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

FINAL PROJECT REPORT FOR

2003 SAGE-GROUSE FUNDING PARTNERS

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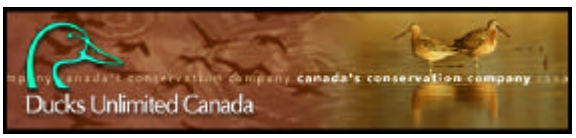

UNIVERSITY OF ALBERTA

ABSTRACT

The endangered Alberta Sage-Grouse population has declined by 66-92% over the last 30 years. Poor recruitment has been shown to be related to the population decline, which 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 1999 data, suggested that the population would continue to decrease, predicting that only 118 males counted on leks in 2003. I counted only 100 males at seven active leks in 2003. Nest success (48%) and chick survival (22% to 48%) were both the highest ever recorded. This was likely related to above average precipitation throughout 2002 and the spring of 2003 enhancing residual cover for concealment and food resources for chicks. I assessed habitat use and selection at nest sites, brood-rearing locations, and at summer loafing sites to obtain an understanding of the what habitats and resources are important to Sage-Grouse. Tracking of radio-collared 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 of both adult and juvenile females. Unfortunately, West Nile virus (WNv) moved into southern Alberta the summer of 2003 and was confirmed as the cause of death for 5 collared Sage-Grouse in August. The impacts of WNv on Sage-Grouse are not fully understood, but could have drastic implications for the small Alberta population. All habitat and demographic data are currently being analyzed, and I present and discuss a preliminary lek occurrence model.

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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 (Fig. 1, 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; 2003). 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; 2003). From this research, the population decline appears to be a result of high juvenile mortality leading to poor juvenile recruitment (Aldridge 2001a, 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 measured population parameters to link these habitat models to population models and conduct habitat-based population viability analyses.

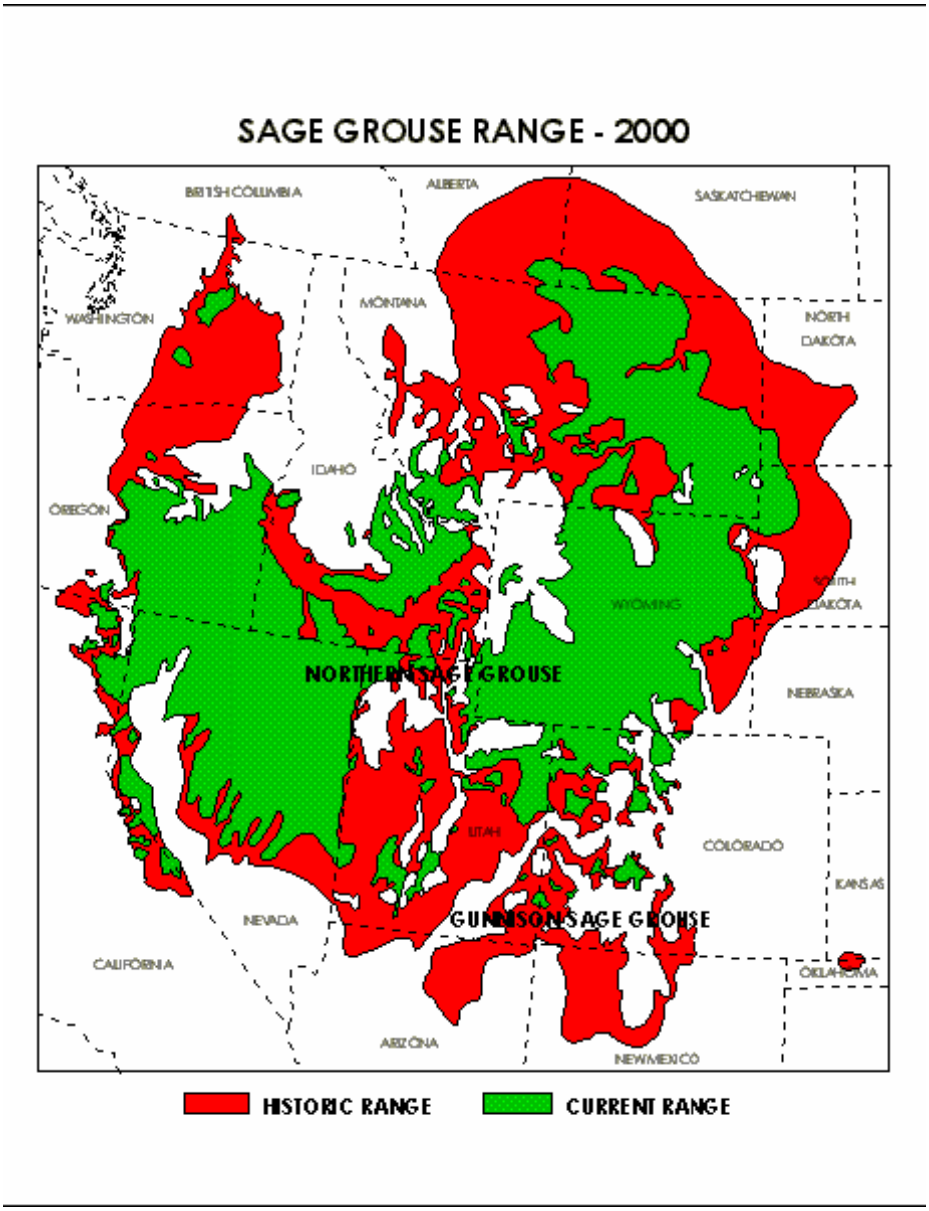

Figure 1. Current and known historic distribution of northern or greater Sage-Grouse (*Centrocercus urophasianus*) and Gunnison sage-grouse (*Centrocercus minimus*) in North America. (Map Provided by Michael Schroeder, Washington Department of Fish and Wildlife).

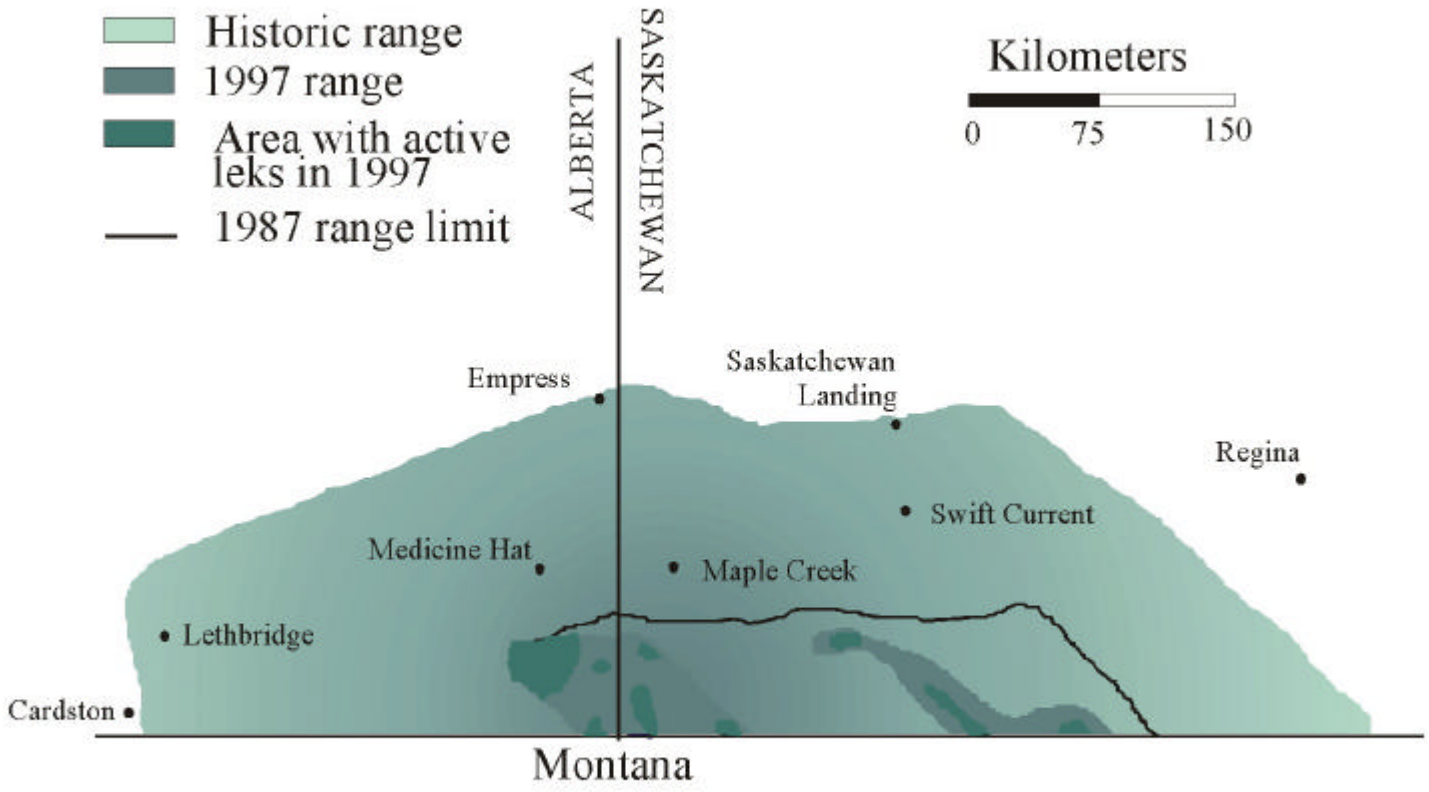

Figure 2. Range of Greater Sage-Grouse in Canada. Historical range is based on anecdotal sightings of birds prior to the 1960s. The present (1997) range is based on the locations of known active leks in 1997. The 1987 range limits are shown to illustrate the range contraction.

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 sagebrush (Aldridge 2000a).

METHODS

Lek counts were conducted from 18 March to 25 May 2003 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 radiotransmitters (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 and Brigham 2001, 2002) 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).

After nesting efforts ceased, nest site characteristics were measured (*see* Aldridge and Brigham 2002). At each nest site, I estimated the percent sagebrush canopy coverage, as well as the percent cover of grasses, forbs, non-palatable forbs (to Sage-Grouse), other shrubs, bare ground, and litter 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. The mean maximum height of the each variable was also calculated for each plot. To determine if the importance of habitat characteristics surrounding nest sites, I placed eight additional dependent non-random 1 m^2 plots at 7.5 and 15 m in each of the four ordinal directions and the same measurements were performed (Aldridge and Brigham 2002). 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 weekly brood flush counts were performed to estimate chick survival.

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 keep the transmitter sung to the chicks midline. Chicks were triangulated every second day to determine if there fate. I attempted to recapture all radio-tagged chicks at 12 weeks of age and replaced their transmitters with a full size necklace-style adult transmitter.

RESULTS

Population Trends

In 2003, lek counts over the breeding season resulted in a maximum count of 100 males on seven active leks (Fig. 3). The decline in population numbers appears to have leveled off, with the same seven remaining active leks containing about 100 males for the past couple of years (Fig. 3).

Adult Data

At the beginning of spring 2003, I was tracking 14 females that were collared in previous years and had survived over the winter. I captured a total of 15 females during the 2003 breeding season (14 adults and 1 yearling; Table 1). Three of these individuals were females originally outfitted in previous years; one with a collar which had failed, and two with collars with low battery power. All 12 new females received a radio transmitter and I replaced the three collars on recaptured females. Thus, I was tracking a total of 27 females at the beginning of the 2003 breeding season. I captured 27 males (20 adults and 7 yearlings) during the 2003 breeding season (Table 1). Of the 27 males captured, 3 were birds captured from previous years. Only 19% (8/42) of captured birds in 2003 were yearlings.

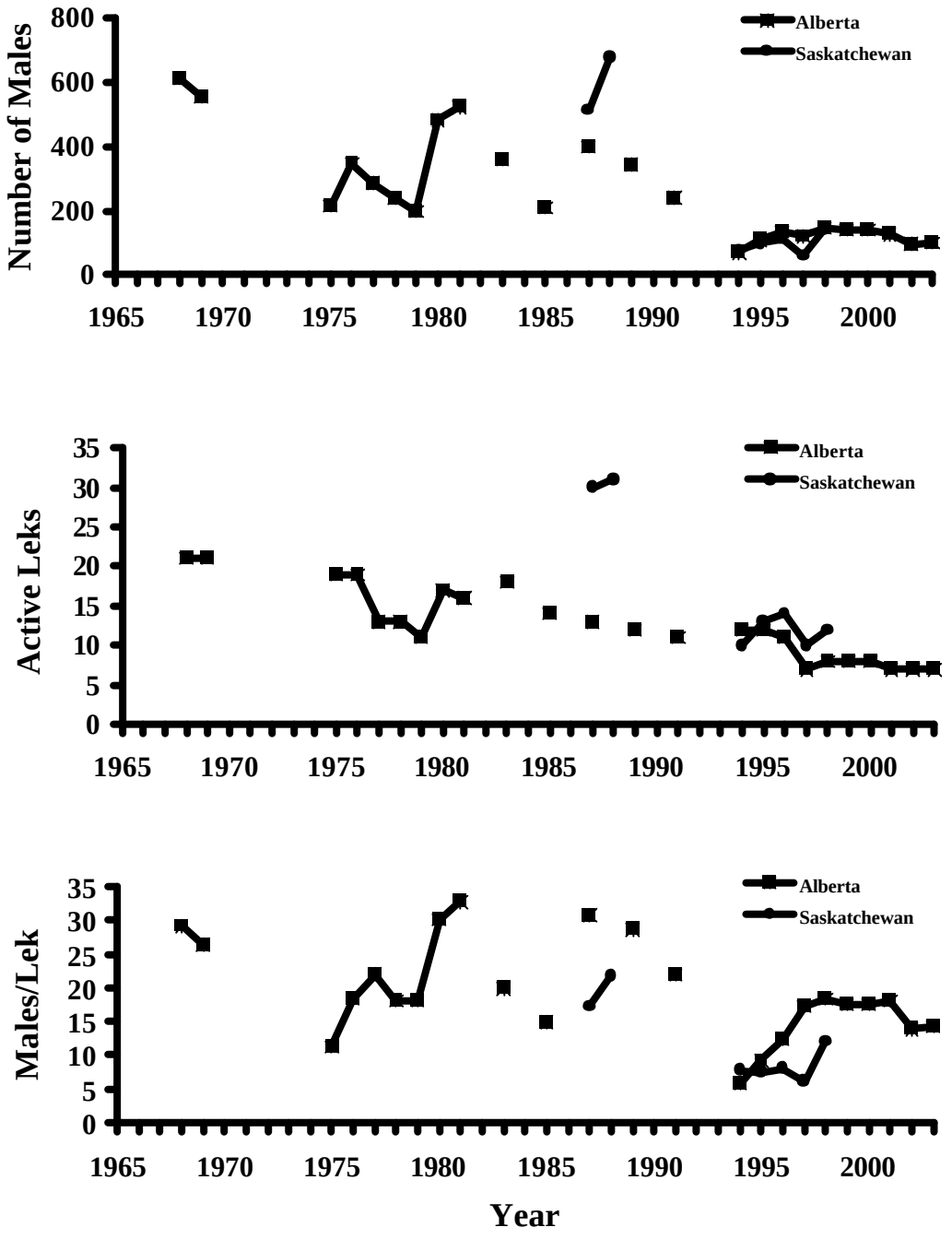

Figure 3. Population trends for Sage-Grouse in Alberta and Saskatchewan over the past 34 years shown as the number of males, number of males per lek, and number of active leks. Years when sampling efforts consisted of less than eight surveyed leks were not included.

Table 1. Body mass for birds captured during the 2003 breeding season in Alberta and the number of birds that received radiotransmitters. Results include three females originally captured in previous years that were refitted with new collars. Standard Errors are shown in brackets.

	Adults		Yearlings	
	Males	Female	Male	Female
Captures	20	14	7	1
Mean Mass	3037 (36.6)	1611 (26.5)	2689 (92.6)	1448
Radios	0	14	0	1

Reproductive Activities

Three of the 27 females I was tracking disappeared shortly after spring capture/relocation, and I was unable to regularly track 2 other females regularly throughout the breeding season. Thus, I gathered breeding information for 22 females in 2003. All females displayed nesting behaviours, and I located a total of 29 nests produced by 22 different females. Eighteen of these were initial nesting attempts and 11 were renesting attempts. Nest success in 2003 was 48% (14/29 nests). Nine of 18 (50%) initial nesting attempts were successful and 45% (5/11) of renesting attempts were successful. Of the ten females that had an unsuccessful initial nesting attempt and survived the rest of the breeding season, 90% of them initiated second nesting efforts. Clutch size for all nests (8.2 ± 0.37, n=26) and successful first nests (9.3 ± 0.17, n=9) was higher than recorded in previous years. Egg viability was 91.4% with 106 of 116 eggs laid in 14 successful nests hatching.

Chicks

I captured a total of 67 chicks from 12 different broods. I attached transmitters to 22 chicks from these 12 broods (2 chicks from each of 10 broods and 1 chick from each of 2 broods). Chick survival to 50 days of age estimated from tagged chicks was 47% (9/19), with

the fate of 3 chicks unknown. Of the 10 chicks that were confirmed dead, I positively identified raptors as killing 2, coyotes as killing 2, one died due to exposure during a hail storm, and the cause of death for the other 5 chicks were attributed to unknown predators. Brood flush counts indicated that only 22% (23/106) of chicks survived to 50 days of age.

Vegetation Measurements

I gathered vegetation data at 195 Sage-Grouse use sites and 195 paired random locations. Use sites included 29 nest sites, 82 brood rearing locations from 12 different broods, and 84 broodless female locations. I collected data on insect availability at each brood use and corresponding random location. All habitat and insect data will be incorporated into my resource selection models.

Summer Tracking

I continued to track the remaining females throughout the summer. Eight females died after the breeding season. One female died in a severe hail storm in mid-June, and seven females died over a 26 day period in August. Three of these females were fully intact, and post-mortem analyses by Alberta Fish and Wildlife confirmed that all three of these birds died of West Nile virus (WNv). At the end of August, I was tracking a total of 16 radio-collared adult females. In the late summer/early fall, I captured 9 juvenile sage-grouse and attached necklace style transmitters to them. In late August, 2 juveniles also died as a result of WNv. The remaining 5 collared juveniles were still alive as of 30 November, 2003. Long-term survival analyses are currently being conducted on these data.

Habitat Models

I currently am developing models identify important Sage-Grouse nesting habitat, brood rearing habitat, summer habitat, and breeding season habitat, at both the local and landscape

scales. I have developed some preliminary models describing the occurrence of leks across the landscape, as well and differentiating active versus inactive leks. Recent Sage-Grouse management guidelines suggest that most breeding habitat occurs within 3200m of lek sites, and this is the scale at which management should occur (Schroeder et al. 2000). For these preliminary models, I used a 3200m moving window in ArcGIS to assess the suitability of habitat for meeting breeding habitat requirements (nesting and brood rearing habitat and escape cover for males), and thus, the probability of occurrence lek sites. Figure 4 shows the probability of lek occurrence across the landscape.

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. 5; Aldridge 2001a). The model suggested that the population should decrease from a spring estimate of 420 to 622 individuals in 1999, to between 354 -525 individuals in 2003 (Aldridge 2001a). Thus, the number of males attending leks was predicted to decline from 140 males in 1999 to 118 in 2003. I counted 100 males on leks in 2003, giving a slightly lower (300 to 444 individuals) than predicted population estimate (Fig. 5). The population appears to have rebounded after the sharp declines experienced in 2001 and 2002. This was likely a result enhanced precipitation after several previous years of drought conditions. I currently am working to stochastically vary each of the parameters in this model, based on the observation variation for each estimate. I will then link these parameters/measures of fitness to my habitat models.

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

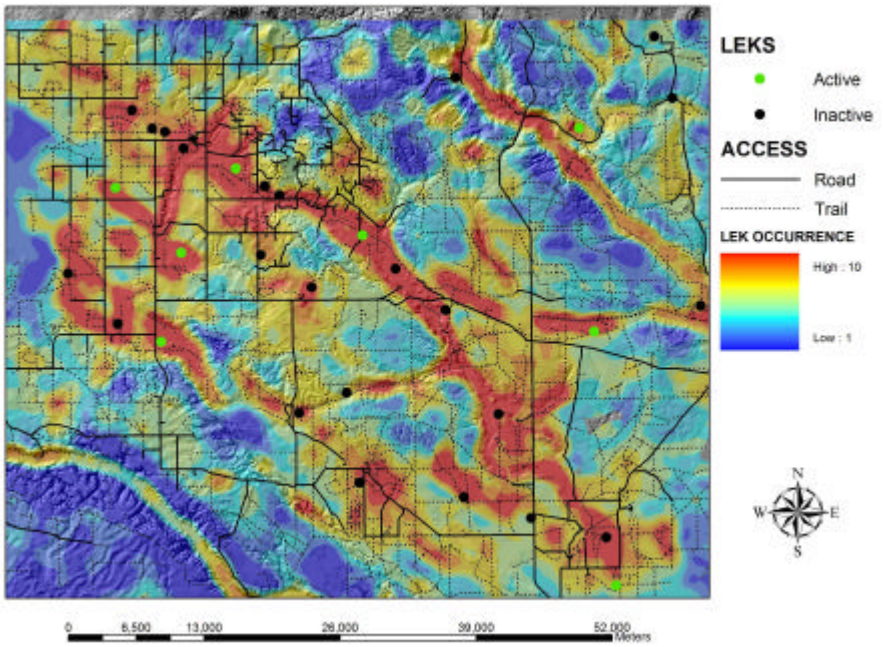

Figure 4. Relative probability of Sage-Grouse lek occurrence in Alberta (scaled from 1 to 10). Active and inactive leks shown for reference. Warm (red) colours indicate a high probability of occurrence, and cool (blue) colours indicate a low probability occurrence.

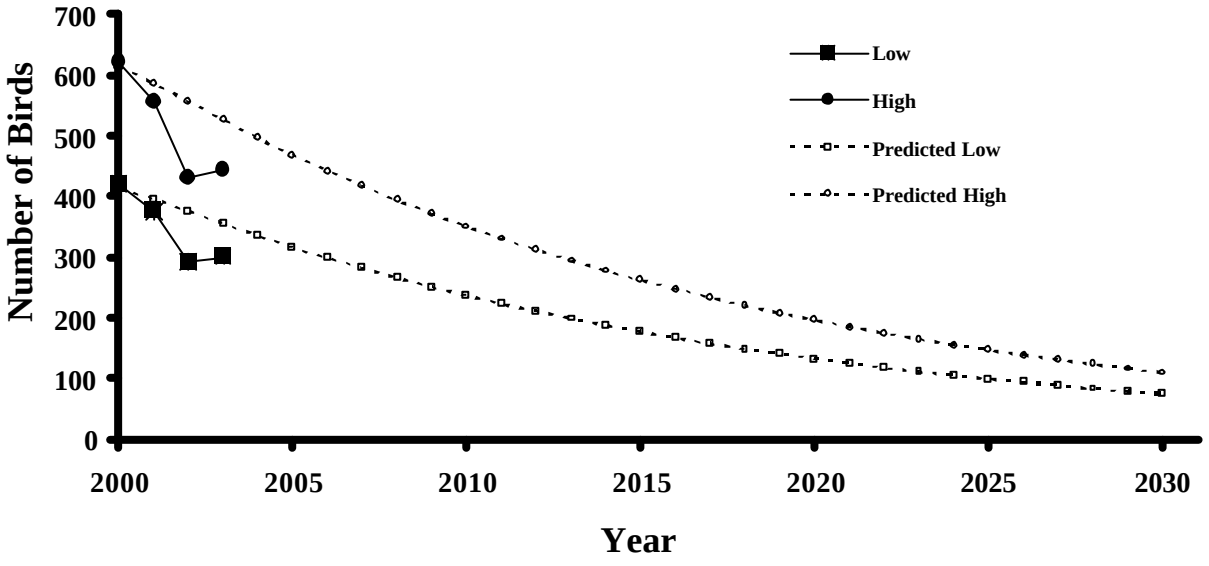

Figure 5. Predicted Alberta Sage-Grouse population projections from 2000 to 2030 shown with actual population High and Low estimates from for 2000-2003 superimposed. Model predictions are based on Aldridge (2000a) and data from 1998 and 1999.

has averaged from 6.9 to 7.75 eggs per nest (Aldridge and Brigham 2001, Aldridge 2000b, 2001b, 2002). Increased precipitation over 2002 and spring 2003 likely enhanced the availability of food resources important for pre-laying hens this spring (Barnett and Crawford 1994). As a result, clutch size was higher (8.2 eggs–all nests; 9.3 eggs–successful first nests) than previously recorded. Egg viability was comparable to previous years, with 91.4% of eggs successful nests hatching. Similar to clutch size, nest success (48%) was the highest it has been since 1998. This was also likely related to above average precipitation resulting in enhanced residual cover for nest concealment. The high quality nesting habitat may have influenced females renesting efforts, with 90% of females renesting in 2003 (90%) compared to previous years (13% to 86%).

Regardless of the technique used (flush counts or tagged chicks), chick survival was high this year (between 22% and 47%) compared to previous years (0-18%; Aldridge and Brigham 2001, Aldridge 2001a, b, 2002). Increased moisture in the summer of 2002 and throughout 2003 resulted in excellent nesting cover and food resources, enhancing reproductive effort and success. This will hopefully result in an increase in population estimates next spring. However, the impacts of the initial exposure to WNv on sage-grouse are unknown. We do not yet know if WNv mortalities will be additive (in addition to baseline mortalities) or compensatory (replace mortalities that would have taken place due to other causes). We also do not know if the any individuals may have immunity, and are able to survive the initial exposure. However, we (C.L. Aldridge, Dr. M.S. Boyce, and Alberta Fish and Wildlife) have partnered with other Sage-Grouse researches in Montana and Wyoming where other populations have also experienced mortalities due to WNv. We are concurrently assessing Sage-Grouse immunity to WNv and the impact it had the 2003 population (using survival over the 2003 WNv season and 2004 population estimates), as well as the impact it may have on the population in the 2004 WNv

season. We will also monitor mosquito populations in southeastern Alberta in 2004, to better understand the ecology and virology of WNvas it relates to the endangered Sage-Grouse.

The preliminary lek occurrence model (Fig. 4) identifies high quality breeding habitat for Sage-Grouse and will assist managers in identifying potentially unknown lek sites across the landscape. This product also gives managers a spatially explicit map identifying critical Sage-Grouse habitat that should be protected from further disturbances. Habitat is also identified that could be managed to improve the quality for Sage-Grouse. I am currently refining these models with improved explanatory variables and working on nest and brood habitat models that more explicitly identify critical Sage-Grouse habitat. In a future report to all Sage-Grouse funding partners, I will provided more detailed descriptions of these refined models and their predictions.

RESEARCH PROJECT SUMMARY

I feel that I have been very successful at achieving all of the objectives outlined in my original proposal and final products from my dissertation will fulfill all objectives. I was successful this year in collaring 9 juvenile Sage-Grouse, and through a collaborative research project with Alberta Fish and Wildlife, and the Alberta Conservation Association, we will obtain estimates for both female and juvenile overwinter survival, as well as habitat requirements (objective 4). The Alberta Government (SRD-Public Lands) through the Provincial Sage-Grouse Recovery Action Group (RAG) is taking the lead on the grazing manipulations (objectives 7 & 8). This will be a long-term process, but the habitat and population models I am currently developing (objectives 5, 6, & 7) will form the foundations for this experimental research. Adaptive management is the key to understanding critical habitat requirements (Aldridge et al. 2004) and will allow for appropriate management implementation, maintaining a viable Canadian Sage-Grouse population.

ACKNOWLEDGEMENTS

I thank Michael Swystun, Jason Sanders, Megan Watters, and Jennifer Carpenter for their assistance in the field this summer. I also thank the many individuals that assisted with fieldwork and the logistics of my research. This research in 2003 was generously supported financially and/or logistically by the Alberta Conservation Association, Alberta Sustainable Resource Development, Cactus Communications (Medicine Hat, Alberta), Challenge Grants in Biodiversity (University of Alberta), Ducks Unlimited Canada (North American Waterfowl Management Plan), Endangered Species Recovery Fund (World Wildlife Fund Canada and the Canadian Wildlife Service), the University of Alberta, a Natural Science and Engineering Research Council Scholarship, a Macnaughton Conservation Scholarship , an Edmonton Bird Club Scholarship, an Izaak Walton Killam Memorial Scholarship, and a Dorothy J Killam Memorial Graduate Prize to C.L. Aldridge. I am appreciative of the many individuals and families who gave us permission to work on their land throughout the course of my research.

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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

Aldridge, C.L. 2000. Reproduction and habitat use by Sage Grouse (*Centrocercus urophasianus*) in a northern fringe population. M.Sc. thesis, University of Regina, Regina, SK. 109 pp.

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Schroeder, M.A., C.L. Aldridge, A.D. Apa, J.R. Bohne, C.E. Braun, D. Bunnell, J.W. Connelly, P. Deibert, S.C. Gardner, M.A. Hilliard, J.D. Kobriger, C. McCarthy, J.J. McCarthy, D. L. Mitchell, E.V. Rickerson, and S.J. Stiver. 2003. Distribution of sage-grouse in North America. *Submitted to Condor,* July 2003.

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Aldridge, C.L. 2000. Assessing chick survival of Sage Grouse in Canada. Alberta Sustainable Resource Development, Fish and Wildlife Service, Alberta Species at Risk Report No. 19. Edmonton, Alberta. 25 pp.

Aldridge, C.L. 2000. The Status of the Sage Grouse (*Centrocercus urophasianus urophasianus*) in Canada. Proceedings of the 5th Prairie Conservation and Endangered Species Workshop. J. Thorpe, T. A. Steves, and M. Gollop (eds). Provincial Museum of Alberta Natural History Occasional Paper. 24:197-205.

Aldridge, C.L. 1998. Status of the Sage Grouse (*Centrocercus urophasianus urophasianus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 13, Edmonton, AB. 23 pp.

Non-refereed Publications

Aldridge, C.L. 2002. Developing a habitat-based population viability model for Sage-Grouse in Southeastern Alberta. Unpubl. Report. Prepared for 2002 Sage-Grouse Funding Partners. Department of Biological Sciences, University of Alberta, Edmonton AB. 25 pp.

Aldridge, C. L. 2001. Developing a habitat-based population viability model for Sage Grouse in Southeastern Alberta. Unpubl. Report. Prepared for 2001 Sage Grouse Funding Partners. Department of Biological Sciences, University of Alberta, Edmonton AB. 24 pp.

Aldridge, C.L. 2000. Assessing chick survival of Sage Grouse in Canada. Unpubl. Report. Prepared for 2000 Sage Grouse funding partners. Department of Biology, University of Regina, Regina, SK. 28 pp.

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.

Aldridge, C.L. 1998. Reproduction and habitat use by Sage Grouse in Canada. Unpubl. Report. Prepared for 1998 Sage Grouse Funding Partners. Department of Biology, University of Regina, Regina, SK. 19 pp.

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. and M.S. Boyce. 2003. Teetering on the Edge: Can anything be done to save eh Sage-Grouse. Petroleum Technology Alliance Canada, Ecological Issues Forum and Workshop for the Upstream Oil and Gas Industry. Calgary, AB (Invited Presentation).

Aldridge, C.L. 2003. Has the Sun Set for the Sage-Grouse: Linking Population Declines to Resources. Gifts of the Grasslands, Canadian Nature Federation 2003 AGM and Conference. Medicine Hat, AB (Invited Presentation).

Aldridge, C.L. and M.S. Boyce. 2003. Sage-Grouse Population Dynamics and Habitat Conservation in Alberta. 2nd Alberta North American Waterfowl Management Biodiversity Conference. Edmonton, AB.

Aldridge, C.L., and M.S. Boyce. 2003. Sage-Grouse management in Alberta: identifying important breeding habitats. Annual conference and meeting of the Alberta Chapter of the Wildlife Society. Red Deer, AB.

Aldridge, C.L., and M.S. Boyce. 2003. What makes a lek a lek? Identifying habitat features related to Sage-Grouse leks in southern Alberta. 2nd Partners in Conservation Conference. Edmonton, AB.

Aldridge, C.L. 2003. Sage-Grouse Habitat Requirements in Alberta. Western Range Science Seminar, Medicine Hat, AB (*Invited Presentation*).

Aldridge, C.L., and M. S. Boyce. 2003. Using resource selection functions to identify sage-grouse breeding habitat. 1st International Conference on Resource Selection by Animals. Laramie, Wyoming.

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) – "Small Populations and Stochastic Events: A Sage-Grouse Case Study" October 2003

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
May 2003	Biodiversity – Alberta NAWMP Publication (Volume 5)	Lavere McAthey	Understanding the decline: Is there hope for Alberta's Sage-Grouse?
May 2003	Edmonton Journal & National Post	Ed Stuzik	Sage-grouse cling to survival
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