



June 27, 2008

Public Comments Processing
Attn: FWS-R6-ES-2008-0022
Division of Policy and Directives Management
U.S. Fish and Wildlife Service
4401 N. Fairfax Drive Suite 222
Arlington, Virginia 22203

Gentlepeople:

I am writing on behalf of WildEarth Guardians, Biodiversity Conservation Alliance, Center for Biological Diversity, Center for Native Ecosystems, Oregon Natural Desert Association, Southern Rockies Ecosystem Project, Western Watersheds Project, and the Wilderness Workshop to submit comments on the remanded status review for greater sage-grouse (*Centrocercus urophasianus*) (73 Fed. Reg. 23172) and status review for the Mono Basin area population of greater sage-grouse (73 Fed. Reg. 23173). These comments contain information produced after January 12, 2005, except where reference to information published prior to that date may be useful to further explicate a point. We support listing greater sage-grouse species and/or subspecies as “threatened” or “endangered” under the Endangered Species Act, collectively or as distinct population segments, across the entirety of the species’ current range .

Thank you for this opportunity to submit comments.

Sincerely,

Mark N. Salvo
Director, Sagebrush Sea Campaign

I. Sage Grouse Ecology, Habitat Requirements

The loss and degradation of nesting and brood-rearing habitats, which leads to reduced nesting success and increased chick mortality, appears to be a primary cause of declining greater sage-grouse populations rangewide (*see* Aldridge and Boyce 2007; Holloran et al. 2005, review of the literature). Hagen et al. (2007) conducted a quantitative meta-analysis of existing research on greater sage-grouse nesting and brood-rearing habitat and confirmed that female sage-grouse typically select nesting sites with greater sagebrush cover and grass height compared to random locations, and that brood areas usually had less sagebrush, taller grasses, and greater forb and grass cover than at random sites. The meta-analysis affirmed guidelines for sage-grouse habitat management in Connelly et al. (2000), and responded to other publications that criticized these prescriptions. The Connelly et al. (2000) guidelines, as well as Braun (2006, unpublished report), were provided to federal land management agencies and state wildlife management agencies.

Holloran et al. (2005) also found that taller, thicker residual grass cover in dense sagebrush with moderate-high canopy cover (up to 40%) appears to increase the probability of sage-grouse nest success. Their research indicated that herbaceous cover and height were more important than shrub cover or height to nest success (Holloran et al. 2005; *see also* Reibold 2007). Reibold (2007) similarly found that increased grass cover improved the likelihood of nest success.

Hausleitner et al. (2005) reported that post-hatch sampling methods used by researchers to analyze sage-grouse preferred nesting habitat also adequately described female sage-grouse selection for structural components of shrub height, visual obstruction, and percent of shrub cover, bare ground, litter and forbs at the time of nest initiation. However, Moynahan et al. (2007) found that research on greater sage-grouse nest success based on apparent nest success rates can be biased high and may lead to erroneous (over-estimated) sage-grouse productivity. Moynahan et al. (2007) recommended increasing grass cover in sagebrush steppe to increase sage-grouse nest success.

Aldridge and Boyce (2007) used models and produced analyses from Alberta indicating that female sage-grouse select heterogeneous sagebrush habitats with moderate cover for nesting and avoided nesting in areas with habitat edges (created by roads, agricultural fields, etc.) or areas with sparse vegetation (although nest success was independent of proximity to anthropogenic features). More diverse, heterogeneous habitats reduced the risk of nest failure (Aldridge and Boyce 2007). Sage-grouse may continue to use less desirable habitat for nesting, even if it increases risk of nest failure (e.g., from predation) (Aldridge and Boyce 2007). This may be further evidence of female fidelity to nesting areas (*see* Holloran 2005).

Holloran and Anderson (2005) found that nests located closer to lek sites, and nests located closer together (greater nest density) experienced greater predation than nests located further from leks and other nests in central and southwestern Wyoming. They recommended that habitat managers should avoid strategies that would negatively affect nesting habitat, and preserve nesting areas within (at minimum) 5 km (3.1 miles) of lek sites.

Beck et al. (2006) studied movements of juvenile greater sage-grouse between September and March in southeastern Idaho. Although overall juvenile sage-grouse survival was relatively high,

juvenile sage-grouse in a mountain valley area typically moved farther distances between seasonal habitats and experienced lower survival than juveniles in a lowland area (Beck et al. 2006). This research points to a need to conserve of sagebrush steppe at lower elevations, including increasingly rare big sagebrush habitat (Welch 2005). Lowland sagebrush steppe has been disproportionately affected by human development and land use, invasive plants and wildfire compared to sagebrush habitats at higher elevations (Connelly et al. 2004). Beck et al. (2006: 1076) also recommended conserving large habitat areas and corridors to reduce risk of predation and facilitate easier movement for migratory sage-grouse.

Beck et al. (2006) noted that, where low recruitment occurs in sage-grouse populations, it may be due to poor nesting success or low early chick survival, which has also been examined in other research (*e.g.*, Holloran et al 2005). Moynahan et al. (2007) found evidence that improved habitat condition may benefit prelaying female sage-grouse and, thus, higher nesting success, corroborating other research on the issue (*e.g.*, Barnett and Crawford 1994). Thompson et al. (2006a) found that the number of juveniles per female was positively related to an abundance of insects and grass cover, and the proportion of females with chicks 14 days post-hatch was positively related to abundant and diverse insects and total herbaceous cover.

Sage-grouse broods selected heterogeneous, high-productivity habitat with sagebrush, and avoided human developments, agricultural land, and high densities of natural gas and oil wells in Alberta (Aldridge and Boyce 2007) (*c.f.* Walker et al. 2007a). While sage-grouse broods prefer mesic, forb-rich habitats, these areas are typically more risky, open habitats (Aldridge 2005). This finding underscores the importance to sage-grouse of maintaining a natural mosaic of habitat patches in various stages of succession in sagebrush steppe that include both mesic sites and areas with tall, dense sagebrush that sage-grouse can use for hiding and escape cover. Management that eliminates or reduces of sagebrush across a large area may not benefit sage-grouse because too much hiding and escape cover will have been removed from the area. (For example, a proposed sagebrush treatment project that would affect 60-75% of sagebrush on 1,500 acres on the Heber-Kamas Ranger District in the Uinta-Wasatch-Cache National Forest—although intended to improve sage-grouse brood-rearing habitat—may not benefit sage-grouse in the short- and/or long-term.)

Rebholz (2007) discovered that grass cover at early brood sites was negatively associated with chick survival, while sites with greater forb cover were associated with higher sage-grouse survival. Danvir (2002, unpublished report) also noted the importance of herbaceous cover to sage-grouse broods.

Holloran (2005) found that females show strong fidelity to nesting areas, and continued to nest in areas even after roads and natural gas wells were developed nearby. He also noted that, while adult females remained in affected areas, yearling females left from natural gas development fields. Holloran (2005) found that adult female sage grouse that remained in areas of natural gas extraction had lower survival rate than female sage-grouse in undeveloped areas. This research and other studies (Coates 2007, nests of adult females less likely to be predated by ravens; Moynahan et al. 2007, probability that adult females will initiate nests and reneest, if necessary, is higher than for yearling females) points to the need to protect nesting habitat and adult female sage-grouse.

The mean distance between the lek where female sage-grouse were identified and their first nest was 4.75 km in northcentral Montana (Moynahan et al. 2007). Renests were typically close to first nests, and the median distance between first nest locations in successive years was 0.6 km (Moynahan et al. 2007).

Moynahan et al. (2006) found that nesting hens had a higher nesting survival than non-nesting hens. They also noticed increased hen mortality in winter associated with severe winter weather, which “contrasts with prior beliefs that sage-grouse populations are typically unaffected by winter weather conditions” (Moynahan et al. 2006: 1529). The researchers suggest that their study underscores the importance of protecting sage-grouse winter habitat.

II. Greater Sage-Grouse Populations, Population Viability

Sage-grouse population data are difficult to obtain from state fish and wildlife agencies (private communication 1, 2007). However, population data included in occasional state reports and population trends reported in public media indicate that sage-grouse populations have declined in 2008. The latest population decline ends a brief period of apparent population increase in some states.

Sage-grouse populations appear to have declined in Wyoming in 2008. (B. Moen (AP). “Moisture could help grouse, spring counts indicate slight decline.” *Casper-Star Tribune* (June 11, 2008)). A Wyoming Game and Fish Department official identified drought and West Nile virus as primary factors in the most recent decline, although numerous other factors probably contributed to the decline as well. *Id.* The slight population decline comports with long-term population declines in Wyoming and other states, as documented in Connelly et al. (2004).

The number of male sage-grouse “checked” on leks in Wyoming between 2005-2007 were significantly greater than the number of males observed in previous years (WGFD data). These data were interpreted to reflect a generally increasing population in Wyoming between 2005-2007 (Christiansen 2008). However, there are many potential problems with the state data (private communication 2, 2008). Also, formulae commonly used to determine total populations may overestimate sage-grouse numbers (*see, e.g.,* Atamian 2007: 12, 25).

Recent, short-term increases in males/lek in Wyoming and Oregon—followed by population declines in 2008—may be indication of decadal population cycling in sage-grouse (Rich 1985) and may not signal an increasing population trend in those states. Referring to sage-grouse population cycling in Nevada, a sage-grouse coordinator for the Nevada Department of Wildlife noted that the “highs and lows are getting lower and lower and the overall trend of sage grouse population is going down.” (S. Sonner (AP). “Island in the West.” *Casper Star-Tribune* (Apr. 27, 2008)).

Sage-grouse populations are down almost 30 percent in southern Idaho in 2008. A spokesperson for Idaho Fish and Game noted that recruitment was “well below normal.” (G. Jameson. “So. Idaho sage grouse numbers down.” KMVT (www.kmvt.com) (visited June 10, 2008)). A record low of 77 male sage-grouse were counted on 18 leks in two populations in North Dakota in 2008.

(_____. “Sage grouse season may be cancelled.” *The Bismarck Tribune* (Apr. 30, 2008)). One biologist noted that weather (precipitation) in 2007 produced favorable conditions (standing water) for the transmission of West Nile virus (via mosquitoes) to sage-grouse in North Dakota in 2007 and stated “sage grouse equipped with radio transmitters in northwestern South Dakota were documented dying from West Nile virus at an alarming rate.” *Id.*

Aldridge et al. (2008) produced analyses and a map indicating that sage-grouse are at risk of extirpation in large areas in Montana, Wyoming, Idaho and Utah, including on Parker Mountain, Utah, where significant time and resources have been invested to conserve sage-grouse. The map also indicated that the Mono Basin area population of greater sage-grouse may be at risk of extirpation in a large portion of its limited range (Aldridge et al. 2008).

Populations of 5,000-50,000 individuals are desirable for long-term persistence of some species (Traill et al. 2008; Frankham et al. 2002; Mills et al. 2005: 692, Box 1). Some subpopulations of sage-grouse are estimated at smaller than 5,000 birds (e.g., Mono Basin area sage-grouse) (71 Fed. Reg. 76061). Small and isolated populations are less able to survive known threats and stochastic events, and may have reduced genetic diversity, which may affect long-term survival (Soulé and Mills 1998; *see also* Benedict et al. 2003). Oyler-McCance et al. (2005) recommend maintaining genetic diversity in Gunnison sage-grouse by “preventing future habitat loss and fragmentation, enhancing existing habitat, and restoring converted sagebrush communities. Wisdom et al. (2005b, citing multiple sources) stated that “[a]lthough populations of species like Greater Sage-grouse may currently be large, it is an illusion to think that such populations can withstand additional habitat loss and degradation at the scales now occurring and projected.”

III. Effects of Hunting and Poaching on Sage-grouse

van Kooten et al. (2007: 65) suggested that mortality in greater sage-grouse from hunting may be compensatory, rather than additive, to natural/background mortality for the species, contrary to some other research on the issue. A technical review of hunting and sage-grouse published by the Wyoming Game and Fish Department also reported that “research conducted to date has not demonstrated that hunting is a primary cause of reduced numbers of greater sage-grouse” (Christiansen 2008: 7). However, Connelly et al. (2003: 255) found that “[l]imited or moderate rates of exploitation apparently slowed population recovery for sage grouse” and that the effects of hunting may be more pronounced on populations in highly fragmented, low elevation (xeric) habitats, and/or close to urban centers.

Sage-grouse hunting in Wyoming may be prohibited in the northeastern corner of the state, and the season length may be reduced in other areas in northeastern Wyoming in recognition of declining populations and degraded habitat conditions in those areas (Christiansen 2008). The daily harvest limit was reduced from four birds to two in Montana in 2007 due to concerns over diminishing habitat and uncertainty over the latest population census. (Kidston, M. J. “Off and flying.” *Helena Independent Record* (Aug. 23, 2007)). Hunting permits for sage-grouse were also reduced in Oregon in 2007 due to reduced populations and the effect of wildfire on sage-grouse habitat. (_____. “ODFW approves seasons, rules.” *Statesman Journal* (Salem, OR) (Aug. 13, 2007)). The North Dakota Game and Fish Department recommended closing the hunting season in North Dakota in 2008 following record low sage-grouse lek counts in spring 2008.

(_____. "Sage grouse season may be cancelled." *The Bismarck Tribune* (Apr. 30, 2008)). Hunting is allowed for Mono Basin area sage-grouse in California.

Wildlife poaching, including illegal take of sage-grouse, has been found to increase near natural gas and oil drilling sites. (Wyoming Game and Fish Department. "Poaching Activity Increasing Near Oil and Gas Drilling Sites in SW Wyoming" (news release) (Nov. 18, 2005)). Poaching may have significant effects on sage-grouse populations that are already under stress from natural gas and oil development.

VI. Effects of Disease and Predation on Sage-grouse

West Nile Virus

West Nile virus (WNV) is an exotic disease that was discovered in greater sage-grouse in 2003 (Naugle et al. 2004). WNV is usually fatal to sage-grouse, resulting in death within six days of infection (Dierauf/USGS bulletin 2006). Sage-grouse are highly susceptible to WNV infection (Walker et al. 2007b). Two separate studies found 100 percent mortality within 6-8 days for 44 birds (Clark et al. 2006; Todd Cornish, Wyoming State Veterinary Laboratory). Only 0-10 percent of a population in the Powder River Basin in Wyoming showed resistance to WNV (Walker et al. 2007b). Further, infection rates are relatively low (4-29%) in the Powder River Basin, indicating that most sage-grouse in the area have not yet been exposed to the virus and remain susceptible (Walker et al. 2007b). Kilpatrick et al. (2007) deemed greater sage-grouse a moderately competent host for WNV.

WNV has had a significant negative impact on local populations of sage-grouse. WNV caused a decline of approximately 25 percent in late-summer survival of breeding-aged females in four populations in the eastern half of the species' range in 2003 (Naugle et al. 2004). A high proportion of sage-grouse mortalities in a small population monitored in South Dakota were thought to have been killed by WNV in 2007 (Jensen 2007, electronic mail). The sage-grouse population in northern Magic Valley in southern Idaho has declined and may be affected by WNV (M. Christensen. "Grouse season takes hit." *Times-News* (Twin Falls, ID) (Sept. 10, 2007)). A local WNV outbreak caused near extirpation of sage-grouse over an approximately 100 km² landscape in the Powder River Basin (Walker et al. 2004). By 2005, no birds were seen on any of the five leks where the outbreak occurred (Wyo. Dept. Fish & Game 2006). No sage-grouse were counted on the leks in 2006 (Wyo. Dept. Fish & Game 2006).

WNV-related mortality rates in greater sage-grouse dropped in 2004 compared to 2003, most likely due to a decrease in summer temperatures that limited mosquito (*Culex tarsalis*) production and reduced WNV transmission (mosquitos vector WNV) (Naugle et al. 2005). Even so, four populations with confirmed WNV-related mortality had ten percent lower female survival during late summer than eight unaffected populations in 2004, suggesting that, even in mild years, WNV may still negatively impact sage-grouse survival (Naugle et al. 2005). Mortality was also low in 2005, but increased again in 2006 to greater than five percent of the population (Brett Walker, University of Montana, unpublished data).

WNV-related sage-grouse mortality rates vary widely and occur in areas with and without coal-bed natural gas development (Naugle et al. 2005). However, ponds created from coal-bed natural

gas development are responsible for a 75 percent increase in mosquito breeding habitat in the Powder River Basin and appear to facilitate the spread of WNV into otherwise semi-arid sage-grouse habitat¹ (Zou et al. 2006). Doherty (2007: ix) also found that CBM wastewater reservoirs are “significantly increasing the overall population of [WNV] vector mosquitoes in the [Powder River Basin]” and “[coalbed natural gas] ponds and associated habitats enhance mosquito abundance and may serve to increase pathogen transmission in an otherwise arid ecosystem.”

The effects of WNV on sage grouse and the potential contributions of CBM development to the spread of the disease are known to the Bureau of Land Management (BLM) (*see, e.g.*, BLM 2006a: 3-122). The BLM even prescribes measures to manage produced water from CBM development to reduce the proliferation of WNV in sage-grouse habitat (BLM 2006b: WMPP-8). But those measures, if they are implemented, do not appear to reduce the spread of WNV (Doherty 2007).

WNV mortalities in sage-grouse have now been documented in 11 of 13 states and Canadian provinces where the species still occurs (Dierauf/USGS bulletin 2006). Hunting seasons for greater sage-grouse have been closed in areas where the species was affected by WNV in Wyoming (Christiansen 2008: 3) and Idaho (____. “Fish and Game changes some sage-grouse seasons.” *Outdoor Daily News* (Aug. 31, 2007)). This exotic disease has now become an endemic and future source of mortality for sage-grouse. A biologist in Idaho considers WNV the worst of all threats currently facing sage-grouse. (C. Sewell. “Rare birds face lethal threat.” *Idaho Statesman* (Aug. 6, 2007)). Naugle et al. (2004: 711) stated that the “emergence of WNV further complicates the difficult task of conserving sage-grouse in western North America.” Sage-grouse populations are becoming increasingly fragmented and the threat of WNV to small, isolated populations of sage-grouse is cause for concern (Naugle et al. 2004). Scientists recommend reducing the spread of WNV by preserving large areas of undeveloped sagebrush-steppe for sage-grouse and eliminating anthropogenic sources of water that support breeding mosquitos (Braun 2006, unpublished report; Naugle et al. 2004; Walker et al. 2007b).

Predation

Coates (2007) confirmed that common ravens (*Corvus corax*) and American badgers (*Taxidea taxus*) depredate sage-grouse nests. Yearling sage-grouse nests were depredated more often than nests of adults, perhaps because yearlings took longer, more frequent recesses from incubating eggs during times of greater daylight than adult females. Sage-grouse incubated eggs for longer periods where nests had greater herbaceous cover (perhaps because denser herbaceous understory reduced parent heat loss). Canopy cover over nests was inversely related to raven

¹ The CBM extraction process requires removal of large quantities of groundwater from coal seams in order to extract the methane trapped below. Methane extraction produces approximately 15,000 gallons of wastewater per day, per well, and significantly impacts underground aquifers (ENS. “Wyoming coalbed methane leases ruled illegal. *Environment News Service* (Apr. 30, 2002)). Because the pumped water is usually loaded with dissolved solids and sodium (and numerous other pollutants), it is often stored in surface holding ponds for indefinite periods, rather than flushed down local streams. These holding ponds (and other naturally occurring and human-made surface waters, such as agricultural irrigation and livestock waters) may serve as breeding habitat for insect vectors that transmit WNV (*see* Doherty 2007; *see also* Johnson, G. Oral report on mosquito surveillance in the Powder River Basin, Sheridan, WY. (Oct. 24, 2003) (abstract). Document obtained via FOIA request to Wyoming BLM; received by Biodiversity Conservation Alliance, Laramie, WY, July 21, 2004).

depredation (where canopy was less than 18%, nearly all predation was due to raven). Herbaceous cover is important to screen nests from badgers. Ravens thrive in human-altered landscapes and ravens occur throughout sage-grouse current range (*see* Connelly et al. 2004: 12-13, Fig. 12.3). The cumulative effects of human induced threats (e.g., natural gas development) plus the presence of ravens could be significant for sage-grouse locally. Sage-grouse populations may be reduced from predation where raven populations exceed 7.30 ravens per 10 square km (Coates 2007). If raven populations are too high, sage-grouse nest success could be reduced to zero. (Coates 2007).

Contrary to traditional views, Mezquida et al. (2006) contend that coyotes have little direct effect on sage-grouse and lethal coyote control may be detrimental to greater sage-grouse conservation. van Kooten et al. (2007: 65) also found “there was no evidence to support ranchers’ contentions that predators are a major contributor to loss of sage grouse” in northeastern Nevada. Coyotes may indirectly benefit sage grouse populations because they control populations of mesopredators (red foxes, badgers, and ravens), predators that are more likely to prey on sage-grouse eggs and chicks (Mezquida et al. 2006; *see also* Danvir 2002, unpublished report). A decrease in coyotes may result in the increase of jackrabbits, which has two results: jackrabbits compete directly with sage grouse for sagebrush and forbs (for both food and cover); and an increase in jackrabbits may lead to an increase in golden eagle populations, which may be “the most important predator of adult sage grouse” (Mezquida et al. 2006). Wolfe et al. (2007) similarly argued that “indiscriminant removal of predators” and subsequent release of mesopredators (red foxes) may “hasten the decline of lesser prairie-chickens.” They do not recommend predator control as a means of restoring prairie grouse (Wolfe et al. 2007: 102).

IV. Threats to Sage-grouse

Sagebrush habitats and wildlife are affected by 26 human-induced threats (Wisdom et al. 2005a: 30-33, Table 1.5). Attachment I presents some landscape-level threats to sagebrush steppe and greater sage-grouse.

Livestock Grazing

Knick et al. (2005: 68) summed that “livestock grazing over the past 140 yr is the single most important influence that has changed sagebrush habitats and influenced fire regimes throughout the Intermountain West.” Citing multiple references, the authors described myriad impacts of grazing on sagebrush steppe, including soil disturbance; reduction of native vegetation and facilitation of the spread of cheatgrass; increased shrub density; and interference with the natural fire regime. A sage-grouse expert contended that the “livestock industry has had [a] more negative impact on sage-grouse than any other single factor” and “[i]t’s rare to find any place that hasn’t been grazed” (Hudak 2007: 28-29). Public land livestock grazing occurs throughout Mono Basin area sage-grouse range.

Rich et al. (2005: 592) suggested that “livestock grazing across the public lands of western landscapes has impacted and will continue to impact the quality of those habitats and their ability to support source populations of sagebrush bird species.” The authors contended that, contrary to prevailing sentiment, the number of AUMs provided on federal public lands in Oregon, Idaho

and Washington, has varied little over the period from 1949 and 2000 and that there were more AUMs on public lands in these states in 2000 than 1949 (when recordkeeping began) (Rich et al. 2005). Further, “livestock have been selected so that the mean mass of individuals has increased over time” and, consequently, “the total grazing impact on the vegetation and other resources is substantially greater than it was historically” (Rich et al. 2005: 599 and figures).

van Kooten et al. (2007) present evidence that livestock grazing indirectly negatively affected greater sage-grouse in northeastern Nevada. Ecological modelling indicates that sheep grazing in sagebrush steppe may cause declines in sage-grouse populations (particularly where large, frequent fires also occur in the same area) (Pederson et al. 2003). Thines et al. (2004) found that pygmy rabbits, another sagebrush obligate species, preferred to make their burrows in ungrazed habitat—and avoided grazed areas where cattle removed approximately 50 percent of the grass cover—in sagebrush steppe in Washington. Walsberg (2005) found that cattle grazing was associated with a dramatic reduction of nest success of dark-eyed juncos (*Junco hyemalis*) as cattle grazing reduced vegetation cover over nests by an average of 41 percent.

Beck and Mitchell (2000) reviewed literature for positive and negative direct and indirect effects of livestock grazing on sage grouse. Their review found more negative than positive impacts from grazing. (Beck and Mitchell 2000: 994, Table 1). However, of greater importance is the scope of the reported positive and negative impacts on sage-grouse and sagebrush steppe habitats. While positive impacts are generally limited to specific areas and circumstances (e.g., light grazing regenerates upland meadow), negative impacts often affect much larger areas, rendering them unusable for sage-grouse.

Impacts should be considered in the context of their scale. For example, a sage grouse population in southeastern Idaho may have benefited indirectly from presence of livestock when they established strutting grounds on sheep salting areas [very small areas relative to overall habitat], whereas weed infestations induced by livestock grazing in the Great Basin may reduce quality of habitat for sage grouse populations across this vast region. (Beck and Mitchell 2000: 997, *citations omitted*).

Connelly et al. (2007), citing Coggins (1998) and Beck and Mitchell (2000), stated that “[t]he large number of documented negative impacts of livestock grazing in sagebrush shrub steppe appears to neutralize or outweigh any positive effects.” Jones (2000) found that 11 of 16 analyses of the effects of livestock grazing in arid ecosystems revealed significant negative effects on a range of ecological components from livestock grazing, including reduced grass and shrub cover, and reduced total vegetation biomass. Attachment III offers examples of BLM grazing management in sage-grouse habitat.

Beck and Mitchell (2000) concluded that livestock grazing appears to most affect productivity of sage grouse populations. Moynahan et al. (2007) also noted that condition of greater sage-grouse nesting habitat, an important factor in sage-grouse productivity, is likely affected by livestock grazing, among other influences. Holloran et al. (2005: 648) documented the importance of herbaceous cover, including residual grass, to sage-grouse nesting success and concluded that “annual grazing in nesting habitat, regardless of the timing, could negatively impact the following year’s nesting success [by reducing residual vegetation].” Aldridge and Boyce (2007:

522), citing Manier and Hobbs (2006), suggested that removing cattle or reducing livestock intensity may result in increased shrub cover and/or plant diversity in shrubsteppe.

Aldridge and Boyce (2007: 523) suggested that eliminating water impoundments (such as earthen livestock watering holes) may allow water to recharge former mesic sites in sagebrush steppe, which would benefit sage-grouse.

Some references recommend implementing high intensity, short-duration (rotation) grazing systems to conserve prairie grouse (*e.g.*, Lupis et al. 2006). Notwithstanding the fact that sagebrush-steppe did not evolve with large, hoofed herbivores (Mack and Thompson 1982), Holechek et al. (1999) reviewed the literature and found that forage production generally did not differ between rotation grazing systems and continuous or season-long grazing. Further, Wolfe et al. (2007) noted that high intensity, short-duration livestock grazing recommended to conserve prairie grouse frequently requires more fencing. There is significant anecdotal evidence of the negative effect of fencing on sage-grouse. Danvir (2002, unpublished report) found that eighteen percent of unmarked grouse died following collisions with barbed-wire fences. Fence-collisions were the second most commonly observed cause of sage-grouse mortality. Additional grouse were discovered with lacerations and broken wings near fences. Fences near leks (0.2 km) appeared to be more problematic for sage-grouse than fences farther from leks (0.8 km) (Danvir 2002, unpublished report: 10). Wolfe et al. (2007) noted that it is difficult to find grouse that have struck fences and contended that the effect of fence collisions on lesser prairie-chicken cannot be understated.

Developing and implementing grazing systems that are positive or neutral for sage-grouse is complex (Vavra 2005) (and may be impossible). Some grazing systems that may be prescribed to (*e.g.*, short-duration, rotation grazing and limiting grazing in sage-grouse nesting habitat in spring) may not be economically feasible for some livestock operators (Torrell et al. 2005, citing references). This suggests that livestock operators that graze in sage-grouse range and who participate in local sage-grouse working groups may not be able or willing to commit to conservation measures that are necessary to conserve and recover sage-grouse (*see, e.g.*, Attachment IV). Kuipers (2004) found (weak evidence) that sage-grouse selected nesting habitat, nest success and brood-rearing habitat were associated with greater canopy cover, residual grass, and forb availability, respectively, on sites that were not grazed, or only lightly grazed in spring in Wyoming. Woodward (2006) (*c.f.* Adams et al. 2004) confirmed some of these findings and noted that reduced grazing/light grazing and/or deferred grazing in sage-grouse nesting habitat in spring reduced impacts on shrubsteppe vegetation and conflicts with sage-grouse. Aldridge et al. (2008) recommended altering grazing practices in sagebrush steppe during times of drought to conserve herbaceous vegetation for sage-grouse.

Cheatgrass

Biological invasions, especially invasion by exotic weeds, is consistently cited as among the most important challenges to maintenance of healthy sagebrush communities (Suring et al. 2005: 114 and citations). A BLM ecologist and program coordinator has warned that “[c]heatgrass is changing the West.” (J. Miller (AP). “Alien invader clings to socks, stokes West’s wildfires.” *Daily Herald* (Provo, UT) (Aug. 8, 2007)).

West (1999b) estimated that 25 percent of the original sagebrush ecosystem has been converted to cheatgrass (*Bromus tectorum*)/medusa-head (*Taeniatherum caput-medusae*) rye annual grassland, and an additional 25 percent of sagebrush steppe has only cheatgrass as an understory. Allen (2003) described conversion of sagebrush steppe to exotic annual grasslands as “massive.” It has been known since at least 1979 that annual-dominated vegetation in sagebrush steppe appears to have crossed a threshold and created its own new equilibrium (Hanley 1979) (from which restoration to functional sagebrush steppe would be very difficult and costly to achieve).

Suring et al. (2005) estimated the amount of land area that is susceptible to cheatgrass invasion in the Great Basin and Nevada. Nearly 80 percent of the Great Basin is estimated to be susceptible to displacement by cheatgrass at low or greater risk (Suring et al. 2005: 138). Sagebrush covers approximately 28 percent of the Great Basin, of which nearly 38 percent are estimated at moderate risk and nearly 20 percent at high risk of invasion by cheatgrass (Suring et al. 2005: 138). Nearly 80 percent of the land area in Nevada is estimated to be susceptible to cheatgrass displacement (Suring et al. 2005: 138). Sagebrush occupies approximately 36 percent of Nevada, of which almost 30 percent is estimated at moderate risk and less than 15 percent at high risk of invasion by cheatgrass (Suring et al. 2005: 138).

Eighty-four percent of Nevada is managed by the federal government, and federal lands (primarily managed by BLM) contain nearly 90 percent of the area estimated to be at moderate risk of cheatgrass invasion (Suring et al. 2005: 140).

Large areas of sagebrush steppe in the Great Basin are estimated to be at moderate or high risk of invasion by cheatgrass or encroachment by pinyon-juniper or both. For example, 90 percent of the eastern Great Basin—including 95 percent of Wyoming/basin big sagebrush habitats—are at moderate or high risk from one or both threats (Suring et al. 2005: 139).

Cheatgrass germinates quickly after fire and there is evidence that cheatgrass will occupy burned areas that are reseeded with native plant seeds. (House, D. and T. Wharton. “Cheatgrass gets better of reseeding efforts.” *Salt Lake Tribune* (July 11, 2007)). Young and Clements (2007: 18) contend that efforts to restore sagebrush steppe with native perennial grasses have largely failed in the face of competition from cheatgrass.

Recent research indicates that thinning *Artemisia* species with tebuthiuron may cause increases in cheatgrass years after treatment (Blumenthal et al 2006). Holloran et al. (2005) also cautioned that, to maintain greater sage grouse populations, managers should limit strategies that negatively affect this sagebrush steppe (i.e. prescribed fire and herbicide application) and protect adequate amounts of suitable nesting habitat during treatment. BLM failed to heed this advice when it approved applying herbicides on up to 1.2 million acres per year (a 140 percent increase over current herbicide applications) to manage vegetation on public land, primarily in sagebrush steppe (Final Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement).

A University of Wyoming extension agent is concerned that cheatgrass could “swamp sagebrush habitat in central and western Wyoming.” (B. Farquahar. “Some sage grouse survive West Nile.” *Casper Star-Tribune* (Aug. 25, 2005)).

Livestock grazing appears to spread cheatgrass through multiple effects (Chambers 2008a) and grazing is probably not effective to control cheatgrass in preparation for restoring sagebrush steppe (Hempy-Mayer and Pyke 2008). Other information suggests that there are simply not enough livestock available to graze at the preferred locations, at the preferred intensity, at the preferred times during the year, to control cheatgrass at a landscape-level (McAdoo et al., undated, factsheet). The number of livestock and grazing intensity required to control cheatgrass would also probably have additional negative effects on native vegetation, soil, and other resources in sagebrush steppe that could outweigh any benefits from cheatgrass control. The removal of herbaceous perennials by grazing may increase water and nitrate availability to cheatgrass, and less perennial herbaceous cover may increase cheatgrass invasion (Chambers et al. 2007). The removal of cheatgrass by grazing may also increase cheatgrass seed production in the following year (Chambers et al. 2007). Cheatgrass invasibility is lowest on sites with relatively high cover of perennial herbaceous species (Chambers et al. 2007).

Intact, lichen-dominated biological soil crusts can significantly inhibit germination and root penetration of cheatgrass (Deines et al. 2007), while the presence of cheatgrass can negatively affect biological soil crust richness and cover (Ponzetti et al. 2007). Moss-dominated biological soil crusts may also effect germination of annual grasses, including cheatgrass (Serpe et al. 2006). The diversity, cover and resiliency of biological crusts are positively correlated to low abundance of cheatgrass, low level of soil disturbance and high moss cover (Ponzetti et al. 2007). Shinneman et al. (2008) discovered that herbaceous and biological soil crust cover and species richness and diversity were generally greater on ungrazed than grazed areas in semi-arid shrubsteppe in western Colorado. Off-road vehicles and other land uses can also damage and destroy biological soil crust.

Young and Clements (2007: 17) opined that the spread of cheatgrass in Nevada was inevitable—with or without excessive livestock grazing. Fortunately for BLM, the agency had already determined that “[t]he effects of livestock grazing on sage-grouse and the spread of invasive species are outside the scope” of newly updated vegetation management plans (Final Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement: III-105).

Unnatural Fire

More than 16 million acres have burned in wildfires in the Great Basin between 1990-2007 (including more than 2.7 million acres in 2007) (BLM, Great Basin Restoration Initiative. Untitled slideshow. (viewed Jan. 23, 2007; available at www.sagestep.org/educational_resources/fire_maps/Animation-PPT2-GB-Wildfires2.html)). Significant areas of sage-grouse habitat have burned in these fires (*see, e.g.*, Nevada Department of Wildlife. “Wildlife & Habitat, Fire Information: Wildlife Values Associated with 2006 Fires within Western Elko County” (webpage). Viewed July 21, 2007; posted at

www.ndow.org/wild/concerns/fire/fire_images/elko_wildlife_fire.shtm and Nevada Department of Wildlife. “New Wildfires Worsen Wildlife Habitat” (news release) (July 20, 2007)).

According to a wildlife biologist with the Nevada Department of Wildlife, “[w]e’ve effectively lost these habitats for the next 30-50 years – conservatively” (Nevada Department of Wildlife. “New Wildfires Worsen Wildlife Habitat” (news release) (July 20, 2007)). Knick et al. (2005) note that low elevation sagebrush steppe (i.e., Wyoming big sagebrush habitat) may require decades to recover from fire, rendering blocks of habitat unsuitable for years. Ecological modelling indicates that frequent, large fires in sagebrush steppe may lead to extirpation of sage-grouse (Pederson et al. 2003).

The Murphy Complex Fire burned 650,000 acres and 75 sage-grouse leks in “prime” habitat in southern Idaho in 2007 (M. Christensen. “Fish and Game may curb hunting in burned areas.” *Times-News* (Twin Falls, ID) (July 27, 2007)). One official called the burn “the most significant fire [he has] ever seen” for its impacts on wildlife. *Id.* The loss of sagebrush habitat from the Murphy Complex Fire has apparently contributed to “the lowest harvest [of sage-grouse] in forty years.” (A. Stiny. “Few grouse bagged as habitat declines.” *Idaho Mountain Express* (Sept. 26, 2007)). A biologist with Idaho Fish and Game noted that restoring habitat burned by the Murphy Complex fire could take 20 to 50 years. (E. W. Johnson. “Threatened species’ even more so after huge Idaho blaze.” *Oregon Public Broadcasting* (July 30, 2007)). The hunting season for greater sage-grouse was closed in the area burned by the Murphy Complex Fire (_____. “Fish and Game changes some sage-grouse seasons. *Outdoor Daily News* (Aug. 31, 2007)).

Approximately 121 square miles (40 percent) on the Hanford Reach National Monument burned in 2007, including important sagebrush habitat. (S. Dininny (AP). “Taking stock of scorched Hanford Reach.” *Seattle Post-Intelligencer* (Sept. 8, 2007)). Approximately 90,000 acres had burned on the monument in the previous six years. *Id.*

Fires burned 337 square miles of wildlands in Nevada in 2006 (M. Griffith. “High winds cause Nevada wildfires to grow in size.” *Las Vegas Sun* (July 29, 2006)), eliminating habitat for more than 10,000. (J. DeLong. “Wildlife officials plan habitat rehab.” *Reno Gazette-Journal* (Oct. 3, 2006)).

Burned areas should be reseeded to help reduce weed invasion in big sagebrush communities that lack residual understory perennial vegetation (Thompson et al. 2006b) (although at least one government expert contends that managers that attempt to reseed with native vegetation “don’t have a prayer” to recover burned areas and should use non-native forage species instead to reduce weed invasion (J. Miller (AP). “Alien invader clings to socks, stokes West’s wildfires.” *Daily Herald* (Provo, UT) (Aug. 8, 2007); also, a wildlife biologist with the Nevada Department of Wildlife recently stated that “[t]he potential for successful restoration is limited” in burned sagebrush steppe (Nevada Department of Wildlife. “New Wildfires Worsen Wildlife Habitat” (news release) (July 20, 2007)). Unfortunately, federal agencies have failed to allocate sufficient resources to collecting, purchasing, storing, and spreading seed on burned sagebrush steppe. Of the millions of acres of sagebrush habitat that burned on BLM land in Nevada in 2006, the agency planned to reseed only a few hundred thousand acres (including 200,000 acres by aerial seeding) (_____. “Wildfire-ravaged land being re-seeded.” *Times-News* (Twin Falls, ID) (Jan. 27, 2007)). Sagebrush habitat restoration is generally quite expensive. (D. Bleizeffer. “Task force:

grouse habitat work expensive.” *Casper Star-Tribune* (Dec. 18, 2004)). The Government Accountability Office reported that BLM’s system tracking habitat restoration could be improved (GAO 2006).

Observations at the Idaho National Laboratory suggest that sagebrush-steppe may recover from fire where residual populations of native plants exist, cheatgrass does not dominate the vegetative community, precipitation favors regrowth, and the burned area is not disturbed following the fire (INL-ESERP, undated).

Energy Development

Other commenters (Biodiversity Conservation Alliance) will submit information on the effects of energy development on sage-grouse. Those comments are incorporated here (see also Attachment II).

BLM’s natural gas and oil permitting activity more than tripled between 1999-2005 (GAO 2005). The federal government has leased or offered for lease 229 million acres of public and private land (subsurface) in 12 western states for oil and gas development (Devoe 2008). An estimated 115,476 new oil and gas wells will be drilled in Colorado, Montana, Utah and Wyoming in the next 15-20 years (The Wilderness Society, undated data), likely resulting in more than 1,000,000 acres being graded, drilled, built upon or otherwise disturbed by energy development (A. J. Morgan, Vice President of the Public Lands Campaign, Testimony to the Energy and Minerals Subcommittee, House Natural Resources Committee (Apr. 17, 2007)). The BLM estimates that there are 1.9 million barrels of oil and 57.5 trillion cubic feet of natural gas available for development on public lands just in southwest Wyoming (USDI 2007). Energy companies are expected to apply to develop these resources and an executive at an oil company opined that “the last chapter in oil and gas exploration has not been written in the United States.” (B. Magill. “Shell VP: oil and gas era not over yet.” *The Daily Sentinel* (Grand Junction, CO) (July 28, 2007)).

Shortly after the Fish and Wildlife Service (USFWS) declined to list greater sage-grouse under the ESA in 2005, a sage-grouse expert stated that the BLM’s standard seasonal one-quarter mile lek buffer for energy development was insufficient to protect sage-grouse. (AP. “Sage grouse advocates criticize BLM plan.” *Billings Gazette* (Feb. 27, 2005)). Holloran (2005) (*also* Holloran and Anderson 2005) found that 64 percent of sage-grouse nested within 5 km (3.1 miles) of a lek site. Walker et al. (2007a) noted negative effects of CBM development on sage-grouse within 0.8km (0.5 mile) and 3.2km (approximately 2 miles) of active sage-grouse leks, and found that persistence of 110 leks was positively influenced by the proportion of sagebrush habitat within 6.4km (approximately 4 miles) of the lek. Holloran (2005: 57) stated that “current development stipulations are inadequate to maintain greater sage-grouse breeding populations in natural gas fields.” Walker et al. (2007a: 2644) concurred, stating that “current lease stipulations that prohibit development within 0.4km (0.25 mile) of sage-grouse leks on federal lands are inadequate to ensure lek persistence and may result in impacts to breeding populations over larger areas.” The authors noted that, if 75 percent of the landscape within 0.8km of an active lek were developed for natural gas, the probability for lek persistence would decrease from 86 percent to 24 percent (Walker et al. 2007a). Similarly, if 98 percent of the landscape were

developed within 3.2km of an active lek, the probability of lek persistence declines from 87 percent to 5 percent (Walker et al. 2007a). Aldridge and Boyce (2007) noted that sage-grouse have a low probability of survival (mortality caused by a variety of factors) where energy development occurs in sagebrush habitat in Alberta. Montana Fish, Wildlife and Parks advocates expanding protective sage-grouse lek buffers to four miles radius during the breeding and nesting season, and 1 mile radius for the rest of the year. (T. Dickson. “The high price of gas.” *Montana Outdoors* (July/Aug. 2007)). Aldridge and Boyce (2007: 523) found that a majority (~90%) of nesting and brood-rearing habitat is within 10 km of active leks in Alberta and suggested that any habitat buffer of less than 10 km (6.2 miles) may be insufficient to protect these critical habitats. Marshall et al. (1996) recommended protecting habitat near sage-grouse leks more than a decade ago.

Despite increased criticism of BLM’s seasonal restrictions to conserve wildlife in natural gas and oil fields, the agency continues to prescribe minimal one-quarter mile radius buffers for sage-grouse leks and 2-mile buffers to protect sage-grouse nesting habitat from energy development projects. *E.g.*, BLM. 2008. Puma prospect EA area – Sweetwater County/Davis Petroleum Corp. (scoping notice). Bureau of Land Management, Rock Springs Field Office. Rock Springs, WY. (May 21, 2008); BLM. 2008. Luman Rim project area/Yates Petroleum Corp., Davis Petroleum Corp., and Pinnacle Gas Resources, Inc. (scoping notice). Bureau of Land Management, Rock Springs Field Office. Rock Springs, WY. (May 21, 2008). At the same time, the BLM has recognized that seasonal one-quarter mile and 2-mile buffers threaten to “extirpate” an important sage-grouse population in the Powder River Basin in Wyoming. (D. Bleizeffer. “BLM imposes restrictions for grouse.” *Casper Star-Tribune* (May 29, 2008)).

More sage-grouse leks in CBM development fields became inactive compared to leks outside CBM development fields in the Powder River Basin in Montana and Wyoming. From 2001-2005, lek count indices in CBM development fields declined by 82 percent, at a rate of 35 percent per year, whereas indices outside CBM development fields declined by 12 percent, at a rate of 3 percent per year (Walker et al. 2007a). Remaining leks in CBM development fields also averaged 45 percent fewer males per active lek than leks outside development fields between 2002-2005 (Walker et al. 2007a). Of leks active in 1997 or later, only 38 percent of 26 leks in CBM development fields remained active by 2004-2005, compared to 84 percent of 250 leks outside CBM development fields (Walker et al. 2007a). Of twelve leks closely monitored in CBM development fields, all 12 became inactive in the same year or shortly after development occurred (Walker et al. 2007a). The average time between CBM development and lek disappearance was slightly longer than 4 years (Walker et al. 2007a). Walker has noted that the effects of CBM development on sage-grouse may have been underestimated in their research. (B. Hargrove. “CBM industry paid for part of sage grouse study.” *The News Record* (Gillette, WY) (July 28, 2007)). Kaiser (2006) noted reduced sage-grouse recruitment in oil and gas development fields.

Results of Walker et al. (2007a) are similar to those of Hollaran (2005) and Holloran et al. (2005). Professor Naugle, a coauthor on many of these energy development impacts studies, ensured that the BLM has copies of the published data and associated maps (AP. “Environmentalists may push for more protection for sage grouse.” _____ (Oct. 8, 2006)). The BLM, Buffalo Field Office is finally considering developing a new plan to manage sage-grouse

in the Powder River Basin in response to these data. A draft plan may not be available for several years. In the interim, the field office may restrict or limit some natural gas and oil drilling and livestock grazing across 1 million acres, or 19% of its jurisdiction. (S. Rzasa. "BLM considers banning new gas well permits on 1M acres." *Buffalo Bulletin* (WY) (May 21, 2008)). The new plan may protect some remaining core sage-grouse habitats identified in the Powder River Basin. (B. Neary (AP). "Gov likes grouse plan." *Casper Star-Tribune* (June 13, 2008)). However, any energy companies that already hold approved permits to drill in the area will be allowed to drill those wells. This continued obeisance to the energy industry appears to run counter to a recent declaration by an Administration official to "think differently" about the effects of energy development on wildlife. (N. Straub. "Interior official seeks new balance for wildlife." *Billings Gazette* (May 15, 2007)). Also, relatively little livestock grazing is currently permitted in the planning area.

In response to findings on the effects of energy development on sage-grouse in the Powder River Basin, the BLM stated it would more closely analyze activities planned on 346,155 acres of high-quality sage grouse habitat in the basin in Wyoming under NEPA—amounting to 7 percent of the basin. (B. Farquhar. "BLM 'sets bar higher' for grouse." *Casper Star-Tribune* (Aug. 16, 2007)). However, a BLM spokesman noted that the agency does not seek to outright prohibit energy development on high-quality habitat areas. *Id.*

A new BLM plan would permit CBM development in the Atlantic Rim area in Wyoming near some leks with the highest spring counts. Wells could be spaced at one per 80 acres, which may cause three to six times the level of disturbance than sage-grouse can tolerate. BLM intends to monitor sage-grouse leks in the planning area once every five years, which may not be sufficiently recurrent to notice and remedy population declines caused by drilling activities, according to a Wyoming Game and Fish Department biologist. (A. Reese. "Wildlife would suffer under BLM plan for Wyo.'s Atlantic Rim, critics say." *Land Letter* (Dec. 7, 2006)). The BLM's plan will allow development of 2,000 CBM wells, plus the construction of 1,000 miles of roads and 1,000 miles of pipelines in the Atlantic Rim area.

Undeveloped sagebrush steppe is under consideration for energy development (J. Gearino. "Bad move or about time?" *Jackson Hole Tribune* (Mar. 18, 2008)) and new development increasingly affects sage-grouse populations in Wyoming. (D. Bleizeffer. "Bird rules send some drillers home." *Casper Star Tribune* (Mar. 2, 2007)). Energy companies have also proposed to drill additional wells in developed fields in sage-grouse habitat (increasing well density). *E.g.*, BLM. 2008. Normally Pressured Lance development project environmental assessment/EnCana Oil & Gas (USA), Inc. (scoping statement). Bureau of Land Management, Rock Springs Field Office. Rock Springs, WY. (Feb. 27, 2008); BLM. 2007. East LaBarge gas exploration and development project/EOG Resources, Inc. (scoping notice). Bureau of Land Management, Rock Springs Field Office. Rock Springs, WY. (June 5, 2007). The BLM approved a Jonah Infill drilling plan that will allow a Canadian petroleum firm to add up to 3,100 new natural gas wells on 30,000 acres in an already dense Jonah gas field. A sage-grouse expert contended that the density of drilling rigs, pipelines and associated infrastructure must be reduced in sage-grouse habitat if the species is to persist. (B. Johansson. "Study: energy use bad for bird." *Craig Daily Press* (CO) (Jan. 24, 2006)). He recommended that the Bureau of Land Management preserve more sagebrush steppe where sage-grouse can escape natural gas development. *Id.* In response to criticism over

additional drilling on the Pinedale Anticline in Wyoming, a BLM spokesperson stated “[w]e are drilling more, yes, and the sage grouse numbers are challenging, *but our wildlife protections are the same as they’ve always been.*” (J. Nichols. “Them on us.” *Planet Jackson Hole* (Aug. 1, 2007) (emphasis added)).

Natural gas production generates significant liquid byproduct that is stored or transported through pipes to other locations. Pipelines constructed in sagebrush steppe may be negative for sage-grouse (D. Webb. “Pipeline proposed from Meeker.” *The Daily Sentinel* (Grand Junction, CO) (Feb. 26, 2008)). Even small developments associated with natural gas drilling, such as an 18-acre shale extraction pit created to supply material for surfacing gas drilling access roads, can disturb and displace sage-grouse. (_____. “EnCana to use shale rock in its roads to gas wells. *The Daily Sentinel* (Grand Junction, CO) (Aug. 23, 2005)).

Doherty et al. (2008) discovered that female sage-grouse avoid areas affected by energy development in otherwise suitable winter habitat in the Powder River Basin in Montana and Wyoming. The authors concluded that lek buffers and seasonal restrictions on activities in CBM development fields are insufficient to conserve sage-grouse because they do not prevent infrastructure from displacing sage-grouse in winter (moreover, many development stipulations are waived by BLM (see below)). For example, a seasonal restriction (Dec. 1 - Mar. 31) on CBM development in Montana intended to protect sage-grouse “crucial winter range” only protects sage-grouse habitat during the winter in which drilling is scheduled. An affected area may be drilled later in the year, in which case it may rendered unusable for sage-grouse the next winter. “Current [natural gas development] stipulations leave only a fraction of land undeveloped, place no restrictions on the location of wells in winter habitat, and allow human access to all areas throughout the life of the producing gas field” (Doherty et al. 2008). Moynahan et al. (2007) urged managers to identify, conserve and enhance important sage-grouse winter habitat, which may influence the abundance and condition of female sage-grouse and their nesting effort and clutch sizes in spring.

BLM continues to grant energy industry requests for waivers from stipulations intended to reduce disturbance to sage-grouse from natural gas and oil extraction in winter habitat, and during the breeding and nesting seasons. The BLM Pinedale and Rawlins field offices have granted more waivers than they have denied in 2007-2008 (BLM-Pinedale Field Office 2008, updated June 5, 2008; BLM-Rawlins Field Office 2008, updated May 28, 2008). As previously noted by commenters, these exceptions are not merely to explore for CBM or conduct other innocuous activities near a sage-grouse lek or in winter or nesting habitat. Energy development companies are in fact requesting waivers from stipulations to drill wells, lay pipe, crush and haul gravel, and install equipment near leks and in nesting habitat from late winter, when the grouse would otherwise be strutting on leks, to late spring, when hens are nesting and raising broods.

The new Bureau of Land Management director has stated that “[t]here’s absolutely no doubt that the interest in oil and gas [in the West] is going to continue” and concern over the effects of energy development on the environment is “to some degree overblown” (J. Heilprin. “BLM director backs western drilling.” *Las Vegas Sun* (Oct. 5, 2007)). Renewed interest in oil shale development may also threaten sage-grouse. (AP. “Controversial oil shale tests get permits.” *MSNBC.com* (July 26, 2007)). Western governors have complained that the federal government has leased vast areas for natural gas and oil development in sage-grouse habitat, and then relies

on states to conjure solutions to conserve declining populations. (D. Bleizeffer. “Western states develop energy, ask for help.” *Casper Star-Tribune* (July 26, 2007)).

Energy Companies’ Self-policing. Energy development companies in Wyoming prefer “friendly encouragement and self-policing” to address impacts of energy development on sage-grouse (D. Bleizeffer. “Working around the grouse.” *Casper Star-Tribune* (Apr. 27, 2007)) and seek to loosen seasonal restrictions intended to protect sage-grouse and its habitat (AP. “Coal-bed methane industry wants wildlife rules relaxed.” *Argus Observer* [Ontario, OR] (Apr. 27, 2007)). Unfortunately, research indicates that even these minimal restrictions (limitations on winter drilling; spring lek buffers) are inadequate to conserve sage-grouse (Naugle et al. 2006). One energy producer called proposed new restrictions on mineral development to conserve sage-grouse in the Powder River Basin “an overreaction” and asserted that “[t]here are plenty of sage-grouse [in the Powder River Basin].” AP. “Coal-bed methane industry objects to sage grouse regs.” *Wyoming Tribune-Eagle* (Cheyenne, WY) (June 5, 2008). Another producer wondered why the federal government should attempt to save sage-grouse from extinction, contending that “[t]here have been species going extinct ever since God created this earth.” *Id.*

There is an 84 percent non-compliance rate in reclamation in the Powder River Basin coal-bed methane industry. (D. Bleizeffer. “Some see rush, others see hush.” *Casper Star-Tribune* (Apr. 29, 2007)).

A BLM spokesman admitted that energy development on public lands sometimes comes at the expense of other resources. (AP. “Group sues over plant for Atlantic Rim.” *Billings Gazette* (Aug. 22, 2007)).

Montana Seeks to Avoid becoming “Another Wyoming.” Montana seeks to avoid becoming “another Wyoming” as it manages impacts from proposed federally permitted natural gas and CBM development in the state. (B. Schneider. “Red Alert on energy leases.” *New West* (Apr. 15, 2007) (viewed Apr. 17, 2006; available at www.newwest.net/index.php/topic/article/red_alert_on_energy_leases/C41/L41) and M. Brown (AP). “Not like Wyo.” *Casper Star-Tribune* (May 14, 2007)). But the chief of field operations for Montana Fish, Wildlife and Parks does not believe that wildlife officials can prevent natural gas and CBM development from harming wildlife. He contends that “[t]he BLM is leasing up the whole state under the radar line” and “you want to speculate that they are trying to get it all leased under the current administration.” (B. Schneider, “Red Alert on energy leases.”). A former director of the Utah Department of Wildlife Resources also expressed concern about the magnitude of proposed energy projects in Montana and noted that even if gas drilling is “done right, it will have a substantial impact on the wildlife resources.” *Id.*

The state of Montana now requires that newly issued state natural gas and oil leases undergo additional analysis by the Montana Department of Fish, Wildlife and Parks if sage-grouse leks and nesting habitat are nearby. (M. Brown (AP). “Montana officials protect sage grouse areas.” *Billings Gazette* (Aug. 6, 2007)). However, it is unclear if the state will impose any additional stipulations on state oil and gas leases, and the state already leased 1.7 million acres of state land for development prior to announcing this new requirement. *Id.*

Reclamation of Energy Development Projects. The BLM typically requires operators to reclaim areas affected by energy development activities in applicable management plans. Reclamation often includes reseeding disturbed areas. However, not all operators are required to reseed a full complement of sagebrush steppe shrubs, grasses and forbs. Citing difficulties with establishing and managing native forbs on disturbed sites, the BLM Glenwood Springs Energy Office (GSEO) eliminated forbs from seed mixes used in interim reclamation in the Glenwood Springs District in Colorado (Crockett 2007). The GSEO also eliminated shrubs, including sagebrushes, saltbushes, and rabbitbrushes, from seed mixes for the same reasons, and because the GSEO claimed that shrubs “readily colonize from nearby undisturbed areas” (Crockett 2007: 2). It is believed that other BLM field offices in Colorado have also eliminated forbs and shrubs from seed mixes used in interim reclamation. Decades often pass following interim reclamation and before permanent reclamation occurs at a given site. By eliminating forbs and shrubs from interim reclamation seed mixes, the GSEO has essentially ordered conversion of disturbed areas in the Glenwood Springs District from sagebrush steppe to grasslands that are less useful to sagebrush obligate species. Also, contrary to the GSEO’s rationale, sagebrush species propagate and grow slowly. Relying on shrubs to colonize disturbed sites from other, undisturbed areas may not be a desirable reclamation strategy.

Contributions of CBM Development to the Spread of WNV. The process used to extract coalbed methane produces huge quantities of waste water. A CBM well produces an average of 12 gallons of water per minute. (M. Sever. 2006. “Coalbed gas enters the energy mix.” *Geotimes* (Sept. 2006). Available at www.geotimes.org/sept06/feature_EnergyMix.html (viewed July 23, 2007)). Billions of gallons of water have been wasted in the search for CBM. (Bleizeffer, D. “Some CBM wells produce only water.” *Casper Star-Tribune* (May 6, 2007)). Produced water—which is often loaded with salt and other minerals—is either sprayed onto surrounding land, sluiced down a nearby creek, or stored in one of an estimated 23,320 wastewater reservoirs (WORC 2005, unpublished report: 16). (Wyoming officials found 153 of 217 of these water storage reservoirs in stream channels were not properly permitted. D. Bleizeffer. “State steps up CBM enforcement.” *Casper Star-Tribune* (Jan. 11, 2005)). CBM wastewater reservoirs are “significantly increasing the overall population of [West Nile virus] vector mosquitoes in the [Powder River Basin]” (Doherty 2007: ix). Walker (2008: iii) stated that “[m]anagement should focus on eliminating man-made water sources that support breeding mosquitos known to vector [WNV].” Trees planted to sop up (relatively little) salty discharge from CBM development may degrade sage-grouse habitat when they grow tall and become potential perches for aerial predators (see AP. “Experiment growing trees with salty CBM water.” *Billings Gazette* (Aug. 28, 2006)).

Utility Corridors

A new draft programmatic environmental impact statement (“draft PEIS”; prepared pursuant to the Energy Policy Act of 2005 [§ 368]) could authorize construction of over 6,000 miles of utility corridors (including pipelines and electricity transmission lines and facilities) (DOE/USDI 2007: 1-15) on approximately 3 million acres on federal land in the eleven western states (DOE/USDI 2007: 3-50). New energy corridors would be located mostly on BLM lands (DOE/USDI 2007) (some will connect to as many as 25 new power plants in the Great Basin (Devoe 2008)). The draft PEIS acknowledges the negative effects of development on sage-

grouse, including reduction and fragmentation of habitat; disturbance from noise associated with construction, maintenance and operation of facilities; and increased predation (DOE/USDI 2007: 3-203 – 3-204).

Numerous transmission lines may be proposed for construction within these utility corridors (WGA 2007, unpublished report: 12, map; WRA 2007, unpublished data) that could negatively affect sage-grouse. For example, the proposed Gateway West Transmission Line Project would extend a total of 1,250 miles across Wyoming and southern Idaho, including 500 miles on public land (300 in Idaho, 200 in Wyoming). BLM. 2008. Gateway West transmission line project (scoping notice). Bureau of Land Management, Gateway West Transmission Line Project. Cheyenne, WY. (May 16, 2008). The Wilderness Society has prepared a sample analysis of the proximity of proposed energy corridors in Idaho to sage grouse leks and habitat, which shows potentially devastating impacts on sage grouse populations.

Walker et al. (2007a) noticed that electricity transmission lines may affect sage-grouse lek persistence depending on their distance from a lek. Other researchers found that common raven (*Corvus corax*) counts increased ~200% along an electricity transmission line in “prime sage grouse habitat” in Eureka County, Nevada (Atamian et al., undated). The number of disturbance events involving common ravens also increased along the transmission line, while the local sage-grouse population appeared to decline in 2007 (Atamian et al., undated). Anecdotal evidence suggests that transmission lines may be hazardous for sage-grouse. One observer reported finding the remains of eighteen sage-grouse along less than 4 km of a transmission line in eastern Montana in 2000 (Harmata, email). Lammers and Collopy (2007) reported that perch deterrents on utility poles generally did not prevent raptors and corvids from using utility poles to prey on sage-grouse.

Braun (2006, unpublished report) recommends that surface occupancy should be restricted within 5.5 km of all active sage-grouse leks. USFWS recommended avoiding siting wind turbines within 5 miles (18 km) of known prairie grouse leks (Manville 2008).

Conifer Encroachment

Since 1870, concurrent with the introduction of domestic livestock and the resultant exclusion of periodic fire, the occurrence of western juniper (*Juniperus occidentalis occidentalis*) in the sagebrush steppe in Oregon, northeastern California, northwestern Nevada, Idaho and Washington has increased approximately ten-fold (Miller et al. 2005). Sage-grouse are known to avoid trees in otherwise suitable sagebrush habitat. Doherty et al. (2008) found that sage-grouse avoid conifer habitats at a 0.65km² scale. Winter et al. (2006) found that even a seemingly small amount of woody vegetation can greatly reduce the number of individuals of bird species in grassland habitats. There is significant circumstantial evidence that conifer encroachment is a response to livestock grazing and fire suppression (Kerr and Salvo (2007), unpublished report). Noson et al. (2006) found that burned sagebrush habitat and western juniper encroachment had a negative impact on sagebrush birds in high-elevation sagebrush steppe.

Roads

Walker et al. (2007a) suggested that roads in CBM development fields disturb sage-grouse. Ingelfinger and Anderson (2004) found that the density of Brewer's sparrow and sage sparrow, two other sagebrush obligate species, were reduced 39-60 percent within a 100-m buffer around lightly traveled dirt roads in a natural gas development field in Wyoming. Barton and Holmes (2007) similarly found evidence of greater nest desertion and abandonment by breeding songbirds within 100 m of off-road vehicle (ORV) trails than at nests more than 100 m from ORV trails in northeastern California. Brown and Laband (2006) found that the incidence of roads, among other factors, is significantly correlated with the ecological imperilment of species.

Climate Change

Up to 80 percent of remaining sagebrush steppe could be lost to the direct or indirect effects of global warming. (Wisdom et al. 2005b: 206, *citing* Neilson et al. 2005). Average temperature has increased 0.6 - 1.1° F in the last 100 years in the Great Basin (Chambers 2008b). CO₂ and other greenhouse gases have increased in the Great Basin. Raupach et al. (2007) discovered that the growth rate in anthropogenic CO₂ emissions increased more rapidly between 2000 and 2004 than even predicted by the highest growth rate (i.e., "worst case") scenario developed by a leading intergovernmental organization in the late 1990s. Drought may also contribute to increased atmospheric CO₂ by reducing the amount of CO₂ that is annually taken up by terrestrial vegetation (Peters et al. 2007). Increased CO₂ may favor the shrub component in sagebrush steppe (Morgan et al. 2007). Increased CO₂ may also favor invasive, annual grasses, including cheatgrass (Smith et al. 2000). Up to 60 percent of the climate-related trends in river flow, winter air temperature and snow pack between 1950-1999 were influenced by human-induced climate change (Barnett et al. 2008). Climate change is projected to cause temperatures to continue to increase in the Great Basin by 3 - 4° F in spring and autumn, and by 5 - 6° F in winter and summer, by 2100 (Chambers 2008b, *citing* Cubashi et al. 2001). Any stabilization or cooling trend in average temperatures is expected to be temporary. (R. A. Kerr. "Mother Nature Cools the Greenhouse, but Hotter Times Still Lie Ahead." *Science* 320(5876) (May 2, 2008): 595). van

Kooten et al. (2007: 68) predicted that climate change could be a significant threat to greater sage-grouse. Moynahan et al. (2007) reported that drought effects sage-grouse nesting probability. Holloran et al. (2005) noticed that annual sage-grouse nest success rates were positively correlated with the precipitation in the previous year. Aldridge et al. (2008) noted that increased temperatures will dry sagebrush steppe and suggested that drought will intensify the effects of other threats to sage-grouse, such as livestock grazing, invasive species and fire frequency. McKenzie et al. (2003) also stated that increased temperature would extend the fire season in the western United States, as well as the total area burned in some regions.

The expert panel convened by USFWS in 2004 to assess threats to sage-grouse underestimated the effects of short-term (drought) and long-term climate change on sagebrush ecosystems and sage-grouse. Further, the Government Accountability Office reported that federal land management and wildlife agencies have not made climate change a priority and have only limited guidance and insufficient information to address the effects of climate change on federal land and water resources (GAO 2007).

Land Use

Urban Development. A number of the fastest growing communities in the Interior West – the fastest growing region of the country – are in sagebrush steppe, in Colorado, Idaho, Nevada, Oregon, and Utah (BLM, undated; BLM 2005b). Nine of twelve states with large tracts of BLM land are among the fastest growing in the nation (BLM 2005b); the growth rates in nine western states exceeded 20 percent or more during the past decade (BLM 2007). Human population expansion, and the myriad impacts of population growth, is expected to continue in the Great Basin (Nevada, western Utah, southern Idaho, and eastern Oregon) (Torregrosa and Devoe 2008). Urban development continues to affect sage-grouse locally. (S. Voyles. “Move seen as ‘nails in coffin’ for antelope, mule deer.” *Reno-Gazette Journal* (Jan. 11, 2006)).

Agriculture. Aldridge et al. (2008) found that sage-grouse have been extirpated from areas with a minimum of 25 percent cultivated cropland, and that the species was more likely to persist further than 30 km from the periphery of their historic range. Walker et al. (2007a) found that conversion of sagebrush steppe to cropland (perhaps using CBM produced water for irrigation) in conjunction with CBM development may be detrimental to sage-grouse. Smith et al. (2005) found varying effects of the existence of cultivated land within 4 km of lek sites on sage-grouse lek attendance in North Dakota and South Dakota.

Water Development. Proposed water development plans in Nevada could negatively affect sagebrush habitats in central Nevada (Deacon et al. 2007). A federal government study estimated that a proposed groundwater withdrawal plan to support urban growth in Las Vegas could cause the loss of more than 60 percent of the phreatophytes in some areas in the Great Basin (Schlyer 2007: 11 (*citing* Schaefer and Harrill 1995)).

The proposed Black Rock reservoir dam in Washington could further reduce limited sage-grouse habitat in that state. (J. Trumbo. “Yakima River water not a win-win. *Tri-City Herald* (Jan. 30, 2008)).

Wind Energy Development

Various government wind atlases identify areas in sagebrush steppe and on BLM land as high value for wind resource development. Seven of the top ten wind energy producing states are in the West, and wind accounted for 93 percent of clean energy development in the West in 2005-2006 (WGA 2007, unpublished report). The federal government has identified 20.6 million acres in the West with wind energy potential.

The construction and placement of windmills negatively affects sage-grouse (*see generally* BLM 2005a). USFWS recommended avoiding siting wind turbines within 5 miles (18 km) of known “prairie grouse” leks (including sage-grouse). However, the agency emphasized that its guideline was only a recommendation, and does not restrict wind energy development within 5 miles of a sage-grouse lek (Manville 2004). Reviewing published sage-grouse management guidelines, USFWS noted

Specifically, for non-migratory populations occupying habitats that are uniformly distributed, they recommended protecting sagebrush and herbaceous understory within 2 mi (3.2 km) of all occupied leks. For non-migratory populations, leks should be considered the center of year-round activity and treated as the focal points for management activities. For non-migratory populations where sagebrush is not uniformly distributed, suitable habitats should all be protected out to 3.1 mi (5 km) from all occupied leks. For migratory populations of Sage Grouse, breeding habitats within 11.2 mi (18 km) of active leks should be protected, recognizing that nesting birds may move > 11.2 mi (18 km) from leks to nest sites. This recommendation ... obviously represents a protected area much larger than the 5-mile suggestion by the Service. (Manville 2004: 8).

BLM management documents fail to prescribe 5-mile lek buffers for wind energy development on BLM land in occupied sage-grouse habitat. BLM sage-grouse guidelines deferred to specific BLM guidance on wind energy development to recommend best management practices (BMPs) for locating wind energy development in sage-grouse habitat (BLM 2004: 3, “BMPs for wind energy are currently being developed in the Wind Energy Programmatic Environmental Impact Statement. These BMPs will be adopted by reference when completed.”). However, neither BLM interim guidance for wind energy development on BLM lands (BLM 2002) (hurriedly drafted under pressure from the Administration (*see e.g.*, Exec. Order 13212, 66 Fed. Reg. 28357, “Actions to Expedite Energy-Related Projects”)) or BLM’s final environmental analyses and plan for wind energy development (BLM 2005a), recommended 5-mile lek buffers for wind energy development in sage-grouse habitat.

BLM has permitted wind energy development in sage-grouse habitat on 14.5 miles of ridgeline on Cotterel Mountain in southern Idaho (J. Sandmann. “Windland Inc. targets 2008 for turbines near albion.” *Times-News* (Twin Falls, ID) (Aug. 20, 2006)). The construction of anemometer towers to test for wind energy potential on Cotterel Mountain already appears to have caused sage-grouse to abandon the area.

Mining

Walker et al. (2007a) noted that four leks were known to have been destroyed by mining in the Powder River Basin in Montana and Wyoming. New coal mining has been approved in the Powder River Basin that may impact up to 15 sage-grouse leks and may affect up to 50 leks within two miles of mining activity (WWC Engineering 2007: 4-68, Table 4-23). (It is unclear from the reference cited if these direct and indirect affects on sage-grouse leks from coal mining are expected to occur over the life of the 20-year project, or for each 5-year phase of the project—in which case, the project could directly impact up to 45 leks and indirectly affect up to 150 leks over the 20-year life of the project in the Powder River Basin). The new mining project may also initially affect “an unquantifiable number of the lek sites” from CBM development, which would occur in advance of coal mine development. “Potential direct impacts to sage-grouse, if present, could include loss of foraging areas, abandonment of a lek site, or loss of eggs or young as a result of development activities (WWC Engineering 2007: 4-67). The BLM also approved a placer gold exploration project on 4,000 acres in sage-grouse nesting and brood-rearing habitat in an Area of Critical Environmental Concern managed by the Rock Springs Field Office in Wyoming (BLM-Rock Springs Field Office 2005). Some sage-grouse seasonal

restrictions were imposed on the mining company that will dig the exploration pits in the project area, but if gold is discovered, a much larger area (and associated infrastructure, traffic, human activity, etc.) may be involved in mine development. Remington and Braun (1991) reported on the effects of mining on sage-grouse in Colorado.

V. Habitat Loss

Conservation Reserve Program

Sage-grouse use habitat on private land enrolled in the federal Conservation Reserve Program administered by the U.S. Department of Agriculture (USDA), Farm Service Agency. Approximately 1.5 million acres of private farmland has been planted to perennial grasses, forbs and shrubs under the CRP in Washington. Sage-grouse nests in CRP fields increased from 31 percent in 1992-1994 to 50 percent in 1995-1997 as the height and cover of herbaceous vegetation increased and big sagebrush became more prevalent (although females still selected native sagebrush steppe for nesting (59%) more often than habitat on CRP-enrolled land (41%) during the course of the study) (Schroeder and Vander Haagen 2006). Nesting success on CRP and native sagebrush steppe were comparable (Schroeder and Vander Haagen 2006).

The USDA frequently allows landowners to “emergency” hay and graze private land enrolled in the CRP. The USDA has announced that more than 24 million acres, or 70 percent of the total acreage enrolled in the CRP will be available to hay and graze in summer 2008. (D. Wilkins. “USDA makes CRP lands eligible for hay, forage use.” *Capital Press* (May 27, 2008)). Livestock grazing is negative for sage-grouse (as described in these comments and other references), and Gunnison sage-grouse were found to avoid CRP-enrolled habitat when livestock were present in San Juan County, Utah (Lupis et al. 2006).

CRP-enrolled habitat was most beneficial to sage-grouse when it contained sagebrush and was located in sagebrush steppe (Schroeder and Vander Haagen 2006). Schroeder et al. (2000) and Hays et al. (1998) stressed the importance of long-term enrollment of fields in the CRP in order for sagebrush and other shrubs to become (re-)established to benefit grouse species. Some ranchers are using federal conservation payments received from the Conservation Reserve Program to plant forage kochia on private lands and burned areas in sagebrush steppe. (D. House. “Wildlife cure a subsidy away?” *Salt Lake Tribune* (July 29, 2007)). Forage kochia is of no benefit for sage-grouse.

Unfortunately, both important and lesser quality habitat on CRP-enrolled lands may soon be lost to sage-grouse. Farmers and ranchers are increasingly withdrawing their fields from the CRP. (D. Streitfeld. “As prices rise, farmers spurn conservation program.” *New York Times* (Apr. 9, 2008)). The U.S. Department of Agriculture considered allowing farmers to withdraw some private land from the CRP without penalty in 2007. (Mehlhop, P., electronic mail to S. Manes “From Greenwire--AGRICULTURE: Despite record corn crop, USDA weighs opening conservation land,” dated Sept. 26, 2007. Document received from U.S. Fish and Wildlife Service.) Conversion of CRP-enrolled lands back to agriculture was recently identified as the single most important threat to Columbian sharp-tailed grouse in Region 2 of the Forest Service and elsewhere (Hoffman and Thomas 2007).

Elimination of Sagebrush Steppe

In its biological opinion on the Bureau of Land Management's Draft Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement, Draft Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report, and Final Biological Assessment for Vegetation Treatments on Bureau of Land Management Lands in 17 Western States, the National Oceanic and Atmospheric Administration, National Marine Fisheries Service noted that "sagebrush habitats are declining rapidly across western North America" and "restoration potential appears limited for populations and habitats of greater sage-grouse" (NMFS 2007: 59).

Wisdom et al. (2005b) contend that the loss of sagebrush steppe is accelerating and Hemstrom et al. (2002) stated that current management efforts have been ineffective in abating the loss. Hemstrom et al. (2002) and Wisdom et al. (2002) found that a six-fold increase in the budgets of the U.S. Department of Interior Bureau of Land Management and U.S. Department of Agriculture Forest Service for sagebrush maintenance and restoration only reduced, but did not reverse the rate of decline in habitat loss and quality. Their findings suggested that conserving existing sagebrush steppe was more cost effective than restoring lost or heavily degraded sagebrush habitat (Wisdom et al. 2005b; *see also* Knick and Rotenberry 1995). Regardless, a dramatic increase in funding for management and restoration of sagebrush steppe is required to reverse accelerating loss and quality of sagebrush habitats (Wisdom et al. 2005b). Chambers et al. (2008) noted that both research and management activities have been "severely" underfunded in the Great Basin.

Wisdom et al. (2005b) identified areas with potential to maintain or restore sagebrush habitat based on elevation and precipitation. They found that areas with high potential to maintain and restore sagebrush steppe are concentrated in Wyoming, eastern Idaho, and northern Nevada, while areas with very low to moderate potential to maintain or restore sagebrush are concentrated in Washington, Oregon, western Idaho and much of Nevada—where large areas of sagebrush steppe have already been lost to agricultural conversion or plant invasion.

Aldridge et al. (2008) analyzed and mapped sage-grouse persistence in the West. The authors discovered that extirpation was more likely in areas having at least 4 persons/km² in 1950, a minimum of 25 percent cultivated cropland (ca. 2002) and severe droughts an average of 3 years per decade (Aldridge et al. 2008). Their map depicts large areas in the West where sage-grouse are at risk of extirpation (including a large area currently occupied by Mono Basin area sage-grouse).

The map also depicts large, continuous areas with "likely secure populations" of greater sage-grouse. Perhaps the coarse scale of the map prevented the researchers from showing areas within the "likely secure" habitat that have been burned, converted to cheatgrass monoculture, or industrialized by natural gas and oil extraction, where sage-grouse are extirpated or at risk of extirpation. Aldridge et al. (2008) noted the limitations of such large scale analyses and maps. The "likely secure" area on the sage-grouse map is probably overestimated.

Winter et al. (2006) noted that large bodied birds (e.g., grouse species) are generally more strongly affected by habitat loss and fragmentation and noted the importance of protecting larger habitat patches to conserve large bodied birds. However, their research also indicated that protecting small habitat patches was also important to conserve smaller birds and maintain avifaunal diversity (Winter et al. 2006).

Aldridge et al. (2008) noted that, while human settlement, agricultural conversion, and drought affected sage-grouse habitat and populations historically, more recent land use and environmental factors may be more important to sage-grouse in the future, including natural gas and oil development, invasive species and West Nile virus.

V. Inadequacy of Existing Regulatory Mechanisms

Other commenters (Advocates for the West, Biodiversity Conservation Alliance, Oregon Natural Desert Association, Western Watersheds Project) will submit detailed information on the efficacy of national, state and local sage-grouse conservation plans. Those comments are incorporated here (see also Attachment V describing potential barriers to the success of local working groups created to conserve sage-grouse). Following is a sampling of additional conservation efforts that have failed or may fail to conserve and recover sage-grouse. We also include examples of new federal law, regulations and resource management plans that, applied, may further endanger sage-grouse.

BLM Vegetation Treatments Plan

The BLM produced a set of updated vegetation management plans for BLM lands in 17 states in 2007. The updated plans approve additional herbicide use and mechanical treatments to manage nonnative plants and fire fuel density—primarily in sagebrush steppe. However, after years of public input and analyses, the BLM refused to consider vegetation management that addresses the root causes of the spread of invasive species and fire fuel density. (The BLM specifically stated that it would not address--or even acknowledge--any causes of invasive weed spread in the plans.). The agency also failed to consider conservationists' science-based recommendations to integrate passive restoration with active management to restore weed-invaded sites and reduce fire fuel buildup in community protection zones. Woodward (2006: 65) advised against sagebrush manipulation in sage-grouse range: “some portions of grouse habitat may benefit from management for greater herbaceous cover, but never at the sake of sagebrush.” See attachment VI.

Green River Basin

The BLM noted that the Green River area in Wyoming has “several of the most intact, native ecosystems in the Intermountain West, including sagebrush steppe” (USDI 2007: DH-42). The agency also admits that the area is experiencing “rapid” and “large-scale” energy development and that past conservation and reclamation efforts “have not been well coordinated or considered on a scale best suited to ensuring viable wildlife populations” in the context of energy development (USDI 2007: DH-42). BLM seeks to launch a new effort through the Healthy

Lands Initiative to restore a total of 71,000 acres in the Green River basin (USDI 2007: DH-42). The agency will depend on partners, such as WAFWA, the Wyoming Landscape Conservation Initiative, and the Western Governor's Association to implement restoration programs (USDI 2007: DH-42). Commenters are unaware if this project was funded. Regardless, the small area identified for restoration is unlikely to mitigate for the thousands of acres of sagebrush affected by natural gas and oil development and other land uses in the Green River Basin.

Healthy Lands Initiative

Demonstration projects for the Department of the Interior, Bureau of Land Management's Healthy Lands Initiative (HLI) in Wyoming would do little to mitigate for the impacts of oil and gas drilling on sagebrush steppe in the state. Rather, initial HLI funding is designated for a swan project that the BLM designed a few years ago and has nothing to do with impacts from energy development; an aspen treatment project (that a non-profit organization was originally committed to pay for); and prescribed burns in intact sagebrush habitat with little energy development (N. Straub. "Interior official seeks new balance for wildlife." *Billings Gazette* (May 15, 2007); private communication 3, 2007). It appears that BLM is rushing to "get projects on the ground" to give the perception that BLM is mitigating impacts from energy development, while HLI funds are actually used for other priorities (private communication 3, 2007). The Healthy Lands Initiative may, in fact, be part of a "bait and switch" strategy, wherein habitat improvement projects that have gone unfunded due to reductions in the BLM's wildlife and fisheries program budgets, coupled with the allocation of BLM wildlife staff time to review drilling permit applications, are now being resurrected as components of the HLI.

The Healthy Lands Initiative received limited funding in FY 2007 and FY 2008. The Bureau of Land Management requested \$15 million for the Initiative for FY 2009. Shell Oil Company contributed \$500,000 to the Healthy Lands Initiative to conserve wildlife habitat on approximately 200,000 acres of private lands in southwestern Wyoming. Shell Oil Company. "Shell Contributes \$500,000 to Healthy Lands Initiative" (news release) (July 20, 2007)).

Wyoming Landscape Conservation Initiative

The Wyoming Landscape Conservation Initiative (WLCI) is a multi-agency effort to plan and manage the effects of energy development on habitat and wildlife at a landscape scale in southwest Wyoming (approximately 15 million acres). The WLCI has a similar function as the Jonah Interagency Office (WLCI 2006, concept paper: 3). The WLCI planning area contains the highest density of greater sage-grouse within their range (WLCI 2006, concept paper: 1). The WLCI acknowledges that energy and other development in southwest Wyoming is resulting in "habitat losses, habitat degradation, wildlife avoidance of developing areas, and habitat fragmentation caused from new roads, road traffic, drill pads, drilling rigs, service units, pipelines, power lines, fencing, water pits, water wells, increased human activity, and dust, among other impacts. The result is the long-term loss of wildlife and fisheries habitat quantity and quality" (WLCI 2006, concept paper: 2). But the WLCI lacks long-term funding and may not succeed in preventing further degradation of sagebrush steppe in any case as primary goals for the initiative include "facilitating responsible development" and supporting a "viable livestock industry" (WLCI 2007, factsheet). Further, the WLCI may focus significant

conservation efforts on restoring and conserving riparian habitats, which would be less useful to sage-grouse than protecting large expanses of sagebrush steppe (*see* Pendery 2007, letter: 3)

Executive Order 13422

On January 23, 2007, President Bush amended a previous Executive Order with another Executive Order that requires that each federal agency have a politically appointed regulatory officer to supervise the development of rules and guidance that affect industry (Exec. Order 13422, 72 Fed. Reg. 2763). The new Executive Order requires that federal agencies must identify “the specific market failure” or problem that justifies new government regulation or guidance. This new Executive Order (which took effect July 23, 2007) is viewed as an attempt by the current Administration to interfere with federal agency decisionmaking. (R. Pear. “Bush directive increases sway on regulation.” *New York Times* (Jan. 30, 2007)). One or more political appointees interfered in a previous ESA listing decision for greater sage-grouse (USDI-OIG 2007; WWP v. USFWS 2007; GAO 2008) and it is feared that political appointees may again influence the current listing decision for sage-grouse.

Loss of Wetland Protection

In *Rapanos v. U.S.*, 126 S.Ct. 2208 (2006), the United States Supreme Court held that the Clean Water Act (CWA) only applies to “waters of the United States” that have a “significant nexus” to navigable waters in the U.S. The Court’s finding upheld guidance previously issued by the current Administration to implement the CWA. It is likely that the narrowed definition of waters protected by the CWA will allow for increased development of seeps, springs, and other non-navigable waters in sagebrush steppe that create important, mesic habitats that sage-grouse use in spring and summer.

Industry Circumvention of Greater Sage-Grouse Issues

Special interests have adopted their own, myopic views of the effects of their activities on sage-grouse. In one week in Wyoming, a representative of a rural electric power cooperative dismissed the potential negative impacts of a 135-mile power line on sage-grouse (____. “Final power plant review is Wednesday.” *The News-Record* (Gillette, WY) (Sept. 25, 2007)); a realtor denied the effects of housing and rural development on sagebrush steppe (B. Neary (AP). “Gov eyes housing sprawl.” *Casper Star-Tribune* (Sept. 26, 2007)); and a mining industry representative expressed concerns over the possibility of new restrictions on mining to protect sage-grouse (B. Neary (AP). “Panel: limit development.” *Casper Star-Tribune* (Sept. 25, 2007)). A spokesman for Western Gas Resources argued that research that demonstrated deleterious effects of natural gas development on sage-grouse in Wyoming was not applicable to development in Colorado because “birds in different regions respond differently to gas development.” (B. Johansson. “Study: energy use bad for bird.” *Craig Daily Press* (CO) (Jan. 24, 2006)). The Montana Stockgrowers Association blamed hunting for declining sage-grouse populations in Montana. (B. French. “Cattlemen ask hunters to shoot fewer grouse.” *Billings Gazette* (Sept. 8, 2005)). While a state representative in Utah admitted that oil shale development could disturb public land, he discounted the affected area as “just sagebrush.” (T. Burr. “Huntsman backs oil shale development.” *Salt Lake Tribune* (May 16, 2008)).

VII. Greater Sage-grouse as Umbrella Species for Sagebrush Steppe

Despite its size, the sagebrush steppe is among the most endangered landscapes in North America” (USGS 2005, news release; Noss et al. 1995). Sagebrush steppe has been reduced in area by as much as 50 percent since European settlement (Wisdom et al. 2005b, *citing* Connelly et al. 2004). European inhabitants, in only 150-300 years, “have brought about more profound changes” to sagebrush steppe “than all those of the previous 13,000 years” (West and Young 1999: 259, citing multiple sources). Perhaps no sagebrush steppe remains in “pristine” condition (West 1999a: 109).

More than 350 species (Wisdom et al. 2005a: 21 and App. 2)² — and as many as 630 species (Rich et al. 2005: 590, citing unpublished data) — of plants, mammals, birds, reptiles, amphibians and invertebrates in the Sagebrush Sea are of conservation concern. Approximately 20 percent of native flora and fauna in the Sagebrush Sea are considered imperiled (CSEE 2002).

Greater sage-grouse may be a better umbrella species³ for sagebrush steppe than previously believed: “conservation of Greater and Gunnison Sage-grouse populations in reasonable numbers well distributed across their historical ranges also will provide for the conservation of many, or even most, other bird species that co-occur with these grouse” (Rich et al. 2005: 602). Rowland et al. (2006) also found that greater sage grouse may be a useful, if imperfect, umbrella species for the sagebrush steppe ecosystem, particularly for sagebrush obligate wildlife.

As documented in these comments, and as Rich et al. (2005) note, much is known about sage-grouse. The species’ requirements for lek sites, nesting, brood-rearing, and wintering habitat are reasonably well understood. Detailed recommendations are already available for conserving and restoring sage-grouse habitats—but they have not been widely implemented.

Sage-grouse require large expanses of sagebrush habitat, perhaps as large as 2,500 square miles per population (Rich and Altman 2001), to persist. While protecting sage grouse would also benefit a suite of other species, scientists note that ideal sage grouse habitat is not preferable for every sagebrush species (A. Holmes, PRBO Conservation Science, pers. comm., July 23, 2004; Rich and Altman 2001; Rowland et al. 2006). For example, some species might require different vegetative composition, structure, or succession than sage grouse prefer. This argues for protecting large sagebrush reserves for sage grouse and other species that include a mosaic of different habitats of varying successional stages (although Winter et al. 2006 noted the importance of protecting small habitat patches as well) (*see also* Aldridge et al. 2008).

Listing sage grouse as threatened or endangered would help drive protection of these landscapes, and perhaps prevent other species from being listed. Many of the species that may benefit from sage grouse listing are also in decline (Knick et al. 2003). By listing sage grouse, USFWS would

² Excluding fish and some other taxa.

³ An “umbrella species” is defined as one “whose conservation confers a protective umbrella to numerous co-occurring species” (Fleishman 2001: 1489). Functionally, an umbrella species should have the following characteristics: “they represent other species, their biology is well known, they are easily observed or sampled, they have large home ranges, are migratory, and are persistent” (Rich and Altman 2001: 10).

help protect sagebrush steppe and may avoid having to process other petitions to list sagebrush species. It would also further the purposes of the Endangered Species Act which includes protecting the “ecosystems upon which endangered species and threatened species depend” (16 U.S.C. § 1531(b)).

References

- Adams, B. W., J. Carlson, D. Milner, T. Hood, B. Cairns and P. Herzog. 2004. Beneficial grazing management practices for sage-grouse (*Centrocercus urophasianus*) and ecology of silver sagebrush (*Artemisia cana*) in southeastern Alberta. Technical Report no. T/049. Alberta Sustainable Resource Development, Public Lands and Forest Division; Alberta Conservation Association. Lethbridge, Alberta, Canada.
- Aldridge, C. L. 2005. Habitats for persistence of greater sage-grouse (*Centrocercus urophasianus*) in Alberta, Canada. Ph.D. Diss. University of Alberta. Edmonton, Alberta, Canada.
- Aldridge, C. L. and M. S. Boyce. 2007. Linking occurrence and fitness to persistence: habitat-based approach for endangered greater sage-grouse. *Ecol. Appl.* 17(2): 508-526.
- Aldridge, C. L., S. E. Nielsen, H. L. Beyer, M. S. Boyce, J. W. Connelly, S. T. Knick, M. A. Schroeder. 2008. Range-wide patterns of greater sage-grouse persistence. *Diversity and Distrib.* (in press).
- Allen, E. B. 2003. Restoration of *Artemisia* shrublands invaded by exotic annual *Bromus*: a comparison between southern California and Intermountain region. Pages 9-17 in A. L. Hild, N. L. Shaw, S. E. Meyer, E. W. Schupp, T. Booth (compilers). *Proc. Seed and Soil Dynamics in Shrubland Ecosystems*; Aug. 12-16, 2002; Laramie, WY. *Proc. RMRS-P-31*. USDA-Forest Service, Rocky Mountain Research Station. Ogden, UT.
- Atamian, M. T., J. Sedinger, C. Frey. Undated (2007?). Dynamics of greater sage-grouse (*Centrocercus urophasianus*) populations in response to transmission lines in Central Nevada. Progress report: year 5. Univ. of Nevada-Reno, Dept. Natural Res. and Environ. Sciences. Reno, NV.
- Atamian, M. T. 2007. Brood ecology and sex ratio of greater sage-grouse in east-central Nevada. M.S. thesis. Univ. Nevada-Reno. Reno, NV.
- Barton, D. C. and A. L. Holmes. 2007. Off-highway vehicle trail impacts on breeding songbirds in northeastern California. *J. Wildl. Manage.* 71(5): 1617-1620.
- Barnett, J. F. and J. A. Crawford. 1994. Pre-laying nutrition of sage-grouse hens in Oregon. *J. Range Manage.* 47: 114-118.
- Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, et al. 2008. Human-induced changes in the hydrology of the western United States. *ScienceExpress* (Jan. 31, 2008).

Beck, J. L. and D. L. Mitchell. 2000. Influences of livestock grazing on sage grouse habitat. *Wildl. Soc. Bull.* 28(4): 993-1002.

Beck, J. L., K. P. Reese, J. W. Connelly, M. B. Lucia. 2006. Movements and survival of juvenile greater sage-grouse in southeastern Idaho. *Wildl. Soc. Bull.* 34(4): 1070-1078.

BLM (Bureau of Land Management). Undated. "The Open Space Agency" (copy on file with WildEarth Guardians, Sagebrush Sea Campaign).

BLM (Bureau of Land Management). 2002. BLM Director, memorandum to All Field Officials, "Interim Wind Energy Development Policy." Instruction Memorandum no. 2003-020. Bureau of Land Management. Washington, DC. (Oct. 16, 2002).

BLM (Bureau of Land Management). 2004. National Sage-Grouse Habitat Conservation Strategy. 1.4.1 Guidance for the Management of Sagebrush Plant Communities for Sage-Grouse Conservation. U.S. Dept. of the Interior, Bureau of Land Management. (November 2004).

BLM (Bureau of Land Management). 2005a. Final Programmatic Environmental Impact Statement on Wind Energy Development on BLM-Administered Lands in the Western United States. FES 05-11. U.S. Dept. of the Interior, Bureau of Land Management. (June 2005).

BLM (Bureau of Land Management). 2005b. Public Rewards from Public Lands 2004-2005. Bureau of Land Management (viewed Apr. 18, 2007; available at www.blm.gov/nhp/browse.htm).

BLM (Bureau of Land Management). 2006a. Draft Supplement to the Montana Statewide Oil and Gas Environmental Impact Statement and Amendment of the Powder River and Billings Resource Management Plans. Vol. I. Bureau of Land Management, Miles City Field Office. Miles City, MT. (Dec. 13, 2006).

BLM (Bureau of Land Management). 2006b. Draft Supplement to the Montana Statewide Oil and Gas Environmental Impact Statement and Amendment of the Powder River and Billings Resource Management Plans. Vol. II. Bureau of Land Management, Miles City Field Office. Miles City, MT. (Dec. 13, 2006).

BLM (Bureau of Land Management). 2007. Final Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report. Bureau of Land Management, Nevada State Office. Reno, NV. (June 2007).

BLM, Pinedale Field Office. 2008. 2007-2008 Wildlife Exceptions (updated June 5, 2008) (viewed June 15, 2008; available at www.wy.blm.gov/pfo/wildlife/exceptions.php).

BLM, Rawlins Field Office. 2008. 2007-2008 Wildlife Exceptions, Waivers & Modifications (updated May 28, 2008) (viewed June 15, 2008; available at www.wy.blm.gov/rfo/wildlife/exceptions.php).

BLM, Rock Springs Field Office. 2005. Finding of No Significant Impact and Decision Record for the Dickie Springs Placer Gold Exploration Project. Bureau of Land Management, Rock Springs Field Office. Rock Springs, WY. (September 2005).

Blumenthal, D. M., U. Norton, J. D. Derner, J. D. Reeder. 2006. Long-term effects of tebuthiuron on *Bromus tectorum*. W. North Amer. Natur. 66(4): 420-425.

Braun, C. E. 2006. A blueprint for sage-grouse conservation and recovery. Unpublished report. Grouse, Inc. Tucson, AZ.

Brown, R. M. and D. N. Laband. 2007. Species imperilment and spatial patterns of development in the United States. Cons. Biol. 20(1): 239-244.

Chambers, J. C. 2008a. Fire and the Great Basin. Pages 33-37 *in* J. C. Chambers, N. Devoe, and A. Evenden (eds.). Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Chambers, J. C. 2008b. Climate change and the Great Basin. Pages 29-32 *in* J. C. Chambers, N. Devoe, and A. Evenden (eds.). Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer, A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? Ecol. Monogr. 77(1): 117-145.

Chambers, J. C., N. Devoe, A. Evenden (eds.). 2008. Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action: Introduction. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Clark, L., J. Hall, R. McLean, M. Dunbar, et al. 2006. Susceptibility of greater sage-grouse to experimental infection with West Nile virus. J. Wildl. Diseases 42(1): 14-22.

Coates, P. S. 2007. Greater sage-grouse (*Centrocercus urophasianus*) nest predation and incubation behavior. Ph.D. Diss. Idaho State Univ. Pocatello, ID.

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

Connelly, J. W., C. E. Braun, M. A. Schroeder, C. A. Hagen. 2007. Setting the record straight: a response to “Sage-Grouse at the Crossroads.” Rangelands 29(6): 35-39.

Connelly, J. W., K. P. Reese, E. O. Garton, M. L. Commons-Kemner. 2003. Response of greater sage grouse *Centrocercus urophasianus* populations to different levels of exploitation in Idaho, USA. *Wildl. Biol.* 9(4): 255-261.

Connelly, J. W., M. A. Schroeder, A. R. Sands, C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. *Wildl. Soc. Bull.* 28(4): 967-985.

Connelly, J. W., S. T. Knick, M. A. Schroeder, S. J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, WY. (July 22, 2004).

Crockett, A. B. 2007. Letter to operators, re: "Revisions to BLM Energy Office Revegetation Requirements." (Apr. 16, 2007). (Allen Crockett, Ph.D., J.D., is Supervisory Natural Resource Specialist for the BLM Glenwood Springs Energy Office Pendency).

CSEE (Center for Science, Economics and Environment). 2002. *THE STATE OF THE NATION'S ECOSYSTEMS: MEASURING THE LANDS, WATERS, AND LIVING RESOURCES OF THE UNITED STATES*. Cambridge University Press. Cambridge, United Kingdom.

Cubashi, U., G. A. Meehl, G. J. Boer. 2001. Projections of future climate change. Pages 525-582 *in* J. T. Houghton and Y. Ding, et al. (eds.). *Climate Change 2001: The Scientific Basis. Contribution of the Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. Cambridge, United Kingdom.

Danvir, R. E. 2002. Sage grouse ecology and management in northern Utah sagebrush-steppe. *Deseret Land and Livestock Wildlife Research Report*. Unpublished report. Deseret Land and Livestock Ranch; Foundation for Quality Resource Management.

Deacon, J. E., A. E. Williams, C. D. Williams, J. E. Williams. 2007. Fueling population growth in Las Vegas: how large-scale groundwater withdrawal could burn regional biodiversity. *BioScience* 57(8): 688-698.

Devoe, N. 2008. Energy development in the Great Basin. Pages 24-28 *in* J. C. Chambers, N. Devoe, and A. Evenden (eds.). *Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action*. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

Deines, L., R. Rosentreter, D. J. Eldridge, M. D. Serpe. 2007. Germination and seeding establishment of two annual grasses on lichen-dominated biological soil crusts. *Plant and Soil* 295(1-2): 23-35.

Dierauf, L. 2006. "West Nile Virus in Greater Sage-grouse." *Wildlife Health Bull.* 06-08. U.S. Geological Survey, National Wildlife Health Center. Madison, WI. (Nov. 6, 2006).

DOE/USDI (U.S. Dept. of Energy/U.S. Dept. of Interior). 2007. Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal land in the 11 Western States.

Vols. 1-3. DOE/EIS-0386. U.S. Dept. of Energy; U.S. Dept. of Interior, Bureau of Land Management. (October 2007).

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. M.S. thesis. Montana State University. Bozeman, MT.

Doherty, K. E., D. E. Naugle, B. L. Walker, J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. *J. Wildl. Manage.* 72(1): 187-195.

Fleishman, E., R. B. Blair, D. D. Murphy. 2001. Empirical validation of a method for umbrella species selection. *Ecol. Appl.* 11(5): 1489-1501.

Frankham, R., J. D. Ballou, D. A. Briscoe. 2002. *INTRODUCTION TO CONSERVATION GENETICS*. Cambridge University Press. Cambridge, United Kingdom.

GAO (Government Accountability Office). 2005. Oil and gas development: increased permitting activity has lessened BLM's ability to meet its environmental protection responsibilities. GAO-05-418. Government Accountability Office. Washington, DC.

GAO (Government Accountability Office). 2006. Wildland fire rehabilitation and restoration: Forest Service and BLM could benefit from improved information on status of needed work. GAO-06-670. Government Accountability Office. Washington, DC. (June 2006).

GAO (Government Accountability Office). 2007. Climate change: agencies should develop guidance for addressing the effects on federal land and water resources. GAO-07-863. Government Accountability Office. Washington, DC. (August 2007).

GAO (Government Accountability Office). 2008. U.S. Fish and Wildlife Service: Endangered Species Act Decision Making. Statement of Robin M. Nazzaro, Director, Natural Resources and Environment; Testimony before the Committee on Natural Resources, House of Representatives. Government Accountability Office. Washington, DC. (May 21, 2008).

Hagen, C. A., J. W. Connelly, M. A. Schroeder. 2007. A meta-analysis of greater sage-grouse *Centrocercus urophasianus* nesting and brood-rearing habitats. *Wildl. Biol.* 13 (Suppl. 1): 42-50.

Hanley, T. A. 1979. Application of an herbivore-plant model to rest-rotation grazing management on shrub-steppe ranges. *J. Range Manage.* 32: 115-118.

Harmata, A. Email to Larry Rau, re. "SAGR threats." (May 3, 2000). Received from BLM, Montana State Office on Nov. 5, 2000 in response to FOIA request.

Hausleitner, D., K. P. Reese, A. D. Apa. 2005. Timing of vegetation sampling at greater sage-grouse nests. *Rangeland Ecol. & Manage.* 58(5): 553-556.

- Hays, D. W., M. J. Tirhi, D. W. Stinson. 1998. Washington state status report for the sage-grouse. Washington Dept. of Fish and Wildlife. Olympia, WA.
- Hempy-Mayer, Kara and D. A. Pyke. 2008. Defoliation effects on *Bromus tectorum* seed production: implications for grazing. *Rangeland Ecol. Manage.* 61(1): 116-123.
- Hemstrom, M. A., M. J. Wisdom, M. M. Rowland, B. Wales, W. J. Hann, R. A. Gravenmier. 2002. Sagebrush-steppe vegetation dynamics and potential for restoration in the Interior Columbia Basin, USA. *Cons. Biol.* 16: 1243-1255.
- Hoffman, R. W. and A. E. Thomas. 2007. Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*): A technical conservation assessment. USDA-Forest Service, Rocky Mountain Region, Species Conservation Project. (Aug. 17, 2007).
- Holechek, J. L., H. Gomez, F. Molinar, D. Galt. 1999. Grazing studies: what we've learned. *Rangelands* 21(2): 12-16.
- Holloran, M. J. 2005. Greater sage-grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Ph.D. Diss. Univ. 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. J. Heath, A. G. Lyon, S. J. Slater, et al. 2005. Greater sage-grouse nesting habitat selection and success in Wyoming. *J. Wildl. Manage.* 69(2): 638-649.
- Hudak, M. 2007. WESTERN TURF WARS: THE POLITICS OF PUBLIC LANDS RANCHING. Biome Books. Binghamton, NY.
- Ingelfinger, F. and S. Anderson. 2004. Passerine response to roads associated with natural gas extraction in a sagebrush steppe habitat. *W. North Amer. Natur.* 64(3): 385-395.
- INL-ESERP (Environmental Surveillance Education Program). Undated. "Cheatgrass at the INL" (webpage). S. M. Stoller Corp. Broomfield, CO. (viewed Sept. 7, 2007; available at www.stoller-eser.com/cheatgrass.htm).
- Jensen, K. C. 2007. "Sage Grouse Update" (electronic mail). (Sept. 10, 2007). (Kent Jenson, Ph.D., is Associate Professor, Department of Wildlife and Fisheries Sciences, South Dakota State University).
- Jones, A. 2000. Effects of cattle grazing on North American arid ecosystems: a quantitative review. *W. North American Natur.* 60(2): 155-164.
- Kaiser, R. C. 2006. Recruitment by greater sage-grouse in association with natural gas development in western Wyoming. M.S. thesis. University of Wyoming. Laramie. WY.

- Kilpatrick, A. M., S. L. LaDeau, P. P. Marra. 2007. Ecology of West Nile virus transmission and its impact on birds in the western hemisphere. *Auk* 124(4): 1121-1136.
- Kerr, A. and M. Salvo. 2007. Managing western juniper to restore sagebrush steppe and quaking aspen stands. Unpublished report. Sagebrush Sea Campaign. Chandler, AZ (available at www.sagebrushsea.org/threat_juniper_invasion.htm).
- Knick, S. T. and J. T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. *Cons. Biol.* 9(5): 1059-1071.
- Knick, S. T., A. L. Holmes, R. F. Miller. 2005. The role of fire in structuring sagebrush habitats and bird communities. Pages 63-75 in V. A. Saab and H. D. W. Powell (eds.). *FIRE AND AVIAN ECOLOGY IN NORTH AMERICA*. Studies in Avian Biology, no. 30. Cooper Ornithological Society. Boise, ID.
- Knick, S. T., D. S. Dobkin, J. T. Rotenberry, et al. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. *Condor* 105(4): 611-634.
- Kuipers, J. L. 2004. Grazing system and linear corridor influences on greater sage-grouse (*Centrocercus urophasianus*) habitat selection and productivity. M.S. thesis. University of Wyoming. Laramie, WY.
- Lupis, S. G., T. A. Messmer, T. Black. 2006. Gunnison sage-grouse use of Conservation Reserve Program fields in Utah and response to emergency grazing: a preliminary evaluation. *Wildl. Soc'y Bull.* 34(4): 957-962.
- Mack, R. N. and J. N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. *Amer. Natur.* 119(6): 757-773.
- Manier, D. J. and N. T. Hobbs. 2006. Large herbivores influence the composition and diversity of shrub-steppe communities in the Rocky Mountains, USA. *Oecologia* 146(4): 641-651.
- Manville, A. M. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. U.S. Fish and Wildlife Service, Division of Migratory Bird Management. Arlington, VA. (peer-reviewed briefing paper).
- Marshall, D. B., M. Chilcote, H. Weeks. 1996. Species at risk: sensitive, threatened, and endangered vertebrates of Oregon. Oregon Dept. of Fish and Wildlife. Portland, OR.
- McAdoo, K., B. Shultz, S. Swanson, R. Orr. Undated. "Northeastern Nevada Wildfires 2006, Part 2 – Can Livestock Grazing be Used to Reduce Wildfires?" (factsheet). Fact Sheet-07-21. University of Nevada Cooperative Extension.

- McKenzie, D., Z. Gedalof, D. L. Peterson, P. Mote. 2003. Climate change, wildfire and conservation. *Cons. Biol.* 18(4): 890-902.
- Mezquida, E. T., S. J. Slater, C. W. Benkman. 2006. Sage-grouse and indirect interactions: potential implications of coyote control on sage-grouse populations. *Condor* 108: 747-759.
- Miller, R. F. J. D. Bates, T. J. Svejcar, F. B. Pierson, L. E. Eddleman. 2005. Biology, Ecology and Management of Western Juniper. Tech. Bull. 152. Oregon State University., Agricultural Exp. Stn. (June 2005).
- Mills, L. S., J. M. Scott, K. M. Strickler, S. A. Temple. 2005. Ecology and management of small populations. Pages 691-713 *in* C. E. Braun (ed.). 2005. *TECHNIQUES FOR WILDLIFE INVESTIGATIONS AND MANAGEMENT*. Sixth ed. The Wildlife Society. Bethesda, Md.
- Morgan, J. A., D. G. Milchunas, D. R. LeCain, M. West, A. R. Mosier. 2007. Carbon dioxide enrichment alters plant community structure and accelerates shrub growth in the shortgrass steppe. *Proc. Nat'l Acad. Sci.* 104(37): 14724-14729.
- Moynahan, B. J., M. S. Lindberg, J. J. Rotella, J. W. Thomas. 2007. Factors affecting nest survival of greater sage-grouse in northcentral Montana. *J. Wildl. Manage.* 71(6): 1773-1783.
- Moynahan, B. J., M. S. Lindberg, J. W. Thomas. 2006. Factors contributing to process variance in annual survival of female greater sage-grouse in Montana. *Ecol. Appl.* 16(4): 1529-1538.
- Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, et al. 2005. West Nile virus and sage-grouse; what more have we learned? *Wildl. Soc'y Bull.* 33(2): 616-623.
- Naugle, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, et al. 2004. West Nile virus: pending crisis for greater sage-grouse. *Ecol. Letters* 7: 707-713.
- Naugle, D. E., K. E. Doherty, B. L. Walker. 2006. Sage-grouse winter habitat selection and energy development in the Powder River Basin: completion report. Univ. Montana, College of Forestry and Conservation, Wildlife Biology Program. Missoula, MT. (June 24, 2006).
- Neilson, R. P., J. M. Lenihan, D. Bachelet, R. J. Drapek. 2005. Climate change implications for sagebrush ecosystems. *Trans. N. Amer. Wildl. & Nat. Res. Conf.* 70: 145-159.
- NMFS (National Marine Fisheries Service). 2007. Biological Opinion: Bureau of Land Management, Proposed Vegetation Treatment Program for 17 Western States. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. (June 26, 2007).
- Noson, A. C., R. A. Schmitz, R. F. Miller. 2006. Influence of fire and juniper encroachment on birds in high-elevation sagebrush steppe. *W. North Amer. Natur.* 66(3): 243-253.

- Noss, R. F., E. T. LaRoe, J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. Biological Report 28. National Biological Service. Washington, DC.
- Oyler-McCance, S. J., J. St. John, S. E. Taylor, A. D. Apa, T. W. Quinn. 2005. Population genetics of Gunnison sage-grouse: implications for management. *J. Wildl. Manage.* 69(2): 630-637.
- Pederson, E. K., J. W. Connelly, J. R. Hendrickson, W. E. Grant. 2003. Effect of sheep grazing and fire on sage grouse populations in southeastern Idaho. *Ecol. Model.* 165(1): 23-47.
- Pendery, B. 2007. Letter to D. Simpson, Wyoming State Office, Bureau of Land Management, re: "Wyoming Landscape Conservation Initiative." (Feb. 27, 2007). (Bruce Pendery, Esq., is Program Director for Wyoming Outdoor Council).
- Peters, W., A. R. Jacobson, C. Sweeney, A. E. Andrews, et al. 2007. An atmospheric perspective on North American carbon dioxide exchange: CarbonTracker. *Proc. Nat'l Academy Sciences* 104(48): 18925-18930.
- Ponzetti, J. M., B. McCune, D. A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. *The Bryologist* 110(4): 706-722.
- Raupach, M. R., G. Marland, P. Ciais, C. Le Quéré, J. G. Canadell, G. Klepper, C. B. Field. 2007. Global and regional drivers of accelerating CO₂ emissions. *Proc. Nat'l Academy Sciences* (Early Edition) (published online May 22, 2007; doi: 10.1073/pnas.0700609104).
- Rebholz, J. L. 2007. Influence of habitat characteristics on greater sage-grouse reproductive success in the Montana Mountains, Nevada. M.S. thesis. Oregon State University. Corvallis, OR.
- Remington, T. E., and C. E. Braun. 1991. How surface coal mining affects sage grouse, North Park, Colorado. *Proc. Issues and Technology in the Management of Impacted Western Wildlife* (Thorne Ecol. Inst.) 5: 128-132.
- Rich, T. 1985. Sage grouse population fluctuations: evidence for a 10-year cycle. *Tech. Bull.* 85-1. Bureau of Land Management, Idaho State Office. Boise, ID.
- Rich, T. and B. Altman. 2001. Under the sage umbrella: will management for sage grouse protect other birds and animals in the sagebrush steppe? *Bird Conservation* 14: 10.
- Rich, T. D., M. J. Wisdom, V. A. Saab. 2005. Conservation priority birds in sagebrush ecosystems. Pages 589-606 in *BIRD CONSERVATION IMPLEMENTATION AND INTEGRATION IN THE AMERICAS: PROC. THIRD INT'L PARTNERS IN FLIGHT CONF.*; Mar. 20-24, 2002; Asilomar, CA. Gen. Tech. Rep. PSW-191. USDA-Forest Service, Pacific Southwest Research Station. Albany, CA. (June 2005).

Schaefer, D. H. and J. R. Harrill. 1995. Simulated effects of proposed ground-water pumping in 17 basins of east-central and southern Nevada. Water Res. Investigations Rpt. 95-4173. U.S. Geol. Surv. Carson City, NV.

Schroeder, M. A. and W. M. Vander Haegen. 2007. Use of Conservation Reserve Program fields by greater sage-grouse and other shrubsteppe-associated wildlife in Washington state. Final report to U.S. Dept. of Agriculture, Farm Service Agency. Washington Dept. of Fish and Wildlife. Olympia, WA. (October 2006).

Schroeder, M. A., D. W. Hays, M. A. Murphy, D. J. Pierce. 2000. Changes in the distribution and abundance of Columbian sharp-tailed grouse in Washington. *Northwestern Natur.* 81: 95-103.

Schlyer, K. 2007. Gambling on the water table: the high-stakes implications of the Las Vegas pipeline for plants, animals, places and people. *Defenders of Wildlife*. Washington, DC.

Serpe, M. D., J. M. Orm, T. Barkes, R. Rosentreter. 2006. Germination and seed water status of four grasses on moss-dominated biological soil crusts from arid lands. *Plant Ecol.* 185: 163-178.

Shinneman, D. J., W. L. Baker, P. Lyon. 2008. Ecological restoration needs derived from reference conditions for a semi-arid landscape in Western Colorado, USA. *J. Arid Environ.* 72(3): 207-227.

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(3): 310-320.

Smith, S. D., T. E. Huxman, S. F. Zitzer, T. N. Charlet, D. C. Housman, J. S. Coleman, L. K. Fenstermaker, J. R. Seemann, R. S. Nowak. 2000. Elevated CO₂ increases productivity and invasive species success in an arid ecosystem. *Nature* 408 (6808): 79-82.

Suring, L. H., M. J. Wisdom, R. J. Tausch, R. F. Miller, M. M. Rowland, L. Schueck, C. W. Meinke. 2005. Modeling threats to sagebrush and other shrubland communities. Chap. 4 in part II: Regional assessment of habitats for species of conservation concern in the Great Basin. Pages 114-149 in M. J. Wisdom, M. M. Rowland, L. H. Suring (eds.). *HABITAT THREATS IN THE SAGEBRUSH ECOSYSTEM: METHODS OF REGIONAL ASSESSMENT AND APPLICATIONS IN THE GREAT BASIN*. Alliance Communications Group. Lawrence, KS.

Thines, N. J. S., L. A. Shipley, R. D. Saylor. 2004. Effects of cattle grazing on ecology and habitat of Columbia Basin pygmy rabbits (*Brachylagus idahoensis*). *Biol. Cons.* 119: 525-534.

Thompson, K. M., M. J. Holloran, S. J. Slater, J. L. Kuipers, S. H. Anderson. 2006a. Early brood-rearing habitat use and productivity of greater sage-grouse in Wyoming. *W. North Amer. Natur.* 66(3): 332-342.

Thompson, T. W., B. A. Roundy, E. D. McArthur, B. D. Jessop, B. Waldron, J. N. Davis. 2006b. Fire rehabilitation using native and introduced species: a landscape trial. *Rangeland Ecol. & Manage.* 59(3): 237-248.

Torregrosa, A. and N. Devoe. 2008. Pages 9-13 *in* J. C. Chambers, N. Devoe, and A. Evenden (eds.). Collaborative Management and Research in the Great Basin—Examining the Issues and Developing a Framework for Action. Gen. Tech. Rep. RMRS-GTR-204. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.

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

Trall, L.; B. W. Brook, C. J. A. Bradshaw (contributing authors); M. McGinley (ed.). 2007. Minimum viable population size *in* C. J. Cleveland (ed.). Encyclopedia of Earth. Environmental Information Coalition, National Council for Science and the Environment. Washington, DC. (last revised Dec. 20, 2007; retrieved June 5, 2008; available at www.eoearth.org/article/Minimum_viable_population_size).

van Kooten, G. C., A. J. Eagle, M. E. Eiswerth. 2007. Determinants of threatened sage grouse in Northeastern Nevada. *Human Dimensions of Wildlife* 12: 53-70.

USDI (U.S. Dept. of the Interior). 2007. Fiscal Year 2008: The Interior Budget in Brief. U.S. Dept. of the Interior. Washington, DC. (February 2007).

USDI-OIG (USDI-Office of Inspector General). 2007. Report on Investigation on Julie MacDonald, Deputy Assistant Secretary, Fish, Wildlife and Parks. U.S. Dept. of the Interior, Office of the Inspector General. (E. E. Devaney, Inspector General).

USGS (U.S. Geological Survey). “State and Federal Partnership Forms to Restore Great Basin Rangelands” (Nov. 8, 2005) (news release). U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis Research Group. Corvallis, OR.

Vavra, M. 2005. Livestock grazing and wildlife: developing compatibilities. *Rangeland Ecol. Manage.* 58(2): 128-134.

Walker, B. L., D. E. Naugle, K. E. Doherty. 2007a. Greater sage-grouse population response to energy development and habitat loss. *J. Wildl. Manage.* 71(8): 2644-2654.

Walker, B. L., D. E. Naugle, K. E. Doherty, T. E. Cornish. 2004. From the field: Outbreak of West Nile virus in greater-sage grouse and guidelines for monitoring, handling, and submitting dead birds. *Wildl. Soc’y Bull.* 32(3): 1000-1006.

Walker, B. L., D. E. Naugle, K. E. Doherty, T. E. Cornish. 2007b. West Nile virus and greater sage-grouse: estimating infection rate in a wild bird population. *Avian Diseases* 51: 691-696.

- Walsberg, G. M. 2005. Cattle grazing in a national forest greatly reduces nesting success in a ground-nesting sparrow. *Condor* 107(3): 714-716.
- Welch, B. L. 2005. Big sagebrush: a sea fragmented into lakes, ponds, and puddles. Gen. Tech Rep. RMRS-GTR-144. USDA-Forest Service, Rocky Mountain Research Station. Fort Collins, CO.
- West, N. E. 1999a. Managing for biodiversity of rangelands. Pages 101-126 *in* W. W. Collins and C. O. Qualset (eds.). BIODIVERSITY IN AGROECOSYSTEMS. CRC Press. Boca Raton, FL.
- West, N. E. 1999b. Synecology and disturbance regimes of sagebrush steppe ecosystems. Pages 15-16 *in* P. G. Entwistle, A. M. Debolt, J. H. Kaltenecker, K. Steenhof (compilers). Proc. Sagebrush Steppe Ecosystems Symposium; June 21-23, 1999; Boise State University, Boise, ID. Publ. no. BLM/ID/PT-0001001+1150. Bureau of Land Management. Boise, ID.
- West, N. E. and J. A. Young. 1999. Intermountain valleys and lower mountain slopes. Pages 256-284 *in* M. G. Barbour and W. D. Bilings (eds.). NORTH AMERICAN TERRESTRIAL VEGETATION. 2nd edition. Cambridge University Press. New York, NY.
- Winter, M., D. H. Johnson, J. A. Shaffer. 2006. Does body size affect a bird's sensitivity to patch size and landscape structure? *Condor* 108(4): 808-816.
- Wolfe, D. H., M. A. Patten, E. Shochat, C. L. Pruett, S. K. Sherrod. 2007. Causes and patterns of mortality in lesser prairie-chickens *Tympanuchus pallidicinctus* and implications for management. *Wildl. Biol.* 13 (Suppl. 1): 95-104.
- WGA (Western Governors' Association). 2007. Clean energy, a strong economy and a healthy environment. Western Governor's Association Clean and Diversified Energy Initiative 2005-2007 Progress Report. Unpublished report. Western Governor's Association. Denver, CO. (June 2007).
- WRA (Western Resource Advocates). 2007. Major Multi-state Power Lines Proposals in the 11 Western United States. Unpublished data. (December 2007).
- The Wilderness Society. Undated. Preliminary Analysis of Current Federal Actions Authorizing Drilling of New Wells (updated August 2007). The Wilderness Society BLM Action Center.
- Wisdom, M. J., M. M. Rowland, B. C. Wales, M. A. Hemstrom, W. J. Hann, M. G. Raphael, R. S. Holthausen, R. A. Gravenmier, T. D. Rich. 2002. Modeled effects of sagebrush-steppe restoration on greater sage-grouse in the Interior Columbia Basin, U.S.A. *Cons. Biol.* 16 (5): 1223-1231.
- Wisdom, M. J., M. M. Rowland, L. H. Suring, L. Schueck, C. W. Meinke, S. T. Knick. 2005a. Evaluating species of conservation concern at regional scales. Chap. 1 in part I: Methods of regional assessment for sagebrush-associated species of conservation concern. Pages 5-74 *in* M.

J. Wisdom, M. M. Rowland, L. H. Suring (eds.). HABITAT THREATS IN THE SAGEBRUSH ECOSYSTEM: METHODS OF REGIONAL ASSESSMENT AND APPLICATIONS IN THE GREAT BASIN. Alliance Communications Group. Lawrence, KS.

Wisdom, M. J., M. M. Rowland, R. J. Tausch. 2005b. Effective management strategies for sage-grouse and sagebrush: a question of triage? *Trans. N. Amer. Wildl. & Nat. Res. Conf.* 70: 206-227.

WLCI (Wyoming Landscape Conservation Initiative). "Wyoming Landscape Conservation Initiative" (factsheet). (Jan. 18, 2007) (viewed Apr. 17, 2007; available at www.wlci.gov/docs/WLCI_Factsheet.pdf).

WLCI (Wyoming Landscape Conservation Initiative). "Wyoming Landscape Conservation Initiative: Concept Paper." (Nov. 28, 2006) (viewed Apr. 17, 2006; available at www.wlci.gov/docs/WLCI_ConceptPaper.pdf).

WORC (Western Organization of Resource Councils). 2005. Law and order in the gas fields: a review of inspection and enforcement programs in five western states. Western Organization of Resource Councils. Billings, MT.

WWC Engineering. 2007. Maysdorf Coal Lease Application Final Environmental Impact Statement. Bureau of Land Management, Casper Field Office. Casper, WY; Wyoming Dept. of Environmental Quality, Land Quality Division. Cheyenne, WY. (April 2007).

(WWP v. USFWS) Western Watersheds Project v. U.S. Fish and Wildlife Service, Case No. CV-06-277-E-BLW (2007). Memorandum Decision, U.S. District Court of Idaho (available at www.sagebrushsea.org/pdf/Greater_Sage-Grouse_SJ_Decision.pdf).

Wyo. Dept. Fish & Game (Wyoming Department of Fish and Game). 2006. Wyoming Sage-Grouse Database (updated 2006). Data provided by B. Walker.

Young, J. A. and C. D. Clements. 2007. Cheatgrass and grazing rangelands. *Rangelands* 29(6): 15-20.

Zou, L., S. N. Miller, E. T. Schmidtman. 2006. Mosquito larval habitat mapping using remote sensing and GIS: implications of coalbed methane development and West Nile virus. *J. Medical Entomology* 43(5): 1034-1041.