DEVELOPING A HABITAT-BASED POPULATION VIABILITY MODEL FOR SAGE-GROUSE IN SOUTHEASTERN ALBERTA

FINAL PROJECT REPORT FOR

2002 SAGE-GROUSE FUNDING PARTNERS

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ABSTRACT

The Alberta Sage-Grouse population has declined by 66-92% over the last 30 years. Previous research in Alberta suggests that the population has declined as a result of poor recruitment. Low levels of recruitment appear to be linked to poor chick survival as a result of limited mesic sites important for brood rearing habitat. My population model developed from 1998 and 199 data suggested that the population would continue to decrease, resulting in only 113 counted on leks in 2002. I counted only 97 males at seven active leks in 2002. Nest success (14%) and chick survival (0-9%) were both the lowest ever recorded. However, chick sample sizes were extremely low, as only 5/37 nests were successful due to cold and wet extreme weather events during the spring. I assessed habitat use and selection at nest sites, brood-rearing locations, and at summer loafing sites to obtain an understanding of the importance of habitat and resources to the population. Tracking of radiocollared female Sage-Grouse extended into the fall and will continue throughout the winter under a collaborative project with Alberta Fish and Wildlife and the Alberta Conservation Association; allowing us to assess winter habitat selection and survival. All of these data will be used to develop population and habitat models that will allow me to conduct population viability analyses for the Alberta Sage-Grouse population.

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INTRODUCTION

Sage-Grouse (*Centrocercus urophasianus*) historically occurred in British Columbia, Alberta, Saskatchewan and 16 U. S. States, but today, they have been extirpated from British Columbia and five states (Braun 1998). Throughout their range, Sage-Grouse have declined by an estimated 45-80% since the 1950s (Braun 1998). The decline has been most severe at the northern fringe of the species' range, with the Alberta population experiencing a 66-92% decline over the last 30 years (Aldridge and Brigham 2001). The reasons for this decline are uncertain, but previous research in Alberta suggests that poor quality habitat has reduced survival, particularly that of chicks (Aldridge and Brigham 2002). From this research, the population decline appears to be a result of high juvenile mortality leading to poor juvenile recruitment (Aldridge and Brigham 2001). Chick survival may be limited by available escape cover, due to limited grass cover and sagebrush (*Artemisia cana*) cover in southern Alberta (Aldridge and Brigham 2002). However, the lack of mesic sites, and thus, lush forbs (Aldridge and Brigham 2002) that are important in the diet of chicks (Johnson and Boyce 1990, Drut et al. 1994, Sveum et al. 1998) also may have reduced chick survival. Grass height is positively correlated with nest success for both artificial and natural Sage-Grouse nests (Aldridge and Brigham 2001, Watters et al. 2002), suggesting that habitat management could benefit both Sage-Grouse productivity and chick survival (Aldridge 2000a).

OBJECTIVES

The overall goal of this research was to relate habitat characteristics to measures of Sage-Grouse productivity, survival, and ultimately, the viability of the population. I will use resource selection functions (RSFs) to develop statistically rigorous habitat models. I will then use

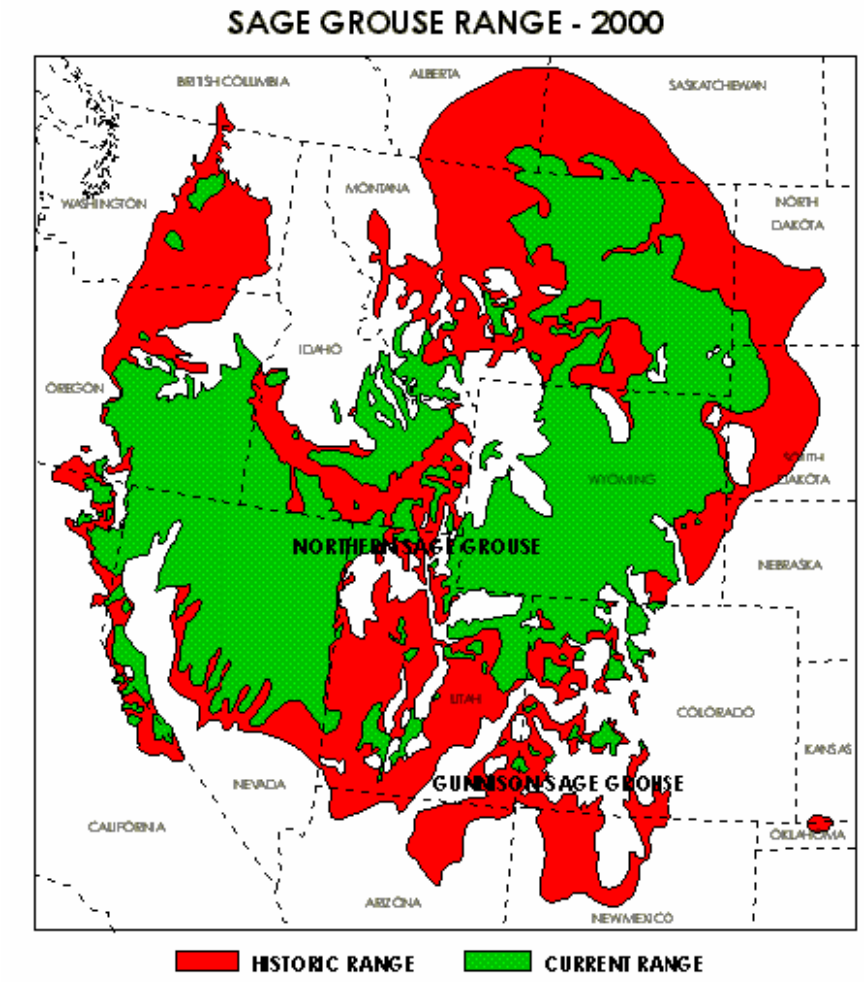

Figure 1. Current and known historic distribution of northern or greater sage-grouse (*Centrocercus urophasianus*) and Gunnison sage-grouse (*Centrocercus minimus*) in North America. (Map Provided by Michael Schroeder, Washington Department of Fish and Wildlife).

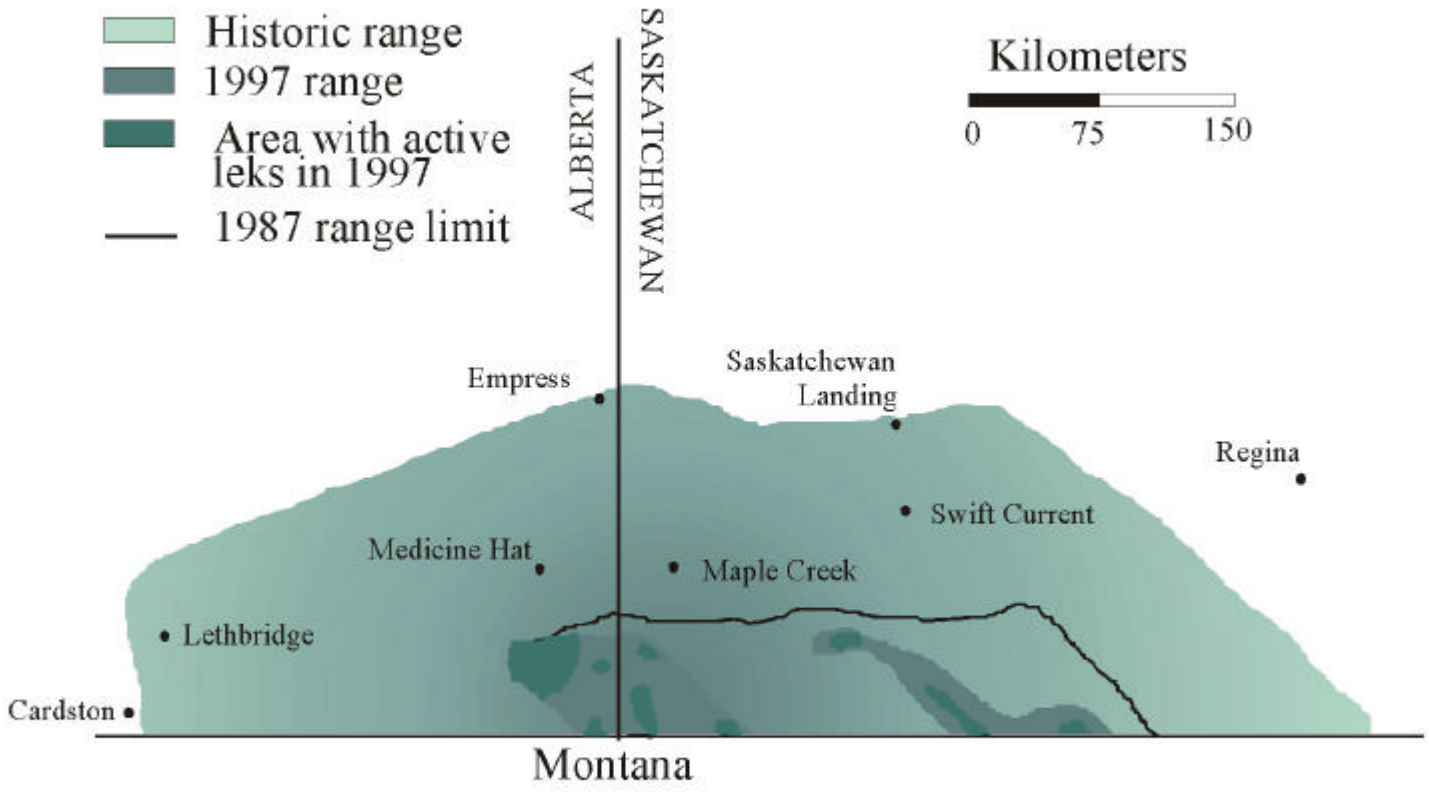

Figure 2. Range of Sage-Grouse in Canada. Historical range is based on anecdotal sightings of birds prior to the 1960s. The present (1997) range is based on the locations of known active leks in 1997. The 1987 range limits are shown to illustrate the range contraction.

measured population parameters to link these habitat models to population models and conduct habitat-based population viability analyses.

Specific Objectives include:

1) Monitor population though lek surveys, and trapping, as well as reproductive effort, reproductive success, recruitment, and survival, focusing on females and chicks.
2) Improve 1999 population model based on variability in these parameters.
3) Assess habitat use at various life history stages using RSFs (specifically nesting and brood-rearing periods and at wintering areas).
4) Assess chick survival (hatch to fledge); overwinter survival (estimate recruitment).
5) Develop habitat use/probability maps to aid in habitat management for Sage-Grouse.
6) Develop a habitat-based population viability model for Sage-Grouse.
7) *Develop active adaptive management strategies for Sage-Grouse i.e. We are working with landowners ACA, and AB SRD to implement experimental grazing manipulations to increase residual grass and litter cover, increasing moisture retention and forb growth.
8) *Ultimately, understand the effects of manipulations; how Sage Grouse respond to/use them (selection of nests/brood sites within manipulations; nest success/chick survival).

*Ongoing Process-habitat response may take several years, then we can measure grouse response

STUDY AREA

The study area is about 4,000 km^2 in size and is located in the southeastern corner of Alberta, south of the Cypress Hills and east to the Saskatchewan border (Fig. 2). This area represents the core range of Sage-Grouse in Canada and is composed of semi-arid mixed-grass prairie, with an abundance of silver sage (Aldridge 2000a).

METHODS

Lek counts were conducted from 30 March to 06 June 2002 at all previously known Sage-Grouse leks to obtain population estimates. Birds were trapped by spotlighting with a long-handled hoop net (Giesen et al. 1982) or in walk-in traps (Schroeder and Braun 1991). Only females received necklace style radio transmitters (Holohil Systems Inc., Carp, Ontario).

Once released, Sage-Grouse were tracked using a 5-element Yagi antenna and an R-1000 scanning telemetry receiver (Communications Specialists, Inc. Orange, CA). Birds were located using triangulation techniques until visually observed. Females were located and observed every other day during the nesting period (Musil et al. 1994, Schroeder 1997, Aldridge 2000a) in order to allow for nest fate to be determined, remaining at least 30 m from the nest site (Aldridge 2000a). Nest fate was determined and various measures of reproductive success were estimated (see Aldridge and Brigham 2001). Nest success was estimated as the % of all nests that hatched ≥ 1 egg. Chick survival was estimated as the % of hatched chicks that lived ≥ 50 days.

After nesting efforts ceased, nest site characteristics were measured (see Aldridge and Brigham 2002). At each nest site, the percent sagebrush canopy coverage, as well as the percent cover of grasses, forbs, non-palatable forbs (to Sage-Grouse), other shrubs and bare ground/dead materials was estimated within a 1 m^2 quadrat using a method similar to Daubenmire's (1959), as well as the amount of residual grass cover and litter build up. The mean maximum height of the each variable was also calculated for each plot. To determine if habitat characteristics near nest sites are important, eight additional dependent non-random 1 m squared plots were placed at 7.5 and 15 m in each of the four ordinal directions and the same measurements were performed (Aldridge 2000a). A modification of Canfield's (1941) line intercept method was used to estimate the live sagebrush canopy coverage along four 15 m transects radiating from the nest site in each ordinal direction (Aldridge 2000a). A similar set of habitat characteristics were also measured at random sites, 100 to 500 m in a random direction from the nest site (dependent random plots). At all brood locations and paired random locations, I also placed nine insect pitfall traps (400 ml plastic beer cups) with 250 ml of a mild soap solution. One trap was placed at the use site, and one trap was placed 5 m and 10 m away in each of the 4 ordinal directions.

I followed radio-collared birds throughout the spring and summer to determine habitat use. Each week, females, with or without broods were tracked (Musil et al. 1994, Schroeder 1997, Aldridge and Brigham 2002) and the same habitat measurements described for nest sites were performed. Brooding females were not intentionally flushed until chicks were at least three weeks of age, and then brood flush counts were performed to estimate chick survival when females were located. I attempted to capture two chicks from each brood and fit each with a transmitter.

Chick transmitters were attached along the dorsal midline with two sutures (5-0 non-absorbable sterile surgical thread, Aldridge 2000b). I applied a small drop of Skin-Bond surgical adhesive (Smith and Nephew Inc., Largo, FL) between the transmitter and the chick's back before tying the sutures to ensure that the transmitter and sutures did not catch on any vegetation as the chick grew. Chicks were triangulated every second day to determine if they were still alive. The goal was to recapture these radio-tagged chicks at 12 weeks of age, and replace their transmitters with a full size necklace-style adult transmitter.

RESULTS

Population Trends

In 2001, lek counts over the strutting period resulted in a maximum count of 97 males on seven active leks (Fig. 3). The decline observed over the last several years is continuing, with 97 males the lowest observed since 1994 (Fig. 3). All historical lek locations were checked for signs of use, and all seven leks actively used in 2001 were used in 2002. However, the maximum number of males decreased for each lek (Fig. 3).

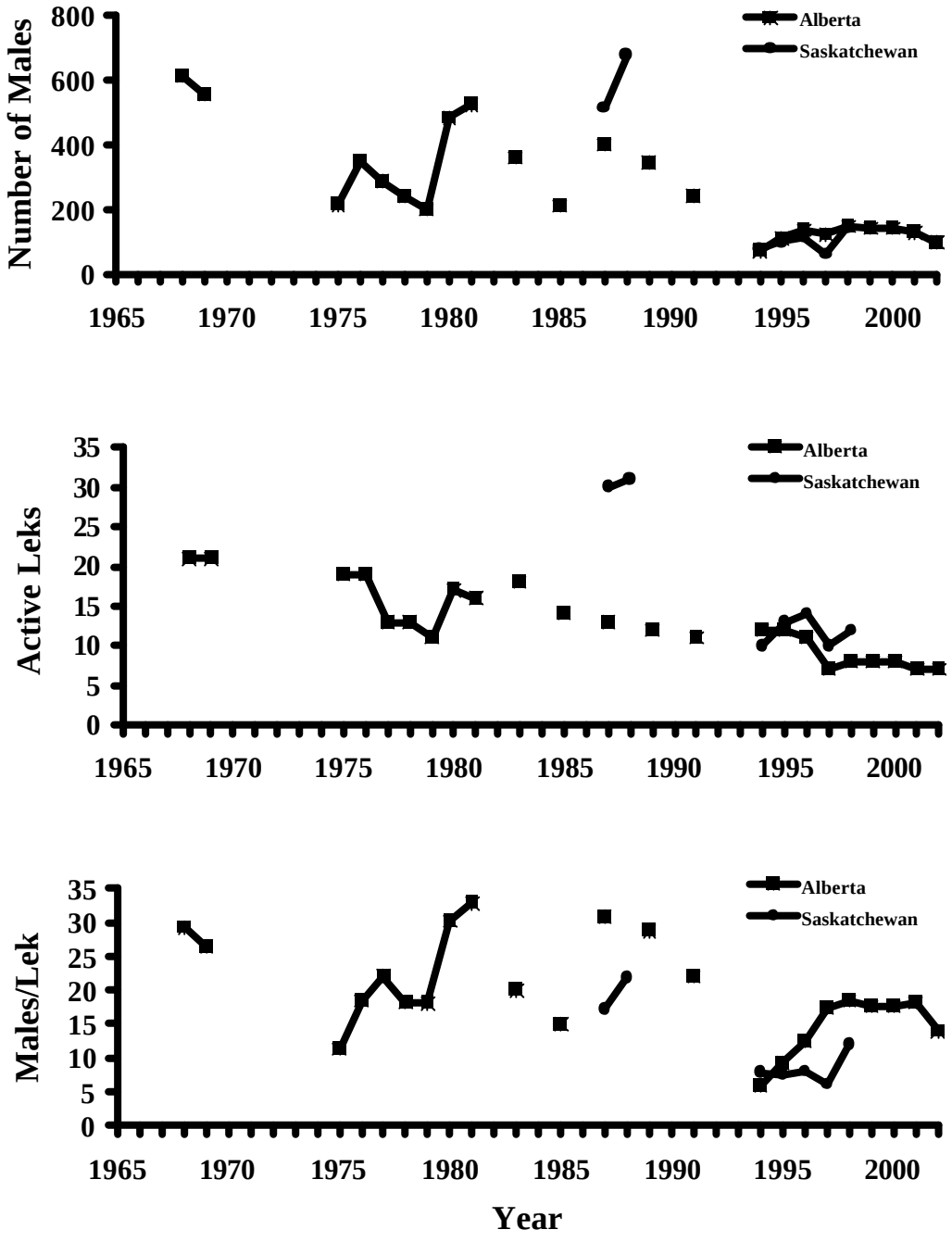

Figure 3. Population trends for Sage-Grouse in Alberta and Saskatchewan over the past 34 years. Shown as the number of males, number of males per lek, and number of active leks. Years when sampling efforts consisted of less than eight surveyed leks were not included.

Adult Data

At the beginning of spring 2002, I located the radio signals of 4 previously collared females that had died over the winter. I also was able to locate the radio signals of 15 females collared in previous years that survived over the winter. I captured a total of 18 new females during the 2002 breeding season (16 adults and 2 yearlings). I also recapture 3 adults that I was tracking from previous years, and a fourth adult female whose radio collar had died. I replaced all 4 collars. Thus, I had a total of 34 females radiocollared in the spring of the 2002. I captured 23 males (17 adults and 6 yearlings) during the 2002 breeding season (Table 1). Of the 23 males captured, only 6 were birds captured from previous years. Masses of males and females (adults and yearlings) were similar to masses in previous years (Table 1). All females received a radio transmitter. Of the 47 captures in 2002, 17% were yearlings.

Table 1. Body mass for birds captured in the 2002 breeding season in Alberta and the number of birds that received radiotransmitters. Results include recaptures of four females collared in previous years. These females were fitted with new collars. Standard Errors are shown in brackets.

	Adults		Yearlings	
	Males	Female	Male	Female
Captures	19	20	6	2
Mass	3195 (45.8)	1582 (29.7)	2779 (86.4)	1372 (44.0)
Radios	0	20	0	2

Reproductive Activities

Of the 34 collared females, one female chose to move onto land that I did not have access to. I relocated here from a fixed-wing aircraft throughout the breading season and summer. She likely nested there, as she displayed similar movement patterns in 2001. Two females died prior to the breeding season, and 3 females disappeared prior to the breeding season, possibly due to

faulty transmitters, or being killed. Thus, I gathered breeding information for 28 females in 2002.

I located nest for all but 1 of these 28 females. However, this individual displayed localized movements and likely initiated both first and second nesting attempts that were destroyed prior to incubation, preventing nest identification. Six additional females also displayed localized movements and likely lost their initial nesting attempts prior to identification, but I was able to locate a second nesting attempt for each female.

I located a total of 37 nests produced by 28 different females. Twenty-one of these were initial nesting attempts and 16 were renesting attempts. Nest success was extremely low at only 13.5% (5/37 nests). This was a direct result of rare weather events; a large mid-May snow storm and 3 days of continuous cold rain in early June resulted in the abandonment at least 6 nests. Two of21 initial nesting attempts were successful. One female lost her chicks a few days after hatch, prior to locating them. The second female and her chicks succumbed to cold weather shortly after hatching, when the nest became an island surrounded by freezing water. Six females were killed shortly after their first nesting attempt failed, and the radiocollar on one female died while she was on her first nesting attempt, after 4 years of data collection. Thus, excluding the one female that I could not find a first or second nesting attempt for, 86% (18/21) of females renested after their initial nesting attempt failed (this includes the six females that I could not locate initial nesting attempts for).

Clutch size was 7.1 eggs per nest (± 0.43, n=34) for all nests and 8.8 eggs per nest (8.8 ± 0.20, n=5) for successful nests. Disregarding the six abandoned nests, egg viability was (86%) with 6 of 44 eggs laid in the five successful nests failing to hatch. However, when including abandoned nests, only 42.2% (38/90) of eggs were viable.

I continued to track the remaining females throughout the summer. I capture and fitted a radiocollar to one new female in the summer. Three females died after the breeding season, 1 female disappeared and 17 radiocollared females were still alive near the end of August. Data are currently being compiled for long-term survival analyses.

Chick Transmitters

As a result of poor nesting success, we were only able to capture a total of 10 chicks out of an estimated total hatch of 43 chicks. However, two of these brood were lost within a couple of days after hatch, so the 10 chicks captured were from three different broods and an estimated 17 total hatched chicks. I affixed transmitters to 2 chicks from each brood. All chicks were captured within three days of hatching, and averaged 34 ± 0.8 g at the time of capture (Table 1). Transmitters weighed 1.6 g, representing a 4.7% increase in mass of newly hatched chicks. Chick survival from the radio tagged chicks was 0% (0/3), with 3 of 6 collared chicks being killed between 10 and 29 days after capture. The predator for one of the 3 killed chicks could not be identified, one of the chick's transmitter was found in coyote scat, and based on feather remains, I speculated that a raptor killed the third chick. The fate of the other three chicks is unknown. Flush counts indicated that only one of the five successfully nesting females had a brood (only 1 chick survived) survive past 50 days of age; (two females lost their chicks immediately after hatch). However, one other female had 3 chicks (33 days old) on the last day I was able to track her before moving onto land that I was refused access for. Assuming these 3 chicks survived to 50 days of age, chick survival from flush counts was about 9% (4/43 chicks).

Habitat Measurements

I gathered vegetation data at 140 Sage-Grouse use sites and 140 random locations. This included 37 nest sites, 14 brood rearing locations from 3 different broods, and 89 from broodless

female locations. I collected data on insect availability at each brood use and corresponding random location. This insect/food selection and availability data will be analyzed in the future with habitat data, and incorporated into resource selection models.

DISCUSSION

The population model that I developed based on my M.Sc. research predicted that the Alberta Sage-Grouse population should continue to decline from 2000 to 2002 (Fig.4; Aldridge 2001a). The model suggested that the population should decrease from a spring estimate of 420 to 622 individuals in 1999, to between 340 -504 individuals in 2002 (Aldridge 2000a). Thus, the

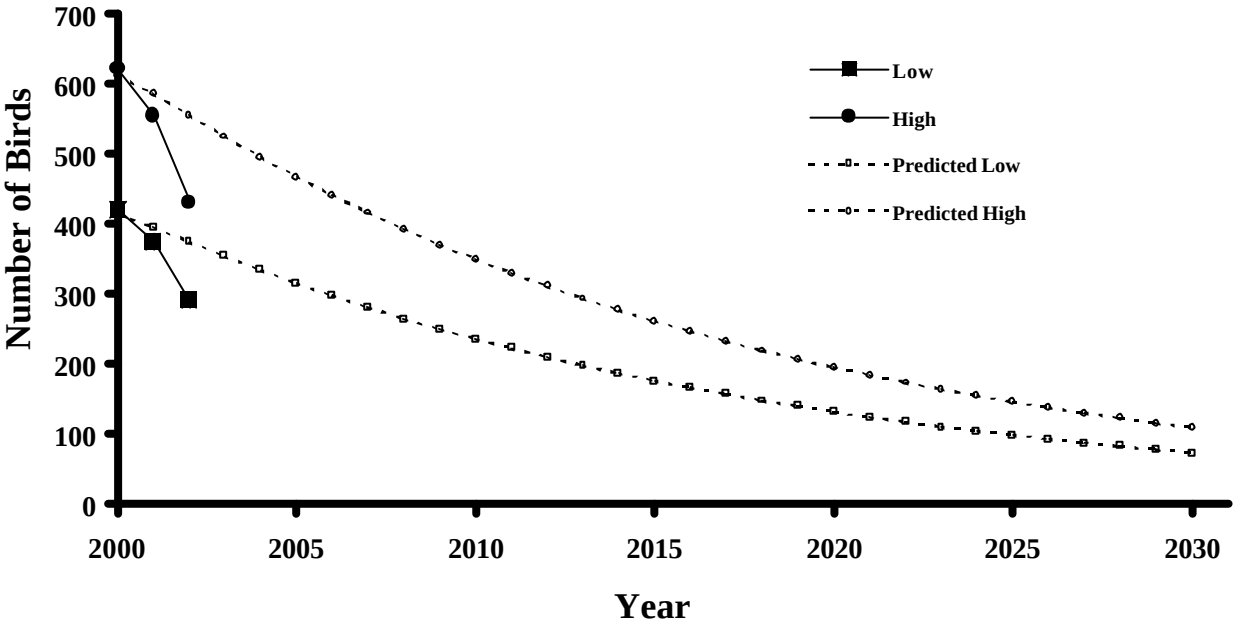

Figure 4. Predicted Alberta Sage-Grouse population projections from 2000 to 2030 shown with actual population High and Low estimates from for 2001-2003 superimposed. Model predictions are based on Aldridge (2000a) and data from 1998 and 1999.

number of males attending leks was predicted to decline from 140 males in 1999 to 113 in 2002. I only counted 97 males on leks in 2002, giving a lower than predicted population estimate of

291 to 431 individuals (Fig. 4). With continued drought conditions and the lowest recorded nest success and chick survival in 2001 (Aldridge 2001b), the population was expected to decline at a rate greater than predicted (Aldridge 2000) by the population model. While lower than expected, the 2002 spring Sage-Grouse population estimate (291-431) still overlaps with the predicted estimate (Fig. 4).

While this model is useful for predicting the general population trends, caution needs to be used when predicting the actual population size, especially when all of the assumptions of lek counts are considered (Braun et al. 1977, Jenni and Hartzler 1978, Aldridge 2000a). Each parameter in the model is highly variable, and variability inherent in each parameter has yet to be incorporated into the model predictions.

Mean clutch size for Sage-Grouse typically ranges from 6-9 eggs (Patterson 1952, Connelly et al. 1993, Schroeder 1997, Schroeder et al. 1999). In the past, clutch size in Alberta has averaged from 6.9 to 7.75 eggs per nest (Aldridge and Brigham 2001, Aldridge 2000b, 2001b). Despite the dry winter and beginning of spring which may have limited food resources that are important to pre-laying hens (Barnett and Crawford 1994), clutch size in 2002 was within the expected range; 7.1 eggs for all nests, and 8.8 eggs for successful nests.

Nest success in 2002 (13.5%) was the lowest ever recorded for this population (37% to 46%; Aldridge and Brigham 2001, Aldridge 2001a). A large mid-May snow storm and three days of continuous cold and heavy rains resulted in at least six nests being abandoned; for at least four of these nests, the female incubated the unviable (frozen early in incubation) eggs for 30 or more days before she abandoned her nest. Early failure of first nesting attempts and suitable late spring moisture probably resulted in suitable resources and resulted in high renesting effort in 2002; 86% of 21 females renested.

It was difficult to obtain suitable estimates of chick survival in 2002, with only five successful nesting attempts, for two of which broods were lost within a couple of days after hatch. Severe weather events limited out sample size and also contributed to the lowest estimates of chick survival (0-7%) recorded over the past 5 years.

From 1998 to 2000, 25% of 133 birds captured in my study area during the breeding season were yearlings. In each 2001 and 2002, only17% birds captured were yearlings. This number should be around 50% for a stable population (Aldridge 2000a). Unfortunately, with 2002 reproductive rates lower that 2001, the spring population estimate will likely decline by at least the 25% decline observed from 2001-spring 2002 and I will likely capture even fewer yearlings next spring.

RESEARCH PROJECT SUMMARY

I feel that I have been very successful at achieving all of the objectives outlined in my original proposal. One of my objectives (Objective 4) for this research was to track radio-collared Sage-Grouse over the winter to understand winter habitat requirements and overwinter survival. Specifically, I had intended to follow juvenile Sage-Grouse to obtain estimates of juvenile overwinter survival, and improve my model. I have collaborated with Alberta Fish and Wildlife, and the Alberta Conservation Association and we are tracking feamale Sage-Grouse this winter, performing habitat measurements at winter locations. Poor recruitment prevented us from following any juveniles throughout the winter this year.

The Alberta Government (SRD-Public Lands) is taking the lead on the grazing manipulations (Objectives 7 & 8) and is still attempting to implement grazing treatments under the direction of the new Provincial Sage-Grouse Recovery Action Group (RAG) which is being

led by Fish and Wildlife. This will be a long-term process, but I have committed to staying involved and assisting with this project over the long-term, as it is essential to the survival of Sage-Grouse in Canada. Once implemented, it will allow us to evaluate the consequences of management alternatives (including grazing) on the long-term probability of Sage-Grouse extirpation/extinction in Alberta and develop suitable management strategies. Adaptive management is the key maintaining a viable Sage-Grouse population in Canada (Aldridge et al. 2002). Once the third year of this research are completed, I will be able to develop my Resource Selection Function models and develop a habitat based PVA (Objectives 5, 6, & 7).

ACKNOWLEDGEMENTS

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APPENDIX A

A list of all

Publications, Presentations, Invited Seminars, and Media Stories

Emanating from Sage Grouse Research.

Publications, Presentation, and Conference Proceedings Emanating from Cameron L. Aldridge's Research on Sage Grouse

Publications

Theses

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Aldridge, C.L. 1999. Reproductive ecology of Sage Grouse in Canada. Unpubl. Report. Prepared for 1999 Sage Grouse Funding Partners. Department of Biology, University of Regina, Regina SK. 38 pp.

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Aldridge, C.L. 1997. 1997 Sage Grouse inventory: A comparison of two techniques used to monitor Sage Grouse in southeastern Alberta. Unpubl. report. Alberta Environmental Protection, Fish and Wildlife Division, Edmonton AB. 39 pp.

Presentations

Scientific Meetings

Aldridge, C. L., M. S. Boyce, and R. K. Baydack. 2002. Adaptive management of prairie grouse: how do we get there? The Wildlife Society's 9th Annual Conference. Bismarck ND.

Aldridge, C.L. 2001. Conservation and Management of Sage Grouse in Canada: An integrated approach. The Wildlife Society's 8th Annual Conference. Reno NV.

Aldridge, C.L. 2001. Conservation of Sage Grouse in Alberta: managing the decline of a northern fringe population. Annual conference and meeting of the Northwest Section and Alberta Chapter of the Wildlife Society. Banff, Alberta.

Aldridge, C.L. 2001. Do Sage Grouse have a future in Canada? Population dynamics and management suggestions. 6th Prairie Conservation & Endangered Species Conference: Sharing Common Ground. Winnipeg, Manitoba.

Aldridge, C.L. 2001. Conservation of Sage Grouse in Alberta: what do we know and how can we manage for them. 1st Partners in Conservation Conference. Nisku, Alberta.

Aldridge, C.L. 2000. The decline in the Canadian Sage Grouse population: Is lack of reproductive effort involved? 23rd Western States Sage and Columbian Sharp-tailed Grouse Workshop. Redmond, Oregon.

Aldridge, C.L. 2000. Conservation ecology of Sage Grouse in Canada. 34th Prairie Universities Biological Symposium. (PUBS). Regina, SK.

Aldridge, C.L. 2000. Reproductive ecology of Sage Grouse (*Centrocercus urophasianus*) in Canada. Alberta North American Waterfowl Management Biodiversity Conference. Edmonton, AB.

Aldridge, C.L. 1999. A drastic decline in a northern Sage Grouse (*Centrocercus urophasianus*) population: Is recruitment the problem? 23rd Prairie Grouse Technical Council Meeting. Gimli, Manitoba.

Aldridge, C.L. 1999. Conservation ecology of Sage Grouse in Canada. The Wildlife Society's 6th Annual Conference. Austin, TX..

Aldridge, C.L. 1999. A drastic decline in a northern Sage Grouse (*Centrocercus urophasianus*)population: Is recruitment the problem? 32nd Annual Prairie Universities Biological Symposium (PUBS). Saskatoon, SK.

Aldridge, C.L. 1998. The status of Sage Grouse (*Centrocercus urophasianus*) in Alberta. 22ndWestern States Sage and Columbian Sharp-tailed Grouse Workshop. Billings, Montana.

Aldridge, C.L. 1998. Status of the Sage Grouse in Canada. 5th Prairie Conservation And Endangered Species Conference (PCAES). Saskatoon, SK. Edmonton, AB.

Invited Seminars and Guest Lectures

Guest Lecture ENCS 464 (Endangered Species Conservation and Management - Undergraduate Class - University of Alberta) – "Addressing the Small and Declining Population Paradigms: Sage-Grouse as a Case Study" October 2002

Invited Speaker - Canadian Falconry Association Annual Meeting - "Sage-Grouse: Can We Save Them?" October 2002

Invited Speaker - Police Point Interpretive Center and the Grasslands Naturalists, Medicine Hat - "Has the Sun Set for Sage-Grouse in Alberta." July 2002

Invited Speaker - Cypress Hills Interpretive Center: Invited Lecture Series - "Where have all Sage Grouse Gone?" August 2001

Invited Speaker - Sherwood Park Fish and Game Association - "Conserving Sage Grouse in Canada: What do we know, what has to be done" February 2001

Guest Lecture - ENCS 464 (Endangered Species Conservation and Management - Undergraduate Class - University of Alberta) – "Conservation Ecology of Sage Grouse In Canada" Oct. 2000

Invited Speaker – Alberta Chapter of the Wildlife Society – "Conservation Ecology of Sage Grouse In Canada: Understanding the decline of an Endangered Species" Sept. 2000

Invited Speaker - Cypress Hills Interpretive Center: Invited Lecture Series - "The Strut of the Sage Grouse" June 2000

Guest Lecture – Ornithology and Conservation (Undergraduate Class - University of Calgary) – "Sage Grouse; Conservation in Action" Aug. 1999

Guest Lecture - Biology 150 (Biological Concepts - Undergraduate Class - University of Regina) - "Conservation Biology on the Prairies" Nov. 1999

Invited Speaker - Regina Natural History Society – "Sage Grouse" Nov. 1999

Invited Speaker - Sacred Hearts Elementary School – Sask. Innovation in Science Series – "Endangered Species" Oct. 1999

Invited Speaker - Cypress Hills Interpretive Center: Invited Lecture Series - “The Sage Grouse” Aug. 1999

Invited Speaker - Grasslands Naturalists, Medicine Hat - “The Status of Sage Grouse in Canada.” May 1999

Invited Speaker - Southern Saskatchewan Old Timers and Naturalists - “The Status of Sage Grouse in Canada.” Feb. 1999

Press Releases Related to
Cameron L. Aldridge's Research on Sage-Grouse in Canada

DATE	PRESS RELEASE	AUTHOR	TITLE
July 2002	Alberta Naturalist - FAN Publication	Dawn Dickinson	Sage-Grouse….Going…Going…Gone?
July 2002	CBC Radio Alberta - WildRose Country		Declining Sage-Grouse
July 2002	The Commentator (Prairie Newspaper)		Researcher concerned about low numbers of sage grouse
July 2002	Medicine Hat News (Newspaper)		Sage grouse in danger of disappearing
July 2001	Operation Grassland Community NwsLtr.	Cameron L. Aldridge	Saving the Sage Grouse in Alberta
Oct., 2000	Discovery Channel Story (on @discovery.ca)	Tom Hince	Sage Grouse
Nov., 1999	Edmonton Journal	Ed Struzik	Wildlife under siege
Sept., 1999	Recovery: An Endangered Species Newsletter	Cameron L. Aldridge	Sage Grouse continue to decline
Spring, 1999	PICA; The Calgary Field Naturalist's Society	Cameron L. Aldridge	Status of Sage Grouse in Canada
Feb., 1999	CBC Radio Saskatchewan	Peter Dick	Sage Grouse
Dec., 1998	Nature Views; Nature Sask. Newsletter	Cameron L. Aldridge	Status of Sage Grouse in Canada
Spring, 1998	The Third Degree; U of R Alumni Magazine	Erika Smishek	Research aims to reverse Sage Grouse saga
May 7, 1998	The Western Producer	Michael Raine	Sage Grouse listed as endangered
May 3, 1998	Lethbridge Herald		Future uncertain for once-vibrant population of Sage Grouse
May, 1998	QR77 Radio; Calgary & Edmonton		Sage Grouse
May, 1998	CBC Radio		Sage Grouse
May, 1998	CBC News (T.V.) Alberta & Saskatchewan	Gary Sieb	Sage Grouse
May, 1998	Alberta Report	Les Sillars	Prairie dancers of the sagebrush
May, 1998	Regina Sunday Sun	Frank Flegel	Getting closer to the vision
April 17, 1998	Calgary Herald	Monte Stewart	Researcher gets funding to track nesting Sage Grouse
April 9, 1998	The Regina Leader-Post		Sage Grouse population in rapid decline
April 1998	CBC NewsWorld (T.V.)		Sage Grouse
March 27, 1998	The Saskatoon StarPhoenix	Colette Derworiz	Shrinking ranks of Sage Grouse baffles researchers