Distribution, Abundance, and Status of the Greater Sage-Grouse, *Centrocercus urophasianus*, in Canada

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We reviewed the historic and present distribution of Greater Sage-Grouse (*Centrocercus urophasianus*) in Canada and found that the species has been eliminated from approximately 90% of its estimated historic distribution. Sage-grouse have been extirpated from British Columbia and reduced to remnant populations in Alberta and Saskatchewan. Estimates of the size of the population decline in Canada range from 66 to 92% over the last 30 years based on currently occupied habitat. As a result, sage grouse have been listed as Endangered in both Alberta and Saskatchewan by provincial governments and federally in Canada by COSEWIC. Intensive surveys from 1994 to 1999 in both provinces suggest that the 1999 spring breeding population had declined to between 813 and 1204 individuals. The number of active lek sites has continued to decline, suggesting that some habitats have become unsuitable to support viable sage-grouse populations. Number of yearling males recruiting to leks each spring has been low, suggesting that production and overwinter survival of young are the major problems related to the decline. Low chick survival rate, with only 18% surviving to 50 days of age, is the most likely parameter contributing to the population decline. These declines could be related to one or any combination of habitat changes, livestock grazing pressure, oil and gas developments, or climate change, all of which could lead to increased predation rates and decreased survival. It is questionable if the present population of sage-grouse in Canada is large enough to remain viable.

Key Words: Greater Sage-Grouse, *Centrocercus urophasianus*, distribution, endangered status, Saskatchewan, Alberta, Canada.

Sage-Grouse (*Centrocercus* spp.) are strongly associated with sagebrush (*Artemisia* spp.) habitats throughout the Great Plains and Intermountain West. Historically, they occurred in British Columbia, Alberta, Saskatchewan, and at least 16 U.S. states, but have been extirpated from British Columbia and five states (Braun 1998; Schroeder et al. 1999). The long-term decline in sage-grouse populations across their range was originally due to the direct loss of sagebrush steppe. This habitat has been reduced by more than 50% (2.5 million ha) since the early 1900s (Patterson 1952; Eng and Schladweiler 1972; Braun 1995).

Both Alberta and Saskatchewan still support Greater Sage-Grouse (*C. urophasianus*) populations, yet springtime lek counts indicate the Canadian population has decreased by approximately 80% since the mid-1980s to between 549 and 813 individuals in 1997 (Aldridge 1998). As a consequence of the decline, Alberta closed the Greater Sage-Grouse hunting season in 1996 for the first time since 1967 (Aldridge 1998). Greater Sage-Grouse have not been hunted in Saskatchewan since 1938 (Kerwin 1971).

In 1997, the Committee On the Status of Endangered Wildlife In Canada (COSEWIC) listed Greater Sage-Grouse as a Threatened species. This listing was upgraded to Endangered in 1998, reflecting the imminent threat of extinction in Canada (Hyslop 1998*).

Sage-grouse are found almost exclusively within the North American range of sagebrush and are associated with sagebrush habitats throughout the year (Patterson 1952; Braun et al. 1977; Connelly et al. 2000). This is also true in Canada, where Greater Sage-Grouse are found within the range of sagebrush in the semi-arid mixed-grass prairie. Silver Sage (*A. cana*) is the dominant species of sagebrush on the Canadian prairies and pasture sage (*Artemisia frigida*) is the main forb (Aldridge and Brigham 2002). Grasses commonly found include June Grass (*Koeleria macrantha*), Blue Grama (*Bouteloua gracilis*), Needle and Thread (*Stipa comata*), and Western Wheatgrass (*Agropyron smithii*) (Aldridge and Brigham 2002). Mean annual precipitation within the Alberta range is about 332 mm, and mean temperatures for July and January average 19.5 and -11.7°C, respectively (Onefour Research Station, Environment Canada).

Although sage-grouse have a close association with sagebrush habitats, specific habitat requirements vary throughout the year. Areas used by sage-grouse must contain suitable habitat which satisfies requirements for strutting grounds (leks), nesting areas, feeding and loafing sites, brood-rearing sites, and wintering areas (Klebenow 1969; Eng and Schladweiler 1972; Beck 1977).

*See Documents Cited section

Here we evaluate the distribution, abundance, status and viability of Greater Sage-Grouse in Canada and review potential factors that might be affecting the population. We also discuss long-term and present population trends, the apparent population decline, and range contraction, and we highlight recent research.

Distribution

Sage-grouse have been extirpated from at least five U. S. states (Arizona, Kansas, Nebraska, New Mexico, and Oklahoma) and one Canadian province, British Columbia (Braun 1998; Schroeder et al. 1999) (Figure 1). Throughout their range, sage-grouse have declined by 45-80% since the 1950s (Braun 1998). The long-term decline was originally due to the direct loss of sagebrush steppe (Patterson 1952; Braun 1995, 1998; Schroeder et al. 1999). Sage-grouse currently inhabit about 50% of the area they once occupied in Oregon (Crawford and Lutz 1985) and Colorado (Braun 1995) at the turn of the 20th century. Range contractions of similar magnitude have occurred throughout the species' range (Crawford and Lutz 1985; Swenson et al. 1987; Braun 1995). The current distribution of sage-grouse is highly fragmented (Eng and Schladweiler 1972; Hupp and Braun 1991; Braun 1995) (Figure 1).

At the northern edge of its range, Greater Sage-Grouse historically occurred in Canada (Figure 1), extending into the southern Okanagan and Similkameen valleys of British Columbia and across southeastern Alberta and southwestern Saskatchewan. The species was considered extirpated from British Columbia by 1918 (Cannings et al. 1987). Historically, Greater Sage-Grouse occupied approximately 100 000 km^2 within Alberta and

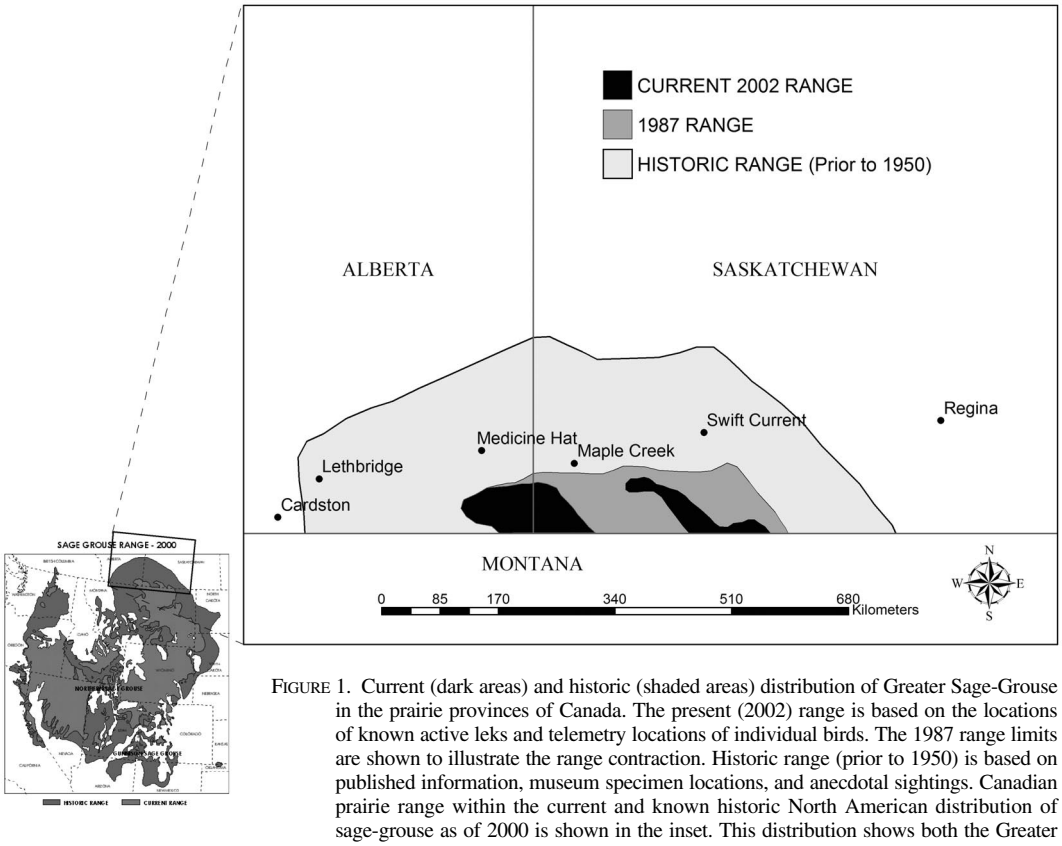

FIGURE 1. Current (dark areas) and historic (shaded areas) distribution of Greater Sage-Grouse in the prairie provinces of Canada. The present (2002) range is based on the locations of known active leks and telemetry locations of individual birds. The 1987 range limits are shown to illustrate the range contraction. Historic range (prior to 1950) is based on published information, museum specimen locations, and anecdotal sightings. Canadian prairie range within the current and known historic North American distribution of sage-grouse as of 2000 is shown in the inset. This distribution shows both the Greater or Northern Sage-Grouse (*C. urophaianus*) and the Gunnison Sage-Grouse (*C. minimus*), of southwestern Colorado and southeastern Utah (map provided by M. A. Schroeder, Washington Department of Fish and Wildlife).

Saskatchewan, but today occupy only about 6000 km^2 (Figure 1). The range contraction within Canada is primarily attributed to habitat loss.

Population Size and Trends

The most cost-effective and time-efficient method to estimate sage-grouse population size and trends is through lek counts. Lek counts involve counting the number of male sage-grouse displaying on a strutting ground during the spring mating season. The maximum number of males observed at each lek is then used as an index of population status (Beck and Braun 1980; Emmons and Braun 1984). Lek counts are used as indicators of population trends and to make population estimates for many lekking species, including all monitored sage-grouse populations.

Seasonal Lek Attendance

Adult males begin returning to leks once the latter are clear of snow. This typically occurs in mid-March in Alberta (Aldridge 2000). Breeding occurs over a one- to two-week period, as indicated by the peak in female attendance at leks: late March to early April in California (Bradbury et al. 1989), mid-April in Colorado (Petersen 1980), early April in Idaho (Autenrieth 1981), mid- to late April in Montana (Wallestad 1975; Jenni and Hartzler 1978), late April in Washington (Schroeder 1997), and in early April in Alberta (Aldridge 2000). The peak in male attendance typically occurs two to three weeks after peak female attendance/breeding at leks (Jenni and Hartzler 1978) (Figure 2). In general, about 50% of male sage-grouse attend leks prior to the peak in female attendance (breeding) (Figure 2). Radiotelemetry studies indicate a later peak in male attendance is due to yearling males first joining the lek two to three weeks after the peak of female attendance (Jenni and Hartzler 1978; Emmons and Braun 1984).

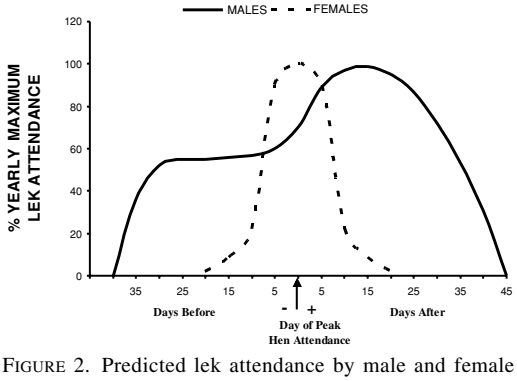

FIGURE 2. Predicted lek attendance by male and female sage-grouse (adapted from Jenni and Hartzler 1978). In Canada, peak female attendance usually occurs in the first week of April. If renesting efforts are high, female attendance is less Gausian in distribution, and female attendance is skewed to the right, overlapping more with peak male attendance.

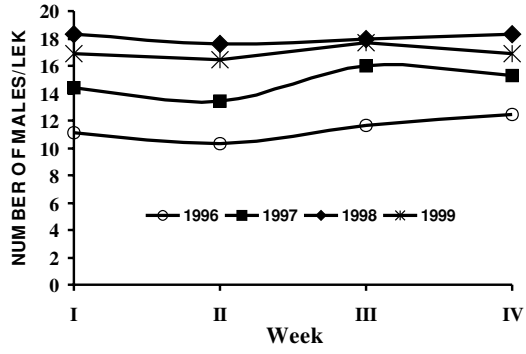

Figure 3. Weekly attendance by male Greater Sage-Grouse on leks in Alberta from 1996 to 1999. Week III represents the time when peak male attendance historically occurred in Alberta and Saskatchewan.

Detailed observations of male Greater Sage-Grouse lek attendance within each breeding season varied slightly from 1996 to 1999 in Alberta (Figure 3). Lek counts were divided into four seven-day periods, spanning the three 10-day periods recommended by Jenni and Hartzler (1978) and Beck and Braun (1980). The third week of counts occurred during the last week of April, when the peak in male attendance at leks should occur (Aldridge 1998) due to the arrival of yearling males (Dalke et al. 1963; Eng 1963; Jenni and Hartzler 1978). We obtained a maximum count for each lek during each of the four-week periods and used a two-way ANOVA to evaluate Week*Year interaction ($F_{9, 100} = 0.02$, $P > 0.10$), Week ($F_{3, 100} = 0.11$, $P > 0.10$) and Year effects ($F_{3, 100} = 1.24$, $P > 0.10$). The lack of significant differences in the attendance of males at leks over each year as a function of week suggests that yearling Greater Sage-Grouse are under-represented in the Canadian population. Capture data from Alberta also suggest that yearlings are under-represented in this population: only 25% (24/96) of captured birds were yearlings (Aldridge and Brigham 2001), compared to 44% of captures in Idaho (Dalke et al. 1963) and 46% of captures in Colorado (Braun and Beck 1985). Less than 18% of chicks in Canada survive to 50 days of age (Aldridge and Brigham 2001; C. L. Aldridge unpublished data), and the low recruitment for sage-grouse in Canada may be linked to poor chick survival.

Between-Year Trends

Greater Sage-Grouse lek counts within Alberta and Saskatchewan have been performed independently and, for this reason, we discuss population trends separately (Figure 4). In Alberta, surveys have been performed every two years on average since 1968, although gaps as long as five years have

occurred. During 1968/69, and in the early 1980s, numbers peaked and approached a total of 600 males counted on about 20 active leks (average > 25 males/lek) (Figure 4a, b). In Saskatchewan, the first surveys were performed in 1987 and 1988. They resulted in a total of nearly 600 males on about 30 active leks (average of about 20 males/lek) (Figure 4a, b). Since surveys in both provinces began, there has been a general decline in population numbers. In 1997, only 8 and 10 leks were active, supporting 122 and 61 males in Alberta and Saskatchewan, respectively (Figure 4a, b).

The most intensive lek counts were conducted in 1998 and 1999 in both provinces. Counts in Alberta resulted in a total of 147 males counted on eight active leks in 1998, and 140 males on eight leks in 1999 (Figure 4a, b). A similar trend occurred in Saskatchewan, where a total of 144 males were counted on 12 active leks in 1998 and a total of 131 males were counted on 10 leks in 1999 (W. C. Harris, personal communication; Figure 4a, b). We estimate the 1999 Canadian spring population was between 813 and 1204 individuals. Fall harvest (Braun 1998*) and winter population surveys (Beck 1977) in the United States suggest that the sex ratio for sage-grouse is female biased, ranging from 1.6 to 2.4 females per male. Thus, our estimates assume a spring sex ratio of two females for every male counted (C. E. Braun, personal communication). The low population estimate is simply the maximum number of males counted plus twice as many females. The high estimate assumes the same 2:1 sex ratio, but also takes into account the potential that only 90% of all leks are located and that only 75% of males attend leks at any given time (C. E. Braun, personal communication).

In 1987, counts were performed in both provinces, and a total of 915 males (400 in Alberta, 515 in Saskatchewan) were counted at 34 active leks (Figure 4a). This gives an estimated 1987 Canadian spring population of between 2745 and 4067 individuals. Based on 1999 estimates, the population has declined by as much as 80% since 1987. However, the 1987 total likely does not represent historic population levels, considering that counts in 1968 and 1981 in Alberta totaled 613 and 524 males respectively, and counts were also greater in Saskatchewan in 1988 (677 males) (Figure 4a). If these numbers are used to estimate a historic (≈ 1968) spring Greater Sage-Grouse population for the Canadian prairies (only within the current range), the population would have been between 3870 and 5733 individuals. This represents a potential decline of 86% within the currently occupied area over the last three decades. This is likely an underestimate, considering the historic range of Greater Sage-Grouse was potentially 90% greater than the currently occupied habitat (Figure 1). Increased search efforts over the last six years in both provinces likely resulted in higher count totals for the surveyed leks and may also mean that the population decline has been underestimated.

Using long-term lek count data for Alberta (Aldridge 1998, Alberta Sustainable Resource Development), we estimated the Greater Sage-Grouse population for each year from 1968 to 1999 using the previously discussed assumptions (Figure 4d). In the late 1960s, the Alberta population was between 1839 and 2724 birds. At its lowest levels in 1994, we estimate the population was between 210 and 311 individuals. In 1999, the population consisted of between 420 and 622 individuals. Thus, the Alberta population has declined from 1968 to 1999 by 66 to 92% (Aldridge 2000). This decline could be even greater, considering that in the early 1990s, Greater Sage-Grouse were known to exist outside of their current range, but these areas were not surveyed in past lek counts.

Active leks have also been decreasing in both Alberta and Saskatchewan. In the late 1960s, there were at least 21 active leks in Alberta and in 1988 there were 31 active leks in Saskatchewan (Figure 4b); 62 and 67% of leks have been abandoned in each province, respectively. The mean number of males per lek has also decreased in both provinces. Alberta averaged 29.2 males per lek in 1968, while Saskatchewan averaged 21.8 in 1988 (Figure 4c). By 1994, these numbers had decreased by 80% in Alberta and 64% in Saskatchewan to 5.8 and 7.8 males per lek, respectively.

Despite the overall decrease in population numbers, counts of males have remained somewhat stable over the last six years in both provinces (Figure 4). However, in both provinces, lek counts have been performed more rigorously over the last six years, and a concerted effort has been made to locate all leks (Aldridge 1998, 2000; W. C. Harris, personal communication). This increased effort may mask a continuing population decline.

Even though counts of males on leks over the last six years have remained relatively stable, the number of active leks in Canada decreased from 22 in 1994 to 18 in 1999 (Figure 4b). Over the same time period, the mean number of males counted per lek has more than doubled from 6.7 males/lek in 1994 to 15.1 in 1999 (Figure 4c). It is common for smaller subsidiary or satellite leks to be abandoned during population lows (Dalke et al. 1963), but the attendance at main lek complexes has increased over this time period. This suggests that changes have been occurring on the landscape, making smaller leks less desirable and causing birds to move to leks located in more suitable habitat.

Although it is evident the Canadian Greater Sage-Grouse population has declined, the exact rate of decline is difficult to ascertain, due to previously mentioned reasons and inconsistent sampling efforts (Aldridge 1998, 2000). It is also difficult to determine whether, in some years, leks that apparently

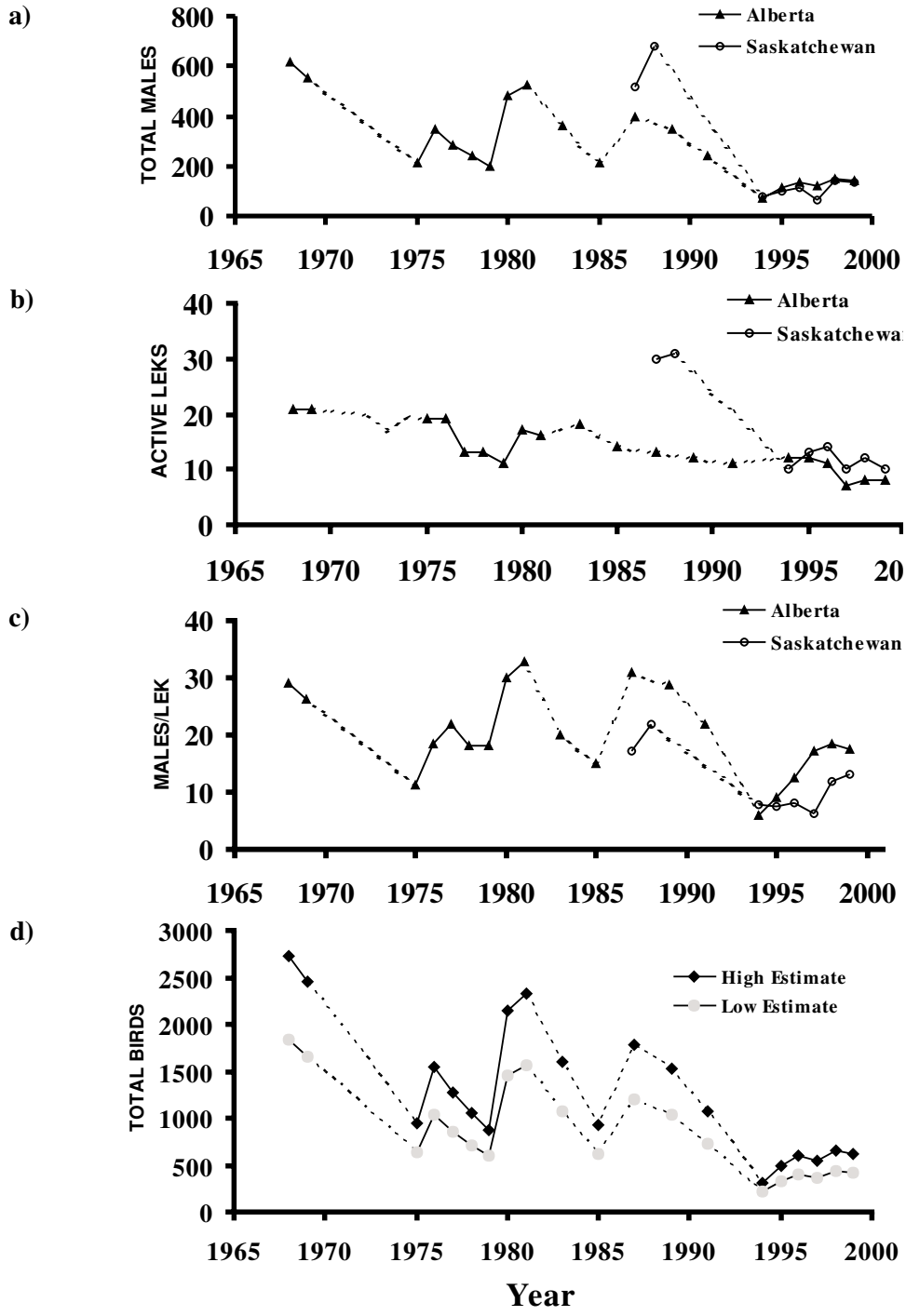

FIGURE 4. Population trends for Greater Sage-Grouse in Alberta and Saskatchewan from 1968 to 1999 shown as (a) total males, (b) active leks, and (c) males per lek. Long-term population estimates (d) are shown for the Alberta population only. Population estimates are based on maximum male lek counts. Low estimates assume a 2:1 female-biased sex ratio. High estimates assume that only 90% of all leks are located and that only 75% of males attend leks at any given time. For all graphs, years are not included when sampling efforts consisted of less than eight leks surveyed. Solid lines illustrate trends between years with consecutive data, and dashed lines estimate trends across years without data.

contained no birds were simply not checked, or could not be located and surveyed. Populations of sage-grouse also naturally fluctuate over periods of 7 to 10 years (Figure 4a), and these cycles (Patterson 1952; Rich 1985; Aldridge 1998) complicate population trends. Regardless of the rate of decline, it has been suggested that a minimum effective population size of 500 breeding individuals (Franklin 1980; Lande 1988) may be required to maintain sufficient genetic diversity to sustain a viable population. Given the lek mating system for Greater Sage-Grouse, the fact that only 10-15% of males actually breed in a given year (Anonymous 1997; C. E. Braun, personal communication), with each having different degrees of reproductive success, and the fact that many may die before successfully reproducing, a population size of 5000 Sage-Grouse may be required to maintain an effective population size of 500 breeding individuals (Braun 1995; Anonymous 1997; Aldridge 2000).

Limiting Factors

Although many different factors may have contributed to a reduction in sage-grouse numbers throughout the species' range, most deal with loss of suitable habitat and the degradation and fragmentation of remaining habitat (Schroeder 1997; Braun 1998; Schroeder et al. 1999). These alterations due to human encroachment and development as well as changes in climate and predator communities all may affect survival and productivity. A number of more localized disturbances, such as industrial development (Braun et al. 2002), have also contributed to the loss of suitable habitat. We address these potential limiting factors below.

Agricultural Practices

The demand for productive agricultural land in the 20th century resulted in massive sagebrush eradication programs. This decreased the range of sagebrush and, thus, potential sage-grouse habitat by an estimated 2.5 million ha from 1952 to 1977 (Braun et al. 1977). Since the late 1960s, when counts began in Alberta, cultivation of sagebrush-grasslands has likely resulted in the desertion of one lek (Braun et al. 2000) and possibly a second (C. L. Aldridge, personal observation). Ploughing in eastern Montana reduced Greater Sage-Grouse habitat by 16%, including 30% of the wintering range, and the population declined by 73% (Swenson et al. 1987). In addition, birds foraging in crop fields can be killed or injured by machines and other farm equipment (Patterson 1952; C. L. Aldridge, personal observation). Insecticides and herbicides are potentially lethal to sage-grouse (Blus et al. 1989), although their use on Canadian rangelands is limited.

Overgrazing has long been suggested as one of the main reasons for declining sage-grouse numbers (Dalke et al. 1963; Braun et al. 1977; Connelly and Braun 1997; Beck and Mitchell 2000). The removal of vegetation cover by cattle can have an impact on sage-grouse populations, either by reducing habitat suitability (Beck and Mitchell 2000) or by increasing the exposure of birds and nests to predators or extreme weather, all of which decrease survival and nest success (Watters et al. 2002). Important mesic sites in southern Alberta that provide lush forbs and insects as food resources for chicks are a limiting factor (Aldridge and Brigham 2002). Livestock grazing in these areas could therefore negatively impact chick survival and should be managed to optimize growth of forbs and grasses so as to increase chick survival (Beck and Mitchell 2000; Aldridge and Brigham 2002). Heavy grazing pressure during drought conditions could intensify these effects. Windberg (1975*) suggested that the declines indicated by lek counts in Alberta since 1968 correspond to an increase in intensity of livestock grazing in the southeastern part of the province. Grazing may simply decrease the carrying capacity of sage-grouse habitat (Windberg 1976*), especially in years with below average annual precipitation.

Human Disturbance

The unique spring mating rituals of sage-grouse attract naturalists, researchers, and interested members of the public each year. Nature photographers set up blinds at leks each spring in an attempt to photograph male sage-grouse in full breeding display. However, if birds are disturbed at leks, individuals will not return until the next day (C. L. Aldridge, personal observation). Continual disturbance at leks could result in abandonment of that site and may ultimately reduce breeding success and survival.

Predation

The predator community on the Canadian prairies has undergone drastic changes over the last 150 years. With the loss of the Plains Grizzly Bear (*Ursus horribilis*) and the Plains Wolf (*Canis lupus*), the Coyote *(Canis latrans)* is now the top predator. The Swift Fox (V*ulpes velox*) was once extirpated from Canada; however, a small population now exists after reintroduction. Raccoons (*Procyon lotor*), Striped Skunks (*Mephitis mephitis*), and Red Fox (*Vulpes vulpes*) have all increased on the prairies, especially in the last half century. Richardson's Ground Squirrels (*Spermophilus richardsonii*) are common nest predators of Greater Sage-Grouse in Alberta (Aldridge 2000; Watters et al. 2002). While Common Ravens (*Corvus corax*) do not coexist with Greater Sage-Grouse in Canada, American Crows (*Corvus brachyrhynchos*) and Black-billed Magpies (*Pica pica*) are common on the prairies and depredate both artificial (Watters et al. 2002) and natural Greater Sage-Grouse nests in Alberta (C. L. Aldridge, personal observation).

These changes in the predator community are tied to alterations in habitat structure and/or species composition. Predator control is not a viable option for managing prairie grouse populations, and enhancing or maintaining suitable habitat has been an effective management tool (see Schroeder and Baydack 2001).

Oil and Gas Exploration and Road Development

Oil and gas exploration and extraction within the Canadian range of Greater Sage-Grouse are key components of the economies of both Alberta and Saskatchewan. The removal of vegetation to construct well sites, access roads, pipelines, and associated facilities reduces and fragments suitable habitat. Human and mechanical activities at well sites may disrupt breeding and nesting activities. Even if sites are reclaimed, birds often fail to return to leks, as has been the case for at least one site in Alberta (C. L. Aldridge, personal observation). At least six of 32 traditional lek complexes in Alberta have been disturbed by oil and gas activities (Braun et al. 2002). Five of these leks are no longer active and the sixth lek complex, which originally had two large mating centers, has been reduced to one smaller site (Braun et al. 2002). Current records suggest that as many as 1500 wells have been drilled within the current range (4000 km^2) of the Greater Sage-Grouse in Alberta, and as many as one third of these are still producing (Braun et al. 2002).

A network of roads, trails, and power lines connects each well site with compressor stations and gas camps. Sage-grouse commonly fly into power lines and are often killed (Borell 1939; Patterson 1952; C. L. Aldridge, unpublished data). Poles associated with power lines provide perch sites for raptorial predators such as the Golden Eagle (*Aquila crysaetos*), which is an avid predator of sage-grouse (Schroeder et al. 1999). Each of these features not only reduces the suitability and availability of habitat for sage-grouse, but also fragments remaining habitat, providing corridors for predators such as Coyotes. Human activities are intense along these linear features which can disrupt breeding activities and negatively affect survival. Sage-grouse frequently travel on the ground, and when they cross roads and highways, many individuals are killed by vehicles (Patterson 1952). In the recent guidelines to manage sage-grouse populations and their habitat, Connelly et al. (2000) suggest that energy related facilities should be located >3.2 km from active leks (habitat protection is discussed below).

Climate

Although sage-grouse are large robust birds, harsh climatic conditions at the northern edge of the species' range likely affect populations. Short summers and particularly harsh winters likely reduce the ability of individuals to find enough food in winter months, especially given the low abundance of sagebrush in Canada (5-11%; Aldridge and Brigham 2002). This would result in decreased lipid reserves that are necessary for reproduction (Back et al. 1987; Hupp and Braun 1989) and possibly reduce overwinter survival (Back et al. 1987).

There is a positive relationship between spring precipitation and sage-grouse productivity (Gill 1966; Aldridge 2000). Years with below-average spring moisture result in less vegetation growth, apparently reducing sage-grouse nest success and reducing the availability of lush vegetation that is an important dietary component, especially for chicks (Aldridge and Brigham 2002). During the 1980s, spring precipitation was considerably below the long-term average (Aldridge 2000; Onefour Research Station, Environment Canada). This likely contributed to decreased productivity and resulted in reduced chick survival in Alberta (Aldridge and Brigham 2001). However, cold, wet spring precipitation events (rain or snow) can also result in increased nest failures (C. L. Aldridge, personal observation).

The effects of other limiting factors may be compounded during drought conditions. For example, consistent cattle-stocking rates in Canada during the droughts of the 1980s may have resulted in a substantial loss of vegetative cover, perhaps lowering nest success, increasing predation, and possibly lowering overwinter survival (Aldridge 1998, 2000). The impacts may have been particularly severe in more moist habitats, which supply important herbaceous growth during nesting and brood rearing. The probable increased attraction of cattle to these areas during drought conditions may decrease chick survival.

Protection

There is some indication that sage-grouse populations can be hunted with minimal effects on population size (Braun 1984; Braun and Beck 1985). However, given that most sage-grouse mortality occurs in the spring/summer (Schroeder et al. 1999) prior to fall hunting seasons, hunting is likely additive rather than compensatory. Thus, hunting small populations in fragmented areas may have significant implications. Greater Sage-Grouse were hunted in Saskatchewan only until 1938, but hunting continued in Alberta until the closure of the hunting season in 1996.

Federal

Due to declining numbers and limited distribution, Greater Sage-Grouse were listed as Threatened by COSEWIC in 1997. The status was upgraded to Endangered in 1998 (Hyslop 1998*) due to decreasing population numbers. However, until the federal Species At Risk Act (SARA) was passed in 2002 allowing habitat regulations to be put in place, the species was afforded little federal protection. Until then, protection of Greater Sage-Grouse was legislatively limited to that provided by provincial regulations.

British Columbia

Native Greater Sage-Grouse have not been observed in British Columbia since 1918 (Cannings et al. 1987). Attempts to reintroduce birds in the 1960s failed (Cannings et al. 1987), and the population was subsequently considered Extirpated (Hyslop 1998*).

Saskatchewan

Based on a declining population and a reduction in range, Greater Sage-Grouse were listed as a provincially Threatened species in Saskatchewan in 1987. In 1999, their status was changed to Endangered. Their habitat is now protected under the Wildlife Habitat Protection Act, which prevents lands containing Greater Sage-Grouse habitat from being sold or having their native vegetation cultivated.

In 1994, Saskatchewan implemented restrictions to limit development and disturbance at Greater Sage-Grouse lek sites. The Saskatchewan Wildlife Act was amended in 1997 to list and protect wild species at risk. With the 1999 Saskatchewan classification of Endangered, sage-grouse are now protected under the Saskatchewan Wildlife Act. These regulations provide protection for Greater Sage-Grouse, their nests, and leks sites. No developments within 500 m of leks are permitted and no construction activities within 1000 m of leks are allowed between 15 March and 15 May.

Alberta

Greater Sage-Grouse in Alberta were assigned a "Yellow" listing in 1991, meaning they were considered a species of concern due to naturally low populations, limited distribution, and limited available habitat (Anonymous 1991). In 1996 they were moved to the "Blue" list of species that may be at risk (Anonymous 1996). This designation was assigned due to the species' limited distribution, declining population numbers, and specific habitat requirements. In May 2000, the Alberta Endangered Species Conservation Committee listed Greater Sage-Grouse as Endangered under the Alberta Wildlife Regulations. Although Greater Sage-Grouse are still considered a game bird in Albert, they were afforded limited protection as a non-hunted species. As a provincially Endangered species, more rigid protection is available to protect against the capture, killing, or harming of individuals or their nests.

Greater Sage-Grouse habitat is not currently protected within the province of Alberta, although there is the potential for enforcement and protection of habitat to occur under other provincial legislation. Listing Greater Sage-Grouse as a provincially Endangered species places the Endangered Species Conservation Committee in charge of the species' recovery. It also affords significantly higher enforcement penalties and provides greater opportunity to protect Greater Sage-Grouse and their habitat.

Alberta Sustainable Resource Development has developed recommendations and land use guidelines which propose to limit activities surrounding sage-grouse leks throughout the year. From 16 June to 29 February, seismic activities, surveying, and monitoring would be prohibited within 100 m of leks, and from 1 March to 15 June, these activities would be prohibited within 500 m. Permanent developments would be prohibited within 1000 m of leks, regardless of time of year. However, these are recommendations only and cannot currently be legally enforced.

Evaluation

Connelly and Braun (1997) reported that range-wide decreases from prior to 1985 to after 1995 averaged 33% (range 17 to 47%). Braun (1998) suggested that overall breeding populations have declined by 45 to 80% since the early 1950s. The decline in Canada over the last 30 years may have been the most drastic: lek counts indicate a decline of between 66 and 92% since 1968 in Alberta, (Aldridge 2000). Greater Sage-Grouse now occur in less than 10% of their historic prairie range within Canada (Aldridge 2000), are listed as Endangered both federally and provincially (Alberta and Saskatchewan), and are considered extirpated from British Columbia.

Suitable Greater Sage-Grouse habitat in Canada is threatened with fragmentation and degradation from energy extraction activities, human developments and disturbances, and intensive livestock operations and agricultural operations. These threats may be magnified by climate change. The implications of each activity alone are poorly understood, yet the cumulative impact of these limitations may pose more serious threats to Greater Sage-Grouse. Changes in land management practices are probably necessary to save one of Canada's most endangered species. Further research into habitat requirements and the viability of sage-grouse is necessary to direct management practices within the conceptual framework of a collaborative adaptive management approach (Walters 1986). This will increase our understanding of Greater Sage-Grouse resource requirements and the viability of the species in Canada.

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