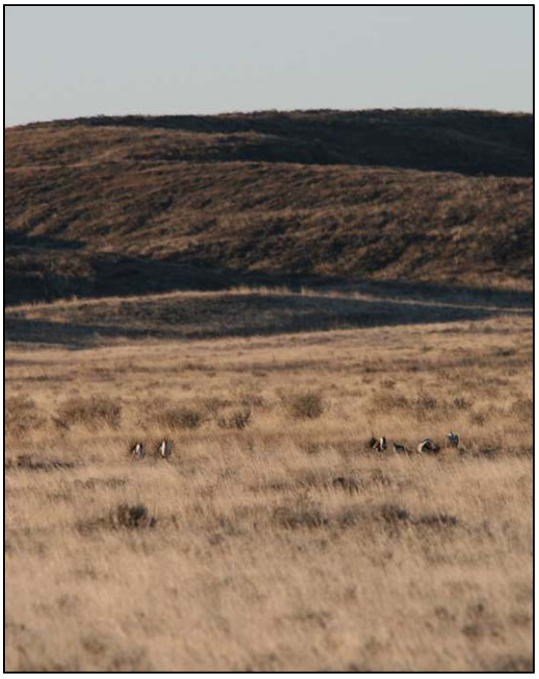
Greater Sage-Grouse (*Centrocercus urophasianus)* Monitoring in Southeast Alberta: 1968-2012



Alberta Species at Risk Report No. 147

Greater Sage-Grouse (*Centrocercus urophasianus)* Monitoring in Southeast Alberta: 1968-2012

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March 2013

Alberta
Environment and Sustainable Resource Development

ISBN: 978-1-4601-1025-6 (Online Edition)
ISSN: 1496-7219 (Printed Edition)
ISSN: 1496-7146 (Online Edition)

Cover photos: Kayla Balderson (bottom-left) and Joel Nicholson (right)

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This publication may be cited as:

Balderson, K.L., D.H. Eslinger and J.T. Nicholson. 2013. Greater Sage-Grouse (*Centrocercus urophasianus*) Monitoring in Southeast Alberta: 1968-2012. Alberta Environment and Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 147, Edmonton, AB. 28 pp.

EXECUTIVE SUMMARY

Greater sage-grouse (*Centrocercus urophasianus*) populations in Canada have declined by at least 80% from historical levels (Aldridge 1998). In the Dry Mixed-grass Natural Subregion of the Grassland Natural Region of southeast Alberta, sage-grouse habitat is limited to the distribution of silver sagebrush (*Artemisia cana*) (Aldridge 2005) which is present in seasonally moist sites or intermittent drainages (Moseley 1999). Threats to the Alberta population of sage-grouse have been well-documented and include agricultural activities, development in the energy sector, road and power line development, increasing predator populations and diseases including West Nile virus. Cultivation, oil and gas exploration, road development, recreational activities and the resulting increased traffic have been linked with abandonment of leks in Alberta. Consistent monitoring effort is very important so that population trends can be compared between years and linked to landscape activities. Lek censuses, brood surveys and aerial surveys have occurred on an irregular basis in Alberta since 1968. The objective of this report is to compile population monitoring efforts and corresponding methodologies that have been conducted and developed in Alberta since 1968 in order to provide an indication of trend for population decline.

Agricultural development has caused a major contraction of sage-grouse habitat in the past 100 years. Energy development has fragmented much of the remainder of available habitat throughout southeast Alberta. Declines in the Alberta sage-grouse population appear to be correlated with periods of increased development in the late 1970s, early 1980s and in the 1990s. The current Alberta sage-grouse population is estimated to be 2.12% of what it was in 1968; this corresponds to a 97.88% population decline over 45 years. Management actions should be focused on the recovery of population numbers through the execution of the provincial recovery strategy. Continued monitoring will be a necessary tool to assess population recovery levels over time.

ACKNOWLEDGEMENTS

Lek censuses have been a collective effort and would not be possible without the assistance of many. We would like to extend a special thank you to all survey participants who have dedicated or volunteered their time over the past 45 years. Furthermore, thank you to the community members and landowners who have participated in monitoring surveys and granted land access.

We would like to extend a special thank you to Léo Dubé (AESRD) for his personal communication regarding survey effort from the 1960s to 1990s, as well as providing the authors with the 1963-1996 monitoring reports. Thank you to Kevin France (AESRD) for providing insight into the Public Lands Act and Regulations and to Gavin Berg (AESRD) for editing the report.

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1.0 INTRODUCTION

Greater sage-grouse (*Centrocercus urophasianus*) are the largest gallinaceous bird species in North America and once occupied 1,200,483 km^2 of sagebrush habitats in 13 of the western United States and three Canadian provinces (Schroeder et al. 2004). Sage-grouse are now found in Alberta, California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, Saskatchewan, South Dakota, Utah, Washington, and Wyoming (Schroeder et al. 2004). Every spring, sage-grouse exhibit a unique mating behaviour known as lekking. According to Walsh et al. (2010), "the lek mating system is a reproductive strategy characterized by males gathering at a traditional site during the breeding season, where they establish and defend territories while engaging in vocal, visual, or chemical displays to attract and entice females into mating." Leks are typically in flat, open areas such as dried mud flats or valley bottoms, in areas of little vegetation but surrounded by sagebrush flats that serve as important roosting sites (Patterson 1952). In Alberta, sage-grouse have been monitored primarily by lek censuses but also by landowner surveys, ground searches and aerial surveys since 1968.

Greater sage-grouse have exhibited a significant decline throughout their range in North America (Schroeder et al. 2004). Sage-grouse populations occurring in areas with large amounts of cultivated cropland, in areas prone to drought and populations in the periphery of sage-grouse range experience greater rates of extirpation than core populations (Aldridge et al. 2008). In Alberta, the northern periphery of the species range, the decline has been well documented and shown to be especially severe, with the population experiencing a 66-92% decline from 1970-2000 (Aldridge and Brigham 2001). The reasons for the decline of sage-grouse in Alberta are numerous and include cropland conversion, isolation from the Montana sage-grouse population, water impediments in native rangelands, industrial development, increased predator densities, natural disturbances, and disease such as West Nile virus (Alberta Sage Grouse Recovery Strategy Action Group 2005). As a result of the complex interactions of activities on the landscape in southeast Alberta, the monitoring of sage-grouse populations provides important insight into the response of the population to threats.

Greater sage-grouse were listed as *Threatened* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1997. This listing was upgraded to *Endangered* in 1998 and the species is now listed as *Endangered* under Schedule 1 of the federal *Species at Risk Act*. Due to low populations of sage-grouse in Alberta, the last hunting season for sage-grouse was in 1995. A provincial listing followed in 1999-2000, with the greater sage-grouse becoming listed as *Endangered* under Alberta's *Wildlife Act*.

Monitoring the population, distribution and trends of sage-grouse to determine the effectiveness of recovery actions is a key element of the Action Plan described in the *Alberta Greater Sage-Grouse Recovery Plan 2013-2018*. Population monitoring is also listed as an action item in the *Recovery Strategy for the Greater Sage-Grouse in Canada 2008* in order to evaluate progress towards population recovery and efficiency of recovery actions.

In 2008, a collaborative project was initiated between Montana Fish, Wildlife and Parks (MFWP) and Alberta Environment and Sustainable Resource Development (AESRD) to augment the remaining Canadian population of sage-grouse. The intention is that the population augmentation will act to maintain a population of sage-grouse on the landscape in Alberta until habitat restoration efforts can be implemented. During the springs of 2011 and 2012, 41 sage-grouse (38 females and three males) were translocated from stable populations in north-central Montana to active leks in southeast Alberta. Thirty-nine sage-grouse were fitted with solar-powered Global Positioning System (GPS) platform transmitter terminal (PTT) telemetry units. The North Star Science and Technology units are programmed to capture up to four GPS waypoints per day. The resulting survival, movement and nesting data is invaluable in assessing landscape use by sage-grouse in Alberta.

The objective of this report is to document population monitoring efforts that have occurred in Alberta since lek censuses began in 1968. Historical data exists in numerous forms including personal communications, data collected from hunter check stations, official and unofficial publications and data sheets that have never been compiled into one document. As a result, it can be difficult to obtain specific historical information that is needed. The intent is that this report can serve as a historical record and that the documentation of the sage-grouse population decline can be quantified as well as correlated with changes on the landscape, such as agricultural expansion and oil and gas development in the early-1980s. The documentation of historical population numbers and the decline in population numbers can also serve as a benchmark for future management goals that are directed at restoring populations to a particular historical level.

2.0 STUDY AREA

In the Dry Mixedgrass Natural Subregion of Alberta (46,937 km^2), grazing is the main agricultural activity, occurring in approximately 55% (25,815 km^2) of the area (Natural Regions Committee 2006). About 35% (16,428 km^2) is under dry-land farming and nearly 10% (4694 km^2) is under irrigation (Natural Regions Committee 2006). Grasses present include needle-and-thread grass (*Stipa comata*), june grass (*Koeleria macrantha*), blue grama (*Bouteloua gracilis*), and western wheatgrass (*Agropyron smithii*) (Aldridge 2005). In this region, sage-grouse habitat is limited to the distribution of silver sagebrush (Aldridge 2005) which is present in seasonally moist sites or intermittent drainages (Moseley 1999). For adult sage-grouse, the importance of sagebrush for nesting cover, concealment from predators and as their primary food source during all life stages has been well documented (Wallestad et al. 1975, Conelly et al. 2003). Sage-grouse supplement their diet at various life stages by incorporating forbs including pasture sage (*Artemisia frigida*), alfalfa (*Medicago sativa*) and dandelion (*Taraxacum officinale*) as additional food sources (Kerwin 1971).

In 1963, farmers, residents and ranchers of southern Alberta were interviewed by Fish and Wildlife staff in order to establish the known distribution of sage-grouse in Alberta

(example questionnaire Appendix A). Sage-grouse range was estimated to extend as far west as the Milk River ridge, east to the Alberta-Saskatchewan border, and from the 49th parallel north to the town of Seven Persons (Sealy 1963), an area of 6734 km^2 (Jestin 1967). Also described was the contiguous range from Etzikom to the Alberta-Saskatchewan border with a westerly branch along the Milk River to a point just east of the Aden Bridge (Sealy 1963), an area of 3364 km^2 (Jestin 1967). Interviews held in the towns of Walsh, Irvine and Seven Persons in 1967 indicated that sage-grouse were known to occur in those areas for up to 30 years previous; Walsh may be a minor observation but could represent the northernmost breeding area in Alberta (Jestin 1967). The northernmost record in Saskatchewan occurred near the community of Anerley in 1965 (Roy 1996); approximately 350 kilometers northeast of Walsh.

In 1967 it was approximated that only 311 km^2 (4.62%) of sage-grouse range were under cultivation (Jestin 1967). This limited amount of cultivation was considered potentially beneficial to sage-grouse because of the density of insects used as forage by chicks, and alfalfa and grasses foraged upon by all age classes during the summer (Armstrong 1968). Conversely, the larger areas of cultivation currently present within this range are considered detrimental due to the cumulative impacts of agriculture and industrial development causing habitat loss and fragmentation.

Currently in Alberta, sage-grouse are located in the extreme southeast corner of the province, an area of approximately 4000 km^2 (Aldridge and Brigham 2001) (Appendix B). This area is predominately crown land under long term grazing leases that are monitored by AESRD staff. Activities in the study area include recreation, ranching, annual crop production and oil and gas development. Currently, there are approximately 25 industrial operators and 411 active wellsites in sage-grouse range (Energy Resources and Conservation Board 2012). The status of energy developments in Alberta sage-grouse range are summarized in Appendix C.

3.0 METHODS

Greater sage-grouse congregate on traditional display areas (leks) every spring (Gillan and Strand 2010). This gathering of sage-grouse affords agencies across North America reasonably simple methods for monitoring breeding populations. According to the *Monitoring of Greater Sage-Grouse Habitats and Populations* handbook by Connelly et al. (2003), “these methods include lek censuses (annually counting the number of male sage-grouse attending leks in a given area), lek routes (annually counting the number of male sage-grouse on a group of leks that are relatively close and represent part or all of a single breeding population or area), and lek surveys (annually counting the number of active leks in a given area).” Due to the relatively small number of leks in Alberta, government staff and other volunteers have performed lek censuses since 1967.

According to Connelly et al. (2003), an active lek is a traditional display area where two or more male sage-grouse have attended in two or more of the previous five years. Therefore, a lek is classified as abandoned when two or fewer males have attended the

particular lek once in the previous five years. It is important to note that the data set of male sage-grouse occupancy on Alberta leks from 1968-2012 was edited in order to reflect this standard definition of lek abandonment used by the Western Association of Fish and Wildlife Agencies.

Government agencies across North America often express concern over the ambiguity associated with lek attendance patterns and the lack of consistency in monitoring procedures. As a result, apprehension over the practice of using lek data to estimate breeding populations has been expressed (Connelly et al. 2003). Efforts usually provide a rudimentary estimate of minimum populations and are not typically used in large areas when making comparisons among years as this may not be representative of the true population (Connelly et al. 2003). However, repeated surveys over time can detect trends in the overall population, especially in a case such as Alberta where the area of remaining habitat is relatively small; the majority of lek locations are known and generally, all active leks are monitored every year.

3.1 Historical methodology and monitoring efforts

Initial searches for sage-grouse leks in Alberta took place after a substantial amount of observations were gathered from landowners and community members. Beginning in 1963, government staff wrote Job Completion Reports to document landowner surveys and sage-grouse observations; however, it was not until 1968 when formal lek monitoring began. All of the reports and data sheets were examined and key points on methodology, surveys and results are presented and discussed. Monitoring efforts in Alberta have involved a number of different methodologies, presented below.

3.1.1 Lek Censuses and Monitoring Effort

In 1963, Lethbridge Fish and Wildlife staff collected information from farmers, ranchers and residents of the Wild Horse, Manyberries, Foremost and Milk River areas in an effort to establish the distribution of sage-grouse in Alberta (Sealy 1963). Observations were marked on a topographical map, along with leks and wintering grounds and knowledge of the landscape, terrain and sagebrush distribution in order to familiarize themselves with suitable lek habitat. Starting in 1968, intensive lek searches took place in order to locate and confirm active sage-grouse leks. As a result, 16 active leks were discovered. Department staff conducted these searches on foot with information gathered in the previous four years from landowners and the local communities regarding sage-grouse observations. In May and June of 1967 and 1968, Canadian Pacific Railway personnel conducted surveys from Pakowki Lake and Manyberries to the Saskatchewan border along the now abandoned rail line. Two observers stood on the front engine making observations while travelling 25 to 40 miles per hour. These observations helped determine areas of high sage-grouse density.

The number of observers that have participated in lek censuses ranges from three observers in 1969, 2001 and 2002 to 23 observers in 2007 and 2008. The majority of observers were government staff, but volunteers from non-government organization’s

(NGO's), colleges and naturalist groups have been involved. Typical census protocol involves observers investigating leks the evening prior to the morning count to check for signs of sage-grouse activity (i.e. scat, feathers and trampled grass) and to ensure that access and vantage points are clear. Vantage points are chosen approximately 200 to 500 meters from the lek site to minimize disturbance to the birds. The next morning, observers are at the vantage point at least 30 minutes before sunrise and record the numbers of males and females on the lek until one hour after sunrise. If there is more sign present at the lek then is represented by the number of sage-grouse observed, and time permits, it is ideal that the observer return to the lek on another morning to confirm the count. Connelly et al. (2003) recommends that there be little to no wind present (< 20 km/hour) and conditions are clear (no snow or rain) when censuses are performed.

Recently, efforts at supplementing lek monitoring by the use of remote time lapse cameras placed and camouflaged strategically near lek sites has been attempted. Reconyx RapidFireTM trail cameras are mounted on rebar stakes and camouflaged with sagebrush. The rebar is also spray painted for camouflage. Cameras are placed 100-200 meters away from the lek centre to avoid disturbance and placed strategically to deter perching by predators. This can provide more precise male occupancy numbers since the camera can document lek activity in the early morning for up to three weeks. Fish and Wildlife staff have demonstrated some level of success in this monitoring method and plan to utilize it in the future when suitable conditions around lek sites exist.

3.1.2 Population Trends

In Alberta, population estimates using extrapolated data from lek censuses have been documented irregularly since 1967. In 1967 a total population estimate of 3160 sage-grouse was derived from multiplying an average of 20 males observed on seven confirmed leks by an estimated 36 total leks (based on suitable sagebrush habitat thought to be available before the aerial survey of habitat in 1968). Using a 1:1 sex ratio, 720 females were multiplied by an estimated 60% nest success and an estimated four birds per brood to survive to the next breeding season [estimates based on Patterson (1952)]. With this information, it was estimated that 1720 juveniles would be available for harvest in 1968, plus 720 males and 720 females. This same method was used in 1968 when an estimated 6240 birds were believed to be in the southeast corner, but these estimates did not account for summer mortality and therefore may have been inflated. Currently, Fish and Wildlife staff use the maximum number of males observed on each lek as a population index to estimate overall population size. This procedure consists of summing the maximum counts of males on leks and dividing the number by 0.75 to adjust for unseen males (Connelly et. al 2003). This value is then multiplied by 2 (assuming a 2:1 sex ratio of females to males) to estimate number of females.

3.1.3 Brood Surveys

In Alberta, brood surveys were initiated in 1963 and consisted of driving along roads at 20-30 km/hour and sometimes walking in ditches in order to observe hens and flush broods. Additional brood counts were conducted in 1967, 1968, 1969, 1975, 1976 and

1985. Brood counts took place in July and August, often consisting of a combination of roadside surveys and incidental counts while conducting unrelated field work. During late summer of 1995, dogs were used to attempt flush counts of chicks around two active leks and surrounding riparian areas (Dale Eslinger pers. comm.). Attempts were not successful and since then brood counts have not been part of the government monitoring program.

3.1.4 Aerial Surveys

In 1968, the first aerial survey of sage-grouse habitat was performed. Densities of sagebrush were sketched onto a map and classified as heavy, medium, sparse, very sparse and 'nil'. Assuming that male occurrence on leks varied directly with sagebrush densities, an arbitrary number of total leks was extrapolated.

Additional aerial surveys were conducted in 1983, 1985, 1995, 2001 and 2008 when efforts were aimed at locating unknown lek sites. Rotary-wing aircraft were used to fly large blocks of sage-grouse habitat during the first hours of daylight. Typically, east/west transect lines spaced one-half mile apart are flown while the aircraft is maintained at as low of a speed as possible (approximately 100km/hour) at an elevation of approximately 300 meters (Madson 1995). During aerial surveys for sage-grouse in Alberta, total flying time has ranged between 4 and 12 hours. Male occupancy counts, although never higher than ground counts, were also obtained by observers in the aircraft. Prior to 2008, drainages in sage-grouse habitat were flown to identify new leks. In 2008, a lek-habitat model developed by C.L. Aldridge (unpublished data) was used to fly a habitat-stratified survey path. Observers first flew over active leks to develop a search image for male sage-grouse and then flew over sagebrush habitat to look for new leks. Snow-free conditions were ideal to allow for increased detection of males on the leks.

3.1.5 Historical Hunting of Sage-Grouse

Sage-grouse were hunted in Alberta from 1967 to 1995. Fish and Wildlife staff manned check stations on an irregular basis along main roads in sage-grouse habitat and hunters voluntarily provided harvest information. The sage-grouse hunting closed in 1996 due to concern over diminishing numbers. While hunting mortality is generally considered compensatory, the optics of hunting a severely declining population is not positive.

5.0 RESULTS AND DISCUSSION

Currently, there are 36 known lek locations, of which five are active, four are inactive, 25 are abandoned and two inactive leks were not monitored (Table 1). The total number of active leks not monitored in 2011 and 2012 increased (Table 1) because of the manpower commitments required for the Alberta-Montana sage-grouse translocation. Only leks that were active in the year previous were monitored to decide on what leks to release the translocated sage-grouse and it was unlikely that old leks would reactivate due to low population numbers.

Brood observations in 1963 yielded 21 broods and 107 chicks (Table 1). The next brood survey took place in 1967, when 21 broods and 223 adult sage-grouse were observed. In 1976, low juvenile:hen ratios (Table 2) indicated poor reproduction in 1975 and 1976 (Windberg 1976). In 1985, 29 broods and 283 adult birds were observed when an intensive search took place in varying habitat types to determine important brood-rearing habitat.

In 1967, 207 hunters participated and harvested 269 birds, resulting in an average harvest of 1.3 birds per hunter (Armstrong 1968) (Table 3). Average hunter harvest and estimated hunter success decreased in the mid 1980s but then increased in the late 1980s and early 1990s (Table 3).

Table 1. Summary of lek monitoring in Alberta from 1968-2012.

Year	Number of Leks Monitored	Number of Active Leks Not Monitored	Number of Active Leks (> 0 males present)	Number of Inactive (0 males present) Leks	Number of Abandoned Leks (< 2 males attended a particular lek once in the previous	**Total Number of Known Leks**
1968	21	0	21	0	0	**21**
1969	20	1	18	2	0	**21**
1975	19	4	19	0	0	**23**
1976	19*	3	19	0	0	**25**
1977	13*	11	13	0	0	**25**
1978	14	11	14	0	0	**25**
1979	11	15	11	0	0	**26**
1980	17*	5	17	0	0	**27**
1981	16	11	16	0	0	**27**
1983	18*	9	18	0	0	**28**
1985	15*	10	15	0	0	**28**
1987	13*	9	13	0	0	**28**
1989	12	16	12	0	0	**28**
1991	11*	12	11	0	0	**28**
1994	22	6	8	13	1	**28**
1995	27	3	12	14	1	**30**
1996	13	17	11	1	1	**30**
1997	30	0	8	21	1	**30**
1998	30	0	8	17	5	**30**
1999	31	0	9	9	13	**31**
2000	31	0	8	9	14	**31**
2001	32	0	9	3	20	**32**
2002	32	0	10	4	18	**32**
2003	32	0	9	4	19	**32**
2004	32	0	9	1	22	**32**
2005	32	0	9	1	22	**32**
2006	28	0	9	1	23	**33**
2007	30	0	10	0	23	**33**
2008	31	0	9	2	23	**34**
2009	32	0	10	3	23	**36**
2010	32	1	9	3	23	**36**
2011	11	2	8	1	25	**36**
2012	9	2	5	4	25	**36**

* = a number of leks not found

Table 2. Greater sage-grouse reproductive data obtained from brood surveys in 1967, 1968, 1969, 1975, 1976 and 1985. Sample size is in parentheses (adapted from Windberg 1976).

Year	Percent Hens With Broods	Mean Brood Size (chicks > 3 weeks in age)	Juvenile:Adult Hen Ratio
1967	42 (61)	4.4 (20)	1.9:1
1968	41 (81)	4.0 (28)	1.7:1
1969	80 (36)	3.7 (21)	2.3:1
1975	47 (47)	3.5 (18)	1.6:1
1976	49 (51)	3.0 (20)	1.5:1
1985	-	3.4 (29)	-

Table 3. Estimated total harvest and hunter success for sage-grouse in Alberta from 1967-1992. Compiled from Gudmundson and Vriend (1995) and 1967-1976 Job Completion Reports.

Year	**Estimated Number of Hunters**	**Estimated Harvest**	**Number of Hunter Hours**	**Estimated Hunter Success (Birds per Hunter)**
1967	207	269	No data available	1.3
1968	220	242	No data available	1.1
1976	500	175	No data available	0.4
1983	57	45	455.45	0.8
1984	106	29	455.45	0.3
1985	41	20	216.25	0.5
1986*	183	180	280	1.0
1987*	305	373	420	1.2
1988	446	452	821	1.0
1989	170	104	222	0.6
1990			No data available	
1991			No data available	
1992	150	103	288	0.7

* Results from hunter check stations document lower estimated hunters and harvest

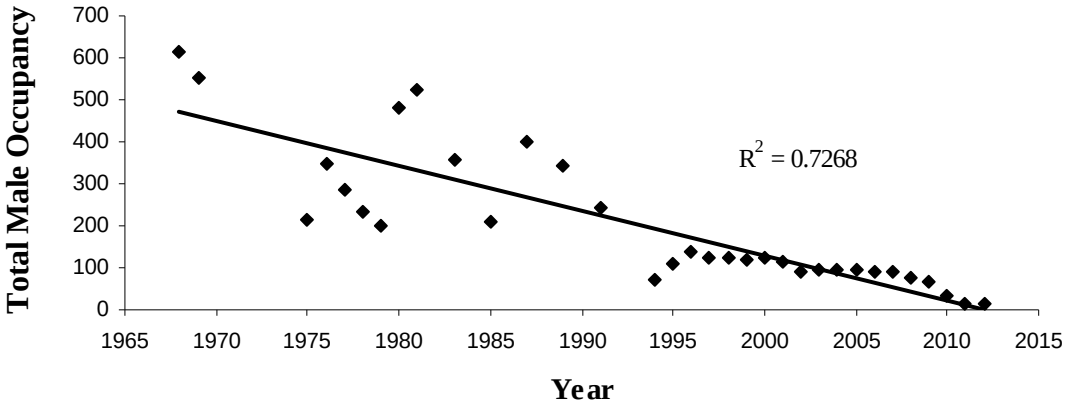

Figure 1. Linear regression of total male occupancy on Alberta leks from 1968-2012.

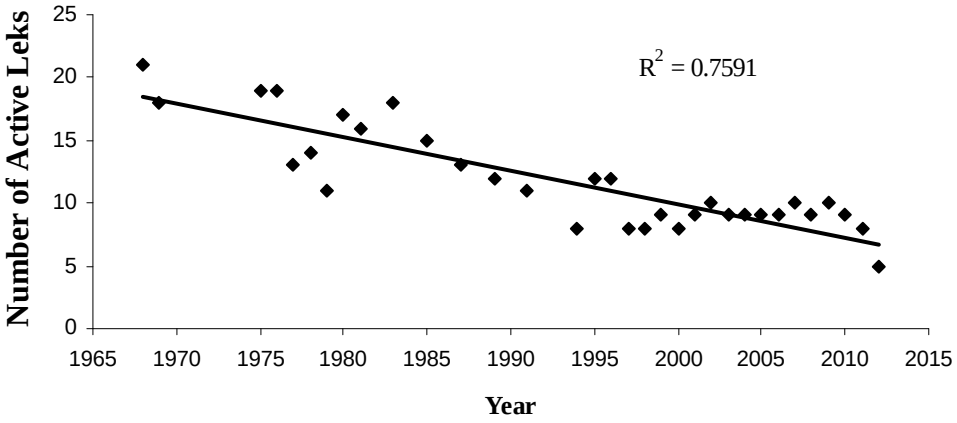

Figure 2. Linear regression of the number of active sage-grouse leks in Alberta from 1968-2012

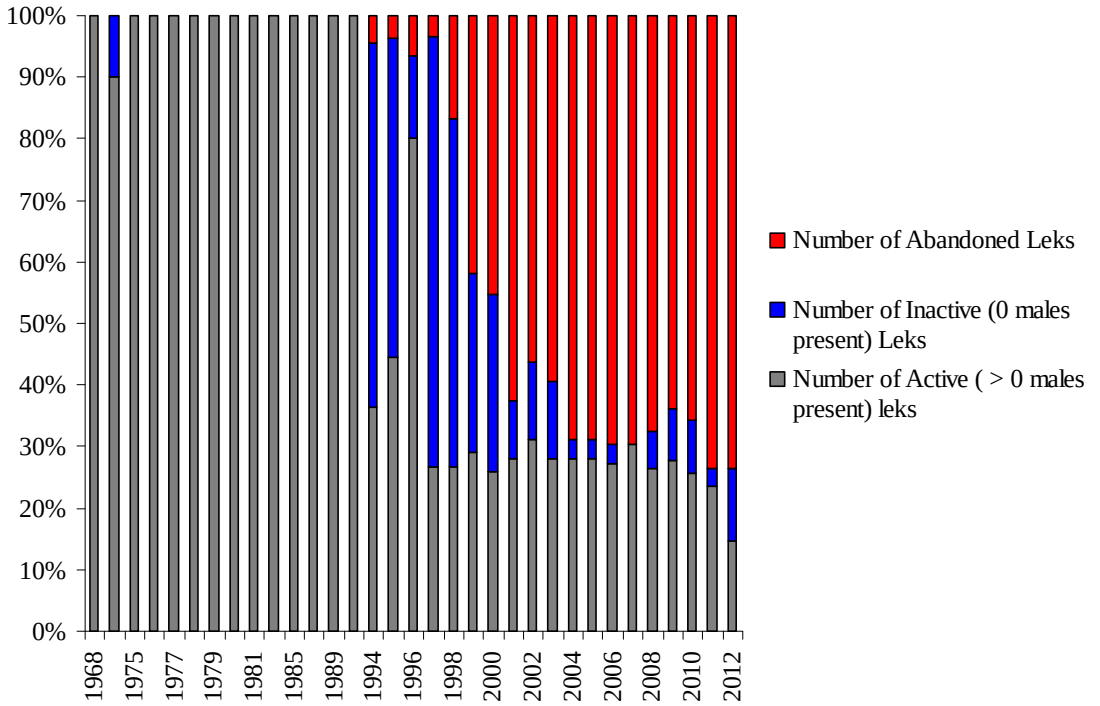

Figure 3. Proportion of active, inactive and abandoned leks in Alberta from 1968-2012.

5.1 Lek Censuses and Monitoring Effort

In Alberta, lek censuses have been performed on average, every two years since 1968, although gaps as long as five years have occurred (Aldridge 2000). The gaps were a consequence of budget limitations and staff availability for given years. Since 1968, 33 lek censuses have been performed. This represents a 73% monitoring effort over the past 45 years. From 1994 to 2012, lek censuses occurred every year. Monitoring efforts were generally fairly consistent through this time period with some variance due to weather, road conditions and the number of staff available. Inconsistencies emanated from variance in the number of repeat visits to leks, the seasonal timing of censuses and the time of day that surveys were performed. These inconsistencies were described in the sage-grouse monitoring reports. However, wildlife managers believed that maximum male occupancy counts were obtained resulting in representative population trends being determined.

In 1996, a comparative study of lek monitoring methods was performed to evaluate the validity of the traditional, one week survey period used in Alberta. Male attendance on nine active leks for the period of April 25th, 1996 to May 5th, 1996 were compared against four weekly lek counts for the period of April 15th, 1996 to May 12th, 1996. An average of 11.7 cocks/active lek was documented during the traditional survey period and 14.6 cocks/active lek was observed during the four week study period (Grue and Watmough 1996). The difference was not found to be significant and the traditional method used in

Alberta was proven to produce similar results to the longer method used in the U.S. where each lek is counted four times from April 10th until May 10th (Grue and Watmough 1996). Repeat visits increase the chance of disturbance to leks and therefore may not be appropriate to monitor an endangered species.

5.2 Population Trends

While it is apparent that the Alberta sage-grouse population has declined, the exact rate of decline is difficult to ascertain due to inconsistent monitoring efforts (Madsen 1995). Assessment of trends is then complicated by the fact that sage-grouse populations appear to cycle every 7 to 10 years (Patterson 1952). Aldridge and Brigham (2001) reported a 66-92% population decline over the last 30 years. This decline has continued at an alarming rate, with the current Alberta sage-grouse population estimated to be 2.12% of what is was in 1968. This corresponds to a 97.88% population decline over 45 years. It is possible that rates of decline are underestimated as a result of historic sage-grouse range likely being greater than when what was documented in the 1960s.

Irregular monitoring efforts between 1968 and 1994 make assessing the exact years of lek abandonments difficult. Using the information available and the definition of lek abandonment discussed by Connelly et al. (2003), years of lek abandonments were determined as accurately as possible, although abandonment on some leks may have occurred earlier than represented in this report. In the early 1990s, 14 leks were declared abandoned. Despite this, male occupancy on leks from 1994-2001 remained relatively stable at just less than 100 males in attendance. During the same time period, the mean number of males/lek almost doubled from 8.8 males/lek in 1994 to 15.8 males/lek in 2000. Male occupancy increased on six leks during this time period. According to Dalke et al. (1963) it is common for smaller satellite leks to be abandoned during population lows, while the attendance at main lek complexes increases over time. This suggests that changes in habitat quality or fragmentation occurred during this time period, forcing birds to move to leks in more suitable habitat.

Since the initiation of lek counts, 25 out of 36 (69%) leks have been abandoned at a rate of 1.5% per year. Sixteen leks became inactive between 1968 and 1989. By 1978, there was a 50% decline in the population since the late 1960s. In the late 1960s and early 1980s, sage-grouse numbers peaked, with 500-600 males counted on approximately 13-20 leks, with an average of greater than 25 males/lek. However, male occupancy counts in 1980 were still 30% below the recorded count in 1967. In 1995, the population made a slight recovery when male occupancy at eight leks increased 45% from 1994, and it was suggested that population levels could recover from similar levels like they did in the early 1980s (Madsen 1995). However, since 1994 average male occupancy on leks has decreased 34.4%, and the increase in 1995 was possibly a result of inter-lek movement due to the abandonment of satellite leks.

5.3 Brood Surveys

Brood observations are simply records of all sage-grouse broods observed in a given area by field personnel (Connelly et al. 2003). This information provides an idea of the juvenile to adult ratio and percentage of hens observed with broods. The downside of brood surveys is that they are not easily replicated making comparisons between years difficult (Connelly et al. 2003). In Alberta, brood surveys were initiated in 1963, when sage-grouse habitat was arbitrarily distinguished between the fragmented habitat surrounding the Manyberries area and the contiguous rangeland in the Wild Horse area. There was no distinction between areas in 1967, however it was reported that more broods were observed in cultivated areas and haylands (Jestin 1968). In 1968, effort was focused on estimating peak breeding and peak hatch dates, which were estimated to be April 29th and June 6th, respectively. Brood counts were only conducted again in 1975, 1976 and 1985. In 1976, low juvenile:hen ratios indicated poor reproduction in 1975 and 1976, which may have been temporary as a result of adverse weather conditions or permanent due to intensified agricultural use (Windberg 1976). In 1985, an intensive brood search took place in varying habitat types to determine important brood-rearing habitat. Most broods were found in wet meadows, tame grass and cereal crops; whereas lone adults were found in sagebrush, forage crops and snowberry habitat types (Dubé 1985).

5.4 Aerial Surveys

As a result of the first aerial survey of sagebrush habitat in 1968, it was found that in the 40% of mapped sagebrush habitat there were 23 known leks, so by approximation, if the remaining 60% of sagebrush habitat was similar, the potential for 57.5 leks existed (Clewes 1968). Aerial surveys have also been effective in identifying winter habitat and active sage-grouse leks throughout North America. If aerial surveys are used, data should be acquired over a series of years with different snow conditions to give a more complete picture of sage-grouse distribution in winter (Connelly et al. 2003). In 1983 during aerial surveys for sharp-tailed grouse (*Tympanuchus phasianellus*), one active sage-grouse lek was found. During an aerial survey the same year for sage-grouse, poor weather conditions minimized flying time and no additional leks were found. Poor weather and strong wind conditions also hampered the aerial search for leks in 1985 and no new leks resulted. In 1995 and 2001 both ground and aerial surveys occurred. Two new leks were discovered in 1995 by ground surveys and two new leks were found in 2001 and 2008 during the aerial surveys. In total, four sage-grouse leks have been discovered by aerial surveys in Alberta. In addition, two new sharp-tailed grouse leks were also discovered in 2001 and 2008. Aerial surveys can be efficient in that more area can be covered in less time in the search for new active leks, but should not replace ground searches which appear to be more accurate for obtaining male occupancy counts.

5.5 Historical Hunting of Sage-Grouse

The first legal hunt of sage-grouse in Alberta took place in October 1967, during which 1000 permits with two-bird limits were available to hunters over three days (Armstrong

1968). The hunter success in 1967 was considered good compared to sage-grouse seasons in the U.S. in 1963 and 1964. Gizzards and crops were collected from 54 harvested sage-grouse to gain insight into their diet. It was reported that 88.9% of crops contained at least 90% sage and lesser amounts of grasses (*Poaceae*), wheat seeds, mustards (*Brassicaceae*), along with ants (*Formicidae*), grasshoppers (Orthoptera) and beetles (Coleoptera) (Armstrong 1968).

In 1969, Gaylen Armstrong, Lethbridge Regional Wildlife Biologist, reported that "Albertans were generally dissatisfied in sage-grouse as a sport and edible bird." However, the sport of grouse hunting remained attractive amongst many hunters, especially to pronghorn (*Antilocapra americana*) hunters who enjoyed hunting the large, "turkey-like" birds while hunting big game. In 1969, Canadian Wildlife Service biologist Ron Jakimchuk described such a hunt with friends and co-workers who travelled to Manyberries from Edmonton to hunt pronghorn and sage-grouse. Jakimchuk describes seeing numerous flocks of 10 to 20 grouse on a large sage-flat near Manyberries and perhaps 300 to 400 birds in total flushing ahead of them as their "gunshots erupted" (*Western Fish and Game* 1969).

Levels of harvest were less than 10% of the total population and as a result were not considered detrimental to the sage-grouse population (Gudmundson and Vriend 1995). Wallestad (1975) suggested that hunters can harvest 30% of the fall population annually without affecting breeding populations. In 1978, it was suspected that environmental conditions were not favourable to facilitate the recovery of sage-grouse from its relatively low population level. With no monitoring of hunter harvest at the time, it was recommended that the pronghorn and sage-grouse seasons should be staggered to avoid excessive harvesting of sage-grouse by pronghorn hunters. However, in 1984 the sage-grouse harvest took place late in the season to coincide with the white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) season in hopes of maintaining interest in sage-grouse hunting.

Sage-grouse hunting in Alberta was unique in North America because of the late season (Banasch 1985). Most seasons in the U.S. were held earlier in the fall before the birds flock up, insinuating the possibility of overharvesting in Alberta. However, the seasons in Alberta were no more than six days in duration with a seasonal possession limit of two birds, making overharvest unlikely (Banasch 1985). More hunters participated in the 1984 hunt than in 1983 when the hunt did not coincide with a big-game season, although fewer sage-grouse were actually harvested. Late season hunts are often more desirable since males are in full plumage (72% of hunters expressed desire to have their sage-grouse mounted in 1983 and 1984). A smaller proportion of hunters expressed the attractiveness of earlier season hunts as sage-grouse eat more forbs during the late summer/early fall and therefore may be more palatable. In Saskatchewan, a sage-grouse hunting season has not existed since 1938 and that province's sage-grouse population also exhibited a significant decline in the 1990s. It is apparent that the remaining threats played a more substantial role in the population decline.

5.6 Threats

5.6.1 Weather and Climate

The prairie climate is subject to extreme variability including temperature and moisture regimes (McNeil et al. 2007). Harsh weather can have direct impacts on sage-grouse nesting success and chick survival and can also impact silver sagebrush, particularly in the fall and winter. Climate variation can also affect forb and insect availability important to sage-grouse at various times of the year (McNeil et al. 2007).

Windberg (1976) suggested that since sage-grouse are at the northern edge of their range in Alberta they may be more susceptible to adverse weather. Wallestad (1975) attributed reproductive success of sage-grouse to rainfall during the egg laying period. Heavy rainfall (> 1 inch) caused poor production in Montana (Wallestad 1975) and as a result, a series of wet springs in Alberta were attributed to the sage-grouse declines in the 1970s. Conversely, a series of extremely dry summers in the mid-1980s, resulting in a decrease in wet meadow areas, was attributed to the population decline.

According to McNeil et al. (2007), climate data in the sage-grouse range in Canada indicates an increase in the frequency of extreme weather since the mid-1970s, including an increase in cold and wet springs, and exceptionally hot and dry conditions in 1985, 1987, 1988 and 1992. Cold and wet days in May occurred more frequently after 1998. Cold and wet springs occurred more frequently after 1999. Sage-grouse populations declined dramatically after the spring of 1988, corresponding to the exceptionally hot and dry conditions in 1987 and 1988. The greater frequency of extreme weather events in the 1990s may be contributing to the continued decline in sage-grouse populations and may be partly related to the greater frequency of cold and wet spring conditions in southeast Alberta between 1999 and 2004 (McNeil et al. 2007).

Aldridge (2003) concluded that a large May snow storm and three days of continuous rain in 2002 resulted in low nest success for the population in southeast Alberta due to eggs being frozen early in incubation. In contrast, Aldridge (2001) concluded that drought conditions decreased clutch and brood success in southeast Alberta in 2001. Only 17% of 52 birds captured in 2001 were yearlings, compared to 25% from 1998 to 2000. This number should be around 50% for a stable population (Aldridge 2001). Drought conditions can be especially harmful in mesic habitats that are depended on for brood rearing. However, the effects of other limiting factors may be exacerbated during drought, such as livestock stocking rates further decreasing vegetative cover and possibly increasing predation rates and decreasing nest success (Aldridge 2000). Historical spring precipitation data for southeast Alberta is presented in Appendix E.

5.6.2 Recreational Activities and Predators

The effects of recreational activities and predators on sage-grouse populations emerged in the late 1970s. In 1978, two lek counts were dismissed due to the abnormal scattering of

birds. Predator activity on one lek and photography of birds on another lek was attributed to this abnormal behaviour. Recreational access caused disturbance to two leks in 1981 and male attendance at these leks decreased in years following. These leks were readily accessible by well-travelled roads and at one lek, tire prints were found around the edge of the lek (Gunmondson 1981). The recreational viewing of sage-grouse for photography purposes continues to be a threat to breeding sage-grouse today. It is apparent that this activity negatively affects breeding behaviours, potentially decreasing reproductive success and male attendance at the disturbed lek in future years.

5.6.3 Predators

The predator community in the prairies has undergone drastic changes in the last 150 years (Aldridge 2000). Nest predation is the main source of sage-grouse nest failure and can account for up to 94% of nest loss in some areas (Moynahan et al. 2007). Coyote (*Canis latrans*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), great horned owl (*Bubo virginianus*), American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*) and common magpie (*Pica hudsonica*) populations have all increased on the prairies, likely a result of increased habitat fragmentation and the presence of anthropogenic features. Anthropogenic features can serve as perching points for hunting and nesting and have been linked to increased predator densities (Holloran and Anderson 2005, Coates and Delehanty 2010).

5.6.4 Agriculture

In southern Alberta and Saskatchewan, large-scale ranching on leased land began in the 1870s (Lyle and Taylor 2007) when the area's dry climate was conquered by irrigation. Large scale immigration began with the arrival of the Canadian Pacific Railway in 1883. Between 1901 and 1931 the amount of cultivated land on the prairies increased from 1.5 to 16.4 million ha (Lyle and Taylor 2007).

In the 1960s and 1970s, opinions about the effects of agriculture in southeast Alberta on sage-grouse habitat varied widely. As early as 1963, concerns were being raised about the relationship of the encroachment of farmland into sage-grouse habitat and the stability of the population. However, Armstrong (1968) stated that land use practices were not affecting sage-grouse range, compared to the U.S. where chemical spray programs resulted in sagebrush removal. Cultivation of sagebrush has directly resulted in the desertion of at least one lek in Alberta (Leo Dubé pers. comm.). Windberg (1976) discussed the possible deterioration of sage-grouse habitat due to increased livestock numbers as a potential explanation for the breeding population decline; however, livestock numbers do not necessarily correlate with range condition, given that intensity, duration, and distribution ultimately affect rangeland health (Holechek et al. 2001). Currently, it is believed that livestock only present a significant risk to sage-grouse during the breeding season when cattle can potentially directly disturb courtship rituals. For example, in 1987 one lek appeared to have been disturbed by a herd of cows (Dubé 1987).

As knowledge of range management has progressed, stocking rates on public lands in southeast Alberta have diminished considerably from the early 1900's (Adams et al. 2004). According to census data for Division 1, located southeast of Medicine Hat, stocking rates decreased to 50 acres per AUY[1] in the 1930s after the depression (Adams et al. 2004). Recommended rates were then set at 60 acres per head by the 1960s and then to an average rate of 90 acres per AUY by the 1990s (Adams et al. 2004). Stock return records (forms submitted by grazing lease holders to AESRD every year) provide a more accurate representation about actual use levels on grazing leases in the sage-grouse area; actual use has averaged between 80 and 120 acres per AUY (Adams et al. 2004). Based on local forage production values and stocking rates, grazing intensity would be considered light to light-moderate in southeast Alberta (Adams et al. 2004). Some studies suggest that appropriate grazing management can be used to stimulate the productivity of forbs important as sage-grouse food (Evans 1986).

The further contraction of sage-grouse range in Alberta is limited due to the presence of provincially-owned grazing leases that encompass the majority of the range (77.2% of land in sage-grouse range is provincially owned) (Appendix F). Section 56 of the *Public Lands Act* and Regulations discusses cultivation of land that is under a grazing disposition. Although there is no specific policy preventing cultivation, it states that the land cannot be cultivated without the approval of the Director. Generally speaking, cultivation would only be allowed for specific purposes such as destroying weeds or removing bush, but not for annual cropping (Kevin France pers. comm.). Federal land (Agriculture Canada Onefour Research Station) consists of 0.39% of sage-grouse range, while 0.84% of the range is managed directly or indirectly by NGO's. Further limiting the contraction of sage-grouse range are restrictions on agricultural crop production as a result of severe soil limitations (Canada Land Inventory 2008). The limitations are a result of topography, adverse climate and the cumulative effect of these limitations (Canada Land Inventory 2008). It is apparent that cultivation and livestock grazing presented significant threats to sage-grouse habitat up until the 1960s. Currently, due to light-moderate grazing practices, land ownership and soil restrictions on agriculture, agriculture and livestock no longer present a significant threat to the further contraction and degradation of sage-grouse range.

5.6.5 Oil and Gas Activity

In 1981, Lethbridge Regional Wildlife Technician Leo Gudmundson strongly recommended that well sites should be drilled later in the summer or in the winter, and that re-routing of access roads near leks should be considered. Despite such warnings, there are reports of oil and gas activity occurring in close proximity to leks in 1983 when a well site was drilled 250 meters from a lek that previously experienced recreational disturbance in 1981. In 1985, two additional leks had drilling activities occur in close proximity to them and a sharp decline in male occupancy was observed, with one lek

[1] An AUY is the forage required to support a standard Animal Unit (AU) for 12 months; an Animal Unit is considered to be one mature cow of about 1,000 pounds (450 kg), either dry or with calf up to 6 months of age (SRM 1998 and Adams et al. 2004).

relocating 0.75 miles west and another lek becoming inactive. Seismic activity was observed in close proximity to one lek and a road was observed intersecting another lek, consequently both leks experiencing a decrease in male attendance. By the end of the 1980s, the Manyberries area had experienced a significant influx of oil and gas related activities (Appendix D). Dubé (1987) stated that out of 12 leks in which travelled roads or pipelines pass within 1.2 km, four are no longer active. By 1991, the inactivity of six leks was attributed to oil and gas activity, all of which are now abandoned.

Avoidance of anthropogenic features by sage-grouse is well documented (Aldridge and Brigham 2003, Holloran 2005, Aldridge and Boyce 2007, Doherty et al. 2008, Carpenter et al. 2010). Construction of oil and gas wells and associated infrastructure results in localized loss of habitat and contributes to anthropogenic edge which sage-grouse have been shown to avoid (Aldridge and Brigham 2003, Holloran 2005, Aldridge and Boyce 2007). In Alberta, sage-grouse select patches of nesting habitat with low proportions of anthropogenic edge and brood-rearing habitat with lower densities of well sites (Aldridge and Boyce 2007). Avoidance of habitat may also result in decreased survival or reproduction if sage-grouse are displaced to marginal habitats (Holloran 2005, Naugle et al. 2011). Disturbed habitats often support invasive plant species that are important forage to which sage-grouse are attracted (Aldridge and Boyce 2007). Aldridge and Boyce (2007) found an increased risk for each additional oil well that is visible within 1 km of brood locations. As a result, a large portion of brood habitat is classified as attractive sink habitats (Aldridge and Boyce 2007).

Anthropogenic noise can limit the ability of sage-grouse to communicate by reducing the distance over which vocal signals can be perceived by a receiver (Blickley and Patricelli 2012). These authors found that noise produced by natural gas infrastructure was dominated by low frequencies, with substantial overlap in frequency with sage-grouse acoustic displays. Such masking could increase the difficulty of mate assessment for breeding sage-grouse. Noise pollution also has the potential to mask other natural sounds important to survival and reproduction, such as the sound of predator approach (Kight and Swaddle 2011).

6.0 MANAGEMENT IMPLICATIONS AND FUTURE DIRECTIONS

The primary focus for sage-grouse management in Alberta is the recovery of population numbers that were prevalent in the late 1960's (Alberta Greater Sage-grouse Recovery Plan 2005-2010). Agricultural development has caused a major contraction of sage-grouse habitat in the past 100 years. Oil and gas activity increased significantly in the late 1970s and early 1980s and the impact on sage-grouse populations became apparent in the mid 1980s, with a severe decline in male lek attendance. Management efforts should focus on recovering the population to 600 males, the number of males present in the late 1960s. Despite the fluctuations in resourcing and time commitments, this report emphasizes the necessity for consistency of monitoring effort in order for accurate population trends to be obtained and correlated with activities on the landscape as well as recovery efforts.

Priority for additional work should be focused on the reclamation of abandoned and suspended well sites on the landscape, as well as the removal of other anthropogenic features including abandoned houses and artificial nest poles, where appropriate. A high standard of land stewardship should continue to be fostered in industrial planning and amongst the ranching community. In addition, the search for new leks or the monitoring of recently inactive and abandoned leks should occur at least once every five years. Continuing to manage and mitigate impacts of natural resource development in critical nesting brood rearing and wintering habitat will be necessary. Recovery goals and action plans are documented and discussed in detail in the *Alberta Greater Sage-Grouse Recovery Plan 2013-2018*. Continued monitoring will be a necessary tool to analyze the response of the sage-grouse population to recovery actions over time.

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8.0 APPENDICES

Appendix A

Sample questionnaire sent out to community members in the 1960s.

GOVERNMENT OF THE PROVINCE OF ALBERTA

DEPARTMENT OF LANDS AND FORESTS

Dear Sir:

We dropped in to see you to obtain information on_____ in your area this year. It would be appreciated if you would answer the following questions. It will help us a great deal in our wildlife management program.

YOUR NAME: _____

ADDRESS: _____

HAVE YOU SEEN ANY? _____

HOW MANY? _____

WHERE? (a) Location: _____

(b) Habitat: (forest cover, at edge or opening of forest, grassland prairie, etc.) _____

WHEN? (a) Date: _____

(b) Time of Sighting: _____

WEATHER CONDITIONS: - cloud cover _____

- clear _____

- warm, cold (estimated temperature) _____

- snow cover _____

- rain _____

ADDITIONAL REMARKS: (such as what were they doing; what was their behavior, etc. _____

_____

_____

_____

_____

PLEASE MAIL THIS FORM IN THE ATTACHED SELF-ADDRESSED ENVELOPE.

Thank you.

Appendix B

Historic (yellow) and currently occupied range (green) of the Greater sage-grouse.

Appendix C

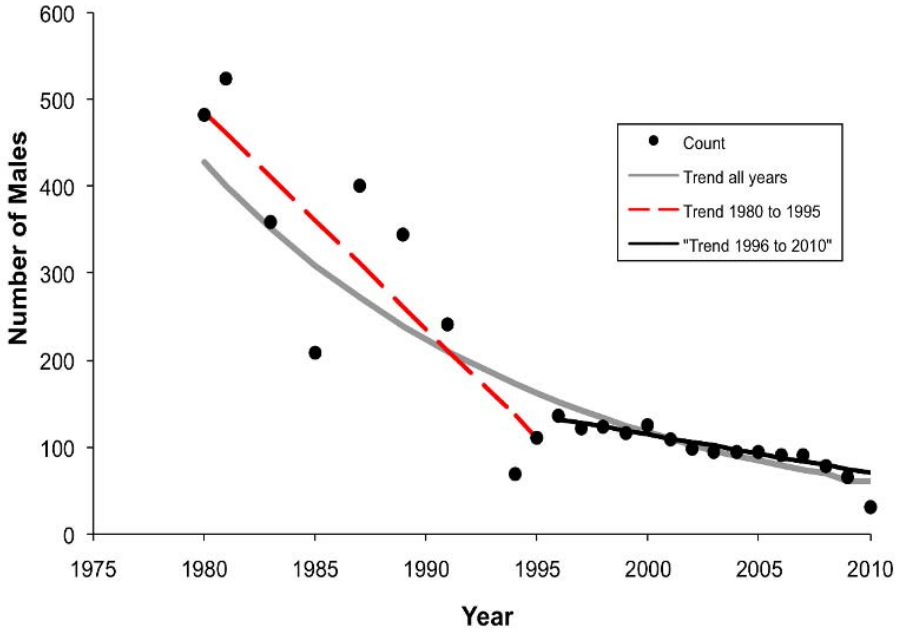
Summary of abandoned, suspended and active wells in townships 1-1 to 6-7 W4M, the extent of sage-grouse range in Alberta, as of 11/2012 (excluding water wells). Source: Energy Resources and Conservation Board (ERCB) – Compliance and Operations Management database (COM).

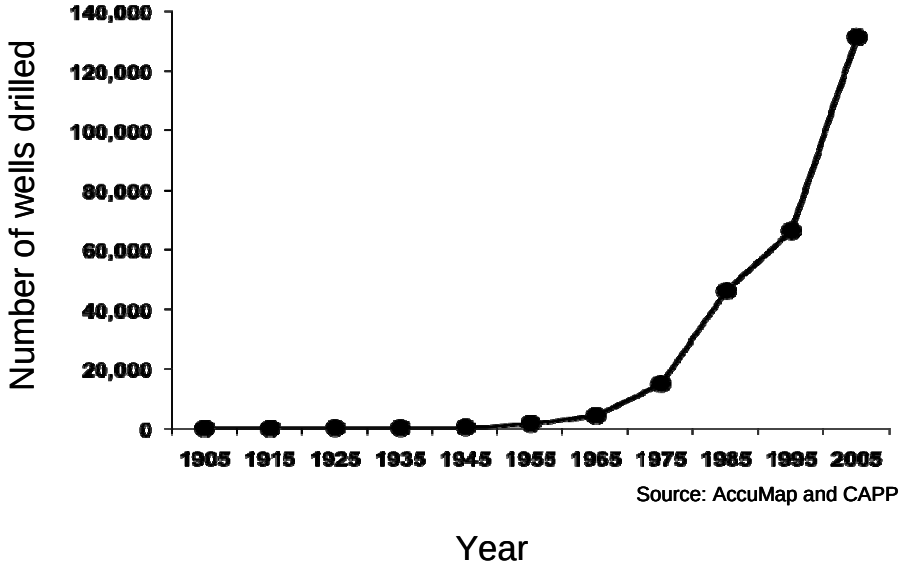
Wellsite Status	**Number of Wellsites**	**Percentage (%) of TOTAL Wellsites**
Abandoned	170	11.09%
Reclamation Certified	617	40.25%
Reclamation Exempt	149	9.72%
Suspended	186	12.13%
Active	411	26.81%
TOTAL	**1533**	

A well is reclamation exempt (no legal obligation to obtain a Reclamation Certificate) if it was drilled pre-1963 on private land or pre-1978 on crown land. Definitions of abandoned and suspended wells can be found in Directive 13 and Directive 20, respectively, at http://www.ercb.ca/regulations-and-directives/directives.

Appendix D

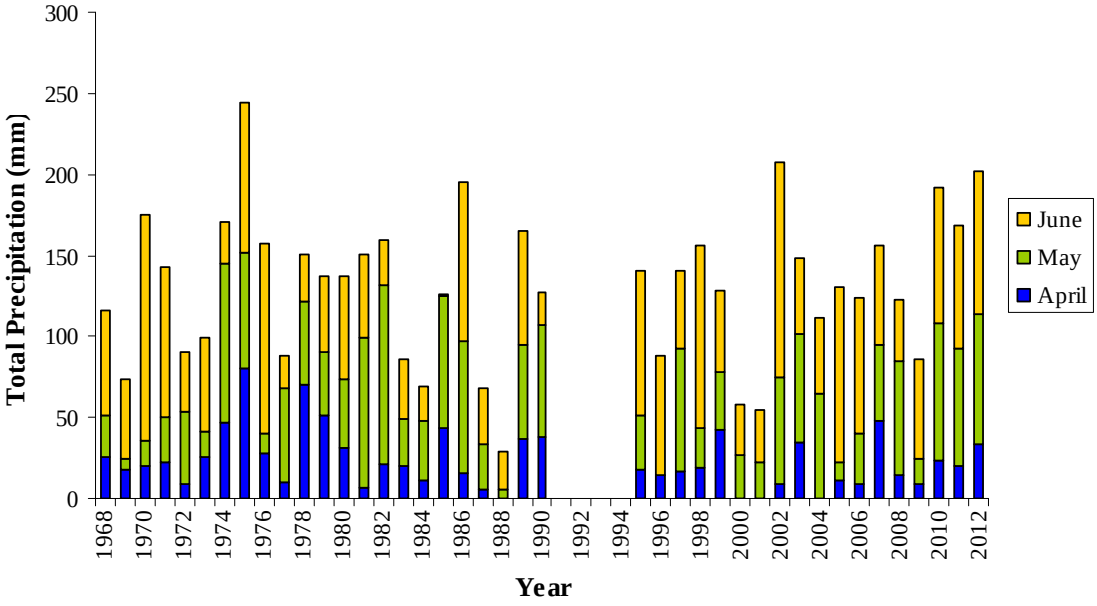
Sage-Grouse trends and natural gas wells in Alberta from 1980 to 2010. The sage-grouse population decline from the early 1980s to the mid 1990s was significantly more drastic than the decline from 1995 to 2010 (top). This correlates with an increase in energy development in Alberta in the 1980s (bottom). Source: AccuMap and CAPP (2010).





Appendix E

Historical spring precipitation data for extreme southeast Alberta from 1968-2012. Total precipitation includes rain and snow. Precipitation data from 1968-1990 is from the historical Manyberries CDA Weather Station (no longer in existence) and precipitation data from 1995-2012 is from the Onefour CDA Weather Station. No historical data exists for 1991-1994. Source: Environment Canada National Climate Data and Information Archive.



Appendix F

Land ownership in Alberta sage-grouse range.