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## Appendix A - Definition of Terms

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## Definitions of Terms Used in the Conservation Plan for the Greater Sage-grouse in Idaho

*Allelopathy:* Any direct or indirect harmful effect by one plant (including microorganisms) on another through production of chemical compounds that escape into the environment.

*Annual Grassland:* Areas dominated or strongly influenced by invasive annuals such as cheatgrass, medusahead wildrye or similar species. Areas with sagebrush may be present, but, in general, understories are not suitable for sage-grouse. Annual grasslands may be reclassified as perennial grasslands once a restoration seeding with perennials is considered “successful”.

*Anthropogenic:* Relating to or resulting from the impacts of human beings on nature.

*Back Fire:* A fire set along the inner edge of a fireline to consume the fuel in the path of a wildfire or change the direction of force of the fire’s convection column. See Burn Out.

*Backfiring:* Backfiring is a tactic associated with indirect attack, intentionally setting fire to fuels inside the control line to slow, knock down, or contain a rapidly spreading fire. Backfiring provides a wide defense perimeter and may be further employed to change the force of the convection column. Backfiring makes possible a strategy of locating control lines at places where the fire can be fought on the firefighter’s terms. Except for rare circumstances meeting specified criteria, backfiring is executed on a command decision made through line channels of authority.

*Breeding Habitat:* Leks, nesting, and early brood-rearing occur in breeding habitats (Connelly et al. 2000b).

*Broad-scale:* Approximately 1:500,000 scale or greater, e.g., state of Idaho.

*Burn Out:* Setting fire inside a control line to consume fuel between the edge of the fire and the control line. See Back Fire.

*Condition:* The state of historical, current, or potential elements. May be a quantitative or qualitative descriptor.

*Conifer Encroachment:* Areas where junipers (*Juniperus* spp.) and/or other conifer species are encroaching into sage-grouse habitat.

*Early brood rearing habitat:* Generally upland sagebrush habitats relatively close to sage-grouse nest sites. These areas are important to broods during the first few weeks after hatching. Forb and insect abundance and diversity are important factors. (See Connelly et al. 2000b)

*Extended attack:* Suppression activity for a wildfire that has not been contained or controlled by initial attack or contingency forces and for which more firefighting resources are arriving, en route, or being ordered by the initial attack incident commander.

*Fine-scale:* 1:24,000 USGS quad, e.g., watershed or specific habitat restoration project scale.

*Fragmentation:* The breaking up of contiguous environmental (habitat) patches into smaller and more disjunct or isolated patches (Morrison et al. 1998).

*Greenstrip:* A type of fuels management treatment utilizing strips of fire-resistant vegetation established at strategic locations.

*Guidelines:* Information intended to advise people on how something should be done or what something should be.

*Habitat Indicator:* Component or attribute of habitat that can be observed and/or measured that provides evidence of habitat suitability.

*Invasive Species:* A species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112, signed by President Clinton, 1999).

*Isolated Habitat:* Areas where breeding and winter habitat remains to support relatively small sage-grouse nesting and winter populations; may be isolated from stronghold sage-grouse populations by farmlands, forests, and/or grasslands.

*Juniper Encroachment Areas:* Sagebrush or perennial grassland areas with juniper encroachment occurring.

*Juxtaposition:* The adjacency of different patch or landscape types (Gutzwiller 2002).

*Key Habitat:* Areas of generally intact sagebrush that provide sage-grouse habitat during some portion of the year including winter, spring, summer, late brood-rearing, fall, transition sites from winter to spring, spring to summer, summer/fall to winter. Key habitat may or may not provide adequate nesting, early brood-rearing, and winter

cover due to elevation, snow depth, lack of early season forbs, limited herbaceous cover, or small sagebrush patch size.

*Land-use Plan:* Land-use plan means a resource management plan or management framework plan, developed under the provisions of 43 CFR 1600. These plans are developed through public participation in accordance with the provisions of the Federal Land Policy and Management Act (FLPMA) of 1976 and establish management direction for resource uses of public lands (43 CFR 4100).

*Late Brood-rearing Habitat:* Variety of habitats used by sage-grouse from late June to early November. Habitats used include but are not limited to meadows, farmland, riparian areas, dry lakebeds, and sagebrush areas (Connelly et al. 2000b).

*Lek (occupied lek):* A traditional display area where two or more male sage-grouse have attended in two or more of the previous five years. The area is normally located in a very open site in or adjacent to sagebrush-dominated habitats (Connelly et al. 2003b).

*Local Working Group:* An advisory group established as a result of the 1997 Idaho Sage-grouse Management Plan, serving under the auspices of the Idaho Fish and Game Commission and statewide Sage-grouse Advisory Committee. LWGs assist in the development of area-specific management recommendations or programs to maintain, improve, and restore local sage-grouse populations and their habitat. LWGs are typically comprised of representatives from federal and state land-management agencies, Idaho Department of Fish and Game, U.S. Fish and Wildlife Service, non-governmental conservation groups, and private landowners or permittees.

*Mid-scale:* 1:100,000 scale, e.g., Sage-grouse Planning Area.

*Migratory Population:* One-stage migratory sage-grouse populations move between two distinct seasonal ranges. Two-stage migratory sage-grouse populations move among three distinct seasonal ranges (Connelly et al. 2000b).

*Non-migratory Population:* Sage-grouse populations that do not make long-distance movements (e.g. greater than 10 km, or 6.2 mi, one-way) Connelly et al. (2000b).

*Occupied lek:* See lek

*OHV (off-highway or off-road vehicle):* Any motorized vehicle capable of or designed for travel on or immediately over land, water, or other natural terrain excluding: 1) Any non-amphibious registered motorboat; 2) Any military, fire, emergency, or law enforcement vehicle while being used for emergency purposes; 3)

Any vehicle whose use is expressly authorized by the authorized officer or otherwise officially approved; 4) Vehicles in official use; and 5) Any combat or combat support vehicle when used in times of national defense emergencies (National Management Strategy for Motorized Off-Highway Vehicle Use on Public Lands, USDI).

*Perennial Grassland:* Sagebrush-limited areas characterized by perennial grass species composition and/or structure that should provide suitable potential nesting habitat in the future once sufficient sagebrush cover is reestablished. Includes native and/or introduced perennial bunchgrasses. These sites have the potential to be restored to good ecological condition for sage-grouse through natural recovery or by seeding/planting sagebrush. These areas need to be protected from future wildfires to facilitate recovery. Sage-grouse may use these sites during summer, late brood-rearing, or fall, depending on forb and sagebrush availability. After restoration or recovery of sagebrush, these sites may become key habitat and may also help to link isolated sage-grouse populations. Perennial grasslands may be reclassified as key habitat once sagebrush canopy cover reaches approximately 10%.

*Potential habitat:* 1) Capable of being but not yet in existence; latent. 2) The ecological community that would be established if all successional sequences of its ecosystem were completed without additional human-caused disturbance under present environmental conditions; often referred to as “potential natural community” (USDA-USDI 1995).

*Proper Functioning Condition (riparian areas):* Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve floodwater retention and ground-water recharge; develop root masses that stabilize stream banks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity (Sources: USDI-BLM 1993, USDI-BLM1994, USDI-BLM1999).

*Red Flag Conditions:* A combination of critical weather and fuel conditions that could lead to an extensive wildfire occurrence or extreme fire behavior.

*Resource Advisor:* An individual tasked with informing a fire incident management team and agency administrator (line officer) about political, social, economic, and resource issues related to a specific fire incident. He/she also provides input during briefings on resources, priorities, and issues of concern; and monitors implementation of fire suppression rehabilitation efforts and compliance with recommendations. In the context of this Plan, a resource advisor will typically be a wildlife biologist,

ecologist, rangeland management specialist, or similar professional with detailed knowledge of local habitat and ecological conditions, objectives, and priorities.

*Sagebrush Areas:* Areas with generally at least 5% sagebrush canopy cover.

*Satellite Lek:* A relatively small lek (usually less than 15 males) that develops near a large lek during years with relatively high grouse populations (Connelly et al. 2003b).

*Standard:* A level of quality.

*Stronghold habitat (previously identified as Source habitat; terminology refined in 2004):* Areas where sufficient breeding (nesting and early brood-rearing) and winter habitat remains to support sage-grouse nesting and winter populations with generally stable or increasing trends.

*Synecology:* The branch of ecology that deals with the structure, development, and distribution of ecological communities.

*Umbrella Species:* Species with large area requirements which, if given sufficient protected habitat area, will also provide habitat for many other species (Noss 1990).

*Watershed:* Any area of land that drains to a common point. A watershed is smaller than a river basin or sub-basin but larger than a drainage or site. The term generally describes areas that result from the first subdivision of a sub-basin, often referred to as a “fifth field watershed” (USDA-USDI 1995).

*Winter Habitat:* Sagebrush habitats that provide access to food and cover during the winter (Connelly et al. 2000b).

## Appendix B - Summary of Sage-grouse Petitions Submitted to the U.S. Fish and Wildlife Service

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**Summary of Sage-grouse Petitions Submitted to the U.S. Fish and Wildlife Service (USFWS) (as of January 27, 2005)<sup>1</sup>**

<b>Petition Date:</b> May 14, 1999 (74 pages)	<b>Petition Date:</b> January 25, 2000 (254 pages)	<b>Petition Date:</b> December 28, 2001 (493 pages)
<b>Species:</b> Washington population of the Western Sage-Grouse <i>Centrocercus urophasianus phaios</i>	<b>Species:</b> Gunnison Sage-Grouse <i>Centrocercus minimus</i>	<b>Species:</b> Mono Basin population of the Greater Sage-Grouse <i>Centrocercus urophasianus phaios</i>
<b>Petition Request:</b> List as threatened or endangered	<b>Petition Request:</b> List as endangered or threatened, emergency listing, and designation of critical habitat	<b>Petition Request:</b> Emergency list as endangered
<b>Petitioners:</b> Northwest Ecosystem Alliance and Biodiversity Legal Foundation	<b>Petitioners:</b> Mark Salvo, American Lands Alliance, Dr. Randy Webb, Net Work Associates, Andy Kerr, The Larch Company, Jasper Carlton, Biodiversity Legal Foundation, Susan Ash, Wild Utah Forest Campaign, Rob Edwards, Sinapu	<b>Petitioners:</b> Donald Randy Webb, Institute for Wildlife Protection
<b>USFWS Determination:</b> Both a 90-day finding (August 24, 2000) and a 12-month finding (May 7, 2001) have been published in the <u>Federal Register</u> . The outcome of USFWS finding was that listing is warranted but precluded for the Columbia Basin Distinct Population Segment (occurs in WA and northern OR). Under USFWS policy it became a candidate by default. The candidate status of this population to be reassessed by USFWS in 2005 using new information, including that present in the USFWS finding published in the <u>Federal Register</u> on January 12, 2005.	<b>USFWS Determination:</b> Note this species was designated as a candidate by USFWS prior to receipt of the petition. The listing priority number was elevated by USFWS in a May 4, 2004 <u>Federal Register</u> Notice of Review to a 2. However the USFWS does not believe that emergency listing is warranted at this time.	<b>USFWS Determination:</b> Initial review indicated that the situation does not warrant an emergency listing. A 90-day finding was initiated August 1, 2002. The 90-day finding was published in the <u>Federal Register</u> December 26, 2002 with an outcome that the information presented in the petition is not substantial.
<b>Legal Action:</b> No Notice Of Intent (NOI**) to date	<b>Legal Action:</b> Court complaint dated September 29, 2000 from the American Lands Alliance et al. In summer 2003 the Court rules in the USFWS's favor. The ruling is that the USFWS candidate process, and the determination by USFWS that a species should be on the candidate list, is equivalent to a 12-month finding. On March 16, 2004 the plaintiffs file a lawsuit in Washington D.C. District Court asking the Court to order the USFWS to emergency list the species as endangered, and challenging the USFWS's determination of warranted but precluded for the species.	<b>Legal Action:</b> A court complaint dated July 3, 2002 was received from the Institute for Wildlife Protection. On December 1, 2003 U.S. District Court judge issued an order in favor of the USFWS and dismissing the plaintiff's case. On May 24, 2004 the plaintiffs filed an appeal of the Courts decision. USFWS responded with an answer brief on August 6, 2004. A hearing on the appeal is scheduled for Feb. 10, 2005. Also plaintiffs filed an NOI, dated January 9, 2003, regarding the merits of the USFWS's 90-day finding.

<sup>1</sup> Table compiled by Kevin Kritz, U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office, 1340 Financial Blvd. Suite #234, Reno, NV 89502-7147 (775) 861-6300

<b>Lead USFWS Office:</b> Upper Columbia Fish and Wildlife Office, Spokane, Washington (509) 891-6839	<b>Lead USFWS Office:</b> Western Colorado Field Office, Grand Junction, Colorado (970) 243-2778	<b>Lead USFWS Office:</b> Nevada Fish and Wildlife Office, Reno, Nevada (775) 861-6325
<b>USFWS Contact:</b> Chris Warren	<b>USFWS Contact:</b> Terry Ireland	<b>USFWS Contact:</b> Kevin Kritz

<b>Petition Date: January 24, 2002 (468 pages)</b>	<b>Petition Date: June 18, 2002 (7 pages)</b>	<b>Petition Date: July 3, 2002 (524 pages)</b>
<b>Species:</b> Western subspecies of the Greater Sage-Grouse <i>Centrocercus urophasianus phaios</i>	<b>Species:</b> Greater Sage-Grouse <i>Centrocercus urophasianus</i>	<b>Species:</b> Eastern subspecies of the Greater Sage-Grouse <i>Centrocercus urophasianus urophasianus</i>
<b>Petition Request:</b> List the subspecies	<b>Petition Request:</b> List as endangered	<b>Petition Request:</b> List as endangered
<b>Petitioners:</b> Donald Randy Webb, Institute for Wildlife Protection	<b>Petitioners:</b> Craig Dremann	<b>Petitioners:</b> Donald Randy Webb, Institute for Wildlife Protection
<b>USFWS Determination:</b> A 90-day finding was initiated October 30, 2002. The 90-day finding was published in the <u>Federal Register</u> on February 7, 2003 with an outcome that the information presented in the petition is not substantial.	<b>USFWS Determination:</b> A 90-day finding was initiated December, 2003. The USFWS published the 90-day finding in the <u>Federal Register</u> on April 21, 2004. The outcome was a positive 90-day finding; the information presented, and in USFWS files, was substantial. USFWS initiates a status review. The status review has now been completed. A 12-month finding was published in the Federal Register January 12, 2005 with an outcome that listing of the greater sage-grouse is not warranted.	<b>USFWS Determination:</b> 90-day finding initiated on October 3, 2003 as per court order. The 90-day finding was published in the <u>Federal Register</u> on January 7, 2004 with an outcome that the information presented in the petition is not substantial.
<b>Legal Action:</b> NOI dated February 7, 2003 from the Institute for Wildlife Protection regarding the 90-day finding. The Institute for Wildlife Protection filed a court complaint, dated June 6, 2003 challenging the merits of the 90-day finding. On August 10, 2004 a U.S. District Court judge issued an order in favor of the USFWS and dismissing the plaintiff's case. An appeal, dated November 24, 2004, has been filed by The Institute for Wildlife Protection regarding this decision.	<b>Legal Action:</b> NOI dated January 7, 2005 from the Institute for Wildlife Protection regarding the 12-month finding. NOI alleges that USFWS 12-month finding is incorrect, arbitrary, unwarranted by the facts, etc.	<b>Legal Action:</b> Court complaint dated January 10, 2003 filed in the Western District Court of Washington by the Institute for Wildlife Protection for failure to do a 90-day finding. On October 3, 2003 the District Court judge ordered the USFWS to make a 90-day finding, due by January 3, 2004. On September 28, 2004 the U.S. District Court judge issued an order in favor of the USFWS and dismissing the plaintiff's case.
<b>Lead USFWS Office:</b> Oregon Fish and Wildlife Office, Portland, Oregon (503) 231-6179	<b>Lead USFWS Office:</b> Wyoming Ecological Services Field Office, Cheyenne, Wyoming (307) 772-2374	<b>Lead USFWS Office:</b> Wyoming Ecological Services Field Office, Cheyenne, Wyoming (307) 772-2374
<b>USFWS Contact:</b> Jeff Dillon	<b>USFWS Contact:</b> Pat Deibert	<b>USFWS Contact:</b> Pat Deibert

<b>Petition Date:</b> March 19, 2003 (992 pages; this is a combination of the previous petitions for Western and Eastern subspecies)	<b>Petition Date:</b> December 22, 2003 (218 pages)
<b>Species:</b> Greater Sage-Grouse <i>Centrocercus urophasianus</i>	<b>Species:</b> Greater Sage-Grouse <i>Centrocercus urophasianus</i>
<b>Petition Request:</b> List as endangered	<b>Petition Request:</b> List as threatened or endangered
<b>Petitioners:</b> Donald Randy Webb, Institute for Wildlife Protection	<b>Petitioners:</b> Mark Salvo American Lands Alliance, Biodiversity Conservation Alliance, Center for Biological Diversity, Forest Guardians, The Fund for Animals, Gallatin Wildlife Association, Great Old Broads for Wilderness, Hells Canyon Preservation Council, The Larch Company, Northwest Ecosystem Alliance, Northwest Council for Alternatives to Pesticides, Oregon Natural Desert Association, Oregon Natural Resources Council, Predator Defense Institute, Sierra Club, Sinapu, Western Fire Ecology Center, Western Watersheds Project, Wild Utah Project, Wildlands CPR, and Center for Native Ecosystems
<b>USFWS Determination:</b> A 90-day finding was initiated December, 2003. USFWS published the 90-day finding in the <u>Federal Register</u> on April 21, 2004. Outcome was a positive 90-day finding; the information presented, and in USFWS files, was substantial. USFWS initiates a status review. The status review has now been completed. A 12-month finding was published in the Federal Register January 12, 2005 with an outcome that listing of the greater sage-grouse is not warranted.	<b>USFWS Determination:</b> A 90-day finding was initiated December, 2003. USFWS published the 90-day finding in the <u>Federal Register</u> on April 21, 2004. The outcome was a positive 90-day finding; the information presented, and in USFWS files, was substantial. USFWS initiates a status review. The status review has now completed. A 12-month finding was published in the Federal Register January 12, 2005 with an outcome that listing of the greater sage-grouse is not warranted.
<b>Legal Action:</b> NOI dated January 7, 2005 from the Institute for Wildlife Protection regarding the 12-month finding. NOI alleges that USFWS 12-month finding is incorrect, arbitrary, unwarranted by the facts, etc.	<b>Legal Action:</b> NOI dated January 7, 2005 from the Institute for Wildlife Protection regarding the 12-month finding. NOI alleges that USFWS 12-month finding is incorrect, arbitrary, unwarranted by the facts, etc.
<b>Lead USFWS Office:</b> Wyoming Ecological Services Field Office, Cheyenne, Wyoming (307) 772-2374	<b>Lead USFWS Office:</b> Wyoming Ecological Services Field Office, Cheyenne, Wyoming (307) 772-2374
<b>USFWS Contact:</b> Pat Deibert	<b>USFWS Contact:</b> Pat Deibert

\*\* 60-day Notice of Intent to Sue (NOI)

## Appendix C - USFWS January 2005 Findings

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# Federal Register

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**Wednesday,  
January 12, 2005**

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## **Part III**

# **Department of the Interior**

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**Fish and Wildlife Service**

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**50 CFR Part 17**

**Endangered and Threatened Wildlife and  
Plants; 12-Month Finding for Petitions To  
List the Greater Sage-Grouse as  
Threatened or Endangered; Proposed Rule**

## DEPARTMENT OF THE INTERIOR

## Fish and Wildlife Service

## 50 CFR Part 17

## Endangered and Threatened Wildlife and Plants; 12-Month Finding for Petitions To List the Greater Sage-Grouse as Threatened or Endangered

**AGENCY:** Fish and Wildlife Service, Interior.

**ACTION:** Notice of a 12-month petition finding.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding for three petitions to list the greater sage-grouse (*Centrocercus urophasianus*) as threatened or endangered under the Endangered Species Act of 1973, as amended. After reviewing the best available scientific and commercial information, we find that listing is not warranted. We ask the public to submit to us any new information that becomes available concerning the status of or threats to the species. This information will help us monitor and encourage the conservation of this species.

**DATES:** The finding announced in this document was made on January 6, 2005. Although further listing action will not result from this finding, we request that you submit new information concerning the status of or threats to this species whenever it becomes available.

**ADDRESSES:** Comments and materials received, as well as supporting documentation used in the preparation of this 12-month finding, will be available for inspection, by appointment, during normal business hours at the Wyoming Ecological Services Field Office, U.S. Fish and Wildlife Service, 4000 Airport Parkway, Cheyenne, Wyoming 82001. Submit new information, materials, comments, or questions concerning this species to the Service at the above address.

**FOR FURTHER INFORMATION CONTACT:** The Wyoming Field Office (see **ADDRESSES** section above), by telephone at (307) 772-2374, by facsimile at (307) 772-2358, or by electronic mail at [fw6\\_sagegrouse@fws.gov](mailto:fw6_sagegrouse@fws.gov).

**SUPPLEMENTARY INFORMATION:****Background**

Section 4(b)(3)(B) of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Lists of Threatened and Endangered Wildlife and Plants that contains substantial scientific or commercial information that the action may be warranted, we

make a finding within 12 months of the date of the receipt of the petition on whether the petitioned action is: (a) Not warranted, (b) warranted, or (c) warranted but precluded by other pending proposals. Such 12-month findings are to be published promptly in the **Federal Register**.

On July 2, 2002, we received a petition from Craig C. Dremann requesting that we list the greater sage-grouse (*Centrocercus urophasianus*) as endangered across its entire range. We received a second petition from the Institute for Wildlife Protection on March 24, 2003 (Webb 2002) requesting that the greater sage-grouse be listed rangewide. On December 29, 2003, we received a third petition from the American Lands Alliance and 20 additional conservation organizations (American Lands Alliance *et al.*) to list the greater sage-grouse as threatened or endangered rangewide. On April 21, 2004, we announced our 90-day petition finding in the **Federal Register** (69 FR 21484) that these petitions taken collectively, as well as information in our files, presented substantial information indicating that the petitioned actions may be warranted. In accordance with section 4(b)(3)(A) of the Act, we have now completed a status review of the best available scientific and commercial information on the species, and have reached a determination regarding the petitioned action.

This status review of the greater sage-grouse does not address our prior finding with regard to the Columbia Basin distinct population segment (DPS). On May 7, 2001, we published a 12-month finding on a petition to list the Washington population of the western subspecies of the greater sage-grouse as a distinct population segment (DPS) (66 FR 22984). Our finding included a summary of the historic distribution of what we then considered to be the western subspecies of the greater sage-grouse (see "Species Information" below regarding taxonomy). In our finding we determined that the population segment that remains in central Washington met the requirements of our policy for recognition as a distinct population segment (61 FR 4722) and that listing the DPS was warranted but precluded by other higher priority listing actions. Because the population in central Washington occurs entirely within the historic distribution of sage-grouse within the Columbia Basin ecosystem, we referred to it as the Columbia Basin DPS (66 FR 22984; May 7, 2001). In subsequent candidate notices of review (CNORs), including the most recent one

published in the **Federal Register** on May 4, 2004 (69 FR 24875), we found that a listing proposal for this DPS was still warranted but precluded by higher priorities. Since that time new information has become available through this status review of the greater sage-grouse. We will use the best scientific and commercial information available (including, but not limited to information that became available during this rangewide status review) to reevaluate whether the Columbia Basin population still qualifies as a DPS under our DPS policy, and if it does, whether the DPS still warrants a listing proposal. Once that evaluation is completed, we will publish an updated finding for the Columbia Basin population in the **Federal Register** either in the next CNOR or in a separate notice.

*Responses to Comments Received*

We received 889 responses to our request for additional information in our 90-day finding for the greater sage-grouse (69 FR 21484). Those responses which contained new, updated, or additional information were thoroughly considered in this 12-month finding. We received a large number of identical or similar comments. We consolidated the comments into several categories, and provide responses as follows.

*Comment 1:* It is premature for the Service to consider listing the sage-grouse until the impact of local and State conservation efforts are realized.

*Response 1:* The Service is required under section 4 of the Act to determine whether or not listing is warranted within 12 months of receiving a petition to list a species. By publishing a positive 90-day finding in April, 2004 (69 FR 21484), we were required by the Act to immediately proceed with the completion of a 12-month finding. We have examined ongoing and future conservation efforts in our status review. This included using our Policy for Evaluation of Conservation Efforts When Making Listing Decisions ("PECE") (68 FR 15100; March 28, 2003) to evaluate conservation efforts by State and local governments and other entities that have been planned but have not been implemented, or have been implemented but have not yet demonstrated effectiveness, to determine which such efforts met the standard in PECE for contributing to our finding. Our analysis of the best available scientific data revealed that the greater sage-grouse is not a threatened species, and in making this finding it was not necessary to rely on the contributions of any of the local, State, or other planned conservation efforts that met the standard in PECE. A

summary of our process with regard to PECE is provided in the section "Status Review Process," below.

*Comment 2:* Listing the sage-grouse could have a negative impact on the conservation efforts being implemented by States for this species.

*Response 2:* We appreciate the fact that prior to acceptance of the listing petitions, States within the range of the greater sage-grouse are fully engaged in developing and implementing conservation efforts for this species, and we encourage them to continue these efforts. Conservation actions which have already been implemented have been considered in this decision. However, our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of population status and threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision.

*Comment 3:* The facts do not support the need for listing this species.

*Response 3:* The Service has considered all factors potentially affecting the greater sage-grouse in our decision and agree that the listing is not warranted. We have made our decision based on the best available scientific and commercial data, as required by the Act.

*Comment 4:* In most western states, sage-grouse populations have been fairly steady and in some cases, increasing over the past decade.

*Response 4:* The Service has considered population trends in all States and Provinces, and across the entire range of the species in our status review, including localized increases.

*Comment 5:* Locally managed efforts are best suited to preserve and protect the greater sage-grouse.

*Response 5:* We acknowledge that local conservation efforts for this species are important to long-term conservation, particularly given the widespread distribution and the variety of habitats and threats. However, most of these efforts have not yet been implemented, or have not been demonstrated to be effective.

Conservation actions that have already been implemented and for which effectiveness is known have been considered in this decision. Our determination of whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision. There is no one best strategy for sage-grouse conservation and we encourage the

continuation of all conservation efforts to conserve the greater sage-grouse. The Service continues to support the development of a Conservation Strategy for the Greater Sage-grouse by Western Association of Fish and Wildlife Agencies (WAFWA), and supports voluntary conservation as the most effective method to protect species and their habitats.

*Comment 6:* The recovery process under the Endangered Species Act has a very low success rate.

*Response 6:* Our decision regarding the greater sage-grouse is a listing, not a recovery decision. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not its potential for recovery under the Act. Therefore, this comment may not be considered in this finding.

*Comment 7:* If the greater sage-grouse is listed there will be a reduction of freedom and private property rights and public land use, and therefore a negative impact on the country. Listing the grouse will also result in economic damage to many entities.

*Response 7:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential social or economic implications of listing. Therefore, this comment may not be considered in this finding.

*Comment 8:* There will be a loss of management options for the greater sage-grouse if this species is listed.

*Response 8:* We are not aware of any management options that are beneficial to the greater sage-grouse that would need to be eliminated if this species is listed under the Act—an action we believe to be not warranted at this time.

*Comment 9:* Listing the greater sage-grouse will divide and polarize local communities.

*Response 9:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are

known at the time of the decision, not the potential socio-political implications of listing. Therefore, this comment may not be considered in this finding.

*Comment 10:* Listing the greater sage-grouse will increase the workload for the U.S. Fish and Wildlife Service.

*Response 10:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential increase in workload for the Service. Therefore, this comment may not be considered in this finding.

*Comment 11:* Listing the greater sage-grouse will result in Federal budget limitations for other Federal agencies and projects.

*Response 11:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential implications for the Federal budget of listing. Therefore, this comment may not be considered in this finding.

*Comment 12:* Conservation planning efforts and current Federal agency actions are sufficient to conserve the greater sage-grouse.

*Response 12:* We acknowledge that many Federal agencies are implementing conservation measures for the greater sage-grouse, and that several conservation efforts for this species are underway. Current federal conservation efforts have been reviewed and considered in our analysis. We evaluated planned conservation efforts under PECE (see Response 1); most of the planned conservation efforts for the greater sage-grouse have not yet been implemented. However, because our analysis of the best available scientific and commercial data revealed that the greater sage-grouse is not warranted for listing under the ESA, it was not necessary to evaluate whether the planned conservation efforts that met PECE reduced the threats to the species.

*Comment 13:* The petition was subjected to an independent analysis and serious problems were found with the science.

*Response 13:* Our 90-day finding was based on the determination that the three petitions submitted met the "substantial information" threshold as defined under section 4(b)(3)(A) of the Act. At the time of the 90-day finding, we did acknowledge that two of the three petitions contained some misstatements (69 FR 21484). However, the petitions were only one information source of many we used in our review for the 90-day finding. For the current 12-month finding, we conducted an exhaustive review of the scientific literature, and included State, industry, and Federal agency data. This finding does not rely on the petitions, but rather the best scientific and commercial data available, as required by the Act.

*Comment 14:* The Western Governor's Association report provides additional information which should be considered.

*Response 14:* The Western Governor's Association report was considered in this finding.

*Comment 15:* Many private sector groups are taking steps to protect sage-grouse habitat.

*Response 15:* We acknowledge that local conservation efforts for this species are important to long-term conservation and strongly support the continuation of these efforts. Most of the planned conservation efforts for the greater sage-grouse have not yet been implemented. As explained above, in making this finding it was not necessary to rely on the contributions of any of the local, State, or other planned conservation efforts that met the standard in PECE (*see* Response 1).

*Comment 16:* Scientific reports detailing the sage-grouse's decline consistently declare more work is necessary to adequately assess the status of sage-grouse populations.

*Response 16:* We agree that additional information on populations would be useful. However, as required by the Act, the Service must use the best scientific and commercial information available when making a 12-month finding. The law does not provide a mechanism for the Service to improve the available information.

*Comment 17:* Hunting is allowed in most states and provides a benefit to hunters and state wildlife programs without a negative impact on sage-grouse populations.

*Response 17:* At this time, it is unclear what area-specific impacts sage-grouse hunting has on sage-grouse populations. Most States are currently managing their populations in conformance with the WAFWA guidelines, which contain the most up-to-date guidelines for sage-grouse

management. Our review indicated that regulated hunting of sage-grouse does not pose a threat that would lead to the likely endangerment of the species in the foreseeable future.

*Comment 18:* Now that there is a coordinated effort to further protect the species, there is no reason to suspect that this progress will not continue.

*Response 18:* We acknowledge that many Federal, State, and local working groups are implementing protective measures for the greater sage-grouse, and that several conservation efforts for this species are underway, have been planned, or are in the process of being planned. Most of the planned conservation efforts for the greater sage-grouse have not yet been implemented. As explained above, in making this finding it was not necessary to rely on the contributions of any of the local, State, or other planned conservation efforts that met the standard in PECE (*see* Response 1). We strongly encourage continued efforts to preserve and protect the greater sage-grouse and its habitat.

*Comment 19:* The Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats provides additional information which should be considered.

*Response 19:* The Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats report was considered in this finding.

*Comment 20:* The worst possible outcome is to list the sage-grouse.

*Response 20:* Our determination of whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision. We strongly encourage all efforts to conserve the greater sage-grouse and its habitat.

*Comment 21:* Predators are causing the decline of sage-grouse.

*Response 21:* We have considered the effects of predators and predator control in our sage-grouse analysis.

*Comment 22:* We need to consider the effects of hunting on sage-grouse.

*Response 22:* We have considered the effects of hunting in our sage-grouse analysis.

*Comment 23:* Sage-grouse are doing well in some areas and therefore, they should not be listed in those areas. Also, the Service should consider the need to list sage-grouse on a state-by-state basis.

*Response 23:* The petitions requested that we determine if the species needed to be listed across its entire range. Therefore, we have to consider the sage-grouse population range-wide. Additionally, our Policy Regarding the

Recognition of Distinct Vertebrate Populations (61 FR 4722) requires that in order to consider separate populations within a species for listing under the Act, such populations must (1) be discrete in relation to the remainder of the species to which it belongs, and (2) have biological and ecological significance for the taxon. We have received no information that suggests any population of the greater sage-grouse is isolated from conspecific populations, with the exception of the Columbia Basin population in central Washington. As described above, we previously determined that a proposal to list the Columbia Basin distinct population segment is warranted but precluded by other higher priority listing actions (66 FR 22984), and in the near future we will reevaluate that determination to consider new information, including (but not limited to) information available as a result of this status review and finding on petitions to list the greater sage-grouse.

*Comment 24:* Drought and other weather conditions have had a major effect on sage-grouse populations.

*Response 24:* We acknowledge that drought and other weather conditions are a natural occurrence in the west and we have considered the effects of drought in our sage-grouse analysis.

*Comment 25:* It was interesting to see flocks of dozens of grouse near fences, since conventional wisdom sees fences as perches for raptors and hence areas of avoidance for raptor-wary grouse.

*Response 25:* We acknowledge that raptors do use fences as perch sites. Sage-grouse tend to avoid perch sites like fences but threats of raptors do not totally exclude sage-grouse use of habitat near fences.

*Comment 26:* The size of sage-grouse populations can be affected by habitat condition.

*Response 26:* We acknowledge that habitat conditions can affect local sage-grouse numbers. We have considered this information in the finding.

*Comment 27:* Disease is a natural event that may be negatively affecting sage-grouse.

*Response 27:* We have considered the effects of disease on greater sage-grouse in this finding. As identified in the Act, it is one of the threat factors we are required to consider in our status review.

*Comment 28:* Listing the greater sage-grouse will remove the flexibility of local planning efforts.

*Response 28:* We recognize that listing may affect local planning efforts, due to its effect on voluntary conservation efforts. However, we may not consider those effects under this status review.

*Comment 29:* Maintaining and improving habitat is the answer to increasing sage-grouse numbers.

*Response 29:* We concur that maintaining habitat is important for the long-term conservation of the greater sage-grouse. We strongly encourage efforts to conserve sage-grouse and sagebrush habitat.

*Comment 30:* Greater sage-grouse numbers and distribution have significantly declined since 1900.

*Response 30:* The information pertaining to the status and distribution of the greater sage-grouse has been reviewed and incorporated in our analysis. Sage-grouse abundance has been scientifically documented as declining since the 1950s, but the rate of decline has decreased since the 1980s and in some places has stabilized, or even increased.

*Comment 31:* Destructive land use practices and management on public and private lands are negatively affecting the greater sage-grouse.

*Response 31:* We have considered the effects of various uses of private and public lands on the status of the greater sage-grouse in this finding.

*Comment 32:* Negative impacts to the greater sage-grouse continue irrespective of efforts by State and local working groups.

*Response 32:* Most State and local working group conservation efforts for the greater sage-grouse have not yet been implemented, and the certainty of implementation and effectiveness of such efforts is unclear. However, we have considered all conservation efforts which have been implemented and shown to be effective. As explained above, in making this finding it was not necessary to rely on the contributions of any of the local, state, or other planned conservation efforts that met the standard in PECE (see Response 1).

*Comment 33:* Listing the sage-grouse would affect much-needed land management reform.

*Response 33:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential land management implications of listing. Therefore, this comment may not be considered in this finding.

*Comment 34:* The ESA requires that listing decisions be based solely on the

best science and biological information about the species and its habitats.

*Response 34:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act.

*Comment 35:* Meaningful regulatory mechanisms are non-existent and existing management is inadequate to conserve the bird.

*Response 35:* We have considered existing regulatory mechanisms and management activities in this finding.

*Comment 36:* Only listing the greater sage-grouse under the Endangered Species Act will save the birds and its habitat.

*Response 36:* Our determination of whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision. We strongly encourage all efforts to conserve the greater sage-grouse and its habitat.

*Comment 37:* Listing the greater sage-grouse would benefit a variety of other sagebrush obligates and sagebrush-dependent species.

*Response 37:* This finding is for the greater sage-grouse only. Therefore, we cannot consider the potential impact of listing the greater sage-grouse on the status of other sagebrush-dependent species in our decision.

*Comment 38:* The WAFWA Conservation Assessment is disturbing in that its findings show a wide discrepancy in how States monitor greater sage-grouse.

*Response 38:* The WAFWA Conservation Assessment represents one component of the best available scientific and commercial data that we used in our analysis, as required by the Act. The fact that the States vary somewhat in how they conduct monitoring of this species was considered in this finding.

*Comment 39:* The loss of small populations of sage-grouse increases the species' risk of extinction when the species occurs primarily in spread out, island-like patches of habitat.

*Response 39:* We have considered the effects of small population sizes and isolated populations in our finding.

*Comment 40:* Current regulatory frameworks are sufficient to protect the greater sage-grouse.

*Response 40:* We have considered existing regulatory mechanisms and management activities in this finding and determined that existing regulatory protections in combination with the existing threats do not warrant listing the greater sage-grouse range-wide.

*Comment 41:* Grazing is good for sage-grouse. Improvements to grazing practices have been positive for sage-grouse.

*Response 41:* We have considered all aspects of grazing impacts on the greater sage-grouse in our finding.

*Comment 42:* Listing the greater sage-grouse will curtail energy development.

*Response 42:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential land management implications of listing. We did evaluate the threat of energy development to greater sage-grouse in this finding.

*Comment 43:* ESA is prohibitively expensive to implement.

*Response 43:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential cost of listing. Therefore, this comment may not be considered in this finding.

*Comment 44:* There is adequate funding available for future conservation efforts for the greater sage-grouse.

*Response 44:* We evaluated the certainty of funding for future conservation efforts as part of our evaluation of efforts that were subject to PECE. We encourage the continued implementation of conservation efforts for the greater sage-grouse.

*Comment 45:* We have additional information for your analysis.

*Response 45:* All relevant additional, new, or updated information received in comments submitted was thoroughly considered in this 12-month finding.

*Comment 46:* We have information regarding proposed actions for your analysis.

*Response 46:* We have examined proposed actions, consistent with PECE (68 FR 15100) in our status review. Our analysis of the best available scientific and commercial data revealed that listing the greater sage-grouse as threatened or endangered is not warranted, and in making this finding it was not necessary to rely on the

contribution of any of the local, State, or other planned conservation efforts that met the standard in PECE (*see* Response 1).

*Comment 47:* The Service's 90-day finding did not consider all available information.

*Response 47:* For a 90-day finding, we are required to review the information in the petition(s), our files, and any information provided by States and Tribes. Based upon this information, the Service determines whether there is substantial information indicating that further review is necessary. We are required to consider the best available scientific and commercial data in our 12-month status review. This finding represents our conclusions based on that information.

*Comment 48:* Falconers take very few sage-grouse. They are a preferred species for only one extremely specialized form of falconry.

*Response 48:* We have considered this information in our analysis.

*Comment 49:* If the Service determines that listing the sage-grouse is appropriate, they will have to designate critical habitat.

*Response 49:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision. We designate critical habitat for listed species as required by the Act.

*Comment 50:* The Service must consider the status of the sage-grouse across the entirety of its range.

*Response 50:* We have considered the status of the greater sage-grouse across the entirety of its range, as petitioned.

*Comment 51:* We do not believe that the designation of the Washington population of sage-grouse as a Distinct Population Segment (DPS) is appropriate.

*Response 51:* This status review of the greater sage-grouse does not address our prior finding with regard to the Columbia Basin distinct population segment (DPS). New information which has become available through this status review of the greater sage-grouse will be considered when we re-evaluate the status of the Columbia Basin population, either through an updated finding or in the next Candidate Notice of Review.

*Comment 52:* Managing agencies lack Best Management Practices due to the

lack of support, manpower, and funding.

*Response 52:* We acknowledge that the extent of support, manpower, and funding may influence some aspects of the implementation of Best Management Practices (BMPs) for sage-grouse. As currently described, most BMPs are very broadly stated mitigation measures that involve incorporating project design features when various resource management activities are planned, in order to reduce or avoid impacts to species.

*Comment 53:* Industry has implemented many mitigation and protection measures for sage-grouse.

*Response 53:* We acknowledge that industries are implementing some mitigation and protective measures for sage-grouse. We evaluated all such information that was available to us. We strongly encourage the continuation of all efforts to conserve the greater sage-grouse and its habitat.

*Comment 54:* Listing the sage-grouse could have profound impacts on a number of military facilities.

*Response 54:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, not the potential impact of listing on military facilities. Therefore, this comment may not be considered in this finding.

*Comment 55:* Loss of habitat to cheatgrass and juniper invasion are major threats to sage-grouse habitat. The technologies and know-how exist to eliminate or reduce the cheatgrass and juniper invasion trends.

*Response 55:* We acknowledge that cheatgrass and juniper invasions are threats to sage-grouse habitats. Currently, technologies have been developed or are being developed to treat problems of cheatgrass and juniper invasions. Our review found mixed results in the current technologies' ability to treat cheatgrass and juniper problems.

*Comment 56:* Historic declines and habitat loss are not relevant to the current listing decision.

*Response 56:* Our decision regarding the greater sage-grouse is based on the best available scientific and commercial data, as required by the Act. Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of

the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision, including information on historic declines and habitat loss to the extent that they contribute to current threats.

*Comment 57:* There is no peer-reviewed science to support a listing.

*Response 57:* We have reviewed scientific, peer-reviewed literature in our analysis, as well as commercial and unpublished data. The cumulative review of this information was used to determine if the greater sage-grouse warrants listing under the Endangered Species Act.

*Comment 58:* Most sage-grouse habitat loss due to agriculture (*i.e.*, conversion to cropland, seeding to crested wheatgrass, etc.) has been eliminated or greatly reduced. Large-scale conversions to agriculture are decreasing.

*Response 58:* We acknowledge that there have been changes in the rate of loss of sage-grouse habitat due to various agricultural conversions. We have considered this information in our analysis.

*Comment 59:* The Service must consider all listing factors when making a determination.

*Response 59:* Our determination regarding whether or not this species warrants listing under the Act must be based on our assessment of the threats to the species, the species' population status, and the status and trend of the species' habitat as they are known at the time of the decision. We consider the effects of all threats on the status of the species when we make our determination.

*Comment 60:* Present habitat provides the necessary elements to sustain a highly viable sage-grouse population.

*Response 60:* We have considered existing habitat conditions for the greater sage-grouse throughout its range in this finding.

*Comment 61:* There is insufficient funding available to adequately fund existing and proposed conservation plans for the greater sage-grouse.

*Response 61:* We have examined ongoing and future conservation efforts in our status review. We have examined proposed actions, consistent with PECE (68 FR 15100), in our status review, and this included consideration of funding, consistent with one of the criteria in PECE. (*See also* Response 1, above).

*Comment 62:* Wildfire is a threat to sage-grouse habitat and can result in habitat elimination across the species' range.

*Response 62:* We have considered the effects of wildfire on sage-grouse habitat in this finding.

### Information Quality Act

In addition to the comments received, two Information Quality Act challenges were submitted. The challenge received from the Partnership for the West was addressed through a response directly to that organization. The second challenge from the Owyhee County Commissioners (Idaho) primarily stated that we failed to conduct an exhaustive search of all scientific literature, and other information in the completion of our 90-day finding. Section 4(b)(3)(A) of the Act only requires that the petitions present "substantial scientific or commercial information indicating that the petitioned action may be warranted." The Act does not require an exhaustive search of all available information at that time. Other concerns identified in the Owyhee County Commissioner's challenge are addressed in our comment responses above, and an overall summary regarding the steps we have taken to ensure conformance with our Information Quality Guidelines is provided below.

The Service's Information Quality Guidelines define quality as an encompassing term that includes utility, objectivity, and integrity. Utility refers to the usefulness of the information to its intended users, including the public. Objectivity includes disseminating information in an accurate, clear, complete, and unbiased manner and ensuring accurate, reliable, and unbiased information. If data and analytic results have been subjected to formal, independent, external peer review, we generally will presume that the information is of acceptable objectivity. Integrity refers to the security of information—protection of the information from unauthorized access or revision, to ensure that the information is not compromised through corruption or falsification.

The Service conducted a thorough pre-dissemination review of the data it is relying on to make this 12-month finding. In particular, the Service used the information in the WAWFA Conservation Assessment, which is a peer-reviewed science document. The WAWFA assessment was based on data provided by the states, provinces, land management agencies, as well as data in published, peer-reviewed manuscripts and other verified sources available to the authors of the assessment. The draft final assessment was reviewed by State agency wildlife biologists to ensure that data submitted by each State were presented accurately and completely. The assessment also was peer reviewed by an independent group of scientists selected by the Ecological Society of America. These reviewers were experts from academia, government, and non-governmental organizations, and included researchers as well as wildlife managers.

The WAWFA Conservation Assessment assembles in one place almost all of the available pertinent data that addresses the current biological and ecological condition of the sage-grouse and its habitat. This compilation of material allows the public to see a large body of information all in one document, making the information more useful than the many separate sources of information would be. Since the document has been subject to an independent, external peer review, the Service believes it is of acceptable objectivity. For these reasons the Service believes this information meets our Information Quality Guidelines.

### Status Review Process

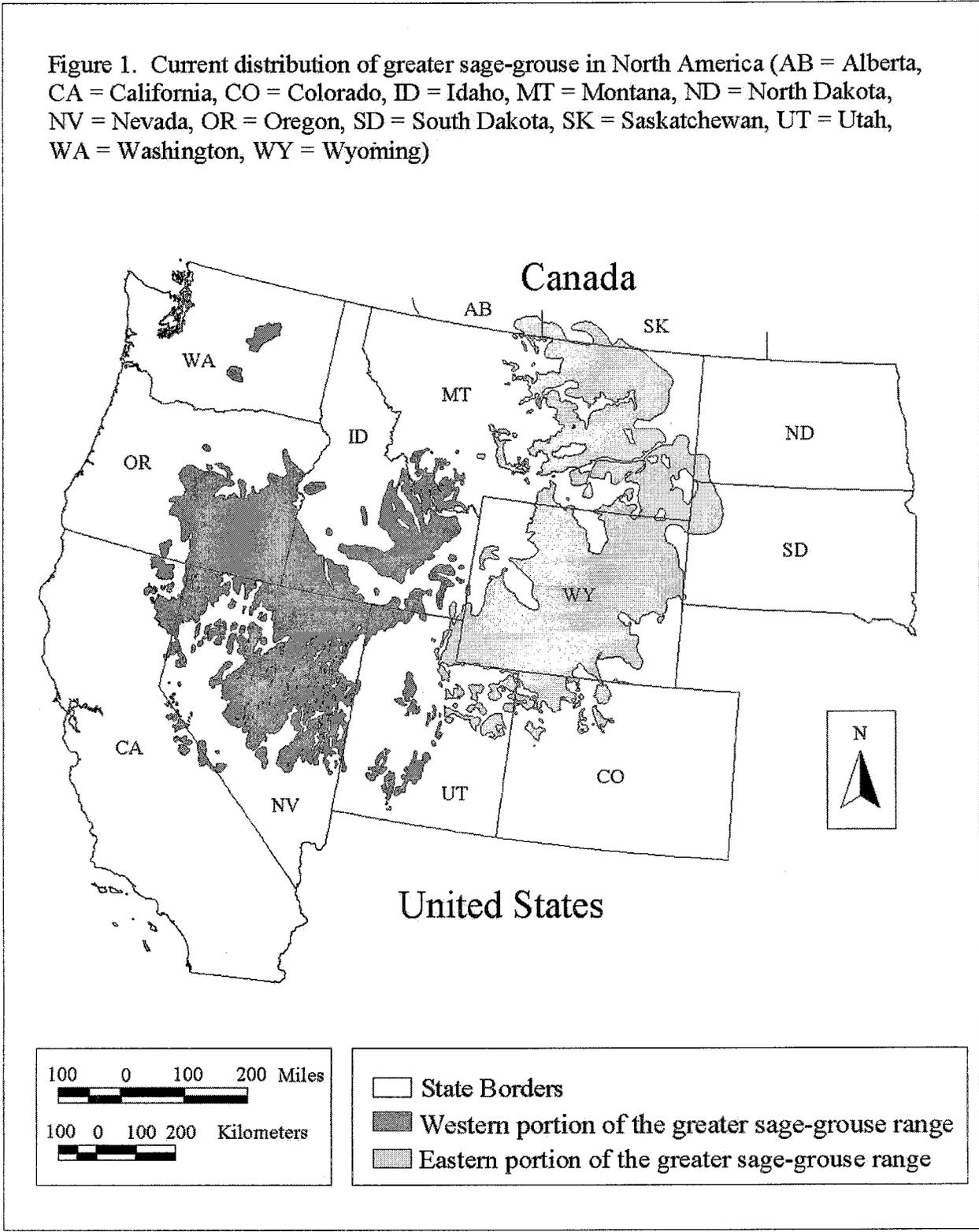
Section 4(b)(1)(A) of the Act requires us to consider the best scientific and commercial data available as well as efforts being made by States or other

entities to protect a species when making a listing decision. To meet this standard we systematically collected information on the greater sage-grouse, its habitats, and environmental factors affecting the species, from a wide array of sources. The scientific literature on greater sage-grouse and sagebrush habitats is extensive. In addition we received a substantial amount of unpublished information from other Federal agencies, States, private industry and individuals. We also solicited information on all Federal, State, or local conservation efforts currently in operation or planned for either the greater sage-grouse or its habitats.

The current distribution of greater sage-grouse and sagebrush habitat encompasses parts of 11 states in the western United States and 2 Canadian provinces (Figure 1). This large geographical scale combined with major ecological differences in sagebrush habitat and myriad of activities occurring across this large area required that the Service employ a structured analysis approach. Given the very large body of information available to us for our decision, structuring our analysis ensured we could explicitly assess the relative risk of changes occurring across the range of the sage-grouse, and integrate those individual assessments, be they regional or rangewide in nature, into an estimate of the probability that sage-grouse would go extinct at defined timeframes in the future. Using such extinction risk analysis to frame listing decisions under the Act has been recommended (National Research Council 1995), and was adopted by the Service as an important component of a structured analysis of the status review of the greater sage-grouse.

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Figure 1. Current distribution of greater sage-grouse in North America (AB = Alberta, CA = California, CO = Colorado, ID = Idaho, MT = Montana, ND = North Dakota, NV = Nevada, OR = Oregon, SD = South Dakota, SK = Saskatchewan, UT = Utah, WA = Washington, WY = Wyoming)



As part of the structuring of this status review, the Service compiled from the best scientific and commercial data available a summary of the changes or impacts occurring to the sagebrush ecosystem that could potentially affect the sage-grouse directly or indirectly. This summary, or synthesis of biological information, was one of many sources of information provided to a panel of seven experts, who, through a two-day facilitated process discussed threats to the species and each generated an estimate of extinction risk for the greater sage-grouse at different timeframes in the future. This information and all other available information were then considered by Service biologists and managers to frame a listing recommendation, and ultimately the decision reported in this finding.

Expert panels are not a required component of structured analysis but are used to help inform decision makers when there is uncertainty (National Research Council 1995). Typically, this uncertainty is due to a lack of information. While the scientific information on greater sage-grouse and their habitats is extensive, substantial gaps and uncertainty remain in the scientific community's knowledge of all the factors that may affect sage-grouse populations across such a wide geographical range encompassing major ecological differences in sagebrush habitats. Further, scientific knowledge of how the species may respond to those factors over time is incomplete. For these reasons, we requested input from scientific experts outside the Service to help us make a reasonable projection of the species' potential extinction risk. The panel consisted of experts in sage-grouse biology and ecology, sagebrush community ecology, and range ecology and management.

The organization of this finding reflects this basic approach. We first describe in more detail the structured process; present a summary of the threats to the species organized according to the 5 listing factors in the Act; then we present results from the facilitated expert panel process, including estimates of extinction risk; and finally present how a team of Service biologists and managers interpreted the extinction risk analysis, the threat ranking of the expert panelists, and other available information in the context of a listing decision under the Act. In order to ensure that the process we used to reach our finding is transparent, discussion of the biological significance of each threat listed under the 5 listing factors, and the geographical scale at which they affect sage-grouse is based on results of the

expert panel and decision support team process. A thorough description of this process and its results is presented later in the finding along with the decision support team's evaluation of the threats in the context of a listing decision under the Act. However, we felt it was important to include a brief discussion of the spatial and biological significance of each threat as they are presented by listing factor.

Following compilation of the best available scientific and commercial information, which is summarized in other sections of this finding and available in full in our administrative record, we conducted three phases of information synthesis and evaluation. First, the information on individual planned conservation efforts was evaluated under PECE to determine which efforts met the following standard in PECE: "To consider that a formalized conservation effort(s) contributes to forming a basis for not listing a species or listing a species as threatened rather than endangered, we must find that the conservation effort is sufficiently certain to be implemented and effective so as to have contributed to the elimination or adequate reduction of one or more threats to the species identified through the section 4(a)(1) analysis" (see 68 FR 15115). Second, we completed a structured analysis of greater sage-grouse extinction risk including the evaluation of all factors that may be contributing to the species' population trends and the likelihood of the species' extinction at various timeframes into the future. Finally, we evaluated whether the available information on status, trends, ongoing conservation efforts, and potential extinction risk indicate that the greater sage-grouse should be listed as a threatened or endangered species. We further structured these three phases by differentiating two distinct stages of the status review: (1) A risk analysis phase which consisted of compiling biological information, conducting the PECE analysis, and assessing the risk of extinction of greater sage-grouse, and (2) a risk management phase where a decision support team of senior Service biologists and managers evaluated whether or not the potential threats identified as part of our section 4(a)(1) analysis, and summarized in this finding, are significant enough to qualify the greater sage-grouse as a threatened or endangered species under the Act.

For the PECE analysis, we received and reviewed 27 plans, or conservation strategies, outlining more than 300 individual efforts. Most of the plans were from States, but we also received

information from the Department of Energy (DOE), Bureau of Land Management (BLM), U.S. Forest Service (USFS), Department of Defense (DOD), Natural Resources Conservation Service (NRCS), Western Governor's Association (WGA), and the North American Grouse Partnership (NAGP).

Each effort within each plan was evaluated under PECE, which provides a framework and criteria for evaluating conservation efforts that have not yet been implemented or have not yet demonstrated whether they are effective at the time of a listing decision. Recognizing that the certainty of implementation and effectiveness of various efforts within a conservation plan, strategy, or agreement may vary, PECE requires that we evaluate each effort individually, and the policy provides criteria to direct our analysis. PECE specifies that "Those conservation efforts that are not sufficiently certain to be implemented and effective cannot contribute to a determination that listing is unnecessary or a determination to list as threatened rather than endangered" (see 68 FR 15115). As described above, when determining whether or not a species warrants listing, with regard to conservation efforts that are subject to PECE we may only consider those efforts that we are sufficiently certain to be implemented and effective so as to have contributed to the elimination or reduction of one or more threats to the species. Using the criteria provided in PECE, we determined that 20 of the individual efforts we evaluated met the standard for being sufficiently certain to be implemented and effective in reducing threats. Hence, we included those 20 efforts in the information used for the extinction risk evaluation.

The expert panelists participated together in a series of facilitated exercises and discussions addressing first the species' inherent biological vulnerability and resilience, then the potential, relative influence of extrinsic or environmental factors on populations, and finally the experts' projections of extinction risk at different geographical scales both with and without the 20 planned conservation efforts from the PECE analysis. The Service would only consider the effect of the conservation efforts that met PECE in our decision if our review of the best available scientific and commercial data revealed that listing the greater sage-grouse under the Act was warranted. The experts participated only in the assessment of biological and environmental factors and related extinction risk without any consideration or discussion of the petition or regulatory classification of

the species. Structuring of the assessment facilitated thorough and careful deliberation by the experts and observing Service biologists and managers on the decision support team, including clarification of what information was critical to forming the experts' views of, where knowledge gaps and areas of uncertainty exist, and confidence experts felt in the biological judgments they expressed. Structuring also facilitated independent contributions from the experts.

In the final status review stage, following the compilation of biological information, PECE analysis of conservation efforts, and the facilitated extinction risk assessment by the expert panel, Service biologists and managers met and conducted a separate facilitated process to assess whether or not the threats to the greater sage-grouse described in this finding were significant enough at this time to meet the definition of a threatened or endangered species under the Act. Specific results from both the facilitated risk analysis stage of the status review and the facilitated risk management stage of the status review are presented later in the finding to clarify how the Service reached its decision. The Service's finding considered all of the available information on record.

### Species Information

The sage-grouse is the largest North American grouse species. Adult males range in length from 66 to 76 centimeters (cm) (26 to 30 inches (in)) and weigh between 2 and 3 kilograms (kg) (4 and 7 pounds (lb)). Adult females range in length from 48 to 58 cm (19 to 23 in) and weigh between 1 and 2 kg (2 and 4 lb). Males and females have dark grayish-brown body plumage with many small gray and white speckles, fleshy yellow combs over the eyes, long pointed tails, and dark green toes. Males also have blackish chin and throat feathers, conspicuous phylloplumes (specialized erectile feathers) at the back of the head and neck, and white feathers forming a ruff around the neck and upper belly. During breeding displays, males exhibit olive-green apteria (fleshy bare patches of skin) on their breasts (Schroeder *et al.* 1999).

In 2000, the species was separated into 2 distinct species, the greater sage-grouse (*C. urophasianus*) and the Gunnison sage-grouse (*C. minimus*) based on genetic, morphological and behavioral differences (Young *et al.* 2000). This finding only addresses the greater sage-grouse.

Although the American Ornithological Union (AOU) recognizes two subspecies of the greater sage-

grouse, the eastern (*C. u. urophasianus*) and western (*C. u. phaios*), based on research by Aldrich (1946), recent genetic analyses do not support this delineation (Benedict *et al.* 2003; Oyler-McCance *et al.* in press). There are no known delimiting differences in habitat use, natural history, or behavior between the two subspecies. Therefore, the Service no longer acknowledges the subspecies designation (68 FR 6500; February 7, 2003; 69 FR 933; January 7, 2004).

Sage-grouse depend on a variety of shrub-steppe habitats throughout their life cycle, and are considered obligate users of several species of sagebrush (*e.g.*, Wyoming big sagebrush (*Artemisia tridentata wyomingensis*), mountain big sagebrush (*A. t. vaseyana*), and basin big sagebrush (*A. t. tridentata*) (Patterson 1952; Braun *et al.* 1976; Connelly *et al.* 2000a; Connelly *et al.* 2004)). Sage-grouse also use other sagebrush species such as low sagebrush (*A. arbuscula*), black sagebrush (*A. nova*), fringed sagebrush (*A. frigida*) and silver sagebrush (*A. cana*) (Schroeder *et al.* 1999; Connelly *et al.* 2004). Thus, sage-grouse distribution is strongly correlated with the distribution of sagebrush habitats (Schroeder *et al.* 2004). While sage-grouse are dependent on large, interconnected expanses of sagebrush (Patterson 1952; Connelly *et al.* 2004), information is not available regarding minimum sagebrush patch sizes required to support populations of sage-grouse. Sage-grouse exhibit strong site fidelity (loyalty to a particular area) for breeding and nesting areas (Connelly *et al.* 2004).

During the spring breeding season, male sage-grouse gather together to perform courtship displays on display areas called leks. Areas of bare soil, short-grass steppe, windswept ridges, exposed knolls, or other relatively open sites may serve as leks (Patterson 1952; Connelly *et al.* 2004 and references therein). Leks are often surrounded by denser shrub-steppe cover, which is used for escape, thermal and feeding cover. Leks can be formed opportunistically at any appropriate site within or adjacent to nesting habitat (Connelly *et al.* 2000a), and therefore lek habitat availability is not considered to be a limiting factor for sage-grouse (Schroeder 1997). Leks range in size from less than 0.04 hectare (ha) (0.1 acre (ac)) to over 36 ha (90 ac) (Connelly *et al.* 2004) and can host from several to hundreds of males (Johnsgard 2002). Males defend individual territories within leks and perform elaborate displays with their specialized plumage and vocalizations to attract females for mating. A relatively small number of

dominant males accounts for the majority of breeding on each lek (Schroeder *et al.* 1999).

Sage-grouse typically select nest sites under sagebrush cover, although other shrub or bunchgrass species are sometimes used (Klebenow 1969; Connelly *et al.* 2000a; Connelly *et al.* 2004). The sagebrush understory of productive nesting areas contains native grasses and forbs, with horizontal and vertical structural diversity that provides an insect prey base, herbaceous forage for pre-laying and nesting hens, and cover for the hen while she is incubating (Gregg 1991; Schroeder *et al.* 1999; Connelly *et al.* 2000a; Connelly *et al.* 2004). Shrub canopy and grass cover provide concealment for sage-grouse nests and young, and are critical for reproductive success (Barnett and Crawford 1994; Gregg *et al.* 1994; DeLong *et al.* 1995; Connelly *et al.* 2004). Vegetation characteristics of nest sites, as reported in the scientific literature have been summarized by Connelly *et al.* (2000a). Females have been documented to travel more than 20 km (12.5 mi) to their nest site after mating (Connelly *et al.* 2000a), but distances between a nest site and the lek on which breeding occurred is variable (Connelly *et al.* 2004). While earlier studies indicated that most hens nest within 3.2 km (2 mi) of a lek, more recent research indicates that many hens actually move much further from leks to nest based on nesting habitat quality (Connelly *et al.* 2004). Research by Bradbury *et al.* (1989) and Wakkinen *et al.* (1992) demonstrated that nest sites are selected independent of lek locations.

Sage-grouse clutch size ranges from 6 to 13 eggs (Schroeder *et al.* 2000). Nest success (one or more eggs hatching from a nest), as reported in the scientific literature, ranges from 15 to 86 percent of initiated nests (Schroeder *et al.* 1999), and is typically lower than other prairie grouse species (Connelly *et al.* 2000a) and therefore indicative of a lower intrinsic (potential) population growth rate than in most game bird species (Schroeder *et al.* 1999). Renesting rates following nest loss range from 5 to 41 percent (Schroeder 1997).

Hens rear their broods in the vicinity of the nest site for the first 2 to 3 weeks following hatching (Connelly *et al.* 2004). Forbs and insects are essential nutritional components for chicks (Klebenow and Gray 1968; Johnson and Boyce 1991; Connelly *et al.* 2004). Therefore, early brood-rearing habitat must provide adequate cover adjacent to areas rich in forbs and insects to assure chick survival during this period (Connelly *et al.* 2004).

Sage-grouse move from sagebrush uplands to more mesic areas during the late brood-rearing period (3 weeks post-hatch) in response to summer desiccation of herbaceous vegetation (Connelly *et al.* 2000a). Summer use areas can include sagebrush habitats as well as riparian areas, wet meadows and alfalfa fields (Schroeder *et al.* 1999). These areas provide an abundance of forbs and insects for both hens and chicks (Schroeder *et al.* 1999; Connelly *et al.* 2000a). Sage-grouse will use free water although they do not require it since they obtain their water needs from the food they eat. However, natural water bodies and reservoirs can provide mesic areas for succulent forb and insect production, thereby attracting sage-grouse hens with broods (Connelly *et al.* 2004). Broodless hens and cocks will also use more mesic areas in close proximity to sagebrush cover during the late summer (Connelly *et al.* 2004).

As vegetation continues to desiccate through the late summer and fall, sage-grouse shift their diet entirely to sagebrush (Schroeder *et al.* 1999). Sage-grouse depend entirely on sagebrush throughout the winter for both food and cover. Sagebrush stand selection is influenced by snow depth (Patterson 1952; Connelly 1982 as cited in Connelly *et al.* 2000a), and, in some areas, topography (Beck 1977; Crawford *et al.* 2004).

Many populations of sage-grouse migrate between seasonal ranges in response to habitat distribution (Connelly *et al.* 2004). Migration can occur between winter and breeding/summer areas, between breeding, summer and winter areas, or not at all. Migration distances of up to 161 kilometers (km) (100 mi) have been recorded (Patterson 1952); however, average individual movements are generally less than 34 km (21 mi) (Schroeder *et al.* 1999). Migration distances for female sage-grouse generally are less than for males (Connelly *et al.* 2004). Almost no information is available regarding the distribution and characteristics of migration corridors for sage-grouse (Connelly *et al.* 2004). Sage-grouse dispersal (permanent moves to other areas) is poorly understood (Connelly *et al.* 2004) and appears to be sporadic (Dunn and Braun 1986).

Sage-grouse typically live between 1 and 4 years, but individuals up to 10 years of age have been recorded in the wild (Schroeder *et al.* 1999). Juvenile survival (from hatch to first breeding season) is affected by food availability, habitat quality, harvest, and weather. Documented juvenile survival rates have ranged between 7 and 60 percent

in a review of many field studies (Crawford *et al.* 2004). The average annual survival rate for male sage-grouse (all ages combined) documented in various studies ranged from 38 to 60 percent (Schroeder *et al.* 1999), and for females 55 to 75 percent (Schroeder 1997; Schroeder *et al.* 1999). Survival rates are high compared with other prairie grouse species (Schroeder *et al.* 1999). Higher female survival rates account for a female-biased sex ratio in adult birds (Schroeder 1997; Johnsgard 2002). Although seasonal patterns of mortality have not been thoroughly examined, over-winter mortality is low (Connelly *et al.* 2004).

### Range and Distribution

Prior to settlement of the western North America by European immigrants in the 19th century, greater sage-grouse lived in 13 States and 3 Canadian provinces—Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Colorado, Utah, South Dakota, North Dakota, Nebraska, Arizona, British Columbia, Alberta, and Saskatchewan (Schroeder *et al.* 1999; Young *et al.* 2000; Schroeder *et al.* 2004). Sagebrush habitats that potentially supported sage-grouse occurred over approximately 1,200,483 km<sup>2</sup> (463,509 mi<sup>2</sup>) before 1800 (Schroeder *et al.* 2004). Currently, sage-grouse occur in 11 States and 2 Canadian provinces, ranging from extreme southeastern Alberta and southwestern Saskatchewan, south to western Colorado, and west to eastern California, Oregon, and Washington. Sage-grouse have been extirpated from Nebraska, British Columbia, and possibly Arizona (Schroeder *et al.* 1999; Young *et al.* 2000; Schroeder *et al.* 2004). Current distribution of the greater sage-grouse is estimated at 668,412 km<sup>2</sup> (258,075 mi<sup>2</sup>) or 56 percent of the potential pre-settlement distribution (Schroeder *et al.* 2004; Connelly *et al.* 2004). The vast majority of the current distribution of the greater sage-grouse is within the United States.

Estimates of current total sage-grouse abundance vary, but are all much lower than the historical estimates of a million or more birds. Braun (1998) estimated that the 1998 rangewide spring population numbered about 142,000 sage-grouse, derived from numbers of males counted on leks. The Service estimated the rangewide abundance of sage-grouse in 2000 was at least 100,000 (taken from Braun (1998)) and up to 500,000 birds (based on harvest data from Idaho, Montana, Oregon and Wyoming, with the assumption that 10 percent of the population is typically harvested) (65 FR 51578). Survey

intensity has increased markedly in recent years and, in 2003, more than 50,000 males were counted on leks (Connelly *et al.* 2004). Therefore, Connelly *et al.* (2004) concluded that rangewide population numbers in 2003 were likely much greater than the 142,000 estimated in 1998 but was unable to generate a rangewide population estimate. Sampling methods used across the range of the sage-grouse differ, resulting in too much variation to reliably estimate sage-grouse numbers (Connelly *et al.* 2004). Since neither pre-settlement nor current numbers of sage-grouse are known with complete precision, the actual rate and extent of decline cannot be exactly estimated.

Periods of historical decline in sage-grouse abundance occurred from the late 1800s to the early-1900s (Hornaday 1916; Crawford 1982; Drut 1994; Washington Department of Fish and Wildlife 1995; Braun 1998; Schroeder *et al.* 1999). Other declines in sage-grouse populations apparently occurred in the 1920s and 1930s, and then again in the 1960s and 1970s (Connelly and Braun 1997; Braun 1998). State wildlife agencies were sufficiently concerned with the decline in the 1920s and 1930s that many closed their hunting seasons and others significantly reduced bag limits and season lengths (Braun 1998) as a precautionary measure.

Following review of published literature and anecdotal reports, Connelly *et al.* (2004) concluded that the abundance and distribution of sage-grouse have declined from pre-settlement numbers to present abundance. Most of the historic population changes were the result of local extirpations, which has been inferred from a 44 percent reduction in sage-grouse distribution described by Schroeder *et al.* 2004 (Connelly *et al.* 2004). In an analysis of lek counts, Connelly *et al.* (2004) found substantial declines from 1965 through 2003. Average declines were 2 percent of the population per year from 1965 to 2003. The decline was more dramatic from 1965 through 1985, with an average annual change of 3.5 percent. Sage-grouse population numbers in the late 1960s and early 1970s were likely two to three times greater than current numbers (Connelly *et al.* 2004). However, the rate of decline rangewide slowed from 1986 to 2003 to 0.37 percent annually, and some populations increased (Connelly *et al.* 2004).

According to Connelly *et al.* (2004), of 41 populations delineated rangewide on geographical, not political boundaries, 5 have been extirpated and 14 are at high risk of extirpation due to small numbers (only one active lek). Twelve additional

populations also have small numbers (7 to 18 known active leks), and 9 of those are declining at a statistically significant rate. However, the remaining 10 populations contained the majority (92 percent) of the known active leks and were distributed across the current range. Five of these populations were so large and expansive that they were divided into 24 subpopulations to facilitate the analysis for a rangewide assessment (Connelly *et al.* 2004).

### Habitat

Sagebrush is the most widespread vegetation in the intermountain lowlands in the western United States (West and Young 2000). Scientists recognize many species and subspecies of sagebrush (Connelly *et al.* 2004), each with unique habitat requirements and responses to perturbations (West and Young 2000). Sagebrush species and subspecies occurrence in an area is dictated by local soil type, soil moisture, and climatic conditions (West 1983; West and Young 2000), and the degree of dominance by sagebrush varies with local site conditions and disturbance history. Plant associations, typically defined by perennial grasses, further define distinctive sagebrush communities (Miller and Eddleman 2000; Connelly *et al.* 2004), and are influenced by topography, elevation, precipitation and soil type.

All species of sagebrush produce large ephemeral leaves in the spring, which persist until soil moisture stress develops in the summer. Most species also produce smaller, over-wintering leaves in the late spring that last through summer and winter. Sagebrush have fibrous, tap root systems, which allow the plants to draw surface soil moisture, but also access water deep within the soil profile when surface water is limiting (West and Young 2000). Most sagebrush flower in the fall. However, during years of drought or other moisture stress, flowering may not occur. Although seed viability and germination are high, seed dispersal is limited. Additionally, for unknown reasons, sagebrush seeds do not persist in seed banks beyond the year of their production (West and Young 2000).

Sagebrush are long-lived, with plants of some species surviving up to 150 years (West 1983). They produce allelopathic chemicals that reduce seed germination, seedling growth and root respiration of competing plant species and inhibit the activity of soil microbes and nitrogen fixation. Sagebrush has resistance to environmental extremes, with the exception of fire and occasionally defoliating insects (*e.g.*, the webworm (*Aroga* spp.; West 1983)).

Most species of sagebrush are killed by fire (Miller and Eddleman 2000; West 1983; West and Young 2000). Natural sagebrush re-colonization in burned areas depends on the presence of adjacent live plants for a seed source or on the seed bank, if present (Miller and Eddleman 2000).

Sagebrush is typically divided into two groups, big sagebrush and low sagebrush, based on their affinities for different soil types (West and Young 2000). Big sagebrush species and subspecies are limited to coarse-textured and/or well-drained sediments, whereas low sagebrush subspecies typically occur where erosion has exposed clay or calcified soil horizons (West 1983; West and Young 2000). Reflecting these soil differences, big sagebrush will die if surfaces are saturated long enough to create anaerobic conditions for 2 to 3 days (West and Young 2000). Some of the low sagebrush are more tolerant of occasionally supersaturated soils, and many low sage sites are partially flooded during spring snowmelt. None of the sagebrush taxa tolerate soils with high salinity (West and Young 2000). Both groups of sagebrush are used by sage-grouse.

The response of sagebrush and sagebrush ecosystems to natural and human-influenced disturbances varies based on the species of sagebrush and its understory component, as well as abiotic factors such as soil types and precipitation. For example, mountain big sagebrush can generally recover more quickly and robustly following disturbance than Wyoming big sagebrush (Miller and Eddleman 2000), likely due to its occurrence on moist, well drained soils, versus the very dry soils typical of Wyoming big sagebrush communities. Soil associations have also resulted in disproportionate levels of habitat conversion across different sagebrush communities. For example, basin big sage is found at lower elevations, in soils that retain moisture two to four weeks longer than in well drained, but dry and higher elevation soils typical of Wyoming big sagebrush locations. Therefore, sagebrush communities dominated by basin big sagebrush have been converted to agriculture more extensively than have communities on poorer soil sites (Winward 2004).

The effects of disturbance to sagebrush are not constant across the range of the sage-grouse. Connelly *et al.* (2004) presented sage-grouse population data by the described delineations of sagebrush ecosystems and communities (Miller and Eddleman 2000, from Kuchler's 1985 map; and West 1983).

Unfortunately, information on impacts to the habitats has not been collected in a compatible manner, making analyses of these impacts specifically within each distinct ecosystem and community impossible. Therefore, while we acknowledge habitat differences across the greater sage-grouse range, we were unable to conduct our review at that level.

### Discussion of Listing Factors

Section 4 of the Act (16 U.S.C. 1531) and implementing regulations at 50 CFR part 424 set forth procedures for adding species to the Federal endangered and threatened species list. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act. These factors and their application to the greater sage-grouse are as follows:

#### A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

##### Habitat Conversion

Sagebrush is estimated to have covered roughly 120 million ha (296 million ac; Schroeder *et al.* 2004) in western North America, but millions of those hectares have been cultivated for the production of potatoes, wheat, and other crops (Schroeder *et al.* 1999, 2000). Western rangelands were converted to agricultural lands on a large scale beginning with the series of Homestead Acts in the 1800s (Braun 1998, Hays *et al.* 1998), especially where suitable deep soil terrain and water were available (Rogers 1964). Connelly *et al.* (2004) estimated that 24.9 million ha (61.5 million ac) within their assessment area for sage-grouse is now comprised of agricultural lands (note, not all of the species' total range is sagebrush habitat, and the assessment area is larger than the sage-grouse current distribution). Influences resulting from agricultural activities adjoining sagebrush habitats extend into those habitats, and include increased predation and reduced nest success due to predators associated with agriculture (Connelly *et al.* 2004). Adding a 6.9 km (4.3 mi) buffer around agricultural areas (for the potential foraging distance of domestic cats and red foxes (*Vulpes vulpes*)), Connelly *et al.* (2004) estimated 115.2 million ha (284.7 million ac) (56 percent) within their assessment area for the greater sage-grouse is influenced by agriculture.

In some States, the loss of sagebrush shrub-steppe habitats through conversion to agricultural crops has been dramatic. This impact has been

especially apparent in the Columbia Basin of the Northwest and the Snake River Plain of Idaho (Schroeder *et al.* 2004). Hironaka *et al.* (1983) estimated that 99 percent of basin big sagebrush (*A. t. tridentata*) habitat in the Snake River Plain has been converted to cropland. Prior to European immigrant settlement in the 19th century, Washington had an estimated 42 million ha (103.8 million ac) of shrub-steppe (Connelly *et al.* 2004). Dobler (1994) estimated that approximately 60 percent of the original shrub-steppe habitat in Washington has been converted to primarily agricultural uses. In eastern Washington, land conversion to dryland farming occurred mostly between 1900 and the 1940s (Hays *et al.* 1998) and then in the 1950s and 1960s large-scale irrigation projects (made possible through the construction of dams) reduced sage-grouse habitat even further (Hofmann 1991 in Hays *et al.* 1998). Deep soils supporting shrub-steppe communities in Washington continue to be converted to agricultural uses (Vander Haegen *et al.* 2000), resulting in habitat loss. In north central Oregon, approximately 2.6 million ha (6.4 million ac) of habitat were converted for agricultural purposes, essentially eliminating sage-grouse from this area (Willis *et al.* 1993). More broadly, across the Interior Columbia Basin of southern Idaho, northern Utah, northern Nevada, eastern Oregon and Washington, approximately 6 million ha (14.8 million ac) of shrub-steppe habitat has been converted to agricultural crops (Altman and Holmes 2000).

Development of irrigation projects to support agricultural production, in some cases conjointly with hydroelectric dam construction, has resulted in additional sage-grouse habitat loss (Braun 1998). The reservoirs formed by these projects impacted native shrub-steppe habitat adjacent to the rivers in addition to supporting the irrigation and direct conversion of shrub-steppe lands to agriculture. The projects precipitated conversion of large expanses of upland shrub-steppe habitat in the Columbia Basin for irrigated agriculture (August 24, 2000; 65 FR 51578). The creation of these reservoirs also inundated hundreds of kilometers of riparian habitats used by sage-grouse broods (Braun 1998). However, other small and isolated reclamation projects (4,000 to 8,000 ha [10,000 to 20,000 ac]) were responsible for three-fold localized increases in sage-grouse populations (Patterson 1952) by providing water in a semi-arid environment which provided additional insect and forb food resources (*e.g.*, Eden Reclamation

Project in Wyoming). Shrub-steppe habitat continues to be converted for both dryland and irrigated crop production, albeit at much-reduced levels (65 FR 51578; Braun 1998).

Although conversion of shrub-steppe habitat to agricultural crops impacts sage-grouse through the loss of sagebrush on a broad scale, some studies report the use of agricultural crops (*e.g.*, alfalfa) by sage-grouse. When alfalfa fields and other croplands are adjacent to extant sagebrush habitat, sage-grouse have been observed feeding in these fields, especially during brood-rearing (Patterson 1952, Rogers 1964, Wallestad 1971, Connelly *et al.* 1988, Fischer *et al.* 1997). Connelly *et al.* (1988) reported seasonal movements of sage-grouse to agricultural crops as sagebrush habitats desiccated during the summer.

Sagebrush removal to increase herbaceous forage and grasses for domestic and wild ungulates is a common practice in sagebrush ecosystems (Connelly *et al.* 2004). By the 1970s, over 2 million ha (5 million ac) of sagebrush had been mechanically treated, sprayed with herbicide, or burned (Crawford *et al.* 2004). Braun (1998) concluded that since European settlement of western North America, all sagebrush habitats used by greater sage-grouse have been treated in some way to reduce shrub cover. The use of chemicals to control sagebrush was initiated in the 1940s and intensified in the 1960s and early 1970s (Braun 1987).

The extent to which mechanical and chemical removal or control of sagebrush currently occurs is not known, particularly with regard to private lands. However, the BLM has stated that with rare exceptions, they no longer are involved in actions that convert sagebrush to other habitat types, and that mechanical or chemical treatments in sagebrush habitat on BLM lands currently focus on improving the diversity of the native plant community, reducing conifer encroachment, or reducing the risk of a large wildfire (BLM 2004a).

Greater sage-grouse response to herbicide treatments depends on the extent to which forbs and sagebrush are killed. Chemical control of sagebrush has resulted in declines of sage-grouse breeding populations through the loss of live sagebrush cover (Connelly *et al.* 2000a). Herbicide treatment also can result in sage-grouse emigration from affected areas (Connelly *et al.* 2000a), and has been documented to have a negative effect on nesting, brood carrying capacity (Klebenow 1970), and winter shrub cover essential for food and thermal cover (Pyrah 1972 and

Higby 1969 as cited in Connelly *et al.* 2000a). Conversely, small treatments interspersed with non-treated sagebrush habitats did not affect sage-grouse use, presumably due to minimal effects on food or cover (Braun 1998). Also application of herbicides in early spring to reduce sagebrush cover may enhance some brood-rearing habitats by increasing the coverage of herbaceous plant foods (Autenrieth 1981).

Mechanical treatments are designed to either remove the aboveground portion of the sagebrush plant (mowing, roller chopping, and rotobearing), or to uproot the plant from the soil (grubbing, bulldozing, anchor chaining, cabling, riling, raking, and plowing; Connelly *et al.* 2004). These treatments were begun in the 1930s and continued at relatively low levels to the late 1990s (Braun 1998). Mechanical treatments, if carefully designed and executed, can be beneficial to sage-grouse by improving herbaceous cover, forb production, and resprouting of sagebrush (Braun 1998). However, adverse effects also have been documented (Connelly *et al.* 2000a). For example, in Montana, the number of breeding males declined by 73 percent after 16 percent of the 202 km<sup>2</sup> (78 mi<sup>2</sup>) study area was plowed (Swenson *et al.* 1987). Mechanical treatments in blocks greater than 100 ha (247 ac), or of any size seeded with exotic grasses, degrade sage-grouse habitat by altering the structure and composition of the vegetative community (Braun 1998).

While many square miles of sagebrush habitat has been lost during the past 150 years to conversion of sagebrush habitat to agriculture, this conversion occurs at such relatively low levels today, that we do not consider it a threat to the greater sage-grouse on a rangewide basis.

#### Habitat Fragmentation

This section considers the various natural and anthropogenic forces that influence sage-grouse habitat and can result in habitat fragmentation. Habitat fragmentation is the separation or splitting apart of previously contiguous, functional habitat components of a species. Fragmentation can result from direct habitat losses that leave the remaining habitat in non-contiguous patches, or from alteration of habitat areas that render the altered patches unusable to a species (*i.e.*, functional habitat loss). Functional habitat losses include disturbances that change a habitat's successional state or remove one or more habitat functions, physical barriers that preclude use of otherwise suitable areas, and activities that prevent animals from using suitable habitats patches due to behavioral avoidance.

Sagebrush communities exhibit a high degree of variation in their resistance and resilience to change, beyond natural variation. Resistance (the ability to withstand disturbing forces without changing) and resilience (the ability to recover once altered) generally increase with increasing moisture and decreasing temperatures, and can also be linked to soil characteristics (Connelly *et al.* 2004). However, most extant sagebrush habitat has been altered since European immigrant settlement of the West (Baker *et al.* 1976; Braun 1998; Knick *et al.* 2003; Connelly *et al.* 2004), and sagebrush habitat continues to be fragmented and lost (Knick *et al.* 2003) through the factors described below. The cumulative effects of habitat fragmentation have not been quantified over the range of sagebrush and most fragmentation cannot be attributed to specific land uses (Knick *et al.* 2003).

Fragmentation of sagebrush habitats has been cited as a primary cause of the decline of sage-grouse populations since the species requires large expanses of contiguous sagebrush (Patterson 1952; Connelly and Braun 1997; Braun 1998; Johnson and Braun 1999; Connelly *et al.* 2000a; Miller and Eddleman 2000; Schroeder and Baydack 2001; Johnsgard 2002; Aldridge and Brigham 2003; Beck *et al.* 2003; Pedersen *et al.* 2003; Connelly *et al.* 2004; Schroeder *et al.* 2004). However, there is a lack of data to assess how fragmentation influences specific greater sage-grouse life history parameters such as productivity, density, and home range. While sage-grouse are dependent on interconnected expanses of sagebrush (Patterson 1952; Connelly *et al.* 2004), data are not available regarding minimum sagebrush patch sizes to support populations of sage-grouse. Estimating the impact of habitat fragmentation on sage-grouse is complicated by time lags in response to habitat changes, particularly since these long-lived birds will continue to return to altered breeding areas (leks, nesting areas, and early brood-rearing areas) due to strong site fidelity despite nesting or productivity failures (Wiens and Rotenberry 1985).

#### Powerlines

Power grids were first constructed in the United States in the late 1800s. The public demand for electricity has grown as human population and industrial activities have expanded (Manville 2002), resulting in more than 804,500 km (500,000 mi) of transmission lines (lines carrying  $\geq 115,000$  volts/115kV) by 2002 within the United States (Manville 2002). A similar estimate is not available for distribution lines (lines carrying  $\leq 69,000$  volts/69kV), and we

are not aware of data for Canada. Within their analysis area (*i.e.*, the pre-European settlement distribution of greater sage-grouse, including Canada, plus a 50-km (31.3-mi) buffer (buffer is to allow for external factors that may have contributed to current trends in populations or habitats)), Connelly *et al.* (2004) state there is a minimum of 15,296 km<sup>2</sup> (5,904 mi<sup>2</sup>) of land (less than 1 percent of their assessment area) in transmission powerline corridors, but could provide no estimate of the density of distribution lines in their assessment area.

Powerlines can directly affect greater sage-grouse by posing a collision and electrocution hazard (Braun 1998; Connelly *et al.* 2000a), and can have indirect effects by increasing predation (Connelly *et al.* 2004), fragmenting habitat (Braun 1998), and facilitating the invasion of exotic annual plants (Knick *et al.* 2003; Connelly *et al.* 2004). In 1939, Borell reported the deaths of 3 adult sage-grouse as a result of colliding with a telegraph line in Utah (Borell 1939). Both Braun (1998) and Connelly *et al.* (2000a) report that sage-grouse collisions with powerlines occur, although no specific instances were presented. Other than an unpublished observation reported by Aldridge and Brigham (2003), we were unable to find documentations of other collisions and/or electrocutions of sage-grouse resulting from powerlines.

In areas where the vegetation is low and the terrain relatively flat, power poles provide an attractive hunting and roosting perch, as well as nesting stratum for many species of raptors (Steenhof *et al.* 1993; Connelly *et al.* 2000a; Manville 2002; Vander Haegen *et al.* 2002). Power poles increase a raptor's range of vision, allow for greater speed during attacks on prey, and serve as territorial markers (Steenhof *et al.* 1993; Manville 2002). Raptors may actively seek out power poles where natural perches are limited. For example, within one year of construction of a 596-km (372.5-mi) transmission line in southern Idaho and Oregon, raptors and common ravens (*Corvus corax*) began nesting on the supporting poles (Steenhof *et al.* 1993). Within 10 years of construction, 133 pairs of raptors and ravens were nesting along this stretch (Steenhof *et al.* 1993). The increased abundance of raptors and corvids within occupied sage-grouse habitats can result in increased predation. Ellis (1985) reported that golden eagle predation on sage-grouse on leks increased from 26 to 73 percent of the total predation after completion of a transmission line within 200 m (220 yd) of an active sage-grouse lek in

northeastern Utah. The lek was eventually abandoned, and Ellis (1985) concluded that the presence of the powerline resulted in changes in sage-grouse dispersal patterns and fragmentation of the habitat. Leks within 0.4 km (0.25 mi) of new powerlines constructed for coalbed methane development in the Powder River Basin of Wyoming had significantly lower growth rates, as measured by recruitment of new males onto the lek, compared to leks further from these lines, which was presumed to be the result of increased raptor predation (Braun *et al.* 2002). Within their analysis area, Connelly *et al.* (2004) estimated that the area potentially influenced by additional perches for corvids and raptors provided by powerlines, assuming a 5 to 6.9-km (3.1 to 4.3-mi) radius buffer around the perches based on the average foraging distance of these predators, was 672,644 to 837,390 km<sup>2</sup> (259,641 to 323,317 mi<sup>2</sup>), or 32 to 40 percent of their assessment area. The actual impact on the area would depend on corvid and raptor densities within the area. The presence of a powerline may fragment sage-grouse habitats even if raptors are not present. Braun (1998; unpublished data) found that use of otherwise suitable habitat by sage-grouse near powerlines increased as distance from the powerline increased for up to 600 m (660 yd) and based on that unpublished data reported that the presence of powerlines may limit sage-grouse use within 1 km (0.6 mi) in otherwise suitable habitat.

Linear corridors through sagebrush habitats can facilitate the spread of invasive species, such as cheatgrass (*Bromus tectorum*) (Gelbard and Belnap 2003; Knick *et al.* 2003; Connelly *et al.* 2004). However, we were unable to find any information regarding the amount of invasive species incursion as a result of powerline construction.

Powerlines are common to nearly every type of anthropogenic habitat use, except perhaps some forms of agricultural development (*e.g.*, livestock grazing) and fire. Although we were unable to find an estimate of all future proposed powerlines within currently occupied sage-grouse habitats, we anticipate that powerlines will increase, particularly given the increasing development of energy resources and urban areas. For example, up to 8,579 km (5,311 mi) of new powerlines are predicted for the development of the Powder River Basin coal-bed methane field in northeastern Wyoming (BLM 2003a) in addition to the approximately 9,656 km (6,000 mi) already constructed in that area. Although raptors associated

with powerlines may negatively impact individual greater sage-grouse and habitats, we could find no information regarding the effect of this impact on a rangewide basis.

#### Communication Towers

Within sage-grouse habitats, 9,510 new communication towers have been constructed within recent years (Connelly *et al.* 2004). While millions of birds are killed annually in the United States through collisions with communication towers and their associated structures (guy wires, lights, etc.; Manville 2002), most documented mortalities are of migratory songbirds. We were unable to determine if any sage-grouse mortalities occur as a result of collision with communication towers or their supporting structures, as most towers are not monitored and those that are lie outside the range of the species (Shire *et al.* 2000; Kerlinger 2000). However, communication towers also provide perches for corvids and raptors (Steenhof *et al.* 1993; Connelly *et al.* 2004). We could find no information regarding the potential impacts of communication towers to the greater sage-grouse on a rangewide basis.

#### Fences

Fences are used to delineate property boundaries and for livestock management (Braun 1998; Connelly *et al.* 2000a). The effects of fencing on sage-grouse include direct mortality through collisions, creation of predator (raptor) perch sites, the potential creation of a predator corridor along fences (particularly if a road is maintained next to the fence), incursion of exotic species along the fencing corridor, and habitat fragmentation (Call and Maser 1985; Braun 1998; Connelly *et al.* 2000a; Beck *et al.* 2003; Knick *et al.* 2003; Connelly *et al.* 2004).

Sage-grouse frequently fly low and fast across sagebrush flats and new fences can create a collision hazard (Call and Maser 1985). Thirty-six carcasses of sage-grouse were found near Randolph, Utah, along a 3.2 km (2 mi) fence within three months of its construction (Call and Maser 1985). Twenty-one incidents of mortality through fence collisions near Pinedale, Wyoming, were reported in 2003 to the BLM (Connelly *et al.* 2004). Fence collisions continue to be identified as a source of mortality (Braun 1998; Connelly *et al.* 2000a; Oyler-McCance *et al.* 2001; Connelly *et al.* 2004), although effects on populations are not understood. Fence posts also create perching places for raptors and corvids, which may increase their ability to prey on sage-grouse (Braun 1998; Connelly *et al.* 2000b;

Oyler-McCance *et al.* 2001; Connelly *et al.* 2004). We anticipate that the effect on sage-grouse populations through the creation of new raptor perches and predator corridors into sagebrush habitats are similar to that of powerlines discussed previously (Braun 1998; Connelly *et al.* 2004). Fences and their associated roads also facilitate the spread of invasive plant species that replace sagebrush plants upon which sage-grouse depend (Braun 1998; Connelly *et al.* 2000a; Gelbard and Belnap 2003; Connelly *et al.* 2004). Greater sage-grouse avoidance of habitat adjacent to fences, presumably to minimize the risk of predation, effectively results in habitat fragmentation even if the actual habitat is not removed (Braun 1998). More than 1,000 km (625 mi) of fences were constructed annually in sagebrush habitats from 1996 through 2002, mostly in Montana, Nevada, Oregon and Wyoming (Connelly *et al.* 2004). Over 51,000 km (31,690 mi) of fences were constructed on BLM lands supporting sage-grouse populations between 1962 and 1997 (Connelly *et al.* 2000a). However, some of the new 1–3 wire fencing being erected across the range may pose less of a collision risk to sage grouse than woven fences.

#### Roads and Railroads

Impacts from roads may include direct habitat loss, direct mortality, create barriers to migration corridors or seasonal habitats, facilitation of predators and spread of invasive vegetative species, and other indirect influences such as noise (Forman and Alexander 1998). Interstates and major paved roads cover approximately 14,272 km<sup>2</sup> (22,835 mi<sup>2</sup>), less than 1 percent of their assessment area (Connelly *et al.* 2004). Secondary paved road densities within this area range to greater than 2 km/km<sup>2</sup> (3.24 mi/mi<sup>2</sup>). Sage-grouse mortality resulting from collisions with vehicles does occur (Patterson 1952), but mortalities are typically not monitored or recorded. Therefore, we are unable to determine the importance of this factor on sage-grouse populations. Data regarding how roads affect seasonal habitat availability for individual sage-grouse populations by creating barriers and the ability of sage-grouse to reach these areas were not available. Road development within Gunnison sage-grouse habitats precluded movement of local populations between the resultant patches, presumably to minimize their exposure to predation (Oyler-McCance *et al.* 2001).

Roads can provide corridors for predators to move into previously

unoccupied areas. For some mammalian species, dispersal along roads has greatly increased their distribution (Forman and Alexander 1998; Forman 2000). Corvids also use linear features such as primary and secondary roads as travel routes, expanding their movements into previously unused regions (Connelly *et al.* 2000b; Aldridge and Brigham 2003; Connelly *et al.* 2004). In an analysis of anthropogenic impacts, Connelly *et al.* (2004) reported that at least 58 percent of their analysis area has a high or medium presence of corvids, known sage-grouse nest and chick predators (Schroeder and Baydack 2001). We have no information on the extent to which corvids prey on sage-grouse chicks and eggs. Additionally, highway rest areas provide a source of food and perches for corvids and raptors, and facilitate their movements into surrounding areas (Connelly *et al.* 2004). It has not been documented that sage-grouse populations are affected by predators using roads as corridors into sagebrush habitats.

The presence of roads also increases human access and their resulting disturbance effects in remote areas (Forman and Alexander 1998; Forman 2000; Connelly *et al.* 2004). Increases in legal and illegal hunting activities resulting from the use of roads built into sagebrush habitats have been documented (Patterson 1952; Connelly *et al.* 2004). However, the actual current effect of these increased activities on sage-grouse populations has not been determined. Roads may also facilitate access for habitat treatments (Connelly *et al.* 2004), resulting in subsequent direct habitat losses. New roads are being constructed to support development activities within the greater sage-grouse extant range. For example, in the Powder River Basin of Wyoming, up to 28,572 km (17,754 mi) of roads to support coalbed methane development are proposed (BLM 2003a).

The expansion of road networks has been documented to contribute to exotic plant invasions via introduced roadfill, vehicle transport, and road maintenance activities (Forman and Alexander 1998; Forman 2000; Gelbard and Belnap 2003; Knick *et al.* 2003; Connelly *et al.* 2004). Invasive species are not limited to roadsides (or verges), but have also encroached into the surrounding habitats (Forman and Alexander 1998; Forman 2000; Gelbard and Belnap 2003). In their study of roads on the Colorado Plateau of southern Utah, Gelbard and Belnap (2003) found that improving unpaved four-wheel drive roads to paved roads resulted in increased cover of exotic plant species within the interior of adjacent vegetative

communities. This effect was associated with road construction and maintenance activities and vehicle traffic, and not with differences in site characteristics. The incursion of exotic plants into native sagebrush systems can negatively affect greater sage-grouse through habitat losses and conversions (see further discussion below).

Additional indirect effects of roads may result from birds' behavioral avoidance of road areas because of noise, visual disturbance, pollutants, and predators moving along a road. The absence of screening vegetation in arid and semiarid regions further exacerbates the problem (Suter 1978). Male sage-grouse depend on acoustical signals to attract females to leks (Gibson and Bradbury 1985; Gratson 1993). If noise interferes with mating displays, and thereby female attendance, younger males will not be drawn to the lek and eventually leks will become inactive (Amstrup and Phillips 1977; Braun 1986). Dust from roads and exposed roadsides can damage vegetation through interference with photosynthetic activities; the actual amount of potential damage depends on winds, wind direction, the type of surrounding vegetation and topography (Forman and Alexander 1998). Chemicals used for road maintenance, particularly in areas with snowy or icy precipitation, can affect the composition of roadside vegetation (Forman and Alexander 1998). We were unable to find any data relating these potential effects to impacts on sage-grouse population parameters.

In a study on the Pinedale Anticline in Wyoming, sage-grouse hens that bred on leks within 3 km (1.9 mi) of roads associated with oil and gas development traveled twice as far to nest as did hens bred on leks greater than 3 km (1.9 mi) from roads. Nest initiation rates for hens bred on leks "close" to roads were also lower (50 vs 65 percent) affecting population recruitment (33 vs. 44 percent) (Lyon 2000; Lyon and Anderson 2003). Lyon and Anderson (2003) suggested that roads may be the primary impact of oil and gas development to sage-grouse, due to their persistence and continued use even after drilling and production have ceased. Braun *et al.* (2002) suggested that daily vehicular traffic along road networks for oil wells can impact sage-grouse breeding activities based on lek abandonment patterns. In a study of 804 leks within 100 km (62.5 mi) of Interstate 80 in southern Wyoming and northeastern Utah, Connelly *et al.* (2004) found that there were no leks within 2 km (1.25 mi) of the interstate and only 9 leks were found between 2

and 4 km (1.25 and 2.5 mi) along this same highway. The number of active leks increased with increasing distance from the interstate. Lek persistence and activity relative to distance from the interstate were also measured. The distance of a lek from the interstate was a significant predictor of lek activity, with leks further from the interstate more likely to be active. An analysis of long-term changes in populations between 1970 and 2003 showed that leks closest to the interstate declined at a greater rate than those further away (Connelly *et al.* 2004). What is not clear from these studies is what specific factor relative to roads (*e.g.*, noise, changes in vegetation, etc.) sage-grouse are responding to, and Connelly *et al.* (2004) caution that they have not included other potential sources of indirect disturbance (*e.g.*, powerlines) in their analyses.

Railroads presumably have the same potential impacts to sage-grouse as do roads since they create linear corridors within sagebrush habitats. Railways were primarily responsible for the initial spread of cheatgrass in the intermountain region (Connelly *et al.* 2004). Cheatgrass, an exotic species that is unsuitable as sage-grouse habitat, readily invaded the disturbed soils adjacent to railroads, being distributed by trains and the cattle they transported. Fires created by trains facilitated the spread of cheatgrass into adjacent areas. Railroads cover 137 km<sup>2</sup> (53 mi<sup>2</sup>) of the sage-grouse in Connelly *et al.*'s (2004) assessment area, but are estimated to influence an area of 183,915 km<sup>2</sup> (71,000 mi<sup>2</sup>), assuming a 3 km (1.9 mi) zone of influence (9 percent of their assessment area). Avian collisions with trains occur, although no estimates of mortality rates are documented in the literature (Erickson *et al.* 2001).

The effects of infrastructure, particularly as related to energy development and urbanization, were identified by some members of the expert panel as an important factor contributing to the extinction risk for greater sage-grouse, particularly in the eastern part of the species range (Montana, Wyoming and Colorado). Across the entire range of the greater sage-grouse, infrastructure ranked second as an extinction risk factor by the expert panel.

#### Grazing

Bison, antelope and other ungulates grazed lands occupied by sage-grouse prior to European immigrant settlement of the western United States in the mid to late 1800s. With settlement, from 1870 to the early 1900s, the numbers of cattle, sheep, and horses rapidly

increased, peaking at the turn of the century (Oliphant 1968, Young *et al.* 1976) with an estimated 26 million cattle and 20 million sheep in the West (Wilkenson 1992). Livestock grazing is the most widespread type of land use across the sagebrush biome (Connelly *et al.* 2004); almost all sagebrush areas are managed for livestock grazing (Knick *et al.* 2003). Cattle and sheep animal unit months (AUMs; the amount of forage required to feed one cow with calf, one horse, five sheep, or five goats for one month) on all Federal land have declined since the early 1900s (Laycock *et al.* 1996). By the 1940s AUMs on all Federal lands were estimated to be 14.6 million, increasing to 16.5 million in the 1950s, and gradually declining to 10.2 million by the 1990s (Miller and Eddleman 2000). As of 2003, active AUMs for BLM lands in States where sage-grouse occur totaled about 10.1 million (BLM 2003b). Most of the 78.3 million acres of BLM-administered land within the current range of the greater sage-grouse are open to livestock grazing (BLM 2004a). Knick *et al.* (2003) state that excessive grazing by domestic livestock during the late 1800s and early 1900s, along with severe drought, significantly impacted sagebrush ecosystems. Long-term effects from this overgrazing, including changes in plant communities and soils persist today.

Few studies have directly addressed the effect of livestock grazing on sage-grouse (Beck and Mitchell 2000, Wamboldt *et al.* 2002, Crawford *et al.* 2004), and there is little direct experimental evidence linking grazing practices to sage-grouse population levels (Braun 1987, Connelly and Braun 1997). Native herbivores, such as pronghorn antelope (*Antilocarpo americana*), were present in the sagebrush steppe region prior to European settlement of western States (Miller *et al.* 1994), and sage-grouse co-evolved with these animals. However, many areas of sagebrush-steppe did not support herds of large ungulates, as large native herbivores disappeared 12,000 years before present (Knick *et al.* 2003). Therefore, native vegetation communities within the sagebrush ecosystem developed in the absence of significant grazing presence (Knick *et al.* 2003).

It has been demonstrated that the reduction of grass heights due to livestock grazing of sage-grouse nesting and brood-rearing areas negatively affects nesting success by reducing cover necessary for predator avoidance (Gregg *et al.* 1994; Delong *et al.* 1995; Connelly *et al.* 2000a). In addition, livestock consumption of forbs may reduce food availability for sage-grouse.

This is particularly important for pre-laying hens, as forbs provide essential calcium, phosphorus, and protein. A hen's nutritional condition affects nest initiation rate, clutch size, and subsequent reproductive success (Connelly *et al.* 2000a). This information indicates that grazing by livestock could reduce the suitability of breeding and brood-rearing habitat, subsequently negatively affecting sage-grouse populations (Braun 1987, Dobkin 1995, Beck and Mitchell 2000).

Exclosure studies have demonstrated that domestic livestock grazing also reduces water infiltration rates and cover of herbaceous plants and litter, as well as compacting soils and increasing soil erosion (Braun 1998). This results in a change in the proportion of shrub, grass, and forb components in the affected area, and an increased invasion of exotic plant species that do not provide suitable habitat for sage-grouse (Miller and Eddleman 2000). Hulet (1983, as cited in Connelly *et al.* 2000a) found that heavy grazing could lead to increases in ground squirrels that depredate sage-grouse nests. Thus, important factors of livestock operations related to impacts on sage-grouse include stocking levels, season of use, and utilization levels.

Other consequences of grazing include several related to livestock trampling. Outright nest destruction by livestock trampling does occur and the presence of livestock can cause sage-grouse to abandon their nests (Rasmussen and Griner 1938, Patterson 1952, Call and Maser 1985, Crawford *et al.* 2004). Call and Maser (1985) indicate that forced movements of cattle and sheep could have significant effects on nesting hens and young broods caught in the path of these drives. Livestock may also trample sagebrush seedlings thereby removing a source of future sage-grouse food and cover (Connelly *et al.* 2000a), and trampling of soil by livestock can reduce or eliminate biological soil crusts making these areas susceptible to cheatgrass invasion (Mack 1981 as cited in Miller and Eddleman 2000; Young and Allen 1997; Forman and Alexander 1998).

Livestock grazing may also compete directly with sage-grouse for rangeland resources. Cattle are grazers, feeding mostly on grasses, but they will make seasonal use of forbs and browse species like sagebrush (Vallentine 2001). Domestic sheep are intermediate feeders making high use of forbs, but also use a large volume of grass and browse species like sagebrush (Vallentine 2001). Pedersen *et al.* (2003) documented sheep consumption of rangeland forbs in areas where sage-grouse occur. The

effects of direct competition between livestock and sage-grouse depend on condition of the habitat and grazing practices, and thus vary across the range of the species. For example, Aldridge and Brigham (2003) suggest that poor livestock management in mesic sites, which are considered limited habitats for sage-grouse in Alberta, results in a reduction of forbs and grasses available to sage-grouse chicks, thereby affecting chick survival.

Some effects of livestock grazing may have positive consequences for sage-grouse. Evans (1986) found that sage-grouse used grazed meadows significantly more during late summer than ungrazed meadows because grazing had stimulated the regrowth of forbs. Klebenow (1981) noted that sage-grouse sought out and used openings in meadows created by cattle grazing in northern Nevada. Finally both sheep and goats have been used to control invasive weeds (Mosely 1996 as cited in Connelly *et al.* 2004; Olson and Wallander 2001; Merritt *et al.* 2001) and woody plant encroachment (Riggs and Urness 1989) in sage-grouse habitat.

Although there are few studies which directly examine the effects of livestock grazing on greater sage-grouse, and no studies on a rangewide scale, the expert panel ranked grazing as a potential extinction risk factor. This ranking incorporates not only the direct effects of grazing, but all associated activities, such as vegetation management, fencing, overuse of riparian habitats by domestic livestock, etc. The expert panel also noted that the recovery of greater sage-grouse populations from the 1930s to the 1950s occurred during a period of a reduction in livestock grazing as well as a change in weather resulting in wetter conditions. However, the panel also noted that proper grazing management may be a beneficial tool for enhancing greater sage-grouse habitats where maintenance and enhancement of these habitats is identified as an objective, although this has not been rigorously tested.

Free-roaming horses and burros have been a component of sagebrush and other arid communities since they were brought to North America at the end of the 16th century (Wagner 1983; Beever 2003). About 31,000 wild horses occur in 10 western States, with herd sizes being largest in States with the most extensive sagebrush cover (Nevada, Wyoming, and Oregon; Connelly *et al.* 2004). Burros occur in five western States, with about 5,000 of these present (Connelly *et al.* 2004). Due to physiological differences, a horse consumes 20 to 65 percent more forage than would a cow of equivalent body

mass (Wagner 1983; Menard *et al.* 2002). We are unaware of any studies that directly address the impact of wild horses or burros on sagebrush and sage-grouse. However some authors have suggested that wild horses could negatively impact important meadow and spring brood-rearing habitats used by sage-grouse (Crawford *et al.* 2004; Connelly *et al.* 2004). Other impacts from wild horse grazing may be similar to the impacts resulting from domestic livestock in sagebrush habitats, but these have not been documented.

Sagebrush removal to increase herbaceous forage and grasses for domestic and wild ungulates is a common practice in sagebrush ecosystems (Connelly *et al.* 2004). Removal from chemical and mechanical means has been discussed previously. The elimination of sagebrush is usually followed with rangeland seedings to improve forage for livestock grazing operations (Knick *et al.* 2003; Connelly *et al.* 2004). Large expanses of sagebrush have been removed and reseeded with non-native grasses, such as crested wheatgrass (*Agropyron cristatum*), to increase forage production on public lands (Shane *et al.* 1983, cited in Knick *et al.* 2003; Connelly *et al.* 2004). These treatments had the effect of reducing or eliminating many native grasses and forbs present prior to the seedings. Sage-grouse are affected indirectly through the loss of native forbs that serve as food and the loss of native grasses that provide concealment or hiding cover within the understories of the former sagebrush stands (Connelly *et al.* 2004). BLM reports that they no longer implement actions that result in removing large expanses of sagebrush and reseeded with non-native grasses (BLM 2004a).

Water developments for the benefit of livestock on public lands are common (Connelly *et al.* 2004). Development of springs and other water sources to support livestock in upland shrub-steppe habitats can artificially concentrate domestic and wild ungulates in important sage-grouse habitats, thereby exacerbating grazing impacts in those areas through vegetation trampling, etc. (Braun 1998). Diverting the water sources has the secondary effect of changing the habitat present at the water source before diversion. This could result in the loss of either riparian or wet meadow habitat important to sage-grouse as sources of forbs or insects.

#### Mining

Development of mines within the distribution of the sage-grouse began before 1900 (Robbins and Ward 1994,

cited in Braun 1998). Surface mining for any mineral resource (coal, uranium, copper, bentonite, gypsum, oil shale, phosphate, limestone, gravel, etc.) will result in direct habitat loss for sage-grouse if the mining occurs in occupied sagebrush habitats. Direct loss of sage-grouse habitat can also occur if the overburden and/or topsoil resulting from mining activities are stored in sagebrush habitats. The actual effect of this loss depends on the quality, amount, and type of habitat disturbed, the scale of the disturbance, and if non-breeding habitat is affected, the availability of adjacent habitats (Proctor *et al.* 1983; Remington and Braun 1991). Sage-grouse habitat losses from all sources of mining have occurred in Utah (Beck *et al.* 2003), Colorado (Braun 1986), and Wyoming (Hayden-Wing Associates 1983), but the actual amount of habitat loss has not been tabulated. Sagebrush habitat has also been lost to mining in other states within the range of sage-grouse although reliable estimates of the amount of loss are not available.

Mined land reclamation is required by either the Federal or State governments in the greater sage-grouse states and Canada (Smyth and Dearden 1998). Due to the relatively recent nature of federal coal and Canadian regulation (27 and 41 years, respectively; Smyth and Dearden 1998) there is limited long-term monitoring data. The laws generally allow for a change in post-mining land use from pre-mining conditions, and restoration of pre-mining sagebrush habitat may not occur if the surface owner determines an alternative habitat type is preferable. However, Federal coal reclamation requires restoration of diversity and density standards if the private landowner agrees. Early efforts to restore sage-grouse habitats on mined lands focused on creating artificial leks, which was largely unsuccessful (Tate *et al.* 1979; Proctor *et al.* 1983). Most efforts now rely on seasonal restrictions for lek destruction and restoration of sagebrush habitats (Proctor *et al.* 1983; Parrish and Anderson 1994). Regulation of non-coal mining in the United States is at the discretion of the individual States, and may or may not include wildlife habitat restoration as a criterion (Pat Deibert, U.S. Fish and Wildlife Service, pers. comm. 2004).

New vegetation types including exotic species may become established on mined areas (Moore and Mills 1977), altering their suitability for sage-grouse. Temporary habitat loss can stem from intentional planting to minimize erosion or for nurse crops (those crops planted to create suitable microhabitat conditions for the desired vegetative

species). The length of this temporary conversion depends on the life of the mine, the success of reclamation, and whether or not reclamation is concurrent with mining disturbance. If reclamation plans call for the permanent conversion of the mined area to a different habitat type (*e.g.*, agriculture) the habitat loss becomes permanent. Invasive exotic plants may also establish on the disturbed surfaces. Removal of the overburden and target mineral may result in changes in topography, subsequently resulting in changes in microclimates and microhabitats (Moore and Mills 1977). Significant topographical changes can affect the ability to successfully restore the mined area to pre-existing vegetative conditions (Moore and Mills 1977). Additional habitat losses can occur if supporting infrastructure, such as roads, railroads, utility corridors, etc., become permanent landscape features after mining and reclamation are completed (Moore and Mills 1977).

In Wyoming and Montana an estimated 38,833 ha (96,000 ac) of disturbed Federal and non-Federal surface are associated with existing coal mining operations (Kermit Witherbee, Bureau of Land Management, pers. comm. 2004). Over the next ten years, it has been estimated that approximately 20,243 ha (50,000 ac) will be disturbed for coal mining activities. This is less than 1 percent of the Connelly *et al.* (2004) assessment area. Of that, 14,170 ha (35,000 ac) should be reclaimed within the same time-period, resulting in a net annual disturbance of 607 ha (1,500 ac). The actual impact to sage-grouse may be longer, as it takes 15 to 30 years for sagebrush regeneration to usable conditions (Connelly and Braun 1997). There will likely be additional losses of sagebrush habitat in other states as a result of mining activities (all types) although we are unable to quantify this.

Mining infrastructure, such as roads, railroads, powerlines, etc., may impact sage-grouse, although those effects are not expected to be different than previously described. Presumably, direct habitat loss will not be as large from subsurface mining. However, the amount of supporting infrastructure and indirect effects may be similar as for surface mines (Thomas and Leistritz 1981). Other indirect effects from mining can include reduced air quality from gaseous emissions and fugitive dust, degradation of surface water quality and quantity, changes in vegetation, topography, land-use practices, and disturbance from noise, ground shock and human presence, and mortality from collision with mining

equipment (Moore and Mills 1977; Brown and Clayton 2004). Gaseous emissions, created from the operation of heavy equipment, trains, etc., are usually quickly dissipated in the windy, open areas typical of sagebrush. Fugitive dust could affect local vegetative and insect resources through coating important respiratory surfaces. In extreme cases, plant photosynthesis may be restricted (Moore and Mills 1977). This may result in reduced food and cover resources for sage-grouse. Fugitive dust may also affect sage-grouse through direct irritation of mucus membranes and/or exposure to toxic minerals that are otherwise trapped in the soils (Moore and Mills 1977). Most large surface mines are required to control fugitive dust, so these impacts are probably limited.

Water quality can generally be reduced through increased sediment loads, leaching of toxic compounds or elements from exposed ore, waste rock and overburden, introduction of excess nutrients from blasting and fertilizers, or introduction of pathogens from septic systems and waste disposal associated with mining activity (Moore and Mills 1977). Contamination of water supplies through toxic elements can result in either direct mortality to wildlife, or long-term chronic health problems. Pathogens can also have a similar detrimental effect on wildlife. Water supplies may decline either through direct removal of wetlands from mining activity or reduction from use for fugitive dust suppression. Remaining wetlands may subsequently receive increased use from other wildlife or domestic livestock, resulting in habitat degradation. In Nevada, extensive dewatering of ground water results from open pit gold mining (Kevin Kritz, U.S. Fish and Wildlife Service, pers. comm. 2004). The actual impact of these effects on sage-grouse is unknown. Since sage-grouse do not require free water (Schroeder *et al.* 1999), we anticipate that impacts to water quality from mining activities have minimal population-level effects. The possible exception is degradation of riparian areas, which could result in brood habitat loss.

If blasting is necessary for removal of overburden or the target mineral, ground shock may occur. The full effects of ground shock on wildlife are unknown, but given its temporary duration and localized impact area, impacts are considered minimal (Moore and Mills 1977). One possible exception is the repeated use of explosives during lekking or nesting, which could potentially result in nest and/or lek abandonment (Moore and Mills 1977).

We are unaware of any research on the impact of these factors to sage-grouse. Noise from mining activities may limit sage-grouse use of surrounding suitable habitat. In a study of sharp-tailed grouse (*Pedioecetes phasianellus*) leks in northeastern Wyoming, data suggested that noise from an adjacent coal mine adversely affected leks by masking vocalizations, which resulted in reduced female attendance and yearling recruitment (Amstrup and Phillips 1977). In that study, the authors found that mining noise was continuous across days and seasons, and did not dissipate as it traveled across the adjacent landscape. The effects on sage-grouse of noise from mining are unknown, but sage-grouse also depend on acoustical signals to attract females to leks (Gibson and Bradbury 1985; Gratson 1993). If noise does interfere with mating displays, and thereby female attendance, younger males will not attend the lek, and eventually leks will become inactive (Amstrup and Phillips 1977; Braun 1986).

Mining can also impact sage-grouse through the increased presence of human activity, either through avoidance of suitable habitat adjacent to mines or through collisions with vehicles associated with mining operations (Moore and Mills 1977; Brown and Clayton 2004). An increased human population in an area, as a result of mine extraction activities, may result in increased hunting pressure, both legal and poaching (Moore and Mills 1977). Although these effects have not been quantified on sage-grouse populations, the State of Wyoming requires coal operators to educate their employees about wildlife regulations when they are hired. Sage-grouse may also be at increased risk for collision with vehicles simply due to the increased traffic associated with mining activities and transport (Moore and Mills 1977; Brown and Clayton 2004). However, we were unable to find any information regarding increased mortality of sage-grouse near mines as a result of this effect.

We were only able to locate a few studies that specifically examined the effects of coal mining on greater sage-grouse (Tate *et al.* 1979; Hayden-Wing Associates 1983; Braun 1986; Remington and Braun 1991; Brown and Clayton 2004). In a study in North Park, Colorado, overall population numbers of sage-grouse were not reduced, but there was a reduction in the number of males attending leks within 2 km (0.8 miles) of three coal mines, as well as a failure to recruit yearling males to these existing leks (Braun 1986; Remington and Braun 1991). New leks formed

further from the mining disturbance (Remington and Braun 1991). Additionally, some leks adjacent to mine areas that had been abandoned at the onset of mining were re-established when mining activities ceased, suggesting disturbance rather than loss of habitat was the limiting factor. There was no decline in hen survival in a population of sage-grouse near large surface coal mines in northeastern Wyoming and nest success was apparently unaffected by the adjacent mining activity (Brown and Clayton 2004). However, the authors concluded that this population could only be sustained by aggressive land management to maintain suitable habitat, as the existing habitat will become fragmented by continued mining.

Braun (1998) concluded that surface coal mining and all associated activities have negative short-term impacts on sage-grouse numbers and habitats near the mines. Sage-grouse will reestablish on mined areas once mining has ceased, but there is no evidence that population levels will reach their previous size. Additionally, the time span for population re-establishment may be 20 to 30 years (Braun 1998). Hayden-Wing Associates (1983) concluded that the loss of one or two leks in a regional area from coal mining was likely not limiting to local populations in their study on the Caballo Rojo Mine in northeastern Wyoming. However, if several leks are affected, local population numbers may decline (Hayden-Wing Associates 1983).

Hard rock mining impacts greater sage-grouse at the local level. The expert panel identified hard rock mining as a threat of relatively low importance compared to other threats. The effect of hard rock mining, when considered independently of other threats to the species, is likely of relatively low importance to the status of the species range-wide.

#### Non-Renewable and Renewable Energy Development

Non-renewable energy development (petroleum products, coal) has been occurring in sage-grouse habitats since the late 1800s (Connelly *et al.* 2004). Interest in development of oil and gas has been sporadic and typically focused in limited geographical areas (Braun *et al.* 2002). The re-authorization of the Energy Policy and Conservation Act in 2000 dictated re-inventory of Federal oil and gas reserves, which identified extensive reserves in the Greater Green River Basin of Colorado, Utah, and Wyoming, the San Juan Basin of New Mexico and Colorado, and the Montana Thrust Belt and the Powder River Basin

of Wyoming and Montana (Connelly *et al.* 2004). All of these basins are located in primarily sagebrush-dominated landscapes (Knick *et al.* 2003; Connelly *et al.* 2004).

The development of oil and gas resources requires surveys for economically recoverable reserves, construction of well pads and access roads, subsequent drilling and extraction, and transport of oil and gas, typically through pipelines. Ancillary facilities can include compressor stations, pumping stations and electrical facilities (Connelly *et al.* 2004). Surveys for recoverable resources occur primarily through seismic activities, using vibroesis buggies (thumpers) or shothole explosives. Well pads vary in size from 0.10 ha (0.25 ac) for coalbed natural gas wells in areas of level topography to greater than 7 ha (17.3 ac) for deep gas wells (Connelly *et al.* 2004). Pads for compressor stations require 5 to 7 ha (12.4 to 17.3 ac; Connelly *et al.* 2004). Well densities and spacing are typically designed to maximize recovery of the resource and are administered by State and Provincial oil and gas agencies and the BLM (on Native American lands) (Connelly *et al.* 2004). Based on their review of project EIS's, Connelly *et al.* (2004) concluded that the economic life of a coalbed methane well averages 12 to 18 years and 20 to 100 years for deep oil and gas wells.

Connelly *et al.* (2004) reviewed oil and gas development environmental impacts statements to determine that approximately 4,000 oil and gas wells have been approved in the Green River Basin of Wyoming, Colorado and Utah, with approval of an additional 9,700 wells pending. In the Powder River Basin of Wyoming and Montana, 15,811 wells have been approved, and an additional 65,635 are being considered (Connelly *et al.* 2004). In the Uinta/Piceance Basin of Utah, 3,500 wells have been drilled and another 2,600 are pending (Connelly *et al.* 2004). Approximately 3,000 more permits will be issued annually for Montana, Colorado, Utah and Wyoming (Connelly *et al.* 2004). Nine million hectares (22.2 million ac) in Montana, Wyoming, Colorado, Utah and New Mexico are available for oil and gas leasing, and approval for 29,000 new oil and gas leases is anticipated by 2005 (BLM 2003c). The BLM has not quantified the portion of these lands that provide sage-grouse habitat. In September, 2004, the Utah BLM office sold 279 oil and gas leases, incorporating approximately 195,000 ha (481,000 ac) on both BLM and Forest Service surfaces (BLM 2004c). Based on a review of National

Environmental Policy Act (NEPA) documents, there are 27,231 existing oil and gas wells in sagebrush habitats, and another 78,938 to 79,647 are proposed.

Potential impacts to sage-grouse and sagebrush habitats from the development of oil and gas resources include direct habitat loss, habitat fragmentation from vegetation removal, roads, powerlines and pipeline corridors, noise, gaseous emissions, changes in water availability and quality, and increased human presence (Suter 1978; Aldridge 1998; Braun 1998; Aldridge and Brigham 2003; Knick *et al.* 2003; Lyon and Anderson 2003; Connelly *et al.* 2004). We found no information regarding the effects of gaseous emissions produced by oil and gas development. Presumably, as with surface mining, these emissions are quickly dispersed in the windy, open conditions of sagebrush habitats (Moore and Mills 1977), minimizing the potential effects on sage-grouse.

Direct habitat losses result from construction of well pads, roads, pipelines, powerlines, and potentially through the crushing of vegetation during seismic surveys. For example, coal-bed methane development in the Powder River Basin of Wyoming is expected to result in the loss of an additional 21,711 ha (53,626 ac) of sagebrush habitat by 2011 (BLM 2003a). This is less than 1 percent of the Connelly *et al.* (2004) assessment area. Current sage-grouse habitat loss in the Basin from coal-bed methane is estimated at 2,024 ha (5,000 ac) (Braun *et al.* 2002).

Connelly *et al.* (2004) estimated that habitat loss from all existing natural gas pipelines in the conservation assessment area was a minimum of 4,740 km<sup>2</sup> (1,852 mi<sup>2</sup>, 1.17 million ac, 474,000 ha; less than 1 percent of their assessment area). Proposed pipelines to support future oil and gas developments are not included in this figure. Although reclamation of short-term disturbances is often concurrent with project development, habitats would not be restored to pre-disturbance conditions for an extended period (BLM 2003a). The amount of direct habitat loss within an area will ultimately be determined by well densities and the associated loss from ancillary facilities. Most Federal land management agencies impose stipulations to preclude exploration in suitable habitat during the nesting season.

Reclamation of areas disturbed by oil and gas development can be concurrent with field development. As disturbed areas are reclaimed, sage-grouse may repopulate the area. However, there is no evidence that populations will attain

their previous size, and re-population may take 20 to 30 years, as habitat conditions are not immediately restored (Braun 1998). For most developments, return to pre-disturbance population levels is not expected due to a net loss and fragmentation of habitat (Braun *et al.* 2002). After 20 years, sage-grouse have not recovered to pre-development numbers in Alberta, even though well pads in these areas have been reclaimed (Braun *et al.* 2002). In some reclaimed areas, sage-grouse have not returned (Aldridge and Brigham 2003).

Habitat fragmentation impacts to sage-grouse resulting from vegetation removal, roads, powerlines and pipeline corridors are similar to those described previously. Fragmentation resulting from oil and gas development and the associated introduced infrastructure may have more effects on greater sage-grouse than the associated direct habitat losses, which may not be extensive. For example, of the total 904,109 ha (2,234,103 ac) project area in the Powder River Basin, an estimated 23,735 ha (58,625 ac) of habitat will be directly disturbed by well construction (BLM 2003a). However, up to 8,579 km (5,311 mi) of powerlines, 28,572 km (17,754 mi) of roads, and 33,548 km (20,846 mi) of pipelines are also proposed for this project. The presence of these ancillary facilities may preclude sage-grouse from using suitable adjacent habitats (see previous discussion). As previously discussed, roads associated with oil and gas development were suggested to be the primary impact to greater sage-grouse due to their persistence and continued use even after drilling and production has ceased (Lyon and Anderson 2003).

Noise can drive away wildlife, cause physiological stress and interfere with auditory cues and intraspecific communication, as discussed previously. Aldridge and Brigham (2003) reported that, in the absence of stipulations to minimize the effects, mechanical activities at well sites may disrupt sage-grouse breeding and nesting activities. Hens bred on leks within 3 km (1.9 miles) of oil and gas development in the upper Green River Basin of Wyoming selected nest sites with higher total shrub canopy cover and average live sagebrush height than hens nesting away from disturbance (Lyon 2000). The author hypothesized that exposure to road noise associated with oil and gas drilling may have been one cause for the difference in habitat selection. However, noise could not be separated from the potential effects of increased predation resulting from the presence of a new road. Above-ground noise is typically not regulated to

mitigate effects to sage-grouse or other wildlife (Connelly *et al.* 2004). Ground shock from seismic activities may affect sage-grouse if it occurs during the lekking or nesting seasons (Moore and Mills 1977). We are unaware of any research on the impact of ground shock to sage-grouse.

Water quality and quantity may be affected in oil and gas development areas. The impacts are similar relative to the contamination of water supplies by toxic elements and pathogens (see previous discussion), with the addition of potential oil contamination in settling and/or condensate ponds. In many large field developments, water produced during the gas dehydration process is stored in tanks, removing this potential threat. Where oil contamination of open water pits has occurred, no sage-grouse mortalities are known (Pedro Ramirez, U.S. Fish and Wildlife Service, pers. comm. 2004). Water may also be depleted from natural sources for drilling or dust suppression purposes. Remaining wetlands may subsequently receive increased use from other wildlife or domestic livestock, resulting in habitat degradation. Since, sage-grouse do not require free water (Schroeder *et al.* 1999) we anticipate that impacts to water quality from mining activities have minimal effects on them. The possible exceptions are a reduction in habitat quality (*e.g.*, trampling of vegetation, changes in water filtration rates), habitat degradation (*e.g.*, poor vegetation growth), which could result in brood habitat loss. However, we have no data to suggest this is a limiting factor to sage-grouse.

Water produced by coal-bed methane drilling may benefit sage-grouse through expansion of existing wetland and riparian areas, and creation of new areas (BLM 2003a). These habitats could provide additional brood rearing and summering habitats for sage-grouse. However, based on the recent discovery of West Nile virus in the Powder River Basin, and the resulting mortalities of sage-grouse (Naugle *et al.* 2004), there is concern that produced water could be a negative impact if it creates suitable breeding reservoirs for the mosquito vector of this disease. There is currently no evidence supporting a link between West Nile virus and coal-bed methane development (Naugle *et al.* 2004). Produced water could also result in direct habitat loss through prolonged flooding of sagebrush areas, or if the discharged water is of poor quality because of high salt or other mineral content, either of which could result in the loss of sagebrush and/or grasses and forbs necessary for foraging broods

(BLM 2003a). We do not have quantitative information on the extent of habitat influenced by produced water, nor the net effects on sage-grouse populations.

Increased human presence resulting from oil and gas development can also impact sage-grouse either through avoidance of suitable habitat, disruption of breeding activities, or increased hunting and poaching pressure (Aldridge and Brigham 2003; Braun *et al.* 2002; BLM 2003a). Sage-grouse may also be at increased risk for collision with vehicles simply due to the increased traffic associated with oil and gas activities (BLM 2003a).

Only a few studies have examined the effects of oil and gas development on sage-grouse. While each of these studies reported sage-grouse population declines, specific causes for the negative impacts were not determined. In Alberta, Canada, the development of well pads and associated roads in the mid-1980s resulted in the abandonment of three lek complexes within 200 m (220 yd) of these features (Braun *et al.* 2002). Those leks have not been active since that time. A fourth lek complex has gone from three to one lek with fewer numbers of sage-grouse on it (Braun *et al.* 2002). The well pads have since been reclaimed, but sage-grouse numbers have not recovered (we do not have information on post-reclamation vegetation). Subsequent to the development of the Manyberries Oil Field in high quality sage-grouse habitat in Alberta, male sage-grouse counts fell to the lowest known level (Braun *et al.* 2002). Two additional leks were directly disturbed, and neither of these leks has been active within the past 10 years (Braun *et al.* 2002). The development of oil reserves in Jackson County, Colorado, was concurrent with decline of sage-grouse numbers in the oil field area (Braun 1998). Sage-grouse populations still occur in at least one long-term oil field development in Colorado where leks are not within line-of-sight of an active well or powerline (Braun *et al.* 2002). Although the number of active leks has declined in this field, sage-grouse have been consistently documented there since 1973.

Of particular relevance to estimating oil and gas development impacts is the fidelity of sage-grouse hens to nesting and summer brood rearing areas demonstrated by Lyon and Anderson (2003). Hens that have successfully nested will return to the same areas to nest every year. If these habitats are affected by oil and gas development, there is a strong potential that previously successful hens will return

but not initiate nests (Lyon 2000). Depending on the number of hens affected, local populations could decline.

Over 200 known leks occur within the coal-bed methane development area in Powder River Basin of northeastern Wyoming. Those leks have been affected by direct habitat losses, higher human activity, and powerlines (Braun *et al.* 2002). Since initiation of field development, 28 percent of known sage-grouse habitat within the project area has been affected. On 30 leks within 0.4 km (0.25 mi) of a well, significantly fewer males have been recorded when compared with other, undisturbed leks. The rate of recruitment to the male breeding population on these leks is also lower when compared with increases on less disturbed leks (Braun *et al.* 2002; BLM 2003a). Powerlines have been constructed within 0.4 km (0.25 mi) of 40 leks within the project area. These leks also have lower recruitment rates, possibly due to increased raptor predation. Lower numbers of grouse have also been counted on leks within 1.6 km (1 mi) of compressor stations (Braun *et al.* 2002). In the Final EIS for this project, the BLM stated that local sage-grouse extirpations may occur as a result of the synergistic effects of all aspects of coal-bed methane development in this area (BLM 2003a).

In the Jonah natural gas field in southwestern Wyoming, 10 of 24 leks in or near the project area are no longer active, although data collection has not been consistent on 4 of those leks (BLM 2004d). Two leks were destroyed by the placement of well pads on the leks, and re-establishment of those leks at that location is not anticipated (BLM 2004d). Based on nest initiation and habitat fidelity results, Lyon and Anderson (2003) concluded that impacts occur greater than 0.4 km (0.25 mi) from well pads, thus current no-surface-occupancy buffers around active sage-grouse based on that distance may not be adequate to avoid adverse effects. However, to our knowledge no information exists concerning whether leks are subsequently re-established.

Protective wildlife stipulations are typically placed on individual oil and gas leases at the time of sale, including seasonal and temporal restrictions around important sage-grouse habitats (Connelly *et al.* 2004). The protection afforded by these stipulations depends on the specific prescriptions, and whether or not important sage-grouse habitats are identified in the area proposed for development. Additional stipulations may be placed on oil and gas development, as identified in BLM

land use plans, and through the NEPA process. Most lease stipulations have exception, waiver, and/or modification criteria that are included in BLM land use plans. Waivers, which are a permanent exemption, and modifications, which are changes to the terms of a stipulation, are described by BLM as being rare, and they also may require public notice (BLM 2004a). Exceptions are a one-time exemption to a lease stipulation. An example cited by BLM is a timing stipulation designed to avoid activity in wintering habitat, which could be the subject of an exception in a mild winter if a company requests an early entry to drill and BLM or the local wildlife agency make an on-the-ground survey and find sage-grouse are not using the winter habitat or have left the area earlier than normal (BLM 2004a).

On June 22, 2004, BLM issued an Instruction Memorandum (IM) establishing policy that BLM field offices consider Best Management Practices (BMPs) for oil and gas and other fluid mineral operations as part of NEPA documents. The purpose of the BMPs is to mitigate anticipated effects to surface and subsurface resources, and to encourage operators to consider BMPs during the application process for permits to drill (BLM 2004e). BLM expects that wells drilled using BMPs will have fewer impacted acres of sagebrush habitat than has been estimated in EISs (*e.g.*, for the Powder River EIS) and consequently there will be less habitat loss and fragmentation (BLM 2004a). The effect of the IM and the BMPs is difficult to predict. Although the IM makes it BLM policy to consider the BMPs, their adoption is voluntary, not mandatory. The Service is available to provide BLM with technical assistance as they implement BMPs.

The Forest Service can place additional seasonal or temporal stipulations to protect sage-grouse on oil and gas developments on lands they manage (Forest Service in litt. 2004). Development of oil and gas resources on private lands does not always require mitigation (Braun 1998; Connelly *et al.* 2004), and most States do not place wildlife stipulations on development occurring on their lands. In Canada, no current legislation commits energy development to adhere to recommendations by Alberta Fish and Wildlife to reduce impacts of drilling in important sage-grouse habitats (Braun *et al.* 2002).

Renewable energy resources, such as windpower and geothermal energy, require many of the same features for construction and operation as do non-

renewable energy resources. Therefore, we anticipate that potential impacts from direct habitat losses, habitat fragmentation through roads and powerlines, noise, and increased human presence (Connelly *et al.* 2004) will generally be the same as already discussed for nonrenewable energy development. Windpower may have additional mortalities resulting from sage-grouse flying into turbine rotors or meteorological towers (Erickson *et al.* 2001). One sage-grouse was found dead within 45 m (148 ft) of a turbine on the Foote Creek Rim wind facility in south-central Wyoming, presumably from flying into a turbine (Young *et al.* 2003). During 3 years of monitoring operation, this is the only known sage-grouse mortality at this facility. Sage-grouse hens with broods have been observed using Foote Creek Rim, under the turbines, during surveys for other species (David Young, WEST, Inc., pers. comm. 2004). Mortalities at other facilities within sagebrush habitats are unknown and may not be monitored. However, most developed windpower facilities are not located within sagebrush habitats, and the average above-ground height of windpower facilities is 107 m (350 ft; Erickson *et al.* 2001), above the normal height of short-distance sage-grouse flights (Johnson *et al.* 2000).

Fifteen thousand wind turbines were projected to be operational in the United States by the end of 2001, not including the wind turbines located in California (Erickson *et al.* 2001). On September 10, 2004, the BLM released a draft programmatic EIS regarding the modification of land use plans in western States (including all States within the extant sage-grouse range) for the increased development of wind resources (BLM 2004f). Locations and potential impacts to sage-grouse were not discussed in specific detail.

Development of hydropower energy may impact sage-grouse through direct habitat losses, and increases in human traffic and activity if a resulting reservoir provides recreational resources. During construction, there may also be additional impacts of fugitive dust, gaseous emissions, road construction, increased traffic, and increased poaching activities. We do not anticipate that the potential for impacts from these activities to sage-grouse are different from those discussed previously for infrastructure issues. During the mid-1900s, a number of hydroelectric dams were developed on the Columbia and Snake Rivers in Washington and Oregon. More than 400 dams were constructed on the Columbia River system alone. The irrigation

projects formed by these reservoirs precipitated conversion of large expanses of upland shrub-steppe habitat in the Columbia Basin for irrigated agriculture adjacent to the rivers as discussed previously in the Agriculture section (65 FR 51578). The creation of these reservoirs also directly inundated hundreds of kilometers of riparian habitats used by sage-grouse broods (Braun 1998). We were unable to find any information regarding the amount of sage-grouse habitat affected by hydropower projects in other areas of the species range beyond the Columbia Basin. We do not anticipate that future dam construction will result in large losses of sagebrush habitats. Although dam removal has been proposed for some areas, upland restoration goals, and the potential benefit to sage-grouse, are unknown.

The development of geothermal energy requires intensive human activity during field development (Suter 1978). Toxic gases may be released, and the type and effect of these gases depends on the geological formation in which drilling occurs. The amount of water necessary for drilling and condenser cooling may be high (Suter 1978). Therefore, water depletions may be a concern if such depletions result in the loss of limiting brood-rearing habitats (*see* discussion above). Geothermal activity on public lands is primarily in California, with over 23 producing leases. Nevada, and Utah also have producing leases (BLM 2004g). Impacts to sage-grouse were not identified.

We were unable to find any information regarding the commercial development of solar energy. We anticipate the effects from this resource will be those associated with direct habitat loss, fragmentation, roads, powerlines, increased human presence, and disturbance during facility construction, where solar energy development occurs.

Energy development was identified by the expert panel as the most significant extinction risk to the greater sage-grouse in the eastern portion of its range (Colorado, Wyoming and Montana). Their primary concern was the rapidity of development and the persistent demand for petroleum products. On a rangewide scale, however, energy development alone (not including the infrastructure associated with it—*see* Roads and Railroads above) ranked as the sixth most important extinction risk factor. To better understand the actual mechanism by which energy development affects greater sage-grouse, the panel suggested excluding some areas from extraction activities so that

comparative analyses could be conducted.

#### Fire

The effects of fire on sagebrush habitats vary according to the species of sagebrush present, other plant species present (*e.g.*, the understory) and the frequency, size and intensity of fires. Widely variable estimates of mean fire intervals have been described in the literature: 35 to 100 years (Brown 2000), greater than 50 years for big sagebrush communities (McArthur 1994), 12 to 15 years for mountain big sagebrush (Miller and Rose 1999), 20 to 100 years (Peters and Bunting 1994), 10 to 110 years depending on sagebrush species and specific geographic area (Kilpatrick 2000), and 13 to 25 years (Frost 1998 cited in Connelly *et al.* 2004).

In general, fire tends to extensively reduce the sagebrush component within the burned areas. Big sagebrush (*A. tridentata* spp.), the most widespread species of sagebrush (McArthur 1994), is killed by fire. It does not re-sprout after burning (Agee 1994, Braun 1998, Wroblewski and Kauffman 2003), and can take as many as 30 to 50 years to recolonize an area (Agee 1994, Telfer 2000, Wambolt *et al.* 2001). This suggests that these sagebrush subspecies evolved in an environment where wildfire was infrequent (interval of 30 to 50 years) and patchy in distribution (Braun 1998). However, as noted by the expert panel, fire has been an important component in sagebrush systems.

A characteristic of natural fire in sagebrush stands is the incomplete burning that leaves areas of unburned sagebrush (sometimes referred to as islands of habitat) (Huff and Smith 2000). Huff and Smith (2000) noted that these unburned islands appear to be important to the future recolonization of the sagebrush community by providing sources of sagebrush seed. Prior to settlement by European immigrants, fire patterns in sagebrush communities were patchy, particularly in Wyoming big sagebrush, due to the discontinuous and limited fuels and unburned islands that remained after a fire (Miller and Eddleman 2000).

Connelly *et al.* (2004) summarized fire statistics from records obtained for the sagebrush biome (both wild and prescribed fires). The total area burned and the number of fires increased across the sagebrush ecoregions from 1960 to 2003. In the Southern Great Basin and Wyoming basins, average fire size increased. In the 40.5 million ha (100 million ac) sagebrush-steppe ecoregion (essentially the northern distribution of sagebrush), or drier sagebrush areas fire regimes have shifted to more frequent

fire episodes (Brown 2000). Fire was identified as the primary factor resulting in sage-grouse habitat conversion in Oregon (1.4 million ac; Oregon Department of Fish and Wildlife in litt. 2004).

In parts of the Great Basin (Nevada, Oregon and Utah) a decline in fire occurrence since the late 1800s has been reported in several studies, which coincides with fire suppression and reduction of fuels by introducing livestock (Touchan *et al.* 1995, Miller and Rose 1999, Kilpatrick 2000, Connelly *et al.* 2004). Long fire intervals and fire suppression can result in increased dominance of woody conifer species, such as western juniper (*Juniperus occidentalis*) (Wroblewski and Kauffman 2003), resulting in a near total loss of shrubs and sage-grouse habitat in localized areas (Miller and Eddleman 2000). Alternatively, invasion of exotic annuals, such as cheatgrass and medusahead (*Taeniatherum asperum*), has resulted in increases in the frequency and number of fires within the range of the greater sage-grouse (Young and Evans 1973, Brown 2000, Wroblewski and Kauffman 2003, Connelly *et al.* 2004). Following fire, sagebrush will not re-establish on its own for long time intervals, while non-native grasses quickly recover from fire and increase, effectively preventing sagebrush return. Management to restore an area to sagebrush after cheatgrass becomes established is difficult and usually ineffective (Paysen *et al.* 2000). As a result of this direct relationship between wildfire and the spread of invasive plants, large areas of habitat in the western distribution of the greater sage-grouse have already been converted to cheatgrass (Connelly *et al.* 2000c). The loss of habitat due to establishment of and dominance by non-native annual grasses results in the loss of sage-grouse populations (Connelly *et al.* 2000c).

Wildfires have removed extensive areas of sagebrush habitat in recent years. For example, 30 to 40 percent of the sage-grouse habitat in southern Idaho was destroyed in a 5-year period (1997–2001) due to range fires (Signe Sather-Blair, U.S. Bureau of Land Management, quoted in Healy 2001). The largest contiguous patch of sagebrush habitat in southern Idaho occupied approximately 283,000 ha (700,000 ac), (Michael Pellant, U.S. Bureau of Land Management, quoted in Healy 2001). Of that total area, about 202,000 ha (500,000 ac) burned in the years 1999 to 2001; half of the acres that burned for the first 3 to 5 years post fire, but accompanying forbs and surviving grasses increased biomass production. In another study, productivity of

perennial herbs had increased by the second year post-burn to an average 2.2 times higher on burned versus control areas (Cook *et al.* 1994). In a 1998 prescribed burn on the Hart Mountain National Antelope Refuge, Crawford (1999) observed little change in species composition between unburned and burned areas. In the same general area, fall burning had no apparent effect on most primary foods although some Cichorieae species did increase (Pyle 1992). Fischer *et al.* (1996) also noted that vegetative cover of important forbs in the diets of sage-grouse was similar in unburned and burned habitat. In a review of 13 sites that had burned during a span of 2 to 32 years, Wambolt *et al.* (2001) reported that perennial grasses and forbs did not benefit from prescribed burning.

A variety of techniques have been attempted at re-establishing sagebrush post-fire, with mixed success (Cadwell *et al.* 1996, Quinney *et al.* 1996, Livingston 1998). Restoration of the sagebrush biome following a fire has been complicated not only by the invasion of exotic annual plant species, but the difficulty associated with establishing sagebrush seedlings (Boltz 1994). Wirth and Pyke (2003) reported that forb response post-fire is dependant on the forb community pre-burn. Habitat rehabilitation following fires has become a major activity in recent years, increasing from 281 km<sup>2</sup> (109 mi<sup>2</sup>) in 1997 to 16,135 km<sup>2</sup> (6,230 mi<sup>2</sup>) in 2002 with most treatments in Oregon, Idaho, and Nevada (Connelly *et al.* 2004), but we have no data on the extent of actual sagebrush restoration.

A clear positive response of greater sage-grouse to fire has not been demonstrated (Braun 1998). Call and Maser (1985) noted that fires could cause adverse conditions where cover is limited. Studies of prescribed fire in mountain big sagebrush at Hart Mountain National Antelope Refuge demonstrate short-term benefits in certain forbs, but the reduction in sagebrush cover potentially rendered habitat less suitable for nesting and brood rearing (Rowland and Wisdom 2002). Similarly, Nelle *et al.* (2000) reported that the removal of sage-grouse nesting and brood-rearing habitat by fire resulted in no increase in invertebrate abundance in the first year post-fire and hence, no benefit for sage-grouse chick foraging. This loss of nesting habitat created a long-term negative impact which would require 20 years of sagebrush re-growth before sufficient canopy cover was available for nesting birds (Nelle *et al.* 2000). Byrne (2002) reported the general avoidance of available burned habitats by nesting,

brood-rearing, and broodless females. Connelly *et al.* (2000c) and Fischer *et al.* (1996) found that prescribed burning did not improve brood rearing habitat in Wyoming big sagebrush, as forbs did not increase and insect populations declined as a result of the treatment. Hence fire in this sagebrush type may negatively affect brood rearing habitat rather than improve it (Connelly and Braun 1997). However, Klebenow (1970), Gates (1983, as cited in Connelly *et al.* 2000c), Sime (1991 as cited in Connelly *et al.* 2000a), and Pyle and Crawford (1996) all indicated that fire could improve brood-rearing habitat. Slater (2003) reported that sage-grouse using burned areas were rarely found more than 60 m (200 feet) from the edge of the burn. In southeastern Idaho, Connelly *et al.* (2000c) concluded that, even though age-grouse populations were in decline across the study area, population declines were more severe in the post-fire years. Fischer *et al.* (1997) concluded that habitat fragmentation, as a result of fire, may influence distribution or migratory patterns in sage-grouse. Hulet (1983, as cited in Connelly *et al.* 2000a) documented the loss of leks as a result of fire.

The expert panel ranked wildfire as the second most important extinction risk factor for the greater sage-grouse in western portions of its range (the Great Basin—Utah, Idaho, Nevada, eastern Oregon), primarily due to the subsequent establishment of invasive species such as cheatgrass (see following discussion). Since invasive species has not become the problem in the eastern part of the greater sage-grouse range, the expert panel did not rank wildfire as high in that area. Across the species range, wildfire was identified as the third most important extinction risk factor by the expert panel.

#### Invasive Species/Noxious Weeds

Invasive species have been defined as those that are not native to an ecosystem and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health (Executive Order 13112, 1999). A wide variety of plants are considered invasive within the range of sagebrush ecosystems that the greater sage-grouse occupies (Wamboldt *et al.* 2002, Crawford *et al.* 2004, Connelly *et al.* 2004). Invasive species often cause declines in native plant populations by reducing light, water, and nutrients, and they grow so quickly that they outcompete other species (Wooten *et al.* 1996). The rate of spread for noxious weeds is approximately 931 ha (2,300 ac) per day on BLM lands and 1862 ha

(4,600 ac) per day on all public lands in the West (Knick *et al.* 2003). The area infested with exotic (non-native) invasive plants increased from 1.1 million ha (2.7 million ac) in 1985 to 3.2 million ha (7.9 million ac) in 1994 on BLM lands (Knick *et al.* 2003). The replacement of sagebrush vegetation communities with exotic species such as Russian thistle (*Salsola* spp.), halogeton (*Halogeton glomeratus*) and medusahead, has resulted in sage-grouse habitat loss (Miller and Eddleman 2000).

Young *et al.* (1972) found that plant communities of the Great Basin are highly susceptible to invasion by alien plants since native annuals are not adapted to occupy conditions created by intensive livestock grazing. Exotic plants can reduce and eliminate populations of plants that sage-grouse use for food and cover. As previously discussed, frequent fires with short intervals within sagebrush habitats favor invasion of cheatgrass, which is unsuitable as sage-grouse habitat (Schroeder *et al.* 1999). Cheatgrass then shortens the fire interval (from approximately 30 years down to 5 years), perpetuating its own persistence and spread, and exacerbating the effects of fire in remaining sage-grouse habitats (Connelly *et al.* 2004). Rehabilitation of an area to sagebrush after cheatgrass becomes established is extremely difficult (Connelly *et al.* 2004).

Large areas of habitat in the western distribution of the greater sage-grouse have already been converted to cheatgrass (Connelly *et al.* 2000a). Exotic plant communities are now dominant on more than 40 million ha in the Intermountain West (Mack 1981, as cited in Miller and Eddleman 2000). This invasive species also occurs in lower abundance throughout the entire range of the sage-grouse. Connelly *et al.* (2004) estimated the risk of cheatgrass invasion into sagebrush and other natural vegetation areas in the western part of the range of greater sage-grouse (Southern and Northern Great Basin, part of the Columbia Basin, and most of the Snake River Plain), where cheatgrass currently is concentrated. Based on elevation, landform, and south-facing slope parameters, Connelly *et al.* (2004) projected that 80 percent of this land area is susceptible to displacement by cheatgrass and that in 65 percent of this area cheatgrass is either already present or will be within 30 years. Wyoming-basin big sagebrush and salt desert scrub, which occupy over 40 percent of the Great Basin, are the cover types most susceptible to cheatgrass displacement (Connelly *et al.* 2004).

We could not find any studies that document or attempted to document a direct relationship between cheatgrass expansion and sage-grouse population declines. Yet the available evidence is clear that cheatgrass has invaded extensive areas in western parts of greater sage-grouse range, supplanting sagebrush plants upon which sage-grouse depend. Although there is a lack of evidence documenting that cheatgrass invasion causes sage-grouse declines, Connelly *et al.* (2000a) indicated that some sage-grouse populations have been affected and some will decline due to projected, continuing spread of cheatgrass domination in the absence of effective management.

Invasive species was ranked as the primary extinction risk factor for the greater sage-grouse by the expert panel. This concern was based on the ability of invasive species to outcompete sagebrush, the inability to effectively control invasives once they become established, and the ease with which invasive species are spread through other factors on the landscape, such as wildfire and infrastructure construction. Additionally, one member of the panel indicated that once invasive species become established, the ecology of the system can be changed, resulting in increased opportunities for other invasive species to establish, and subsequently, permanent habitat loss. Although cheatgrass has been identified as the primary invasive species resulting in sagebrush habitat conversion, the expert panel also cautioned that many other invasive species (*i.e.*, Japanese brome and various species of mustards and knapweeds) may be a greater threat in the future. The expert panel advised that based on current knowledge, prevention is the only effective tool to preclude large-scale habitat loss from invasive species in the future. However, they did not believe that the current rate of invasive species spread was sufficient to result in the complete loss of sagebrush, and therefore the extinction of sage grouse within the reasonably foreseeable future.

#### Pinyon-juniper

There has been an unprecedented expansion of pinyon-juniper woodlands, a native habitat type dominated by pinyon pine (*Pinus edulis*) and various juniper species (*Juniperus* spp.), with an estimated 10-fold increase in the Intermountain West since European immigrant settlement (Miller and Tausch 2001). The expansion of pinyon-juniper forests has resulted in the loss of many bunchgrass and sagebrush-bunchgrass communities that formerly dominated the

Intermountain West (Miller and Tausch 2001). The major factor cited for the increase in the pinyon-juniper forest type is a decrease in fire return intervals (Miller and Tausch 2001). Other factors facilitating the increase include historical livestock grazing patterns, which reduced the buildup of fine fuels that more readily carry fire, and possibly increases in global carbon dioxide concentrations and climate change (Miller and Rose 1999, Miller and Tausch 2001).

Connelly *et al.* (2004) estimated the risk of pinyon-juniper displacement of sagebrush for a large portion of the Great Basin, based on site elevation, proximity to extant pinyon-juniper, precipitation, and topography. Using these parameters, Connelly *et al.* (2004) projected the risk that sagebrush habitats would be displaced by pinyon-juniper within the next 30 years. They found that about 60 percent of sagebrush in the Great Basin was at low risk of being displaced by pinyon-juniper, 6 percent of sagebrush is at moderate risk, and 35 percent of sagebrush habitats are at high risk of displacement (Connelly *et al.* 2004). Connelly *et al.* (2004) also found that mountain big sagebrush appears to be the sagebrush type most at risk for pinyon-juniper displacement. When juniper increases in mountain big sagebrush communities, shrub cover declines and the season of available succulent forbs is shortened due to soil moisture depletion (Crawford *et al.* 2004). Connelly *et al.* (2004) caution that additional field research is needed to support their estimates.

Pinyon-juniper expansion into sagebrush habitats, with subsequent replacement of sagebrush shrub communities by woodland has been documented (Miller *et al.* 1999, Miller and Tausch 2001, Crawford *et al.* 2004, Connelly *et al.* 2004). It is likely that further losses of sagebrush habitat due to pinyon-juniper expansion will occur within the western part of greater sage-grouse range, especially the southern Great Basin. We could find no documentation, however, that pinyon-juniper expansion is a factor affecting sage-grouse habitat persistence in the eastern portion of the range (Wyoming Basin, Colorado Plateau, and silver sagebrush areas (Connelly *et al.* 2004)). Although we could not locate any studies that documented the effect of pinyon-juniper expansion on greater sage-grouse, Commons *et al.* (1999) found that the number of male Gunnison sage-grouse on leks in southwest Colorado doubled after pinyon-juniper removal and mechanical treatment of mountain sagebrush and

deciduous brush. Hence we can infer that some sage-grouse populations have been affected and some will decline due to projected increases in the pinyon-juniper type, at least within parts of the Great Basin. The expert panel considered pinyon-juniper as an extinction risk for the greater sage-grouse in the western portion of its range, but only ranked it as a moderate risk across the entire species' range.

#### Urbanization

Low densities of indigenous peoples have been present for more than 12,000 years in the historical range of sage-grouse. By 1900, Connelly *et al.* (2004) reported that less than 1 person/km<sup>2</sup> resided in 51 percent of the 325 counties within their assessment area, and densities greater than 10 persons/km occurred in 4 percent of the counties. By 2000, counties with less than 1 person/km<sup>2</sup> occurred in 31 percent of the 325 counties and densities greater than 10 persons/km<sup>2</sup> occurred in 22 percent of the counties (Connelly *et al.* 2004). Today, the dominant urban areas are located in the Bear River Valley of Utah, the portion of Bonneville Basin southeast of the Great Salt Lake, the Snake River Valley of southern Idaho, and in the Columbia River Valley of Washington (Rand McNally Road Atlas 2003, Connelly *et al.* 2004).

Urban development has eliminated some sage-grouse habitat (Braun 1998). Interrelated effects from urban/suburban development include construction of associated infrastructure (roads, powerlines, and pipelines) and predation threats from the introduction of domestic pets and increases in predators subsidized by human activities (*e.g.*, landfills). More recent urban expansion into rural subdivisions is also resulting in direct habitat loss and conversion, as well as alteration of remaining sage-grouse habitats around these areas due to the presence of humans and pets (Braun 1998; Connelly *et al.* 2000a). In some Colorado counties, up to 50 percent of sage-grouse habitat is under rural subdivision development, and it is estimated that 3 to 5 percent of all sage-grouse historical habitat in Colorado has already been converted into urban areas (Braun 1998). We are unaware of similar estimates for other States within the range of the greater sage-grouse, and therefore cannot determine the effects of this factor on a range-wide basis.

Municipal solid waste landfills (landfills) have been shown to contribute to increases in common raven populations (Knight *et al.* 1993, Restani *et al.* 2001, Webb *et al.* 2004).

Ravens are known to prey on sage-grouse and have been considered a restraint on sage-grouse population growth in some locations (Batterson and Morse 1948, Autenrieth 1981, Altstatt 1995). Landfills are found in every State and a number of these are located within or adjacent to sage-grouse habitat. However, no studies could be found that linked landfill presence, common raven populations, and sage-grouse population levels. Urbanization was considered as a moderate extinction risk for the greater sage-grouse by the expert panel, primarily as a result of habitat loss and fragmentation from increasing resource needs to support expanding human populations.

#### Summary of Factor A

Loss of sagebrush and greater sage-grouse habitat has been occurring since arrival of European settlers in the 1800s, as evidenced by the change in the sage-grouse's distribution and loss of local populations (Schroeder *et al.* 2004). Habitat loss and fragmentation continues today as a result of the many factors described in the preceding paragraphs. When the expert panel was asked to identify and rank extinction risk factors for the greater sage-grouse, the threats ranked highest in importance were, in order: invasive species, infrastructure as related to energy development and urbanization, wildfire, agriculture, grazing, energy development, urbanization, strip/coal mining, weather, and pinyon-juniper expansion. However, the majority of the expert panel did not believe that these threats were occurring at such a rate to cause the extinction of the greater sage-grouse within the next 60 to 100 years. Other threats (*e.g.*, disease and predation, hard-rock mining, hunting, contaminants) were considered by the expert panel to be of lesser importance to the sage-grouse. Several experts identified concerns with the synergistic effects of threat factors (*e.g.*, infrastructure increases and invasive species expansion). The expert panelists also discussed that the range of the greater sage-grouse would likely contract and fragment due to habitat modifications and losses.

Based on the information gathered through the scientific literature, industry, public comments and State and Federal agencies, as well as the opinions of the expert panel, Service biologists determined that the principal habitat-related threats are not proceeding at a rate that will threaten the continued existence of the species within the foreseeable future. In addition, the wide distribution of the species, presence of large "core"

populations, recent population trends in some areas throughout the species range (indicating that populations are stable and/or increasing), and large blocks of sagebrush habitat are all factors that contributed to the determination that the greater sage-grouse is not in danger of extinction within the foreseeable future. Thus, based on the best available scientific and commercial data, we have concluded that present or threatened destruction, modification, or curtailment of the sage-grouse's habitat or range is not a factor that threatens or endangers the species over all or a significant portion of its range. In reaching this conclusion, we did identify that continued efforts to conserve sagebrush ecosystems and address habitat threats are important to long-term persistence of the greater sage-grouse.

#### *B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

Presently, there is no commercial trade in greater sage-grouse, and under State and Federal laws the sale of sage-grouse meat, feathers and body parts is illegal. Historically, the greater sage-grouse was heavily exploited by commercial and sport hunting in the late 1800s and early 1900s (Patterson 1952; Autenrieth 1981). Hornaday (1916) and others alerted the public to the risk of extinction to the species as a result of this overharvest. In response, many States closed sage-grouse hunting seasons by the 1930s (Patterson 1952, Autenrieth 1981). The impacts of hunting on greater sage-grouse during those historical decades may have been exacerbated by impacts from human expansion into sagebrush-steppe habitats (Girard 1937). With the increase of sage-grouse populations by the 1950s, limited hunting seasons were again allowed in most portions of the species range (Patterson 1952, Autenrieth 1981).

#### Hunting

Greater sage-grouse are currently legally sport-hunted in 10 of 11 States where they occur (Connelly *et al.* 2004), and hunting is regulated by State wildlife agencies. The hunting season for sage-grouse in Washington was closed in 1988 (Stinson *et al.* 2004). In Canada sage-grouse hunting is not allowed (Connelly *et al.* 2004). Most State agencies base their hunting regulations on local population information and peer-reviewed scientific literature regarding the impacts of hunting on greater sage-grouse (Bohne in litt., Wyoming Game and Fish Department, 2003). Hunting seasons are reviewed annually, and

States change harvest management based on harvest and population data (Bohne in litt., Wyoming Game and Fish Department, 2003). For example, Wyoming delayed their season to allow for more equitable distribution of hunting mortality across all age and sex classes, thereby reducing female mortality as compared to previous seasons (Bohne in litt., Wyoming Game and Fish Department, 2003).

Relatively few studies have addressed the effect of recreational hunting on sage-grouse populations. These studies suggest that hunting may be compensatory (*i.e.*, mortality that replaces deaths that would have happened otherwise due to other causes such as predation, or mortality that is compensated by increased productivity; Crawford 1982), have no measurable effect on spring sage-grouse densities (Braun and Beck 1996), or may be additive (*i.e.*, mortality that adds more deaths per year to the total otherwise attributable to other causes, and is not compensated by increased productivity; Zunino 1989, Connelly *et al.* 2000a). Johnson and Braun (1999) concluded that harvest mortality may be additive for the species if brood hens and young birds sustain the highest hunting mortality within a population. No studies have demonstrated that regulated hunting is a primary cause of widespread reduced numbers of greater sage-grouse (Connelly *et al.* 2004).

Hunting seasons that are managed so as to evenly distribute mortality across all age and sex classes are less likely to negatively affect subsequent breeding populations (Braun 1998). Connelly *et al.* (2000a) state that most greater sage-grouse populations can sustain hunting if the seasons are carefully regulated to keep total mortality within sustainable levels—but do not evaluate the extent to which such careful regulation has been successfully implemented. A maximum sustainable harvest rate has not been determined for greater sage-grouse populations (Connelly *et al.* 2004). All States with hunting seasons have changed limits and season dates to more evenly distribute hunting mortality across the entire population structure by harvesting birds after females have left their broods (Bohne in litt., Wyoming Game and Fish Department, 2003). Total annual gun harvest of sage-grouse across the 10 western States that have seasons was approximately 24,000 birds in 2003 (Connelly *et al.* 2004). We could not locate any data to assess how those changes correlate with population trends.

All 10 States that allow gun hunting of sage-grouse also allow falconers to hunt sage-grouse, although no falconers

are currently hunting sage-grouse in South and North Dakota (John Wrede, South Dakota Game, Fish and Parks, pers. comm. 2004; Gerald Kobriger, North Dakota Game and Fish Dept., pers. comm. 2004). Montana (Rick Northrup, Montana Dept. Fish, Wildl. Parks, pers. comm. 2004), Oregon (Dave Budeau, Oregon Dept. Fish and Wildlife, pers. comm. 2004), and Idaho (Tom Hemker, Idaho Dept. Fish and Game, pers. comm. 2004) indicated that they do not have data on the level of harvest through falconry, but believe such harvest is low due to the few numbers of falconers and their dispersed activities. Wyoming reported a take of 63 sage-grouse by falconers. We are not aware of any studies that demonstrate that falconry take of greater sage-grouse influences population trends.

We surveyed the State fish and wildlife agencies within the range of greater sage-grouse to determine what information they had on illegal harvest (poaching) of the species. Two states, South Dakota and North Dakota indicated that they had no known incidents of poaching (John Wrede, South Dakota Game, Fish and Parks, pers. comm. 2004; Gerald Kobriger, North Dakota Game and Fish Dept., pers. comm. 2004). None of the remaining States had any quantitative data on the level of poaching in their States. Based on these results, illegal harvest of greater sage-grouse poaching appears to occur at low levels. We are not aware of any studies or other data that demonstrate that poaching has contributed to sage-grouse population declines.

#### *Religious, Scientific, and Recreational Use*

Some Native American tribes harvest sage-grouse as part of their religious or ceremonial practices. In Wyoming, Native American hunting occurs on the Wind River Indian Reservation, with about 20 males per year taken off of leks in the spring (Tom Christiansen, Wyoming Game and Fish Dept., pers. comm. 2004), and a harvest of 30 males in the fall (U.S. Fish and Wildlife Service, in litt. 2004). No harvest by Native Americans for religious or ceremonial purposes occurs in South Dakota, North Dakota, Colorado, Washington, or Oregon (John Wrede, South Dakota Game, Fish and Parks affiliation pers. comm. 2004; Gerald Kobriger North Dakota Game and Fish Dept., pers. comm. 2004; Anthony Apa, Colorado Div. Wildl., pers. comm. 2004; Michael Schroeder, Washington Dept. Fish and Wildlife, pers. comm. 2004;

and Dave Budeau, Oregon Dept. Wildl., pers. comm. 2004).

Greater sage-grouse are the subject of many scientific research studies and some of these field studies include the capture and handling of the species. Of the 11 western States where sage-grouse occur, all except South Dakota and North Dakota (John Wrede, South Dakota Game, Fish and Parks, pers. comm. 2004; Gerald Kobriger, North Dakota Game and Fish Dept., pers. comm. 2004) reported some type of field studies on sage-grouse between 1999 to 2004 that included the capture, handling, and subsequent banding, or banding and radio-tagging of sage-grouse. For these 9 States, 2,491 birds were captured and processed over six years, of which 68 birds (about 2.7 percent of handled birds) died due to capture, handling, or radio-tagging processes. We are not aware of any studies that document that this level of taking has affected any sage-grouse population trends.

Greater sage-grouse have been translocated in several States and the Province of British Columbia (Reese and Connelly 1997). Reese and Connelly (1997) documented the translocation of over 7,200 birds between 1933 and 1990, and additional translocation efforts have taken place since 1990. Only 5 percent of the translocation efforts documented by Reese and Connelly (1997) were considered to be successful in producing sustained, resident populations at the translocation sites. In 2004 the State of Nevada supplied the State of Washington with greater sage-grouse to increase the genetic diversity of geographically isolated populations. No information is available at this time regarding the success or effectiveness of this translocation. Given the low numbers of birds that have been used for translocation spread over many decades it is unlikely that the removals from source populations have contributed to greater sage-grouse declines, while the limited success of translocations has also likely had nominal impact on rangewide population trends.

Greater sage-grouse are also subject to a variety of non-consumptive uses such as bird watching or tour groups visiting leks, general wildlife viewing, and photography. Daily human disturbances on sage-grouse leks could cause a reduction in mating, and some reduction in total production (Call and Maser 1985). Only a few leks in each state receive regular viewing use visitation by humans during the strutting season, and most States report no known impacts from this use (John Wrede, South Dakota Game, Fish and

Parks, pers. comm. 2004; Rick Northrup, Montana Dept. Fish, Wildl. Parks, pers. comm. 2004; Tom Christiansen, Wyoming Game and Fish Dept., pers. comm. 2004; Tom Hemker, Idaho Dept. Fish and Game, pers. comm. 2004). Only Colorado had data regarding the effects of non-consumptive use, which suggested that controlled lek visitation has not impacted sage-grouse (Anthony Apa, Colorado Div. Wildl., pers. comm. 2004). State agencies in Oregon, Nevada, and North Dakota report that there is potential for impacts at individual leks that are the most heavily used for viewing (Dave Budeau, Oregon Dept. Wildl., pers. comm. 2004; Shawn Espinosa, Nevada Division of Wildl., pers. comm., 2004; Gerald Kobriger North Dakota Game and Fish Dept., pers. comm. 2004). The BLM has reported movement of a sage-grouse lek, and decreasing male numbers on the same lek apparently in response to lek viewing at that location (Jan Hanf, BLM, pers. comm. 2004). We were not able to locate any studies documenting how lek viewing, or other forms of non-consumptive recreational uses, of sage-grouse are related to sage-grouse population trends and we have no indication that they are contributing to declining trends.

#### Summary of Factor B

The expert panel did not identify hunting as a primary threat factor for the greater sage-grouse. In their discussion of extrinsic threat factors, the expert panel identified that hunting occurs within a limited timeframe and at a time of the year when productivity is unlikely to be affected significantly. In addition, they noted that hunting is a regulated management technique that can be quickly adjusted to changing conditions. No data were collected suggesting that poaching, non-consumptive use, or scientific use limit greater sage-grouse populations rangewide. Based on the best scientific and commercial data available, including input from the expert panel, we have concluded that overutilization for commercial, recreational, scientific, or educational purposes is not a factor that endangers or threatens the sage-grouse throughout all or a significant portion of its range.

#### C. Disease or Predation

##### Disease

There have been few systematic surveys for parasites or infectious diseases of the greater sage-grouse, and therefore, their role in population declines is unknown for this species (Connelly *et al.* 2004). Some early

studies have suggested that sage-grouse populations are adversely affected by parasitic infections (Batterson and Morse 1948). Parasites have also been implicated in sage-grouse mate selection, with potentially subsequent effects on the genetic diversity of this species (Boyce 1990; Deibert 1995), but Connelly *et al.* (2004) note that while these relationships may be important to the long-term ecology of greater sage-grouse, they have not been shown to be significant to the immediate status of populations. Connelly *et al.* (2004) have suggested that diseases and parasites may limit isolated sage-grouse populations. The potential effects of emerging diseases require additional study.

Sage-grouse are hosts to many parasites (Connelly *et al.* 2004; Thorne *et al.* 1982). Only the protozoan, *Eimeria* spp., which causes coccidiosis (Connelly *et al.* 2004), has proven to be fatal, but mortality is not 100 percent, and young birds that survive an initial infection typically do not succumb to subsequent infections (Thorne *et al.* 1982). Infections tend to be localized to specific geographic areas. Most cases of coccidiosis in greater sage-grouse have been found where large numbers of birds congregated, resulting in soil and water contamination by fecal material (Connelly *et al.* 2004). While the role of this parasite in population changes is unknown, Petersen (2004) hypothesized that coccidiosis could be limiting for local populations, as this parasite causes decreased growth and significant mortality in young birds, thereby potentially limiting recruitment. However, no cases of sage-grouse mortality resulting from coccidiosis have been documented since the early 1960s (Connelly *et al.* 2004).

Other parasites which have been documented in the greater sage-grouse include, *Sarcosystis* ssp (another form of coccidia), blood parasites (including avian malaria, *Leucocytozoon* spp., *Haemoproteus* spp., and *Trypanosoma avium*), *Tritrichomonas simoni*, tapeworms, gizzard worms (*Habronema* spp. and *Acuaria* spp.), cecal worms, and filarid nematodes (Thorne *et al.* 1982; Connelly *et al.* 2004; Petersen 2004). None of these parasites have been known to cause mortality in the greater sage-grouse. Sub-lethal effects of these parasitic infection on sage-grouse have never been studied.

Greater sage-grouse host many external parasites, including lice, ticks, and dipterans (midges, flies, mosquitoes, and keds) (Connelly *et al.* 2004). Most ectoparasites do not produce disease, but can serve as disease vectors or cause mechanical

injury and irritation (Thorne *et al.* 1982). Many biologists contend that ectoparasites can be detrimental to their hosts, particularly when the bird is stressed by inadequate habitat or nutritional conditions (Petersen 2004). Some studies have suggested that lice infestations can affect sage-grouse mate selection (Boyce 1990; Spurrier *et al.* 1991; Deibert 1995), but population impacts are not known (Connelly *et al.* 2004).

Greater sage-grouse are also subject to a variety of bacterial, fungal, and viral pathogens. The bacteria *Salmonella* spp., has caused mortality in the greater sage-grouse; the bacteria apparently contracted through of exposure to contaminated water supplies around livestock stock tanks (Connelly *et al.* 2004). Other bacteria found in sage-grouse include *Escherichia coli*, botulism (*Clostridium* spp.), avian tuberculosis (*Mycobacterium avium*), and avian cholera (*Pasteurella multocida*). These bacteria have never been identified as a cause of mortality in greater sage-grouse and the risk of exposure and hence, population effects, is low (Connelly *et al.* 2004). One case of aspergillosis, a fungal disease, has been documented in sage-grouse, but there is no evidence to suggest this fungus plays a role in limiting greater sage-grouse populations (Connelly *et al.* 2004; Petersen 2004).

Viral diseases could cause serious diseases in grouse species and potentially influence population dynamics (Petersen 2004). However, prior to 2003 only avian infectious bronchitis (caused by a coronavirus) had been identified in the greater sage-grouse. No clinical signs of the disease were observed.

West Nile virus (WNV; *Flavivirus*) was introduced into the northeastern United States in 1999 and has subsequently spread across North America (Marra *et al.* 2004). This virus was first diagnosed in greater sage-grouse in 2003, and has been shown to affect sage-grouse survival rates. Data from four studies in the eastern half of the sage-grouse range (Alberta, Montana, Wyoming) showed survival in these populations declined 25 percent in July and August as a result of the WNV infection (Naugle *et al.* 2004). Populations of grouse that were not affected by WNV showed no similar decline. Additionally, individual sage-grouse in exposed populations were 3.4 times more likely to die during July and August, the "peak" of WNV occurrence, than birds in non-exposed populations (Connelly *et al.* 2004; Naugle *et al.* 2004). Subsequent declines in both male and female lek attendance in infected areas in 2004 compared with years

before WNV was detected in this area suggest outbreaks could contribute to local population extirpation (Walker *et al.* 2004). Lek surveys in 2004, however, indicated that regional sage-grouse populations did not decline, suggesting that the initial effects of WNV were localized (Oedokoven, unpublished data, 2004). Five sage-grouse deaths resulting from WNV have been identified in 2004, four from the Powder River Basin area of northeastern Wyoming and southeastern Montana (Dave Naugle, U. Montana, pers. comm. 2004), and one from the northwestern Colorado, near the town of Yampa (Anthony Apa, Colorado Division of Wildlife, pers. comm. 2004). An additional three sage-grouse deaths in California from WNV were reported in 2004 (Scott Gardner, Ca. Dept. Fish Game, pers. comm. 2004). In 2004, WNV was detected in a variety of species in western Colorado, Utah, Idaho, Nevada, California and Oregon (U.S. Geological Service, National Wildlife Health Laboratory, 2004). Outside of the Powder River Basin of Wyoming and Montana, California and western Colorado, we are unaware of comprehensive efforts to track sage-grouse mortalities. Therefore, the actual distribution and extent of WNV in sage-grouse in 2004 is unknown.

Greater than 300 serum samples taken from live-captured wild grouse in known WNV infected areas were negative for WNV antibodies, indicating that these animals had not been exposed to the virus (Todd Cornish, U. Wyoming, pers. comm. 2004). The lack of birds with antibodies suggests that sage-grouse do not survive a WNV infection because if any were surviving, at least some of the birds sampled from the exposed areas should be survivors with antibodies (Connelly *et al.* 2004; Oedokoven 2004). All 25 wild sage-grouse brought into a controlled research laboratory and inoculated with various doses of WNV, including doses thought to be less than the amount that would be delivered by a typical mosquito bite, perished within 8 days of infection (Todd Cornish, U. of Wyoming, unpublished data, 2004). In addition, direct exposure of non-infected sage-grouse to infected sage-grouse under laboratory conditions also resulted in 40 percent mortality of 6 individuals, in the absence of the mosquito vector for WNV (*Culex tarsalis*) (Todd Cornish, U. of Wyoming, unpublished data, 2004). These experimental results, combined with field data, suggest that a widespread WNV infection could negatively impact greater sage-grouse.

Late-summer habitat requirements of sage-grouse potentially increase their exposure to WNV. Sage-grouse hens and broods congregate in mesic habitats in the mid- to late summer, thereby placing them in the same potential habitats as the WNV mosquito vector when the mosquitoes are likely to be active. Surface water sources that have been created for agricultural, livestock, and oil and gas activities may increase the contact between sage-grouse and the mosquito vector (Naugle *et al.* 2004; Connelly *et al.* 2004; Walker *et al.* 2004). Losses from WNV come at a time of year when survival is otherwise typically high for adult females (Schroeder *et al.* 1999; Connelly *et al.* 2000a; Aldridge and Brigham 2003), thus potentially making these WNV deaths additive to other mortality sources and reducing average annual survival.

#### Predation

Predation is the most commonly identified cause of direct mortality for sage-grouse (Schroeder *et al.* 1999, Connelly *et al.* 2000b). Greater sage-grouse have many predators, which vary in relative importance depending on the sex and age of the bird and the time of year. Predators of adult greater sage-grouse include coyotes (*Canis latrans*), bobcats (*Lynx rufus*), weasels (*Mustela* spp.), golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*), Swainson's hawks (*B. swainsoni*), and ferruginous hawks (*B. regalis*) (Hartzler 1974, Schroeder *et al.* 1999, Rowland and Wisdom 2002, Schroeder and Baydack 2001). In the Strawberry Valley of Utah, Bambrough *et al.* (2000) noted that low survival of greater sage-grouse may have been due to an unusually high density of red foxes.

Adult male greater sage-grouse are most susceptible to predation during the mating season as they are very conspicuous while performing their mating display. And, because leks are attended daily, predators may be attracted to these areas during the breeding season (Braun in litt. 1995). However, given the greater sage-grouse's breeding system, where only a few males are selected by all the females for mating, loss of some adult males on the lek is not likely to have significant population effects (Braun in litt. 1995).

Adult female greater sage-grouse are most susceptible to predators while on the nest or during brood-rearing when they are with young chicks (Schroeder and Baydack 2001). Autenrieth (1981), referencing annual predator losses, concluded that predation of eggs was the most important population constraint in Idaho at that time.

Juvenile grouse are susceptible to predation from badgers, red foxes, coyotes, weasels, American kestrels (*Falco sparverius*), merlins (*F. columbarius*), northern harriers (*Circus cyaneus*), and other hawks (Braun in litt. 1995; Schroeder *et al.* 1999). Gregg *et al.* (2003a, 2003b) found that chick predation mortality ranged from 27 percent to 51 percent in 2002 and 10 percent to 43 percent in 2003 on three study sites in Oregon. The juvenile mortality rate, during the first few weeks after hatching, was estimated to be 63 percent (Wallestad 1975 in Schroeder and Baydack 2001). While chicks are very vulnerable to predation during this period, other causes of mortality, such as weather, are included in this estimate.

Nesting success is positively correlated with the presence of big sagebrush and relatively thick grass and forb cover (Schroeder and Baydack 2001). Losses of nesting adult hens and nests appear to be related to the amount of herbaceous cover surrounding the nest (Braun in litt. 1995; Braun 1998; Coggins 1998, Connelly *et al.* 2000b; Schroeder and Baydack 2001). DeLong *et al.* (1995) found a lower probability of nest predation at nest sites with tall grass and medium shrub cover in Oregon. Removal or reduction of this cover, by any method, can reduce nest success and adult hen survival. Similarly, habitat alteration that reduces cover for young chicks can increase the rate of predation on this age class (Schroeder and Baydack 2001). Losses of breeding hens and young chicks can influence overall greater sage-grouse population numbers, as these two groups contribute most significantly to population productivity.

Agricultural development, landscape fragmentation, and human populations have the potential to increase predation pressure by forcing birds to nest in marginal habitats, by increasing travel time through habitats where they are vulnerable to predation, and by increasing the diversity and density of predators (Ritchie *et al.* 1994, Schroeder and Baydack 2001, Connelly *et al.* 2004; Summers *et al.* 2004). Increasing populations of predators that historically were relatively rare in the sagebrush landscape, and are very effective nest predators, such as red fox and corvids (Sovada *et al.* 1995), have the potential to increase rates of predation on sage-grouse. Connelly *et al.* (2000a) noted that ranches, farms, and housing developments have resulted in the introduction of nonnative predators including domestic dogs (*Canis domesticus*) and cats (*Felis domesticus*) into greater sage-grouse

habitats. Where greater sage-grouse habitat has been altered in localized areas, the influx of predators can limit populations (Gregg *et al.* 1994; Braun in litt. 1995; Braun 1998; DeLong *et al.* 1995; Schroeder and Baydack 2001). Habitat fragmentation and the resultant predation increase may be a limiting factor for the Gunnison sage-grouse (Oyler-McCance *et al.* 2001).

Research conducted to determine nest success and greater sage-grouse survival has concluded that predation typically does not limit greater sage-grouse numbers (Connelly and Braun 1997, Connelly *et al.* 2000a, Connelly *et al.* 2000b, Wambolt *et al.* 2002). The conclusion that predation is not generally a limiting factor is supported by evidence showing that predator removal does not have long-lasting effects on sage-grouse population size or stability over large regions (Cote and Sutherland 1997, Schroeder *et al.* 1999, Wambolt *et al.* 2002). For example, Slater (2003) demonstrated that coyote control failed to produce an effect on greater sage-grouse nesting success in southwestern Wyoming. In their review of literature regarding predation, Connelly *et al.* (2004) noted that only two of nine studies examining survival and nest success indicated that predation had limited a sage-grouse population by decreasing nest success. However, both studies indicated low nest success due to predation was ultimately related to poor nesting habitat. Connelly *et al.* (2004) further noted that the idea that predation is not a widespread factor depressing sage-grouse populations is supported by studies of nest success rates (which indicate nest predation is not a widespread problem), by the relatively high survival of adult birds, and by the lack of an effect on nesting success as a result of coyote control in Wyoming.

#### Summary of Factor C

The expert panel did not identify disease or predation as primary extinction risk factors for the greater sage-grouse. The experts expressed concerns about the potential effects of future WNV outbreaks, but were unable to draw any definitive conclusions about extinction risk to sage-grouse posed by this disease because insufficient information is available to do so. Connelly *et al.* (2004) noted that prior to the recent emergence of WNV there was little evidence to suggest that pathogens or parasites were major threats to the greater sage-grouse.

Although we have relatively poor understanding of the actual effects of disease or parasites on sage-grouse populations, since systematic surveys

have never been conducted, we continue to be concerned about the potential effects of WNV on greater sage-grouse. We will closely monitor future infections and observed population effects to the greater sage-grouse. Predation has also not been identified as a limiting factor to sage-grouse populations, except in areas of habitat degradation and loss. Thus, based on the best scientific and commercial data available, we have concluded that disease and predation are not factors that endanger or threaten the sage-grouse throughout all or a significant portion of its range at this time.

#### D. The Inadequacy of Existing Regulatory Mechanisms

##### Local Laws and Regulations

Approximately 27 percent of the sagebrush land in the United States is privately owned (Connelly *et al.* 2004). We are not aware of any county or city ordinances that provide protection specifically for the greater sage-grouse or their habitats on private land, although we recognize that such ordinances could be proposed as rural governments and local sage-grouse working groups investigate strategies to protect sage-grouse on private lands. We recognize that county or city ordinances that address agricultural lands, transportation, and zoning for various types of land uses have the potential to influence sage-grouse (*e.g.*, zoning that protects open space can retain suitable sage-grouse habitat, and zoning that allows a housing development and associated roads can result in destruction and/or fragmentation of habitat occupied by sage-grouse during some part of their life cycle). However, we have no detailed information regarding the nature or extent of zoning efforts within the species range and its direct or indirect effects on populations and habitats.

##### State Laws and Regulations

In the United States, greater sage-grouse are managed by State wildlife agencies on all lands within the State as resident native game birds (Connelly *et al.* 2004), except in Washington, where the bird was listed as a State-threatened species in 1998 and they are managed as a State-listed threatened species (Stinson *et al.* 2004). The classification as a resident game bird (with the exception of Washington) allows the direct human taking of the bird during hunting seasons authorized and conducted under State laws and regulations. Currently, harvest of greater sage-grouse is authorized by 10 of the 11 western States where they occur

(Connelly *et al.* 2004). Sage-grouse hunting is prohibited in Washington, where the season has been closed since 1988 (Stinson *et al.* 2004).

Each State agency bases its hunting regulations on local population information and peer-reviewed scientific literature regarding the impacts of hunting on the greater sage-grouse (Bohne in litt., Wyoming Game and Fish Department 2003). Hunting seasons are reviewed annually by each State, and they implement adaptive management based on harvest and population data (U.S. Fish and Wildlife Service 2004; 69 FR 21484; Montana Sage Grouse Work Group (MSGWG) 2004).

State agencies directly manage 5 percent of the total landscape dominated by sagebrush in the United States and various State laws and regulations identify the need to conserve wildlife habitat (Connelly *et al.* 2004). As an example, in Colorado, "wildlife and their environment" are to be protected, preserved, enhanced and managed (Colorado Revised Statutes, Title 33, Article 1-101 in Connelly *et al.* 2004). Laws and regulations in Oregon, South Dakota, and California have similar provisions, and allow for acquisition of funding to acquire and conserve wildlife habitat (Connelly *et al.* 2004). Some States also have the legal authority to make land purchases and/or to enter into easements with landowners regarding wildlife habitats. For example, Montana Fish Wildlife and Parks (MTFWP) has authority to acquire easements or purchase land directly to protect wildlife habitat (MSGWG 2004). The Washington Department of Fish and Wildlife (WADFW) has designated sage-grouse habitat as a "priority habitat" which identifies this habitat as a priority for conservation and management, and provides species and habitat information to interested parties for land use planning purposes (Stinson *et al.* 2004). However, the recommendations provided under this program are guidelines, not regulations; thus, their use is not required.

Alternatively, some States have laws that directly address the management of certain State lands and require that it be based on maximizing financial returns. For example, under a provision of the State Constitution (Article IX-Section 8), the Idaho Department of Lands (IDL) is directed to manage approximately 2.4 million acres of state endowment lands "in such a manner as to secure the maximum long-term financial return to the beneficiary institution to which granted." The IDL can take measures that protect or enhance wildlife habitat subject to their fundamental

requirement to secure maximum long-term financial returns (Idaho Dept. Fish and Game in litt. 2004). The Montana Department of Natural Resources and Conservation (MTDNRC) is responsible for managing approximately 5.1 million surface acres and 6.3 million acres of subsurface trust land distributed across the State (MSGWG 2004). Under State law, proceeds from the sale and management of this trust land are used to support and maintain public schools and various State institutions. The obligation for management and administration of these trust lands is to obtain the greatest benefit for the school trusts, and the monetary return must be weighed against the long-term productivity of the land to ensure continued future returns to the trusts (MSGWG 2004). State lands which are managed to enhance economic returns for the benefit of education trust funds may or may not include benefits for wildlife habitat. The Service does not have complete information pertaining to all State laws and regulations that directly or indirectly relate to greater sage-grouse habitat on these lands.

All States within the extant range of the greater sage-grouse have, or are developing, conservation plans for the species and its habitats. These efforts are in addition to current research and monitoring efforts for the greater sage-grouse conducted by State agencies. The conservation plans are focused on addressing local sage-grouse or sagebrush habitat concerns through a variety of mechanisms (*i.e.*, changes in regulations, habitat improvement projects, etc.). These plans are in various stages of development, and many have not yet begun implementation of actual habitat conservation practices. As previously stated, 20 of approximately 300 individual efforts contained within the 27 plans we received met the standard in PECE (*see* 68 FR 15115) for having sufficient certainty of implementation and effectiveness (*see* the "Status Review Process" section, above, for further details regarding PECE). Of these 20 efforts, 15 involved state wildlife agencies (the other 5 involved the BLM or Forest Service). The members of the expert panel were provided with information regarding these 20 projects, and were given the opportunity to re-evaluate their projections of extinction risk to the greater sage-grouse on a rangewide basis considering these. Only one panelist determined that these cumulative efforts would reduce the risk of extinction to the species. All the panelists agreed that local conservation efforts are necessary to the long-term

conservation of the species, but the existing plans were too early in development and implementation to influence their opinion at this time.

#### United States Federal Laws and Regulations

The greater sage-grouse is not covered or managed under the provisions of the Migratory Bird Treaty Act (16 U.S.C. 703–712). Federal agencies in the United States are responsible for managing 66 percent of the sagebrush landscape (Connelly *et al.* 2004). The Federal agencies with the most sagebrush are the Bureau of Land Management (BLM), an agency of the Department of the Interior, and the U. S. Forest Service (USFS), an agency of the Department of Agriculture. The U.S. Department of Defense, U.S. Department of Energy, and several agencies in the Department of the Interior also have responsibility for lands and/or decisions that involve habitat of the greater sage-grouse.

The BLM estimates that about 46 percent of greater sage-grouse habitat is on BLM-administered land, with approximately 78.3 million acres of BLM-administered lands falling within the range currently occupied by the greater sage-grouse (BLM 2004a). The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701 *et seq.*) is the primary federal law governing most land uses on BLM-administered lands. Section 102(a)(8) of FLPMA specifically recognizes wildlife and fish resources as being among the uses for which these lands are to be managed: "The Congress declares it is the policy of the United States that the public lands be managed in a manner that \* \* \* will provide food and habitat for fish and wildlife and domestic animals. \* \* \*" Regulations pursuant to FLPMA and the Mineral Leasing Act (30 U.S.C. 181 *et seq.*) that address wildlife habitat protection on BLM-administered land include 43 CFR 3162.3–1 and 43 CFR 3162.5–1; 43 CFR 4120 *et seq.*; 43 CFR 4180 *et seq.*

BLM policy and guidance for species of concern occurring on BLM managed land is addressed under BLM Manual 6840—Special Status Species Management (BLM 2001). In 1998 the greater sage-grouse was State-listed as a threatened species in Washington (Stinson *et al.* 2004), and therefore BLM decisions and actions involving greater sage-grouse habitat on BLM-administered lands in Washington have been subject to the policy guidance in BLM Manual 6840 since then. The BLM has designated the greater sage-grouse a sensitive species across all 11 States in the sage-grouse range. BLM's policy

regarding sensitive species is that "The protection provided by the policy for candidate species shall be used as the minimum level of protection for BLM sensitive species" (BLM 2001). The BLM policy regarding candidate species includes: implementation of management plans for conserving the species and its habitats; ensuring actions authorized, funded, or carried out by the BLM do not contribute to the need for the species to become listed; ensuring the species are considered in land use plans; developing and/or participating in management plans and species and habitat assessments; and monitoring the species for evaluating of management objectives (BLM 2001).

Land use plans are the basis for all actions and authorizations involving BLM-administered lands and resources: they establish allowable resource uses, resource condition goals and objectives to be attained; program constraints and general management practices needed to attain the goals and objectives; general implementation sequences; and intervals and standards for monitoring and evaluating the plan to determine its effectiveness and the need for amendment or revision (43 CFR 1601.0–5(k)). According to a draft Report provided to the Service by BLM, there are 98 land use plans that involve sage-grouse habitat (BLM 2004a). Based on information provided by BLM field offices, 13 of the 98 plans do not contain any direction that specifically pertains to the greater sage-grouse or its habitat (BLM 2004a). The other 85 plans contain standards and/or prescriptions that "contribute positively to on-the-ground sage-grouse habitat conservation" and/or "contribute positively to on-the-ground sagebrush conservation." Examples include fencing areas with value to sage-grouse, and applying distance stipulations around leks (BLM 2004a). However, the BLM does not provide or describe the criteria or process used to determine that the standards and/or prescriptions listed in this report contribute positively to sage-grouse habitat or sagebrush conservation (BLM 2004a).

Land use plans provide a framework and programmatic guidance for implementation (activity) plans, which are site-specific plans written to implement decisions made in a land use plan. Examples include allotment management plans (AMPs) that address livestock grazing, oil and gas field development, travel management, and wildlife habitat management. Implementation/activity plan decisions normally require additional planning and NEPA analysis. With regard to special status species, BLM Manual

6840.22A states: "Implementation-level planning should consider all site-specific methods and procedures which are needed to bring the species and their habitats to the condition under which the provisions of the ESA are not necessary, current listings under special status species categories are no longer necessary, and future listings under special status species categories would not be necessary."

On November 16, 2004, BLM Instruction Memorandum (IM) No. 2005-024 transmitted information to all BLM field and Washington Office officials regarding the development of a National BLM Sage-grouse Habitat Conservation Strategy for BLM-administered lands. This strategy is described as the framework to address the conservation of sage-grouse and risk to sagebrush habitats on lands and activities administered by the BLM. It commits the BLM to work with States and local interests on this issue. The IM instructed BLM State Directors to develop a process and schedule to update deficient land use plans to adequately address sage-grouse and sagebrush conservation needs no later than April 1, 2005. Implementation plans are also covered by this IM.

BLM has the regulatory authority for oil and gas leasing, as provided at 43 CFR 3100 *et seq.*, and they are authorized to require stipulations as a condition of issuing a lease. Program-specific guidance for fluid minerals (which include oil and gas) in the BLM planning handbook specifies that land use plan decisions will identify restrictions on areas subject to leasing, including closures, as well as lease stipulations (BLM 2000). This handbook further also specifies that all stipulations must have waiver, exception, or modification criteria documented in the plan, and notes that the least restrictive constraint to meet the resource protection objective should be used (BLM 2000). BLM states that some "older" oil and gas leases do not have stipulations that address sage-grouse (BLM 2004a), but we do not have information on how many of these leases are in this category. BLM has the regulatory authority to condition the application for drill use authorizations, conducted under a lease, that does not contain sage-grouse conservation stipulations (BLM 2004a). Also, some oil and gas leases have a 200-meter (0.12-mile) stipulation, which allows movement of the drilling area by that distance (BLM 2004a). BLM states that many of their field offices work with the operators to move a proposed drilling site farther or justify such a move

through the site-specific NEPA process (BLM 2004a).

In developing stipulations for oil and gas the BLM considers the best available scientific information, including, but not limited to, the sage-grouse population and habitat management guidelines developed by the Western States Sage and Columbian Sharp-tailed Grouse Technical Committee under the direction of the Western Association of Fish and Wildlife Agencies, as published by Connelly *et al.* (2000a) (BLM 2004a). BLM states that a site-specific evaluation decision is required to implement conservation measures given the complexity and variability of the habitat and other variables (BLM 2004a).

The oil and gas leasing regulations authorize BLM to modify or waive lease terms and stipulations if the authorized officer determines that the factors leading to inclusion of the term or stipulation have changed sufficiently to no longer justify protection, or if proposed operations would not cause unacceptable impacts (43 CFR 3101.1-4). The Service does not have information on the type or number, or the basis for, exceptions, modifications, or waivers of stipulations pertaining to the greater sage-grouse and/or their habitat that have been granted by BLM.

The Energy Policy and Conservation Act (EPCA) of 2000 included provisions requiring the Secretary of the Interior to conduct a scientific inventory of all onshore Federal lands to identify oil and gas resources underlying these lands and the nature and extent of any restrictions or impediments to the development of such resources (U.S.C. Title 42, Chapter 77, section 6217(a)). On May 18, 2001, the President signed Executive Order 13212—Actions to Expedite Energy-Related Projects (E.O. 13212) (66 FR 28357, May 22, 2001), which states that it is the Administration's policy that the executive departments and agencies shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy. The Executive Order specifies that this includes expediting review of permits or taking other actions as necessary to accelerate the completion of projects, while maintaining safety, public health, and environmental protections. The BLM has responded to these declarations with the issuance of several IM to their staff that may influence sage-grouse conservation during these actions, including providing guidance for land use planning relative to oil and gas operations and focusing efforts for

resource recovery in seven areas, six of which are within occupied greater sage-grouse habitats ((IM 2003-137, April 3, 2003; IM No. 2003-233, July 28, 2003).

As discussed previously, BLM land use plans and implementation plans may include BMPs, which are defined as "a suite of techniques that guide, or may be applied to, management actions to aid in achieving desired outcomes. IM 2004-194 (June 22, 2004) addresses the integration of Best Management Practices (BMPs) into Application for Permit to Drill (APD) approvals and associated rights-of-way. This IM states that BLM Field Offices "shall incorporate appropriate BMPs into proposed APDs and associated on and off-lease rights-of-way approvals after appropriate NEPA evaluation. The wildlife management criteria are broadly stated. For example, one BMP is: "To minimize habitat loss and fragmentation, re-establish as much habitat as possible by maximizing the area reclaimed during well production operations. In many cases, this "interim" reclamation can cover nearly the entire site. It is OK to set up well workover operations or park on the restored vegetation. Just repair the damage when you are done." Another example is: "Consider drilling multiple wells from a single well pad to reduce the footprint of oil and gas activity on wildlife habitat." The Service has no information regarding the results of BLM monitoring and evaluation of the effectiveness of these or similar BMPs that may have been adopted previously in BLM planning documents or as part of other, more site-specific planning decisions.

BLM regulatory authority for grazing management is provided at 43 CFR part 4100 (Regulations on Grazing Administration Exclusive of Alaska). Livestock grazing permits and leases contain terms and conditions determined by BLM to be appropriate to achieve management and resource condition objectives on the public lands and other lands administered by the BLM, and to ensure that habitats are, or are making significant progress toward being, restored or maintained for BLM special status species (43 CFR 4180.1(d)). Grazing practices and activities subject to standards and guidelines include the development of grazing related portions of implementation/activity plans, establishment of terms and conditions of permits, leases and other grazing authorizations, and range improvement activities such as vegetation manipulation, fence construction, and development of water.

The State or regional standards for grazing administration must address habitat for endangered, threatened, proposed, candidate, or special status species, and habitat quality for native plant and animal populations and communities (43 CFR 4180.2(d)(4) and (5)). The guidelines must address restoring, maintaining or enhancing habitats of BLM special status species to promote their conservation, and maintaining or promoting the physical and biological conditions to sustain native populations and communities (43 CFR 4180.2(e)(9) and (10)). BLM is required to take appropriate action not later than the start of the next grazing year upon determining that existing grazing practices or levels of grazing use are significant factors in failing to achieve the standards and conform with the guidelines (43 CFR 4180.2(c)). BLM agreed to work with their Resource Advisory Councils to expand the rangeland health standards required under 43 CFR part 4180 so that there are public land health standards relevant to all ecosystems, not just rangelands, and that they apply to all BLM actions, not just livestock grazing (BLM Manual 4180.06.A). All States within the range of greater sage-grouse have a resource advisory council, except Wyoming.

The BLM states that 89 percent of lands are meeting standards, or are not meeting standards but appropriate actions have been implemented to ensure significant progress towards the standards (BLM 2004a). The remaining 11 percent are not meeting standards due to either livestock grazing or other causes. We have no information on how these rangeland health categories affect sage-grouse habitats.

On December 8, 2003, BLM issued a proposed rule (68 FR 68452) that would modify the current grazing management regulation in two ways: (1) It provides that assessment and monitoring standards are needed to support a determination that livestock grazing significantly contributes to not meeting a standard or conforming with a guideline; and (2) It requires BLM to analyze, formulate and propose appropriate action within 24 months of the determination (rather than "before the start of the next grazing year"). This proposed rule has not been finalized.

The Forest Service (USFS) has management authority for 8 percent of the sagebrush habitat in the United States (Connelly *et al.* 2004). Management of Federal activities on National Forest System lands is guided principally by the National Forest Management Act (NFMA) (16 U.S.C. 1600–1614, August 17, 1974, as amended 1976, 1978, 1980, 1981, 1983,

1985, 1988 and 1990). NFMA specifies that all National Forests must have a land and resource management plan (LRMP) (16 U.S.C. 1600) to guide and set standards for all natural resource management activities on each National Forest or National Grassland. NFMA requires the USFS to incorporate standards and guidelines into LRMPs (16 U.S.C. 1600). This has historically been done through a NEPA process, including provisions to manage plant and animal communities for diversity, based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives. The Forest Service planning process is similar to BLM's.

The 1982 NFMA implementing regulation for land and resource management planning (1982 rule, 36 CFR part 219), under which all existing forest plans were prepared, requires the Forest Service to manage habitat to maintain viable populations of existing native vertebrate species on National Forest System lands (1982 rule, 36 CFR 219.19). Management indicator species were used to estimate the effects of each alternative on fish and wildlife populations, and were selected because their population changes are believed to reflect the effects of management activities (1982 rule, 36 CFR 219.19(a)). The regulation requires that during the planning process, each alternative considered needed to establish objectives for the maintenance and improvement of habitat for management indicator species, to the degree consistent with overall multiple use objectives of the alternative (1982 rule, 36 CFR 219.19(a)). Fourteen National Forests identified greater sage-grouse as a Management Indicator Species, including Beaverhead National Forest, Little Missouri National Grassland, Thunder Basin National Grassland, Buffalo Gap National Grassland, White River National Forest, Ashley National Forest, Boise National Forest, Caribou National Forest, Curlew National Grassland, Humboldt National Forest, Toiyabe National Forest, Sawtooth National Forest, Inyo National Forest, and Modoc National Forest.

Revisions to the planning regulations adopted on November 9, 2000 (65 FR 67514) did not retain the management indicator species requirement, but rather stated: "Plan decisions affecting species diversity must provide for ecological conditions that the responsible official determines provide a high likelihood that those conditions are capable of supporting over time the viability of native and desired non-native species well distributed throughout their ranges within the plan

area \* \* \*" (65 FR 67514). Further revisions have been proposed (67 FR 72770; December 6, 2002) but a final rule has not been promulgated. Until such time a rule is completed, officials responsible for planning decisions may use the management indicator provisions.

As part of our status review process, the members of the expert panel and the Service's decision support team of senior Service biologists and managers were provided with information regarding NFMA and related regulations, including the 1982 and 2000 planning regulations and the recent interpretive rule, along with information explaining that the Forest Service had proposed, but not promulgated, changes to the 2000 regulation. Since the meeting by the expert panel and the Service's decision support team, the Forest Service has promulgated a final planning rule at 36 CFR 219 and eliminated the 2000 planning rule. The new Forest Service planning regulation became effective when it was published in the **Federal Register** on January 5, 2005 (70 FR 1023).

As described by the Forest Service, plans developed under the new regulation will be more strategic and less prescriptive in nature than those developed under the 1982 planning rule (which has guided the development of all forest plans to date). For instance, plans previously might have included standards for a buffer for activities near the nest sites of birds sensitive to disturbance during nesting, whereas under the new rule a desired condition description and guidelines will be provided, rather than a set of prescriptive standards that would apply to projects. Planning and decisions for projects and activities will address site-specific conditions and identify appropriate conservation measures to take for each project or activity.

Under the new rule, the purpose of forest plans is to establish goals and to set forth guidance to follow in pursuit of those goals. The rule calls for five components of plans: desired conditions, objectives, guidelines, suitability of areas, and special areas (36 CFR 219.7(a)(2)). The rule states that these components are intended to provide general guidance and goals or other information to be considered in subsequent project and activity decisions, and that none of these components are commitments or final decisions approving projects and activities (36 CFR 219.7(a)(2)). Approval of a plan, plan amendment, or plan revision comprised of these five components may be categorically

excluded from NEPA documentation (36 CFR 219.4(b)). In a separate **Federal Register** publication issued in conjunction with the new planning rule, the Forest Service announced a proposed revision to one of its handbooks (FSH 1909.15, Chapter 30) to include final decisions on proposals to develop, amend, or revise land management plans as one of the categories of actions that will not result in significant impacts on the human environment and which are therefore exempt from requirements to prepare further NEPA documentation (70 FR 1062; January 5, 2005).

The new rule requires that an environmental management system (EMS) be established for each unit of the National Forest System and the EMS may be established independently of the planning process (36 CFR 219.5). Plan development, amendment, or revision must be completed in accordance with direction at 36 CFR 219.14 and with the EMS. The EMS must conform to the standard developed by the International Organization for Standardization (ISO), specifically ISO 14001: Environmental Management Systems—Specification With Guidance for Use (36 CFR 219.5)(b)).

The new rule requires maintenance of three types of evaluation reports: (1) Comprehensive evaluation of current social, economic, and ecological conditions and trends that contribute to sustainability (to be updated at least every five years); (2) evaluation for a plan amendment, which must analyze issues relevant to the purposes of the amendment; and (3) annual evaluation of monitoring information (36 CFR 191.6). The rule specifies that the plan must describe the monitoring program for the plan area, and describes general categories of items to be provided for in the monitoring program (*e.g.* determining the effects of various resource management activities on the productivity of the land) (36 CFR 219.6(b)). The new rule also includes a provision that the responsible official must take into account the best available science (36 CFR 219.11) in the planning process; the official also will consider public input, competing use demands, budget projects and other factors as appropriate.

The new planning regulation does not include provisions regarding habitat for species viability. Rather, with regard to ecological sustainability, plans are to provide a framework to contribute to sustaining native ecological systems by providing ecological conditions to support diversity of native plants and animal species in the plan area (36 CFR 219.10 (b)). Ecosystem diversity is described as being the primary means

by which a plan contributes to sustaining ecological systems (36 CFR 219.10 (b)), and the Forest Service states that this focus is expected to conserve most species. If the Responsible Official determines that provisions in plan components, beyond those addressing ecosystem diversity, are needed “to provide appropriate ecological conditions for specific threatened and endangered species, species-of-concern, and species-of-interest, then the plan must include additional provisions for these species, consistent with the limits of agency authorities, the capability of the plan area, and overall multiple use objectives” (36 CFR 219.10(b)(2)). The rule defines species-of-concern as “Species for which the Responsible Official determines that management actions may be necessary to prevent listing under the Endangered Species Act” and defines species-interest as “Species for which the Responsible Official determines that management actions may be necessary or desirable to achieve ecological or other multiple use objectives” (36 CFR 219.16).

The new rule does not include Management Indicator Species. It specifies that for national forest system units with plans developed, amended, or revised using the 1982 planning regulations, compliance with any obligations relating to management indicator species may be achieved by considered data and analysis relating to habitat (as compared to the 1982 regulation that required population trend data) unless the plan specifically requires population monitoring or population surveys for the species, and also specifies that site-specific monitoring or survey of a proposed project or activity area (pertaining to such species) is not required in relation to such species (36 CFR 219.14(f)).

For each unit of the National Forest System, the transition period for the new rule is three years or at the unit’s establishment of an EMS, whichever comes first (36 CFR 219.14). A document approving a plan developed, revised, or amended using the new regulation must include a description of the effects of the plan on existing, permits, contracts, or other instruments implementing approved projects and activities (36 CFR 219.8(a)). If not expressly excepted, approved projects and activities must be consistent with the applicable plan components, subject to provisions in 36 CFR 219.8(e) that provide options for addressing a use, project or activity that is not consistent with the applicable plan.

The supplementary information provided with the new rule states that the Forest Service is developing

planning directives (*i.e.*, manuals and handbooks) regarding the use of this new rule, and that proposed changes in the directives will be available for public comment as soon as possible after adoption of the final rule.

The greater sage-grouse is designated as a USFS sensitive species in Regions 1 (Northern Region—northern ID, MT, ND, and northern SD), 2 (Rocky Mountain Region—CO, WY), 4 (Intermountain Region—southern ID, southwestern WY, UT, NV, eastern CA), 5 (Pacific Southwest Region—CA), and 6 (Pacific Northwest Region—OR, WA) (USDA Forest Service, in litt. 2004). These regions encompass the entire range of the species in the United States (USDA Forest Service, in litt. 2004).

Many forests within the range of sage-grouse provide important seasonal habitats for the species, particularly the Thunder Basin National Grassland and the Humboldt-Toiyabe National Forest (USDA Forest Service, in litt. 2004). While the 1982 planning regulation, including its provision for population viability, was used in the development of the existing Forest Plans, no information has been provided to the Service regarding specific implementation of the above regulations and policies for the greater sage-grouse. Also, we have no information regarding the results of sage-grouse population monitoring for those National Forests that identified it as a management indicator species, and thus were subject to the requirement in the 1982 rule to monitor population trends and determine relationships to habitat changes.

Of the 34 National Forests within greater sage-grouse range, approximately half do not specifically address sage-grouse in their Forest Plans (USDA Forest Service, in litt. 2004). Reasons for this include lack of species occurrence, incidental use of the National Forest System lands by sage-grouse, or the Forest Plan pre-dated concern for sage-grouse conservation (pre-2000; USDA Forest Service, in litt. 2004). Direction for the conservation of sage-grouse and their habitats (at least indirectly) was provided in 15 plans relative to minerals management, 18 plans for fire and fuels management, 24 for livestock grazing actions, 10 for realty actions, 15 for recreation activities, 8 for recreation, and 20 for vegetation management (USDA Forest Service, in litt. 2004). The effectiveness of these efforts for sage-grouse and their habitats was not reported to us by the USFS (USDA Forest Service, in litt. 2004).

The USFS incorporates conservation measures for sage-grouse protection at the project level through site-specific

NEPA analyses, using the Western Association of Fish and Wildlife Agencies Sage-grouse management guidelines (Connelly *et al.* 2000a) as a reference (USDA Forest Service, in litt. 2004). According to USFS, if a specific project location does not meet these guidelines, management use standards are developed and incorporated into the design of the project to achieve these conditions (USDA Forest Service, in litt. 2004). Temporal and seasonal restrictions can also be implemented to protect sage-grouse resources.

Other Federal agencies in the U.S. Department of Defense, U.S. Department of Energy, and the U.S. Department of Interior (including the Bureau of Indian Affairs, Fish and Wildlife Service, and National Park Service) are responsible for managing less than 5 percent of sagebrush lands within the United States (Connelly *et al.* 2004). The National Park Service Organic Act (39 Stat. 535; 16 U.S.C. 1, 2, 3 and 4) states that the NPS will administer areas under their jurisdiction “\* \* \* by such means and measures as conform to the fundamental purpose of said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historical objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

The National Wildlife Refuge System Administration Act (16 U.S.C. 668dd–668ee) provides guidelines and directives for administration and management of all areas in the National Wildlife Refuge system. This includes wildlife refuges, areas for the protection and conservation of fish and wildlife that are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, or waterfowl production areas. Relatively few units within the Refuge system have habitat for the greater sage-grouse. Refuges are managed for species conservation, consistent with direction in the National Wildlife Refuge System Administration Act, as amended, and related Service policies and guidance.

The Department of the Army has developed Integrated Natural Resources Management Plans for their facilities within sage-grouse habitats. These plans “reflect the mutual agreement of the facility, the Fish and Wildlife Service and the appropriate State fish and wildlife agency on the conservation, protection and management of fish and wildlife resources” (Department of the Army, in litt. 2004). Six Army facilities have confirmed sage-grouse presence, and integrated plans have been

developed for all. While some agencies have developed site-specific plans for conserving sage-grouse habitats on their lands (*i.e.*, Yakima Training Center, Seedskaadee National Wildlife Refuge), we do not have monitoring data regarding the effectiveness of these management actions.

In 1992, we entered into a voluntary Conservation Agreement with the Army and the WADFW for sage-grouse occurring at the Yakima Training Center (66 FR 22984) in Washington. The Conservation Agreement expired April 30, 2000 (66 FR 22984). Efforts to update and implement a revised Conservation Agreement for sage-grouse throughout Washington are ongoing (66 FR 22984). In our 2003 Candidate Notice of Review we concluded that the Army is implementing conservation measures and considerably less-than-planned training activities in Yakima and Kittitas Counties, the location of the sage-grouse that are part of the Columbia Basin DPS of the greater sage-grouse (69 FR 24875).

The Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture assists farmers, ranchers, and other private landowners in reducing threats to sage-grouse habitat by providing technical assistance and financial resources to support management and habitat restoration efforts; helping farmers and ranchers maintain and improve habitat as part of larger management efforts; and developing technical information to assist NRCS field staff with sage-grouse considerations when working with private landowners. The United States Congress recently appropriated \$5 million for NRCS to use in 2005 to fund sage-grouse conservation efforts on public and private lands across the range of the greater sage-grouse (PL 108–447). One example of these conservation efforts is found in Douglas County, Washington, the site of the northern subpopulation of the Columbia Basin DPS. Large areas of privately-owned lands are currently withdrawn from crop production and planted to native and non-native cover under the NRCS’ Conservation Reserve Program (CRP) (69 FR 24875).

Executive Order 13112 on Invasive Species (64 FR 6183) was signed on February 3, 1999. It seeks to prevent the introduction of invasive species and provide for their control and minimize their impacts through better coordination of federal agency efforts under a National Invasive Species Management Plan to be developed by an interagency Invasive Species Council. The Order directs all federal agencies to address invasive species concerns as

well as refrain from actions likely to increase invasive species problems (E.O. 13112).

Executive Order 13112 requires the National Invasive Species Council (Council) to produce a National Management Plan (NMP) for Invasive Species every two years (E.O. 13112). In January 2001, the Council released the first NMP, which serves as a blueprint for all federal action on invasive species. It provides goals and objectives for invasive species management, research needs, and measures to minimize the risk of species introductions. Although individual States have regulations regarding invasive species, we were unable to determine if these regulations will affect sage-grouse habitats.

#### Canadian Federal and Provincial Laws and Regulations

Greater sage-grouse are cooperatively managed by Provincial and Federal governments in Canada. The species is afforded Federal legal protection under schedule 1 of the Species at Risk Act (SARA; Canada Gazette, Part III, Chapter 29, Vol. 25, No. 3, 2002). Passed in 2002, the Species at Risk Act is similar to the Endangered Species Act and allows for habitat regulations to protect sage-grouse (Aldridge and Brigham 2003). The purpose of the SARA is to prevent the extinction or extirpation of any indigenous Canadian wildlife species, subspecies or distinct population segment. SARA also provides for the recovery of endangered or threatened wildlife and encourages the management of other species to prevent them from becoming species at risk (Connelly *et al.* 2004).

Greater sage-grouse are classified as resident wildlife by the Provinces (Connelly *et al.* 2004). The species is listed as endangered at the Provincial level in Alberta and Saskatchewan, and neither Province allows harvest (Aldridge and Brigham 2003; Connelly *et al.* 2004). Alberta manages greater sage-grouse under the statutory authority of Chapter W–10 of its Wildlife Act (Revised Statutes of Alberta (RSA) 2000). Individual birds are protected in Alberta, but their habitat is not. The Provincial laws also provide for the development of recovery strategies and plans (Connelly *et al.* 2004). Alberta has developed voluntary guidelines to protect leks (Aldridge and Brigham 2003). Provincial laws in Saskatchewan prevent sage-grouse habitat from being sold or from having native vegetation cultivated (Aldridge and Brigham 2003). The Saskatchewan Wildlife Act provides protection for sage-grouse nests and lek sites by

providing spatial and temporal restrictions. No developments are permitted within 500 m (550 yards) of leks and no construction is allowed within 1,000 m (1,100 yards) of leks between March 15 and May 15 (Aldridge and Brigham 2003).

#### Summary of Factor D

Various regulatory mechanisms that guide the protection and conservation of the greater sage-grouse are in place. The members of the expert panel and the Service's decision support team were provided with more detailed information than we have summarized above regarding regulatory mechanisms pertaining to the greater sage-grouse. Based on the best scientific and commercial data available we have concluded that existing regulatory mechanisms do not endanger or threaten the greater sage-grouse throughout all or a significant portion of its range. Based on the current status of the greater sage-grouse and the fact that the lands administered by the Forest Service comprise a relatively small percentage of sagebrush habitat (approximately 8 percent) in the United States, the new Forest Planning regulation does not result in a change in our conclusion regarding the adequacy of existing regulatory mechanisms.

#### *E. Other Natural or Manmade Factors Affecting Its Continued Existence*

##### Pesticides

Few studies have examined the effects of pesticides to sage-grouse, but at least one has documented direct mortality of greater sage-grouse as a result of ingestion of alfalfa sprayed with organophosphorus insecticides (Blus *et al.* 1989, Blus and Connelly 1998). In this case, a field of alfalfa was sprayed with dimethoate when approximately 200 sage-grouse were present; 63 of these sage-grouse were later found dead, presumably as a result of pesticide exposure (Blus *et al.* 1989, Blus and Connelly 1998). A comparison of applied levels of herbicides with toxicity studies of grouse, chickens, and other gamebirds (Carr 1968, as cited in Call and Maser 1985) concluded that herbicides applied at recommended rates should not result in sage-grouse poisonings.

Game birds that ingested sub-lethal levels of pesticides have been observed exhibiting abnormal behavior that may lead to a greater risk of predation (Dahlen and Haugen 1954, McEwen and Brown 1966, Blus *et al.* 1989). McEwen and Brown (1966) reported that wild sharp-tailed grouse poisoned by malathion and dieldrin exhibited

depression, dullness, slowed reactions, irregular flight, and uncoordinated walking. Although no research has explicitly studied the indirect levels of mortality from sub-lethal doses of pesticides (*e.g.*, predation of impaired birds), it has been assumed to be the reason for mortality among some study birds (McEwen and Brown 1966, Blus *et al.* 1989, Connelly and Blus 1991). Both Post (1951) and Blus *et al.* (1989) located depredated sage-grouse carcasses in areas that had been treated with insecticides. Exposure to these insecticides may have predisposed sage-grouse to predation. Sage-grouse mortalities were also documented in a study where they were exposed to strychnine bait type used to control small mammals (Ward *et al.* 1942 as cited in Schroeder *et al.* 1999).

A reduction in insect population levels resulting from insecticide application can potentially affect nesting sage-grouse females and chicks (Willis *et al.* 1993, Schroeder *et al.* 1999), although we could find no information on this specific issue for the greater sage-grouse. Eng (1952) noted that after a pesticide was sprayed to reduce grasshoppers, bird population levels decreased by 50 to 100 percent depending upon which chemical was used. He further stated that it appeared that nestling development was adversely affected due to the reduction in grasshoppers. Potts (1986 in Connelly and Blus 1991) determined that reduced food supply resulting from the use of pesticides ultimately resulted in high starvation rates of partridge chicks. In a similar study on partridges, Rands (1985) found that pesticide application adversely affected brood size and chick survival by reducing chick food supplies.

Three approved insecticides, carbarayl, diflubenzuron, and malathion, are applied across the extant range of sage-grouse as part of implementation of the Rangeland Grasshopper and Mormon Cricket Suppression Control Program, under the direction of the Animal and Plant Health Inspection Service (APHIS) (APHIS 2004). Carbaryl is applied as bait, while the others are sprayed. Application rates are in compliance with U.S. Environmental Protection Agency regulations. APHIS has general guidelines for buffer zones around sensitive species habitats. These pesticides are applied wherever grasshopper and Mormon cricket control are requested by private landowners (APHIS 2004). We were unable to find any information regarding the effects these pesticide applications may have on sage-grouse.

Herbicide applications can kill sagebrush and forbs important as food sources for sage-grouse (Carr 1968 as cited in Call and Maser 1985). The greatest impact resulting from a reduction of either forbs or insect populations is for nesting females and chicks due to the loss of potential protein sources that are critical for successful egg production and chick nutrition (Schroeder *et al.* 1999; Johnson and Boyce 1991).

In summary, pesticides can result in direct mortality of individuals, and can also reduce the availability of food sources, which in turn could contribute to mortality of sage-grouse. Despite these potential effects we could find no information to indicate that the use of pesticides, at current levels, negatively affects greater sage-grouse populations (*see also* Schroeder *et al.* 1999), and many of the pesticides that have been shown to have an effect have been banned in the U.S. for more than 20 years.

##### Contaminants

Across the range of the greater sage-grouse exposure to various types of environmental contaminants either occur, or may potentially occur, as a result of a variety of human activities, including agricultural and rangeland management practices, mining, energy development and pipeline operations, nuclear energy production and research, and transportation of materials along highways and railroads. Many of these potential exposures and their effects have been discussed above. In addition, numerous gas and oil pipelines occur across the range of the species. Exposure to oil or gas from spills or leaks could impact sage-grouse and cause mortalities or morbidity. Similarly, given the extensive network of highways and railroad lines that occur throughout the range of the greater sage-grouse there is some potential for exposure to contaminants resulting from hazardous materials spills or leaks along these transportation corridors. However these types of spills occur infrequently in only small portions of sage-grouse range and we could not locate any documented occurrences of impacts to sage-grouse from them.

There are no nuclear power plants within the area of current distribution of the greater sage-grouse and there is only one that occurs in range formerly occupied by the species (Nuclear Energy Institute Web page <http://www.nei.org> 2004). Sage-grouse do occur on the U.S. Department of Energy's Idaho National Engineering Laboratory in eastern Idaho (Connelly and Markham 1983). Exposure of sage-grouse to

radionuclides (radioactive atoms) has been documented at this site (Connelly and Markham 1983). Although researchers noted the presence of varying levels of radionuclides in greater sage-grouse at this site they did not report any harmful effects to the population (Connelly and Markham 1983).

Indirect effects of contaminants on greater sage-grouse include loss of habitat components, such as food or cover. The indirect effects of contaminants from agriculture, mining operations, energy development and distribution, or hazardous waste spills along roads and railroad lines, can result in the killing of plants or insects that provide food for sage-grouse. Although the expert panel identified contaminants in the list of extinction risk factors for sage-grouse, it received the lowest ranking of relative importance.

#### Recreational Activities

Studies have determined that non-consumptive recreational activities can degrade wildlife resources, water, and the land by distributing refuse, disturbing and displacing wildlife, increasing animal mortality, and simplifying plant communities (Boyle and Samson 1985). Sage-grouse response to disturbance may be influenced by the type of activity, recreationist behavior, predictability of activity, frequency and magnitude, activity timing, and activity location (Knight and Cole 1995). Examples of recreational activities in sage-grouse habitats include hiking, camping, pets, and off-highway vehicle (OHV) use. Although we have not located any published literature concerning recreational effects on sage-grouse, they could disturb sage-grouse on leks and in nesting areas. Baydack and Hein (1987) reported displacement of male sharp-tailed grouse at leks from human presence resulting in loss of reproductive opportunity during the disturbance period. Female sharp-tailed grouse were observed at undisturbed leks while absent from disturbed leks during the same time period (Baydack and Hein 1987). Disturbance of incubating female sage-grouse could cause displacement from nests, increased predator risk, or loss of nests. Disruption of sage-grouse during vulnerable periods at leks, or during nesting or early brood rearing, however, could affect reproduction or survival (Baydack and Hein 1987). However, we were unable to find any published information regarding effects to sage-grouse as a result of these factors. The presence of pets in proximity to sage-

grouse can result in sage-grouse mortality or disturbance, and increases in garbage from human recreators can attract sage-grouse predators and help maintain their numbers at increased levels.

Indirect effects to sage-grouse from recreational activities include impacts to vegetation and soils, and facilitating the spread of invasive species. Payne *et al.* (1983) studied OHV impacts to rangelands in Montana, and found long-term (2 years) reductions in sagebrush shrub canopy cover as the result of repeated trips in the area. Increased sediment production and decreased soil infiltration rates were observed after disturbance by motorcycles and four-wheel drive trucks on two desert soils in southern Nevada (Eckert *et al.* 1979). However, we could find no information that quantified impacts to the sagebrush community or to sage-grouse populations.

We are unaware of scientific reports documenting direct mortality of greater sage-grouse through collision with off-road vehicles. Similarly, we did not locate any scientific information documenting instances where snow compaction as a result of snowmobile use precluded greater sage-grouse use, or affected their survival in wintering areas. Off-road vehicle or snowmobile use in winter areas may increase stress on birds and displace sage-grouse to less optimal habitats. However, there is no empirical evidence available documenting these effects on sage-grouse, nor could we find any scientific data supporting the possibility that stress from vehicles during winter is limiting greater sage-grouse populations.

The expert panel identified human activities within greater sage-grouse habitats as an extinction risk factor. However, this factor ranked relatively low.

#### Drought/Climate Change

Drought is a common occurrence throughout the range of the greater sage-grouse (Braun 1998). Drought reduces vegetation cover (Milton *et al.* 1994; Connelly *et al.* 2004), potentially resulting in increased soil erosion and subsequent reduced soil depths, decreased water infiltration, and reduced water storage capacity. Drought can also exacerbate other natural events, such as defoliation of sagebrush by insects. Approximately 2,544 km<sup>2</sup> (982 mi<sup>2</sup>) of sagebrush shrublands died in Utah in 2003 as a result of drought and infestations with the *Aroga* (webworm) moth (Connelly *et al.* 2004). Sage-grouse are affected by drought through the potential loss of vegetative habitat components and reduced insect

production (Connelly and Braun 1997). These habitat component losses can result in declining sage-grouse populations due to increased nest predation and early brood mortality associated with decreased nest cover and food availability (Braun 1998; Schroeder *et al.* 1999).

Sage-grouse populations declined during the 1930s period of drought (Patterson 1952; Willis *et al.* 1993; Braun 1998). Drought conditions in the late 1980s and early 1990s also coincided with a period when sage-grouse populations were at historically low levels (Connelly and Braun 1997). Although drought has been a consistent and natural part of the sagebrush-steppe ecosystem, drought impacts on the greater sage-grouse can be exacerbated when combined with other habitat impacts that reduce cover and food (Braun 1998). Many studies discuss the effects of decreased insect and forb production to sage-grouse, but we could find no research specifically addressing drought effects on sage-grouse populations.

Short-term climatic cycles over timescales of decades can affect plant community dynamics, potentially resulting in a shift in successional stage (Connelly *et al.* 2004). Long-term changes in climate and atmospheric conditions over timescales of centuries will shift competitive advantage among individual plant species (Connelly *et al.* 2004). Environmental changes resulting from climate change could facilitate invasion and establishment of invasive species or exacerbate the fire regime, thereby possibly accelerating the loss of sagebrush habitats (Connelly *et al.* 2004). Increases in the expansion of pinyon and juniper woodlands in the Great Basin may have resulted from a combination of poor habitat management and climate change (Connelly *et al.* 2004). The potential conversion of habitats as a result of climate change could have long-term effects on sage-grouse populations (Connelly *et al.* 2004). We have no evidence however, that past climate change has directly affected sage-grouse populations.

One expert panelist identified climate change as the primary extinction risk factor for the greater sage-grouse. While the other panelists did not score this factor as highly, most acknowledged that long-term ongoing climate change will result in changes within the sagebrush ecosystem that may be negative for the greater sage-grouse.

### Life History Traits Affecting Population Viability

Sage-grouse have comparatively low reproductive rates and high annual survival (Schroeder *et al.* 1999; Connelly *et al.* 2000a), resulting in slower potential or intrinsic population growth rates than typical of other game birds. Therefore, recovery of populations after a decline from any reason may require years. Also, as a consequence of their site fidelity to breeding and brood-rearing habitats, measurable population effects may lag behind, negative habitat impacts that may occur (Wiens and Rotenberry 1985). While these natural history characteristics would not limit sage-grouse populations across large geographic scales under historical conditions of extensive habitat, they may contribute to local population declines when humans alter habitats or mortality rates.

Sage-grouse have one of the most polygamous mating systems observed among birds (Deibert 1995). Asymmetrical mate selection (where only a few of the available members of one sex are selected as mates) should result in reduced effective population sizes (Deibert 1995), meaning the actual amount of genetic material contributed to the next generation is smaller than predicted by the number of individuals present in the population. With only 10 to 15 percent of sage-grouse males breeding each year (Aldridge and Brigham 2003), the genetic diversity of sage-grouse would be predicted to be low. However, in a recent survey of 16 greater sage-grouse populations, only the Columbia Basin population in Washington showed low genetic diversity, likely as a result of long-term population declines, habitat fragmentation, and population isolation (Benedict *et al.* 2003; Oyler-McCance *et al.*, In press). The level of genetic diversity in the remaining range of sage-grouse has generated a great deal of interest in the field of behavioral ecology, specifically sexual selection (Boyce 1990; Deibert 1995). There is some evidence of off-lek copulations in sage-grouse (copulations that occur off the lek by subordinate males), as well as multiple paternity within one clutch (Connelly *et al.* 2004). Dispersal may also contribute to genetic diversity, but little is known about dispersal in sage-grouse (Connelly *et al.* 2004). However, the lek breeding system suggests that population sizes in sage-grouse must be greater than non-lekking birds to maintain long-term genetic diversity.

Aldridge and Brigham (2003) estimated that up to 5,000 individual

sage-grouse may be necessary to maintain an effective population size of 500 birds. Their estimate was based on individual male breeding success, variation in reproductive success of males that do breed, and the death rate of juvenile birds. We were unable to find any other published estimates of minimal population sizes necessary to maintain genetic diversity and long-term population sustainability in sage-grouse.

### Summary of Factor E

In our 90-day petition finding, we identified several other natural or manmade factors (*i.e.* endocrine disruption, competition with other bird species, and direct mortality from fires and snowmobiles) that might potentially pose a threat to the greater sage-grouse. However, for this analysis, we could find no supporting information to indicate that any of these are endangering or threatening sage-grouse populations.

One expert panelist identified climate change, and resultant habitat changes from invasive species establishment, as the most significant threat factor for the sagebrush ecosystem. However, the imminent threats to this ecosystem were not thought to be sufficient to endanger or threaten the greater sage-grouse within the defined foreseeable future. Thus, based on the best scientific and commercial data available, including input from the expert panel, we have concluded that other natural and manmade factors do not endanger or threaten the sage-grouse throughout all or a significant portion of its range.

### Petition Finding

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats faced by this species. We reviewed the three petitions, information available in our files, other published and unpublished information, and comments submitted to us during the public comment period following our 90-day petition finding, and we consulted with recognized experts and other resource agencies. On the basis of the best scientific and commercial information available, we find that the petitioned action to list the greater sage-grouse is not warranted at this time. Although sagebrush habitat continues to be lost and degraded in parts of the greater sage-grouse's range (albeit at a lower rate than historically observed), from what we know of the current range and distribution of the sage-grouse, its numbers are well represented. As a result, we find that the species is not in danger of extinction,

nor is it likely to become endangered in the foreseeable future. We are encouraged that sage-grouse and sagebrush conservation efforts will moderate the rate and extent of habitat loss for the species in the future. We strongly encourage the continuation of these efforts.

As described earlier in this document (*see* Status Review Process), the status review was conducted in two stages: (1) A risk analysis stage which consisted of compiling biological information, conducting the PECE analysis of conservation efforts, and conducting a facilitated extinction risk assessment by a panel of experts, and (2) a risk management stage where senior Service biologists and managers evaluated whether or not the greater sage-grouse qualifies as threatened or endangered under the Act.

Prior to estimating the risk of extinction in the risk analysis stage, the expert panel agreed on the 19 most important threats to sage-grouse across its range. To better understand the impact of these threats to the survival of the species, each expert assigned a relative rank to each threat within each of three different geographical distinctions. These included the eastern and western portion of the range of the greater sage-grouse and the whole range of the species (Figure 1). Dividing the range of the species into an eastern and western region for the purposes of the expert panel exercises was intentional to help Service biologists and managers and the expert panelists understand the importance of the various threats to the species at different geographical scales. The relative rankings of the identified threats reflect that some threats are regional in nature while others express themselves across the whole range of the species. Threats that ranked low on a regional and rangewide basis were considered to operate at the local or site-specific level where they occurred.

In reaching these rankings the expert panelists reviewed an initial list of threats that was generated from the synthesis of biological information the Service had prepared, and through a discussion among the panelists held in front of the Service's decision support team, added to that list and modified it before agreeing to a list of the most important threats. Ranking of the relative importance of those threats occurred in two stages. First, each panelist was asked to anonymously rank the 19 threats from most to least significant. After an initial scoring by the experts occurred, the ranks were presented to the expert panel by a facilitator in front of the decision support team and the experts discussed

why they ranked as they did. After this discussion the experts rescored the threats. The threats that moved to the top of the list are, in order, invasive species, infrastructure as related to energy development and urbanization, wildfire, agriculture, grazing, energy development, urbanization, strip/coal mining, weather, and pinyon-juniper expansion.

The threat ranking component of the structured process was important for three reasons: (1) It provided an informed, science based, ranking of the threats to the species, (2) the discussions that occurred in formulating the threat list and the discussions among the experts after their initial scoring played a critical role in helping the Service's decision support team understand the magnitude of a threat and the geographical scale at which a threat operated, and (3) it provided via the threat ranking and the discussion among experts, the foundation for the expert panel to conduct an extinction risk analysis.

The highest ranking threats exert their influence primarily through habitat loss. Thus, our structured analysis process revealed that at this time habitat loss appears to be the most important threat to the greater sage-grouse, a conclusion consistent with the available biological information and our 90-day finding.

It is clear there are various threats to the sagebrush steppe ecosystems upon which the greater sage-grouse depends. However, we are aware of no quantitative projections of extinction risk for the greater sage-grouse in the face of these rangewide, regional and local threats. This information gap is important because the Act's definitions of threatened and endangered are closely tied to risk of extinction. We therefore elicited quantitative estimates of time to extinction from the expert panelists. Besides their own expertise, the panelists prepared for estimating future risk by reading a wide variety of background materials, and they participated in two days of discussions of relevant sage-grouse life history attributes, threats (summarized above), the land ownerships and allocations, the regulatory setting and management challenges currently existing across the landscape, the size and distribution of the major sage-grouse population centers, and state by state indices of population status. After these deliberations, the expert panelists were asked to quantitatively express their beliefs about when the greater sage-grouse might go extinct.

Panelists expressed their beliefs about most likely time to extinction on score sheets where the future was broken

down into the following time intervals: 1–20, 21–40, 41–60, 61–80, 81–100, 101–200 and more than 200 years. Panelists expressed biological uncertainty about the most likely time to extinction by spreading 100 points over the various time intervals. The experts were not uniform in their estimates of the most likely time to extinction although five of the seven panelists believed that the sage-grouse would not face extinction for at least 100 years. One panelist, for example, believed the most likely time to extinction is in the time period 61 to 80 years from present, one believed the most likely time is 81 to 100 years from present, 2 panelists believed the most likely time to extinction is in the period 101 to 200 years from present, 1 panelist split points equally between the 101 to 200 year and 200+ year categories, and 2 panelists believed the most likely time to extinction was in the 200+ year category. Most of the panelists, for example spread points over several time intervals, from a period less than 100 years in the future to the greater than 200 years category, expressing individual uncertainty about the most likely time to extinction. On one count the experts performed very uniformly; no points were allocated by any panelist for the two time intervals within 40 years of present.

In their deliberations about the most likely time to extinction, the experts engaged in wide-ranging discussions of future risk which included West Nile virus, management advances in addressing threats, the expectation that there will still be some vast areas of sagebrush habitat at least 100 years in the future, looking into the past to help predict the future, the difficulty of controlling invasive annual plants, the major native perennial grass communities and their resiliency in the eastern versus the western part of the range, the role and geographic extent of infrastructure development, role of population subdivision for population vulnerability, plant community oscillations, climate oscillations, limited role of predators, and the elusiveness of cause-effect relationships for sage-grouse population trends, especially the increases seen in the most recent sampling (1993 to 2003).

After the extinction risk estimate exercise was completed the experts were asked to describe data gaps that, if resolved, could reduce uncertainty in their scores or even change their estimates. This question generated a wide-ranging discussion of uncertainty and data gaps. In some cases research programs were proposed. Areas of uncertainty discussed by the experts

included: systematic relationships among various grouse species; underlying mechanisms by which sage-grouse populations respond to habitat changes; how to scale grouse habitat preference up to the level at which federal land is managed; lack of studies across the range limits inferences; effects of invasive plants; application of grazing techniques to favor sagebrush habitat; underutilization of the case study approach for sage-grouse management; future gas and oil development impacts; future advances in horticulture and fire suppression; the role of crested wheatgrass in sagebrush management; and the effectiveness of CRP program. No attempt was made to rank the effects of these and other areas of uncertainty on the estimates of future risk.

This list of data gaps and uncertainties helps explain some of the biological uncertainty that limits our understanding of future risk to the greater sage-grouse. The Service, however, must make its decision about whether this species qualifies as threatened or endangered under the Act based on the best available scientific and commercial data, even if there is uncertainty. To help increase the chances of making an optimal decision about whether or not to list, the decision support team of senior Service biologists and managers (described above—see Status Review Process) participated in a structured analysis that included a discussion of the Act's statutory requirements, in particular the Act's definitions of threatened and endangered, and a review of the information from the risk analysis and all other compiled biological information. Finally they participated in an exercise where they compared the information about risk to sage-grouse, including explicit measures of uncertainty, against the statutory requirements of the Act. In this exercise, much like the extinction risk exercise described above, the decision support team was asked to express their beliefs about the optimal status category for the greater sage-grouse. The Act defines endangered and threatened as:

*Endangered species* means any species in danger of extinction throughout all or a significant portion of its range.

*Threatened species* means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The basic question facing the decision support team was whether the factors influencing the greater sage-grouse and its habitat place it in danger of extinction or whether they are likely to

cause it to become endangered in the foreseeable future. Estimates of extinction risk help address this question; however, neither general classification thresholds nor standardized criteria for establishing species-specific thresholds have yet been adopted for Service use.

The Service decision support team discussed the extinction risk threshold concept generally, and discussed previous Service applications. With regard to the foreseeable future, team members agreed by consensus that given all of the uncertainties, a reasonable timeframe for "foreseeable future" for the threatened definition is approximately 30 to 100 years (about 10 greater sage-grouse generations to 2 sagebrush habitat regeneration cycles). The decision support team reflected on the "significant portion of the range" term, and discussed previous applications by the Service. The team reviewed the findings of the risk analysis phase and found that while different threats are asserting themselves at different rates in different parts of the range, it is difficult to find major variation in risk over significant portions of the range. Discussions by the expert panel in the risk analysis phase indicated that if the species continues to decline, the most likely scenario would include some combination of losses around the edges of some portions of the range, some localized losses and fragmentation of larger core areas, but these projected losses are geographically unknown at this time and difficult to predict. Thus, in the absence of major geographical variation in projected extinction risk, or any measure of the spatial extent or location of projected future losses, it was decided by consensus that there was not a significant portion of the range in which threats to sage-grouse are greater than range-wide threats.

To help further inform the Service's finding, the decision support team's final exercise assessed their beliefs about what the appropriate petition finding should be: not-warranted, threatened, or endangered. The team had read the compiled background materials, observed the two-day risk assessment discussions of the expert panelists, which included explicit measures of uncertainty, and participated in general and specific discussions about the application of the Act's definitions of the threatened and endangered categories.

None of the decision support team assigned any of their 100 points to the endangered category; however, all decision support team members placed some of their points in the threatened

category. The average number of points assigned to the not-warranted and threatened categories were, respectively, 74 (range 50–85) and 26 (range 15–50). The fact that all decision support team members placed some of their points in the threatened category reflects a degree of biological uncertainty associated with making scientific decisions. Nevertheless, the "not warranted" finding was based on the best scientific and commercial information available at the time of their recommendation.

The best available scientific and commercial information, as summarized within this finding and in the Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats prepared by WAFWA, clearly reflect that there are a myriad of changes occurring within the sagebrush ecosystem that can impact sage-grouse. Our structured analysis process not only confirmed that many of these changes are indeed threats to the sage-grouse but it clarified the relative importance of these threats at different geographical scales which is an important factor when making a listing determination of such a widely dispersed species. The results reflect the opinion of the expert panelists that some threats are clearly important across the range of the sage-grouse while others are important on a regional scale.

In determining that the greater sage-grouse does not warrant protection under the Act, the Service biologists and managers who participated in the structured analysis process acknowledged that there are real threats to the sage-grouse and its habitat. However, in formulating their recommendation, these biologists and managers noted that there is uncertainty in how these threats will impact the grouse in the future and that there were reasons to be encouraged by current assessments of grouse population status, trends and distribution.

The higher ranking threats, while rangewide and regional in scale, are to a large degree prospective in nature (e.g., invasive species, infrastructure, wildfire, oil and gas development and conifer invasion). Neither the Service nor the expert panelists could predict how these threats will develop over time or interact with each other or with different less important threats to accelerate habitat loss or other impacts to the grouse. This uncertainty was explicitly noted by several of the Service biologists and managers as part of the reason for a not-warranted recommendation. The Act requires the Service to make a decision based on what is known at the time of listing. However, most Service biologists and

managers on the decision support team also noted the future health of both the sagebrush system and the sage-grouse would depend on how the threats are expressed and how managers responded to them in the next 5 to 20 years. This uncertainty about the future impact of the threats to sage-grouse may also be reflected in why some experts projected sage-grouse extinction risk at 60 years while others felt that beyond 200 years was more realistic.

It is clear that the number of greater sage-grouse rangewide has declined from historically high levels, with well documented declines between 1960 and 1985. However, the most recent data reflect that overall declines have slowed, stabilized or populations have increased. These data and the fact that 92% of the known active leks occur in 10 core populations across 8 western states, and that 5 of these populations "were so large and expansive that they were subdivided into 24 subpopulations to facilitate analysis" (Connelly *et al.* 2004: page 13–4), was cited by managers on the decision support team as part of the reason for their not warranted recommendation.

Although the decision support team referenced the prospective nature of the higher ranking threats in reaching their recommendation, they also acknowledged and considered the fact that these threats were currently occurring at some level across the range of the sage-grouse or in smaller regions within the range. However, because of the relatively long projected risk of extinction, in many cases greater than 200 years, which was minimally 100 years beyond the foreseeable future the Service considered in this case, combined with considering the variety of sources of information generated for and during the risk analysis phase, including the expert panel deliberations and the Conservation Assessment from WAFWA, the decision support team found that the levels of these existing threats, although very real, when considered against the status, trends and distribution of the current population, were not sufficient to result in the greater sage-grouse becoming an endangered species in the next 40 to 100 years.

Other factors cited by the managers as most important for their beliefs about the appropriate listing category included, the large size of the current range, the slow pace with which some of the threat factors are exerting themselves, synergistic effects between threats, large blocks of existing sagebrush habitat, expected range contractions, relative stability of core population areas, expected increases in

infrastructure development in areas that currently have little or none, expected population losses to increase the impact of stochastic events, resiliency of sagebrush habitats to some threats, recent sage-grouse population trends as stable or increasing, and some evidence of positive changes on the sagebrush landscape.

Factors contributing most to uncertainty among the decision support team members included the prospective nature of some of the threats, uncertainty about how pending threats will be managed, and uncertainty about how and if leks can persist in the presence of disturbances.

Since the publication of our 90-day finding we have compiled additional materials and information on the greater sage grouse. We believe we have a fairly complete compilation of the existing relevant information and much of it is summarized above. We also convened a panel of experts and conducted a

structured analysis of risk. A decision support team of Service biologists and managers read selected background materials and observed the deliberations of the expert panel. To further inform the Service's final petition response, the decision support team participated in a structured analysis of the optimal listing category where they assessed whether the greater sage grouse qualifies as threatened or endangered. After considering the compiled information, the risk assessment, the applicable conservation actions, and the assessment of the decision support team, we find that the petitioned actions are not warranted at this time.

We will continue to monitor the status of the greater sage-grouse and sagebrush ecosystems, and to accept additional information and comments from all governmental agencies, the scientific community, industry, or any other interested party concerning this finding.

## References

A complete list of references used in the preparation of this finding is available upon request from the Wyoming Field Office (see **ADDRESSES** section).

## Author

The primary author of this document is Wyoming Field Office, U.S. Fish and Wildlife Service, Cheyenne, Wyoming (see **ADDRESSES** section).

## Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: January 6, 2005.

## Steve Williams,

*Director, U.S. Fish and Wildlife Service.*  
[FR Doc. 05-583 Filed 1-10-05; 8:45 am]

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## Appendix D - Guidelines to Manage Sage-grouse Populations and Their Habitats

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# Guidelines to Manage Sage-grouse Populations and Their Habitats

John W. Connelly, Michael A. Schroeder, Alan R. Sands, and Clait E. Braun. 2000. Wildlife Society Bulletin 28(4): 967-985.

## ABSTRACT

The status of sage-grouse populations and habitats has been a concern to sportsmen and biologists for >80 years. Despite management and research efforts that date to the 1930s, breeding populations of this species have declined throughout much of its range. In May 1999, the western sage-grouse (*C. urophasianus phaios*) in Washington was petitioned for listing under the Endangered Species Act because of population and habitat declines (C. Warren, United States Fish and Wildlife Service, personal communication). Sage-grouse populations are allied closely with sagebrush (*Artemisia* spp.). Despite the well-known importance of this habitat to sage-grouse and other sagebrush obligates, the quality and quantity of sagebrush habitats have declined for at least the last 50 years. Braun et al. (1977) provided guidelines for maintenance of sage-grouse habitats. Since publication of those guidelines, much more information has been obtained on sage-grouse. Because of continued concern about sage-grouse and their habitats and a significant amount of new information, the Western States Sage and Columbian Sharp-tailed Grouse Technical Committee, under the direction of the Western Association of Fish and Wildlife Agencies, requested a revision and expansion of the guidelines originally published by Braun et al. (1977). This paper summarizes the current knowledge of the ecology of sage-grouse and, based on this information, provides guidelines to manage sage-grouse populations and their habitats.

Keywords: *Artemisia*, *Centrocercus urophasianus*, guidelines, habitat, management, populations, sage-grouse, sagebrush.

The status of sage-grouse populations and habitats has been a concern to sportsmen and biologists for >80 years (Hornaday 1916, Patterson 1952, Autenrieth 1981). Despite management and research efforts that date to the 1930s (Girard 1937), breeding populations of this species have declined by at least 17–47% throughout much of its range (Connelly and Braun 1997). In May 1999, the western sage-grouse (*C. urophasianus phaios*) in Washington was petitioned for listing under the Endangered Species Act because of population and habitat declines (C. Warren, United States Fish and Wildlife Service, personal communication).

Sage-grouse populations are allied closely with sagebrush (*Artemisia* spp.) habitats (Patterson 1952, Braun et al. 1977, Braun 1987). The dependence of sage-grouse on sagebrush for winter habitat has been well documented (Eng and Schladweiler 1972, Beck 1975, Beck 1977, Robertson 1991). Similarly, the relationship between sagebrush habitats and sage-grouse nest success has been described thoroughly (Klebenow 1969, Wallestad and Pyrah 1974, Wakkinen 1990, Connelly et al. 1991, Gregg et al. 1994). Despite the well-known importance of this habitat to sage-grouse and other sagebrush obligates (Braun et al. 1976, Saab and Rich 1997), the quality and quantity of sagebrush habitats have declined for at least the last 50 years (Braun et al. 1976, Braun 1987, Swenson et al. 1987, Connelly and Braun 1997).

Braun et al. (1977) provided guidelines for maintenance of sage-grouse habitats. Since publication of those guidelines, much more information has been obtained on relative size of sagebrush habitats used by these grouse (Connelly 1982, Connelly et al. 1988, Wakkinen et al. 1992), seasonal use of sagebrush habitats (Benson et al. 1991, Connelly et al. 1991), effects of insecticides on sage-grouse (Blus et al. 1989), importance of herbaceous cover in breeding habitat (Wakkinen 1990, Connelly et al. 1991, Gregg 1991, Barnett and Crawford 1994, Drut et al. 1994a, Gregg et al. 1994), and effects of fire on their habitat (Hulet 1983; Benson et al. 1991; Robertson 1991; Fischer 1994; Fischer et al. 1996a, 1997; Pyle and Crawford 1996; Connelly et al. 2000c). Because of continued concern about sage-grouse and their habitats and a significant amount of new information, the Western States Sage and Columbian Sharp-tailed Grouse Technical Committee, under the direction of the Western Association of Fish and Wildlife Agencies, requested a revision and expansion of the guidelines originally published by Braun et al. (1977). This paper summarizes the current knowledge of the ecology of sage-grouse and, based on this information, provides guidelines to manage sage-grouse populations and their habitats.

## POPULATION BIOLOGY

### Seasonal Movements and Home Range

Sage-grouse display a variety of annual migratory patterns (Beck 1975, Wallestad 1975, Hulet 1983, Berry and Eng 1985, Connelly et al. 1988, Wakkinen 1990, Fischer 1994). Populations may have: 1) distinct winter, breeding, and summer areas; 2) distinct summer areas and integrated winter and breeding areas; 3) distinct winter areas and integrated breeding and summer areas; or 4) well-integrated seasonal habitats (non-migratory populations). Seasonal movements between distinct seasonal ranges may exceed 75 km (Dalke et al. 1963, Connelly et al. 1988), which complicates attempts to define populations. Thus, Connelly et al. (1988) suggested that sage-grouse populations be defined on a temporal and geographic basis. Because of differences in seasonal movements among populations (Dalke et al. 1963, Wallestad 1975, Connelly et al. 1988, Wakkinen 1990), three types of sage-grouse populations can be defined: 1) non-migratory, grouse do not make long-distance movements (i.e., >10 km one way) between or among seasonal ranges; 2) one-stage migratory, grouse move between two distinct seasonal ranges; and 3) two-stage migratory, grouse move among three distinct seasonal ranges. Within a given geographic area, especially summer range, there may be birds that belong to more than one of these types of populations.

On an annual basis, migratory sage-grouse populations may occupy areas that exceed 2,700 km<sup>2</sup> (Hulet 1983, Leonard et al. 2000). During winter, Robertson (1991) reported that migratory sage-grouse in southeastern Idaho made mean daily movements of 752 m and occupied an area >140 km<sup>2</sup>. For a non-migratory population in Montana, Wallestad (1975) reported that winter home range size ranged from 11 to 31 km<sup>2</sup>. During summer, migratory sage-grouse in Idaho occupied home ranges of 3 to 7 km<sup>2</sup> (Connelly and Markham 1983, Gates 1983).

Despite large annual movements, sage-grouse have high fidelity to seasonal ranges (Keister and Willis 1986, Fischer et al. 1993). Females return to the same area to nest each year (Fischer et al. 1993) and may nest within 200 m of their previous year's nest (Gates 1983, Lyon 2000).

### Survival

Wallestad (1975) reported that annual survival rates for yearling and adult female sage-grouse were 35 and 40%, respectively, for poncho-tagged birds. However, Zablan (1993) reported that survival rates for banded yearling and adult females in Colorado were similar and averaged 55%; survival rates for yearling and adult males differed, averaging 52 and 38%, respectively. In Idaho, annual survival of male sage-grouse ranged from 46 to 54% and female survival from 68 to 85% (Connelly et al. 1994). Lower survival rates for males may

be related to physiological demands because of sexual dimorphism and greater predation rates (Swenson 1986).

## **Reproduction**

Bergerud (1988) suggested that most female tetraonids nest as yearlings. Although essentially all female sage-grouse nested in Washington (Schroeder 1997), Connelly et al. (1993) reported that in Idaho up to 45% of yearling and 22% of adult female sage-grouse do not nest each year. Gregg (1991) indicated that, of 119 females monitored through the breeding season in eastern Oregon, 26 (22%) did not nest. However, Coggins (1998) reported a 99% nest initiation rate for three years for the same population in Oregon. The differences may be related to improved range condition that resulted in better nutritional status of pre-laying hens (Barnett and Crawford 1994).

Estimates of sage-grouse nest success throughout the species' range vary from 12 to 86% (Trueblood 1954, Gregg 1991, Schroeder et al. 1999). Nest success also may vary on an annual basis (Schroeder 1997, Sveum et al. 1998a). Wallestad and Pyrah (1974) observed greater nest success by adults than yearlings. However, significant differences in nest success between age groups have not been reported in other studies (Connelly et al. 1993, Schroeder 1997).

Clutch size of sage-grouse is extremely variable and relatively low compared to other species of gamebirds (Edminster 1954, Schroeder 1997). Average clutch size for first nests varies from 6.0 to 9.5 throughout the species' range (Sveum 1995, Schroeder 1997). Greatest and least average clutch sizes have been reported in Washington (Sveum 1995, Schroeder 1997).

Renesting by sage-grouse varies regionally from <20% (Patterson 1952, Eng 1963, Hulet 1983, Connelly et al. 1993) to >80% (Schroeder 1997). Despite regional variation, differences in renesting rates due to age have not been documented (Connelly et al. 1993, Schroeder 1997). Because of variation in nest initiation, success, and renesting rates, the proportion of females successfully hatching a brood varies between 15 and 70% (Wallestad and Pyrah 1974, Gregg et al. 1994). Despite this variation, sage-grouse generally have low reproductive rates and high annual survival compared to most gallinaceous species (Zablan 1993, Connelly et al. 1994, Connelly and Braun 1997, Schroeder 1997, Schroeder et al. 1999).

Little information has been published on mortality of juvenile sage-grouse or the level of production necessary to maintain a stable population. Among western states, long-term ratios have varied from 1.40 to 2.96 juveniles/hen in the fall; since 1985, these ratios have ranged from 1.21 to 2.19 (Connelly and Braun 1997). Available data suggest that a ratio >2.25 juveniles/hen in the fall should result in stable to increasing sage-grouse populations (Connelly and Braun 1997, Edelman et al. 1998).

## HABITAT REQUIREMENTS

### Breeding Habitats

Leks, or breeding display sites, typically occur in open areas surrounded by sagebrush (Patterson 1952, Gill 1965); these sites include, but are not limited to, landing strips, old lakebeds, low sagebrush flats and ridge tops, roads, cropland, and burned areas (Connelly et al. 1981, Gates 1985). Sage-grouse males appear to form leks opportunistically at sites within or adjacent to potential nesting habitat. Although the lek may be an approximate center of annual ranges for non-migratory populations (Eng and Schladweiler 1972, Wallestad and Pyrah 1974, Wallestad and Schladweiler 1974), this may not be the case for migratory populations (Connelly et al. 1988, Wakkinen et al. 1992). Average distances between nests and nearest leks vary from 1.1 to 6.2 km, but distance from lek of female capture to nest may be >20 km (Autenrieth 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994, Lyon 2000). Nests are placed independent of lek location (Bradbury et al. 1989, Wakkinen et al. 1992).

Habitats used by pre-laying hens also are part of the breeding habitat. These areas should provide a diversity of forbs high in calcium, phosphorus, and protein; the condition of these areas may greatly affect nest initiation rate, clutch size, and subsequent reproductive success (Barnett and Crawford 1994, Coggins 1998).

Most sage-grouse nests occur under sagebrush (Patterson 1952, Gill 1965, Gray 1967, Wallestad and Pyrah 1974), but sage-grouse will nest under other plant species (Klebenow 1969, Connelly et al. 1991, Gregg 1991, Sveum et al. 1998a). However, grouse nesting under sagebrush experience greater nest success (53%) than those nesting under other plant species (22%, Connelly et al. 1991).

Mean height of sagebrush most commonly used by nesting grouse ranges from 29 to 80 cm (Appendix Table F-1), and nests tend to be under the tallest sagebrush within a stand (Keister and Willis 1986, Wakkinen 1990, Apa 1998). In general, sage-grouse nests are placed under shrubs having larger canopies and more ground and lateral cover as well as in stands with more shrub canopy cover than at random sites (Wakkinen 1990, Fischer 1994, Heath et al. 1997, Sveum et al. 1998a, Holloran 1999). Sagebrush cover near the nest site was greater around successful nests than unsuccessful nests in Montana (Wallestad and Pyrah 1974) and Oregon (Gregg 1991). Wallestad and Pyrah (1974) also indicated that successful nests were in sagebrush stands with greater average canopy coverage (27%) than those of unsuccessful nests (20%). Gregg (1991) reported that sage-grouse nest success varied by cover type. The greatest nest success occurred in a mountain big sagebrush (*A. t. tridentata vaseyana*) cover type where shrubs 40–80 cm in height had greater canopy cover at the site of successful nests than at unsuccessful nests (Gregg 1991). These observations were consistent with the results of an artificial nest study showing greater coverage of medium-height shrubs improved success of artificial nests (DeLong 1993, DeLong et al. 1995).

Appendix Table F-1. Habitat characteristics associated with sage-grouse nest sites.

State	Sagebrush		Grass		Reference
	Height (cm) <sup>a</sup>	Coverage (%) <sup>b</sup>	Height (cm)	Coverage (%) <sup>c</sup>	
CO	52				Peterson 1980
ID		15		4	Klebenow 1969
	58-79	23-38			Autenrieth 1981
	71	22	18	3-10	Wakkinen 1990
			19-23	7-9	Connelly et al. 1991
	61		22	30	Fischer 1994
MT		15-32	15-30		Klott et al. 1993
	69	19	34	15	Apa 1998
	40	27			Wallestad 1975
OR	80	20			Keister and Willis 1986
		24	14	9-32	Gregg 1991
WA		20		51	Schroeder 1995
		19		32	Sveum et al. 1998a
WY	36				Patterson 1952
	29	24	15	9	Heath et al. 1997
	31	25	18	5	Holloran 1999
	33	26	21	11	Lyon 2000

Grass height and cover also are important components of sage-grouse nest sites (Appendix Table F-1). Grass associated with nest sites and with the stand of vegetation containing the nest was taller and denser than grass at random sites (Wakkinen 1990, Gregg 1991, Sveum et al. 1998a). Grass height at nests under non-sagebrush plants was greater ( $P < 0.01$ ) than that associated with nests under sagebrush, further suggesting that grass height is an important habitat component for nesting sage-grouse (Connelly et al. 1991). Moreover, in Oregon, grass cover was greater at successful nests than at unsuccessful nests (Gregg 1991). Grass >18 cm in height occurring in stands of sagebrush 40–80 cm tall resulted in lesser nest predation rates than in stands with lesser grass heights (Gregg et al. 1994). Herbaceous cover associated with nest sites may provide scent, visual, and physical barriers to potential predators (DeLong et al. 1995).

Early brood-rearing areas occur in upland sagebrush habitats relatively close to nest sites, but movements of individual broods may vary (Connelly 1982, Gates 1983). Within two days of hatching, one brood moved 3.1 km (Gates 1983). Early brood-rearing habitats may be relatively open (about 14% canopy cover) stands of sagebrush (Martin 1970, Wallestad 1971) with >15% canopy cover of grasses and forbs (Sveum et al. 1998b, Lyon 2000). Great plant species richness with abundant forbs and insects characterize brood areas (Dunn and Braun 1986b, Klott and Lindzey 1990, Drut et al. 1994a, Apa 1998). In Oregon, diets of sage-grouse chicks included 34 genera of forbs and 41 families of invertebrates (Drut et al. 1994b). Insects, especially ants (*Hymenoptera*) and beetles (*Coleoptera*), are an important

component of early brood-rearing habitat (Drut et al. 1994b, Fischer et al. 1996a). Ants and beetles occurred more frequently ( $P = 0.02$ ) at brood-activity centers compared to non-brood sites (Fischer et al. 1996a).

### **Summer - Late Brood-rearing Habitats**

As sagebrush habitats desiccate, grouse usually move to more mesic sites during June and July (Gill 1965, Klebenow 1969, Savage 1969, Connelly and Markham 1983, Gates 1983, Connelly et al. 1988, Fischer et al. 1996b). Sage-grouse broods occupy a variety of habitats during summer, including sagebrush (Martin 1970), relatively small burned areas within sagebrush (Pyle and Crawford 1996), wet meadows (Savage 1969), farmland, and other irrigated areas adjacent to sagebrush habitats (Connelly and Markham 1983, Gates 1983, Connelly et al. 1988). Apa (1998) reported that sites used by grouse broods had twice as much forb cover as independent sites.

### **Fall Habitats**

Sage-grouse use a variety of habitats during fall. Patterson (1952) reported that grouse move from summer to winter range in October, but during mild weather in late fall, some birds may still use summer range. Similarly, Connelly and Markham (1983) observed that most sage-grouse had abandoned summering areas by the first week of October. Fall movements to winter range are slow and meandering and occur from late August to December (Connelly et al. 1988). Wallestad (1975) documented a shift in feeding habits from September, when grouse were consuming a large amount of forbs, to December, when birds were feeding only on sagebrush.

### **Winter Habitats**

Characteristics of sage-grouse winter habitats are relatively similar throughout most of the species' range (Appendix Table F-2). Eng and Schladweiler (1972) and Wallestad (1975) indicated that most observations of radio-marked sage-grouse during winter in Montana occurred in sagebrush habitats with >20% canopy cover. However, Robertson (1991) indicated that sage-grouse used sagebrush habitats that had average canopy coverage of 15% and average height of 46 cm during three winters in southeastern Idaho. In Idaho, sage-grouse selected areas with greater canopy cover of Wyoming big sagebrush (*A. t. wyomingensis*) in stands containing taller shrubs when compared to random sites (Robertson 1991). In Colorado, sage-grouse may be restricted to <10% of the sagebrush habitat because of variation in topography and snow depth (Beck 1977, Hupp and Braun 1989). Such restricted areas of use may not occur throughout the species' range because in southeastern Idaho, severe winter weather did not result in the grouse population greatly reducing its seasonal range (Robertson 1991).

Appendix Table F-2. Characteristics of sagebrush at sage-grouse winter-use sites.

State	Canopy		Reference
	Coverage (%) <sup>a</sup>	Height (cm) <sup>a</sup>	
Colorado		24-36 <sup>b,c</sup>	Beck 1977
		20-30 <sup>c,d</sup>	Beck 1977
		43 <sup>b</sup>	Schoenberg 1982
		37 <sup>d</sup>	Schoenberg 1982
		30-38 <sup>c,e</sup>	Hupp 1987
Idaho		56 <sup>e</sup>	Autenrieth 1981
		29 <sup>b</sup>	Connelly 1982
		26 <sup>d</sup>	Connelly 1982
		15	Robertson 1991
Montana		25	Eng and Schladweiler 1972
		>20	Wallestad 1975
Oregon	12-17 <sup>c</sup>		Hanf et al. 1994

<sup>a</sup> Mean canopy coverage or height of sagebrush above snow.

<sup>b</sup> Males.

<sup>c</sup> Ranges are given when data were provided for more than one year or area.

<sup>d</sup> Females.

<sup>e</sup> No snow present when measurements were made or total height of plant was measured.

During winter, sage-grouse feed almost exclusively on leaves of sagebrush (Patterson 1952, Wallestad et al. 1975). Although big sagebrush dominates the diet in most portions of the range (Patterson 1952; Wallestad et al. 1975; Remington and Braun 1985; Welch et al. 1988, 1991), low sagebrush (*A. arbuscula*), black sagebrush (*A. nova*, Dalke et al. 1963, Beck 1977), fringed sagebrush (*A. frigida*, Wallestad et al. 1975), and silver sagebrush (*A. cana*, Aldridge 1998) are consumed in many areas depending on availability. Sage-grouse in some areas apparently prefer Wyoming big sagebrush (Remington and Braun 1985, Myers 1992) and in other areas mountain big sagebrush (Welch et al. 1988, 1991). Some of the differences in selection may be due to preferences for greater levels of protein and the amount of volatile oils (Remington and Braun 1985, Welch et al. 1988).

## EFFECTS OF HABITAT ALTERATION

### Range Management Treatments

#### Breeding Habitat

Until the early 1980s, herbicide treatment (primarily with 2,4-D) was the most common method to reduce sagebrush on large tracts of rangeland (Braun 1987). Klebenow (1970) reported cessation of nesting in newly sprayed areas with <5% live sagebrush canopy cover. Nesting also was nearly nonexistent in older sprayed areas containing about 5% live

sagebrush cover (Klebenow 1970). In virtually all documented cases, herbicide application to blocks of sagebrush rangeland resulted in major declines in sage-grouse breeding populations (Enyeart 1956, Higby 1969, Peterson 1970, Wallestad 1975). Effects of this treatment on sage-grouse populations seemed more severe if the treated area was subsequently seeded to crested wheatgrass (*Agropyron cristatum*, Enyeart 1956).

Using fire to reduce sagebrush has become more common since most uses of 2,4-D on public lands were prohibited (Braun 1987). Klebenow (1972) and Sime (1991) suggested that fire may benefit sage-grouse populations. Neither Gates (1983), Martin (1990), nor Bensen et al. (1991) reported adverse effects of fire on breeding populations of sage-grouse. In contrast, following a nine-year study, Connelly et al. (1994, 2000c) indicated that prescribed burning of Wyoming big sagebrush during a drought period resulted in a large decline (>80%) of a sage-grouse breeding population in southeastern Idaho. Additionally, Hulet (1983) documented loss of leks from fire and Nelle et al. (2000) reported that burning mountain big sagebrush stands had long-term negative impacts on sage-grouse nesting and brood-rearing habitats. Canopy cover in mountain big sagebrush did not provide appropriate nesting habitat 14 years after burning (Nelle et al. 2000). The impact of fire on sage-grouse populations using habitats dominated by silver sagebrush (which may resprout following fire) is unknown.

Cheatgrass will often occupy sites following disturbance, especially burning (Vallentine 1989). Repeated burning or burning in late summer favors cheatgrass invasion and may be a major cause of the expansion of this species (Vallentine 1989). The ultimate result may be a loss of the sage-grouse population because of long-term conversion of sagebrush habitat to rangeland dominated by an annual exotic grass. However, this situation largely appears confined to the western portion of the species' range and does not commonly occur in Wyoming (J. Lawson, Wyoming Department of Game and Fish, personal communication).

Mechanical methods of sagebrush control have often been applied to smaller areas than those treated by herbicides or fire, especially to convert rangeland to cropland. However, adverse effects of this type of treatment on sage-grouse breeding populations also have been documented. In Montana, Swenson et al. (1987) indicated that the number of breeding males declined by 73% after 16% of their study area was plowed.

### **Brood-rearing Habitats**

Martin (1970) reported that sage-grouse seldom used areas treated with herbicides to remove sagebrush in southwestern Montana. In Colorado, Rogers (1964) indicated that an entire population of sage-grouse appeared to emigrate from an area that was subjected to several years of herbicide application to remove sagebrush. Similarly, Klebenow (1970) reported that herbicide spraying reduced the brood-carrying capacity of an area in southeastern Idaho. However, application of herbicides in early spring to reduce sagebrush cover may enhance

some brood-rearing habitats by increasing the amount of herbaceous plants used for food (Autenrieth 1981).

Fire may improve sage-grouse brood-rearing habitat (Klebenow 1972, Gates 1983, Sime 1991), but until recently, experimental evidence was not available to support or refute these contentions (Braun 1987). Pyle and Crawford (1996) suggested that fire may enhance brood-rearing habitat in montane settings but cautioned that its usefulness requires further investigation. A nine-year study of the effects of fire on sage-grouse did not support that prescribed fire, conducted during late summer in a Wyoming big sagebrush habitat, improved brood-rearing habitat for sage-grouse (Connelly et al. 1994, Fischer et al. 1996a). Prescribed burning of sage-grouse habitat did not increase amount of forbs in burned areas compared to unburned areas (Fischer et al. 1996a, Nelle et al. 2000) and resulted in decreased insect populations in the treated area compared to the unburned area. Thus, fire may negatively affect sage-grouse brood-rearing habitat rather than improve it in Wyoming big sagebrush habitats (Connelly and Braun 1997), but its effect on grouse habitats in mountain big sagebrush communities requires further investigation (Pyle and Crawford 1996, Nelle et al. 2000).

Sage-grouse often use agricultural areas for brood-rearing habitat (Patterson 1952, Wallestad 1975, Gates 1983, Connelly et al. 1988, Blus et al. 1989). Grouse use of these areas may result in mortality because of exposure to insecticides. Blus et al. (1989) reported die-offs of sage-grouse that were exposed to methamidiphos used in potato fields and dimethoate used in alfalfa fields. Dimethoate is used commonly for alfalfa, and 20 of 31 radio-marked grouse (65%) died following direct exposure to this insecticide (Blus et al. 1989).

### **Winter Habitat**

Reduction in sage-grouse use of an area treated by herbicide was proportional to the severity (i.e., amount of damage to sagebrush) of the treatment (Pyrah 1972). In sage-grouse winter range, strip partial kill, block partial kill, and total kill of sagebrush were increasingly detrimental to sage-grouse in Montana (Pyrah 1972) and Wyoming (Higby 1969).

In Idaho, Robertson (1991) reported that a 2,000-ha prescribed burn that removed 57% of the sagebrush cover in sage-grouse winter habitat minimally impacted the sage-grouse population. Although sage-grouse use of the burned area declined following the fire, grouse adapted to this disturbance by moving 1 to 10 km outside of the burn to areas with greater sagebrush cover (Robertson 1991) than was available in the burned area.

## **Land Use**

### **Mining–energy Development**

Effects of mining, oil, and gas developments on sage-grouse populations are not well known (Braun 1998). These activities negatively impact grouse habitat and populations over the short term (Braun 1998), but research suggests some recovery of populations following initial development and subsequent reclamation of the affected sites (Eng et al. 1979, Tate et al. 1979, Braun 1986). In Colorado, sage-grouse were displaced by oil development and coal-mining activities, but numbers returned to pre-disturbance levels once the activities ceased (Braun 1987, Remington and Braun 1991). At least six leks in Alberta were disturbed by energy development and four were abandoned (Aldridge 1998). In Wyoming, female sage-grouse captured on leks disturbed by natural gas development had lower nest-initiation rates, longer movements to nest sites, and different nesting habitats than hens captured on undisturbed leks (Lyon 2000). Sage-grouse may repopulate an area following energy development but may not attain population levels that occurred prior to development (Braun 1998). Thus, short-term and long-term habitat loss appears to result from energy development and mining (Braun 1998).

### **Grazing**

Domestic livestock have grazed over most areas used by sage-grouse and this use is generally repetitive with annual or biennial grazing periods of varying timing and length (Braun 1998). Grazing patterns and use of habitats are often dependent on weather conditions (Vallentine 1990). Historic and scientific evidence indicates that livestock grazing did not increase the distribution of sagebrush (Peterson 1995) but markedly reduced the herbaceous understory over relatively large areas and increased sagebrush density in some areas (Vale 1975, Tisdale and Hironaka 1981). Within the intermountain region, some vegetation changes from livestock grazing likely occurred because sagebrush steppe in this area did not evolve with intensive grazing by wild herbivores, as did the grassland prairies of central North America (Mack and Thompson 1982). Grazing by wild ungulates may reduce sagebrush cover (McArthur et al. 1988, Peterson 1995), and livestock grazing may result in high trampling mortality of sagebrush seedlings (Owens and Norton 1992). In Wyoming big sagebrush habitats, resting areas from livestock grazing may improve understory production as well as decrease sagebrush cover (Wambolt and Payne 1986).

There is little direct experimental evidence linking grazing practices to sage-grouse population levels (Braun 1987, Connelly and Braun 1997). However, grass height and cover affect sage-grouse nest site selection and success (Wakkinen 1990, Gregg 1991, Gregg et al. 1994, DeLong et al. 1995, Sveum et al. 1998a). Thus, indirect evidence suggests grazing by livestock or wild herbivores that significantly reduces the herbaceous understory in breeding habitat may have negative impacts on sage-grouse populations (Braun 1987, Dobkin 1995).

## **Miscellaneous Activities**

Construction of roads, power lines, fences, reservoirs, ranches, farms, and housing developments has resulted in sage-grouse habitat loss and fragmentation (Braun 1998). Between 1962 and 1997, >51,000 km of fence were constructed on land administered by the Bureau of Land Management in states supporting sage-grouse populations (T. D. Rich, United States Bureau of Land Management, personal communication). Structures such as power lines and fences pose hazards to sage-grouse because they provide additional perch sites for raptors and because sage-grouse may be injured or killed when they fly into these structures (Call and Maser 1985).

## **Weather**

Prolonged drought during the 1930s and mid-1980s to early 1990s coincided with declining sage-grouse populations throughout much of the species' range (Patterson 1952, Fischer 1994, Hanf et al. 1994). Drought may affect sage-grouse populations by reducing herbaceous cover at nests and the quantity and quality of food available for hens and chicks during spring (Hanf et al. 1994, Fischer et al. 1996a).

Spring weather may influence sage-grouse production. Relatively wet springs may result in increased production (Wallestad 1975, Autenrieth 1981). However, heavy rainfall during egg-laying or unseasonably cold temperatures with precipitation during hatching may decrease production (Wallestad 1975).

There is no evidence that severe winter weather affects sage-grouse populations unless sagebrush cover has been greatly reduced or eliminated (Wallestad 1975, Beck 1977, Robertson 1991).

## **Predation**

Over the last 25 years, numerous studies have used radio-telemetry to address sage-grouse survival and nest success (Wallestad 1975; Hulet 1983; Gregg 1991; Robertson 1991; Connelly et al. 1993, 1994; Gregg et al. 1994; Schroeder 1997). Only Gregg (1991) and Gregg et al. (1994) indicated that predation was limiting sage-grouse numbers, and their research suggested that low nest success from predation was related to poor nesting habitat. Most reported nest-success rates are >40%, suggesting that nest predation is not a widespread problem. Similarly, high survival rates of adult (Connelly et al. 1993, Zablan 1993) and older (>10 weeks of age) juvenile sage-grouse indicate that population declines are not generally related to high levels of predation. Thus, except for an early study in Oregon (Batterson and Morse 1948), predation has not been identified as a major limiting factor for sage-grouse (Connelly and Braun 1997).

Constructing ranches, farms, and housing developments has resulted in the addition of non-native predators to sage-grouse habitats, including dogs, cats, and red foxes (*Vulpes vulpes*; J. W. Connelly, Idaho Department of Fish and Game, unpublished data; B. L. Welch, United States Forest Service, personal communication) and may be responsible for increases in abundance of the common raven (*Corvus corax*, Sauer et al. 1997). Relatively high raven populations may decrease sage-grouse nest success (Batterson and Morse 1948, Autenrieth 1981), but rigorous field studies using radio-telemetry do not support this hypothesis. Current work in Strawberry Valley, Utah, suggests that red foxes are taking a relatively high proportion of the population (Flinders 1999). This may become a greater problem if red foxes become well established throughout sage-grouse breeding habitat.

## **RECOMMENDED GUIDELINES**

Sage-grouse populations occupy relatively large areas on a year-round basis (Berry and Eng 1985, Connelly et al. 1988, Wakkinen 1990, Leonard et al. 2000), invariably involving a mix of ownership and jurisdictions. Thus, state and federal natural resource agencies and private landowners must coordinate efforts over at least an entire seasonal range to successfully implement these guidelines. Based on current knowledge of sage-grouse population and habitat trends, these guidelines have been developed to help agencies and landowners effectively assess and manage populations, protect and manage remaining habitats, and restore damaged habitat. Because of gaps in our knowledge and regional variation in habitat characteristics (Tisdale and Hironaka 1981), the judgment of local biologists and quantitative data from population and habitat monitoring are necessary to implement the guidelines correctly. Further, we urge agencies to use an adaptive management approach (MacNab 1983, Gratson et al. 1993), using monitoring and evaluation to assess the success of implementing these guidelines to manage sage-grouse populations.

Activities responsible for the loss or degradation of sagebrush habitats also may be used to restore these habitats. These activities include prescribed fire, grazing, herbicides, and mechanical treatments. Decisions on land treatments using these tools should be based on quantitative knowledge of vegetative conditions over an entire population's seasonal range. Generally, the treatment selected should be that which is least disruptive to the vegetation community and has the most rapid recovery time. This selection should not be based solely on economic cost.

### **Definitions**

For the purpose of these guidelines, we define an occupied lek as a traditional display area in or adjacent to sagebrush-dominated habitats that has been attended by >2 male sage-grouse in >2 of the previous five years. We define a breeding population as a group of birds associated with one or more occupied leks in the same geographic area separated from other leks by >20 km. This definition is somewhat arbitrary but generally based on maximum distances females move to nest.

## Population Management

1) Before making management decisions, agencies should cooperate to first identify lek locations and determine whether a population is migratory or non-migratory. In the case of migratory populations, migration routes and seasonal habitats must be identified to allow for meaningful and correct management decisions.

2) Breeding populations should be assessed by either lek counts (census number of males attending leks) or lek surveys (classify known leks as active or inactive) each year (Autenrieth et al. 1982). Depending on number of counts each spring (Jenni and Hartzler 1978, Emmons and Braun 1984) and weather conditions when the counts were made, lek counts may not provide an accurate assessment of sage-grouse populations (Beck and Braun 1980) and the data should be viewed with caution. Despite these shortcomings, lek counts provide the best index to breeding population levels and many long-term data sets are available for trend analysis (Connelly and Braun 1997).

3) Production or recruitment should be monitored by brood counts or wing surveys (Autenrieth et al. 1982). Brood counts are labor-intensive and usually result in inadequate sample size. Where adequate samples of wings can be obtained, we recommend using wing surveys to obtain estimates of sage-grouse nesting success and juvenile:adult hen (including yearlings) ratios.

4) Routine population monitoring should be used to assess trends and identify problems for all hunted and non-hunted populations. Check stations, wing collections, and questionnaires can be used to obtain harvest information. Breeding population and production data (above) can be used to monitor non-hunted populations.

5) The genetic variation of relatively small, isolated populations should be documented to better understand threats to these populations and implement appropriate management actions (Young 1994, Oyler-McCance et al. 1999).

6) Hunting seasons for sage-grouse should be based on careful assessments of population size and trends. Harvest should not be based on the observations of Allen (1954:43), who stated, "*Our populations of small animals operate under a 1-year plan of decimation and replacement; and Nature habitually maintains a wide margin of overproduction. She kills off a huge surplus of animals whether we take our harvest or not.*" To the contrary, sage-grouse tend to have relatively long lives with low annual turnover (Zablan 1993, Connelly et al. 1994) and a low reproductive rate (Gregg 1991, Connelly et al. 1993). Consequently, hunting may be additive to other causes of mortality for sage-grouse (Johnson and Braun 1999, Connelly et al. 2000a). However, most populations appear able to sustain hunting if managed carefully (Connelly et al. 2000a).

7) If populations occur over relatively large geographic areas and are stable to increasing, seasons and bag limits can be relatively liberal (2- to 4-bird daily bag limit and a 2- to 5-week season) for hunting seasons allowing firearms (Braun and Beck 1985).

8) If populations are declining (for three or more consecutive years) or trends are unknown, seasons and bag limits should be generally conservative (1- or 2-bird daily bag limit and a 1- to 4-week season) for hunting seasons allowing firearms, or suspended (for all types of hunting, including falconry and Native American subsistence hunting) because of this species' population characteristics (Braun 1998, Connelly et al. 2000a).

9) Where populations are hunted, harvest rates should be 10% or less of the estimated fall population to minimize negative effects on the subsequent year's breeding population (Connelly et al. 2000a).

10) Populations should not be hunted where <300 birds comprise the breeding population (i.e. <100 males are counted on leks [C. E. Braun, Colorado Division of Wildlife, unpublished report]).

11) Spring hunting of sage-grouse on leks should be discouraged or, if unavoidable, confined to males only during the early portion of the breeding season. Spring hunting is considered an important tradition for some Native American tribes. However, in Idaho, 80% of the leks hunted during spring in the early 1990s (n=5) had become inactive by 1994 (Connelly et al. 1994).

12) Viewing sage-grouse on leks (and censusing leks) should be conducted so that disturbance to birds is minimized or preferably eliminated (Call and Maser 1986). Agencies should generally not provide all lek locations to individuals simply interested in viewing birds. Instead, one to three lek locations should be identified as public viewing leks, and if demand is great enough, agencies should consider erecting 2–3 seasonal blinds at these leks for public use. Camping in the center of or on active leks should be vigorously discouraged.

13) Discourage establishment of red fox and other non-native predator populations in sage-grouse habitats.

14) For small, isolated populations and declining populations, assess the impact of predation on survival and production. Predator control programs are expensive and often ineffective. In some cases, these programs may provide temporary help while habitat is recovering. Predator management programs also could be considered in areas where seasonal habitats are in good condition but their extent has been reduced greatly. However, predator management should be implemented only if the available data (e.g., nest success <25%, annual survival of adult hens <45%) support the action.

## General Habitat Management

The following guidelines pertain to all seasonal habitats used by sage-grouse: 1) Monitor habitat conditions and propose treatments only if warranted by range condition (i.e., the area no longer supports habitat conditions described in the following guidelines under habitat protection). Do not base land treatments on schedules, targets, or quotas. 2) Use appropriate vegetation treatment techniques (e.g., mechanical methods, fire) to remove junipers and other conifers that have invaded sage-grouse habitat (Commons et al. 1999). Whenever possible, use vegetation control techniques that are least disruptive to the stand of sagebrush, if this stand meets the needs of sage-grouse (Appendix Table F-3). 3) Increase the visibility of fences and other structures occurring within 1 km of seasonal ranges by flagging or similar means if these structures appear hazardous to flying grouse (e.g., birds have been observed hitting or narrowly missing these structures or grouse remains have been found next to these structures). 4) Avoid building power lines and other tall structures that provide perch sites for raptors within 3 km of seasonal habitats. If these structures must be built, or presently exist, the lines should be buried or poles modified to prevent their use as raptor perch sites.

Appendix Table F-3. Characteristics of sagebrush rangeland needed for productive sage-grouse habitat.

	Breeding		Brood-rearing		Winter <sup>a</sup>	
	Height (cm)	Canopy (%)	Height (cm)	Canopy (%)	Height (cm)	Canopy (%)
Mesic sites <sup>b</sup>						
Sagebrush	40-80	15-25	40-80	10-25	25-35	10-30
Grass-forb	>18 <sup>c</sup>	≥25 <sup>d</sup>	variable	>15	N/A	N/A
Arid sites <sup>b</sup>						
Sagebrush	30-80	15-25	40-80	10-25	25-35	10-30
Grass-forb	>18 <sup>c</sup>	≥15	variable	>15	N/A	N/A
Area <sup>e</sup>		>80		>40		>80

<sup>a</sup> Values for height and canopy coverage are for shrubs exposed above snow.

<sup>b</sup> Mesic and arid sites should be defined on a local basis; annual precipitation, herbaceous understory, and soils should be considered (Tisdale and Hironaka 1981, Hironaka et al. 1983).

<sup>c</sup> Measured as “droop height”; the highest naturally growing portion of the plant.

<sup>d</sup> Coverage should exceed 15% for perennial grasses and 10% for forbs; values should be substantially greater if most sagebrush has a growth form that provides little lateral cover (Schroeder 1995).

<sup>e</sup> Percentage of seasonal habitat needed with indicated conditions.

## Breeding Habitat Management

For migratory and non-migratory populations, lek attendance, nesting, and early brood rearing occur in breeding habitats. These habitats are sagebrush-dominated rangelands with

a healthy herbaceous understory and are critical for survival of sage-grouse populations. Mechanical disturbance, prescribed fire, and herbicides can be used to restore sage-grouse habitats to those conditions identified as appropriate in the following sections on habitat protection. Local biologists and range ecologists should select the appropriate technique on a case-by-case basis. Generally, fire should not be used in breeding habitats dominated by Wyoming big sagebrush if these areas support sage-grouse. Fire can be difficult to control and tends to burn the best remaining nesting and early brood-rearing habitats (i.e., those areas with the best remaining understory), while leaving areas with poor understory. Further, we recommend against using fire in habitats dominated by xeric mountain big sagebrush (*A. t. xericensis*) because annual grasses commonly invade these habitats and much of the original habitat has been altered by fire (Bunting et al. 1987).

Although mining and energy development are common activities throughout the range of sage-grouse, quantitative data on the long-term effects of these activities on sage-grouse are limited. However, some negative impacts have been documented (Braun 1998, Lyon 2000). Thus, these activities should be discouraged in breeding habitats, but when they are unavoidable, restoration efforts should follow procedures outlined in these guidelines.

### **Habitat Protection**

1) Manage breeding habitats to support 15–25% canopy cover of sagebrush, perennial herbaceous cover averaging >18 cm in height with >15% canopy cover for grasses and >10% for forbs and a diversity of forbs (Barnett and Crawford 1994, Drut et al. 1994a, Apa 1998) during spring (Appendix Table F-3). Habitats meeting these conditions should have a high priority for wildfire suppression and should not be considered for sagebrush control programs. Sagebrush and herbaceous cover should provide overhead and lateral concealment from predators. If average sagebrush height is >75 cm, herbaceous cover may need to be substantially greater than 18 cm to provide this protection. There is much variability among sagebrush-dominated habitats (Tisdale and Hironaka 1981, Hironaka et al. 1983), and some Wyoming sagebrush and low sagebrush breeding habitats may not support 25% herbaceous cover. In these areas, total herbaceous cover should be >15 % (Appendix Table F-3). Further, the herbaceous height requirement may not be possible in habitats dominated by grasses that are relatively short when mature. In all of these cases, local biologists and range ecologists should develop height and cover requirements that are reasonable and ecologically defensible. Leks tend to be relatively open; thus, cover on leks should not meet these requirements.

2) For non-migratory grouse occupying habitats that are distributed uniformly (i.e., habitats have the characteristics described in guideline 1 and are generally distributed around the leks), protect (i.e., do not manipulate) sagebrush and herbaceous understory within 3.2 km of all occupied leks. For non-migratory populations, consider leks the center of year-round activity and use them as focal points for management efforts (Braun et al. 1977).

- 3) For non-migratory populations where sagebrush is not distributed uniformly (i.e., habitats have the characteristics described in guideline 1 but distributed irregularly with respect to leks), protect suitable habitats for <5 km from all occupied leks. Use radio-telemetry, repeated surveys for grouse use, or habitat mapping to identify nesting and early brood-rearing habitats.
- 4) For migratory populations, identify and protect breeding habitats within 18 km of leks in a manner similar to that described for non-migratory sage-grouse. For migratory sage-grouse, leks generally are associated with nesting habitats but migratory birds may move >18 km from leks to nest sites. Thus, protection of habitat within 3.2 km of leks may not protect most of the important nesting areas (Wakkinen et al. 1992, Lyon 2000).
- 5) In areas of large-scale habitat loss (>40% of original breeding habitat), protect all remaining habitats from additional loss or degradation. If remaining habitats are degraded, follow guidelines for habitat restoration listed below.
- 6) During drought periods (>2 consecutive years), reduce stocking rates or change management practices for livestock, wild horses, and wild ungulates if cover requirements during the nesting and brood-rearing periods are not met. Grazing pressure from domestic livestock and wild ungulates should be managed in a manner that at all times addresses the possibility of drought.
- 7) Suppress wildfires in all breeding habitats. In the event of multiple fires, land management agencies should have all breeding habitats identified and prioritized for suppression, giving the greatest priority to those that have become fragmented or reduced by >40% in the last 30 years.
- 8) Adjust timing of energy exploration, development, and construction activity to minimize disturbance of sage-grouse breeding activities. Energy-related facilities should be located >3.2 km from active leks whenever possible. Human activities within view of or <0.5 km from leks should be minimized during the early morning and late evening when birds are near or on leks.

### **Habitat Restoration**

- 1) Before initiating vegetation treatments, quantitatively evaluate the area proposed for treatment to ensure that it does not have sagebrush and herbaceous cover suitable for breeding habitat (Appendix Table F-3). Treatments should not be undertaken within sage-grouse habitats until the limiting vegetation factor(s) has been identified, the proposed treatment is known to provide the desired vegetation response, and land-use activities can be managed after treatment to ensure that vegetation objectives are met.

- 2) Restore degraded rangelands to a condition that again provides suitable breeding habitat for sage-grouse by including sagebrush, native forbs (especially legumes), and native grasses in reseeding efforts (Ara 1998). If native forbs and grasses are unavailable, use species that are functional equivalents and provide habitat characteristics similar to those of native species.
- 3) Where the sagebrush overstory is intact but the understory has been degraded severely and quality of nesting habitat has declined (Appendix Table F-3), use appropriate techniques (e.g., brush beating in strips or patches and interseed with native grasses and forbs) that retain some sagebrush but open shrub canopy to encourage forb and grass growth.
- 4) Do not use fire in sage-grouse habitats prone to invasion by cheatgrass and other invasive weed species unless adequate measures are included in restoration plans to replace the cheatgrass understory with perennial species using approved reseeding strategies. These strategies could include, but are not limited to, use of pre-emergent herbicides (e.g., Oust®, Plateau®) to retard cheatgrass germination until perennial herbaceous species become established.
- 5) When restoring habitats dominated by Wyoming big sagebrush, regardless of the techniques used (e.g., prescribed fire, herbicides), do not treat >20% of the breeding habitat (including areas burned by wildfire) within a 30-year period (Bunting et al. 1987). The 30-year period represents the approximate recovery time for a stand of Wyoming big sagebrush. Additional treatments should be deferred until the previously treated area again provides suitable breeding habitat (Appendix Table F-3). In some cases, this may take <30 years and in other cases >30 years. If 2,4-D or similar herbicides are used, they should be applied in strips such that their effect on forbs is minimized. Because fire generally burns the best remaining sage-grouse habitats (i.e., those with the best understory) and leaves areas with sparse understory, use fire for habitat restoration only when it can be convincingly demonstrated to be in the best interest of sage-grouse.
- 6) When restoring habitats dominated by mountain big sagebrush, regardless of the techniques used (e.g., fire, herbicides), treat <20% of the breeding habitat (including areas burned by wildfire) within a 20-year period (Bunting et al. 1987). The 20-year period represents the approximate recovery time for a stand of mountain big sagebrush. Additional treatments should be deferred until the previously treated area again provides suitable breeding habitat (Appendix Table F-3). In some cases, this may take <20 years and in other cases >20 years. If 2,4-D or similar herbicides are used, they should be applied in strips such that their effect on forbs is minimized.
- 7) All wildfires and prescribed burns should be evaluated as soon as possible to determine whether reseeding is necessary to achieve habitat management objectives. If needed, reseed with sagebrush, native bunchgrasses, and forbs whenever possible.

8) Until research unequivocally demonstrates that using tebuthiuron and similar-acting herbicides to control sagebrush has no long-lasting negative impacts on sage-grouse habitat, use these herbicides only on an experimental basis and over a sufficiently small area that any long-term negative impacts are negligible. Because these herbicides have the potential of reducing but not eliminating sagebrush cover within grouse breeding habitats, thus stimulating herbaceous development, their use as sage-grouse habitat management tools should be examined closely.

### **Summer - Late Brood-rearing Habitat Management**

Sage-grouse may use a variety of habitats, including meadows, farmland, dry lakebeds, sagebrush, and riparian zones from late June to early November (Patterson 1952, Wallestad 1975, Connelly 1982, Hanf et al. 1994). Generally, these habitats are characterized by relatively moist conditions and many succulent forbs in or adjacent to sagebrush cover.

### **Habitat Protection**

- 1) Avoid land-use practices that reduce soil moisture effectiveness, increase erosion, cause invasion of exotic plants, and reduce abundance and diversity of forbs.
- 2) Avoid removing sagebrush within 300 m of sage-grouse foraging areas along riparian zones, meadows, lakebeds, and farmland, unless such removal is necessary to achieve habitat management objectives (e.g., meadow restoration, treatment of conifer encroachment).
- 3) Discourage use of very toxic organophosphorus and carbamate insecticides in sage-grouse brood-rearing habitats. Sage-grouse using agricultural areas may be adversely affected by pesticide applications (Blus et al. 1989). Less toxic agri-chemicals or biological control may provide suitable alternatives in these areas.
- 4) Avoid developing springs for livestock water, but if water from a spring will be used in a pipeline or trough, design the project to maintain free water and wet meadows at the spring. Capturing water from springs using pipelines and troughs may adversely affect wet meadows used by grouse for foraging.

### **Habitat Restoration**

- 1) Use brush beating or other mechanical treatments in strips 4–8 m wide in areas with relatively high shrub-canopy cover (>35% total shrub cover) to improve late brood-rearing habitats. Brush beating can be used to effectively create different age classes of sagebrush in large areas with little age diversity.
- 2) If brush beating is impractical, use fire or herbicides to create a mosaic of openings in mountain big sagebrush and mixed-shrub communities used as late brood-rearing habitats

where total shrub cover is >35%. Generally, 10–20% canopy cover of sagebrush and <25% total shrub cover will provide adequate habitat for sage-grouse during summer.

3) Construct water developments for sage-grouse only in or adjacent to known summer-use areas and provide escape ramps suitable for all avian species and other small animals. Water developments and “guzzlers” may improve sage-grouse summer habitats (Autenrieth et al. 1982, Hanf et al. 1994). However, sage-grouse used these developments infrequently in southeastern Idaho because most were constructed in sage-grouse winter and breeding habitat rather than summer range (Connelly and Doughty 1989).

4) Whenever possible, modify developed springs and other water sources to restore natural free-flowing water and wet meadow habitats.

### **Winter Habitat Management**

Sagebrush is the essential component of winter habitat. Sage-grouse select winter-use sites based on snow depth and topography, and snowfall can affect the amount and height of sagebrush available to grouse (Connelly 1982, Hupp and Braun 1989, Robertson 1991). Thus, on a landscape scale, sage-grouse winter habitats should allow grouse access to sagebrush under all snow conditions (Appendix Table F-3).

### **Habitat Protection**

1) Maintain sagebrush communities on a landscape scale, allowing sage-grouse access to sagebrush stands with canopy cover of 10–30% and heights of at least 25–35 cm regardless of snow cover. These areas should be high priority for wildfire suppression and sagebrush control should be avoided.

2) Protect patches of sagebrush within burned areas from disturbance and manipulation. These areas may provide the only winter habitat for sage-grouse and their loss could result in the extirpation of the grouse population. They also are important seed sources for sagebrush reestablishment in the burned areas. During fire-suppression activities, do not remove or burn any remaining patches of sagebrush within the fire perimeter.

3) In areas of large-scale habitat loss (>40% of original winter habitat), protect all remaining sagebrush habitats.

### **Habitat Restoration**

1) Reseed former winter range with the appropriate subspecies of sagebrush and herbaceous species unless the species are recolonizing the area in a density that would allow recovery (Appendix Table F-3) within 15 years.

2) Discourage prescribed burns >50 ha, and do not burn >20% of an area used by sage-grouse during winter within any 20 to 30-year interval (depending on estimated recovery time for the sagebrush habitat).

## CONSERVATION STRATEGIES

We recommend that each state and province develop and implement conservation plans for sage-grouse. These plans should use local working groups comprised of representatives of all interested agencies, organizations, and individuals to identify and solve regional issues (Anonymous 1997). Within the context of these plans, natural resource agencies should cooperate to document the amount and condition of sagebrush rangeland remaining in the state or province. Local and regional plans should summarize common problems to conserve sage-grouse and general conditions (Appendix Table F-3) needed to maintain healthy sage-grouse populations. Local differences in conditions that affect sage-grouse populations may occur and should be considered in conservation plans. Natural resource agencies should identify remaining breeding and winter ranges in Wyoming big sagebrush habitats and establish these areas as high priority for wildfire suppression. Prescribed burning in habitats that are in good ecological condition should be avoided. Protection and restoration of sage-grouse habitats also will likely benefit many other sagebrush obligate species (Saab and Rich 1997) and enhance efforts to conserve and restore sagebrush steppe.

Although translocating sage-grouse to historical range has been done on numerous occasions, few attempts have been successful (Musil et al. 1993, Reese and Connelly 1997). Thus, we agree with Reese and Connelly (1997) that translocation efforts should be viewed as only experimental at this time and not as a viable management strategy.

More information is needed on characteristics of healthy sagebrush ecosystems and the relationship of grazing to sage-grouse production. Field experiments should be implemented to evaluate the relationship of grazing pressure (i.e., disturbance and removal of herbaceous cover) to sage-grouse nest success and juvenile survival (Connelly and Braun 1997). The overall quality of existing sage-grouse habitat will become increasingly important as quantity of these habitats decrease. Sage-grouse populations appear relatively secure in some portions of their range and at risk in other portions. However, populations that have thus far survived extensive habitat loss may still face extinction because of a time lag between habitat loss and ultimate population collapse (Cowlishaw 1999).

### **Acknowledgments.**

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Appendix E - Executive Summary Threat  
Prioritization and Extirpation Risk Idaho Sage-Grouse  
Science Panel

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**Executive Summary**  
**Threat Prioritization and Extirpation Risk**  
**Idaho Sage-Grouse Science Panel**  
**Boise, ID**  
**February 1-2, 2005**

**Background:**

On February 1 and 2, 2005, the Idaho Sage-Grouse Science Panel was convened at the Idaho Department of Fish and Game's Morrison-Knudsen Nature Center, Boise. The Panel was facilitated by Steve Morey, USFWS, and Bob Ruesink, retired USFWS, and consisted of six scientists with expertise in sage-grouse, range, fire, and landscape ecology.

Panelists included Dr. Steve Bunting, Professor, Department of Range Science, University of Idaho; Dr. Jack Connelly, Principal Wildlife Research Biologist, Idaho Department of Fish and Game; Dr. Steve Knick, U.S. Geological Survey/Biological Resources Division; Dr. Karen Launchbaugh, Chairperson, Department of Range Science, University of Idaho; Dr. Kerry Reese, Professor, Department of Fisheries and Wildlife, University of Idaho; and Dr. Mike Scott, Leader, Cooperative Fisheries and Wildlife Research Unit, University of Idaho. Others in attendance included Steve Huffaker, Director, IDFG; Jim Caswell, Administrator, Office of Species Conservation; K Lynn Bennett, State Director, Idaho BLM; Ruth Monahan, Sawtooth National Forest Supervisor; and several agency staff members.

**Threat Prioritization:**

Following introductory presentations by IDFG and BLM wildlife biologists on sage-grouse biology, population and habitat status/trends, and threats to sage-grouse in Idaho, the Panel was first tasked with prioritizing the statewide threats previously identified by the planning subcommittee. After discussion among the Panelists, certain threats or threat categories were: (1) *revised* (fragmentation was renamed infrastructure; perennial grasslands refined to mean seeded perennial grasslands), (2) *combined* (wind energy was combined with infrastructure; Native American harvest as related to spring hunting was added to the category named human disturbance), (3) *dropped* (agency land use plan adequacy, effectiveness of Local Working Groups, mixed land ownerships, training upland bird dogs) or (4) *added* (Urban/exurban expansion, agricultural conversion, climate change). Nineteen threats were identified.

In ranking the 19 threats, each Panelist was asked to assign a score of 100 to the threat he or she thought was of highest priority; a zero to the lowest, and intermediate scores (1 to 99) for each of the remaining 17. In some cases, due to limited information, one or more Panelists assigned scores of equal value to two or more of the intermediate threats. After an initial

scoring exercise, and subsequent facilitated discussion, a second, final scoring was made. Individual threat scores from this final exercise were then averaged across the six Panelists, to create a composite score for each threat. These composite scores were then displayed in a bar chart portraying the relative composite ranking of the 19 threats (Figure 1).

**Figure 1. Summary ranking of threats to sage-grouse in Idaho. Threat score reflects an average of scores assigned by six Panelists. Idaho Sage-Grouse Science Panel. February 1-2, 2005, Boise.**

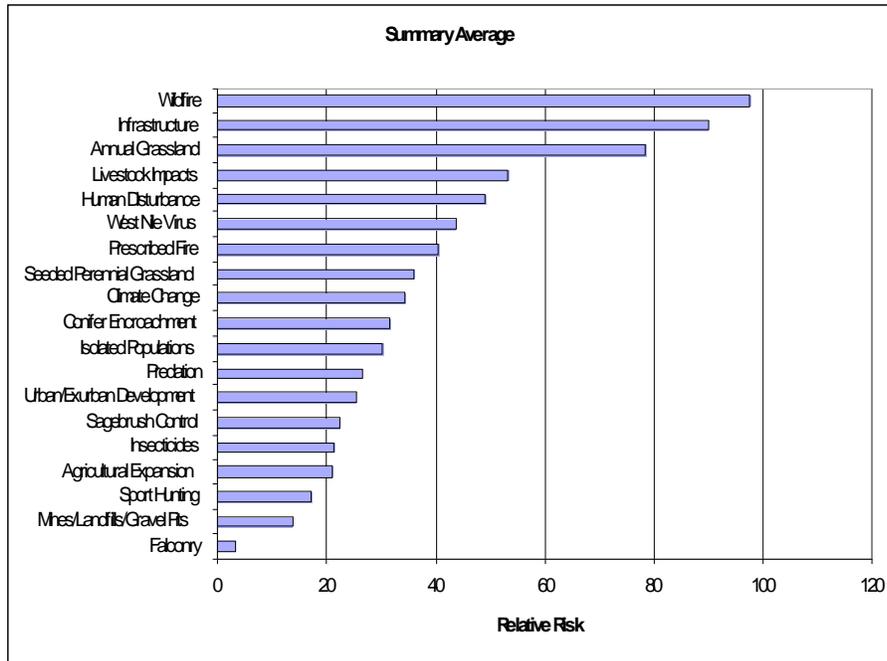


Figure 1 indicates that the top three ranking threats as scored by the Panel were (1) wildfire, (2) infrastructure, and (3) annual grasslands. Wildfire ranked highest, due to potentially large-scale impacts to already reduced habitat, its link with expanding annual grasslands, climate change and drought, and slowness of recovery times. Annual grass dominance and infrastructure development also ranked high since these factors can constitute essentially irretrievable losses of habitat. At least two Panelists suggested that there are few places on the Idaho landscape free of infrastructure or other indicators of human presence.

Livestock impacts ranked fourth in relative magnitude, partly because of the widespread extent of this factor on the landscape. It was also suggested that due to long-term, large-scale habitat losses arising from a variety of causes, there is less margin for error with the direct and indirect impacts from livestock management and other factors, since sage-grouse have fewer options or alternate places to go in the face of disturbance. It was also noted, however,

that proper livestock management can provide habitat supportive of sage-grouse, and that if there are problems, livestock management practices can be changed.

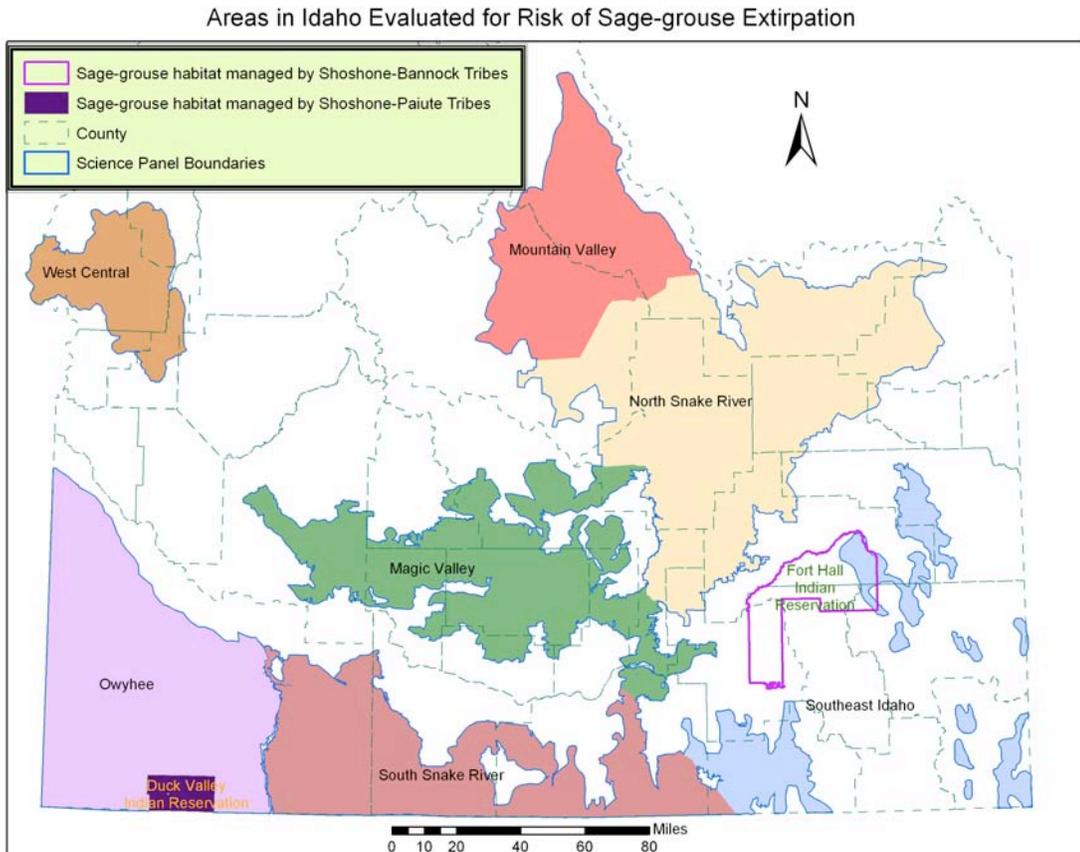
Predation and hunting ranked relatively low in priority (rank 12 and 17 respectively). Predation was not perceived to be a large issue controlling populations in good habitat, but could play a role in areas with small habitat patches. Most states, including Idaho, have adopted conservative hunting seasons for sage-grouse. Also, we have greater management control over hunting and little control over many other factors.

**Extirpation Risk:**

In this exercise, the Panelists were asked to prioritize specific geographic areas in Idaho with respect to the relative likelihood of sage-grouse extirpation, assuming status-quo management, and continued trends and trajectories of habitats, populations and threats. The Panel was reluctant to prioritize the existing 13 Idaho Sage-Grouse Planning Areas, due to a lack of familiarity of the Panelists with local conditions at that scale. Consequently, the state was divided into seven broader areas (Table 1, and Figure 2). In most cases, two or more SGPAs were combined, however three SGPAs, including the Owyhee, West-Central and Challis, were sufficiently large or distinct to warrant separate consideration. The Panelists were not comfortable estimating time to extirpation of sage-grouse for specific areas, though in general, they worked within the conceptual framework of decades from the present, as opposed to, for example, time-frames 200 years out.

**Table 1. Areas evaluated for risk of sage-grouse extirpation. Idaho Sage-Grouse Science Panel. February 1-2, 2005. Boise.**

<b>Evaluation Area</b>	<b>Comments</b>
West Central	West Central Sage-Grouse Planning Area (SGPA)
Owyhee	Owyhee SGPA
South Snake River	Jarbidge, Shoshone Basin, South Magic Valley SGPAs combined
North Snake River	Big Desert, Upper Snake SGPAs combined
Magic Valley	East Magic Valley, West Magic Valley, Mountain Home SGPA combined
Southeast Idaho	Curlew, East Idaho Uplands SGPAs combined
Mountain Valley	Challis SGPA



**Figure 2. Areas in Idaho evaluated for risk of sage-grouse extirpation. Idaho Sage-Grouse Science Panel. February 1-2, 2005. Boise.**

After an initial ranking exercise and subsequent discussion by the Panel, a final ranking of the seven areas was completed (Table 2). The West Central area ranked first in terms of sage-grouse extirpation risk, due to its isolated nature, high proportion of private property, low sage-grouse population numbers, high amount of annual grasslands, and lack of connectivity with sage-grouse populations in Oregon. The Panel felt sage-grouse populations there could be extirpated within 25-50 years without active conservation efforts. In contrast, the Owyhee area was ranked lowest in sage-grouse extirpation risk since it is a largely intact system and is contiguous with habitats and populations in Oregon and Nevada.

**Table 2. Relative risk of sage-grouse extirpation by geographic area. Idaho Sage-Grouse Science Panel. February 1-2, 2005. Boise.**

<b>Risk of Sage-Grouse Extirpation (1= highest risk)</b>	<b>Evaluation Area</b>	<b>Rationale</b>
1	West Central	Isolated population, mostly private property, annual grasslands, no connectivity to Oregon
2	Southeast Idaho	More secure than West Central, fragmented habitat, private lands
3	Magic Valley	Wildfire, annual grasses
4	South Snake River	Intermediate score, but breeding/wintering habitat fragmented
5	North Snake River	Intermediate score; large area, substantial remaining Key habitat; fires in the Big Desert
6	Mountain Valley	Intact System, fire relatively uncommon, good ecological condition, mostly public land, less risk of annual grass and juniper, 90% Key habitat, far from human population centers
7	Owyhee	Largely intact; contiguous with populations in Nevada, Oregon

## Appendix F – Key Contacts

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## Primary Contacts

The following individuals are the primary contacts for sage-grouse conservation and planning activities in the state of Idaho (as of June 2006). Please see the Idaho Sage-grouse Advisory Committee, Technical Advisory Committee, and Agency Director, lists on the following pages for complete contact information and additional contacts.

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- **Paul Makela** (BLM/IDFG) – Lead writer/coordinator Conservation Plan for the Greater Sage-grouse in Idaho
- **Alan Sands** (IDFG) - Sage-grouse Habitat Restoration Coordinator

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(As of June 2006)<sup>1</sup>

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## Appendix G – Ranking Criteria for Idaho Sage-grouse Grants

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# Idaho Sage-grouse Grants

## Ranking Criteria

Adopted 8/13/04<sup>1</sup>

1. Ownership (Largest ownership in the area impacted by the project)
  - a. Federal land 1
  - b. State or Tribal 3
  - c. Private land 5
  
2. Match (Includes both in-kind costs and actual funds)
  - a. Less than 25% 1
  - b. 25-50% 5
  - c. Over 50% 10
  
3. Justification (Is the need for this project clearly explained with clear objectives?)
  - a. Need and objectives unclear or inappropriate Disqualify
  - b. Need unclear or some unrealistic objectives 5
  - c. Clear need and likely to meet all objectives 10
  
4. Methods and probability of success (Do research projects have complete study plans? Do inventory projects have realistic objectives? Are habitat improvement projects feasible and do they have clear monitoring plans to measure impact of the project?)
  - a. Methods and monitoring unclear Disqualify
  - b. Methods or monitoring plan unclear 5
  - c. Clear methods and monitoring plan 10
  
5. Benefits to sage grouse (Is this project impacting a small area for only a short period of time, or doing something important but impacting only a single area, or doing something unique that will impact many parts of the state?)
  - a. Some but limited benefits 1
  - b. Important but not unique 5
  - c. Unique information or effort 10

---

<sup>1</sup> These criteria may be updated periodically. Check the web site at <http://fishandgame.idaho.gov/cms/hunt/grouse/> for most current grant criteria.

6. Scale of project (Size of area impacted)
- a. Small (less than 1,000 acres) 1
  - b. Medium (1,000-10,000 acres) 3
  - c. Large (more than 10,000 acres) 5
7. Overhead costs
- a. 10% or less 5
  - b. More than 10% 0
8. Endorsed by a LWG (all proposed projects outside of existing LWG areas also receive 3 points)
- a. Yes, and LWG's #1 priority 5
  - b. Yes, but not LWG's #1 priority 3
  - c. No 0
9. Funding from other sources unlikely? (i.e. has the applicant made it clear that that other sources of funding are not possible)
- a. Yes 5
  - b. No 0
10. An ongoing and successful project?
- a. Yes 5
  - b. No 0

70 TOTAL POSSIBLE POINTS

## Appendix H – Monitoring of Greater Sage-grouse Habitats and Populations

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College of Natural  
Resources Experiment  
Station  
Moscow, Idaho

Director  
Steven Daley Laursen

 University of Idaho

# Monitoring of Greater Sage-grouse Habitats and Populations



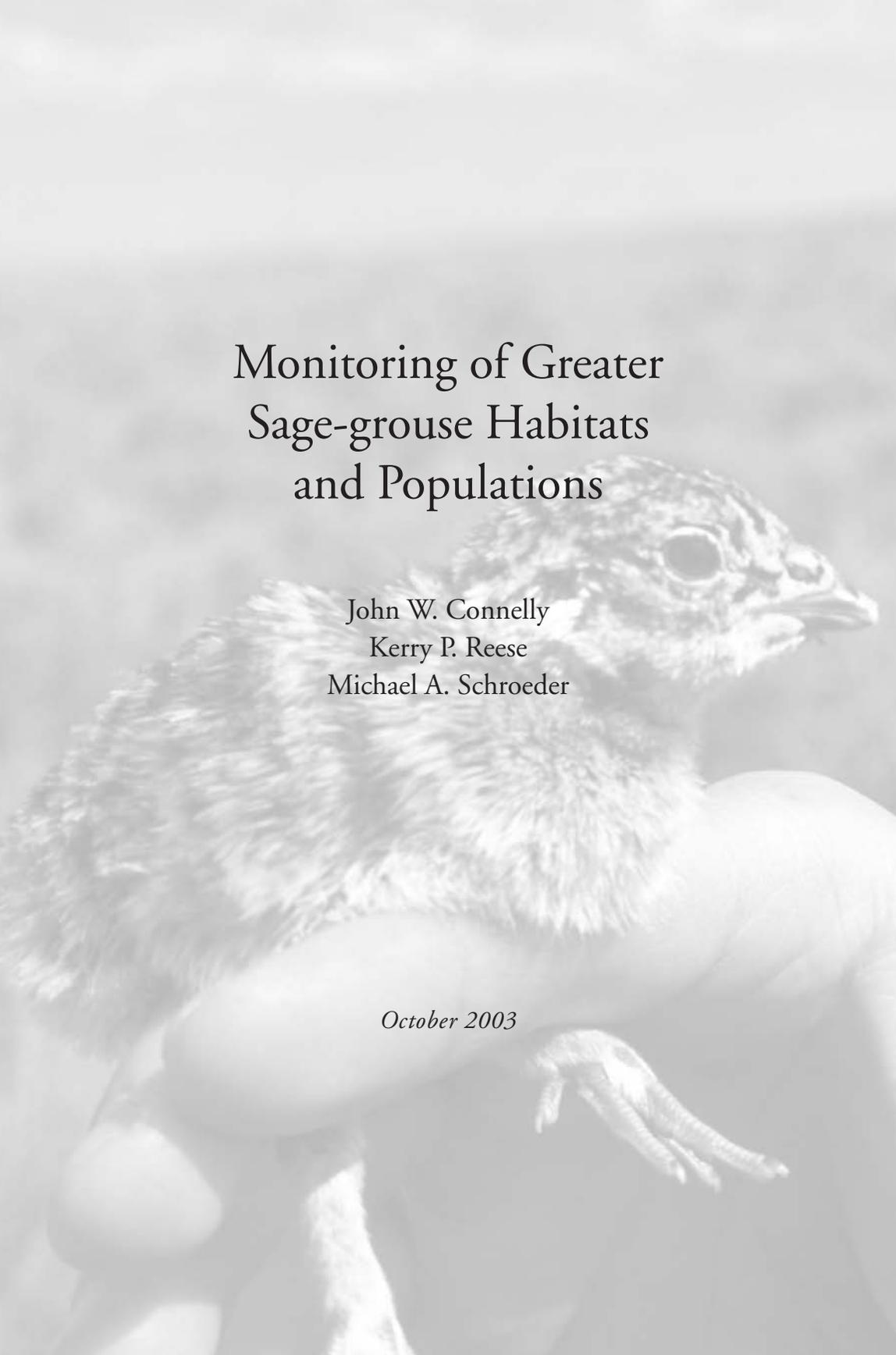
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Cover photograph by N.A. Burkepile



# Monitoring of Greater Sage-grouse Habitats and Populations

John W. Connelly  
Kerry P. Reese  
Michael A. Schroeder

*October 2003*

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## Introduction

Numerous studies have reported on characteristics of greater sage-grouse (*Centrocercus urophasianus*) populations and habitats throughout the species' range (Gregg et al. 1994, Fischer et al. 1996a, Schroeder 1997, Apa 1998, Sveum et al. 1998, Commons et al. 1999, Lyon 2000, Nelle et al. 2000, Smith 2003, and others). Additionally, Connelly et al. (2000b) provided guidelines for managing sage-grouse populations and habitats and identified monitoring as an important component of a sage-grouse management program.

Most studies of sage-grouse relied on published techniques for assessing range vegetation, monitoring, and trapping sage-grouse (Canfield 1941, Daubenmire 1959, Floyd and Anderson 1982, Giesen et al. 1982, Emmons and Braun 1984, Wakkinen et al. 1992, Burkepille et al. 2002, Connelly et al. 2000a, and others). However, published methods for assessing vegetation were not developed specifically for sage-grouse habitats. Some population monitoring techniques have not been described in detail while others were based on work done in a single area or over a relatively short time.

Because of declines in sage-grouse populations (Connelly and Braun 1997, Braun 1998) and continuing threats to this species and its habitats (Connelly and Braun 1997, Wambolt et al. 2002), standard techniques for monitoring populations and habitats are necessary to allow valid comparisons among areas and years and provide rigorous and consistent data sets. To date, no effort has been made to compile and standardize all major monitoring techniques useful for assessing sage-grouse habitats and populations. The purpose of this report is to describe various techniques suitable for assessing sage-grouse habitat characteristics, monitoring sage-grouse populations, and capturing and marking sage-grouse. We attempt to standardize techniques where variations may exist and make recommendations about the use of some techniques. We also provide a glossary at the end of this report to help standardize terms used in sage-grouse management. We intend this report to be used with the guidelines to manage sage-grouse populations and their habitats (Connelly et al. 2000b).



## Habitat Assessment

Sagebrush (*Artemisia* spp.) habitats have changed markedly over the last 25 to 50 years and fire and agricultural development have played major roles in this change in many portions of the west (Knick and Rotenberry 1997, Connelly et al. 2000*a*, Wambolt et al. 2002). In other areas, energy development has impacted sagebrush rangeland (Braun 1998, Lyon 2000). Recently, revised guidelines for managing greater sage-grouse populations and habitats were published (Connelly et al. 2000*b*). These guidelines strongly suggest that management decisions should be based on the best available data. Therefore, the quality and quantity of sage-grouse habitats must be documented to make appropriate management decisions. There are four general reasons for assessing habitats: 1) to document current condition and trend of habitat; 2) to evaluate impacts of a land treatment; 3) to assess the success of a habitat restoration program; and 4) to evaluate the ability of habitat to support a reintroduced population. This section provides information on how sage-grouse habitat assessments may be made for any of these reasons and discusses techniques used to make these measurements.

In virtually all cases, habitat characterization should follow habitat selection processes described by Johnson (1980). Therefore, habitat assessment should initially reflect first-order selection or the geographic range of the sage-grouse population of interest. Within this range, second-order selection of habitat should be examined based on home ranges of individuals or subpopulations (e.g., birds associated with a lek or lek complex). Assessing the condition of various habitat components within the home range describes third-order selection and further refines the habitat assessment process (e.g., breeding habitat). Finally, if necessary, assessment can be made at the fourth-order selection level that involves the quality and quantity of food or cover at particular use sites.

### LANDSCAPES

Many, if not most, sage-grouse populations are migratory, have large annual ranges, and use different habitats at different times of the year (Connelly et al. 1988, 2000*b*). For non-migratory populations these habitats may be well interspersed but for migratory populations they may be separated by many kilometers (Schroeder et al. 1999; Connelly et al. 1988, 2000*b*, Leonard et al. 2000). Before assessing habitats over a landscape, seasonal movements by grouse must be well understood. Once these data have been obtained, the size and quality of the available habitats can be measured. Aerial photos, satellite im-

agery, and digitized maps can be used to measure the size and juxtaposition of these habitats (Homer et al. 1993). Remote sensing technology will often form the basis for inventorying, evaluating, and monitoring rangeland resources (Tueller 1989, Anderson and Gutzwiller 1994). Landscape assessment corresponds to first-order habitat selection (Johnson 1980). Landscape characteristics that should be measured include patch size, habitat quality, connectivity (availability of corridors connecting patches), amount of edge and distance between habitat patches. Hamerstrom et al. (1957) provided an early example of landscape assessment for managing greater prairie chickens (*Tympanuchus cupido*).

For non-migratory populations, seasonal habitats should be well interspersed with no major barriers (e.g., reservoirs, urban areas) between habitats. These areas (sagebrush uplands, mesic areas) can be identified by aerial photographs, satellite imagery, or field inspection and mapping. Generally, breeding habitats may be about 23 km<sup>2</sup> (Wallestad and Pyrah 1974), summer habitats may range from 0.4 to 0.9 km<sup>2</sup> in Montana (Wallestad 1971) to 28 km<sup>2</sup> in northeastern Colorado (Hausleitner 2003). Winter ranges may vary from 11 to 31 km<sup>2</sup> (Wallestad 1975).

For migratory populations, grouse may use an area the size of the state of Rhode Island on an annual basis, and these movements may vary depending on annual precipitation (Connelly 1982, Fischer et al. 1996b). However, within this large area there are specific seasonal habitats used by these birds each year. These habitats may be disjunct, but corridors dominated by sagebrush should connect adjacent seasonal ranges. These ranges may vary in size, but generally breeding habitats will be 150 to more than 600 km<sup>2</sup> (Leonard et al. 2000, J. W. Connelly unpublished data), summer range will be 0.5 to 7 km<sup>2</sup> (Connelly and Markham 1983) and winter range may exceed 400 km<sup>2</sup> (Leonard et al. 2000).

A study by Leonard et al. (2000) provides an example of the use of remote sensing for analyzing spatial components and juxtaposition of sage-grouse seasonal habitats for a migratory sage-grouse population. On a landscape scale, this study compared seasonal habitats available to sage-grouse in the 1970s with those available in the 1990s. Analysis was based on landsat imagery obtained from the U.S. Geological Survey's Earth Resources Observation Systems Data Center. Image processing software was used to classify habitats from this imagery. Land ownership was documented with Arc View software (ESRI, Inc., 380 New York St., Redlands, CA 92373-8100). This research indicated that agricultural lands within sage-grouse habitat in eastern Idaho increased by more than 70% over a 17 year period, and also showed an in-

verse relationship between development of cropland and sage-grouse population levels (Leonard 1998, Leonard et al. 2000).

Landscape analysis is becoming a relatively common approach for assessing sage-grouse habitat. Oyler-McCance et al. (2001) employed a landscape approach similar to that of Leonard et al. (2000) to assess changes in habitat for Gunnison sage-grouse (*C. minimus*) in Colorado. A Geographic Information System and low-level aerial photographs allowed researchers to document changes in sagebrush-dominated habitats between the 1950s and 1990s (Oyler-McCance et al. 2001). Smith (2003) also used a similar approach to investigate sage-grouse habitat in the Dakotas.

## VEGETATION

The type and amount of vegetation data recorded usually depends on the goal of the habitat assessment or research project but may also be influenced by time, budget, and manpower limitations. Regardless of the goal of the study, an unbiased characterization of habitat will require random sampling and this approach will often be a stratified random sample. The strata will depend on vegetative and topographic characteristics of the area. Thus, involving a statistician in the early planning stages should result in a characterization that will withstand critical review.

Long-term studies (normally more than 3 years) often involve numerous personnel changes. Therefore, data collection techniques should be adequately described to all personnel, all field personnel should receive adequate training, and these techniques should generally not be modified during the study. This approach will result in consistent data collection among years and observers.

Most habitat assessments for sage-grouse include estimates of one or more of the following: cover, height, density, frequency, and visual obstruction for individual plant species or groups of species. Density is the number of individuals per unit area (e.g., plants/m<sup>2</sup>) and can be used to assess the abundance of specific plants important to sage grouse. Frequency is the percentage of plots of uniform size, in a series of samples, in which a specified species or genus occurs (Daubenmire 1968). Frequency can be used to assess the relative abundance or distribution of specific plants. Visual obstruction reflects the relative density and height of a stand of vegetation. The term "cover" is generally used in vegetation field studies to describe ground cover (plant material, litter, rocks, or bare soil at the ground surface) or the canopy projection of a plant. Canopy cover is the attribute most often measured to characterize sage-grouse habitat.

Density, height, and frequency are direct counts or measurements, but a number of methods exist to estimate canopy cover (Table 1). Three general approaches are used to quantify shrub and herbaceous canopy cover in shrub steppe habitats: line transects, quadrats, and ocular estimates (Table 1). Line transect methods are generally more suitable for estimating shrub cover while quadrat methods have advantages in estimating herbaceous cover. Within each of these general categories several techniques have been developed. Often, different techniques will yield comparable results. Hanley (1978) reported that line interception and Daubenmire plots gave similar results for estimating canopy cover of sagebrush in northwestern Nevada. However, line intercepts are preferable to Daubenmire frames when high levels of precision and confidence are required (Hanley 1978). Common techniques for estimating canopy cover in sagebrush-dominated rangeland will be discussed under their respective vegetation types below.

**Table 1.** Attributes of methods used to estimate canopy cover in shrub-steppe habitats. Yes or no indicates suitability of the technique.

Characteristic Attribute	Technique					
	Line Transect		Quadrat Methods			Ocular Estimate
	Line Intercept	Point Intercept	Daubenmire Plot	Circular Plot	Point Intercept Frame	
Shrub Cover	Yes	Yes	Yes	Yes	Yes	
Time <sup>a</sup>	2	2	1	3	2	1
Precision <sup>b</sup>	3	2	1	2	2	1
Replication <sup>c</sup>	2	1	2	2	2	1
Other measures <sup>d</sup>	1,3,4	1,3,4	1,3,4	1,2,3,4		—
Herbaceous Cover	Yes	Yes	Yes	Yes	Yes	
Time <sup>a</sup>	2	2	1	NA <sup>e</sup>	1	1
Precision <sup>b</sup>	2	2	3	NA	3	1
Replication <sup>c</sup>	2	2	2	NA	2	1
Other measures <sup>d</sup>	1,3,4	1	1,2,3,4	NA	1,2,3,4	—
Reference	Canfield 1941	Evans and Love 1957	Daubenmire 1959	Connelly 1982	Floyd and Anderson 1982	Daubenmire 1968

<sup>a</sup>Approximate time needed to complete a plot, line, or area: 1 = less than 10 minutes; 2 = 11-30 minutes; 3 = 31-60 minutes for a 20 m transect, standard Daubenmire plot and point intercept frame and 1-m radius circular plot.

<sup>b</sup>1 = low; 2 = medium; 3 = high.

<sup>c</sup>An indication of the relative bias involved in repeating the process by other observers: 1 = not easily replicated, large differences may occur among different observers; 2 = easily replicated, few differences should occur among different observers.

<sup>d</sup>Other data that can be recorded while using this technique: 1 = height; 2 = density; 3 = frequency; 4 = species composition.

<sup>e</sup>NA = not applicable

Several methods are used to measure visual obstruction (Table 2). Unlike measurements of canopy cover, density and frequency, visual obstruction is not specific to individual species or genera of plants. Instead, these techniques provide a value that indicates the relative cover of all vegetation, alive and dead, at a given point. This value reflects both the density and height of vegetation. For sage-grouse, these data are most useful for assessing nesting cover. However, a visual obstruction value alone may have limited use in describing nesting habitat because the same value could be obtained for habitats dominated by sagebrush (i.e., potentially important for nesting sage-grouse) or dominated by other shrubs or grasses (i.e., not generally important for nesting grouse).

**Table 2.** Attributes of methods used to estimate visual obstruction in shrub and grass dominated habitats.

Attribute	Technique			
	Robel Pole	Cover Pole	Jones Cover Board	Profile Board
Time <sup>a</sup>	1	1	1	1
Precision <sup>b</sup>	2	2	1	2
Replication <sup>c</sup>	2	2	1	2
Other measures <sup>d</sup>	1	1	1	1
Reference	Robel et al. 1970	Griffith and Youtie 1988	Jones 1968	Nudds 1977

<sup>a</sup>Approximate time needed to complete a plot, line or area: 1 = less than 10 minutes; 2 = 11-30 minutes; 3 = 31-60 minutes.

<sup>b</sup>Estimated for use in sagebrush dominated habitats only: 1 = low; 2 = medium; 3 = high.

<sup>c</sup>An indication of the relative bias involved in repeating the process by other observers: 1 = not easily replicated, large differences may occur among different observers; 2 = easily replicated few differences should occur among different observers.

<sup>d</sup>Other data that can be recorded while using this technique: 1 = height; 2 = density; 3 = frequency; 4 = species composition.

Sometimes classification of dominant vegetation within an area is necessary (e.g., classifying the relative amount of sagebrush-dominated habitat within an area of rangeland). If so, Marcum and Loftsgaarden (1980) described a simple non-mapping technique for describing general habitats. This method involves selecting a number of random points within the area of interest, locating those points (easily accomplished from the ground or air with a GPS unit) and classifying the dominant vegetation at each point (e.g., sagebrush, annual grass, bare ground, etc.). Marcum and Loftsgaarden (1980) also provided an appropriate method of analyzing these data.

More recently, Rotenberry et al. (2002) described a model that predicts animal use based on a minimum combination of the species' requirements. They reported that this model functioned well for predicting habitat use by sage sparrows (*Amphispiza belli*) in an altered landscape.

Sather-Blair et al. (2000) described an approach to assessing sage-grouse habitats and making management decisions based on these assessments. Although numerous methods may be used to characterize sagebrush landscapes, Sather-Blair et al. (2000) presented a qualitative method and two quantitative methods for gathering data. Methods of habitat assessment may vary but all should be relatively objective and biologically defensible.

## SHRUB VEGETATION

Prior to measuring characteristics of shrub vegetation, observers should be able to identify different species of shrubs as well as differentiate among the different species and subspecies of sagebrush. Several keys have been published to aid identification of sagebrush taxa (e.g., Atwood 1970; Winward and Tisdale 1969, 1977; Shultz 1984).

### *Cover*

Shrub, specifically sagebrush, overstory is a vital component of sage-grouse habitat. Normally, shrub overstory is referred to as canopy cover and is defined as a projection of the crown or stems of the plant onto the ground surface (Higgins et al. 1994). It is the most commonly reported measurement in studies of sage-grouse habitat. Live shrub canopy cover allows an assessment (along with measurements of herbaceous vegetation) of the suitability of an area as sage-grouse nest habitat, early brood-rearing habitat, and winter habitat. In virtually all cases, the species and subspecies of shrub are noted and data for each are recorded separately.

Line intercept (Canfield 1941) is one of the most common techniques used to estimate shrub canopy cover (Figure 1). This technique involves stretching a tape out (usually for 15 to 50 m) and measuring the amount of the live shrub canopy intersected by an imaginary vertical plane that is bisected lengthwise by the tape (Appendix 1). Care should be taken to exclude large spaces (e.g., 5 cm and greater) between branches or foliage so that only live shrub cover intersecting the line is counted (Baker 1968). The amount of total shrub intersecting the line is tallied and then divided by the length of the line (example: 580 cm of sagebrush/2500 cm of total line = 23.2% canopy cover). Often, line intercepts are run in conjunction with the Daubenmire technique (Daubenmire 1959) to estimate herbaceous cover (see Herbaceous vegetation section).



Figure 1. The line intercept method is used to measure shrub canopy cover.

Line intercept may be somewhat more time consuming than other methods of estimating cover, but it is less subjective than other methods, generally has greater accuracy and precision than other methods (Higgins et al. 1994), and is widely accepted as a method for estimating shrub canopy cover. Use of line intercept also allows direct comparison with data from many other studies because this is a very common method of measuring sagebrush canopy cover (Wakkinen 1990, Connelly et al. 1991, Gregg et al. 1994, Fischer 1994, Holloran 1999, Lyon 2000).

Point intercept (Evans and Love 1957, Hanson et al. 1988, Sather-Blair et al. 2000) involves dropping a pin or small-diameter rod to the ground (or using a notch or point at the toe of a boot) and recording a hit each time the pin strikes a portion of the canopy. Canopy cover is calculated as the total number of hits divided by the total number of pin drops times 100. The diameter of the pin and the way in which the pin is dropped or lowered towards the ground can affect the accuracy of the estimate (Higgins et al. 1994). Very large numbers of samples are needed in areas with sparse shrub overstory. Thus, this may be a very inefficient method of sampling areas characterized by relatively few shrubs (Heady et al. 1959, Higgins et al. 1994). Hanson et al. (1988) evaluated three types of point methods for estimating cover: step-point, wheel-point, and point-frame. They reported that data obtained from step-point and wheel point methods differed from that obtained from the point-frame method. They also indicated that all methods

were subject to operator bias. In most sagebrush stands, point methods will provide results comparable to those generated by line intercept, but the point intercept may often be faster (depending on the number of samples needed) and perhaps subject to greater observer bias than the line intercept.

Quadrat sampling has been used to estimate shrub canopy cover (Connelly 1982, Aldridge 2000). This technique involves estimating the amount of cover of individual species or groups of species occurring within a frame placed on or just above the ground. Quadrats can vary in size and shape, but are often square or rectangular. The Daubenmire frame (Daubenmire 1959) and variations of this frame (Leonard 1998) are some of the most common types of quadrat sampling frames. Some frames can be relatively bulky and awkward (e.g. point intercept frame [Floyd and Anderson 1982], but many can be easily constructed to be highly portable in the field (Neal et al. 1988)

The circular plot (Connelly 1982) is another form of quadrat sampling that is seldom used. It was originally developed to estimate cover on big game winter range (Lyon 1968, Peek et al. 1978) and was subsequently used to characterize sage-grouse winter habitat (Connelly 1982). This technique requires establishing circular plots (often 1-m radius) along a transect in the area of interest and measuring the width and length of sagebrush plants within these plots. The average crown area for plants can be estimated from these measurements and the percentage of the crowns covering the total area encompassed by plots provides an estimate of canopy cover.

One advantage of quadrat techniques is that they also allow a relatively quick estimate of shrub density. Unfortunately, the definition of canopy cover used for some quadrat sampling techniques (e.g., Daubenmire frame) differs somewhat from the definition used in the line intercept technique. Often in quadrat sampling, canopy cover is considered the surface area over which a plant has influence, thus root systems can be included and plant canopies are viewed as polygons. Because of this, quadrat sampling (using this definition of canopy cover) may over-estimate nesting cover for sage-grouse.

Ocular estimates are also used for estimating shrub cover (Leonard 1998). Although the Daubenmire frame may be considered an ocular estimate (Higgins et al. 1994), it involves the use of a sampling frame and cover classes that provide similar estimates regardless of the number of observers (Daubenmire 1959). True ocular estimates are simply characterizations of the canopy cover, sometimes by cover class, but without the aid of sampling frames or other standardized techniques. This approach may be useful for broad categorizations (Leonard 1998) but is subject to a great deal of observer bias and is difficult to standardize among observers. Thus, it should only be used to

roughly characterize shrub cover in a stand.

### *Density*

The number of shrubs per unit area is sometimes of interest in sage-grouse habitat studies. However, density by itself does not provide a sufficient characterization of shrub overstory for nesting or wintering birds. As an example, a relatively high density of shrubs could be produced following successful seedling establishment, but overall canopy cover would be low and plants would be very short because of their young age. This parameter may be most useful in assessing the success of an effort to reseed sagebrush or natural regeneration of sagebrush following a disturbance.

Density can be estimated by counting the number of shrubs occurring in plots established within the area of interest. These plots are often placed along transects randomly established within the study area.

### *Frequency*

The frequency of shrub species or subspecies is not normally collected when assessing the shrub component of sage-grouse habitat. However, some species, subspecies, or plants of sagebrush are preferred over others by foraging sage-grouse (Remington and Braun 1985, Welch et al. 1988, Welch et al. 1991). Thus, frequency of preferred plants may provide an indicator of overall habitat quality, especially for sage-grouse winter range. Frequency may also help to minimize errors related to use of different observers and may help indicate trend over time (R. Miller, personal communication). Frequency of important shrubs can be assessed using quadrat-sampling procedures that employ relatively large frames or plots and allow counting individuals within a series of samples of uniform size (i.e., frames) contained in a single stand (Daubenmire 1968). Frequency can also be measured with points (Higgins et al. 1994). The point of a pin or small-diameter rod is dropped to the ground repeatedly (usually along a transect). The percentage of hits for each species encountered gives an estimate for the frequency of those species. If frequency information is needed, it is most efficiently collected while assessing shrub density.

### *Height*

Most sage-grouse use breeding habitats characterized by sagebrush 40-80 cm tall (Connelly et al. 2000*b*). During winter, sage-grouse feed on relatively short sagebrush, at least with respect to its height above snow (Robertson 1991, Connelly et al. 2000*b*). Shrub height is normally measured in conjunc-

tion with estimating canopy cover. The tallest live part of shrubs occurring along a transect or within a plot is recorded (Figure 2). Normally the average height is reported. Time of year may affect height measurement and observers should indicate whether seed heads were included in their measurements.

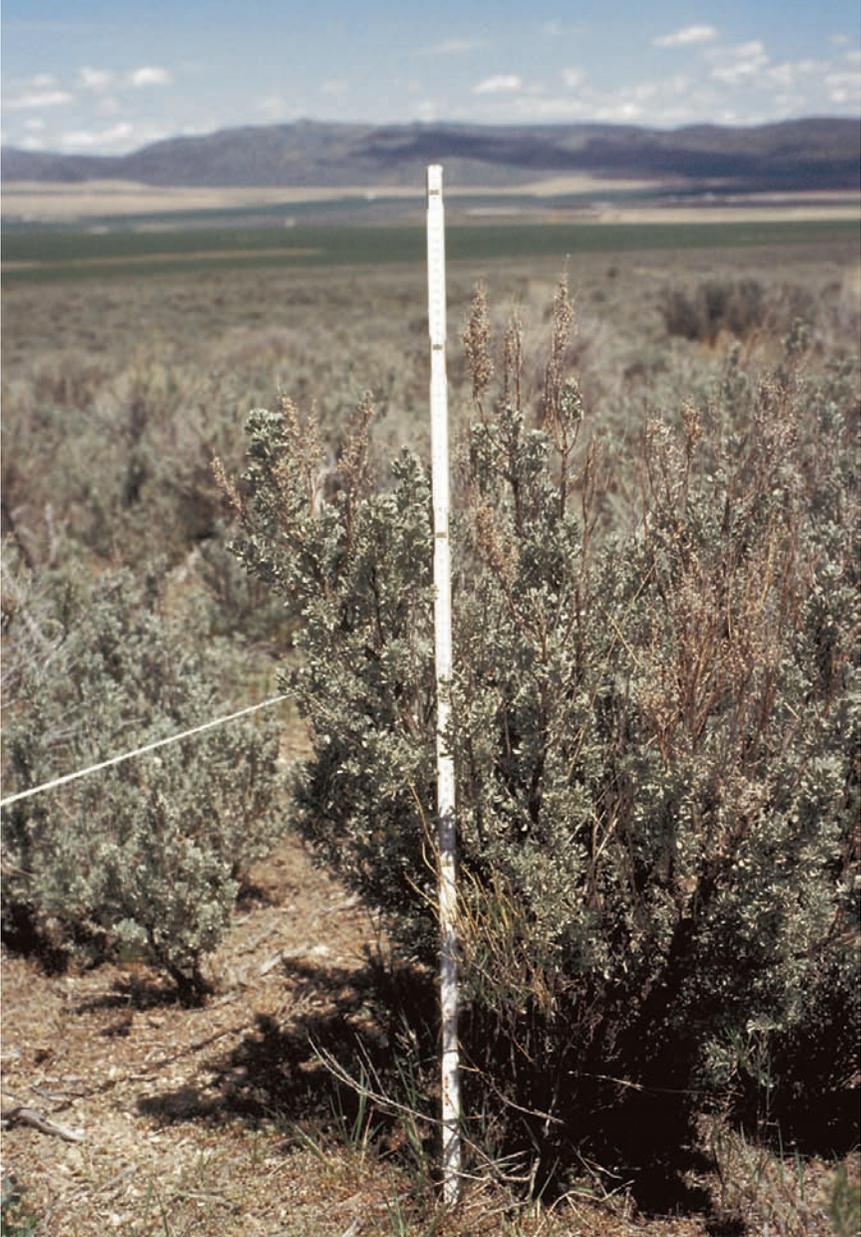


Figure 2. Shrub and grass heights are measured with a meter stick.

## HERBACEOUS VEGETATION

### *Cover*

Herbaceous understory is a critical component of sage-grouse breeding, early brood-rearing, and summer range. One of the most common methods for assessing the condition of this vegetation is by estimating canopy cover (Fischer 1994, Gregg et al. 1994, Hanf et al. 1994, Apa 1998, Lyon 2000). Canopy cover of herbaceous vegetation can be estimated using the same techniques described for estimating shrub canopy cover. However, quadrat and point intercept sampling are generally faster than line intercept. The Daubenmire technique (Figure 3) is one of the most common methods of estimating herbaceous cover (also litter and bare ground) in sagebrush steppe habitats (Daubenmire 1959). Regardless of method used, cover for both grasses and forbs should be recorded by species, and measurements are normally recorded in late May and early June to coincide with hatching.

Except in a very general way (e.g., classifying herbaceous cover as relatively dense or sparse), ocular estimates should be avoided because shrub overstory can block much of the understory from view. Moreover, shrubs and grasses may obscure the forb component.



Figure 3. Daubenmire frame placed along a 50-m tape for estimation of herbaceous cover.

*Density*

The density of important forbs can provide an indication of habitat quality for pre-laying hens (Barnett and Crawford 1994) and early brood-rearing. Density can be estimated by counting the number of individual plants in circular, square or rectangular quadrats. The quadrat should be large enough so that the species of interest occurs in a majority of quadrats examined, yet small enough to allow counting of individuals in an efficient manner.

*Frequency*

Assessing the quality of breeding and brood-rearing habitat often involves identifying and quantifying forbs available for pre-breeding hens and, following hatch, chicks (Barnett and Crawford 1994, Drut et al. 1994). Frequency of important forbs can be assessed using any of the quadrat sampling procedures that allow counting individuals within a series of samples of uniform size (i.e., frames) contained in a single vegetative stand (Daubenmire 1968). Hyder et al. (1963) suggested that a quadrat 230 to 645 cm<sup>2</sup> was appropriate for frequency sampling in a sagebrush habitat in eastern Oregon. If frequency information is needed, it can be collected while assessing herbaceous cover or density.

*Height*

Herbaceous cover averaging 18 cm and greater in height has been identified as an important characteristic of sage-grouse nest sites (Wakkinen 1990, Gregg et al. 1994). This was supported by an experiment with artificial nests in Oregon (DeLong et al. 1995). Height of grasses and forbs (both residual and new growth) can be easily obtained along transects or within quadrats established for estimating cover. When mature, most grasses and many forbs tend to bend or droop somewhat near the top of the plant, often because of the weight of the seed head. Normally, the natural or droop height of the plant should be recorded, rather than total length. This will provide a better indication of the lateral cover afforded by the herbaceous vegetation than would a measurement of total length. Height measurements for sage-grouse studies have normally been made in late May and early June, and coincide with hatching. Windy conditions may affect the accuracy of height measurements and if wind is a problem, measurements should be deferred until winds decrease. A modified, sample data sheet used in research on sage-grouse habitat in southern Idaho is presented in Appendix 2.

## VISUAL OBSTRUCTION

The Robel pole (Robel et al. 1970), cover pole (Griffith and Youtie 1988) and Jones cover board (Jones 1968) can be used to assess visual obstruction (cover) in sagebrush-dominated rangeland (Wakkinen 1990, Fischer 1994, Gardner 1997). Nudds (1977) also described a cover board that may have application in sagebrush rangeland. Although a Robel pole provided some useful data for analyzing nest sites, the Jones cover board (3-sided or 4-sided) did not appear sensitive enough to detect differences that might have occurred among areas and may not be easily repeated by different observers (Wakkinen 1990, Fischer 1994). The Jones cover board is shorter than a Robel pole and, because of its height, most of the readings from this cover board tend to be grouped near 100% in some sagebrush habitats (Wakkinen 1990). However, Fischer (1994) and Apa (1998) successfully used the Jones cover board to help differentiate sage-grouse nest sites from dependent random sites. The Robel pole (Figure 4) was developed to assess habitat characteristics for greater prairie chickens in grassland habitat (Robel et al. 1970). Its use is now generally widespread and it appears applicable for numerous species and habitats, unless vegetation is very sparse (Higgins et al. 1994). The cover pole (Griffith and Youtie 1988) was developed to assess deer hiding cover in a variety of habitats including sagebrush-dominated rangeland. It has not been widely used to assess sage-grouse habitat and its application for these habitats should be investigated. Given the lack of data on cover poles in sage-grouse habitat and the concern expressed over the use of the Jones cover board, we generally recommend the Robel pole for assessing visual obstruction in sage-grouse habitat.

## INSECTS

Insects are an important component of early brood-rearing habitat (Patterson 1952, Klebenow and Gray 1968, Johnson and Boyce 1990). A complete assessment of early brood-rearing habitat should include an evaluation of insect abundance. Several methods exist for estimating insect numbers including sweep nets, beating sheets, and pitfall traps (Fischer 1994). Ants and beetles are often the most important groups of insects for young sage-grouse chicks (Johnson and Boyce 1990, Fischer et al. 1996*a*), and their abundance can easily be assessed with pitfall traps. Pitfall traps can vary in size and shape. A common method of using this technique in sage-grouse habitat is to place test tubes so that they are flush with the ground in a grid arrangement (e.g., a 4x4 grid with tubes placed 50 cm apart) (Nelle 1998). Tubes are filled with a 1:1 solution of water and ethylene glycol and then sealed with a cork or rub-

ber stopper until sampling begins. We suggest sampling over at least one 24-hour period from late May to mid-June (a time coinciding with the early brood-rearing period).



Figure 4. Robel pole showing amount of visual obstruction at a successful sage-grouse nest.

## Population Monitoring and Assessment

Sage-grouse populations in various parts of western North America have been monitored for well over 50 years (Patterson 1952, Dalke et al. 1963). Unfortunately, even within a given state, monitoring techniques have varied among areas and years. This variation complicates attempts to understand grouse population trends and make comparisons among areas. Incomplete information on sage-grouse seasonal movements and the juxtaposition of various seasonal habitats also inhibits a manager's ability to understand population trends and effects of habitat changes. Thus far, only Autenrieth et al. (1982) attempted to standardize population data collection techniques and describe methods available for documenting sage-grouse population characteristics. The sage-grouse guidelines (Connelly et al. 2000*b*) stress the importance of population monitoring and collecting quality data in sage-grouse management programs. This section describes methods for routine monitoring as well as techniques for capturing and marking sage-grouse if more detailed information is necessary.

### MONITORING

#### BREEDING POPULATIONS

Because sage-grouse gather on traditional display areas (leks) each spring, wildlife biologists are afforded relatively easy methods for tracking breeding populations. These methods include lek censuses (annually counting the number of male sage-grouse attending leks in a given area), lek routes (annually counting the number of male sage-grouse on a group of leks that are relatively close and represent part or all of a single breeding population or deme), and lek surveys (annually counting the number of active leks in a given area). All monitoring procedures are conducted during early morning (1/2 hour before to 1 hour after sunrise), with reasonably good weather (light or no wind, partly cloudy to clear) from early March to early May. Timing is dependent on elevation of leks and persistence of winter conditions. Sage-grouse will begin displaying in late February at lower elevations with milder climates and in years with mild winter weather (e.g., southern Washington). Lek attendance will persist into early or mid-May at higher elevations.

#### *Locating Leks*

Before a monitoring program for sage-grouse breeding populations can be designed, lek locations must be documented. Leks can be located by searching from the ground or air from early March to early May.

Helicopters or fixed-wing airplanes can be used for air searches. In either case, suspected breeding habitat should be flown on north - south transects with lines about one km apart. Transects should be flown 100 to 150 meters above ground level. Whenever possible, two observers should be used in addition to the pilot so that one observer is always looking away from the sun regardless of the direction the aircraft is flying. Special attention should be paid to old lakebeds, stock-watering areas, and other relatively open sites largely surrounded by sagebrush of 15 to 25% canopy cover. Lek searches from an aircraft should be conducted from  $1/2$  hour before to one hour after sunrise, although during peak attendance the time can be stretched to  $1\ 1/2$  hours after sunrise.

Lek searches can be conducted from the ground by driving along roads in suspected or known breeding habitat and stopping every kilometer to listen for sounds of displaying grouse. Ground searches can be started an hour before sunrise. In less accessible areas, searches can be made from a mountain bike, trail bike, 4-wheel all terrain vehicle (ATV), horseback, or on foot. On a calm morning, breeding sage-grouse may be heard at a distance of 1.5 km. All openings in big sagebrush and stands of low sagebrush and black sagebrush should be searched for breeding birds with binoculars or a spotting scope.

A variation of the ground survey can be used following snowfall during the night or early morning. Although lek activity is minimal during stormy weather and the birds may flush at the first sign of an intruder, some male sage-grouse will attend leks on virtually every morning during the spring, regardless of weather. Areas that are suspected of being leks can be searched immediately following a snowfall. If grouse use the area, tracks will be evident in the snow, and the number of tracks may give some indication of the relative size of the lek. This technique is particularly useful for locating relatively small leks at higher elevations where spring weather is often severe. During a one-week period in southwestern Idaho, three new leks were found using this technique in an area that had been previously searched from the air (J. W. Connelly, unpublished data). The air search failed to locate these leks, likely because they were quite small (less than 12 males).

### *Lek Counts*

Lek counts are a relatively common means of monitoring sage-grouse populations. In a lek count, male sage-grouse attending some or perhaps most of the leks in a given area are counted using accepted techniques (Jenni and Hartzler 1978, Emmons and Braun 1984). However, leks may be widely sepa-

rated and no assumption is made that the census samples a single breeding population. Because some sage-grouse may use several leks in a given breeding season (Dalke et al. 1960, 1963), changes in lek attendance observed during a lek census may be due to some birds shifting to other leks rather than actual changes in the grouse population. Unless all leks are counted during a lek count, there would be no way to assess observed changes. As an example, a lek censused in the Big Desert of southeastern Idaho generally had few or no males attending after about 15 April. The first census usually reported 20 to 30 males, but the second and third replicate counts indicated few or no males. After some of the grouse were marked, researchers discovered that most males moved to another lek that was previously unknown, about three km away. The abandoned lek was relatively close (less than 300 m) to a cabin that was the center for ranching activities during spring. Apparently grouse abandoned this lek in response to human and livestock disturbance that occurred around 15 April each year as cattle were brought to that grazing allotment.

Although lek counts are widely used, concern over their usefulness has been expressed (Beck and Braun 1980). However, techniques for correctly conducting lek counts have been described (Jenni and Hartzler 1978, Emmons and Braun 1984) and problems generally seem to be related to disregarding accepted techniques. A recent review of raw data recorded while conducting lek counts in Idaho indicated that leks were sometimes counted when conditions were windy, ceiling was overcast, and during rainstorms; in some cases counts were begun greater than 1.5 hours after sunrise (M. L. Commons-Kemner, unpublished data).

### *Lek Routes*

A lek route is a type of lek count with an important distinction—an attempt is made to census a group of leks that are relatively close and represent part or all of a single breeding population (i.e., deme). Lek routes have some of the same problems as lek counts (Beck and Braun 1980) but problems are usually related to disregarding accepted techniques (Jenni and Hartzler 1978, Emmons and Braun 1984). Whenever possible, leks should be counted along routes to facilitate repetition by other observers, increase the likelihood of recording satellite leks, and account for shifts in breeding birds if they occur. Lek routes should be established so that all leks along the route can be counted within 1.5 hours. Lek routes should be run from 0.5 hour before sunrise to one hour after sunrise and each route should be run at least four times during the spring. Normally, lek routes are conducted in late March or early April (i.e., March

20-April 7), mid-April (i.e., April 10-20), and late April (i.e., April 22-30). Counts can start a week earlier at lower elevations in relatively mild climates (e.g., southern Washington) and can be extended by a week for higher elevations or areas with relatively harsh climates (e.g., North Park, Colorado). The four counts will roughly coincide with peak hen attendance (early count), and maximum male attendance (middle or late counts).

Lek routes should only be conducted when weather conditions are characterized by clear to partly cloudy skies and winds less than 15 kph. Routes should never be conducted during rain or snowstorms. If weather degenerates after a route has begun, the route should be run again. If a lek is not occupied (and it had been in previous weeks or years), the observer should leave his/her vehicle and (with the engine off) listen for sounds of displaying grouse. Leks will move if birds are subject to continuing disturbance. Grouse may also be flushed from a lek by a predator and, if it is still reasonably early in the morning, may display nearby once the predator leaves the area.

Individual leks within lek routes should be counted at least three times. Subdominant males are often less active than more dominant males occupying the center of the lek and may be easily missed with a single count. A lek may be effectively counted in the following manner:

1. Locate a spot that provides good visibility of the entire lek. If the lek is very large (100 or more birds) it may be necessary to select two or more vantage points. Be careful not to get so close that an observer's presence disturbs the grouse.
2. Record the time that the lek count begins.
3. Count the birds from left to right (or vice versa).
4. Wait one to two minutes, then count from right to left.
5. Wait one to two more minutes, then again count from left to right.
6. Record the highest number of males and females separately, and then move to the next lek.

Before establishing lek routes in a given area, thought should be given to personnel available for conducting routes. It is much better to have a few routes with high quality data than many routes with questionable or missing data.

### *Lek Surveys*

Lek surveys require less manpower and time than lek censuses. They can also be conducted from fixed-wing aircraft or helicopter. The major drawback of this technique is that it is not sensitive to a change in sage-grouse population size unless the change is very large. As an example, a group of five leks could

have a total of 50 males during one spring and a total of 75 males two years later (a 50% increase). A lek survey would only indicate that all five leks were active each year (a stable population).

Some sage-grouse breeding habitat is inaccessible during spring because of mud and snow, or so remote that leks cannot be routinely counted. In these cases, lek surveys are the only reliable means of monitoring these populations. To provide the most useful information on population trends, lek surveys should be conducted in the same manner each year. For example, they should not be conducted from a fixed-wing aircraft one year and a helicopter the next year. The date and beginning and ending times should be recorded for each survey. UTM coordinates for each lek encountered should also be noted, as well as any other information that observers might consider important. Although it is difficult to get an accurate count of birds from an aircraft, it is usually possible to classify the number of birds observed into groups (e.g., 1-10, 11-50, and so on). Whenever possible, these data should be recorded to further refine monitoring efforts.

#### *Data Analysis*

Prior to analysis, field forms (i.e., raw data) should be reviewed to ensure that information was collected properly. Lek routes conducted during stormy weather, high winds or late in the morning (i.e., routes completed more than 1.5 hours after sunrise) should not be included in the analysis.

To assess breeding population trends, the minimum amount of information needed is a record of the number of active leks in a given area over a period of years. This information can be obtained from lek surveys and lek routes, but these data will only reflect gross changes in the population and may provide misleading results. For example, Connelly et al. (2000a) documented an 88-93% decline in a sage-grouse breeding population in southeastern Idaho following a prescribed burn and long-term drought, while the number of active leks in this area only decreased by 58% (Connelly et al. 1994). Connelly et al. (1994, 2000a) tracked changes in active leks, males per lek, males per major lek (a lek with 50 or more males) and maximum counts of males per route to assess changes in a sage-grouse breeding population in southeastern Idaho.

Lek route data that have been correctly collected are more useful for assessing population trends than information on the number of active leks. Lek routes provide the following data: active leks/route; average number of males/route; maximum number of males/route; average number males/lek; maximum number of males/lek; males/area (all males counted on a group of lek

routes). The maximum number of males per lek and males per route are normally recorded.

Sometimes the number of leks along a route changes because the route has changed, the habitat has changed or satellite leks have developed or disappeared. If this occurs, then the most effective means of tracking populations and analyzing changes will be by examining the number of males per lek. If the number of leks does not change over a period of years or only the number of satellite leks change, the number of males per route should form the basis of breeding population assessment.

Female sage-grouse are usually counted along lek routes, but because of their secretive nature and cryptic appearance they are difficult to detect. Although the number of females counted may provide some information on peak of breeding, these data should not be used to assess population change.

Occasionally, lek data are used to estimate breeding populations but this is not a common practice among agencies. This procedure often consists of summing the maximum counts of males on leks representing the population of interest and dividing the number by 0.75 to estimate number of males (to adjust for unseen males). This value is then multiplied by 2 (assuming a 2:1 sex ratio of females to males) to estimate number of females. To our knowledge, this method has never been experimentally validated or recommended as a population estimator. Because of uncertainty associated with lek attendance patterns (Beck and Braun 1980, Emmons and Braun 1984, Walsh 2002), possible differences in sex ratios among years and areas (Swenson 1986), and some lack of uniformity in counting procedures, these efforts can only provide very crude estimates of minimum populations and are not generally useful for making comparisons among areas or years. However, Walsh (2002) identified a procedure using Bowden's estimator (Bowden and Kufeld 1995) that may be useful for estimating sage-grouse populations in relatively small, discrete areas.

## PRODUCTION

Brood observations, brood routes, and wing surveys have been used to assess sage-grouse production (Autenrieth et al. 1982). Brood observations, sometimes called random brood routes, are simply records of all sage-grouse broods observed in a given area by any field personnel that find themselves in that area. This information provides some idea of the juvenile to adult ratio and percent of hens observed with broods. Thus, it is somewhat better than anecdotal data. However, it is not easily replicated and comparisons among years can be difficult to interpret.

Brood routes were commonly conducted in many states during the 1960's and 1970's (Autenrieth 1981) and are still used in some areas (Willis et al. 1993, Danvir 2002). Routes are usually driven at speeds less than 32 kph in the morning (sunrise to about 0900) and evening (1800 to sunset) during late June, July, and early August. Routes may also be walked or conducted from horseback, trail bike, mountain bike or ATV. Brood routes are normally established in areas known to have concentrations of sage-grouse (Autenrieth et al. 1982). These areas are often in or adjacent to wet meadows, riparian zones and agricultural fields. Each brood is recorded separately and the presence of a hen is also recorded. Groups of unsuccessful females and males are also normally tallied. Because chicks are quite secretive it is usually necessary to flush the brood to obtain an accurate count. A trained bird dog can increase the efficiency of this procedure. If sufficient numbers of grouse are observed such that the sample size is adequate, this technique can provide a reliable indication of trends in production. Brood routes provide the following information: birds/km, broods/km, average brood size, and chick:adult hen ratio. For non-hunted populations or populations subject to very light hunting where relatively few wings can be collected, brood routes are the only method available for assessing production, short of using radiotelemetry.

A sage-grouse wing collected in September and sometimes early October can be used to determine age, gender, and for females, reproductive status. For hunted populations, wing surveys are the most useful technique for assessing sage-grouse production. However, sample sizes should be 100 or more wings for adult and yearling hens, and could be considerably larger depending on the size of the area and population being sampled (Autenrieth et al. 1982). Wings are normally collected at wing barrels (Figure 5, Hoffman and Braun 1975) or hunter check stations. Several keys have been developed to aid in classifying sage-grouse wings (Eng 1955, Crunden 1963, Dalke et al. 1963, Beck et al. 1975, Braun personal communication). Some differences exist among the keys and this may reflect regional variation in breeding activities and molts. Some of the earliest work on sage-grouse molt and age and gender classification using known-age birds was conducted in Idaho (Pyrah 1963). A simple key currently used in Idaho to classify wings of greater sage-grouse is presented in Appendix 3.

In addition to primary replacement and length, the general size and color helps to classify wings to age and gender. Wings of males are larger than wings of females and juvenile females consistently have the smallest wings. Wings of females tend to have more white speckling along the leading edge than do wings of males.

Wing analyses and brood routes allow an assessment of trends in production and a comparison of production among areas (Autenrieth 1981). However, these data may not reflect population trends. For example, a portion of a population's winter habitat may be lost but the breeding range could remain intact. Production (juvenile:adult ratio) may be stable but the overall population may decline because of increased mortality on winter range. Thus, it is best to use this information in conjunction with data on breeding populations to make inferences on population trends.

#### WINTER POPULATIONS

Unlike breeding populations and production, there are no widely accepted methods for assessing winter populations. In part, this is because birds may be spread out over large areas during mild winters but clumped in less than 10% of the available habitat in severe winters (Beck 1977).

Beck (1977) searched probable winter use areas in Colorado by 4-wheel drive vehicles, snowmobiles, and snowshoes to document sage-grouse winter habitat. Similarly, Connelly (1982) used survey routes traversed by 4-wheel drive truck or snowmobile, depending on conditions, to document winter habitat use of sage-grouse in southeastern Idaho. Flock size, location, cover type, snow depth, and temperature were recorded along these routes (Connelly 1982).

Aerial surveys using either a fixed-wing aircraft or helicopter may be effective in identifying sage-grouse winter habitats and can often be done in conjunction with surveys for pronghorn (*Antilocapra americana*; Patterson 1952). If aerial surveys are used, data should be acquired over a series of years with different snow conditions to give a more complete picture of sage-grouse distribution in winter.

#### TRAPPING AND MARKING

##### TRAPPING

The capture and subsequent marking of sage-grouse has been employed as a method of assessing and delineating populations for well over 50 years (Patterson 1952). Over the years, techniques have been modified and the quality of radio transmitters has improved considerably. Nevertheless, there remains two main periods for effectively capturing sage-grouse, spring and late summer, although Colorado biologists have had success trapping grouse during winter (A. D. Apa, personal communication). Techniques used will vary depending on terrain, access, weather, and population size.



Figure 5. Wing barrel used to collect gamebird wings.

### *Night-lighting*

During March and much of April, male and female sage-grouse will often roost on or near leks at night. This is especially common during peak hen attendance, usually the last week of March and first week of April, but occurs in mid-April in some high elevation areas. At this time, birds are quite vulnerable to being captured by night-lighting (Giesen et al. 1982, Wakkinen et al. 1992). One of the common difficulties encountered with this technique is that males are much easier to see than females. Consequently, more males are captured, often at the expense of missing a female. Moreover, males will tend to roost in the center of the lek while females are found near the edges, sometimes in rocky areas. These sites may be more difficult to traverse with a 4-wheel drive truck. To overcome these difficulties, researchers in Idaho made two modifications to the standard night-lighting technique: binoculars and rock and roll music (i.e., an entertaining form of “white noise”).

Before beginning night grouse trapping, the research leader should make assignments and brief the trapping crew about general trapping procedures. An ideal crew will consist of four people: driver, spotter, primary netter and secondary netter. If possible, people should switch jobs during the night to keep everyone fresh.

To start, binoculars are used with a 1-million candlepower spotlight (more powerful spotlights may be available) to search the lek area as the crew ap-

proaches using a 4-wheel drive truck (Wakkinen et al. 1992). The spotlight should be equipped with a shroud to help narrow the beam (Figure 6). A coffee can or plastic container for garden plants will work well as a shroud. As the crew moves around the lek the driver should stop about every 100-200 m or whenever signaled by the spotter and the spotter will search the lek and area immediately surrounding it with the binoculars and spotlight. If possible, driving to higher ground adjacent to the lek will increase search efficiency and afford a better opportunity for spotting birds roosting in heavier cover.

Sage-grouse eyes resemble sparkling emeralds in the glare of a spotlight and can be seen for over 200 m, depending on terrain and vegetation. Depending on distance, it may not be possible to distinguish males from females. Normally, males, when viewed from less than 100 m, can be identified by their white breast feathers. Location of the bird with respect to the lek also provides a clue to the gender of the observed bird. Males tend to roost singly in the relative open area of the lek and sometimes on sparsely vegetated ridges adjacent to the lek. Females are often more secretive, roosting closer to sagebrush at the perimeter of the lek, sometimes in small groups.



Figure 6. Night-lighting sage-grouse.

Once a bird has been spotted and a decision made to try to capture it, the music previously mentioned comes into play. Trapping trucks are equipped with tape players or compact disc players with external speakers or tape player with reasonably powerful speakers. As the approach begins, loud rock music is played which, together with the sound of the vehicle's engine, covers the footsteps of approaching trappers and tends to disorient the roosting bird. Tape recordings of snowmobiles, generators, and other white noise will also serve the same function, but music tends to improve spirits and generally make cold spring nights more tolerable. When making an approach, two netters

dressed in dark clothing are walking along the driver's side of the truck. All netting should be done from the driver's side to facilitate communication between the driver and netters and allow the driver an awareness of the netter's location relative to the truck for safety. As the truck approaches the bird, the spotlihter will eventually be able to easily see the bird without binoculars. At this point, the spotter begins to shimmy the light rapidly, to produce a strobe effect, but keeps the light on the bird to further confuse the roosting grouse. Netters on the ground will likely not be able to see the bird at this point but when they notice the rapidly moving light, they move 5-10 m from the truck, careful to stay out of the spotlight. Even though they may not be able to see the bird, the netter has to concentrate on the center of the light. Eventually, the netter will see the bird. As the truck's fender is about to pass the grouse, the trapper should be placing the net on the bird. The movement of the net should be relatively low and parallel to the ground. It should not be swung down on the bird from the shoulder like a butterfly-net; to do so increases the possibility of injuring the grouse. If the netters are somewhat slow, the driver should begin to circle the bird at a distance of about 5 m. Throughout all of this activity, the spotter continually shines the spotlight directly on the bird's eyes, continuing the shimmy movement to help mesmerize the bird. Once the bird is in the net, the netter should restrain the bird by holding its wings next to its body, not allow it to struggle in the net, and wait for help to remove it from the net. This reduces both chance of injury to the bird and chance of escape. However, an experienced netter will be able to remove the grouse from the net and safely handle it without additional help. As soon as the spotter sees that the captured grouse is under control, he or she should search the immediate area (out to about 100 m) for other grouse. If another bird is found, the trapping crew can move off after it. If trapping crew waits until after processing the captured bird, any nearby birds will likely flush before another approach can be made. The second netter has two purposes. The first is to replace the primary netter if he/she should stumble or fall on an approach to the bird. The second is to aid in a rapid second capture.

Although most sage-grouse captured with this technique are caught within a few meters of the truck, some grouse may be captured up to 20 m from the truck. The only time the long distance captures should be attempted is when a grouse is roosting in a rock pile or muddy area where driving is unsafe. The same procedure is used as described above, but the netter must move quite rapidly and take special care to stay out of the light. The loud music is especially helpful in concealing footsteps in this kind of effort.

If the soil is very muddy or otherwise difficult to traverse in a truck,

procedures used for night-lighting from a truck can be employed from a 4-wheel ATV. Birds may be more difficult to spot from an ATV because the observer does not have the high vantage point afforded by the truck. Normally, only two or three trappers are used with an ATV.

Sage-grouse can also be captured by night-lighting on foot. This technique can be especially useful when birds' roosting areas are known and search time is minimal. It also has the advantage of only requiring two people, although three are optimum, and it can be used in rough terrain that cannot be traversed by a vehicle. With this type of night-lighting, one person is equipped with a rechargeable power-pack (normally used to jump start engines and available at most auto supply and hardware stores) carried in a backpack, a portable spotlight connected to the power-pack, and a tape recorder or compact disc player with loud rock music. Binoculars are also useful because trappers can stop on high points and glass for sage-grouse. The other trapper carries a long-handled net and the marking supplies in a backpack. When a grouse is found the approach should be swift, although running often results in one or more of the trappers falling and the bird escaping. The netter should stay even with, but a few meters to the side of, the person with the spotlight. If the grouse begins to walk (usually a prelude to flushing), the netter may have to sprint ahead to make the capture. We recommend entering the GPS coordinates of the vehicle as a waypoint before leaving it to night-light on foot. This assures that the trapping crew can return to the vehicle later that night.

When trapping from a truck we often carry a portable power-pack in case we find grouse roosting in inaccessible areas. We also night-light on foot when capturing birds associated with a radio-marked bird (normally a hen and her brood) and when trying to capture a grouse to replace a radio. In these cases, the individual with the spotlight also has an antenna and telemetry receiver connected to headphones. Without headphones, the transmitter signal cannot be heard over the rock music.

Night-lighting is normally used to capture sage-grouse during spring, summer, and early fall. It may be less effective during winter when grouse often roost in large flocks, snow cover allows trappers to be seen at long distances, and deep or crusty snow impedes the netters' movements. However, recent information from Colorado (A. D. Apa, personal communication) indicates night-lighting during winter can be very effective. Colorado biologists captured 40 hens during the 2001 winter. They reported that this technique worked well until snow was shin deep or became very crusty.

Night-lighting is also not very effective on bright, moon-lit nights because birds can easily see approaching trappers before being confused by the lights and music. Normally, we avoid night-lighting within three days of a full moon unless the sky is heavily overcast.

### *Walk-in Traps*

Walk-in traps (Gill 1965, Schroeder and Braun 1991) can be used to capture sage-grouse on leks (Schroeder 1997, Leonard et al. 2000, Aldridge and Brigham 2002) and on summer foraging areas (Connelly 1982). These traps can be round, square, or rectangular (Figure 7). They are about 50 cm high, and 100 to 150 cm deep (a round trap would have a 100-150 cm diameter). Funnel openings are used that allow birds unobstructed entrance but hinder their escape. Normally, several traps (pods) are connected by leads (wings) which the sage-grouse walk along as they move into the trap entrances. Trap leads should be set to intersect hens walking onto a lek or grouse walking onto a feeding area. Leads are generally 25 to 75 meters long and about 35 cm high. Traps should be made from nylon or cotton netting; never from poultry netting because it can inflict deep cuts on grouse trying to escape. A door can be fashioned into the side or roof to allow removal of birds. Traps should be constantly tended when set. Otherwise, there is a risk that a captured bird may injure itself when trying to escape or be killed by a predator that detects it in the trap.

### *Mist Nets*

Mist nets have been used to capture sage-grouse on summer range (Connelly 1982, Browsers and Connelly 1986). We have also used mist nets on leks but could only catch one or two males each morning. As soon as males were caught we had to remove them to prevent their injury and this disrupted breeding activities for the remainder of the morning. Mist nests can be an effective way of capturing broods foraging on summer range. We have also used them in conjunction with walk-in traps. We placed mist nests behind walk-in traps to catch birds that would flush at the funnel entrance to the trap. Like walk-in traps, mist nets must be constantly monitored to prevent injury to captured birds.

### *Drop Nets*

Drop nets can be used to capture sage-grouse on leks (Leonard et al. 2000). However, drop nets are infrequently used because their use tends to disrupt lek activities and they are not as efficient as other trapping techniques.

### *Cannon and Rocket Nets*

Cannon and rocket nets have been used to capture sage-grouse for many years and were commonly used for this purpose. Research personnel in Colorado have recently used a relatively new type of cannon net (CODA Netlauncher) to capture a number of hens on leks (Hausleitner 2003, A. D. Apa, personal communication). However, their use also tends to disrupt lek activities and they may not be as efficient as other trapping techniques.

### *Pointing Dogs*

Well-trained pointing dogs can be used to capture sage-grouse chicks up to about four weeks of age. We used pointing dogs to capture the chicks of radio-marked hens by first locating and flushing the hen. We then let the dog search an area within about a 200 m radius of the site where the hen flushed. The dog will normally go on point within 50 cm of the chick and then it is a matter of reaching down and picking up the chick. For older chicks (more than two weeks old) a long-handled net can be used to capture the bird. Experienced, steady dogs are necessary for this technique to be successful.



Figure 7. Walk-in trap for sage-grouse on atypical summer range (lawn at the Idaho National Engineering and Environmental Laboratory).

## MARKING

A variety of techniques have been used to identify individual sage-grouse including numbers and patterns of tail feathers (Wiley 1973), leg-bands (Patterson 1952, Dalke et al. 1963), wing markers (Connelly 1982), ponchos (Wallestad 1975), colored back-tags (Autenrieth 1981), and radio-transmitters (Wallestad 1975, Autenrieth 1981). Two researchers even resorted to shooting off tips of tail feathers of displaying males as a means of identifying individual birds (Hartzler and Jenni 1988). Generally leg bands and radio-transmitters are the most common methods currently used for marking grouse. Patagial tags may also have some value in providing movement and distribution data at a relatively low cost.

### *Banding*

Virtually all captured sage-grouse are marked with serially numbered leg bands, very young chicks (less than 10 weeks of age) being the only exception. In most cases, the bands contain a unique identifying number and an address for reporting a recovered band. It is also wise to use identifying letters in addition to the number (e.g., sgm [sage-grouse, male], sgf [sage-grouse, female]) in case other game birds are being marked in the state or province. With a letter prefix, the species being reported can be immediately ascertained. In some studies, grouse (especially males) have been marked with a series of color-coded leg bands to allow identification of individuals in the field. This works well if re-observations are made on leks or other reasonably open areas, but much of the time grouse are in relatively heavy cover and viewing markers on legs may be difficult. Band return data provide information on harvest rates, survival, and seasonal movements (Zablan et al. 2003). If a sufficient number of grouse are marked and subsequently recaptured, population size may be estimated. The actual number of captures and recaptures needed for this estimate depends on the number of birds available and the size of the area occupied by the sage-grouse population of interest.

### *Wing-markers*

Wing-markers or patagial tags have also been used to identify individual birds (Connelly 1982, Musil et al. 1993). These tags are often modified cattle ear markers with an identifying letter or number, although Wallestad (1975) used numbered metal clips to mark wings of young chicks. Patagial tags may be more easily seen than colored bands and their use should result in more re-observation data than use of colored leg bands. Thus, they provide a relatively inexpensive means of obtaining information on local and seasonal movements.

However, because of their visibility, they may result in greater losses to predators, so their use should be restricted to males and applied only if other marking methods are ineffective.

### *Radio-telemetry*

Radio-transmitters provide the most common and most useful means of documenting sage-grouse seasonal habitat selection and movements. Radio-telemetry also allows an estimate of daily, seasonal, and annual survival rates. Biologists have been marking sage-grouse with radio-transmitters since at least 1965 (Autenrieth 1981). Unfortunately, early transmitters weighed more than 70 g (five percent or more of an adult female's mass) and had relatively short battery lives. Thus, information collected during these early studies should be considered with the utmost care. By the mid- to late 1970s, transmitter weights had been reduced to about 25 g (two percent or less of an adult female's mass) and these transmitters would generally last for six months or more. Throughout the 1970s and early 1980s, transmitters were attached to sage-grouse using variations of a backpack harness (Brander 1968). During the early 1980s, we learned that backpack harnesses increased the vulnerability of sage-grouse to predation and thus switched to a poncho-mounted transmitter (Amstrup 1980).

Poncho-mounted transmitters were used on sage-grouse throughout much of the 1980s and early 1990s. Both battery-powered and solar powered transmitters were mounted on ponchos. The opening in the poncho was custom fit to individual birds, then the opening was pulled over the bird's head and feathers were preened around the poncho material. The transmitter was fixed to the poncho so that it would lie against the bird's crop. Although the method provided a quick, reliable way to mark a sage-grouse with a radio-transmitter, problems were identified when solar transmitters were mounted in this fashion. During summer, sage-grouse often feed on succulent forbs including dandelion (*Taraxacum officinale*), salsify (*Tragopogon dubius*), lettuce (*Lactuca* spp.) and hawksbeard (*Crepis acuminata*). These plants contain a milky substance that will run down the bird's bill onto their breast feathers. In doing so, the substance collects and hardens on radio-transmitters and in the case of solar transmitters reduces the light to the solar panel so that the transmitter stops functioning.

By the mid 1990s, most research biologists had settled on a battery-powered transmitter attached around the bird's neck by a necklace usually made of plastic-coated cable. This radio-harness was somewhat lighter than a poncho, but could be attached just as quickly. It had an added advantage because

a transmitter could be more quickly fixed to a necklace than to a poncho. When using this attachment technique care must be taken to leave the cable loose enough to avoid crop impaction and thus harm the grouse. Normally, a finger's width of room between the throat and cable will result in sufficient space to allow birds to forage normally but still retain the transmitter.

Although a great deal of information has been obtained from radio-marked sage-grouse, virtually all of the birds marked were older than 10 weeks of age. Few, if any attempts, were made to radio-mark sage-grouse chicks less than 10 weeks old until 1998. A major concern involved the attachment of a transmitter to a day-old chick weighing about 30 grams. The technique should pose a low risk to grouse chicks but still result in an attachment that lasted at least two weeks. A simple attachment arrangement has been developed for a sage-grouse chick that involves piercing the skin just in front and behind the transmitter with a 20-gauge hypodermic syringe. Sutures are then threaded through the syringe and through holes in the 1-gm transmitter and tied off (Figure 8). Cyanoacrylic glue is applied to the knots to enhance security of the attachment (Burkpile et al. 2002).



Figure 8. Three-week old sage-grouse with 1-gm radio transmitter. Note antenna extends posteriorly.

## Glossary

**Adult**—A sage-grouse that is at least 15 months of age and has entered or is about to enter its second breeding season.

**Breeding habitat**—Habitat used by sage-grouse for breeding, nesting, and early brood rearing; generally occupied from early March to mid-June.

**Breeding population**—A group of sage-grouse associated with 1 or more occupied leks in the same geographic area separated from other leks by more than 20 km.

**Canopy cover**—a) The percentage of the ground included in a vertical projection of imaginary polygons drawn about the total natural spread of foliage of the individuals of a species (usually used for herbaceous plants); or b) The percentage of the ground covered by a projection of the crown, stems, and leaves of the plant onto the ground surface (usually used for shrubs).

**Canon nets**—A net attached to cylindrical projectiles that are shot from tubes and quickly carry the net over the animal(s) to be trapped. At one time commonly used to capture sage-grouse on leks, but have been largely replaced by rocket nets.

**Chick**—A sage-grouse up to 10 weeks of age.

**Climax**—A state reached by a plant community characterized by a fluctuation of its vegetative populations rather than a unidirectional change. A climax community will remain in a self-perpetuating state as long as climatic, edaphic, and biotic conditions remain relatively constant.

**Cover**—An indication of the relative amount of shelter or protection of all vegetation at a given point; normally used to assess nesting habitat.

**Daubenmire frame**—Normally a 20 x 50 cm wooden, metal or PVC frame used to estimate canopy cover. The frame has a painted pattern that allows reference for visual estimates of 5, 25, 50, 75, and 95 percent of the frame.

**Deme**—A local population of closely related plants or animals.

**Density**—The number of plants, animals, or other items in a defined area (e.g., number of plants/m<sup>2</sup>).

**Droop height**—The height of a grass or forb measured from the ground to the point where the plant naturally bends. There may be no droop to some plants with relatively short stature.

**Drop net**—A net that is elevated above an area commonly used by animals (e.g., a lek) and designed to fall and trap the target animals when a trigger is mechanically or electronically activated.

**Forb**—An herbaceous plant other than a grass, sedge, or other plant with similar foliage.

**Frequency**—The percent occurrence of a species in a series of samples of uniform size contained in a single stand.

**Habitat type**—A collective term for all parts of a land surface supporting or capable of supporting the same kind of climax vegetation.

**Herbaceous vegetation (herbs)**—Plants that die back to the ground surface each year, normally with soft, non-woody stems.

**Juvenile**—A sage-grouse that is more than 10 weeks of age but has not entered into its first breeding season.

**Lek**—A traditional display area where two or more male sage-grouse have attended in two or more of the previous five years. The area is normally located in a very open site in or adjacent to sagebrush-dominated habitats.

**Lek surveys**—A classification of leks as active or inactive, often done from an aircraft.

**Lek census**—A count of male sage-grouse on a lek or group of leks.

**Lek routes**—A count of male sage-grouse on a group of leks that are relatively close and represent part or all of a single breeding population.

**Line intercept**—A technique for measuring canopy cover that involves placing a tape between 2 points and measuring the amount of plant (crown, stems, leaves) that intersects a vertical projection of this line. Normally used for shrubs.

**Mist net**—A finely constructed net that is difficult for birds to see. When a net is stretched between two poles, birds fly into the net and become entangled.

**Night-lighting**—The use of powerful spotlights (usually 750,000 or more candle-power) and long-handled nets to capture sage-grouse. This technique usually involves the use of binoculars to spot birds at a distance and “white noise” (often loud rock and roll music) to cover approaching footsteps and further disorient the birds.

**Non-migratory population**—Sage-grouse that do not move more than 10 km between seasonal ranges.

**One-stage migratory population**—Sage-grouse that move more than 10 km between two distinct seasonal ranges.

**Patagial tag**—A type of marker for birds that is attached to the wing(s) through the patagium.

**Patch**—A habitat unit of variable size that contains a homogeneous set of characteristics.

**Production**—The number of juvenile birds recruited to the fall population, often reported as a ratio of juveniles to adult females (including yearlings).

**Renesting**—A nesting attempt that follows the loss of an initial nest.

**Rocket net**—A net attached to cylindrical projectiles that are powered by propellant in the base of the cylinder and quickly carry the net over the animal(s) to be trapped. Normally used to capture breeding sage-grouse on leks.

**Satellite lek**—A relatively small lek (usually less than 15 males) that develops near a large lek during years with relatively high grouse populations.

**Shrub-steppe**—Temperate zone vegetation with the understory dominated by grasses and a conspicuous shrub element providing a relatively open overstory above the grass layer.

**Summer population**—A group of sage-grouse associated with one or more summer habitats (usually moist, forb-rich areas) in the same geographic area.

**Two-stage migratory population**—Sage-grouse that migrate among three distinct seasonal ranges; each range is separated from the others by more than 10 km.

**Visual obstruction**—An index of the relative density and height of a stand of vegetation.

**Walk-in traps**—Cages (usually made of netting or welded wire) with wings or leads (usually made of chicken wire) extending from funnel entrances. Birds are captured when they walk along the leads, enter the funnel opening, and cannot find their way out.

**Winter population**—A group of sage-grouse associated with a single winter range, normally separated from other winter ranges by more than 20 km.

**Wing barrel**—A barrel or other container placed in areas frequented by bird hunters and used as a collection site for wings from hunter-harvested birds.

**Wing survey**—A collection and classification of wings by age and sex. Wings are normally collected at hunter check stations, wing barrels, or through mail solicitation.

**Yearling**—A sage-grouse that has entered its first breeding season but not completed its second summer molt, normally between 10 and 17 months of age.

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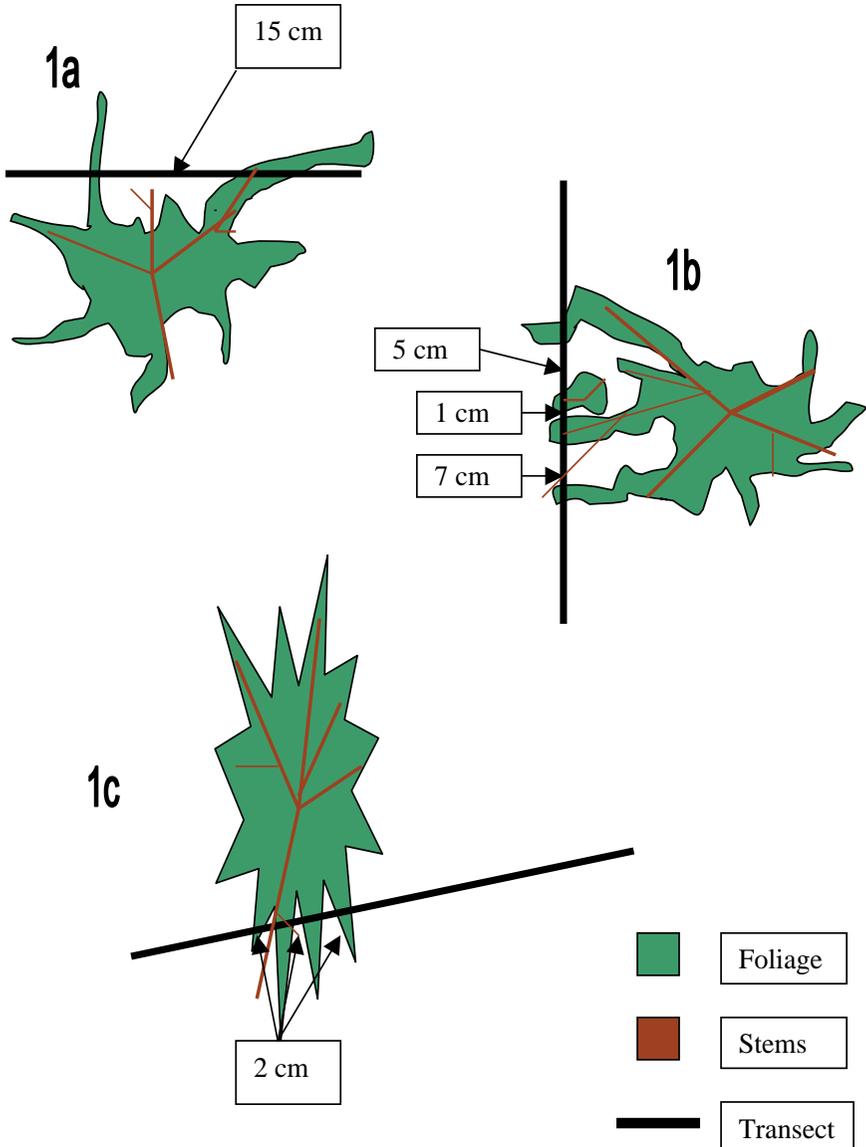
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**Appendix 1.** Illustrations of Canfield (1941) line intercept technique showing gaps in foliage from overhead. Figure 1a, the gap should be excluded from the measurement. Figure 1b, the 1 cm gap should be included while the 5 and 7 cm gaps are excluded. Figure 1c, the 2 cm gaps are included in the measurement.



**Appendix 2.** A general procedure for assessing sage-grouse breeding habitat with an example of a data sheet (one side only) used for habitat monitoring in southern Idaho.

Before going into the field:

1. Acquire the necessary equipment.
  - a. 50 meter tape
  - b. Meter stick
  - c. Daubenmire frame
  - d. Field forms
  - e. Pens/pencils
  - f. Camera/film
  - g. GPS unit
2. Select an appropriate number of random points. The actual number of points (or points within strata) will depend on the size and homogeneity of the area to be assessed.

*Collecting field data at random points:*

1. Be certain the random point is located in sagebrush steppe (seedings and CRP could be included in this definition) and not in a non-habitat area such as a livestock pond or wheat field. If the point is not acceptable select another.
2. Select the sagebrush plant closest to the random point. A sagebrush plant can also be randomly selected by having one of the field crew toss an object (stake, rock, etc) over their shoulder and select the sagebrush plant closest to the object.
3. Run a tape at a random bearing (0-359 degrees) the distance of the transect (normally 20 to 50 meters).
4. Take a photo of the line from one or both ends (optional).
5. Measure intercept of shrub crowns (by species) along the tape, careful to work along only one side of the tape. Measurements should be made with a meter stick and not by trying to use measurements on the transect tape.
6. Work back along the opposite side of the tape from which the canopy measurements were taken and place a Daubenmire frame at 1-meter intervals (i.e., a 50-m transect would yield 50 Daubenmire plots).
  - a. For every frame estimate cover of forbs (by species), grasses, annual grasses, litter, and bare ground.
  - b. Measure the height of the sagebrush plant or other shrub nearest the outside right (or left) corner of the frame.
  - c. Measure the droop height of the grass plant nearest the outside right (or left) corner of the frame. This can be done separately for annuals and perennials or just perennials.
7. Move to the next random point.

50-m Transect: Location \_\_\_\_\_

Photo numbers \_\_\_\_\_ Date \_\_\_\_\_

Elevation \_\_\_\_\_ Slope \_\_\_\_\_

Aspect \_\_\_\_\_ Crew \_\_\_\_\_

Line Intercept – Shrubs

Artemisia tridentata wyomingensis \_\_\_\_\_

Art. tripartita \_\_\_\_\_

Other \_\_\_\_\_

Daubenmire – 1=0-1%, 2=1.1-5%, 3=5.1-25%, 4=25.1-50%, 5=50.1-75%, 6=75.1-100%

Shrub ht (cm)	Grass ht (cm)	Grass	Bare	Litter	Minor forbs	Cheat- grass	Major forbs by species: abundant or eaten by sage-grouse
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1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

5. \_\_\_\_\_

6. \_\_\_\_\_

7. \_\_\_\_\_

8. \_\_\_\_\_

9. \_\_\_\_\_

10. \_\_\_\_\_

11. \_\_\_\_\_

12. \_\_\_\_\_

13. \_\_\_\_\_

14. \_\_\_\_\_

15. \_\_\_\_\_

16. \_\_\_\_\_

17. \_\_\_\_\_

18. \_\_\_\_\_

19. \_\_\_\_\_

20. \_\_\_\_\_

### Appendix 3. Key to sage-grouse wings in Idaho.

Molting primaries 10 or 9 .....	Adult
Primary 1 less than 150 mm .....	Female
Primary 1 greater than 149 mm .....	Male
Molting primary 9 with worn, pointed primary 10 .....	Yearling
Molting primary 9 with rounded primary 10 .....	Adult
Molting primaries 8, 7 or 6:	
Primaries 10 and 9 pointed and in good condition .....	Juvenile
Primary 1 less than 126 mm .....	Female
Primary 1 greater than 126 mm .....	Male
Primaries 10 and 9 pointed, worn and faded .....	Yearling
Primary 1 less than 150 mm .....	Female
Primary 1 greater than 149 mm .....	Male
Primaries 10 and 9 rounded, somewhat faded .....	Adult
Primary 1 less than 150 mm .....	Female
Primary 1 greater than 149 mm .....	Male

Note: A yearling or adult female molting primary 6, 7 or 8 (rarely) can be classified as having brought off a brood, although it should not be implied that any chicks survived to fall.

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## Appendix I – Lek Forms

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### Sage/Sharp-tailed Grouse Lek Route Survey

<input type="checkbox"/> Sage Grouse	<input type="checkbox"/> Sharp-tailed Grouse	County:
Lek Route Name:		Date of Survey:
Observer:		Official Sunrise:
Weather:		Start Time: <span style="float: right;">End Time:</span>
Summary: Active Leks		Comments:
Total Males Counted		

Time	Lek No.	Lek Name	Males	Legal Description <sup>a</sup>				UTM Coordinates <sup>A</sup>		Comments
				Twp.	Range	Sect.	¼ ¼ ¼ Sect.	Northing	Easting	
Total Males Counted				<sup>a</sup> Record location if lek has moved from previous years, if previously recorded location is inaccurate, or if lek is new.						

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## SAGE GROUSE LEK SURVEY

LEK CODE		LEK NAME	
----------	--	----------	--

NEW LEK	
KNOWN LEK	

VISITS TO THE LEK									
DATE	TIME	OBSERVER	TEMP	CLOUDS	PRECIP	WIND	NO. MALES	NO. FEMALES	UNK. SEX

LEK LOCATION			
LEGAL DESCRIPTION	T.	R.	SEC.
UTM'S	N		E
LATITUDE/LONGITUDE	N		W
7.5 MIN. USGS QUAD			
COUNTY			



VEGETATION	
LAND USE	
LAND OWNERSHIP	
ELEVATION	

COMMENTS:

## Instructions for Sage-Grouse Lek Survey Form

**LEK CODE:** Enter the assigned alphanumeric code for known leks (from the maps or database). If the lek is new or if you are unsure whether it is a known lek, coordinate with the appropriate IDFG wildlife manager or data steward to determine status and assign the appropriate lek identification number to the new lek. If the lek is new or uncertain status, be sure to check this location 3-4 times to determine whether it is a new lek or whether birds from an existing lek were disturbed and merely displayed at that location once. It is also important to recheck this location multiple times in the next couple of years to determine whether it is actually a new lek. A lek is not considered “occupied” unless at least 2 males have been observed displaying there for at least 2 of the last 5 years.

**LEK NAME:** Record the common lek name, if known (e.g. Laidlaw Airstrip). If the lek is new, give it a name, if you wish, or leave this cell blank.

**NEW LEK or KNOWN LEK:** Check the appropriate box. Is the lek newly discovered or is it one already identified on the maps? Any males observed displaying within 0.5 mile of a known lek may be associated with that lek. Thus, that particular display location may be a satellite lek, or a result of a disturbance on the known lek. Be sure to check a “new” lek multiple times to determine status. See “lek code” section above for additional details.

**VISITS TO THE LEK:** Enter the date, time, your name, ambient temperature (make your best guess if you cannot measure it), percent cloud cover, whether it is raining (or snowing), and wind (use the Beaufort Scale).

### Beaufort Scale

- 0 = <1 mph - smoke rises vertically;
- 1 = 1-3 mph - direction of wind shown by smoke drift but not by wind vanes;
- 2 = 4-7 mph - wind felt on face, leaves rustle, ordinary wind vane moves;
- 3 = 8-12 mph - leaves and small twigs in constant motion, wind extends light flag;
- 4 = >12 mph

First, count birds from right to left, wait 1-2 minutes. Second, count birds from left to right, wait 1-2 minutes. Finally, count birds from right to left again. Record the highest number of males and females separately. If no birds are present, it is very important that you record a zero. Do not leave a space blank.

**LEK LOCATION:** Obtain an accurate location of the lek. Legal Description-- enter the Township, Range, and Section down to the nearest 10 acres. (e.g., T.15 S., R. 27 E. Sec.24 SWNESE). UTM's and Lat/Long-- Use a GPS unit to obtain accurate UTM or latitude/longitude coordinates for the lek. Record the appropriate county, 7.5 minute topographic map and/or BLM Surface Management map for future reference.

**VEGETATION:** Briefly describe the lek site and plant community surrounding the lek. e.g. "The lek is in a crested wheatgrass seeding"; "On a small knoll in a CRP field"; "A 5 acre clearing in big sagebrush"; "A mountain shrub community"; "A low sage ridge"; "A wet meadow surrounded by big sage"; "A road intersection surrounded by big sagebrush".

**LAND USE:** Record the primary use of this land e.g. livestock grazing, cultivated agriculture, CRP, ungrazed or lightly grazed native plant community, etc. Make a subjective judgment about overall range condition beyond the actual display area (e.g. poor, fair, good, excellent).

**LAND OWNERSHIP:** BLM, USFS, Private, State, NPS

**ELEVATION:** Record general elevation using a topographic map or GPS unit.

**COMMENTS:** Record any interesting observations (e.g., how active are the birds? Observed changes in the plant community, coyote ran through lek, golden eagle flushed birds from lek, sheep camp on lek and birds are displaying one half mile to west, etc.).

## Appendix K – County/IDFG MOU Template

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## Memorandum of Understanding

BETWEEN THE STATE OF IDAHO, BY AND THROUGH THE DEPARTMENT OF FISH AND GAME

AND

\_\_\_\_\_ COUNTY COMMISSION

This Memorandum of Understanding (MOU) is entered into by the STATE OF IDAHO DEPARTMENT OF FISH AND GAME (IDFG), \_\_\_\_\_ COUNTY COMMISSION (collectively referred to as the Parties).

### INTRODUCTION

WHEREAS, the parties agree that sage-grouse are an important natural component of the sagebrush ecosystem. To this end, the parties hereby enter into this MOU for the purpose of supporting and implementing, to the extent practicable and where appropriate, the intent and actions contained in the **2006 Conservation Plan for the Greater Sage-grouse in Idaho**.

WHEREAS, the parties herein agree that increased cooperative efforts, consistent with applicable statutory requirements, Local Working Groups (LWGs) and their respective Plans, and the Statewide Plan, are necessary to conserve sagebrush ecosystems for the benefit of sage-grouse, other sagebrush dependent species, and people.

WHEREAS, the aforementioned government agencies continue to recognize and applaud the efforts of LWGs in conserving sage-grouse. Said agencies will continue to support these LWGs and their respective Plans, as they represent the heart of Idaho's sage-grouse conservation strategy.

### I. AUTHORITIES

**Idaho Department of Fish and Game:** Title 36, section 1102 of the Idaho Code grants authority to IDFG to protect birds, including game birds like sage-grouse, in Idaho.

\_\_\_\_\_ County

## **II. PURPOSE**

The **purpose** of this MOU is to recognize the importance of the 2006 Conservation Plan for the Greater Sage-grouse in Idaho, as a backdrop for conserving sage-grouse in Idaho. In order to fully capture the value of said Plan, this MOU aims to illustrate the roles and responsibilities of the parties. Additionally, said MOU is intended to both emphasize the benefit contributed by the LWGs and encourage the efforts of the government agencies in supporting these vital groups.

The Parties herein also agree that increased cooperative efforts, consistent with applicable statutory requirements, LWGs and their respective Plans, and the State-wide Plan, are necessary to conserve sustainable healthy rangeland ecosystems to benefit sagebrush dependent species and the local economies that rely on them.

## **III. AGREEMENT PERIOD**

This MOU shall be in effect when signed by all of the parties and remain in effect for five years. The MOU, however, may be extended or amended upon written request of either party and the subsequent written concurrence of the other.

## **IV. RESPONSIBILITIES OF THE PARTIES**

The Parties will coordinate activities and resources, when appropriate; however, the parties will control the expenditure of their own funds, in pursuing coordinated objectives.

Any costs borne by the parties under this MOU and any continuation thereof shall be contingent upon the availability of funds.

## **V. OBLIGATIONS**

### **a. BOTH PARTIES SHALL:**

- i. Continue to support and recognize the important role of the LWGs and their respective plans in conserving sage-grouse;
  1. Consider and implement, to the extent possible, completed LWG plans as appropriate under agency regulations, policies and the law.

2. Actively participate, to the extent possible, in the planning and implementation of LWG goals and objectives outlined in their respective plans;
    - a. Attend scheduled meetings and provide information to the LWG upon request;
    - b. Make available to the LWG all relevant information regarding the management of sagebrush and sage-grouse habitats; and
    - c. Cooperate with and provide advice to the LWG to the extent possible and consistent with the law, agency policy and regulations.
  3. Continue to assist in the development and completion of new LWG plans, for areas where none currently exist, by providing the aforementioned services. IDFG will assume the lead role in initiating, coordinating, and maintaining functional LWGs.
- ii. Implement, to the extent possible, the actions identified in the 2006 Conservation Plan for the Greater Sage-grouse in Idaho;
    1. Work collaboratively to the extent possible, in supporting the intent and actions identified in said Plan; and
    2. Work collaboratively through the Idaho LWGs, and other appropriate mechanisms, to support the intent and actions contained in said Plan.

## **VI. MODIFICATIONS**

This agreement can be modified by the mutual, written consent of the parties at any time.

## **VII. TERMINATION**

This MOU may be terminated by any party upon sixty (60) days written notice to the other parties. The remaining party can continue operating in accordance with the provisions of the MOU.

## **VIII. ESTABLISHMENT OF RESPONSIBILITY**

This MOU is not intended to, and does not create, any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity, by a party

against the United States, the State of Idaho, or \_\_\_\_\_ County its agencies, officers, or employees.

**Furthermore**, this MOU establishes the aforementioned agencies' commitment to continue to actively participate and cooperate with the LWGs, and consider LWG plans, as appropriate under the law and agency regulation.

**IX. NON-FUND OBLIGATING DOCUMENT**

Nothing in this MOU shall obligate any of the parties to obligate or transfer any funds. Specific work projects or activities that involve the transfer of funds, services, or property among the various agencies and offices of the parties will require execution of separate agreements and be contingent upon the availability of appropriated funds. Such activities must be independently authorized by appropriate statutory authority. This MOU does not provide such authority. Negotiation, execution, and administration of each such agreement must comply with all applicable statutes and regulations.

IN WITNESS WHEREOF, the parties hereto have executed this MOU as of the last date written below:

**IDAHO DEPARTMENT OF FISH AND GAME**

By: \_\_\_\_\_ Date: \_\_\_\_\_

Title: \_\_\_\_\_

\_\_\_\_\_ **COUNTY COMMISSION**

By: \_\_\_\_\_ Date: \_\_\_\_\_

Title: \_\_\_\_\_