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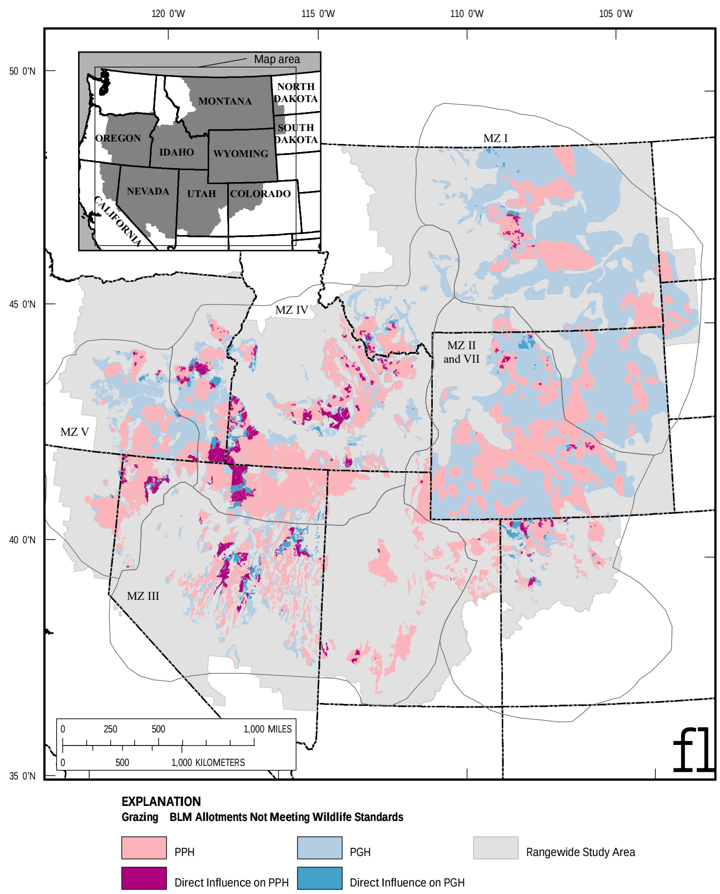

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Figure 28. Areas where BLM allotments did not meet Wildlife Standards due to grazing (as the causal factor) overlapping sage-grouse habitats (PPH and PGH) within each Management Zone (federal lands only).

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Livestock grazing can affect soils, vegetation, and water and nutrient availability by consuming or altering vegetation, redistributing nutrients and plant seeds, trampling soils and vegetation, and disrupting microbiotic crusts (Connelly et al. 2004). At *unsustainable* levels of grazing, these impacts can lead to loss of vegetative cover, reduced water infiltration rates, decreased plant litter on soil surface, increased bare ground, reduced nutrient cycling, decreased water quality, increased soil erosion, and reduced overall habitat quality for wildlife including sage-grouse (Knick et al. 2011). Ultimately, livestock function as keystone species; grazing does not preclude wildlife and vegetation, but it influences ecological pathways and can influence which plant and animal species persist (Knick et al. 2011). Thus the major influence of grazing on sage-grouse habitat is the influence on annual conditions and transitions changes in vegetation dominance over time due to chronic, selective pressure that affects perennial plant condition, inter-specific competition and composition (Beck and Mitchell 2000, Erichsen-Arychuk et al. 2002, Holechek et al. 2003, Connelly et al. 2004, Pyke 2011), and while specific effects and conditions are localized in most cases, the cumulative effect of these transitions across the species range may affect the condition of sage-grouse habitats regionally.

Comment [SSK50]: unclear

There is little scientific data directly linking grazing practices to sage-grouse population levels (Knick et al. 2011). Direct positive and negative effects of livestock grazing on sage-grouse reported in the literature include: (1) light to moderate rest-rotation cattle grazing in mesic upland meadows promoted forb growth and availability and sage-grouse use; (2) sage-grouse used sheep salting grounds as leks; (3) heavy grazing in wet meadows deteriorated hydrology and reduced the extent of habitats suitable for summer; these sites were avoided by sage-grouse; and (4) sheep and cattle trampled nests and caused nest desertions (Beck and Mitchell 2000). To help make the connection between the effects of livestock grazing on plant community dynamics in sagebrush ecosystems, the context of state and transition theory (states being discrete, observable communities or conditions, and transitions represent

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the influence of drivers of change that move the community among alternative states) is used to describe the observed range of variation of plant communities (Pyke 2011) and frame a discussion of grazing effects on vegetation and habitat conditions, habitat treatments, wild horse and burro herds, and water developments. While differences in tolerance and resilience may exist among different communities within the sagebrush ecosystem (for example, eastern versus western, northern versus southern), multiple lines of evidence indicate the presence of thresholds in the response of grasses and other native vegetation, including sagebrush, to variations in grazing pressure which, in turn, have important implications for sage-grouse habitat quality in multiple-use environments (Beck and Mitchell 2000, Erichsen-Arychuk et al. 2002, Holechek et al. 2003, Connelly et al. 2004, Pyke 2011).

Sage-grouse population persistence has been linked to the availability and condition of sagebrush habitat; the dependence of the species on sagebrush through all seasonal periods has been well documented and cannot be over-emphasized (Connelly et al. 2004). Nesting sage-grouse consistently select areas with more sagebrush canopy cover and taller grasses compared to available habitats (Hagen et al. 2007); tall, dense herbaceous cover – including residual grasses – in selected dense sagebrush stands increases the probability of a successful hatch. Thermal cover, predator protection, and food availability are important for chick survival during the early brood-rearing period with tall (>30cm) grasses and sagebrush creating this habitat this structure. Grazing intensity – including stocking rate, duration and frequency – has consistently been identified as having impacts on ecosystem and rangeland health (Vallentine 1990, Briske et al. 2008, Veblen et al. 2011). Similarly, the timing of grazing relative to plant phenology in particular can influence the sustainability of grazing (Briske and Hendrickson 1998, Briske et al. 2003, Veblen et al. 2011). Resting pastures from livestock grazing during periods of fastest growth of dominant grasses and forbs in intermountain sagebrush steppe generally enhances herbaceous plant growth and reproduction and increases culm height, long-term

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tiller production, and flower and seed production (Pyke 2011), improving range conditions and habitat. Repeated grazing during this time tends to favor sagebrush growth (Pyke 2011) through reduced competitive ability of grasses. Seasonal monitoring of range conditions would allow removal of livestock when stubble heights required to protect nests and broods are reached, however this information is difficult to attain accurately and timely across large regions, therefore surrogate measures or indices of condition would likely benefit this effort.

Heavy fall utilization of sagebrush habitats **by livestock** has been deemed detrimental to sagebrush overstories **and** thus may negatively influence sage-grouse habitat suitability (Wright 1970, Owens and Norton 1990, Angell 1997, Beck and Mitchell 2000). Trampling by livestock under short-duration or season-long grazing may kill sagebrush, particularly seedlings growing in interstitial spaces (Beck and Mitchell 2000). Domestic sheep browsing in fall and winter can reduce the density and vigor of sagebrush, especially where sagebrush densities are low (Beck and Mitchell 2000) and may require avoidance (rest, removal) in important sage-grouse habitats with limited sagebrush cover. Spring grazing may benefit sage-grouse winter range because grass reductions can increase sagebrush densities (Wright 1970, Owens and Norton 1990, Angell 1997, Beck and Mitchell 2000), suggesting an opportunity for adaptation of grazing systems to graze winter habitats in spring when brood-rearing habitats would be avoided, and vice versa.

A study compiling results from 18 western grazing system studies reported that adjustments in livestock numbers resulted in increased herbage production of approximately 35% and 28% when grazing use levels were reduced from heavy (60-80%) to moderate (40-60%) and from moderate to light (20-40%), respectively. **The** authors concluded stocking intensity was more important than grazing system for herbage production (Van Poolen and Lacey 1979), a key habitat feature associated with hatching success of sage-grouse nests and chick survival during early brood-rearing. In contrast, others

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found season of use to influence production: grazing heavily during the spring, or during spring and fall, was detrimental to herbaceous understories (Mueggler 1950, Laycock 1978, Owens and Norton 1990). Insect diversity and density was positively correlated with herbaceous density and diversity (Hull 1996, Jamison et al. 2002), thus spring or spring-fall grazing could negatively impact nesting sage-grouse and young chick survival during early brood-rearing, and avoidance through rotation or rest may benefit nesting or brood-rearing success. Grazing during the fall had minor effects on herbaceous understories (Mueggler 1950, Laycock 1978, Owens and Norton 1990). However, grazing during the dormant season (late summer through winter) may influence residual grass stubble height (Pyke 2011), which would influence nesting habitat quality for sage-grouse the following spring.

A study conducted in central Wyoming compared vegetative conditions in grazed pastures to conditions selected by sage-grouse in the area and found that reduced forage utilization, extended periods of rest, and reduced spring grazing provided conditions most suitable for sage-grouse nesting and early brood-rearing, even during a drought (precipitation 68% of normal during study, Kuipers 2004). Grazing system (based on rotation period) was less important relative to stocking rates and season of use in this study. Long-term removal of livestock generated a steady increase in the richness of shrubs, perennial grasses and forbs, and vegetative heterogeneity through 45 years post-removal of livestock in southwestern Idaho (Anderson and Inouye 2001). Comparing grazed to ungrazed (not grazed for 25 to 40 years), big sagebrush communities in Utah and Idaho, researchers reported increased sagebrush canopy cover of 13 to 54% (Beck and Mitchell 2000). In contrast, no increases in total herbaceous standing crop after removal of livestock for 13 years were reported in Utah (Beck and Mitchell 2000). Studies tracking changes in vegetation after removal of livestock in sagebrush systems report that initial proportions of the different growth forms were retained, and that a minimum of 10 to 15 years were required for seed production, seedling establishment, and growth to occur (Connelly et al.

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2004, Pyke 2011). Thus, well-prescribed livestock management may positively influence sage-grouse habitat suitability especially for nesting, early brood-rearing, and winter, but extended rest may be required for areas that are currently degraded.

Livestock distribution patterns are directly linked with water availability, and this bias has also had relevant, measureable impacts to riparian habitats, which are of primarily importance for sage-grouse as late brood-rearing and summer habitats. The most direct effect of livestock on riparian vegetation is removal of the lower vegetation layers; livestock exclusion from riparian habitats resulted in increased sedge cover, forb cover, foliage height diversity and water-table depth along with expansion of riparian vegetation laterally from stream channels (Dobkin et al. 1998). High stocking rates in areas with limited water availability were particularly detrimental to forage productivity on lands immediately surrounding water sources (Hall 1995, Dobkin et al. 1998). Similarly, summer grazing on riparian habitats concentrated livestock on riparian corridors, resulting in decreased low vegetative growth (typically the forb communities essential in sage-grouse summer diets) and reduced lateral extent of succulent vegetation associated with the riparian corridor due to a reduction in the hyporheic zone (i.e., the region beneath and alongside a *water* body where there is mixing of *groundwater* and *surface water*). However, sage-grouse preferred grazed over ungrazed wet meadows where protective cover conditions were otherwise equal, and rest-rotation grazing provided the best effects on sage-grouse summer habitat through moderate stocking levels and rest minimum of every 3 years (Neel_80).

Most sagebrush grasslands are in winter-dominated precipitation regions, and cool season plants generally dominate the herbaceous layers (Pyke 2011). Exceptions are the Colorado Plateau in southern Utah, eastern Utah, northeastern Colorado, eastern Wyoming, and eastern Montana (eastern portions of both MZ I and MZ III) where monsoon moisture creates a second peak of predictable moisture in late

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summer; warm-season plants co-dominate with cool-season plants in the herbaceous layers of these regions (Pyke 2011). Therefore, the most significant long-term influence of grazing on sage-grouse habitat is the potential for transition from an ecological state dominated by sagebrush and early (cool) season grasses to a site dominated by sagebrush, grazing tolerant grasses (increasers), invasive annual grasses and forbs, or woodlands (Pyke 2011) driven by persistent, selective herbivory that can affect composition, dominance and community structure (Manier and Hobbs 2007). Importantly, not all sagebrush communities are identical. Sagebrush steppe is one of the most widespread and characteristic vegetation types in the intermountain west, and it is found in the northern portion of the range-wide sage-grouse distribution (West 1988). In these communities, co-dominance of perennial bunchgrasses along with one, or more, of the 12 different species of sagebrush, creates a variety of types and conditions which supported moderate species diversity and historically some limited populations of large herbivores (West 1988). Great Basin sagebrush characterizes sagebrush communities in the southern and southwestern portions of the sage-grouse range (MZs III, IV, V and VII) , and while there are similarities in composition and structure, these systems have significantly lower diversity, productivity and resilience to disturbance owing to greater aridity across these regions (West 1988). Thus, while the northern, sagebrush steppe has proven similar, in response to disturbance and management, to semi-arid grasslands, Great Basin types are more similar to deserts, with islands of fertility surrounding shrubs, increased potential for erosion due to limited cover (soil exposure), and seasonal drought and precipitation patterns (West 1988). Thus, it is probable that the impacts of over-grazing are more severe in these arid regions compared to northern wetter regions. **Further** impacts of drought and prolonged shifts in precipitation patterns may trigger shifts in systemic condition, productivity and resilience in areas that were previously more robust, and this may cause significant differences in effects of local grazing practices.

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Sage-grouse generally initiate nesting in April, prior to production of new herbaceous cover, thus residual grasses left from the previous year represent the initial cover available for nesting sage-grouse (Hausleitner et al. 2005, Holloran et al. 2005). With few exceptions, ensuring adequate residual herbaceous cover through the nesting season (e.g., through June in most areas) will provide for both long-term (e.g., resilient plant communities that include healthy bunch grass understories) and annual vegetation (e.g., adequate residual grass cover and height) objectives (Pyke 2011). The potential exists to successfully manage for the sagebrush / bunchgrass plant community but fail to achieve sage-grouse habitat objectives if annual management of standing crop is not considered. According to research conducted in sagebrush steppe, adherence to light utilization standards is the most dependable way to ensure a healthy plant community (Cagney et al. 2010). Conclusions from a review of the effects of herbivory on bluebunch wheatgrass (*Pseudoroegneria spicata*), an important sagebrush associate, indicated: (1) utilization levels of 30 to 40% under deferred grazing systems is a recommended maximum use-level if maintaining the community is desirable; (2) onetime growing season utilization levels of over 50% have long term (up to a decade) impacts on plant vigor and productivity (even if followed by complete protection); and (3) grazing following the growing season has little effect, although yield reductions the following year may occur if grazed to 2 inch stubble height (Anderson 1991). Annual and seasonal monitoring of production and standing crop, with subsequent removal of livestock as range utilization reaches capacity (Holechek et al. 1989, Thurow and Taylor 1999) is important for providing for habitat quality rangewide and would be facilitated by development within local monitoring, planning, and adaptive management cycles.

Comment [SSK52]: Why? Maybe define standing crop for the reader

Even though livestock numbers have been considerably lower since the implementation of the Taylor Grazing Act in 1934, and grazing management across the West has steadily improved, the acreage transitioning away from Reference Conditions is still accumulating (Cagney et al. 2010).

Comment [SSK53]: define

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Because of lasting historic impacts (late 1800 – early 1900s), the reduced numbers of livestock in the modern era often do not simply represent reduced grazing effects (Knick et al. 2011), but rather, a slower rate of accumulation of effects. Importantly, environmental patterns, historic and current uses vary tremendously in space and time, and while some generalizations may be made, local conditions and appropriate solutions will be based on local understanding and adaptations. Thus in some areas, grazing on sage-grouse habitat may be a component of both long-term management to promote resilient, desirable plant communities and annual management of the standing crop to provide residual cover for sage-grouse (Cagney et al. 2010, Pyke 2011). However, if the desired vegetative components are not present in a priority site, additional manipulations may be required such as addition of desired species through active restoration (Pyke 2011), and because these treatments may be expensive, prioritization based on habitat value and site potential may be warranted.

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Interactions between grazing and recent disturbances can have lasting effects on recovery of sage-grouse habitat values in the post-disturbance environment. Deferring grazing for two growing seasons **after** disturbance has been recommended because it allows the cool season bunchgrasses – which are especially vulnerable to grazing **after** treatment – to capitalize on resource availability created by the disturbance (Knick et al. 2011). However, reintroduction of livestock to a disturbed area prior to the native or reseeded plant community becoming established, regardless of the number of years of rest afforded the site, can result in failed rehabilitation efforts and increased levels of exotic grasses (Knick et al. 2011). While rest is often prescribed, timing, intensity, and duration of grazing of treated rangelands may be more important than a specific period of rest after fire (Bates et al. 2009). Moderate grazing after perennial grass dormancy (i.e., late season) in the first two summers after fire is not likely to reduce the recovery ability of herbaceous communities in sagebrush steppe (Bates et al. 2009) when rest during the growing season is permitted. Differences in herbaceous cover among burn–ungrazed and

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burn–grazed areas were not observed during the first 6 years after fire, but between 7 and 18 years post-fire, perennial grass cover in grazed areas was less than cover in ungrazed areas (West and Yorks 2002), so long-term post-treatment monitoring may be important. Treated areas may draw grazing pressure from all herbivores, thus treatment designs that consider the possibility of an unplanned escalation of use by wild horses or elk (Cagney et al. 2010) when significant populations of these species are present, have better chances of meeting productivity and habitat targets.

Wild Horses

Free-roaming horses (*Equus caballus*) and burros (*E. asinus*) have been a component in the dynamics of sagebrush and other semiarid communities since they were brought to North America at the end of the 16th century (Connelly et al. 2004). Approximately 40,000 free-roaming horses currently live in ten western U.S. states; areas managed for horses and or burros from 1971 to 2007 constitute approximately 18% of currently occupied sage-grouse range predominantly in Nevada, southwest Wyoming, and southeast Oregon (Connelly et al. 2004, Beever and Aldridge 2011). Because of physiological differences, a horse consumes 20 to 65% more forage than would a cow of equivalent body mass (Connelly et al. 2004). Comparing horse-removed sites to horse-occupied sites, researchers have documented the following equid-induced changes to sagebrush communities: (1) reduced total vegetative and grass abundance and cover; (2) lower sagebrush canopy cover; (3) increased fragmentation of shrub canopies; (4) lower species richness; (5) increased compaction in surface soil horizons; and **(6)** increased dominance of unpalatable forbs (**Bartmann et al. year?** Beever and Aldridge 2011). Additionally, because horses separate themselves from cattle by using higher elevations and steeper slopes, horse occupancy of a sagebrush ecosystem reduces the occurrence of ungrazed areas (Connelly et al. 2004). Areas federally managed as wild horse and burro range constitute approximately 14.6 million acres (10.24%) of sage-grouse habitats across the range of the species (Table 23, Figure

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29). Wild horse and burrow range coincides with sage-grouse habitat predominantly in Nevada, southwest Wyoming and southeast Oregon; in these MZs (III, V, and II and VII) 19.9% of priority habitats are influenced.

Comment [SSK54]: are there many burros? Or are there just a few confined to certain areas?

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Table 23. Federally Managed Wild Horse and Burro Herd Management Areas and Territories overlapping sage-grouse habitats (PPH and PGH) within each Management Zone.*

Management Zone Entity	PPH SG Habitat (acres)	PPH Direct Footprint (acres)	PPH Direct Footprint (%)	PPH Relative Influence[1] (%)	PGH SG Habitat (acres)	PGH Direct Footprint (acres)	PGH Direct Footprint (%)	PGH Relative Influence[1] (%)
MZ I - GP	11,636,400	0	0.00		34,663,000	0	0.00%	
MZ II and VII - WB & CP	17,476,000	2,217,100	12.69		19,200,200	2,734,700	14.24	
BLM	9,021,200	1,792,900	19.87	81	9,012,500	2,007,200	22.27	73
Forest Service	162,000	0	0.00	0	452,500	0	0.00	0
Tribal and Other Federal	784,000	69,800	8.90	3	1,354,600	50,700	3.74	2
Private	6,233,900	271,200	4.35	12	7,394,800	602,400	8.15	22
State	1,244,800	83,200	6.68	4	979,800	74,300	7.58	3
Other	30,100	0	0.00	0	6,000	0	0.00	0
MZ III - SGB	10,028,500	2,479,800	24.73		3,970,100	1,635,800	41.20	
BLM	6,309,400	2,199,200	34.86	89	3,199,800	1,463,200	45.73	89
Forest Service	1,236,200	210,100	17.00	8	356,200	136,100	38.21	8
Tribal and Other Federal	260,800	11,700	4.49	0	29,100	14,700	50.52	1
Private	1,836,200	44,500	2.42	2	384,800	21,800	5.67	1
State	385,900	14,300	3.71	1	200	0	0.00	0
MZ IV - SRP	21,930,600	1,244,200	5.67		10,958,500	642,600	5.86	
BLM	13,710,700	1,177,200	8.59	95	4,928,200	601,400	12.20	94
Forest Service	1,613,800	0	0.00	0	1,113,500	0	0.00	0
Tribal and Other Federal	633,600	0	0.00	0	522,500	7,200	1.38	1
Private	4,890,200	51,900	1.06	4	3,516,742	29,100	0.83	5
State	1,019,373	15,000	1.47	1	846,200	4,800	0.57	1
Other	62,900	0	0.00	0	31,400	0	0.00	0
MZ V - NGB	7,097,200	2,190,000	30.86		5,808,000	1,476,300	25.42	
BLM	5,117,500	2,002,900	39.14	91	4,196,700	1,399,600	33.35	95
Forest Service	62,200	0	0.00	0	114,900	0	0.00	0

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Management Zone Entity	PPH				PGH			
	SG Habitat (acres)	Direct Footprint (acres)	Direct Footprint (%)	Relative Influence[1] (%)	SG Habitat (acres)	Direct Footprint (acres)	Direct Footprint (%)	Relative Influence[1] (%)
Tribal and Other Federal	717,100	4,300	0.60	0	101,800	700	0.69	0
Private	798,000	73,400	9.20	3	1,199,000	75,000	6.26	5
State	64,900	5,600	8.63	0	115,800	400	0.35	0
Other	337,500	103,800	30.76	5	79,800	600	0.75	0

[*] Data Source: BLM 2012, USFS Enterprise Data Warehouse 2012. Non-federal lands fall within these areas and the presence of wild horses and burros on those lands is dependent on local management practices, such as, fencing or tolerance of trespass.

[1] For management entities within a management zone, these were calculated as the percent of the total direct impact in the management zone represented by that management entity; i.e. the relative area of direct influence among management entities.

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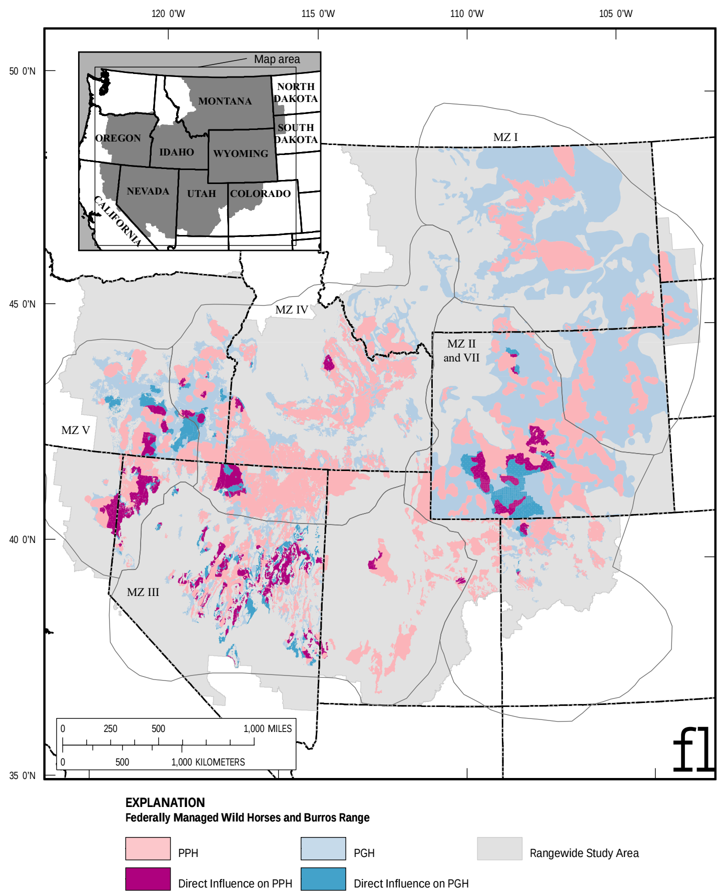

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Figure 29. Federally Managed Wild Horse and Burro Herd Management Areas and Territories overlapping sage-grouse habitats (PPH and PGH) within each Management Zone.

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Water Developments

Open water has been suggested as a limiting factor for summering sage-grouse. While water availability may influence the species' summer distribution (Patterson 1952, Autrienth 1981), movements to summer range are probably in response to lack of succulent forbs in an area rather than a lack of free water (Connelly and Doughty. 1989). Existing research suggests that sage-grouse do *not* regularly use water developments even during relatively dry years, but obtain required moisture from consuming succulent vegetation **in the vicinity** (Connelly 1982, Connelly and Doughty. 1989, Connelly et al. 2004). **More than** 56,500 water development projects have been implemented on lands managed by the BLM within the current distribution of sage-grouse plus a 50 km (31 mile) buffer around this distribution (Connelly et al. 2004).

Comment [SSK55]: For what purposes? Watering livestock primarily? Or many diverse purposes?

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Artificial water sources may facilitate the spread of West Nile virus (WNv) within sage-grouse habitats as these water developments support abundant populations of the mosquito vector responsible for the majority of WNv infections (*Culex tarsalis*) longer than natural, ephemeral water sources (Walker and Naugle 2011). Additionally, projects that create mesic zones around water developments to promote the growth of succulent vegetation may inadvertently contribute to the proliferation of WNv as *Culex tarsalis* regularly breed in water-filled hoofprints in these areas (Walker and Naugle 2011). Water developments tend to attract other animals and thus may serve as predator sinks for sage-grouse (Connelly and Doughty. 1989). Additionally, water developments have substantially influenced the movements and distribution of livestock in arid western habitats and have increased the amount of sagebrush area available for livestock (Connelly et al. 2004), which – although these practices may benefit riparian conditions (e.g., sage-grouse summer habitats) – may increase the effect of livestock across the landscape**,** expanding impacts to upland areas important for sage-grouse during nesting, early brood-rearing and winter seasons.

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A10. Climate dynamics

Climate change is a complex process in which interactions among natural and anthropogenic sources affect atmospheric characteristics leading to long-term changes in temperature and precipitation (Miller et al. 2011). Climate change is defined as a change in the state of the climate **due to** human-induced or natural causes that can be identified by changes in the mean and/or the variability of climate properties and that persist for an extended period, typically decades or longer (Miller et al. 2011). Notably, the climate has always been understood as a highly dynamic system, and while it has been possible to develop understanding and theories using persistent patterns (in space and time), the climate has always been changing. Modern issues and concerns over climate change are generally focused on rapid warming and associated circulation feedbacks that have been linked to human industrial activities. Global climate change models predict that more variable and severe weather events (drought, storms), higher temperatures, drier summer soil conditions, and wetter winter seasons will dominate future weather patterns at mid-latitude, semi-arid regions like the American West (Miller et al. 2011). Atmospheric carbon dioxide, methane, nitrous oxide, and halocarbons are also predicted to increase under most global climate change scenarios (Miller et al. 2011).

Changing climate conditions may render some locations less suitable for sagebrush than for other species, creating potential shifts in ecosystem distributions (Bradley 2010). Increased temperatures, the trend for decreased snowpack, earlier onset and warmer spring periods, and reduced summer water flows in the western U.S. could exert stresses on sagebrush; sagebrush seedling recruitment may be particularly susceptible to these changes in climate (Miller et al. 2011). A substantial increase in temperature could impart a competitive advantage to woodland vegetation currently dominating the Chihuahuan and Sonoran Deserts and these woodlands may expand northward and displace large areas of sagebrush (Miller et al. 2011). Increased levels of carbon dioxide may favor

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Comment [SSK56]: Miller primarily writes on sagegrass steppe. Does he cite a primary source for these climate predictions?

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exotic annual grasses; in controlled laboratory tests, reproductive biomass of cheatgrass doubled and time to maturation decreased at elevated levels of carbon dioxide (Miller et al. 2011). Under current atmospheric carbon dioxide levels, cheatgrass competes successfully against native grasses because of earlier maturation, shallow root systems preempting water in soils, greater seed production, and the ability to respond quickly to disturbance (Miller et al. 2011). Thus, an increase in the competitive advantage of cheatgrass may facilitate the species' spread, exacerbating the cycle of fire and cheatgrass-dominance already eliminating substantial acreages of sagebrush annually (Miller et al. 2011).

Summer precipitation and temperature are the best predictors of sagebrush regional distribution of sagebrush, suggesting that changing summer conditions may have the most impact on long-term viability of sagebrush habitats (Bradley 2010). Climate change risk to sagebrush due to changing summer conditions may be most pronounced in southern portions of the species' range where decreased precipitation and/or rising temperatures may make current habitat climatically unsuitable in the future (Bradley 2010). However, in an experimental study where rainout shelters excluded natural rainfall and seasonal distribution of precipitation was controlled, Bates and others (2006) found that Wyoming big sagebrush (*A. t. wyomingensis*) did not respond in terms of cover or density to shifts in the timing of precipitation from predominantly winter (e.g., normal precipitation timing on site of 75% occurring between October and April) to spring (80% of total water applied between April and July) in the short term (7 years), suggesting changes to the shrub overstory **may** take at least decades to materialize. Additionally, increasing summer temperatures were related to increases in threetip sagebrush (*A. tripartita*) population growth, a result driven by increased survival of this species (Dalgleish 2011).

The loss of approximately 12% of the current distribution of sagebrush was predicted to occur with each 1°C increase in temperature, primarily to increasing distributions of other woody vegetation (Miller et al. 2011). However, most scenarios do not factor in the potential response of exotic annual

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grasses and the consequences these changes may have on the distribution of sagebrush habitats, therefore estimates of range contraction may be biased low (Miller et al. 2011). The current distribution of sagebrush is predicted to decline by 80% under one of the most extreme global climate change scenarios of an increase of 6.6°C (Miller et al. 2011). A general geographic pattern of future sagebrush occurrence is characterized by substantial decreases in southern parts of the species' range combined with some increases in the northern parts; models also forecast small increases in distribution at higher elevations, for example, at the interface with coniferous forest (Schlaepfer et al. 2012). Forecasts additionally suggest **that sagebrush ecosystems may split** into several **large but** disjoint areas: Washington, Sierra Nevada area, Oregon- northern Nevada, central Idaho, an area encompassing eastern Utah, Wyoming, Colorado, and eastern Montana-Saskatchewan (Schlaepfer et al. 2012).

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Decreased annual precipitation negatively influenced needle-and-thread (*Hespirostipa comata*) population growth in sagebrush habitats, primarily by reducing survival of this grass species (Dalgleish 2011). Herbaceous plants were detrimentally affected by a shift in precipitation timing in sagebrush habitats from predominantly winter (75% of total water occurring between October and April) to spring (80% of total water applied between April and July) as indicated by a pattern of lower herbaceous biomass, cover, and densities compared to the other treatments (Bates et al. 2006).

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Importantly, the potential effects of climate change on sagebrush and sage-grouse outlined above are not supported – nor are they falsified – by empirical data. Projecting the potential consequences of global climate change requires scientists to extend correlational relationships beyond observed data. However, the potential effects of climate change may be reasonably factored into long-term conservation actions through recognition of risks and possibilities, but predicted responses of species and habitats to long-term, imprecise forecasts are unlikely to provide accurate details regarding future conditions. Projections of sage-grouse population trends and extinction probabilities used for

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management of the species generally extend 100 years into the future (see Garton 2011), and over this period the projected changes to the climate and the effects these changes may have on sagebrush habitats **may** become sufficiently large to overwhelm any current trajectory of habitat loss and alteration (Miller et al. 2011). The empirical data presented suggests that potential effects of global climate change (such as prolonged drought) may influence the herbaceous understory in sagebrush habitats before effects on the shrub overstory become apparent.

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A11. Habitat Treatments & Vegetation Management

Given the historic reduction and re-purposing of the most productive communities within the sagebrush ecosystem, less than half of the original distribution of sagebrush ecosystems currently exists (Knick and Connelly 2011a, Pyke 2011) making conservation of existing sagebrush habitats a priority. Consideration of modern **habitat** treatments in the context of historic treatments and disturbances, which can affect the regional distribution and condition of sagebrush at multiple scales, may be useful for planning, maintenance and restoration of priority sagebrush habitats (albeit with different emphases depending on local conditions). Historic habitat treatments often focused on removal or reduction of sagebrush in favor of improved herbaceous cover and productivity (Knick et al. 2011), whereas modern era treatments have focused on fire control and fuel mitigation, noxious species control, and surface (soil) stabilization. Between 1929 and 2004, more than 6000 land and vegetation treatments (burning, mowing, chaining, cabling, chipping, logging, chemical application, furrowing, ripping, tillage, pitting, terracing, checks, scalping, and seeding) were conducted on BLM lands in Colorado, Idaho, Montana, Nevada, Oregon and Wyoming[1] (BLM Range Improvement Project database, Knick et al. 2011) which

Comment [SSK58]: Conversion to agriculture?

Comment [SSK59]: With the best soils?

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Comment [SSK60]: Wow!

[1] Not all of these treatments were in sagebrush habitats (but we are unable to separate them at this time) so for these states these values may over-estimate treatments in sagebrush, however CA, ND, NM, SD and UT were excluded from this calculation as these states have lower ratio of sage to other types on BLM lands (e.g., grasslands and woodlands) thus we underestimate contribution to range-wide assessment by excluding these states -- leading to some balance in this index. These values are clearly not precise, but help provide context.

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represents a large and coordinated effort to manipulate vegetation composition and structure, increase productivity, improve forage-browse quality, rejuvenate old-growth, remove noxious or poisonous species, and/or manage structure and composition to protect buildings and manage fuels (Knick et al. 2011).

Although range-wide compilation of precise acreage and locations of historic treatments does not exist, recent estimates suggest more than 4000 km^2 (988,400 acres) were treated within these states between 1997 and 2006 [2500 km^2 (617,750 acres) of prescribed burns; 1400 km^2 (346,000 acres) of mechanical fuel treatments; and 626 km^2 (154,700 acres) of mechanical habitat treatments]. This results in an estimate of more than 33,000 km^2 (8.15 million acres) treated (approaching 12% of SG Habitat area, based on mean values and a data-limited estimate of a highly variable activity). **Vegetation** manipulations were more prominent during the post-war (WWII) era, circa 1940-60, making this extrapolation based on modern treatment areas a conservative estimate.

Accumulation of habitat treatments across a targeted landscape may outpace natural disturbance (Manier et al. 2005), suggesting that natural and anthropogenic disturbance history could be considered together for a comprehensive perspective on disturbance patterns and processes (capturing spatial and temporal dynamics) that influence sage-grouse habitats. While treatments may have varied post-treatment effects, management treatments are typically designed to mimic natural processes, such as stimulating post-disturbance regeneration and/or creating post-disturbance hazard levels (Baughman et al. 2010), without negative effects on public safety (for example, due to wildfire). Treated areas often have lasting effects which accumulate across the landscape and can affect resource use patterns for many years (Miller 2008, Chong and Anderson, USGS unpublished data). Comprehensive (accurate and inclusive) records for historic treatments have not been compiled or published at this time (making accurate assessment of historic effects impossible at this time), however local planning and management

Comment [SSK61]: How was this esxtrapolation made? Across time? Assuming that all similar time periods had 4000 km2 of treatments?

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efforts may incorporate this information when available. Importantly, due to perceived threat of wildfire, and due to strong similarities in the detrimental effects of prescribed fire, mechanical and chemical treatments on habitat value for sage-grouse, "an immediate and potentially long-term result [of treatments in sagebrush habitats] is the loss of habitat" (U.S. Fish and Wildlife Service 2010b).

Current treatments and active vegetation management typically focus on vegetation composition and structure for fuels management, habitat management, and/or productivity manipulation for improving the habitat and forage conditions for ungulates and other grazers, for example thinning sagebrush cover or treating invasive plants (Knick et al. 2011). Locally and cumulatively across a region, the distribution of these treatments can affect the distribution of sage-grouse and sagebrush habitats. Therefore, regional plans may consider the distribution, composition and condition of habitat (and potential habitat with restoration), along with evaluation of costs and potential benefits of possible treatments and treatment sites within this framework and thereby integrating decisions about spatial patterns, habitat conditions and treatment methods.

Comment [SSK62]: This sentence could be clearer. What framework are you referencing?

In addition to landscapes with large, intact patches of sagebrush, sage-grouse require high-quality habitat conditions including a diversity of herbaceous species, vegetative and reproductive health of native grasses, as well as an abundance of sagebrush, making management for high-condition in seasonally important habitats a priority; recent and ongoing management activities have sought to address these values making current activities relevant as they assist natural processes to recover from past disturbances. Residual vegetation cover, especially grass and litter, has often been noted as essential for concealment during nesting and brood-rearing (Sveum et al. 1998a, Sveum et al. 1998b, Kirol et al. 2012), suggesting opportunities to improve herbaceous cover (without sacrificing safety of sagebrush cover) may benefit fecundity. For example, adjusting timing and duration of livestock-use to support quality conditions during seasonal use (i.e., reduce or eliminate spring grazing in nesting and

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brood-rearing areas). Passive restoration is typically the most affordable approach to restoration treatment because it does not require directed human activities) but rather depends on adjustments in processes and management structure that can be imparted through revised use strategies (Connelly et al. 2004, p.320). "The greatest land-use adjustment within the sage-grouse region that might bring about passive restoration is to change livestock management, largely because of the prevalence of livestock grazing as a land use" (Pyke 2011, p.537). A previous review of literature discussed positive *and* negative impacts of grazing on sage-grouse habitats (Beck and Mitchell 2000) **and indicated** that simple modifications (such as removing livestock) may not have the desired consequences for habitat conditions (Also see Section III.A9. Grazing). They suggested that treatments (prescribed fire, mechanical, herbicide) that eradicate large areas of sagebrush be ceased, but also indicated that thinning dense sagebrush down to approximately 15% cover can support herbaceous production as well as provide sufficient cover in Wyoming sagebrush communities (Beck and Mitchell 2000). If historic alteration of the habitat has not been too severe, then adjusting management practices (the grazing system, or seasonal recreation closures, for example) has a reasonable chance of improving degraded or altered habitat conditions (Connelly et al. 2004). While these activities do not typically alter landscape scale habitat patterns, treatment areas and effects can accumulate with regional effects, revised and re-focused treatment approaches can help adjust and improve condition and trajectory of historic treatments.

Because local priorities may include improved connectivity or increased habitat area, active restoration treatments may be warranted if target areas have transitioned into a new vegetation states or other degradation of the site has occurred (Pyke 2011). Site degradation may be severe in some locations such that critical soil surface horizons have been reduced or lost, and/or establishment of "undesirable" species has been sufficient to displace native species and require direct manipulation

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making passive management approaches unsuitable (Connelly et al. 2004). For example, if invasive species (for example, cheatgrass) or native species (for example, junipers, pinyon pines, rabbitbrush) have replaced desirable dominant species, as is common in parts of the Great Basin, Snake River Plain (MZ III, IV) and elsewhere, then active removal of the invaders and seedings of native species may be required for successful restoration (Connelly et al. 2004). Importantly, given the limited distribution of suitable sagebrush habitats and the cost of habitat restoration treatments, management plans that **strategically** protect intact sagebrush and restore impacted areas to enhance existing habitats (for example, connectivity of intact sagebrush) have the best chance of increasing the amount and quality sagebrush cover and creating management flexibility in the future. Recognition of the relative condition and potential value of habitats can help determine options and priorities among regional and adjacent treatment areas and support considerations of cost, benefit and risk (Table 24). Further, distinction of well-directed, designed and located treatments from historic treatments (with alternate goals but similar names) is useful for clarity in assessment and planning.

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Table 24. Range Condition for Treatment and Restoration: An adaptable and consistent decision matrix using vegetation and soil characteristics*.

Level of implementation for restoration.[1]	Good to High Condition, little departure from reference conditions	Moderate to Good Condition, some departure from reference conditions but some important components remain	Poor Condition, Change in Dominance, full departure from reference conditions, typically associated with change of system state
Description			
Differences may be ascribed to: good range conditions reducing need, complicating environmental factors that reduce potential, and/or social-political-management factors that limit options.	***Structural and functional groups of vegetation are present – relative abundance and vigor of populations may vary; minor exotic/invasive species component may be part of pre-existing.***	***Functional or structural vegetation groups may be missing, under-represented or in decline; invasive plants may be common, but not dominant such that natives have been entirely displaced.***	***Sagebrush and tall grasses (usu. native) are missing or rare; invasive species dominate large areas; soil stability, water and nutrient retention are likely altered; disturbance regimes may be altered.***
Low effort	Minimal actions: maintain status and protect intact shrub stands (for example, from wildfire), monitor and treat invasive species, monitor productivity and grazing intensities to reserve appropriate cover. Adjust management as necessary to maintain status.	Passive Restoration, including rest from grazing may be supplemented with localized (small areas) treatments or restoration actions. If habitat and range conditions are not improved consider increasing Active Restoration.	Active Restoration required. Prioritize based on regional habitat distribution and spatially explicit strategic planning; Potential for success with minimal (less) effort exists if soil quality and condition is good, invasive species control is possible and practical (not cost prohibitive).
Moderate effort	Minimal actions: maintain status and protect intact shrub stands (for example, from wildfire), monitor and treat invasive species, monitor productivity and grazing intensities to reserve appropriate cover. Increase effort and alter management if condition decline is documented or suspected.	Passive Restoration, including rest from grazing may be supplemented with localized (small areas) treatments or restoration actions. If habitat and range conditions are not improved consider increasing Active Restoration.	Active Restoration required. Prioritize based on regional habitat distribution and spatially explicit strategic planning; Potential for success with minimal (less) effort exists if soil quality and condition is good, invasive species control is possible and practical (for example,not cost prohibitive).

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Level of implementation for restoration.[1]	Good to High Condition, little departure from reference conditions	Moderate to Good Condition, some departure from reference conditions but some important components remain	Poor Condition, Change in Dominance, full departure from reference conditions, typically associated with change of system state
High effort	Minimal actions: monitor and treat invasive species, monitor productivity and grazing intensities to reserve appropriate cover, maintain status and protect intact shrub stands (for example, from wildfire),. Implement Passive Restoration and consider further altering management if condition decline is documented.	Passive Restoration recommended unless significant funds and motivation exist (for example, industrial site reclamation) for conducting Active Restoration of soils and vegetation. No change in action (for example, grazing rotation) will be the best practice in many areas – to avoid a sudden change in disturbance regime and/or exotic species invasion.	Unless significant funds and motivation exist (for example, industrial site reclamation) for conducting Active Restoration of soils and vegetation, inventory and reclassification is recommended. . New management plans may be developed based on the new designation.

[*] Adapted from (Pyke 2011).

[1] Field estimation and comparison of results to models and/or reference conditions is required for accurate determination of position within this matrix.

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A12. Other Land Uses

Recreation

Dispersed recreation activities (including **but** not limited to OHVs, camping, bicycling, and hunting) which utilize the extensive network of official and unofficial roads, have an extensive and difficult to measure impact on sagebrush and sage-grouse (also see Section III.A4. Infrastructure). Potential impacts include noise (Blickley et al. 2012), distribution of invasive plants, (With 2004, Christen and Matlack 2009, Bradley 2010, Huebner 2010), generation of fugitive dust (Gillies et al. 2005, Lee et al. 2007, Ouren et al. 2007, Padgett et al. 2008), and effects on predator and prey behavior (Gavin and Komers 2006, Poulin and Villard 2011, Whittington et al. 2011). Uninhabited areas within the Great Basin ecoregion (MZs III and V) decreased 90% (90,000 km^2; 22.2 million acres) to less than 12,000 km^2 (3 million acres) with expansion driven by economic and recreation opportunities in the region (Knick et al. 2011); similarly, population densities have increased 19% in the Wyoming Basin region (MZ II) and 31% on the Colorado Plateau (MZ VII) since 1920 (Knick et al. 2011). With expanding populations comes greater human impacts (Leu et al. 2008), especially as a result of many people living in the region because of access to public lands (Hansen et al. 2005) and these dispersed uses expand the human footprint. Ecological impacts of roads and motorized trails include mortality due to collisions, behavior modifications due to noise, activity and/or habitat loss, alteration of physical environment, leaching of nutrients, erosion, spread of invasive plants, increased use and alteration **of habitats** by humans due to accessibility (Knick et al. 2011). Closing and reclaiming unused, minimally used, and/or unnecessary roads in and around sagebrush habitats to recreation during seasonal use by sage-grouse may reduce the footprint and presumably impacts to wildlife. Restricting access to important habitat areas based on seasonal use and coincident with grouse activities (for example, lekking, nesting, brood-rearing, wintering) may decrease the impacts associated with humans, but will not eliminate other

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Comment [SSK67]: interesting adjective for dust!

Comment [SSK68]: This sentence is too wordy

Comment [SSK69]: Actually, this sentence speaks of ecological impacts but also impacts to sage-grouse

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Comment [SSK70]: You can close roads “to”recreation, but the word “reclaiming” makes it aawkward. Need to rework the sentnece

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impacts such as spread of invasive plants, predator movements, loss of cover, and erosion. Although specific work addressing effects of roads, trails and OHV use on sagebrush habitats and sage-grouse has not been conducted, research suggests common effects, including habitat loss and fragmentation, invasive plant spread, induced displacement or avoidance behavior, creation of movement barriers, noise and direct encounters (Knick et al. 2011), and reducing the extent and influence of roads and trails can be incorporated into near-term and long-term plans for consolidating, conserving and improving priority habitat areas. Other human-dimensions approaches may also prove valuable whereby closures and restrictions may be avoided by adjusting user behaviors through education and voluntary behavior changes.

Training Facilities

There are 87 Department of Defense (DoD) managed facilities distributed across the Sage-grouse Conservation Area with various operations and intensity of use among and within those facilities. Obvious land-use impacts were evident on approximately 17% of those lands, leaving substantial portions of some facilities available for conservation and management of native species (Knick et al. 2011). However, only 26% (6,815 km^2; 1.68 million acres) of DoD facilities in the region are sagebrush dominated, and thus they represent only 0.01% of the currently estimated sage-grouse range (670,000 km^2; 165.5 million acres, total area). While the land-use and conservation activities of DoD may have important local effects on the distribution of sage-grouse habitats (including effects on disturbance regimes) as well as some populations (for example, the Saylor Creek Range in Idaho), they represent only a small portion of the species' range and therefore a small component of the conservation effort. Localized effects include woody plant eradication due to high frequency fire returns (munitions testing and training) and fine-scale fragmentation due to concentrated, repeated vehicle maneuvers (Knick et al. 2011).

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Factor B. Population Overutilization

In their review of threats to sage-grouse, USFWS recognized potential of "Overutilization for Commercial, Recreational, Scientific or Educational Purposes" as limited and not likely a factor (Valone et al. **2002**) in the range-wide decline of sage-grouse. However, USFWS also recognized the ability of hunting to have significant effects on some populations, and further, the potential for interactive effects with indirect pressures from land-use development and other direct pressures including predation and disease makes close monitoring and annual adjustment of harvest rates a potentially important aspect of local population management. Importantly, sage-grouse are not currently commercially exploited anywhere in their range, and hunting of this species is prohibited in Canada and Washington. The other States within the species range have direct management authority over hunting which is exercised through Fish and Game Divisions (see Section IV. Factor D). Utilization of sage-grouse populations includes hunting, religious and traditional uses, and research and education; the number of animals affected by hunting far outweighs the number of mortalities associated with traditional, research and educational activities which have been considered and were deemed insignificant. Therefore, hunting practices and regulations are primarily discussed here.

To put hunting mortality in perspective, we recognize that sage-grouse, like other upland game birds, are exposed to a variety of predators including: corvids (for example, common raven, *Corvus corax*), raptors (for example, golden eagle, *Aquila chrysaetos*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), badger (*Taxidea taxus*), weasels (*Mustela* spp.), ground squirrels (*Spermophilus* spp.), bobcat (*Lynx rufus*), western rattlesnake (*Crotalus viridus*) and bull snake (*Pituophis catenifer*, Connelly et al. 2011a). Most mortality of sage-grouse is caused by predators during spring, summer, and fall seasons with limited mortality observed during winter months. Despite these natural pressures, significant mortality can be associated with hunting (Connelly et al. 2000b, Connelly et al. 2011a, p.66, Gibson et al. 2011). Hunting is generally concentrated during short periods of time in the fall, but several

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indigenous American tribes occasionally harvest animals in spring months. Besides concerns over additive mortality effects, which account for direct reductions in population numbers, research has documented potential bias towards adult-female mortality due to hunting, in particular, with an estimated 42% of seasonal female mortality associated with harvest practices (compared to 15% in males) in Idaho; however, this differentiation was not observed in Montana and Wyoming (Connelly et al. 2011a). If widespread and consistent, **adult female bias** could have important effects by altering the reproductive capacity of populations (Connelly et al. 2000b); further research and monitoring are needed along with potential for adjustment to harvest regulations, if warranted. At this time, "[n]o studies have demonstrated that hunting [or any other direct Utilization] is a primary cause of reduced numbers of Greater sage-grouse" (Reese 2011), but evidence indicates harvest can have a measureable role in variability in the abundance and distribution of birds through time and across landscape units (Sedinger et al. 2011).

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B1. Hunting

In recent decades, as information about sage-grouse mortality, survival and reproductive rates has improved, and paradigms regarding population management were adjusted as state wildlife management agencies responded to population dynamics and declining population numbers by reducing annual harvests. Wyoming, Utah, Idaho, Oregon, Montana and California reduced harvests in recent years through various regulatory mechanisms, Washington no longer permits harvest of sage-grouse, and Colorado, Nevada, North Dakota and South Dakota have retained fairly consistent regulations during the past decade (Reese 2011). Sage-grouse have not been commercially harvested since the 1930s, therefore, commercial hunting does not currently affect sage-grouse population dynamics (U.S. Fish and Wildlife Service 2010b). Recent work comparing populations with consistently different harvest structures indicated **that** populations in areas closed to hunting **had growing** breeding

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populations **whereas** areas open to hunting **had declining population growth rates**, even **under** moderate rates of harvest (Connelly et al. 2003a). Importantly, hunted populations within this study demonstrated both decreasing trends and increasing trends during the 6-year study, emphasizing the importance of *local* factors for determining harvest levels and **the need to balance** mortality within the tolerance of each population (Connelly et al. 2003a).

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Approaches and concepts used in upland small game management were developed during early in the 20th century (circa 1930s), and these early approaches employed little empirical evidence and a single universal paradigm to establish harvest rates (Strickland et al. 1994, Reese 2011). These early approaches assumed that all small game populations exhibited high reproductive rates and low year-to-year survival, thereby suggesting that hunting, even at high harvest levels, was compensatory to over-wintering mortality. Based on this paradigm, harvest regulations have varied tremendously over time and from state-to-state during the past 100 years, including a population crash and subsequent recovery in the late 1800s (Reese 2011). As research and harvest data for sage-grouse began to increase, evidence indicated that in some situations, harvest *can* have an *additive* effect on mortality, and the in mid 1990s, revised estimation of sage-grouse vital rates (life-span, mortality, and survival) caused Idaho and Wyoming to reduce the number of harvested animals (Reese 2011) to avoid additive mortality effects.

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Monitoring of harvest demographics along with lek counts and targeted population research combined have contributed to understanding of the dynamics of sage-grouse populations at landscape scales, including calculation of sex and age ratios, nest and brood success rates, and seasonal mortality (Autrienth 1981). Further, hunters and hunting associations represent important supporters of wildlife conservation efforts from a range of social and political backgrounds; this constituency can be important for species conservation (Reese 2011). Nonetheless, appropriate harvest rates have not been determined for sage-grouse populations region-wide, however several studies have addressed this issue (Autrienth

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1981, Crawford 1982, Braun and Beck 1985, Connelly et al. 2000a). Since public interest, population data and management funds are derived from harvest of sage-grouse, hunting might be a part of conservation management in the future, for instance if population numbers exceed suitable habitat. However, because populations appear to respond positively when released from hunting pressure, relief from hunting may remain a useful management strategy for (Romanya et al. **year?**) populations with multiple, interacting stressors.

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B2. Religious & Traditional

Several indigenous American tribes harvest sage-grouse populations within their jurisdictions associated with ceremonial practices **and** subsistence. Annual hunting occurs on the Wind River Indian Reservation (Wyoming), the Shoshone-Bannock Reservation (Idaho), and formerly on the Duck Valley Indian Reservation (Idaho-Nevada; U.S. Fish and Wildlife Service 2010b). Harvest activities on the Duck Valley Indian Reservation were suspended after West Nile virus caused precipitous population declines, demonstrating the ability of local governance bodies to respond to population estimates and adjust harvest practices accordingly. Harvest on the Wind River Reservation is limited to males on leks and has little to no measureable effect on the local populations (Hnilicka, USFWS, Lander, Wyoming, personal communication). There are no known harvests of sage-grouse by indigenous tribes in Colorado, Oregon, North Dakota, South Dakota or Washington (U.S. Fish and Wildlife Service 2010b).

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B3. Science & Education

Dozens of scientific studies have been conducted on **sage**-grouse, including at least 50 which have directly handled birds. “In 2005, the overall mortality rate due to the capture, handling, and/or radio-tagging process was calculated at approximately 2.7 percent of the birds captured (68 mortalities of 2,491 captured)” (U.S. Fish and Wildlife Service 2010b); there is no evidence that this level of mortality

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causes measureable impacts on sage-grouse populations. Efforts to re-establish populations in several U.S. States and British Columbia documented translocation of more than 7,000 birds (Reese 1997), however only 5% of these were successful in producing sustained resident populations, thus indicating high mortality risks and limited benefits from these activities (Reese 1997). However at least one **translocation** effort (Strawberry Valley, Utah) demonstrated greater success with estimated 60% survival rates (Baxter et al. 2008). Based on the low number of translocated animals distributed across many years, and the low number of mortalities associated with research and restoration activities relative to population totals and other sources of mortality, USFWS indicated that research and education effects on source populations were **minimal** (U.S. Fish and Wildlife Service 2010b).

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Factor C: Population Disease and Predation

Disease

While sage-grouse are host to a wide array of parasites and pathogens, including macroparasitic arthropods, helminthes, and microparasites (protozoa, bacteria, viruses, and fungi; Thorne et al. 1982, Connelly et al. 2004, Christiansen 2011), little effort **was** devoted to the monitoring of disease in sage-grouse prior to the emergence of West Nile Virus (WNv). As such, few records exist **to reveal** the role disease may have played in population declines of sage-grouse (Connelly et al. 2004, Christiansen 2011, Connelly et al. 2011c). Thorough reviews of disease impacts on sage-grouse can be found in Christiansen and Tate (Wyoming Executive Order) and Connelly et al. (2004). Ectoparasites supported by sage-grouse include lice, ticks, and dipterans (Connelly et al. 2004, Christiansen 2011, Connelly et al. 2011c). Most ectoparasites cannot produce disease but serve as vectors of transmission and can be detrimental if the bird is stressed (Thorne et al. 1982, Peterson 2004). High louse concentrations have been shown to limit breeding opportunities of male sage-grouse and may therefore potentially impact the genetic diversity of the species (Boyce 1990, Deibert 1995, Connelly et al. 2011c).

Two internal parasites have caused fatalities in sage-grouse. The disease Coccidiosis is spread via protozoans *Eimeria spp.* (Connelly et al. 2004, Hagen and Bildfell 2007) and possibly ixodid ticks (*Haimaphysalis cordeilishas*). A tularemia (*Francisella tularenis*) outbreak coincided with the mortalities attributed to an ixodid tick infestation (Parker et al. 1932, Christiansen 2011). It is likely that the tularemia, in combination with the high number of ticks feeding on the birds, resulted in bird mortalities (Christiansen 2011). This is the only reported case of tularemia in sage-grouse. Coccidiosis, while not common today, was once prevalent throughout sage-grouse range (Christiansen 2011). This parasite causes decreased growth and significant mortality in young birds (Thorne et al. 1982, Connelly et al. 2004, Christiansen 2011). Those birds that survive appear to develop immunity from subsequent

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infections (Thorne et al. 1982, Connelly et al. 2004). Outbreaks of coccidiosis have been clustered in areas where large numbers of birds gather, causing the soil and water to become contaminated with fecal material (Scott 1940, Honess 1968, Connelly et al. 2004, Christiansen 2011) and may regulate small, isolated populations of grouse (Peterson 2004). Some researchers suggest that the decline in coccidiosis cases is directly related to the declining density of sage-grouse (Christiansen 2011).

Bacteria and fungi can also occur in sage-grouse (Scott 1940, Honess 1968, Hausleitner 2003, Connelly et al. 2004, Peterson 2004, Hagen and Bildfell 2007, Christiansen 2011), but none currently play a role in limiting sage-grouse populations. This may change if environmental conditions result in **greater** concentrations of birds, leading to contamination of water supplies with fecal material (Christiansen 2011). Prior to 2002, avian infectious bronchitis was the only identified virus infecting sage-grouse, and no clinical signs were noted (Peterson 2004). West Nile Virus (WNv) was introduced into North America in 1999 (Marra et al. 2004) and was first documented in sage-grouse in 2002 (Walker and Naugle 2011). Although the disease is presently patchily distributed, it represents the only active disease which threatens sage-grouse populations with heavy mortality (U.S. Fish and Wildlife Service 2010b). Sage-grouse are highly susceptible to WNv and suffer high rates of mortality (Clark et al. 2006, McLean 2006). For example, data from four studies showed a 25% decline in grouse numbers in July and August of 2003 (Naugle et al. 2004) and decline in male and female lek attendance in 2004 (Walker et al. 2004). Populations not exposed to WNv did not experience a similar decline. Deaths from WNv occur in mid-summer, a time when survival is typically high (Schroeder et al. 1999, Aldridge and Brigham 2003a) making these losses additive and reducing annual survival (Naugle et al. 2005a). These data suggest that WNv could contribute to local population extirpation (Walker et al. 2004, Naugle et al. 2005b). Resistance to WNv is very low with exposure to the virus typically resulting in mortality of sage-grouse (Clark et al. 2006, Walker and Naugle 2011). It is unknown if birds surviving exposure to

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WNv develop immunity to future exposure (Clark et al. 2006, Walker and Naugle 2011) or if residual effects such as reduced productivity or overwinter survival occur (Walker et al. 2007b).

The distribution and probability of WNv outbreak in these rural semi-arid environments is poorly understood, however the WNv life-cycle provides applicable insights. The primary vector of WNv in sagebrush ecosystems is the mosquito *Culex tarsalis* (Naugle et al. 2004, Naugle et al. 2005a, Walker and Naugle 2011). WNv persists through a mosquito-bird-mosquito infection cycle (McLean 2006), although bird-to-bird transmission has been observed (McLean 2006, Walker and Naugle 2011). The severity of WNv outbreaks and the transmission of the disease is primarily regulated by environmental factors, including temperature, precipitation, and proximity to anthropogenic water sources which support mosquito larvae (McLean 2006, Reisen et al. 2006, Walker and Naugle 2011). Mosquito activity and virus amplification is hindered by cold temperatures, restricting transmission to the summer months (Naugle et al. 2005b, Zou et al. 2007). Cooler ambient temperatures at higher elevations and in more northerly locations may reduce the exposure risk of sage-grouse living in these areas (Naugle et al. 2004, Naugle et al. 2005a, Walker and Naugle 2011)

Although *C. tarsalis* is able to overwinter **and** individual **mosquito**s emerge as infected adults in the spring (Clark et al. 2006, Walker and Naugle 2011), the species is dependent on the availability of warm pools of water for larval development. As such, the ongoing proliferation of anthropogenic surface water features (stock ponds, coal-bed methane discharge ponds, irrigated agricultural fields, etc.) could help maintain or possibly increase the occurrence of WNv on the landscape (Friend 2001, Zou 2006, Walker et al. 2007b, Walker and Naugle 2011). Mosquitoes are able to disperse up to 18 km (11.2 mi) from their larval pond (Clark et al. 2006, Walker and Naugle 2011) meaning the entire sage-grouse range could potentially be exposed to the virus and that the prevalence of it will increase (U.S. Fish and Wildlife Service 2010b). If minimizing the impact of WNv on sage-grouse is warranted due to local

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population dynamics, controlling the number of mosquito emerging from anthropogenic water sources and reducing availability of these water features as habitat may be important options. Sage-grouse do not require standing water (Schroeder et al. 1999, Connelly et al. 2004), therefore, the practice of placing water developments in arid landscapes for the benefit of sage-grouse may be reduced or eliminated (Clark et al. 2006, Walker and Naugle 2011) without expectation of population impacts. Water sources may have specific value for managing some landscapes, but the threat of spreading WNv through anthropogenic water sources indicates consideration of control or mitigation to discourage breeding mosquitos either through construction, modification, or management (Doherty 2007) may be warranted. The biting midge *Culicoides sonorensis* has also been identified as a possible vector of WNv (Schmidtmann, 2005); this species requires muddy banks to lay its eggs and therefore may particularly be a factor in areas with large numbers of stock ponds. *C. sonorensis* is an important vector of bluetounge in ruminanats, and while it is not known if they actively feed on avifauna, WNv was found in a midge sample from the Powder River Basin, Wyoming (Schmidtmann, 2005). Because of the large number of water sources and their **widespread** distribution, mitigation measures may be cost prohibitive (U.S. Fish and Wildlife Service 2010b), but may be warranted when sage-grouse populations are small, isolated or genetically limited (U.S. Fish and Wildlife Service 2010b). Caution is warranted when employing mosquito control to ensure that benefit from reducing the occurrence of WNv is not overshadowed by cascading ecological effects (Marra et al. 2004). WNv fowl vaccines were tested in captive birds and were largely ineffective (Clark et al. 2006, Walker and Naugle 2011). Development of a sage-grouse specific vaccine would require market incentive and would likely not be practical for large scale deployment (U.S. Fish and Wildlife Service 2010b).

Models suggest that the prevalence of WNv is likely to increase throughout the range of sage-grouse as the number of anthropogenic water sources and ambient temperatures increase (U.S. Fish and

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Wildlife Service 2010b). Sage-grouse populations will respond differently to WNv infections depending on factors that affect exposure and susceptibility (Clark et al. 2006, Walker and Naugle 2011). While larger populations may be able to absorb losses from WNv as long available habitat is sufficient (Clark et al. 2006, Walker and Naugle 2011), a WNv outbreak in small, isolated, or genetically limited populations may be devastating and **may** reduce **a** population beyond a point where recovery is possible (Clark et al. 2006, Walker and Naugle 2011).

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Sage-grouse gather in mesic habitats during the mid to late summer (Connelly et al. 2000c)**,** making them potentially more vulnerable to all of the pathogens discussed. **M**ore dispersed populations in less arid habitats may not suffer the same threats. Historically, obvious morbidity and mortality in sage-grouse caused by the pathogens discussed above was tied to higher concentrations of grouse localized near water sources during dry conditions (Scott 1940, Honess 1968, Connelly et al. 2004, Christiansen 2011). "Likely" climate-change scenarios according to the Intergovernmental Panel on Climate Change, (IPCC 2007), suggest the impacts of disease on sage-grouse will likely increase (Neilson et al. 2005) due to increased temperatures and drought conditions predicted to occur across the sagebrush biome (IPCC 2007). If realized, these conditions would limit the availability of mesic areas, potentially leading to high densities of grouse around these areas and other anthropogenic water sources. Past outbreaks of bacterial infections, coccidiosis, and WNv have been linked to such circumstances.

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Predation

Typically sage-grouse live between 3 and 6 years, with individuals up to 9 years of age reported in the wild (Connelly et al. 2004). Predation is commonly identified as the primary cause of direct mortality for sage-grouse at all life stages (Schroeder et al. 1999, Connelly et al. 2000a, Connelly et al. 2011a), but there is little published support for predation being a limiting factor in sage-grouse populations (Connelly et al. 2004), particularly in areas where there is high quality habitat (Hagen

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2011). Sage-grouse have co-evolved with a suite of predators, **including** coyotes (*Canis latrans*), badgers (*Taxidea taxus*), bobcats (*Felis rufus*), red fox (*Vulpes vulpes*)**. S**everal raptor species **are** common predators of juvenile and adult sage-grouse (Patterson 1952, Schroeder et al. 1999, Schroeder and Baydack 2001b)**,** and coyote, badger, common raven (*Corvus corax*), and black-billed magpie (*Pica hudsonia*) are regular nest predators. Ground squirrels (*Spermophilus* spp.) were once thought to be major nest predator**,**s but recent evidence indicates that the mandibles of some ground squirrel species are physically unable to puncture sage-grouse eggs (Holloran 2003, Coates 2007). The degree and significance of snake predation on sage-grouse nests in unknown (Holloran 2003, Coates 2007). Cryptic coloration, habitat selection, and behavioral patterns have allowed sage-grouse to persist throughout sagebrush habitats (Schroeder et al. 1999), co-existing with these predators. Although sage-grouse have a number of predators, none are known to focus on sage-grouse as a primary food source. Most predators of sage-grouse depend primarily on rodents and lagomorphs (Schroeder et al. 1999), however alternate prey, such as sage-grouse, may still experience high predation rates either because they are targeted when the primary prey become scarce or if predators kill indiscriminately as predator numbers increase (Norrdahl and Korpimaki 2000).

Male sage-grouse have the greatest exposure to predation **at leks** (Schroeder et al. 1999, Schroeder and Baydack 2001a, Hagen 2011) where they congregate and perform conspicuous mating displays. The concentration of birds present may attract a variety of predators and affect grouse avoidance behavior (Aspbury and Gibson 2004, Boyko et al. 2004). Because of the disproportionate predation on males during the breeding season, female sage-grouse have a longer life expectancy (Schroeder et al. 1999). Female sage-grouse are more susceptible to predators while nesting, but mortality rates are low, as hens will abandon their nests when disturbed by predators (Hagen 2011). Predation on sage-grouse outside of the lekking, nesting**,** and brood rearing periods is rare (Connelly et

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al. 2000a, Moynahan et al. 2006, Hagen 2011). The highly polygynous nature of sage-grouse suggests that sage-grouse populations are more sensitive to predation upon females (U.S. Fish and Wildlife Service 2010b) since only a few males per lek breed each year. Predation of breeding hens and young chicks may negatively affect sage-grouse population numbers as these two cohorts are the most significant contributors to population productivity (Baxter et al. 2008, Connelly et al. 2011a).

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Human encroachment into sagebrush habitats has affected the predator-sage-grouse dynamic. The act of altering the landscape can create an influx of predators into an area and lead to a decline in annual recruitment (Gregg et al. 1994, Delong et al. 1995, Braun 1998a, Schroeder and Baydack 2001b, Coates 2007, Hagen 2011). Predators that are closely associated with human development, red fox and corvids, have increased in abundance over the sagebrush landscape (Sovada et al. 1995). These species in particular have been shown to be efficient predators of nests and juvenile sage-grouse (Schroeder et al. 1999). As sage-grouse habitat is lost or fragmented due to energy development, agriculture, or ex-urban development, quality nesting and brood rearing habitat becomes restricted (Bui 2009). The higher density of grouse in lower quality habitat combined with potentially easier predator access along roads, fences rows, edges, and trails, may make foraging easier for predators (Connelly et al. 2004, Holloran 2005, Holloran et al. 2005, Aldridge and Boyce 2007, Bui 2009). In addition to habitat loss and fragmentation, ranches, farms, and other housing developments have led to the introduction of domestic dogs (*Canis domesticus*) and cats (*Felis domesticus*) into sage-grouse habitats, both of which may pray upon grouse (Connelly et al. 2004, Holloran 2005, Holloran et al. 2005, Aldridge and Boyce 2007, Bui 2009). Roads have been shown to be particularly efficient as mechanisms of distribution for predators throughout the sagebrush landscape. Some mammalian species (Forman and Alexander 1998, Forman 2000) and ravens (Knight et al. 1993, Connelly et al. 2004) have used these linear features to expand their distribution into previously unused regions, increasing the risk of predation to sage-grouse.

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Nest predation has been linked to low herbaceous cover (Gregg et al. 1994, Delong et al. 1995, Braun 1998a, Schroeder and Baydack 2001b, Coates 2007, Coates et al. 2008, Hagen 2011). Sage-grouse select nesting sites specifically based on the amount of grass and forb cover present (Hagen et al. 2007) as it is needed for predator avoidance. Reduction of grass height due to livestock grazing below 18 cm (4 in.) has been shown to negatively affect nest survival (Gregg et al. 1994). However, abundant cover has also been shown to facilitate badger predation as it attracts small mammals, the primary prey of badgers (Coates 2007). Adequate grass and forb cover provides valuable hiding cover for young chicks (Schroeder and Baydack 2001b), **a life stage during which** mortality due to predation has been estimated to be highest, at 82% (Gregg et al. 2007).

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To support maintenance of suitable grass and forb cover and minimize associated predation risks, careful monitoring of grazing allotments within sage-grouse nesting habitat may be coupled with livestock management to ensure suitable grass and forb cover is reserved. In addition, pasture fencing creates perching sites for raptors and corvids and travel corridors for coyotes and foxes, increasing predation risk across many habitats (Call and Maser 1985, Braun 1998b, Connelly et al. 2000b, Beck et al. 2003, Knick et al. 2003a, Connelly et al. 2004) and leading to habitat avoidance by sage-grouse (Call and Maser 1985, Braun 1998b, Connelly et al. 2000b, Beck et al. 2003, Knick et al. 2003a, Connelly et al. 2004).

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Similarly, power poles, towers and fence posts provide attractive hunting and roosting perches for corvids and raptors (Steenhof et al. 1993, Connelly et al. 2000b, Manville 2002, Vander Haegen et al. 2002, Connelly et al. 2004). Power poles increase a raptor's range of vision and allow for greater speed during attacks, increasing their hunting efficiency (Steenhof et al. 1993, Connelly et al. 2000b, Manville 2002, Vander Haegen et al. 2002, Connelly et al. 2004). After the installation of transmission lines, densities of raptors and corvids increase markedly (Ellis 1985, Steenhof et al. 1993, Atamian

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2007) as does predation on sage-grouse (Ellis 1985, Steenhof et al. 1993, Atamian 2007). Power lines may also cause changes in lek dynamics, with lower growth rates observed on leks within 0.4 km (0.25 mi) of new power lines in the Powder River Basin of Wyoming as compared to those further from the lines. This was attributed to increased raptor predation (Braun et al. 2002). Raptors and corvids forage on average 5- to 6.9 km (3.1- to 4.3 mi) from perching sites, potentially impacting 32 to 40 percent of the sage-grouse conservation area (Connelly et al. 2004). Removing or reducing the number of perching structures and landfills in key nesting, brood rearing, and lekking habitats may reduce predation pressure on sage-grouse (Bui 2009, Leu 2011).

Predator Control

Although there is little published information supporting the notion that predation is a major limiting factor on sage-grouse (Connelly and Braun 1997, Connelly et al. 2000b, Schroeder and Baydack 2001a), arguments continue to be made supporting predator control as an important management action (Wambolt et al. 2002). Additionally, relatively high annual survival rates of adult **sage-grouse** (0.59-0.77 for females, 0.37-0.63 for males; Zablan et al. 2003) accompanied by documented ineffectiveness of coyote control in affecting nest survival in one area in Wyoming (Slater 2003), further reinforce the idea that predation is not a widespread factor acting to depress sage-grouse populations. Where predator removal has been used as a management tool, higher numbers of grouse have sometimes been observed in the fall, but these gains have not carried over to spring breeding populations (Cote 1997, Hagen 2011, Leu 2011). The removal of coyotes in some areas has resulted in an increase in the numbers of mesopredators, which may have greater impacts on grouse populations (Mezquida et al. 2006). Similarly, raven removal in northeastern Nevada resulted in only short-term reductions in raven numbers (Coates 2007), and any benefits to sage-grouse populations were negated by an increase in badger predation (Coates 2007). Predator removal may be warranted in areas with low

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habitat quality (i.e. heavily fragmented or areas of high anthropogenic disturbance) supporting inflated numbers of synanthropic predators, however predator numbers will rebound quickly without continual control (Hagen 2011).

Factor E: Pesticides and Contaminants

Because of the overlap between current cropland distributions and historically high-quality sagebrush habitats (deep loamy and sandy loam soils, valley bottoms and wet meadows) and fidelity of sage-grouse populations to these habitats, there can be considerable summer use of agricultural lands by sage-grouse even though current sagebrush cover may be relatively low. With these overlapping uses comes risk of poisoning by pesticides (Blus et al. 1989, Connelly and Blus 1991) and other chemicals used in vegetation and pest management. Many of these factors may have indirect effects on health and fitness, in addition to the obvious effects on survival (Connelly et al. 2004; Table 25).

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Pesticides

Sage-grouse typically avoid human developments and highly cultivated landscapes, however because these lands often replaced historically important habitats and remain adjacent to remaining sagebrush habitats, use of these areas characterized by “low nest success” and “poor chick survival” (due to increased risks) remains common on some landscapes (Aldridge and Boyce 2007). Nonetheless, irrigated crops, hay, and pastures represent an attractive source of foods, including insects, especially during drought years and later in the brood-rearing season when native forbs become desiccated (Hagen 2007, Connelly et al. 2011d, Knick et al. 2011). Research using collared animals found that 18% of marked sage-grouse in Idaho used croplands adjacent to sagebrush habitat that had been sprayed by dimethoate and methamidophos (Blus et al. 1989). Posthumous assessments indicated 5% mortality in the first year, and 16% in the following year due to organophosphorus poisoning. This research was focused in an area with extensive agricultural development adjacent to sagebrush habitats, therefore

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similar concentrations may be anticipated in similarly developed areas, but this level of mortality would extend range-wide only with similar applications.

In addition to direct impacts of pesticides through direct contact (Blus et al. 1989, Connelly et al. 2004), reduction of important seasonal foods such as forbs and insects can affect the forage base (Eng 1952, Connelly et al. 2004), therefore effects on sage-grouse seasonal habitat requirements may be an important consideration for pest and pesticide management. Insects are an important component of early brood-rearing habitat (Patterson 1952, Klebenow 1968, Johnson and Boyce 1991). A complete assessment of early brood-rearing habitat includes an evaluation of insect abundance, because they are an important part of seasonal diets. A paucity or undependable invertebrate resource base is likely to depress growth rates and brood-rearing success (Connelly et al. 2004), however vegetation alteration due to population peaks (“outbreaks”) may have negative effects on the forage base (Ritchie and Tilman 1992, Scherber et al. 2010) suggesting need for future evaluation and management adaptation regarding population interactions with insect herbivores.

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Herbicides

In addition to pesticides, several herbicides are commonly applied in and around the sagebrush ecosystem; alteration of desirable components of the habitat may be targeted or unintentional, depending on the vegetation targets, for example, sagebrush or invasive species. Many enhancement and sagebrush restoration treatments involved alterations that include the removal of sagebrush (Carr and Glover 1970, Klebenow 1970, Connelly et al. 2004) to increase the cover and productivity of herbaceous species in the treatment areas. Although these treatments continue in many areas, decreased emphasis on sagebrush removal or reduction and increased emphasis on reducing invasive plant species distributions mean that some chemicals may be applied on, or adjacent to, priority habitat areas. Most modern chemicals are applied at levels expected to decay quickly with minimal soil residuals. **For**

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example 2,4-D (2,4-Dichlorophenoxyacetic acid) degrades rapidly with half-life values estimated at 1-14 days (Gervais et al. 2008; Table 25), however detectable residues can persist for up to a year (Tu et al. 2001). Similarly, other commonly applied chemical herbicides, i.e., Imazapic (Plateau®, American Cyanamid Co.), Tebuthiuron (Spike80®, Dow AgroSciences LLC), and Glyphosphate (Round-up®, Rodeo®, Monsanto Co.) that interrupt cell chemistry had minimal effects on test animals and decay quickly in the environment. Tebuthiuron may cause mild skin irritation in mammals but is essentially non-irritating (tested on rabbits and guinea pigs); single-dose oral toxicity is moderate in mammals (LD50 for rats is 488mg/kg) but it is not a known carcinogen (Dow AgroSciences 1999). Glyphosphate inhibits enzyme and amino acid formation in chloroplasts of most plant species; these organelles are not present in animal cells making transferred toxicity unlikely. **Glyphosphate** has an average half-life of 47 days (Tu et al. 2001). **According to the manufacturers, direct** exposure to these chemicals may cause eye irritation, absorption through the skin, and inhalation toxicity effects. **T**hey are not known to bioaccumulate in animals and are rapidly excreted in urine and feces, rendering them mostly non-toxic to a wide range of non-target organisms, including mammals, birds, fish, aquatic invertebrates, and insects (Tu et al. 2001). Direct assessment of toxicity effects on sage-grouse have not been conducted, but existing information indicates little concern for direct effects of certified herbicides on sage-grouse health.

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Chemical	Use	Direct/Acute Effects	Indirect Effects
Dimethoate	Pesticide, forage, seed alfalfa	Very Toxic (Blus et al. 1989)	Reduced availability of insects for food
Methamidophos	Pesticide, seed alfalfa, potatoes; US registration cancelled 9/23/2009	Very Toxic (Blus et al. 1989)	Reduced availability of insects for food
Malathion	Pesticide, grasshoppers	Toxic	Reduced availability of insects for food
Carbaryl	Pesticide, grasshoppers	Low to Moderately Toxic	Reduced availability of insects for food
Dimilin	Pesticide, grasshoppers	Low Toxicity	Reduced availability of insects for food
2,4-D	Herbicide, sagebrush thinning	Low Toxicity	Reduced sagebrush cover; reduced forb availability
Plateau ® (Imazapic)[1]	Herbicide, cheatgrass	No more than slightly toxic	Reduced forb availability
Spike ® (Tebuthiuron)[1]	Herbicide, sagebrush thinning	Low to Moderately Toxic	Reduced sagebrush cover
Roundup ® (Glyphosphate)[1]	Herbicide	No more than slightly toxic	Reduced sagebrush cover; reduced forb availability

[1] Imazapic, Tebuthiuron, and Glyphosphate have chemical actions that target plant physiology, it is highly unlikely that they have a direct effect on sage-grouse at levels typically applied (according to manufacturer instructions).

Table 25. Insecticides and herbicides certified for application and commonly applied on and around sagebrush habitats

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IV. Factor D: Policies and Programs Affecting Sage-grouse Conservation

One of the key challenges in implementing sage-grouse conservation efforts is the mixed pattern of surface land ownership and jurisdiction across the species' range (Knick 2011b). This patchwork of land ownership is a result of historical public land policies that have guided disposition of public lands in the Western U.S. since their settlement (Knick 2011b). With such diverse ownership across a large range (Table 26), regulatory actions and policies aimed at sage-grouse conservation require coordination across traditional geopolitical and landownership boundaries; a given population of sage-grouse can migrate between privately owned land and land administered by numerous federal and state agencies (Stiver 2011a). Each class of surface ownership carries different management requirements and objectives. Notably, the BLM and USFS manage approximately 60 percent of the surface area across all MZs, with the BLM having jurisdiction over 52 percent of the sage-grouse range and the USFS administering nearly 8 percent of the range (Knick 2011a). Therefore, 60 percent of the surface area across the range is managed for multiple (often competing) uses, including requirements to balance commodity production with wildlife (Knick 2011a). The USFWS is the only federal agency with an exclusive wildlife conservation mandate; however, it manages only one percent of the species' habitat (Knick 2011a). A large percent (31%) of surface area within the sage-grouse range remains in private ownership (Knick 2011a). States and other federal agencies and departments manage the remainder of the surface area within the range (Knick 2011a).

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Table 26. Percent Surface Ownership of sage-grouse habitats (PPH and PGH) within the Sage-grouse Management Zones.*

	PPH			PGH		
Management Zone Entity	SG Habitat (acres)	Area (acres)	Area (%)	SG Habitat (acres)	Area (acres)	Area (%)
MZ I - GP	11,636,400	485,500	4.17	34,663,000	879,100	2.54
BLM	2,994,300	136,300	4.55	4,524,900	120,400	2.66
Forest Service	292,400	100	0.03	515,300	0	0.00
Tribal and Other Federal	219,700	130,700	59.49	2,427,700	393,900	16.23
Private	7,132,500	202,700	2.84	24,682,800	334,200	1.35
State	995,600	15,700	1.58	2,498,400	30,500	1.22
Other	1,900	0	0.00	13,900	0	0.00
MZ II and VII - WB & CP	17,476,000	641,600	3.67	19,200,200	1,140,400	5.94
BLM	9,021,200	252,200	2.80	9,012,500	569,300	6.32
Forest Service	162,000	2,500	1.54	452,500	46,300	10.23
Tribal and Other Federal	784,000	93,400	11.91	1,354,600	105,900	7.82
Private	6,233,900	220,500	3.54	7,394,800	366,300	4.95
State	1,244,800	44,500	3.57	979,800	47,200	4.82
Other	30,100	28,400	94.35	6,000	5,500	91.67
MZ III - SGB	10,028,500	305,000	3.04	3,970,100	198,000	4.99
BLM	6,309,400	170,900	2.71	3,199,800	130,800	4.09
Forest Service	1,236,200	102,500	8.29	356,200	62,700	17.60
Tribal and Other Federal	260,800	11,000	4.22	29,100	3,700	12.71
Private	1,836,200	13,700	0.75	384,800	500	0.13
State	385,900	6,900	1.79	200	200	100.00
MZ IV - SRP	21,930,600	2,055,900	9.37	10,958,500	1,343,600	12.26
BLM	13,710,700	1,745,900	12.73	4,928,200	879,400	17.84
Forest Service	1,613,800	26,600	1.65	1,113,500	3,100	0.28
Tribal and Other Federal	633,600	99,900	15.77	522,500	261,900	50.12
Private	4,890,200	149,600	3.06	3,516,742	166,800	4.74
State	1,019,373	33,900	3.33	846,200	30,800	3.64
Other	62,900	0	0.00	31,400	1,500	4.78
MZ V - NGB	7,097,200	2,514,500	35.43	5,808,000	1,275,500	21.96
BLM	5,117,500	1,801,700	35.21	4,196,700	1,181,000	28.14
Forest Service	62,200	0	0.00	114,900	100	0.09
Tribal and Other Federal	717,100	695,700	97.02	101,800	74,900	73.58
Private	798,000	11,900	1.49	1,199,000	13,400	1.12
State	64,900	2,900	4.47	115,800	5,300	4.58
Other	337,500	2,200	0.65	79,800	800	1.00

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* Data Sources: BLM GSSP Surface Management Agency 2012, USFS Enterprise Data Warehouse 2012

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Many agreements and partnerships have been established across the sage-grouse range, with varying levels of commitment, jurisdiction and participation; however **in 2010,** lack of adequate regulatory mechanisms was determined to be a substantial threat to sage-grouse 12-Month Findings for Petitions to List the Greater Sage-Grouse (U.S. Fish and Wildlife Service 2010b). To support continued facilitation and integrated management across political boundaries, this section reports existing and proposed conservation efforts directed at sage-grouse, including regulatory and non-regulatory approaches by federal, state and local agencies, as well as private lands and, where appropriate, the threats those efforts seek to address.

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Range-wide Conservation Efforts

The range of the sage-grouse includes habitat within the United States and Canada, with 99% of the current population found in the United States and the remaining 1% found in Canada (Stiver et al. 2006a). However, because the sage-grouse is not considered to be a migratory species, it is not afforded the protections of the Migratory Bird Treaty Act (16 U.S.C. § 703 *et seq.*; U.S. Fish and Wildlife Service 2010b).

Though not regulatory mechanisms, a series of Memoranda of Understanding (MOUs) have been entered into by various state and federal agencies which acknowledge the collaboration among the signatories. The partnerships formed by the MOUs have produced a range-wide conservation framework (Stiver 2011a). In 2004, the Western Association of Fish and Wildlife Agencies (WAFWA) in cooperation with the USFS, BLM, USFWS and United States Geological Survey, published the Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats (Connelly et al. 2004), a comprehensive, ecologically-focused analysis that documented the current status and potential factors influencing the long-term conservation of sage-grouse populations and sagebrush ecosystems. In 2006, WAFWA released the Greater Sage-Grouse Comprehensive Conservation Strategy (Stiver et al. 2006a), which includes seven sub-strategies to “maintain and enhance populations and distribution of

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sage-grouse by protecting and improving sagebrush habitats and ecosystems that sustain these populations." This strategy was itself a collaborative effort, reflecting the collective knowledge of local working groups, state and provincial conservation plans, federal and state agencies, and a range-wide issues forum (Stiver 2011a). In 2011, agency, academic and private sector experts published a monograph on sage-grouse populations, sagebrush habitats, and the relationships between land use and sage-grouse populations across the sage-grouse range (Knick 2011a)

In the 2006 strategy, WAFWA recommended passage of the North American Sagebrush Ecosystem Conservation Act (NASECA, Stiver et al. 2006a). The NASECA is modeled after the North American Wetland Conservation Act, calls for leadership through the establishment of an NASECA Council, and proposes an initial five-year budget of $425 million to be administered by a fiduciary entity and dispersed across each MZ, States and Provinces (Stiver et al. 2006a). The precise details of NASECA are to be determined by the Western Governors' Association, which along with WAFWA completed a draft version of the Act in 2009 (Stiver et al. 2006a, Western Governors' Association 2011). In 2011, the Western Governors' Association requested congress to pass the NASECA and appropriate the necessary funds for implementation (Western Governors' Association 2011), and if approved, it will provide a range-wide funding mechanism to implement WAFWA's Comprehensive Conservation Strategy.

Deleted: the Western Association of Fish and Wildlife Agencies

Canadian Conservation Efforts

The sage-grouse is a protected species in Canada under schedule 1 of the Species at Risk Act (SARA, Canada Gazette 2002, U.S. Fish and Wildlife Service 2010b). The Species at Risk Act , like its counterpart the Endangered Species Act, prohibits "harming" individuals within a protected species and allows for the protection of critical habitat (Aldridge and Brigham 2003a, p.31).

Sage-grouse are also protected under the laws of the provinces of Alberta and Saskatchewan, neither of which allow harvesting of individual birds (Aldridge and Brigham 2003a, p.31). In

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Saskatchewan, sage-grouse are listed as endangered under the Saskatchewan Wildlife Act, which restricts development within 500 m (1,640 ft.) of leks and prohibits construction within 1,000 m (3,281 ft.) of leks between March 15 and May 15 (Aldridge and Brigham 2003a), p.32). Additionally, under Saskatchewan's Wildlife Habitat Protection Act, sage-grouse habitat is afforded protection from transfer and cultivation (Aldridge and Brigham 2003a, p.32). Alberta protects individual birds, but not sage-grouse habitat (Aldridge and Brigham 2003a, p.32). USFWS has acknowledged these protections, but concluded they are insufficient to assure conservation of the species (U.S. Fish and Wildlife Service 2010b, p.13981).

United States Federal Agency Conservation Efforts

Natural Resources Conservation Service: Sage Grouse Initiative

Launched in 2010, the United States Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) Sage-Grouse Initiative (SGI) is working with private landowners in 11 western States to improve habitat for sage-grouse while simultaneously improving working ranches (U.S. Natural Resources Conservation Service 2012c). With approximately 31% of all sagebrush habitat across the range in private ownership (Table 27; Stiver 2011a, p.39), a unique opportunity exists for NRCS to benefit sage-grouse and ensure the persistence of large and intact rangelands through implementation of the SGI (U.S. Fish and Wildlife Service 2010a, p.5).

Deleted: U.S. Natural Resources Conservation Service

Participation in the SGI program is voluntary, but willing participants enter into binding contracts or easements to ensure that conservation practices that enhance sage-grouse habitat are implemented (U.S. Fish and Wildlife Service 2010a). Though participation is voluntary, and thus not a traditional regulatory approach, participating landowners are bound by contract (usually three to five years in duration) to implement, in consultation with NRCS staff, conservation practices if they wish to receive the financial incentives offered by the SGI. These financial incentives generally take the form of

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payments to offset costs of implementing conservation practices and easement or rental payments for long-term conservation (U.S. Fish and Wildlife Service 2010b). Demand to participate in the program has been strong; as of March 2012, 462 ranchers were enrolled in the SGI, covering 1.7 million acres (6880 km^2, U.S. Natural Resources Conservation Service 2012a). Funding for the SGI, through conservation programs provided for in the Food, Conservation, and Energy Act of 2008 (Farm Bill), has increased to meet the interest – from $21 million in FY 2010 to over $92 million in FY 2011 (U.S. Natural Resources Conservation Service 2012c). In addition to the economic incentives offered by the SGI, participating landowners also have the benefit of knowing that if the sage-grouse is listed as threatened or endangered, their efforts under the SGI will comply with the ESA (though participation does not by itself offer permits for incidental take or protection similar to a Candidate Conservation Agreement with Assurances). While potentially effective at conserving sage-grouse populations and habitat on private lands, incentive-based conservation programs that fund the SGI generally require reauthorization from Congress under subsequent Farm Bills, and therefore these funding streams are potentially variable as they are subject to the political process.

Deleted: , as the USFWS determined the SGI does not jeopardize the continued existence of the species (U.S. Natural Resources Conservation Service 2012a)

The NRCS is working to implement SGI conservation measures on private lands that address many of the threats to sage-grouse identified in the 2010 Listing Decision. Many of those threats, including fragmented landscapes and urban expansion, overgrazing, and conifer encroachment are also threats to sustainable ranching (U.S. Natural Resources Conservation Service 2012c). Conversely, intact landscapes, an abundance of perennial grasses and forbs, invasive species management and well-designed grazing plans benefit both sage-grouse and promote sustainable ranching (U.S. Natural Resources Conservation Service 2012c).

Across the range, application of SGI conservation standards, including improved grazing systems, fence modification and removal, tree removal, and conservation easements vary from state to

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state. Grazing is the most widespread land use across the sagebrush biome (Connelly et al. 2004) and through the SGI, NRCS is working with landowners to implement grazing practices that, among other benefits to the species, increase cover in seasonal habitats (U.S. Natural Resources Conservation Service 2012a). Nearly 415,000 acres (1680 km^2) in Wyoming have (or are under contract to receive) some form of improved grazing system that could support increased hiding cover (U.S. Natural Resources Conservation Service 2012a). A component of grazing management, pasture fencing, has created a variety of threats to sage-grouse, such as mortality from collisions, increased predation due to perch sites and corridors, and habitat fragmentation (Call and Maser 1985, Braun 1998b, Oyler-McCance et al. 2001, Beck et al. 2003, Knick et al. 2003b, Connelly et al. 2004). Nearly 625 miles of fences were constructed annually from 1996 to 2002 in the sage-grouse range, with most being constructed in Montana, Nevada, Oregon and Wyoming (Connelly et al. 2004). Through the SGI program, participants have agreed to remove or mark nearly 350 miles of high-risk fence (U.S. Natural Resources Conservation Service 2012a). In Idaho, a recent study demonstrated that fence marking can lead to reduced sage-grouse collisions (Stevens 2011).

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SGI has two particular approaches to restoring sagebrush habitats that have been degraded or modified. NRCS is working with landowners to remove juniper and other expanding conifers from valuable habitats. For example, 54,626 acres (405 km^2) of juniper and pine have already been treated in Oregon (MZs IV and V; Table 27). Urbanization and conversion of habitat to agriculture, at the other end of the habitat change spectrum, have caused habitat loss and fragmentation across the western U.S., which has been determined to be a “key cause, if not the primary cause, of the decline of sage-grouse populations” (U.S. Fish and Wildlife Service 2010b). Conservation easements are one important approach to creating and maintaining large, intact sagebrush communities (U.S. Natural Resources Conservation Service 2012a). The NRCS has secured conservation easements on 208,023 acres (840

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km^2) across the sage-grouse range (U.S. Natural Resources Conservation Service 2012a) with the largest percentage of easements occurring in Wyoming (120,706 acres; 490 km^2), Montana (42,191 acres; 171 km^2) and Idaho (21,434 acres; 87 km^2; U.S. Natural Resources Conservation Service 2012a).

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State	Grazing (Total[1] Acres to be Treated with Improved Grazing Systems)	Fences (Total[1] Feet of "High Risk" Fence to be Marked or Removed)	Pinon-Juniper Expansion (Total[1] Acres to be Removed)	Habitat Loss Due to Fire or Conversion for Agriculture (Total[1] Acres to be Restored[2])	Late-Brood Rearing Habitat Degradation (Total[1] Acres to be Improved[3])	Urbanization or Habitat Conversion for Agriculture (Acres of Conservation Easements Secured)
California	23,395	420,501	28,665	1,020	66	-
Colorado	18,817	9,676	555	3,661	4	5,017
Idaho	206,170	309,892	5,600	4,449	370	21,434
Montana	246,814	460,854	-	883	-	42,191
Nevada	4,571	81,637	7,423	3,732	5883	3,695
N. Dakota	4,213	2,909	-	565	-	-
Oregon	8,488	5,280	54,626	-	-	-
S. Dakota	127,812	-	-	-	-	-
Utah	48,462	52,765	18,525	11,986	-	14,980
Wyoming	414,422	401,281	22	29	60	120,706
TOTALS	1,103,164	1,744,795	115,416	26,325	6,383	208,023

Table 27. SGI efforts by state (through 2011) with delineation of threats to sage-grouse targeted with mitigation.

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Farm Service Agency: Conservation Reserve Program

Similarly to the incentive-based programs that fund the SGI, the Conservation Reserve Program (CRP) is a program administered by the USDA Farm Service Agency (FSA, U.S. Farm Service Agency 2010). CRP lands are generally taken out of agricultural production and planted with perennial vegetative cover. Generally, contracts under the CRP program run for 10-15 years (U.S. Farm Service Agency 2010). Conversion of sagebrush to agriculture influences the ability of sagebrush-dominated landscapes to support sage-grouse through direct habitat loss and fragmentation (Connelly et al. 2004). CRP fields have provided valuable habitat in Washington (Schroeder and Vander Haegen 2006), but the value of these lands to sage-grouse across its entire range has not been demonstrated (Stiver et al. 2006b). Launched in 2008, State Acres for Wildlife Enhancement (SAFE) is a program within CRP designed to "address state and regional high-priority wildlife objectives" (U.S. Farm Service Agency 2008). Several states across the sage-grouse range have directed SAFE efforts towards enhancing sagebrush habitat. In Colorado, SAFE project partners hope to enroll 12,600 acres (51 km^2) in CRP to restore and enhance habitat for several species of grouse, including sage-grouse. Montana and North Dakota are each aiming to enroll 1,000 acres (4 km^2) in SAFE to restore cropland to sagebrush habitat to benefit sage-grouse and other sagebrush obligate birds. South Dakota is looking to add 500 acres (2 km^2) to SAFE for the same purpose. Lastly, a SAFE program in Northeast Wyoming is seeking to add 10,000 acres (40 km^2) to restore critical habitat by converting cropland to perennial plant communities (U.S. Farm Service Agency 2008).

Deleted: (U.S. Farm Service Agency 2010)

Other Federal Agencies

In addition to BLM (DOI) and the Forest Service (USDA), the United States Departments of Defense (DoD), Energy (DoE) and other Interior Bureaus [DOI, including USFWS, National Park

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Service (NPS) and Bureau of Indian Affairs (BIA)] manage publically owned lands across sage-grouse range, and many **lands** of these are protected (Table 28, Figure 30). While BLM and USFS manage most of the sagebrush and sage-grouse habitats -- other entities and agencies, combined manage only 5% of sagebrush lands in the United States (Stiver 2011a) -- cooperative management strategies may have local impacts or benefits and lands managed for other, specified purposes remain part of distribution and management of the sage-grouse across the landscape.

Comment [SSK79]: Is there a distinction here between managed and protected?

Fish and Wildlife Service, National Park Service and Other Federal Designations

The USFWS directly manages only 1% of sage-grouse habitats as part of the National Wildlife Refuge System (Knick 2011b). Refuges are administered under the National Wildlife Refuge Administration Act of 1966 (16 U.S.C. §668dd – 668ee), as amended, for the purpose of, "conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources." Several refuges within the range are currently revising their Comprehensive Conservation Plans (CCPs) as required by the 1997 National Wildlife Refuge Improvement Act. For instance, Hart Mountain National Antelope Refuge, which consists of 277,893 acres (1125 km^2) of sagebrush-steppe in Lake County, Oregon, published a Notice of Intent in the Federal Register to revise its CCP in May 2012 (U.S. Fish and Wildlife Service 2012, p.31379). The Notice of Intent identifies key issues to be analyzed in the CCP, many of which can benefit the Refuge's sage-grouse population: the impact of fire and juniper encroachment on the Refuge's sagebrush habitat, invasive species control, and land protection and planning to reduce habitat fragmentation (U.S. Fish and Wildlife Service 2012, p.31380). Sheldon National Wildlife Refuge, which encompasses 575,000 acres (2327 km^2) of sagebrush-steppe in northwest Nevada, issued its Draft CCP in 2011 (U.S. Fish and Wildlife Service 2011). Sage-grouse conservation is a major component of the CCP, which calls for, among other actions, restoration of sagebrush habitat, aggressive reduction of encroaching juniper, and control of invasive species, namely

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cheatgrass (*Bromus tectorum*; U.S. Fish and Wildlife Service 2011). Again, where BLM or USFS administered lands border National Wildlife Refuges, there exists the potential for collaborative efforts that may have localized benefits to sage-grouse populations.

Several units within the National Park System are also planning for sage-grouse and sagebrush conservation. The City of Rocks National Reserve (which is co-managed by the Idaho Department of Parks and Recreation; CIRO) and Craters of the Moon National Monument and Preserve (which is co-managed by the BLM; CRMO) are located in the Upper Columbia Basin in southern Idaho (MZ IV). Additionally, habitat selection studies have been conducted on the Jackson Hole sage-grouse population in and around Grand Teton National Park (Chong 2011), a small, but high-profile, population in Wyoming.

CRMO encompasses roughly 737,700 acres (2985 km^2) in south central Idaho, of which 70 percent is designated as either Wilderness Study Area or Wilderness (U.S. National Park Service and Bureau of Land Management 2006). Observations by the Idaho Department of Fish and Game indicate a 36% decrease in the number of sage-grouse leks in the last quarter century, with 53 known leks recorded on BLM-administered lands within the monument (U.S. National Park Service and Bureau of Land Management 2006). As described in the CRMO General Management Plan (2006), the agencies intend to prioritize vegetation restoration projects relative to sage-grouse populations (including enlarging and connecting habitats), as well as implement protective measures from the Idaho Sage-grouse Advisory Committee's Conservation Plan, including use restrictions where needed near occupied leks (U.S. National Park Service and Bureau of Land Management 2006). CIRO is currently in the process of revising its General Management Plan.

Wilderness designations may also play a role in sustaining sage-grouse populations and conserving their habitat, however very few Wilderness areas contain sagebrush (e.g., Table 28);

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expansion to include current roadless areas could increase the area from about 6% to 9% of the sagebrush landscape (Crist et al. 2005). Lands designated as Wilderness must generally contain at least 5,000 acres (20 km^2)and are managed by the agency having jurisdiction over such lands before they were included in the National Wilderness Preservation System (16 U.S.C. § 1131 *et seq*.). Wilderness designations are subject to the political process, as only Congress can designate Wilderness areas (16 U.S.C. § 1131 *et seq*.). Wilderness areas are characterized by the absence of motorized equipment and mechanical transport, and commercial enterprises are prohibited (16 U.S.C. § 1131 *et seq*.); therefore, they do not host many of the anthropogenic threats to sage-grouse identified in the USFWS's 2010 Listing Decision, such as habitat conversion for agriculture, urbanization, infrastructure and energy development.

Department of Defense

There are approximately 87 Department of Defense (DoD) managed facilities distributed across the sage-grouse range, with various operations and intensity of use among and within those facilities (Connelly et al. 2004). Because human access to many military installations is limited, these lands present an opportunity to conserve sage-grouse habitat; however, with only 26% (6,815 km^2, 1.7 million acres) of DoD managed lands being sagebrush dominated, they represent approximately 0.01% of the currently estimated sage-grouse range (670,000 km^2, 165.5 million acres). Seven military installations have confirmed sage-grouse populations, five of which are under the control of the Army: Dugway Proving Ground (UT), Sheridan Training Area (WY), Camp Guernsey (WY), Hawthorne Army Depot (NV), and the Toole Army Depot (UT). Two Air Force Bases (AFB) manage for known populations: Nellis AFB in Nevada and Mountain Home AFB, which administers the Saylor Creek and Juniper Butte Ranges in Idaho (U.S. Department of Defense and U.S. Fish and Wildlife Service 2006).

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At sites where military training exercises occur, such activities are generally destructive by their nature (Connelly et al. 2004) and may have substantial effects on habitats, including the spread of exotic species, the potential for soil erosion, and the possibility of reduced ecosystem productivity from tracked and wheeled vehicle maneuvering, as well as fires from ordnance impacts (Belcher and S.D. Wilson 1989, Shaw and V.E. Diersing 1990, Watts 1998). Obvious land-use impacts were evident on approximately 17% of the military lands surveyed by the Land Condition Trend Analysis, leaving substantial portions of some facilities available for conservation and management of native species (Knick et al. 2011).

While the land-use and conservation activities of DoD may have important local effects on the distribution of sage-grouse habitats (including effects on disturbance regimes) as well as some populations, they represent only a small portion of the species' range and therefore a small component of the conservation effort. When DoD facilities with sagebrush habitats fall within (partially or entirely) or adjacent to BLM or USFS planning and management units, then actions and planning that address sage-grouse conservation may benefit from recognition of resources, authorities and activities associated with DoD lands which may benefit or harm sage-grouse, in the planning process. Cooperation and collaboration with DoD, and other agencies that affect land-use patterns and habitat conditions (e.g., Bureau of Reclamation, Department of Energy, USFS), during regional planning processes is important to ensure sound management and efficient use of public resources across political boundaries.

Department of Energy

The Idaho National Laboratory (INL) site consists of 2305 km^2 (570,000 acres) in the Upper Snake River Plain of southeastern Idaho (Whiting and Bybee 2011) of which 115 square miles was designated as the Sagebrush-Steppe Ecosystem Reserve in July 1999 by the Secretary of Energy (INL Campus Development Office and North Wind Inc. 2011). The INL site is home to several sage-grouse

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populations and hosts numerous sage-grouse leks (INL Campus Development Office and North Wind Inc. 2011, Whiting and Bybee 2011). The INL includes most of the same issues found on the larger sage-grouse range. Wildland fires are relatively common on the site and an on-site fire department provides wildfire management in cooperation with the BLM and local authorities (INL Campus Development Office and North Wind Inc. 2011). BLM administers permits to graze cattle and sheep on up to 340,000 acres (1375 km^2) of the INL (INL Campus Development Office and North Wind Inc. 2011). Nearly six percent of INL (approximately 34,000 acres, 138 km^2) consists of public roads and utility right of ways (INL Campus Development Office and North Wind Inc. 2011). Other infrastructure includes an extensive power delivery system, including substations and a 62 mile, 100 km (60 miles of which are above ground) transmission loop (INL Campus Development Office and North Wind Inc. 2011).

From 1978 to 1980, fixed-wing aircraft and four-wheel drive surveys identified 59 sage-grouse leks on or near the INL (Connelly 1980). According to this data, it was determined that the INL populations were stable or increasing (Connelly 1980). Monitoring of the INL sage-grouse populations was sporadic until a recent study collected data on lek attendance, activity, and distribution within the INL during the springs of 2009 and 2010 (Whiting and Bybee 2011). Upon revisit, the number of active sage-grouse leks within the INL was less than half of historical leks (Whiting and Bybee 2011), although uncertainty associated with historic data and dynamic populations may confound this data. The authors concluded that the INL likely follows the regional trend of sage-grouse, with populations declining in the 1980s and 1990s, but stabilizing at the current low levels over the past decade (Garton et al. 2011a, Whiting and Bybee 2011). Annual spring surveys will be conducted on the INL to ultimately produce an index of population trends at the site (Whiting and Bybee 2011).

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Comment [SSK80]: Consider putting overall column totals in several tables

1 Table 28. Areas managed for conservation and/or protection within Sage-grouse habitat.*

Management Zone Entity	PPH SG Habitat (acres)	PPH Area (acres)	PPH Area (%)	PGH SG Habitat (acres)	PGH Area (acres)	PGH Area (%)
MZ I - GP	11,636,400	364,800	3.13	34,663,000	811,000	2.34
BLM	2,994,300	68,600	2.29	4,524,900	103,900	2.30
Forest Service	292,400	100	0.03	515,300	0	0.00
Tribal and Other Federal	219,700	91,400	41.60	2,427,700	373,700	15.39
Private	7,132,500	195,700	2.74	24,682,800	315,800	1.28
State	995,600	9,000	0.90	2,498,400	17,600	0.70
Other	1,900	0	0.00	13,900	0	0.00
MZ II and VII - WB & CP	17,476,000	624,700	3.57	19,200,200	1,068,300	5.56
BLM	9,021,200	241,300	2.67	9,012,500	511,100	5.67
Forest Service	162,000	2,500	1.54	452,500	46,800	10.34
Tribal and Other Federal	784,000	93,300	11.90	1,354,600	105,700	7.80
Private	6,233,900	217,100	3.48	7,394,800	358,900	4.85
State	1,244,800	44,000	3.53	979,800	41,400	4.23
Other	30,100	26,500	88.04	6,000	4,400	73.33
MZ III - SGB	10,028,500	295,600	2.95	3,970,100	191,500	4.82
BLM	6,309,400	170,900	2.71	3,199,800	130,800	4.09
Forest Service	1,236,200	93,900	7.60	356,200	56,200	15.78
Tribal and Other Federal	260,800	11,000	4.22	29,100	3,700	12.71
Private	1,836,200	12,900	0.70	384,800	500	0.13
State	385,900	6,900	1.79	200	200	100.00
MZ IV - SRP	21,930,600	1,760,600	8.03	10,958,500	1,181,600	10.78
BLM	13,710,700	1,510,700	11.02	4,928,200	741,400	15.04
Forest Service	1,613,800	26,600	1.65	1,113,500	3,000	0.27
Tribal and Other Federal	633,600	76,000	11.99	522,500	254,800	48.77
Private	4,890,200	124,800	2.55	3,516,700	164,300	4.67
State	1,019,400	22,500	2.21	846,200	16,600	1.96
Other	62,900	0	0.00	31,400	1,500	4.78
MZ V - NGB	7,097,200	2,113,400	29.78	5,808,000	1,050,300	18.08
BLM	5,117,500	1,400,900	27.37	4,196,700	955,900	22.78
Forest Service	62,200	0	0.00	114,900	100	0.09
Tribal and Other Federal	717,100	695,700	97.02	101,800	74,900	73.58
Private	798,000	11,700	1.47	1,199,000	13,400	1.12
State	64,900	2,900	4.47	115,800	5,300	4.58
Other	337,500	2,200	0.65	79,800	800	1.00

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* Data Sources: National Conservation Easement Database; USGS Protected Areas Database (PAD-US); BLM NLCS, ACECs and Wilderness and USFS Wilderness.

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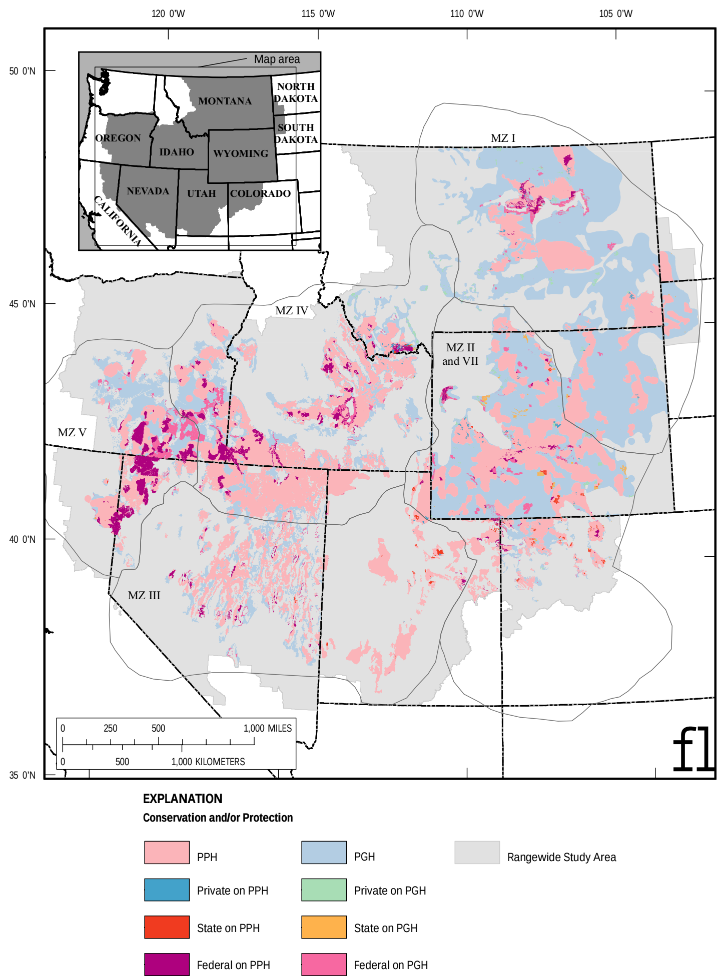

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Figure 30. Location of federal, state, and private (e.g., NGO) conservation areas within priority (PPH) and general (PGH) habitats across the sage-grouse range.

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State and Local Working Group Conservation Efforts

States generally have broad authority to manage wildlife within their borders. All states within the range of sage-grouse have laws addressing wildlife conservation, but such laws are general in nature without specific mention of sage-grouse (U.S. Fish and Wildlife Service 2010b, p.13974); nevertheless, states and local working groups (LWGs) across the sage-grouse range have developed conservation plans that direct management efforts at the state and regional (Stiver 2011a). While such plans generally provide a management framework rather than regulations, they are a valuable mechanism for implementing efforts that conserve sage-grouse populations and their habitat.

In addition to developing state and LWG conservation strategies, states can affect sage-grouse conservation by several other means. Governors of several states have issued executive orders (White et al.) to offer greater regulatory force to sage-grouse conservation. Moreover, in addition to state fish and wildlife agencies, other state-level agencies may have authority to regulate activities that are threats to sage-grouse. This includes state agencies or commissions responsible for regulating oil and gas developments or siting power transmission lines. Lastly, all 10 States within the sage-grouse range own state trust lands, which each state manages for the benefit of various trustees (U.S. Fish and Wildlife Service 2010b, p.13974). Trust lands consist of two sections per township (four sections in Utah), and therefore usually represent a checkerboard of lands scattered around each State (Culp 2005). Nevertheless, the cumulative area of state trust lands can be large – Montana's trust lands include 5 million acres (20,230 km^2) of surface property, Utah holds 3.5 million surface acres (14,150 km^2) in trust, Wyoming and Colorado each have about 3 million (12,140 km^2) surface acres, and Idaho holds about 2.5 million acres (10,100 km^2) in trust (Culp 2005). States generate revenue on state trust lands through various activities – disposition or leases for residential or commercial development, timber harvesting, mineral development, agricultural uses and recreation, including fishing and hunting (Culp 2005). These lands represent a potentially important component of long-term sage-grouse conservation;

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however limitations due to the scattered distribution of these lands (reducing the **potential benefit** unless coordinated with management efforts on adjacent lands) and potential change in ownership and management due to the fiduciary trust responsibilities.

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The following section presents a brief overview of conservation efforts within each state, and where applicable, the major threats those efforts seek to mitigate. A complete description of management efforts in each state is out of the scope of this report and such information is available from individual states and LWGs. In 2011, the Western Governors Association released an inventory of state and local conservation initiatives for sage-grouse (Western Governors' Wildlife Council 2011).

California/Nevada

In August, 2000, then Nevada Governor Kenny Guinn appointed a Sage-grouse Conservation Team that developed a conservation strategy for sage-grouse (Nevada Sage-Grouse Conservation Team 2004). Through collaboration with the California Department of Fish and Game, the strategy was later expanded to include Eastern California and LWGs in each state were identified and tasked with designing practical solutions for their respective region. The seven LWGs (including a Bi-State Planning Group) developed local conservation plans, which were submitted to the Governor's Team for synthesis into a conservation plan for Nevada and Eastern California (Nevada Sage-Grouse Conservation Team 2004).

The Greater Sage-Grouse Conservation Plan for Nevada and Eastern California prioritizes conservation efforts within both states. Immediate priorities identified include a comprehensive spatial analysis to determine those areas which support large populations of sage-grouse and are at high risk for wildfire or invasion of cheatgrass (Nevada Sage-Grouse Conservation Team 2004). In 2012, the Nevada Department of Wildlife published its sage-grouse habitat categorization analysis, which delineated five classes of sage-grouse habitat ranging from essential/irreplaceable habitat to unsuitable habitat to direct

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mitigation and conservation efforts within Nevada and California (Nevada Department of Wildlife 2012).

Other top priorities identified by the Governor's Team include wildfire pre-suppression treatments/fire control and vegetation management. The average fire size in the Southern Great Basin (MZ III) increased from 1980 to 2007 (U.S. Fish and Wildlife Service 2010a). As much as 80 percent of the land within the Great Basin ecoregion (MZs III, IV, and V) is at risk of being displaced by cheatgrass in the next 30 years, and an estimated 35 percent of sagebrush in the region is at high risk of displacement by pinyon-juniper in the same time (Connelly et al. 2004).

The Nevada Division of Wildlife, in cooperation with various federal agencies, has untaken numerous conservation projects to date to confront these threats, dedicating over $2 million and totaling nearly 69,000 treated acres (280 km^2) on private lands and lands administered by federal agencies from 2001 to 2009. These projects include pinyon-juniper removal, weed treatments, and fire rehabilitation (Nevada Department of Wildlife 2011). More recently, Governor Brian Sandoval issued an Executive Order forming the Governor's Greater Sage-Grouse Advisory Committee to recommend policies for the protection of sage-grouse (Nevada Executive Order Mar. 30, 2012). The recommendations, released in July 2012 provide management strategies to achieve "no net loss" for controllable activities and aggressive pre-suppression, initial attack and restoration for uncontrollable events (Nevada Greater Sage-grouse Advisory Committee 2012).

Colorado

Colorado's Greater Sage-grouse Conservation Plan (2008) prioritized threats across each of the state's six sage-grouse populations: Meeker-White River, Middle Park, North Park, Northern Eagle-Southern Routt Counties, Northwest Colorado, and Parachute-Piceance-Roan (Colorado Greater Sage-grouse Steering Committee 2008). Urbanization and associated habitat fragmentation are substantial

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threats to sage-grouse in portions of the sage-grouse range in Colorado (U.S. Fish and Wildlife Service 2010a). The Colorado Division of Wildlife, through its Habitat Protection Program, has secured 40,000 acres (162 km^2) of sage-grouse habitat through either purchases or conservation easements (Western Governors' Wildlife Council 2011). Such actions are part of the State's strategy to mitigate what the USFWS described as the "key cause, if not the primary cause, of the decline of sage-grouse populations," habitat fragmentation (U.S. Fish and Wildlife Service 2010a). Urbanization is occurring most heavily in the Middle Park and Northern-Eagle-Southern Routt Counties sage-grouse areas. Conservation easements benefiting sage-grouse total 8,883 acres (36 km^2) and 2,430 acres (10 km^2) of occupied habitat in the Middle Park and Northern Eagle-Southern Routt County areas, respectively (Colorado Greater Sage-grouse Steering Committee 2008).

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Oil and gas development is expanding at a rapid rate in portions of Colorado (threats to sage-grouse associated with such development is presented in previous sections of this report). Applications for permits-to-drill increased 50 percent between 2004 and 2005, and increased by an additional 35 percent from 2005 to 2006. In 2005, 99 percent of these permits were for new wells. **Oil and gas development** is concentrated in the Northwest Colorado (labeled as "moderate; increasing exponentially") and Parachute-Piceance-Roan ("high; increasing exponentially") areas (Colorado Greater Sage-grouse Steering Committee 2008). In 2009, then Colorado Governor Bill Ritter signed into law regulations to address sage-grouse conservation applicable to the Colorado Oil and Gas Conservation Commission. Pursuant to an MOU among that Commission, BLM and USFS, these regulations apply to oil and gas permitting decisions on both private and federal land within the state (Interagency MOU 2009, U.S. Fish and Wildlife Service 2010a). The new regulations require operators seeking a permit to drill to first determine if the proposed development occurs within "sensitive wildlife habitat" (C.R.S. § 34-60-128 and COGCC Rules and Regulations § 1201). Operators are required to

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consult with the Colorado Division of Wildlife to avoid impacts on wildlife resources and mitigate any unavoidable impacts (COGCC Rules and Regulations § 1202(a).

Idaho

Wildlfire, infrastructure, and proliferation of invasive species are the three most pressing threats (in order of priority) to sage-grouse in Idaho as determined by a panel of leading scientists in 2006 (Idaho Sage-grouse Advisory Committee 2006). The occurrence of these threats and the state's conservation measures addressing them are discussed below. The Idaho Sage-grouse Conservation Plan contemplates the full spectrum of threats. On March 9, 2012, Idaho Governor C.L. Otter issued Executive Order 2012-02, which established a 15-member Sage-Grouse Task Force to provide recommendations on the long-term viability of the species within the state.

With its ability to negatively affect vast acres of sage-grouse habitat, wildfire is a substantial threat to the persistence of the species and remains a top management priority in Idaho (Idaho Sage-grouse Advisory Committee 2006). Spread and establishment of cheatgrass and other annuals has contributed to reduced fire-return intervals in portions of the Snake River Plain (Young et al. 1987, Connelly et al. 2004). The Governor's Sage-Grouse Task Force recommends identifying perennial grasslands with the highest risk for wildfire which are most likely to benefit from fuel break construction (Idaho Sage-Grouse Task Force 2012). Numerous weed and fuel break efforts have been undertaken, and a substantial number of acres have been treated on private, state, and federally managed lands within the state with funds from the Governor's Office of Species Conservation. The state is also focusing efforts on fire restoration; several reseeding and rehabilitation projects have occurred since 2002, totaling 3,399 treated acres (13.75 km^2, Idaho Sage-grouse Advisory Committee Technical Assistance Team 2012).

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Infrastructure is also a substantial threat to sage-grouse in Idaho. There are approximately 1,500 miles of major power transmission lines within the state's sage-grouse planning areas (Idaho Sage-grouse Advisory Committee 2006). Including a 5 km (3.1 mile) buffer on either side of these lines expands the affected area to over 4.5 million acres (18,200 km^2; Idaho Sage-grouse Advisory Committee 2006). There are approximately 975 miles (1560 km) of major paved roads (interstate, federal, state) within Idaho sage-grouse planning areas, which when a 10 km (6.2 mile) buffer is considered, account for over 6.8 million acres (27,500 km^2) of affected area (Idaho Sage-grouse Advisory Committee 2006). The Governor's Task Force recommends several management practices to mitigate the effects of infrastructure on sage-grouse, including co-locating linear facilities, building new roads to the minimum standards necessary and time restrictions on construction of new facilities (Idaho Sage-Grouse Task Force 2012).

Spatial studies reveal several large tracts of annual grasslands, totaling nearly one million acres (4050 km^2) within Idaho's sage-grouse planning areas in south central, southwestern and western Idaho. The BLM manages approximately 62 percent of these identified grasslands, while 29 percent are under private ownership (Idaho Sage-grouse Advisory Committee 2006). LWGs report numerous weed control efforts across various types of land ownership within the state. As of 2011, nearly 9,300 acres (38 km^2) have been treated to control weeds (Idaho Sage-grouse Advisory Committee Technical Assistance Team 2012). The Governor's Task Force recently recommended best management practices regarding invasive species control to be incorporated into BLM and USFS land use plan revisions (Idaho Sage-Grouse Task Force 2012).

Montana and the Dakotas

Energy development, grazing, and habitat conversion to agriculture are among the primary threats to sage-grouse in Montana (U.S. Fish and Wildlife Service 2010a). Portions of two geological

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basins within the state are experiencing increased levels of **energy** development – the Powder River Basin (predominately coal bed methane) in southeastern Montana and northeastern Wyoming and the Williston Basin in Eastern Montana and the Dakotas (U.S. Fish and Wildlife Service 2010a). The Powder River Basin serves as a link between the Wyoming basin and central Montana sage-grouse populations; it is anticipated that this connectivity could be lost in the near future because, in part, of the intensive development in this region (U.S. Fish and Wildlife Service 2010a). Montana's Management Plan and Conservation Strategy for Sage Grouse (2005) proposed several conservation actions to meet energy demands while minimizing effects to sage-grouse, including surface occupancy restrictions (0.25 miles around existing leks), restricting noise levels near leks, and avoidance of leks and critical habitat in siting infrastructure. Notably, in 2007, the Montana Department of Natural Resources and Conservation rejected a recommendation from the State's Department of Fish, Wildlife and Parks to amend a stipulation placed on state trust land oil and gas leases to include sage-grouse protections (e.g., increase the no surface occupancy buffer radius to between 1 and 1.8 miles and timing restrictions extending 4 miles from known leks), citing concerns that the recommended restrictions would prevent the Department of Natural Resources and Conservation from protecting oil and gas resources on state lands from drainage by adjacent mineral owners (Montana Department of Natural Resources & Conservation Trust Land Management Division 2007).

While sagebrush communities in the Northern Great Plains, including Montana, may have evolved with some level of grazing, many of these rangelands were overstocked in the late 1800s and early 1900s which altered the composition and productivity of sagebrush communities (Montana Sage Grouse Work Group 2005). Montana's State Plan (2005) prescribes grazing management actions that maintain and enhance sagebrush rangelands while providing for agricultural commodities. These include incentivizing private landowners to help achieve sage-grouse objectives (Montana Sage Grouse

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Work Group 2005). As described above, the NRCS is working with private landowners around the state to implement improved grazing systems on over 246,000 acres (995 km^2) in the state through its SGI program (U.S. Natural Resources Conservation Service 2012a). The Montana Department of Fish, Wildlife and Parks, through contracts with private landowners, has implemented grazing standards on over 550,000 acres (2226 km^2) of privately owned land in the state (Montana Sage Grouse Work Group 2005).

Large losses of sagebrush resulting from conversion to agriculture have occurred in the Great Plains MZ (MZ I). Across the state, the amount of acres converted to tilled agriculture increased annually from 2005 to 2009, with over 25,000 acres (101 km^2) converted in that time. This threat is particularly prominent in the eastern two-thirds of the state (U.S. Fish and Wildlife Service 2010a). Montana's State Plan reported that the state's Department of Fish, Wildlife and Parks intended to continue to negotiate conservation easements to conserve native rangelands by prohibiting subdivision and conversion to cropland. With funding through the Landowner Incentive and Upland Game Bird Programs, the Department of Fish, Wildlife and Parks anticipates protecting 183,000 acres (740 km^2) of occupied private lands from herbicide spraying, prescribed burning, and conversion to cropland (Montana Sage Grouse Work Group 2005).

The populations in North and South Dakota, at the eastern reaches of the range, occupy a relatively small area in the western portions of both states. The issues threatening these populations are representative of the threats associated with neighboring populations in southeastern Montana and northeastern Wyoming, including oil and gas development. Fourteen (14) percent of the federal mineral estate (902,000 acres, 3550 km^2, combined) within the sage-grouse conservation area in North and South Dakota are authorized for development (U.S. Fish and Wildlife Service 2010a).

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Oregon

Oregon's "Wildlife Policy," codified in Section 496.012 of the Oregon Revised Statutes states "[i]t is the policy of the State of Oregon that wildlife should be managed to prevent serious depletion of any indigenous species…" Oregon's Greater Sage-Grouse Conservation Assessment and Strategy (Wyoming Executive Order) provides a framework to maintain and enhance sage-grouse in the State. It accomplishes this by combining a "core area" approach, modeled after Doherty et al. (2011b) with a complementary method to estimate connectivity corridors to approximate seasonal ranges (Oregon Department of Fish and Wildlife 2011). Once core areas were identified, various sagebrush habitat within the state was categorized based on its suitability for sage-grouse and management guidelines were recommended for each category, with greater restrictions in higher value habitat (Oregon Department of Fish and Wildlife 2011).

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The Oregon conservation plan addresses many of the threats identified by the USFWS in the 2010 Listing Decision. The plan offers voluntary guidelines to mitigate each threat. Implementation of the guidelines will be directed by local Implementation Teams, consisting of Oregon Department of Fish and Wildlife personnel, federal land management agency representatives and private entities. There are five Implementation Teams, corresponding to various BLM district boundaries within the state. Implementation Teams have initiated projects under the guidance of the state plan – from removing 90,000 acres (365 km^2)of juniper within the Burns District to treating nearly 30,000 acres (121 km^2) of invasive weeds in the Vale District (Oregon Department of Fish and Wildlife 2011).

Utah

Four MZs divide Utah (Connelly et al. 2004), representing the state's diverse ecological and biological composition. Such variation also presents numerous threats to the state's sage-grouse populations. Utah's Sage-grouse Plan Committee, comprised of members representing various

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backgrounds from public and private entities, prioritized threats to the species across the state. This prioritization incorporated the identification and prioritization of threats within Utah's 11 Management Areas by LWGs (Utah Division of Wildlife Resources (UDWR)).

State-wide, the Plan Committee identified six major threats: invasive species expansion, habitat conversion, conifer encroachment, energy development, altered fire cycles and predation (Utah Division of Wildlife Resources (UDWR)). Utah's Greater Sage-Grouse Management Plan (2009) seeks to protect and maintain occupied habitat, while restoring 175,000 acres (700 km^2) of habitat by 2014. The Plan provides an overall strategy for use in implementing conservation actions by LWGs. LWGs in Utah provide annual updates detailing those actions taken for specific strategies identified in each LWG plan. In one recent accomplishment report for the Strawberry Valley Adaptive Resource Management Area, that LWG reports that 10,223 acres (41 km^2) have been purchased within the Management Area by the Utah Reclamation and Mitigation Commission. A full discussion of the management efforts within the state are accessible from the Utah State University Cooperative Extension.

Wyoming

Estimates of sage-grouse populations indicate that Wyoming is home to the largest number of birds in the range of the species (U.S. Fish and Wildlife Service 2010a). The state's sage-grouse populations face a variety of threats - intensive energy development in the Powder River and Greater Green River Basins and extensive infrastructure, including powerlines, fences and roads (U.S. Fish and Wildlife Service 2010a). Eight LWGs around the state have completed conservation plans, many of which prioritize threats and prescribe management actions at the LWG scale.

At the state level, Wyoming Governor Matt Mead issued an executive order (Wyoming Executive Order June 2, 2011) that complemented (and replaced) several executive orders issued by his predecessor, Governor Dave Freudenthal (Wyoming Executive Order August 1, 2008, August 18,

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2010). The 2011 order further articulates the State's Core Population Area Strategy (as initially described in the 2008 executive order) as an approach to balance sage-grouse conservation and development. It provides an approach to mitigating anthropogenic disturbances to sage-grouse. The USFWS believes that Wyoming's Core Population Strategy, if extended to all landowners via regulatory mechanisms, would provide adequate protection for sage-grouse (U.S. Fish and Wildlife Service 2010a), however universal implementation remains uncertain due to variety in ownership and management.

Specifically, the 2011 order contains consultation requirements with the Wyoming Game and Fish Department for proposed activities requiring a state permit (Wyoming Executive Order June 2, 2011) – the Wyoming Game and Fish Department has no authority to either approve or deny the project. The order does apply to state trust lands in Wyoming, covering almost 23 percent of sage-grouse habitat and contributing habitat benefiting approximately 80 percent of the estimated breeding-population in the state (U.S. Fish and Wildlife Service 2010a). The executive order does not restrict activities with a defined project boundary existing prior to August 1, 2008. All proposed activities are evaluated through a Density/Disturbance Calculation Tool to determine if the project would exceed recommended density/disturbance thresholds. Additionally, the 2011 order includes stipulations to be included in such permits, with varying restrictions depending on whether the proposed development activity occurs within or outside delineated Core Population Areas (Wyoming Executive Order June 2, 2011). Wyoming's Industrial Siting Council (within the State's Department of Environmental Quality), which permits large development projects on all lands within the State, regardless of ownership, is subject to the terms of the executive order. This could offer sage-grouse considerable regulatory protection in considering large wind energy and other development projects within Wyoming (U.S. Fish and Wildlife Service 2010a).

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V. Risk, Policies and Actions: Assessment of dominant threats and potential interactions within Management Zones

Increasing human populations and the concurrent increases in demand for consumptive resources and recreation, and potential synergistic feedbacks among invasive plant species, fire and climate change will combine to increase rates of disturbance – both natural and anthropogenic – that will likely further influence and change sagebrush-dominated landscapes throughout the western U.S. challenging conservation of sage-grouse populations and habitats into the future (Knick et al. 2011). Projections for urban and ex-urban (suburban and rural subdivision) growth across the western U.S. mirror national projections, and some urban-growth areas are outpacing national trends (U.S. Census Bureau; http://www.census.gov/population/www/projections). Fences, power transmission lines, communication towers, and roads are ubiquitous, albeit not evenly distributed, across sage-grouse range and all have known, or presumed, effects on sage-grouse populations. Conversion of land for crops, livestock, resource extraction and domestic expansion has long been a basic tenant of western civilization, and while the land has provided these essential goods and services, alteration of resource conditions, wildlife habitats and ecosystem function creates a critical trade-off between land-use and conservation of resources and natural heritage values (Defries et al. 2004). Further, industrial development of public and private lands, including traditional fossil fuels, tar sands, and coal-bed methane along with expansion of “renewable” energy sources, such as wind, solar and geothermal, and the infrastructure required to support these operations represent widespread, unevenly distributed, pressures and impacts on sagebrush ecosystems and sage-grouse populations. This apparently philosophical or sociological debate regarding the balance among different land uses may seem peripheral to sage-grouse conservation, however the management of these competing uses also involves

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fundamental, practical issues that affect the successful conservation of sage-grouse, and sagebrush ecosystems.

Sage-grouse are currently widespread (although in some areas densities are low) and relatively large areas continue to provide sagebrush habitats for the species, thus long-term conservation of sage-grouse populations should be possible (Connelly et al. 2011b). The distributions of habitats, species and human land-uses is notably heterogeneous across large landscapes, and understanding the relationships and processes that create these patterns, correlations and aversions, will assist in long-term planning by helping to identify risks to habitat and resource conservation success, control and mitigate our activities to reduce impacts and insure resiliency, and protect and conserve our natural heritage and natural resources for future generations. Rather than any single source of habitat degradation, the cumulative and synergistic impact of multiple disturbances, continued spread and dominance of invasive species, and increased impacts of land use continue to have the most significant influence on the trajectory of sagebrush ecosystems and sage-grouse populations (Connelly et al. 2011b). Future patterns of land-use, combined with *effective* restoration and management may improve, or degrade, the remaining sage-grouse ranges, but natural dynamics and unforeseen stochasticity promise to add complexity to future plans and landscapes, and these interactions are more difficult to control. Finally, population and habitat dynamics may be exaggerated for sage-grouse due to their strong affinity (obligate relationship) with extensive, intact, and well-functioning sagebrush ecosystems, and because habitat limitations may magnify the effects of population stressors such as disease and disturbances such as wildfires.

Actions and Activities

The numerous efforts undertaken to identify threats to sage-grouse cumulatively suggest that invasive species, wildfire, grazing management and energy development – with the relative importance of each varying throughout the range of the species – pose the greatest risk to long-term conservation of sage-grouse (Connelly et al. 2011b). The Greater Sage-Grouse Comprehensive Conservation Strategy

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(GSGCCS, Stiver 2011b) ranked potential habitat issues by region (eastern and western portions of the sage-grouse range) in order of immediacy.

In the western portion of the range (especially MZs III, IV, and V) control of fire (removal from management, reduced human ignitions, suppression of wildfires) and management of dispersed recreation have been identified as regional priorities for reducing disturbance to habitats and populations. Combatting habitat degradation due to invasive plants was also deemed critical, and the current wide-distribution and dominance by several invasive species (for example, cheatgrass and Medusa-head) requires risk assessment, prioritization and strategic planning to focus funds and efforts to strategically protect and improve priority habitats. A combination of regional planning to determine priority areas, followed by local planning and implementation, will likely be required to address these species which both degrade local habitats and agricultural productivity through severe infestations and are widespread across the region causing extensive seed sources and the necessity to manage across vast areas, multiple management units and mixed ownership and administration. Manipulation of livestock grazing rotations and intensity to support conservation objectives for habitat condition and invasive plant control was identified as an important tool for managers throughout western portions of the sage-grouse range. In addition, increasing land-use on, and around, public lands increases displacement of sage-grouse due to noise and activities; consideration of both near- and long-term habitat impacts of dispersed recreation, urban and exurban development were also identified as issues requiring attention. Trends in resource conditions and utilization, assessed locally and adapted seasonally, will be the most likely actions to affect short-term population trends when they are supported by regional planning and policy to reduce industrial impacts, eliminate new developments in priority habitats, and promote intact sagebrush ecosystems providing the necessary structure to substantiate local actions.

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Similarly, on the eastern portion of the range (MZs I, II and VII), invasive plant management and fire suppression remain important components of the conservation strategy. However, the GSGCCS (Stiver et al. 2006a) identified the reduction of impacts from the development of non-renewable energy, and the support infrastructure (pipelines, roads, structures) necessary for these developments, as top regional priorities for addressing declining sage-grouse populations. The potential for impacts across scales makes careful and deliberate planning at local *and* regional scales relevant to local populations. Consistent criteria for locating energy corridors, facilities and infrastructure with minimal impacts to intact sagebrush communities and associated sage-grouse populations may incur benefits by concentrating activities and directing them away from the most sensitive areas and populations. To be useful and accurate, monitoring effectiveness of restoration and remediation projects may be coupled to landscape accounting for cumulative effects to insure treated and restored lands have required habitat values before additional sagebrush habitat is disturbed.

Historically, sagebrush was common across the range of sage-grouse (all MZs), but it was least common on the Colorado Plateau (eastern half of MZ III), Columbia Plateau (MZ VI) and Great Plains (MZ I). Historically and currently, sagebrush is most common in the northern Great Basin (MZ V) and eastward across the sagebrush steppe found in the Snake River Plain and the Wyoming Basin (MZs II and IV), however as previously noted, the best big sagebrush ecological sites (those with deep loamy soils) have been largely converted to agriculture. Because sage-grouse depend on sagebrush through all seasons, with consistent selection for areas with more sagebrush canopy cover (Johnson et al. 2011), landscape scale management for greater extent and connectivity of sagebrush communities, and management and monitoring to maintain suitable shrub and herbaceous cover within that matrix are basic, defining goals to direct conservation in all regions. Lek trends across the species range are positively associated with sagebrush cover at multiple scales; functioning sagebrush ecosystems which

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provide cover and forage during all seasons are a necessary condition for viable sage-grouse populations (Johnson et al. 2011). Treatments that reduce sagebrush cover in the near-term are not recommended but may be successful if carefully prescribed within a region possessing "excess sagebrush cover" and with reasonable expectations for realization of increased sagebrush cover and habitat quality in the future (likely 25 years or more). Importantly, the risk of wildfire, estimated using fuel models is pronounced across several MZs with the greatest risk in the Great Basin region (MZs III, IV and V) due largely to the influence of cheatgrass (See Figures 26 and 27), however large portions of other regions (MZs I and II) are also projected to be at high risk. Fuel mitigation while maintaining and sustaining sagebrush habitat values across large landscapes will remain an important and challenging balance for habitat managers.

Management Zone Summaries

MZ I – Northern Great Plains

Management Zone I consists of 4 sage-grouse populations each encompassing relatively large regions: Dakotas, Northern Montana, Powder River Basin, and Yellowstone Watershed populations (Garton et al. 2011a). Predicted population trends indicate that populations in this MZ have an 11% chance of falling below 200 males by 2037, and a 24% chance of falling below 200 males by 2107 (Garton et al. 2011a). A majority (66%) of the sagebrush landscape in this MZ is privately owned, however sage-grouse leks in the region remain relatively well connected (Knick 2011b, Knick and Hanser 2011b). Because a majority of the sage-grouse habitats within MZ I are privately owned, current options for habitat conservation – for example conservation easements and farm bill programs that can only be applied to private lands – are a viable option for effective sage-grouse conservation throughout the region. Some CRP lands may create habitat refugia within converted landscapes when they include sagebrush cover; enrollment of 17% of an agricultural landscape in eastern Washington succeeded in

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reversing short-term population declines (Schroeder and Vander Haegen 2011). Cover and productivity of native rangelands, including silver sagebrush (*A. cana*) and big sagebrush (*A. tridentata*), is essential for effective conservation of sage-grouse in this region. Limited sagebrush cover (naturally, due to environmental gradients favoring grassland systems) coupled with historic, agricultural uses and current energy production infrastructure make natural and induced habitat limitations a fundamental, limiting factor for local sage-grouse populations in this region.

Major threats to sage-grouse habitats and populations occurring across populations in this MZ include oil and gas developments and conversion of native rangeland to crops (Conservation Objectives Team et al. 2012). Regional assessments estimated that 7.2% of priority and general habitats in MZ I are directly influenced by agricultural development, and >99% of these habitats are within 6.9 km (4.3 mi) of agriculture (Table 4); less than 1% of sage-grouse habitats are directly influenced by a natural gas or oil well, however nearly all (100%) lie within 19 km (11.8 mi) of a well (Table 11; Figure 15) - the estimated effects area (Johnson et al. 2011, Taylor et al. 2012). Over 6.3 million acres (25,500 km^2, 14%) of sage-grouse habitat is currently leased for the development of federal fluid minerals (Table 13). Additionally, most sage-grouse habitats within the MZ have the potential to be influenced by coal mining and/or the development of geothermal energy (Figure 21 and 22), although coal and mineral developments currently directly influence <1% of the lands in the region (Tables 16 and 17). BLM managed grazing allotments not meeting wildlife standards constitute 2% of MZ I and are not widespread throughout the region (Figure 28); however most of the sage-grouse habitats in MZ I are privately owned and are not addressed in this analysis. Livestock grazing is consistently mentioned across populations in the region as being a potential threat to the persistence of sage-grouse (Conservation Objectives Team et al. 2012). Fire risk is generally low across MZ I, with 17% of priority and general habitats having a high risk for fire (Table 19); however isolated areas, especially in central

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Montana, South Dakota, the border between Montana and Wyoming, and eastern Wyoming, are identified as having high fire risk (Figure 26). Risk of cheatgrass presence was not available for this region, but cheatgrass (and Japanese brome, *Bromus arvensis*) are known to occur in this region. Thus, risk of annual grass invasion, as well as annual-induced fire, appear to need better documentation across the region. To help prevent increasing cheatgrass dominance on these rangelands, potential for invasion can be assessed when planning habitat treatments and rehabilitating disturbed areas, with pre-disturbance abundance being a good indicator of potential for post-disturbance response (Davies et al. 2012). Urban development, power lines, vertical structures and railroads, although directly influence only <1.7% of the sage-grouse habitats in the region, however this distribution is relatively dense within this MZ compared to western portions of the range of sage-grouse (Tables 5- 9; Figures 10-13).

MZ II and VII – Wyoming Basin the Colorado Plateau

Management Zones II and VII include 9 sage-grouse populations with the bulk of the area constituting the Wyoming Basin population; several smaller areas occupied by sage-grouse are distributed around the Wyoming Basin population, especially south of this population on the Colorado Plateau (Garton et al. 2011a). Northern portions of this MZ currently represent the highest abundance of sage-grouse relative to other MZs across the range of the species (Conservation Objectives Team et al. 2012); the chance of populations in this region falling below 200 males by 2037 is 0.3% and there is a 16% chance populations will fall below 200 males by 2107 (Garton et al. 2011a). Leks in northern portions of MZs II and VII are the most highly connected in the range (Knick and Hanser 2011a). Conversely, populations in southern portions of MZs II and VII (Colorado Plateau) are not as robust with a 96% chance of populations declining below 200 males by 2037 and a 98% chance by 2107 (Garton et al. 2011a). Additionally, leks in southern regions of the MZs are the least connected across the range of the species (Knick and Hanser 2011a). In contrast to MZ I, 54% of the sagebrush habitats in

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MZA II and VII are federally managed (Knick 2011b). Therefore, conservation easements and farm bill programs that can only be applied to private lands will likely be ineffective as a sole means of conserving sage-grouse in these MZs; comparable programs affecting effective rehabilitation and restoration on public lands, at similar scales, are needed (Connelly et al. 2011b). The Wyoming Basin (MZ II) is currently home to the largest regional extent and highest breeding density of sage-grouse in the western U.S., with several important satellite populations, including Jackson, Wyoming and Routt County, Colorado. Livestock grazing has been ubiquitous across these sagebrush dominated ranges, which also have seasonal importance for native elk, mule deer, pronghorn and several herds of feral horses, for more than a century. Non-renewable energy extraction (coal, oil and natural gas), and more recently renewable energy production (wind farms), are superimposed over the habitat gradients created by natural environmental patterns and historic land uses, and the current combination of use and natural dynamics are sufficiently intense to cause measureable changes in sagebrush cover (Xian et al. 2012). Therefore, trends in land cover and land use are recognized as contributing to population declines, in this region, in the recent past.

The major threat to sage-grouse habitats and populations occurring across populations in MZ II and VII is energy development – primarily oil and gas development – and supporting infrastructure (Conservation Objectives Team et al. 2012); less than 1% of priority and general habitats are directly influenced by a natural gas or oil well, however 99% are within the likely effects buffer (19 km, 11.8 mi) providing some indication of the cumulative influence of energy infrastructure (Table 11; Figure 14). Further, approximately 7.8 million acres (31,500 km^2, 21%) of the sage-grouse habitats in the MZ are currently leased for development of federal natural gas or oil reserves (Table 13). This management zone also has federal leases for the research of oil shale extraction overlapping the southern populations (Figure 19). The potential for coal mining, geothermal energy development, oil shale development, and

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wind energy development are additionally widespread throughout this MZ (Figures 18-24). The loss of habitat from subdivision and housing development and associated infrastructure (for example, roads) has been identified as the greatest threat to sage-grouse populations in southern portions of MZs II and VII (Conservation Objectives Team et al. 2012). Urban development, power lines, vertical structures and railroads, although directly influencing individually <2.3% of the sage-grouse habitats in the entire MZ, are relatively dense in MZ II and VII compared to western portions of the range of sage-grouse (Tables 5-9; Figures 10-13). For example, the proportion of sage-grouse habitat influenced directly by urban development in MZs I and II and VII combined is 3.1 times higher, the amount directly influenced by power lines is 2.1 times higher, and the amount directly influenced by railroads is 1.9 times higher than the proportion directly influenced in the other MZs combined (Tables 5-9).

BLM managed grazing allotments not meeting wildlife standards consist of 4% of MZs II and VII, and are not widespread throughout region except in southern portions of the MZ (Table 22; Figure 28); however considerable portions of this region have not been recently assessed. Although areas not meeting standards are not widespread in the region, the Greater Sage-grouse Comprehensive Conservation Strategy (Stiver et al. 2006a) ranked livestock grazing just below energy development and urbanization as an issue requiring immediate attention in eastern portions of the range of sage-grouse. Additionally, a large portion of central regions of this MZ (close to 5 million acres, 20,200 km^2, across the entire MZ; Table 23) is federally managed wild horse and burro range (Figure 29), suggesting potential effects to sage-grouse of livestock grazing and the compounding effects of feral grazers need to be considered across the region. Fire risk is generally low across MZ II and VII, with 10% of priority and general habitats at high risk for fire (Table 19); however areas in northern and southern portions of the MZ are identified as having high fire risk (Figure 26).

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Cheatgrass is distributed across the region, however, generally not with the same abundance observed in the Great Basin region; some portions of this region, for example, the ownership “checkerboard” in southern Wyoming, are notably more thoroughly invaded than cooler parts of the region. Where severe infestation overlaps with PPH and PGH, management intensive restoration may be considered. Current levels of disturbance have been sufficient to spread invasive species, and the historic combination of drought-stress and over-utilization left sufficient niche space among native perennials for local proliferation. In many areas, short-term adaptations of grazing rotations to increase the cover of native perennials may be sufficient to restore high-quality habitats. Despite the perceived abundance and persistence of sagebrush in some parts of this region, extensive (or cumulative) treatments that remove sagebrush cover (even temporarily) are discouraged, unless said treatments represent a very small portion of an extensive, intact sagebrush stand (very rare) or are expressly designed to rehabilitate degraded, underutilized habitats.

MZ III – Southern Great Basin (and western Colorado Plateau)

Management Zone III consists of 12 sage-grouse populations distributed throughout the region, including the Southern Great Basin population in central and eastern Nevada, which contains the largest numbers of sage-grouse in MZ III (Conservation Objectives Team et al. 2012), several small populations in central Utah, and the Bi-State Distinct Population Segment along the California-Nevada border (Garton et al. 2011a). Predicted population trends indicate that populations in this MZ have almost no chance of falling below 200 males by 2037, and an 8% chance of falling below 200 males by 2107 (Garton et al. 2011a); however these scenarios are limited in their ability to predict the future, especially stochastic events and novel environmental conditions, so caution is warranted. A majority (82%) of the sagebrush landscape in this MZ is federally managed (predominantly BLM and USFS; (Table 26), indicating that actions on federal lands are expected have measurable population effects, but

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conservation measures on private lands may be less influential, as a whole, for conserving sage-grouse in this MZ, However as noted in sections above, large areas of influence exist from some threats, therefore cooperation and prioritization of habitats across jurisdictions is still important in this management zone. This region is best characterized (for sage-grouse) by the large Southern Great Basin population which occupies much of central and eastern Nevada, however several smaller but significant populations persist, and priority management issues and challenges associated with these small populations may be distinctive from other populations in the region.

Sagebrush cover is naturally limited and patchy across much of this region, as dictated by geologic substrates and formations which also help dictate (via topography) micro-climates and local environmental conditions that enable sagebrush dominance, and this is evident in the lack of connectivity among sub-populations in this region (Knick and Hanser 2011a). Well densities are currently low, compared to other MZs (for example, MZ I and II). Current energy developments influence sage-grouse habitats in eastern portions of the MZ but are not widespread (Figures 14 and 16); however, more than 1.8 million acres (7285 km^2; 13%) of the sage-grouse habitats in the MZ are currently leased for federal fluid mineral development (Table 13), suggesting that some areas may receive increased pressure from energy development in the future. Additionally, coal and oil shale potential are high in eastern areas (Utah) of MZ III (Figures 19 and 23), indicating that development of these resources could affect already isolated populations in Utah. High potential for geothermal energy development also occurs in sage-grouse habitats in central and western portions of MZ III (Figure 21), and solar energy potential is high in southern portions of the region indicating that these alternate energy sources could have impacts on sage-grouse habitats in southern Nevada and Utah in the future (depending on technology, financial markets and public policies)..

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In contrast, the number and size of areas affected annually by fire are an order of magnitude greater (in MZs III, IV *and* V) than is typical in the Wyoming Basin (MZ II) suggesting that land-use disturbance has been replaced, or substituted, with frequent fire in these areas; this condition is often closely tied to the invasion and dominance of annual grasses, especially cheatgrass, due to their effect on fuels and fire return intervals (Figures 25 and 26). Therefore, primary threats to sage-grouse habitats and populations occurring across populations in MZ III include habitat loss and fragmentation as a result of wildfire and conifer encroachment (Conservation Objectives Team et al. 2012). Over the last decade, 110,900 acres (450 km^2; 0.8%) of priority and general sage-grouse habitats (PPH and PGH combined) have burned in this MZ. Annual means suggest that only 12,000 acres (48km^2; < 1%) of priority habitats burn (PPH and PGH) each season, however the observed maximum is more than 55,000 acres (220 km^2; 0.5% of PPH and 1.4% of PGH in this region); importantly, 62% of the region is considered at high risk for fire (Tables 19; Figure 26). Conifers encroachment potentially affects over 1.8 million acres (7285 km^2; 13%) of priority and general habitats in MZ III (Table 21); precise estimates of actual impact are not available, therefore evaluation local habitat priorities, and potential treatment benefits, to inform planning efforts may require higher resolution data. Cheatgrass invasion has been widespread in this region for decades, and some former (historic) habitats are likely "unrecoverable" without unreasonable infusion of restoration effort (i.e., it would be too expensive given current knowledge and technology); many of these areas are already excluded from current habitat distributions (Figure 1). Nonetheless, current estimates indicate more than 8% of PPH and 11% of PGH remain at high risk of invasion, with notable risks remaining in some areas. Beyond managing risk, restoration of potentially valuable areas, such as those that would increase connectivity among seasonal habitats or sub-populations, or simply increase area and/or quality of current seasonal ranges, may

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become an important management option where natural and anthropogenic patterns and processes have fragmented and degraded habitats.

In addition to cheatgrass, widespread, intense land-use coupled with natural variability and limitations of climate, has resulted in measurable effects on rangeland conditions. Currently (2006), 1.6 million acres (6475 km^2) of the BLM-managed sage-grouse habitats in MZ III (17%) that currently do not meet wildlife standards due to grazing impacts (Table 22). Further, over 4.1 million acres (16,590 km^2; 29%) of this area is designated wild horse and burro range, most of these areas are in central Nevada (Table 23; Figure 29); horse and burro herbivory have been connected to intense resource use and measureable effects on range conditions and habitat quality (Beever and Aldridge 2011).

Urbanized areas, power lines, and railroads influence habitats in eastern portions (Utah) of this MZ, but are not widespread in central and western portions. Agricultural development influences <1% of the MZ, however due to indirect influences, 78% (the lowest proportion across MZs) of priority and general habitats are estimated to be affected by cropland (Table 4; Figure 9).

MZ IV – Snake River Plain

Management Zone IV consists of 11 sage-grouse populations distributed throughout the region with the bulk of the occupied area consisting of the Northern Great Basin and Snake-Salmon-Beaverhead ID populations (Garton et al. 2011a). Similarly to other regions, the Snake River Plain of Southern Idaho has a long history of agricultural land-uses that include irrigated crops and open-range livestock management. Historic conversion of the best sites (deepest soils) to agriculture (a practice that was widespread with nearly complete conversion in this region), has resulted in a residual sagebrush landscape which is inherently less productive than those of the past (prior to European colonization). Subsequently, most known populations in the region are relatively small and/or separated from adjacent populations; important exceptions are the large population living in central Idaho (the largest outside of

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the Wyoming Basin) within the upper watershed of the Snake, Salmon and Beaverhead Rivers, and the Northern Great Basin population living on the Snake River Plain (Conservation Objectives Team et al. 2012). Several small, isolated populations are located in predominantly northern portions of this MZ (Garton et al. 2011a). Nonetheless, habitat availability remains a primary limiting factor in this region due to the combination of land-use and disturbance (fire) influences, and influences of current and historic land uses add to these effects through effects on the health and condition of available ranges.

Population trends and vulnerability models indicate that populations in this MZ have an 11% chance of falling below 200 males by 2037, and a 40% chance of falling below 200 males by 2107 (Garton et al. 2011a). A majority (63%) of the sagebrush landscape in this MZ is federally managed (Knick 2011b), suggesting conservation measures on public lands may be expected to have measurable effects on sage-grouse populations, and the role of private lands will likely be limited, in general, as a means of conserving sage-grouse in this MZ; local importance and effectiveness of projects may be greater than rangewide effects due contributions to seasonal habitat quality and connectivity at the local scale.

Primary threats to sage-grouse habitats and populations occurring across populations in MZ IV include habitat loss and fragmentation as a result of wildfire (Conservation Objectives Team et al. 2012). Over the last decade (2001-2011) more than 3.8 million acres (15,380 km^2; 10% of PPH and 13% of PGH) of priority and general sage-grouse habitats have burned in this MZ, with an average of more than 237,000 acres (960 km^2) of priority habitats burned annually with more than 1 million acres (4047 km^2) burned in some years (Table 18; Figure 25). For example, the Murphy Fire in Idaho and Nevada affected over 650,000 acres (2630 km^2) of habitat in this MZ in 2007 (Conservation Objectives Team et al. 2012). Additionally, 81% of the region is considered at high risk for fire (Table 19; Figure

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26). Approximately 8.5 million acres (34,400 km^2; 26%) of MZ IV is considered high risk for cheatgrass, and these high risk areas are widespread throughout the MZ (Table 20; Figure 27).

Geothermal energy development potential is particularly high throughout MZ IV (Figure 21). Few oil and gas wells exist in the MZ (Figure 14), and less than 350,000 acres (1400 km^2; 1%) of sage-grouse habitats are currently leased for federal fluid mineral exploration (Table 13). Additionally, coal and solar potential are low throughout the MZ (Figures 20 and 22). Urbanized areas, power lines, and railroads influence habitats predominantly in eastern portions (eastern Idaho and southwestern Montana) of MZ IV (Tables 5-8; Figures 10-13). However, designated energy corridors are located in southern portions of the MZ and transmission lines are proposed in these areas; for example Gateway West (see http://www.wy.blm.gov/nepa/cfodocs/gateway_west/map.html). Agricultural development influences 1% of the MZ and 85% of priority and general habitats are within 6.9 km (4.3 mi) of cropland (Table 4; Figure 9).

Finally, historic and current land-use patterns affect habitat conditions, in addition to regional distributions. Currently (2006 assessment), over 3.5 million acres (14,160 km^2) of BLM-managed sage-grouse habitats (19%) do not meet wildlife standards due to livestock (Table 22; Figure 28); this is the largest area, absolutely and proportionally, of all MZs (albeit large portions of some other MZs were not assessed). Compounding the effects of large herbivores on ecosystem conditions, some habitat within this MZ (6%) is federally managed wild horse and burro range, including a relatively large area of priority habitat in northern Nevada is managed for horses and burros (Table 23; Figure 29). While managed grazing likely remains a part of the tools used to manage habitats into the future, including fuel accumulation and fire potential, invasive plants, and vegetation structure and composition, non-prescribed grazing (a.k.a. over-grazing), as determined by local conditions and climate patterns, is clearly implicated for its detrimental effects on rangeland health as well as habitat conditions, in some

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areas. Thus in this MZ, and other areas, where the interactions of ecosystem conditions, climate and multiple herbivores may result in habitat degradation, close monitoring of productivity and off-take to manipulate and adjust use levels to maintain seasonal habitat quality may be necessary. Importantly, local conditions and environmental patterns (e.g., climate) are highly variable, and these assessments are dated (> 5 years old in most cases), therefore trends and conditions assessed here may have changed; this reinforces the need for frequent evaluation and adjustments to balance multiple-uses with habitat requirements of the native wildlife.

MZ V – Northern Great Basin

This MZ includes three large populations living on the western 1/3 of the Northern Great Basin region and a fourth, relatively large population in Central Oregon (Garton et al. 2011a). Predicted population trends indicate that populations in this MZ have a low (2%) chance of falling below 200 males by 2037, and a greater (29%) chance of falling below 200 males by 2107 (Garton et al. 2011a). A majority of the sagebrush landscape in this MZ (77%) is federally managed (Knick 2011b), suggesting conservation measures that can only be applied to private lands may be insufficient for conserving sage-grouse in this region, but federal habitat management may be expected to have a strong influence on these populations. Sage-grouse leks in this region are relatively well connected (second in rank behind Wyoming Basin, Knick and Hanser 2011b), however a national team of experts identified habitat loss and fragmentation due to wildfire and conifer encroachment as primary threats to sage-grouse in this region (Conservation Objectives Team et al. 2012).

The Northern Great Basin region contains less ‘moderately’ and ‘highly’ affected sage-grouse habitat than the west-wide average. But it also contains the most extensive ‘low’ land-use intensity distribution of all MZs indicating priorities focused on managing low-intensity, distributed land-uses to conserve and improve habitat for grouse (passive approaches should be effective and efficient) may be

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critical to regional conservation success. Similarly, areas with intensive use that overlap priority habitats (PPH, PGH) may be readily prioritized for habitat improvements as these areas are less extensive than in adjacent regions. However, over the last decade more than 490,000 acres (1980 km^2; 3.8%) of priority (4%) and general (3.5%) sage-grouse habitats burned with an average of more than 26,000 acres (105 km^2) per year during this time span (Table 18; Figure 25). Additionally, 67% of the region is considered at high risk for fire (Table 19; Figure 26). Despite these fires, conifers have encroached on approximately 1.4 million acres (5670 km^2; 11%) of priority and general habitats in MZ V (Table 21), indicating, again, that the spatial heterogeneity in habitat threats and conditions require local interpretation and adaptation to differentiate threats and develop specific management solutions. As another example, low sagebrush (*A. arbuscula*) is common only in the Northern Great Basin, although it occurs throughout the range at varying abundance (Johnson et al. 2011), and it is utilized by sage-grouse consistently here, in multiple seasons, including nesting and brood-rearing, making proper management and conservation of this ecological type important for sage-grouse conservation in this region.

Over 2.4 million acres (9700 km^2; 19%) of MZ V is considered high risk for cheatgrass; a large block of high risk priority habitat is located in northwestern Nevada (Table 21; Figure 27). Over 3.6 million acres (14,570 km^2; 28%) of sage-grouse habitats distributed throughout MZ V is federally managed wild horse and burro range (Table 23; Figure 29). Approximately 6% of BLM managed sage-grouse habitats in MZ V do not meet wildlife standards (Table 22; Figure 28), with again a relatively large block of priority habitat not meeting standards in northwestern Nevada.

Finally, while no single threat supersedes others, there are various forms of industrial development that affect habitats in this region. Few oil and gas wells currently exist in the MZ (Figure 15), and no, measurable, additional acreage has been leased for fluid mineral exploration (Table 13). However, geothermal energy potential is high throughout the region indicating potential for future

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development (Figure 21). Urbanized areas, power lines, and railroads are less dense in MZ V than in eastern portions of the sage-grouse range (Tables 5-7; Figures 10 - 12). However, the Warm Springs Valley population, a small area on the California-Nevada border (Garton et al. 2011a) is known to be influenced by urbanization and a transmission line (Conservation Objectives Team et al. 2012). Agricultural developments currently influence less than 1% of the MZ, however 75% of priority and general habitats are within the influence cropland (Table 4; Figure 9) indicating a high likelihood of influence, without direct displacement.

MZ VI* - Columbia Basin

The sage-grouse habitats within the Columbia Basin are among the most developed (primarily agriculture) and heavily used landscapes still occupied by sage-grouse. These two, small populations are also affected by living near the distribution limits of the species and suitable sagebrush habitats. Washington populations do not significantly occupy BLM lands, so while important to the overall conservation of the species, this region is not directly addressed in this assessment. CRP lands can create habitat refugia within converted landscapes when they include sagebrush cover; enrollment of 17% of an agricultural landscape in eastern Washington succeeded in reversing short-term population declines, whereas declines continued on adjacent landscape with fewer CRP-designated lands (Schroeder and Vander Haegen 2011). These populations are recognized here, but are part of an independent plan and assessment process.

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Science Summary FOIA Response-Part 8

Referenced Cited

Aldrich, J. W. 1946. New subspecies of birds from western North America. Pages 129-136. Proceedings of the Biological Society of Washington.

Aldrich, J. W. 1963. Geographic orientation of American tetraonidae. Journal of Wildlife Management **27**:529-545.

Aldrich, J. W. and A. J. Duvall. 1955. Distribution of American Gallinaceous Game Birds. **34**:12-17.

Aldridge, C. L. 2000. Reproduction and habitat use by Sage Grouse (*Centrocercus urophasianus*) in a northern fringe population. Unverisity of Regina.

Aldridge, C. L. and M. S. Boyce. 2007. Linking occurrence and fitness to persistence: Habitat-based approach for endangered Greater Sage-Grouse. Ecological Applications **17**:508-526.

Aldridge, C. L. and R. M. Brigham. 2003a. Distribution, abundance, and status of the Greater Sage-Grouse, Centrocercus urophasianus, in Canada. Canadian Field-Naturalist **117**:25-34.

Aldridge, C. L. and R. M. Brigham. 2003b. Sage-grouse nesting and brood habitat use in southern Canada. . Journal of Wildlife Management **67**:910-910.

Aldridge, C. L., S. E. Nielsen, H. L. Beyer, M. S. Boyce, J. W. Connelly, S. T. Knick, and M. A. Schroeder. 2008. Range-wide patterns of greater sage-grouse persistence. Diversity and Distributions **14**:983-994.

Aldridge, C. L., D. J. Saher, T. M. Childers, K. E. Stahlnecker, and Z. H. Bowen. 2012. Crucial nesting habitat for Gunnison sage-grouse: A spatially explicit hierarchical approach. Journal of Wildlife Management **76**:391-406.

Allendorf, F. W. and R. W. Leary. 1986. Heterozygosity and fitness in natural populations of animals. Pages 51–65 *in* M. E. Soule, editor. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, Massachusetts, USA.

American Ornithologists', U. 1957. Check-list of North American birds. **5th ed**:139pp.

Anderson, E. D., R. A. Long, M. P. Atwood, J. G. Kie, T. R. Thomas, P. Zager, and R. T. Bowyer. 2012. Winter resource selection by female mule deer Odocoileus hemionus: functional response to spatio-temporal changes in habitat. Wildlife Biology **18**:153-163.

Anderson, J. E. and R. S. Inouye. 2001. Landscape-scale changes in plant species abundance and biodiversity of a sagebrush steppe over 45 years. Ecological Monographs **71**:531-556.

Anderson, L. D. 1991. Bluebunch wheatgrass defoliation effects and vigor recovery. Page 25pp. *in* B. o. L. Management, editor. Bureau of Land Management, Salmon, Idaho.

Angell, R. F. 1997. Crested wheatgrass and shrub response to continuous or rotational grazing. Journal of Range Management **50**:160-164.

Aspbury, A. and R. M. Gibson. 2004. Long-range visibility of greater sage grouse leks: a GIS-based analysis. Animal Behaviour **67**:1127-1132.

Assal, T. J., K. E. Veblen, M. A. Farinha, C. L. Aldridge, M. E. Cassaza, and D. A. Pyke. 2012. Data resources for range-wide assessment of livestock grazing across the Sagebrush Biome: U.S. Geological Survey Data Series 690.*in* U. S. G. Survey, editor. U.S. Geological Survey Fort Collins, CO.

Atamian, M. J. S. C. F. 2007. Dynamics of greater sage-grouse (Centrocercus urophasianus) populations in response to transmission lines in central Nevada. Page 39 pp.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Atamian, M. T., J. S. Sedinger, J. S. Heaton, and E. J. Blomberg. 2010. Landscape-Level Assessment of Brood Rearing Habitat for Greater Sage-Grouse in Nevada. Journal of Wildlife Management **74**:1533-1543.

Autrienth, R. E. 1981. Sage grouse management in Idaho. Idaho department of Fish and Game, Boise, ID.

Baker, W. L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin **34**:177-185.

Baker, W. L. 2011. Pre- Euro-american and recent fire in sagebrush ecosystems. Pages 185-202 *in* S. T. Knick and J. W. Connelly, editors. Greater sage-grouse: ecology and conservation of a landscape species. University of California Press, Berkeley, CA.

Bartmann, R. M., G. C. White, L. H. Carpenter, and R. A. Garrott. 1987. Aerial mark-recapture estimates of confines mule deer in pinyon-juniper woodland. . Journal of Wildlife Management **51**:41-46.

Bates, J. D., K. W. Davies, and R. N. Sharp. 2011. Shrub-Steppe Early Succession Following Juniper Cutting and Prescribed Fire. Environmental Management **47**:468-481.

Bates, J. D., E. C. Rhodes, K. W. Davies, and R. Sharp. 2009. Postfire Succession in Big Sagebrush Steppe With Livestock Grazing. Rangeland Ecology & Management **62**:98-110.

Bates, J. D., T. Svejcar, R. F. Miller, and R. A. Angell. 2006. The effects of precipitation timing on sagebrush steppe vegetation. Journal of Arid Environments **64**:670-697.

Baughman, C., T. A. Forbis, and L. Provencher. 2010. Response of Two Sagebrush Sites to Low-Disturbance, Mechanical Removal of Pinyon and Juniper. Invasive Plant Science and Management **3**:122-129.

Baxter, R. J., J. T. Flinders, and D. L. Mitchell. 2008. Survival, movements, and reproduction of translocated greater sage-grouse in Strawberry Valley, Utah. Journal of Wildlife Management **72**:179-186.

Beck, J. L., J. W. Connelly, and K. P. Reese. 2009. Recovery of Greater Sage-Grouse Habitat Features in Wyoming Big Sagebrush following Prescribed Fire. Restoration Ecology **17**:393-403.

Beck, J. L. and D. L. Mitchell. 2000. Influences of livestock grazing on sage grouse habitat. Wildlife Society Bulletin **28**:993-1002.

Beck, J. L., D. L. Mitchell, and B. D. Maxfield. 2003. Changes in the distribution and status of sage-grouse in Utah. Western North American Naturalist **63**:203-214.

Beck, J. L., K. P. Reese, J. W. Connelly, and M. B. Lucia. 2006. Movements and survival of juvenile greater sage-grouse in southeastern Idaho. Wildlife Society Bulletin **34**:1070-1078.

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

Beever, E. A. and C. L. Aldridge. 2011. Influences of free-roaming equids on sagebrush ecosystems, with focus on greater sage-grouse. Pages 273-291 *in* S. T. C. J. W. Knick, editor. Studies in Avian Biology. Cooper Ornithological Union, University of California Press, Berkeley.

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

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

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

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Bi-State Local Planning, G. 2004. Greater sage-grouse conservation for the bi-state plan area of Nevada and eastern California. **First Edition**:193 pp.

Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology **26**:461-471.

Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology **26**:461-471.

Blus, L. J., C. S. Staley, C. J. Henny, G. W. Pendleton, T. H. Craig, E. H. Craig, and D. K. Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management **53**:1139-1146.

Bouzat, J. L., H. H. Cheng, H. A. Lewin, R. L. Westemeier, J. D. Brawn, and K. N. Paige. 1998. Genetic evaluation of a demographic bottleneck in the greater prairie chicken. Conservation Biology **12**:836-843.

Boyce, M. S. 1990. The red queen visits sage grouse leks. American Zoology **30**:263-270.

Boyko, A. R., R. M. Gibson, and J. R. Lucas. 2004. How predation risk affects the temporal dynamics of avian leks: Greater sage grouse versus golden eagles. American Naturalist **163**:154-165.

Bradley, B. A. 2010. Assessing ecosystem threats from global and regional change: hierarchical modeling of risk to sagebrush ecosystems from climate change, land use and invasive species in Nevada, USA. Ecography **33**:198-208.

Braun, C. E. 1998a. Sage grouse declines in western North America: what are the problems? Pages 139-156 *in* Proceedings of the Western Association of State Fish and Wildlife Agencies.

Braun, C. E. 1998b. Sage grouse declines in western North America: What are the problems? Pages 139-156 *in* Proceedings of Western Association of Fish and Wildlife Agencies (WAFWA). WAFWA.

Braun, C. E., M. F. Baker, R. L. Eng, J. W. Gashwiler, and M. H. Schroeder. 1976. Conservation committee report on effects of alteration of sagebrush communities on the associated avifauna. The Wilson Bulletin **88**:165-171.

Braun, C. E. and T. D. I. Beck. 1985. Effects of changes in hunting regulations on Sage Grouse harvest and populations. Pages 335-343 *in* S. L. Beason and S. F. Roberson, editors. Game harvest mangement. Caesar Kleberg Wildlife Research Institute, Kingsville, TX.

Braun, C. E., O. O. Oedekoven, and C. L. Aldridge. 2002. Oil and gas development in western North America: Effects on sagebrush steppe avifauna with particular emphasis on sage grouse. Pages 337-349 *in* J. Rahm, editor. Transactions of the Sixty-Seventh North American Wildlife and Natural Resource Conference. Wildlife Management Inst, Washington.

Briske, D. D., J. D. Derner, J. R. Brown, S. D. Fuhlendorf, W. R. Teague, K. M. Havstad, R. L. Gillen, A. J. Ash, and W. D. Willms. 2008. Rotational grazing on rangelands: Reconciliation of perception and experimental evidence. Rangeland Ecology & Management **61**:3-17.

Briske, D. D., S. D. Fuhlendorf, and F. E. Smeins. 2003. Vegetation dynamics on rangelands: a critique of the current paradigms. Journal of Applied Ecology **40**:601-614.

Briske, D. D. and J. R. Hendrickson. 1998. Does selective defoliation mediate competitive interactions in a semiarid savanna? A demographic evaluation. Journal of Vegetation Science **9**:611-622.

Brockway, D. G., R. G. Gatewood, and R. B. Paris. 2002. Restoring grassland savannas from degraded pinyon-juniper woodlands: effects of mechanical overstory reduction and slash treatment alternatives. Journal of Environmental Management **64**:179-197.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Brown, J. K. 1982. Fuel and fire behavior prediction in big sagebrush. Research paper INT; 290 83-B, USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Bruce, J. R., W. D. Robinson, S. L. Petersen, and R. F. Miller. 2011. Greater Sage-Grouse movements and habitat use during winter in central Oregon. Western North American Naturalist **71**:418-424.

Bui, T. D. 2009. The effects of nest and brood predation by common ravens (Corvus corax) on greater sage-grouse (Centrocercus urophasianus) in relation to land use in western Wyoming. University of Washington.

Bureau of Land Management. 2008. Wildfire Season and Sage-grouse Conservation. Department of Interior, Washington, D.C.

Bureau of Land Management. 2011a. BLM National Sage-Grouse Land Use Planning Strategy. Instruction Memorandum, Bureau of Land Management, Washington, D.C.

Bureau of Land Management. 2011b. Greater Sage-Grouse Interim Management Policies and Procedures. Instruction Memorandum, Bureau of Land Management, Washington, D.C. .

Bureau of Land Management. 2011c. Notice of Intent To Prepare Environmental Impact Statements and Supplemental Environmental Impact Statements To Incorporate Greater Sage-Grouse Conservation Measures Into Land Use Plans and Land Management Plans *in* Federal Register, 40 CFR 1501.7. Land Management Bureau, Washington, D.C.

Bureau of Land Management. 2012. Notice of Correction to Notice of Intent To Prepare Environmental Impact Statements and Supplemental Environmental Impact Statements To Incorporate Greater Sage-grouse Conservation Measures Into Land Use Plans and Land Management Plans. Pages 7178-7179 *in* F. Register, editor. 43 CFR 1610.2. Land Management Bureau, Washington, D.C.

Burkhardt, J. W. and E. W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology **57**:472-484.

Cagney, J., E. Bainter, R. Budd, T. Christiansen, V. Herren, M. J. Holloran, B. Rashford, M. D. Smith, and J. Williams. 2010. Grazing influence, objective development, and mangement in Wyoming's Greater Sage-Grouse Habitat. University of Wyoming, Laramie.

Call, M. and W. C. Maser. 1985. Wildlife habitats in managed rangelands - The Great Basin of southeastern Oregon sage grouse. Page 30 pp General Technical Report. U.S. Department of Agriculture, Forest Service, La Grande, OR.

Canada Gazette. 2002. Species at risk act. Page 428 pp.

Carpenter, J., C. Aldridge, and M. S. Boyce. 2010. Sage-Grouse Habitat Selection During Winter in Alberta. Journal of Wildlife Management **74**:1806-1814.

Carr, H. D. and F. A. Glover. 1970. Effects of sagebrush control on sage grouse. North American Wildlife and Natural Resources Conference Transcripts:205-215.

Chong, G. W., W. C. Wetzel, and M. J. Holloran. 2011. Greater sage-grouse of Grand Teton National Park: Where do they roam? Park Science **27**:42-49.

Christen, D. C. and G. R. Matlack. 2009. The habitat and conduit functions of roads in the spread of three invasive plant species. Biological Invasions **11**:453-465.

Christensen, N.L. 1985. Shrubland Fire Regimes and Their Evolutionary Consequences. Pages 85-100 *in* Pickett, S.T.A. and P.S. White, The Ecology of Natural Disturbance and Patch Dynamics. Academic Press, San Diego California.

Christiansen, T. 2009. Fence marking to reduce greater sage-grouse (Centrocercus urophasianus) collisions and mortality near - summary of interim results. Wyoming Game and Fish Department, Farson, Wyoming

Christiansen, T. J. C. M. T., editor. 2011. Parasites and infectious disease of greater sage-grouse. Cooper Ornithological Union, University of California Press, Berkeley.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Clark, L., J. Hall, R. McLean, M. Dunbar, K. Klenk, R. Bowen, and C. A. Smeraski. 2006. Susceptibility of greater sage-grouse to experimental infection with West Nile virus. Journal of Wildlife Diseases **42**:14-22.

Clifford, M. J., N. S. Cobb, and M. Buenemann. 2011. Long-Term Tree Cover Dynamics in a Pinyon-Juniper Woodland: Climate-Change-Type Drought Resets Successional Clock. Ecosystems **14**:949-962.

Coates, P. S. 2007. Greater sage-grouse (Centrocercus urophasianus) nest predation and incubation behavior. Idaho State University, Boise, ID.

Coates, P. S., J. W. Connelly, and D. J. Delehanty. 2008. Predators of Greater Sage-Grouse nests identified by video monitoring. Journal of Field Ornithology **79**:421-428.

Colorado Greater Sage-grouse Steering Committee. 2008. Colorado Greater Sage-grouse Conservation Plan. Colorado Division of Wildlife, Denver, Colorado.

Condon, L., P. J. Weisberg, and J. C. Chambers. 2011. Abiotic and biotic influences on Bromus tectorum invasion and Artemisia tridentata recovery after fire. International Journal of Wildland Fire **20**:597-604.

Connelly, J. 2005. Challenging dogma-changing paradigms- Sage grouse harvest management in the United States. Sage Grouse News **29**:7-11.

Connelly, J. W. 1980. Ecology of sage grouse on the INEL Site. Idaho Department of Fish and Game. Report Federal Aid Project W-160-R-7.

Connelly, J. W. 1982. An ecological study of sage grouse in southeastern Idaho. Washington State University, Pullman, WA, USA.

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

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

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

Connelly, J. W. and L. J. Blus. 1991. Effects of pesticides on upland game- a review of herbicides and organophosphate and carbamate insecticides. Pages 238-239. U.S. Environmental Protection Agency, Corvallis, Oregon.

Connelly, J. W. and C. E. Braun. 1997. A review of long-term changes in sage grouse populations in western North America. Wildlife Biology **3**:229-234.

Connelly, J. W. and L. A. Doughty., editors. 1989. Sage grouse use of wildlife water developments in southeastern Idaho. , Boise, Idaho.

Connelly, J. W., C. A. Hagen, and M. A. Schroeder. 2011a. Characteristics and dynamics of greater sage-grouse populations. Pages 53-68 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Connelly, J. W., S. T. Knick, C. E. Braun, W. L. Baker, E. A. Beever, T. Christiansen, K. E. Doherty, E. O. Garton, C. A. Hagen, S. E. Hanser, D. H. Johnson, M. Leu, R. F. Miller, D. E. Naugle, S. J. Oyler-McCance, D. A. Pyke, K. P. Reese, M. A. Schroeder, S. J. Stiver, B. L. Walker, and M. J. Wisdom. 2011b. Conservation of greater sage-grouse: a synthesis of current trends and future management. Pages 549-563 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornthological Union, University of California Press, Berkeley, California.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Connelly, J. W., S. T. Knick, C. E. Braun, W. L. Baker, E. A. Beever, T. Christiansen, K. E. Doherty, E. O. Garton, S. E. Hanser, D. H. Johnson, M. Leu, R. F. Miller, D. E. Naugle, S. J. Oyler-McCance, D. A. Pyke, K. P. Reese, M. A. Schroeder, S. J. Stiver, B. L. Walker, and M. J. Wisdom. 2011c. Conservation of greater sage-grouse: a synthesis of current trends and future management. Pages 549-563 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies (WAFWA).

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

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003b. Monitoring of greater sage-grouse habitats and populations. College of Natural Resources Experiment Station University of Idaho, Moscow, ID, USA.

Connelly, J. W., E. T. Rinkes, and C. E. Braun. 2011d. Characteristics of greater sage- grouse habitats- a landscape species at micro and macro scales. Pages 69-84 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Connelly, J. W., E. T. Rinkes, and C. E. Braun. 2011e. Characteristics of greater sage- grouse habitats: a landscape species at micro and macro scales. Pages 69-84 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

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

Conservation Objectives Team, S. Abele, R. Budd, D. Budeau, J. Connelly, P. A. Deibert, J. Delevan, S. Espinosa, S. C. Gardner, K. Griffin, J. Harja, R. Northrup, A. Robinson, M. Schroeder, and P. Souza. 2012. Sage-Grouse Conservation Objectives Report. Page 73pp + Append. *in* S.-G. C. O. Team, editor. WAFWA, USFWS.

Cote, I. M. W. J. S. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology **11**:395-405.

Crawford, J. A. 1982. History of sage grouse in Oregon. Oregon Wildlife:3-6.

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

Cresswell, W., J. Lind, and J. L. Quinn. 2010. Predator-hunting success and prey vulnerability: quantifying the spatial scale over which lethal and non-lethal effects of predation occur. Journal of Animal Ecology **79**:556-562.

Crist, M. R., B. Wilmer, and G. H. Aplet. 2005. Assessing the value of roadless areas in a conservation reserve strategy: biodiversity and landscape connectivity in the northern Rockies. Journal of Applied Ecology **42**:181-191.

Culp, P. W., D. B. Conradi, and C. C. Tuell. 2005. Trust Lands in the American West: A Legal Overview and Policy Assessment. Lincoln Institute of Land Policy/Sonoran Institute Joint Venture on State Trust Lands, Cambridge, MA.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

D'Antonio, C. M., J. C. Chambers, R. Loh, and J. T. Tunison. 2009. Applying Ecological Concepts to the Management of Widespread Grass Invasions. Management of Invasive Weeds:123-149.

Dalgleish, H. J., D. N. Koons, M. B. Hooten, C. A. Moffet, and P. B. Adler. 2011. Climate influences the demography of three dominant sagebrush steppe plants. Ecology **92**:75-85.

Davies, G. M., J. D. Bakker, E. Dettweiler-Robinson, P. W. Dunwiddie, S. A. Hall, J. Downs, and J. Evans. 2012. Trajectories of change in sagebrush steppe vegetation communities in relation to multiple wildfires. Ecological Applications **22**:1562-1577.

Davies, K. W. 2010. Revegetation of Medusahead-Invaded Sagebrush Steppe. Rangeland Ecology & Management **63**:564-571.

Defries, R. S., J. A. Foley, and G. P. Asner. 2004. Land-use choices: balancing human needs and ecosystem function. Ecology Abstracts.

Deibert, P. A. 1995. The effects of parasites on sage grouse (Centrocercus urophasianus) mate selection. University of Wyoming, Laramie, WY.

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

Dobkin, D. S., A. C. Rich, and W. H. Pyle. 1998. Habitat and avifaunal recovery from livestock grazing in a riparian meadow system of the northwestern Great Basin. Conservation Biology **12**:209-221.

Doherty, K. E., J. L. Beck, and D. E. Naugle. 2011a. Comparing Ecological Site Descriptions to Habitat Characteristics Influencing Greater Sage-Grouse Nest Site Occurrence and Success. Rangeland Ecology & Management **64**:344-351.

Doherty, K. E., D. E. Naugle, H. Copeland, A. Pocewicz, and J. Kiesecke. 2011b. Energy development and conservation tradeoffs: systematic planning for greater sage-grouse in their eastern range.*in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Berkeley, California.

Doherty, K. E., D. E. Naugle, H. Copeland, A. Pocewicz, and J. Kiesecker. 2011c. Energy development and conservation tradeoffs: systematic planning for greater sage-grouse in their eastern range. Pages 505-516 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Cooper Ornithological Society, Berkeley, California.

Doherty, K. E., D. E. Naugle, and J. S. Evans. 2010a. A Currency for Offsetting Energy Development Impacts: Horse-Trading Sage-Grouse on the Open Market. Plos One **5**.

Doherty, K. E., D. E. Naugle, and B. L. Walker. 2010b. Greater Sage-Grouse Nesting Habitat: The Importance of Managing at Multiple Scales. Journal of Wildlife Management **74**:1544-1553.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management **72**:187-195.

Doherty, K. E., J. D. Tack, J. S. Evans, and D. E. Naugle. 2010c. Mapping breeding densities of greater sage-grouse: A tool for range-wide conservation planning. Bureau of Land Management, Denver, CO.

Doherty, M. K. 2007. Mosquito populations in the Powder River Basin, Wyoming - A comparison of natural, agricultural and effluent coal bed natural gas aquatic habitats. Montana State University, Bozeman, MT.

Dow AgroSciences, L. 1999. Spike*80 DF Herbicide. Dow AgroSciences, LLC, Indianapolis, IN.

Drut, M. S. 1994. Status of sage grouse with emphasis on populations in Oregon and Washington.42 pp.

Dunn, P. O. and C. E. Braun. 1985. NATAL DISPERSAL AND LEK FIDELITY OF SAGE GROUSE. Auk **102**:621-627.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Dzialak, M. R., C. V. Olson, S. M. Harju, S. L. Webb, and J. B. Winstead. 2012. Temporal and hierarchical spatial components of animal occurrence: conserving seasonal habitat for greater sage-grouse. Ecosphere **3**:1-17.

Dzialak, M. R., S. L. Webb, S. M. Harju, J. B. Winstead, J. J. Wondzell, J. P. Mudd, and L. D. Hayden-Wing. 2011. The spatial pattern of demographic performance as a component of sustainable landscape management and planning. Landscape Ecology **26**:775-790.

Ellis, K. L. 1985. Effects of a new transmission line on distribution and aerial predation of breeding male sage grouse. **Final report**:28 pp.

Eng, R. L. 1952. A two-summer study of the effects on bird populations of chlordane bait and aldrin spray as used for grasshopper control. Journal of Wildlife Management **16**:326-337.

Eng, R. L. 1963. Observations of the breeding biology of male Sage Grouse. . Journal of Wildlife Management **27**:841-846.

Epanchin-Niell, R., J. Englin, and D. Nalle. 2009. Investing in rangeland restoration in the Arid West, USA: Countering the effects of an invasive weed on the long-term fire cycle. Journal of Environmental Management **91**:370-379.

Erichsen-Arychuk, C., E. W. Bork, and A. W. Bailey. 2002. Northern dry mixed prairie responses to summer wildlife and drought. Journal of Range Management **55**:164-170.

Eva, K. S., P. R. Andrew, and C. B. Stephen. 2007. Spatial patterns on the sagebrush steppe/Western juniper ecotone.

Fedy, B. C., C. L. Aldridge, K. E. Doherty, M. O'Donnell, J. L. Beck, B. Bedrosian, M. J. Holloran, G. D. Johnson, N. W. Kaczor, C. P. Kirol, C. A. Mandich, D. Marshall, G. McKee, C. Olson, C. C. Swanson, and B. L. Walker. 2012. Interseasonal movements of greater sage-grouse, migratory behavior, and an assessment of the core regions concept in Wyoming. Journal of Wildlife Management **76**:1062-1071.

Fedy, B. C. and K. E. Doherty. 2011. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia **165**:915-924.

Fedy, B. C., K. Martin, C. Ritland, and J. R. Young. 2008. Genetic and ecological data provide incongruent interpretations of population structure and dispersal in naturally subdivided populations of white-tailed ptarmigan (Lagopus leucura). Molecular Ecology **17**:1905-1917.

Finch, W. I. 1996. Uranium provinces of North America—their definition, distribution and models. Page 24 pp *in* D. o. Energy, editor.

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

Forman, R. T. T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology **14**:31-35.

Forman, R. T. T. and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics **29**:207-+.

Frankham, R. 1995. Effective population size/adult population size ratios in wildlife: a review. Genetical Research **66**:95–107.

Friend, M. R. G. M. F. J. D. 2001. Disease emergence in birds- Challenges for the twenty-first century. The Auk **118**:290–303.

Garton, E. O., J. W. Connelly, J. S. Horne, C. A. Hagen, A. Moser, and M. Schroeder. 2011a. Greater sage-grouse population dynamics and probability of persistence. Pages 293-381 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Garton, E. O., J. W. Connelly, J. S. Horne, C. A. Hagen, A. Moser, and M. A. Schroeder. 2011b. Greater sage-grouse population dynamics and probability of persistence. Pages 293-381 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Gavin, S. D. and P. E. Komers. 2006. Do pronghorn (Antilocapra americana) perceive roads as a predation risk? Canadian Journal of Zoology-Revue Canadienne De Zoologie **84**:1775-1780.

Gervais, J. A., B. Luukinen, K. Buhl, and D. Stone. 2008. 2,4-D Technical Fact Sheet. Oregon State University Extension Services.

Gibson, R. M., V. C. Bleich, C. W. McCarthy, and T. L. Russi. 2011. Hunting lowers population size in Greater Sage-Grouse. Pages 307-315 *in* B. K. Sandercock, K. Martin, and G. Segelbacher, editors. Ecology, conservation and management of grouse. University of California Press, Berkeley, CA.

Gillies, J. A., V. Etyemezian, H. Kuhns, D. Nikolic, and D. A. Gillette. 2005. Effect of vehicle characteristics on unpaved road dust emissions. Atmospheric Environment **39**:2341-2347.

Gilpin, M. and I. Hanski. 1991. Metapopulation dynamics: empirical and theoretical investigations. Academic Press, London, UK.

Gilpin, M. E. and M. E. Soule. 1986. Minimum viable populations: processes of species extinctions. Pages 19-34 *in* M. E. Soule, editor. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, MA.

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

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

Gregg, M. A., M. R. Dunbar, and J. A. Crawford. 2007. Use of implanted radiotransmitters to estimate survival of greater sage-grouse chicks. Journal of Wildlife Management **71**:646-651.

Hagen, C. A. 2010. Impacts of energy development on prairie grouse ecology: a research synthesis. Transactions North American Wildlife and Natural Resources Conference **75**:96-103.

Hagen, C. A. 2011. Predation on greater sage-grouse-Facts, process and effects. Greater Sage-Grouse: ecology of a landscape species and its habitats **No38**:95-100.

Hagen, C. A. and R. J. Bildfell. 2007. An observation of Clostridium perfringens in Greater Sage-Grouse. Journal of Wildlife Diseases **43**:545-547.

Hagen, C. A., J. W. Connelly, and M. A. Schroeder. 2007. A meta-analysis of greater sage-grouse Centrocercus urophasianus nesting and brood-rearing habitats. Wildlife Biology **13**:42-50.

Hagen, C. A., M. J. Willis, E. M. Glenn, and R. G. Anthony. 2011. Habitat selection by Greater Sage-Grouse during winter in southeastern Oregon. . Western North American Naturalist **71**:529-538.

Hagen, C. A. J. W. C. M. 2007. A meta-analysis of greater sage-grouse Centrocercus urophasianus nesting and brood-rearing habitats. Wildlife Biology **13**:42-50.

Hall, F. C., and L. Bryant. 1995. Herbaceous stubble height as a warning of impending cattle grazing damage to riparian areas.*in* U. S. D. o. A. F. Service, editor. Pacific Northwest Research Station, Portland, OR, USA.

Hansen, A. J., R. L. Knight, J. M. Marzluff, S. Powell, K. Brown, P. H. Gude, and K. Jones. 2005. Effects of exurban development on biodiversity- Patterns, mechanisms and research needs. Ecological Applications **15**:1893-1905.

Hanski, I. 1998. Metapopulation Dynamics. Nature **396**:41-49.

Hanski, I. and C. D. Thomas. 1994. Metapopulation dynamics and conservation: A spatially explicit model applied to butterflies. Biological Conservation **68**:167-180.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Harju, S. M., M. R. Dzialak, R. C. Taylor, L. D. Hayden-Wing, and J. B. Winstead. 2010. Thresholds and Time Lags in Effects of Energy Development on Greater Sage-Grouse Populations. Journal of Wildlife Management **74**:437-448.

Hausleitner, D. 2003. Population dynamics, habitat use and movements of greater sage- grouse in Moffat County, Colorado. University of Idaho.

Hausleitner, D., K. P. Reese, and A. D. Apa. 2005. Timing of vegetation sampling at greater sage-grouse nests. Rangeland Ecology & Management **58**:553-556.

Hedrick, P. W. and S. T. Kalinowski. 2000. Inbreeding depression in conservation biology. Annual Review of Ecology and Systematics **31**:139–162.

Hess, J. E. and J. L. Beck. 2012. Burning and Mowing Wyoming Big Sagebrush: Do treated sites meet minimum guidelines for Greater Sage-Grouse breeding habitats? Wildlife Society Bulletin **36**:85-93.

Holechek, J., D. Galt, J. Joseph, J. Navarro, G. Kumalo, F. Molinar, and M. Thomas. 2003. Moderate and light cattle grazing effects on Chihuahuan Desert rangelands. Journal of Range Management **56**:133-139.

Holechek, J. L., R. D. Pieper, and C. H. Herbel. 1989. Range management: principles and practices. Regents-Prentice Hall, Englewood Cliffs, New Jersey.

Holloran, M. J. 2005. Greater sage-grouse (Centrocercus urophasianus) population response to natural gas field development in western Wyoming. University of Wyoming, Laramie, WY.

Holloran, M. J. and S. H. Anderson. 2005. Spatial distribution of Greater Sage-Grouse nests in relatively contiguous sagebrush habitats. Condor **107**:742-752.

Holloran, M. J., B. C. Fedy, and J. Dahlke. In Review. Winter habitat seleciton of greater sage-grouse relative to activity levels at natural gas well pads. Journal of Wildlife Management.

Holloran, M. J., B. J. Heath, A. G. Lyon, S. J. Slater, J. L. Kuipers, and S. H. Anderson. 2005. Greater Sage-Grouse nesting habitat selection and success in Wyoming. . Journal of Wildlife Management **69**:638-649.

Holloran, M. J., R. C. Kaiser, and W. A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management **74**:65-72.

Holloran, M. J. S. H. A. 2003. Direct identification of northern sage-grouse, Centrocercus urophasianus, nest predators using remote sensing cameras. The Canadian Field Naturalist **117**:308-310.

Honess, R. F. G. P. 1968. History of an epizootic in sage grouse. **Science Monograph 14**:32 pp.

Hornaday, W. T. 1916. Save the sage grouse from extinction- A demand from civilization to the western states. NYZoological Park Bulletin **5**:179-219.

Huebner, C. D. 2010. Spread of an invasive grass in closed-canopy deciduous forests across local and regional environmental gradients. Biological Invasions **12**:2081-2089.

Hull, S. D., R. J. Robel, and K. E. Kemp. 1996. Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP. Prairie Naturalist **28**:1-12.

Hupp, J. W. and C. E. Braun. 1991. GEOGRAPHIC-VARIATION AMONG SAGE GROUSE IN COLORADO. Wilson Bulletin **103**:255-261.

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

Idaho Exec. Order No. 2012-02. Mar. 9, 2012. Establishing the Governor's Sage-Grouse Task Force.

Idaho Sage-grouse Advisory Committee. 2006. Conservation Plan for the Greater Sage-grouse in Idaho.

Idaho Sage-grouse Advisory Committee Technical Assistance Team. 2012. Idaho Sage-grouse Local Working Groups Statewide Annual Report 2011.

Idaho Sage-Grouse Task Force. 2012. Idaho Governor's Sage-Grouse Task Force Recommendations.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

INL Campus Development Office and North Wind Inc. 2011. Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report. Idaho National Laboratory, Idaho Falls, ID, Unpublished Report.

Interagency MOU. 2009. Memorandum of Understanding Among Bureau of Land Management (Colorado State Office), U.S. Forest Service (Rocky Mountain Region), and Colorado Oil and Gas Conservation Commission Concerning Oil and Gas Permitting on BLM and NFS Lands in Colorado

IPCC. 2007. An assessment of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change.

Jamison, B. E., R. J. Robel, J. S. Pontius, and R. D. Applegate. 2002. Invertebrate biomass: associations with lesser prairie-chicken habitat use and sand sagebrush density in southwestern Kansas. Wildlife Society Bulletin **30**:517-526.

Jensen, B. M. 2006. Migration, transition range and landscape use by Greater Sage-Grouse (Centrocercus urophasianus). University of Wyoming, Laramie, WY, USA.

Jimenez, J. A., K. A. Hughes, G. Alaks, L. Graham, and R. C. Lacy. 1994. An experimental study of inbreeding depression in a natural habitat. Science **266**:271-273.

Johnsgard, P. A. 1983. The grouse of the world.411 pp.

Johnson, D. J., M. J. Holloran, J. W. Connelly, S. E. Hanser, C. L. Amundson, and S. T. Knick. 2011. Influences of environmental and anthropogenic features on greater sage-grouse population, 1997-2007. Pages 407-450 *in* S. T. Knick and J. W. Connelly, editors. Studies in Avian Biology. Cooper Ornithological Union, University of California Press, Berkeley.

Johnson, G. D. and M. S. Boyce. 1991. Survival, growth//reproduction of captive- reared sage grouse. Wildlife Society Bulletin **19**:88-93.

Johnson, J. A. and P. O. Dunn. 2006. Low genetic variation in the heath hen prior to extinction and implications for the conservation of prairie-chicken populations. Conservation Genetics **7**:37-48.

Kahn, N. W., C. E. Braun, J. R. Young, S. Wood, D. R. Mata, and T. W. Quinn. 1999. Molecular analysis of genetic variation among large- and small-bodied sage grouse using mitochondrial control-region sequences. Auk **116**:819-824.

Keane, R. E., J. K. Agee, P. Fule, J. E. Keeley, C. Key, S. G. Kitchen, R. Miller, and L. A. Schulte. 2008. Ecological effects of large fires on US landscapes: benefit or catastrophe? International Journal of Wildland Fire **17**:696-712.

Keller, L. F., P. Arcese, J. N. M. Smith, W. M. Hochachka, and S. C. Stearns. 1994. Selection against inbred song sparrows during a natural population bottleneck. Nature **372**:356–357.

Keller, L. F. and D. M. Waller. 2002. Inbreeding effects in wild populations. Trends in Ecology & Evolution **17**:230–241.

Kirol, C. P., J. L. Beck, J. B. Dinkins, and M. R. Conover. 2012. Microhabitat selection for nesting and brood-rearing by the Greater Sage-Grouse in xeric big sagebrush. Condor **114**:75-89.

Klebenow, D. A. 1970. Sage grouse versus sagebrush control in Idaho. [Herbicides]. Journal of Range Management **23**:396-400.

Klebenow, D. A. G. M. G. 1968. Food habits of juvenile sage grouse. Journal of Range Management **21**:80-83.

Klemmedson, J. O. and J. G. Smith. 1964. Cheatgrass (Bromus Tectorum L.). **30**:226-262.

Knapp, P. A. 1996. Cheatgrass (Bromus tectorum L) dominance in the Great Basin Desert - History, persistence, and influences to human activities. Global Environmental Change-Human and Policy Dimensions **6**:37-52.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Knick, S. T. 2011a. Historical development, principal federal legislation and current management of sagebrush habitats implications for conservation. Pages 13-32 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Berkeley, CA.

Knick, S. T. 2011b. Historical development, principal federal legislation and current management of sagebrush habitats: implications for conservation. Pages 13-32 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Knick, S. T. and J. W. Connelly. 2011a. Greater sage-grouse and sagebrush - Introduction to the landscape. Pages 1-9 *in* S. T. Knick and J. W. Connelly, editors. Greater sage-grouse: Ecology and conservation of a landscape species and its habitats. Cooper Ornithological Society, University of California Press, Berkeley.

Knick, S. T. and J. W. Connelly, editors. 2011b. Greater sage-grouse: ecology and conservation of a landscape species and its habitats. University of California Press, Berkeley.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry, M. A. Schroeder, W. M. Vander Haegen, and C. Van Riper III. 2003a. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. Condor **105**:611-634.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry, M. A. Schroeder, W. M. Vander Haegen, and C. Van Riper III. 2003b. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. Condor **105**:611-634.

Knick, S. T. and S. E. Hanser. 2011a. Connecting pattern and process in greater sage- grouse populations and sagebrush landscapes. Pages 383-406 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Knick, S. T. and S. E. Hanser. 2011b. Connecting pattern and process in greater sage-grouse populations and sagebrush landscapes. Pages 383-405 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Berkeley.

Knick, S. T., S. E. Hanser, R. F. Miller, D. A. Pyke, M. J. Wisdom, S. P. Finn, E. T. Rinkes, and C. J. Henny. 2011. Ecological influence and pathways of land use in sagebrush. Pages 203-252 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.

Knick, S. T. and J.W. Connelly, editors. 2011. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Berkeley, CA.

Knight, R. L., H. A. L. Knight, and R. J. Camp. 1993. Raven populations and land-use patterns in the Mojave Desert, California. Wildlife Society Bulletin **21**:469-471.

Kolada, E. J., J. S. Sedinger, and M. L. Casazza. 2009. Nest Site Selection by Greater Sage-Grouse in Mono County, California. Journal of Wildlife Management **73**:1333-1340.

Kuipers, J. L. 2004. Grazing system and linear corridor influences on greater sage-grouse (Centrocercus urophasianus) habitat selection and productivity. Thesis. University of Wyoming, Laramie, WY, USA.

Lacy, R. C. 1997. Importance of genetic variation to the viability of mammalian populations. Journal of Mammalogy **78**:320-325.

Lacy, R. C., G. Alaks, and A. Walsh. 1996. Hierarchical analysis of inbreeding depression in Peromyscus polionotus. Evolution **50**:2187–2200.

Larson, T. A. 1978. History of Wyoming. 3rd edition. Univerisity of Nebraska Press, Lincoln, Nebraska.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Laycock, W. A. 1978. Factors affecting choice of management strategies within the sagebrush ecosystem United States, Artemisia tridentata. Pages 230-236 *in* The Sagebrush ecosystem : a symposiuml. Utah State University, College of Natural Resources, Logan, UT.

LeBeau, C. W. 2012. Evaluation of greater sage-grouse reproductive habitat and response to wind energy development in south-central, Wyoming. Thesis. University of Wyoming, Laramie, WY, USA.

Lee, C. H., C. A. Shih, C. C. Chien, S. S. Fang, L. L. Lin, and M. D. Lin. 2007. Estimation of fugitive dust emission factor for truck moving in dredging road. Page 467.

Leonard, K. M., K. P. Reese, and J. W. Connelly. 2000. Distribution, movements and habitats of sage grouse Centrocercus urophasianus on the Upper Snake River Plain of Idaho: changes from the 1950s to the 1990s. Wildlife Biology **6**:265-270.

Leu, M., and S. E. Hanser. 2011. Influences of the human footprint on sagebrush landscape patterns. Pages 253-271 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, California.

Leu, M. and S. E. Hanser. 2011. Influences of the human footprint on the sagebrush landscape patterns. Pages 253-272 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, Berkeley, California.

Leu, M., S. E. Hanser, and S. T. Knick. 2008. The human footprint in the west - A large scale analysis of anthropogenic impacts. Ecological Applications **18**:1119-1139.

Lowe, B. S., D. J. Delehanty, and J. W. Connelly. 2009. Greater sage-grouse Centrocercus urophasianus use of threetip sagebrush relative to big sagebrush in south-central Idaho. Wildlife Biology **15**:229-236.

Lyon, A. G. and S. H. Anderson. 2003. Potential gas development impacts on sage grouse nest initiation and movement. Wildlife Society Bulletin **31**:486-491.

Manier, D. J. and N. T. Hobbs. 2007. Large herbivores in sagebrush steppe ecosystems: livestock and wild ungulates influence structure and function. Oecologia **152**:739-750.

Manier, D. J., N. T. Hobbs, D. M. Theobald, R. M. Reich, M. A. Kalkhan, and M. R. Campbell. 2005. Canopy dynamics and human caused disturbance on a semi-arid landscape in the Rocky Mountains, USA. Landscape Ecology **20**:1-17.

Manville, A. M. 2002. Bird strikes and electrocutions at power lines, communication towers and wind turbines -- State of the art and state of the science – next steps toward mitigation.28 pp.

Marra, P. P., S. Griffing, C. Caffrey, A. M. Kilpatrick, R. McLean, C. Brand, E. Saito, A. P. Dupuis, L. Kramer, and R. Novak. 2004. West Nile virus and wildlife. BioScience **54**:393-402.

McLean, R. G. 2006. West Nile virus in North American birds. Ornithological Monographs **60**:44-64.

Meinke, C. W., S. T. Knick, and D. A. Pyke. 2009. A Spatial Model to Prioritize Sagebrush Landscapes in the Intermountain West (USA) for Restoration. Restoration Ecology **17**:652-659.

Mezquida, E. T., S. J. Slater, and C. W. Benkman. 2006. Sage-Grouse and indirect interactions: Potential implications of coyote control on Sage-Grouse populations. Condor **108**:747-759.

Miller, M. E. 2008. Broad-scale assessment of rangeland health, Grand Staircase-Escalante National Monument, USA. Rangeland Ecology & Management **61**:249-262.

Miller, R. F. and L. L. Eddleman. 2000. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State University Agricultural Experiment Station, Corvallis, Oregon.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Miller, R. F. and E. K. Heyerdahl. 2008. Fine-scale variation of historical fire regimes in sagebrush-steppe and juniper woodland: An example from California, USA. International Journal of Wildland Fire **17**:245-254.
Miller, R. F., S. T. Knick, D. A. Pyke, C. W. Meinke, S. E. Hanser, M. J. Wisdom, and A. L. Hild. 2011. Characteristics of sagebrush habitats and limitations to long-term conservation. Pages 145-184 *in* S. T. C. J. W. Knick, editor. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.
Miller, R. F. and J. A. Rose. 1995. Historic expansion of Juniperus occidentalis (Western juniper) in southeastern Oregon. Great Basin Naturalist **55**:37-45.
Miller, R. F., T. J. Svejcar, and J. A. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management **53**:574-585.
Miller, R. F., T. J. Svejcar, and N. E. West. 1994. Implications of livestock grazing in the intermountain sagebrush region- Plant composition. Pages 101-146 *in* M. Vavra, W. A. Laycock, and R. D. Pieper, editors. Ecological implications of livestock herbivory in the west.
Montana Department of Natural Resources & Conservation Trust Land Management Division. 2007. Sage Grouse Mitigation for Oil & Gas Operations on State School Trust Lands.
Montana Sage Grouse Work Group. 2005. Management Plan and Conservation Strategies for Sage Grouse in Montana - Final.
Mooney, H. A. and E. E. Cleland. 2001. The evolutionary impact of invasive species. Proc National Acad Sci **98**:5446-5451.
Moynahan, B. J., M. S. Lindberg, J. J. Rotella, and J. W. Thomas. 2007. Factors affecting nest survival of greater sage-grouse in northcentral Montana. Journal of Wildlife Management **71**:1773-1783.
Moynahan, B. J., M. S. Lindberg, and J. W. Thomas. 2006. Factors contributing to process variance in annual survival of female Greater Sage-Grouse in Montana. Ecological Applications **16**:1529-1538.
Mueggler, W. F. 1950. Effects of spring and fall grazing by sheep on vegetation of the upper snake river plains. Journal of Range Management **3**:308-315.
Natural Resources Conservation Service. 2011. Introduction to NRCS' New Sage-Grouse Initiative: Wildlife Conservation Through Sustainable Ranching. Department of Agriculture, Washington, D.C.
Naugle, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, B. J. Moynahan, M. J. Holloran, K. Brown, G. D. Johnson, E. T. Schmidtmann, R. T. Mayer, C. Y. Kato, M. R. Matchett, T. J. Christiansen, W. E. Cook, T. Creekmore, R. D. Falise, E. T. Rinkes, and M. S. Boyce. 2004. West Nile virus - Pending crisis for greater sage- grouse. Ecology Letters **7**:704-713.
Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, M. R. Matchett, J. McIntosh, T. E. Cornish, and M. S. Boyce. 2005a. West Nile virus and sage-grouse- What more have we learned? Wildlife Society Bulletin **33**:616-623.
Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, M. R. Matchett, J. McIntosh, T. E. Cornish, and M. S. Boyce. 2005b. West Nile virus and sage-grouse: What more have we learned? Wildlife Society Bulletin **33**:616-623.
Naugle, D. E., K. E. Doherty, B. L. Walker, M. J. Holloran, and H. E. Copeland. 2011. Energy development and greater sage-grouse. Pages 489-504 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, , Berkeley, CA.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Neilson, R. P., J. M. Lenihan, D. Buchelet, and R. J. Drapek. 2005. Climate change implication for sagebrush ecosystems. Pages 145-159 *in* 70th North American Wildlife and Natural Resources Conference, Transactions of Wildlife Management Institute, Arlington, VA.

Nelle, P. J., K. P. Reese, and J. W. Connelly. 2000. Long-term effects of fire on sage grouse habitat. Journal of Range Management **53**:586-591.

Nevada Department of Wildlife. 2011. NDOW Actions to Avoid ESA Listing of Greater Sage-grouse.*in* Nevada Board of Wildlife Commissioners Meeting

Nevada Department of Wildlife. 2012. Greater Sage-grouse Habitat Categorization.

Nevada Executive Order. Mar. 30, 2012. Establishing a Greater Sage-grouse Advisory Committee.*in* G. s. O. State of Nevada, editor. No. 2012-09, Reno, NV.

Nevada Greater Sage-grouse Advisory Committee. 2012. Strategic Plan for Conservation of Sage-Grouse in Nevada.

Nevada Sage-Grouse Conservation Team. 2004. Greater Sage-Grouse Conservation Plan for Nevada and Eastern California.

Norrdahl, K. and E. Korpimaki. 2000. Do predators limit the abundance of alternative prey? Experiments with vole-eating avian and mammalian predators. Oikos **91**:528-540.

Oregon Department of Fish and Wildlife. 2011. Greater Sage-grouse Conservation Assessment and Strategy for Oregon: A Plan to Maintain and Enhance Populations and Habitat.

Ouren, D. S., C. Hass, C. P. Melcher, P. Stewart, D. Ponds, N. R. Sexton, L. Burris, T. Fancher, and Z. H. Bowen. 2007. Environmental effects of off-highway vehicles on Bureau of Land management lands: a literature synthesis, annotated bibliographies, and internet resources., USDI Geological Survey, Reston, VA.

Owens, M. K. and B. E. Norton. 1990. Survival of juvenile basin sagebrush under different grazing regimes. Journal of Range Management **43**:132-135.

Oyler-McCance, S. J., K. P. Burnham, and C. E. Braun. 2001. Influence of changes in sagebrush on Gunnison sage grouse in southwestern Colorado. Southwestern Naturalist **46**:323-331.

Oyler-McCance, S. J., N. W. Kahn, K. P. Burnham, C. E. Braun, and T. W. Quinn. 1999. A population genetic comparison of large- and small-bodied sage grouse in Colorado using microsatellite and mitochondrial DNA markers. Molecular Ecology **8**:1457-1465.

Oyler-McCance, S. J., J. St John, S. E. Taylor, A. D. Apa, and T. W. Quinn. 2005a. Population genetics of Gunnison sage-grouse: Implications for management. Journal of Wildlife Management **69**:630-637.

Oyler-McCance, S. J., S. E. Taylor, and T. W. Quinn. 2005b. A multilocus population genetic survey of the greater sage-grouse across their range. Molecular Ecology **14**:1293-1310.

Padgett, P. E., D. Meadows, E. Eubanks, and W. E. Ryan. 2008. Monitoring fugitive dust emissions from off-highway vehicles traveling on unpaved roads and trails using passive samplers. Environmental Monitoring and Assessment **144**:93-99.

Parker, R. R., C. B. Philip, and G. E. Davis. 1932. Tularaemia Occurrence in the sage hen, Centrocercus urophasianus. Public Health Reports **47**:479-487.

Patterson, R. L. 1952. The sage grouse in Wyoming. Wyoming Game and Fish Commission, Sage Books, Inc., Denver, Colorado. 344 pp.

Petersen, S. L., T. K. Stringham, and B. A. Roundy. 2009. A Process-Based Application of State-and-Transition Models: A Case Study of Western Juniper (Juniperus occidentalis) Encroachment. Rangeland Ecology & Management **62**:186-192.

Peterson, M. J. 2004. Parisites and infectious diseases of prairie grouse: should managers be concerned? Wildlife Society Bulletin **32**:35-55.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Pickett, S.T.A. and P.S. White. 1985. Patch Dynamics: a Synthesis. Pages 371-384 *in* Pickett, S.T.A. and P.S. White, The Ecology of Natural Disturbance and Patch Dynamics. Academic Press, San Diego, California.

Piertney, S. B., A. D. C. MacColl, P. J. Bacon, and J. F. Dallas. 1998. Local genetic structure in red grouse (Lagopus lagopus scoticus): evidence from microsatellite DNA markers. Molecular Ecology **7**:1645-1654.

Ponzetti, J. M., B. McCune, and D. A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. Bryologist **110**:706-722.

Poulin, J. F. and M. A. Villard. 2011. Edge effect and matrix influence on the nest survival of an old forest specialist, the Brown Creeper (Certhia americana). Landscape Ecology **26**:911-922.

Provencher, L., T. A. Forbis, L. Frid, and G. Medlyn. 2007. Comparing alternative management strategies of fire, grazing, and weed control using spatial modeling. Ecological Modelling **209**:249-263.

Pyke, D. A. 2011. Restoring and rehabilitating sagebrush habitats. Pages 531-548 *in* S. T. C. J. W. Knick, editor. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.

Rau, B. M., D. W. Johnson, R. R. Blank, R. J. Tausch, B. A. Roundy, R. F. Miller, T. G. Caldwell, and A. Lucchesi. 2011. Woodland expansion's influence on belowground carbon and nitrogen in the Great Basin US. Journal of Arid Environments **75**:827-835.

Reed, D. H. and E. H. Bryant. 2000. Experimental tests of minimum viable population size. Animal Conservation **3**:7-14.

Reed, D. H. and R. Frankham. 2003. Correlation between fitness and genetic diversity. Conservation Biology **17**:230-237.

Reese, K. P. J. W. C. 1997. Translocations of sage grouse Centrocercus urophasianus in North America. Wildlife Biology **3**:235-241.

Reese, K. P. J. W. C. 2011. Harvest management for greater sage-grouse. Pages 101-112 *in* S. T. C. J. W. Knick, editor. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.

Reisen, W. K., Y. Fang, and V. M. Martinez. 2006. Effects of temperature on the transmission of West Nile virus by Culex tarsalis (Diptera-Culicidae). Journal of Medical Entomology **43**:309-317.

Remington, T. E. and C. E. Braun, editors. 1991. How surface coal mining affects sage grouse, North Park, Colorado.

Rhodes, E. C., J. D. Bates, R. N. Sharp, and K. W. Davies. 2010. Fire Effects on Cover and Dietary Resources of Sage-Grouse Habitat. Journal of Wildlife Management **74**:755-764.

Ritchie, M. E. and D. Tilman. 1992. Interspecific competition among grasshoppers and their effect on plant abundance in experimental field environments. Oecologia **89**:524-532.

Romanya, J., P. Casals, and V. R. Vallejo. 2001. Short-term effects of fire on soil nitrogen availability in Mediterranean grasslands and shrublands growing in old fields. Forest Ecology and Management **147**:39-53.

Romme, W. H., C. D. Allen, J. D. Balley, W. L. Baker, B. T. Bestelmeyer, P. M. Brown, K. S. Eisenhart, M. L. Floyd, D. W. Huffman, B. F. Jacobs, R. F. Miller, E. H. Muldavin, T. W. Swetnam, R. J. Tausch, and P. J. Weisberg. 2009. Historical and Modern Disturbance Regimes, Stand Structures, and Landscape Dynamics in Pinon-Juniper Vegetation of the Western United States. Rangeland Ecology & Management **62**:203-222.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Root, H. T. and B. McCune. 2012. Regional patterns of biological soil crust lichen species composition related to vegetation, soils, and climate in Oregon, USA. Journal of Arid Environments **79**:93-100.

Rowland, M. M., M. Leu, S. Hanser, S. P. Finn, C. L. Aldridge, S. T. Knick, L. H. Suring, J. M. Boyd, M. J. Wisdom, and C. W. Meinke. 2006. Assessment of threats to sagebrush habitats and associated species of concern in the Wyoming Basins.*in* S. R. F. S. unpublished report on file at USGS Biological Resources Discipline, editor., Boise, Idaho.

Rowland, M. M., L. H. Suring, and M. J. Wisdom. 2010. Assessment of Habitat Threats to Shrublands in the Great Basin: A Case Study. Pages 673-685 *in* J. M. Pye, H. M. Rauscher, Y. Sands, D. C. Lee, and J. S. Beatty, editors. Environmental Threat Assessment and Application to Forest and Rangeland Management. U S Forest Service, General Technical Report, PNW, Bozeman, MT.

Sankey, T. T. and M. J. Germino. 2008. Assessment of juniper encroachment with the use of satellite imagery and geospatial data. Rangeland Ecology & Management **61**:412-418.

Scherber, C., J. Heimann, G. Kohler, N. Mitschunas, and W. W. Weisser. 2010. Functional identity versus species richness: herbivory resistance in plant communities. Oecologia **163**:707-717.

Schlaepfer, D. R., W. K. Lauenroth, and J. B. Bradford. 2012. Effects of ecohydrological variables on current and future ranges, local suitability patterns, and model accuracy in big sagebrush. Ecography **35**:374-384.

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

Schroeder, M. A. 2008. Variation in greater sage-grouse morphology by region and population. Page 19pp. U.S.F.W.S. Draft Report.

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

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

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

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

Schroeder, M. A. and W. M. Vander Haegen. 2006. Use of Conservation Reserve Program Fields by Greater Sage-Grouse and other Shrub Steppe-associated wildlife in Washington State., Washington Department of Fish and Wildlife, Wildlife Program, Olympia, Washington.

Schroeder, M. A. and W. M. Vander Haegen. 2011. Response of greater sage-grouse to the conservation reserve program in Washington State. Pages 517-530 *in* S. T. C. J. W. Knick, editor. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.

Schroeder, M. A., J. R. Young, and C. E. Braun. 1999. Sage grouse (Centrocercus urophasianus). Page 28 *in* A. W. Poole and F. Gill, editors. The Birds of North America, No.425, Ithaca, NY.

Scott, J. W. 1940. The role of coccidia as parasites of wild life. Journal of the Colorado- Wyoming Academy of Science **2**:45.

Sedinger, B. S., J. S. Sedinger, S. Espinosa, M. T. Atamian, and E. J. Blomberg. 2011. Spatial-temporal variation in survival of harvested Greater Sage-Grouse. Pages 317-328 *in* B. K. Sandercock, K.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Martin, and G. Segelbacher, editors. Ecology, conservation and management of grouse. University of California Press, Berkeley, CA.

Shaw, R. B. and V.E. Diersing. 1990. Tracked vehicle impacts on vegetation at the Pinon Canyon Maneuver Site, Colorado. Journal of Environmental Quality **19**:234-243.

Shinneman, D. J. and W. L. Baker. 2009. Environmental and climatic variables as potential drivers of post-fire cover of cheatgrass (Bromus tectorum) in seeded and unseeded semiarid ecosystems. International Journal of Wildland Fire **18**:191-202.

Shinneman, D. J., W. L. Baker, and P. Lyon. 2008. Ecological restoration needs derived from reference conditions for a semi-arid landscape in Western Colorado, USA. Journal of Arid Environments **72**:207-227.

Simberloff, D. 1988. The contribution of population and community biology to conservation science. Annual Review of Ecology and Systematics **19**:473–511.

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

Smith, J. T., L. D. Flake, K. F. Higgins, G. D. Kobriger, and C. G. Homer. 2005. Evaluating lek occupancy of Greater Sage-Grouse in relation to landscape cultivation in the Dakotas. Western North American Naturalist **65**:310-320.

Sovada, M. A., A. B. Sargeant, and J. W. Grier. 1995. Differential effects of coyotes and red foxes on duck nest success. Journal of Wildlife Management **59**:1-9.

State of Wyoming. 2011. Greater Sage-Grouse Core Area Protection. Casper, Wyoming.

Steenhof, K., M. N. Kochert, and J. A. Roppe. 1993. Nesting by raptors and common ravens on electrical transmission line towers. Journal of Wildlife Management **57**:271-281.

Stevens, B. S. 2011. Impacts of fences on greater sage-grouse in Idaho: collision, mitigation, and spatial ecology. Thesis. University of Idaho, Moscow, ID, USA.

Stevens, B. S., K. P. Reese, J. W. Connelly, and D. D. Musil. 2012. Greater sage-grosue and fences: does marking reduce collisions? Wildlife Society Bulletin **36**:297-303.

Stevens, B. S., K. P. Reese, and J. W. Connelly. 2011. Survival and Detectability Bias of Avian Fence Collision Surveys in Sagebrush Steppe. Journal of Wildlife Management **75**:437-449.

Stiver, S. J. 2011a. The Legal Status of Greater Sage-Grouse: organizational structure of planning efforts. Pages 33-49 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, CA.

Stiver, S. J. 2011b. The Legal Status of Greater Sage-Grouse: organizational structure of planning efforts. Pages 33-52 *in* S. T. Knick and J. W. Connelly, editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. University of California Press, Berkeley, CA.

Stiver, S. J., A. D. Apa, J. Bohne, S. D. Bunnell, P. A. Deibert, S. C. Gardner, M. A. Hilliard, C. W. McCarthy, and M. A. Schroeder. 2006a. Greater Sage-Grouse: Comprehensive Conservation Strategy. Western Association of Fish and Wildlife Agencies (WAFWA), Cheyenne, Wyoming.

Stiver, S. J., A. D. Apa, J. R. Bohne, S. D. Bunnell, P. A. Deibert, S. C. Gardner, M. A. Hilliard, C. W. McCarthy, and M. A. Schroeder. 2006b. Greater Sage-Grouse: Comprehensive Conservation Strategy. Western Association of Fish and Wildlife Agencies (WAFWA), Cheyenne, Wyoming.

Strickland, M. D., H. J. Harju, K. R. McCaffery, H. W. Miller, L. M. Smith, and S. R.J. 1994. Harvest management. Pages 445-473 *in* T. A. Bookhout, editor. Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, MD.

Suter Ii, G. W. 1978. Effects of geothermal energy development on fish and wildlife Topical briefs. No6 Fish and wildlife resources and electrical power generation **FWS/OBS-76/206**:26 pp.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Sveum, C. M., J. A. Crawford, and W. D. Edge. 1998a. Use and selection of brood-rearing habitat by sage grouse in south central Washington. Great Basin Naturalist **58**:344-351.

Sveum, C. M., W. D. Edge, and J. A. Crawford. 1998b. Nesting habitat selection by sage grouse in south-central Washington. Journal of Range Management **51**:265-269.

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

Tack, J. D. 2009. Sage-grouse and the human footprint: Implications for conservation of small and declining populations. University of Montana, Missoula, MT.

Tack, J. D., D. E. Naugle, J. C. Carlson, and P. J. Fargey. 2012. Greater sage-grouse Centrocercus urophasianus migration links the USA and Canada: a biological basis for international prairie conservation. Oryx **46**:64-68.

Taylor, R. L., B. L. Walker, D. E. Naugle, and L. S. Mills. 2012. Managing multiple vital rates to maximize greater sage-grouse population growth. Journal of Wildlife Management **76**:336-347.

Taylor, S. E. J. R. Y. 2006. A comparative behavioral study of three greater sage-grouse populations. The Wilson Journal of Ornithology **118**:36-41.

Thompson, T. R. 2012. Dispersal ecology of greater sage-grouse in northwestern Colorado: evidence from demographic and genetic methods. Dissertation. University of Idaho, Moscow, ID, USA.

Thorne, E. T., N. Kingston, W. R. Jolley, and R. C. Bergstrom. 1982. Diseases of wildlife in Wyoming, second edition.353 pp.

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

Tischendorf, L. and L. Fahrig. 2000. On the usage and measurement of landscape connectivity. Oikos **90**:7-19.

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed control methods handbook-Tools & techniques for use in natural areas.

U.S. Department of Defense and U.S. Fish and Wildlife Service. 2006. Greater Sage-Grouse Fact Sheet.

U.S. Farm Service Agency. 2008. Conservation Reserve Program State Acres For wildlife Enhancement (SAFE) Fact Sheet.

U.S. Farm Service Agency. 2010. Record of Decision for Conservation Reserve Program Supplemental Environmental Impact Statement.

U.S. Fish and Wildlife Service. 2010a. Conference Report for the Natural Resource Conservation Service Sage-grouse Initiative.

U.S. Fish and Wildlife Service. 2010b. Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered. Page 107pp. *in* F. a. W. S. Department of the Interior, editor. FWS-R6-ES-2010-0018. Federal Register, Washington, D.C.

U.S. Fish and Wildlife Service. 2010a. Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered. Federal Register Vol. 75, No. 55 (March 23, 2010). Washington, D.C.

U.S. Fish and Wildlife Service. 2010b. Conference Report for the Natural Resource Conservation Service Sage-grouse Initiative.

U.S. Fish and Wildlife Service. 2011. Sheldon National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Impact Statement.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

U.S. Fish and Wildlife Service. 2012. Hart Mountain National Antelope Refuge, Lake County, OR; Draft Comprehensive Conservation Plan and Draft Environmental Impact Statement. Federal Register Vol. 77, No. 102 (May 25, 2012). Washington, D.C.

U.S. National Park Service and Bureau of Land Management. 2006. Craters of the Moon National Monument and Preseve Management Plan.

U.S. Natural Resources Conservation Service. 2012a. NRCS Contributions to the Annual Status Review for Greater Sage-Grouse

U.S. Natural Resources Conservation Service. 2012b. The PLANTS database (*http://plants.usda.gov/plants)*. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

U.S. Natural Resources Conservation Service. 2012c. Sage-Grouse Initiative Status Report Fiscal Year 2010-2011

Utah Division of Wildlife Resources (UDWR). 2009. Utah Greater Sage-grouse Management Plan. Utah Department of Natural Resources, Division of Wildlife Resources, Publication 09-17, Salt Lake City, Utah.

Vallentine, J. F. 1990. Kind and mix of grazing animals. In Grazing management, first edition:217-242.

Valone, T. J., M. Meyer, J. H. Brown, and R. M. Chew. 2002. Timescale of perennial grass recovery in desertified arid grasslands following livestock removal. Conservation Biology **16**:995-1002.

Van Poolen, H. W. and J. R. Lacey. 1979. Herbage response to grazing systems and stocking intensities. . Journal of Range Management **32**:250-253.

Vander Haegen, W. M., M. A. Schroeder, and R. M. DeGraaf. 2002. Predation on real and artificial nests in shrub steppe landscapes fragemented by agriculture. The Condor **104**:496-506.

Veblen, K. E., D. A. Pyke, C. L. Aldridge, M. L. Casazza, T. J. Assal, and M. A. Farinha. 2011. Range-wide assessment of livestock grazing across the sagebrush biome. . U.S. Geological Survey Reston, VA.

Vitousek, P. M. 1990. Biological invasions and ecosystem processes -Towards an integration of population biology and ecosystem studies. Oikos **57**:7-13.

Walker, B. L. and D. E. Naugle. 2011. West Nile virus ecology in sagebrush habitat and impacts on greater sage-grouse populations. Pages 127-143 *in* S. T. C. J. W. Knick, editor. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley.

Walker, B. L., D. E. Naugle, and K. E. Doherty. 2007a. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management **71**:2644-2654.

Walker, B. L., D. E. Naugle, K. E. Doherty, and T. E. Cornish. 2004. Outbreak of West Nile virus in greater sage-grouse and guidelines for monitoring, handling and submitting dead birds. Wildlife Society Bulletin **32**:1-7.

Walker, B. L., D. E. Naugle, K. E. Doherty, and T. E. Cornish. 2007b. West Nile Virus and Greater Sage-Grouse: Estimating Infection Rate in a Wild Bird Population. Avian Diseases **51**:691-696.

Wambolt, C. L., A. J. Harp, B. L. Welch, N. Shaw, J. W. Connelly, K. P. Reese, C. E. Braun, D. A. Klebenow, E. D. McArthur, J. G. Thompson, L. A. Torell, and J. A. Tanaka. 2002. Conservation of Greater sage-grouse on public lands in the western US:
implications of recovery and management policies., Policy Analysis Center for Western Public Lands (PACWPL)

Watts, S. E. 1998. Short-term influence of tank tracks on vegetation and microphytic crusts in shrubsteppe habitat. Environmental Management **22**:611-616.

Weins, J. A., N. C. Stenseth, B. Van Horn, and R. A. Ims. 1993. Ecological mechanisms and landscape ecology. Oikos **66**:369-380.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

West, N. E. 1983. Western intermountain sagebrush steppe. Pages 351-374 *in* N. E. West, editor. Ecosysytems of the World.

West, N. E. 1988. Intermountain Deserts, Shrub steppes, and Woodlands. Pages 209-230 *in* M. G. Barbour and W. D. Billings, editors. North American Terrestrial Vegetation. Cambridge University Press, New York.

West, N. E. and T. P. Yorks. 2002. Vegetation responses following wildfire on grazed and ungrazed sagebrush semi-desert. Journal of Range Management **55**:171-181.

West, N. E. and J. A. Young. 2000. Intermountain valleys and lower mountain slopes. In Barbour, MG and WD Billings, eds North American Terrestrial Vegetation, 2nd Edition:256-284.

Westemeier, R. L., J. D. Brawn, S. A. Simpson, T. L. Esker, R. W. Jansen, J. W. Walk, E. L. Kerschner, J. L. Bouzat, and K. N. Paige. 1998. Tracking the long-term decline and recovery of an isolated population. Science **282**:1695–1698.

Western Association of Fish and Wildlife Agencies (WAFWA). 2008. Greater sage- grouse population trends- An analysis of lek count databases 1965-2007.126 pp.

Western Governors' Association. 2011. Policy Resolution 11-9: Sage-grouse and Sagebrush Conservation.

Western Governors' Wildlife Council. 2011. Inventory of State and Local Governments' Conservation Initiatives for Sage Grouse.

White, D., P. G. Minotti, M. J. Barczak, J. C. Sifneos, K. E. Freemark, M. V. Santelmann, C. F. Steinitz, A. R. Kiester, and E. M. Preston. 1997. Assessing risks to biodiversity from future landscape change. Conservation Biology **11**:349-360.

Whiting, J. C. and B. Bybee. 2011. Annual Report of Surveys for Historic Sage-Grouse Leks on the Idaho National Laboratory Site.

Whittington, J., M. Hebblewhite, N. J. DeCesare, L. Neufeld, M. Bradley, J. Wilmshurst, and M. Musiani. 2011. Caribou encounters with wolves increase near roads and trails: a time-to-event approach. Journal of Applied Ecology **48**:1535-1542.

Wiens, J. 2002. Predicting species occurrences: progress, problems, and prospects.*in* J. M. Scott, P. J. Heglund, M. L. Morrison, J. B. Haufler, M. G. Rapheal, W. A. Wall, and F. B. Samson, editors. Predicting species occurrences: issues of accuracy and scale. Island Press, Washington, DC.

Winward, A. H. 2004. Sagebrush of Colorado- Taxonomy, distribution, ecology//management.39 pp.

Wisdom, M. J., C. W. Meinke, S. T. Knick, and M. A. Schroeder. 2011. Factors associated with extirpation of sage-grouse. Pages 451-474 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, CA.

With, K. A. 2004. Assessing the risk of invasive spread in fragmented landscapes. Risk Analysis **24**:803-815.

Wright, H. A. 1970. Response of big sagebrush and three-tip sagebrush to season of clipping. J range manage. Jan **23**:20-22.

Wrobleski, D. W. and J. B. Kauffman. 2003. Initial effects of prescribed fire on morphology, abundance, and phenology of forbs in big sagebrush communities in southeastern Oregon. Restoration Ecology **11**:82-90.

Wyo. Exec. Order No. 2011-5. June 2, 2011. Greater Sage-Grouse Core Area Protection.

Wyoming Executive Order. August 1, 2008. Greater Sage-Grouse Core Area Protection.*in* G. s. O. State of Wyoming, editor. No. 2008-2. State of Wyoming, Casper, Wyoming.

Wyoming Executive Order. August 18, 2010. Greater Sage-Grouse Core Area Protection.*in* G. s. O. State of Wyoming, editor. No. 2010-4, Casper, Wyoming.

EXHIBIT G-8
Science Summary FOIA Response-Part 8

Wyoming Executive Order. June 2, 2011. Greater Sage-Grouse Core Area Protection.*in* G. s. O. State of Wyoming, editor. No. 2011-5, Casper, Wyoming.

Xian, G., C. G. Homer, and C. L. Aldridge. 2012. Effects of Land Cover and Regional Climate Variations on Long-Term Spatiotemporal Changes in Sagebrush Ecosystems. Geoscience & Remote Sensing **49**:378-396.

Yost, A. C., S. L. Petersen, M. Gregg, and R. Miller. 2008. Predictive modeling and mapping sage grouse (Centrocercus urophasianus) nesting habitat using Maximum Entropy and a long-term dataset from Southern Oregon. Ecological Informatics **3**:375-386.

Young, J. A. and R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. Journal of Range Management **31**:283-289.

Young, J. A., R. A. Evans, and B. L. Kay. 1987. Cheatgrass. Rangelands **9**:266-270.

Young, J. R., C. E. Braun, S. J. Oyler-McCance, J. W. Hupp, and T. W. Quinn. 2000. A new species of sage-grouse (Phasianidae : Centrocercus) from southwestern Colorado. Wilson Bulletin **112**:445-+.

Young, J. R., J. W. Hupp, J. W. Bradbury, and C. E. Braun. 1994. Phenotypic divergence of secondary sexual traits among sage grouse, Centrocercus urophasianus populations. Animal Behaviour **47**:1353-1362.

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

Zou, L., S. N. Miller, and E. T. Schmidtmann. 2007. A GIS tool to estimate West Nile virus risk based on a degree-day model. Environ Monit Assess **129**:413-420.

Zou, L. S. N. M. E. 2006. Mosquito larval habitat mapping using remote sensing and GIS - Implication of coalbed methane development and West Nile virus. Journal of Medical Entomology **43**:1034-1041.