Assessment of Managed Grazing Systems for Productivity and Abundance in Non-Game Birds

By

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ABSTRACT

A primary objective of the North American Waterfowl Management plan is to encourage multipurpose programs that will provide long-term benefits to waterfowl and many other species while at the same time permitting some agricultural return. The purpose of this study was to evaluate one of these extensive programs, managed grazing systems, and its ability to increase the productivity and abundance of grassland non-game birds. Managed grazing systems are believed to simulate effects of periodic grazing by bison, and could potentially provide substantial benefits to both game and non-game birds. Twenty and seventeen managed grazing systems sites were monitored for two field seasons, (1995, 1996), respectively, and compared with 18 (1996) and 17(1995) continuous or season-long grazing sites. Study plots were evaluated to compare non-game bird species abundance, richness, and productivity for any differences between the two grazing regimes. Circular plots with a 100-m radius were used in both treatment and control sites. Vegetation physiognomy was evaluated to determine the influence on species abundance and productivity. Emphasis was also placed on the management of each system and whether a particular landowner's method of management was conducive to increasing vegetation cover.

Results indicate that managed grazing does not increase non-game bird species abundance or species richness. Average non-game species productivity for managed grazing systems did not differ from season-long grazing systems in 1995, but in 1996 significant differences in non-game bird productivity were detected. Some vegetative differences in percent bare soil, vegetation height and grass to forb ratios were noted between season-long and managed grazing. Finally, there was a large difference in non-game species abundance and productivity between the two field seasons.

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1.0 INTRODUCTION

1.1 Preamble

The North American Waterfowl Management Plan represents a continental agreement between Canada, the United States and Mexico to design and support programs aimed at promoting wetland ecosystem and waterfowl population restoration and management (NAWMP 1994). The Plan recognized that loss of habitat is one of the major migratory bird management problems currently facing North Americans. Solutions require the cooperation and participation of private landowners to incorporate sustainable integrated agricultural practises that promotes habitat improvements on those lands. The intent is to ensure that there is a sufficient habitat base to maintain endemic grassland bird populations (NAWMP 1994). It is hoped that the application of such practises will provide effective, long-term benefits to the conservation of biological diversity and the overall environmental integrity of the prairie ecosystem (NAWMP 1994).

1.2 Background

Initially, the NAWMP considered principally waterfowl. Waterfowl have considerable social, cultural, and economic benefit to millions of North Americans. For example, in the United States, over three million migratory bird hunters spent more than $700 million in 1991 and, in that year, more than 76 million people spent $18 billion participating in non-consumptive wildlife recreation (NAWMP 1994). In 1991, 90% of the Canadian population participated in a wide range of fish- and wildlife-related activities. The economic stimulus provided by fish and wildlife contributes over $12 billion to Canada's economy each year and sustains more than one-quarter of a million jobs (NAWMP 1994). By the early 1990s, the NAWMP began to receive criticism for being a "ducks-only" plan. This, in fact, was not true, because most of the habitat programs being undertaken should benefit not only waterfowl but many other species as well (PHJV undated). This argument, however, was questioned by opponents who asked for proof of benefits to other species. Thus, the concept of sustaining biodiversity through habitat alterations became a primary goal of NAWMP (1994). The Plan now recognizes that a vast array of migratory aquatic and upland nesting birds have similar ecological requirements, and that they contribute to the biodiversity of wetland and upland ecosystems (NAWMP 1994).

To transform the NAWMP goals into reality, a thorough knowledge of regional environments is required. This is best achieved through the NAWMP Habitat Joint Ventures. These function on a regional level as the principal vehicle to incorporate broad population goals and habitat objectives (NAWMP 1994). The Prairie Habitat Joint Venture (PHJV), which covers the most productive waterfowl breeding habitat in North America, is within Manitoba, Saskatchewan, and Alberta. The PHJV program has recognized that the prairie region' s wildlife, including waterfowl, are primarily threatened by loss of critical breeding habitat due to the destruction and drainage of wetlands and the alteration of uplands for agricultural, urban, and transportation purposes (NAWMP 1994).

A central component of the PHJV program is the desire to promote large-scale landscape changes through modifications of management practises on agricultural lands. Habitat goals focus on implementing an ecosystem-based approach that includes setting population or habitat goals for a variety of avian species, including non-game birds. These goals are to be accomplished by determining the value of various habitat types formed under PHJV programs and by characterizing the avian communities represented in these habitat areas (Prescott et al. 1995).

Strategies to meet habitat goals focus on encouraging sound soil and water conservation practises on private lands that will produce economic benefits to the owner, as well as societal benefits and the enhancement and sustainability of wildlife populations (NAWMP 1994). The PHJV program incorporates both intensive and extensive programs. Intensive management programs are exclusively wildlife oriented (PHJV undated). Programs such as dense nesting cover (DNC) and production and maintenance of nesting structures are site-specific, costly, and labour-intensive (PHJV undated). These programs are, however, believed to be generally successful, and can be accomplished relatively quickly (PHJV undated).

Extensive programs involve more complex management activities. They are multiple-use oriented and require landowner cooperation and education. The extensive program goal is to provide long-term benefits to both wildlife and the landowner. It is expected to deliver sound conservation practises that will, eventually, be self-supporting (PHJV undated).

One of the extensive agricultural habitat enhancement activities employed by NAWMP in the upland regions is managed grazing systems. Managed grazing is a rotational grazing practise formed by subdividing a landowner's pasture into smaller pasture units and then grazing these units in a planned sequence. It is believed that animals are forced to graze more evenly due to their confinement in smaller areas (NAWMP 1992).

Managed grazing requires the cooperation of the landowners and the communication of current research results describing the potential benefits to landowners should they participate in managed grazing programs. The benefits to the landowner may include increased livestock carrying capability, better-quality forage, and higher beef or milk production due to the higher quality forage (NAWMP 1992). Managed grazing has been beneficial as a management strategy to most game bird species since it provides pastures free from disturbance during nesting and other critical seasons (staging, etc.) (Holechek et al. 1982), and retains significantly more residual grass cover when compared with season-long grazing (Manske 1994b). Other findings indicate that this management tool provides increased nesting cover, controls erosion, and provides higher water quality for wetland complexes found within the grazing area (NAWMP 1992). Previous research has suggested that there are variable benefits for wildlife associated with managed grazing. For species such as Baird's sparrow (*Ammodramus bairdii*), savannah sparrow (*Passerculus sandwichensis*), and clay-colored sparrow (*Spizella pallida*), managed grazing is thought to be an effective management tool (Berkey et al. 1993). Berkey et al 's (1993) study considered managed grazing to be detrimental to other species such as the chestnut-collared longspur (*Calcarius ornatus*) and horned lark (*Eremophila alpestris)* when compared with conventional or season-long grazing. However, Berkey et al. (1993) concluded that as a result of the abundance of continuously grazed areas that persist, these species should not be significantly affected.

To quantify the quality of habitat created under the PHJV program, it is necessary to evaluate its attractiveness by using species richness and abundance indices and measuring the productivity of birds selecting the habitat (Dale 1994). Thus, the objective of this project is to determine whether non-game bird richness, abundance and productivity are increased in NAWMP managed grazing systems when compared with continuously grazed paddocks.

1.3 Problem Statement

The problem seems multifaceted. The underlying assumption of NAWMP is that the key to maintaining and improving biodiversity is habitat. Administrators of the Plan are anticipating spending more than 1.5 billion dollars continentally, with two-thirds of the money being spent in Canada, to achieve habitat requirements to meet wildlife population goals. For example more than 700,000 dollars has been spent to date, on implementing managed grazing systems in the Canadian Prairie Biome (Prescott et al. 1995).

Previous studies of the effects of habitat enhancement programs for waterfowl and non-game birds conducted throughout North America have produced inconclusive results regarding the potential benefits to avifauna (Braun et al. 1978; Holechek et al. 1982, Knopf 1985; Hartley 1994). These results suggest that there is a need to evaluate each individual conservation program and determine its effectiveness in creating and maintaining species diversity and richness, especially for non-game birds in the Canadian Prairie Biome. Particular attention should be focused on obtaining a clear evaluation of managed grazing system productivity versus the season-long grazing system productivity, which has not previously been done in Manitoba.

1.4 Research Objectives

Specific objectives include an evaluation of both season-long grazing and managed grazing systems to:

1) Compare avian species richness between managed grazing and season-long grazing sites.
2) Compare species abundance in both managed grazing and season-long grazing sites.
3) Quantify individual avian species productivity.
4) Determine the cumulative productivity of common bird species found in managed grazing and season-long grazing sites.
5) Determine whether habitat differences exist between the grazing regimes in terms of vegetative height, plant physiognomy, and incidence of bare soil.
6) Provide recommendations for future research on non-game birds species abundance, richness, and productivity.

1.5 Research Delimitations

This study examines the effects of managed grazing on non-game birds' abundance and productivity during a two-year period. Considerable annual variation of confounding factors such as the spring flooding in 1995, below normal spring temperatures in 1996, above average summer temperatures in 1995 and high annual precipitation levels may have influenced some of the results of the study. Confounding factors are further discussed in section 5.2 (p.80). Study plots were dependant on landowner cooperation and landowner management of the respective grazing regimes. I recognize that these are legitimate research constraints and I have attempted to minimize these biases wherever possible.

2.0 LITERATURE REVIEW

2.1 Declining Trends in Avian Populations

The recognition of habitat loss as one of the major sources of migratory bird management problems has considerable implications for any conservation program. According to Robbins et al. (1993), endemic grassland bird species have declined more than any other groups of animals in North America. Endemic species breed in North American grasslands and overwinter on the continent and are, therefore, influenced by a variety of landscape changes (Kantrud 1981). Habitat loss has occurred through large-scale alterations of wetlands and uplands by agricultural, urbanization and industrial activities (NAWMP 1994). These activities have resulted in reductions in nesting, feeding and roosting cover, and declines in the quality of migratory and overwintering habitat. These factors have probably contributed to declines in populations of waterfowl, upland and grassland species. As the 1990-1991 Breeding Bird Survey (BBS) indicated, grassland nesting birds have the highest rate of decline of any group of North American species (Peterjohn and Sauer 1993).

Many recent bird population declines involve species that were not previously in jeopardy. A recent Breeding Bird Survey (1990-1991) suggests that bobolinks (*Dolichonyx oryzivorus)*, and savannah sparrows (which were not declining in the 1960's and 1970's) are now in decline (Robbins et al. 1993). These recent population trends may be symptomatic of greater changes yet to come (Robbins et al. 1993). It has been stated that the trend toward continuing declines must be retarded to ensure population stability. This can be achieved primarily through the prevention of future landscape degradation (Robbins et al. 1993).

2.2 Current Efforts to Restore Non-Game Bird Populations

The 1994 NAWMP update (NAWMP 1994) acknowledged that waterfowl populations are only one part of the complex avian community supported by wetlands and their associated uplands. It is believed that agriculture is the biggest factor contributing to the loss of biodiversity in Canada (State of the Environment Report (SOE) 1991). Agricultural practises such as clearing forests, crop cultivation, draining of wetlands, and continued use of chemical fertilizers, insecticides and herbicides are responsible for the dramatic reduction in numbers and range of some wildlife species and the introduction of new species (SOE 1991).

In response to the impacts of agricultural practises, NAWMP has instituted a number of different programs as previously described in the Introduction. The Plan has recognized that both public and private lands must be involved to create long- term differences in habitat quality and quantity. It targets the overall improvement of biodiversity at a "gamma level." Gamma diversity refers to landscape levels of species diversity (Whittaker 1991). Pielou (1992) suggests that the most desirable measure of gamma diversity reflects species richness, habitat diversity, and the degree of isolation of species populations. In this study "biodiversity " is defined based on birds communities. The value of habitats to other animals are likely to be different, and may require further research (Prescott and Arbuckle 1995).

One aspect of NAWMP is to assess the effects of existing habitat on non-game birds. This is to ensure that the benefits of waterfowl enhancement programs either aid the endemic birds, or in the very least, do not negatively impact them (Dale 1992). However, a limited number of studies have used control sites for concurrent comparisons and evaluations with enhancement programs. It is difficult to assess the effects of an enhancement program without comparing it with the existing agricultural practise that can function as a baseline.

2.3 Habitat Use by Non-Game Birds

Over 150 species, primarily breeding passerines, are associated with terrestrial upland habitats, and are inconspicuous because of their small size and habitats (Poston et al. 1990). The most serious impact affecting these species is the incremental loss of breeding habitat (NAWMP 1994). Endemic grassland species that are dependant upon the prairie provinces for major portions of their breeding range are of greatest concern. Primary endemic species such as LeConte's sparrow, sharp-tailed sparrow (*Ammodramus caudacutus*) and clay-colored sparrow have more than 50% of their breeding distribution within the prairie provinces (Poston et al.1990). Habitat loss as a result of cultivation and agricultural development to these species, can have serious impacts on their survival. Therefore, special attention to the habitat needs of primary endemic species should be included whenever habitat enhancement programs are being considered. Enhancement programs should consider creating a patchwork of different vegetation conditions on a local scale, that provide habitat for a broad range of species (Ryan 1986). Habitat patches created in enhancement programs should be large enough to satisfy the minimum-area requirements of endemic grassland species (Graul 1980). Wiens and Dyer (1975) suggest this minimum size to be at least 1-2 km^2. Smaller pastures could be managed as a single habitat type, whereas larger paddocks could be grazed to provide a "continuum" of habitat types (Renken and Dinsmore 1987). The continuum of habitat types would include a range of vegetation height, density, and plant species composition within the pastures.

Previous research has indicated that most grassland birds were sensitive to changes in vegetation structure and composition, and that pastures with diverse vegetation gradients (ranging from short and sparse, to tall and dense) supported virtually distinct avian communities (Prescott and Murphy 1996). Rangelands have the potential to provide breeding habitat for species with vastly different habitat requirements because small changes in vegetation that may result from different grazing patterns, can have dramatic impacts on community structure. This may be further confounded by the tendency for different grassland bird species to respond differently to grazing treatments (Holechek et al 1987). Management techniques such as managed grazing systems may help to create a mosaic of habitat that provides suitable habitat for a wide variety of breeding grassland birds and may help to maximize biodiversity at the landscape level (Ryan 1986).

Subdividing a pasture may result in a diverse array of micro-habitats that could, for example, provide LeContes sparrows with tall, dense grass in close proximity to wetlands, while at the same time providing vesper, savannah and clay-colored sparrows habitat that fulfills their breeding requirements. Lightly grazed areas can be beneficial to vesper sparrows because of their preference for short dense ground cover (Reed 1984). Clay-coloured sparrows are generally associated with shrubby habitats and are tolerant to grazing (Dale 1983). Both vesper sparrows and clay-colored sparrows have broad habitat niches and moderate grazing should not affect the productivity or abundance of these species (Prescott and Wagner 1996)

2.4 Historic Context of Managed Grazing

Managed grazing as a range management practise has been used as a means to redistribute livestock seasonally and to reduce grazing in a particular area. In season-long grazing systems the most palatable plant species tend to be grazed and re-grazed by livestock at the same growth stages year after year (Manske 1996b). The repetitive selection of these preferred plants by livestock favours growth of plant species that are less palatable and provides them with unique competitive advantages over the preferred plants (Manske 1996b). While not detracting from the primary objective of beef forage production, managed grazing systems are thought to mimic the historic grazing patterns of bison (*Bison bison)* and other ungulates. Historically, bison herds moved around unrestricted, and any given area of the prairies was not subjected to the same intense, sustained grazing pressures for as long of a duration (Dobkin 1994). Rather, prairie ungulates would overgraze arease of the grassland, browse shrubs and destroy trees by rubbing and trampling (Bird 1961). This left the landscape in a mosaic of micro-habitats, ranging from areas or regions grazed down to the soil, and to other regions that were completely ungrazed (Berkey et al. 1994), and retarded the sucession to forest (Bird 1961).

A secondary effect of expanded livestock grazing since the late 1800s has been the reduction of frequency and intensity of fires. This has allowed the invasion of shrubs and woody plants, which have altered the prairie ecosystem (Dobkin 1994). The introduction of tall, woody vegetation into the prairie landscape has resulted in displacement and, occasionally, direct loss of many prairie plant species. The change in landscape has also affected surrounding bird communities although not to the same level as agricultural practises such as crop cultivation, wetland draining, land clearing (NAWMP 1994). An increase in woody plants and shrubs results in a corresponding increase in woodland edge species. In such a scenario, it is the endemic grassland birds that suffer from these successional changes (Berkey et al. 1994).

2.5 Managed Grazing Defined

As stated previously, managed grazing is a rotational grazing practise formed by subdividing a landowner's pasture into smaller units and then grazing each unit in a planned sequence. By subdividing the pastures into smaller paddocks it is believed that animals will be forced to graze more evenly due to their confinement into smaller areas, while leaving other areas free of disturbance (NAWMP 1992). Managed Grazing Systems are part of the extensive management enhancement programs initiated by NAWMP. Landowners sign an agreement with a PHJV administering body that dictates when they can put their cattle out, how long cattle can remain in the pasture and, in some instances, when certain paddocks may be grazed.

Savoury (1988) claims that managed grazing systems can shift vegetation botanical composition of rangelands toward a more palatable, more nutritious, more successionally advanced, climatically resilient plant community. When compared with season-long grazing, it is claimed that managed grazing systems produces increased forb abundance, increased residual grass cover, erosion control, and increased water quality for wetland complexes within the grazed area (Berkey et al. 1994). The greater diversity of cover is in turn, attractive to nesting birds. Moderately grazed meadows have been found to be more attractive to some upland birds (Holechek et al. 1982).

Bryant (1982) reported that managed grazing systems generally had fewer impacts on wildlife habitat when compared with continuous or season-long grazing. However the establishment of a grazing system, does not guarantee benefits to wildlife. For example, Van Poolen and Lacey (1979) found that herbaceous response was greater with changes in stocking rates rather than with implementation of a grazing system. However, most of these studies have been done outside the Canadian parklands, and Manitoba,and there is little information regarding the effects of managed grazing practises on non-game bird species that would apply to this study area.

There are many different forms of managed grazing, and each system claims to produce better quality habitat for wildlife. The present study examined two methods: deferred managed grazing and twice-over rotational grazing.

2.6 Twice-Over Rotation Grazing

There is considerable debate concerning the best method of managed grazing and the effects of managed grazing on plant production (Gammon and Roberts 1978; Weltz and Wood 1986; Savory 1988; Gillen et al. 1990; Hart et al. 1993; Manske 1994b; Manske 1994c). For example, Manske (1994c) believes that twice-over rotational grazing manipulates two mechanisms that have evolved with grass plants and herbivores. The first mechanism influences numerous changes in the physiological responses within grassland plants. This mechanism can be manipulated by defoliation between the third and sixth leaf stages. A by-product of manipulating the defoliation mechanism is an increase in the number of secondary grass tillers (Manske 1994b). Secondary tillers increase total aboveground herbage biomass, which may permit subsequent increases in stocking rates and improvement in individual livestock weight performance or more abundant biomass to serve as cover for wildlife (Manske 1994c).

The second mechanism that has evolved within the dynamics of grass plants and herbivore relationships, is the herbivore's ability to influence many changes in the activity level of the symbiotic soil organisms in the rhizosphere (Manske 1994c). Defoliation between the third and sixth leaf stage can also be used to manipulate this second mechanism. An implicit result from this manipulation is the increase in nitrogen flow in the ecosystem (Manske et al.1988).

Manipulation of these two mechanisms by grazing results in increased basal cover (plant density), increased aboveground herbage biomass, and reduces the frequency and size of bare soil areas (Manske 1994b).

Inherent in any managed grazing system is the active participation of the landowners. They are required to identify when the grass plant is in the third and sixth leaf stage, and ensure that all the grazing paddocks are stimulated within the critical 45 day period needed for new or grazed grasses to mature to the sixth leaf stage. (Manske 1994b).

However, there is a large school of thought that dictates that it is stocking rates and not grazing management that influences plant cover, species composition and plant density (Hart and Balla 1982; Weltz and Wood 1986; Ruyle et al. 1988; Hart et al. 1993).

2.7 Deferred Managed Grazing Systems

Most of the managed grazing systems chosen for this study are part of a deferred managed grazing system. The idea behind deferred grazing is that grazing is delayed until a critical growth stage of the plant was passed (e.g., flowering, seed ripening) (Adams et al. 1991). It is intended to permit seed production, seedling establishment and restoration of plant vigour. The deferment from grazing is to provide an area free of disturbance by cattle during the period when nests are being initiated and early incubation in an area that has sufficient cover to attract nesting birds. Figure 1 illustrates a potential management plan for a deferred grazing regime:

The landowner decides in the fall which of his paddocks will be deferred the following grazing season, and is not permitted to graze that section after September 1 as outlined in their landowner agreement.

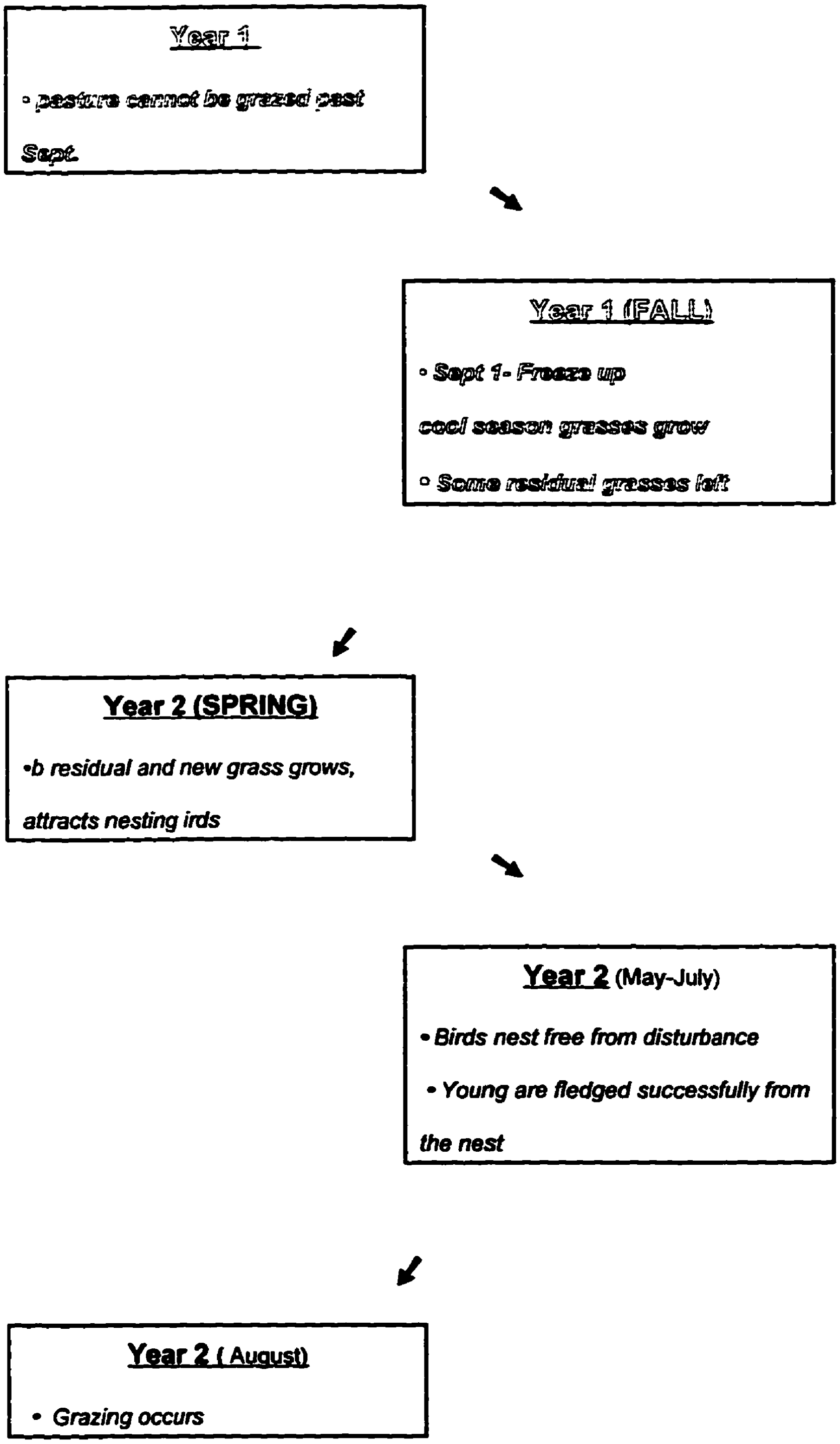

Figure 1: Deferred Managed Grazing Plan

However, there is a growing body of literature that suggests that deferred grazing, or excluding certain paddocks from early grazing, may lead to a decline in net primary productivity and to a rapid ecotypical selection toward less productive, and less grazing resistant plants (McNaughton 1985; Manske 1995b).

2.8 Effects of Livestock Grazing on the Landscape

Direct alteration of habitat by livestock can take the form of changes in plant community composition by reducing species that are palatable, increasing less palatable species, and changing vegetation structure. Generally, species richness is directly related to the structural diversity of the vegetation or plant community (Bock and Webb 1984; Knopf 1985). Wildlife species that are migratory and adaptable to a large diversity of habitats tend to be less directly impacted by livestock grazing than less mobile species that are more directly dependant on narrowly defined habitats. Species of wildlife dependent on riparian habitats are the most directly influenced by livestock grazing (Chaney et al. 1990)

Residual plant cover remaining from the previous growing season is important to breeding birds because the plant material conceals nests (Gregg et al.1994; Delong et al. 1995). In studies of waterfowl, results suggest that light or rotational grazing by livestock is preferred to moderate or heavy grazing (Gjersing 1975; Duebbert et al. 1986). Braun et al. (1978) reviewed 55 studies of the impacts of livestock grazing on waterfowl and found only one study not reporting decreased reproductive success or other detrimental effects. However, Braun's study was completed almost 20 years ago, when managed grazing was not a common habitat management or livestock production technique.

A seasonal short-duration grazing system seemed compatible with breeding densities of select migratory species (Sedgewick and Knopf 1987). Brown (1978) reported that a well-considered grazing management plan could perpetuate and even increase populations of grassland game birds by the interspersion of suitable and sizable areas of ungrazed climax grassland within pastures managed in a successional grassland stage by grazing or burning.

2.9 Creating Effective Managed Grazing Systems for Livestock and Wildlife

According to Manske (1994a) there are three major problems that need to be considered when implementing grazing management programs:

- the potential for plant growth is limited by temporal and environmental factors,
- ungrazed grasses are low in nutritional quality during the later portion of the grazing season,
- Early season grazing can negatively effect vegetation.

Short duration grazing (7-24 days in a 6 paddock systems) can increase plant tillering, produce greater aboveground herbage biomass, produce higher nutrient content, and increase exudate material in the rhizosphere (Box and Hammond 1990). This allows for subsequent increases in stocking and for improvement in individual livestock weight performance during a second grazing period after anthesis (Manske 1994b). During middle and late growth, carbon and nitrogen are distributed more evenly throughout the plant, defoliation does not remove a disproportionate amount of nitrogen, and very little or no carbon is exuded into the rhizosphere (Manske 1994b).

Effective managed grazing systems can enhance wildlife habitat by providing pastures free from disturbance, permitting increased ground cover that provides protection from predators and may enhance wetland quality by controlling the amount of livestock trampling and fecal matter in the riparian areas surrounding wetlands (Holechek et al 1982; NAWMP 1992; Berkey et al 1993; Manske 1994b).

Effective managed grazing systems from a wildlife management perspective should produce increased ground cover, create a mosaic of habitat types, preserve native rangeland and be of a sufficient size to satisfy minimum area requirements of non-game bird species (Prescott and Murphy 1990). Research by Prescott and Murphy (1996) suggest that non-game bird species richness and abundance will increase in response to increases in ground cover and plant biomass.

Grassland bird communities evolved in association with grazing and fire disturbances that created a patchwork of different vegetation communities on a local scale and provided habitat for a broad range of species on local and regional scales (Ryan 1986). Effective managed grazing systems should mimic historic disturbances in so much as they can provide a mosaic of habitat types within each of the pastures' paddocks. Wherever possible native ranges should be incorporated into managed grazing systems as research has indicated that native ranges support a greater diversity of avian species when compared with tame pastures (Prescott and Wagner 1996).

Finally, effective managed grazing systems should create habitat patches that are sufficiently large enough to satisfy the minimum-area requirements of non-game birds.

Smaller paddocks could be used as a single habitat type, and larger paddocks could provide a continuum of habitat types that can satisfy the diverse habitat requirements of non-game birds (Renken and Dinsmore 1987).

2.10 Evaluating Managed Grazing Systems

Managed grazing cannot return the prairie to its pristine state, but it can be beneficial to wildlife species and plant species. Studies have indicated that managed grazing is beneficial to sage grouse (*Centrocercus urophaisianus),* mule deer (*Odocoileus hemionus*), and elk (*Cervus elephus) (*Holechek et al. 1982).

Other research (Berkey et al. 1993) suggests that this treatment may be a favourable approach for upland nesting ducks, northern harrier(*Circus cyaneus)*, Baird's sparrow, bobolink, lark bunting (*Calamospiza melanocorys)*, Wilson's phalarope (*Phalaropus tricolor)*, grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow, and many other grassland species (Berkey et al. 1993). Studies completed on waterfowl have indicated that there is a 42% increase in breeding pairs when a managed grazing system was implemented (Mundinger 1976). However; Mundinger's (1976) study did not address whether the breeding pairs were more successful at raising their young. This is problematic because it is difficult to determine whether the birds are productive on the treatment habitat or whether they are falling prey to an artificial "ecological trap" . An ecological trap occurs when a species is attracted to a given habitat, but is unable to reproduce within the habitat (Gates and Gysel 1978). An evaluation of a project' s ability to increase biodiversity must consider more than simple abundance counts.

Without incorporating a productivity index, the success of a project cannot be determined. The calculation of a species productivity in a habitat represents the combination of its abundance and breeding success and together these two variables indicate whether a species is truly benefiting from the enhanced habitat (Dale 1993) .

Equally important in evaluating the success of any project is determining which components of a particular habitat may be attractive to a species. As stated previously, avian habitat choice and breeding success have frequently been linked to habitat structure (Wiens 1969; Ryan 1896; Dale 1993). Robbins et al. (1993) suggest that a high diversity of bird life requires a high diversity of micro-habitats with vegetation at various heights. A higher diversity of vegetation may be produced by managed grazing relative to conventional grazing. Managed grazing results in increased forb abundance, and moderately grazed meadows are more attractive to upland birds (Holechek et al. 1982).

One of the more important conclusions derived from the literature is that no single generalization can be made about the response of non-game birds to managed grazing (Dobkin 1994). All grassland types support some species that may be grazing tolerant, intolerant or dependant. For example, horned larks are known to respond favourably to areas that have been grazed , whereas savannah sparrows, Baird's sparrows, and bobolinks respond negatively to any level of livestock grazing (Dobkin 1994). The key to successful habitat management lies in the landscape manager's ability to provide a mosaic of land cover that creates a diversity of habitats for the greatest number of species that traditionally inhabit the area. Thus, the avian diversity of an ecosystem can be maintained. Managed grazing systems are but one program in a complex of management techniques being implemented by landscape managers. This study is being evaluated in isolation from these other management techniques although all of them contribute to avian abundance, richness, and productivity. Managed grazing systems, if undertaken correctly, should provide better quality forage, reduce the incidence of bare soil and promote a higher diverse and rich wildlife species population. If enhancement programs such as managed grazing are to be successful, they must examine species productivity, abundance and habitat requirements.

3.0 METHODS

3.1 Sample Area Selection

The study area was located in the rural municipalities of Shoal Lake and Strathclair (lat 100 ° / long 51°), in southwestern Manitoba. Study sites were located within the aspen parkland ecoregion. Aspen parkland is a transition zone between grassland and boreal mixed forest zone and it is within the black soil zone. It is characterized by chernozmic soils , and aspen groves that are interspersed within open grassland and shrub communities (Bird 1961). Aspen parkland contains two major plant communities, forest and grassland which are intermingled in a mosiac of irregular isolated patches (Bird 1961). Current agricultural activities within the area include livestock grazing (cattle and horse) , and mixed farming of alfalfa, canola, flax, wheat and barley.

3.1.1 Site Descriptions

Potential study sites from known livestock grazing pastures were identified by NAWMP field staff in 1995. The sites were examined using aerial photographs to identify possible sample areas. All sample areas were located within a 30-km radius of the town of Shoal Lake (Figure 2). As a result of severe flooding in the spring of 1995, it was necessary to select patches of land that were less prone to flooding, and efforts were made to include only grassland habitat. However, because of the heterogenous habitat typical of aspen parkland, many sample areas also contained wetlands, shrubs and trees. Once potential sample areas were located, landowners were approached and permission to

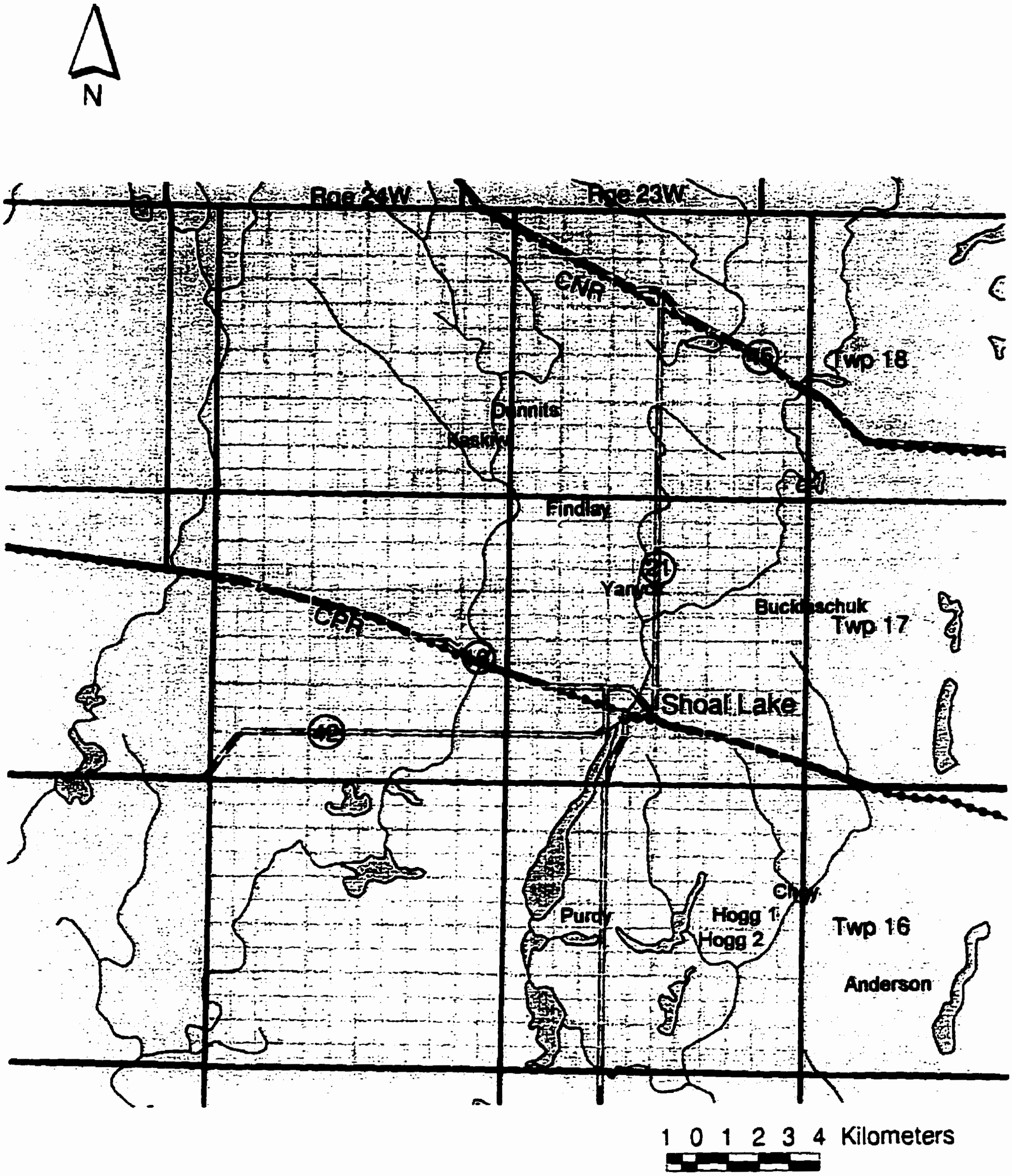

Figure 2: Site Locations for 1995 and 1996 Study Plots

within the R.M. Of Shoal Lake

conduct the project was obtained. To reduce confounding variables contributing to grazing impacts, only those landowners who raise beef cattle were considered in this project. Ground-truthing of potential study plots was also completed to ensure that all plots had similar physiognomy, and at a minimum amounts of trees, shrubs, and wetlands were consistent for both grazing systems.

The managed grazing treatment plots were chosen from those sample areas enrolled in the conservation program for four years or less. Table 1 shows managed grazing information, by landowner, location and livestock numbers. The table indicates that three out of five managed grazing landowners increased their stocking rates during the two-year study period. One landowner substantially increased cattle numbers from 35 cow/calf units to 62 cow/calf units. The stocking rate increases largely reflected the landowner's reluctance to sell cattle because of low market prices. Managed grazing landowners put their cattle out to pasture within the first two weeks of June and cattle were rotated through the paddock system until early to mid-October. Season-long or conventional grazing plots were selected for their proximity to managed grazing systems and from landowners who granted permission to access their pastures.
In 1996, only one landowner increased his stocking rates on the season-long grazing systems. Most of the season-long pastures have had similar stocking rates for the last 10 years. All season-long landowners indicated that their cattle are put out to pastures mid- to late May and are left until mid-October.

Table 1: Managed Grazing Landowner Histories
Shoal Lake, MB:

Landowner	Plot Number	Legal Descriptions	Year of Agreement	No. Cattle 1995	No. Cattle 1996
1)Hogg (2)	1, 2, 3	N 10 16 23W	1993	23 Units*	23 Units, 7 Heifers
2)Kaskiw	4, 5(95),6(95) 7(95)	SE 16 18 24W	1993	42 Units	35 Units
3)Anderson	8,9,10,11	SE 12 16 23 & SW 7 16 23	1992	72 Yearlings	80 Yearlings
4)Dunits	12,13,14,15	SE 27 18 24W	1989	80 Units	80 Units
5)Hogg (1)	16,17,18,19,20	N1/2 23 16 23	1993	35 Units	62 Units

* 1 unit = cow and calf

Table 2: Season-long Landowner Histories
Shoal Lake , MB:

Landowner	Plot number	Legal description	No. Cattle 1995	No. Cattle 1996
Bucklaschuk	1, 2, 3	SW 19 17 22W	50 Units	50 Units
Yanyck	4, 5, 6,7	33 17 23W	50 Units	50 Units
Findlay	8(95), 9	19 17 23W	60 Units	60 Units
Choy	10, 11, 12, 13	25 16 23W	120 Units 20 Heifers	200 Units
Purdy	14, 15, 16, 17, 18	17 16 23W	50 Units	50 Units

Twenty 100-m fixed-radius circular plots were used to assess managed grazing (treatment) versus season-long grazing (control), for a total of 40 sites. Managed grazing and control plots were established between May 1-18, 1995. As a result of the 1995 spring flooding, some landowners were unable to decide whether they were going to graze their cattle, or leave the pasture for hay. Two potential season-long grazing plots were never grazed and were consequently removed from the study. A further three plots were hayed before the productivity and final abundance counts were completed, but they have been incorporated into the data with some modifications. They are included in the study as conventional grazing plots because cattle had access to them throughout the grazing season. In 1996, one of the 18 remaining season-long plots was used for hay and was consequently eliminated from the study that year. Three of the 20 managed grazing plots were also used for hay and had to be removed from the 1996 data.

Dale (1994) suggested that 10 to 12 plots are sufficient to detect a 25% difference in abundance indices in grassland communities. However, the addition of trees and shrubs may complicate the observer's detection ability and increase the number of study plots required. Studies completed by Hutto et al. (1986) indicate the 100-m radius provides a standard distance that facilitates comparisons of abundance between treatment groups.

Care was taken to ensure that the physiognomy (percentage of wetlands, shrubs, native or tame pastures, etc.) of each study site was as similar as possible. The literature indicates that birds select habitats based largely on structure or physiognomy of the vegetation and not plant species composition (Whittaker 1970; Dale 1994). Detailed landowner histories were obtained to record the following:

- the number of cattle grazed each year
- length of total grazing period
- grazing sequence (if a managed grazing system)
- degree of diversity between the plots

Dale (1994) recognized the importance of ensuring that sample plots are as similar as possible, in terms of soil, moisture regime, topography and distance to source habitats. This increases confidence in attributing any detected difference to the enhancement program.

3.2 Sample Design

Once potential study sites were located, the centre of the 100-m radius was marked by a brightly painted rock to simplify relocation. The perimeters were flagged using willow twigs with a maximum of four poles for each survey plot (Hartley 1994). Wherever possible, naturally occurring landmarks (fence lines, shrubs, etc.) were used to indicate plot boundaries in order to reduce the number of artificial perches. The total number of plots found within a given quarter-section ranged from three to five. To ensure that a singing male was not counted twice, the perimeter of the study plots were separated by at least 50 m. Attempts were made to ensure that a maximum amount of grassland was included in each plot. However, avoiding the inclusion of wetlands and woodland edges was not always possible. Whenever wetlands and woodlands were included within the plot's boundaries, their presence was noted.

3.2.1 Abundance and Species Richness Indices

Avian abundance is defined as the mean number of singing males (pooling all species) that are recorded or observed, per plot, per visit. A total of three abundance censuses were completed during each field season. Data obtained from the abundance index were averaged for common species, over the total number of censuses conducted for each study site (Hartley 1994). Common species were selcted on the basis of freqency of observation within the study plots and also because these species represented a wide spectrum of habitat requirements (Renken and Dinsmore 1987). Species richness refers to the total number of species with a singing male heard at least once in each study site (Hartley 1994). Species richness data were compiled in conjunction with the abundance censuses.

Two observers were used throughout the study. Training sessions prior to the beginning of abundance counts focused on observers identifying the same species, and approximating the locations. Each observer counted singing males from the centre of the survey plot for a total of five minutes (Hutto et al. 1986). All censuses occurred between 0500 and 0800 C.D.T. (Dale 1994). On days of inclement weather (fog, wind greater than 20 km/hour, or rain) surveys were not undertaken. Each plot was surveyed in mid-May, early June and mid-July.

3.2.2 Productivity Indices

A behavioural index (Vickery et al. 1992; Dale 1992; Jones 1994) was used to determine avian productivity, or evidence of nesting behaviour. Each plot was visited for a 30-min period. Training sessions were provided prior to the initiation of productivity counts to reduce observer bias, and to ensure that field observations were consistent. The observer walked slowly throughout the area and recorded any behaviour that was evidence of nesting. Productivity was measured by tabulating all behaviour that indicated the presence of a nest (territorial singing, alarm calls, distraction displays, birds carrying food or feces, birds flushed from a nest, and/or sightings of fledglings). Different behaviour types were assigned a value ranging from 0.5 to 5.0 (Vickery et al 1992). Table 3 summarizes how reproductive behaviour was quantified.

If the observer noted the presence of a singing male during a census, they would then record the species name and location of the individual. If subsequent visits to the plots, revealed the same species in approximately the same location, the recorder would note its presence again.

Total points, based on the behavioural index (Vickery et al. 1992; Jones 1994) were tabulated following the completion of the census week. An individual species found only once in a plot achieved a maximum value of 0.5 , whereas an individual viewed at least twice on the same plot in the same location received a value of 1. A male and female of the same species, observed in the same location would achieve a value of 2. A value of 3 was given to males and/or females carrying nest building material, giving distraction displays, or flushed from a nest. Thus, it was possible for multiple pairs of the same species to be found on a given plot, with individual points being given to the observed behaviours. Once the maximum value of 5.0 was given to an identified pair and their fledglings, no further points were attributed to them. Total productivity for each plot was derived by tabulating all individual behavioural observations of birds observed.

Each study site was visited once per week from the beginning of May until mid-July. Care was taken to follow birds carrying food to their nesting area because birds use the available habitat to find food (Jones 1994). Located nests were flagged by a coloured ribbon placed a minimum of 5 m from the nest to alleviate any possible increases in predation due to the nest- monitoring practises (Ralph et al. 1993).

Table 3: Productivity Index (from : Vickery et al. 1992)

Rank	Definition
0.5	• Territorial male observed one trip
1	• Territorial male observed two trips
2	• Territorial male and female observed
3	• Pair found nest building, laying or incubating eggs, giving distraction displays
4	• Adults observed carrying food to presumed nestlings
5	• Evidence of fledgling success

Observations were made in the early morning or early evening when bird activity was prevalent (Dale 1994). Each observer completed an equal proportion of the productivity counts at each sample site, in order to reduce observer bias (Ralph et al. 1993; Dale 1994). In 1995, a total of 8 productivity counts was completed; in 1996, 10 counts were completed.

3.2.3 Vegetation Sampling

Vegetation sampling was conducted principally for physiognomy, or life-form characteristics. Wiens (1969) stated that this determines habitat suitability for birds. Vegetation sampling methods followed a combination of those outlined by Wiens (1969) and the point-centre method of Cottam et al. (1953). A transect of the 100-m radius was randomly selected and a half metre square quadrat was placed every 10-m. A visual estimate of the percent cover of shrubs, forbs, bare-ground and grass, as well as a plant species inventory was compiled. The distance to the nearest perch was also estimated in each quadrat. Study plots were sampled in late June (1995) and early July (1996). Weekly readings of vegetation height, density and life form characteristics were measured in each study plot (Robel et al. 1970) . Vegetation height is an important trait in avian habitat selection, and was measured using a modified Robel et al. (1970) pole. In 1995, vegetation height was measured concurrent to the vegetation sampling. We modified the study design in 1996, and measured the vegetative height each week. This was an attempt to document the change in vegetative cover throughout the breeding study.

3.3 Statistical Analysis

Results of abundance and productivity censuses were analysed using a multivariate ordination technique (Begon et al.1990). Ordination positions abundance and productivity censuses results in a two-dimensional ordination diagram such that sites having similar species abundance, or productivity are closer together, while dissimilar sites are placed far apart. The ordination diagram functions as a summational picture of overall community relationships. Corresponding diagrams illustrating species affinities were also produced. The ordination technique referred to as Correspondence analysis (CA) was used in this study. Abundance data for common non-game species were log-transformed to help normalize discontinuous species distribution. Productivity was not transformed as the data are a ranked index rather than simple quantitative/continuous data. Only common species were selected for inclusion in the analysis. Data outliers such as rare or infrequently occurring non-game bird species were not included to prevent them from dominating the analysis. Rare species are also chance occurrences and may not provide a reliable depiction of non-game bird species abundance or productivity. Ordination analyses were undertaken using the ORDIN SYNTAX-V. (Podani 1995). Four ordination diagrams summarizing the abundance data from 1995, 1996, and productivity data from 1995, 1996, were produced.

Multiple discriminant analysis was used to determine whether avian abundance and productivity on managed grazing regimes were significantly different from season-long grazing regimes. Abundance and productivity data from managed grazing sites and season-long grazing sites were considered separate "treatments", with different replicates in each year. Abundance and productivity in 1995 had 20 managed grazing replicates and 18 season-long grazing replicates. In 1996, both managed grazing and season-long grazing had 17 replicates. Discrimination of the study site positions in the two dimensional ordination space was tested. The method determines a 95% "confidence envelope" for each group centroid. Group discrimination is tested using a chi-squared test. Discriminant analysis was undertaken on each of the four ordination results (1995, and 1996 field data of abundance and productivity). Analysis was completed using the SYNTAX-V program ORDIN (Podani, 1995).

4.0 RESULTS

4.1 Species Richness

Species richness, the total number of species with a singing male heard or observed at least once in any one of the survey plots, averaged 13 species/ plot in 1995 and 23 species /plot in 1996 in managed grazing plots. Season-long grazing species richness averaged 14 species / plot in 1995 and 22 species/ plot in 1996. Although there is considerable year- to year- variation in species richness data, overall species richness does not differ between the two grazing regimes. A list of all bird species observed on managed grazing and season-long grazing plots is provided in appendix A.

4.2 Avian Abundance

Common avian species were those species that were most frequently observed throughout both field seasons (at least 3 times a season). Infrequently occurring species (less than 3) were not included to ensure that the data did not violate parametric statistical assumptions. Mean abundance data for the common species in 1995, and 1996 are found in Table 4.

Mean avian abundance for managed grazing in 1995 was 2.6 species per plot. In 1996, the average number of avian species per plot was 4.6. Season-long averages were 2.1 species (1995) and 4.5 species (1996).

Table 4: Mean Abundance Data for Managed Grazing and Season-Long Grazing Plots, 1995 and 1996 Field Seasons

Species	Managed Grazing		Season-Long Grazing	
	1995*	1996*	1995*	1996*
1. Clay-colored sparrow	4.2	3.2	3.8	2.5
2. LeConte's sparrow	1.3	1.9	1.6	2.1
3. Western meadowlark	1.2	3.7	1.3	4.8
4. Red-winged blackbird	2.6	8.3	0.9	6.2
5. Savannah sparrow	4.6	8.6	4.6	10.0
6. Vesper sparrow	0.5	1.8	.44	1.5
	20 plots	17 plots	18 plots	17 plots

*column numbers represent singing ♂♂/ plot/ visit

Table 4 illustrates the similarity between the mean abundance for both managed grazing and season-long grazing systems for the most common species. There were large annual fluctuations in avian species abundance between the two years; in 1995 clay-colored sparrows were slightly more abundant in both grazing regimes in 1996; in 1996 savannah sparrows were somewhat more numerous in both grazing systems and particularly in the managed grazing systems. It is difficult to determine whether this annual fluctuation represents increases in species abundance, or is the result of confounding factors such as observer bias, changes in seasonal temperatures or precipitation levels.

CA analysis ordination and discriminant analysis results were used to evaluate whether the two communities (managed grazing and season-long grazing) differed in species composition and abundance. Results for 1995 abundance data is shown in Figure 3.

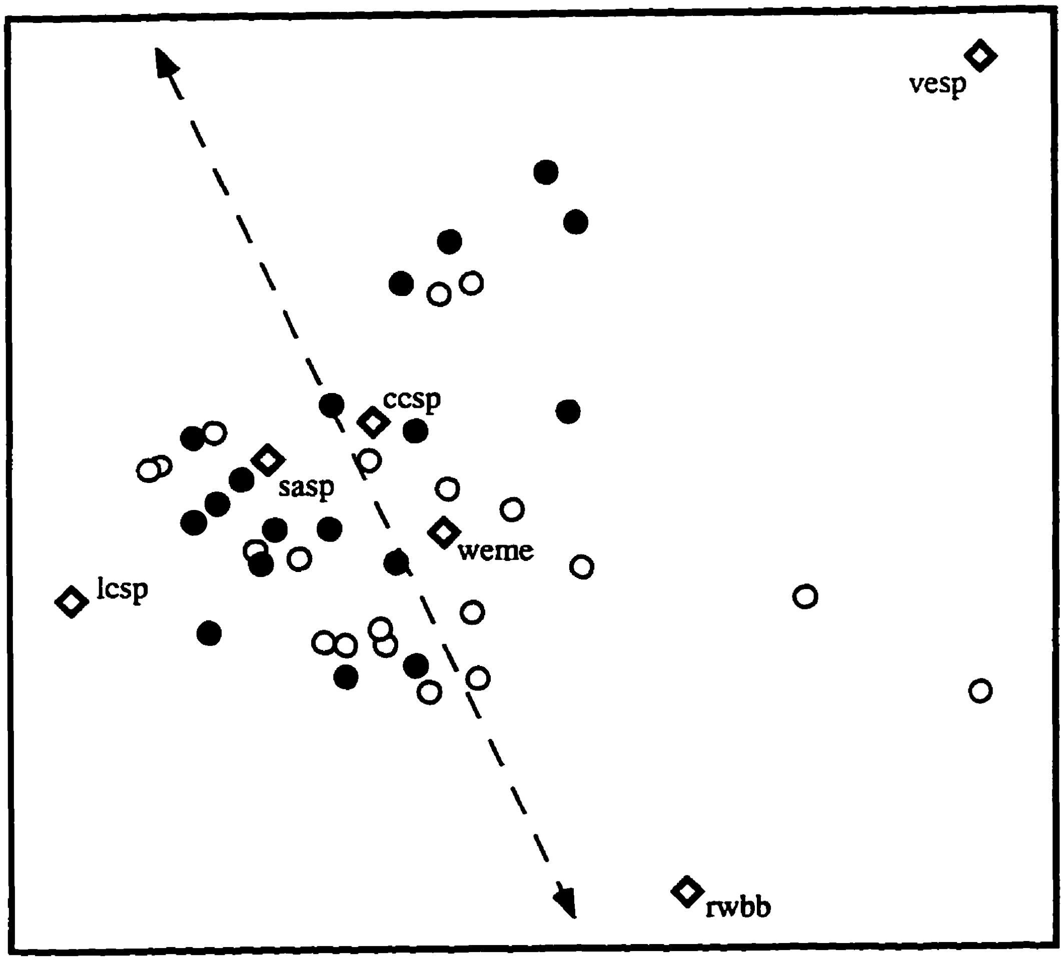

Figure 3: Correspondence Analysis Ordination (axes I and II) 1995 Abundance Data. Symbol codes: open circles = managed grazing; closed circles = season-long grazing; shaded diamonds = species. The dashed line is the discriminant axis for the two grazing systems (χ^2 =5.24, p=.073).

The 1995 data indicate that managed grazing plots are scattered throughout the two-dimensional ordination space, whereas the season-long grazing plots are clustered in the centre of the ordination axis. The most common avian species are included in figure 3 to indicate the relative composition of all the sample plots. Those plots that appear closest together on the graphs represent plots with similar species composition and relative abundance. Those plots located on the left-hand side of the axis contained a greater number of savannah sparrows and LeConte's sparrows, whereas those plots on the right-hand side had a higher proportion of vesper sparrows and red-winged blackbirds.

The discriminant axis is indicated by the dashed line separating the two grazing systems. The discriminant axis indictes whether avian abundance in managed grazing plots were significntly different than avian abundance on season-long grazing plots. Discriminant analysis for common non-game birds was not significantly different in the two grazing systems (χ^2= 5.24, df= 2, P =.073). Results of the 1995 abundance censuses indicate that managed grazing systems and season-long grazing systems scores show similar species richness and species composition.

The total mean abundance per plot for 1995 data was 14 individual singing males per plot / per visit for managed grazing systems, and 12.6 individual singing males per plot / per visit for season-long grazing. There is greater abundance variability within each grazing system than there is between the systems. For example, season-long grazing plot 6 (Yanyck) had a total abundance score of 23, whereas season-long grazing plot 2 (Bucklaschuk) had a total score of 5. This within-group variability also occurred between plots on managed grazing systems.

CA Ordination examined managed grazing plots for both species abundance and species composition relative to season-long grazing systems. The plot located on the extreme right of the axis is plot 20 which was located on Hoggs (1) managed grazing system. This plot had a mean abundance total of 9, which is below the average abundance for managed grazing systems. Most of the abundance scores for this plot was derived from red-winged blackbird observations (n=7). The plots clustered in the center of the ordination axis had the highest abundance scores; for example season-long grazing plot 6 (Yancyk) had one of the highest overall abundance scores (n=23) and this plot is located in the lower region of the ordination axis. The abundance totals for this plot were obtained from observations of clay-colored sparrows, LeConte's sparrows, western meadowlarks, and savannah sparrows. No observations of red-winged blackbirds or vesper sparrows were made.

Figure 4 depicts the results of CA ordination analysis of 1996 data. The 1996 abundance data are dispersed throughout the two-dimensional ordination axis. Considerable within-group variability also exists between plots in managed grazing systems. For example, the managed grazing plot located in the upper right-hand corner of the figure (Kaskiw, plot 4) had the highest abundance of LeConte's sparrows of all the sample plots. This plot also had the highest abundance of savannah sparrows which contradicts the 1995 trend that savannah sparrows were more abundant in season-long grazing systems. The unusual species composition of this plot is indicated by its placement on the ordination axis. The greatest abundance scores were detected on those plots located in the centre of the axis between the red-winged blackbird, savannah sparrow, and clay-colored sparrows. Managed grazing plot 1 (Hogg) and season-long grazing plot 7 (Yanyck) had abundance scores that were greater than a combined total of 40.

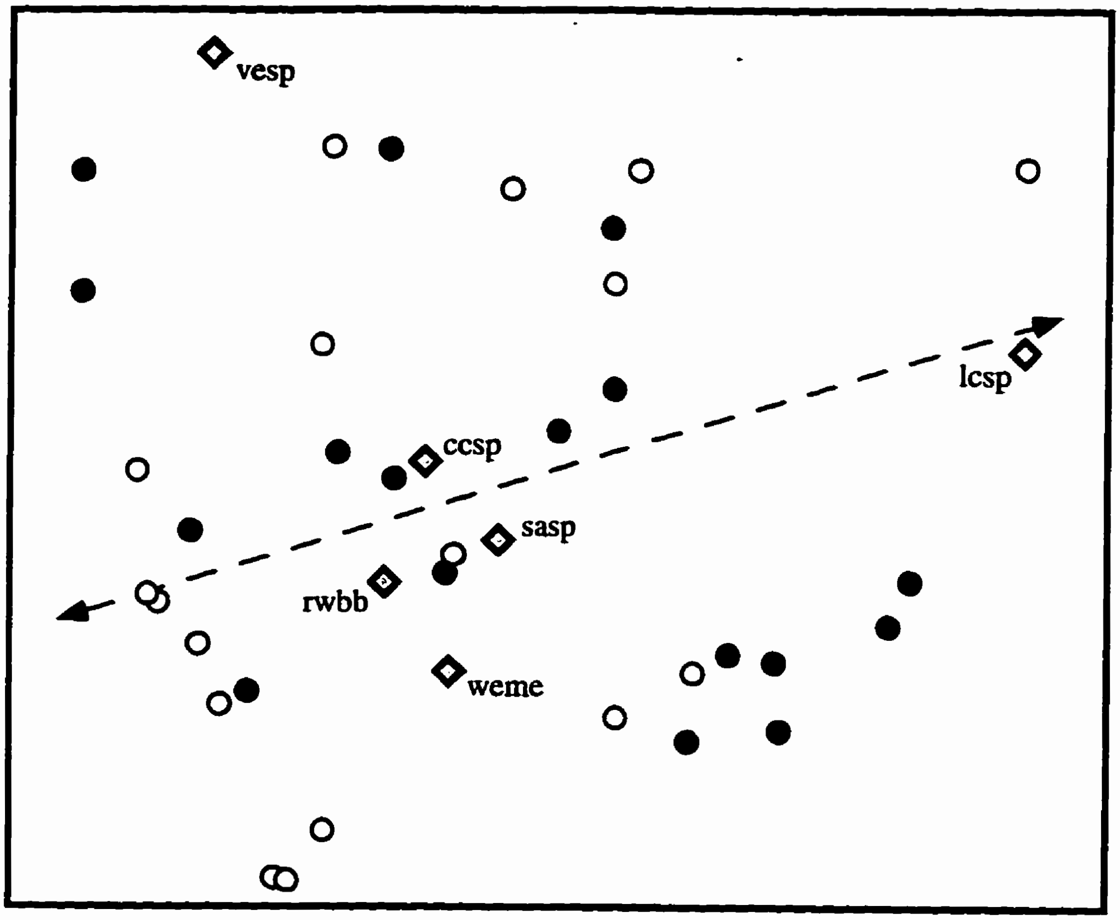

Figure 4: Correspondence Analysis Ordination (axes and II) 1996 abundance data. Symbol codes; open circles = managed grazing; closed circles = season-long grazing; shaded diamonds = species. The dashed line is The discriminant axis for the two grazing systems (χ^2=1.44, p=o.49) I

The managed grazing plot contained one of the largest populations of red-winged blackbirds and vesper sparrows whereas the season-long grazing plot contained a considerable population of western meadowlarks and savannah sparrows. The season-long grazing plot also had a large population of red-winged blackbirds. The managed grazing plot was the deferred pasture for 1996 and was composed of a brome and native pasture and the plot was productive throughout both field seasons. The season-long grazing pasture was located in a native stand that was productive in 1995.

The lowest abundance scores were noted in managed grazing plot 5 (Anderson) and 7 (Anderson) and season-long grazing plots 1 (Bucklaschuk) and 5 (Yancyk). Managed grazing plot 5 and 7 were located on Anderson's managed grazing systems. This system had a high stocking rate and livestock were rotated in a similar manner every year. The total abundance score for plot 5 was 18 and plot 7 was 19. When these totals are compared with the average abundance of 27.4 for managed grazing systems, it becomes apparent that the management regime for this site is not producing the anticipated results.

Season-long grazing plots 1(Bucklaschuk) and 5 (Yanyck) also had low abundance scores. Plot 1 had the lowest abundance score of all the sample plots. This plot is located in Bucklaschuk' s smooth brome-blue grass pasture and exhibited low abundance scores for both field seasons. Plot 5 is located on the Yanyck season-long grazing pasture. This plot had a higher than average abundance in 1995, and the low abundance score for 1996 indicating that strong annual fluctuations are occurring in this pasture.

The results of abundance scores for 1995 and 1996 indicate that there is a substantial within-group variability between plots within each grazing regime. In 1995, abundance scores range from a low of 5 (season-long plot 2) to a high of 25 (managed grazing plot 2). In 1996 abundance scores were considerably higher in all plots with the lowest scores found in season-long grazing plot 1 and the highest abundance score found in managed grazing plot 1. In sum, managed grazing abundance scores showed similar species richness and species composition when compared with season-long grazing despite the considerable differences within plots in each of the two grazing regimes. No differences between avifauna abundance or richness between the two grazing systems was detected.

Discriminant analysis of non-game abundance indicates that managed grazing systems did not differ significantly from abundance on season-long grazing plots (χ^2= 1.44, df=2, p= .49).

4.3 Species Productivity

Observations from each treatment census were summed and then compared using ordination and multiple discriminant analysis for all common species. Total productivity scores for common species for 1995 and 1996 are presented in Tables 5 and 6. Tables 5 and 6 indicate that there is little divergence between productivity scores between the most common non-game bird species recorded in managed grazing and season-long grazing systems. Paired *t*-test analysis of total productivity scores for 1995 managed grazing and season-long grazing was not significant (t=.13, p$\geq$ .90). The greatest differences by species are found in the productivity of LeConte's sparrows, western meadowlarks, savannah sparrows and red-winged blackbirds. However, it is more likely that these species keyed into particular habitat features (wetlands, shrubs, grasslands) rather than grazing systems.

Table 5: Productivity Indices Summary, 1995 Field Season

Species	Managed Grazing n = 20 plots ∗	Season-Long Grazing n = 17 plots∗
1) Clay-colored Sparrow	41.5	29
2) Western Meadowlark	24.5	14
3) Savannah Sparrow	152	164.5
4) Red-winged Blackbird	61	50
5) Yellow-headed Blackbird	18	0.5
6) Common Flicker	3	1
7) Common Snipe	1	3.5
8) LeConte's Sparrow	21	32.5
9) Vesper Sparrow	29.5	24
10) Marsh Wren	6	2.5
11) Wilson's Phalarope	3.5	5.5
12) Willet	3	3.5
13) Bobolink	18.5	18.5
Totals	382.5	349
Average	19.1	19.3

∗Scores based on Vickery et al. (1992) behavioural index

Table 6 : Productivity Indices Summary, 1996 Field Season

Species	Managed Grazing n= 17 plots*	Season-Long Grazing n= 17 plots*
1)Clay-colored Sparrow	66.5	57.0
2) Western Meadowlark	31.0	37.5
3) Savannah Sparrow	258.5	307.5
4) Red-winged Blackbird	173.0	123.0
5) Yellow-headed Blackbird	56.5	10.5
6) Common Flicker	5.5	4.5
7) LeConte's Sparrow	63.0	65.5
8) Vesper Sparrow	44.0	56.5
9) Marsh Wren	23.5	16.5
10) Sedge Wren	4.0	23.0
11) Wilson's Phalarope	7.5	0.00
12) Willet	3.5	6.0
13) Bobolink	5.0	19.5
Totals	741.5	728
Average	43.6	42.8

*Scores based on Vickery et al. (1992) behavioural index

Paired *t*-test analysis of 1996 productivity data indicates that managed grazing systems did not appear to increase overall productivity (t=.643, p$\geq$ .566). The largest difference between managed grazing systems and continuously grazed plots appears to be with wetland species. For example, yellow-headed blackbirds, marsh wrens and red-winged blackbirds achieve greater productivity with managed grazing systems. Grassland species such as bobolinks, savannah sparrows and sedge wrens were more productive on season-long grazing plots than on managed grazing plots. Average productivity or the mean of all productivity points observed using the behavioural index (Vickery et al.

1992) between the two groups was quite similar; 43.6 for managed grazing and 42.8 for season-long grazing. Paired *t*-tests were also used to assess the preference of red-winged blackbirds, clay-colored sparrows, vesper sparrows and yellow-headed blackbirds for managed grazing sites and results indicate that this preference was not significant (t=0, p=1).

Thirteen common non-game species were included in the multivariate analysis. These species were selected because they were the most frequently occurring non-game species on the plots, and because these species require a wide spectrum of habitat requirements (Renken and Dinsmore 1987). All non-game birds species observed on the plots could not be included because of the restrictions that parametric statistical analysis place on the data.

CA ordination was used to summarize the differences in productivity between species composition and richness of managed grazing and season-long grazing systems.

The 1995 data indicate that the majority of the sample plots are located in the lower left-hand corner of the two-dimensional space. Those plots with higher productivity scores are generally in the lower left corner, and those plots with lower total productivity scores are located at the outer edges of the ordination diagram. Season-long grazing plot 15 (Purdy) has the lowest productivity totals of all the sample plots . Managed grazing plot 15 (Dunits) has the second lowest total productivity, this plot also had the lowest abundance score for 1995 as well. This managed grazing plot is located in the Dunit's grazing system, which is the oldest grazing system in the study. The highest productivity scores were found in managed grazing plot 1 and season-long plot 16. The managed grazing plot is located on the Hogg 2 managed grazing system. This pasture also had one of the highest abundance scores in 1995. Productivity censuses revealed that this plot had a number of red-winged blackbirds, savannah sparrows, western meadowlarks, marsh wrens and yellow-headed blackbirds nesting and exhibiting territorial behaviour on this plot. The most productive season-long grazing plot was located on the Purdy pasture. This plot had a productivity total of 40 and contained diverse species composition of Wilson's phalaropes, savannah sparrows, LeConte's sparrows and western meadowlarks. The Purdy pasture is a sedge meadow pasture and non-game birds were productive throughout the majority of the study plots.

Figure 5 illustrates that discriminant analysis indicated that there are no statistically significantly differences in productivity scores for common non-game bird species between the two grazing systems in 1995 (χ^2=.87, df=2, p =.66). Non-game bird species productivity appears to be uniformly distributed throughout the two grazing systems. There are, however, some intra-group differences between plots located in both managed grazing and season-long grazing plots. The two plots located on the outer edges of the two dimensional space indicate that their species composition and productivity are highly variable when compared with other plots located toward the centre of the the ordination diagram.

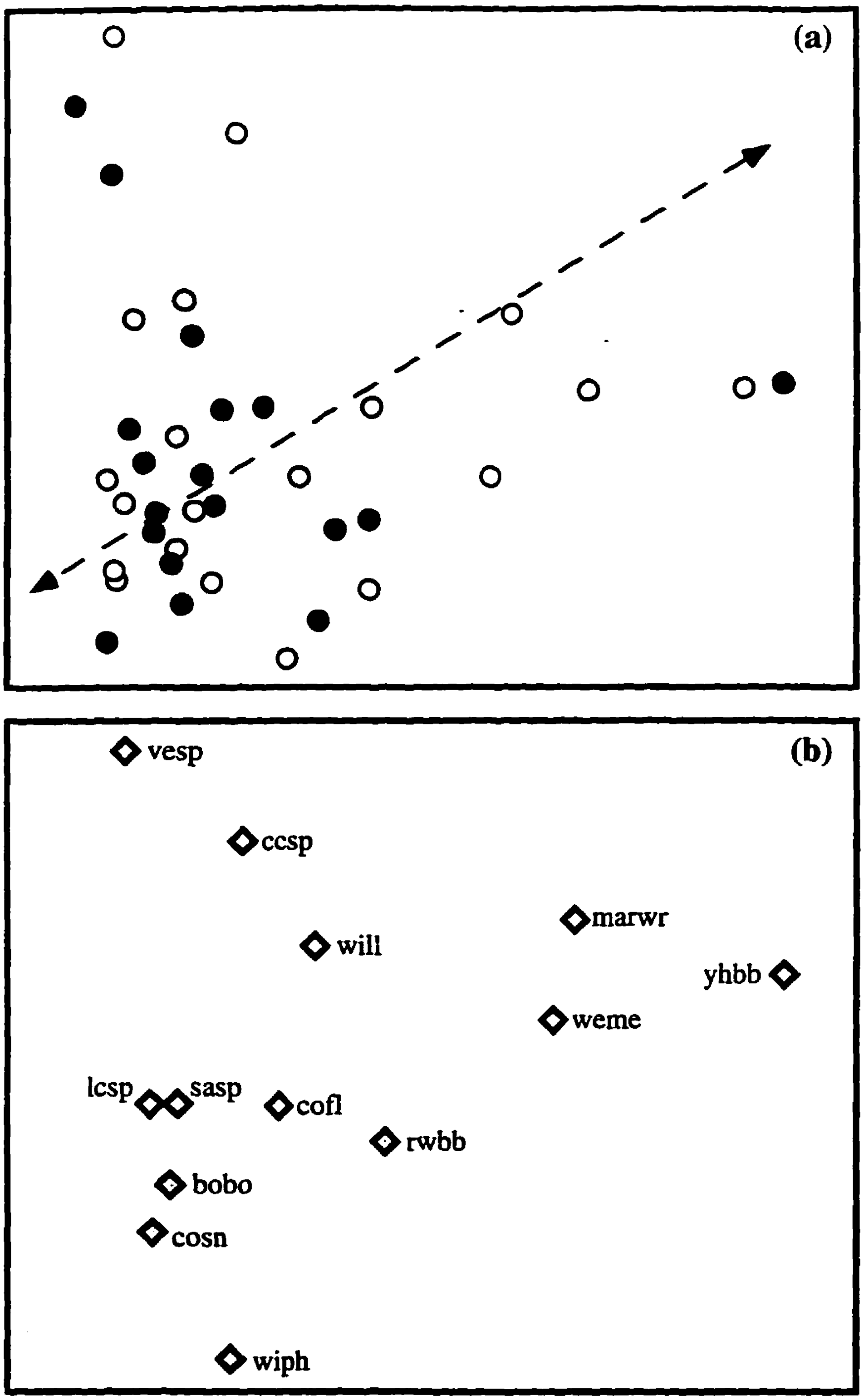

Figure 5: Correspondence Analysis Ordination (axes I and II) 1995 productivity data : (a) sites, (b) species. Symbol codes; open circles = managed grazing; closed circles = season-long grazing; shaded diamonds = species. The dashed line I in (a) is the discriminant axis for the two grazing systems (χ^2=0.87, p=0.66).

Figure 6 describes the results of the CA analysis for 1996 productivity data. Those plots located in the left of the two dimensional space axis had high sedge wren productivity. This species was infrequent on all the managed grazing sites, and was considerably more prevalent on season-long grazing sites. Those plots located to the right of the two dimension axis had high yellow-headed blackbird and red-winged blackbird productivity. There is a strong propensity for managed grazing systems to be clustered in the center of the two dimensional axis. Season-long grazing plots are considerably more dispersed throughout the ordination axis and, therefore, display a high degree of variability in species productivity within the plots. Paired t-tests assessed the preference of red-winged blackbirds, clay-colored sparrows, vesper sparrows and yellow-headed blackbirds for managed grazing sites and results indicated that this preference was not significant (t=1.0, p=.36).

The largest productivity score, was noted in managed grazing plot 2. This plot is also located on the Hogg 2 pasture and had a total productivity score of 68. The majority of these points were obtained by the successfully fledged several savannah sparrow and red-winged blackbird young. The highest season-long productivity score was 67 and was located in the Yanyck pasture (plot 4). A bobolink pair, several savannah sparrows and red-winged blackbird pairs successfully fledged young on this plot.

The plots which experienced the lowest productivity were managed grazing plot 17 and season-long grazing plot 10. Plot 17 had a productivity total of 27 and is located in the Hogg 1 grazing system. This plot had a higher than average productivity score in 1995, and the 1996 score may simply reflect annual fluctuations in non-game species

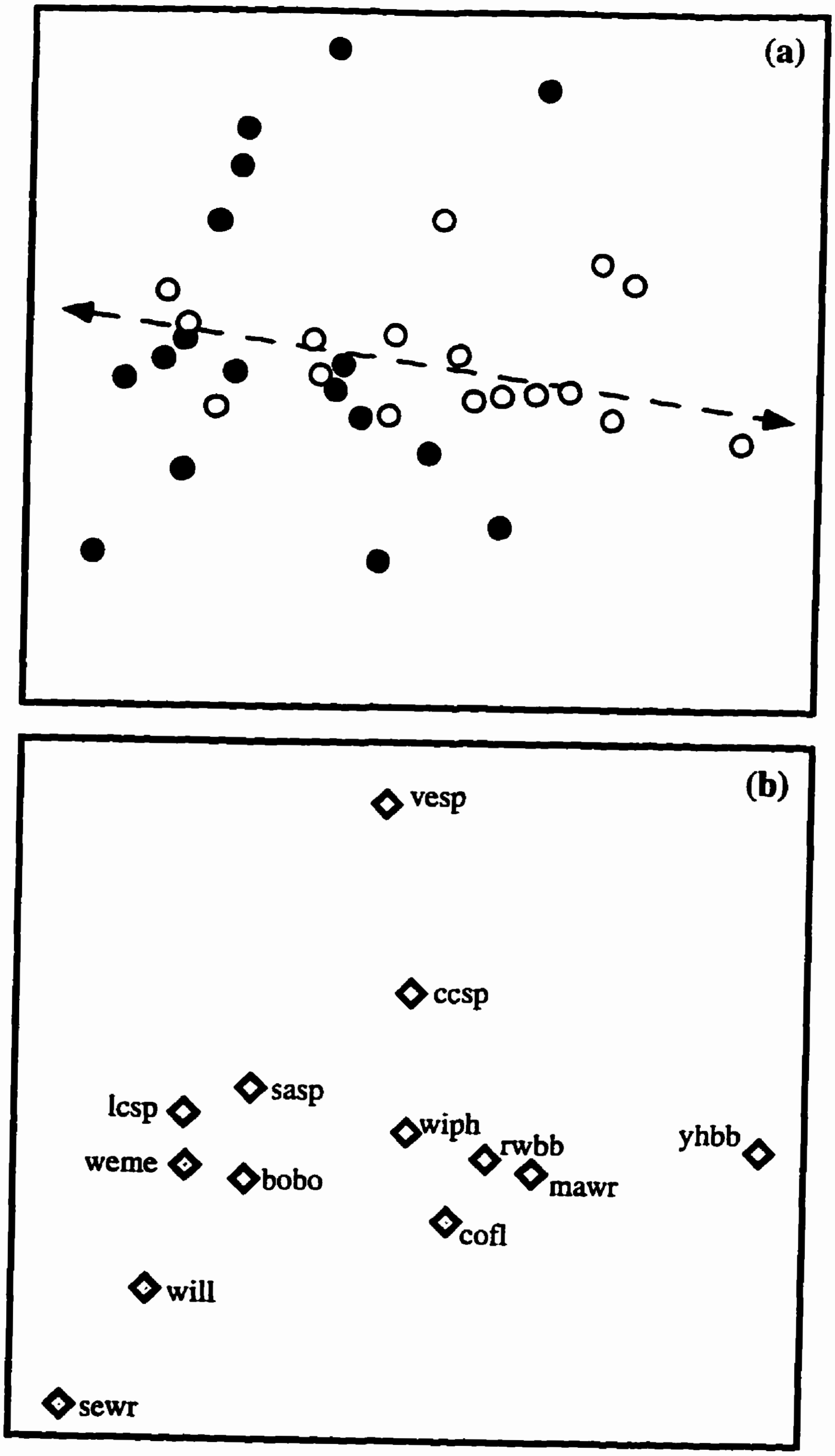

Figure 6: Correspondence Analysis Ordination (axes I and II) 1995 productivity data : (a) sites, (b) species. Symbol codes; open circles = managed grazing; closed circles = season-long grazing; shaded diamonds = species. The dashed line I in (a) is the discriminant axis for the two grazing systems (χ^2= 7.67, p=0.022).

abundance. However, this site experienced a 78% increase in stocking rates from the 1995 to 1996. The corresponding decrease in abundance and productivity may be a result, as increasing stocking rates can influence vegetative cover, quality of the habitat, and level of disturbance to non-game birds (Holechek 1982). Season-long grazing plot 10 had a low of 1 with only a single savannah sparrow and red-winged blackbird being observed on the plot. This plot is located on a tame pasture and achieved only a moderate productivity in 1995 as well.

Discriminate analysis of 1996 productivity does reveal a statistical difference between the two grazing systems (Figure 6, χ^2=7.67, df=2, p=.022). Managed grazing systems are typically more productive for clay-colored sparrows, red-winged blackbird, yellow-headed blackbirds, marsh wrens, and Wilson's phalaropes. Productivity data indicate that on season-long grazing systems the following species are more productive; western meadowlark, savannah sparrow, LeConte's sparrow, willet, and bobolinks.

Another useful way to evaluate differences between productivity of managed grazing and season long or continuous grazing is to examine the differences that exist between individual sites. The following section describes the total number of productivity points attributed to the plot, the number of nests, nestlings, and juveniles found on the plot, the number of predated nest and eggs located, and the total number of species recorded inside the plot.

4.3.1 Productivity Summary for Managed Grazing Sites

Site No. 1 (Hogg 2)

Total productivity within the two grazing systems increased between 1995 and 1996. Although locating nests was not a primary focus of this project, they were recorded whenever possible. The number of nests located and number of juveniles identified was reduced when compared with the 1995 field season. No evidence of predated nests or eggs was found in 1995. In 1996, there was evidence of three predated nests on this site. The total number of non-game bird species recorded on each plot increased between the two field seasons. However, it is difficult to determine whether these changes were a result of actual increases or simply a by-product of a change in observers from 1995 to 1996.

Site No. 2 (Kaskiw)

It was difficult to assess any changes in productivity that may have occurred between 1995 and 1996 field seasons as the landowners only grazed one out of the four managed grazing paddocks in 1996. They also decreased their number of cattle from 42 cow /calf units to 35 cow/calf units. Plots 5, 6 and 7 are all alfalfa and brome stands and it is interesting to note that the number of species present in this type of planted stand is less than the number of species present in native habitat.

Site No. 3 (Anderson)

The Anderson managed grazing system is a deferred system. Plot number 11 was located in the deferred paddock. Fewer species are present , and overall productivity is quite reduced in this system. The landowner has a high stocking rate (80 yearlings) and rotates his cattle in the same manner every year. This site typically had the least amount of vegetative cover and lowest overall productivity for managed grazing sites.

Site No. 4 (Dunits)

The Dunits' grazing system was established in 1989 and it is the oldest managed grazing system incorporated into this study. Stocking rates have remained steady for several years, and species richness, and productivity scores for plots 12, 13, and 14 have remained high throughout the study. The highest productivity score in 1995 was recorded by the deferred paddock. Overall productivity and species richness was low for plot 15.

Site No. 5 (Hogg1)

There is a large year to year variation in total productivity and number of species found on each plot. This variation may be a result of different observers , a by-product of increasing the total number of productivity counts completed, or it may represent an actual increase in productivity and species richness.

Table 7: Productivity Summary for Managed Grazing Site No. 1,

1995 and 1996 Field Seasons

Hogg 2	Plot 1		Plot 2		Plot 3	
	1995	1996	1995	1996	1995	1996
Total Productivity	45	78	27	90.5	31.5	75.5
Nests	1	1	2	1	2	1
Nestlings	0	0	4	0	1	0
Juveniles	4	2	3	1	3	2
Incidence of predation	0	1	0	2	0	0
No.Species	13	25	11	23	15	26

Table 8: Productivity Summary for Managed Grazing Site No. 2,

1995 and 1996 Field Seasons

Kaskiw	Plot 4		Plot 5		Plot 6		Plot 7*	
	1995	1996	1995	1996	1996	1996	1995	1996
Total Productivity	25.5	79	23.5	♦	22	♦	36.5	♦
Nests	0	3	1	♦	0	♦	1	♦
Nestlings	0	0	0	♦	0	♦	0	♦
Juveniles	3	5	2	♦	2	♦	6	♦
Incidence of predation	0	1	10	♦	0	♦	0	♦
No.Species	18	17	2	♦	9	♦	15	♦

♦ plots were hayed in 1996
* Deferred paddock

Table 9:Productivity Summary for Managed Grazing Site No. 3, 1995 and 1996 Field Seasons

Anderson	Plot 8		Plot 9		Plot 10		Plot 11*	
	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	21.5	49	26.5	66	27.5	66	14	62
Nests	0	0	1	0	0	3	1	1
Nestlings	0	0	0	0	0	0	0	0
Juveniles	0	3	0	4	1	1	2	1
Incidence of predation	0	0	1	0	0	0	0	0
No. Species	17	18	22	26	13	22	9	22

† was deferred paddock for 1995, 1996

Table 10:Productivity Summary for Managed Grazing Site No. 4, 1995 and 1996 Field Seasons

Dunits	Plot 12		Plot 13		Plot 14†		Plot 15	
	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	29.5	81	15	58	43.5	103	9.5	37.5
Nests	0	2	1	2	6	3	0	2
Nestlings	0	5	0	0	5	0	0	4
Juveniles	1	3	0	0	2	13	0	0
Incidence of predation	1	0	1	1	1	0	0	1
No.species	11	28	14	22	16	26	10	13

† was deferred paddock for 1995

Table 11: Productivity Summary for Managed Grazing Site No. 5, 1995 and 1996 Field Seasons

Hogg 1	Plot 16		Plot 17		Plot 18		Plot 19		Plot 20	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	38.5	77.5	18	81	15.5	57	21	43	23	52
Nests	1	1	1	1	1	2	1	0	1	0
Nestlings	0	0	3	0	1	4	0	0	0	0
Juveniles	2	0	2	2	3	0	3	0	2	0
Incidence of predation	0	1	0	0	0	0	0	0	0	2
No.species	16	24	10	30	9	21	10	17	12	26

4.3.2 Productivity Summary of Season-long Grazing Sites

There appears to be a greater variability within individual managed grazing and season-long grazing plots rather than between the two grazing regimes. The following summaries depict a plot-by-plot comparison of non-game species productivity.

Site No. 1 (Bucklaschuk)

There is a substantial year to year variation between the total productivity scores, number of species, and number of juveniles found on the study plots. Plot 3 had one of the highest predation rates when compared with all study plots in 1995. Predation rates were lower for this plot in 1996, perhaps as an result of an overall increase in vegetative cover that was observed.

Site No.2 (Yanyck)

The plot contained highly diverse micro-habitats. Perhaps the high number of species recorded is indicative of the heterogenous habitat. Total productivity is higher in 1996, but the number of juveniles and number of nests located remained approximately the same.

Site No. 3 (Findlay)

No nests were located on this site. Plot 8 was a brome/ alfalfa pasture that was hayed in 1996 and therefore not included in that year' s data. Despite the absence of located nests, productivity remained above the average for both years (42.8/ plot in 1996 and 19.2/ plot 1995).

Site No. 4 (Choy)

The site had one native pasture (plot 11) which proved to be productive throughout the two field seasons. Choy has a high stocking rate (>150 units), and the below- normal productivity scores may reflect this.

Site 5 (Purdy)

The Purdy site had more of the most productive plots in the 1995 season. Plot 5 was a predominately sedge meadow and as a result of the spring flooding, ample water was available. The site is also bordered by a shrub fencelike that provides perches and nesting habitat. Finally, this plot contains the largest contiguous grassland habitat of all the study plots.

Table 12: Productivity Summary for Season-long Grazing Site No. 1,

1995 and 1996 Field Seasons

Bucklaschuk	Plot 1		Plot 2		Plot 3	
	1995	1996	1995	1996	1995	1996
Total Productivity	12	62.5	9	48	36	77
Nests	1	1	1	1	3	1
Nestlings	0	2	0	0	0	0
Juveniles	0	5	0	4	0	4
Incidence of predation	0	0	0	1	4	0
No.species	10	21	10	18	11	21

Table 14: Productivity Summary for Season-long Grazing Site No. 2,

1995 and 1996 Field Seasons

Yanyck	Plot 4		Plot 5		Plot 6		Plot 7	
	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	42.5	84	37	72.5	29	70.5	28	78
Nests	2	1	2	1	1	1	0	1
Nestlings	4	3	0	0	0	0	0	.
Juveniles	5	7	5	7	4	6	2	6
Incidence of predation	0	0	0	0	1	0	0	0
No.species	12	33	12	25	9	23	11	24

Table 15: Productivity Summary for Season-long Grazing Site No. 3,

1995 and 1996 Field Seasons

Findlay	Plot 8		Plot 9	
	1995	1996	1995	1996
Total Productivity	26.5	◆	32	69
Nests	0	◆	1	1
Nestlings	0	◆	0	0
Juveniles	0	◆	4	0
Incidence of predation	0	◆	0	1
No.species	19	◆	17	26

◆ plot was hayed in 1996

Table 15: Productivity Summary for Season-long Grazing Site No. 4,

1995 and 1996 Field Seasons

Choy	Plot 10		Plot 11		Plot 12		Plot 13	
	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	11	70	23	29.5	13.5	37	18	41.5
Nests	1	1	1	0	0	0	2	0
Nestlings	0	0	0	0	0	0	4	0
Juveniles	0	0	0	13	0	0	0	0
Incidence of predation	0	0	0	0	0	0	0	0
No.species	15	30	11	32	10	20	12	19

Table 16: Productivity Summary for Season-long Grazing Site No. 5, 1995 and 1996 Field Seasons

Purdy	Plot 14		Plot 15		Plot 16		Plot 17		Plot 18	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Total Productivity	39.5	79	44	65.5	45	71	36.5	56	52	77
Nests	3	3	2	4	1	2	0	2	1	3
Nestlings	3	0	0	0	0	0	0	0	0	0
Juveniles	4	0	5	7	6	6	4	3	4	1
Incidence of predation	0	0	0	2	0	1	0	0	0	0
No.species	17	22	13	16	11	21	12	18	21	27

4.3.3 Nest Information

Although the primary methodology utilized in this study was the behavioural index (Vickery et al. 1992 ; Jones 1994), non-game species nests were incidentally located on the sample areas. If nests were located, efforts were made to monitor their progress. Table 17 describes the nesting information gathered for both field seasons.

Table 17: Nest Information, 1995 and 1996 Field Seasons

	Managed Grazing		Continuous Grazing	
	1995	1996	1995	1996
Nests	34	23	13	23
Nestlings	18	13	11	5
Juveniles	57	37	28	69
Number of plots surveyed	20	17	20	17

In 1995, more nests were located on the managed grazing sample areas, although the total productivity for these sites did not appear to differ from the control sites. In 1996, fewer nests were found on all of the sites. This is a surprising result, because the total number of productivity censuses increased from 8 in 1995 to 10 in 1996. The number of visits to each sample site was also increased because the growth rate of the vegetation was monitored on a weekly basis. However, a greater number of juveniles were located in 1996 field season, most of them on the season-long grazing plots.

4.4 Vegetation

The combination of the percent cover of plant species, and information concerning the ratio of forbs to grasses and bare soil, indicates the relative success of managed grazing systems to provide increase forb production. Vegetation sampling can also measure the ability of managed grazing to reduce the percent of bare soil. Overgrazing indicator species such as pussy toes (*Antennaria sp.)*, and prairie and pasture sage *(Artemisia sp.)* may also indicate whether the particular grazing regime that the landowner is utilizing is maximizing the potential for rangelands plants.

4.4.1 Percent Cover Estimates for Managed Grazing and Season-Long Grazing Plots

Tables 18 and 19 illustrate percent cover estimates for managed grazing and season-long grazing plots. Although attempts were made to ensure that a maximum amount of grassland was included in each sample site, it was not always possible to avoid the inclusion of shrubs and wetlands.

Managed grazing plots were composed of almost 86% (1995) and 84% (1996) grasses and forbs. Percent cover estimates exceed 100% because shrubs and wetlands often were found in conjunction with grasses and forbs. Approximately 10% of the managed grazing plots were wetlands. This table demonstrates that the heterogeneity of the habitat in which the plots were located. Despite all attempts to include the maximum quantity of grassland available, 25% of the plots were comprised of shrub or wetlands.

Results of discriminant analysis ordination indicate that the differences between the vegetation on managed grazing and season-long grazing are not significant (1995;χ^2 =2.79, p=.4, and 1996;χ^2 = 4.32, p=.2) Thus, on a macro- level, sample sites within both grazing systems are similar.

Table 18: Percent Cover Estimates of Managed Grazing Plots,

1995 and 1996 Field Seasons

Site	Grass and Forbs (%)		Shrub (%)		Wetland (%)	
	1995	1996	1995	1996	1995	1996
Hogg 2	87	91.7	30	4	6.7	5
Kaskiw	90	*	3	*	12.5	*
Anderson	79	87.5	23	2.5	9.25	7.5
Dunits	93	77.5	2.25	10.5	8.75	13.8
Hogg 1	82.4	78	13.4	13.75	9	16.75
Mean	86.2	83.68	14.3	7.69	9.24	10.76

* plots were hayed in 1996

Table 19: Percent Cover Estimates of Season-long Grazing Plots

1995 and 1996 Field Seasons

Plot Number	Grass and Forbs (%)		Shrubs (%)		Wetland (%)	
	1995	1996	1995	1996	1995	1996
Bucklaschuk	94.3	96.7	0	0	5.67	1.75
Findlay	94	*	1.5	*	7.5	*
Yanyck	88.75	88.8	5	4.3	11.25	9.3
Choy	90.5	83.8	4.5	2.5	4.5	12.5
Purdy	85	88.8	5	13.75	15.8	25.5
Mean	90.5	89.5	3.2	5.14	8.05	12.27

* 1995 plot was hayed

4.4.2 Percent Cover Estimates for Vegetation Transects

Comparison of grass, forbs, bare-ground and dead results for 1995 are found in Table 20 and in Table 21 for 1996. Percent cover estimates are higher in 1995. There is a possibility that this could be a result of two different observers recording the data, or seasonal variation. Vegetation transects were completed in the month of June (1995) and the first week of July (1996). Discriminant analysis ordination was completed to determine whether the differences between managed grazing and season-long grazing was significant. The results indicate that no significant difference was detected in 1995 (χ^2 =2.29, df= 2, p=.21)or in 1996 (χ^2 = 3.19, df=2, p=.25).

Table 20: Percent Cover Estimates for 1995 Managed Grazing and Season-long Vegetation Transects

Site	Grass		Forbs		Bare Ground		Dead	
	MG*	SL**	MG*	SL**	MG*	SL**	MG*	SL**
1	52.8	65.9	33.9	7.3	23.1	31.4	5.7	0.0
2	39.2	46	43.7	36.3	41	41.3	2.3	2.4
3	48.1	37.1	23.8	29.2	33.7	30.2	1.4	14.5
4	48.8	43.4	35.8	36.1	28.8	42.3	2.5	0.o
5	43.8	51	34.2	31.2	26.4	29.6	0.9	9.7
Mean	46.5	48.7	34.3	28	30.6	34.9	2.6	5.3

*Managed grazing systems
** Season-long grazing

Table 21: Percent Cover Estimates for 1996 Managed Grazing and Season-long Grazing Vegetation Transects

Plot	Grass		Forbs		Bare Ground		Dead	
	MG*	SL**	MG*	SL**	MG*	SL**	MG*	SL**
1	30.1	35.2	21.9	3.9	20.5	31.4	18.5	28.4
2	34	27.2	29.05	23.7	23.8	30.2	17.4	17.8
3	32.9	18.4	14.35	26.6	14.6	43.3	24.1	13.1
4	18.9	25.2	31.4	24.2	22.4	27	5.8	25.5
MEAN	23.2	26.5	24.2	19.6	16.3	32.9	16.45	21.2

*Managed Grazing system
** Season-long grazing systems

The similarity between the managed grazing and season-long grazing transects is illustrated in Figures 7 and 8. Data from each year were analysed separately. While completing the vegetation transects, percent cover estimates of plant species were also conducted. In many cases, the grass was completely grazed down and only identification to genus was possible. The frequency of the most common plant species found on managed and season-long grazing plots is presented graphically in Figures 9 and 10.

There was not a large difference in plant species composition between the two grazing systems. In 1995, season-long pastures had a greater percentage of brome, aster, plantago, and pussy toes. The incidence of pale commandra (*Commandra pallida)* and yarrow (*Achillea millefolium)* was high for managed grazing. In 1996 managed grazing systems had a higher bluegrass (*Poa sp.),* pussy toes, and sedge (*Carex sp.)* composition. Season-long pastures continued to have a greater content of brome (*Bromus sp.),* and saline grasses (*Distichlis sp.).*

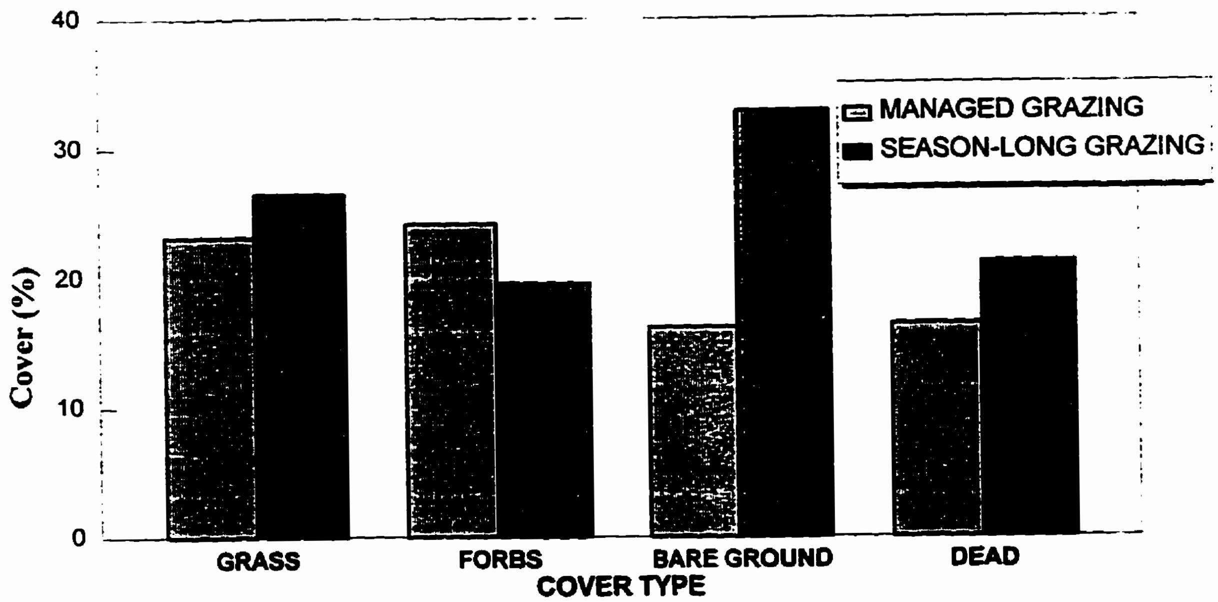

Figure 7: Percent Cover Estimates for 1995 Vegetation Transects

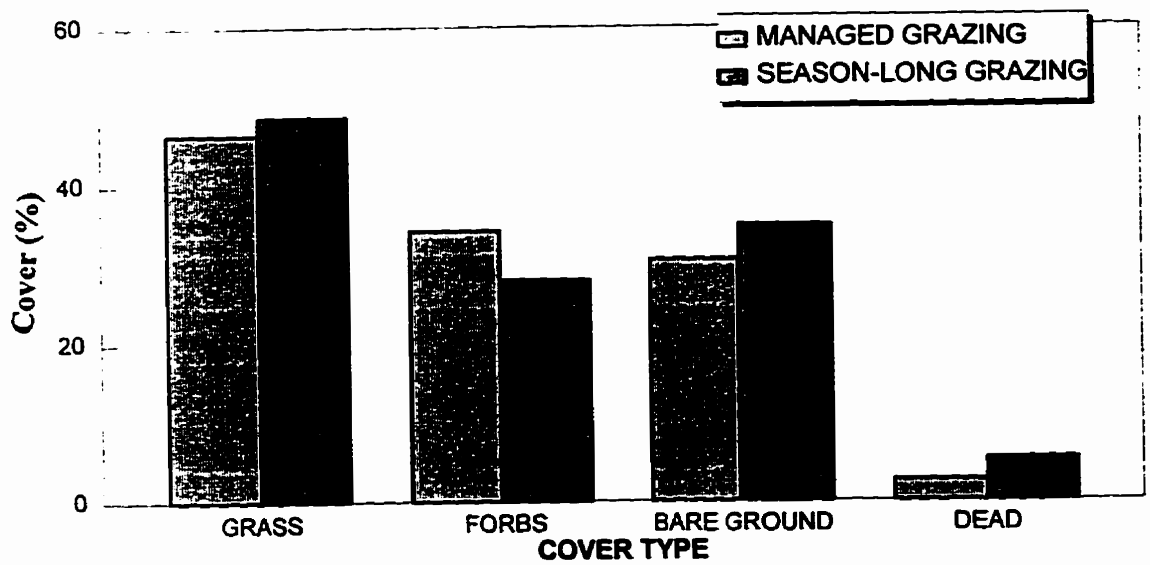

Figure 8: Percent Cover Estimates for 1996 Vegetation Transects

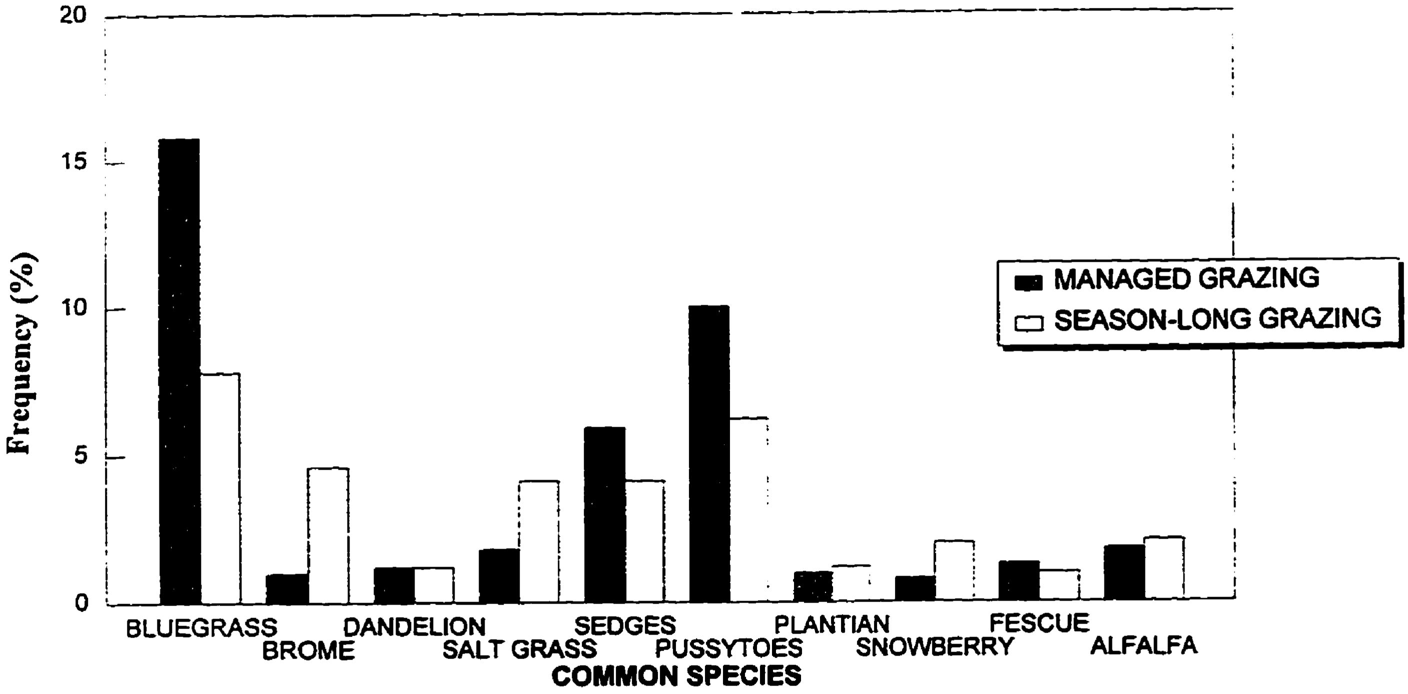

Figure 9: Most Common Plant Species found on Managed Grazing and Season-long Grazing Study Plots 1995

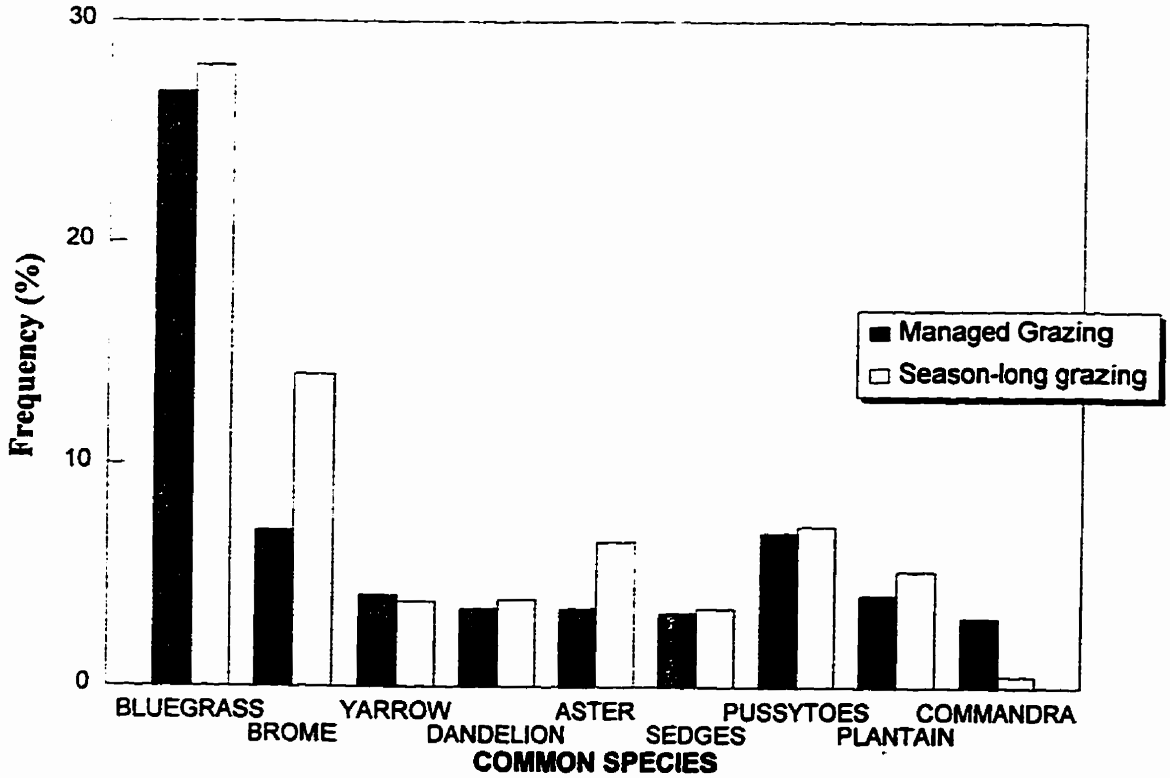

Figure 10: Most Common Plant Species found on Managed Grazing and Season-long Grazing Study Plots 1996

4.4.3 Vegetation Height

The overall average of the weekly vegetation height measurements for 1996, is presented in Figure 11. Figure 12 contrasts the average vegetation height obtained in 1995 with the average height in 1996

The vegetation measurements indicate that on average, managed grazing systems produce more litter, and greater vegetative height . This was true for the 1995 and 1996 field seasons. However, the majority of the vegetation height and structure is found only in the 10 cm narrow-leaved (n) and 10 cm broad-leaved (b) range. This may not be sufficient to protect non-game species nests or nestlings from predators.

Managed grazing also had more "contacts" with wetlands in 1996 when compared with season-long grazing plots of that same year. However, the percent cover estimates of the entire plot indicate that the frequency of wetlands is comparable for the two grazing system (9.3% for managed grazing and 9.7 % for season-long grazing).

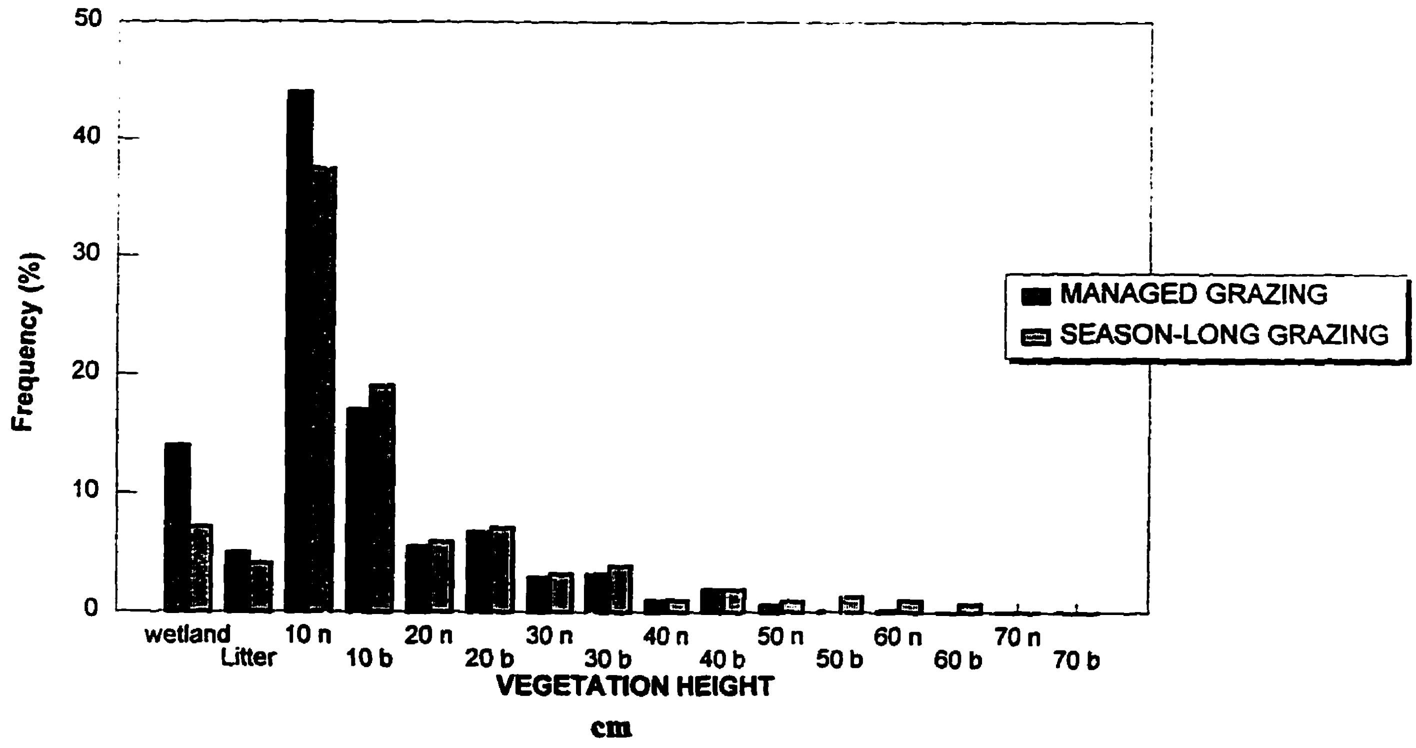

Figure 11: Average Weekly Vegetation Height For 1996 Field Season

(*n= narrow blade grass, *b=broad blade grass)

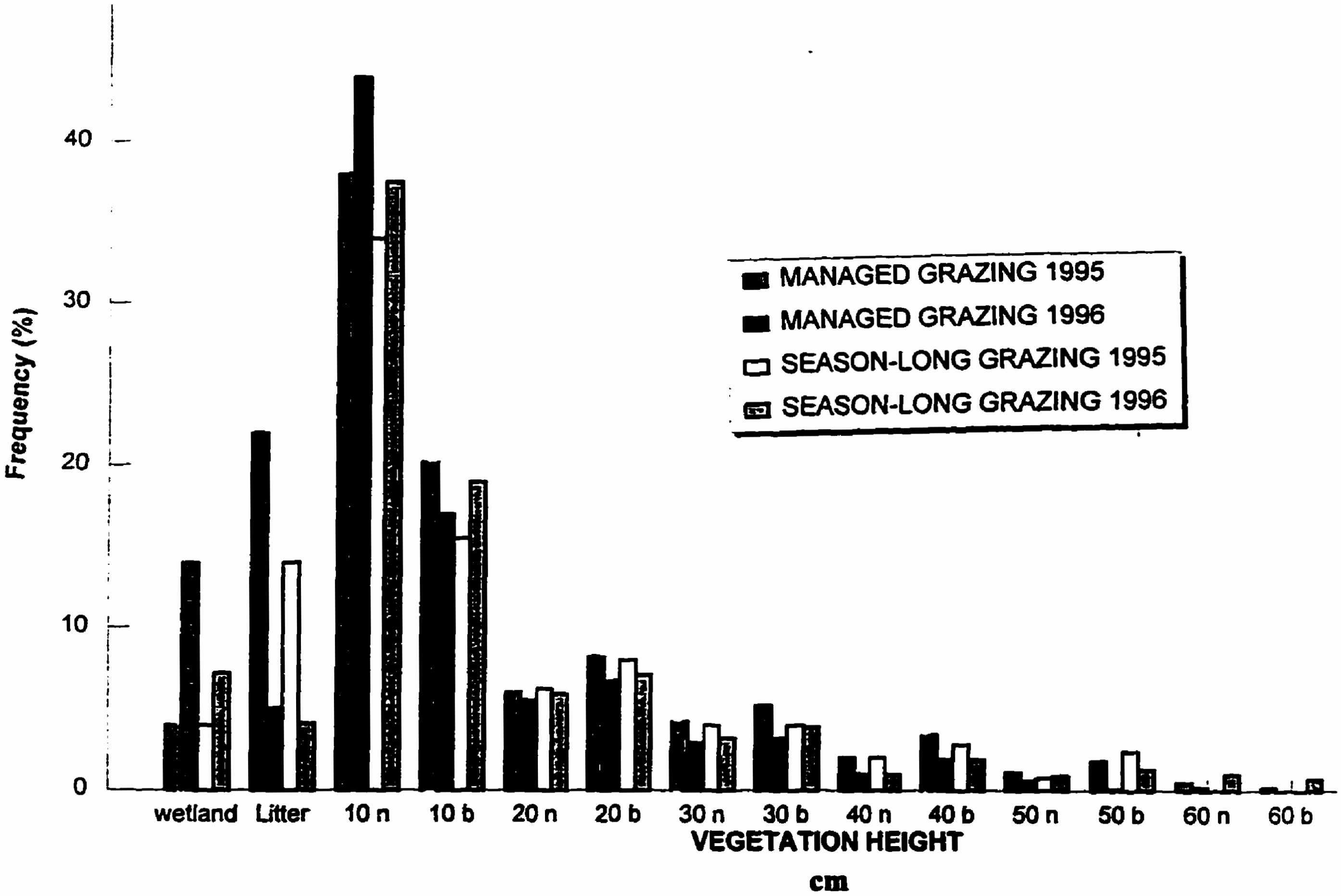

Figure 12: Comparison of Vegetation Height for 1995 and 1996 Field Seasons

(*n= narrow blade grass, *b=broad blade grass)

5.0 DISCUSSION

5.1 Interpretation of Results

The results indicate that the managed grazing systems examined in this study did not significantly increase non-game bird species abundance, richness, or productivity when compared with season-long grazing systems. Managed grazing also did not significantly change the ratio of grasses, forbs, bare-ground, although forbs are more abundant and bare ground is less abundant on managed grazing system sites when compared with season-long grazing sites. The question remains why managed grazing systems do not enhance non-game species abundance, richness, productivity, or habitat ?

5.1.1 Abundance Results

Abundance results for both the 1995 and 1996 seasons indicate that managed grazing does not significantly increase species richness or species diversity. However, some non-game bird species distribution patterns have emerged: savannah sparrows, LeConte's sparrows and western meadowlarks are more abundant on season-long grazing systems. The intensity of grazing within the two grazing systems may also influence avian habitat selection. These species favour open habitat with tall dense grass and are considered true grassland species (Curnutt et al. 1996; Kantrud 1981). Another pattern that is apparent is that red-winged blackbirds and clay-colored sparrows are more abundant on managed grazing systems. These species prefer more heterogenous habitats, such as shrubs and wetlands (Kantrud 1981).

Perhaps unknown habitat attributes are influencing which non-game birds are found on each of the grazing regimes. The micro-habitats created by the fencing of rotational paddocks reduces the amount of open habitat available for those species such as western meadowlark, savannah sparrow, and LeConte's sparrows that prefer large contiguous grassland habitat (Curnutt et al. 1996). The literature indicates that savannah sparrows and clay-coloured sparrows would be more tolerant to grazing (Kantrud 1981) while LeConte' s sparrows would be eliminated by moderate to severe grazing (Kantrud 1981 : Dale 1983). The diversity of non-game bird species found on both managed grazing and season-long grazing sites would suggest that both grazing regimes are providing a mosaic of habitat that meets the specific habitat requirements of different species.

Other studies completed on managed grazing systems in the aspen parkland have indicated that most grassland birds are very sensitive to changes in vegetation structure and plant species composition , so pastures containing a diverse range of vegetation gradients may support virtually distinct bird communities (Prescott and Murphy 1996). Rangelands have the potential to provide breeding habitat for species with vastly different habitat requirements because small changes in vegetation that result from different grazing regimes, can have dramatic impacts on community structure (Prescott and Wagner 1996)

Abundance and species richness varied greatly between the field seasons. Average abundance and richness were substantially higher in 1996 than in 1995. Other research conducted on grassland birds have also found significant year-to year variation in species abundance and species richness (Wiens and Dyer 1975; Prescott and Wagner 1996). These fluctuations may be attributed to two explanations; taller vegetation within a given field season may attract more birds to a particular site, or, grassland songbirds may experience significant fluctuations in annual population numbers (Dale 1984).

5.1.2 Productivity Results

The species incorporated into the productivity analysis were included because they were the most common species, but also because these species required a wide spectrum of habitat requirements in mixed prairie grasslands (Renken and Dinsmore 1987). By including a large group of species, one can best determine the relative success of an enhancement program in terms of its ability to provide habitat for a diverse group of species. Non-game bird species do not persist in isolation, and they are influenced by a number of factors that include habitat, but also inter- and intra-species population dynamics.

Although managed grazing does not preclude the use of habitat by other grassland species, it does appear to favour certain species. Both 1995 and 1996 productivity data indicate that red-winged blackbirds, clay-colored sparrows and vesper sparrows are more productive on managed grazing sites. The trend for those species preferring wetter habitat is also apparent in the productivity of yellow-headed blackbirds, and marsh wrens. Marsh wrens are known to destroy yellow-headed blackbird eggs and it is therefore difficult to determine their presence is due to habitat selection or because of the presence of yellow-headed blackbirds. The apparent preference for wetter habitat for both theses species is more apparent in 1996. This could reflect annual fluctuations, or an increase in the number of productivity counts that occurred in that field season.

On the other hand, species like the savannah sparrow which was ubiquitous to all plots, achieves greater productivity on the season-long pastures when compared with the managed grazing ones. This may be a result of the species' preference for open grassland habitats (Herkert, 1994). In 1995 LeConte's sparrows were more productive on the season-long sites when compared with the managed grazing sites. However, there was little difference in LeConte's sparrow productivity on season-long grazing sites in 1996.

There are some ambiguous trends as well. In 1995, some species achieved greater productivity in managed grazing systems but in 1996, the same species increased their productivity in the season-long systems. Grassland songbirds are sensitive to changes in vegetation structure and species composition, and small "micro" changes in the habitat can produce changes in songbird habitat selection (Prescott and Murphy 1996). However, these differences are not significant, and year to year variation is quite small. It may be possible that the differences are a result of observer bias, chance, climatic effects, or annual population fluctuations (see section 5.2.3).

5.1.3 Vegetation Results

Vegetation is perhaps the most important proximate predictor of bird abundance (Bollinger, 1995). Vegetation structure, species composition, and volume all influence which avian community may persist within a given habitat (Bollinger, 1995). Savory (1988) claims that properly managed grazing systems can change the species composition of grassland plants. Properly managed pastures should experience a shift toward a more palatable, more nutritious, and more successionally advanced plant species composition (Savory 1988).

The managed grazing systems examined in this study had a higher, (although not statistically significant), percentage of forbs, fewer grasses, and less bare-ground (see section 4.4.2). The literature indicates that managed grazing systems should increase forb abundance, increase residual grass cover, and reduce incidence of bare-ground (Berkey et al. 1994; NAWMP 1994).

Vegetation sampling along random transects of managed and season-long plots indicates that the managed grazing plots are producing more vegetation height, and more litter (see Figures 9, 10). The combined results of the vegetation data suggest that managed grazing may be having a positive effect on the grassland habitat (although not statistically significant). This positive effect is occurring despite the concurrent increases in stocking rates (see section 3.1) that occurred on four of the managed grazing system sites. However, this slight change in vegetation vigour may not be sufficient to elicit a response from avian species.

Managed grazing plots also had a higher percentage of shrub cover, which may influence the non-game bird species that inhabit the plot. For example, shrub density was found to be negatively correlated with presence of western meadowlarks (McAdoo et al. 1989), and positively correlated with the presences of clay-colored sparrows (Kantrud 1981). The higher incidence of shrubs on the managed grazing plots may explain why western meadowlarks preferred the season-long grazing pastures, whereas clay-colored sparrows were more abundant and productive on managed grazing sites.

5.2 Other Potentially Confounding Factors

What other factors could be influencing non-game bird habitat? Bollinger (1995) indicated that vegetative characteristics may be the most important determinants of avian habitat selection, but there are other factors that may influence non-game bird populations. According to Bollinger (1995), they are:

- intraspecific competition
- interspecific competition
- size of habitat patches
- site tenacity
- densities of predators and brood parasites

Intraspecific and interspecific competition may indeed be a critical component of why non-game birds may be more abundant and more productive on a given site. For example, conflicting territorial size and feeding requirements may influence whether a given habitat area is selected by non-game birds. Interspecific and intraspecfic interactions were not examined within this study but a large body of research on these factors already exits (see Wiens 1985; Robbins et al. 1989; Picman 1986).

The size of a habitat, site tenacity, and the densities of predators and brood parasites have been examined indirectly within this study. For example the size of habitat patches can be critical for some species. Vickery et al. (1994) recently examined six bird species and determined that their presence was clearly related to the area of habitat available. Their study indicated that for grassland birds, sites must be more than 50 ha, preferably 200 ha, if they are likely to support a diverse scolpacine and passerine fauna. They noted that relatively small grassland sites (i.e., 5 to 10 ha) may have a beneficial effect as secondary breeding sites for vesper sparrows and savannah sparrows. Herkert (1994) indicated that fragment area strongly influenced bird communities within grasslands and accounted for a high percentage of variation in mean breeding bird species richness among habitat fragments. He also noted that even if the habitat fragment contained suitable vegetation structure and sufficient cover, breeding birds would still avoid the site.

It may be that given the heterogeneity of the habitat within which these plots were situated, managed grazing may be contributing to increasing fragmentation of the habitat. My inability to find study sites that were comprised of contiguous grassland habitat indicates the heterogeneity of the habitat that is characteristic of the aspen parkland (see Bird 1961). On average 15 to 20% of the managed grazing and season-long grazing plots included habitat cover (shrubs, wetlands) that was not grassland. Only 87% of the study plots was grassland. This indicates how fragmented the surrounding landscape really is. Studies completed by Herkert (1994) and Knopf (in press) attribute the present decline of grassland species to the increasingly fragmented landscape that persists. Thus, managed grazing, by its very design, may contribute to increasing this fragmentation.

Bollinger (1995) also describes two other factors that affect avian habitat selection: site tenacity and density of predators and brood parasites. Site tenacity refers to the potential for a time lag to occur between habitat selection patterns and breeding dispersion patterns. An individual may demonstrate site fidelity, despite the fact that a particular site is no longer an optimal habitat. Managed grazing pastures could be creating a better habitat for grassland species, but as a result of breeding dispersal patterns, a sufficient density of individual species has not yet dispersed to the improved habitat in numbers that are sufficient to detect a difference between the two grazing systems. In addition, the managed grazing sites used in this study may have not been sufficiently established to collapse a species site fidelity for a habitat that is no longer optimal. Thus, a species may continue to persist in a habitat that is less than optimal, because it has yet disperse to the "enhanced" habitat. Bollinger's (1995) study examined the idea of bobolinks exhibiting site fidelity with respect to successional changes in hayfield communities. He found that site fidelity may only have a minor influence on breeding dispersion.

According to Bollinger (1995) the final influencing factor may be depredation rates and frequency of brood parasitism. This study revealed that in 1995, six nests in each of the managed grazing and season-long grazing nest were lost to predation. In 1996 eight nests were preyed upon in the managed grazing sites, whereas only four nest were depredated in the season-long sites. Table 22 illustrates the number of nests found and the level of nests predation for both managed grazing and season-long grazing.

Table 22: Comparison of Number of Nests Found and Number of Nests Lost to Predation

Grazing System	Managed Grazing	%	Season-long Grazing	%
Total Nests Located' 95	24	-	22	-
Total Nests Located '96	20	-	23	-
Predation 1995	6	25%	6	27%
Predation 1996	8	40%	4	17%

The data suggest that incidence of nest predation in 1996 is higher in managed grazing systems when compared with season-long systems. However, paired *t*-test analysis results indicate that the difference is not significant (t=1.0, p=.36). A recent study examining the effects of habitat fragmentation supports the idea that predation rates will increase as habitat becomes more fragmented (Herkert 1994). Managed grazing systems may exacerbate fragmentation through the small paddock size and boundaries created by paddock fences.

Frequency of brood parasitism does not appear to differ between the two grazing systems. Whenever the observers noted the presence of a brown-headed cowbird (*Molothrus ater*), or located a nest with cowbird eggs in it, a productivity rank of 3 would be recorded for that particular site. Productivity indices for brown-headed cowbirds totalled 18 in 1995, and 30 in 1996 for plots located within managed grazing systems. In the season-long grazing, brown-headed cowbirds scored 11 in 1995 and 31 in 1996.

5.2.1 Climate Influence

Biodinini and Manske (1996) have indicated that annual variation in rainfall may be more important to maintaining or enhancing grassland conditions, than the actual management of the range. Shoal Lake, MB has an average annual rainfall of 358 mm (Canadian Monthly Climate Data, 1994) with 51% of annual precipitation falling between the months of May, June, and July. In 1995, a severe spring flood occurred in the area. Local landowners have indicated that water levels in the regions' wetlands and ephemeral ponds were at record levels.

The summer of 1995 was exceptionally hot. Landowners frequently commented on the extended stretch of 30 ° Celsius weather. In 1996, spring was delayed by approximately two weeks, and the temperature stayed within the normal temperature ranges. The average historical temperature for the months of May, June, and July is 14.8 Celsius (Canadian Monthly Climate Data, 1994).

The combination of warmer temperatures and high precipitation provide ideal growing conditions for grassland plant species. Therefore, it is difficult to determine whether pasture management programs or climatic conditions affected vegetative conditions. However, because all pastures were equally affected by regional climatic conditions, it is possible to presume that all pastures had equivalent opportunities to benefit from the ideal conditions that prevailed. Therefore the opportunity for vegetation growth should be optimal in all of the study sites, and avian abundance and productivity would be reflected equally throughout the study plots.

5.2.2 Observer Bias

Observer bias between years could not be avoided. Abundance, productivity counts, and percent cover vegetation estimates are all subjective estimates. Wherever possible, attempts were made to minimize observer bias, although it was impossible to avoid between year differences. Each observer rotated census sites after each count, and time of counts was also alternated. Population estimates, species identified, and numbers of juveniles found on the plots increased in the 1996 field season. It is for this reason that year- to- year variation was not compared, and all statistical manipulations were conducted within each field season. This in an inherent limitation of a two-year study and caution should be exercised when extrapolating results from the two field seasons.

There is another potential bias with the study methodology. Point-count circles may overestimate avian density because territorial birds are attracted to the observer moving throughout the study plot (Bollinger et al.1988). Bollinger et al's. (1988) study indicated that territorial bobolinks are far more visible and vocal during the breeding season and their behaviour could result in an overestimate of their population numbers. Polygamous birds are also more susceptible to double counting because of their tendency to vocalize more frequently when compared with monogamous avian species (Knight and Temple

1988). Bollinger et al.(1988) does point out that although avian densities are over estimated with the circular plots, the technique still provides a reasonable estimate of population abundance. Circular plots were used to evaluate both managed grazing and season-long grazing sites, therefore, any overestimation of population numbers as a result of observation methodology, would have been consistent in both grazing regimes. The use of circular plots in both grazing systems permits a direct comparison between the two grazing regimes, but may not permit a comparison between other studies using a different census methodology.

5.3 Management of Managed Grazing Systems

5.3.1 Relative "Newness" of Managed Grazing Systems

The majority of managed grazing systems in Shoal Lake have been in place for less than four years. According to Holechek et al. (1989), under conditions in which soil erosion has not been severe, recovery from severe overgrazing in the grasslands of the Great Plains should require less than 10 years. A separate review of the grazing literature in the Great Plains by Kipple and Bement (1961) concluded that most of the improvements in range conditions that can be expected from the adoption of specialized grazing management systems or changes in stocking rates occur during the first five to seven years. The time lag between range improvement and detectable increases in non-game bird abundance and productivity may be further increased as a result of avian site fidelity or site tenacity (Bollinger 1995).

The managed grazing plots included in this study may simply have not had adequate opportunity to recover. Managed grazing systems maintained approximately the same levels of forbs and grasses in 1996, despite the increase in stocking rates that occurred on many of the sites. The implementation of managed grazing systems are permitting the landowners to increase their stocking rates and thus, maximize their forage production for their pastures.

5.3.2 Evidence of Overstocking and Overgrazing

The effect of grazing by domestic livestock on grassland plant communities depends on:

- The season of use
- Intensity of grazing
- Duration of grazed and ungrazed periods (Manske et al. 1988)

Many of the managed grazing landowners increased their stocking rates within the two field seasons. Only one season-long grazing landowner increased his cattle numbers. This may or may not be indicative of the management strategies employed by managed grazing landowners and could be dependent on short term cattle markets. The literature suggests that as frequency and intensity of grazing increases, plant production and vigour decreases. Palatable plants are replaced by fewer palatable plants and the range carrying capacity is reduced (Ralph et al. 1990). Vegetation sampling indicated that there was evidence of overgrazing in all of the managed grazing and season-long grazing sites. Pussy-toes, plantain, and pasture sage were prevalent in many of the pastures (Anon, n.d.). These species are considered " increaser" plant species, and will increase as a result of over-grazing. Table 14 illustrates the stocking rate changes that occurred.

Table 23: Changes in Stocking Rates from 1995 - 1996 Field Seasons

Site	Managed Grazing	Season Long Grazing
Site 1	+ 30 % *	0 %
Site 2	- 17 %	0 %
Site 3	+ 11 %	0 %
Site 4	0 %	+50 %
Site 5	+78 %	0 %

* Heifers only, no calves

To date, managed grazing landowners are not maximizing the potential benefits for both range forage production and wildlife habitat that could be derived from their respective grazing systems. Many landowners were simply leaving their cattle too long in one pasture, increasing stocking rates, and repeating the grazing pattern year after year (Anderson site). This site had fewer species, and lower total productivity (Table 9). This further suggests the anticipated recovery of the plant community will occur much more slowly, and will in turn affect the avifauna nesting ability and response to the habitat created.

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Objectives Reviewed

Briefly, the research objectives of this study were to :

- Quantify individual avifauna species richness, and species abundance
- Determine the cumulative productivity of common species
- Compare managed grazing effectiveness in increasing non-game species abundance, richness and productivity when compared with season-long grazing.
- Provide recommendations for future research evaulating non-game bird species richness, abundance and productivity in the Manitoba parkland areas

6.1.1 Species Richness and Species Abundance

Species richness in each grazing system was similar. In 1995 species richness for managed grazing was 13 species per plot compared with 14 species per plot in season-long grazing. In 1996 species richness for managed grazing was 22.7 species per plot compared with season-long grazing that had 21.7 species per plot.

Abundance results were not statistically different, although some species were more prevalent on managed grazing sites when compared with season-long grazing sites. Red-winged blackbirds and clay-colored sparrows were more abundant on managed grazing systems during both field seasons (although not statistically significant) and savannah sparrows, western meadowlarks, and LeConte' s sparrows were more abundant on season-long sites. Theses differences occurred despite the macro-habitat similarities of the study plots.

6.1.2 Species Productivity

Nebulous conclusions can be derived from productivity results. Some species, such as red- winged blackbirds, yellow-headed blackbirds and marsh wrens, experienced greater productivity on managed grazing sites. Others, savannah sparrows, bobolinks and sedge wrens achieved higher productivity on season-long systems sites. Productivity data yielded inconsistent results, as significant differences were detected in 1996 but not in 1995.

6.1.3 Vegetation

No significant differences were detected in vegetation structure, composition, or height when season-long and manged grazing sites were compared. It does appear that vegetation litter, and height have been marginally increased in managed grazing sites. Incidence of bare ground is also reduced in managed grazing sites when the percent cover estimates between managed grazing and season-long grazing sites were compared. However, it is not apparent if such increases are sufficient to provide increased cover and protection for non-game species.

6.2 Conclusion

The results suggest that it is not only the type of grazing system on a particular habitat that influences nongame species abundance and productivity. Rather, there may be a whole spectrum of factors that may affect what quality of habitat is available for non-game birds. This study has examined some of these factors (stocking rates, habitat fragmentation, predation rates, etc.) but there is still a plethora of factors that may influence avian habitat selection. To date very little published research has been conducted on grassland songbird communities and current knowledge is restricted to a general understanding of their distribution, habitat requirements and life history (Poston et al. 1990). Exactly what factors may influence nongame birds habitat selection may never really be determined, but conservation efforts should take into consideration that non-game bird species require diverse habitats. It is also important to know what influencing factors increase a species vulnerabilty, to guide further conservation efforts directed at maintaining species population levels (Bohning-Gaese and Bauer, 1996). Non-game bird species were not influenced by the macro-habitat similarity between the grazing systems (percentage of wetland, grass, shrubs etc.) and specific habitat requirements may be very different for some species. The results of this study indicates that non-game birds may be cueing into subtle micro-indicators of habitat.

It is difficult to integrate all the factors that contribute to whether a non-game bird species may succeed in a particular environment. Many external factors influence what habitat is found in a given plot at any one time. The current stocking rates, and methods of managing the grazing systems examined in this study, do not appear to be significantly increasing the amount of vegetation cover available to non-game birds and non-game birds are subsequently not more abundant, or more productive on the managed grazing sites.

6.3 Recommendations

This research has answered a few questions but a larger question still remains: why are managed grazing systems not increasing non-game productivity and abundance? What other factors are at work and can they be improved so that non-game bird populations can be stabilized? To determine what these factors are, the following recommendations should be included in future studies;

1) Improvement of the research design;

- Plot sizes should be reduced, so that habitat heterogeneity can be reduced. Censuses were designed to capture the essential composition of breeding bird communities and were not designed to provide an exhaustive list of bird species. However, the accuracy of non-game bird identification within heterogeneous habitat and a reduction of observer bias can be achieved by reducing the size of the study plot. Similar studies conducted in the aspen parkland of Alberta have used 75-m plots because of the naturally occurring habitat heterogenity (Prescott and Murphy, 1996; Prescott and Wagner, 1996).

- Increase the number of study plots, so that if plots are hayed, or not grazed according to the managed grazing agreement, the plot can be removed from the study. Increasing the number of plots will permit the inclusion of more non-game bird species so that a larger avian community can be examined without affecting the statistical "robustness".

- Gather data for a three-year period so that trends in non-game species abundance, richness, and productivity may be more thoroughly investigated and an overall average rather than annual averages may be determined.

2) Enhance landowner/ conservation agency communication;

- Researcher and conservation group field managers should work more closely with the landowners. Landowners should be provided with frequent feedback suggesting the range conditions and plant community compositions so that they can be better informed for when they make their stocking rate decisions.
- Managed grazing systems should by evaluated on a semi- regular basis, by conservation authorities such as Ducks Unlimited Canada and/or Manitoba Habitat Heritage Corporation. This will ensure that maximum benefits for forage production and wildlife can occur.
- Re- examine the managed grazing systems in this study after they have been established for 5 of 6 years. It is possible that the managed grazing systems examined in this study had not had sufficient time to recover from chronic over-grazing, or the avifauna community had yet to experience the benefits from the improved range condition.

Do managed grazing systems really work? The answer may depend on the management goal. If the main management concern of managed grazing systems is to maintain avian species abundance, richness and productivity then in the very least, they maintain approximately the same levels when compared with season-long grazing. If managed grazing systems are designed to increase forage production, the increased stocking rates on the pastures would suggest that grazing systems are successful. Whether the goals of enhancing wildlife habitat and maximizing forage production can be compliementary, it may simply be too early to tell. In the increasingly fragmented landscapes in which grassland avifauna subsists, it does appear that, in the very least, managed grazing systems are not detrimental to non-game bird species.

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Appendices

Appendix A

Species list 1995 and 1996

(Order and Nonmenclature follows American Ornithologists Union 1983)

Species Observed in	1995	1996
Horned Grebe★ (*Podiceps auritus)*	✓	✓
American Bittern (*Botaurus lentiginosus)*	✓	✓
Canada Goose (*Branta canadensis)*	✓	✓
Mallard (*Anas platyrhynchos)*	✓	✓
Gadwall (*Anas strepera)*	✓	✓
Green-winged Teal (*Anas crecca)*	✓	✓
Northern Pintail (*Anas acuta)*	✓	✓
Northern Shoveler (*Anas clypeata)*	✓	✓
Blue-winged Teal (*Anas discors)*	✓	✓
Canvasback (*Aythya valisineria)*	✓	✓
Redhead (*Aythya americana)*	✓	
Common Merganser (*Mergus merganser)*	✓	✓
Virginia Rail (*Rallus limicola)*	✓	
Sora (*Porzana carolina)*	✓	✓
Yellow Rail (*Coturnicops noveboracensis)*		✓
American Coot (*Fulica americana)*	✓	✓
American Avocet ★(*Recurvirostra americana)*		✓
Killdeer (*Charadruis vociferus)*	✓	✓
Marbled Godwit (*Limosa fedoa*)	✓	✓
Willlet (*Catoptrophorus semipalmatus)*	✓	✓
Greater Yellowlegs (*Tringa melanoleuca*)	✓	
Wilson's Phalarope (*Phalaropus tricolor)*	✓	✓
Common Snipe *(Gallinago gallinago*)	✓	✓
Upland Sandpiper (*Bartramia longicauda)*	✓	✓
Ring-billled Gull (*Larus delwarensis)*	✓	
Black Tern (*Chlidonias niger)*	✓	✓
Bald Eagle (*Haliaeetus leucocephalus)*	✓	✓
Northern Harrier (*Circus cyaneus)*	✓	✓
Sharp-shinned Hawk (*Accipter striatus)*	✓	✓
Broad-winged Hawk *(Buteo platypterus)*	✓	✓
Red-tailed Hawk *(Buteo jamaicensis)*	✓	✓
Sharp-Tailed Grouse (*Tympanuchus phasianellus*)	✓	
Mourning Dove (*Zenaida macroura)*	✓	✓
Great Horned Owl (*Bubo virginianus)*	✓	
Northern (Common) Flicker (*Colaptes auratus)*	✓	✓
Downy Woodpecker (*Picoides pubescens)*	✓	✓
Eastern Kingbird (*Tyrannus tyrannus)*	✓	✓
Western Kingbird ▲(*Tyrannus verticalis)*	✓	
Eastern Phoebe (*Sayornis phoebe)*	✓	✓
Least Flycatcher (*Empidonax minimus)*	✓	✓

Species Observed	1995	1996
Alder Flycatcher (*Empidonax alnorum)*	✓	✓
Horned Lark (*Eremophila alpestris)*	✓	✓
Tree Swallow (*Tachycineta bicolor)*	✓	✓
Barn Swallow (*Hirundo rustica)*	✓	✓
Blue Jay *(Cyanocitta cristata*)	✓	✓
Black-billed Magpie (*Pica pica)*	✓	✓
American Crow (*Corvus brachyrhynchos)*	✓	✓
Common Raven (*Corvus corax)*	✓	✓
Black-capped Chickadee (*Parus atricapillus)*	✓	✓
House Wren (*Troglodytes aedon)*	✓	✓
Marsh Wren (*Cistothorus palustris)*	✓	✓
Sedge Wren (*Cistothorus platensis)*	✓	✓
Mountain Bluebird (*Sialia currucoides)*	✓	✓
Swainson's Thrush (*Catharus ustulatus*)		✓
American Robin (*Turdud migratorius)*	✓	✓
Gray Catbird (*Dumetella carolinensis)*	✓	✓
Brown Thrasher (*Toxestoma rufum)*	✓	✓
Sprague's Pipit (*Anthus spragueii)*	✓	
Cedar Waxwing (*Bombycilla cedrorum)*	✓	✓
Red-eyed Vireo (*Vireo olivaceus)*	✓	✓
Warbling Vireo (*Vireo gilvus)*	✓	✓
Cape May Warbler (*Dendroica tigrina)*		✓
Yellow-rumped Warbler *(Dendroica coronata)*	✓	✓
Palm Warbler (*Dendroica palmarum)*		✓
Yellow Warbler (*Dendroica petechia)*	✓	✓
Common Yellowthroat (*Geothlypis trichas)*	✓	✓
Rose-breasted Grosbeak (*Pheuticus ludovicianus)*	✓	✓
Grasshopper Sparrow▲ (*Ammodramus savannarum*)	✓	✓
LeConte's Sparrow (*Ammodramus leconteii)*	✓	✓
Sharp-tailed Sparrow (*Ammodramus caudacutus)*	✓	✓
Vesper Sparrow (*Pooecetes gramineus*)	✓	✓
Savannah Sparrow *(Passerculs sandwichensis)*	✓	✓
Song Sparrow (*Melospiza melodia)*	✓	✓
Chipping Sparrow (*Spizella passerina)*	✓	✓
Clay-colored Saprrow (*Spizella pallida)*	✓	✓
White-throated Sparrow (*Zonotricha albicollis*)	✓	✓
Swamp Sparrow★ (*Melospiza georgiana)*	✓	
Bobolink (*Dolichonyx oryzivorus)*	✓	✓
Western Meadowlark (*Sturnella neglecta)*	✓	✓

Species Observed	1995	1996
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus)*	✓	✓
Red-winged Blackbird (*Agelaius phoeniceus*)	✓	✓
Brewer's Blackbird (*Euphagus cyancephalus)*	✓	✓
Brown-headed Cowbird (*Molothrus ater)*	✓	✓
Common Grackle (*Quiscalus quiscalus)*	✓	✓
Northern Oriole (*Icterus galbula)*	✓	✓
American Goldfinch (*Carduelis tristis)*	✓	✓
Purple Finch (*Carpodacus purpureus*)	✓	✓

▲ Species found only on season-long grazing sites
★ Species found only on managed grazing sites
✓ Species observed in 1995 and/or 1996 field season

Appendix B

Abbundance 1995

plot	ccsp	lcsp	weme	rwbb	sasp	vesp	totals	avg/plo
1	3	1	2	4	11	0	21	14.2
2	8	2	3	6	6	0	25	
3	11	0	2	4	6	1	24	
4	5	2	0	4	6	0	17	
5	4	3	0	1	6	1	15	
6	3	3	0	0	7	0	13	
7	3	3	0	0	7	0	13	
8	10	0	1	0	2	1	14	
9	3	2	0	1	10	0	16	
10	4	1	0	0	3	0	8	
11	1	0	1	6	0	2	10	
12	3	0	1	4	3	0	11	
13	0	1	3	1	6	1	12	
14	3	3	1	2	2	0	11	
15	2	0	1	0	7	1	11	
16	5	3	3	1	4	0	16	
17	5	0	1	5	2	1	14	
18	5	0	3	1	1	0	10	
19	5	1	1	5	2	0	14	
20	0	0	0	7	0	2	9	
	83	25	23	52	91	10	284	
	4.15	1.25	1.15	2.6	4.55	0.5		

1	2	1	0	0	2	1	6	avg/plo
2	3	0	0	0	1	1	5	12.61
3	2	1	0	0	7	0	10	
4	5	3	0	1	4	0	13	
5	0	6	1	1	7	0	15	
6	2	5	5	0	11	0	23	
7	7	2	0	1	7	0	17	
8	1	1	0	2	4	0	8	
9	3	0	0	0	5	1	9	
10	4	0	1	1	1	1	8	
11	2	0	2	0	2	2	8	
12	1	2	1	0	1	0	5	
13	3	2	2	0	2	0	9	
14	9	0	2	0	4	0	15	
15	4	0	2	2	10	0	18	
16	7	4	3	1	4	2	21	
17	8	1	2	1	6	0	18	
18	5	1	2	6	5	0	19	
	68	29	23	16	83	8	227	
	3.78	1.61	1.28	0.89	4.61	0.44		

Abundance 1996

ccsp	lcsp	weme	rwbb	sasp	vesp	totals	avg/plo
3	2	4	15	17	0	42	27.41
2	0	8	10	11	1	32	
6	0	6	8	7	1	28	
3	10	0	2	19	1	35	
7	1	1	3	3	3	18	
1	0	2	11	8	0	22	
2	0	2	4	11	0	19	
3	3	3	17	7	0	33	
1	6	3	8	9	5	32	
2	4	5	7	12	7	37	
1	4	3	7	12	3	30	
2	0	5	10	10	3	30	
2	1	5	5	6	1	20	
8	1	3	6	3	3	26	
4	0	4	10	3	1	21	
5	0	3	7	2	1	19	
2	0	62	11	6	0	22	
54	32	3	141	146	30	466	
3.17	1.88	3.65	8.29	8.59	1.76		

3	1	0	5	4	2	15
4	0	0	5	8	3	20
2	2	1	4	14	1	24
2	1	6	6	11	2	28
2	3	4	1	8	0	18
0	2	6	5	9	2	24
2	2	6	17	12	3	41
3	3	3	10	5	0	24
4	0	3	7	7	5	26
1	0	5	5	13	2	26
2	1	5	7	10	1	26
5	4	3	3	7	3	25
1	0	7	6	15	1	30
3	2	10	2	18	0	35
1	4	10	8	13	0	36
4	7	5	4	10	0	30
4	5	7	11	6	0	33
43	36	81	106	170	25	461
2.53	2.11	4.76	6.23	10	1.47	

Appendix C

Productivity 95

plot	ccsp	weme	sasp	rwbb	yhbb	cofl	cosn	lcsp	vesp	mawr	wiph	will	bobo	totals	avg/plo
1	2	8	9	14	5	0	0	1	1.5	0.5	0.5	2	2	45.5	19.12
2	0	0	10	8.5	0.05	0.5	0.5	0.5	0	0	3	0	0	23.5	
3	3	1	19	3.5	0	0	0	1	0.5	0	0	0.5	2	30.5	
4	0.5	0.5	9.5	1	0	0	0	1	0	0	0	0	0.5	13	
5	2	0	7.5	5	0	0	0	1	7	0	0	0	0	22.5	
6	1.5	0	15	0	0	0	0	2	1	0	0	0	1.5	21	
7	8	0	9	0	0	0	0	7	3	0	0	0	0	27	
8	4.5	0	2.5	0	0	0	0	0	5.5	0	0	0	0	12.5	
9	1.5	0	5	2	0.5	2	0	1	0	0.5	0	0.5	0	13	
10	1	0	10	3.5	0	0	0	2	3	0	0	0	0	19.5	
11	0	0.5	8	2	0	0	0	0	0	0	0	0	1	11.5	
12	1	0	16	0	0	0	0	1.5	0.5	0	0	0	5.5	24.5	
13	0.5	0	0	8	0	0	0.5	1	0.5	0	0	0	1	11.5	
14	0.5	0	9.5	0	0	0	0	1	0.5	0	0	0	5	16.5	
15	0	0	3.5	0	0	0	0	0.5	0.5	0	0	0	0	4.5	
16	3.5	2.5	5.5	4.5	1	0.5	0	0.5	1	0	0	0	0	19	
17	5.5	0.5	4	0	0.05	0	0	0	4	1	0	0	0	15.5	
18	3.5	5	2.5	1	0	0	0	0	0	2	0	0	0	14	
19	1.5	4	1.5	4	5.5	0	0	0	0	1	0	0	0	17.5	
20	1.5	2.5	5	4	5	0	0	0	1	1	0	0	0	20	
Total	41.5	24.5	152	61	18	3	1	21	29.5	6	3.5	3	18.5	382.5	
Avg	2.07	1.22	7.6	3.05	0.09	0.15	0.05	1.05	1.475	0.3	0.175	0.15	0.925		

cont															
1	1	0	2	0	0	0	0	3	0.5	0	0	0	0	6.5	19.28
2	0.05	0	3	0.5	0	0	0	1	0	0	0	0	0	5	
3	0	0	5	13.5	0.5	0	0	1.5	0.5	0	0	0	6	27	
4	1.5	0.5	23.5	3	0	1	0	2.5	5	0	0	0	2.5	39.5	
5	0	0.5	18	3.5	0	0	3.5	2	3	0	0	0	0	30.5	
6	0	0.5	21	2	0	0	0	2.5	0	0.5	0	0.5	0.5	27.5	
7	5	0.5	10.5	2	0	0	0	1	3	0	0	2	0.5	24.5	
8	0.5	2	8	7	0	0	0	2	0.5	2	0	0	2.5	24.5	
9	1	2.5	6	5	0	0	0	0	0	0	0	0	0	14.5	
10	0	0	0.5	0	0	0	0	2	0	0	0	0	2	4.5	
11	0	0	3	0	0	0	0	0	5	0	0	0.5	0	8.5	
12	0	0.5	7	0	0	0	0	0	2	0	0	0	1	10.5	
13	3.5	0	1.5	0	0	0	0	0	4	0	0	0	2.5	11.5	
14	9	0.5	15.5	5	0	0	0	0.5	0	0	0	0	0	30.5	
15	2	2	0	0	0	0	0	6	0	0	0	0.5	0	10.5	
16	0	1	0	0	0	0	0	0	0	0	0	0	0	1	
17	0	3.5	24	0	0	0	0	7	0.5	0	5	0	0	40	
18	5	0	16	6.5	0	0	0	1.5	0	0	0.5	0	1	30.5	
Total	29	14	164.5	48	0.5	1	3.5	32.5	24	2.5	5.5	3.5	18.5	347	
Avg	1.61	78	20.56	2.67	0.028	0.055	0.194	1.8	1.33	0.055	0.305	0.194	1.028		

Productivity 96

plot	ccsp	weme	sasp	rwbb	yhbb	cofl	lcsp	vesp	mawr	sewr	wiph	will	bobo	totals	avg/plo
1	4.5	3.5	22.5	14.5	3	2.5	6	1.5	2	0.5	0	0	1	61.5	43.62
2	4	3	27.5	14.5	8	0	2	2.5	3	0	2	1	0.5	68	
3	6.5	4	18.5	10.5	7	0.5	1	2	4.5	0.5	0	0	0	55	
4	2.5	0	22	8	0	0.5	18.5	1	0	0	0	0	0	52.5	
5	6	0	9	5.5	0	0	0.5	3	1	0	0	0	0	25	
6	3	1	13.5	10	1	0	2	2	2	0	0	0	0	34.5	
7	4.5	0.5	13.5	13.5	5.5	0	2.5	1.5	1.5	0	0	0	0	43	
8	2	1	12	18	6.5	1	2	2.5	0	0	0	0	0	45	
9	2	3.5	19.5	7.5	0	0	3.5	1	0	0.5	0	1	1	39.5	
10	4	5	15	1.5	1	0	6	2	0	0	0	0	2	36.5	
11	1	0	20	15.5	0	1	10	3.5	0	0	5	0.5	0	56.5	
12	2.5	2	21.5	1.5	0	0	0	1.5	0	0	0	0	0	29	
13	1.5	1.5	8.5	15.5	10	0	1	2	1.5	0	0	0	0	41.5	
14	6.5	2.5	13.5	9.5	3.5	0	6.5	6.5	3	2.5	0	0	0.5	54.5	
15	6.5	0	10	11	6.5	0	0.5	5.5	1	0	0	0.5	0	41.5	
16	6	2	5	7	4.5	0	1	4.5	0.5	0	0.5	0	0	31	
17	3.5	1.5	7	9.5	0	0	0	1.5	3.5	0	0	0.5	0	27	
Total	66.5	31	258.5	173	56.5	5.5	63	44	23.5	4	7.5	3.5	5	741.5	
Avg	3.9	1.8	15.2	10.17	3.23	0.323	3.7	2.59	1.38	0.235	0.44	0.205	0.29		

cont															
1	3	0	14.5	3.5	0	0.5	1.5	11.5	0	0	0	0	0	34.5	42.82
2	1.5	0	21.5	2.5	0	0	2	8.5	0	0	0	0	0	36	
3	3.5	0	27	12	2	0.5	5	0	0.5	0	0	0	1	51.5	
4	4	1.5	23	10.5	5	0.5	3.5	3.5	2.5	2	0	1.5	9.5	67	
5	0.5	2.5	26	8	0	0.5	4.5	0.5	2	2.5	0	0	2	49	
6	1	1.5	29.5	4.5	0	0.5	10	11	2.5	0.5	0	2	0	63	
7	7	3.5	34	4	0	0	3	1	0	0	0	1	0	53.5	
8	1.5	1.5	9.5	17.5	1.5	0.5	2	0	3.5	0.5	0	0	2	40	
9	10	0.5	2	8	0.5	2	1.5	9	1.5	0	0	0	0	35	
10	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	1	
11	2	2	14	7	1	0	1.5	1	0.5	0	0	0	0	29	
12	4	0	8.5	1	0	0	4	4.5	0	0	0	0	2	24	
13	4.5	4	24.5	11	0	0	6.5	2.5	0	1	0	0	2.5	56.5	
14	4	5.5	24	4.5	0	0	5.5	0.5	0	0	0	0	0.5	44.5	
15	2	4.5	21.5	8	0	0	8.5	1	1	9	0	2	0	57.5	
16	5.5	9	18.5	2	0	0	2	2	0	2.5	0	0	0	41.5	
17	3	1.5	9	18.5	0.5	0	4.5	0	2.5	5	0	0	0	44.5	
Total	57	37.5	307.5	123	10.5	5	65.5	56.5	16.5	23	0	6.5	19.5	728	
Avg	3.35	2.2	18.08	7.23	0.617	0.29	3.85	3.23	0.97	1.35	0	0.38	1.14		