Oil and Gas Development in Western North America: Effects on Sagebrush Steppe Avifauna with Particular Emphasis on Sage-grouse

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Sagebrush (*Artemisia* spp.) steppe was once a dominant feature of the landscape in western North America covering at least 243 million acres (60 million ha) (Beetle 1960, Vale 1975) in 16 states and 3 provinces. Most of this vast expanse has been altered by human activity. Estimates of complete loss of sagebrush-dominated areas exceed 50 % (Schneegas 1967, Braun et al. 1976, Braun 1998). The remaining sagebrush steppe has been markedly altered through treatments to benefit livestock grazing including livestock grazing as a treatment, fragmentation (roads, power lines and other structures, pipelines, reservoirs, fences, etc.), and degradation (Braun 1998). More recently, urban expansion as well as development of housing scattered through large tracts has impacted wildlife use of sagebrush habitats (Braun 1998).

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While the sagebrush steppe is seasonally host to a large number of avian species (Braun et al 1976, Paige and Ritter 1999), only 5 species (Gunnison and Northern sage-grouse [*Centrocercus minimus, C. urophasianus*], sage thrasher [*Oreoscoptes montanus*], sage sparrow [*Amphispiza belli*], Brewer's sparrow [*Spizella breweri*]) are truly sagebrush obligates (Braun et al. 1976). However, at the grassland or shrub steppe interfaces with sagebrush-dominated areas, other species such as Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), mountain plover (*Charadrius montanus*), and burrowing owl (*Athene cunicularia*) were locally abundant. All of these species are now known or thought to be declining in distribution and abundance.

Oil and gas developments and their attendant structures including power lines, roads, and collection stations are not recent additions to western North America with some activity dating to the late 1800's. Exploration and development activity has tended to be cyclical depending on apparent needs, extraction costs, and price (per barrel or cubic foot). In the 1970's and early 1980's, the interest was in development of oil shale. In the early and mid 1980's, the emphasis was in the Rocky Mountain Overthrust Belt. Today, interest in oil and gas development is everywhere in the West where reserves are thought to be present. Nowhere is this more apparent than in development of coal-bed methane, especially in the area near Gillette, Wyoming. Because of the interest in rapid expansion and development of oil and gas reserves, this paper examines what is known about the effects of energy exploitation on sagebrush steppe dependent avian species and what might be logically expected during and after exploration, facilities development, and extraction. Case history examples are provided from Alberta, Colorado, and

Wyoming.

What Is Known

A relatively large body of literature exists for game species such as sage-grouse (summarized by Connelly et al. 2000) and Columbian sharp-tailed grouse (reviewed by Giesen and Connelly 1993). Reasonable information is available for passerine species breeding in sagebrush steppe and it is known that presence of sagebrush (Feist 1968; Best 1972; Schroeder and Sturges 1975; Reynolds and Rich 1978; Rich 1978, 1980; Reynolds 1981; Peterson and Best 1985a, b, 1987) and patch size (Rotenberry and Wiens 1980; Wiens and Rotenberry 1981, 1985; Wiens et al. 1987; Knick and Rotenberry 1995, Aldridge and Brigham 2002) are important for all sagebrush obligates. Relatively little is known about the effects of habitat alteration on other species such as burrowing owls and mountain plover, which seasonally occupy the interface of sagebrush steppe and grasslands. It is known that burrowing owls are negatively impacted by plowing, reseeding, and other disturbances in breeding areas (Rich 1986, Haug et al. 1993). Plowing of native habitats and reseeding with taller grasses is also negative for mountain plovers and restrictions have been placed on oil and gas exploration in key breeding areas in Colorado, Montana, and Wyoming (Knopf 1996).

Review of the available information suggests that habitat alteration that removes live sagebrush and reduces patch size is negative for all sagebrush obligates, specifically sage-grouse, sage sparrow, sage thrasher, and Brewer's sparrow. Plowing of native habitats is also negative for burrowing owls and mountain plovers. Columbian (and other subspecies) sharp-tailed grouse are less impacted as they can positively respond to some altered habitats, provided that native shrub habitats useful in winter remain available.

Thus, sharp-tailed grouse have the best potential to maintain their distribution and abundance with changes in habitat use and disturbance.

Oil and Gas Developments and Sage-grouse

Alberta

Sage-grouse were historically abundant across southeastern Alberta, occupying as much as 18,920 mi² (49,000 km^2) in the early 1900's (Aldridge 2000). However, the current distribution of sage-grouse has been reduced to ~ 1,544 mi² (4,000 km^2), less than 10% of their historic range. Sage-grouse population data exist for the currently occupied area; however, lek counts only began in 1968 and were conducted sporadically prior to the 1990's. Thus, direct comparisons and cause and effect studies are not possible, but the available data are compelling.

Records of oil and gas developments are incomplete and difficult to obtain, but the earliest records suggest that exploration for gas began as early as 1940. The oil boom of the mid 1980's resulted in intensive oil extraction activities in southern Alberta. Over this time, the number of male sage-grouse displaying at lek sites decreased from as many as 524 males prior to the oil boom, to between 200 and 300 during and afterwards (Aldridge 2000). Similar correlations were seen in the early 1990's, with a resurgence of development activity in the heart of sage-grouse habitat (Manyberries Oil Field). Number of male sage-grouse counted in Alberta fell to the lowest known level with only 70 males counted in 1994 (Aldridge 2000). Direct disturbances (development of road or well sites) within ~ 220 yds (200 m) of three different lek complexes were noted between 1983 and 1985. None of these leks has been active since the disturbance. At that same time, drilling activities occurred within view of a fourth lek complex and the two lek satellites

were reduced to one smaller lek. This site has since been reclaimed, but numbers have never recovered. Two additional known lek sites were directly disturbed at some unknown time in the past; one is now a reclaimed well site and the second was seeded to tame grass (it most likely is also a reclaimed well site). Neither of these leks has been active for at least 10 years.

To date, approximately 1,500 wells have been drilled within the current range of sage-grouse in Alberta. It is estimated that 575 wells are still producing. Thus, there are approximately 8 well sites/mi² (one active and two inactive well sites/km²) of sage-grouse habitat. Connecting each of these well sites is a series of roads and trails, as well as power lines and pipelines that are interlaced with compressor stations and gas camps. These structures and linear features result in direct habitat loss, and fragment remaining suitable habitat. The effect of daily vehicular traffic along these road networks can also impact breeding activities or directly reduce survival.

There are relatively few limitations placed on spacing and density of well sites in Alberta. Each company is 'restricted' to drilling 16 well sites per section of land, but is allowed 16 wells per zone in which they are drilling. Thus the total number of wells could potentially far exceed 16 per section. Recommendations and guidelines are made by Alberta Fish and Wildlife to reduce the impact of such intensive drilling, particularly in important sage-grouse habitats. However, there is no current legislation that commits Alberta Public Lands or the Alberta Energy Utility Board to follow these recommendations. Under the Alberta Provincial Wildlife Act, an individual cannot willfully destroy the nest or den site of an endangered species (sage-grouse are listed as endangered in Alberta and Canada). This provincial legislation offers little or no

protection for sage-grouse breeding and nesting habitat and, currently, there is no federal legislation in place.

Over the last three decades, the Alberta sage-grouse population has declined by 66-92% (based on the currently occupied range only, Aldridge 2000). Currently, only seven of 31 historic lek complexes remain active. The future plans for oil and gas developments within the range of sage-grouse are unknown, but expansion is expected. The cumulative impacts of further activities could result in reduction of the Alberta sage-grouse population to non-viable levels.

Colorado

Sage-grouse historically occurred (Braun 1995) in at least eight counties in Colorado in which oil and gas development is common. No replicated, designed cause and effect studies have explored the impacts of oil and gas production on sage grouse populations although Braun (1987, 1998) generally discussed the apparent short-term impacts. Presently, active oil and gas production occurs in only four counties (Jackson, Moffat, Rio Blanco, and Routt) while sage-grouse populations within areas impacted by coal-bed methane production (LaPlata and Montezuma) or that could be potentially impacted by development of oil shale (Garfield) are no longer present due to a complexity of factors.

Oil and gas developments preceded formalized counts of sage-grouse in Colorado and date to at least the early 1920's. Counts of sage-grouse were initiated on a sporadic basis in Colorado in the late 1940's. These counts were incomplete and primarily focused on larger, more accessible leks. Thus, data collected from the 1940's to the early 1970's are not directly comparable to those collected in the last 25-30 years.

Therefore, it is not possible to be definitive about actual impacts of oil and gas development on sage-grouse.

The most complete data set for sage-grouse and oil and gas production is from North Park in Jackson County. Development of the McCallum Field was initiated in 1926 and it continues to be active with 47 producing wells, 39 water injection wells, 25 abandoned (plugged) wells, and 6 approved but not drilled wells in an area of approximately 8,600 acres (2,125 ha). This area has a well-developed unimproved road network with one paved road to a processing plant, numerous pipelines, but only a few power lines. Sage-grouse were reported to occur in the McCallum Field in the 1940's but no data are available. During the 1973-2001 interval, at least 11 leks were active within or immediately adjacent to the McCallum Field. Seven of these leks were active in 2001 with a combined total of 181 males, 12.8 % of the total males counted and 20.6 % of the active leks in North Park. Examination of each active lek site indicated that only two were within sight of an active well or power line. Most were out of sight because of topography that also made noises associated with pumping and oil field activities inaudible to the human ear when an observer was on the lek site. Only three active leks were within the main oil field and most (8 of 11 known lek sites) were on the periphery. During the 1973-2001 interval, number of male sage-grouse counted and active leks in this area fluctuated in synchrony with the entire sage-grouse population in North Park. Sage-grouse are also known to over winter within the McCallum Field (Beck 1975) because a series of ridges are wind swept of most snow.

Locations of the known active sage-grouse leks in the McCallum Field suggest selection for sites that are removed from disturbance such as active wells, the processing

plant, the paved road, and power lines. The McCallum Field is a relatively small, older, moderately developed oil production area and demonstrates that sage-grouse continue to use areas in and near oil production facilities provided that suitable sagebrush-dominated habitats are available and that they have opportunity to select sites that are not disturbed by or apparent from physical structures and paved roads. Despite the fragmented (by trails, pipelines, power lines, and several roads) nature of the habitat in this area, only small areas are no longer useable by sage-grouse.

Wyoming

Oil and gas development in Wyoming dates to at least to 1883 (Salt Creek Field). Since that time, many additional oil and gas fields have been discovered and developed throughout areas occupied by sage-grouse. Presently, the focus is on development of coal-bed methane in northeastern Wyoming (and adjacent southeastern Montana).

Coal-bed methane (CBM) gas development in northeast Wyoming first began in 1987 with a test well. Over the next 10 years, more wells were drilled and markets were developed for the gas. From 1997 through 2001, nearly 12,000 CBM wells were brought into production. Another 40,000 wells are expected to be developed within the Powder River Basin over the next 10 years (BLM Draft EIS for the Powder River Basin Oil and Gas Project, January 2002). Nearly 80 % of the production to date occurs on private surface lands with the remainder on State, BLM, and USFS owned lands. Over half of the mineral ownership within the Basin is private. CBM production involves drilling relatively shallow water wells into the coal seams to pump off the water and release the gas. The gas is then sent through a series of compressor stations and finally released into large transportation pipelines for sale. Discharge water is either impounded locally or

released into area drainages. Each well has at least one unimproved road, an electrical line, a gas pipeline, and a water discharge pipeline. For every 6-10 wells, there is a small single-stage compressor. Larger, two-stage compressor stations are built for every 3-5 smaller compressor stations and there is a larger facility for third stage gas compression. All facilities have improved road access, utility lines, overhead power lines, and underground pipelines. The expected production life of a CBM well is about 7-15 years depending upon the depth of the coal seam and the amount of gas present. With an estimated 25 trillion cubic feet of CBM within the Powder River Basin, the life of the development is expected to be 30-50 years.

Prior to 2001, wells were drilled on a 40-acre (16 ha) spacing. Currently, wells are drilled on an 80-acre (32 ha) spacing; however, exceptions to this rule are often granted to facilitate production. The amount of disturbance from pipelines, power lines, and roads is fairly similar with either well spacing criteria. Although the actual disturbed area from wells, compressors, pipelines, and roads is relatively small (typically 15-20 acres [6-8 ha]) per section, the overall project area is very large and mostly contiguous. Currently, the 12,000 active wells occur over an area of ~ 4,500 mi^2 (11,655 km^2). The total field development area is ~ 11,000 mi^2 (28,490 km^2), which will result in a total of over 300,000 acres (121,410 ha) in direct habitat loss. Predominate habitats within the CBM development area include sagebrush/grassland types, agricultural lands (hay and grain fields), and some mixed shrub communities. Most of the area is considered yearlong sage-grouse habitat with over 200 known active leks. Not all of the area has been extensively searched for sage-grouse so the actual number of leks is considered to be much higher.

Impacts to sage-grouse from CBM development include direct loss of habitats from all production activities along with indirect affects from new power lines and significantly higher amounts human activity, both during initial development and during production. Direct habitat loss to sage-grouse to date with nearly 12,000 wells in production includes an estimated 5,000 acres (2,024 ha). CBM activity has affected an estimated 28 % of the known sage-grouse habitats within the project area. Development will continue to affect more sage-grouse habitats over the next 30-50 years as new wells are drilled within areas that contain known sage-grouse populations and their habitats. Should all of the project area be placed into production, over 50 % of the known sage-grouse range will be either directly or indirectly affected.

Sage-grouse population responses to CBM development are just beginning to be observed as most of the current production has only occurred over the past 4 years and nearly 70 % of the current production in just the past 2 years. Although CBM production is fairly recent; there are a few early indications of detrimental affects on sage-grouse as a result of this development.

There are 200 CBM wells within 0.25 miles (0.4 km) of 30 known sage-grouse leks. For these leks, there has been significantly fewer males/lek and the rate of growth is much lower when compared to other less disturbed leks (Fig 1). Direct disturbance and loss of habitats are the suspected causes for these differences. Some 6,000 miles (9,656 km) of new overhead power lines have been constructed since CBM development began. Another 5,000 miles (8,046 km) of overhead power lines are expected as CBM development continues over the next 10 years. Currently, there are 40 known sage-grouse leks that have an overhead power line within 0.25 miles (0.40 km) of

the lek. Sage-grouse numbers for these leks have a significantly lower growth rate than observed on leks that do not have an overhead power line so close to the breeding ground. Higher raptor predation rates because of perches are the expected cause. The proximity of CBM compressor stations to sage-grouse leks is also having a measurable negative impact on sage-grouse. Currently, there are nearly 200 CBM facilities within 1 mile (1.6 km) of a sage-grouse lek. Sage grouse numbers are consistently lower for these leks than they are for leks that do not have this disturbance. Direct habitat losses from the site itself, roads and traffic, and the associated noise are mostly likely the reasons behind this finding.

The cumulative impact to sage-grouse from all CBM activities is just starting to be observed (Fig. 2). Currently, nearly 90 sage-grouse leks lie within the CBM development area, or about 40 % of the known leks within northeast Wyoming. As development continues, another 50-70 leks areas will be impacted by CBM. Population monitoring will most likely reveal severe consequences to sage-grouse from this activity; however, this knowledge will most likely come too late to result in any major initiatives to protect the birds or their habitats.

Mitigation of CBM impacts on sage-grouse has been mostly minimal and usually voluntary by the operators involved because nearly 80 % of the surface ownership is private. On federal lands, companies are required to avoid lek disturbance during the spring breeding season, reduce compressor noise near leks, and to place overhead power lines at least 0.5 miles (0.8 km) from any sage-grouse breeding or nesting grounds. Companies are also required avoid sagebrush habitats when locating impoundments.

All of these requirements can be waived by the federal land management agencies. There are no mitigation requirements or stipulations for sage-grouse on private land/private mineral CBM production.

Concluding Comments

The effects of oil and gas developments on sage-grouse and other sagebrush-grassland avifauna are poorly understood because of the lack of replicated, well designed studies. However, it is clear that all sagebrush-grassland dependent birds have specific habitat requirements including shrub structure and patch size. We believe the immediate effects of development are clearly negative because of loss of habitat and disturbances associated with structures, roads, and noise, especially during the breeding season. We hypothesize that numbers of individual birds of each species decrease with initial development, and then increase to some unknown level below that prior to development. A return to pre-disturbance levels of abundance is not expected because of loss of habitat. The length of time of the expected decrease is unknown and may be species dependent, as well as dependent upon the level of activity and density of physical disturbances. Increased roads and power lines have the most potential to be negative, as does the decrease in available habitat. Increased long-term and well-funded research is needed on all bird species in areas to be developed and presently developed for oil and gas production so that a sound scientific basis becomes available. Cause and effect studies using an active adaptive management approach (Walters 1986) are necessary to fully understand the implications of energy developments on wildlife species. We believe it is the responsibility of the oil and gas industry to demonstrate their activities have no negative impacts initially, short-term, or over the long-term. We especially believe the

impacts of oil and gas development have been and are negative for sage-grouse and this species, because of its' requirement for large areas of sagebrush-dominated habitats, will be placed at risk of local extirpation in intensively developed areas. Thus, we strongly recommend the published "Guidelines to manage sage grouse populations and their habitats" (Connelly et al. 2000) be followed in all areas with populations of sage-grouse. This is not presently done, as some agencies pick and choose which guidelines to follow and vary their application among states, districts, and resource areas or virtually ignore them, as is the case in both Alberta and Saskatchewan. Further, it would be desirable to have uniformity in application of habitat guidelines for all bird species among all agencies across the entire shrub-steppe region. Finally, the oil and gas industry should be expected to fully mitigate for documented decreases in useable habitat as well as in populations of specific bird species. Mitigation should also consider those impacts that can be reasonably expected including cumulative effects. Consideration should be given to removing other uses of sagebrush habitats that also have cumulative effects on specific avian species as well as other wildlife.

Acknowledgments

We thank M. D. Strickland and F. G. Lindzey for encouraging preparation of this paper. C. C. Cesar of the Bureau of Land Management and J. L. Hicks of the Colorado Division of Wildlife provided current data for North Park, Colorado.

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Figure Captions

Figure 1. Sage-grouse response to CBM wells and drilling in Wyoming. Average males/lek for both leks within ¼ mile of a CBM Well (n = 30) and leks outside ¼ mile of a CBM well (n = 200). Note, since 1996 when CBM production started to significantly increase, sage grouse response in areas of gas production has been increasing at significantly lower rate that for those leks outside of this area.

Figure 2. Sage-grouse response to the cumulative affects of CBM development in Wyoming. There are 90 sage grouse leks that have CBM development within 2 miles of the lek. Within this area, there are 3,688 wells, 168 facilities, and 872 miles of overhead power lines. The amount of direct habitat loss and displacement can only be estimated at this time. As development continues, adverse affects on sage grouse will continue.

Fig. 1

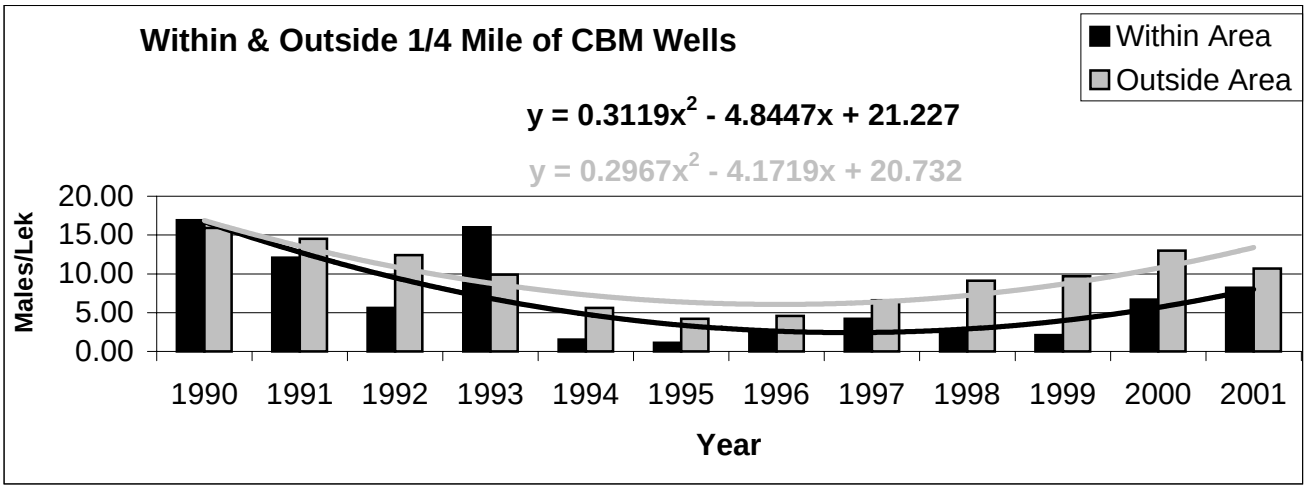
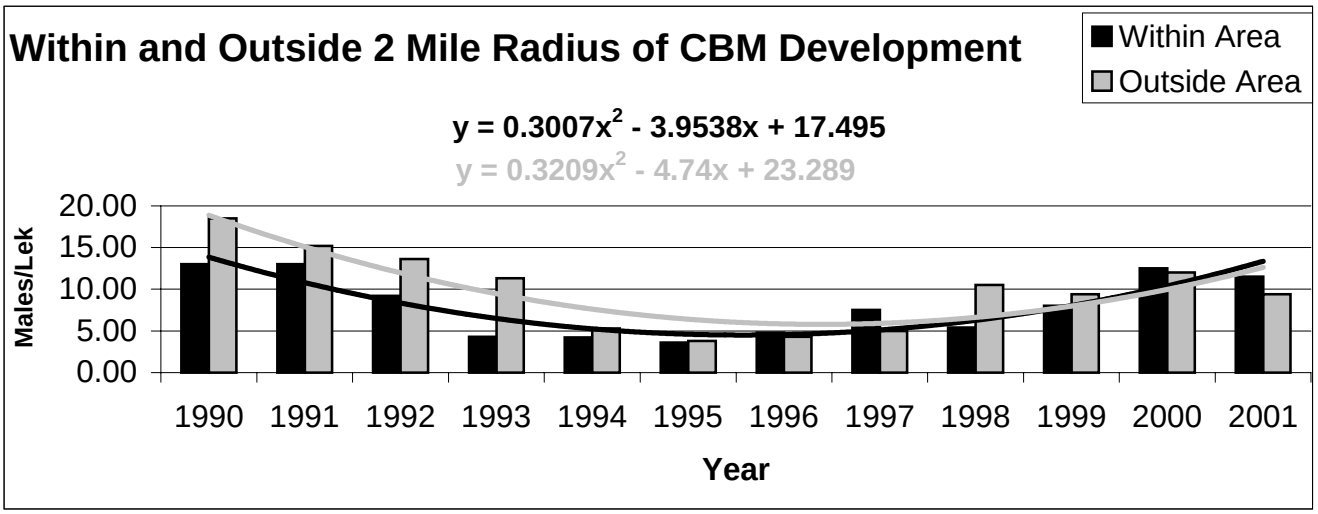

Within & Outside 1/4 Mile of CBM Wells
Within Area
Outside Area
y = 0.3119x2 - 4.8447x + 21.227
y = 0.2967x2 - 4.1719x + 20.732
Males/Lek
20.00
15.00
10.00
5.00
0.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year

Fig. 2


Within and Outside 2 Mile Radius of CBM Development
Within Area
Outside Area
y = 0.3007x2 - 3.9538x + 17.495
y = 0.3209x2 - 4.74x + 23.289
Males/Lek
20.00
15.00
10.00
5.00
0.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
Year