Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Greater Sage-Grouse (*Centrocercus urophasianus urophasianus*) in Canada

Greater Sage-Grouse

January 2008

Parks Canada Parcs Canada

Canada

About the Species at Risk Act Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

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Additional copies:

You can download additional copies from the SARA Public Registry (http://www.sararegistry.gc.ca/)

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DECLARATION

Under the *Accord for the Protection of Species at Risk* (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada. The *Species at Risk Act* (S.C. 2002, c.29) (SARA) requires that federal competent ministers prepare recovery strategies for listed Extirpated, Endangered and Threatened species.

The Minister of the Environment presents this document as the recovery strategy for the Greater Sage-Grouse, *urophasianus* subspecies as required under SARA. It has been prepared in cooperation with the jurisdictions responsible for the species, as described in the Preface. The Minister invites other jurisdictions and organizations that may be involved in recovering Greater Sage-Grouse to use this recovery strategy as advice to guide their actions.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide further details regarding measures to be taken to support protection and recovery of the Greater Sage-Grouse, *urophasianus* subspecies. Success in the recovery of this Greater Sage-Grouse depends on the commitment and cooperation of many different constituencies that will be involved in implementing the actions identified in this strategy. In the spirit of the *Accord for the Protection of Species at Risk*, all Canadians are invited to join in supporting and implementing this strategy for the benefit of the species and of Canadian society as a whole. The Minister of the Environment will report on progress within five years.

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A document of this nature requires the dedication and commitment of many organizations and individuals. The authors are especially indebted to Pat Fargey and Joanne Tuckwell of Parks Canada for guidance, information and many interesting discussions relevant to recovery planning. Special thanks are also extended to Dale Eslinger and Joel Nicholson of Alberta Sustainable Resource Development and Sue McAdam of Saskatchewan Environment for valuable information and insight into Greater Sage-Grouse conservation initiatives in the two provinces. Above all, the energy and the wisdom of the people from government, academia, and private agencies that participated at a recovery strategy development workshop (see Appendix A) and reviewed drafts of the document are greatly appreciated.

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, a strategic environmental assessment (SEA) is conducted on all *Species at Risk Act* (SARA) recovery strategies. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision making. Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The results of the SEA (Forrestall 2006) are summarized below.

This Greater Sage-Grouse recovery strategy will clearly benefit the environment by promoting the recovery of the Greater Sage-Grouse (*Centrocercus urophasianus urophasianus*). Species that will benefit from protection of the shrinking sagebrush ecosystems include the endangered Sage Thrasher (*Oreoscoptes montanus*) and Burrowing Owl (*Speotyto cunicularia*), the threatened Loggerhead Shrike (Lanius ludovicianus excubitorides) and Mormon metalmark butterfly (*Apodemia mormo*), and the Long-billed Curlew (*Numenius americanus*), listed as special concern. This recovery strategy will also have a positive effect on native culture by promoting the recovery of the Greater Sage-Grouse, a living part of native culture. However, three situations were identified where there is the potential for negative effects.

First, it was determined that a strategy researching the use of fire as a tool to stimulate and revitalize sagebrush communities could lead to activities involving the controlled burning of prairie habitat. This could potentially have a negative impact on other species directly or through disturbance or destruction of their habitat and/or residences. Being aware of other species at risk in the specific area and following best fire management practices would reduce or eliminate any potential negative effects on other species. Any prescribed burning within a national park would require a more detailed environmental assessment under CEAA.

Second, investigations into the impacts of human created water control structures on natural hydrology and the resulting effects on sagebrush could lead to actions involving the alteration of hydrology. Altering the hydrology of an area could have potential negative effects on other plant and animal species directly or through disturbance or destruction of their habitat and/or residences. Any alterations to hydrology should take into account effects on non-target species and may require a more detailed environmental assessment under CEAA.

Third, strategies relating to the protection or increase of silver sagebrush habitat would have a positive effect on all species that share the same habitat as the Greater Sage-Grouse, as discussed above. However, increasing available sagebrush habitat for the Greater Sage-Grouse could potentially have a negative impact on the Mountain Plover (*Charadrius montanus*), which requires short vegetation and bare ground. However, the Mountain Plover is a species listed under the SARA and therefore requires a recovery strategy that will address monitoring, research and threats, which may include impacts as a result of increasing sagebrush habitat.

The SEA concluded that this recovery strategy will have many positive effects and not cause any important negative effects, as long as the mitigation measures recommended are implemented.

This includes any further assessments of actions identified as a result of research conducted in this recovery strategy, such as burning or altering hydrology within a national park.

RESIDENCE

SARA defines residence as: "*a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*" **[SARA S2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

Sage-Grouse residences are protected from damage or destruction under the SARA. The species experts involved in the recovery of Sage-Grouse consider nests to be residences.

PREFACE

This Recovery Strategy addresses the recovery of the Greater Sage-Grouse, *urophasianus* subspecies. In Canada, this species can be found in southeastern Alberta and southwestern Saskatchewan.

This recovery strategy for the Sage-Grouse was developed by the authors for the Parks Canada Agency on behalf of the competent minister (the Minister of the Environment). It was developed in cooperation with a Sage-Grouse working group that met in February 2006. Members of that working group consisted of representatives from provincial government wildlife and land management agencies, land managers, conservation organizations, industry, academia, Parks Canada, Environment Canada, and Agriculture and Agri-Food Canada (Appendix A).

A Greater Sage-Grouse recovery team was established in 1997 by Alberta and Saskatchewan. In 2001, a Canadian Greater Sage-Grouse recovery strategy was produced (Canadian Sage-Grouse Recovery Team 2001) that reviewed Greater Sage-Grouse background and status, established recovery goals and objectives, and provided strategies for population recovery. This recovery strategy updates the one developed in 2001 by Alberta and Saskatchewan and will be the first recovery strategy for the Greater Sage-Grouse, *urophasianus* subspecies under the *Species at Risk Act*.

EXECUTIVE SUMMARY

The Greater Sage-Grouse, *Centrocercus urophasianus urophasianus* is the largest of the North American indigenous grouse species and is a sagebrush obligate within the sagebrush range of southeastern Alberta, southwestern Saskatchewan, Montana, North Dakota, South Dakota, Idaho, Wyoming, Colorado, Utah, Washington, Oregon, California, and Nevada. This report deals with the *C. u. urophasianus* population that occupies habitat in southeastern Alberta and southwestern Saskatchewan at the northern fringe of the North American Greater Sage-Grouse range. In the U.S., *C. urophasianus phaios* was considered the western subspecies and *C. urophasianus urophasianus* the eastern subspecies, however using genetic and ecological data (Benedict *et al.* 2003), the U.S. Fish and Wildlife Service decided that the two Sage-Grouse subspecies would be considered one species (*Centrocercus urophasianus*) across its range. In Canada, COSEWIC and SARA still list the scientific name as *Centrocercus urophasianus urophasianus* and the common name as Greater Sage-Grouse, *urophasianus* subspecies.

Greater Sage-Grouse (hereafter known as Sage-Grouse) are dependent on sagebrush for food and shelter, thus the silver sagebrush-grassland communities of the native Canadian prairie provide necessary habitat. Currently, Sage-Grouse inhabit approximately 6000 km^2 of sagebrush range in the two provinces. Both the range and size of Sage-Grouse populations have declined considerably in all parts of their North American range.

Threats to Sage-Grouse populations in prairie Canada include habitat loss and degradation (agriculture and industry), habitat fragmentation (agriculture, industry, utility, and transportation infrastructure), predation (low annual recruitment), altered landscape hydrology (altered food and habitat resources), diseases, direct mortality factors, and climate fluctuation (compounding effects). Recovery of Sage-Grouse populations is considered to be feasible because: a) the population currently remains unchanged at low levels with sufficient numbers of birds and active leks to produce offspring for population growth; b) there currently exists 'source' habitat that yields positive net production, and sub-optimal habitat that yields poorer recruitment but could be improved to produce net population gains; and c) mitigation and manipulation of land uses can minimize or eliminate threats to the birds and their habitat. Initiatives identified within this strategy will test and refine unproven techniques for development of landscape-scale best management practices for optimal Sage-Grouse production and maintenance.

The following goals focus on the elimination of further losses to population numbers and habitat, while striving to improve availability of quality habitat for population increases via short and long-term targets:

- No loss of active Sage-Grouse leks or Sage-Grouse population numbers in any portion of the current Sage-Grouse range in Alberta and Saskatchewan,
- By 2012, improve Sage-Grouse population status and productivity within Alberta and Saskatchewan so that all populations within the current range show a positive trend in the number of strutting males at leks and the number of active leks for the period 2000 to 2012, and,
- By 2026, achieve a stable or increasing Sage-Grouse population with:

1) ≥ 365 strutting males at leks in Alberta and ≥ 500 strutting males at leks in Saskatchewan, and
2) ≥16 active leks in Alberta and ≥ 30 active leks in Saskatchewan.

Objectives include the following: monitoring populations to measure progress towards goals; ensuring habitat connectivity to preserve gene flow; determining causative factors for population declines and best management practices to enable recovery; identifying, protecting and enhancing key habitat; and integrating Sage-Grouse conservation activities with broader prairie grassland landscape-scale management and conservation initiatives. Comprehensive critical habitat for Sage-Grouse has not been identified in this document but a schedule of studies to identify partial critical habitat has been included.

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1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Common Name: Greater Sage-Grouse, *urophasianus* subspecies

Scientific Name: *Centrocercus urophasianus urophasianus*

Assessment Summary: This population, estimated to be between 550 – 800 individuals in 1997, is small and declining. Historic population levels and range are greatly reduced due to limiting factors including loss and fragmentation of sagebrush habitat on which the species depends, human disturbance, drought and harsh winter weather.

COSEWIC Status: Endangered

Reason for designation: Declining low population numbers; decreased occupied range.

Canadian Occurrence: Alberta and Saskatchewan

COSEWIC Status History: Listed as threatened in 1997. Listed as endangered in 1998. Confirmed as endangered in 2000.
(COSEWIC, 2006)

1.2 Description

Greater Sage-Grouse are the largest of the indigenous North American grouse in the Tetraonidae family and include two species; *Centrocercus urophasianus urophasianus* (Greater Sage-Grouse hereafter Sage-Grouse) and *C. minimus* (Gunnison's Sage-Grouse) (see Canadian Sage-Grouse Recovery Team, 2001). This report deals with the *C. u. urophasianus* population that occupies habitat in southeastern Alberta and southwestern Saskatchewan at the northern fringe of North American Sage-Grouse range. In the U.S., *C. urophasianus phaios* was considered the western subspecies and *C. urophasianus urophasianus* the eastern subspecies, however using genetic and ecological data (Benedict *et al.* 2003), the U.S. Fish and Wildlife Service decided that the two Sage-Grouse subspecies would be considered one species (*Centrocercus urophasianus*) across its range. In Canada COSEWIC and SARA still list scientific name as *Centrocercus urophasianus urophasianus* and the common name as Greater Sage-Grouse, *urophasianus* subspecies.

The Sage-Grouse is a large, round-winged, ground-dwelling grouse that has finely marked brown, black, buff, and dull white upper parts. Both sexes have a black abdominal patch, which is larger on males. The long tail feathers are variegated and gradually taper to an acute point. Males have an arched yellow comb above the eye, a black throat, a large white patch on the breast and long feathers behind the head at the back of the neck (Connelly *et al.* 2004). Concealed within the white breast feathers of males are two large air sacs that are inflated and deflated during courtship displays. Male Sage-Grouse average 2.6 kg and measure an average of 65 – 75 cm in length. Females average 1.3 kg and measure 48-58 cm in length (Godfrey 1986, Nelson and Martin 1953, Sibley 2003). There is some indication that Sage-Grouse in Alberta

(and perhaps Saskatchewan) are larger than their southern counterparts with an average breeding weight of 3.1 kg for males (Aldridge 2000), and lengths of 69-86 cm for males and 46-61 cm for females (Fisher and Acorn 1998).

1.2.1 Reproduction and productivity

Sage-Grouse are polygynous (one male mating with more than one female with the female selecting the male with which she mates) (Bergerud 1988a, Connelly *et al.* 2004) with males performing ritualistic displays (strutting) on communal leks to attract and mate with receptive females (Connelly *et al.* 2004). Males begin displaying at leks as soon as sites are clear of snow (mid-March in Alberta) and continue until late-May (Aldridge 2000). Strutting commences before sunrise each morning and continues until about a half hour after sunrise (Aldridge 2000, Jenni and Hartzler 1978). Males also display during the pre-sunset hours but Kerwin (1971) found that typically the evening display was less intense, of shorter duration, and attended by fewer birds. However, males may also display well into the night during a full moon. Males arrive on leks earlier and display longer as the breeding season progresses, especially if there are females present (Jenni and Hartzler 1978, Patterson 1952, Scott 1942). In Alberta, breeding normally occurs over a two-week period with peak female attendance in early April. Most yearling males attend leks about 2-3 weeks after peak female attendance and after the majority of breeding has occurred (Aldridge 2000, Emmons and Braun 1984, Eng 1963, Jenni and Hartzler 1978). Not all males display at leks as some yearling males may display infrequently or not at all. There may also be mobile groups of yearling males that display for females away from traditional lek sites (Dunn and Braun 1986).

Sage-Grouse nest in a shallow bowl on the ground lined with vegetation and feathers. Most female grouse nest as yearlings (Bergerud 1998b, Coggins 1998, Schroeder 1997) but not all hens nest (range 63% - 100%) (Connelly *et al.* 2004, Holloran *et al.* 2001). More adults (78-92%) than yearlings (55-79%) initiate nests (Connelly *et al.* 1993, Connelly *et al.* 2004) and renesting rates vary from <20% to >80% (Connelly *et al.* 1993, Connelly *et al.* 2004, Eng 1963, Patterson 1952, Schroeder 1997). In studies by Aldridge (2000) and Aldridge and Brigham (2001), Alberta Sage-Grouse hens exhibited high reproductive effort with all adult and yearling hens initiating a nest. Of those that had a failed first nesting attempt, 36% renested. Average clutch size was 7.8 eggs (range 4-11) with first nesting attempts averaging 8.2 eggs and renests averaging 5.6 eggs. This is at high end of range-wide averages but similar to the average of 8.25 eggs (8.49 first attempt and 7.23 for renests) found in Montana (Moynahan *et al.* in press [a]). The mean date of initiation of incubation in Alberta was May 10 and nearly all (92%) eggs laid were fertile. Incubation averaged 27 days with a mean hatch date of June 5 (first nests May 28, renests June 30). Nest success (first and renests) was 46.2%, although adults were more successful (50%) than yearlings (25%). Hen breeding success was 55% and both nest and hen breeding success were within the range anticipated in more southerly locations. During subsequent research, Aldridge (2005) found lower nest success (35.3%) and suggests that drier conditions during his second study led to lower reproductive success (see Limiting Factors).

Sage-Grouse chicks are precocial, leave the nest soon after hatching, and are capable of weak flight at 10 days and strong flight at five weeks (Schroeder *et al.* 1999). Generally, chick survival is low with brood size declining by as much as 68% during the summer (Schroeder *et al.*

1999). Chick survival to 50 days of 33-38% is necessary to maintain populations (Schroeder 1997) but chick survival in Alberta was only 18% (Aldridge 2000 and 2001, Aldridge and Brigham 2002). Aldridge (2000) states that the proportion of yearlings captured at leks (25%) is low compared to averages elsewhere (44-46%) (Beck and Braun 1978, Dalke *et al.* 1963, Wallestad 1975) and this indicates low annual recruitment into the Alberta population.

Sage-Grouse are characterized as having low annual productivity but high adult survival (Connelly *et al.* 1994, Connelly *et al.* 2004, Schroeder 1997, Zablan 2003). There has been little research that documents seasonal mortality (Connelly *et al.* 2004). Aldridge *et al.* (2001) estimated female annual survival in Alberta to be 57%. Aldridge *et al.* (2004b) estimated 73-88% overwinter survival for adult females and 43% for juveniles in Alberta.

1.3 Populations and Distribution

Sage-Grouse distribution in North America is tightly linked to the distribution of sagebrush (*Artemisia* spp.) (Connelly *et al.* 2004). Historically, the continental Sage-Grouse range spanned 1,200,483 km^2 in fourteen states and three provinces (British Columbia, Alberta and Saskatchewan) (Schroeder *et al.* 2004) (Figure 1). The current distribution has been reduced to half of the historical range (668,412 km^2) occurring in eleven states and two provinces (Alberta and Saskatchewan) (see Canadian Sage-Grouse Recovery Team [2001]). The remaining range has been severely reduced and fragmented (Schroeder *et al.* 2004). What was formerly considered the Northern Great Plains race, *C. u. urophasianus*, (Benedict *et al.* 2003) currently occurs in Alberta, Saskatchewan, Montana, North Dakota, South Dakota, Idaho, Wyoming, Colorado, Utah, and Nevada.

Within prairie Canada, Sage-Grouse once occupied about 100,000 km^2, split between Alberta and Saskatchewan (Aldridge 2000, Aldridge and Brigham 2003) (Figure 1). The current Sage-Grouse range in Canada has been reduced to about 6% of the historic range (6000 km^2) (Aldridge 2000, Aldridge and Brigham 2003) (Figure 1). For detailed descriptions see Canadian Sage-Grouse Recovery Team (2001). Sage-Grouse populations are defined as a group of birds associated with one or more active leks in the same geographic area separated from other leks by >20 km (Connelly *et al.* 2004). Using these criteria, there are at least two and possibly more separate populations within prairie Canada outside of GNP including the southwest Saskatchewan leks that are at least 20 km apart (S. McAdam, pers. comm., Saskatchewan Environment). One population occurring across southeastern Alberta, southwestern Saskatchewan and north-central Montana, is separated by approximately 60 km from a second population spanning south-central Saskatchewan (Grasslands National Park (GNP) and surrounding area) and northeastern Montana.

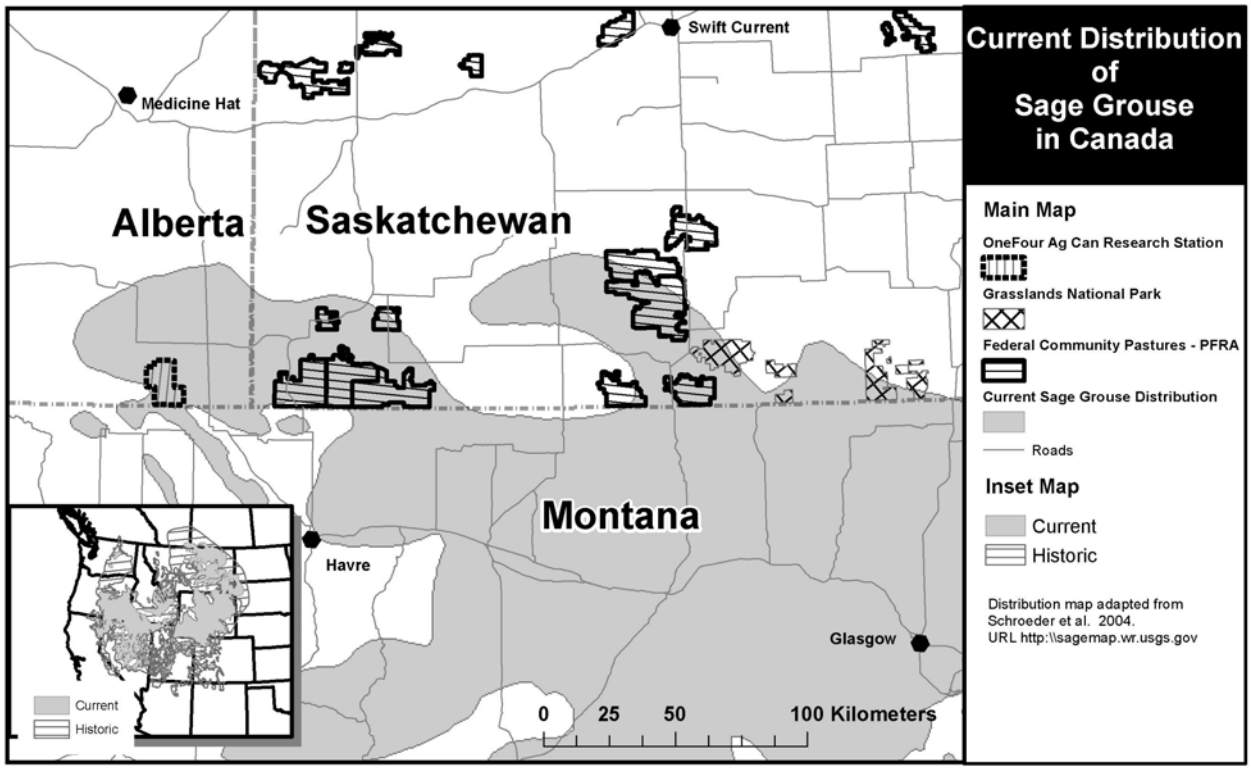

Figure 1. Current distribution of Sage Grouse in Canada and (inset) historic and current distribution of Sage-Grouse in North America (Schroeder *et al.* 2004) (U.S. Geological Surveys, Forest and Rangeland Ecosystem Science http://sagemap.wr.usgs.gov/FTP/images/fig1.12.jpg)

1.3.1 Population status and trends

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed Sage-Grouse in Alberta and Saskatchewan as a threatened species in 1997 and in 1998 this listing was elevated to endangered. Provincially, the Sage-Grouse was listed in Saskatchewan as potentially threatened in 1984, threatened in 1987 (Weichel and Hjertaas, 1992) and endangered in 1999, and endangered in Alberta in 2000. In 2000, COSEWIC confirmed the listing as endangered and it was listed as such under the *Species at Risk Act* in 2003.

There is no universal method for a complete census of a Sage-Grouse population. Instead, lek counts of strutting males during spring courtship displays are used as an index for local population status and trends (Autenrieth *et al.* 1982, Beck and Braun 1980, Connelly *et al.* 2000, Connelly *et al.* 2003). Frequent lek counts were conducted in Alberta from 1968 through 1991 (Appendix B). Commencing in 1994, annual lek counts have been conducted at all known active and inactive lek sites in Alberta (Appendix B). Some of the earliest lek counts in Saskatchewan were conducted in 1970 and 1971 (Kerwin 1971) and Provincial Wildlife staff throughout the 1970s and 1980's counted select leks, however most of those data were incomplete or inconsistent (Appendix C) (see Weichel and Hjertaas 1992, S. McAdam, pers. comm., Saskatchewan Environment). Range-wide counts in Saskatchewan were not conducted until

1987 and 1988 (Harris and Weidl 1988) when 170 potential lek sites were checked (Appendix C) and annual lek counts were initiated in 1994 with varying levels of intensity.

Lek count data show considerable fluctuation in numbers of males, lending support to the suggestion that Sage-Grouse populations exhibit 8-10 year cycles of abundance (Braun 1998, Aldridge 1998a, Aldridge and Brigham 2003). However, the trend for North American Sage-Grouse populations has been a 2% per year decline between 1965 and 2003 (Connelly *et al.* 2004) with Canadian populations decreasing at a faster rate (Appendices A and B). Alberta's numbers dropped from a high of 613 males in 1968, to a low of 70 in 1994, with a 2006 count of 90 males. Similarly, the number of occupied leks in Alberta has dropped from a high of 21 in 1968, to a low of 8 in 1994, with a slight increase to 9 in 2005 (Appendix B). The number of males/active lek increased from 29.2 in 1968, to a high of 32.8 in 1981, to a low of 8.8 in 1994, and is currently at 10.6 males/lek. Alberta's lek data from 1968 to 2005 show a decrease of 84% in total number of males at leks, a decrease of 57% in number of active leks, and a decrease of 64% in number of males per active lek.

Data for Saskatchewan show similar declines with a high of 934 males in 1988, to lows of around 60 in 1997, 2004, and 2005 with some intermittent fluctuations (Appendix C). The number of active leks has decreased from a high of 61 in 1988 to a low of 8 in 1999, increasing somewhat during the early 2000s but dropping to 8 leks again for 2004 and 2005 (Appendix C). The number of males/active lek dropped from a high of 15.3 in 1988 with historical highs of 26.6 in 1970 and 28.4 in 1971 (Kerwin 1971) to a low of 6.1 in 1997, with current numbers of 7.8 in 2005. Between 1988 and 2005 in Saskatchewan, the number of males at leks has decreased 93%, the number of active leks has decreased by 87% and the number of males/active lek has decreased by 49%.

Data on the number of males attending leks can be extrapolated to provide a crude estimate of total spring breeding populations (Aldridge 1998a, Aldridge and Brigham 2003, Connelly *et al.* 2004). The low population estimate assumes a sex ratio of 2 females:1 male attending leks. The high population estimate assumes the same 2:1 sex ratio but also assumes that only 90% of lek locations are known, and that only 75% of males attend leks. Based on these estimates, Alberta's Sage-Grouse population was highest in 1968 (1839-2724 birds) (Appendix B), lowest in 1994 (210-311 birds) and is between 285-422 birds in 2005. Alberta's population decreased 77-84% from 1968 to 2005. Saskatchewan's population estimates ranged from 2802-4151 birds in 1988 (Appendix C), dropping to a low of 180-267 birds in 2004, and currently is estimated at 186-276 birds. The Sage-Grouse population in Saskatchewan has declined 90-96% from 1988 to 2005. Harris (1998) speculated that the pre-settlement population of Sage-Grouse in Saskatchewan may have been near 10,000 birds and using this estimate the decline to 2005 has exceeded 97%. The total Canadian population (AB and SK) has declined from somewhere between 3834-5680 birds in 1988 to a total of approximately 471-698 birds in 2005, a decrease of 82-92% in less than two decades, while the historical range of Sage-Grouse in prairie Canada has been reduced by 94 percent (Aldridge 2000).

1.3.2 Proportion of population in Canada

Although North American population estimates for Sage-Grouse are difficult to calculate, Braun (1998) estimated the 1998 population to be 142,000 birds. Connelly *et al.* (2004) estimated the

population of males at 50,566 and if the 2:1 sex ratio were used, this would indicate that the minimum breeding population is just over 150,000 birds. Hence, Canada's population makes up less than one percent of the population of Sage-Grouse remaining in North America.

1.4 Needs of the Greater Sage-Grouse

1.4.1 Ecological and social role

Sage-Grouse are the largest of indigenous North American grouse species (Aldridge 1998a, Connelly *et al.* 2004, Nelson and Martin 1953, Sibley 2003) and are sagebrush obligates. They are year-round residents in the sagebrush-grasslands of the semi-arid mixed-grass prairie of southeastern Alberta and southwestern Saskatchewan where they are at the northern extremes of the Sage-Grouse range in North America (Aldridge 1998a, Braun 1998, Connelly *et al.* 2000, Connelly *et al.* 2004). Sage-Grouse feed primarily on sagebrush leaves, with dependency on forbs and insects at various times of the year.

The Sage-Grouse is a unique upland bird with very high public appeal. Land users are acutely aware of and protective of Sage-Grouse on their properties. The annual breeding display by males at traditional leks is a wildlife viewing attraction for ecotourists and photographers. Educational institutions incorporate lek surveys into upland bird natural science programs and the unique status of the Sage-Grouse makes it an excellent candidate for inclusion in any educational program regarding sagebrush-grassland prairie ecosystems. In Alberta however, a moratorium on visiting lek sites has been recommended because of the potential for disrupting the birds (D. Eslinger, pers. comm., Alberta Sustainable Resource Development).

The dramatic courtship displays by breeding males at leks was of cultural interest among First Nations who created dances and costumes to mimic male strutting behaviour (Autenrieth 1981). Sage-Grouse were considered a source of food both prior to and after European settlement, albeit low quality because of poor taste. Sage-Grouse were hunted in Saskatchewan in an unregulated fashion until 1938, after which the species received protection under *The Wildlife Act* (Canadian Sage-Grouse Recovery Team 2001). There is evidence of numerous closed seasons during the early 1900s in Saskatchewan and anecdotal evidence suggests that residents hunted Sage-Grouse for food during the 1930s depression period (McAdam 2003). The species was considered a game bird in Alberta and was hunted from 1967 through 1995. Hunting seasons were short with small bag limits. Demand was low and birds were hunted primarily as a trophy species (Canadian Sage-Grouse Recovery Team 2001).

1.4.2 Food habits

Sagebrush is important for food as well as cover (Braun *et al.* 1977, Connelly *et al.* 2000, Connelly *et al.* 2004, Patterson 1952), with leaves comprising virtually 100% of the Sage-Grouse winter diet (Connelly *et al.* 2004, Patterson 1952, Wallestad *et al.* 1975). Forbs and insects are dietary requirements at other times of the year (Drut *et al.* 1994a and 1994b, Wallestad *et al.* 1975) and may be critical for hen reproductive success (Barnett and Crawford 1994) as well as growth and survival of chicks (Johnson and Boyce 1990, Johnson and Boyce 1991, Huwer

2004). The availability of forbs to pre-laying hens can influence nest initiation, clutch size, and reproductive success (Barnett and Crawford 1994, Coggins 1998, Connelly *et al.* 2004).

Insects and forbs are essential in the diet of chicks (Connelly *et al.* 2004, Drut *et al.* 1994b, Fischer *et al.* 1996, Huwer 2004, Kerwin 1971, Klebenow and Gray 1968, Patterson 1952, Peterson 1970, Connelly *et al.* 2004), with insects comprising up to 60% of the diet of week-old chicks (Peterson 1970). Newly hatched chicks deprived of insects die within 10 days of hatching (Johnson and Boyce 1990). Chicks <21 days of age need 15 g of insects/chick/day for survival and development, while those >21 days of age need insects for optimal development (Johnson and Boyce 1991). Chicks begin to consume forbs at about two weeks of age (Klebenow and Gray 1994, Peterson 1970) and forbs comprise up to 80% of their diet during later summer months (Kerwin 1971). Sage-Grouse production is greater when >80% of the chick diet is comprised of insects and forbs (Drut *et al.* 1994b). Forbs are a rich source of protein and provide habitat that enhances the availability of insects (Huwer 2004). Adult Sage-Grouse consume sagebrush, forbs and insects (Rasmussen and Griner 1938, Wallestad *et al.* 1975) during summer with sagebrush comprising <60% of their diet during this period (Hanf *et al.* 1994, Wallestad *et al.* 1975). Although Thorpe (2002) notes that the majority of forbs used by Sage-Grouse during the summer (Kerwin 1971) are exotic species, indicative of heavily used range, it is unknown if these forbs are selected preferentially or if they are used as the only nutritional foods available in an altered environment.

1.4.3 Habitat requirements

Sage-Grouse have specific habitat requirements within the sagebrush-grassland complex for feeding and loafing sites, breeding areas, nesting cover, brood-rearing areas, and wintering grounds (Braun *et al.* 1977, Connelly *et al.* 2003). The majority of research on Sage-Grouse habitat comes from the U.S. range of big sagebrush (*Artemisia tridentata*) (Connelly *et al.* 2004), which is taller, more robust, and provides greater cover than the silver sagebrush (*A. cana*) found in prairie Canada (Aldridge 2001, Aldridge and Brigham 2002, Thorpe 2002, McAdam 2003). The descriptions below use information from both types of habitat.

Breeding Habitat

Leks are open areas of sparse vegetation (<26% ground cover) (Connelly *et al.* 2004, Patterson 1952) located slightly lower than surrounding areas, often near standing water (Aldridge 2000) with widely spaced sagebrush (7% cover, <10cm) (Peterson 1980). Leks range in size from 0.4 - 16 ha (Dalke *et al.* 1963, Patterson 1952, Scott 1942) and are typically surrounded by taller (15-30 cm) sagebrush flats (Peterson 1980) used for feeding, roosting, and nesting (Clark and Dube 1984, Peterson 1970, Thorpe *et al.* 2005). Females may pre-select areas with good nesting habitat, with lek site selection by males resulting from the presence of females (Connelly *et al.* 2000). Degradation of sagebrush flats near leks is an important factor in lek abandonment (McAdam 2003, Thorpe *et al.* 2005).

Nesting Habitat

Sage-Grouse nesting habitat is typically a broad area of sagebrush (>1 km^2 in Alberta) with horizontal and vertical vegetative diversity (Aldridge 2000). Alberta hens select large patches

containing a heterogeneous distribution of taller and denser sagebrush (Aldridge 2000, Aldridge and Brigham 2002, Aldridge 2005) and taller (>18 cm) but less dense grass cover than random (Aldridge 2000, Aldridge 2005, Aldridge and Brigham 2002). Herbaceous cover provides both scent and physical nest concealment (DeLong *et al.* 1995). Nesting habitat is usually located near leks with average lek-to-nest distance ranging from 1.1 to 6.2 km. Autenrieth (1981) found 85% of nests ≤6.4 km from leks and Wakkinen *et al.* (1992) found >90% of nests ≤3 km from leks. In Wyoming and Montana, Holloran (2005) and Moynahan *et al.* (in press [a]) found 64% and 60% of nests within 5 km of leks. In Alberta, average lek-to-nest distance is 4.7 km (0.42 – 15.4 km) with only 41% of nests located within 3.2 km of a lek (Aldridge 2000). The degree of fragmentation of prairie habitat is important to success of ground-nesting birds as nests in small patches (<100 ha) of cover are subject to higher nest depredation than those in large patches (>1000 ha) (Herkert *et al.* 2003).

Brood/Summer Habitat

During the first 2-3 weeks post-hatch, Sage-Grouse use brood-rearing areas near nest sites (<3 km) consisting of sagebrush habitat (Berry and Eng 1985, Connelly *et al.* 2000). These areas have less sagebrush cover (14% canopy), with a greater canopy (15%) of grasses and forbs (Autenrieth 1981, Kerwin 1971, Martin 1970, Sveum *et al.* 1998, Wallestad 1971) with a diversity of insects (Dunn and Braun 1986, Drut *et al.* 1994a), which are important criteria for brood habitat (Huwer 2004, Klebenow 1969, Sveum *et al.* 1998). As sagebrush habitat dries during June and July, hens with broods seek out mesic wet meadow sites that are also richer in forbs and insects, (Klebenow 1969, Patterson 1952) and select nearby areas with larger sagebrush for roosting and loafing (Dunn and Braun 1986). Availability of these mesic habitats may be a limiting factor in both Alberta and Saskatchewan (Aldridge 2000, Aldridge 2001, Aldridge and Brigham 2002) and the risk of chick death increases as the drought index increases (Aldridge 2005). Low availability of mesic forb habitat may result in hens and broods spending greater time using riskier habitats to meet daily nutritional requirements (Aldridge 2005). Males tend to move away from lek sites to separate summer habitat areas (up to 9 km) that provide high-density sagebrush cover (Hagen 1999). Hens and broods move into dense sagebrush in late summer and fall before moving to wintering grounds (Drut *et al.* 1994a, Patterson 1952, Wallestad 1971).

Winter Habitat

During the fall, Sage-Grouse congregate in sexually segregated flocks (Beck 1977, Eng and Schladweiler 1972, Connelly *et al.* 1988). Winter flocks normally consist of <50 birds (median = 10-16 birds for males, 15-20 birds for females) (Beck 1977). There has been little investigation into winter habitat used by Sage-Grouse in prairie Canada but in other areas, habitat used during winter is influenced by temperature, exposure to winds, and snow depth (Connelly *et al.* 2004). Sage-Grouse will burrow into snow to reduce exposure to inclement conditions (Beck 1977). Winter sites are commonly on west or south facing slopes (<5% slope) or drainages (Beck 1977, Crawford *et al.* 2004). Most winter sites consist of tall (25-80 cm), dense (>20% canopy) sagebrush (Crawford *et al.* 2004, Eng and Schladweiler 1972, Hagen 1999, Hanf *et al.* 1994, Wallestad 1975) with access to sagebrush above snow for food (Connelly *et al.* 2000, Crawford *et al.* 2004, Eng and Schladweiler 1972, Patterson 1952, Wallestad *et al.* 1975) and cover (Beck 1977). Females tend to use denser stands than males (Beck 1977).

Connelly *et al.* (2000) recommend maintenance of sagebrush with a canopy of 10-30% and plant height that is 25-30 cm above the snow.

1.4.4 Limiting factors

Aldridge (2005) suggests that only 11% of the entire sagebrush habitat in southeastern Alberta can be classed as primary or secondary nesting habitat with reasonable expectations of nest success. Evidence suggests that the availability of secure habitat for nesting and the lack of adequate forb and insect rich mesic habitat for chick survival is limiting in prairie Canada (Aldridge 2000, Aldridge 2005, Aldridge and Brigham 2003). Only 5% of this range can be considered primary or secondary brood rearing habitat with reasonable expectations of brood survival (source habitat) (Aldridge 2005). Finally, Aldridge (2005) considers 63% of the nesting habitat and 75% of the brood rearing habitat chosen and used by Sage-Grouse in Alberta to be high risk habitat for nests and broods, respectively, acting as sink habitat for production (high occurrence but low fitness). Sage-Grouse either miscue in their selection of habitat types or are forced, through habitat availability, to nest and rear broods in sink habitat with resulting poor annual production and recruitment (Aldridge 2005). The availability of quality winter habitat and the related effect on annual recruitment and survival has not been evaluated in Canada.

1.5 Threats

Sage-Grouse require large blocks of interconnected sagebrush habitats (Connelly *et al.* 2004, Patterson 1952). Habitat alteration that reduces patch size and removes or degrades the quality of sagebrush generally has negative consequences for all sagebrush obligates (Braun *et al.* 2002). Historically, bison (*Bison bison*), pronghorn (*Antilocapra americana*) and elk (*Cervus elaphus*) inhabited southern prairie Canada (Hood and Gould 1992, Rangeland Conservation Service Ltd. 2004), and varying levels of disturbance by grazing and fire resulted in a landscape typified by patchiness (England and DeVos 1969, Bradley and Wallis 1996, Hood and Gould 1992). Major factors involved in the decline of Sage-Grouse populations are the loss, fragmentation, and degradation of habitat (Braun 1998). Humans have altered all of the sagebrush-grassland range in North America (Braun 1998, Connelly *et al.* 2004, Perdix Professionals 2005) and the potential to sustain populations in an altered landscape is dependant on remaining suitable habitats to continue to provide the seasonally required habitat components. It is important to recognize that declines in Sage-Grouse populations have likely been caused by a complex of factors (Braun 1998) that also include predation, disease, direct mortality factors, alteration of hydrological regimes and climatic factors.

1.5.1 Habitat loss

Cultivation of sagebrush-grassland range is one of the primary causes of habitat loss and fragmentation across the North American Sage-Grouse range (Dalke *et al.* 1963, Harris 1998, McAdam 2003, Patterson 1952, Wallestad and Pyrah 1974). More than 70% of sagebrush-dominated rangeland has been converted to agricultural crops (Braun 1998) with losses of 80% in Saskatchewan since the early 1900s (Harris 1998). Loss of sagebrush habitat near leks has resulted in abandonment of leks in both Saskatchewan and Alberta (Aldridge 1998b, Dube 1993,

McAdam 2003). McAdam (2003) assessed habitat parameters around occupied and abandoned Sage-Grouse leks in Saskatchewan. Cultivation rates within 3.2 km of currently active leks were 5.4 ha/year from 1955 to 1971, and 24.3 ha/year from 1971 to 1996, while those rates at abandoned leks were 25.5 ha/year and 63.7 ha/year for the same time periods (McAdam 2003). On a finer temporal scale, Thorpe *et al.* (2005) suggested that cultivation may have contributed to loss of habitat and lek abandonment historically, but loss of habitat since 1981 has been insignificant. Cultivation since 1988 is not thought to be a causative factor in population declines and lek abandonment in Saskatchewan (McAdam 2003, Thorpe *et al.* 2005).

1.5.2 Habitat degradation

Livestock grazing is one of the major agricultural impacts on the Canadian prairie. There are 2.3 million cattle in Alberta Agriculture's Southern Region and 50% of the farmland (2.6 million ha) in that region is comprised of native pasture (Alberta Agriculture, Food and Rural Development 2003, Statistics Canada 2001). This magnitude of use is certain to have some impact on the vegetation composition and structure of native grasslands (Perdix Professionals 2005). For example, stocking intensity can markedly affect the amount of residual vegetation that remains after grazing (Van Poollen and Lacey 1979). There is some indication that a conservative level of grazing may be beneficial to Sage-Grouse. Natural succession on ungrazed range will result in climax vegetation communities (Bird 1961) leading to homogeneous plant composition (Rangeland Conservation Services Ltd. 2004). Light grazing maintains greater plant diversity (Stohlgren *et al.* 1999), and could increase abundance of forbs necessary for chick survival (Thorpe and Godwin 2003). Heavy grazing leads to natural selection for low-growing, prostrate forms of vegetation (Milchunas and Lauenroth 1993), which provides lower quality nesting cover. Thorpe and Godwin (2003) found that moderate grazing results in higher dominance of shorter grasses allowing forbs to flourish but also results in less vertical structure as cover for Sage-Grouse (Thorpe and Godwin 2003). Heavy grazing can decrease both annual and perennial forbs in grasslands (Hayes and Holl 2003). Depending on intensity, grazing can result in changes in habitat structure and species composition of both upland and riparian areas, and degradation of riparian habitat (Autenrieth *et al.* 1982, Call and Maser 1985, Patterson 1952, Rasmussen and Griner 1938). Thorpe and Godwin (2003) studied differences between grazed and ungrazed areas in Grasslands National Park. They looked at vegetation components important for sage grouse habitat and found only modest differences. This lack of difference was attributed to the fact that either grazing was at moderate levels, or because the period of protection in GNP had been too short for vegetation changes to become apparent; they concluded that vegetation patches that varied between lightly and heavily impacted may be needed to provide the best sage grouse habitat (Thorpe and Godwin 2003).

Removal of vegetation affects habitat suitability by increasing exposure of Sage-Grouse to predators and weather extremes (Aldridge 1998b). Reduction of tall grass and mid-height shrub cover in nesting habitat can increase nest predation rates (Gregg *et al.* 1994, Seida 1998, Watters *et al.* 2002). Residual grass cover in the spring following grazing is necessary for concealment of nests from predators (Beck and Mitchell 2000). Livestock grazing in Sage-Grouse range may result in trampling of sagebrush seedlings and a subsequent decline in sagebrush health in areas where cattle congregate (Adams *et al.* 2004, Connelly *et al.* 2000, Owens and Norton 1992) as well as a reduction in herbaceous understory required for secure nesting sites (Dobkin 1995). Adams *et al.* (2004) propose that silver sagebrush decreases in response to moderate to heavy

grazing intensity while Thorpe and Godwin (2003) suggest that silver sagebrush is an 'increaser' species in response to grazing. It may be that sagebrush is an increaser under light to moderate grazing (Thorpe and Godwin's study area) but a decreaser under moderate to heavy grazing intensity.

Prior to fire suppression, periodic fires were important in shaping the prairie landscape (Adams *et al.* 2004, Hood and Gould 1992, Rangeland Conservation Service Ltd. 2004) however, there is little information on the effects of fire in sagebrush areas. A combination of unburned and burned areas is often essential in providing a diversity of conditions needed to meet the requirements of species inhabiting sagebrush communities (Wrobleski and Kauffman 2003). Fire suppression is thought to increase big sagebrush canopy cover rendering it unsuitable as brood-rearing habitat (Kaufman 1990, Winward 1991). Fire can be used to open up dense sagebrush stands so that understory vegetation can increase (Nelle *et al.* 2000). Silver sagebrush, on the other hand, reproduces by both seeds and sprouting (Thorpe 2002). Light spring burning may result in increased production of new shoots (Adams *et al.* 2004) as well as resprouting in senescent plants or in areas trampled by livestock (Connelly *et al.* 2000, Owens and Norton 1992). There is a need for greater knowledge of the relationship between fire and the sagebrush community.

1.5.3 Habitat fragmentation

Human alteration of the environment via construction and water impoundments causes physical loss of sagebrush habitat (Braun 1998) and the creation of anthropogenic edge causes many bird species including Sage-Grouse to avoid areas adjacent to edges (Herkert 1994, Herkert *et al.* 2003, Holloran 2005, Howerter 2003, Koper 2004, Pasitchniak-Arts and Messier 1995, Stephens 2003). Noise and activity caused by humans disrupts local breeding activities and Sage-Grouse tend to avoid these areas (Braun 1998). Fences and power lines across sagebrush habitat create additional travel corridors for mammalian predators and perch sites for avian predators, effectively fragmenting Sage-Grouse habitat (Aldridge 1998b, Braun 1998).

Road construction impacts Sage-Grouse population viability by physically removing and fragmenting potential habitat as well as creating travel corridors for mammalian predators (Aldridge 1998b, Braun 1998). Increased vehicle traffic and disturbance of leks by people can disrupt breeding activities and may result in lek abandonment (Aldridge 1998b, Braun 1998, Connelly *et al.* 2000, Herkert *et al.* 2003). Even low levels of vehicular traffic (≤12 vehicles/day) within 3 km of leks may reduce nest initiation rates by hens and increase distances that hens move from leks during nest selection (Lyon and Anderson 2003). The avoidance of habitat near roads reduces range availability and contributes to decreased survival (Braun *et al.* 2002, Holloran 2005).

Increases in petroleum industry activities in southern Alberta in the late 1970s to early 1980s, and again in the 1990s coincide with dramatic Sage-Grouse population declines (Braun *et al.* 2002), although the declining Sage-Grouse population cannot be attributed to any single factor (Braun 1998). More than 1500 wells have been drilled within the Sage-Grouse range of southeastern Alberta and approximately 30% are still active (Braun *et al*. 2002). Exploration and extraction involves construction and/or operation of drilling rigs, pump jacks, pump shacks, compressor stations, as well as construction of roadways, pipelines, and power lines to service

these facilities (Aldridge 2000). Most of these activities result in either direct habitat alteration through removal of vegetative cover (Aldridge 1998b, Braun *et al.* 2002) or fragmentation and increased disturbance. Noise from nearby pump jacks disrupts breeding activity at leks (Aldridge 2005, Braun *et al.* 2002, Dube 1993, Holloran 2005) and leads to lek abandonment (Aldridge 2000, Holloran 2005). Hens with broods show strong avoidance of human dominated landscapes and the risk of brood failure increases substantially with each well site that is visible within 1 km of brood-rearing areas (Aldridge 2005). Impacts from oil and gas extraction activities are both short and long-term (Braun *et al.* 2002, Holloran 2005). In Alberta, disturbance by oil and gas extraction and construction near leks has resulted in abandonment of at least six leks (Aldridge 1998a, Braun *et al.* 2002, Dube 1993) and, although not the sole cause of Sage-Grouse declines, there is no question that these activities are a major contributor to the cumulative landscape effects that are suppressing populations.

Currently, there appears to be acceptable gene flow between birds in Alberta, northern Montana, and Saskatchewan (K. Bush, pers. comm., University of Alberta) but loss of habitat or avoidance of habitat linkages by Sage-Grouse due to anthropogenic impacts could result in effective fragmentation of populations and loss of genetic heterozygosity. Isolation of populations can result in inbreeding depression as exhibited in isolated populations of other lekking species such as Greater Prairie-Chickens (Westemeier *et al.* 1998). Associated effects of population isolation can include loss of genetic diversity, inbreeding, reproductive morphological deformities and, ultimately, population extirpation.

1.5.4 Predation

Golden Eagles (*Aquila chrysaetos*), Ferruginous Hawks (*Buteo regalis*), Red-tailed Hawks (*B. jamaicensis*), Swainson's Hawks (*B. swainsonii*), Rough-legged Hawks (*B. lagopus*), Gyrfalcons (*Falco rusticolus*), Northern Goshawks (*Accipiter gentilis*), Great Horned Owls (*Bubo virginianus*), Common Ravens (*Corvus corvax*), coyotes (*Canis latrans*), bobcats (*Felis rufus*), weasels (*Mustela* spp.) and American badgers (*Taxidea taxus*) are known to prey on Sage-Grouse (Autenrieth 1981, Schroeder *et al.* 1999, Patterson 1952). Northern Harriers (*Circus cyaneus*) and rattlesnakes (*Crotalus viridis*) are known to prey on Sage-Grouse chicks (Huwer 2004, Schroeder *et al.* 1999) and there is some indication that harriers may also attempt predation on adult males on leks (Fletcher *et al.* 2003). Coyotes, badgers, American Crows (*Corvus brachyrhynchos*), raccoons (*Procyon lotor*), skunks, weasels, red foxes, common Ravens, and Black-billed Magpies (*Pica pica*), are known predators of Sage-Grouse nests (Autenrieth 1981, Schroeder *et al.* 1999, Patterson 1952). Normal predation in an unaltered environment is not considered a limiting factor for Sage-Grouse (Connelly *et al.* 2000). Changes in predator and prey guild composition and abundance brought about by habitat alteration and human intrusion has an increasingly important effect on Sage-Grouse productivity (Aldridge and Brigham 2003). The cumulative result of these impacts appears to be manifested in low Sage-Grouse chick survival and recruitment into the breeding population despite high reproductive effort (Aldridge 2000, Aldridge 2005, Connelly *et al.* 2004). High predation rates are usually a secondary symptom of habitat deficiencies in an altered and fragmented habitat that does not provide protection from predators and may increase predator foraging efficiency through amplified amounts of edge (Braun 1998, Connelly *et al.* 2000, Greenwood *et al.* 1995, Sargeant

et al. 1993, Stephens 2003). For example, Sage-Grouse will avoid habitat within 600 m of power lines and risk from predators is increased within 1 km of power lines (Braun 1998).

There is some indication that the numbers of some predators (e.g., coyotes) have increased on the southern prairies (Hyslop 1998, Vriend and Gudmundson 1996), likely in response to low fur prices, declines in harvest for the fur trade, and changing intraguild dynamics with the loss of the prairie wolf (Canadian Sage-Grouse Recovery Team 2001, Pruss 1994). Raccoons have increased substantially in the Canadian prairies over the past 30 years (Lungle 1991). The Sage-Grouse range overlaps with the reintroduced swift fox (*Vulpes velox*), which is a historical predator of Sage-Grouse egg and chicks.

Farm and ranch yards also alter the natural environment and create microcosms suitable to support of a suite of predators (Connelly *et al.* 2004, Howerter 2003, Stephens 2003). Domestic dogs (*Canis familiaris*) and cats (*Felis cattus*) can be predators while wild species, such as red foxes (*Vulpes vulpes*), and skunks (*Mephitis mephitis*), readily adapt to and thrive in these altered environments (Connelly *et al.* 2004).

Declines in the populations of the primary prey species of predators may increase the impact of predation on Sage-Grouse. The abundance of small mammals as prey species for avian and mammalian predators is strongly influenced by the degree of grazing that occurs (Koper 2004, Skinner *et al.* 1995). Skinner *et al.* (1995) found that the greatest biomass of small mammals occurs on ungrazed grasslands, suggesting that grazing intensity plays a major role in determining the abundance of small mammals as a food source for avian and mammalian predators. Predation is also of major importance to hens with broods as the amount of forb and insect food decreases (Braun 1998). Poorer quality feeding areas may force birds to spend greater times fulfilling nutritional requirements, to feed in poorer quality and potentially riskier habitat, or to travel farther to obtain adequate food, resulting in greater risk of predation and greater energy expenditure (Gregg *et al.* 1993, Fischer *et al.* 1996, Pyle and Crawford 1996).

1.5.5 Disease

Sage-Grouse are host to a variety of parasites and disease-causing organisms (Connelly *et al.* 2004, Kerwin 1971) but these are not considered major mortality factors (Connelly *et al.* 2004, Patterson 1952). However, the recent discovery of West Nile virus (WNv) in Sage-Grouse populations may be cause for concern. Mortality from WNv was discovered in four populations of Sage-Grouse in 2003, (Alberta, Montana, Montana-Wyoming border, and Wyoming) (Moynahan *in press* [b], Naugle *et al.* 2004) with survival decreasing by 25% (Naugle *et al.* 2004, Walker *et al.* 2004). Late summer survival in the WNv areas of Montana and Wyoming was 20% compared to 76% outside of WNv-infected areas (Walker *et al.* 2004) and male and female lek attendance was substantially lower during the following spring (Walker *et al.* 2004). Although no WNv antibodies were found in 112 blood samples collected from live birds within the infected areas in 2003 (Naugle *et al.* 2004), subsequent sampling in Wyoming revealed that 10% of infected Sage-Grouse do survive WNv and develop antibodies (D. Naugle, pers. comm., University of Montana, Missoula). However, with very low Sage-Grouse survival rates, WNv could potentially be devastating for small, fragmented populations (Naugle *et al.* 2004).

1.5.6 Direct Mortality Factors

Hens and broods using cultivated crops (e.g. alfalfa fields) as foraging areas are subject to injury and mortality from farm equipment (Aldridge 2000, Patterson 1952). Increased traffic volumes on roads and trails can increase collisions with vehicles (Aldridge 2005). Physical structures in the sagebrush-grassland range can result in avoidance behaviour by Sage-Grouse (fragmentation effect) and increased predator foraging efficiency (predator perches). Sage-Grouse are also killed by flying into power lines and fences (Aldridge 2000, Patterson 1952) and structures, such as hydro line towers, or communication towers (Call and Maser 1985). The increasing focus on wind power as a source of electricity generation should be of concern (D. Eslinger, pers. comm. Alberta Sustainable Resource Development) especially if wind turbine towers are erected in or near Sage-Grouse habitat.

1.5.7 Alteration of Natural Hydrology

Water impoundments in xeric landscapes can affect the health of sagebrush communities and the availability of mesic meadows and the associated food sources necessary for chicks. Impediments to natural flow of waters reduce the frequency of flood events that are important for the maintenance of sagebrush habitat (McNeil and Sawyer 2001). In southeastern Alberta, the number of water impoundments has increased four-fold in the last 50 years (McNeil and Sawyer 2003). Watters *et al.* (2004) suggest that the number of dams within 3.2 km of leks in southern Saskatchewan has increased 20% in the last 50 years and the number of reservoirs (as a result of these dams) has more than doubled. Livestock use is often intensified near impoundments resulting in degradation of surrounding sagebrush habitat (Canadian Sage-Grouse Recovery Team 2001). Water impoundments >50 ha can result in loss of brood habitat, lek sites, and winter habitat (Braun 1998).

1.5.8 Climate

Climatic variation, when combined with other stressors, can compound the effects of other impacts. Anthropogenic threats are compounded by impacts of drought. Drought conditions may affect Sage-Grouse through reduced herbaceous cover at nests and decreased availability of forb vegetation and insects in wet meadows during spring and summer (Aldridge 1998b, Fischer *et al.* 1996, Hanf *et al.* 1994). The availability of forbs in upland sagebrush habitat fluctuates dramatically and rapidly in response to temperature and precipitation (Huwer 2004). McNeil and Sawyer (2003) suggest that the lack of significant precipitation events from 1978 to 1995 in southeastern Alberta compounded the effect of increased impediments to natural water flows and may have adversely impacted sagebrush habitat. Not only is vegetative growth reduced under drought conditions but also livestock grazing in wet meadow areas intensifies as these areas usually have better vegetation production than upland areas (Canadian Sage-Grouse Recovery Team 2001). There may be interspecific competition between wildlife species (pronghorn and Sage-Grouse) for food resources (sagebrush and/or forbs) during drought events. Drought can exacerbate the degradation of habitat by grazing livestock if stocking rates are not reduced dramatically during these periods (Braun 1998). Reduction in the quality of habitat and vegetative cover not only results in lower reproductive effort but the lack of adequate cover may also increase predation rates and brood mortality (Braun 1998). Birds that are already

reproductively stressed by other footprints on the landscape may not be able to cope with the additional stressor associated with drought conditions.

Years with good winter moisture carryover or springs with average or above average moisture regimes may result in increased Sage-Grouse production (Autenrieth 1981, Wallestad 1975). However, heavy rainfall during egg laying or unseasonably cold temperatures with precipitation during the hatch period may result in nest failure or poor hatch rates (Wallestad 1975).

1.6 Actions Already Completed or Underway

A number of initiatives have enhanced knowledge about Sage-Grouse in silver sagebrush communities of prairie Canada. Pertinent studies that have been completed or are in progress are:

- Ongoing annual spring surveys of strutting males at active and inactive leks in Alberta, Saskatchewan, and Grasslands National Park (pers. comm., S. McAdam, Saskatchewan Environment; D. Eslinger Alberta Sustainable Resource Development; P. Fargey, Parks Canada Agency).
- One spring aerial survey (2004) in search of new Sage-Grouse leks in southern Saskatchewan (pers. comm., S. McAdam).
- Aerial photographic interpretation/mapping of silver sagebrush communities in Alberta and Saskatchewan (Jones *et al.* 2005, Penniket and Associates Ltd. 2003, 2004).
- Relationships between silver sagebrush soils and landscapes associated with silver sagebrush and Sage-Grouse in Alberta with predictive mapping tools to assist in habitat management (McNeil and Sawyer 2001).
- Relationships between soil nutrients, grazing patterns and the presence or absence of active and inactive leks in southern Saskatchewan (King *et al.* 2005).
- The ecology of silver sagebrush and beneficial grazing management practices for Sage-Grouse in southeastern Alberta (Adams *et al.* 2004).
- Assessment of sagebrush range health and water impediments around Sage-Grouse leks in southern Saskatchewan with site plans for areas surrounding leks in the Frenchman Valley watershed, Saskatchewan (Watters *et al.* 2004).
- Effects of water impediments and precipitation on sagebrush habitat in southeastern Alberta (McNeil and Sawyer 2003).
- Habitat vegetative characteristics and land use patterns around active and inactive leks in southern Saskatchewan (McAdam 2003, Thorpe *et al.* 2005).
- Vegetative differences between grazed and ungrazed sagebrush lands in Grasslands National Park (Thorpe and Godwin 2003).
- Habitat use, habitat characteristics, and reproductive parameters of Sage-Grouse in southeastern Alberta (Aldridge 2002, 2005).
- Ongoing research (Ph.D. study – K. Bush, in progress) into level of historic and current genetic diversity and genetic isolation in Sage-Grouse populations in Alberta, Saskatchewan, and Montana.

- Established study sites to monitor relationship between livestock use and habitat characteristics pertinent to Sage-Grouse (D. Eslinger, pers. comm., Alberta Sustainable Resource Development).
- Completion of a provincial Sage-Grouse recovery plan for Alberta outlining objectives and strategies to be pursued to achieve population recovery (Alberta Sage-Grouse Recovery Action Group 2005)
- Completion of conservation plans by a multi-jurisdictional northern mixed-grass trans-boundary initiative for several ecosystem landscapes in southern Alberta, southern Saskatchewan, and northern Montana with Sage-Grouse as one of the target species of special significance (Smith Fargey 2004).

2 RECOVERY

2.1 Recovery Feasibility

Recovery of the Sage-Grouse in Canada is determined to be feasible because the species meets all the four necessary conditions (Environment Canada 2005), as described below.

1) Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?

Sage-Grouse populations in prairie Canada have exhibited marked declines over the past 3-4 decades and have remained relatively unchanged at low levels for the past five years. In Alberta, the population has remained between 90 – 136 males attending leks for the past 11 years (D. Eslinger, 2006, pers. comm., Alberta Sustainable Resource Development). Annual Canadian spring populations have averaged 530 to 785 birds. Annual recruitment (chick survival) is adequate for population maintenance but inadequate for significant population growth and recovery. Therefore, individuals capable of reproduction are available but increases in Sage-Grouse productivity and annual recruitment are needed for population growth.

2) Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?

There is sufficient habitat available to support Sage-Grouse populations particularly if land management initiatives favourable to Sage-Grouse are implemented. Much of the habitat utilized by Sage-Grouse in Alberta and Saskatchewan is crown owned land and used for grazing. Research has shown that there is good quality 'source' habitat being used by Sage-Grouse and annual productivity on these lands is sufficient for growth (Aldridge 2005). Sage-Grouse also use a considerable amount of 'sink' habitat (where reproduction is not sufficient to offset local mortality (Pulliam 1988)) that is sub-optimal for population growth, but has high potential for positive population growth with land management initiatives.

3) Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?

Sage-Grouse are listed as endangered in Alberta (*Alberta Wildlife Act*) and Saskatchewan (*Saskatchewan Wildlife Act*), with protection against the capturing, killing, or harming of birds, or destruction of nests. Although there is no specific legislative protection for Sage-Grouse habitat in Alberta, land use guidelines are in place with respect to activities and development around leks. The Saskatchewan *Wildlife Habitat Protection Act* provides protection for Sage-Grouse habitat by precluding cultivation of native vegetation and destruction of habitat without a permit. Lands within Grasslands National Park, SK may be the most secure with protection for Sage-Grouse and their habitat provided through the *Species At Risk Act* and the *National Parks Act*.

There is some awareness with respect to the plight of Sage-Grouse amongst land users and land use regulators across the current range of Sage-Grouse. Representatives of the agriculture industry, land use administrators, and industry are actively involved in planning and implementing Sage-Grouse protection and recovery efforts in Alberta. Efforts are being directed at development of best management practices for sagebrush-grassland complexes to provide optimal benefits to Sage-Grouse. With a collaborative effort directed at improving productive and sub-optimal habitats, current reproductive effort of Sage-Grouse can translate into annual recruitment that enables population recovery.

4) Do the necessary recovery techniques exist and are they demonstrated to be effective?

Techniques to enhance habitat for increased annual recruitment are unproven but studies incorporated into the Sage-Grouse recovery strategy and the Alberta Recovery Plan (Alberta Sage Grouse Recovery Action Group 2005) will provide valuable insight into best management practices for habitat enhancement. Efforts to develop best management practices for Sage-Grouse habitat are ongoing. Should catastrophic events (e.g., disease) occur that dramatically reduce Canadian populations, or if population genetic viability is questionable, translocation of Sage-Grouse from other jurisdictions could be pursued to augment existing populations or to promote population expansion.

2.2 Recovery Goals and Population and Distribution Objectives

Goals for recovery of Sage-Grouse populations are immediate, short-term, and long-term, with the recognition that these goals are established without the benefit of a population viability analysis. Goals may change pending results of such an assessment.

1. No loss of active Sage-Grouse leks or Sage-Grouse population numbers in any portion of the current Sage-Grouse range in Alberta and Saskatchewan.

2. By 2012, improve Sage-Grouse population status and productivity within Alberta and Saskatchewan so that all populations show a positive trend in the number of strutting males at leks and the number of active leks for the period of 2000 to 2012.

3. By 2026, achieve a stable or increasing Sage-Grouse population, based on historical averages, with
   - ≥ 365 strutting males at leks in Alberta (1968 to 1989 average, range 198-613), and ≥ 500 strutting males at leks in Saskatchewan (Canadian Sage-Grouse Recovery Team 2001), and
   - ≥ 16 active leks in Alberta (1968 to 1989 average, range 11-21), and ≥ 30 active leks in Saskatchewan (Canadian Sage-Grouse Recovery Team 2001).

2.3 Approaches Recommended to Meet Recovery Objectives

Table 1. Recovery Planning Table

(Critical = without which population will decline, urgent = needed to evaluate and guide recovery, necessary = beneficial to recovery)
(SG = Sage-Grouse)

Objective	Priority	Threat Addressed	General Strategies
Monitor Sage-Grouse populations and population parameters to evaluate progress towards population recovery and efficiency of recovery actions.	Urgent	All	Annually conduct spring counts of strutting males at all known active and inactive leks in AB and SK.
	Urgent	All	Once every 3 years, conduct spring surveys to search for new active leks in AB and SK.
	Urgent	All	By 2010, develop a winter survey methodology. Conduct annual winter surveys of SG populations in AB and SK.
	Urgent	All	By 2012, develop methodology for calculating productivity and recruitment index using results of spring lek surveys, winter population surveys and other techniques.
Maintain the reproductive and genetic viability of Sage-Grouse populations or segments of populations in prairie Canada.	Urgent	All	By 2008, conduct morphological and histological analysis for developmental anomalies and associated reproductive success using eggs from failed nests and abandoned eggs (analyses should be ongoing whenever hens are radio-collared)
	Urgent	Habitat fragmentation.	By 2009, assess genetic isolation and interchange of individual or groups of leks in Canadian and northern Montana SG
	Critical	Habitat loss, fragmentation.	By 2008, define genetic viability of Canadian SG leks or lek complexes and viability of small Canadian lek clusters.
	Urgent	Habitat fragmentation, degradation.	By 2009, determine need for translocation of SG into Canada, based on genetic analyses, population viability analyses, demographic evaluations, success of North American SG transplants, and the Alberta Recovery Plan.
	Urgent	Habitat loss, fragmentation.	By 2011, define boundaries of the Canada/northern Montana SG population, using genetic and ecological (telemetry) data.
	Necessary	Habitat loss, fragmentation.	By 2012, and every five years thereafter, assess (via blood, feather collection, etc.) the degree of genetic diversity and gene flow between Canada and northern Montana.
	Necessary	Habitat fragmentation	Opportunistically collect and preserve SG samples (blood, feathers, etc.) from range of SG in Canada and northern Montana, for future genetic analyses.
	Urgent	Habitat loss, fragmentation.	By 2012, collaboratively, develop and refine captive-breeding, translocation and reintroduction methods for SG.
	Urgent	Habitat fragmentation.	By 2009, quantify the degree of hybridization between SG and sharp-tailed grouse.
	Urgent	Habitat loss, degradation, fragmentation.	By 2012, identify core habitat areas essential for maintaining ecological linkages and gene flow between SG in Canada and northern Montana.

Objective	Priority	Threat Addressed	General Strategies
	Urgent	Habitat loss, degradation, fragmentation.	By 2016, work with jurisdictions to secure habitat linkages between SG sub-populations in Canada and northern Montana.
	Necessary		By 2016, establish and maintain a captive flock of SG with Alberta (or other appropriate stock) genetics to preserve genetics in perpetuity.
Determine environmental and anthropogenic factors affecting Sage-Grouse life requisites that may have caused post-1988 population declines, and may impede or contribute to population recovery. When possible develop mitigation measures.	Urgent	Disease, altered hydrology, climate.	By 2009, assess impacts of disease (West Nile virus and others) and parasites on SG annual recruitment, include potential losses as endemic mortality factors in population viability analyses and cumulative effects assessment. Monitor losses to disease and parasites and when possible develop mitigation measures (ongoing).
	Urgent	Habitat degradation, fragmentation, predation, altered hydrology, climate.	By 2009, initiate a predation study to evaluate the impacts on SG annual recruitment, determine relationships between land-use practices and predation rates, and role of predation within the suite of stressors (coordinate with surface water management and grazing research).
	Urgent	Habitat loss, fragmentation, degradation, predation, altered hydrology, climate.	By 2009, initiate research to assess the impacts of surface water management on viability and productivity of sagebrush communities, including relationships between water management and availability of insect and forage resources for SG within SG range in Canada (coordinate with predation and grazing research).
	Urgent	Habitat degradation, predation, altered hydrology, climate.	By 2009, initiate research to assess relationships between grazing management practices in silver sagebrush communities and hydrology in achieving optimal SG habitat conditions for all life cycle requisites (coordinate with predation and surface water management research).
	Urgent	Habitat degradation, climate.	By 2009, initiate studies to evaluate potential impacts of interspecific competition (e.g. pronghorn) for food resources (sagebrush and forbs) on SG productivity.
	Critical	Habitat loss, degradation, fragmentation, predation, altered hydrology.	By 2009, complete modeling to characterize anthropogenic footprint and cumulative effects of industry and agriculture within SG range in Canada. When possible develop mitigation measures.
	Critical	Habitat loss, degradation, predation, altered hydrology.	By 2009, work with Canadian and United States jurisdictions to develop best management practices for silver sagebrush communities that will result in habitat for all SG life requisites.
	Urgent	Habitat loss, degradation.	By 2009, work with producers, industry and policy-makers to conduct an evaluation of agriculture support programs and industrial policies to determine impacts on SG and SG habitat.
	Necessary	Habitat degradation, fragmentation.	By 2012, initiate research into the efficacy of using fire as a tool to stimulate or revitalize silver sagebrush communities.

Objective	Priority	Threat Addressed	General Strategies
Identify, secure, and enhance habitat of significant importance to the Sage-Grouse life cycle.	Critical	Habitat loss, degradation, fragmentation.	By 2008, define, identify and map all winter habitat used by SG in Alberta and Saskatchewan.
	Critical	Habitat loss, degradation, fragmentation.	By 2009, define, identify and map all 'source' and sub-optimal 'sink' nesting and brood rearing habitat used by SG in Alberta and Saskatchewan.
	Critical	Habitat fragmentation.	By 2008, complete a review to evaluate and refine land-use guidelines for industrial activity around leks.
	Urgent	Habitat degradation, fragmentation.	By 2009, develop techniques and methodologies for re-establishment and propagation of silver sagebrush within grassland communities.
	Critical	Habitat loss, degradation, fragmentation.	By 2008, conduct a 'risk analysis' to identify portions of SG range in Canada that could potentially be lost due to changes in land use and cultivation (e.g. irrigated potato production, conversion to tame forage/other crop types).
	Critical	Habitat fragmentation.	By 2008, contact all key land users within the SG range in Canada to encourage compliance with land-use guidelines to minimize disturbance and impacts on SG.
	Urgent	Habitat loss.	By 2010, secure all identified wintering habitat, all lek areas, and all 'source' and sub-optimal nesting and brood rearing habitat used by SG in Canada.
	Urgent	Habitat degradation, predation.	By 2011, determine the limiting factors within identified sub-optimal habitat used by SG.
	Urgent	Habitat degradation, fragmentation, loss.	By 2011, develop land-use guidelines for core nesting, brood rearing, and winter habitat used by SG.
	Urgent	Habitat loss, fragmentation.	By 2012, identify areas and develop maps of areas within current historical range of SG in Canada that have potential for re-establishment of silver sagebrush-grassland communities. Opportunities to include silver sage brush restoration and sage brush enhancement in areas proximal to SG should be pursued and encouraged though stewardship, agricultural, or other programs whenever possible.
	Urgent	Habitat degradation, fragmentation, altered hydrology, predation	By 2012, evaluate the productivity and habitat conditions on identified source habitat to determine management initiatives that can be applied to maximize SG annual recruitment.
	Urgent	Habitat degradation, fragmentation, predation, altered hydrology.	By 2012, initiate experimental habitat enhancement, within an adaptive resource management framework, on sub-optimal nesting and brood rearing habitat used by SG.
	Urgent	Habitat loss, fragmentation, predation.	By 2012, work with key industry stakeholders to decommission all unnecessary infrastructure and re-vegetate (when required) such sites into silver sagebrush communities.

Objective	Priority	Threat Addressed	General Strategies
Develop and maintain broad sector support for Sage-Grouse recovery and conservation efforts.	Urgent	Habitat loss, degradation, fragmentation.	By 2009, develop and distribute public and media-focused information products that promote recovery efforts and the need for conservation actions.
	Urgent	Habitat loss, degradation, fragmentation.	By 2009, develop and distribute agriculture and industry-focused information products that relate to impacts of disturbance on SG.
	Urgent	Habitat loss, degradation, fragmentation.	By 2009, contact all key industrial and agricultural stakeholders in SG range to promote enhancement of habitat for optimal recruitment and to enlist direct active involvement of producers and industry in conservation initiatives.
Integrate Sage-Grouse recovery efforts into broader conservation planning programs for prairie grassland species and prairie conservation initiatives.	Necessary	Habitat loss, degradation, fragmentation, predation, altered hydrology, direct mortality.	By 2008, integrate SG recovery into more comprehensive prairie conservation/endangered species planning initiatives. Coordinate with WAFWA Greater Sage-Grouse Comprehensive Conservation Strategy as needed / appropriate.
	Necessary	Habitat loss, degradation, fragmentation, predation, altered hydrology, direct mortality.	By 2009, coordinate a collaborative forum with recovery teams for other Canadian prairie grassland species at risk to explore landscape scale conservation initiatives that may be beneficial to all species concerned.

2.4 Narrative to Support Recovery Planning Table

Sage-Grouse populations in prairie Canada are precariously low with scattered distribution (Aldridge 1998a, Aldridge 2005). Canadian membership in and coordination with the Western Association of Fish and Wildlife Agencies (WAFWA) Greater Sage-Grouse Comprehensive Conservation Strategy (Stiver *et al.* 2006) is an important priority for successful cooperative Sage-Grouse and sagebrush conservation. Land management actions and an adaptive management approach are required for population maintenance and growth throughout the current and historic range. Well-designed experimental manipulations of important landscape factors within the fragmented prairie sagebrush-grassland ecosystem would be valuable. Manipulations should include resources dedicated to monitoring and evaluating effects in order to provide meaningful feedback to the adaptive resource management process (Aldridge *et al.* 2004a). Management efforts could be refined and improved through incorporation and application of knowledge gained from experimental manipulations. Objectives and strategies for recovery presented in Table 1 are based on cooperative, collaborative efforts by all sectors (wildlife and land managers, industry, agriculturists, and other wildlife enthusiasts) with a confirmed commitment to make an adaptive resource management process work.

Monitor Sage-Grouse populations and population parameters to evaluate progress towards population recovery and efficiency of recovery actions.

Annual spring lek surveys must be conducted to maintain a temporal index of population status and trends and to assess progress towards recovery goals. All occupied and, to the extent possible, abandoned leks should be monitored in accordance with accepted standards for lek monitoring (Connelly *et al.* 2004). Winter census techniques should be developed to provide baseline data on distribution and for an index of population recruitment and status. Efforts should be directed at using spring lek surveys in conjunction with winter population surveys to obtain non-intrusive indices to annual productivity and recruitment within Sage-Grouse populations.

Maintain the reproductive and genetic viability of Sage-Grouse populations or segments of populations in prairie Canada.

Genetic heterozygosity and gene flow within populations is critical for maintaining genetic viability of small populations (K. Bush pers. comm.). Fragmented populations with low genetic diversity may result in increased inbreeding and greater susceptibility to diseases and parasites (Oyler-McCance *et al.* 2005) or increased frequency of hybridization with sharp-tailed grouse (Aldridge *et al.* 2001). The boundaries of the northern Montana Sage-Grouse population, of which Canadian birds comprise a part, should be defined and habitat continuity maintained to ensure that genetic diversity and gene flow are not compromised. Currently, translocations are not generally accepted management practices since the size of populations are typically limited by the carrying capacity of existing habitats. However, the potential for, and the mechanics of Sage-Grouse translocations should be investigated. If populations or segments of populations are no longer considered to be genetically viable, or if catastrophic events occur (e.g., West Nile virus) that eliminate or endanger the viability of populations, translocation of birds from other

portions of prairie Canada or other jurisdictions may be a valid and justifiable management option.

Determine the environmental and anthropogenic factors affecting Sage-Grouse life requisites that may have caused the post-1988 population declines, and may impede or contribute to population recovery in an effort to mitigate these factors, if possible, in the future.

Research to improve knowledge about Sage-Grouse and the relationship between Sage-Grouse and land and water use is essential to provide feedback for adaptive resource management principles. Best range management practices must be developed for maintenance of the cattle industry while providing optimal breeding, nesting, brood rearing and winter habitat for Sage-Grouse. There is a need to monitor and assess the impact of potentially fatal/adverse health threats, including West Nile virus, on Sage-Grouse populations. Developmental anomalies and associated reproductive success should be studied using eggs from failed or abandoned nests. Additionally, if eggshells are collected, excess samples should be saved for potential screening for heavy metals and other contaminants. The potential for use of fire to enhance Sage-Grouse habitat, especially through stimulation of silver sagebrush growth, should be explored. Many water control structures exist on the prairie landscape, altering the natural hydrology. The impacts of these actions on Sage-Grouse productivity, especially maintenance of sagebrush and mesic meadows, should be investigated. All existing programs, policies, and incentives related to agriculture and the petroleum industry should be examined to determine if there are adverse impacts on Sage-Grouse population maintenance and recovery efforts. Collaborative efforts with policy-makers and industries may be required to ensure that industries remain viable without adverse impact on Sage-Grouse recovery. Modeling of cumulative effects of all environmental and anthropogenic stressors is essential to understanding impacts on Sage-Grouse population sustainability.

Identify, secure and enhance habitat of significant importance to the Sage-Grouse annual life cycle.

The lack of quality winter habitat can be detrimental to annual survival and recruitment in Sage-Grouse populations (Moynahan *et al. in press* (b)). Little is known about winter habitat use by Sage-Grouse in Canada and analysis of existing data (Aldridge *et al.* 2004b) is critical. Additionally, an understanding of Sage-Grouse movement to winter habitat, distribution of winter habitat, and physical characteristics of habitat requirements throughout the Canadian range is needed. Habitat areas within Sage-Grouse range that are critical to survival and reproduction (breeding, nesting, brood-rearing and winter habitat) must be identified, enhanced, and protected.

Both Alberta and Saskatchewan have land-use guidelines related to activities around leks (Canadian Sage-Grouse Recovery Team 2001) however, there is a need to re-examine them and determine if they provide adequate protection. There are currently no land-use guidelines related to critical nesting, brood rearing, or winter habitat. Although not yet approved, the Alberta guidelines have recently been re-drafted and contain buffer distances and timing windows for critical nesting, brood rearing and winter habitat for Sage-Grouse (D. Eslinger, pers.comm.,

Alberta Sustainable Resource Development). Collaborative development of land-use guidelines should be pursued with the direct involvement of industry and other land users. Monitoring of land-use activities should occur to ensure compliance with guidelines.

Research indicates that Sage-Grouse use both source (net population gain) and sink (net population loss) habitats (Aldridge 2005). Only 11% of the southern Alberta landscape is considered source habitat for nesting and only 5% is quality source habitat for brood rearing (Aldridge 2005). The majority of habitat used by Sage-Grouse is sink habitat. There is a need to identify all existing source and sink habitat within the current range of Sage-Grouse. Source habitats should be protected and managed to maintain or improve annual productivity. Sink habitats should be evaluated to determine factors that inhibit productivity and cooperative efforts with land users should be undertaken to convert sink habitat into source habitat.

The spatial distribution of Sage-Grouse in Canada has decreased substantially from historical periods (Canadian Sage-Grouse Recovery Team 2001). Unoccupied Sage-Grouse habitat should be evaluated for deficiencies and management efforts should be directed at modification of habitat to encourage population expansion into historic range.

Although knowledge about the cause of Sage-Grouse population declines and the relationships between Sage-Grouse and land use practices is far from comprehensive (Aldridge 2005, Connelly *et al.* 2004), this should not hamper implementation of well designed management actions directed at recovery. Initiatives should include resources for monitoring and evaluation to provide feedback into the adaptive management process.

Develop and maintain broad sector support for Sage-Grouse recovery and conservation efforts.

Recovery efforts can be more successful with broad sector support for conservation initiatives. Information and educational material should be developed to encourage awareness and support for Sage-Grouse conservation and recovery across all sectors of the general public. Information and extension efforts should be directed towards all land users, including industry, to encourage protection and enhancement of Sage-Grouse habitat and to take steps to minimize disturbance impacts. One example of some broader initiatives is the United States Geological Survey (2006) Sagemap website which is a gateway for current spatial data used in research and management of Sage-Grouse and shrub steppe systems. Additionally, the Local Working Group Locator Project (RS/GIS Laboratory 2006) is a forum for working groups, government and non-government agencies to catalogue and share Sage-Grouse conservation and habitat management information. Wherever possible, direct involvement of land users in conservation initiatives should be encouraged. Community-based initiatives result in shared ownership, shared goals, and shared successes.

Integrate Sage-Grouse recovery efforts into broader conservation planning programs for prairie grassland species and prairie conservation initiatives.

The Sage-Grouse is sagebrush obligate species that shares the sagebrush-grassland prairie habitat with other wildlife species that are at risk. Land use issues relevant to management of habitat for Sage-Grouse may be common to other prairie wildlife species. Efforts to enhance populations of Sage-Grouse should be coordinated with other initiatives or programs relevant to sustainable management of the prairie ecosystem. An important collaborative prairie conservation initiative is WAFWA's conservation assessment of the Greater Sage-Grouse and its habitat of which Phase I is an assessment of Greater Sage-Grouse populations and sagebrush ranges (Connelly *et al.* 2004). Phase II is a conservation strategy for Greater Sage-Grouse and sagebrush ranges that encompasses the entire historical distribution of potential sagebrush habitat (Stiver *et al.* 2006).

The WAFWA conservation goals involve local, state, provincial, and agency conservation strategies in addition to regional and range-wide strategies in an effort to augment and facilitate other conservation plans and strategies (Stiver *et al.* 2006). The conservation strategy proposes seven management zones that are biologically based Sage-Grouse and sagebrush areas which typically cross jurisdictional boundaries, thus necessitating continued collaboration and coordination for effective adaptive management (Stiver *et al.* 2006). Ultimately, the goal of the Strategy is to have positive or neutral population trends in all of the Management Zones by 2025.

Another important collaborative recovery initiative is the Alberta Greater Sage-Grouse Recovery Plan 2005-2010 written by the Alberta Sage Grouse Recovery Action Group (Alberta SGRAG 2005). The primary goal for this plan integrates well with this strategy and is quoted as follows:

1. Enhance and maintain habitat for Sage-Grouse to satisfy life cycle requirements in support of a viable population within its remaining historical range.

Whenever appropriate or practical, efforts will be made to coordinate with the Province of Alberta's recovery objectives outlined by the Alberta SCRAG (2005).
Specifically:

- Protect known current and historical lek sites.
- Enhance brooding, rearing and wintering habitat.
- Manage for appropriate range health on both public and private lands.
- Restore and enhance habitat quality through appropriate range management practices.
- Review effectiveness of current guidelines for oil and gas development on native prairie in relation to Sage-Grouse and amend as necessary.
- Disseminate information on the effects of industrial activities, grazing practices and recreational activities on Sage-Grouse.

2.5 Knowledge Gaps

Knowledge gaps:

- Lack of monitoring data on population recruitment as well as winter census methodologies
- Genetic viability and connectivity of prairie Sage-Grouse and the need to refine translocation methodology and develop the necessary expertise
- Best range management practices, cumulative effects, and natural processes that sustain silver sage habitats and the mitigation of anthropogenic changes and health threats
- Clarification of the factors causing the recent decline in Sage-Grouse and the specific habitat restoration required to generate more source habitat
- Location of winter habitat

2.6 Critical Habitat

Critical habitat cannot be identified for the Sage-Grouse at this time. While a considerable amount is known about Sage-Grouse habitat requirements, several knowledge gaps and technical activities must be addressed before critical habitat can be identified.

Partial identification will be based on currently available information and information that will be available from ongoing studies (initial results available as of March 2008). The general approach to identify Sage-Grouse critical habitat will be to use the nesting and brood rearing habitat model in Aldridge (2005) and extrapolate it to the recent historic distribution of sage grouse in Alberta and Saskatchewan. When available, recent information on wintering habitat will be added to this model. Only partial critical habitat identification is possible, as the information necessary for this model does not exist for the entire recent historic Saskatchewan distribution. Additionally, ongoing research is contributing new information on Sage Grouse habitat requirements.

A schedule of studies and supporting activities including an approach for consultation has been prepared. Completion of these steps should enable the identification of partial critical habitat in an addendum posted in December 2008. It is expected that with new information the majority of existing critical habitat in Alberta and Saskatchewan will be identified. Information on habitat requirements from studies in progress will facilitate our understanding of Sage Grouse habitat requirements. Comprehensive identification of critical habitat, necessary for the recovery of the species, will probably contain degraded habitat. Plans for restoring Sage-Grouse habitat will be part of the action plan.

2.6.1 Schedule of studies to identify critical habitat

Table 2. Schedule of Studies

Action	Completion Date
1) Synthesize the best available knowledge about the species' life history, population ecology, and habitat requirements.	
• Integrate existing information into a cumulative effects assessment of human disturbance. This would include the identification of knowledge gaps and future research and monitoring priorities. This would contribute to the development of best management practices and environmental assessment mitigations to be used in critical habitat management.	Fall 2007
2) Locate the species and appropriate habitat.	
• Compile historical information of the Saskatchewan lek (active and inactive) and observation database.	
• Conduct a population study(s) to determine winter habitat, and confirm the nesting and brood rearing habitat use relationships developed by Aldridge (2005) in other parts of the species distribution.	
• Compile the GIS base information needed to extrapolate the nesting and brood rearing habitat developed by Aldridge (2005) to the rest of the Albertan and Saskatchewan recent historic distribution to the extent that existing information allows	
• Where data is incomplete (e.g. air photo mapping of the distribution of silver sage for parts of Saskatchewan), the necessary GIS data will be developed as part of future planning/critical habitat identifications.	Draft maps March 2008.
• Use existing information and new information from ongoing population studies to identify the location of sage grouse wintering habitat.	
3) Post a partial critical habitat identification addendum	December 2008
4) Stakeholder Consultation on the action plan.	
• Consult with stakeholder representatives in communities proximal to Canadian Sage-Grouse habitat on the proposed action plan.	
• Gather information on the potential socio-economic impacts (positive and negative) of various critical habitat designation options and develop strategies for mitigating the socio-economic impact. Use this process with stakeholders to inform the larger socio-economic analyses.	
• Evaluate the potential ecological, social, and economic impacts and mitigations for critical habitat identification, protection, enhancement, and management.	November 2008 – April 2009
5) Final Draft Action Plan Ready for Final Review/Approval	July 2011

2.7 Effects On Other Species

Please refer to the Strategic Environmental Assessment (Forrestall 2006) summary at the beginning of this document.

2.8 Statement on Action Plans

The identification of partial critical habitat will be made in a recovery strategy addendum posted in December 2008. A draft action plan will be ready for approval in July 2011. Within the next 5 years the focus will be on critical habitat, research, and partnerships. The complete action plan for Sage-Grouse will be a cooperative effort when and if possible for all jurisdictions involved.

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APPENDIX A: PARTICIPANTS AT THE FEBRUARY 9 AND 10, 2006 RECOVERY STRATEGY DEVELOPMENT WORKSHOP

Participant	Affiliation
Barry Adams	Alberta Sustainable Resource Development, Public Lands and Forests Division, Range Management Branch
Bill Bristol	Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration
Dwight Bunnell	Coordinator, Sage-Grouse Conservation Planning Team, Western Association of Fish and Wildlife Agencies
Krissy Bush	University of Alberta
Jennifer Carpenter	University of Alberta
Diane Casimir	Calgary Zoological Society
Jennifer Chandler	Alberta Sustainable Resource Development, Fish and Wildlife Division
Dale Eslinger	Alberta Sustainable Resource Development, Fish and Wildlife Division
Pat Fargey	Parks Canada Agency, Grasslands National Park of Canada
Guy Greenaway	Mistakis Institute of the Rockies
Ken Lungle	Perdix Professionals
Sue McAdam	Saskatchewan Environment
Glen McMaster	Saskatchewan Watershed Authority
Ron McNeil	Landwise Inc.
Dave Naugle	University of Montana, Missoula
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Jeff Thorpe	Saskatchewan Research Council
Lorne Veitch	Saskatchewan Agriculture and Food

APPENDIX B: SAGE-GROUSE LEK COUNT DATA AND POPULATION ESTIMATES IN ALBERTA FOR 1968-2005.

Year	# Leks Checked	# Active Leks	Total # Males	# Males/Lek	Spring Popn. Low Est.	Spring Popn. High Est.
1968	21	21	613	29.2	1839	2724
1969	21	19	554	29.2	1662	2462
1975	20	19	212	11.2	636	942
1976	19	19	347	18.3	1041	1542
1977	13	13	286	22.0	858	1271
1978	14	13	235	18.1	705	1044
1979	11	11	198	18.0	594	880
1980	17	16	482	30.1	1446	2142
1981	16	16	524	32.8	1572	2329
1983	18	18	358	19.9	1074	1591
1985	15	14	208	14.9	624	924
1987	13	13	400	30.8	1200	1778
1989	12	12	344	28.7	1032	1529
1991	12	11	241	21.9	723	1071
1994	22	8	70	8.8	210	311
1995	27	12	110	9.2	330	489
1996	12	10	136	12.4	408	604
1997	31	8	122	15.3	366	542
1998	31	8	124	15.5	372	551
1999	31	9	117	13.0	351	520
2000	31	8	126	15.8	378	560
2001	32	9	114	12.7	342	507
2002	32	10	91	9.1	273	404
2003	32	9	96	10.7	288	427
2004	32	9	94	10.4	282	418
2005	32	9	95	10.6	285	422

Data provided by Alberta Sustainable Resource Development.

APPENDIX C: SAGE-GROUSE LEK COUNT DATA AND POPULATION ESTIMATES IN SASKATCHEWAN FOR 1970-2005.

Appendix 2. Sage-Grouse lek count data and population estimates in Saskatchewan for 1988-2005.

Year	# Leks Checked	# Active Leks	Total # Males	# Males/Lek	Spring Popn. Low Estimate	Spring Popn. High Estimate
* 1970	5	5	133	26.6		
*1971	8	7	199	28.4		
*1983	13	12	144	12.0		
*1987	45	29	497	17.1		
1988	**170	61	934	15.3	2802	4151
*1989	15	7	94	13.4		
1994	71	15	93	6.2	279	413
1995	56	16	105	6.6	315	467
1996	47	19	123	6.5	369	547
1997	26	10	61	6.1	183	271
1998	18	11	122	11.1	366	542
1999	27	8	101	12.6	303	449
2000	37	10	126	12.6	378	560
2001	19	10	106	10.6	318	471
2002	21	10	84	8.4	252	373
2003	17	10	81	8.1	243	360
2004	18	8	60	7.5	180	267
2005	11	8	62	7.8	186	276

Data provided by Saskatchewan Environment and Resource Management
Note * denotes partial survey of Sage Grouse Range in Saskatchewan
** number of potential lek locations surveyed.