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

Clait E. Braun
Colorado Division of Wildlife
Fort Collins

Olin O. Oedekoven
Wyoming Game and Fish Department
Gillette

Cameron L. Aldridge
University of Alberta
Edmonton

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 three provinces. Most of this vast expanse has been altered by human activity. Estimates of complete loss of sagebrush-dominated areas exceed 50 percent (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).

While the sagebrush steppe is seasonally host to a large number of avian species (Braun et al. 1976, Paige and Ritter 1999), only five species (Gunnison and northern sage-grouse [Centrocercus minimus, C. urophasianus], sage thrasher [Oreoscoptes montanus], sage sparrow [Amphispiza belli] and 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

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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, since some activity dates to the late 1800s. Exploration and development activity tends to be cyclical, depending on apparent needs, extraction costs and cost per barrel or cubic foot. In the 1970s and early 1980s, the interest was in development of oil shale. In the early and mid-1980s, 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 coalbed methane, especially in the area near Gillette, Wyoming. Because of the rapid expansion and development of oil and gas reserves, this paper examines what is known about the effects of energy exploitation on sagebrush dependent avian species and logical expectations during and after exploration, facility 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 (Connelly et al. 2000) and Columbian sharp-tailed grouse (Giesen and Connelly 1993). Reasonable information is available for passerine species; breeding in sagebrush steppe and the presence of sagebrush (Feist 1968; Best 1972; Schroeder and Sturges 1975; Reynolds and Rich 1978; Rich 1978, 1980; Reynolds 1981; Peterson and Best 1985a, 1985b, 1987) and patch size (Rotenberg and Wiens 1980; Wiens and Rotenberg 1981, 1985; Wiens et al. 1987; Knick and Rotenberg 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 plovers, 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 native habitats to reseed with taller grasses also has negative effects 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 has negative effects 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 sharp-tailed grouse (and other subspecies) are less impacted, as they can positively respond to some altered habitats, providing that native shrub habitats 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 square miles (49,000 km²) in the early 1900s (Aldridge 2000). However, the current distribution of sage-grouse has been reduced to approximately 1,544 square miles (4,000 km²), less than 10 percent 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 1990s. 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-1980s 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 to as few as 300 (Aldridge 2000). Similar correlations were seen in the early 1990s, with a resurgence of development activity in the heart of sage-grouse habitat (Manyberries Oil Field). The number of male sage-grouse in Alberta fell to the lowest known level, with only 70 males in 1994 (Aldridge 2000). Direct disturbances (development of road or well sites) within approximately 220 yards (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 the 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; the latter, most likely, is also a reclaimed well site. Neither of these leks have 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 eight well sites per square mile (one active and two inactive well sites/km²) within 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 each is allowed 16 wells per zone in which they are drilling. Thus the total number of wells potentially could exceed 16 per section. Recommendations and guidelines are made by the Alberta Department of 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 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 at least 66 percent (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 in at least eight counties in Colorado (Braun 1995) in which oil and gas development is common. No 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 coalbed methane (CBM) production (LaPlata and Montezuma) or that could be potentially impacted by development of oil shale (Garfield) are no longer present, due to complex factors.

Oil and gas developments preceded formal counts of sage-grouse in Colorado and date to at least the early 1920s. Counts of sage-grouse were initiated on a sporadic basis in Colorado in the late 1940s. These counts were incomplete and focused on larger, more accessible leks. Thus, data collected from the 1940s to the early 1970s are not directly comparable to those collected in the last 25 to 30 years. Therefore, it is not possible to be definite 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 six approved plans for 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 and a few power lines. Sage-grouse were reported to occur in the McCallum Field in the 1940s but no data are available. During the 1973 to 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 total of 181 males, which is 12.8 percent of the total males counted on 20.6 percent of the active leks in North Park. Examination of each active lek indicated that only two were within sight of an active well or power line. Most were out of sight because of topography, but there were noises associated with pumping and oil field activities inaudible to the human ear, on the lek site. Only three active leks were within the main oil field and 8 of 11 known lek sites were on the periphery. During the 1973 to 2001 interval, the 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 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 disturbances, such as active
wells, the processing plant, the paved road and power lines. The McCallum
Field is a relatively small, old, moderately developed oil production area, which
demonstrates that sage-grouse continue to use areas in and near oil production
facilities providing that suitable sagebrush-dominated habitats are available
and that they have opportunity to select sites that are not disturbed by physical
structures or paved roads. Despite the fragmented nature of the habitat (trails,
pipelines, power lines and several roads) 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 CBM in northeastern Wyoming. CBM gas
development, in northeast Wyoming, 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 to 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, according to the Bureau of Land Management's
(BLM) Draft EIS for the Powder River Basin Oil and Gas Project (2002). Nearly
80 percent of the production to date occurs on private surface lands with the
remainder on state-, BLM-, and US Forest Service- (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 six to 10 wells, there is a small single-
stage compressor. Larger, two-stage compressor stations are built for every
three to five smaller compressor stations and there is a large 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 seven 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

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be 30 to 50 years. Prior to 2001, wells were drilled with 40-acre (16 ha) spacing. Currently, wells are drilled with 80-acre (32 ha) spacing, however exceptions to this rule are often granted to facilitate production. The disturbance from pipelines, power lines and roads is 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 approximately 4,500 square miles (11,655 km²). The total field development area is approximately 11,000 square miles (28,490 km²), 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 and 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 effects from new power lines and significantly higher amounts of human activity, during both 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 percent of the known sage-grouse habitats within the project area. Development will continue to affect more sage-grouse habitats over the next 30 to 50 years, as new wells are drilled within areas that contain sage-grouse populations and their habitats. Should all of the project area be placed into production, over 50 percent of the 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 four years and nearly 70 percent of the current production in just the past two 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 per lek and the rate of growth is much lower, compared to other less disturbed leks.
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 most likely the reasons behind this finding.

The cumulative impact to sage-grouse from all CBM activities is just starting to be observed (Figure 2). Currently, nearly 90 sage-grouse leks lie within the CBM development area, or about 40 percent of the known leks within

![Figure 1. Sage-grouse response to CBM wells and drilling in Wyoming. Average males per 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.](image-url)
Within area \[ Y = 0.3007x^2 - 3.9538x + 17.495 \]
Without area \[ Y = 0.3209x^2 - 4.74x + 23.289 \]

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.

In northeast Wyoming. As development continues, another 50 to 70 lek areas will be impacted by CBM. Population monitoring most likely will reveal severe consequences to sage-grouse from this activity, however this knowledge most likely will 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 minimal and usually voluntary by the operators involved because nearly 80 percent 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 place overhead power lines at least 0.5 mile (0.8 km) from any sage-grouse breeding or nesting grounds. Companies are also required to 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 or 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 negative and are caused by loss of habitat and disturbances associated with structures, roads and noise—especially during the breeding season. We hypothesize that the number of birds of each species will decrease with initial development, 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 for all bird species in areas presently and to be developed for oil and gas production, so 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 that their activities have no negative impacts initially or eventually. 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, it will be placed at risk of local extirpation in intensively developed areas. Thus, we strongly recommend 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 agencies choose which guidelines to follow and vary their application among states, districts and resource areas, or agencies may 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 the removal of other uses of sagebrush habitats that also have cumulative effects on specific avian species as well as other wildlife.
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