine-scale.— The presence of sagebrush cover, its configuration and spatial relationships are likely important. There is an opportunity to combine techniques of the mid-scale and site-level, to increase the understanding of sage-grouse ecology. The task is to inventory landscape characteristics of a given block of habitat as well as the shrub, forb, and grass composition of the site. Ideally the "habitat blocks" would be identified as breeding, brood-`rearing or winter habitat. U.S. Department of Interior (2005) provided the following description of fine scale monitoring: (which excluded landscape statistics, although they should be applied to this inventory).

The multi-scale approach requires integration of GIS and field techniques to identify the extent of sagebrush habitats in a region (Appendix II). At the **broad** and **mid-scale** habitat quality can be evaluated with landscape statistics that describe, for example, **patch size**, **patch connectivity, patch configuration** (area/perimeter ratios), and **patch isolation**. Ultimately, habitat inventory is most beneficial when conducted in known seasonal habitats. Generally, the larger and more

contiguous habitats will have a better quality rating. However, baseline data are lacking to compare these landscape metrics with respect to population trends. The most recent landcover maps may serve as a baseline from which to track changes in these metrics with respect to populations.

At the allotment/pasture level (**fine scale**), line intercept (transects) are used to measure the canopy cover of sagebrush and quadrats (40 x 50 cm frame) for herbaceous cover understory vegetation across the pasture or at sites within it. As the condition of each pasture is documented, information can be added as a data field in the existing GIS database. Thus, each pasture will be represented in the GIS with an attribute indicating condition, which will include at a minimum sagebrush community type (class 1-5), and a proportional value as to how much of a given polygon is in that type. This will allow for easy quantification and inventory of a particular area, ultimately providing an assessment at the mid- and broad-scale. This assessment technique provides a comprehensive method for assessing rangeland health, while inventorying wildlife habitats.

Research Needs

Rowland and Wisdom (2002) outlined 8 areas of research for Oregon sage-grouse based on current knowledge gaps in the state. Their prioritized list recognized a need to identify spatial structure (i.e., geographic subdivisions) of populations and that "fall and winter studies were not well represented in the literature compared to studies of grouse during brood rearing, lekking, or nesting periods." Furthermore, little work has been done in Oregon to identify if populations are largely sedentary or migratory and the interrelationship between breeding and wintering areas.

Basic research.—Because much of the sage-grouse research in Oregon has focused on Hart Mountain National Antelope Refuge, there is a lack of basic ecology from regions such as Baker County, Trout Creek Mountians, most of Malheur County, and areas north of Burns. A well designed research project can provide basic information and address some of the more complex questions identified below.

Population ecology—Understanding annual survival and seasonal mortality is critical and largely undocumented in Oregon. Similarly, there is a need to refine ,methods to estimate spring population size.

A greater understanding of the effects of harvest on sage-grouse in Oregon is needed. In Oregon with established management units there is potential to conduct experiments with hunting seasons to better understand the effects of harvest on population dynamics.

Benedict et al. (2003) examined the spatial structuring (geographic subdivision) and genetic diversity of sage-grouse populations throughout the southern portion of Oregon. However, it would be beneficial to determine if the Baker and Prineville birds are genetically isolated from the rest of the state. Generally, a more detailed account of sage-grouse (sub)populations would be instrumental in determining mechanisms which may be limiting gene flow in the state.

Data are still lacking that demonstrate the level of connectivity of populations and the sedentary and/or migratory behavior of sage-grouse throughout much of the state. Identifying seasonal

movements and migrations are key factors in assessing and monitoring core sage-grouse habitats (seasonal and yearlong) and its management (Connelly et al. 2000b).

Similarly there are no data describing natal dispersal of sage-grouse in Oregon, and how that process impacts the spatial structuring of populations.

Sagebrush ecology—One of the greatest threats facing sage-grouse is loss of habitat to invasive species and considerable research is needed to improve current knowledge of habitat maintenance (prevention) and enhancement (rehabilitation). The effectiveness and use of non-native plantings (namely crested wheatgrass) as a stabilizing mechanism for disturbed sagebrush communities, and methods to return those sites to native shrublands and grasslands should be identified.

The influence of community scale structural heterogeneity on habitat selection and reproductive success should be evaluated. For example, one would use 2 sagebrush communities, both with 15% shrub cover as the observational unit. One of the communities has a few dense patches of shrubs with grass in between patches. The other has homogenous shrub distribution across the entire community. The primary question is: how well do these 2 communities serve the various habitat needs of sage-grouse (particularly nesting)?

There are few data that directly demonstrate the effects of livestock grazing on sage-grouse populations or habitat structure and composition, and research in the area would be a significant contribution. In particular, examining how timing, duration, intensity, and season of grazing effect sage-grouse productivity and/or the influence on the vegetative community (i.e., changes in residual cover and forb production). There is a limited understanding of livestock grazing impacts on vegetation at large time and spatial scales. Given the prevalence of livestock grazing across the range of sage-grouse, it is critical that the knowledge of the impacts of this practice on sage-grouse and other sage-brush obligate species be improved.

SOCIO-ECONOMIC FACTORS AND SAGE-GROUSE CONSERVATION

Sage-grouse are a valued game bird species to hunters in Oregon and abroad. Similarly, birdwatchers are drawn to the elaborate breeding displays and make concerted efforts to observe sage-grouse each spring. In 2001, all wildlife viewing generated $769.4 million and 21,535 jobs statewide (Caudill 2003). All hunting activity generated $879.6 million and 8,279 jobs and upland bird hunting contributed $39 million and 767 jobs to these totals (IAFWA 2002). While the direct economic impact of these activities to local communities is unknown, it is clear that the species has both societal and economic values. The habitats on which sage-grouse depend are highly valued for other recreation as well: trails for OHV, horseback riding, rock hunting and other recreational pursuits (e.g., camping, hiking, big game hunting). The actual economic impacts of these activities are largely unknown, but likely contribute to seasonally local economies.

Currently, livestock use of sagebrush habitat for forage is the largest economic activity in Oregon sage-grouse range. While there are significant economic issues with regards to livestock grazing (Torell et al. 2002), there is an important social value associated with a ranching lifestyle as well.

The economic impacts of sage-grouse conservation on other activities will vary regionally, but are currently unknown except for one modeling study on the economics of grazing. Modeling the removal of early-spring grazing from public lands indicated substantial economic impacts for ranches in Oregon, Idaho, and Nevada (Torell et al. 2002).

OTHER SPECIES ASSOCIATED WITH SAGEBRUSH STEPPE HABITATS

Managing sagebrush communities as dynamic systems in various stages of succession will provide habitat for the maximum number of species. Even those species using grassland dominated stands as habitat should have ≤30% of a region to breed and forage. The habitats providing cover and forage for the largest number of species will occupy ≥70% of a region. Considering other species in the Plan is important because conservation efforts for individual species will be time-consuming and costly, and a species-by-species approach is not likely to include all structural components and functional relationships of sagebrush communities. Despite the potential problems with single-species management, many species like sage-grouse require individual attention, particularly where conservation efforts will require considerable effort. In addition, some kinds of species warrant management emphasis because their conservation will provide benefits to other species. In many situations, management is most efficient when focused directly on the community or the assemblage of interacting species. Our main focus in this effort was on vertebrate animals that occur in Oregon, because this was the group for which most published information was available.

Several articles have been published that provide descriptions species associated with shrub steppe communities (Paige and Ritter 1999, Wisdom et al. 2000, Vander Haegen et al. 2001, Rowland and Wisdom 2002, Dobkin and Sauder 2004). These references provided the major source of information for this section, and their lists of species differ because of differing objectives and geographic emphasis. For example, Dobkin and Sauder (2004) list 37 and 24 species of birds and mammals, respectively that are closely associated with shrub steppe communities in the Intermountain West. Wisdom et al. (2000) list 16 species of birds, 10 mammals, and 5 reptiles that are associated with shrub steppe in the Interior Columbia Basin. More specific to this effort, Vander Haegen et al. (2001) identified 103 species of birds, mammals, reptiles, and amphibians that are generally associated with shrub-steppe communities and 49 species that are closely associated with sagebrush communities in Oregon and Washington (Table 21). In addition, they identified 41 species that depend on shrubs, primarily sagebrush, as key elements in their life history where shrubs are used either for nesting, foraging, or key winter habitat (i.e., sagebrush obligates). Therefore removal of shrub habitats due to fire, mechanical conversion, or invasion of exotic species may result in reduced population sustainability of these species, and can cause dramatic changes in the wildlife community. Many of these species are considered sagebrush obligates (see below) like sage-grouse.

Birds

Vander Haegen et al. (2001) list 44 species of birds that are generally associated with sagebrush communities in Oregon and Washington (Table 21). Twenty-two of these species use shrubs as a key element in their life history requirements. Most breeding birds in shrub steppe are migrants that winter south of the United States and are therefore called Neotropical Migrants.

The winter bird community is supplemented by species that breed in higher elevations or more northern latitudes but spend part of the winter in shrub steppe, including rough-legged hawks, northern shrikes, and Townsend's solitaires. Although most of these species are songbirds, 2 native gallinaceous birds (sage-grouse, Coulmbian sharp-tailed grouse) and several predatory birds (burrowing owls, short-eared owls, ferruginous hawks, Swainson's hawks, and long-eared owls) occur regionally. The list of species that are considered obligates or near-obligates usually includes sage-grouse, sage sparrow, Brewer's sparrow, vesper sparrow, black-throated sparrow, lark sparrow, lark bunting (not common in Oregon), loggerhead shrike, green-tailed towhee, and sage thrasher.

Population trends of birds associated with shrub steppe in the Intermountain West indicate that 16 to 25 upland birds species are declining in one or more regions of their geographic range (Dobkin and Sauder 2004). Based on Breeding Bird Surveys, long- and short-term declines have declined for 10 species for 13 species, respectively. Five of 12 riparian species exhibited significant long-term or short-term declines, and only 4 of 37 species exhibited significant long-term increases. Consequently, there is concern for the population status of breeding birds in shrub steppe communities in the Intermountain West, and some of these species are considered candidates for federal listing in the future.

Table 21. Numbers of species associated with shrubsteppe habitat and shrubs as a key element in Oregon and Washington (from Vander Haegen et al. 2001)

	Shrubsteppe habitat		
Species Group	Generally Associated	Closely Associated	Shrubs as a key element
Birds	44	22	22
Mammals	26	27	12
Reptiles	20	0	6
Amphibians	9	0	1
Total	101	49	41

Mammals

Vander Haegen et al. (2001) list 27 species of mammals that are closely associated with shrub steppe communities in Oregon and Washington and. Of these species, 12 are dependent on shrubs as a key element in their life history. Species richness is typically related to the structural complexity of the dominant vegetation. The list of species includes a variety of small to medium-sized mammals, carnivores, and ungulates. Small mammal communities include deer mouse, Great Basin pocket mouse, northern grasshopper mouse, sagebrush vole, and vagrant shrew. Medium-sized mammals of the shrub steppe include several lagomorphs, such as white-tailed and black-tailed jackrabbits, mountain cottontails, pygmy rabbits, and species of ground

squirrels of the genus *Spermophilus*. Ground squirrels are important prey for many avian and mammalian carnivores in shrub steppe communities. Carnivores of the shrub steppe include badgers, long-tailed weasels, and coyote. In addition, kit fox occur in low densitites in extreme southeastern Oregon. The 2 most prominent large mammals in shrub steppe are mule deer and pronghorn; only pronghorn is a shrub steppe specialist. The list of mammals considered obligate or near obligates species includes the sagebrush vole, pygmy rabbit, Townsend's ground squirrel, kit fox, and pronghorn. For example, pygmy rabbits are uncommon and found primarily in areas dominated by tall, dense stands of sagebrush on deep soils that allow for their burrowing life style. Sagebrush voles have a strong affinity for sagebrush but may occur in areas lacking sagebrush overstory if grass understories are thick enough. Pronghorns are the only large herbivore that have a strong association for sagebrush and are most successful where sagebrush species are available for winter forage.

In contrast to the Breeding Bird Surveys for birds, there are no long-term standardized surveys for mammal populations (Dobkin and Sauder 2004). Consequently, there is little information on the long-term trends in mammal populations in sagebrush communities. Nonetheless, Dobkin and Sauder 2004 found only one species of mammal in more than 70% of sampled localities, and no species was found in more than 62% of potentially suitable locations. Trapping studies showed a negative response of 12 species of small mammals to livestock grazing, and 8 species have been demonstrated to respond negatively to the presence of exotic grasses. Consequently, alteration of sagebrush communities may affect long-term suitability of these habitats for several mammal species (Dobkin and Sauder 2004).

Reptiles and Amphibians

Because xeric climatic conditions and lack of open water, species richness and density of amphibians in shrub steppe communities is low. Nine species of amphibians are generally associated with shrub steppe habitats, but none are closely associated with these habitats (Table 21). Only 2 species of salamander occur in shrub steppe communities in Oregon: long-toed salamander, and tiger salamander (Vander Haegen et al. 2001). Seven of 11 species of native toads and frogs occur in shrub steppe habitat; Great Basin spadefoot toads, western toad, and Woodhouse's toad are the species most likely to be found in this habitat. Columbian spotted frogs and northern leopard frogs are found in shrub steppe communities but usually in close association with standing water.

In contrast to amphibians, species richness and density of reptiles is relatively high in shrub steppe communities because of the warm and dry climatic conditions. Twenty species of reptiles are generally associated with shrub steppe habitats in Oregon and Washington (Table 21). Lizards are the group of reptiles most closely associated with shrub steppe. The Mojave black-collared lizard, long-nosed leopard lizard, and desert horned lizard occur only in shrub steppe, dwarf shrub steppe, and desert playa/salt scrub shrublands. Ten of 15 snake species in Oregon and Washington occur in shrub steppe communities or related shrub communities. The ground snake, longnose snake, and striped whipsnake are associated with shrub steppe habitats, and 6 other species (racer, gopher snake, western rattlesnake, rubber boa, western terrestrial garter snake, and common garter snake) occur in a variety of habitats including shrub steppe. Although

Table 22. Terrestrial vertebrate species associated with sagebrush ecosystems and status in Oregon (adapted from Wisdom et al. 2000 and Rowland and Wisdom 2002).[a]

Common Name	Scientific Name	ODFW Status[b]
Birds:		
Ferruginous hawk	*Buteo regalis*	SC
Burrowing owl	*Athene cunicularia*	SC[c]
Short-eared owl	*Asio flammeus*	NL[d]
Vesper sparrow	*Pooecetes gramineus*	SC[e]
Lark sparrow	*Chondestes grammacus*	NL
Brewer's sparrow	*Spizella breweri*	NL
Black-throated sparrow	*Amphispiza bilineata*	SP
Sage sparrow	*Amphispiza belli*	SC
Grasshopper sparrow	*Ammodramus savannarum*	SV/SP
Western meadowlark	*Sturnella neglecta*	SC[f]
Greater sage-grouse	*Centrocercus urophasianus*	SV[g]
Columbian sharp-tailed grouse	*Tympanuchus phasianellus*	NL
Sage thrasher	*Oreoscoptes montanus*	NL
Loggerhead shrike	*Lanius ludovicianus*	NL
Mammals:		
Preble's shrew	*Sorex preblei*	NL
Pygmy rabbit	*Brachylagus idahoensis*	SV
Sagebrush vole	*Lemmiscus curtatus*	NL
White-tailed antelope squirrel	*Ammospermophilus leucurus*	SU
Washington ground squirrel	*Spermophilus washingtoni*	LE
Kit fox	*Vulpes macrotis*	LT
Pronghorn	*Antilocapra americana*	NL
Reptiles:		
Mojave black-collared lizard	*Crotaphytus bicinctores*	SV
Longnose leopard lizard	*Gambelia wislizenii*	SU
Striped whipsnake	*Masticophis taeniatus*	NL
Ground snake	*Sonora semiannulata*	SP

[a]Criteria for identifying species of concern included habitat conditions resulting in increased likelihood of population isolation, a global ranking of 1 or 2 by The Nature Conservancy, and species whose habitats were projected to increase or decrease significantly under a land management alternative as part of the Interior Columbia Basin Ecosystem Management Project. Further details in Volume I, Wisdom et al. (2000).
[b]Status as of 2000. Sensitive species are those defined as "naturally reproducing native vertebrates which are likely to become threatened or endangered throughout all or a significant portion of their range in Oregon." Sensitive species codes begin with "S" and are further defined as follows: SC = critical; SP = peripherally or naturally rare; SU = undetermined status; and SV = vulnerable (Oregon Natural Heritage Program 2001). LE = listed as endangered and LT = listed threatened.
[c]status reported for western subspecies only (*A. c. hypugaea*).
[d]Denotes a species not listed as sensitive by Oregon Department of Fish & Wildlife.
[e]Status reported for Oregon subspecies only (*P. g. affinis*).
[f]Status applies to only 1 ecoregion, or a set of ecoregins, in the state, not the species entire range in the state.
[g]Status applies only to populations in the Ochoco-Blue Mountains, Columbia Plateau, and East Cascade Range ecoregions.

species richness of amphibians and reptiles is lower than that of birds and mammals in shrub steppe in Oregon and Washington, they can be important ecologically. Because the long-term conversion efficiencies of energy are many times higher for amphibians and reptiles, they can contribute disproportionately to biomass production and make large amounts of energy available to other trophic levels (Vander Haegen et al. 2001).

Threatened, Endangered, and Species of Concern

As of the year 2000, there were 26 species of birds, mammals, and reptiles associated with shrub steppe communities that were threatened, endangered, or considered sensitive (Table 22, Wisdom et al. 2000, Rowland and Wisdom 2002). However, many of these species are common in Oregon. Of this total, 14 species are birds (including sage-grouse), 8 are mammals, and 4 are reptiles. This list provides examples of other species that are currently listed as threatened or endangered or are of concern and may be proposed for listing in the future. Consequently, it is important for this Plan to identify opportunities to benefit these species and not to impact them negatively while managing for sage-grouse.

Summary of Sagebrush Associated Species

In consideration of other species associated with shrub steppe communities, this section emphasizes species that are broadly or closely associated with these habitats plus those listed as threatened, endangered, or of special concern. The list includes approximately 150 species of vertebrates, most of which are birds and mammals. Many of these species should benefit from the Plan for sage-grouse in Oregon. Although the exact habitat associations or local distributions of these species are unknown, large blocks of sagebrush will likely provide habitat for many of them. There is a need for more surveys, research, and monitoring of management activities for many sagebrush associated species. Information about their ecological requirements is needed to develop management strategies to sustain populations of all organisms associated with shrub steppe communities. As adaptive management for sage-grouse proceeds during the next decades, the effects of management on other species will need to be considered so they will not be negatively affected.

SYNOPSIS

Sage-grouse are sagebrush obligates requiring large areas with a variety of sagebrush communities to meet life-history needs. The primary objective of this Plan is to maintain large expanses of intact sagebrush habitat for the benefit of sage-grouse and other sagebrush associated species. Based on the assessment of habitat and populations, several core areas of habitat (>100,000 acres) have sustained populations over the last 20+ years. Protecting large expanses of sagebrush communities from fragmentation and habitat degradation should ensure sustainable populations into the future. The conservation guidelines provided in this Plan will assist local implementation groups and land managers maintain and enhance sagebrush communities throughout Oregon; and ultimately enable Oregon to achieve population and habitat objectives provided.

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GLOSSARY

Allotment- An area designated for the use of a prescribed number and kind of livestock under one plan of management.

Animal Unit- Considered to be one mature cow (1000 lb), either dry or with calf up to 6 months of age, or the equivalent based on average daily forage consumption of 26 lb dry matter/day.

Animal-Unit-Month (AUM)- The amount of oven-dry forage (forage demand) required by one animal unit for a standardized period of 30 animal-unit-days. Not synonymous with animal month.

BLM- U.S. Department of Interior, Bureau of Land Management administers significant areas of public land that are sage-grouse habitat in Oregon and western U.S.

Connectivity model-geographic information system analysis depicting connected sagebrush habitats, it DOES NOT depict understory condition of the sagebrush patch, the output is a map

Forb-an herbaceous broad-leafed plant

DSL-Oregon Department of State Lands, administers several thousand acres of state owned rangeland in eastern Oregon managed to raise money for Oregon schools

Habitat Viability- refers to the presence of available sagebrush in a given community, the ranking of viability of high, moderate, low, or negligible is a result of the **connectivity model** inputs

Lek-an area where male sage-grouse display during the breeding season to attract females (also referred to as strutting-ground)

No surface occupancy- use or occupancy of the land surface for fluid mineral exploration or development is prohibited to protect identified resource values.

No surface use- use of the land surface for fluid mineral exploration or development is protected during certain time periods to protect identified resource values. This does not apply to on-going production.

NRCS- U.S. Department of Agriculture, Natural Resource Conservation Service, provides technical expertise on conservation practices for to private land owners, administers a number of federal conservation programs under the Farm Bill for private lands

ODFW-Oregon Department of Fish and Wildlife, agency mandated to manage the states fish and wildlife resources

Productivity-an estimate of nest success and chick survival in a given year determined from the number of chicks observed per female. These data are obtained either from brood routes or wing-data obtained from hunter harvests.

Residual cover- remaining dead standing herbaceous cover from previous growing season consider an important feature for sage-grouse nesting habitat

RMP- resource management plan, a BLM planning document specific to resource areas there are 8 resource areas in Oregon

Steady state- vegetation community requiring management intervention to change community type to one more desirable for sage-grouse habitat

Transitory state-vegetation community in the process of succession moving from early to later seral stages

USFWS-U.S. Department of Interior, U.S. Fish and Wildlife Service, mandated to manage migratory species (birds), national wildlife refuges, and protect and recover endangered or threatened species

LITERATURE CITED

Aldridge, C. L. 2005. Identifying habitats for persistence of greater sage-grouse (*Centrocercus urophasianus*) in Alberta, Canada. Dissertation, University of Alberta, Regina, Alberta.

Aldridge, C. L., and R. M. Brigham. 2001. Nesting and reproductive activities of greater sage-grouse in a declining northern fringe population. Condor 103: 537-543.

American Ornithologists' Union. 1998. Check list of North American Birds, 7th ed. American Ornithologists' Union, Washington, D.C., USA.

Asher, J. 1994. Crushing the wilderness spirit: alien plant invasions. Unpublished report on file: U.S. Department of the Interior, Bureau of Land Management, Oregon State Office, Portland, Oregon, USA.

Autenrieth, R. E. 1981. Sage grouse management in Idaho. Idaho Department of Fish and Game, Boise, Idaho, USA.

Back, G. N., M. R. Barrington, and J. K. McAdoo. 1987. Sage grouse use of snow burrows in northeastern Nevada. Wilson Bulletin 99: 488-490.

Baker, H. G. 1986. Patterns of plant invasion in North America. Pages 44-57 in: H. A. Mooney and J. A. Drake, editors. Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York USA.

Barnett, J. K., and J. A. Crawford. 1994. Pre-laying nutrition of sage grouse hens in Oregon. Journal of Range Management 47: 114-118.

Barney, M.A., and N. C. Frischknecht. 1974. Vegetation changes following fire in the pinyon-juniper type of west-central Utah. Journal of Range Management 27:91-96.

Bates, J., K. Davies, and R. Miller. 2004. Ecology of the Wyoming big sagebrush alliance in the northern Great Basin: 2004 Progress Report. Eastern Oregon Agricultural Research Center. Burns, Oregon.

Batterson, W. M., and W. B. Morse. 1948. Oregon sage grouse. Oregon Fauna Series 1. Portland Oregon, USA.

Bazzaz, F. A. 1986. Life history of colonizing plants: Some demographic, genetic, and physiological features. Pages 96-110 in: H. A. Mooney and J. A. Drake, editors. Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York USA.

Beck, T. D. I. 1975. Attributes of a wintering population of sage grouse, North Park, Colorado. Thesis, Colorado State University, Fort Collins, USA.

Beck, T. D. I. 1977. Sage grouse flock characteristics and habitat selection in winter. Journal of Wildlife Management 41: 18-26.

Belcher, J. W., and Wilson, S. D. 1989. Leafy spurge and species composition of a mixed-grass prairie. Journal of Range Management 42**:**172-175.

Benedict, N. G., S. J. Oyler-McCance, S. E. Taylor, C. E. Braun, and T. W. Quinn. 2003. Evaluation of the eastern (*Centrocercus urophasianus urophasianus*) and western (*Centrocercus urophasianus phaios*) subspecies of sage-grouse using mitochondrial control-region sequence data. Conservation Genetics 4: 301-310.

Bergerud, A. T. Mating systems in grouse. 1988. Pages 439-472 in: Bergerud, A. T. and Gratson, M. W. Adaptive strategies and population ecology of northern grouse. University of Minnesota Press, Minneapolis, USA.

Berry, J. D., and R. L. Eng. 1985. Interseasonal movements and fidelity to seasonal use areas by female sage grouse. Journal of Wildlife Management 49: 237-240.

Blus, L. J., C. S. Staley, C. J. Henny, G. W. Pendleton, T. H. Craig, E. H. Craig, and D. K.

Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management 53: 1139-1146.

Borell, A. E. 1939. Telephone wires fatal to sage grouse. Condor 41: 85-86.

Box, T.W. 1990. Rangelands, Pages 101-120. in: R. N. Sampson, and W. Hair, editors. Natural Resources for the 21st Century. Island Press, Washington D.C., USA.

Braun, C. E. 1987. Current issues in sage grouse management. Western Association of State Game and Fish Commissioners 67: 134-144.

Braun, C. E. 1998. Sage grouse declines in western North America: what are the problems? 78: 139-156.

Braun, C. E., and T. D. I. Beck. 1985. Effects of changes in hunting regulations on sage grouse harvest and populations. Pages 335-343 in: S. L. Beasom and S. F. Roberson, editors. Game Harvest Management. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA.

Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildlife Society Bulletin 5: 99-106.

Braun, C. E., O. O. Oedekooven, and C. L. Aldridge. 2002. Oil and gas development in western North America: effects on sagebrush steppe avifauna with particular emphasis on Sage Grouse. Transactions of North American Wildlife and Natural Resources Conference 67: 337-349.

Burkhardt, J.W. 1996. Herbivory in the Intermountain West. Forestry, Wildlife and Range Experiment Station Bulletin 58. University of Idaho, Moscow, Idaho, USA.

Call, M. W. 1979. Habitat requirements and management recommendations for sage grouse. U.S. Department of Interior, Bureau of Land Management. Technical Note 330.

Call, M. W., and C. Maser. 1985. Wildlife habitats in managed rangelands--the Great Basin of southeastern Oregon: sage grouse (*Centrocercus urophasianus*). U.S. Department of Agriculture, Forest Service. General Technical Report PNW-187.

Caudill, J. 2003. National and state economic impacts of wildlife watching: addendum to the 2001 national survey of fishing, hunting and wildlife associated recreation. U.S. Fish and Wildlife Service. Report 2001-2. Washington D.C., USA.

Coates, P. S., and D. J. Delehanty. 2004. The effects of raven removal on sage grouse nest success. Vertebrate Pest Conference 21: 17-20.

Coggins, K. A. 1998. Relationship between habitat changes and productivity of sage grouse at Hart Mountain National Antelope Refuge, Oregon. Thesis. Oregon State University, Corvallis, USA.

Commons, M. L., R. K. Baydack, and C. E. Braun. 1999. Sage grouse response to pinyon-juniper management. Pages 238-239 in Proceedings: ecology and management of pinyon-juniper communities. S. B. Monsen and R. Stevens, editors. U.S. Department of Agriculture, Forest Service. RMRS-P9.

Connelly, J. W. 1982. An ecological study of sage grouse in southeastern Idaho. Ph.D. dissertation, Washington State University,

Connelly, J. W., and C. E. Braun. 1997. Long-term changes in sage grouse *Centrocercus urophasianus* populations in western North America. Wildlife Biology 3: 229-234.

Connelly, J. W., and O. D. Markham. 1983. Movements and radionuclide concentrations of sage grouse in southeastern Idaho. Journal of Wildlife Management 47: 169-177.

Connelly, J. W., W. J. Arthur, and O. D. Markham. 1981. Sage grouse leks on recently disturbed sites. Journal of Range Management 34: 153-154.

Connelly, J. W., H. W. Browers, and R. J. Gates. 1988. Seasonal movements of sage grouse in southeastern Idaho. Journal of Wildlife Management 52: 116-122.

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003a. Monitoring of greater sage-grouse habitats and populations. Experiment Station Bulletin 80 University of Idaho. Moscow, USA.

Connelly, J. W., A. D. Apa, R. B. Smith, and K. P. Reese. 2000a. Effects of predation and hunting on adult sage grouse *Centrocercus urophasianus* in Idaho. Wildlife Biology 6: 227-232.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agencies. Cheyenne, Wyoming, USA.

Connelly, J. W., K. P. Reese, E. O. Garton, and M. L. Commons-Kemner. 2003b. Response of greater sage-grouse *Centrocercus urophasianus* populations to different levels of exploitation in Idaho, USA. Wildlife Biology 9: 335-340.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000b. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28: 967-985.

Connelly, J. W., W. L. Wakkinen, A. D. Apa, and K. P. Reese. 1991. Sage grouse use of nest sites in southeastern Idaho. Journal of Wildlife Management 55: 521-524.

Connelly, J. W., R. A. Fischer, A. D. Apa, K. P. Reese, and W. L. Wakkinen. 1993. Renesting by sage grouse in southeastern Idaho. Condor 95: 1041.

Connelly, J. W., K. P. Reese, W. L. Wakkinen, M. D. Robertson, and R. A. Fischer. 1994. Sage

grouse response to a controlled burn: movements, distribution, survival, and reproduction of sage grouse before and after a fire (Job 1). The effects of a controlled burn on sage grouse winter and nesting habitat (Job 2). Federal Aid Report, Idaho Department of Fish and Game. Pocatello, Idaho.

Cottam, W. P. and G. Stewart. 1940. Plant succession as a result of grazing and of meadow desiccation by erosion since settlement in 1892. Journal of Forestry 38: 613-626.

Council for Agricultural Science and Technology. 1974. Livestock grazing on federal lands in the 11 western states. Journal of Range Management 27: 174-181.

Crawford, J. A. 1982. Factors affecting sage grouse harvest in Oregon. Wildlife Society Bulletin 10: 374-377.

Crawford, J. A., and L. A. Carver. 2000. Habitat use by sage grouse on the Beatys Butte allotment. Oregon State University. Final Report. Corvallis, USA.

Crawford, J. A. and R. S. Lutz. 1985. Sage grouse population trends in Oregon, 1941-1983. Murrelet. 66:69-74.

Crawford, J. A., R. A. Olson, N. E. West, J. C. Mosley, M. A. Schroeder, T. D. Whitson, R. F. Miller, M. A. Gregg, and C. S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habitat. Journal of Range Management 57: 2-19.

Dalke, P. D., D. B. Pyrah, D. C. Stanton, J. E. Crawford, and E. F. Schlatterer. 1963. Ecology, productivity, and management of sage grouse in Idaho. Journal of Wildlife Management 27: 811-841.

DeLong, A. K., J. A. Crawford, and D. C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial sage grouse nests. Journal of Wildlife Management 59: 88-92.

Dobkin, D. S., and J. D. Sauder. 2004. Shrub steppe landscapes in jeopardy. Distributions, abundances, and the uncertain future of birds and mammals in the Intermountain West. High Desert Ecological Research Institute, Bend, Oregon.

Drut, M. S. 1992. Habitat use and selection by sage grouse broods in southeastern Oregon. M.Sc. thesis, Oregon State University, Corvallis, USA.

Drut, M. S., W. H. Pyle, and J. A. Crawford. 1994. Diets and food selection of sage grouse chicks in Oregon. Journal of Range Management 47: 90-93.

Edelmann, F. B., M. J. Ulliman, M. J. Wisdom, K. P. Reese, and J. W. Connelly. 1998. Assessing habitat quality using population fitness parameters: a remote sensing/GIS-based habitat-explicit population model for sage grouse (*Centrocercus urophasianus*). Technical report 25 Idaho Forest, Wildlife and Range Experiment Station. University of

Idaho. Moscow, USA.

Edminster, F. C. 1954. American game birds of field and forest. Charles Scribner's Sons, New York, USA.

Eng, R. L. 1963. Observations on the breeding biology of male sage grouse. Journal of Wildlife Management 27: 841-846.

Eng, R. L., and P. Schladweiler. 1972. Sage grouse winter movements and habitat use in central Montana. Journal of Wildlife Management 36: 141-146.

Enyeart, G. W. 1956. Responses of sage grouse to grass reseeding in the pines area, Garfield County, Utah. Thesis. Utah State University, Logan, USA.

Fischer, R. A. 1994. The effects of prescribed fire on the ecology of migratory sage grouse in southeastern Idaho. Dissertation. University of Idaho, Moscow, USA.

Fischer, R. A., K. P. Reese, and J. W. Connelly. 1996a. An investigation on fire effects within xeric sage grouse brood habitat. Journal of Range Management 49: 194-198.

Fischer, R. A., K. P. Reese, and J. W. Connelly. 1996b. Influence of vegetal moisture content and nest fate on timing of female sage grouse migration. Condor 98: 868-872.

Fischer, R. A., A. D. Apa, W. L. Wakkinen, K. P. Reese, and J. W. Connelly. 1993. Nesting-area fidelity of sage grouse in southeastern Idaho. Condor 95: 1038-1041.

Gates, R. J. 1983. Sage grouse, lagomorph, and pronghorn use of a sagebrush grassland burn site on the Idaho National Engineering Laboratory. Thesis. Montana State University, Bozeman, USA.

Gates, R. J. 1985. Observations of the formation of a sage grouse lek. Wilson Bulletin 97: 219-221.

Gill, R. B. 1965. Distribution and abundance of a population of sage grouse in North Park, Colorado. Thesis. Colorado State University, Fort Collins, Colorado.

Gill, R. B. 1966. Weather and sage grouse productivity. Colorado Game, Fish and Parks Department. Game information leaflet no. 37.

Gray, G. M. 1967. An ecological study of sage grouse broods with reference to nesting, movements, food habits, and sagebrush strip spraying in the Medicine Lodge Drainage, Clark County, Idaho. Thesis. University of Idaho, Moscow, USA.

Gregg, M. A. 1991. Use and selection of nesting habitat by sage grouse in Oregon. Thesis. Oregon State University, Corvallis, USA.

Gregg, M. A., J. A. Crawford, M. S. Drut, and A. K. Delong. 1994. Vegetational cover and predation of sage grouse nests in Oregon. Journal of Wildlife Management 58: 162-166.

Hagen, C. A. 1999. Sage grouse habitat use and seasonal movements in a naturally fragmented landscape, northwestern Colorado. Thesis. Natural Resources Institute, University of Manitoba, Winnipeg, Canada.

Hanf, J. M., P. A. Schmidt, and E. B. Groshens. 1994. Sage grouse in the high desert of central Oregon: results of a study, 1988-1993. U.S.Department of the Interior, Bureau of Land Management. Portland, Oregon, USA.

Higby, L. W. 1969. A summary of the Longs Creek sagebrush control project [and effects on sage grouse]. Proceedings of the 6th Biennial Western States sage grouse Workshop. Rock Springs, Wyoming, USA.

Holocheck, J. L., H. Gomez, F. Molinar, and D. Galt. 1999. Grazing studies what we've learned. Rangelands 21: 12-16.

Hupp, J. W., and C. E. Braun. 1989. Topographic distribution of sage grouse foraging in winter. Journal of Wildlife Management 53: 823-829.

IAFWA. 2002. Economic importance of hunting in America. International Association of Fish and Wildlife Agencies. Washington DC.

Johnson, G. D., and M. S. Boyce. 1990. Feeding trials with insects in the diet of sage grouse chicks. Journal of Wildlife Management 54: 89-91.

Johnson, K. H., and C. E. Braun. 1999. Viability and conservation of an exploited sage grouse population. Conservation Biology 13: 77-84.

Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. Journal of Wildlife Management 33: 649-662.

Lacey, J. R., Marlow, C. B. and Lane, J. R. 1989. Influence of spotted knapweed (*Centaurea maculosa*) on surface runoff and sediment yield. Weed Technology 3**:**627-631.

Lancia, R. A., C. E. Braun, M. W. Collopy, R. D. Dueser, J. G. Kie, C. J. Martinka, J. D. Nichols, T. D. Nudds, W. R. Porath, and N. G. Tilghman. 1996. ARM! for the future: adaptive resource management in the wildlife profession. Wildlife Society Bulletin 24: 436-442.

Laycock, W. A., D. Loper, F. W. Obermiller, L. Smith, S. R. Swanson, P. J. Urness, and M. Vavra. 1996. Grazing on public lands. Council for Agriculture Science and Technology Task Force Report 129. Ames, Iowa, USA.

Lyon, L. A., and S. H. Anderson. 2003. Potential gas development impacts on sage grouse nest

initiation and movement. Wildlife Society Bulletin 31: 486-491.

Mack, R. N. 1986. Alien plant invasion into the Intermountain West: A case history. Pages 191-213 in: H. A. Mooney and J. A. Drake, editors. Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York USA.

Mack, R. N., and J. N. Thompson 1982. Evolution in steppe with few large, hoofed mammals. American Naturalist 119:757-773.

Macnab, J. 1983. Wildlife management as scientific experimentation. Wildlife Society Bulletin 11: 397-401.

Manville, A. M. II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. U.S. Department of Interior, Arlington,Virginia, USA.

Martin, N. S. 1970. Sagebrush control related to habitat and sage grouse occurrence. Journal of Wildlife Management 34: 313-320.

Maser, C., J. W. Thomas, and R. G. Anderson. 1984. Wildlife habitats in managed rangelands—the Great Basins of southeastern Oregon: The relationship of terrestrial vertebrates to plant communities and structural conditions. U.S. Department of Agriculture Forest Service. General Technical Report PNW-172.

McArthur, E. D. and J. E. Ott. 1996. Potential natural vegetation in the 17 conterminous western United States. Pages 16-28 in Proceedings: Shrub land ecosystem dynamics in a changing environment, J. R. Barrow, E. D. McArthur, R. E. Sosebee and R. J. Tausch, compilers. U.S. Department of Agriculture Forest Service. General Technical Report INT-GTR-338.

Miller, R. F., and J. A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. Great Basin Naturalist 55:37-45.

Miller, R. F. and J. A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management 52:550–559.

Miller, R. F., and L. L. Eddleman. 2001 Spatial and temporal changes of Sage Grouse habitat in the sagebrush biome. Oregon State University Agricultural Experiment Station Technical Bulletin 151.

Miller, R. F. and R. J. Tausch. 2001. The role of fire in juniper and pinyon woodlands: a descriptive analysis. Pages 15–30. in: K. E. M. Galley and T. P. Wilson, editors. Proceedings invasive species workshop: the role of fire in the control and spread of invasive species. Miscellaneous Publication 11. Tall Timbers Research Station Tallahassee, Florida, USA.

Miller, R. F., J. D. Bates, T. J. Svejcar, F. B. Pierson, L. E. Eddleman. 2005. Biology, Ecology,

and Management of Western Juniper (*Juniperus occidentalis*). Oregon State University, Agricultural Experiment Station, Technical Bulletin *In press*

Miller, R. F., T. J. Svejcar, and N. E. West. 1994. Implications of livestock grazing in the Intermountain sagebrush region: plant composition, p. 101-146. in: M. Vavra, W.A. Laycock, and R. D. Pieper, editors. Ecological Implications of Livestock Herbivory in the West. Society for Range Management Denver, Colorado, USA.

Monsen, S. B., R. Stevens, and N. L. Shaw. 2004. Restoring western ranges and wildlands. Department of Agriculture, Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-136-vol-2. Fort Collins, Colorado, USA.

Naugle, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, B. J. Moynahan, M. J. Holloran, K. Brown, G. D. Johnson, E. T. Schmidtmann, R. T. Mayer, C. Y. Kato, M. R. Matchett, T. J. Christiansen, W. E. Cook, T. Creekmore, R. D. Falise, E. T. Rinkes, and M. S. Boyce. 2004. West nile virus: pending crisis for greater sage-grouse. Ecology Letters 7: 704-713.

Nudds, T.D. 1999. Adaptive management and the conservation of biological diversity. Pages 177-193 in R. K. Baydack, H. Campa, and J. B. Haufler, editors. Practical approaches to conservation of biodiversity. Island Press, Washington D.C., USA.

Oakleaf, R. J. 1971. The relationship of sage grouse to upland meadows in Nevada. Thesis. University of Nevada, Reno, USA.

Olson, B. E. 1999. Impacts of noxious weeds on ecological and economic systems. Pages 4-18. in: Biology and Management of Noxious Rangeland Weeds R. L. S. and J. K. Petroff, editors. Oregon State University Press, Corvallis, USA.

Olson, R. A., and T. D. Whitson. 2002. Restoring structure in late-successional sagebrush communities by thinning with tebuthiuron. Restoration Ecology 10: 146-155.

Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight Western Working Group, Boise, USA.

Patterson, R. L. 1952. The sage grouse in Wyoming. Wyoming Game and Fish Commission and Sage Books, Inc., Denver, Colorado, USA.

Pellant, M. 1990. The cheatgrass-wildfire cycle--are there any solutions? Pages 11-17 in: McArthur, E. Durant, E. M. Romney, S. D. Smith, and P. T Tueller, compilers. Proceedings: symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. U.S. Department of Agriculture, Forest Service. General Technical Report. INT-276.

Pellant, M. 1996. Use of indicators to qualitatively assess rangeland health. Rangelands in a Sustainable Biosphere. Pages 434-435 in: N. E. West, editor. Society for Range Management. Denver, Colorado, USA.

Petersen, B. E. 1980. Breeding and nesting ecology of female sage grouse in North Park, Colorado. Thesis, Colorado State University, Fort Collins, USA.

Peterson, J. G. 1970. The food habits and summer distribution of juvenile sage grouse in central Montana. Journal of Wildlife Management 34: 147-155.

Pitman, J. C., C. A. Hagen, R. J. Robel, T. M. Loughin, and R. D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. Journal of Wildlife Management 69: 000-000.

Quigley, T.M., and S. J. Arbelbide, technical editors. 1997. Volume II of: An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. U.S. Department of Agriculture, Forest Service. General Technical Report PNW-GTR-405.

Randall, J. M. 1996. Weed control for the preservation of biological diversity. Weed Technology 10**:**370-383.

Remington, T. E., and C. E. Braun. 1985. Sage grouse food selection in winter, North Park, Colorado. Journal of Wildlife Management 49: 1055-1061.

Robel, R. J., J. A. Harrington, C. A. Hagen, J. C. Pitman, and R. R. Recker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by lesser prairie-chickens in southwestern Kansas. Transactions of the North American Natural Resources Conference 69:251-266.

Robertson, M. D. 1991. Winter ecology of migratory sage grouse and associated effects of prescribed fire in southeastern Idaho. Thesis, University of Idaho, Moscow, USA.

Rowland, M. M., and M. J. Wisdom. 2002. Research and problem analysis for greater sage-grouse in Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Final Report. La Grande, Oregon,USA.

Savage, D. E. 1968. The relationship of sage grouse to upland meadows in Nevada. Thesis, University of Nevada, Reno, USA.

Schroeder, M. A. 1997. Unusually high reproductive effort by sage grouse in a fragmented habitat in north-central Washington. Condor 99: 933-941.

Schroeder, M. A., and R. K. Baydack. 2001. Predation and the management of prairie grouse. Wildlife Society Bulletin 29: 24-32.

Schroeder, M. A., and L. A. Robb. 2003. Fidelity of greater sage-grouse *Centrocercus urophasianus* to breeding areas in fragmented landscapes. Wildlife Biology 9: 291-299.

Schroeder, M. A., J. R. Young, and C. E. Braun. 1999. Sage grouse (*Centrocercus*

urophasianus). No. 425 in: The birds of North America, A. Poole, and F. Gill, editors. The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C., USA.

Schroeder, M. A., D. W. Hays, M. F. Livingston, L. E. Stream, J. E. Jacobson, and D. J. Pierce . 2000. Changes in the distribution and abundance of sage grouse in Washington. Northwestern Naturalist 81: 104-112.

Schroeder, M. A., C. L. Aldridge, A. D. Apa, J. R. Bohne, C. E. Braun, S. D. Bunnell, J. W. Connelly, P. Diebert, S. C. Gardner, M. A. Hilliard, G. D. Kobriger, S. M. McAdam, C. W. McCarthy, J. J. McCarthy, D. L. Mitchell, E. V. Rickerson, and S. J. Stiver. 2004. Distribution of sage-grouse in North America. Condor 106: 363-376.

Schultz, B. 2004. Analysis of studies used to develop herbaceous height and cover guidelines for sage grouse nesting habitat. Agriculture Experiment Station SP-04-11. University of Nevada. Reno, USA.

Slater, S. J. 2003. Sage-grouse (*Centrocercus urophasianus*) use of different-aged burns and the effects of coyote control in southwestern Wyoming. Thesis, University of Wyoming, Laramie, USA.

Sveum, C. M., J. A. Crawford, W. D. Edge, and L. L. Cadwell. 1998. Sage grouse nesting habitats in southcentral Washington. Page16 *in* Proceedings of the 1st Joint Meeting: 20th Prairie Grouse Technical Council Meeting and 18th Western States Sage/Columbian Sharp-Tailed Grouse Workshop. Colorado Division of Wildlife, Fort Collins, Colorado .

Swenson, J. E. 1986. Differential survival by sex in juvenile sage grouse and Gray Partiridge. Ornis Scandinavica 17: 14-17.

Swenson, J. E., C. A. Simmons, and C. D. Eustace . 1987. Decrease of sage grouse *Centrocercus urophasianus* after ploughing of sagebrush steppe. Biological Conservation 41: 125-132.

Thurow, T. L., and C. A. Taylor. 1999. The role of drought in range management. Journal of Range Management 52:413-419.

Tobalske, C. 2002. Historic Vegetation (1909) from the Oregon Natural Heritage Program, 1:100,000. http://www.gis.state.or.us/data/metadata/k100/historic_vegetation.html

Torell, L. A., J. A. Tanaka, N. Rimbey, T. Darden, L. Van Tassell, and A. Harp. 2002. Ranch-level impacts of changing grazing policies on BLM land to protect the Greater Sage-Grouse: evidence from Idaho, Nevada, and Oregon. PACWPL Policy Paper SG-01-02. Policy Analysis Center for Western Public Lands, Caldwell, Idaho, USA.

Trueblood, R. W. 1954. The effect of grass reseeding in sagebrush lands on sage grouse populations. Thesis. Utah State University, Logan, USA.

Tyser, R.W., and C. H. Key. 1988. Spotted knapweed in natural area fescue grasslands: An ecological assessment. Northwest Science 62:151-160.

U.S. Department of Interior and U.S. Department of Agriculture. 1995. Federal wildland fire management policy and program review. Washington, D.C., USA.

U.S. Department of Interior. 2005. Technical Manual 417: Identifying and linking multiple scale vegetation components for conserving wildlife species that depend on big sagebrush habitat: a case example southeast Oregon, U.S. Department of Interior, Bureau of Land Management. Technical Publication. Lakewood, Colorado, USA.

U.S. Department of Interior. 1990. State of the public rangelands. Bureau of Land Management, U.S. Department of Interior, Washington, D.C., USA.

Valentine, J. F. 1990. Grazing management. Academic Press, Incorporated. San Diego, California, USA.

Vander Haegen, W. M., S. M. McCorquadale, C. R. Peterson, G. A. Green, and E. Yensen. 2001. Wildlife of eastside shrubland and grassland habitats. Pages 292-316. in: D.H. Johnson, and T.A. O'Neil, editors. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, USA.

Vitousek, P. M., C. M. D'Antonio, L. L. Loope, and R. Westbrooks. 1996. Biological invasions as global environment change. American Scientist 84**:**468-479.

Wagner, F.H. 1978. Livestock grazing and the livestock industry. Pages 121-145 in: H. Brokaw editor. Wildlife in America. Council on Environmental Quality, Washington D.C., USA.

Wakkinen, W. L. 1990. Nest site characteristics and spring-summer movements of migratory sage grouse in southeastern Idaho. Thesis. University of Idaho, Moscow, USA.

Wakkinen, W. L., K. P. Reese, and J. W. Connelly . 1992. Sage grouse nest locations in relation to leks. Journal of Wildlife Management 56: 381-383.

Wallestad, R. O. 1971. Summer movements and habitat use by sage grouse broods in central Montana. Journal of Wildlife Management 35:129-136.

Wallestad, R. 1975. Life history and habitat requirements of sage grouse in central Montana. Montana Department of Fish and Game, Helena, USA.

Wallestad, R., and D. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38: 630-633.

Wallestad, R., and P. Schladweiler. 1974. Breeding season movements and habitat selection of male sage grouse. Journal of Wildlife Management 38: 634-637.

Wallestad, R. O., and R. C. Watts. 1972. Small game research: Factors effecting annual sage grouse productivity in central Montana. Montana Department of Fish and Game .

Wallestad, R., J. G. Peterson, and R. L. Eng. 1975. Foods of adult sage grouse in central Montana. Journal of Wildlife Management 39: 628-630.

Willis, M. J. Sage Grouse habitat use and survival. 1990. Progress report, Study Number II, Project Number W-87-R-6, Oregon Department of Fish and Wildlife, Portland, USA.

Willis, M. J., G. P. Keister, Jr., D. A. Immell, D. M. Jones, R. M. Powell, and K. R. Durbin. 1993. Sage grouse in Oregon. Wildlife Research Report 15. Oregon Department of Fish and Wildlife. Portland, USA.

Wisdom, M. J., M. M. Rowland, B. C. Wales, M. A. Hemstrom, W. J. Hann, M. G. Raphael, S. Holthausen, R. A. Gravenmier, and T. D. Rich. 2002. Modeled effects of sagebrush-steppe restoration on greater sage-grouse in the Interior Columbia Basin, USA. Conservation Biology 16: 1223-1231.

Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D. Hargis, V. A. Saab, D.C. Lee, W. J. Hann, T. D. Rich, M. M. Rowland, W. J. Murphy, and M. R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. U.S. Department of Agriculture, Forest Service, General Technical Report PNW-GTR-485.

Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: a state-of-the-art review. U.S. Department of Agriculture, Forest Service, General Technical Report INT-58.

Young, J. A. and B. A. Sparks. 1985. Cattle in the cold desert. Utah. State University Press, Logan, USA.

Young, J. A, R. A. Evans, and J. Major. 1972. Alien plants in the Great Basin. Journal of Range Management 25:194-201.

Young, J. A., R. A. Evans, and P.T. Tueller. 1976. Great Basin plant communities-pristine and grazed, p. 187-215. in: R. Elston and P. Headrick, editors. Holocene environmental change in the Great Basin. Nevada Archeaological Survey, Research Paper 6, University of Nevada, Reno, USA.

Zablan, M. A., C. E. Braun, and G. C. White. 2003. Estimation of greater sage-grouse survival in North Park, Colorado. Journal of Wildlife Management 67: 144-154.

APPENDIX I: Sage-grouse Population Monitoring Procedures

SAGE-GROUSE LEK MONITORING, POPULATION ESTIMATION, AND HUNTING SEASON PROCEDURES/GUIDELINES

January 2002

INTRODUCTION

This protocol will standardize collection of data across the range of sage-grouse in Oregon and allow a better evaluation of sage-grouse population status and trend over time. The methodologies described are designed to help wildlife managers collect adequate data for annual sage-grouse breeding population evaluations where lack of resources (personnel, equipment or funding) precludes conducting research studies, complete inventories, or counts of all known leks (strutting grounds) each year.

Two types of lek situations can be encountered in the field: individual leks or lek complexes. A lek consists of a particular site where two or more males are displaying or strutting for the purpose of attracting and mating, two or more times during the breeding season. A lek complex is as an area that includes all closely allied leks within approximately one mile of each other (C.E. Braun pers. commun., 1999), which male grouse attend on different days during the breeding season. Counting either leks or lek complexes can be used for trend comparisons.

Three types of data have been identified which are needed to evaluate and monitor sage-grouse breeding population status. Each is described below:

1. Lek/Lek Complex Searches: Lek searches consist primarily of determining the location of all leks using aircraft. This allows us to identify the breeding distribution of sage-grouse, allows an assessment of the location of nesting habitat, and identifies future population inventory locations.

2. Trend Lek/Lek Complex Counts: Counts of the number of sage-grouse (primarily males) attending designated leks each spring. This survey provides a measure of population trend over time and serves as the basis for making annual population estimates.

3. Lek/Lek Complex Checks: Within Oregon there may be several hundred active sage-grouse leks, many more than can possibly be counted each year. Many of these leks are remote and difficult to access, especially in the wet, muddy, spring period. Therefore, some leks may not be part of annual trend lek counts. However, in terms of sage-grouse population trend, these leks must be monitored to determine if they remain active, and what level of attendance they have through time. In addition, lek checks allow lek extinction rates to be calculated.

LEK/LEK COMPLEX COUNTING PROCEDURES: The following lek counting procedures are based on the premise that once lek attendance begins, a high proportion of the males that attend any given lek do so each day. Some authors have indicated that each lek should be counted at least three (Jenni and Hartzler 1978) or four (Emmons and Braun 1984) times each season at 7 to 10 day intervals between mid- March and early mid-May to reduce count variability within a given year. The highest of the three/four (lek or lek complex) counts should be used in population estimation/modeling exercises (Emmons and Braun 1984, Autenreith 1981). The following criteria should guide lek counts in Oregon:

1. Counts should be conducted between March 15 and April 30 each year. (Note: There may be local variation between districts that will dictate minor modifications to these dates).

2. Counting ideally should be done within the first 2 hours after daybreak under clear, calm, and dry weather conditions.

3. Each lek/ lek complex should be counted at least 3 times at 7 to 10 day intervals; four counts are preferred.

4. If a lek complex is counted, all leks in the vicinity of the complex area should be counted on the same day. Count results for each individual lek site should be kept separate for individual lek trend comparisons. Data from all leks within lek complex should be summed and reported as a total for population trend analysis.

LEK SEARCH PROCEDURES

This type of survey is necessary to identify the entire breeding range of sage-grouse in Oregon, to identify lek establishment, and to identify leks for future inventory and population estimation. This complete systematic survey should be repeated every 10 years.

Location of new leks and status (active or inactive) of known leks, which are not counted regularly can be determined from verification of sighting reports to locating with aircraft. Vehicle searches are limited to areas adjacent to roads, and may not be the most practical method of locating lek sites throughout sage-grouse habitat in Oregon.

1. Lek searches are most successful within two hours after daybreak.

2. If done with aircraft, the search area should be flown in a transect pattern so that the entire area is systematically covered. The distance between transects will vary depending on light conditions (sunny vs. cloudy), ground vegetation structure (extensive sagebrush stands vs. juniper/sagebrush mixes), topography (rolling vs. flat), and type of aircraft (fixed wing vs. helicopter). However, a distance of 1/4 to 1/2 mile between transects is generally recommended.

3. Helicopters work best for aerial searches. If a helicopter is used, a recommended flight level is 23 to 30 feet above ground (Autenrieth 1981) although 50 to 100 feet will increase the margin of safety and may improve sighting distance. Past experience has shown that under optimal flying conditions, approximately one township can be surveyed in a 2 to 3 hour flight with a helicopter. Fixed wing aircraft surveys, preferably with a Super-cub, work well for lek occupancy checks where verification of occupancy is more important than count information.

Note: for aerial lek searches, the following information should be recorded on the provided Aerial Observer Field Data Form (Appendix A).

1. Date, observer name, and county/management unit where survey is being conducted.

2. Time when flying begins and ends, and the time when the survey begins and ends.

3. Lek name and/or designated number. Lek names may be derived from a nearby landmark or geographic feature.

4. Time lek is observed (hh:mm).

5. UTM coordinate of lek (using GPS unit).

6. Sky conditions (i.e. sunny, cloudy, raining or snowing).

7. Ground conditions (i.e. bare ground vs. snow covered).

8. Number of males, females, unclassified birds, and total number observed.

9. Directions to lek – If possible, a detailed description of the location and the best way to access each lek/lek complex should be recorded. This should include mileage from nearest town to junctions or crossroads, and directions to the lek location to the nearest $1/10^{th}$ mile.

10. In addition, at the conclusion of the day's survey efforts, all lek locations should be plotted on USGS topographical maps with an indication of number of birds present for future reference.

TREND LEK COUNT PROCEDURES

Individual leks, and/or lek complexes are to be surveyed annually from the ground to determine a breeding population estimate. A minimum of 10 leks or a total of 100 male sage-grouse should be counted in each WMU, where possible (C.E. Braun pers comm. 2000).

If possible, all known leks in an area (district or WMU) should be inventoried annually. Currently ODFW is developing a methodology for sub-sampling areas that cannot be censused completely each year.

"Lek Count" survey protocol are tied closely to "Lek Check" protocol, please review the following "lek check" section closely for proper recording procedures.

LEK CHECK PROCEDURES

Since lek occupancy changes over time, with use of some leks occasionally discontinued and new leks established, monitoring of all known leks and searches for new leks is an important facet of sage-grouse population trend monitoring. Emmons and Braun (1984) indicated that the number of leks increases with increasing sage-grouse populations and decreases with decreasing sage-grouse populations. Annually a random sample of leks should be monitored for activity, and size. For large areas with numerous leks, a sub-sample of all known leks should be checked periodically and at the same time searches for new leks can be conducted. Counts should be done at the same time.

However, if the lek check is done from the air, the accuracy of the count may be poor. Therefore, it is recommended that any total counts be done from the ground. If the count is done from a helicopter, it is advisable to land and survey the lek on foot since some birds will not flush from the helicopter (Autenreith 1981).

Annually at least 10% of the leks in a district should be checked and leks to be checked should be selected randomly. Lek checks should be done from the ground, when at all possible to determine the number of attending males and females. Fixed wing or helicopters may be used when ground counts are not possible. An inactive lek should be denoted as a "0" on the data sheet. Three to four counts per lek are adequate unless the biologist feels that the count wasn't representative of the lek. If this occurs then an additional count should be conducted. If three counts are done on one of these leks then not only does it count as a "lek check", but it can also be used as part of the annual population estimation, if birds are present.

Note: For lek checks, the following information should be recorded on the provided Ground Observer Field Data Form (Appendix B):

1. Date, observer name, and county/management unit where survey is being conducted.

2. Lek name and/or designated number. Lek names may be derived from a nearby landmark or geographic feature.

3. Time lek is observed (hh:mm).

4. UTM coordinate of lek (using GPS unit).

5. Township, Range, and Section number

6. Topographic map quad name

7. Elevation (derived from topo map)

8. Sky conditions (i.e. sunny, cloudy, raining or snowing).

9. Ground conditions (i.e. bare ground vs. snow covered).

10. Number of males, females, unclassified birds, and total number of birds observed.

11. Lek description (size and type). General description of the habitat type (i.e. wet meadow, dry meadow, pasture, low, Wyoming or mountain big sagebrush community, livestock feed or watering site, etc.) at the lek site and approximate size of the lek.

12. Distance to nearest juniper or other tree.

13. Distance to nearest road.

14. Photograph roll number and picture series. A total of 5 photographs of each lek should be taken. These should include one photograph each from the four cardinal compass directions and one from the vantage-point were observations of strutting birds were initially made.

15. Directions to lek – If possible, a detailed description of the location and the best way to access each lek/lek complex should be recorded. This should include mileage from nearest town to junctions or crossroads, and directions to the lek location to the nearest 1/10th mile.

LEK REPORTING PROCEDURES AND DATABASE MANAGEMENT

To ensure that information obtained from lek counting procedures is comparable from area to area, and from year to year, the following record keeping system is recommended for each district:

1. Assign all leks a common name that references a local land mark. In addition the lek database should include USGS quadrangle map name, wildlife management unit name/number, UTM coordinates (using a Global Positioning System (GPS)), map datum (found on map legend, i.e. NAD 1927, this relates to what USGS survey data was used in map development and is important in setting up a GPS unit before using it to find leks by UTM coordinates), legal description, date the lek was found, date of count, time of count, method of count and all count information collected on the lek. The database should be kept on a personal computer using compatible spreadsheet (Microsoft Excel) or database (Microsoft Access) software so that information can be shared among offices

2. Plot each lek location on a 7.5' USGS quadrangle map complete with GPS coordinates, common name, and year that the lek was located.

3. Maintain a lek database in each district. This database will include all known leks (active or inactive) so that the trend in the number of active leks can be assessed. Maintenance of this database should be coordinated with the local BLM/USFS offices.

4. Copies of each district database should be submitted to the Upland Bird Program Manager who will be responsible for maintaining a complete database listing all lek survey information for the entire state.

POPULATION ESTIMATION

Sage-grouse population estimates can be made from lek count information (Willis et al. 1993:31). Lek counts seldom represent the total attendance by males and females (Emmons and Braun 1984), therefore a population estimate based on lek attendance will provide a minimum population estimate. It has been postulated that for every male that attends a lek, approximately 2.0 females/male will also attend the lek (Johnsgard 1973:87). Analysis of Oregon wing data indicates that prior to winter there are 2 adult female (range 1.6 to 2.3 females per male) for every adult male in the population. Each modeled hunt unit should use it's long term average (from the wing data) number of adult female:adult male ratio. In addition, when conducting three counts/lek, Jenni and Hartzler (1978) estimated the peak count enumerates 90% of the male component of the population. C.E. Braun (CDOW, pers. Comm., 1994) suggests that in Oregon, three lek counts may only enumerate 75% of the male component. As a result, 75% male lek attendance should be used in population calculations.

While annual counts of trend leks or lek complexes can be used for monitoring population trend, care must be taken in using the information to make a population estimate due to variability in lek size. Selection of larger than average leks would provide an over-estimate of population size, and selection of smaller than average leks would provide an under-estimate of population size. Therefore leks should be stratified by size and a random sample selected for counts that will be used to estimate the adult population.

Count data can then be entered into the following formula to determine breeding population size:

Note: All means are the mean of the maximum count of three counts/lek

1. Mean number of males/lek by area (county or WMU) (x) total number of active leks in stratum ÷ 0.75 = total males in survey area.

2. Calculate total number of females in survey area by multiplying male population by a factor of 2.

3. Add total males + total females to determine total adults in survey area.

4. Sum all survey areas in the sample for Statewide Total Spring Population Estimate.

This estimate should be considered conservative because all active leks may not be known.

BROOD PRODUCTION SURVEYS

Brood production surveys are conducted to provide a measure of annual reproductive success and trend in sage-grouse productivity. Timing of brood surveys may very depending on annual weather conditions and timing of nesting. Likewise, the general weather conditions that have preceded the count will affect the count results. For example, drought conditions normally cause many ephemeral water sources or meadow sites to dry up and subsequently cause birds to concentrate at remaining water sources or meadow sites. Generally, wet spring and summer periods often cause birds to be more widely dispersed. Both situations will impact count results. When conducting brood surveys, the following criteria should be considered:

1. Routes should be conducted between July 15 and August 10, depending on plant phenology and timing of the hatch. Routes should be counted in the same manner (time of day, method of transportation) each year.

2. Counting should not be done during periods of inclement weather when observations of grouse are difficult to classify according to age and sex.

3. All birds observed will be counted. Birds will be classified as male, female, juvenile, and unknown. Classification information will be used to calculate chicks per brood, chicks per adult, and chicks per female. Total count will be used to calculate the number of birds seen per 10 miles of route as an index to population trend. The following characteristics will be used to help the observer separate chicks from females or other adults during brood classification:

    A. Pronounced stripe through the eye of chicks.

    B. Smaller size of chicks, (usually noted with late hatches, however, if counts are done late, chicks may be as large as adult females).

    C. Lack of black patch on chest of chicks as compared to adults.

    D. Uneven lengths in tail feathers; on younger birds which are early in their molt sequence (adults have an even outer margin resulting in a more “pointed” tail).

A minimum number of routes should be established in each WMU and will be distributed through representative habitat within each WMU or county (Willis et al. 1993:50).

HARVEST QUOTA

Total allowable harvest can be calculated as a percent of the estimated total fall population. The harvest goal, coupled with past hunter success information can be used to determine hunter numbers, season length and bag limit for any given area in any year. Braun and Beck (1985) in Colorado indicated that bird abundance in the fall has more of an impact on hunting season success than length of season or bag limit. Additionally, they reported that hunting had no measurable impact on following spring densities of male sage-grouse attending leks. Similar

results were reported for sage-grouse seasons in Oregon, indicating that hunting mortality, at least at levels previously authorized in Oregon, is compensatory (Crawford 1982).

Due to the current political sensitivity of sage-grouse status, it is recommended that a conservative harvest goal be set. Braun and Beck (1985), determined that a harvest rate of 7 - 11% of the total population did not have an impact on subsequent breeding population size. Connelly et al. (2000b) estimated a 5-10% harvest rate in Idaho with no detectable impact on breeding population size. Others have documented harvest rates of up to 25% but no evaluation of the impact of hunting on the populations was conducted (Braun and Beck 1985).

A harvest goal based on population estimates made from lek counts will be conservative because lek counts are an underestimate of the total breeding population. Jenni and Hartzler (1978) indicated that the highest of three lek counts would represent 90% of the total adult males attending the lek. C.E. Braun (letter of 26 May 1992) indicated that only 50% of the males were represented on single lek counts. Initially a recommend a harvest goal should not exceed 5% of the estimated fall population for each hunt area (population analysis area). This estimate would be based on the number of birds attending known leks plus production estimates from brood counts. The harvest goal could be increased over time if subsequent data analysis indicates that the previous harvest rate is not depressing the population, or if the increase is not needed to meet a recovery goal in a low population.

The following equation may be helpful in setting harvest quotas:

> **Harvestable Surplus** = {[Adult Breeding Population Size + (Adult Breeding Population Size × 0.66 × chicks/female)] × 0.05} ÷ Tag number/unit (= mean birds/hunter/unit).

Note: Chicks/female (use from brood or wing data). One variable that is not factored in is adult mortality between spring pop. est. and fall pop./tag estimate, We may be able to acquire this figure from past telemetry studies.

The number of hunters needed to attain this harvest can then be estimated. Crawford (1982) in Oregon, indicated that harvest could be predicted rather precisely using the following equations for a 2-3 day season: [harvest = (1.97 × number of hunters) -- 804]; or a 9 day season: [harvest = (2.85 × number of hunters) -- 904]. Another way to estimate allowable hunter numbers would be to look at historic harvest success figures for the particular area that harvest will be allowed in.

HUNTER HARVEST/WING DATA

Although the hunting season for sage-grouse in Oregon is tightly regulated through the controlled hunt process and is primarily designed to collect additional information on sage-grouse population composition, the hunting season remains popular among many hunters in Oregon.

Wings provide information on the proportion of adults/yearlings/juveniles, chicks/females, and the sex ratio in the population prior to winter. Cumulative impacts of annual harvest on the

population should be evaluated (prior years' harvest analysis, population estimate, brood production surveys, and wing analysis) before the next years' harvest goals are set. The following rationale must be considered in hunting season design so that the maximum amount of information can be obtained from wing collections:

1. Season should occur in the early August to mid-September time frame so that feather replacement and wear patterns are not so advanced to preclude interpretation of wing data for nest success and hatch date purposes.

2. Tag numbers and/or wing collection strategies are designed to allow collection of a minimum of 100 wings from a Data Analysis Unit (DAU) where possible. However, due to the current conservative hunting season framework, collection of 100 wings from each DAU is not possible at this time. DAU's are combinations of existing Hunt Codes (Wildlife Management Units) and will be used to assess sage-grouse populations on a larger scale and assist with conservation planning efforts. Below are the combination of existing Hunt Codes that are combined to create six DAU's for the state of Oregon:

   DAU # 1. Beaty's Butte – Juniper – Warner

   DAU # 2. Owyhee - Whitehorse

   DAU # 3. Malheur River – Steens Mountain

   DAU # 4. Beulah - Sumpter

   DAU # 5. Wagontire – Silvies – Maury – Paulina – Ochoco – Fort Rock – Silver Lake

   DAU # 6. Lookout Mountain – Catherine Creek - Keating

3. Wing collection bags and a postage paid return envelope will be mailed to all sage-grouse hunters along with a letter requesting assistance in the collection of sage-grouse wings for sage-grouse management purposes.

4. Telephone harvest survey of all successful controlled hunt applicants will be conducted to determine hunter effort, total harvest, and wing collection rate.

5. All wings collected will be classified to sex and age (adult, yearling, and juvenile). In addition, hatch dates and percentage of successful females will be calculated.

LITERATURE CITED

Autenreith, R. E. 1981. Sage-grouse management in Idaho. Wildlife Resource Sec. Idaho Dept. of Fish and Game. Wildlife Bulletin No. 9. 238pp.

Braun, C. E., and T. D. I. Beck. 1985. Effects of changes in hunting regulations on sage-grouse harvest and populations. Pages 335-343 In. S. L. Beasom and S. F. Roberson, Eds. Game Harvest Management, Caesar Kleberg Wild. Res. Inst., Kingsville Tex.

Crawford, J. A. 1982. Factors affecting sage-grouse harvest in Oregon. Wildlife Society Bulletin 10:374-377.

Emmons, S. R., and C. E. Braun. 1984. Lek attendance of male sage-grouse. Journal of Wildlife Management 48:1023-1028.

Jenni, D. A., and J. E, Hartzler. 1978. Attendance at a sage-grouse lek: implications for spring censuses. Journal Wildlife Managment. 42:46-52.

Johnsgard, P. A. 1973. Grouse and quails of North America. Univ. of Nebraska Press, Lincoln and London.

Willis. M. J., G. P. Keister, Jr., D. A. Immel, D. M. Jones, R. M. Powell, and K. R. Durbin. Sage-grouse in Oregon. 1993. Wild. Res. Rpt. No. 18. Ore. Dept. Fish and Wild., Portland, Ore. 55pp.

APPENDIX II. SAGEBRUSH CLASSIFICATION FOR HABITAT MONITORING AND RANGELAND ASSESSMENTS

The following sub-classifications of sagebrush stand characteristics are taken directly from BLM Technical Manual 417 (2005). These are not meant to be an exhaustive or exclusive classification system there may be additional stand types in Oregon. This list is provided to give managers a starting point for rangeland and sagebrush assessments. The habitat monitoring section is parallel to the draft Sage-Grouse Habitat Assessment Framework proposed by Idaho's conservation strategy and currently being modified for use as a fine scale habitat assessment tool by the BLM .

Class 1 No sagebrush canopy cover

Class 1(A): Plant communities that are dominated by native grasses and forbs which generally provide a portion of habitat needs for sage grouse and other wildlife that use sagebrush-steppe habitats. These plant communities are typically observed after fire, before sagebrush species recolonize. These plant communities may occur in a patchy, mosaic pattern within the sagebrush-steppe, intermingled with Class 2(A, C), Class 3(A, B, C), Class 4(B), and Class 5(B:25% to near 35% canopy cover) plant communities. However, early structural stages should be a minimal proportion of a given landscape.

Class 1(B): Plant communities that are dominated by introduced annual grasses and forbs such as cheatgrass, medusahead, and tumblemustard, which do not provide habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitats. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies). Before converting to annual grasses and annual forbs, these Class 1(B) plant communities were more likely to have been Wyoming big sagebrush or basin big sagebrush plant communities than either low sagebrush or mountain big sagebrush plant communities (Miller and Eddleman 2001). These plant communities are biologically and physically unstable because of high risk for repeated fire. High plant density of these annual plants, combined with great amounts of litter, effectively eliminate biological soil crusts. The combination of these conditions inhibit native plant recovery.

Class 1(C): Plant communities that are dominated by seedings of crested wheatgrass or other exotic perennial grasses which generally do not provide habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitats. These plant communities are lacking in sagebrush canopy cover either because a sagebrush seed source is lacking, or there has not been sufficient time elapsed for sagebrush species to recolonize the seeding. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies).

Class 1(D): Plant communities that are closed woodlands dominated by species such as western juniper. Particularly in the mountain big sagebrush and low sagebrush plant communities, western juniper encroachment and increasing density can result in near total loss of sagebrush canopy cover (Miller and Eddleman 2001). These Class 1(D) plant communities do not provide habitat needs for sage-grouse (sage-grouse did not select western juniper communities in central Oregon for nesting or winter habitat [BLM 1994; Miller and Eddleman 2000]) and other wildlife that use sagebrush-steppe habitats. In many of these plant communities, excessive livestock grazing pressure and/or fire suppression have been the main contributors to their formation. These plant communities have depleted herbaceous understories in addition to depleted shrub canopy cover, and could have depleted biological soil crusts if the sites are capable of supporting biological soil crusts. The depletion of the shrub, herbaceous, and biological soil crust cover can result in accelerated erosion on these sites. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies) and supported a sagebrush plant community(ies) before the western juniper encroached.

Class 2 Sagebrush Cover = Trace to 5%

Class 2(A): Plant communities that are dominated by native grasses and forbs with some recruitment of sagebrush species, which provide a portion of habitat needs for sage-grouse and other wildlife that use sagebrush-steppe

habitats. These plant communities are typically observed after fire, when sagebrush species are recolonizing. These plant communities are desirable to achieve in a patchy, mosaic pattern within the sagebrush-steppe, intermingled with Class 1(A), Class 2(C), Class 3(A, B, C), Class 4 (B), and Class 5(B:25% to near 35% canopy cover) plant communities.

Class 2(B): Plant communities that are dominated by introduced annual grasses and forbs such as cheatgrass, medusahead, and tumblemustard, where sagebrush species are generally declining in abundance attributable to too frequent of fire. These plant communities are typically not providing habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitats. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies). These plant communities are biologically and physically unstable because of high risk for repeated fire. High plant density of these annual plants, combined with great amounts of litter, effectively eliminate biological soil crusts. The combination of these conditions inhibit native plant recovery.

Class 2(C): Plant communities that are dominated by seedings of crested wheatgrass or other exotic perennial grasses, where sagebrush species are in the early stages of recolonization. These plant communities might not be providing the complex shrub-grass-forb cover and food needs of sage-grouse and other wildlife that use sagebrush-steppe habitat, but if there is active recolonization of sagebrush species, there is high future likelihood for providing habitat needs. These plant communities are desirable to sustain if they are moving successionally to greater abundance of sagebrush species.

Class 2(D): Plant communities that are woodlands dominated by species such as western juniper. Particularly in the mountain big sagebrush and low sagebrush plant communities, western juniper encroachment and increasing density can result in near total loss of sagebrush canopy cover (Miller and Eddleman 2001). These plant communities do not provide habitat needs for sage-grouse (sage-grouse did not select western juniper communities in central Oregon for nesting or winter habitat [BLM 1994; Miller and Eddleman 2001]) and other wildlife that use sagebrush-steppe habitats. In many of these Class 2(D) plant communities, excessive livestock grazing pressure and/or fire suppression have been the main contributors to their formation. These plant communities have depleted herbaceous understories in addition to depleted shrub canopy cover, and could have depleted biological soil crusts if the sites are capable of supporting biological soil crusts. The depletion of the shrub, herbaceous, and biological soil crust cover can result in accelerated erosion on these sites. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies) and supported a sagebrush plant community(ies) before the western juniper encroached.

Class 3 Sagebrush Cover = Greater than 5%, up to 15%

Class 3(A): Plant communities supporting low sagebrush or Wyoming big sagebrush, with an understory of native grasses and forbs (typically about 10% grass canopy cover and less than 10% forb canopy cover), and intact biological soil crusts in interplant spaces, represent the potential natural vegetation for these plant communities (Miller and Eddleman 2001). Class 3(A) low sagebrush or Wyoming big sagebrush plant communities provide habitat needs for sage-grouse (e.g., winter habitat [Miller and Eddleman 2001]) and other wildlife that use sagebrush-steppe habitat. They are desirable to sustain in a patchy, mosaic pattern within the sagebrush-steppe, intermingled with Class 1(A), Class 2(A, C), Class 3(B, C), Class 4(B), and Class 5(B:25% to near 35% canopy cover) plant communities.

Class 3(B): Plant communities supporting basin big sagebrush or mountain big sagebrush, with an understory of native grasses and forbs, which are typically moving successionally to greater abundance of sagebrush species and are not yet at the potential natural vegetation for these two plant communities. Despite this, Class 3(B) basin big sagebrush or mountain big sagebrush plant communities provide habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitat. Their presence in a mosaic, intermingled with Class 1(A), Class 2 (A, C), Class 3 (A, C), Class 4 (B), and Class 5 (B:25% to near 35% canopy cover) plant communities, should be considered desirable for sagebrush-steppe habitat. It should be recognized however, that these Class 3 (B) plant communities are probably transitory and should be permitted to move successionally to Class 4 (see Class 4 (B) for more detail).

Class 3(C): Plant communities that are dominated by seedings of crested wheatgrass or other exotic perennial

grasses, where sagebrush canopy cover is on the increase attributable to sagebrush colonization. While not providing the quality of habitat that Class 3(A) or Class 3(B) plant communities do, because typically there is not a diverse grass or forb component in these seedings, Class 3(C) plant communities do provide added structure because of the sagebrush, which provides habitat for some wildlife that use sagebrush-steppe habitat.

Class 4 Sagebrush Cover = Greater than 15%, up to 25%

Class 4(A): Plant communities supporting low sagebrush or Wyoming big sagebrush, which typically show a decrease in native grass and forb canopy cover (particularly where sagebrush canopy cover is 20% or greater [Miller and Eddleman 2001]), and biological soil crust development, compared with Class 3(A) low sagebrush or Wyoming big sagebrush plant communities. Disturbances such as excessive livestock grazing pressure are often contributory to development of Class 4(A) plant communities (Miller and Eddleman 2001). Class 4(A) is not the potential natural vegetation, nor a desirable outcome, for these two plant communities when the inherent capabilities of soils, landform, and climate are factored in. However, Class 4(A) plant communities can provide some habitat needs for sage-grouse (e.g., winter habitat [Miller and Eddleman 2001]) and other wildlife that use sagebrush-steppe habitat.

Class 4(B): Plant communities supporting basin big sagebrush or mountain big sagebrush, with an understory of native grasses and forbs, more often than not represent the potential natural vegetation for these plant communities. Class 4(B) plant communities provide habitat needs for sage-grouse (e.g., nesting and brood-rearing habitat [Miller and Eddleman 2001]) and other wildlife that use sagebrush-steppe habitat. Their presence in a mosaic, intermingled with Class 1(A), Class 2(A and C), Class 3(A, B, C), and Class 5(B:25% to near 35% canopy cover) plant communities, should be considered desirable for sagebrush-steppe habitat.

Class 4(C): Plant communities supporting mountain big sagebrush or low sagebrush, with tree seedlings (particularly western juniper) in the understory. Particularly in the mountain big sagebrush and low sagebrush plant communities, western juniper encroachment and increasing density can result in near total loss of sagebrush canopy cover (Miller and Eddleman 2001). These Class 4(C) plant communities currently provide habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitats. However, with continued growth and increasing density of the western juniper, sagebrush will decline and these plant communities will transition and at some point not provide habitat needs for sage-grouse and other wildlife that use sagebrush-steppe habitats. On many of these Class 4(C) plant communities, excessive livestock grazing pressure and/or fire suppression have been the main contributors to their formation. These plant communities are not desirable to sustain in their present condition if the sites are capable of supporting a sagebrush plant community(ies) and supported a sagebrush plant community(ies) before the western juniper encroached.

Class 5 Sagebrush Cover = Greater than 25%

Class 5(A): Plant communities supporting basin big sagebrush or mountain big sagebrush, with an understory of native grasses and forbs, can represent the potential natural vegetation for these plant communities, particularly for canopy cover that ranges from 25% to less than 35% (Miller and Eddleman 2001). However, as sagebrush canopy cover approaches 35%, the understory of native grasses and forbs decreases. Class 5(B) basin big sagebrush or mountain big sagebrush plant communities can provide habitat needs for sage-grouse (e.g., nesting and brood-rearing habitat [Miller and Eddleman 2001]) and other wildlife that use sagebrush-steppe habitat (e.g., pygmy rabbit). Class 5(B) that has sagebrush canopy cover in the range of 25% to less than 35% is probably within the range of what the soils, landform, and climate would sustain for these two plant communities, whereas canopy cover Class 5(B) that approaches or exceeds 35% in these two plant communities is probably undesirable and a result of excessive livestock grazing pressure and/or fire suppression

Class 5(B): Plant communities supporting low sagebrush or Wyoming big sagebrush, which typically are depauperate in understory native grasses and forbs (Miller and Eddleman 2001) and often have an understory composed of exotic annuals such as cheatgrass and mustards. Understory native grasses, forbs, and biological soil crusts would be primarily restricted to microsites beneath shrub canopies and would rarely be found in interspace microsites. Disturbances such as excessive livestock grazing pressure are often contributory to development of Class 5(A) plant communities (Miller and Eddleman 2001). Although these low sagebrush or Wyoming big

sagebrush plant communities can provide some habitat needs for sage-grouse (e.g. winter habitat; Miller and Eddleman 2001) and other wildlife that use sagebrush-steppe habitat, these Class 5(A) plant communities are not the potential natural vegetation, nor a desirable outcome, for these two plant communities when the inherent capabilities of soils, landform, and climate are factored in.

INVENTORY AND MONITORING TECHNIQUES FOR EACH SCALE

Mid-scale.—The multi-scale approach requires integration of GIS and field techniques to determine the extent of sagebrush habitats. Landscape composition of sagebrush to non-sagebrush habitats can be delineated and other landscape level statistics should be considered when inventorying habitat patches and ranking potential quality: fragmentation, patch size, and isolation.

At mid-scale, habitat suitability is defined by patterns of habitat patches on the landscape. Unlike site-specific indicators of productive habitat such as sagebrush canopy cover or sagebrush height, little research has been done to better discern discrete, mid-scale, habitat indicator values for sage-grouse. However, sage-grouse habitat suitability declines as sagebrush shrubland patches decrease in size and become more isolated and surrounded by vegetation communities with undesirable components. Therefore, a mid-scale habitat description should have a trend context including extent and pattern of change. The extent and pattern of change gives the mid-scale habitat description a relevant basis for baseline description.

A mid-scale evaluation should include the following steps (from Bureau of Land Management Technical Bulletin 417 (2005):

Step 1. Clearly define the purpose and objectives associated with the proposed mid-scale baseline assessment of sage-grouse habitat.

Before delineating the assessment area, clearly define the purpose and objectives of the overall project. This will help in the analysis design and help identify which mid-scale habitat indicators to focus on.

Step 2. Delineate the assessment area and map habitat using mid-scale cover types

Clearly delineate the assessment area on a map. Review the purpose and objectives of the project and insure that the assessment area includes components necessary for a mid-scale description.

After the assessment area has been defined on the statewide sage-grouse 1: 100,000 planning maps, it should be refined to coincide with defined cover types important for mid-scale habitat descriptions. These refinements are needed for mid-scale habitat descriptions associated with some of the habitat indicators.

Step 3. If possible, identify a historical reference period and delineate assessment area and map habitat using the mid-scale cover types

For some mid-scale projects, a historical reference point may help document habitat trend (positive, neutral or negative) and the significance of the mid-scale indicators for the assessment

area. Detailed historical vegetation data are not necessary. This historical reference point should be selected based on the following factors:

1. General vegetation data for the assessment area are available,

2. Historic sage-grouse distribution data are available or there is reasonable confidence that sage-grouse once occupied currently unoccupied habitat in the assessment area, and

3. The historical reference point allows for a reasonable description of trend for the assessment area. The historic reference period should be relevant to a time period when most of the habitat changes occurred. For some areas like the Big Desert in eastern Idaho the historical reference point may only be a decade ago before the large fires of the 1990's, while for other areas, with a longer history of habitat change, a reference period during the 1970's may be more appropriate.

Step 4. Describe mid-scale baseline habitat conditions using all or selected habitat indicators (A – G) discussed below:

Once a mid-scale habitat map is developed, then a variety of spatial habitat indicators should be considered for describing baseline habitat conditions. Not all of these indicators need to be used – they should be selected based on habitat trends and needs of the assessment area. However, at a minimum, habitat availability and internal patch fragmentation should be measured for all mid-scale assessments. Use of other indicators will depend on the spatial habitat characteristics of the assessment area.

A. Habitat Availability

The total sage-grouse habitat and general composition in the assessment area is an important mid-scale habitat indicator. As the amount of key habitat increases in an assessment area, suitability improves. As the amount of sagebrush shrubland with a native understory increases suitability also improves although this will not always be the case.

B. Habitat Patch Size and Number

While the amount of habitat available to sage-grouse is very important, just as critical to long-term survival is the habitat pattern. Sage-grouse require large, intact and connected expanses of sagebrush shrubland to exist (Connelly et al. 2003a). As sagebrush is fragmented into distinct patches separated by grassland, woodland or other cover type, sage-grouse habitat suitability declines.

C. Habitat Patch Fragmentation

For many areas, one of the most important mid-scale habitat indicators will be the degree of internal habitat patch fragmentation. There are still large key habitat patches but the degree of habitat fragmentation within the patch in the form of roads, powerline corridors, energy sites, livestock watering pipeline systems, OHV trails, mineral sites, canals, landfills, etc. affects patch habitat suitability. The amount and density of these uses can individually affect habitat suitability

in different ways but generally, when considered cumulatively, as habitat fragmentation increases for a unit area the habitat suitability decreases.

GIS can be used to calculate roads per unit area or number of communication sites or amount of other land uses per unit patch area. For any given assessment area it will be important to identify fragmentation factors of most concern. To measure cumulative effects an objective inventory of all possible fragmentation factors should be conducted.

D. Habitat Patch Connectivity and Isolation

The number of habitat patches in close proximity and the distance between habitat patches affect movement patterns and dispersal of habitat obligate species. For a highly fragmented landscape in Washington Schroeder and Robb (2003) noted that migrating sage-grouse females were usually located in corridors of sagebrush and avoided crossing agricultural fields on the ground.

E. Habitat Patch Dynamics

Habitat patch dynamics takes into account temporal changes of habitat patches either in a positive or negative direction. For sage-grouse, certain plant communities have the potential to contribute towards positive habitat trends (e.g., native perennial grassland may succeed to shrubland) and others have crossed ecological thresholds (e.g., annual grassland) or been converted to other land uses (e.g., agricultural land) with significant negative influence on habitat trends. The greater the ratio of positive influence cover types to negative influence cover types, the better the potential future for sage-grouse survival.

F. Edge Characteristics: Area/Edge Ratio, Edge Effect, Edge Contrast and Edge Permeability

Shape of the key habitat patch and the vegetation communities surrounding it can have a significant effect on suitability of the patch and future risks. For sage-grouse, suitability declines as the amount of habitat patch edge increases per unit area.

Besides patch shape, suitability is also influenced by the adjacent plant community. A key habitat patch surrounded by annual grassland is less suitable habitat than a similar shaped patch surrounded by native perennial grassland. Landscape ecologists use the terms **edge effect, edge contrast and edge permeability** to describe the effects adjacent plant communities can have on plants and animals. Effects of adjacent plant communities are important for obligate species like sage-grouse that have very specific habitat needs.

G. Habitat Corridors

In some areas sage-grouse will migrate a great distance between seasonal habitats. These movements often include areas outside of a mid-scale planning area. The assessment area of interest may have habitat that is only seasonally used by sage-grouse that may breed or winter some distance away. Connelly et al. (2003a) recommends that seasonal movements should be well understood before landscape assessments are conducted and that “corridors dominated by sagebrush should connect adjacent seasonal ranges.”

Historic and current corridors between seasonal ranges should be identified where seasonal movement data exist. The amount of sagebrush cover between seasonal ranges will help define suitability. As corridors are fragmented and there is a loss of sagebrush cover, suitability of these areas will decline.

Fine-scale.—At the allotment/pasture level the goal is to determine structure and composition of a sagebrush community. As condition of each pasture is documented that information should be added as a data field in existing GIS database.

This will allow for easy quantification and inventory of a particular area, ultimately providing an assessment at the mid- and broad-scale. Moreover, this technique provides a comprehensive method for assessing rangeland health, while inventorying wildlife habitats.

At this scale understory conditions and perhaps insect abundance associated with cover and food should be documented. Areas that were identified at larger scales as potentially suitable based on shrub canopy cover and dominant grass understory may only be marginal or even unsuitable at a fine scale due to understory conditions. Fine and site-scale assessments refine larger scale monitoring efforts. This scale of monitoring could be for inventory purposes, habitat rehabilitation efforts, or other range management projects.

Fine-scale assessments can involve qualitative and quantitative data collection depending on management needs. Typically, an area (e.g., pasture or allotment) will have several to many sites identified using a stratified random approach. Qualitative assessments are useful for reconnaissance level reviews and as a means of communication and education. They should not be used as a decision tool unless the outcomes are so obvious to any reasonable person that data collection is not needed. For example, a general description of baseline conditions for creasted wheatgrass seeding may not require quantitative data collection since the lack of sagebrush currently makes the site unsuitable as habitat. However, one of the main purposes of baseline descriptions is for predictive modeling of habitat. Quantitative data on shrub, grass and forb cover in a seeding could help predict future habitat suitability for the area.

Not all areas have equal priority for monitoring. Given the limited resources of most agencies, breeding habitats should be given highest priority, followed by winter habitats, and summer habitats. Within breeding habitats, areas with declining sage-grouse populations where the cause of the decline is not obvious (e.g., fire) should be given the highest priority followed by projects intended to improve breeding habitat. The same approach should apply to winter and summer habitats.

An area evaluation should include the following steps:

Step 1. As needed for the project area refine maps that delineate cover types, seasonal habitats, and land uses that may affect habitat use.

The following information should be collated and displayed on maps, as appropriate, for the evaluation area:

1. Shrubland, grassland, woodland, and other pertinent cover types for the area,
2. Seasonal habitats including locations of all known existing and historic leks within 18 km (11 miles) of the area,
3. High human use areas such as residences, recreational sites, or major highways, and
4. Livestock facilities such as watering troughs, fences designated water gaps or trail crossings.

Generally, habitats that are located within 2 km (1 miles) of high human use areas should not be considered as habitat unless local information indicates otherwise.

Step 2. Identify ecological sites within the area and visit ecological reference areas (ERAs).

ERAs should provide information on ecological site potential as it relates to vegetative conditions associated with sage-grouse habitat suitability. At the fine and site scale, site potential is an important factor in an area's ability to provide suitable sage-grouse habitat conditions. Site potential is based on the soil characteristics and precipitation that define certain vegetation communities. For sagebrush communities site potential in terms of shrub, grass and forb composition is mostly determined by precipitation patterns and soil characteristics (Miller and Eddleman 2001).

At this stage a specialist should be consulted to help select the ecological sites within the project area. Directions provided in Pellant et al. (2004) should be used as a reference. When possible, ecological site inventory or soil maps should be obtained. When using soil maps it will be important to remember that most soil units will contain small inclusions of other ecological sites. For sage-grouse these inclusions can provide important habitat.

Step 3. Stratify the cover types in the area by ecological sites, select sampling points within stratified mapping units and develop a data collection method.

A. Qualitative Data Collection

There are some land management situations where qualitative information can be used to determine rangeland conditions using indicators of rangeland health (Pellant et al. 2004). Qualitative assessments should only be used for reconnaissance level reviews. It will be important to document limitations of the data. If data are collected for only one ecological site within a cover type then the data only provide a qualitative description of that ecological site. They cannot be used to broadly characterize the cover type or the project area.

B. Quantitative Data Collection

Sampling sites should be randomly selected for each of mapping units. Random sites located within 2 km (1 mi) of high human use areas or livestock troughs (breeding habitat only) should be not be used. A statistician should help develop appropriate sampling levels. Follow protocols described in Connelly et al. (2003a) for vegetation measurement and data collection.

Staffing constraints and budget limitations, may affect sampling intensity. Thus, in some situations an acceptable approach at describing baseline habitat conditions could include a mixture of qualitative and quantitative data collection. Qualitative descriptions for cover types or ecological sites that are vegetatively simple or not important may suffice. The more important the habitat, the more intensive sampling should be. Professional judgment will be required and rationale for sampling design must be documented.

Step 4. Organize data collection to correspond to season use periods.

Data must be collected at the proper time of year. For example, forbs are nutritionally very important during the breeding season for females and young broods. Breeding habitat data collected in late summer would miss many forbs that are evident during spring and misrepresent habitat conditions.

Breeding Habitat: Data collection must occur in May-June as soon as broods are hatched. Timing within this time frame will vary depending on elevation and climatic conditions. Data collection in low elevation areas should occur in mid-May to early June while higher elevation sites should occur later.

Late Brood-rearing Habitat: Data must be collected July – September. Timing within this 3-month period will depend on elevation and climatic conditions.

Winter Habitat: Data collection can occur at any time since sagebrush distribution, cover and height are the only habitat indicators of concern.

Step 5. Collect field data at sampling locations for the seasonal habitats of interest.

Sample forms that may be useful in collection of field data are presented in Connelly et al. (2003a).

A. Breeding Habitat

There are 9 habitat indicators for which field data are needed. Two protocols are recommended for the canopy cover and height measurements – line transect with Daubenmire frame (LTDF) or point intercept (PI) method method. These methods will produce similar results although there are advantages and disadvantages to both (Elzinga et al. 1998, Connelly et al. 2003a). Both protocols are consistent with guidance developed by an interagency technical team for rangeland vegetation monitoring (U.S. Department of Interior 1995). If the PI method is used at least 300 points should be collected per site to address biases (Connelly et al. 2003a).

1. Leks

There are two "proximity to" indicators that describe lek suitability. Close, protective sagebrush cover and lack of perch sites for avian predator.

B. Late Brood-rearing or Summer Habitat

During summer females and broods move to areas where succulent plants and an abundance of insects are available. They either move to higher elevation sagebrush communities, riparian areas, wet meadows, or in some cases sagebrush communities near agricultural lands. In the latter situation the sagebrush community is providing the protective cover while agricultural field provides succulent forbs. Habitat indicators are slightly different for these three late brood-rearing areas.

C. Winter Habitat

Winter areas must have sagebrush of sufficient height and canopy cover to provide food and cover under most snow conditions. In some areas sage-grouse use low sagebrush communities for food and daytime loafing (e.g., wind swept ridges) while adjacent big sagebrush community provides cover and when weather conditions make the low sage areas unavailable.

Winter habitat measurement can be taken at any time of the year although values will differ depending when measurements were taken. Winter access may limit assessment at that time, so indicators were developed for describing habitat conditions during other seasons (see Bureau of Land Management 2004). Winter measurements should be taken if the project area is accessible.

Step 6. Summarize field data within the cover types.

Once field data have been collected for all sites data should be summarized for each ecological site within the cover types of interest. Standard statistical packages can be used to calculate means and standard deviations for each of the measured habitat indicators.

Step 7. Describe sage-grouse habitat conditions for each habitat type within the area of interest.

Suitability worksheets for breeding, late brood-rearing, and winter were developed from Connelly et al. (2000b). For the purpose of standardizing habitat descriptions, discrete ranges of numeric values or qualitative habitat descriptions were used to describe suitable, marginal and unsuitable habitat. Local adjustments can be made to the suitability criteria provided there are adequate research data to support adjustments.

Place the collected field information in a format for describing baseline habitat suitability for the sites within the area of interest. Two other points concerning the assessment area should also be addressed:

1. Ecological sites that do not have the potential to ever provide suitable habitat.
2. Current weather conditions in terms of drought or above normal precipitation that may affect baseline conditions.

The worksheets have places to record ecological site suitability in relation to sage-grouse habitat and weather conditions.

Professional judgment will be needed to interpret data for sage-grouse habitat suitability. As an example, certain abundant, low-statured perennial forbs (e.g., Hood's phlox (*Phlox hoodii*) and grasses (e.g., Sandberg's bluegrass (*Poa secunda*) may skew perennial grass and forb heights and grass canopy cover and wrongly describe site suitability for these indicators. When these species dominate a site they may overwhelm the habitat influence of taller-statured plants that provide protective cover. This can have an effect on the suitability description in two ways. First, they can skew the herbaceous height data such that the herbaceous height indicator for the site is rated as marginal when there is actually enough protective cover in the form of taller perennial plants for the site to be suitable. Second, Sandberg's bluegrass, which is often only 1" tall (excluding the seed stalks), can have canopy cover > 40% and if included in the suitability description may misrepresent grass canopy cover indicator that is intended to help describe protective cover. However, eliminating these species from the analysis will also bias the results—an area may be in relatively poor shape if it is almost entirely dominated by *Poa* but if only measurements for bluebunch wheatgrass and other tall perennials are reported (even though they are relatively rare), the area would be judged to be in good shape from a herbaceous height standpoint. If these conditions are encountered additional samples may be needed to better evaluate overall area quality.

Step 8. Describe baseline sage-grouse habitat conditions for the area for the seasonal use period(s) of interest.

Organize site assessments and then describe baseline habitat conditions for the area. The level of complexity will vary greatly depending on the size of the area and habitat complexity. For small or vegetatively simple areas collating the information will be relatively easy while in other areas it would be advisable to use spreadsheets.

APPENDIX III:
TECHNICAL ASPECTS OF TREND ANALYSES

This Appendix was developed to retain the scientific merit of this document while providing the general public with a less technical discussion in the main body of the text. Some of what is found in this appendix is a duplicate of the main document but was retained for continuity and interpretation.

METHODS FOR LEK DATA TREND ANALYSIS

Data

Lek attendance data were obtained from counts of males attending leks during March and April. Historically, the number of times a lek was counted in a year was variable, as of 1996 ODFW field staff attempted to count each trend lek at least 3 times during the breeding season between 0.5 before and 1.5 hours after sunrise. Trend leks are breeding sites that have been counted consistently over a number of years, and generally are a sub-sample of all leks in a region. We provide 3 measures of population trend for sage-grouse in Oregon, changes in males per lek, changes in population rate index (Schroeder et al. 2000), and changes in lek size. The indices chosen and methods for data analyses are similar to those used in the *Conservation Assessment for Greater Sage-Grouse* (Connelly et al. 2004) and have been implemented for continuity and comparison.

Sample size and units

Based on the variance (25.01) of males per lek for the 1957 to 2003 period, a minimum sample size of 10 leks was needed to be counted to make a population estimate within 20% of the mean, and with 80% confidence limits (Zar 1999:106). Thus, Burns and Lakeview districts data sets were truncated to 1981 based on this minimum sample size. Prineville assessment period began in 1980 but in 1984 and 1985 the number of leks monitored fell well below 10 leks, these years were retained for continuity but should be viewed with caution. Vale and Baker began systematic monitoring in 1993 and 1996, respectively, as does the assessment period.

Analyses

We calculated mean and median males per lek for all leks to assess changes in males per lek, rate of population change and lek sizes over time. A lek site is defined as an area with ≥2 males observed displaying. Generally such small sites are associated with a larger lek site in the vicinity (≤ 1 mile) and were categorized as a lek complex. A count of a lek complex generally includes censusing all displaying males in series of leks where no 2 lek sites are >1 mile apart. This rule was adaptive in some cases, based on the field knowledge of District Biologists. Thus all summaries that refer to males per lek, are accounting for lek complexes. Trend data for males per lek are based solely on leks monitored annually and did not include data from helicopter surveys, which likely would have lowered the numbers of males per lek in a given year. Linear regression was used to determine if trends in males per lek were significantly different from 0, at $P < 0.05$. We report the slope coefficient (β_{slope}) and its 95% confidence limits to provide a measure of the magnitude of the trend and the error associated with it. The 95% confidence limits are closely tied to the *P*-value of a regression, and generally a significant *P*-value will result in 95% confidence limits that do not include 0.

Population rates of change were calculated based on the method described by Schroeder et al. (2000). Briefly, rates of change were estimated by comparing the numbers of birds counted at all leks in consecutive years. Thus, a lek must be counted at least 2 years consecutively to be included in the estimate of population change. Moreover, this alleviates spurious observations or data from single year helicopter surveys from biasing the analyses. The rate of change (r) is formally defined as:

$$r = (n_{t+1} - n_t) / n_t,$$

where n_{t+1} = number of males in year 1, and n_t = number of males in year 0. This provides a proportional change in population size based on leks consistently counted between years. We used r to estimate spring populations backward for the duration of the assessment period using 2003 as the baseline. The 2003 population estimate was calculated by:

$$nM + nF = nT,$$

where nM = number of males counted / 0.75 (adjustment for unseen males); nF (number of females) = nM x 1.67 (11 year avg of M:F ratios in the harvest). The adjustments for unseen males and sex ratios for estimating total numbers of birds follows Connelly et al. (2003a). The following example describes how the backward projection of the population size was estimated. The 2003 estimate (nT) was divided by 1+ r from the 2002-2003 interval, and yielded a population estimate of 2002 birds based on the estimated rate of change, similarly the 2002 estimate was divided by 1 + r from the 2001-2002 interval, etc., Thus, providing an index to past population size based on active leks in 2003.

Lek size was determined by classifying each as small (<20), medium (≥20 and <50) and large (≥50) and compared the change in the frequency of size classes over time. Because of the annual variability in count data, much of the descriptive statistics were summarized in five year intervals.

RESULTS: TREND ANALYSIS FOR LEKS

TABLE A-1 Trend analysis of Oregon sage-grouse lek data by BLM districts and statewide. Analysis period (Years) varies for each area, the coefficient of determination (r^2), the slope (β), the 95% confidence limits of slope (95% CL), and the P-value are reported. A trend was considered significant when $P < 0.05$.

District	Years	r^2	Slope (β)	95% CL (β)	P-value
Statewide	1957-03	0.001	-0.09	-0.84, 0.65	0.80
Statewide	1980-03	0.077	-0.35	-0.88, 0.19	0.19
Baker	1996-03	0.030	0.18	-0.80, 1.20	0.60
Vale	1993-03	0.006	0.06	-0.50, 0.63	0.80
Burns	1981-03	0.185	-0.27	-0.53, -0.01	0.04
Lakeview	1981-03	0.002	-0.03	-0.26, 0.21	0.80
Prineville	1980-03	0.06	-0.08	-2.14, 0.56	0.23

Discussion

Although many of the population fluctuations are reflected in the males per lek trend analysis, the annual rates of change analysis contradicts the overall trend. Because *r* is a projection of an estimated population size it has the potential to show "actual" losses and gains in population size relative to the trend in average males per lek. If gains do not exceed losses then previous population sizes will tend to be larger than the current population size.

Population Estimate

Based on 2003 report from ODFW field staff it was assumed that 40 leks were active in the Baker region. Burns, Prineville, and Lakeview districts lek activity was estimated from the average percent of active leks for a five year period (1999-03) and multiplying that proportion by the total number of known leks. The Vale district was most problematic because a large number of leks originally located by helicopter survey had not been revisited in 5-10 years. However, 191 of the 282 lek sites have been active in the last 10 years. Thus, it was conservatively assumed that only 141 (50%) of the 282 known leks in the region were active in 2003.

The 2003 population size is based on both the median and mean numbers of males per active leks to provide a low and high estimate. The median males per lek provides a measure of central tendency for skewed distributions, and perhaps equally weights smaller leks in the sample, and provides the lower limit of the estimate, the mean males per lek weights (usually fewer) but larger leks unequally and provides the upper limit of the estimate. We generated *nM* (described

above) by multiplying the median and mean by the number of active leks. The estimates of *nF* and *nT* are calculated as described in the **Methods**.

TREND ANALYSIS FOR PRODUCTIVITY

METHODS

Reconstructing the locations of brood routes prior to 1993 with respect to BLM districts was difficult, and production was estimated from brood routes only at the state level for the long-term. These data are assessed from 1957 to 2003 to provide a perspective as to the long-term trends in productivity at the gross scale, and from 1980-2003 to be consistent with the assessment of males per lek trend analysis. Wing-data were analyzed statistically only for the 1993-2003 period, per BLM district and at the state level. All trends were analyzed using linear regression.

Wing-data are collected by wildlife management units (MUs) and analyzed by data analysis units (DAUs) which assist in achieving appropriate sample sizes ($n > 99$) for analyses. However, these units do not correspond with BLM district boundaries. Therefore, MUs were pooled to represent each of the BLM districts in this assessment (Table 12). This included using Wagontire and Silvies units twice; combined they represented Prineville, and individually they were included in Lakeview and Burns districts, respectively. Lookout Mountain had too few samples to provide reliable data analyses and separate estimates of productivity for Baker were not provided, Vale estimates were inclusive of Baker.

Table A-2. Regression statistics from trend analyses of sage-grouse chick production in Oregon from 1957-2003.

Data type	Years	r^2	Slope β)	95% CL (β)	P-value
Trend data					
Brood routes	1957-03	0.279	-0.04	–0.05 to –0.02	<0.001
Brood routes	1980-03	0.383	0.05	0.02 to 0.08	<0.001
Wing-data	1993-03	0.416	0.11	0.01 to 0.20	0.032
Route × Wing	1993-03	0.492	0.75	0.29 to 1.20	0.003
Predicting spring lek data					
IM: IF	1993-03	0.693	92.0	42.1 to 141.8	0.003
Wing-data	1993-03	0.543	5.50	1.4 to 9.7	0.020
Brood routes	1993-03	0.064	1.70	–3.6 to 7.0	0.480

APPENDIX IV.

SAGE-GROUSE HABITAT CLASSIFICATION IN OREGON

Several steps were used to define habitat patches in the connectivity model. This appendix discusses the assumptions and limitations of the connectivity model and provides the summary outputs for the model based on each BLM District. It is important to note that data summarized in each table is inclusive of the entire district and is not limited to areas occupied by sage-grouse.

ASSUMPTIONS/LIMITATIONS TO GIS DATA

Classification of viability

Invasive juniper is a difficult landcover to classify with satellite imagery, because low densities or small stature trees are not readily differentiated from sagebrush cover where these to vegetation types co-occur. It is likely that estimates of juniper coverage are conservative because of these difficulties. As with any GIS model ground-truthing is vital to understanding model performance. A sample of 45 points where cover type and suitability was evaluated and 90% of those visually inspected were correctly classified.

The result of combining the two datasets provided a significant amount of detail at the 30-m (0.2 acre) cell size. Such detail was important in developing the baseline information but cumbersome from a land management perspective. Therefore the map was reclassified based on 160 acre units. Briefly, a grid with 160 acre cell size was overlaid on the Oregon map and each 160 acre cell was ranked from 1 to 4 based on the majority of 0.2 acre cell rankings in that area. However, the landcover detail of each 160 acre cell was retained if such information was needed. The final output are maps with 4 colors each representing a viability category, and the base unit for that map is 160 acres.

Ranking of viability

Sagebrush habitats were ranked the highest (1), second was non-sagebrush shrublands and grasslands, all other native vegetation received a rank of 3, and bare rock, alkaline flats, and agriculture were of negligible viability (4). There were four categories of habitat that were adjusted to better reflect conditions on the ground. Pasture/hay land-cover class (includes alfalfa fields and irrigated meadows) was initially ranked as a 4 (negligible viability), because sage-grouse are known to use these habitat types in late summer this viability score was adjusted to reflect this usage. Where sagebrush cover was adjacent to pasture/hay, a 105 m radius from that point into the pasture/hay cover received a viability score of 2. This adjustment reflected the potential use and benefit of this anthropogenic habitat, while recognizing that large areas of pasture/hay are no substitute for native habitat. The potential impact of juniper on sagebrush habitat was characterized by creating a 105 m radius, where juniper was adjacent to sagebrush and reclassifying that 105 m as juniper/sage mix. This buffer distance was based on the estimated average seed dispersal distance of juniper and area of impact on sage-grouse (Commons et al. 1999, Miller et al. 2005). Lastly, the viability of sagebrush habitat was adjusted based on two

slope categories 1) slopes >15% and 2) standard deviation of slope. In the case of the former, all sagebrush slopes >15% were ranked as a 2 because the suitability of nesting and brooding diminishes beyond this point (Edelmann et al. 1998). The standard deviation of slope (SD > 6%) quantifies highly rugged topography and steep canyon walls that typically are not used by sage-grouse, these areas were adjusted to negligible viability (rank = 4).

Table A-3. Acres of habitat viability scores for sagebrush habitats by land management entity (percentage) in Oregon 2003.

	Habitat viability								
Status	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	6,501,663	70.6	5,324,593	38.6	428,373	3.5	1,124,021	14.6	13,378,650
Private	1,940,570	21.1	6,823,480	49.5	3,401,859	27.6	4,723,182	61.2	16,889,091
State	385,583	4.2	221,187	1.6	34,515	0.3	63,325	0.8	704,610
USFS	64,414	0.7	946,390	6.9	7,806,533	63.4	1,270,995	16.5	10,088,332
USFWS	235,320	2.6	121,695	0.9	76,456	0.6	124,421	1.6	557,892
Other	80,416	0.9	348,433	2.5	569,740	4.6	416,568	5.4	1,415,157
Total	9,207,966		13,785,778		12,317,476		7,722,512		43,033,732

Table A-4. Habitat viability amounts (acres) in each BLM District, Oregon 2003.

	BLM District				
Habitat viability	Burns	Lakeview	Prineville	Vale	Total
High	2,438,789	2,473,689	1,003,974	3,291,514	9,207,966
Moderate	1,985,358	1,923,427	4,260,792	5,616,201	13,785,778
Low	650,394	3,535,368	5,599,800	2,531,914	12,317,476
Negligible	695,499	1,204,963	2,182,150	3,639,900	7,722,512
Total	5,770,040	9,137,447	13,046,716	15,079,529	43,033,732

Table A-5. Habitat viability amounts (acres) and percent ownership in Baker Resource Area, Baker County Oregon 2003.

	Habitat viability								
Ownership	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	55,227	31.2	224,206	28.9	20,587	3.2	57,870	15.4	357,890
Private	119,407	67.5	497,051	64.0	120,456	18.5	214,859	57.1	951,774
State	1,128	0.6	2,619	0.3	4,333	0.7	817	0.2	8,897
USFS	912	0.5	50,572	6.5	504,464	77.6	93,494	24.8	649,442
USFWS	0	--	0	--	0	--	0	--	0
Other	121	0.1	2,152	0.3	116	0.02	9,565	2.5	11,954
Total	176,796		776,600		649,957		376,605		1,979,957

Table A-6. Habitat viability amounts (acres) and percent ownership in the Burns BLM District, Oregon 2003.

	Habitat viability								
Ownership	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	1,789,081	73.4	1,231,773	62.0	60,038	9.2	262,160	37.7	3,343,052
Private	533,200	21.9	561,988	28.3	91,939	14.1	293,749	42.2	1,480,876
State	72,000	3.0	60,546	3.0	1,311	0.2	3,191	0.5	137,048
USFS	8,820	0.4	72,828	3.7	463,219	71.2	33,117	4.8	577,984
USFWS	15,928	0.7	49,737	2.5	31,257	4.8	90,331	13.0	187,253
Other	19,760	0.8	8,486	0.4	2,630	0.4	12,951	1.9	43,827
Total	2,438,789		1,985,358		650,394		695,499		5,770,040

Table A-7. Habitat viability amounts (acres) and percent ownership in the Lakeview BLM District, Oregon 2003.

	Habitat viability								
Ownership	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	1,917,524	77.5	1,057,779	55.0	128,959	3.6	323,086	26.8	3,427,348
Private	262,188	10.6	555,701	28.9	1,227,342	34.7	616,621	51.2	2,661,852
State	62,297	2.5	50,873	2.6	17,818	0.5	29,173	2.4	160,161
USFS	11,979	0.5	200,476	10.4	1,952,517	55.2	44,125	3.7	2,209,097
USFWS	219,348	8.9	44,328	2.3	30,555	0.9	19,566	1.6	313,797
Other	353	0.0	14,270	0.7	178,177	5.0	172,392	14.3	365,192
Total	2,473,689		1,923,427		3,535,368		1,204,963		9,137,447

Table A-8. Habitat viability amounts (acres) and percent ownership in the Prineville BLM District, Oregon 2003.

	Habitat viability								
Ownership	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	407,181	40.6	839,547	19.7	196,726	3.5	153,778	7.0	1,597,232
Private	481,107	47.9	2,859,732	67.1	1,296,191	23.1	1,573,944	72.1	6,210,974
State	31,268	3.1	22,001	0.5	9,017	0.2	5,305	0.2	67,591
USFS	40,548	4.0	320,409	7.5	3,714,690	66.3	317,490	14.5	4,393,137
USFWS	44	0.0	25,545	0.6	14,644	0.3	9,241	0.4	49,474
Other	43,826	4.4	193,558	4.5	368,532	6.6	122,392	5.6	728,308
Total	1,003,974		4,260,792		5,599,800		2,182,150		13,046,716

Table A-9. Habitat viability amounts (acres) and percent ownership in the Vale BLM District, Oregon 2003.

	Habitat viability								
Ownership	High	%	Moderate	%	Low	%	Negligible	%	Total
BLM	2,387,877	72.5	2,195,494	39.1	42,650	1.7	384,997	10.6	5,011,018
Private	664,075	20.2	2,846,059	50.7	786,387	31.1	2,238,868	61.5	6,535,389
State	220,018	6.7	87,767	1.6	6,369	0.3	25,656	0.7	339,810
USFS	3,067	0.1	352,677	6.3	1,676,107	66.2	876,263	24.1	2,908,114
USFWS	0	-	2,085	0.0	0	-	5,283	0.1	7,368
Other	16,477	0.5	132,119	2.4	20,401	0.8	108,833	3.0	277,830
Total	3,291,514		5,616,201		2,531,914		3,639,900		15,079,529

Table A-10. Regulatory mechanisms and programmatic protection of sagebrush habitats in Burns District BLM.

	Stipulation				
Programs	Closed or No Surface Occupancy	Controlled Surface Use	Prohibited Use Timing Nesting	Prohibited Use Timing Winter	Noise Limitation
Acres	38,600	23,100	40,000	29,000	None
Total acres	1,344,800	639,000	229,500	1,378,200	None
Fire fuels					
Grazing	X		X		
Locatable Minerals	X				
Leasable Fluids and Solid Minerals	X		X	X	
Salable Minerals (aggregate)	X		X		
OHV/recreation	X			X	
Riparian	X		X		
Realty	X	X			
Weed					
Wild horses					
Wildlife	X		X	X	

Table A-11. Regulatory mechanisms and programmatic protection of sagebrush habitats in Lakeview District BLM.

Programs	Stipulation				
	Closed or No Surface Occupancy	Controlled Surface Use	Prohibited Use Timing Nesting	Prohibited Use Timing Winter	Noise Limitation
Acres	68,800	68,800	40,400	91,400	None
Total acres	2,310,900	2,310,900	711,300	711,600	None
Fire fuels		X			
Grazing		X	X	X	
Locatable Minerals					
Leasable Fluids and Solid Minerals					
Salable Minerals (aggregate)	X	X		X	
OHV/recreation		X	X	X	
Riparian					
Realty		X	X		
Weed		X			
Wild horses		X			
Wildlife	X	X		X	

Table A-12. Regulatory mechanisms and programmatic protection of sagebrush habitats in Vale District BLM.

Programs	Stipulation				
	Closed or No Surface Occupancy	Controlled Surface Use	Prohibited Use Timing Nesting	Prohibited Use Timing Winter	Noise Limitation
Acres	54,014	123,042	126,800	118,700	118,700
Total acres	1,664,727	2,480,596	3,504,295	3,504,295	3,504,295
Fire fuels	X	X	X	X	X
Grazing	X	X	X	X	X
Locatable Minerals	X	X	X	X	X
Leasable Fluids and Solid Minerals					
Salable Minerals (aggregate)	X	X	X	X	X
OHV/recreation	X	X	X	X	X
Riparian					
Realty	X	X	X	X	X
Weed	X	X	X	X	X
Wild horses					
Wildlife	X	X	X	X	X