Nesting and Brood Rearing Ecology of Plains Sharp-tailed Grouse (*Tympanuchus phasianellus jamesi*) in a Mixed-Grass/Fescue Ecoregion of Southern Alberta

By

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A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the
Requirements for the Degree of

Master of Natural Resources Management

Natural Resources Institute
University of Manitoba
Winnipeg, Manitoba

August 2001

0-612-62836-1

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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ABSTRACT

The primary use of prairie lands across sharp-tailed grouse range is livestock production. As such, the health of sharp-tailed grouse populations is closely associated with the intensity of cattle grazing. Indeed, poor range management has been implicated in the reduction of sharp-tailed grouse populations in both the United States and Canada. Populations inhabiting the prairie regions of Alberta have not escaped such declines due to the predominance of the cattle industry within this portion of the province. In an effort address these issues a research project was undertaken to evaluate the nesting (chapter 2) and brood rearing (chapter 3) habitat requirements of sharp-tailed grouse in the Milk River Ridge Region. Management recommendations resulting from this study (chapter 4) could then be utilized to evaluate and enhance the reproductive habitats in areas where sharp-tailed grouse populations are in decline.

Sharp-tailed grouse hens on the Milk River Ridge occupied smaller home ranges than reported by previous sharp-tailed grouse researchers, which may be an indication of the habitat quality of the area. Hens tended to nest in "hotspots" and did not utilize the entire breeding complex (2 km surrounding the lek) for nesting purposes. Nests sites contained more woody cover than random sites, while random sites contained more grass than nest sites. Bare ground and moss/lichen, both indicators of poor range condition were present at a ratio of 4:1 at random sites as compared to nest sites. Litter and forbs were found in comparative compositions at both nesting and randomly located sites. Heights of all vegetative categories were higher for nest sites.

Brood use sites were characterized by increased proportions of grass and decreased proportions of litter, bare ground, and moss/lichen than randomly located sites. Woody and forb compositions were comparable at both use and random sites. Grass heights were significantly higher at brood use sites, whereas the heights of woody vegetation, forb and litter were comparable to random sites.

In order to effectively and efficiently manage for sharp-tailed grouse reproductive habitats, a methodology to identify critical reproductive areas was developed. This management strategy recognizes the needs of livestock producers and proposes to isolate only those areas identified as critical nesting areas from grazing. This challenge to the traditional management approach results in increased lands available to cattle and increased protection of those areas identified as nesting "hotspots".

The predominance of shrubs at nesting locations suggests that a component of shrub patch retention should be included in management directives aimed at enhancing sharp-tailed grouse reproductive habitats. Underlying all of the management recommendations is the necessity for proper range management and the protection of contiguous native grasslands. Lastly, a discussion of the utility of sharp-tailed grouse as an indicator of prairie health concludes the thesis.

ACKNOWLEDGEMENTS

Funding for this research was provided by the Alberta Conservation Association, Ducks Unlimited Canada (North American Waterfowl Management Plan), the Biodiversity Challenge Grants Program, and Alberta Sport, Recreation Parks and Wildlife Foundation.

This thesis is dedicated to my grandmother Maria Breedveld. Her undying love and concern for everyone around her was a true inspiration. We miss her dearly.

I would like to begin by thanking my beautiful wife Tracy, whom through her extraordinary support is as dedicated to my profession as I am. I am grateful for the love, strength and confidence with which she surrounds me on a daily basis.

I would like to thank my parents for standing by me every step of the way. Without their encouragement and assurance, I would not be where I am today. Individually, I would like to thank my mother Ann Roersma, for always being there in every manner of support. I would like to thank my father Jan Roersma, for introducing me to the beauty of the natural world on our countless fishing trips during my youth.

Thanks to my in-laws Scott and Sheila Forbes, for providing me with a second home and a truly supportive extended family.

Thanks to my pal Malcolm for being my constant companion with a loyalty that would rival any relationship between a man and his dog.

Thanks to Derek Kroeker for his more than competent assistance in the field (and the bar). Thank you also for the friendship that we have garnered.

Thanks to my advisor Rick Baydack, for convincing me to follow my dreams of becoming a biologist some 6 years ago. Rick has served as my mentor during those years and has become a friend in the process.

Thank you to the members of my academic committee. To Norm Kenkel for his statistical and sampling advice. To Don Sexton for his expertise on sharp-tailed grouse. And lastly, to Rick Riewe for helping out late in the game with valuable comments on wildlife management.

Finally I would like to thank the landowners of the Milk River Ridge and the people of Warner, Alberta for their hospitality, kindness and friendship. You made my time away from home that much easier.

"In wildness is the preservation of the world"

~ Henry David Thoreau ~

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Introduction

CHAPTER 1.0: Introduction

1.1 Issue Statement

Habitat requirements specific to the six subspecies of sharp-tailed grouse are not known with any great deal of certainty. Knowledge of these requirements becomes increasingly important in the present era of competing land uses and with consideration of the 30-year lag in management-directed research that has resulted in quiescent management strategies (Gutierrez 1994). In order for deliberate management of populations to be undertaken, additional research is required to differentiate between optimal and marginal habitats in an effort to determine techniques of improving marginal sharp-tailed grouse habitat (Braun et al. 1994). In order to implement effective management strategies the ecological requirements specific to the subspecies should be reflected in the management directives.

The plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) is considered to be the most successful of all sharp-tailed grouse subspecies in terms of distribution and population density (Hamerstrom and Hamerstrom 1961, Johnsgard 1973). Despite this fact, populations have decreased over much of their southern range as a result of land use practices (Kessler and Bosch 1982, Baydack 1986, Kirby and Grosz 1995). Plains sharp-tailed grouse have been extirpated from New Mexico, Oklahoma and Kansas, and are now listed as an endangered species in Colorado, occupying less than 10 percent of their former range (Miller and Graul 1980). Similarly, plains sharp-tailed grouse occupy only

10 to 50 percent of its former range in North Dakota and Wyoming, and 50 to 90 percent in Montana, Nebraska, Saskatchewan, and South Dakota (Johnsgard 1983). Greg (1987) stated that designated management areas are required in order to ensure the future existence of sharp-tailed grouse in Wisconsin. Reporting on the Alberta situation, Moyles (1986) states that prime sharp-tailed grouse habitats are being lost at ever-increasing rates with as much as a 33 percent loss over a five year period in the eastern prairie region.

Little is known of the exact relationship between land use practices and their effect on prairie grouse populations (Kirsch et al. 1973), although it is recognized that intensive cattle grazing and cropland conversions both contribute to loss of sharp-tailed grouse habitats (Hamerstrom and Hamerstrom 1961, Aldrich 1963, Evans 1968, Kirsch et al. 1973, Hillman and Jackson 1973, Johnsgard 1983, Swenson 1985, Baydack 1986, Kirby and Grosz 1995, Sedivec et al. 1995, Giesen 1997). However, grazing regimes that are compatible with good range condition can be beneficial to prairie grouse. The application of moderate grazing pressure can enhance grassland diversity and prevent the accumulation of excess debris, which decreases productivity (Evans 1968, Mitchell 1984). Hillman and Jackson (1973) report that the optimal habitats for sharp-tailed grouse in South Dakota consists of lightly grazed grasslands, which reproduces historic conditions when bison roamed the prairies. Therefore grazing levels compatible with good range management have the potential to provide secure habitat for prairie grouse (Mitchell 1984).

Because the primary use of private and leased lands within prairie grouse range is grazing (Brown 1981), cooperative research should be undertaken in order to devise management strategies that would benefit both ranchers and sharp-tailed grouse (Evans 1968). Additionally, Kessler and Bosch (1982) identify the need for research on grazing management practices and intensity effects on sharp-tailed grouse habitats.

Being a relatively short-lived species with a life span of approximately 3 years, the loss of one season's hatch could potentially reduce sharp-tailed grouse populations by 70-80 percent (Evans 1968). Nesting success and brood survival as they relate to quality nesting and brood rearing habitats, are therefore limiting factors throughout sharp-tailed grouse range (Hillman and Jackson 1973), and are the keys to abundant sharp-tailed grouse populations.

Sharp-tailed grouse research in Alberta has primarily focused on the Parkland regions of the province, which is dominated by aspen stands interspersed with croplands and grassland. The majority of the information gleaned from these studies is not directly applicable to the mixed-grass prairie zones, which is characterized by a completely different vegetation community than found within the Parkland regions. Coupled with the lack of information concerning the nesting a brood rearing habitat requirements of Plains sharp-tailed grouse within the mixed-grass prairies of Southern Alberta are the continuous pressures faced by theses areas by land use demands. In order for resource managers to effectively manage wildlife in these prairie ecosystems, information on the critical ecological requirements of the species is required

Consequently, Alberta Wildlife agencies have declared the need for additional research on sharp-tailed grouse hens in order to substantiate management directives in the prairie zones of the province (Gary Erickson, pers. comm. Alberta Natural Resources Service, Lethbridge, Bryan Millar, pers. comm. Alberta Conservation Association, Lethbridge). Similarly, it has been the conclusion of many studies that knowledge of the nesting and brood rearing habitat requirements of sharp-tailed grouse is lacking (Evans 1968, Hillman and Jackson 1973, Robel 1980), and thus further management oriented habitat studies are required.

Prairie grouse populations can only be increased and/or maintained through effective management practices that are based on knowledge of the specific habitat requirements (Evans 1968, Probst 1989). The majority of previous sharp-tailed grouse habitat studies have focused on areas of declining grouse populations, whereas little research has been undertaken in regions with stable populations (Robel 1980, Brown 1981). More studies are therefore required in areas that represent the central portions of sharp-tailed grouse ranges, such as southern Alberta where the habitat requirements of sharp-tailed grouse have not been researched.

1.2 Objectives

The objective of this research was to determine the specific nesting and brood rearing habitat requirements of the Plains sharp-tailed grouse

(*Tympanuchus phasianellus jamesi*) inhabiting the Milk River Ridge in southern Alberta.

The following is a breakdown of the specific objectives addressed:

1. determination of prairie grouse nesting and brood rearing habitats from the literature,
2. identification of the nesting and brood rearing habitat attributes utilized by sharp-tailed grouse hens in the mixed grass/ fescue ecoregion of the Milk River Ridge,
3. analysis of the data in terms of habitat type preference vs. habitat type availability,
4. determination of nesting success,
5. comparing and contrasting the relationship between range condition and the nesting habitats utilized by sharp-tailed grouse,
6. development of management recommendations for Plains sharp-tailed grouse on the Milk River Ridge grasslands in southern Alberta.

1.3 Scope

Two subspecies of sharp-tailed grouse occur in Alberta, the Alaska (*Tympanuchus phasianellus caurus*) and the Plains (*Tympanuchus phasianellus jamesi*). The Alaska subspecies is associated with the boreal ecozone located in the northern portion of the province, where anthropogenic disturbances to their habitats have been minimal. In contrast, Plains sharp-tailed grouse occupy both the parkland and prairie ecozones, which are associated with high anthropogenic disturbances in the form of decreasing habitat and habitat conditions resulting from agricultural activity. As a consequence, Plains sharp-tailed grouse have decreased substantially in Alberta, especially in the prairie region (Moyles 1981, Goddard 1995). This project defined and described the reproductive habitat requirements of a population of Plains sharp-tailed grouse in a remnant portion of "prime habitat" (Goddard 1995) in the southern prairie region of Alberta (Fig. 1-1).

1.3.1 Study Area

The following research was conducted on the Milk River Ridge, located in the mixed grass/fescue ecoregion of southern Alberta.

1.3.2 Description

Extending 80 km from east to west, the Milk River Ridge of southern Alberta is a large upland complex originating from a base elevation of 950m on its northern slope. The ridge quickly transforms into a rolling plateau reaching an average altitude of 1200m and approaching 1400m at its highest point. Known as the Hudson's Bay Divide in Montana, the Milk River Ridge was formed through the processes of differential erosion and claims no geological relation to the Rocky Mountains located to the South and West. The rolling, uneven topography is the result of uneven deposition of glacial till and fluvial materials during the

Pleistocene epoch. The topography is described as hummocky, ridged and inclined with the majority of slopes falling in the 6 to 15 percent range with stronger slopes in the 16 to 30 percent range (Milk River Ridge Ecological Site Information, Adams 1999). The ridge is traversed by the Milk River, which marks the division of the north and south drainage systems, emptying into the Hudson's Bay and the Gulf of Mexico respectively (Hrapko 1996).

The actual study area encompasses 2,728 ha or approximately 10.5 sections of mixed grass/ fescue prairie. Radio-marked bird movements defined the study area boundaries. Total area encompassed within the study was determined with the use of CALHOME© Home Range Analysis Program, MS-DOS Version 1.0 (Kie et al. 1994) and was best described using a 98 percent probability ellipse minimum convex polygon (MCP) estimator. A total of 8 known leks were distributed throughout the study area translating to a lek density of 1 lek per 341 ha or 1 lek per 3.41 km^2. This density surpasses those reported from Manitoba, Nebraska and South Dakota where densities ranged from 0.02 - 0.25 lek/km^2 (Connelly et al. 1998).

1.3.3 Climate

The climate in Southern Alberta can be characterized as having short, relatively warm summers with long, cold winters. On the Milk River Ridge, both the high and low temperature ranges are moderated as a result of differences in elevation between the ridge and the surrounding plains (Hrapko 1996). Additionally, this region experiences approximately 30 Chinook days per year.

The ridge receives an average annual precipitation of 400-600 mm, with approximately 60 percent (230-290 mm) occurring during the May to September growing period (National Soil Survey Committee 1974). The maximum amount of precipitation occurs in June. Orographic effects account for the higher precipitation levels on the ridge than that received on the plains (Hrapko 1996, National Soil Survey Committee 1974).

1.3.4 Soils

The Milk River Ridge is predominated by orthic black chernozemic soils with secondary compositions of dark brown chernozems. Areas receiving increased precipitation and decreased temperatures resulting from increased elevation and northerly aspect are characterized by black soils, whereas lower elevations and southerly slopes contain dark brown soils. The fescue grasslands are associated with black soils and the mixed grasslands with dark brown soils (Hrapko 1996), although grazing can alter this association.

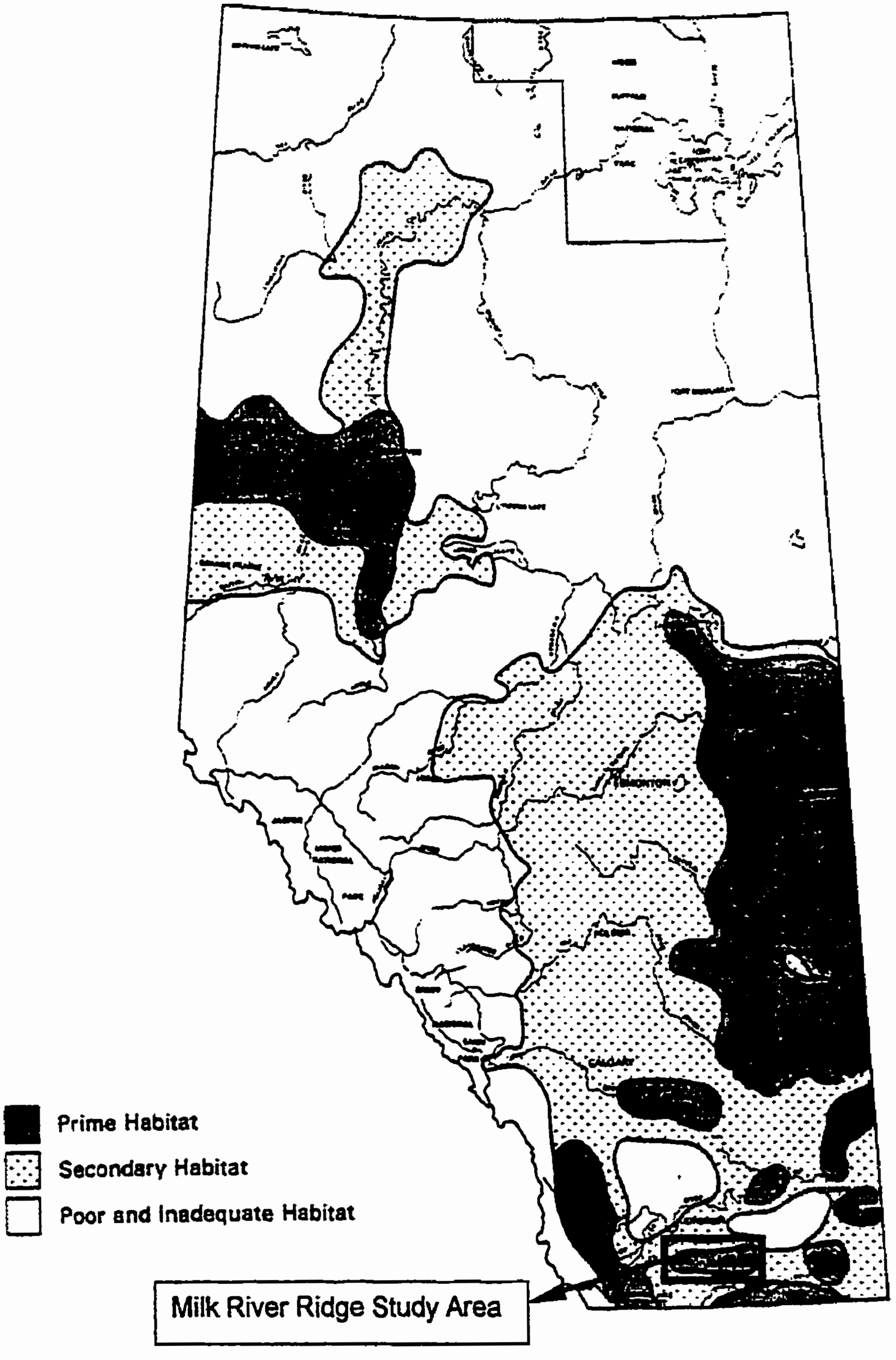

FIG 1-1. GENERAL DISTRIBUTION OF SHARP-TAILED GROUSE HABITAT IN ALBERTA (AFTER GODDARD 1995)

1.3.5 Vegetation

The Milk River Ridge is located in the transitional zone between the mixed grass ecoregion of the prairies and the fescue grassland ecoregion of the southwestern Foothills. The semi-arid climatic conditions promote the development of graminoid vegetation. The study area is composed wholly of native mixed-grass prairie with inclusions and pockets of fescue prairie interspersed throughput.

In the mixed grass prairie, spear grass (*Stipa comata*) is the dominant species with grama (*Bouteloula gracilis*) and wheat grass (*Agropyron* spp.) forming secondary compositions. The fescue grass ecoregion, which occurs on both plains and foothill topography, is composed primarily of rough fescue (*Festuca scabrella*) and parry oat grass (*Danthonia parryi*) (Hrapko 1996, National Soil Survey Committee 1974).

The Milk River Ridge is largely devoid of trees, consisting mainly of shrubs ranging from ½ to 2 meters in height. Low-lying shrubs in the shallow depressions are dominated by western snowberry (*Symphoricarpos occidentalis*) and prairie rose (*Rosa arkansana*). In addition to snowberry and rose, shrub compositions in coulees consist of saskatoon or serviceberry (*Amelanchier alnifolia*), choke cherry (*Prunus virginiana*) and northern gooseberry (*Ribes oxyacanthoides*) (Hrapko 1996, National Soil Survey Committee 1974).

1.3.6 Agricultural Activity

Agriculture in the mixed grass region consists of both irrigation and dry land farming, with small grains being the most common crops. Cattle grazing occurs in areas unsuitable for tilled crops and where irrigation is not possible. Agriculture in the fescue grass region consists primarily of grazing on native grasslands with some grain production on arable lands (National Soil Survey Committee 1974). The actual study area is composed wholly of native mixed-grass prairie with inclusions and pockets of fescue prairie interspersed throughout. This region has been left relatively undisturbed with cattle grazing being the main use of the area. Cropland conversions were not located throughout the study site and non-native pastures extend into only 2 small regions of the area.

1.4 Range Management and Wildlife Habitats

The Province of Alberta contains approximately 6.7 million hectares of rangeland utilized specifically for livestock grazing. These rangelands contain 1.65 million head of cattle, representing 43 percent of the national total. Public ownership accounts for 68 percent of Alberta's total rangelands, 33 percent of which are under Crown grazing leases. Alberta rangelands are an extremely valuable resource providing the foundation for an industry, which generates 200 million dollars in primary benefits and 540 million dollars in secondary benefits from Crown grazing leases alone (Adams et al. 1993).

Rangelands provide for the needs of both livestock grazing and wildlife habitat, and therefore the impacts of grazing can have significant effects upon wildlife populations. Within prairie grouse range, the primary use of private and leased lands is grazing (Brown 1981). Poor range management has continually been cited as a major factor in the declines of prairie grouse (Hamerstrom and Hamerstrom 1961, Aldrich 1963, Evans 1968, Kirsch et al. 1973, Hillman and Jackson 1973, Johnsgard 1983, Swenson 1985, Baydack 1986, Kirby and Grosz 1995, Sedivec et al. 1995, Giesen 1997). Overgrazing is not only detrimental to wildlife but also to the range resource, which ultimately affects the profit potential of the landowner or grazing leaseholder (Grosz and Kirby 1986). It is therefore in the best interests of the land manager to maintain healthy range condition.

Many researchers have concluded that effective range management creates the habitats required for prairie grouse and other prairie nesting species (Brown 1978, Evans 1968, Christenson 1970, Kantrud 1981, Grosz and Kirby 1986, Mitchell 1984, Kantrud and Higgins 1992, Kirby and Grosz 1995). Management of rangelands on both private and leased lands would therefore determine the ultimate fate of prairie grouse.

Wildlife agencies in Alberta such as the Alberta Conservation Association have recognized the importance of effective range resource stewardship and the potential benefits for wildlife habitat. The Alberta Conservation Association and Alberta Public Lands are taking steps to assist landowners in the development of grazing regimes that will secure both wildlife habitats and the economic well being of rangeland agriculture. Evaluation of range condition ensures that the grazing regimes are managed for long-term forage production without over-utilization of the vegetation.

Research on the relationship between range condition and the habitat requirements of prairie grouse and other prairie nesting species, should be undertaken in order to provide agencies such as Alberta Public Lands with the information required to manage Alberta's rangelands for the benefit of both agriculture and wildlife.

1.5 Organization

This thesis will consist of four self contained chapters written in the Journal of Wildlife Management format. Chapter 2 discusses nesting habitat use, while chapter 3 deals with the specifics of brood rearing habitat. In addition to presentation of the methodologies utilized and their respective results concerning this study, chapters 2 and 3 also review the relevant literature on sharp-tailed grouse nesting and brood rearing ecology. Chapter 4 will discuss reproductive habitat management recommendations for Plains sharp-tailed grouse inhabiting the grasslands of southern Alberta.

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Chapter 2.0: NESTING ECOLOGY OF PLAINS SHARP-TAILED GROUSE ON THE MILK RIVER RIDGE GRASSLANDS

2.1 General Habitat Requirements of Plains Sharp-tailed Grouse

Plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) have the most extensive range of the 6 subspecies of sharp-tailed grouse (Johnsgard 1973, Hamerstrom and Hamerstrom 1961), extending from east-central British Columbia to southwestern Manitoba, through the Great Plains and into eastern Colorado (Miller and Graul 1980). Plains sharp-tailed grouse retain game bird status in 9 states and provinces; British Columbia, Alberta, Saskatchewan, Manitoba, North Dakota, South Dakota, Nebraska, Wyoming and Montana (Prose 1987). The most stable populations of sharp-tailed grouse are found in the northern latitudes where anthropogenic alterations to their habitats have been less severe (Giesen and Kobriger 1996). However, other populations have not escaped the pressures of decreasing habitat availability, which has substantially decreased grouse numbers in a variety of areas (Fig. 2-1). The grassland, edge, and sub-forest habitat requirements vary considerably across the 6 subspecies, and have not been adequately described for all (Swenson 1985, Johnsgard 1973).

Populations of sharp-tailed grouse are directly related to the quality and quantity of the vegetation comprising the grassland environments they occupy (Brown 1978, Christenson 1970). The structure of the vegetation in terms of height and density seems to be more important than particular species (Pepper

1972, Hillman and Jackson 1973, Prose 1987, Meints et al. 1991). However, components of brushy cover seem to be a requisite for good sharp-tailed grouse habitat, with each subspecies occupying habitats with differing amounts of woody vegetation (Aldrich 1963).

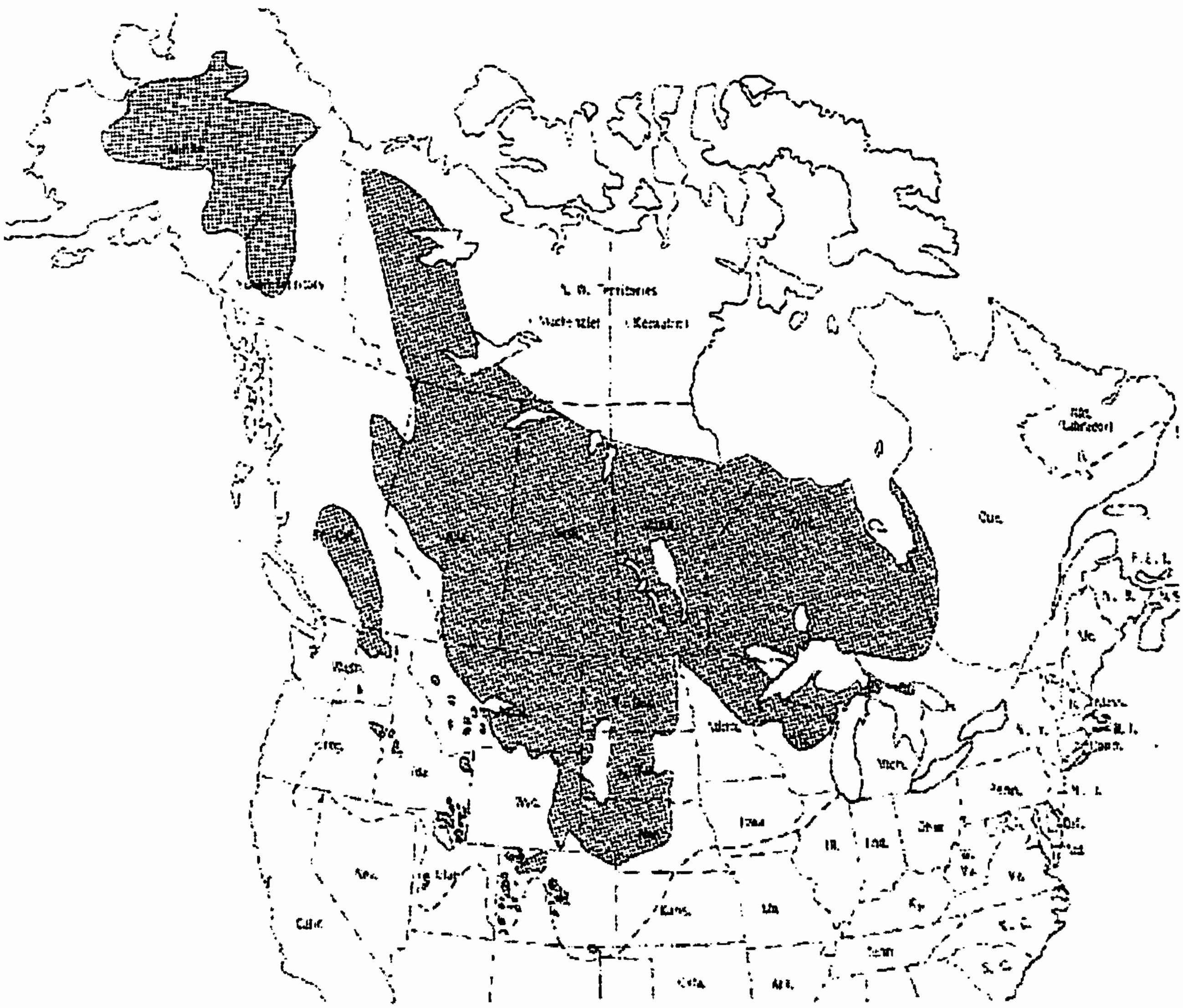


FIG. 2-1. CURRENT (SHADED) AND RECENT (DASHED) DISTRIBUTIONS OF SHARP-TAILED GROUSE (JOHNSGARD 1983)

The plains subspecies occupies grassland habitats interspersed with shrubby areas. Lightly grazed grasslands are preferred (Hillman and Jackson 1973), which presumably is indicative of an evolutionary adaptation to the effects that historic populations of bison had on the prairies. The importance of particular vegetation types to sharp-tailed grouse varies in relation to certain stages of the seasonal life cycle (Prose 1987). Swenson (1985) found that upland grass areas were important in all seasons and were found within 1 kilometer of all lek sites. He describes the optimal plains sharp-tailed grouse habitat in the mixed-grass prairie of Montana to be a mosaic of plant communities, particularly grasslands, and grassland/shrub mixtures. Johnsgard (1973) suggests that the *jamesi* subspecies are generally found in open and relatively dry grassland habitats, and Berger (1992) describes the primary habitat in Manitoba as large open grasslands often interspersed with agricultural activity.

Plains sharp-tailed grouse appear to be better adapted to agricultural activity than any other subspecies (Wyoming Fish and Game n.d), however the importance of healthy grasslands should not be overlooked (Brown 1978). Evans (1968) describes the habitat in South Dakota as a mixture of lightly grazed tall and mid-grasses with interspersions of croplands. Swenson (1985) found croplands to be an important component in mixed grass habitats in Montana however, croplands were utilized only if they were located within 500-750 m from woody cover and rarely farther than 50 m from a field edge. Because the conversion of native prairie to croplands are recognized as limiting factors of sharp-tailed grouse habitats, the movement of grouse into these areas is most likely due to the opportunistic nature of the birds in adapting to losses of vigor and successional changes in local vegetation conditions (Kirsch et al. 1973), and not representative of prime sharp-tailed grouse habitat.

2.2 Ecological Requirements for Nesting

Sharp-tailed grouse hens move through nesting habitat during a month long period prior to egg laying (Gratson 1988), and will begin nesting activities during or possibly before the onset of mating (Evans 1968, Johnsgard 1983). A nest scrape is constructed on the ground approximately 0.8 to1.6 km from the lek (Evans 1968, Hillman and Jackson 1973, Sexton 1979, Kobriger 1980). One egg per day is laid until an average total clutch of 12 eggs is achieved (range 5-12). Incubation lasts approximately 23 to 24 days and commences on the day that the last egg is laid (Johnsgard 1983, Baicich and Harrison 1997).

Nesting cover varies geographically from prairie to northern forest habitats, but grasslands with shrub compositions seem to be the preferred habitats. Giesen (1997) found that the *columbian* subspecies of sharp-tailed grouse nested in dense cover and found snowberry (*Symphoricarpos* spp.) and big sagebrush (*Artemisia tridentata*) to be the preferred shrubs for nest sites. In the parklands of Manitoba, the *campestris* subspecies nests in heterogeneous compositions of shrubs, grasses and forbs (Sexton 1979) suggesting that the structure of the habitat may be more important than the particular plant species themselves in the selection of nest sites (Evans 1968). In agricultural regions, alfalfa and grain stubble fields may attract nesting hens (Hart et al. 1950), which may jeopardize nest success when haying and plowing coincide with egg laying and incubation. However, several studies indicate that sharp-tailed grouse may avoid nesting in cultivated areas (Hamerstrom 1939, Amman 1957, Gratson 1988).

The above descriptions refer to a variety of nesting habitats occupied by sharp-tailed grouse, however the nesting requirements of the Plains subspecies may differ somewhat from these generalizations (Johnsgard 1983).

Gratson (1988) found the majority of Plains sharp-tailed grouse nests to be located in shrub/grass cover. Hillman and Jackson (1973) suggest that height and density of vegetative cover are important characteristics in nest site selection. Prose (1992) found mean effective heights of nest sites to be greater than those of random sites in the Nebraska Sandhills. On pasturelands in North Dakota, Kohn (1976) found the majority of nests to be located in deferred-rotation grazing systems in grass communities with visual obstruction readings (VORs) greater than 2.0 dm. Also in North Dakota, Sedivic et al. (1995) reported twice the nesting densities in nonuse rangelands (with VORs of 2.16 dm) than found in grazed treatments, however nesting success in grazed treatments was three times higher than in nonuse treatments. Kirby and Grosz (1995) report similar results and hypothesize that the increased cover on nonuse treatments functions to attract predators and increase nest depredation rates. Kobriger (1980) states that *jamesi* hens in South Dakota prefer nesting in taller vegetation within grassy upland habitats, however if availability and quality of such habitat is low, brushy lowland draws may be utilized. This suggests that habitat is selected based on optimality in consideration of available habitat conditions. Amman (1957) suggests that the majority of sharp-tailed grouse nests are found under some assemblage of overhead cover or are found within a few feet of such cover.

Prose (1992) reported on the importance of residual herbage cover for *jamesi* in the Nebraska Sandhills. Similarly, Eng et al. (1987) state that the amount and distribution of residual cover (heights ranging 15-50 cm) are key factors influencing prairie grouse numbers. Initial successful nests are therefore found in taller and denser cover, and the increased nest success of renest attempts can be attributed to increased cover provided by vegetative growth (Eng et al. 1987). Residual cover would then be a critical factor in initial nest success of sharp-tailed grouse because nesting activities commence prior to initiation of the growing season. Throughout many regions of the *jamesi* range, grazing substantially limits the amount of residual herbage available for nesting during the spring season (Kirby and Grosz 1995). In many situations the only vegetative component capable of providing adequate nesting cover are shrubs. Numerous researchers have reported that western snowberry (*Symphoricarpos occidentalis*) is the most commonly utilized shrub for sharp-tailed grouse nesting cover (Grosz and Kirby 1986, Kantrud and Higgins 1992, Kirby and Grosz 1995).

Bergerud and Gratson (1988) state that the primary objective in nest site selection is the avoidance of predator detection and therefore selection criteria will be based on characteristics that serve to decrease predation rates. Such criteria would differ from region to region and habitat to habitat. Prose (1992) found high nest predation rates in Nebraska in areas where shrubby draws were the only suitable vegetative component for sharp-tailed grouse nesting. Similarly, Christenson (1970) reported high predation rates on nests located in areas of woody vegetation in North Dakota. These areas may provide visual cues for predators or may be utilized as predator lanes. Lack of overhead cover may also be an important factor in increased predation rates during egg laying or feeding intervals when the hen is off of the nest (Dwernychuck and Boag 1972).

These findings outline the need for research on the optimal and marginal sharp-tailed grouse nesting habitats in order to implement effective management strategies.

2.3 Methods and Study Design

In order to determine the specifics of the vegetative composition and structure of sharp-tailed grouse nests on the Milk River Ridge, a sample of sharp-tailed grouse hens was captured and fitted with radio-transmitters. Hens were subsequently tracked in order to discover the nest site in an effort to describe the habitat attributes selected.

2.3.1 Trapping

In order to trap and radio-mark a sample of Plains sharp-tailed grouse hens, a variety of trapping methods were utilized. Trapping was attempted during both winter and spring seasons.

During winter, sharp-tailed grouse have been known to congregate on grain fields to forage on waste grain. Swenson (1985) found that placing grain baits in fields attracted large numbers of Plains sharp-tailed grouse. The feeding and flocking behavior of sharp-tailed grouse can then be exploited in order to capture the birds. Walk-in funnel traps were utilized for winter trapping (Hillman and Jackson 1973, Sexton 1979, Kobriger 1980, Baydack 1986, Schroeder and Braun 1992, Giesen 1997) after a feeding routine had been established.

An infra-red camera used in conjunction with the spotlighting technique as described by Giesen et al. (1982) was also employed in the winter of 1998. The infra-red camera was utilized in an attempt to ascertain individual grouse roosting sites. After locating roosting birds, a 1,000,000-candle power spotlight is directed towards the grouse in order to elicit a freeze response. The bird is then captured using a long handled-net pole similar to what is utilized in the capture of sage grouse (Giesen et al. 1982). Capture attempts utilizing the above method proved unsuccessful.

The circle trap method described by Toefper et al. (1987) was utilized to capture hen prairie grouse on display grounds. Circle traps consist of chicken wire drift fences a half a meter in height, arranged in a circular or cloverleaf pattern with funnels leading into 4-5 traps (Fig. 2-2). The trap arrangement is set up with the dominant male located in the center of the circle, therefore this method requires previous knowledge of the hierarchical positioning of the birds on the lek. A priori observations were made at each dancing ground prior to trapping in order to determine hen attendance patterns which served to enhance trapping success. Additionally, extensive coverage of the display ground area and attention to activity sign proved to be effective criteria for decisions on trap arrangement. Similar methods were employed with a lesser degree of success with the use of panel traps (Baydack 1986).

Hens were captured from various areas of the Milk River Ridge in order to obtain a sample of the nesting requirements of Plains sharp-tailed grouse for the region as a whole. After extraction from the traps, hens were weighed, fitted with aluminum leg bands (Alberta Fish and Wildlife) and marked with battery powered necklace style radio transmitters (Model RI-2B, Holohil Systems Ltd., Carp, Ontario). Average transmitter weight was 14.1 grams, weighing less than 2 percent of grouse body mass, lower than the recommended 3 percent for grouse species (Boag 1972). Attachment was via an adjustable Dacron line neck loop. Battery life was approximately 24 months. This design was chosen because of decreased handling time in attachment, upright antenna position, and decreased visibility to predators. Birds were subsequently tracked throughout the nesting and brood-rearing seasons with the use of a Lotek scanning receiver and a 4-element hand held yagi antenna.

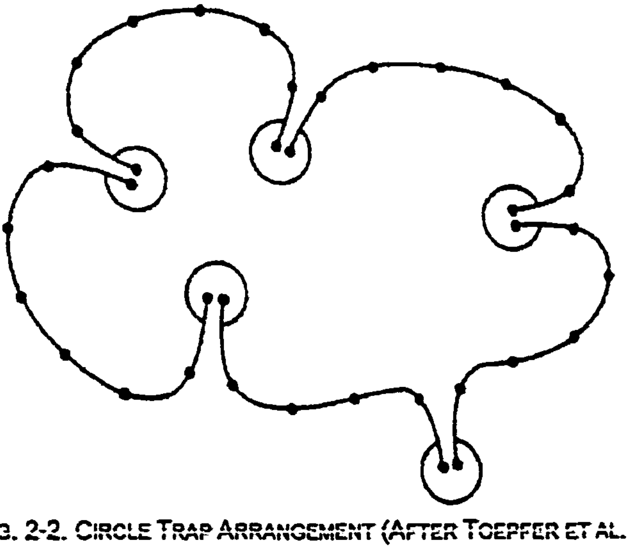


FIG. 2-2. CIRCLE TRAP ARRANGEMENT (AFTER TOEPFER ET AL. 1987)

2.3.2 Nest Searching

Hens were tracked until a locational pattern was established. The hen was then flushed in order to ascertain if a nest had been initiated. Nests were marked using trail flagging situated 4 m north of the nest in order to facilitate relocation of the nest site.

A modified cable-chain drag was utilized to locate additional nesting locations (Higgins et al. 1969, Kobriger 1980, Gosz and Kirby 1986, Kantrud and Higgins 1992, Kirby and Grosz 1995). Designed for use with ATVs, the cable-chain consisted of an 18 m long – 5 cm diameter nylon braided rope with three 4.5 m sections of light chain spaced equidistantly along its length. The three loops of chain were then attached via two additional lengths of chain. The cable-chain was dragged across grass and shrub throughout the study area at low speeds until a bird was flushed. Each nest discovered was marked using trail flagging situated 4 meters north of the nest site. 1 m diameter wire traps placed over the nest were utilized to capture incubating hens. Birds were then extracted through a 0.5 m x 0.5 m opening and fitted with radio transmitters.

2.3.3 Vegetation Sampling Protocol

At each newly discovered nesting location, several nest site characteristics were measured prior to the return of the laying or incubating hen. Care was taken to utilize one trail to access the nest. Time at the nest site was restricted to less than 5 minutes to minimize disturbance and avoid attracting predators. Mean effective height of the vegetation surrounding the nest bowl was measured along with cover-board measurements in the four cardinal directions.

Visual estimates of horizontal cover were obtained with the use of a cover-board. The cover board was 30 cm in width and 1 m in length arranged in 4 black and white alternating increments of 25 cm each (Fig. 2-3). The 30 cm width was chosen to better approximate the size of a sharp-tailed grouse in cover. The height of 1 m was deemed sufficient because little vegetation in the mixed grass/ fescue prairies would approach such heights and heights beyond 1 m would offer limited value in terms of obstruction for a primarily cursorial bird. Cover board obstruction estimates were taken at a height of 1 m and a distance of 2 m. The cover-board data was indexed into one score by utilizing a weighted average formula giving increased weight to the first two increments (0.25 m, 0.5 m) of the cover-board.

Overhead cover was measured with the use of 15 cm diameter cover disc with 9 black 2 x 2 cm squares arranged equidistantly around it (Fig. 2-4). The disc was placed in the nest bowl and the percent obstruction of each square was estimated visually directly overhead of the nest at a height of approximately 1.5 m. The 9 percent obstruction values were then averaged to obtain an index of over-head cover. Photographs of each nest with and without the overhead cover disc were taken. The author conducted all vegetation estimates in order to maximize objectivity and accuracy.

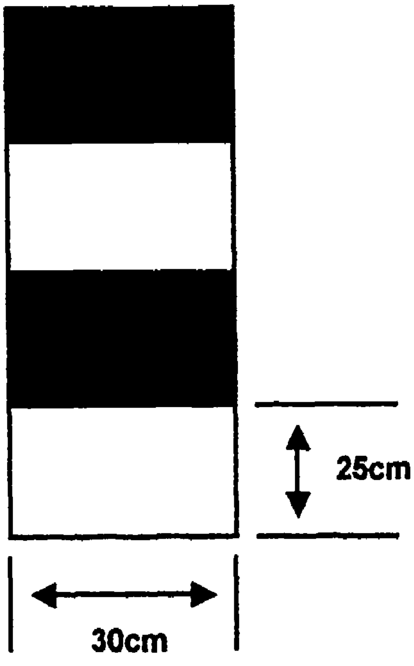


FIG. 2-3. HORIZONTAL COVER BOARD SPECIFICATIONS

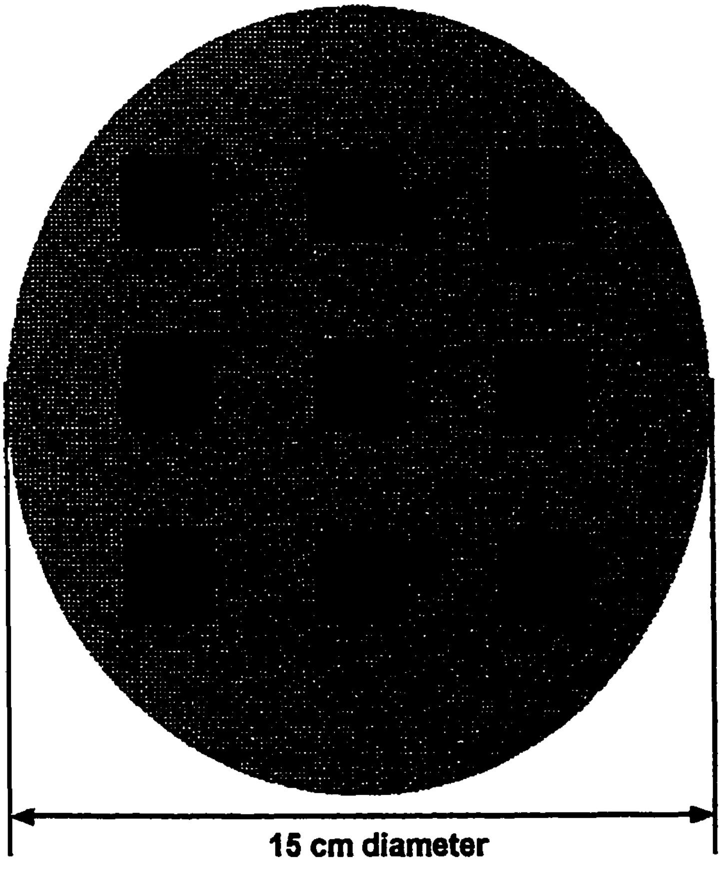


FIG. 2-4. OVERHEAD NESTING COVER DISC SPECIFICATIONS

2.3.3a Quadrat Vegetation Attribute Sampling

At each nest location a series of 13 - 1x1 m quadrats were utilized to characterize the vegetation (Fig. 2-5). Parameters measured include; percent composition of vegetation/cover types (shrub, grass, forb, litter, bare ground, and moss/lichen), mean effective heights (average of 4 heights per vegetation type) and horizontal cover (cover board). Slope and aspect were also recorded. Vegetation was sampled at random sites using identical techniques. Random locations were obtained by pacing off a randomly determined distance in a random direction from the nest or brood-use site. A random number generator (Microsoft Excel 97) was utilized to obtain random distances (100-200m) and directions (N,E,S,W). The author conducted all of the vegetation estimates in order to increase accuracy and objectivity.

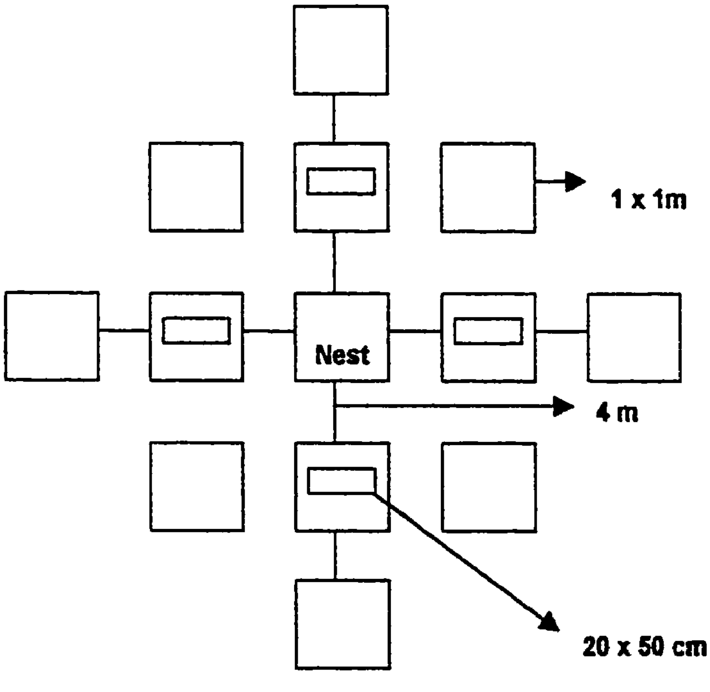


FIG. 2-5. VEGETATION SAMPLING QUADRAT ARRANGEMENT

2.3.3b Range Condition Evaluation

A total of 376, 20-x-50cm Daubenmire frames were analyzed in an attempt to determine the range condition of the habitat selected by nesting hens. Four frames were analyzed per nest site (n = 47) and paired random location (n = 47). Frames were arranged around the nest site corresponding to the four cardinal directions (Fig. 2-5). At random sites the frames were arranged around the center quadrat.

This sampling arrangement deviates somewhat from traditional range condition assessment, which utilizes transects for placement of the sample frames (Wroe et al. 1988). These transects are not random, being selected for range site characteristics of consistency, uniformity, topography and distance to stock water (Rangeland Conservation Service Limited, Boyle 1998). For the purposes of this study, we were interested in the range condition at the nest site in comparison to random sites. Thus the hen under analysis determined the relative positioning of the Daubenmire frames as a function of selecting her nest site. As such, the relative range condition of the nest site may not be indicative of the condition of the field or pasture as a whole (Barry Adams, pers. comm. Alberta Public Lands, Lethbridge).

Range condition evaluation followed protocol developed by Alberta Public Lands (Wroe et al. 1988). Species composition within the Daubenmire frames was estimated and analyzed as per species response to grazing pressure and deviation from the climax community. Response variables included, decreaser, increaser, invader and noxious. Existing species compositions were compared to compositions that were inferred to have existed within "the climax community" of that site. Sites were classified into one of 4 ecological condition classes (Table 2-1). Species compositions are the primary criteria for evaluating the ecological condition of the sampled sites using this methodology. Allowable species compositions (as found in Wroe et al. 1988) correspond to precipitation tables. Precipitation information was obtained for 3 areas, which encompass the study area (Rangeland Conservation Service Limited, Boyle 1998). The precipitation data ranges from 310 mm – 452 mm (12.2 -17.8 inches). The northern and western most areas of the Milk River Ridge receive more precipitation than the southern or eastern portions and therefore more weight was given to precipitation data obtained from these areas. Species composition allowances were therefore taken from the 355 mm – 457 mm (14 – 18 inch) tables (Rangeland Conservation Service Limited, Boyle 1998, Wroe et al. 1988). Ecological range conditions were based on calculations on data recorded on the LC55 range inventory data sheets (Robertson and Adams 1990).

Condition Class	Percent of Climax
Excellent	76 – 100%
Good	51 – 75%
Fair	26 – 50%
Poor	0 – 25%

Table 2-1. Range condition classes (Wroe et al. 1988)

2.3.4 Data Analysis

2.3.4a Analysis of vegetative and cover attributes at nest and random locations

A total of 47 nests and their corresponding random sites were analyzed with respect to cover attributes. Hotelling's multivariate T-test (T^2) was utilized to analyze percent composition and heights data at both nest and paired random sites. Critical T^2 values were converted to an F statistic for tests of significance (Manly 1986). Percent composition, heights and lateral density index data were analyzed separately to ensure commensurability.

2.3.4b Analysis of vegetative and cover attributes at nonpredated and predated nests

A total of 47 nests were located of which 1 was abandoned (cause unknown) and 3 were destroyed due to all terrain vehicle use. This resulted in 43 nests eligible for this analysis. We defined nests as nonpredated if at least one egg hatched. Predated nests were identified by the presence of crushed or broken eggs with firmly attached membranes or by missing eggs.

Analysis of the vegetational habitat components between nonpredated and predated nests is apportioned into two scales. One scale addresses differences between the vegetational characteristics over the entire 13 quadrat-sampling grid while the other compares habitat attributes at the immediate nest site utilizing the center 1 x 1 m quadrat. Variables included in the analysis for the immediate nest site quadrat were; horizontal cover index (cover board), mean effective heights of vegetation surrounding the immediate nest bowl and over-head cover. Variables included in the analysis for the entire sampling grid were, lateral cover index, percent composition of 5 habitat components, and heights of 4 habitat components.

Hotelling's multivariate T-test (T^2) was utilized to analyze percent composition and heights data at both predated and nonpredated nests utilizing the entire sampling grid. Critical T^2 values were converted to an F statistic for tests of significance (Manly 1986). Percent composition, heights and lateral density index data were analyzed separately to ensure commensurability. Univariate T-tests were utilized to analyze differences between predated and nonpredated nests within the immediate nest site quadrat.

2.3.4c Habitat Use vs. Availability

This study was focused upon analyzing and describing the microhabitat composition and structure at sharp-tailed grouse nesting locations. At this scale, aerial interpretation of available habitat resources would be insufficient as a method for comparing against actual habitat resource utilization. In addition, the coarse grained aerial habitat estimation would be of little benefit to wildlife managers charged with the task of managing for sharp-tailed grouse reproductive habitats on the native mixed-grass prairie.

Utilizing grassland as a habitat type when considering nest site selection vs. availability can obscure selection processes for certain components within that larger grassland habitat type (Cowardin et al. 1984). Because of the diversity of grassland ecosystems, it cannot be assumed that a hen is merely selecting grassland. Grasslands are composed of numerous other plant assemblages other than graminoid compositions. Hens may be selecting for forb, shrub or residual cover within this larger habitat type. Therefore the diversity of grassland ecosystems can result in numerous selections based on microhabitat criteria. As such, the present analysis of habitat resource use vs. availability utilized the data and measurements obtained at random plots for what is available in comparison to what sharp-tailed grouse hens are actually utilizing for their nesting purposes.

This approach permitted a more detailed analysis of habitat use. This analysis includes data on heights and horizontal cover estimates in addition to microhabitat compositions of litter, forb, grass, and woody cover. This amount of detail is not possible with aerial photo or digital cover map interpretation.

Additionally, in research on nest site selection it is important to note whether the species is phylopatric and if so the scale of selection chosen for analysis should reflect the resources available at that scale of interest (Johnson 1980). Previous studies have shown sharp-tailed grouse to exhibit phylopatry with average nesting proximities of 0.12 km to previous year nest sites being reported (Connelly et al. 1998). Nesting data obtained from 5, 2 year hens indicates that the sharp-tailed grouse inhabiting the Milk River Ridge exhibit similar phylopatric behavior. These hens nested within an average of 0.36 km in year two from their last nest in the previous year (min. = 0.23 km, max. = 0.57 km). This suggests that habitat attributes at the scale of the nest site are selected for year after year. Since the random locations obtained in this study were located anywhere from 100-200 m in a random direction from the nest site, hens would have had the opportunity to select for the habitat that was randomly sampled since these distances fall within the range of selection as outlined by the phylopatric behaviour exhibited by these hens. Furthermore, the sampling criteria meet assumptions postulated by Neu et al. (1974) that in observations of habitat use vs. availability: 1) the individuals must have an opportunity to select for any of the habitat variables deemed available, 2) that all observations are collected in a random and unbiased manner.

Traditionally the home range of an animal is utilized for estimation of what habitat is available to that individual animal (Cowardin et al. 1984, Gilmer et al. 1975, Johnson 1980, Manly et al.1993). However, Johnson (1980) points out that utilizing home range may be biased towards a selection event that has already occurred within the larger study area that encompasses the sample of individuals under analysis. Secondly, home range estimates are directly a function of the number of radiolocations obtained and utilized for estimation of each individual animals home range (Odum and Kuenzler 1955, Manly et al. 1993). Because the number of radiolocations obtained prior to the nesting event was low, comparison of nest site selection amongst available habitat within a defined home range would not be justified. Utilizing the more accurate home range (resulting from more radiolocations) obtained from the brood-rearing analysis would also violate the analysis of nest site habitat selection vs. availability since hens may be redefining home ranges based on the habitat necessities required for brood-rearing. This would also exclude a number of nest sites from the analysis due to hen and nest depredation, because for these hens the number of radiolocations would not have been increased. Additionally, nests found from non-radio marked hens would also have to be excluded because these hens would have no defined home range. As such, the resource availability data referred to herein, was obtained through sampling of microhabitat components found within a randomly located sampling grid identical to those utilized to analyze habitat composition at use sites. Therefore the random sites will comprise the universe of available resource units (Manly et al. 1993, Dunn and Braun 1986).

The Rank Order procedure described by Johnson (1980) was utilized to analyze habitat utilization vs. habitat availability. This method allows for the analysis of habitat attributes and compositions whereas those methods utilizing derivations of the chi-square statistic can only deal with nominal data or categories of habitat types. These methods require proportional estimates of use within habitat types for the analysis, whereas the rank order method allows for the use of percentages for compositional data. These tests also pool the use of habitats across individuals and as such are less sensitive to the selection of habitat by individuals (Aebischer et al. 1993). Additional advantages of the Johnson rank-order method include: its relative insensitivity to the arbitrary inclusion or exclusion of habitats (Johnson 1980, Thomas and Taylor 1990), it overcomes the unit-sum constraint (Aebischer et al. 1993), and ranking inherently approximates real data more closely than absolute statements regarding habitat preference or avoidance (Johnson 1980).

The rank order procedure tests two hypotheses. The first hypothesis utilizes a multivariate Hotelling T^2 statistic to test the null hypotheses that differences of rank between use and availability are equal. If the first hypothesis is rejected then the Waller-Duncan multiple comparison procedure (Waller and Duncan 1969) is utilized to test the second hypotheses that the differences in relative selection between habitat attribute i is equal to that of habitat j.

Microhabitat attributes utilized in the analysis include; the percent composition of forb, grass, litter and shrub, mean effective heights of these cover types, and horizontal obstruction (cover board).

The moss/lichen and bare ground cover types were excluded from the analysis because these attributes contribute little towards the overall composition of both use sites and sites comprising the availability data. Additionally, this data was characterized by non-normal distributions and log transformation failed to bring about approximation to normality. As such, outcomes that result with the inclusion of these attributes in the analysis may not be indicative of selection, but may be due to an artifact of the non-normality of the distributions. There are three justifications for excluding the moss/lichen and bare ground habitat attributes from the habitat use vs. availability analysis.

1. There are both *a priori* and *post facto* knowledge that these habitat attributes are not selected by upland nesting birds, and as such it would be

illogical to include them in the analysis because of their potential to obscure real selection.

2. The Johnson rank-order method is relatively insensitive to the inclusion or exclusion of questionable attributes or habitats within the analysis; that is to say that relative rankings will remain the same whether the questionable habitat attribute or type is excluded.

3. The distributions for both the moss/lichen and bare ground categories are highly skewed (non-normal) and do not transform appreciably and therefore do not meet the assumptions of the analysis.

All of the other habitat attributes meet the criteria and assumptions of the analysis.

Since the present study is concerned only with the reproductive habitat requirements of Sharp-tailed grouse, the temporal consideration of habitat availability need only be concerned with those months encompassing the nesting and brood-rearing activities (April-mid August) during which time hens occupy distinct home ranges (Connelly et al. 1998).

2.4 Results

2.4.1 Trapping and Nest Searching

Winter trapping efforts in 1998 resulted in minimal success. Due to the mild winter conditions in southern Alberta, natural food sources were plentiful and as such, a bait-feeding pattern could not be established for any extended period of time. Winter trapping in 1998 resulted in the capture of four males and one hen at the edge of an agricultural field, with the use of a baited panel trap. Due to poor success, this method was not utilized in 1999.

Trapping on the dancing grounds proved more successful. Spring trapping efforts commenced in mid April and ceased in early May. Birds were trapped from five dancing ground locations. A total of 25 hens were captured on the dancing grounds, 13 in 1998 and 12 in 1999. A total of 31 trapping hours were employed to capture 25 hens equating to a 1.24 hour / per hen capture efficiency.

Chain dragging efforts commenced in early may and continued intermittently until early June. In 1998, five sharp-tailed grouse nests were discovered while chain dragging and two additional nests were discovered incidentally while tracking radioed birds. Chain dragging resulted in the discovery of eight nests in 1999. In additional to sharp-tailed grouse nests, a variety of nests from other prairie dwelling species were also discovered (Table 2-2).

Three hens occupying nests found via chain dragging were later trapped while incubating in 1998. Three more were similarly trapped in 1999. These hens were radio collared to determine brood success and brood-rearing habitat use.

Table 2-2. Chain-dragging results, Milk River Ridge, Warner County, Alberta, 1998-99.

Species	n	General Nesting Habitat
Sharp-tailed Grouse	13	Shrub/Grass
Mallard	11	Shrub
Pintail	4	Short-Mid Grass
American Wigeon	4	Shrub/Grass
Northern Shoveler	1	Shrub/Grass
Gadwall	9	Shrub/Grass
Willet	3	Short Grass
Long-billed Curlew	1	Short Grass
Kildeer	2	Short Grazed Grass
Horned Lark	5	Short-Mid Grass
Western Meadow Lark	1	Mid Grass
Vesper Sparrow	2	Mid Grass
Clay-colored Sparrow	3	Shrub/Grass
Northern Harrier	2	Shrub
Total Species = 14	**Total Nests = 61**	

(Total chain-dragging hours = 38, Hours per STG nest = 2.9)

2.4.2 Nesting Statistics

During the 1998 field season a total of 10 nests were discovered from 14 radio marked hens captured on dancing grounds, including one renest attempt. One hen did not nest during the 1998 reproductive season, 1 was lost to predation prior to initiating a nest and 2 could not be located due to radio failure and movement away from the study area. With the addition of 5 nests found through chain-dragging efforts and the discovery of 2 incidental nests, an overall total of 17 nests were analyzed in 1998.

A total of 12 hens were captured from 4 different dancing grounds in 1999. Five hens collared in 1998 carried over into the 1999-nesting season. All of these birds nested in the 1999 reproductive season. With the addition of 5 renests and 8 nests found while chain dragging, a total of 30 nests were analyzed in 1999.

Due to nest depredations and incidental nest disturbances resulting from researcher activities, sample sizes for the nesting statistics were adjusted according to the qualifications relating to the nature of the statistic.

Nesting statistics are summarized and separated into 1998 and 1999 field seasons in Table 2-3. Due to researcher disturbance (n = 3) and one abandonment (cause unknown), 43 of 47 nests were utilized to determine apparent nest success. Over the two field seasons, 28 nests hatched successfully and 15 were depredated, calculating to 65 percent apparent nest success. Average clutch size was 12.3. Hatchibility was 0.91 over the two field seasons and was not significantly different (t= 1.72, P= 0.176) between field seasons, 1998 (0.94) and 1999 (0.88). Only 1 hen renested in 1998, with 5 renests occurring in 1999. The only hen that renested in 1998 also renested in the next reproductive season.

Table 2-3. Sharp-tailed grouse nesting statistics, Milk River Ridge, Warner County, Alberta, 1998-99.

Statistic	1998	n	1999	n	1998-99	n
Apparent Nest Success*	0.71	14	0.62	29	0.65	43
Average Clutch Size	12.4	13	12.2	17	12.3	30
Fertility/Hatchibility**	0.94	9	0.88	14	0.91	23
Renests	1		5		6	

*Ns (successful) / Ns (successful) + Nu (unsuccessful), ** total hatched / total clutch

Hen survival rate was defined as hens surviving until the end of the brood rearing season, which was August 12th in 1998 and August 5th in 1999. Due to radio failure (n = 2), shedding of radio collars (n = 2) and a recording error, only 12 of the 17 hens collared in 1998 were utilized in the hen survival statistic. Of these 12 hens, 3 were depredated which accounts to a 0.75 hen survival rate. One of the hens was depredated prior to initiating a nest, one was depredated while incubating and one was depredated while brooding. Four of the surviving hens were harvested in the 1998 fall hunting season, therefore only 5 hens actually survived into the 1999 reproductive season.

Out of 20 radioed hens in 1999, 18 were included in the hen survival statistic, 2 having shed their radio collars prior to August 5th. Four of these hens were depredated (2 while incubating and 2 with brood), equating to a hen survival rate of 0.78. Over the 1998 and 1999 field seasons, hen survival was calculated at 0.77.

2.4.3 Nesting Dispersal Distances

Five different dancing grounds were sampled in order to capture hen sharp-tailed grouse. Dispersal from lek of capture (assumed lek of reproduction) to initial nest site was calculated for 24 hens. Nesting dispersal distances differed amongst field seasons (Table 2-4). Mean dispersal from lek of capture to initial nest site was 0.66 km ± 0.36 in 1998 and 1.25 km ± 0.32 in 1999 ($t = 1.72$, $P < 0.05$). This difference may have been due to a mid-May snow event in 1999, which served to blanket the study area with snow. Wind action influenced the accumulation of snow to be greatest within the shrub patches that form the majority of the residual cover during the spring. These shrub patches function as an important nesting cover for sharp-tailed grouse inhabiting the Milk River Ridge (see nesting vegetation section). Therefore hens may have had to travel longer distances in 1999 to find sufficient snow-free nesting habitat.

Average nesting distance to initial nest site across the 5 dancing grounds and across both field seasons was 1.1 ± 0.26 km. Not including renest attempts, 92 percent of hens whose lek of reproduction was known nested within 1.5 km of their respective leks. Similar to reports from Idaho (Meints 1991), renest attempts ($n = 6$) resulted in larger mean dispersal from original lek of capture (2.0 ± 1.66 km), however it was not determined if another lek was attended for the purposes of fertilization after initial efforts were concluded. This suggests that hens may travel longer distances in search of "better" nesting habitat once depredation has determined the fate of their initial nest.

Mean initial nest dispersal distances for 2 year hens differed among years, 0.82 ± 0.63 in 1998 and 1.56 ± 2.05 in 1999, although not approaching significance ($t = 1.94$, $P = 0.15$). The high variability in 1999 was due to one hen nesting 3.4 km from her original lek of capture in her second year. This hen may have attended a lek in 1999 other than her lek of capture in 1998. This same hen renested in year 1 a distance of 3.78 km from her lek of capture, suggesting that a different lek may have been visited in the interim between the conclusion of her initial attempt and her renest. The longer distances may also be due to an active search for "better" habitat since her first nest was unsuccessful. In 1999 this hen's initial nest was near her 1998 renest suggesting a selection for the nesting habitat in this region. However, all of this hen's nesting attempts were unsuccessful.

A number of hens (n = 5) nested closer to a different lek than the lek on which they were captured. This has been reported for the majority of Greater Prairie Chicken nests in Minnesota and Colorado (Svedarsky 1988, Schroeder 1991), however this accounts for only 20 percent of the sharp-tailed grouse nests initiated by hens associated with a particular lek in this study. If renests are excluded, this statistic drops down to 10 percent. This conservative percentage is probably more appropriate since the lek of reproduction for renesting hens was not determined.

Table 2-4. Nesting dispersal distances, Milk River Ridge, Warner County, Alberta, 1998-99.

INITIAL NESTS						RENESTS	
1998		1999		1998-1999		1998-1999	
Dist. (km)	*N*	Dist. (km)	*N*	Dist. (km)	*N*	Dist. (km)	*N*
< 0.5	3	< 0.5	1	< 0.5	4	< 0.5	0
0.5 - 1.0	3	0.5 - 1.0	6	0.5 - 1.0	9	0.5 - 1.0	3
1.1 - 1.5	1	1.1 - 1.5	8	1.1 - 1.5	9	1.1 - 1.5	1
1.6 - 2.0	0	1.6 - 2.0	1	1.6 - 2.0	1	1.6 - 2.0	0
> 2.1	0	> 2.1	1	> 2.1	1	> 2.1	2
$N^I = 7$		$N^I = 17$		$N^I = 24$		$N^R = 6$	
X = 0.66km ± 0.36		X* = 1.25km ± 0.32		X = 1.1km ± 0.26		X = 2.0km ± 1.66	
Range (0.26-1.40 km)		Range (0.46-3.40 km)		Range (0.26-3.40 km)		Range (0.53-4.20 km)	

[I] Sample of initial nests where lek of reproduction is known

[R] Sample of renests for where lek of reproduction is known

* $P < 0.05$ (t-Test: Two-Sample Assuming Equal Variances)

2.4.4 Spatial distribution and dispersion of nests associated with 5 dancing grounds

Distance traveled from lek of reproduction to the nest site and associated home range sizes can be an indication of habitat quality or availability (Giesen 1997). As such, management for prairie grouse nesting habitat has traditionally focused upon management within that zone surrounding the dancing ground that encompasses the majority of the nest sites. This approach results in the management of habitat within a prescribed radius around the lek, which is termed the breeding complex (Giesen and Connelly 1993). A breeding complex of 2 km has been recommended as the management focal point for Columbian sharp-tailed grouse (Giesen and Connelly 1993). Similar management prescriptions for a focal radius of 1.8 km have been proposed for lesser prairie-chickens (Giesen 1994). Larger focal areas are recommended for sage grouse, reflecting the longer nest dispersal distances characteristic of this species (Wakkinen et al. 1992). No apparent relationships between the dispersion of nesting habitat and leks have been reported for greater prairie-chickens (Schroeder and Robb 1993).

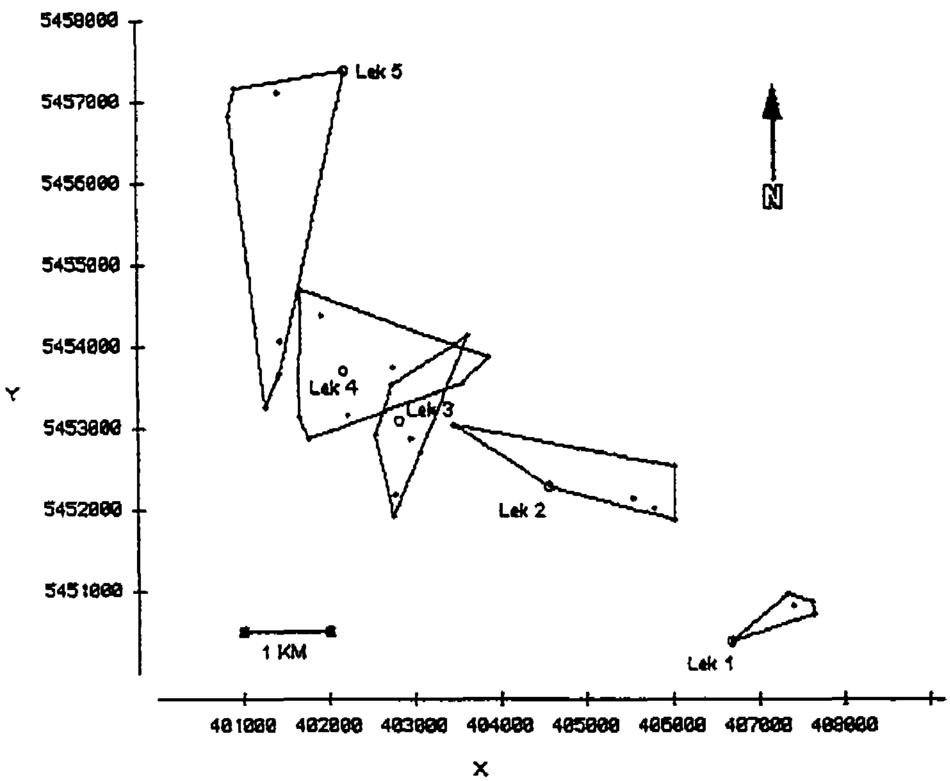
The breeding complex approach may be sufficient for areas that have not undergone intensive research prior to the implementation of management regimes (Giesen 1997). However in areas where financial and logistical conditions permit research into the reproductive activities of sharp-tailed grouse, information such as direction of nesting movements and total nesting area per dancing ground should be incorporated into the management directive. Analysis of the dispersion and spatial distribution of 5 dancing grounds located on the Milk

River Ridge indicates that direction of movement and total nesting area may be important factors in identifying the appropriate areas to be managed.

Average total nesting area (TNA) and nesting dispersal distance were calculated for each of the 5 dancing grounds from which a representative sample of hens was radio-marked (Fig. 2-6). The area encompassing all nest sites associated with a particular dancing ground found via radio-telemetry defined the total nesting area statistic. This included all nests associated with hens captured at each lek, renests and second year nests. This area was determined using a minimum convex polygon estimator (Mohr 1947) using 100 percent of all nest locations and the location of the dancing ground. Estimates of TNA were obtained using CALHOME© Home Range Analysis Program, MS-DOS Version 1.0 (Kie et al. 1994).

The smallest TNA was that of lek 1. This lek was associated with 4 nests occurring from 3 captured hens. One of the 4 nests was a renest. This area appears to be one of the "hotspot" nesting areas along the northern slope of the Milk River Ridge. Although the lek of reproduction is not known for hens found via chain dragging, nest-searching activities resulted in the discovery of an additional 3 nests in this area for a total of 7 nests. Excluding the lek from the area analysis and using a 100 percent MCP estimator, this "hotspot" encompasses 7.35 ha which equates to 1.05 ha per nest. These hens traveled in a northeast direction to their nesting locations suggesting a selection process is at work. This portion of the Milk River Ridge is part of the Milk River Ridge Environmentally Sensitive Area.

Another "hotspot" identified in this study was the area associated with hens captured on lek 2. All of these hens except for 1 nested on the northeastern slope of the ridge. This is the same directional bias displayed by those hens captured on lek 1. Including the nests found while chain dragging, this area contained 5 nests within a 21.1 ha area, translating to 1 nest per 4.2 ha.



Lek	No. Nests	TNA (ha)*	$\bar{x}$ Dist. to Nest (km)
1	4	18.6	0.94
2	5	116.8	1.3
3	7	90.4	0.7
4	8	222	0.97
5	6	292.5	2.5

FIG. 2-6. SPATIAL DISTRIBUTION, TOTAL NESTING AREA* AND MEAN DISTANCES OF SHARP-TAILED GROUSE NESTS ASSOCIATED WITH RESPECTIVE LEK OF CAPTURE ON THE MILK RIVER RIDGE, ALBERTA, 1998-99.

2.4.5 Comparison of paired nest and random sites

Percent composition of 6 cover types and corresponding heights of 4 cover types were analyzed at 47 sharp-tailed grouse nest and paired random sites. Vegetation composition differed significantly ($F_{6,40} = 14.26$, $P < 0.001$) in the multivariate condition with nest sites containing greater compositions of woody cover ($\bar{x} = 25.5 \pm 1.8\%$) and less grass ($\bar{x} = 27.4 \pm 1.0\%$) and bare ground ($\bar{x} = 0.67 \pm 0.2\%$) coverage than randomly located sites (woody: $\bar{x} = 8.0 \pm 1.7\%$, grass: $\bar{x} = 37.1 \pm 1.2\%$, bare ground: $\bar{x} = 2.78 \pm 0.5\%$) (Table 2-5).

Multivariate analysis revealed the heights of all 4 vegetation cover types to be significantly higher ($F_{4,42} = 18.02$, $P < 0.001$) at nest sites than those found at random sites (Table 2-6).

Horizontal cover differed significantly between nest ($\bar{x} = 29.8 \pm 1.4$) and random sites ($\bar{x} = 16.9 \pm 1.3$, $t = 6.60$, $P < 0.001$).

Analysis of the slope percentages at nest ($\bar{x} = 11.9 \pm 1.4\%$) and random sites ($\bar{x} = 8.4 \pm 1.1\%$) revealed nests sites occupying slightly steeper slopes than random locations ($t = 2.23$, $P = 0.031$).

Table 2-5. Multivariate analysis of percent composition of cover types at sharp-tailed grouse nesting ($n = 47$) and random ($n = 47$) sites, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 14.26	Sites					
P < 0.001	Nest		Random		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	25.5	1.8	8.0	1.7	0.398	1.082
Grass	27.4	1.0	37.1	1.2	-0.219	-0.041
Litter	25.6	0.9	28.9	1.3	-0.108	0.020
Forbs	20.1	0.9	20.6	0.9	-0.115	0.100
Moss/Lichen	0.60	0.2	2.38	0.6	-0.451	0.079
Bare Ground	0.67	0.2	2.78	0.5	-0.447	-0.054

[a]Determined for Hotelling's multivariate T^2 test (log transformed data) and interpreted as variable weights, same sign values indicate significance.

Table 2-6. Multivariate analysis of vegetation heights (cm) at sharp-tailed grouse nesting ($n = 47$) and random ($n = 47$) sites, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 18.02	Sites					
P < 0.001	Nest		Random		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	30.0	1.4	11.6	2.0	0.417	0.999
Grass	32.6	0.9	27.2	0.9	0.031	0.132
Litter	12.8	0.9	10.1	0.8	0.032	0.189
Forbs	23.7	0.7	19.6	0.8	0.023	0.166

[a]Determined for Hotelling's multivariate T^2 test (log transformed data), same sign values indicate significance.

2.4.6 Comparison of nonpredated and predated nests

Percent composition of 6 cover types and corresponding heights of 4 cover types were analyzed at successful (n = 28) and depredated (n = 15) sharp-tailed grouse nests. No significant difference in vegetation composition was found between successful and predated nests ($F_{6,35} = 1.81$, $P = 0.22$) (Table 2-7). Similarly, there was no significant difference in heights at successful and predated sites ($F_{4,37}$ = 2.34, P = 0.07) (Table 2-8). Average horizontal cover values of non-depredated nests ($\bar{x}$ = 31.0 ± 1.6) did not differ (t = -0.762, P = 0.45) from depredated nests ($\bar{x}$ = 28.3 ± 3.1).

Analysis of habitat attributes at the immediate nest site (center quadrat) revealed no significant differences between depredated and successful nests. Average heights at the nest bowl did not differ (t = - 0.35, P = 0.73) between depredated ($\bar{x}$ = 35.7 ± 1.7) and non-depredated nests ($\bar{x}$ = 36.5 ± 1.4). No difference (t = 0.557, P = 0.58) was detected in over-head cover obstruction at successful ($\bar{x}$ = 67.9 ± 4.7) and depredated nests ($\bar{x}$ = 63.8 ± 5.5). Similarly average horizontal cover values at the immediate nest site of non-depredated nests ($\bar{x}$ = 34.1 ± 2.3) was comparable (t = 0.119, P = 0.91) to those of depredated nests ($\bar{x}$ = 34.6 ± 2.2). Lastly the dominant vegetation surrounding the immediate nest bowl at both successful and unsuccessful nests was shrub.

Table 2-7. Multivariate analysis of percent composition of cover types at successful (*n* = 28) and predated (*n* = 15) sharp-tailed grouse nests, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 1.81	Sites					
P = 0.220	Successful		Predated		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	24.4	2.0	26.5	3.9	-0.338	0.352
Grass	28.8	1.3	24.9	1.7	-0.242	0.103
Litter	23.8	1.0	28.8	1.9	-0.020	0.227
Forbs	21.6	1.2	18.4	1.2	-0.251	0.119
Moss/Lichen	0.71	0.2	0.48	0.3	-0.384	0.279
Bare Ground	0.52	0.1	0.81	0.4	-0.267	0.318

[a]Determined for Hotelling's multivariate T^2 test (log transformed data), same sign values indicate significance.

Table 2-8. Vegetation heights (cm) at successful (n = 28) and predated (n = 15) sharp-tailed grouse nests, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 2.34	Sites					
P = 0.07	Successful		Predated		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	29.6	1.5	29.3	2.9	-0.387	0.175
Grass	34.2	1.1	29.8	1.6	-0.193	0.017
Litter	11.6	1.0	14.1	2.1	-0.156	0.282
Forbs	25.0	0.9	21.6	1.0	-0.131	0.229

[a]Determined for Hotelling's multivariate T^2 test (log transformed data), same sign values indicate significance.

2.4.7 Use vs. Availability of habitat attributes

Habitat use data was analyzed for 47 nests and their corresponding random habitat availability locations for the 1998 and 1999 field seasons using Prefer© Preference Assessment Program, Windows version 5.1 (Johnson 1980). The Rank Order calculation revealed a statistical difference in habitat preference ($F_{3,44}$ = 7.15, W = 1.94). Woody cover was utilized greater than its availability and was preferred over all other cover types (Table 2-9). Similarly, a statistically significant selection for litter cover was evident over grass cover. Forb cover was selected equal to availability, whereas grass cover was selected less than grass availability.

Table 2-9. Relative habitat type preference of sharp-tailed grouse as determined by comparison of habitat use at the nest site vs. availaibility of habitat at random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

	Percent Habitat		
Habitat Type	Use	Available	Preference Rank[a]
Grass	27.4	37.1	4
Litter	25.6	28.9	2 [G]
Woody	25.5	8.0	1 [G, F, L]
Forb	20.1	20.6	3

[a]Abbreviations signify statistically significant ($P < 0.05$) preference over other habitat components (G =grass, F = forb, L = litter)

Analysis of habitat attributes at the nest site and available random locations revealed that all habitat attribute values were not equally preferred ($F_{4,43}$ = 14.1, W = 1.86). Habitats with taller woody cover were preferred over all other habitat attributes and were utilized in greater proportions to its availability (Table 2-10). A significant preference for higher horizontal cover values was also evident over grass, forb, and litter heights. Use of habitats with higher horizontal cover values was greater than availability of such habitat. Preference over taller grass heights than forb heights was also statistically significant. Habitats with taller grass heights were also utilized in greater proportions than their availability. Habitats with higher forb and litter heights were not preferred over other habitat attribute values.

Table 2-10. Relative attribute value preference of sharp-tailed grouse as determined by comparison of habitat use at the nest site vs. availability of habitat at random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

	Attribute Values		
Habitat Attribute[a]	Use	Available	Preference Rank[b]
Grass Height	32.6	27.2	3^{F}
Woody Height	30.0	11.6	$1^{G,F,L,HC}$
Forb Height	23.7	19.6	5
Litter Height	12.8	10.1	4
Horizontal Cover	29.8	16.9	$2^{G,F,L}$

[a]attribute heights in cm, horizontal cover values derived from cover board index
[b]abbreviations signify statistically significant ($P < 0.05$) preference over other habitat components (G =grass, F = forb, L = litter, HC = Horizontal Cover)

2.4.8 Range Condition / Range Inventory

Community types were described utilizing the 3 species comprising the greatest proportion of the vegetation within the Daubenmire sampling frames. Community types are described for both the nesting and random locations. Species are listed in order of greatest overall proportion at both the nest sites (n = 47) and random sites (n = 47).

Nesting sites were best described by a western snowberry (*Symphoricarpos occidentalis*) – Kentucky bluegrass (*Poa pratensis*) – prairie rose (*Rosa arkansana*) community, comprising 25, 9 and 8 percent of the overall compositions respectively (Appendix A). Both western snowberry and prairie rose are considered increasers while Kentucky bluegrass is considered an invader within the 355 mm - 457 mm (14 –18 inch) precipitation zone. Utilizing Alberta Public Lands protocol to determine range condition at these sites invariably resulted in poor ratings due to climax species comprising less than 25 percent of the range site (Wroe et al. 1988). At the nest site, shrubs dominated the lifeform structure within the sampling frames at 37 percent composition, whereas grass and forb composed 32 and 31 percent respectively (Table 2-11).

Table 2-11. Lifeform composition within Daubenmire sampling frames at the nest site, Milk River Ridge, Warner County, Alberta. 1998-99.

NEST (n = 47)		Percent Cover	
Lifeform Composition	Species (n)	Mean	Range
Grass	18	32	0 - 68
Forb	45	31	0 - 64
Shrub	6	37	0 - 100
TOTAL	*69*	*100*	

Random sites were best described by an idaho fescue (*Festuca idahoensis*) – northern wheat grass (*Agropyron dasystachyum*) – western snowberry community comprising 15, 11 and 9 percent of overall compositions (Appendix B). Idaho fescue is considered an increaser in the majority of range soil groups in the 14 –18 precipitation zone, while northern wheat grass is considered a decreaser. With western snowberry considered an increaser and the allowances for Idaho fescue not exceeding 5 percent for most range sites, the range condition of random sites also resulted in poor ratings. Within these sites 52 percent of the lifeform cover was grass, while forb and shrub constituted 36 and 12 percent respectively (Table 2-12).

Table 2-12. Lifeform composition within Daubenmire sampling frames at random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

RANDOM n = 47		Percent Cover	
Lifeform Composition	Species (n)	Mean	Range
Grass	20	52	0 - 100
Forb	48	36	0 - 70
Shrub	4	12	0 - 85
TOTAL	*72*	*100*	

In order to characterize range condition at sharp-tailed grouse nesting sites, the vegetation surrounding the immediate nest site was analyzed. Due to the random nature of this protocol, range condition evaluation as described by Wroe et al. (1988) could not be utilized due to increaser shrub, grass and forb selection by the hen at the nest site. Similarly, the random procedure utilized to obtain random samples of range condition was truly random, and as such failed to meet the criteria for the Alberta Public Lands evaluation procedure. Hence, range condition ratings using the nest site and random locations would in no way reflect the actual range condition in areas that would otherwise be selected in accordance with Alberta Public Lands protocol (Barry Adams, pers. comm. Alberta Public Lands, Lethbridge). As such, this methodology was not utilized in the present analysis.

This is not to infer that the data extracted from this portion of the research is invalid. The utility of the information gleaned from the Daubenmire sampling frames stems from the description of the communities in which sharp-tailed grouse will select their nest sites. The majority of the species comprising these communities are considered increasers and not part of the climax community, however these species provide the majority of structure and cover for nesting and are selected for these properties. Hence, actual species composition is not likely to influence sharp-tailed grouse nest site selection as much as structure of the vegetation. Areas with sufficient residual cover in early spring and areas with taller stands of cover throughout the nesting season are selected for the structure that they provide as opposed to actual species present. This is supported by the 99 percent vegetation coverage of all Daubenmire frames sampling range condition at the nest site while random sites were 93 percent vegetated with bare ground and moss/lichen comprising 4 and 3 percent of the total coverage (Table 2-13). This is also supported by the taller heights of all vegetation lifeforms being at the nest site than at random sites (see comparison of paired nest and random sites section).

Table 2-13. Cover percentages within Daubenmire sampling frames at nest and random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

COVER CHARACTERISTICS	NEST Percent Cover		RANDOM Percent Cover	
	Mean	Range	Mean	Range
Total Vegetative Cover	99	58 - 100	93	22 - 100
Bareground	0.7	0 - 43	4	0 - 78
Moss/Lichen Cover	0.3	0 - 15	3	0 - 58

The presence of shrubs may not always be indicative of poor range condition. While an increase in shrubs can result from over grazing, shrubs will occur naturally where moisture gradients can support more vigorous growth (Alan Robertson, pers. comm. Highland Range Consultants). Indeed shrub densities were highest on north facing slopes and in depressions where aspect and slope created moisture and temperature gradients that favor shrub growth. Additionally, the presence of increaser grasses such as Kentucky bluegrass may not necessarily depict recent grazing practices and does not necessarily relate to poor range condition. If the range is productive and bare ground and moss/lichen are kept to a minimum, then actual biological range condition may be considered healthy, apart from climax community predictions. Hence, total vegetative cover and residual herbage can also describe range health (Holechek et al. 1989, Saab and Marks 1992). In this respect, the nest sites occupied by sharp-tailed grouse were in healthy condition.

2.5 Discussion

Residual grasses have been reported to be an important nesting habitat component for plains sharp-tailed grouse (Eng et al. 1987, Hillman and Jackson 1973, Prose 1992), however woody vegetation was the dominant vegetation type at sharp-tailed grouse nests on the Milk River Ridge and was utilized in greater proportions compared to availability. Although residual grasses on the Milk River Ridge are not necessarily limiting, shrub cover is still the selected habitat for nest sites. This preference may not be based on the shrub component in itself, but based on the compositional cover attributes found within the shrub patches.

Similar to sharp-tailed grouse across their range (Amman 1957, Hillman and Jackson 1973, Pepper 1972, Sisson 1976, Brousquet and Rotella 1998) sharp-tailed grouse hens on the Milk River Ridge initiated their nests in May, at a time when growth has yet to commence due to vegetation dormancy. Although shrub foliage is lacking at this time of year, the structure of woody vegetation is still present, providing a framework for the retention of other forms of residual vegetation. Hence, residual grasses do contribute to overall nesting habitat however; the residual cover offered by the woody vegetation in combination with residual grasses and forbs is the preferred nesting condition on the Milk River Ridge.

The primary objective of nest site selection is the avoidance of predator detection (Bergerud and Gratson 1988). Nest site selection would then be based on habitat characteristics that best serve to decrease predation rates such as dense horizontal cover. To that end, I propose that the combination of shrubs, grasses, litter and forbs (in that order) provides the cover densities required by nesting hens. Indeed, horizontal cover board values at nest sites were nearly twice those found at random locations. In terms of preference of habitat attributes, higher horizontal cover values were second only to woody heights in selection preference. Additionally, woody heights at the nest site were three times those at random sites. Lastly, with consideration of significantly taller compositions of all other vegetation components at the nest site, the importance of dense tall cover for nesting is substantiated.

Contrary to findings in other studies (Christenson 1970, Prose 1992), nest success in this study was not negatively affected by the use of shrubs, and in fact may have been enhanced as a result of the vegetational attributes that shrubby habitats offer. The nest success rate of 0.62 experienced on the Milk River Ridge falls in between averages (range 0.50 to 0.72) reported by several other researchers (Sisson 1976, Marks and Marks 1987, Meints 1991, Connelly et al. 1998) which further suggests that high use of shrubby habitats need not equate to high predation rates. The results of this study also compare favorably to those for sage grouse in Oregon, where it was shown that greater amounts of shrub cover and tall grasses contributed to greater nest success (Gregg et al. 1994). In comparison of successful and depredated nests on the Milk River Ridge, no significant differences could be detected among any of the habitat attributes, which lend support to consistency in nest site selection. This further speaks to the availability of suitable nesting habitats and predator concealment efficacy when shrubby habitats are dispersed in a heterogeneous manner across the grassland.

Numerous researchers have also commented on the importance of shrubs, specifically western snowberry for sharp-tailed grouse nesting cover (Grosz and Kirby 1986, Kantrud and Higgins 1992, Kirby and Grosz 1995, Giesen 1997). Dependent upon year-to-year grazing practices, precipitation levels, and the onset of vegetation growth, woody cover may provide the only reliable nesting habitat year after year, and as such may represent one of the most important cover components within mixed grassland ecosystems for sharp-tailed grouse nesting purposes. Relating to cover and time of year, Eng et al. (1987) suggested that higher success rates of renesting attempts are primarily due to the improved cover that arises as a function of increased vegetation growth later in the nesting season. If cover is deemed as a main determinant of nesting success (Hillman and Jackson 1973, Eng et al. 1987, Bergerud and Gratson 1988, Prose 1992, Kirby and Grosz 1995, Giesen 1997), then low nest success would not be experienced if appropriate cover in the form of shrubby and residual vegetation is maintained on the Milk River Ridge.

Several researchers have postulated that nesting sharp-tailed grouse hens only make use of shrubby habitats in the absence of suitable grass cover (Christenson 1970, Kobriger 1980, Prose 1992). These statements may be clarified by outlining the differences in the ecosystems in which these studies were conducted. Our study was carried out on the native mixed grass / fescue prairie, where shrubs comprise a natural component of the ecosystem and are found in numerous sites throughout the study area. Additionally, grass cover was not limiting in this region. As such predators are not "attracted" to specific predator lanes that arise when shrubs are sparse or are located only in draws and overgrazed portions of tame and native grasslands (Christenson 1970, Kobriger 1980, Haensly et al. 1987, Prose 1992). Hence, the poor nest success in shrubby cover reported by previous studies could be due to sparse distribution of shrubs, nesting in regions of shrub with insufficient grass cover, or the predominance of shrubs due to overgrazing of the grasslands. Use of shrub cover under these conditions could in fact decrease nesting success because these areas may function as predator lanes or predator sinks (Christenson 1970, Haensly et al. 1987).

In his study on the nesting habitat selection of Plains sharp-tailed grouse on the Nebraska Sandhills, Prose (1992) found little use of shrubs for nesting. This was likely due to the scarcity and sparse distribution of shrubs within this community type (Prose 1992). Prose did find that hens selected for the tallest cover available within the study area, which was typified by tall assemblages of residual herbage, namely grass. The same statement can be made for the Milk River Ridge, with shrub communities comprising the bulk of the taller residual herbage during the early spring nesting season. Thus tall residual grass cover can provide adequate cover for sharp-tailed grouse nesting requirements in the absence of shrubby habitats. However, as revealed in this study, shrubby cover may be the preferred habitat when both residual grasses and shrubby cover exist within the community in natural proportions. As such, grazing practices that incorporate some element of shrub retention should be a priority.

In the management of sharp-tailed grouse nesting habitat, focusing management dollars on those areas that provide optimal nesting cover should be the focus of any directive. As discussed in the nesting distribution section, past management recommendations have focused within a 2.0 km radius of the dancing ground (Giesen and Connelly 1993, Connelly et al. 1998). As revealed in this research, this approach may not be appropriate with consideration of directional nesting tendencies and nesting "hotspots". As such, prior research or reconnaissance should be undertaken prior to initiating a management directive if fiscal conditions allow. This approach would then help to identify critical nesting areas. This information could then be utilized to delineate cattle use of areas, possibly decreasing cattle use of the critical nesting areas for 2 months (May and June), while opening up the majority of the range where sharp-tailed grouse are not nesting during this time.

A comparison of the total nesting area (TNA) associated with leks on which hen sharp-tailed grouse were captured with the 2.0km cattle exclusion zone, will highlight the utility and efficiency of this method. As revealed in this research, sharp-tailed grouse tend to nest in "hotspots". The average TNA across 5 dancing grounds was 148.1 ha (range 18.6 - 292.5 ha). The management area encompassed within the traditional 2.0km breeding complex prescription (2.0km radius from lek) is 12.6 km^2 or 1,260 ha. When the average TNA of 148.1 ha is deducted from the area around the theoretical dancing ground, 1,112 hectares remain. This then would have resulted in the loss of 1,112 ha of potential grazing area under the traditional management regime.

This is not to suggest that only those areas identified as optimal nesting areas require protection from grazing. The remainder of the breeding complex should be grazed appropriately to ensure long-term health of the range for both wildlife and cattle. As such, wildlife and range managers need not be concerned with the removal of large tracts of range during the nesting season, if these prime nesting areas are identified before hand.

In consideration of management of specific plant species, the range inventory data revealed that species composition does not necessarily need to mimic the predicted climax community of that range type to fulfill sharp-tailed grouse nesting requirements. As found in previous studies on sharp-tailed grouse nesting ecology, structural diversity of the vegetation was shown to be more important than the presence of particular species of plants (Evans 1968, Pepper 1972, Meints et al. 1992). Similar to results in North Dakota (Christenson 1970, Kohn 1973, Kobriger 1980, Kirby and Grosz 1995), tame or increaser species provided the majority of the cover for nesting hens on the Milk River Ridge. However, there is no reason why robust decreaser species could not provide similar cover benefits. Hence, in order to fulfill both wildlife and livestock management goals, proper and prudent range management should be undertaken in order to eventually bring about a return of the climax species, should that most effectively benefit livestock (Holecheck et al. 1989).

In summary, this project has revealed that sharp-tailed grouse nesting requirements are compatible with requirements for users of the grassland, namely the cattle industry. This research supports the findings of several other studies that prairie grouse management need not hinder livestock productivity and livestock productivity need not hinder wildlife management should it be conducted in an appropriate and prudent manner (Evans 1968, Kessler and Bosch 1982, Mitchell 1984, Kirby and Grosz 1995).

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Chapter 3.0: Brood Rearing Habitat Requirments of Plains Sharp-tailed Grouse

3.1 General Habitat Requirements of Plains Sharp-tailed Grouse

Plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) have the most extensive range of the 6 subspecies of sharp-tailed grouse (Johnsgard 1973, Hamerstrom and Hamerstrom 1961), extending from east-central British Columbia to southwestern Manitoba, through the Great Plains and into eastern Colorado (Miller and Graul 1980). Plains sharp-tailed grouse retain game bird status in 9 states and provinces; British Columbia, Alberta, Saskatchewan, Manitoba, North Dakota, South Dakota, Nebraska, Wyoming and Montana (Prose 1987). The most stable populations of sharp-tailed grouse are found in more northern latitudes where anthropogenic alterations to their habitats have been less severe (Giesen and Kobriger 1996). However, other populations have not escaped the pressures of decreasing habitat availability, which has substantially decreased grouse numbers in a variety of areas (Fig. 3-1). The grassland, edge, and sub-forest habitat requirements vary considerably for the species, and have not been described for all of the subspecies (Swenson 1985, Johnsgard 1973).

Populations of sharp-tailed grouse are directly related to the quality and quantity of the vegetation comprising the grassland environments they occupy (Christenson 1970). The structure of the vegetation in terms of height and density seems to be more important than particular species (Hillman and Jackson 1973, Prose 1987). However, components of brushy cover seem to be a requisite for good sharp-tailed grouse habitat, with each subspecies occupying habitats with differing amounts of woody vegetation (Aldrich 1963).

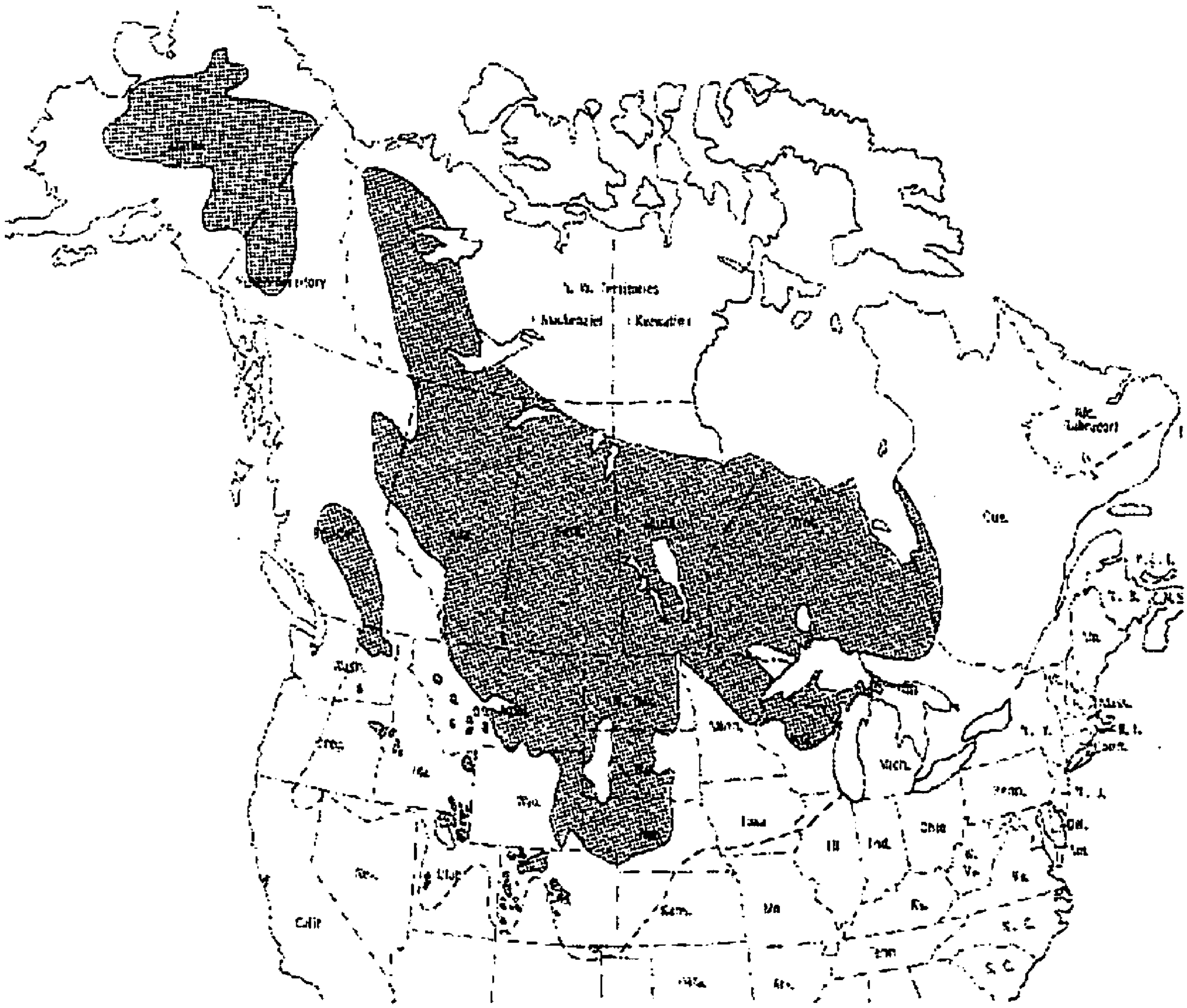

FIG. 3 -1. CURRENT (SHADED) AND RECENT (DASHED) DISTRIBUTIONS OF SHARP-TAILED GROUSE (JOHNSGARD 1983)

The plains subspecies occupies grassland habitats interspersed with shrubby areas. Lightly grazed grasslands are preferred (Hillman and Jackson 1973), which presumably is indicative of an evolutionary adaptation to the effects that historic populations of bison had on the prairies. The importance of particular vegetation types to sharp-tailed grouse varies in relation to certain stages of the seasonal life cycle (Prose 1987). Swenson (1985) found that upland grass areas were important in all seasons and were found within 1 kilometer of all lek sites. He describes the optimal plains sharp-tailed grouse habitat in the mixed-grass prairie of Montana to be a mosaic of plant communities, particularly grasslands, and grassland/shrub mixtures. Johnsgard (1973) suggests that the *jamesi* subspecies are generally found in open and relatively dry grassland habitats, and Berger (1992) describes the primary habitat in Manitoba as large open grasslands often interspersed with agricultural activity.

Plains sharp-tailed grouse appear to be better adapted to agricultural activity than any other subspecies (Wyoming Fish and Game n.d). Evans (1968) describes the habitat in South Dakota to consist of mixtures of lightly grazed tall and mid grasses with interspersions of croplands, and Swenson (1985) found croplands to be an important component in mixed grass habitats in Montana. However, croplands were utilized only if they were located within 750-500 m of woody cover and rarely farther than 50 m from a field edge. Because the conversion of native prairie to croplands are recognized as limiting factors of sharp-tailed grouse habitats, the movement of grouse into these areas is most likely due to the opportunistic nature of the birds in adapting to losses of vigor and successional changes in local vegetation conditions (Kirsch et al. 1973), and not representative of prime sharp-tailed grouse habitat.

3.2 Ecological Requirements for Brood Rearing

Being a precocial species, the sharp-tailed grouse hen and her brood leave the nest site shortly after hatching in search of protective cover and food sources such as insects and green herbaceous vegetation (Evans 1968, Johnsgard 1983). Up until the age of 10 weeks the diet of juveniles consists primarily of insects (Kobriger 1965), and therefore habitat selection during this time is largely due to cover type associations with insect abundance (Evans 1968). The percentage of animal matter in the diet continues to decline with age, and at 12 weeks of age the diet of is comprised of over 90 percent vegetable matter similar to that of adult birds (Kobriger 1965). The hen may remain with the broods until late September (Gratson 1988).

Brood rearing habitats consist of cover for protection and grasslands for foraging. The majority of brood cover should be composed of grasslands with some shrubs and trees present, but with a negative correlation between tree height and tree numbers (Johnsgard 1973). Evans (1968) suggests that there is an increasing selectivity for brushy habitats as the young develop, which may reflect an increasing dependence on herbaceous food sources. Plains sharp-tailed grouse prefer brood rearing habitats with areas of low shrub cover densities (0 -15%) and high grass cover densities for foraging (Wyoming Game and Fish n.d). Shrubs are more important than tree species because of the protective cover and food sources, such as the berries and catkins that they supply. Sharp-tailed grouse broods in Wyoming were found to inhabit mountain shrub and sagebrush-snowberry habitats with significantly less total cover percentages than surrounding habitats (Klott and Lindzey 1990). Hamerstrom (1963) outlined the importance of croplands, weedy fields, meadows, and savannahs as open cover brood habitats in Wisconsin. He indicates that management for Prairie sharp-tailed grouse brooding cover should focus on the maintenance and creation of grassland-savannah habitats. Moyles (1981) reported that Plains sharp-tailed grouse in the parklands of Alberta were not distributed randomly relative to available plant communities and that hens with broods were observed utilizing grassland and grassland-low shrub transition zones significantly more than adults without broods. This concurs with Sexton's (1979) conclusions that broods did not select habitats in relation to availability but in relation to cover type and site temperatures. Kobriger (1965) reports the majority of *jamesi* brood sightings on the Nebraska Sandhills to be located in wetland meadows. The importance of clover (*Trifolium spp.*) and common dandelion (*Taraxacum officinale*) as food sources, coupled with shade provision, were identified as the main attractants of broods to this area. Kobriger (1965) also indicates that production of these food sources was increased via mowing of the meadows, which suggests that moderate grazing could benefit the sharp-tailed grouse in this region. Kobriger (1980) reported that over 75 percent of the visual obstruction recordings at brood flush sites had a minimum of 22.5cm, suggesting that vegetation height may be an important factor in brood ecology, a finding also reported by Kohn (1976) in North Dakota. However, Gratson (1988), found that hens and chicks shifted habitat use to shorter and sparser vegetation along with a smaller percentage of shrubs than used during the nesting period. Gratson (1988) also indicates that broods generally moved from undisturbed cover immediately surrounding the nest site into more disturbed habitats such as hayed or grazed alfalfa.

Various other factors can affect brood habitat use according to time of day, habitat availability, climatic factors, developmental stage, and amount of disturbance (Evans 1968, Kohn 1976, Sexton 1979, Kobriger 1980).

Evans (1968) states that in areas of good habitat, protective cover is utilized to escape predator detection and in such cases, predation may not be a significant factor in substantial reductions of grouse populations. Hens will attempt to renest if a clutch is destroyed (Evans 1968), however a hen will not attempt to renest if a brood is lost. This fact delineates the importance of brood rearing habitat in the recruitment of birds to the fall population. Nesting success and brood survival are therefore the keys to abundant sharp-tailed grouse populations.

3.3 Methods and Study Design

In order to determine the specifics of the vegetative composition and structure of sharp-tailed grouse brood rearing sites on the Milk River Ridge, a sample of sharp-tailed grouse hens were captured and fitted with radio-transmitters. Hens were subsequently tracked in order to locate areas utilized for brood rearing in an effort to describe the habitat attributes selected.

3.3.1 Tracking

Hens were captured from various areas of the Milk River Ridge in order to obtain a sample of the brood rearing requirements of Plains sharp-tailed grouse for the region as a whole. After extraction from traps, hens were weighed, fitted with aluminum leg bands (Alberta Fish and Wildlife) and marked with battery powered necklace style radio transmitters (Model RI-2B, Holohil Systems Ltd., Carp, Ontario). Average transmitter weight was 14.1 grams, weighing less than 2 percent of grouse body mass, lower than the recommended 3 percent for grouse species (Boag 1972). Attachment is via an adjustable dacron line neck loop. Battery life is approximately 24 months. This design was chosen because of decreased handling time in attachment, upright antenna position, and decreased visibility to predators. Birds were subsequently tracked throughout the nesting and brood-rearing seasons with the use of a Lotek scanning receiver and a 4-element hand held yagi antenna.

3.3.2 Vegetation Sampling Protocol

At each brood use location a series of 13 - 1x1 m quadrats were utilized to characterize the vegetation (Fig. 3-2). Parameters measured include; percent composition of vegetation/cover types (shrub, grass, forb, litter, bare ground, and moss/lichen), mean effective heights (average of 4 heights per vegetation type) and horizontal cover (cover board). Visual estimates of horizontal cover were obtained with the use of a cover-board. The cover board was 30 cm in width and 1 m in length arranged in 4 black and white alternating increments of 25 cm each (Fig. 3-3). The 30 cm width was chosen to better approximate the size of a sharp-tailed grouse in cover. The height of 1 m was deemed sufficient because little vegetation in the missed grass/ fescue prairies would approach such heights and heights beyond 1 m would offer limited value in terms of obstruction for a primarily cursorial bird. Cover board obstruction estimates were taken at a height of 1 m and a distance of 2 m. The cover-board data was indexed into one score by utilizing a weighted average formula giving increased weight to the first two increments (0.25 m, 0.5 m) of the cover-board. Vegetation was sampled at random sites using the same techniques. Random locations were obtained by pacing off a randomly determined distance in a random direction from the brood-use site. A random number generator (Microsoft Excel 97) was utilized to obtain random distances (100-200m) and directions (N,E,S,W). The author conducted all of the vegetation estimates in order to increase accuracy and objectivity.

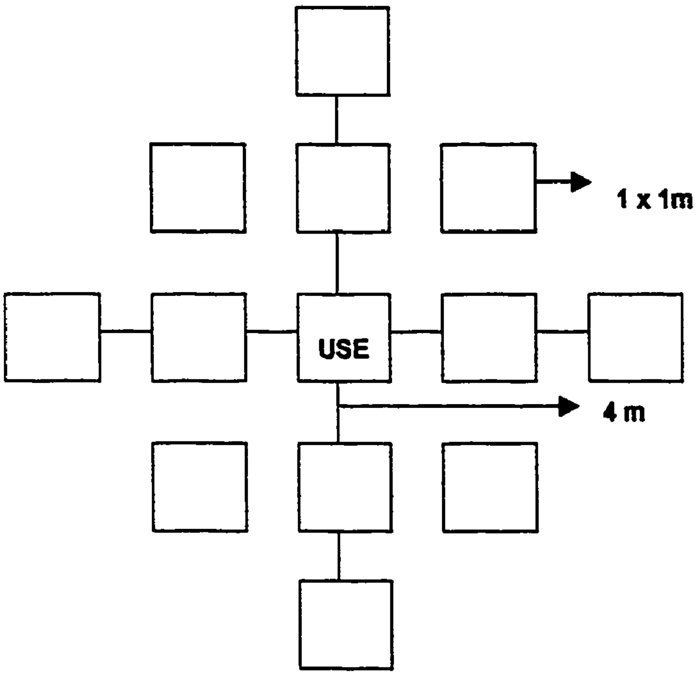

FIG. 3-2. VEGETATION SAMPLING QUADRAT ARRANGEMENT

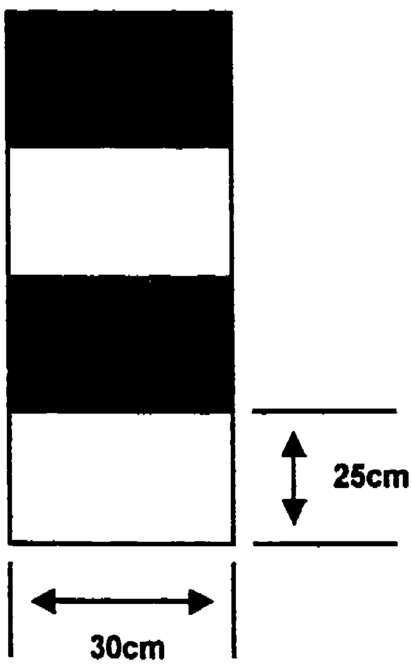

FIG. 3-3. HORIZONTAL COVER BOARD SPECIFICATIONS

3.3.3 Data Analysis

3.3.3a Home Range Analysis

Home range calculations were obtained using CALHOME© Home Range Analysis Program, MS-DOS Version 1.0 (Kie et al. 1994). The Minimum Convex Polygon (MCP) method (Mohr 1947) was utilized to describe home range sizes of hens associated with each of the 5 different dancing grounds that were trapped. Home ranges were also calculated for hens trapped while incubating and for whose lek of reproduction was unknown. These home ranges were not included in the overall lek home range estimations. Because the accuracy of home range estimates are a direct function of the number of radiolocations obtained, hens with <12 locations were excluded from the analysis (Odum and Kuenzler 1955, Manly et al. 1993).

3.3.3b Analysis of vegetative and cover attributes at Brood Use and random locations

A total of 77 brood use sites and corresponding random sites were analyzed with respect to cover attributes. Hotelling's multivariate T-tests (T^2) was utilized to analyze percent composition and heights data at both brood use and paired random sites. Critical T^2 values were converted to an F statistic for tests of significance (Manly 1986). Percent composition, heights and lateral density index data were analyzed separately to ensure commensurability.

3.3.3c Habitat Use vs. Availability

This study was focused upon analyzing and describing the microhabitat composition and structure at sharp-tailed grouse brood rearing locations. At this scale, aerial interpretation of available habitat resources would be insufficient as a method for comparing against actual habitat resource utilization. In addition, the course grained aerial habitat estimation would be of little benefit to wildlife managers charged with the task of managing for sharp-tailed grouse reproductive habitats on the native mixed-grass prairie.

Utilizing grassland as a habitat type when considering use vs. availability can obscure selection processes for certain components within that larger grassland habitat type (Cowardin et al. 1984). Because of the diversity of grassland ecosystems, it cannot be assumed that a hen is merely selecting grassland. Grasslands are composed of numerous other plant assemblages other than graminoid compositions. Hens may be selecting for forb, shrub or residual cover within this larger habitat type. Therefore the diversity of grassland ecosystems can result in numerous selections based on microhabitat criteria. As such, the present analysis of habitat resource use vs. availability utilizes the data and measurements obtained at random plots for what is available in comparison to what sharp-tailed grouse hens are actually utilizing for their brood rearing purposes.

This approach permitted a more detailed analysis of habitat use. This analysis includes data on heights and horizontal cover estimates in addition to microhabitat compositions of litter, forb, grass, and woody cover. This amount of detail is not possible with aerial photo or digital cover map interpretation.

The proposed sampling criteria meet assumptions postulated by Neu et al. (1974) that in observations of habitat use vs. availability: 1) the individuals must have an opportunity to select for any of the habitat variables deemed available, 2) that all observations are collected in a random and unbiased manner.

Traditionally the home range of an animal is utilized for estimation of what habitat is available to that individual animal (Cowardin et al. 1984, Gilmer et al. 1975, Johnson 1980, Manly et al.1993). However, Johnson (1980) points out that utilizing home range may be biased towards a selection event that has already occurred within the larger study area that encompasses the sample of individuals under analysis. Secondly, home range estimates are directly a function of the number of radiolocations obtained and utilized for estimation of each individual animals home range (Odum and Kuenzler 1955, Manly et al. 1993). Because the number of radiolocations obtained prior during the brood rearing season was relatively low, comparison of habitat selection amongst available habitat within a defined home range would not be justified. Additionally, broods found from non-radio marked hens would also have to be excluded because these hens would have no defined home range. As such, the resource availability data referred to herein was obtained through sampling of microhabitat components found within a randomly located sampling grid identical to those utilized to analyze habitat composition at use sites. Therefore the random sites will comprise the universe of available resource units (Manly et al. 1993, Dunn and Braun 1986).

The Rank Order procedure described by Johnson (1980) was utilized to analyze habitat utilization vs. habitat availability. This method allows for the analysis of habitat attributes and compositions whereas those methods utilizing derivations of the chi-square statistic can only deal with nominal data or categories of habitat types. These methods require proportional estimates of use within habitat types for the analysis, whereas the rank order method allows for the use of percentages for compositional data. These tests also pool the use of habitats across individuals and as such are less sensitive to the selection of habitat by individuals (Aebischer et al. 1993). Additional advantages of the Johnson rank-order method include: it's relative insensitivity to the arbitrary inclusion or exclusion of habitats (Johnson 1980, Thomas and Taylor 1990), it overcomes the unit-sum constraint (Aebischer et al. 1993), and ranking inherently approximates real data more closely than absolute statements regarding habitat preference or avoidance (Johnson 1980).

The rank order procedure tests two hypotheses. The first hypothesis utilizes a multivariate Hotelling T^2 statistic to test the null hypotheses that differences of rank between use and availability are equal. If the first hypothesis is rejected then the Waller-Duncan multiple comparison procedure (Waller and Duncan 1969) is utilized to test the second hypotheses that the differences in relative selection between habitat attribute i is equal to that of habitat j.

Microhabitat attributes utilized in the analysis include; the percent composition of forb, grass, litter and shrub, mean effective heights of these cover types, and horizontal obstruction (cover board). The moss/lichen and bare ground cover types were excluded from the analysis because these attributes contribute little towards the overall composition of both use sites and sites comprising the availability data. Additionally, this data was characterized by non-normal distributions and log transformation failed to bring about approximation to normality. As such, outcomes that result with the inclusion of these attributes in the analysis may not be indicative of selection, but may be due to an artifact of the non-normality of the distributions.

Since the present study is concerned only with the reproductive habitat requirements of Sharp-tailed grouse, the temporal consideration of habitat availability need only be concerned with those months encompassing the nesting and brood-rearing activities (April-mid August) during which time hens occupy distinct home ranges (Connelly et al. 1998).

3.4 Results

3.4.1 Survival Statistics

The hen survival rate was defined as hens surviving until the end of the brood rearing season, which was August 12th in 1998 and August 5th in 1999. Due to radio failure (2), shedding of radio collars (2) and a recording error, only 12 of the 17 hens collared in 1998 were utilized in the hen survival statistic. Of these 12 hens, 3 were depredated which calculates to a 0.75 hen survival rate. One of the hens was depredated prior to initiating a nest, one was depredated while incubating and the last was depredated while brooding. Four of the surviving hens were harvested in the 1998 fall hunting season, therefore only 5 hens actually survived into the 1999 reproductive season.

Out of 20 radioed hens in 1999, 18 were included in the hen survival statistic, 2 having shed their radio collars prior to August 5th. Four of these hens were depredated (2 while incubating and 2 with brood), equating to a hen survival rate of 0.78. Over the 1998 and 1999 field seasons, hen survival was calculated at 0.77.

Brood survival was defined as broods surviving until the end of the brood rearing season. In an effort to minimize unnecessary dispersal and disturbance to broods, total numbers of individual chicks comprising the brood were not ascertained consistently. As such, a successful brood was defined as survival of any one individual chick counted within a brood of a radio-marked hen surviving until the end of the field season (August 12th in 1998 and August 5th in 1999).

In 1998 brood data was collected on 9 radio marked hens successfully hatching a clutch of eggs. One of these hens subsequently shed her radio and brood fate could not be determined. Two of the remaining 8 broods produced one or more chicks during the 1998 reproductive season, translating to a brood survival rate of 0.25. Fate of all broods was not determined, however several broods are suspected of succumbing to exposure during a period of cold prolonged rain in mid-June. This was somewhat confirmed by the incidental discovery of a non-study hen lying dead on top of 3 dead chicks. Upon necropsy of the hen, it was determined that the hen indeed died of exposure. When the crop of the hen was checked, only a small snowberry leaf was found. Inference suggests that the hen was attempting to thermoregulate for her chicks and had forgone feeding during this extended rainy period. Although no radio-marked hens were lost to exposure, 3 of the 8 broods are suspected of experiencing a similar fate. One brood is suspected of succumbing to predation due to the discovery of the hen's remains near the entrance of a coyote den. Fate of the remaining 2 broods was undetermined.

In 1999 data on 16 radio marked hens experiencing a successful hatch was collected. Of these hens, 2 shed their radios prior to the end of the brood rearing season, 2 were lost to predation, 7 lost their broods to an unknown fate and the remaining 5 successfully reared one or more chicks. Coyotes are suspected of predating the two hens. One of these hens was discovered shortly after the occurrence of the predation. Her 8-day-old brood was heard in the vicinity and was not suspected of surviving the season. Brood survival in 1999 was calculated at 0.36 and 0.32 over the two field seasons.

3.4.2 Home range

Home range area was estimated for 15 hens, 5 of which were followed throughout both the 1998 and 1999 field seasons (Table 3-1). Hens with <12 locations were excluded from the analysis. Average home range size was 69 ± 12.4 hectares. Several hens maintained home range sizes substantially greater than the 69 ha average. Hens 617, 717 and 941 utilized home ranges of 131, 134 and 196 ha respectively. The larger home range of 617 is explained by a long distance move immediately after hatch. This hen left the promontory on which she nested and descended down a northeast slope towards what appeared as less optimal habitat. To reach this destination the hen and her brood crossed a road and traversed a portion of seeded pasture, which lacked the cover attributes of the area from which the hen was heading. The final destination was a small portion of native pasture, which had been heavily grazed and provided little in the way of cover. Hen 717 abandoned her initial nest (causes unknown) and renested approximately 0.6 km from her previous nest location. Prior to establishing this renest this hen made several movements around the southeastern portion of the study area, which may account for her larger home range size. Presumably the impetus behind these movements was nest site selection. The larger home range size of hen 941 is the result of 2 renesting attempts, one in year 1 and the other in year 2. This hen traveled 3 km from her initial nest site, which was depredated, to her renest location in 1998. It is not known if 941 re-mated at the lek of capture for her renesting attempt, however her renest location was closer to another much larger lek. Off lek copulation may also be a possibility (Sexton 1979). In 1999 both 941's initial nest and renest were located near her 1998 renest location.

The smallest home range size (20 ha) was that of hen 900. This hen inhabited the northwestern portion of the study area; primarily utilizing north facing slopes consisting of tall stands of rough fescue and dense patches of western snowberry. Smaller home ranges have been equated to relative habitat quality (Giesen 1997) suggesting that the habitat conditions within this home range were such that this hen was able to fulfill her habitat requirements with minimal movements.

Table 3-1. Sharp-tailed grouse home range estimations, MRR, Alberta. 1998-99

Year	Hen	# Locations	km To Nest*	Home Range (ha)
2	736	19	1.0	54.8
2	757	17	1.7	36.8
2	775	14	1.1	48.9
2	916	15	1.0	25.3
2	617	14	0.7	130.7
2	817	15	1.3	61.6
2	638	16	0.8	63.5
2	717	16	0.9	134.0[R2]
2	579	16	1.2	54.5[R2]
2	697	12	1.2	32.4[R2]
1,2	900	18	—	20.3
1,2	858	14	1.3[1] - 1.5[2]	83.3
1,2	799	27	0.8[1] - 0.9[2]	58.6[R2]
1,2	941	18	0.9[1] - 3.4[2]	195.8[R1,R2]
1,2	837	21	0.3[1] - 0.5[2]	44.3
N		15	18	15
Mean		16.8 ± 0.9	1.1 ± 0.16	69 ± 12.4
Range		(12 - 27)	(0.3 - 3.4)	(20.3 - 195.8)

*Distance from lek of capture to <u>initial</u> nest site

[1] Distance to initial nest year 1, [2] Distance to initial nest year 2

[R1] Includes renest attempt year 1, [R2] Inludes renest attempt year 2

3.4.3 Comparison of Vegetation at paired brood use sites and random sites

Percent composition of 6 cover types and corresponding heights of 4 cover types were analyzed at 77 sharp-tailed grouse brood use and paired random sites. Vegetation composition differed significantly ($F_{7,70} = 16.61$, $P < 0.001$) with brood use sites containing greater compositions of grass cover ($\bar{x} = 36.4 \pm 0.9\%$) and reduced compositions of litter ($\bar{x} = 22.8 \pm 0.8\%$) and moss/lichen ($\bar{x}$ = 0.76 ± 0.2%) than randomly located sites (grass: $\bar{x}$ = 30.0 ± 0.7%, litter: $\bar{x}$ = 26.4 ± 0.8%, moss/lichen: $\bar{x}$ = 3.72 ± 0.7%) (Table 3-2).

Multivariate analysis also revealed significant differences ($F_{4,72}$ = 5.71, P < 0.001) in the comparison of vegetative heights at brood use and random sites, with brood use sites containing taller assemblages of grass ($\bar{x}$ = 30.2 ± 0.6%) and forbs ($\bar{x}$ = 22.9 ± 0.5%) than random sites (grass: $\bar{x}$ = 23.6 ± 0.7%, forb: $\bar{x}$ = 19.1 ± 0.7%) (Table 3-3).

Horizontal cover values were significantly higher at brood use sites ($\bar{x}$ = 23.8 ± 0.92) as compared to random locations ($\bar{x}$ = 20.1 ± 1.39) (t = 2.23, P = 0.027). Slope percentages did not differ (t = -0.47, P = 0.64) between brood sites ($\bar{x}$ = 9.5 ± 1.12%) and random sites ($\bar{x}$ = 10.2 ± 0.89%).

Table 3-2. Multivariate analysis of percent composition of cover types at sharp-tailed grouse brood use (*n* = 77) and random (*n* = 77) sites, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 16.61	Sites					
P < 0.001	Brood use		Random		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	13.4	1.2	12.9	1.6	-0.204	0.502
Grass	36.4	0.9	30.0	0.7	0.032	0.137
Litter	22.8	0.8	26.4	0.8	-0.126	-0.006
Forbs	25.6	0.8	25.0	0.8	-0.055	0.089
Moss/Lichen	0.76	0.24	3.72	0.70	-0.513	-0.031
Bare Ground	1.03	0.30	2.01	0.45	-0.299	0.120

[a]Determined for Hotelling's multivariate T^2 test (log transformed data), same sign values indicate significance.

Table 3-3. Multivariate analysis of vegetation heights (cm) at sharp-tailed grouse brood use (n = 77) and random (n = 77) sites, Milk River Ridge, Warner County, Alberta, 1998-99.

F = 5.71	Sites					
P < 0.001	Brood use		Random		Confidence Limits[a]	
COVER	$\bar{x}$	SE	$\bar{x}$	SE	Lower	Upper
Woody	16.8	1.2	14.9	1.6	-0.101	0.466
Grass	30.2	0.6	23.6	0.7	0.071	0.164
Litter	5.9	0.3	5.9	0.3	-0.053	0.071
Forbs	22.9	0.5	19.1	0.7	0.044	0.149

[a]Determined for Hotelling's multivariate T^2 test (log transformed data), same sign values indicate significance.

3.4.4 Use vs. Availability of Habitat Attributes

Habitat use data was analyzed for 77 brood sites and their corresponding random habitat availability locations for the 1998 and 1999 field seasons using Prefer© Preference Assessment Program, Windows version 5.1 (Johnson 1980). Rank Order calculations revealed a statistical difference in habitat preference ($F_{4,73}$ = 8.19, W = 1.89). Grass cover was preferred over all other habitat types and was used in greater proportion to its availability (Table 3-4). Forb cover was utilized in proportion to its availability, and was preferred over litter cover. Woody cover selectivity equaled its availability, whereas litter cover used in lesser proportions to availability.

Table 3-4. Relative habitat type preference of sharp-tailed grouse as determined by comparison of habitat use at brood sites vs. availaibility of habitat at random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

Habitat Type	Percent Habitat Use	Percent Habitat Available	Preference Rank[a]
Grass	36.4	30.0	1 F,W,L
Forb	25.6	25.0	2 L
Litter	22.8	26.4	4
Woody	13.4	12.9	3

[a]Abbreviations signify statistically significant ($P < 0.05$) preference over other habitat components (F = forb, W = woody, L = litter)

Analysis of habitat attribute values at brood sites revealed taller grass heights to be selected in greater proportions to availability of such attributes and a significant preference of taller grass heights over both forb heights and litter heights (Table 3-5). Litter heights were utilized in exact proportion to availability of habitat with similar litter heights, whereas woody heights and forb heights approximated equal use relative to availability.

Table 3-5. Relative attribute value preference of sharp-tailed grouse as determined by comparison of habitat use at brood sites vs. availability of habitat at random sites, Milk River Ridge, Warner County, Alberta. 1998-99.

Habitat Attribute[a]	Attribute Values Use	Attribute Values Available	Preference Rank[b]
Grass Height	30.2	23.6	1 F,L
Forb Height	22.9	19.1	5
Woody Height	16.8	14.9	3
Litter Height	5.9	5.9	4
Horizontal Cover	23.8	20.1	2

[a]attribute heights in cm, horizontal cover values derived from cover board index
[b]abbreviations signify statistically significant ($P < 0.05$) preference over other habitat components (F = forb, L = litter)

3.5 Discussion

A paradox exists in relation to the importance of sharp-tailed grouse brood rearing habitat characteristics. Several researchers have emphasized the importance of open cover types (Hammerstrom 1963, Christenson 1970, Kobriger 1980) for foraging while others have highlighted the importance of dense cover for thermoregulation and predator escape (Connelly et al. 1998). Although open cover types are utilized heavily during the early stages of brood rearing, a movement to more dense cover in the form of shrubby habitats as broods age has been acknowledged (Evans 1968, Christenson 1970, Kobriger 1980). Hence, the literature indicates that both open and closed habitats are important for brood rearing. Researchers have proposed that the appropriate balance should be accomplished by maintaining diverse grassland regions with interspersions of shrubs, grass and forb cover to address requirements for foraging, thermoregulation and predator escape (Hammerstrom 1963, Evans 1968, Hillman and Jackson 1973, Sisson 1976, Sexton 1979, Moyles 1981, Johnsgard 1983, Swenson 1985, Klott 1987, Gratson 1988, Klot and Lindzey 1990, Meints 1991).

Similar to results reported by these researchers, broods on the Milk River Ridge utilized diverse grassland areas. Grass comprised an average of 36 percent of the compositions at use sites, significantly greater than found at random locations. Although forbs were utilized in similar proportions to availability, forbs formed a larger component of brood rearing sites (26%) than nesting sites (20%). Contrary to findings in North Dakota (Kohn 1976), woody cover was found in smaller compositions at brood sites than at nesting sites. Although shrubs comprised only 13.4 percent of the brood use sites (compared to 25.5 percent at nesting sites), I concur with previous researchers that the presence of shrubby habitats is essential to brood rearing and should not be overlooked. In the analysis of preference for habitat attributes, horizontal cover values were selected second only to taller grass heights. I propose that the combination of shrubs and stands of taller grass were responsible for the horizontal cover selected by brood rearing hens. Across all habitat components the mean effective height at brood use sites was 19 cm, which parallels results reported by Kohn (1976) and Kobriger (1980).

Weather conditions can be a major factor in brood mortality. Several researchers have identified extended periods of wet cold weather as a cause of brood loss (Christenson 1970, Hillman and Jackson 1973, Brousquet and Rotella 1998). Hens is this study experienced a significant loss of broods due to similar conditions in mid June of 1998. During this time 3 broods were lost to exposure, which constituted 37.5 percent of the total broods. In addition to 1 predation and 2 unconfirmed losses, brood survival in 1998 was 0.25. These results parallel those documented by Brousquet and Rotella (1998), who in one year reported a 0.30 brood survival rate due to inclement weather. Hence, the presence of dense cover to escape inclement weather conditions is essential to ensure sufficient year-to-year recruitment of juvenile individuals into the population.

With the exception of a few studies, brood survival has been poorly represented in the literature. Across two field seasons, Brousquet and Rotella

(1998) reported a brood survival rate of 0.48. Christenson (1970) reported a survival rate of 0.18 in one field season. Over the two field seasons on the Milk River Ridge brood survival was calculated at 0.32, falling within the rates reported above. Although brood survival in this study was not exceptionally high, I do not attribute the losses to lack of suitable habitat. On the contrary, I feel that the habitats available to brood rearing hens on the Milk River Ridge mitigated any further brood losses due to the effects of weather. If home range size can be utilized as an indication of habitat condition (Saab and Marks 1992, Giesen 1997), then comparison of the smaller mean home ranges (69 ± 12.4 ha) occupied by hens on the Milk River Ridge to mean home range sizes reported by other researchers (Marks and Marks 1987 [$\bar{x}$ = 190ha], Saab and Marks 1992 [$\bar{x}$ = 187ha], Giesen 1997 [$\bar{x}$ = 110ha]), lends support to the above claim.

Management for brood rearing habitats should include proper grazing regimes that secure the persistence of tall stands of grass, with interspersions of forbs and shrubby cover. Actual management for these habitat types need not take place if proper stocking takes place in combination with appropriate timing and duration of grazing. The retention of shrubby habitats need not be a priority for brood rearing habitat if management for shrubby nesting areas is included. The 1-1-1 management prescription of shrub to grass to forb would be beneficial to both nesting and brood rearing requirements of sharp-tailed grouse. Klott and Lindzey (1990) in south-central Wyoming and Sexton (1978) in Manitoba found a similar relationship with respect to the ratio of vegetation composition at brood use sites.

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Chapter 4.0: REPRODUCTIVE HABITAT MANAGEMENT RECOMMENDATIONS FOR PLAINS SHARP-TAILED GROUSE ON THE MILK RIVER RIDGE GRASSLANDS

4.1 Introduction

Native grasslands are one of the most threatened ecosystems in North America. Across prairie grouse range it is recognized that cropland conversions have substantially contributed to the loss of native grassland habitat (Hamerstrom and Hamerstrom 1961, Aldrich 1963, Evans 1968, Kirsch et al. 1973, Hillman & Jackson 1973, Johnsgard 1983, Swenson 1985, Baydack 1986, Kirby and Grosz 1995, Sedivec et al. 1995, Giesen 1997). Within Alberta's grassland natural region, only 43 percent of the original 24 million acres exists today as native prairie (Jones and Lee 2001). What is securing the future of native grasslands is the existence the livestock industry on the productive rangelands of the west. This being said, proper range management is essential in order to secure the livelihoods of both the rancher and the wildlife species inhabiting these areas. To that end, results from this research will be utilized to produce several recommendations in regards to managing reproductive habitats for sharp-tailed grouse with potential benefits to other prairie nesting species. These recommendations will be made in a fashion as to benefit both the livestock producer as well as wildlife, which share the native mixed grass / fescue grasslands of the Milk River Ridge, Alberta.

4.2 Range Health

In order for the mixed grass / fescue prairie to fulfill the demands of the livestock industry and support a wide array of wildlife, it must be in a healthy state. Rangeland health is directly related to grazing pressures placed upon it. As such appropriate and prudent range management is paramount.

To meet the objectives of the livestock industry, rangeland should be managed in order to perpetuate nutritious forage year after year. If it is determined that native decreaser species are the optimal forage type for cattle, then the range should be managed accordingly. However, in an effort to return the range to its perceived climax community, the importance of shrubby cover should not be overlooked. In the majority of range sites for the 355 mm – 457 mm (14-18 inch) precipitation zone in southern Alberta, shrubby cover is considered an increaser (Wroe et al. 1988), however in certain portions of the mixed grass prairie shrubby cover will occur naturally, apart from increases due to over grazing (Al Robertson, pers. comm. Highland Range Consultants).

The rangeland inventory describing the vegetation surrounding sharp-tailed grouse nesting sites on the Milk River Ridge was dominated by western snowberry (*Symphoricarpos occidentalis*), Kentucky bluegrass (*Poa pratensis*) and prairie rose (*Rosa arkansana*) community. Both of the shrub species are considered increasers in the majority of range sites within the study area and Kentucky bluegrass is considered to be an invader. Although it has been shown that game bird species show a marked affinity for vigorous sub-climax communities (Kirsch et al. 1973, Snyder 1996), if it was deemed beneficial to bring about a slow return to the climax community through parsimonious grazing practices and shrubs were retained, the replacement of Kentucky bluegrass with a native decreaser species (ie. rough fescue) would have little effect on the nesting ecology of sharp-tailed grouse. A return of the species comprising the climax community may in fact enhance nesting habitats should sufficient height and density of grasses be maintained. Hence, management for cattle need not conflict with wildlife management goals.

Range management principles should be directed at the maintenance of areas of taller vegetation (preferably between 25-30 cm) during the summer months for brood rearing habitat as well as into the fall in order to provide residual cover for the spring nesting season. For nesting purposes specifically, areas identified as optimal nesting cover (see section 4.4) should be left undisturbed as much as possible in order to maximize residual cover each spring (George et al. 1979). Where displacement and scaling back of grazing cannot take place to achieve the taller vegetation required, shrub conservation should move up in priority (see section 4.4).

Methods that could be utilized to accomplish these objectives include; strategic livestock distribution, strategic distribution of cattle water stations, delayed spring grazing, rest-rotation grazing and ultimately, appropriate animal stocking. No one grazing plan would be appropriate in all situations (Brown 1978), hence intensive on site reconnaissance should be undertaken in order to implement the most effective rangeland management plan and to ensure that management practices are in line with identified wildlife management goals.

4.3 Protection of contiguous native grassland areas

A major priority for management agencies should be the discouragement of conversion of native grassland to croplands. The large unfragmented nature of the Milk River Ridge should be maintained in order to effectively meet the demands of the wildlife inhabiting the region.

Some researchers have commented on the importance of cropland interspersions for a variety of prairie grouse species including sharp-tailed grouse (Crawford and Bolen 1976, Evans 1968, Swenson 1985). However, conversion of native prairie to croplands is recognized as a major limiting factor for sharp-tailed grouse habitats. The movement of grouse into these areas is most likely due to the opportunistic nature of the birds in adapting to losses of vigor and successional changes in local vegetation conditions (Kirsch et al. 1973), and not representative of prime sharp-tailed grouse habitat. The potential of croplands to alleviate food shortages with waste grains and other man-made food items should in no way reduce the ultimate importance of the existence of natural, unfragmented grasslands to these birds (Brown 1978). If these contiguous grasslands are grazed appropriately, food shortages should not be of a concern. Additionally, croplands are primarily utilized during the winter months (Swenson 1985) and do not provide the appropriate cover required for successful nesting. Previous research has revealed that prairie nesting ducks inhabiting regions of high fragmentation due to cropland conversions experience excessive nest depredation (Greenwood et al. 1995). Habitats interspersed with croplands tend to concentrate nesting in defined habitat patches. The predator assemblages that thrive in these disturbed regions show increased activity around these habitat discontinuities, increasing predatory efficiency (Haensly et al. 1987). In contrast, habitat on the contiguous grasslands of the Milk River Ridge is "homogeneous in its heterogeneity". With this statement I am implying that one region, although in no way a low diversity area, appears a lot like another area in regards to the composition of habitat components (ie. shrubs, grass, forbs) and topography. In terms of sharp-tailed grouse nesting locations, the selection of one shrub patch edge is very similar in composition and structure to numerous other such areas within very proximal distances. This is not to suggest that all of the areas of the Milk River Ridge provide good sharp-tailed grouse nesting habitat. Indeed various habitats do exist in which sharp-tailed grouse nests would not be found however these are distributed relatively evenly throughout the study area. Hence, the homogeneous nature of the heterogeneous habitat reduces predator habituation to, and convergence on, defined habitat patches.

Nest success in this study compare favorably with sharp-tailed grouse inhabiting large contiguous grasslands in central Montana. Bousquet and Rotella (1998) in part attributed their 0.74 average nest success to the lack of fragmentation in the grassland ecosystem in which they conducted their research. I concur with their hypotheses and propose that an essential element in retaining sharp-tailed grouse populations into the future exists in the protection of the remaining contiguous grasslands. Management interests should take into account the importance of large unfragmented areas and should discourage conversions to cropland when alternate land use such as cattle grazing can be viable.

4.4 Shrub Conservation / Retention

Motivation to decrease shrub cover on the rangelands of the Milk River Ridge has been expressed by some in order to increase forage potential for cattle (Brian Millar, Wildlife Biologist, Alberta Conservation Association, Lethbridge, Alberta). Cursory observations of cattle behaviour during this study revealed that cattle do in fact make use of the vegetation found amongst the shrub patches. These patches, when managed appropriately can harbor taller and more robust species of grass and forb, which dependent upon species can be highly palatable to cattle.

Methods to eradicate woody vegetation include the use of herbicides, fire, mechanical means and placement of cattle mineral/oiling stations within shrub patches to deter shrub growth as a function of trampling. Due to the importance of shrubs to nesting sharp-tailed grouse and the fact that many of the shrub communities found on portions of the Milk River Ridge grasslands occur "naturally" apart from increases due to over-grazing (Al Robertson, pers. comm. Highland Range Consultants), I propose that shrub eradication practices be discouraged.

The high use and preference of shrubs by nesting sharp-tailed grouse in this study speaks to the importance of shrub conservation. These data suggest that shrub retention is imperative for the perpetuation of sharp-tailed grouse on the Milk River Ridge, Alberta and should be a consideration in similar mixed grassland regions if sharp-tailed grouse management is deemed a priority.

As revealed in the research, shrubby habitats were not selected in isolation of other habitat components, however shrubs did constitute the dominant lifeform at nest sites. The residual cover provided by shrubs in the spring is essential for early nesting species such as sharp-tailed grouse. The structural ability of shrubs to maintain grass cover in the form of residual herbage may also be an "attractant" to nesting hens, and therefore sites are chosen not just for their shrubby component but also for the grass cover that they provide.

Goddard (1995) included an element of woody protection for sharp-tailed grouse winter cover in his outline of the Sharp-tailed Grouse Habitat Program administered by the Alberta Conservation Association. He proposed the use of fencing to exclude cattle use of these areas. It is likely that shrub communities that provide the essentials for nesting cover would also function as winter cover. In terms of fencing and excluding cattle, only those areas that are identified as optimal sharp-tailed grouse nesting habitat should be fenced (see section 4.5). Areas of shrub that are not fenced should also be retained in order to maintain the heterogeneity of the grassland and to avoid the creation of predator sinks. Retention of these patches need not include actual management, but should include dissuasion of shrub eradication practices.

Total exclusion of cattle throughout the grazing season should not take place. Periodic grazing after the nesting season has been completed (late June to early July to account for renesting efforts) will assist in opening up the stands and help to discourage the creation of large monotypic stands which could eventually crowd out the necessary grasses and forbs. Additionally, periodic grazing will help to rejuvenate all of the cover types (shrub, grass, forb) found within theses stands by preventing the accumulation of excessive litter.

4.5 Identification of critical sharp-tailed grouse nesting areas

Attempts at creating habitat suitability indices for sharp-tailed grouse have resulted in limited utility due to site specificity. Prose (1992) found that evaluating the vegetation of the Nebraska Sandhills utilizing a sharp-tailed grouse habitat suitability index based upon vegetation data obtained from North and South Dakota (Prose 1987) was inappropriate. The differences in the vegetation communities at these locations rendered the habitat criteria incommensurable. Hence, the best approach to identifying potential sharp-tailed grouse reproductive habitat is to conduct *a priori* research on critical nesting areas in the region targeted for management. However, fiscal climates do not always permit such research to be conducted. To that end, the presence of particular habitat components identified by this study can be used as indicators of the capacity of an area in the mixed grass prairie of southern Alberta, to support sharp-tailed grouse nests.

Because nesting takes place in areas of exceptionally heavy cover, areas to be targeted for management can be identified through on site inspections. Optimal sharp-tailed grouse nesting habitat has been described as an interspersion of several cover types (Hamerstrom and Hamerstrom 1961, Henderson 1964, Evans 1968, Pepper 1972, Sisson 1976, Kobriger 1980, Moyles 1981, Swenson 1985, Meints et al. 1992). The results from this research substantiate this description and can be utilized to determine appropriate amounts of each cover type for the purposes of nesting. Prime nesting areas should consist of shrub cover with adequate amounts of grasses and forbs. This cover should consist of species with heights approaching 25 - 30 cm. Proportionally, the micro scale lifeform composition found within the range condition quadrats was 1:1:1 (shrub to grass to forb). This proportion compares to those found within the larger percent composition vegetation quadrats found at the nest site with the inclusion of litter. If we consider litter to encompass dead shrub, grass and forb, then the relative proportion of 1:1:1 holds true. A similar management prescription was previously proposed by Sexton (Don Sexton, pers. comm., Ducks Unlimited Canada) based on his results of sharp-tailed grouse nesting habitat in Manitoba.

In the determination of suitable nesting areas, I propose the use of nine 1 x 1 m quadrats arranged in a square fashion (Fig. 4-1). Each quadrat should be placed 4 meters apart to ensure appropriate coverage of the habitat components. Within each quadrat the percent composition of shrub, grass and forb should be estimated. Residual vegetation of each habitat component should be included within their respective categories. Four height measurements should be obtained within all 3 vegetation types and averaged across vegetation types (i.e. x /12).

For the sake of expediency and efficiency, the 9-quadrat method is suggested in lieu of the more intensive 13-quadrat star-patterned methodology utilized in this research. Comparison of the nest site vegetation data found within the smaller 9-quadrat arrangement to the larger 13-quadrat arrangement revealed no differences in percent composition, therefore utilization of the less intensive 9-quadrat methodology for evaluation of nesting habitat potential is sufficient.

Establishment of the sampling locations should be accomplished in a random fashion using a random number table to determine distance (100-500 m) and direction (N,S,E,W) from an arbitrary starting point. Repetition of the sampling procedure is dependent upon the size of the habitat to be evaluated.

Average proportions of habitat components across sampling units should approximate the 1:1:1 prescription and average heights should approach 25-30 cm.

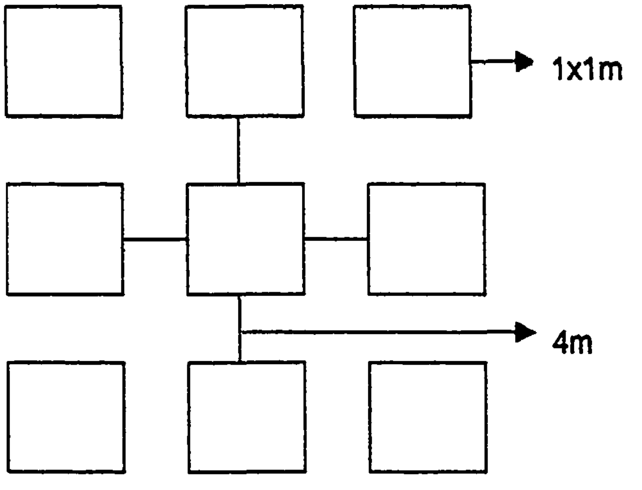

FIG. 4-1. PROPOSED QUADRAT ARRANGEMENT FOR SAMPLING OF VEGETATION TO DETERMINE SHARP-TAILED GROUSE NESTING HABITAT POTENTIAL

4.6 Challenging the traditional approach to management of sharp-tailed grouse nesting habitats

The distance traveled by a sharp-tailed grouse hen from lek of capture to a nest site can be an indication of habitat quality or availability of suitable habitat within that distance traveled (Giesen 1997). Hence, management for prairie grouse (lekking species) nesting habitat has traditionally focused upon management within that zone surrounding the dancing ground that encompasses the majority of the nest sites. This area has been termed the breeding complex (Giesen and Connelly 1993). Previous researchers have recommended management within a radius of 2.0 km around sharp-tailed grouse lekking sites (Giesen and Connelly 1993, Connelly et al. 1998). Such an approach, although prudent, may exclude cattle use in areas that would otherwise not be utilized for nesting purposes. This management approach should be reevaluated and strategies should be developed in an attempt to mitigate any losses to cattle producers occupying the lands in question. Preliminary results on the Milk River Ridge suggest that an alternate approach, although more labor intensive, may in fact be the most efficient method to manage for sharp-tailed grouse nesting habitat and the needs of cattle producers.

Analysis of hen movements from the dancing ground to initial nest site reveals patterns of directionality, mostly to the northern slope of the ridge where moist/cooler soils promote the growth of woody vegetation. Several of these nesting "hotspots" were identified in this study. This suggests that sharp-tailed grouse hens on the Milk River Ridge are selecting for certain nesting habitat characteristics that may not be evenly distributed around the lek of reproduction. This would then imply that managing habitat around a prescribed area surrounding dancing grounds may not be the most efficient method of managing for nesting habitat, if removal of cattle from the area is considered.

These results support the necessity for the identification of critical nesting areas (see section 4.5) prior to instituting a management regime within an arbitrarily defined prescription radius. Once these "hotspots" have been identified, management strategies can be appropriately developed to exclude cattle from these areas while permitting use of other areas, which would have otherwise fallen into that 2.0 km radius cattle exclusion zone.

As mentioned previously, shrub conservation within these areas should be a priority, along with management for taller grass and forb cover. However, this is not to imply that shrubs located outside of these critical areas should not also be retained. Additional areas of naturally occurring shrub should be conserved in order to maintain the heterogeneity of the grassland and provide for alternate nesting refugia should they be required. Safeguarding only those areas identified to contain superior nesting habitat, while removing shrubby habitats in the vicinity could result in the creation of predator sinks, where strips of suitable nesting areas in the absence of other such areas will attract predators to nesting locations (Haensly et al. 1987).

4.7 Sharp-tailed grouse and umbrella species management

Considering the present day budgetary restrictions within the field of wildlife management, it is no longer prudent to manage for a single species. Beyond fiscal motivations, multi-species management seems to be the direction that wildlife management is now taking. Biologists and wildlife managers are starting to recognize the importance of biodiversity considerations in research and management directives. This is exemplified by the biodiversity initiatives undertaken by the North American Waterfowl Management Plan (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1994).

Although the study under consideration did focus on a single species, the management recommendations derived can be extended to other prairie nesting species utilizing similar nesting habitats (ie. waterfowl). Although nesting requirements may not be exact (ie. waterfowl will nest in the middle of shrub patches whereas sharp-tailed grouse will utilize the peripheries), the management mosaic should encompass the requirements for a larger array of species (ie. the retention of larger shrub patches will benefit waterfowl and sharp-tailed grouse) (Brown 1978).

As an example of the sympatric habitat use by sharp-tailed grouse and other prairie nesting species, I offer a quick description of our chain dragging results. In addition to sharp-tailed grouse nests, a number of waterfowl nests were found over the two field seasons. Species discovered include; mallard, American wigeon, gadwall, pintail and northern shoveler. Rudimentary comparison of waterfowl and sharp-tailed grouse nest sites reveals similarities in vegetative structure. The high utilization of shrubby cover at sharp-tailed grouse and waterfowl nests suggests the possibility for complementary habitat management prescriptions. In addition to the waterfowl and sharp-tailed grouse nests discovered, numerous other species were observed throughout the nesting season including; Wilson's phalaropes (*Phalaropus tricolor*), upland sandpipers (*Bartramia longicauda*), long-billed curlews (*Numenius americanus*), marbled godwits (*Limosa fedoa*), bobolinks (*Dolichonyx oryzivorus*) and various sparrow and songbird species.

Because successful sharp-tailed grouse populations are dependent upon large healthy contiguous grasslands comprised of a diverse interspersion of habitat components, I propose that the existence of healthy sharp-tailed grouse populations can be utilized as an indicator of the ability of the grassland to support a wide variety of prairie nesting species including the aforementioned. Hence, managing grassland habitats for sharp-tailed grouse has the potential to benefit a myriad of prairie nesting species. This multi-species management paradigm is consistent with present trends in wildlife management and opens doors for the expansion of partnership approaches to wildlife management.

Further research into the shared reproductive habitat requirements of sharp-tailed grouse, waterfowl, and other prairie nesting species in the mixed grass prairies should be undertaken.

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Appendix A:

Species vegetation inventory within Daubenmire sampling fames (n = 47) at sharp-tailed grouse nesting sites on the Milk River Ridge, Warner County, Alberta. 1998 - 1999.

SHRUBS (n = 6)	MEAN	MINIMUM	MAXIMUM
Big Sage Brush *(Artemesia cana)*	0.05	0	10
Buckbrush *(Symphoricarpos occidentalis)*	24.91	0	100
Choke Cherry *(Prunus virginiana)*	1.74	0	90
Prairie Rose *(Rosa arkansana)*	8.48	0	95
Northern Gooseberry *(Ribes oxyacanthoides)*	0.18	0	17
Saskatoon/Servicberry *(Amelanchier alnifolia)*	1.52	0	90
FORBS (n = 45)			
American Vetch *(Vicia americana)*	0.21	0	9
Arnica *(Arnica fulgens)*	0.19	0	12
Ascending Purple Milk Vetch *(Astragalus striatus)*	0.37	0	28
Bastard Toadflax *(Comandra umbellata)*	0.01	0	2
Bladder Campion *(Silene vulgaris)*	0.02	0	4
Bluebell *(Campanula rotundifolia)*	0.02	0	3
Blue Burr *(Lappula echinata)*	0.44	0	28
Broomweed *(Gutierrezia sarothrae)*	0.03	0	3
Buffalo Bean *(Thermopsis rhombifolia)*	3.44	0	48
Canada Thistle *(Cirsium arvense)*	0.76	0	44
Common Dandelion *(Taraxacum officnale)*	1.52	0	33
Common Nettle *(Urtica dioica)*	0.11	0	15

Appendix A continued.

Common Yarrow *(Achillea millefolium)*	1.52	0	32
Cut-leaved Anenome *(Anenome multifida)*	1.38	0	41
Death Camas *(Zigadenus venenosus)*	0.06	0	12
Gaillardia *(Gaillardia aristata)*	0.04	0	7
Goatsbeard *(Tragopogon dubius)*	0.84	0	15
Golden Aster *(Chrysopsis villosa)*	0.08	0	15
Goldenrod *(Solidgo decumbens)*	0.14	0	10
Graceful Cinguefoil *(Potentilla pensylvanica)*	0.36	0	30
Meadow Rue *(Thalictrum spp.)*	0.02	0	2
Moss Phlox *(Phlox hoodi)*	0.02	0	3
Mouse-eared Chickweed *(Cerastium arvense)*	0.10	0	7
Narrow-leaved Puccoon *(Lithospermum incisum)*	0.43	0	43
Narrow-leaved Milk Vetch *(Astragalus pectinatus)*	0.20	0	38
Nodding Onion *(Allium cernuum)*	0.01	0	2
Northern Bedstraw *(Galium boreale)*	3.25	0	38
Pasture Sage (Artemisia frigida)	0.62	0	18
Prairie Crocus *(Anemone patens)*	0.26	0	37
Prairie Sage *(Artemisia ludoviciana)*	3.00	0	64
Rock Cress *(Arabis spp.)*	0.01	0	2
Shooting Star *(Dodecatheon conjungens)*	0.17	0	19
Showy Locoweed *(Oxytropis splendens)*	0.13	0	24
Silky Perennial Lupine *(Lupinus sericeus)*	6.56	0	50
	0.20	0	10

Appendix A continued.

Slender Blue beard tongue *(Penstemon procerus)*			
Smartweed *(Polygonum spp.)*	0.04	0	8
Star-Flowered False Solomon's-Seal *(Smilacina stellata)*	0.22	0	17
Sticky Purple Geranium *(Geranium viscosissimum)*	1.51	0	34
Three-flowered Avens *(Geum triflorum)*	0.47	0	27
Tufted White Prairie Aster *(Aster ericoides)*	0.00	0	0
Wild Licorice *(Glycyrrhiza lepidota)*	0.06	0	12
Wild Strawberry *(Frageria virginiana)*	0.08	0	9
Yellow Paint Brush *(Castilleja lutescens)*	0.53	0	21
Increaser Forb	1.44	0	37
GRASSES (n = 18)			
Awned Wheat Grass *(Agropyron subsecundum)*	1.01	0	32
Blue Grama *(Bouteloua gracilis)*	0.11	0	15
Brome *(Bromus spp.)*	1.00	0	28
Foothill's Rough Fescue *(Festuca campestris)*	0.72	0	38
Green Needle Grass *(Stipa viridula)*	1.73	0	31
Hooker's Oat Grass *(Helichtotrichon hookeri)*	0.23	0	21
Idaho Fescue *(Festuca idahoensis)*	5.20	0	58
Junegrass *(Koeleria macrantha)*	0.47	0	23
Kentucky Bluegrass *(Poa pratensis)*	9.07	0	68
Needle and Thread Grass *(Stipa comata)*	0.20	0	7
Northern Wheat Grass *(Agropyron dasystachyum)*	5.44	0	45
Reed Canary Grass *(Phalaris arundinacea)*	0.04	0	8

Appendix A continued.

Rush *(Juncus spp.)*	**0.89**	**0**	**29**
Sandberg's Bluegrass (Poa sandbergii)	**0.01**	**0**	**2**
Sedge (*Carex* spp.)	**3.51**	**0**	**28**
Tickle Grass *(Agrostis scabra)*	**0.08**	**0**	**15**
Western Porcupine Grass *(Stipa curteseta)*	**1.63**	**0**	**29**
Western Wheat Grass *(Agropyron smithii)*	**0.88**	**0**	**41**

TOTAL SPECIES = 69

Appendix B:

Species vegetation inventory within Daubenmire sampling frames (n = 47) at randomly located sites on the Milk River Ridge, Warner County, Alberta. 1998 - 1999.

SHRUBS (n = 4)	MEAN	MINIMUM	MAXIMUM
Big Sage Brush *(Artemesia cana)*	0.43	0	80
Buckbrush *(Symphoricarpos occidentalis)*	8.60	0	85
Choke Cherry *(Prunus virginiana)*	0.07	0	10
Prairie Rose *(Rosa arkansana)*	2.42	0	53
FORBS (n = 48)			
Allum Root *(Heuchera richardsonii)*	0.06	0	11
American Vetch *(Vicia americana)*	0.84	0	21
Arnica *(Arnica fulgens)*	0.15	0	15
Ascending Purple Milk Vetch *(Astragalus striatus)*	0.71	0	24
Bastard Toadflax *(Comandra umbellata)*	0.61	0	19
Bluebell *(Campanula rotundifolia)*	0.03	0	5
Blue Burr *(Lappula echinata)*	0.23	0	24
Broomweed *(Gutierrezia sarothrae)*	0.44	0	37
Buffalo Bean *(Thermopsis rhombifolia)*	4.68	0	46
Canada Thistle *(Cirsium arvense)*	0.41	0	30
Common Dandelion *(Taraxacum officnale)*	1.12	0	30
Common Nettle *(Urtica dioica)*	0.15	0	10
Common Plantain *(Plantago major)*	0.06	0	12
Common Yarrow *(Achillea millefolium)*	0.90	0	24

Appendix B continued.

Cut-leaved Anenome *(Anenome multifida)*	1.20	0	37
Dotted Blazing Sar *(Liatris puncatata)*	0.09	0	16
Flixweed *(Descurainia sophia)*	0.07	0	11
Gaillardia *(Gaillardia aristata)*	0.14	0	8
Goats Beard *(Tragopogon dubius)*	0.11	0	10
Golden Aster *(Chrysopsis villosa)*	0.56	0	41
Goldenrod *(Solidgo decumbens)*	0.54	0	39
Graceful Cinguefoil *(Potentilla pensylvanica)*	0.07	0	9
Lambs Quarters *(Chenopodium album)*	0.05	0	10
Meadow Rue *(Thalictrum spp.)*	0.02	0	3
Moss Phlox *(Phlox hoodi)*	0.18	0	14
Mouse-eared Chickweed *(Cerastium arvense)*	0.01	0	2
Narrow-leaved Milk vetch *(Astragalus pectinatus)*	0.45	0	37
Narrow-leaved Puccoon *(Lithospermum incisum)*	0.33	0	33
Nodding Onion *(Allium cemuum)*	0.08	0	5
Northem Bedstraw *(Galium boreale)*	3.05	0	62
Pasture Sage (Artemisia frigida)	4.46	0	45
Prairie Crocus *(Anemone patens)*	2.09	0	78
Praire Groundsel *(Senecio canus)*	0.03	0	6
Prairie Sage *(Artemisia ludoviciana)*	1.46	0	40
Pussy Toes *(Antennaria parvifolia)*	0.03	0	6
Shooting Star *(Dodecatheon conjungens)*	0.63	0	21
	3.68	0	56

Appendix B continued.

Silky Perennial Lupine *(Lupinus sericeus)*			
Slender Blue beard tongue *(Penstemon procerus)*	0.13	0	14
Smartweed *(Polygonum spp.)*	0.32	0	27
Smooth Aster *(Aster laevis)*	0.27	0	18
Sticky Purple Geranium *(Geranium viscosissimum)*	1.27	0	30
Star-Flowered False Solomon's-Seal *(Smilacina stellata)*	0.10	0	18
Three-flowered Avens *(Geum triflorum)*	0.56	0	22
Tufted White Prairie Aster *(Aster ericoides)*	0.15	0	18
Viscid Locoweed *(Oxytropis viscida)*	0.14	0	26
Western Dock *(Rumex occidentalis)*	0.47	0	70
Yellow Paint Brush *(Castilleja lutescens)*	0.38	0	18
Increaser Forb	2.54	0	57
<u>GRASSES (n = 20)</u>			
Awned Wheat Grass *(Agropyron subsecundum)*	0.60	0	23
Blue Grama *(Bouteloua gracilis)*	0.29	0	13
Brome *(Bromus spp.)*	0.82	0	22
Foothill's Rough Fescue *(Festuca campestris)*	0.41	0	36
Foxtail Barley *(Hordeum jubatum)*	0.57	0	47
Green Needle Grass *(Stipa viridula)*	0.91	0	44
Hooker's Oat Grass *(Helichtotrichon hookeri)*	0.86	0	25
Idaho Fescue *(Festuca idahoensis)*	14.51	0	60
Junegrass *(Koeleria macrantha)*	0.68	0	15
Kentucky Bluegrass *(Poa pratensis)*	6.39	0	70

Appendix B continued.

Needle and Thread Grass *(Stipa comata)*	2.64	0	28
Northern Wheat Grass *(Agropyron dasystachyum)*	11.43	0	69
Reed Canary Grass *(Phalaris arundinacea)*	0.20	0	18
Rush *(Juncus spp.)*	1.99	0	100
Sandberg's Bluegrass (Poa sandbergii)	0.04	0	8
Sedge (*Carex* spp.)	6.21	0	100
Slough Grass *(Beckmannia syzigachne)*	0.08	0	15
Timothy *(Phleum pratense)*	0.41	0	24
Western Porcupine Grass *(Stipa curteseta)*	1.51	0	31
Western Wheat Grass *(Agropyron smithii)*	1.70	0	55

Total Species = 72