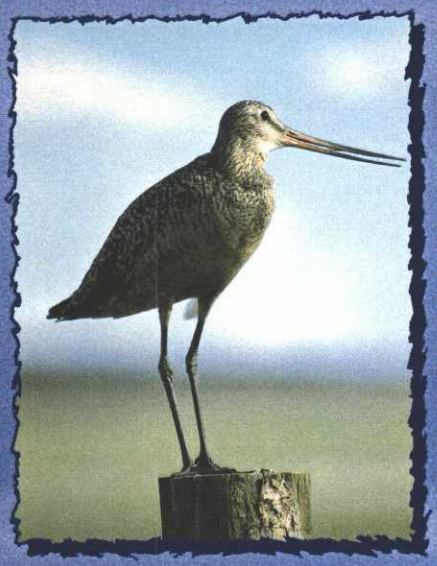

Avifauna Component Report

Canadian Forces Base Suffield National Wildlife Area Wildlife Inventory

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

AVIFAUNA COMPONENT REPORT

CANADIAN FORCES BASE SUFFIELD NATIONAL WILDLIFE AREA

WILDLIFE INVENTORY

Canadian Wildlife Service
Environment Canada
Prairie and Northern Region
Edmonton, Alberta

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December 1999

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Other reports prepared for the CFB Suffield National Wildlife Area wildlife inventory project include:

Flora Component
Vegetation Component
Wetlands Component
Raptor Component
Carnivore Component
Ungulate Component
Reptile and Amphibian Component
Small Mammal Component
Insect Component

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EXECUTIVE SUMMARY

Birds populations were inventoried and studied on the proposed CFB Suffield National Wildlife Area (SNWA) during 1994, 1995 and briefly in 1996, as part of a multi-disciplinary wildlife inventory. The purpose was threefold: to update the inventory and improve the knowledge on the status of birds in the area; relate the presence and diversity of bird species to the ecological land classification, vegetative cover types, and topographic segments (Upland, Ravines/Slopes, Wetlands, Riparian); and identify avian response to activities and processes in the area.

Systematic sampling during the breeding season was conducted over the Upland (grassland and sand dunes), which comprised much of the SNWA. Specialized breeding and some migration surveys were undertaken in Wetlands and the Ravine/Slopes, and Riparian habitats associated with the South Saskatchewan River valley.

Status

One hundred and ninety-four species were encountered, or present historically. This total is comparable to the 198 bird species found at Matador, Saskatchewan during the 1967 to 1971 International Biological Program study. A substantial number (64 species) had no previous records for the SNWA. Many of the new species were migrants or summer visitants but some new breeding species were also encountered. In all 111 species were proven or expected to breed. Most of the 60 migrant species were associated with woody vegetation. We believe winter and migrant use were underestimated during the inventory.

The presence of other biomes nearby (e.g., Cypress Hills) likely influenced the composition of the bird community. Large as it is, the SNWA does not support bird populations in isolation. Without other river valley habitat nearby many of the species associated with woody habitats in Ravines/Slopes or Riparian segments would not occur. Adjacent grassland habitat (the remainder of CFB Suffield, Remount Pasture and pastures to the south and across the river) add to the high value of the SNWA for grassland birds by creating a large habitat block.

Influence of Topographic Segments

Each topographic segment contained some species restricted to that portion of the SNWA so the inclusion of the physical and vegetative variety of these 4 different areas is a big part of the reason for the high number of species. Using the simplest measure of *local diversity* (number of species), the Ravines/Slopes, Wetlands, and Riparian segments contribute the majority of the species encountered on the SNWA, but most birds are present in low numbers. In contrast, the Upland is relatively poor in bird species at any given point, but many species are present in high numbers over the extent of the segment. There is also some evidence to suggest the avian community is highly productive on the SNWA, although early summer fires may have negative effects. The avian community appears to suffer only mildly from nest parasitism, especially when compared to current high parasitism in fragmented portions of the prairies.

The Upland is important to *regional diversity* because of the varied and healthy populations of *regionally unique* species (characteristic and restricted to a region) and several species that are considered *at risk* nationally or provincially. Virtually all grassland *regionally unique* bird species, that could reasonably be expected to occur, were present in the SNWA in far greater frequency than in the prairies as a whole. Because most of these populations are *declining* in the Canadian or North American prairies, the conservation significance of the SNWA in maintaining large populations of these species is increased. Most migrants used Riparian habitats and since many were *rare* or *declining* this helps to maintain *regional diversity*. Wetlands and Ravines had a few breeding *regionally unique* species. Wetlands, Ravines/Slopes, and Riparian also make a contribution to *regional diversity* because of *rare* or *declining* species breeding in these uncommon habitats. Most species using Ravines/Slopes, Wetlands, or Riparian were present in low numbers within those segments. A number of shrub and tree nesting species are shared between Riparian, Ravines/Slopes, shrubby portions of Upland (North Block) and similar habitats across the South Saskatchewan River and up and downstream.

Influence of Ecosections and Vegetation Cover Types

Wooded ecosections and vegetation cover types (VCT) contain more bird species while the Eolian, Glacial and Morainal ecosites and grass dominated VCTs are species poor but contribute immensely to *regional diversity* because of *unique* and *at risk* species. No single ecosection or VCT sustained all *unique* or *at risk* grassland birds so the variety of Upland sites adds to the SNWA's high value in maintaining *regional diversity*. **The decision, made decades ago, to set aside both the North and South Blocks as environmentally sensitive areas resulted in the maintenance of a site of outstanding national importance to birds characteristic of grasslands.**

Within any segment we found ecosections, VCTs, vegetation structure and primary habitats (for Ravines/Slopes) and wetland types each influenced bird populations, which meant the variety of topography, soil, and cover was needed to attract and maintain *local* and *regional diversity*.

Influence of Management

Livestock grazing reduces the number of bird species in woody habitats. Grazing at low intensity increases numbers of bird species in Upland; however, since each bird species has slightly different habitat needs, the mixture of grazing intensity and timing is what maintains the full suite of *regionally unique* and *species at risk* birds. The current system of rest-rotation grazing using large pastures, few watering sites, few rotations per season and conservative stocking rates is instrumental in creating the habitat heterogeneity necessary to attract a broad array of grassland birds.

Fire reduces *diversity* (*local* and *regional*), particularly in Ravines, Riparian and Wetland segments but also in the Upland as well. However, some individual bird species do better where fires have occurred so the current irregular occurrence of fire in the Upland helps to maintain the

complete bird community. The timing of fires may differ from the historic norm which has implications for the reproductive success of the bird community since nests will be lost to fires occurring in April through July.

The sheer size and shape of the SNWA, as well as the topographic and vegetation diversity within it and the uneven and irregular occurrence of grazing and fires, combine to make the area capable of sustaining many species and a regionally representative bird community. Irregular fire and grazing may mimic some historical driving forces in prairie ecology (wildfire and bison grazing) although fires at SNWA may be more frequent and occur in different seasons than historically.

The final major factor in prairie ecosystems is periodic drought. Because our surveys occurred during years of average or above-average moisture we anticipate that bird communities and bird responses to fire and grazing may shift during drier periods. We advocate conservative stocking rates and maintenance of "high good" to "excellent" range condition as a means of ensuring sufficient habitat for all *regionally unique* and *species at risk* birds, even during drought.

The 1995 flood on the South Saskatchewan River inundated all Riparian areas and the lowest portion of many ravines. Should a permanent water level change occur (a dam placed upstream from the SNWA), it would have a devastating effect on SNWA *local* and *regional diversity* through the loss of species numbers and *rare* species

The negative reproductive impact of the European Starling (an introduced bird species) on high avian *local diversity* in Riparian areas appears to be substantial. The negative impact of introduced plant species on the *regional diversity* of birds in the SNWA is small at this time, but we recommend that further monitoring and research be undertaken. Future grazing management may well be a trade off between the negative impact of grazing on woody vegetation and the beneficial control of introduced plant species with grazing.

Future Monitoring or Research

Additional future monitoring or research projects that would provide information useful for management of the area include the following:

- Studies of bird communities to determine their response to drought conditions, elk browsing, changes in stocking rates, protection from grazing (river valley and North Block), and range condition.
- Avian productivity and brood parasitism studies.
- Research focused on the effect of roads on bird distribution, abundance and productivity.

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Dave Prescott was instrumental in report production. He performed all the final Upland segment data analysis (contracts KE501-6-0361 and KE501-6-0756) and reviewed the manuscript.

Ross Dickson aided us in almost every post fieldwork phase of this project. He performed some data entry, data checking and cross-checking. He assisted in data compilation for the riparian, wetland and ravine segments of the report, in preparation of several appendices, and with checking the manuscript at several stages of its development.

Sam Barry prepared most of the figures and gave us valuable comments on text and presentation methods. The GIS section of Environment Canada produced the figures reproduced from previous reports. Ed Telfer, Dave Prescott, Ed Driver and Cleve Wershler kindly provided peer review of this manuscript. Maja Laird provided comments on clarity and format.

David Gummer provided a large number of avian records for the night time hours. Without him, we would have been unaware of the presence of Common Poorwill. He contributed a summary of habitat use and ecology of Common Poorwill, which we used in writing this report. We thank all the Suffield inventory team for submitting incidental records.

Ron Mellick collected structural vegetation measurements in 1995 and performed most data entry that year. Lonny Bilyk participated in some 1994 vegetation and wetland surveys. Odile Daku entered the majority of incidental observations and Ravine surveys. Val Goossen assisted in data compilation, and in checking and editing drafts of the Riparian and Wetland portions of the report. Pam Martin conducted preliminary Upland analyses. David Ingstrup provided data for the grazing index and helped us with illustrations. Connie Downes, the National Breeding Bird Survey (BBS) coordinator, provided access to over 30 years of BBS data for the prairies. Jocelyn Hudon, Gary Erickson and Bruce McGillivray of the Provincial Museum of Alberta shared their observations and collection records. Michael Bradstreet and Judith Kennedy helped remove sample stakes in 1996 and participated in auxiliary surveys. Mona Adams spent many hours solving formating problems for us and Vi Jespersen typed drafts of several appendices.

We wish to thank Major Dan Davies, Captain Chuck Romain, Lieutenant Mike Sox and the Range Control staff of CFB Suffield for logistic support and ensuring safe passage on the military training range. Sargeant Bill Bennett, Master Bombadier Pete Huffam, and Corporal Tim Bonneville worked with our field crews to coordinate field safety procedures. We thank Alberta Energy Company for access to the warehouse and storage facilities at South Gate 24. We particularly thank Bill Scott for his efforts and many acts of kindness and support.

Don Kraft, Suffield Community Pasture manager, provided advice and assistance during the course of our studies, and the Kraft family tolerated the strange hours we kept, because of our fieldwork, in the compound adjacent to their home.

This project was funded by Environment Canada through the Green Plan Program, the Department of National Defence-Director General Environment, and Canadian Forces Base Suffield. Bob Woods, Department National Defence-Director General Environment, encouraged the wildlife inventory project and coordinated the National Defence funding contribution.

Without Garry Trottier, none of this would have been possible. Garry performed the often thankless task of coordinating this project with great skill and thoughtfulness.

1.0 INTRODUCTION

The Canadian Forces Base (CFB) Suffield National Wildlife Area (SNWA) in southeastern Alberta (Figure 1) was proposed through a Memorandum of Understanding (MOU) between the Department of National Defence (DND) and Environment Canada (DOE) on 11 March 1992.

An integrated wildlife inventory was undertaken in the proposed SNWA to obtain information needed for a management plan. The avifauna study, like other components of the SNWA integrated inventory, related wildlife observations to physical or vegetation features.

1.1 Previous Avian Studies

The Canadian Wildlife Service (CWS) conducted summer raptor surveys along the South Saskatchewan River from 1969 to 1971 (Reynolds and Armbruster 1971). Further bird observations are reported in Woynarski (1971), Stevens et al. (1971), and Stevens (1972). Karasiuk (1976) and Stelfox and Vriend (1977) reported on a preliminary reconnaissance of bird response to grazing. Bird observations were summarized in a review by Shandruk et al. (1984). Major Crease reported ornithological observations made during his stay at CFB Suffield from April to July 1990 (Crease 1990). Portions of the proposed SNWA were also covered by the Alberta Bird Atlas (Semenchuk 1992). These and other wildlife studies were summarized by Patriquin and Skinner (1992).

1.2 Objectives and Products

The objectives of the avian component of the wildlife inventory were as follows:

- Inventory bird populations and prepare an updated species list, including revised seasonal and breeding status, for the SNWA.
- Relate avian distribution, abundance, and diversity to ecological land classification units and vegetation cover types and topographic segments eg. Ravines, Wetlands.
- Identify and describe the response of bird populations, during the study period, to several natural and human-related disturbances.
- Identify management opportunities.

Products of the avian component of the wildlife inventory are as follows:

- Maps of diversity and the distribution and abundance of selected species.
- Rating of local and regional avian diversity by topographic segment, ecosection and vegetation cover types.
- Updated bird status list.
- Electronically archived dataset of bird species abundance at permanently geo-referenced, systematically located plots throughout the SNWA (sites shared with other wildlife inventory components), supplemented by sites in undersampled ecosites.
- Geographically related file, electronically archived, of fire and grazing parameters for each systematically located sampling site.

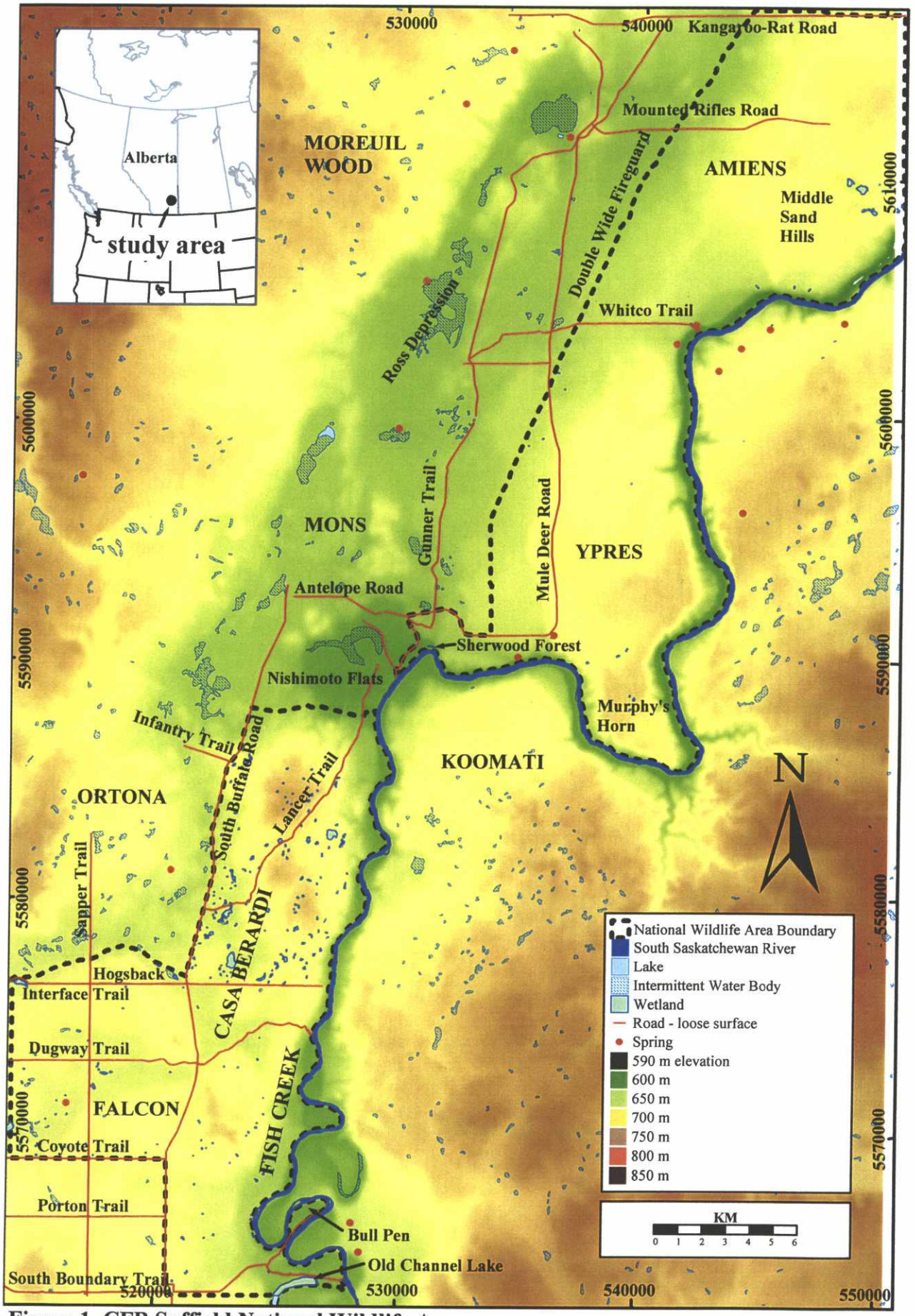


Figure 1. CFB Suffield National Wildlife Area.

2.0 BACKGROUND

2.1 Terminology

Definitions and descriptions of concepts and terms are presented below.

- **Diversity**–the variety of (avian) life forms, the ecological roles they perform, and the genetic diversity they contain (Wilcox 1984, p. 640). Multiple levels of diversity are measurable. Definitions vary with the viewpoint of the author (West 1993).
- **Local diversity** (species richness or alpha diversity)–the number of (avian) species in any given place, regardless of distribution, rarity elsewhere, or whether they are at risk.
- **Regional diversity** (gamma or lambda diversity)–the sum of (avian) species present in a region (in this case 3 prairie provinces). Key measures are the presence/abundance of *regionally unique* species, *species at risk*, *regionally rare* or *declining* species.
- **Regionally unique**–Avian species (or races) entirely or largely restricted to a single geographic area of Canada. Their presence in Canada depends on regional populations.
- **Species at risk**–rated at short- or long-term risk of extirpation by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1999) or Alberta government (Alberta Environmental Protection 1996).
- **Regionally rare**–Breeding species that occur on less than 0.5% of Breeding Bird Survey stops in the 3 prairie provinces.
- **Segment (topographic)**–major topographic area within the SNWA (Upland, Ravines/Slopes, Wetlands, Riparian).
- **Native**–naturally occurring species.
- **Introduced**–species present in Canada only because of deliberate or accidental introduction.
- **Guild**–group that exploits the same resources in a similar manner or exhibits similar characteristics related to part of their behaviour or life cycle (Ehrlich et al. 1988).
- **Migrant**–species that move through an area while going to northern breeding areas in spring and to southern wintering areas in fall.
- **Disturbance**–a relatively discrete event in time (e.g., fire, grazing) that disrupts ecosystems, communities or population structure and changes availability of resources or habitats, physically altering the environment (Turner 1989, p 181). In everyday use disturbance often has a negative meaning. In ecological use, disturbance is not necessarily harmful and may be necessary to maintain an ecosystem.
- **Habitat**–the place where an animal or plant usually lives, often characterized by a dominant plant form or physical characteristic (Ricklefs 1979, p. 871).
- **Fragmentation**–alteration of a large habitat patch to create isolated or poorly connected patches of original habitat interspersed with other habitat patches (Koford et al. 1994).

The Journal of Wildlife Management guidelines have been used for plant and mammal names and the American Ornithologists' Union (1998) for common and scientific bird names (which appear in Appendix 1). Raptors are included in our inventory but a more detailed coverage appears in Banasch and Barry (1998).

2.2 Ecological Land Classification

A preliminary ecological land classification (ELC) of the SNWA, the initial step in conducting a wildlife inventory of the SNWA, mapped recurring patterns of landscape and vegetation (Usher and Strong 1994). The classification system consisted of 4 levels (Table 1), with the ecosite as the basic unit. An ecosite contains a unique set of vegetation, landform, site, and soil characteristics. The land classification legend for the SNWA contains 98 ecosites based on 1 ecoregion, 5 ecodistricts, and 13 ecosections (Figure 2). Eolian, glacio-fluvial, and morainal ecodistricts account for the majority of the SNWA.

2.3 Vegetation Cover Types (VCT)

In the ELC, similar plant communities might be separated on the basis of soil. Plant survey data from the vegetation inventory (Adams et al. 1997) were classified into 28 vegetation cover types (Figures 3 and 4). Grasslands (38%), grassland-shrubs (32%) and shrub-grasslands (26%) dominate the SNWA. Wetlands and tree-dominated landscapes comprise less than 1%. About 1% has been tilled at some time in the past (Adams et al. 1997)

2.4 Land Use and Disturbance Factors

2.4.1 General

Military activities in the SNWA consist mainly of patrols and maintenance. Alberta Energy Company (AEC), under agreement with DND, maintains a network of petroleum extraction sites and access roads and trails. Wellsites have minimal above-ground exposure and through the years, pipeline corridors were reclaimed in accordance with the Suffield Environmental Protection Regulations. In 1985 use of introduced cultivar species, including crested wheatgrass (*Agropyron cristatum*), in revegetation seed mixes was discontinued.

2.4.2 Water Fluctuations and Stabilization

Water levels on Old Channel Lake are managed by Ducks Unlimited Canada (DU). Upstream dams regulate the South Saskatchewan River, reducing flooding frequency and intensity, and indirectly altering plant species composition (Macdonald 1997; Adams et al. 1997).

2.4.3 Livestock Grazing

The prairie ecosystem evolved with periodic grazing by wild herbivores (Kirsch et al. 1978). Large bison (*Bison bison*) herds once roamed the Great Plains, but not all areas were visited equally in terms of season or intervals between grazing events. Grazing was often extremely intense but rarely sustained since herds moved continually. The result of this uneven grazing

was a mosaic of habitat patches, varying through a continuum of heights and uniformity. Based on modern observations in Nebraska, grassy sand dunes are not commonly grazed by bison, who have to be lured into this habitat with bait (Al Steuter, The Nature Conservancy, personal communication to G. Trottier). More than 75% of Canada's grasslands have been broken. The norm on remaining grassland is annual grazing of medium to high intensity so the other historic elements (short duration very high intensity, annual to infrequent low intensity) of the prairie patchwork are currently under-represented.

Table 1. Ecological land classification hierarchy for the CFB Suffield National Wildlife Area.[1]

Ecoregion An area characterized by a distinctive climate as expressed by vegetation. The identification of ecoregions was based on those recognized within the provincial system (Strong 1992).	**Ecodistrict** A subdivision of the ecoregion based on distinct physiographic and/or geological patterns. The primary requirements for this subdivision are areas having similar patterns of relief, geology, geomorphology, and genesis of parent materials.	**Ecosection** A subdivision of an ecodistrict based on recurring patterns of slope, landform, soil, and vegetation. **Ecosite** A subdivision of an ecosection with a unique recurring combination of vegetation, soil, landform, and other environmental components.
Dry Mixed Grass Ecoregion (Map symbol - 1)	**Eolian Landforms** - Landforms developed from wind erosion and deposition. (Map symbol - E)	**E1** - Sand dunes are the dominant feature. 10 ecosites (E1.1-E1.10)
	Fluvial Landforms - Landforms created by flowing water; can be either erosional or depositional. (Map symbol - F)	**F1** - Fluvially incised channels with steep side slopes. 7 ecosites (F1.1-F1.7) **F2** - Fluvial landforms associated with the South Saskatchewan River. 15 ecosites (F2.1-F2.15) **F3** - Secondary stream channels. 7 ecosites (F3.1-F3.7)
	Glacio-Fluvial Landforms - Fluvial features created by flowing water at the time of deglaciation. (Map symbol - G)	**G1** - glacio-fluvial channel banks. 11 ecosites (G1.1-G1.11) **G2** - Glacio and post glacio-fluvial terraces. 27 ecosites (G2.1-G2.27) **G3** - Glacio-fluvial outwash. 12 ecosites (G3.1-G3.12)
	Morainal Landforms- Unconsolidated deposits at time of glaciation. (Map symbol -M)	**M1** - Ground moraine. 8 ecosites (M1.1-M1.8) **M2** - Morainal plain with eolian features. 1 ecosite (M2.1)
	Wetlands - (Map symbol -W)	**W1** - Ravine channels and drainages **W2** - Slump basins and seepages **W3** - River floodplains **W4** - Morainal and glacio-fluvial basins, flats

[1] From Adams et al. 1997.

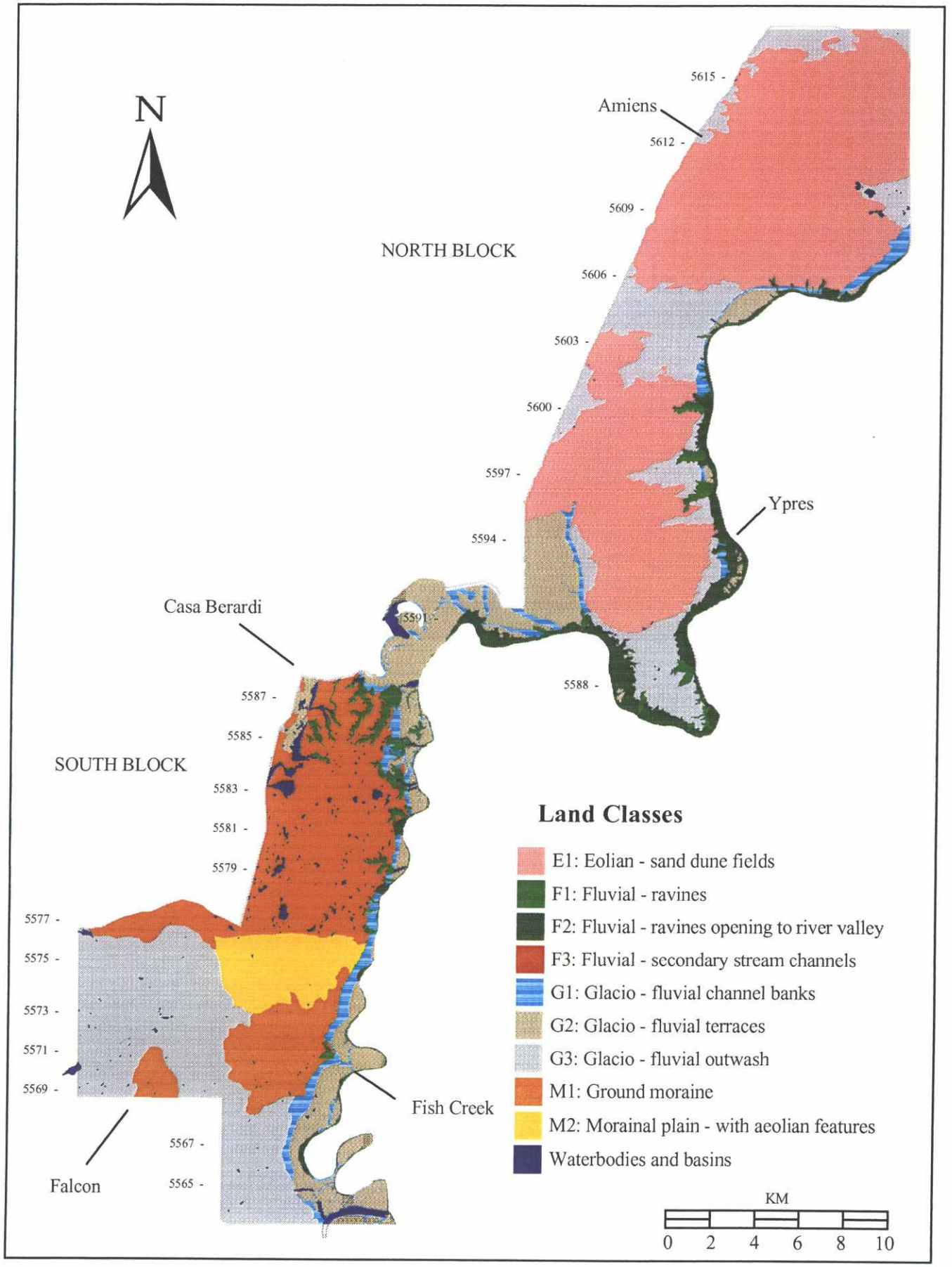


Figure 2. Ecosection map, CFB Suffield National Wildlife Area (Source: Usher and Strong 1994).

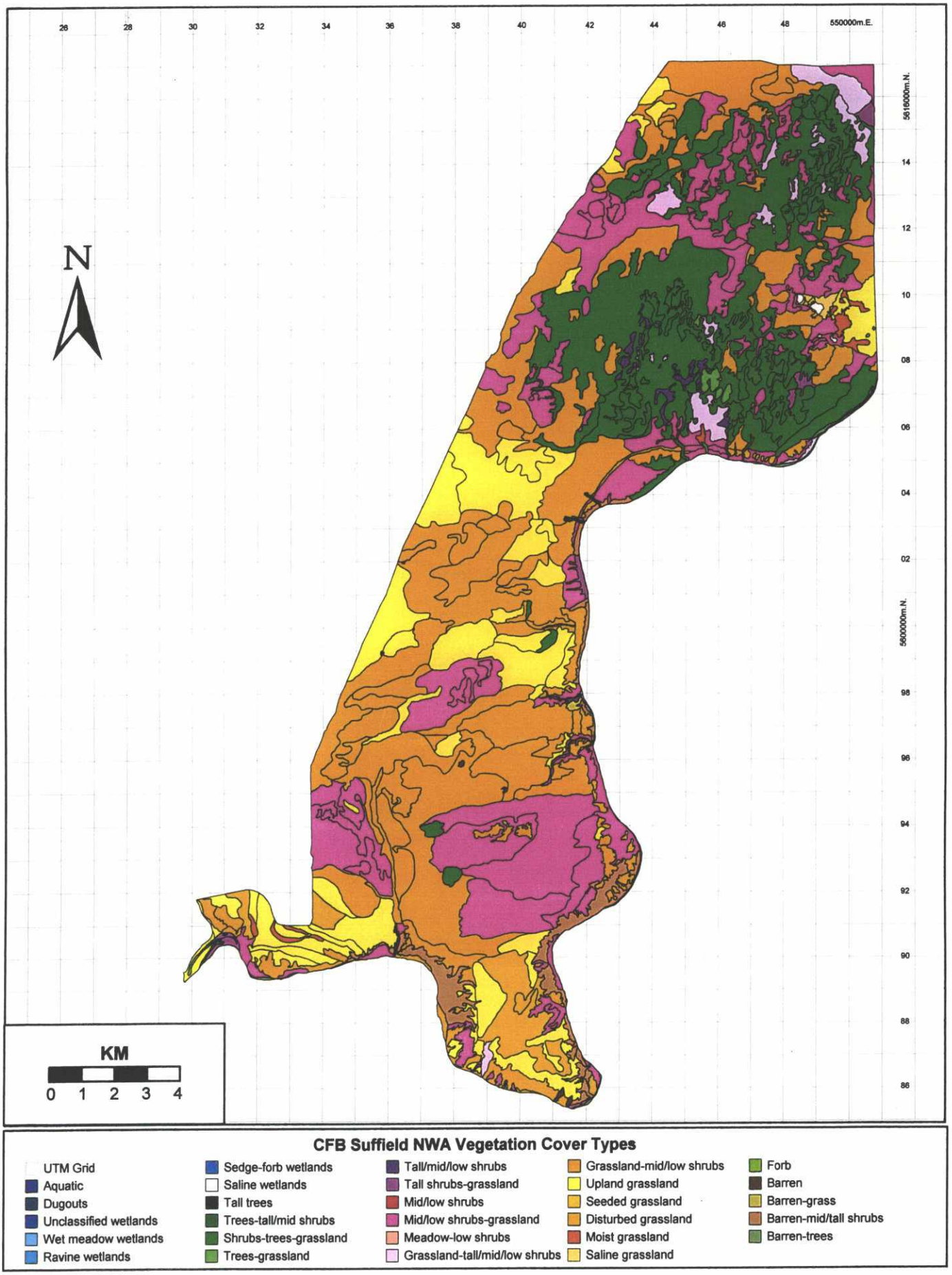


Figure 3. Vegetation cover map, North Block, CFB Suffield National Wildlife Area (Adams et al. 1997).

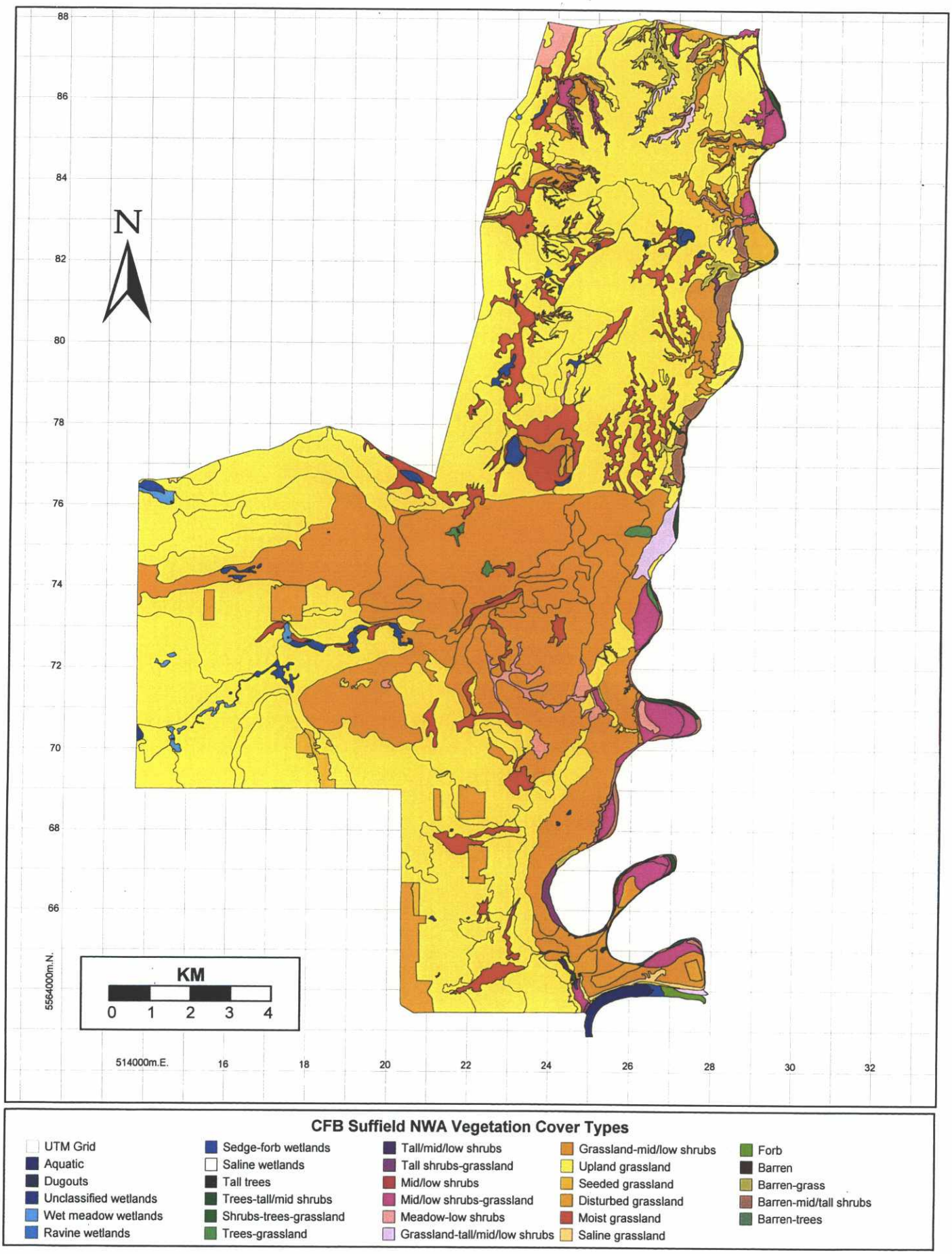


Figure 4. Vegetation cover map, South Block, CFB Suffield National Wildlife Area (Adams et al. 1997).

The SNWA has been subject to various levels of livestock grazing since European settlement (Johnson and Vriend 1977) and to a combination of trespass and sanctioned grazing since the base was established in 1941. CFB Suffield Community Pasture was established in 1964. Prairie Farm Rehabilitation Administration (PFRA) administers it in accordance with the terms in their MOU with DND. Much of the South Block is grazed each summer as a cow-calf operation (Adams et al. 1997). Some fields are grazed all summer. The 4 largest fields are managed on a rest-rotation system, and 4 other fields are lightly grazed periodically in the fall (September/October). Grazing management is reviewed annually by the Suffield Grazing Advisory Committee (SGAC), and recommendations are made to DND.

Grazing pressure in the Casa Berardi pasture was reduced in 1982 and range condition (plant community health) monitoring was initiated (Chu 1993). During the period 1973-1975, concerns about grazing in the Middle Sand Hills area were addressed by removing fencing and cattle. The entire herd of feral horses was removed in 1994.

2.4.4 Wildfire

In the past, fire was a natural disturbance and played an integral part in maintaining and aiding ecological processes in the grasslands (Kirsch et al. 1978; Kruse and Higgins 1990). All grasslands did not burn with equal frequency. Moisture, soil type, and removal of cover by grazers and aboriginal hunting practices, either alone or in combination, influenced the amount of material available to support a fire. The average fire interval varied from 6-25 years in Mixed Prairie (latter occurring in dry sites/poor soils and probably typical for areas like Suffield) according to some authorities (Bragg 1995), but others estimate between 5-10 years (Wright and Bailey 1982). In modern times, fire has been suppressed primarily to protect human interests.

Fire in SNWA is currently more frequent than in other parts of the prairies because of military artillery exercises (Adams et al. 1997). During 1983-1997, there were 22 fires within the SNWA (Figure 5). Fire frequency has been higher in the South Block (Figure 6), but the total area burned is slightly greater in the North Block (Figure 5). DND fireguards limit the spread of range fires from the adjacent military area. Only the 1987 and 1995 burns in Amiens have been confirmed as resulting from natural ignition (Figure 5).

3.0 METHODS

3.1 Study Area

The SNWA is located in southeast Alberta, north of Medicine Hat (Figure 1). The prairie grassland and associated river valley, totalling 458.7 km^2, is contained in 2 discontinuous segments along the easterly portion of CFB Suffield. It is in the dry Mixed Grass ecoregion and characterized by low precipitation and high evapotranspiration rates (Strong 1992). Descriptions are available for climate, soils, vegetation (Adams et al. 1997), and wetlands (Adams et al. 1998). Topographic segments were the basis for division of avian studies.

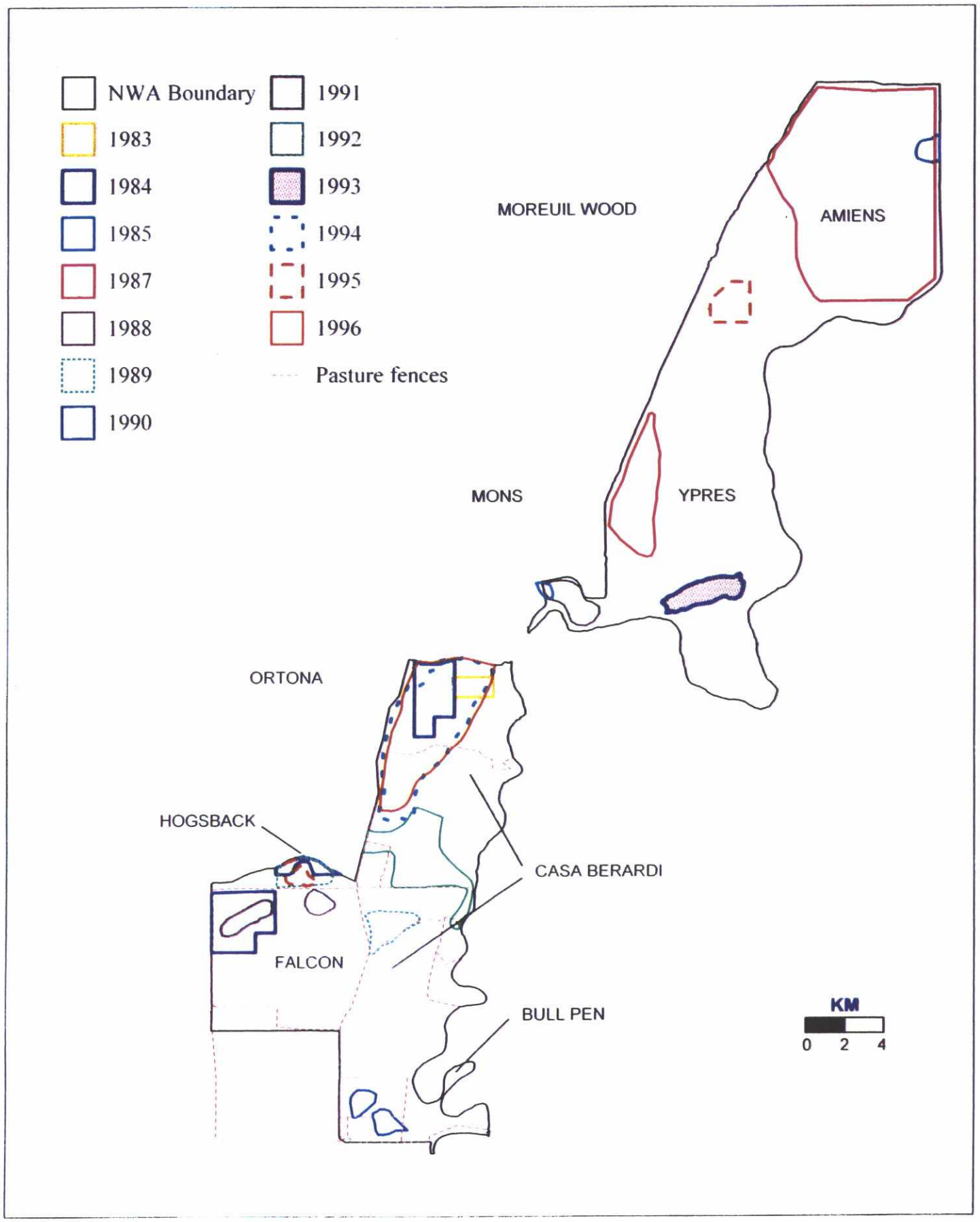


Figure 5. Wildfires in the CFB Suffield National Wildlife Area, 1983-1996 (Adams et al. 1997).

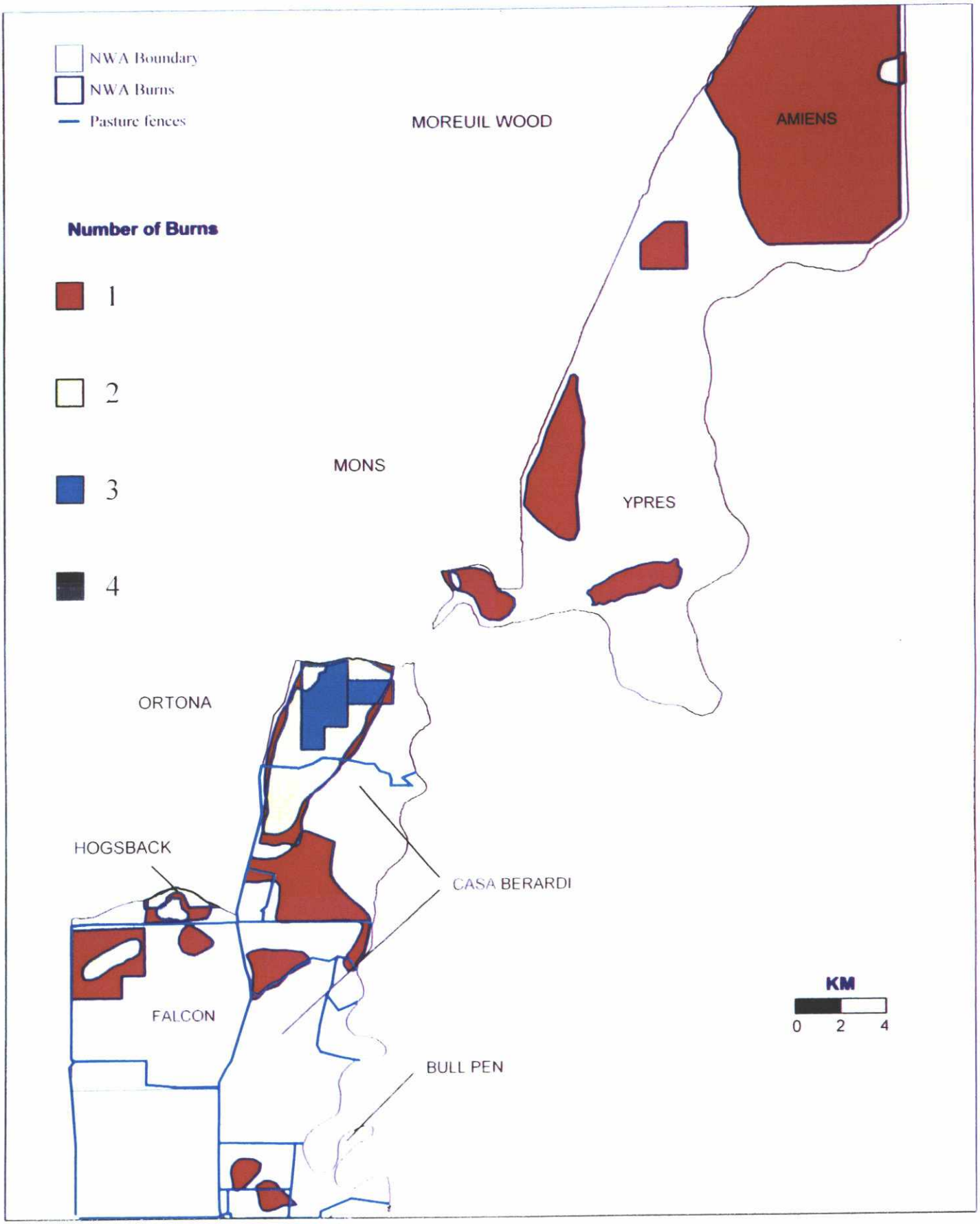


Figure 6. Wildfire frequency in the CFB Suffield National Wildlife Area, 1983-1996 (Adams et al. 1997)

The dunes and plains together make up the **Upland**. The Middle Sand Hills, in the North Block, are gently rolling to steep and there are a few active dunes. In general, the dunes in the Amiens portion are more uniform in shape and size and are more systematically organized, while dunes in Ypres are less well defined and more discontinuous. Much of Casa Berardi, Falcon and Fish Creek consists of steep hills or flat to undulating plains of Mixed Grassland Prairie. The Upland represents 96.9% of the SNWA.

The river valley becomes narrower towards the NE with steep, deeply incised banks called river breaks or **Slopes**. At various points along the SNWA river valley, these incisions cut deep in the valley wall and form **Ravines** whose upper reaches emerge in the Upland. Ravines/Slopes constitute 1.90% of the SNWA.

Wetlands are lands saturated with water long enough to promote aquatic processes (National Wetlands Working Group 1987). They make up a small portion (0.56%) of the SNWA (Adams et al. 1998). Most wetlands, including Old Channel Lake, are in the South Block (Figure 1) but most saline wetlands are in the North Block. Twelve wetland types are recognized in the SNWA (Adams et al. 1998).

The South Saskatchewan River Valley is characterized by floodplains and terraces, especially in the south and central portion of SNWA. Some of these currently support woody vegetation. The close proximity of trees and shrubs to water creates unique **Riparian** communities) that represent only 0.64% of the extent of the SNWA.

3.2 Upland Techniques

3.2.1 Avian Sampling

We collected avian occurrence data at sample sites, systematically located every 500 m along northing lines (Figure 7). The same sites were used for vegetation and mammal surveys (Adams et al. 1997; Shandruk et al. 1998; Reynolds et al. 1999). We visited as many sites as possible rather than replicating counts at fewer sites (Link et al. 1994; Petit et al. 1995).

To control possible sources of bias (observer, time of day and within breeding season, year–Best 1981; Ralph 1981; Bart and Schoultz 1984; Verner 1985; Bibby et al. 1992; Dawson et al. 1995) we did not sample northing lines in numerical order. In 1994, we tried to sample every other line in the South Block and every third in the North Block. Remaining lines, except a few segments dominated by common ecosections and VCTs, were sampled in 1995 (Figure 7).

Within each year, we minimized observer bias by trying to equalize observer effort within ecosections (divided sample sites on northing lines between 2 observers starting at the same time of day, or ran adjacent lines in the opposite direction). To avoid any bias created by the time of year when samples were collected, we shifted our sampling areas every few days within the restrictions imposed by DND area closures.

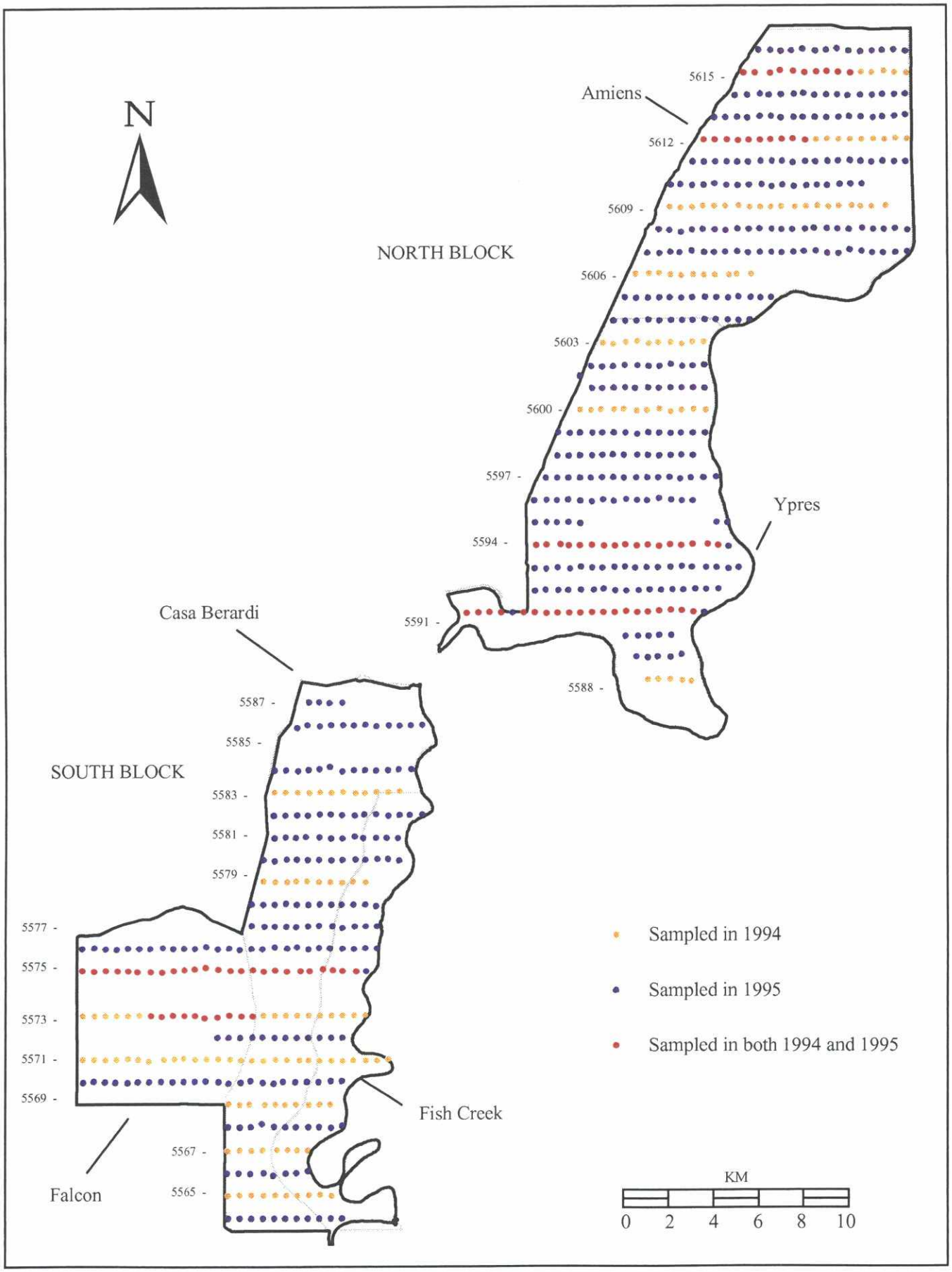


Figure 7. Upland avian sample sites, CFB Suffield National Wildlife Area, 1994-1995.

We used 100-m limited radius point counts (Hutto et al. 1986) to collect data on the relative abundance of birds. For most goals (including those of this inventory), an index method (measuring relative abundance) is appropriate and more efficient than a density method (Bull 1981; Verner 1985; Bibby et al. 1992). A total of 258 counts were conducted by 2 of us in 1994. In 1995, we repeated 92 of these counts (same observer and on similar dates as in 1994); as well 483 new counts were done by the 2 original and 1 new observers. We sampled from sunrise to about 09:00 on days in late May to early July that had wind speeds less than 15 km/hour and no rain or fog. We recorded the date, observer, line and plot number and, in 1994 only, the percentage of the 100-m radius plot visible to the observer. The observer, who stood in the center of the plot, recorded all birds seen and heard within (hereafter "In") and outside (hereafter "Out") the estimated 100-m limited radius during the 5-minute observation period. We noted simultaneous observations of 2 or more singing males during the count (Tomialojc 1980) and additional species observed while travelling to the next sample site ("T").

3.2.2 Vegetation Structure Sampling

We measured height, thickness and patchiness of vegetation and relative abundance of various plant growth forms (Table 2). The structure of vegetation is often an important cue in avian habitat choice (Cody 1968; Wiens 1969; Knopf et al. 1990). A subset of avian plots (Figure 8) was selected for vegetation structure sampling each year. Within these plots, we randomly selected 16 vegetation structure sample points (see Dale 1994 for selection procedure). We used a point intercept methodology (Dale 1994) based on concepts in Wiens (1969) by placing a metal rod (5 mm in diameter, marked in decimeters) perpendicular to the ground, and recording the number of contacts the metal rod had with each growth form (Table 2) in each decimeter (DM) above the ground. Litter depth was recorded in millimetres (mm).

Table 2. Growth form definitions[1]

Growth form	Definition
Dead	Standing dead vegetation
Forb	Herbaceous plants (without above-ground perennial woody stems) other than grass-like plants.
Grass (Narrow)	Grasses, sedges or grass-like plants (leaves less than 6 mm in width).
Grass (Broad)	Grasses, sedges or grass-like plants (leaves more than 6 mm in width).
Shrub	Plants, less than 2 m in height, with above-ground woody stems but are not dwarf or semi-shrubs.
Dwarfshrub	Woody plants less than 25 cm high and spreading in their growth form. (e.g., prairie selaginella *Selaginella densa*).
Semi-shrub	Woody plants in which the upper stems and branches die back during winter. (e.g. pasture sagewort *Artemisia frigida*)

[1] (Whittaker 1970)

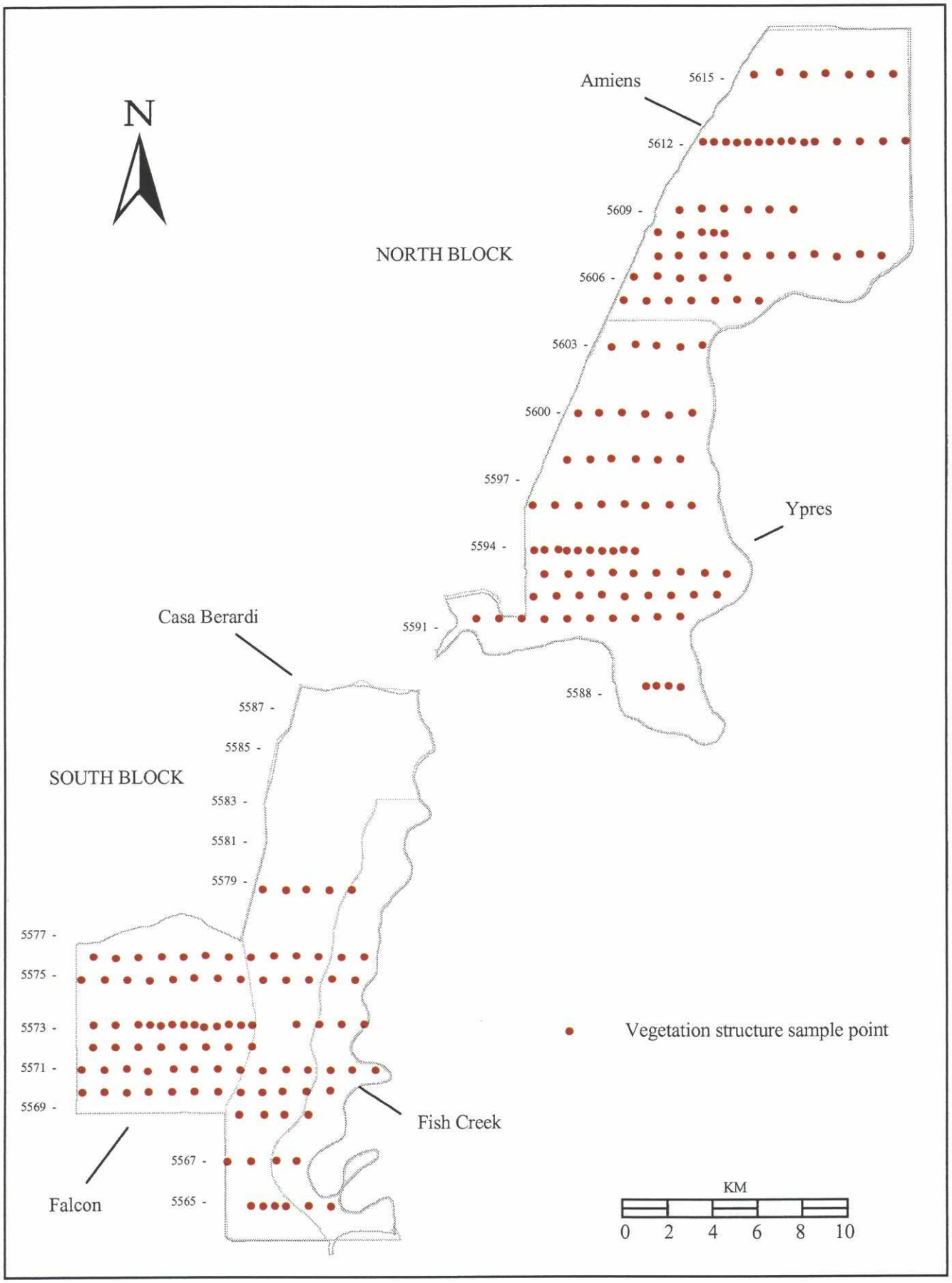


Figure 8. Upland vegetation structure sample sites, CFB Suffield National Wildlife Area, 1994-1995.

3.2.3 Data Compilation and Manipulation

Ecosites, as designated by Usher and Strong (1994), and VCT (Adams et al. 1997) were cross-referenced with bird and vegetation structure data for the same sites. We identified sample sites dominated by introduced vegetation from ecosite descriptions.

Counts of old and new cattle and horse faecal piles from systematic sample sites (Shandruk et al. 1998) were combined to create an index of **grazing history** (Figure 9). The pile counts per point were arbitrarily divided into 3 levels of grazing: "None"; "Low" (>0 to <25 pellets point); and "High" (25 to 51).

We used military burn maps (Figures 5 and 6) from 1983 to 1995 to determine if and how frequently burning occurred within recent history. Following Madden (1996) we calculated the burn index for each systematic sample point as the total number of fires divided by the number of years since the last burn. The index was arbitrarily set at 0.5 if there was a fire in the year the bird count was done. We divided fire indices into 3 levels: "None"; "Low" (index of >0 to <1); "High" (1-2).

Each sample point was assigned to 1 of 4 treatments: "Graze Only" (pellet counts >0 and fire index of 0); "Burn Only" (pellet count of 0 and fire index >0); "Burned and Grazed" (pellet counts >0 and fire index >0); "Pristine" (both pellet counts and fire index equal 0). The frequency of occurrence of each bird species within the 100-m circle (In), and inside and outside combined (In and Out) was calculated separately for each year. The composite (both years pooled and corrected for 92 duplicate counts), frequency of occurrence of bird species overall (both In and In and Out) and by ecosection and VCT was calculated (In and Out). We calculated the number of bird species and individuals observed per point, and the average number of species per point (overall and by ecosite, ecosection and VCT).

We calculated a series of variables based on the 16 vegetation structure samples within each of the 242 selected avian sites (includes 23 sites sampled both years). These were:
Mean Litter (MLITTER) - the average (n=16) litter depth (in mm).
Mean Height (MHIGHDM) - the average value of the highest DM in which a vegetation contact was made with the sampling rod.
Mean Vigor (MVIGOR) - average of the 16 ratios (live vegetation contacts divided by total contacts). This variable has not been used in previous studies.

We also calculated the average number of contacts of the rod with:
Narrow-leaved (< 6mm) grasses (MNARROW). Includes most native grasses;
Broad-leaved (> 6mm) grasses (MBROAD). Several introduced (and some native) grasses have broad leaves. Broad leaves offer a different structural configuration and several grassland bird species avoid them (Wilson and Belcher 1989; Dale 1991, 1992; Madden 1996);
Forbs (MFORB);
Shrub (MSHRUB);
Cactus (MCACTUS);
Semi-shrub (MSEMI);

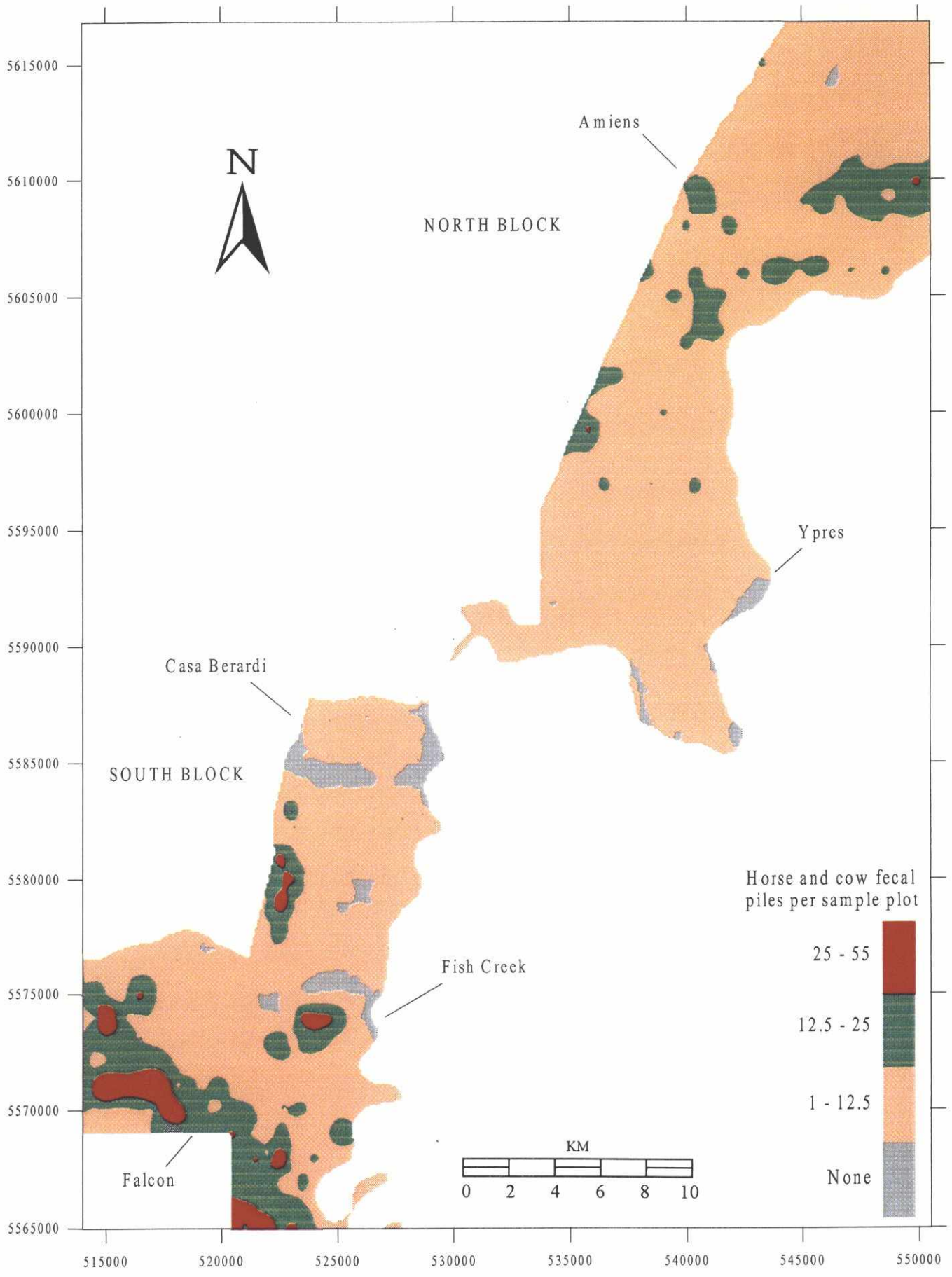


Figure 9. Index of grazing history, CFB Suffield National Wildlife Area (data from Shandruk et al.1998).

Dwarfshrub (MDWARF);
Dead plant material of any growth form (MDEAD);
Any growth form, live or dead (MTOTAL);
Any growth form in the first (lowest) DM on the rod (MFIRST). Cover near the ground is an important habitat cue for a variety of grassland species (Dale 1983, 1991, 1992).

The coefficient of variation (CV) provides a measure of patchiness. Habitat uniformity or variability is important in characterizing bird communities (Wiens 1974) or as a cue for individual species (Dale 1991; Herkert 1994). We calculated the coefficient of variation of the ratio of live to dead (CVVIGOR), litter depth (CVLITTER), highest decimeter (CVHIGHDM), and contacts with:
Narrow-leaved grass (CVNARROW);
Dead material (CVDEAD);
All plant material (CVTOTAL);
All plant material in the 1st DM (CVFIRST).

For each common bird species, we calculated the means of vegetation variable values from sample sites where species were present.

3.2.4 Analyses

Data were subjected to Shapiro-Wilks test of normality before analyses. Non-parametric tests were used for non-normal or non-continuous data.

3.2.4.1 Bias

Frequency values, by year, of each bird species recorded on the 92 points sampled both years were compared (Goodness of Fit–Sokal and Rohlf 1969). The between-year comparison of vegetation variables values for the 23 sites, sampled both years, was done with a sign rank test.

Not all sample sites (100-m radius plots) were fully visible to the observer. Using 1994 data, we checked for a correlation between the percentage of each plot that could be observed and the number of species and individuals recorded there. Separate analyses were done for ecosections and sites with samples sizes greater than 15.

We used Goodness of Fit to test if ecosites, ecosections and VCTs were equally represented in Burn Only, Graze Only, Burned and Grazed and Pristine segments of the SNWA.

3.2.4.2 Burning and Grazing

We compared the number of species per point in 3 levels (None, Low and High) of grazing and 3 levels of fire using ANOVA. We tested for overall differences in frequency of occurrence of the

10 most common species in the 3 levels of fire and 3 levels of grazing using Goodness of Fit. Tests were conducted by ecosections and VCTs with sufficient sample size (E1, G2, G3, M1, upland grassland, grass-mid/low shrubs, low shrubs-grassland, and shrubs-trees-grassland). We also tested the frequency of occurrence of the 6 most common species in various grazing levels by ecosection. Sample sizes were too small to test additional species, test by grazing level in separate VCT, or to test individual species by fire level in ecosections or VCT.

For the 10 most common species, we compared numbers observed in 4 categories of land use: Burn Only, Graze Only, Burned and Grazed, and Pristine. We also performed analyses separately for those ecosections (E1, G2, G3 and M1) or VCT (upland grassland, grassland-mid/low shrubs, low shrubs-grassland, and hrubs-trees-grassland) with sufficient sample size. After our analyses were complete a large polygon (>2000 ha) was changed from G.3.8 to M1.11 (Adams et al. 1997). This reflects a change in assessment of the substrate since the 2 categories have similar vegetative communities. We did not repeat our analyses on a corrected data set.

We compared structural measurements for the vegetation at points in Burn Only, Graze Only, Burned and Grazed, and Pristine sites (Kruskall-Wallis followed by simultaneous test procedures [STP], Conover 1980). An overall analysis was performed since sample sizes of disturbance regimes within any ecosite or VCT were too small for meaningful analyses.

3.2.4.3 Bird/Habitat Analyses

For sites with both avian and vegetation structure data, we looked for relationships between the number of bird species per point and structural characteristics. We used correlation and multiple regression followed by back selection to find variables providing explanatory value. We used percent shrub data (PERSHRUB) collected by the vegetation inventory team as a measure of shrub occurrence.

Principal Components Analysis (PCA) was chosen to simplify the multi-dimensional space defined by the numerous vegetation variables. Multivariate analysis transforms and reduces original variables creating fewer, new independent variables (Pimentel 1979). Birds apparently choose territories based on a simultaneous assessment of numerous aspects of the physical environment (Hilden 1965), a process paralleled by multivariate statistics. PCA explores variation within the vegetation structure of the SNWA and the axes created by the analysis represent independent patterns of variation within the sample. Each axes represents a recombination of old variables that co-vary to a significant degree.

3.3 Ravines/Slopes Techniques

3.3.1 Avian Sampling

We designed surveys to document species presence and to determine status because the rugged terrain made it impossible to use the systematic surveys we employed in Upland habitats.

We chose a subsample of the 30 ravines opening onto the river valley (Figure 10), and surveyed 8 ravines in 1994 and 11 in 1995. In all, surveys were completed for 15 ravines and 3 associated slope areas. Survey periods were 16 June to 20 June 1994; 30 May to 6 June (breeding) and 6 to 12 September 1995 (migration). Start times in Ravines (06:20 to as late as 16:00, most 06:20 to 10:30 hours) began later than at Upland sites since bird activity was delayed until the sun reached down into the ravines. Several ravines were usually surveyed per day.

Almost all ravine surveys were conducted by the same observer. We walked a timed survey route down the centre of each ravine, as close to the ravine bottom as possible. We used the upper ravine rim as the limit of our observations, as did Driver (1992). The amount of time spent in each ravine varied based on its area, complexity, and the number of species encountered. This allowed us to get as complete a species list as possible, and confirm the status of any birds we observed. The non-standardized speed and variable width of our "timed walk" resembles the "look-see method" of Bibby et al. (1992). We recorded UTMs and time at the start and end, and at various points along the route. Locations were difficult to determine in deep parts of ravines where satellite signals were not always available. We noted all birds seen and heard, any proof of breeding status, and the type of vegetation used. We conducted a limited number of 5-minute 100-m radius point (Hutto et al. 1986) counts in several ravines from 30 May to 5 June 1995.

3.3.2 Habitats and Physical Attributes

We noted habitat types and special features of ravines while conducting bird surveys. Various physical parameters were estimated for each ravine using maps and air photos. These were: orientation, number of branches, primary branch length, elevation drop, and distance from ravine mouth to river. Distances were estimated to the nearest 25 m and elevation to the nearest 5 m.

The presence or absence of fluvial ecosites was determined from maps. VCTs present in each ravine were compiled from GIS mapped data to determine the ravine area and give an index of habitat diversity. For polygons shared between 2 adjacent ravines (e.g. ravines 13, 14) we estimated what percentage of the polygon fell within each ravine.

The VCTs were reclassified (on the basis of dominant cover type) into 5 broader **primary habitat types**: wetlands, grasslands, shrublands, tall shrubs and trees and eroded slopes/cliffs. A sixth primary habitat type–river–was associated with all surveyed ravines. The presence of major habitat elements and patchiness of habitat structure (Wiens 1974) may be more appropriate scales of comparison for avian guild usage than VCT or detailed habitat measures required to determine individual species' habitat selection (Knight and Morris 1996).

3.3.3 Compilation, Manipulation and Analyses

The number of species recorded in ravines over the length of the project was tallied. Species encounter rates (number of species or individuals per 5 min), for each ravine, were calculated by dividing the total number of species or individuals at a given site by the total survey time (taking

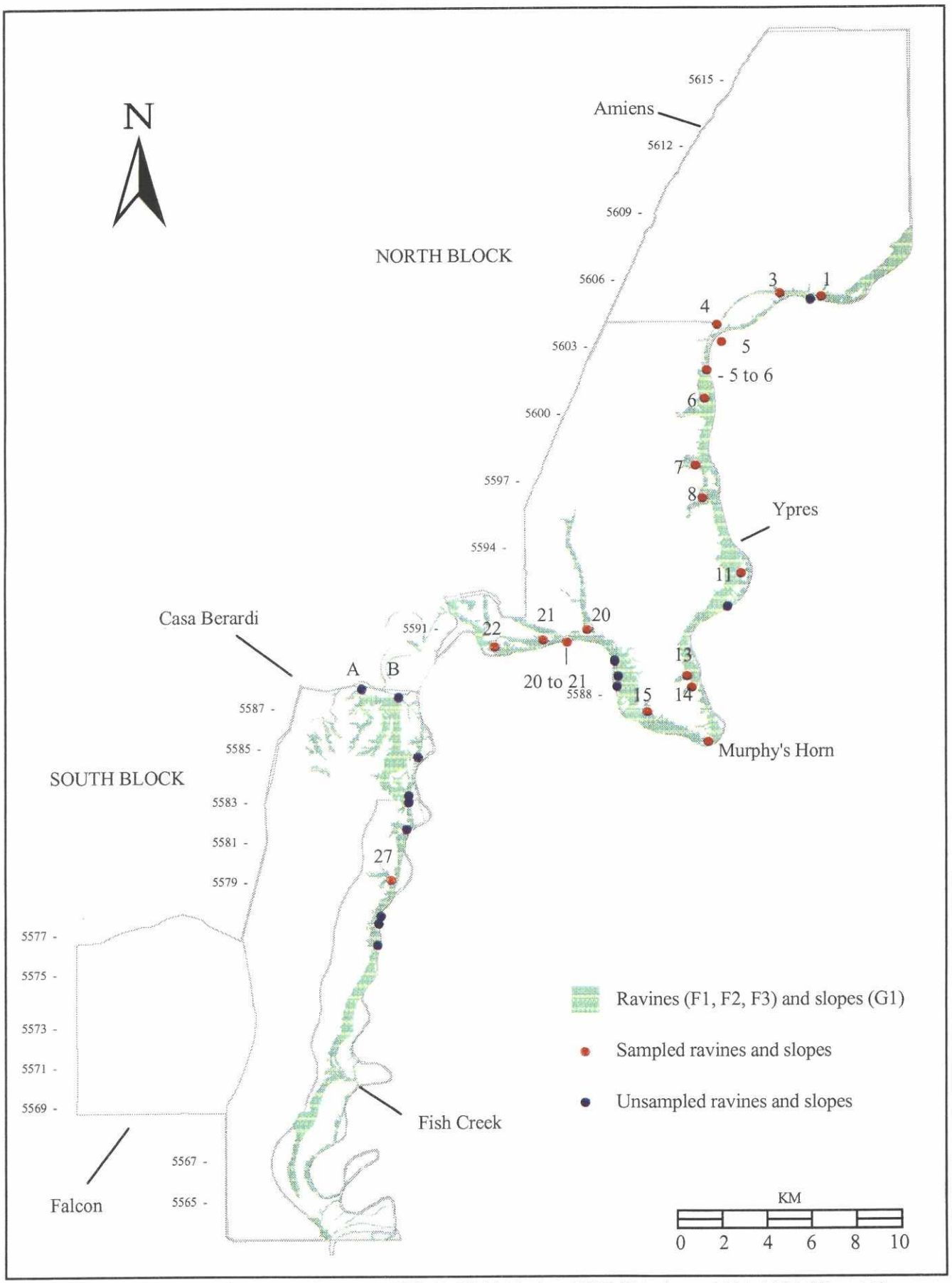


Figure 10. Ravine and slope sample areas, CFB Suffield National Wildlife Area, 1994-1995 (Vegetation data from Reynolds et al. 1999).

into consideration the number of observers) and multiplying by 5. We examined records and literature descriptions of habitat requirements for rare species seen during Ravine surveys. We divided Ravine birds into guilds, with each showing affinities to 1 of the 6 primary habitat types and then determined how well guilds were represented in each ravine. The ravine where the guild was commonest scored 1.5, ravines with 4 or more species/guild scored 1 and ravines with 1 to 3 species scored 0.5. A cumulative guild index was derived by summing the 6 guild scores. We performed correlations between the number of primary habitat classes per ravine and: total species; the guild index. We performed similar correlations between the number of VCT and bird measures.

3.4 Wetlands Techniques

Wetlands have a limited extent within the SNWA but have potential importance for migrants as well as breeding birds. The few wetlands differed in size, shape, surrounding habitat and associated disturbance regime. Because of these characteristics we chose to emphasize the inventory/clarification of status objective.

3.4.1 Avian Sampling

Eight of the 12 wetland types recognized by Adams et al. (1998) were surveyed for wetland birds. In 1994, 11 wetlands were surveyed on 15 and 16 May (Figure 11). The largest wetland, Old Channel Lake, was surveyed repeatedly in 1995, both in spring (4, 11, 30 May, 8 June) and late summer (9, 12 September). In 1996, 29 wetlands were surveyed on 14, 15, 16,18, 29, 30 May. Six were surveyed twice in 1996 and 7 had also been surveyed in 1994.

One or 2 observers participated in wetland counts but a single observer carried out the majority of counts. Counts were done at various times throughout the day. Observers walked slowly around each selected wetland area (or scanned small water bodies with binoculars or spotting scope), and recorded any birds that were seen or heard. Birds seen flying over surveyed wetlands were included. We did not distinguish between dowitcher species (Short-billed Dowitcher has been reported in the SNWA by Crease [1990]). Scaup were assumed to be Lesser Scaup and all other birds were identified to species.

3.4.2 Data Manipulation

The wetland type, physical characteristics and surrounding ELC category of wetlands were determined by other project field staff (see Adams et al. 1998). Species number and encounter rates were determined in the same manner as for Ravines/Slopes. Each wetland bird species was categorized as either aquatic (totally dependent on wetlands) or aqua-terrestrial (species that use both aquatic and terrestrial habitats) based on literature accounts.

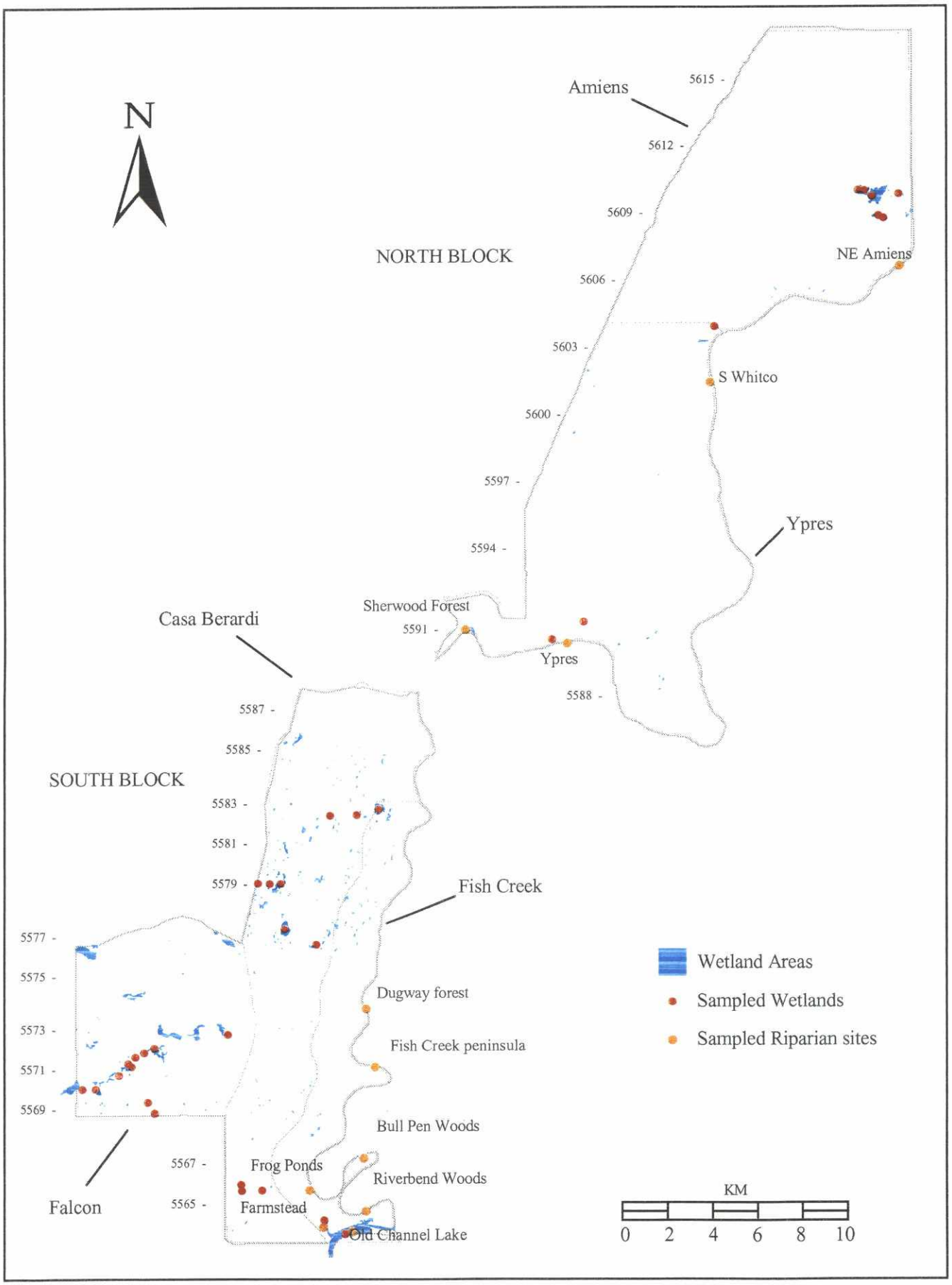


Figure 11 Wetland and riparian survey sites, CFB Suffield National Wildlife Area, 1994-1996.

3.5 Riparian Techniques

The Riparian segment made up a small proportion of the SNWA but had potential importance as both breeding and migration habitat. Individual stands were different in size, shape, and disturbance regime. Because of these characteristics we emphasized the inventory/clarification of status aspects of our objectives.

3.5.1 Avian Sampling

Eleven riparian sites were surveyed during spring, summer and fall of 1994-1996 (Figure 11). Most sites were associated with the South Saskatchewan River but 3 sites (Old Channel Lake Area, Farmstead and South Whitco) were associated with wetlands. Most sites were surveyed repeatedly to determine their use by both breeding and migrant birds. Single visits underestimate species richness (Mac Nally 1997), which can be countered by visiting more sites (not possible in the SNWA) or by multiple visits (Link et al. 1994).

Usually 1, but as many as 3, observers participated in any given count. Observers moved slowly through the woody habitat, recording birds when first seen or heard and noting any evidence of breeding. Individual observer routes varied, as did start locations, but generally observers counted in similar areas. Birds seen in associated wetlands (except at Old Channel Lake) and those seen on the adjacent half of the South Saskatchewan River were included. Start and end times were recorded or estimated.

3.5.2 Physical Attributes

The presence of ecosites and VCTs at sites was determined from maps and the total area per site estimated. Sites were assigned to 1 of 3 habitat categories: riparian shrub (only shrub); riparian shrub/tree (some trees); and riparian woods (trees dominate tall cover but there may be a shrub understory). In August 1995 the silt, deposited during the June 1995 flood, was measured in 3 places within Dugway Forest. To do this 3 pits were dug to the former ground level in the interior, and 1 pit was dug on each of the east and west edges of the wooded stand. The depths of the 5 pits were then measured.

3.5.3 Data Compilation and Manipulation

Birds used in analyses were those identified to species (goldeneye was presumed to be Common Goldeneye). The species richness and encounter rates were determined as for Ravines/Slopes.

To assist in analyses of specific habitats, we divided riparian species into 3 habitat guilds: aquatic species, aqua-terrestrial riparian species and terrestrial species. Terrestrial species, such as most passerines, use nonaquatic habitats like shrubs, trees and adjacent upland habitats.

We determined possible grazing pressure on wooded sites from the PFRA records in Adams et al. (1997). The relevant factors were stocking rates and season of grazing. We used the number of cavity nesting bird species to indicate recovery from grazing, since dead trees used by cavity nesters may be pushed over by cattle. We counted up the number of shrub-associated birds, since shrub may be diminished by grazing. Birds have been used as an indicator of vegetation quality elsewhere (Sedgwick and Knopf 1987).

3.6 Incidental Observations

We recorded incidental (casual) observations (species, number, breeding evidence, UTM location) for birds we encountered while travelling within the SNWA or outside of sampling periods. Our observations were supplemented by those from interested individuals (e.g., AEC staff) and other SNWA wildlife inventory participants. Two members of the bird inventory team spent much of 24 November 1994 in the SNWA and recorded all species seen. During July 1995, a nocturnal mammal team played tape recorded Common Poorwill calls at 6 sites in potential habitat. We also included records from specimens collected by the Provincial Museum of Alberta (PMA) in portions of the SNWA 26-31 May 1994 and 21-22 May 1997.

Incidental records were screened to verify they were obtained within the SNWA (rejected Red-headed Woodpecker (*Melanerpus erythrocephalus*) across the river, Blue Jay *(Cyanocitta cristata)* outside Gate 24, and shorebirds from Dishpan Lake). We assigned records to a segment (Upland, Ravines/Slopes, Wetlands or Riparian) based on location or habitat preferences. We used UTM co-ordinates (when available) to assign records to ecosites and VCTs.

We calculated the proportion of all songbird nests found in the incubation or nestling stage, that contained eggs or young of the Brown-headed Cowbird. Brown-headed Cowbirds are an obligate nest parasite, building no nest of their own. Historically, they were associated with nomadic herds of bison, feeding on insects disturbed by grazing activity. Females observe activities of nesting passerines and add their eggs to an existing nest, often removing a host egg at the same time. Host productivity often decreases and bird populations may be negatively affected because of egg losses and parental energy spent on raising cowbird chicks (Fox 1961; Rothstein 1975; Hill 1976; Payne 1977; Davis 1994; Romig and Crawford 1995).

3.7 Status and Other Designations

Species were rejected if insufficient details had been provided. We evaluated historical records and used incidental records and count data from our work to determine the seasonal occurrence and breeding status for all species that had confirmed records within the SNWA.

We disregarded historical species from Stevens (1972) based on the assessment of Banasch and Barry (1998) for Peregrine Falcon (*Falco peregrinus*), possible misidentification (Bewick's Wren *[Thryomanes bewickii]*, Le Conte's Sparrow *[Ammodramus leconteii]*), or reported only from elsewhere on CFB Suffield (Ruby-throated Hummingbird [*Archilochus colubris]* and

several shorebirds). We checked on the sighting of Black-necked Stilt *(Himantopus mexicanus)*, reported in Dickson (1992), and found it was actually made south of Old Channel Lake.

We used frequency of occurrence on Upland point counts and encounter rates on Ravines/Slopes, Wetlands and Riparian counts to determine which segment of the SNWA was *preferred* by each species. Where rates were similar for several segments, we also looked at total number seen (including incidental records) and percentage of surveyed sites where they were observed. For raptors, we relied entirely on the assessment of Banasch and Barry (1998). We used all available sources of data to determine, for each segment, which species were uncommon (i.e., $\leq$5 seen during the inventory).

We excluded introduced species from all measures of *regional diversity*. For each *native* SNWA species we examined the known distribution in Godfrey (1986) and breeding abundance in Sauer et al. (1998). We deemed a species *regionally unique* if >95% of a species population or subpopulation was confined to the prairie provinces. The future existence of these species depends on maintaining healthy populations in the prairies, so their presence in the SNWA indicates an important contribution to both *regional* and *national diversity*.

For each SNWA species, we calculated prairie-wide frequency of occurrence–the percentage of all 3-minute stops on Breeding Bird Survey (BBS) routes in the prairie provinces on which the species had been recorded. Data for BBS were obtained from the CWS databank in Ottawa. We termed species *regionally rare* if their frequency of occurrence on prairie BBS stops was less than 0.5% and at least 10% of their breeding range is within BBS coverage in the prairie provinces. This latter qualification was necessary to exclude species that appear scarce only because they infrequently, if ever, occur within range of our measurement tool (e.g., Snow Goose, Wilson's Warbler). We intend *regional rarity* to be a measure of species with sparse, not marginal, distribution–rare, but natural, elements of the region's diversity.

Species whose populations are declining are increasingly important elements of *regional diversity*. Species were considered *declining* if their BBS trend was negative at 1 or more scales (physiographic region containing SNWA, Canada or the North American continent) throughout BBS coverage (1966-1996) or recently (1980-1996). The decline was significant if the probability was <0.05.

3.8 Graphical Techniques

A series of maps was created. For common Upland (SNWA frequency >15%) *regionally unique* species and *species at risk*, the number of individuals per point (In and Out) for the 741 unique Upland avian sample sites were contoured into 4 intervals (0-1 per point, >1-2, >2-3, >3). We plotted observations for additional *regionally unique* species, *species at risk*, and *regionally rare* and *declining* species. For some species, this included incidental data.

Species per Upland point count and cumulative total number of species detected per ravine, wetland or riparian area were contoured. For the latter categories, the value was assigned to a

centroid within the sampled polygon. Values of PERSHRUB, MTOTAL, MLITTER, MHIGHDM were contoured (n=219). Intervals were based on the range of values exhibited.

4.0 RESULTS

4.1 Upland

In total, 55 of 99 terrestrial ecosites were sampled to some degree by point counts. All 9 terrestrial ecosections received at least some coverage, but ecosections F1, F2, and F3 (associated with ravines, slopes and stream channels) and ecosection W1 were poorly covered (10, 9, 2 and 1 counts respectively). Twenty-one of 28 VCTs were sampled to some degree.

4.1.1 Biases

Of the 13 common species (occurred on >5 of the 92 circles done in both years), most show no between-year variation. About a quarter showed significant between-year differences (Sprague's Pipit - Chi-Square 9.85, $p < 0.01$, Vesper Sparrow - 3.88, $p < 0.05$, Lark Bunting - 16.70, $p < 0.0001$).

The 1994 correlation analyses between percent observability of plots and number of individuals and species was not significant for any ecosections (E1, G2, G3, M1) and ecosites (E1.1, E1.3, E1.5, G3.12, G3.8 and M1.1) with sufficient samples to test.

Mean litter, semi-shrub, dead, narrow-leaved grass, forb, and shrub values were higher in 1994, while values of broad-leaved grasses and CVs of dead and narrow-leaved grasses were higher in 1995.

Burn Only, Graze Only, Burned and Grazed and Pristine are not equally represented across ecosections (Chi-Square=133, $p < 0.001$) or VCT (Chi-Square = 51, $p < 0.001$). Burn Only represents a disproportionately high amount of M2, Graze Only dominates G3, and Burned and Grazed is the most common condition of E1 and shrubs-trees-grassland. Pristine is not a common state in any ecosection or VCT (n=33) but is best represented in M2 and not at all represented in shrub-trees-grassland.

4.1.2 Upland Birds

Ninety-six species were recorded during the inventory, with 76 species noted inside or outside point count circles (frequency - Column 2, Appendix 2). Twelve more species were recorded only while travelling from point to point ("T" - Column 2, Appendix 2) and 8 through incidental records ("I" - Column 2, Appendix 2). Five additional species (Rough-legged Hawk, Gyrfalcon, Snowy Owl, Lapland Longspur and Rusty Blackbird) have been recorded at some time in the past ("H" - Column 2, Appendix 2).

4.1.2.1 Local Diversity

Fifteen of the 101 Upland species were not found anywhere else on the SNWA. Ecosections varied in extent, total species observed within them, and the number of species whose Upland distribution was restricted to them (Table 3).

Table 3. Total species by ecosection, CFB Suffield National Wildlife Area 1994-1995.

Number :	E1 n=337	F1 n=10	F2 n=9	F3 n=2	G1 n=30	G2 n=66	G3 n=200	M1 n=138	M2 n=40
Of species[1]	51	18	29	7	48	51	50	30	23
Found only in 1 ecosection	9	0	4	0	6	8	7	1	0

[1]Based on point counts and site specific incidental records for species seen in the Upland.

The number of species observed at any given point was low. The mean number of species (and individuals) detected inside (In), and either inside or outside (In and Out) of 100-m circles varies little between ecosections (Table 4).

The greater the extent of a VCT, the more species were detected within it (Table 5). No single VCT stands out in terms of number of species detected In or In and Out of 100-m circles (Table 6). Differences in numbers between VCT are too small to be significant and low numbers of species within the 100-m circles for a particular ecosection or VCT tend to be compensated for by having among the highest number of species In and Out of circles.

Table 4. Mean species number and abundance by ecosection, CFB Suffield National Wildlife Area 1994-1995.

	E1 n=337	G1 n=30	G2 n=66	G3 n=200	M1 n=138	M2 n=40
Species (In)	2.15 (0.07)[1]	1.83 (0.23)	2.14 (0.16)	2.41 (0.08)	2.04 (0.10)	1.93 (0.17)
Species (In and Out)	5.54 (0.09)	5.83 (0.46)	5.42 (0.27)	5.55 (0.08)	4.79 (0.10)	5.75 (0.25)
Individuals (In)	3.31 (0.13)	2.57 (0.35)	3.26 (0.32)	4.11 (0.20)	2.80 (0.15)	3.18 (0.37)
Individuals (In and Out)	12.87 (0.42)	11.67 (1.2)	12.77 (1.5)	13.61 (0.57)	9.47 (0.35)	14.5 (1.3)

[1] Standard deviation in brackets.

Table 5. Total species by vegetation cover type, CFB Suffield National Wildlife Area 1994-1995.

Number:	Disturbed grass n=17	Moist grassland n=36	Grass-mid/ low shrub n=266	Upland grass n=241	Low shrubs-grassland n=126	Shrubs-trees-grassland n=113
Of species	17	20	53	50	46	40
Found in only 1 VCT	0	0	4	8	6	3

[1]Based on point counts and site specific incidental records for species seen in the Upland.

Table 6. Mean species number and abundance by vegetation cover type, CFB Suffield National Wildlife Area 1994-1995.

Number of:	Disturbed grass n=17	Moist grassland n=36	Grass-mid /low shrub n=266	Upland grass n=241	Low shrubs-grassland n=126	Shrubs-trees-grassland n=113
Species (In)	2.88 (0.32)	2.31 (0.22)	1.96 (0.07)	2.33 (0.08)	1.94 (0.11)	2.35 (0.13)
Species (In and Out)	5.35 (0.31)	5.08 (0.19)	5.41 (0.10)	5.29 (0.09)	5.29 (0.13)	5.82 (0.16)
Individuals (In)	3.65 (0.51)	3.28 (0.43)	3.12 (0.14)	3.71 (0.17)	3.02 (0.22)	3.55 (0.24)
Individuals (In and Out)	9.29 (0.59)	10.94 (0.94)	12.81 (0.48)	11.84 (0.46)	13.06 (0.72)	12.53 (0.72)

[1] Standard deviation in brackets.

For most ecosections, sites with a low-intensity grazing history clearly supported more species per point than no grazing at all (Table 7). There was a significant and positive relationship between the number of bird species (In) and degree of grazing (currently or in recent past) with $F=7.12$ and $p<0.001$. On an ecosection by ecosection comparison (Table 7), this relationship applied only to G3 ($F=5.49$, $p=0.0209$) and M1 ($F=3.34$, $p=0.0403$). For E1 and G2 ($F=0.26$ and 0.08, respectively), this relationship was not significant.

Some degree of grazing history seems to increase the number of species for most VCT (Table 8), although none of the differences are close to significant.

On the SNWA, fire reduces bird species richness overall ($F= 2.71$, $p<0.01$) but areas with Low fire indices were not significantly lower in species richness than Pristine areas. The negative response to fire was not significant for any individual ecosection or VCT (Tables 9 and 10), nor was the response uniform. In M1, the highest species richness occurred where there was limited fire history (Table 9). In most VCTs the highest number of species per point was in areas untouched by fire except for low shrubs-grassland where the greatest numbers occurred where the fire index was high (Table 10).

Table 7. Mean species number in response to grazing history in major ecosections, CFB Suffield National Wildlife Area 1994-1995.

Grazing intensity (sample size)	Overall	E1	G2	G3	M1
Graze=high (n=23,0,0,15,7)[1]	2.74 (0.25)[2]			3.0 (0.26)	2.29 (0.57)
Graze=low (n=455,219,40,100,67)	2.24 (0.06)	2.24 (0.09)	2.33 (0.20)	2.19 (0.12)	2.30 (0.15)
Graze=none (n=69,24,4,0,18)	1.74 (0.14)	1.50 (0.24)	2.25 (0.48)		1.39 (0.24)

[1]Sample shown for overall and then by ecosection.
[2] Standard deviation in brackets.

Table 8. Mean species number in response to grazing history in major vegetation cover types, CFB Suffield National Wildlife Area 1994-1995.

Grazing intensity (sample size)	Grassland-mid/ low shrubs	Upland grassland	Low shrubs - grassland	Shrubs- trees-grassland
Graze=high (n=0,16,0,0)[1]		2.56 (0.30)[2]		
Graze=low (n=155,112,88,70)	2.15 (0.10)	2.46 (0.12)	2.03 (0.13)	2.24 (0.17)
Graze=none (n=26,19,14,3)	1.96 (0.20)	1.68 (0.24)	1.5 (0.33)	2.00 (0.56)

[1]Sample shown for overall and then by ecosection.
[2] Standard deviation in brackets.

Table 9. Mean species number in response to fire history in major ecosections, CFB Suffield National Wildlife Area 1994-1995.

Fire index (sample size)	Overall	E1	G2	G3	M1
Fire=high (n=45,8,1,3,30)	1.84 (0.16)	2.13 (0.35)	3	2.33 (0.88)	1.70 (0.20)
Fire=low (n=279,180,14,41,24)	2.10 (0.08)	2.06 (0.10)	1.71 (0.37)	2.20 (0.21)	2.54 (0.19)
Fire=none (n=533,166,51,163,84)	2.26 (0.05)	2.35 (0.10)	2.24 (0.18)	2.48 (0.09)	2.01 (0.13)

[1] Standard deviation in brackets.

Table 10. Mean species number in response to fire history in major vegetation cover types, CFB Suffield National Wildlife Area 1994-1995.

Fire index (sample size)	Grassland-mid/ low shrubs	Upland grassland	Low shrubs-grassland	Shrubs-trees-grassland
Fire=high (n=7,23,6,0)	1.57 (0.20)	1.83 (0.24)	2.33 (0.42)	
Fire=low (n=78,44,47,82)	1.69 (0.13)	2.25 (0.16)	1.94 (0.19)	2.32 (0.16)
Fire=none (n=196,176,74,33)	2.16 (0.08)	2.43 (0.09)	1.92 (0.15)	2.42 (0.23)

[1] Standard deviation in brackets.

Avian species richness on Upland point counts was positively correlated to MDEAD, MNARROW and MTOTAL, and negatively correlated to the CV of DEAD, NARROW, BROAD and TOTAL. The multiple regression with back selection retained CVDEAD, MBROAD and PERSHRUB ($F=9.19$, $p<0.0001$, accounting for 9.4% of variation).

4.1.2.2 Regional Diversity

Seventeen *regionally unique* species are found in the Upland. Some are raptors, which are discussed in detail in Banasch and Barry (1998). Not only do many *unique* species exist in the Upland, but most (16) were breeding species and many occur in greater abundance than in the broad prairie landscape (Table 11). A few wetland-related *unique* breeding species occur in equal (Marbled Godwit) or lower (American Avocet, Willet, Wilson's Phalarope) numbers in the SNWA Upland than in the prairies. Most *unique* species nest on the ground or in shrubs.

A total of 6 species considered nationally *at risk* (on COSEWIC list) were encountered on the Upland. The 3 non-raptor national *species at risk* (bold in Table 11) are more common in the SNWA than in the rest of the prairies. Flocks of 58 and 70 Long-billed Curlews on 2 dates in 1995 indicate the area is also important for post-breeding activities. Loggerhead Shrike is more common than was indicated by the point counts–many observations were incidental (Appendix 3, Map 2). Five Upland species are considered *at risk* provincially (Red or Blue categories) and they overlap with the 6 national *species at risk*. Almost 23% (22) of native Upland species are *regionally rare*. Most (except Spotted Towhee and Common Nighthawk) are uncommon in the Upland (Table 11). About 66% of native Upland species (67) are *declining* (45.4% significantly). Many *declining* species are more common on the SNWA Upland than in the prairies (Table 11). Sharp-tailed Grouse were more common than indicated by point count frequency alone (Appendix 3, Map 3).

In total, 80.4% of native Upland species are important to maintaining *regional diversity* based on 1 or more measures. No single ecosection (Table 12) sustains all these species. Eolian and glacial sites have similar numbers of regionally important species but each species shows a preference for particular ecosections (common non-raptor species shown in Table 13).

The number of *regionally unique, species at risk, rare* or *declining* species in each VCT varies with sampling effort (Table 14). Regionally important species make up a large proportion of birds (from 84.9% in grass-mid/low shrubs to 100% of moist grassland) recorded in common VCTs. Certain vegetation types are preferred by individual species (Table 15). No single VCT maintains all elements of *regional diversity* (Tables 14 and 15).

Bird community composition (In) varied with grazing history intensity (10 most common species in Table 16). Some species peaked in High and others in Low. No single disturbance intensity maintained good numbers for all *unique, at risk* or *declining* breeding species.

The response sometimes varied by ecosection. Chestnut-collared Longspur preferred None in G2 (4.94, $p=0.026$) and High in G3 and M1 (21.42, $p=0.001$ and 7.92, $p=0.019$). Horned Lark was

most common in Low in G2 and M1 (n.s.) but approached a statistical significant preference for High in G3 (3.62, p=0.057). Western Meadowlark preferred Low in G2, M1 (both non-significant [n.s.].) and E1 (6.75, p=0.009), but was most common (n.s.) in High in G3.

Table 11. Frequency (%) of some breeding Upland species contributing to *regional diversity*[1] at CFB Suffield National Wildlife Area and in the Prairies.

Species	SNWA frequency	Prairie BBS frequency	Nest guild[4]
Regionally unique			
Long-billed Curlew[2]	12.55	2.39[3]	Ground
Marbled Godwit	6.21	6.22	Ground
Loggerhead Shrike	2.43	**0.99**	Shrub
Sprague's Pipit	54.12	**3.75**	Ground
Brewer's Sparrow	20.78	**0.11**	Shrub
Lark Sparrow	2.7	**0.17**	Ground/Shrub
Lark Bunting	15.52	3.03	Ground
Baird's Sparrow	22.81	3.48	Ground
McCown's Longspur	4.99	1.42	Ground
Chestnut-collared Longspur	24.02	6.47	Ground
Regionally rare			
Common Nighthawk	2.70	**0.21**	Ground
Spotted Towhee	9.18	0.26	Ground/Shrub
Declining			
Sharp-tailed Grouse	3.51	**0.57**	Ground
Upland Sandpiper	22.4	1.89	Ground
Horned Lark	62.08	**44.28**	Ground
Clay-colored Sparrow	19.57	**36.11**	Shrub
Vesper Sparrow	51.14	**32.56**	Ground
Grasshopper Sparrow	64.51	**0.72**	Ground
Western Meadowlark	97.84	**52.94**	Ground

[1] Five raptors (covered in Banasch and Barry 1998) and introduced species were excluded.
[2] COSEWIC and (Alberta Environmental Protection 1996) *species at risk* species appear in bold type.
[3] All species (except Spotted Towhee) have declining BBS trends (frequency in bold if significant).
[4] Nest guild based on Ehrlich et al. 1988

Table 12. Number of species contributing to *regional diversity* by ecosection, CFB Suffield National Wildlife Area, 1994-1995.

Number of species that are:	E1 n=337	F1 n=10	F2 n=9	F3 n=2	G1 n=30	G2 n=66	G3 n=200	M1 n=138	M2 n=40
Unique	10	5	3	3	11	12	14	11	8
National *species at risk*	5	2	1	1	3	2	4	3	3
Provincial *species at risk*	4	2	1	1	3	2	4	3	3
Rare	10	3	6	0	10	5	22	6	4
Declining	40	17	21	7	37	39	42	26	21
Declining significantly	30	12	19	5	24	24	28	17	14
Contributing to *regional diversity*	43	18	24	7	41	41	46	28	23

Fire also influenced habitat and therefore bird species composition. Some of the 10 most common bird species reached their peak in each of the 3 conditions (Table 17). The distribution maps (Appendix 3) suggest additional bird species responded both positively and negatively to habitat created by fire.

Individual *at risk, regionally unique*, or *declining* species preferred different combinations of fire and grazing histories (Table 18). Sprague's Pipit preferred Graze Only, Lark Bunting preferred Burned and Grazed and Grasshopper Sparrow Pristine. Clay-colored Sparrow was common in Burned and Grazed and Pristine conditions. Other species showed near significant tendencies: Baird's Sparrow for Graze Only; Chestnut-colored Longspur for both Grazed and Burned and Graze Only; while Western Meadowlark avoided Burn Only. None of the 10 common species preferred Burn Only.

The response varied by ecosection for some species. Chestnut-collared Longspur and Horned Lark both showed a non-significant preference for Graze Only in E1 but were most abundant in Burned and Grazed in M1 (Chi Square=17.66, p=0.001, 8.88, p=0.031, respectively). Grasshopper Sparrow was more abundant in Graze Only in E1 (14.10, p=0.003), but preferred Pristine in M1 (18.83, p=0.001).

The response also varied by VCT. Chestnut-collared Longspur preferred Graze Only in grass-mid/low shrubs and Burned and Grazed in upland grassland (10.59, p=0.014 and 18.15, p=0.001 respectively), and did not occur in shrubby habitats. The Grasshopper Sparrow was more abundant (n.s.) in Pristine conditions of grass-mid/low shrubs and it preferred Graze Only in upland grassland and low shrubs-grassland (24.64, p=0.001, and 7.40, p=0.060, respectively), and Burn Only in shrubs-trees-grassland (n.s.).

Table 13. Frequency (%), by ecosection, of some breeding Upland species contributing to *regional diversity* at CFB Suffield National Wildlife Area, 1994-1995.

Species	E1 n=337	G1 n=30	G2 n=66	G3 n=200	M1 n=138	M2 n=40
Regionally unique						
Long-billed Curlew[1]	4.2	16.7	16.7	13.5	23.9	10
Marbled Godwit	0.3	6.7	12.1	12	6.5	5
Loggerhead Shrike	5.3	0	0	0	0	0
Sprague's Pipit	31.5	43.3	50	77	63.8	60
Brewer's Sparrow	34.7	13.3	13.6	10	1.5	35
Lark Bunting	29.7	3.3	7.6	3	2.9	20
Lark Sparrow	3.9	3.3	1.5	0.5	0.7	0
Baird's Sparrow	8.3	20	16.7	51.5	18.8	15
McCown's Longspur	0	0	12.1	0	22.5	0
Chestnut-collared Longspur	5.1	13.3	19.7	49	42	10
Regionally rare						
Common Nighthawk	2.7	10	6.1	1	0	5
Spotted Towhee	16	10	6.1	0.5	0.7	0
Declining						
Sharp-tailed Grouse	6.8	0	0	1	0.7	0
Upland Sandpiper	29.4	10	9.1	12	15.9	40
Horned Lark	35.6	50	68.2	83	89.9	45
Clay-colored Sparrow	36.5	13.3	9.1	3	1.5	22.5
Vesper Sparrow	72.1	56.7	37.9	30	23.2	80
Grasshopper Sparrow	55.2	56.7	62.1	79	52.2	87.5
Western Meadowlark	99.7	96.7	98.5	100	92	100

[1]Species in bold listed by the COSEWIC

Table 14. Number of species contributing to *regional diversity*, by vegetation cover type, CFB Suffield National Wildlife Area 1994-1995.

Number of species that are:	Disturbed grass n=17	Moist grassland n=36	Grass-mid/ low shrub n=266	Upland grass n=241	Low shrubs-grassland n=126	Shrubs-trees-grassland n=113
Unique	6	9	14	12	12	6
National *species at risk*	2	2	5	4	4	2
Provincial *species at risk*	2	2	4	4	4	1
Rare	0	3	8	10	11	7
Declining	16	19	41	42	35	33
Decline significant	9	10	31	28	24	25
Contributing to *regional diversity*	16	20	45	46	40	35

Table 15. Frequency (%), by vegetation cover type, of some Upland species contributing to *regional diversity*, CFB Suffield National Wildlife Area 1994-1995.

Species	Disturbed grassland n=17	Moist grassland n=36	Grass-mid/ low shrub n=266	Upland grassland n=241	Low shrubs -grassland n=126	Shrubs- trees-grassland n=113
Regionally unique						
Long-billed Curlew[1]	23.5	27.8	10.2	19.1	3.2	0
Marbled Godwit	5.9	11.1	3.8	10.4	1.6	0
Loggerhead Shrike	0	0	0.8	0	0	9.7
Sprague's Pipit	94.1	58.3	55.3	76.8	28.6	9.7
Brewer's Sparrow	0	8.3	30.8	3.3	49.2	12.4
Lark Sparrow	0	0	1.1	0.8	1.6	10.6
Lark Bunting	0	2.8	13.5	3.3	35.7	28.3
Baird's Sparrow	47.1	25	18.8	42.3	5.6	0.9
McCown's Longspur	0	22.2	1.9	7.9	4.8	0
Chestnut-collared Longspur	41.2	50	15	49.4	4.8	0
Regionally rare						
Common Nighthawk	0	0	2.3	0.8	2.4	6.2
Spotted Towhee	0	0	1.9	0.4	4.8	42.5
Declining						
Sharp-tailed Grouse	11.8	0	2.6	0.8	5.6	6.2
Upland Sandpiper	11.8	13.9	21.1	10.8	18.3	44.3
Horned Lark	82.4	80.6	63.9	84.7	42.1	17.7
Clay-colored Sparrow	0	0	14.3	1.3	28.6	61.1
Vesper Sparrow	11.8	33.3	65.8	23.2	65.9	69
Grasshopper Sparrow	70.6	52.8	74.4	69.3	69.1	20.4
Western Meadowlark	100	91.7	99.6	97.1	98.4	100

[1]Species in bold are listed by COSEWIC

Table 16. Breeding species' frequency of occurrence in response to grazing history, CFB Suffield National Wildlife Area 1994-1995.

	Graze=High n=23	Graze=Low n=441	Graze=None n=69	Chi-Square, P value
Regionally unique				
Sprague's Pipit[1]	26.1	16.3	8.7	4.55, p=0.103
Brewer's Sparrow	4.3	9.1	4.3	2.24, p=0.326
Lark Bunting	0	9.3	5.8	3.16, p=0.21
Baird's Sparrow	13	3.4	0	8.99, p=0.01
Chestnut-collared Longspur	73.9	13.2	4.3	71.32, p=0.001
Declining				
Horned Lark	60.9	35.8	34.8	6.03, p=0.049
Clay-colored Sparrow	0	12.7	10.1	3.60, p=0.166
Vesper Sparrow	0	15.2	11.6	4.58, p=0.102
Grasshopper Sparrow	39.1	45.8	34.8	3.18, p=0.204
Western Meadowlark	34.8	37.6	26.1	3.47, p=0.176

[1] Species in bold listed by COSEWIC

Table 17. Breeding species' frequency of occurrence in response to fire history, CFB Suffield National Wildlife Area 1994-1995.

	Fire=High n=45	Fire=Low n=276	Fire=None n=512	Chi-Square, P value
Regionally unique				
Sprague's Pipit[1]	8.9	10	19.7	17.13, p=0.001
Brewer's Sparrow	2.2	8.7	6.3	3.28, p=0.194
Lark Bunting	4.4	12	3.3	23.12, p=0.001
Baird's Sparrow	2.2	2.9	4.1	1.08, p=0.604
Chestnut-collared Longspur	28.9	12.3	13.9	8.83, p=0.012
Declining				
Horned Lark	71.1	23.9	42.4	48.44, p=0.001
Clay-colored Sparrow	2.2	19.2	7.8	27.14, p=0.001
Vesper Sparrow	8.9	17	11.9	4.88, p=0.087
Grasshopper Sparrow	13.3	32.6	55.5	57.76, p=0.001
Western Meadowlark	11.1	32.3	37.5	13.60, p=0.001

[1] Species in bold listed by COSEWIC

Table 18. Common breeding species' frequency of occurrence in response to both fire and grazing history, CFB Suffield National Wildlife Area 1994-1995.

	Burn Only n=36	Graze Only n=277	Burned and Grazed n=187	Pristine n=33	Chi-square, P value
Regionally unique					
Sprague's Pipit[1]	5.6	21.7	9.6	12.1	15.72, p=0.001
Brewer's Sparrow	5.6	8.3	9.6	3	2.00, p=.572
Lark Bunting	3.3	5.1	14.4	3	14.06, p=0.003
Baird's Sparrow	0	5.7	1.6	0	7.74, p=.052
Chestnut-collared Longspur	2.8	15.5	17.1	6.1	7.09, p=.069
Declining					
Horned Lark	33.3	40.8	31.6	36.4	4.31, p=.230
Clay-colored Sparrow	5.6	8.7	17.1	15.2	9.38, p=.025
Vesper Sparrow	16.7	12.3	17.6	6.1	4.67, p=.198
Grasshopper Sparrow	25	55.2	31	83.3	32.27, p=.001
Western Meadowlark	19.4	40.4	33.2	33.3	7.40, p=.060

[1]Species in bold are listed by COSEWIC

4.1.3 Vegetation Structure

Vegetation structure values from the 23 points surveyed in both 1994 and 1995 varied significantly between the 2 years. MLITTER, MSEMI, MDEAD, MNARROW, MFORB were all higher in 1994, while CVDEAD, CVNARROW and MBROAD were higher in 1995.

Ecoregions did show differences in vegetation structure (Table 19). Litter was higher in morainal ecosections. E1 had the tallest cover and most shrub while the most residual cover was in G3 and M1. G3 also had the most cover as well as the most cover in the layer near the ground. E1 had the lowest values of residual cover, total cover and cover at ground level. G2 had low values of all variables. The maps (Appendix 4) of key vegetation structure variables illustrate the resulting cover variability over the SNWA.

The comparison of structural vegetation variables in the 4 disturbance regimes revealed only a few important differences. Shrub cover was highest in Burn Only and lowest in Graze Only (Chi-Square=12.27, p=0.007). The thickness of cover near the ground was greatest in Graze Only and Pristine sites (7.42, p=0.06).

Table 19. Vegetation structure measurements by ecosection, CFB Suffield National Wildlife Area 1994-1995.

Vegetation variable	E1 n=89	G2 n=20	G3 n=81	M1 n=23	M2 n=20
Litter depth (mm)	2.3	2.12	2.8	4.8	3.13
Vegetation height (DM)	2.22	1.78	1.91	1.82	2.03
Dead cover	3.14	3.48	4.79	4.78	4.04
Shrub cover	0.21	0.06	0.02	0.01	0.13
Total cover	6.06	5.99	7.75	7.61	6.5
Cover (1st DM)	2.72	2.88	3.66	3.54	3.24

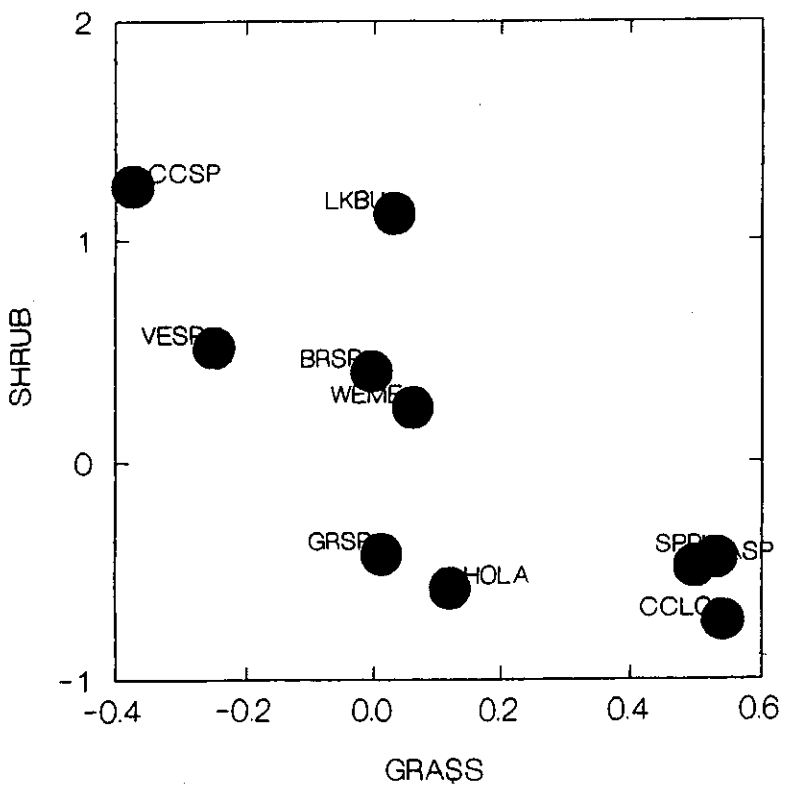
4.1.4 Bird/Habitat Relationships

The Principal Components Analysis (PCA) created new axes that were combinations of various vegetative components measured (CVs excluded). We retained 3 axes (Eigenvalues >1) and used unrotated axes (Figure 12). PC1 explained 23.9% of the variation over the SNWA and loaded high for the variables MLITTER, MDEAD, MNARROW, and MTOTAL. It measured COVER, including contributions from past years (litter and dead vegetation components). PC2 explained 18.3% of the variation and loaded highest for MHIGHDM, MSEMI, MSHRUB, and PERSHRUB making this largely a SHRUB vector although it was influenced by vegetation height. The last axis–PC3–explained 9.9% of the variation and loaded highly on MVIGOR and MBROAD; it will be referred to as the VIGOR vector. Our plot of the means of locations where each common bird species was encountered clearly illustrates that no 2 species chose exactly the same kind of habitat (Figure 12). Each *regionally unique, at risk,* or *declining* species found different portions of the Upland attractive. Species' distributions were found to only partially overlap (Appendix 3, maps 2-16). No one area of the SNWA supported all species.

4.1.5 Introduced Species

Gray Partridge were uncommon and Ring-necked Pheasant were seen only twice in the Upland (Appendix 3, Map 3). European Starling and Rock Dove were rarely encountered.

We could not statistically test avian response to introduced plants because few avian point counts fell within pure stands of the most common introduced plants. Brome (*Bromus inermis*) was in ditches and along the river (Macdonald 1997) and most crested wheat grass occurred only in narrow strips. However, 2 points that were clearly within crested wheat grass ecosites (G2.2 and M1.8) averaged 1 bird species per point–much lower than the remainder of the Upland.



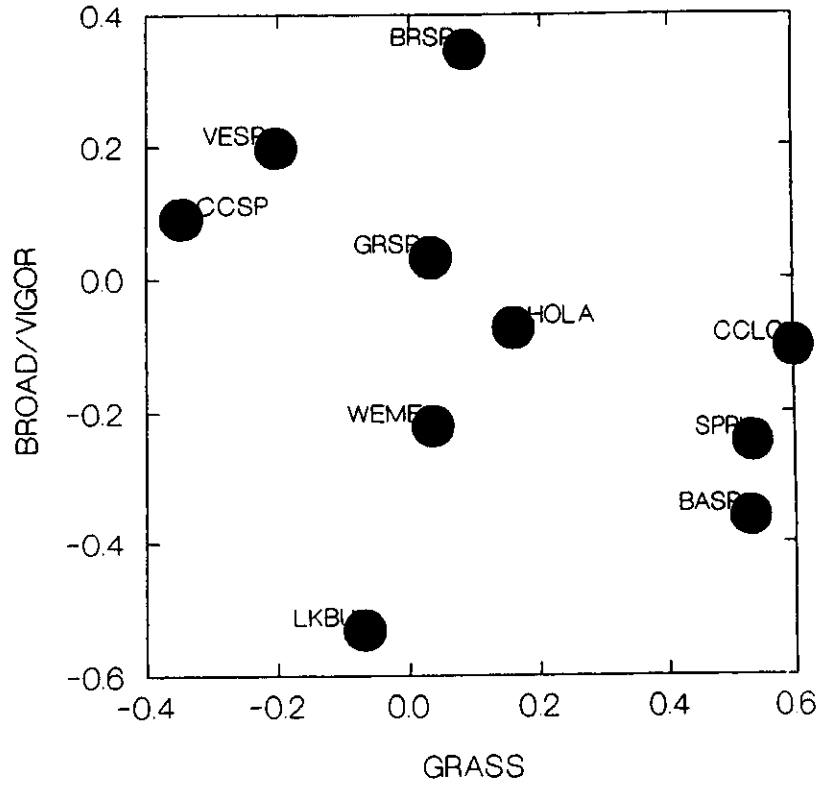


Figure 12. Multivariate habitat scores of common bird species, CFB Suffield National Wildlife Area

4.2 Ravines/Slopes

4.2.1 Ravine Habitats and Physical Attributes

Ravines 1 to 22 are in the North Block and 23 to 30 in the South Block. Ravines contained 1 or more of 3 fluvial landforms (Usher and Strong 1994, Table 20). F2.1 and F1.1 were the most common ecosites. F3.3 occurred only in South Block ravines.

Table 20. Ecosites of the primary ravines and slopes of CFB Suffield National Wildlife Area.

	Ravines containing this ecosite	Total
F1.1	6, 8, 13, 14, 15, 20, 23-30, M. Horn	14 ravines, 1 slope
F1.2	1-7, 21	8 ravines
F2.1	1-7, 9-14, 16-22, 26, 5/6, 20/21, M. Horn	21 ravines, 3 slopes
F2.2	16-17, 22-23, M. Horn	4 ravines, 1 slope
F2.3	3, 7-12, 21, 28-29, 20/21	10 ravines, 1 slope
F3.3	24, 25, 27	3 ravines

Nineteen of 28 VCTs on the SNWA are found in ravines (Adams et al. 1997). Virtually the entire extent of the 4 Barren VCTs was within the Ravines/Slopes segment. Five additional cover types are either found nowhere else (ravine wetlands) on the SNWA or a significant portion of their total area is in sampled ravines (mid/low shrubs 59.5%, trees-tall/mid shrubs 35.9%, tall shrubs-grassland 14.6%, grassland-tall/mid/low shrubs 12.4%).

Individual river corridor ravines contain 1 to 9 VCTs, the average being 4.33 per ravine (4.95 in North Block and 2.62 in South Block (Appendix 5). They contain 1 to 6 of the simpler *primary* habitat types (Figure 13). Typically, upper reaches of a ravine supported grass-dominated VCTs; the mid-reaches supported VCTs with a mix of scattered shrubs in moist areas and some grass; and the lower reaches, where moisture was least limited, supported vegetation classes with tall shrubs and trees. Woody vegetation of lower reaches often merged with adjacent Riparian habitat. Shrub habitats extended away from the ravines along protected river slopes. Water (i.e., springs, seeps, rivulets, marshes and open pools) could occur at any point along the ravine and was most evident in areas of low slope/grade.

Extensive rock outcroppings and rubble slopes were encountered along the South Saskatchewan River corridor, most notably in the North Block of the SNWA. Cliff development was strongest in the lower reaches of ravines. Clay banks and associated solution holes were common, but more so in the North Block (Amiens and Murphy's Horn). Hoodoo formations occurred in the lowest reaches of a few ravines (e.g., Ravines 7, 8). Occasionally, strong similarities existed between neighbouring ravines but not all habitats were present in every ravine.

Ravines in the North Block were generally deeper (87.5 m vs. 69.4) and had a steeper grade (0.1m drop per m of distance vs. 0.09) than those in the South Block (Table 21). North Block Ravines opened nearer the river (118 vs 231 m) and contained fewer branches (1.1 vs. 1.6). Most of the north-south oriented ravines were in the North Block.

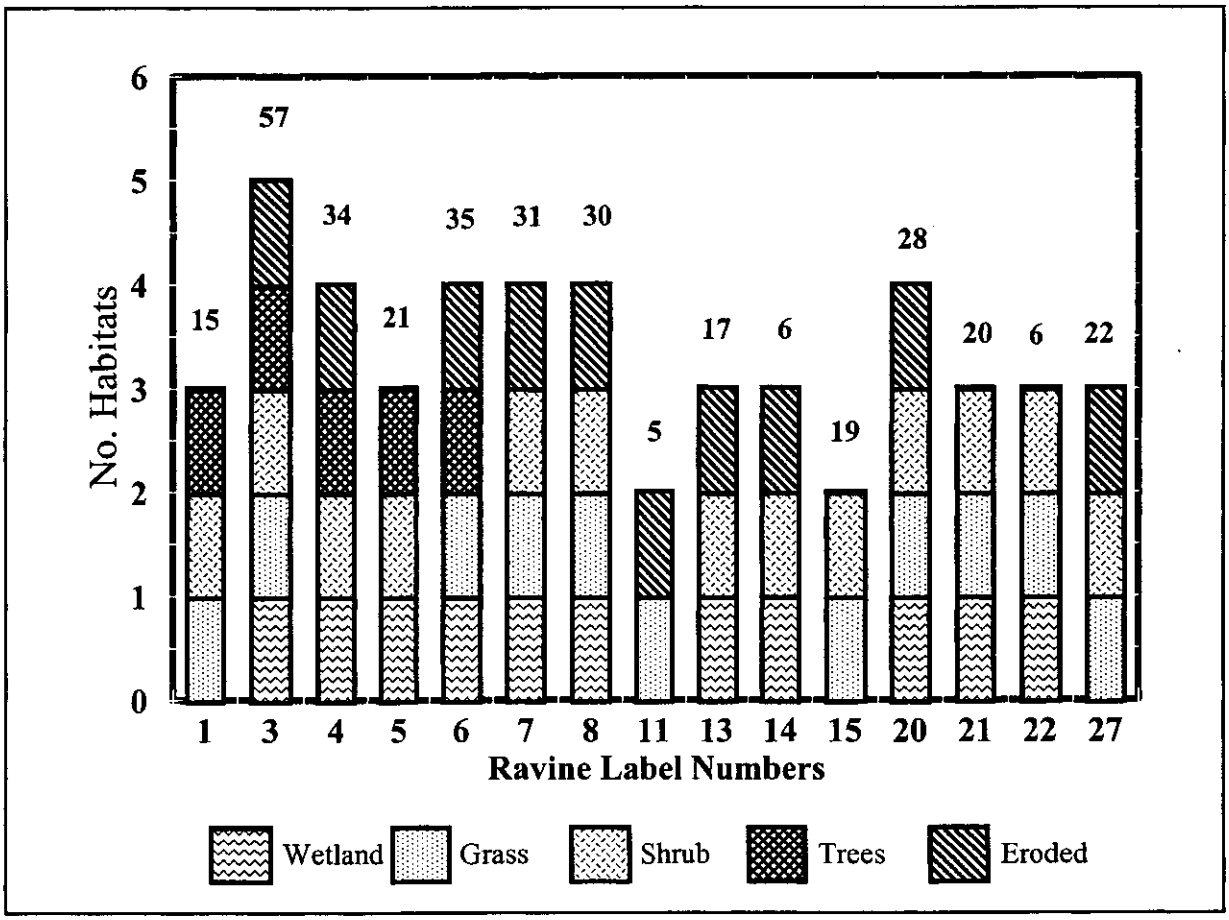


Figure 13. Number of bird species and types of primary habitat present in selected ravines, CFB Suffield National Wildlife Area.

Table 21. Physical attributes of primary ravines within the South Saskatchewan River corridor, CFB Suffield National Wildlife Area.

Ravine number	Distance (mouth to river) (m)	Orientation	Length of primary branch (m)	Number of branches	Elevation drop (m)	Grade (drop/m)
North						
1	250	NE-SW	900	1	85	0.09
2	125	N-S	750	1	80	0.11
3	100	Upper NW-SE Lower N-S	925	1	70	0.08
4	100	NW-SE	300	1	30	0.1
5	25	W-E	650	1	65	0.1
6	50	WSW-ENE	500	1	60	0.11
7	125	W-E	1500	1	105	0.07
8	125	WSW-ENE	2000	1	100	0.05
9	75	WSW-ENE	925	1	125	0.14
10	75	WSW-ENE	1100	1	125	0.12
11	125	WSW-ENE	850	1	100	0.12
12	75	NW-SE	750	1	130	0.17
13	150	NW-SE	1000	2	125	0.13
14	175	SW-NE	900	2	115	0.13
15	100	N-S	1000	1	110	0.11
16	100	ENE-WSW	800	1	90	0.11
17	150	ENE-WSW	1150	2	100	0.09
18	75	E-W	950	1	90	0.1
19	75	NE-SW	1050	1	90	0.09
20	125	N-S	850	1	55	0.07
21	100	NW-SE	650	1	30	0.05
22	300	ENE-WSW	550	1	45	0.08
South						
23	150	W-E	1400	3	80	0.06
24	400	WNW-ESE	1700	1	80	0.05
25	550	SW-NE	750	1	45	0.06
26	150	Upper SW-NE Lower NW-SE	650	3	65	0.1
27	350	WNW-ESE	1500	2	95	0.06
28	400	WNW-ESE	400	1	70	0.18
29	125	W-E	500	1	60	0.12
30	75	WNW-ESE	600	1	60	0.10

4.2.2 Ravines/Slopes Birds

We detected 86 of the 96 bird species during timed walks, with 10 more species being recorded incidentally. The amount of time spent per ravine or slope varied widely (Table 22). The factors that necessitated increased survey time related to size, complexity and steepness of the terrain and the number of species watched for breeding evidence. Long survey periods resulted in decreased encounter rates. Point counts (n=11) tallied considerably fewer species (28), and no new ones when compared to timed walks from the same ravines. Encounter rates from point counts were higher (2.55 species/5 minutes) than for timed walks (0.95 species/5 minutes).

Only 29 species were confirmed as actually breeding in ravines (32 more were expected to breed). The number of confirmed breeding species varied by guild (tall shrubs/trees-10, eroded-8, shrub-6, grassland-2, wetland-2, and river-1) and by ravine (Table 22).

Table 22. Number of bird species, survey effort, and habitat types for selected ravines and slopes, CFB Suffield National Wildlife Area 1994-1995.

Ravine	Survey minutes	Number of species	Number breeding [1]	Number migrants	No. sp./ 5 minutes	No. primary Habitats	Number of VCT
1	45	15	10	2	1.67	3	4
3	269	57	36	9	1.06	5	5
4	204	34	22	6	0.83	4	6
5	55	21	19	2	1.91	3	6
5/6	60	11	9	0	0.92	3	3
6	215	35	28	1	0.81	4	5
7	195	31	29	0	0.8	4	9
8	215	30	28	0	0.7	4	9
11	30	5	5	0	0.83	2	2
13	182	17	16	0	0.47	3	3
14	103	6	6	0	0.29	3	3
15	125	19	16	1	0.76	2	2
20	150	28	23	0	0.93	4	6
20/21	90	15	14	0	0.83	5	5
21	90	20	14	1	1.11	3	3
22	30	6	5	0	1	3	3
27	131	22	18	0	0.84	3	3
M. Horn	60	16	15	0	1.33	not rated	not rated
Mean	124.9	21.6	17.4	1.2	0.95	3.4	4.2

[1] Species confirmed or expected to breed in Ravines/Slopes.

We observed at least 40 bird species using both sides of the river. Forty-six species were seen 5 times or less. The 13 migrant species made uneven use of ravines (Table 22) with most occurring in Ravines 3 and 4. Three raptor species were observed flying above (not in) ravines: Northern Harrier, Red-tailed Hawk and Swainson's Hawk. They are breeding summer residents in the Upland, but their status in Ravines/Slopes is unclear.

4.2.2.1 Local Diversity

Only 2 of 96 bird species (Varied Thrush and Lazuli Bunting) were restricted to Ravines/Slopes exclusively, but many species, associated with shrubby and barren habitats, were rarely recorded in other parts of the SNWA (Appendix 3, Maps 17 to 21). Seven ravines supported high numbers of species (Table 22). There were no clear relationships between particular ecosites and the number of species. F2.1 occurred in all but 1 species-rich ravine but was also associated with low species counts. Species number was more correlated to the number of primary habitat types in a ravine ($r=0.6803$, $p<0.01$, Figure 13) than to the number of VCT ($r=0.5529$, $P<0.05$). Ravines with many birds (28-57 species) contained more than 4 primary habitats. Low species richness (6-22 species) was characteristic of ravines with 3 or fewer primary habitat types.

4.2.2.2 Regional Diversity

About 12% of Ravines/Slopes species were *regionally unique* (11) or *at risk* (3) species (Table 23). Most (including the *species at risk*) are species more commonly associated with Upland or Wetlands segments of the SNWA and are found in only 1 or 2 ravines. A few are closely or exclusively associated with Ravines/Slopes (Table 24).

Almost a third (30.2%) of Ravines/Slopes species were *regionally rare,* and 63.5% are declining (37.5% to a significant degree). There is overlap among *regional diversity* categories but 79.2% of Ravines/Slopes species qualify under 1 or more of the categories. This includes many common breeding Ravine species (Table 24). Not all ravines or slopes were equally important in maintaining elements of *regional diversity* (Tables 23 and 24).

4.2.2.3 Bird/Habitat Relationships

Several ravines stand out as having more bird guilds or better guild representation than the others (Table 25). Ravine 3 had the most species and multiple species representives of each guild. Ravines 4, 6, 7, 8, 20 and 27 also had species from all 6 guilds. A diverse bird community was related to the number of habitats available. Guild indices were more closely associated ($r=0.6245$, $p<0.01$) with Primary habitat types than with the number of VCT ($r=0.5072$, $p<0.05$). Several guilds were characteristic of the 18 ravines and adjacent slope areas of the SNWA. Shrub, tall shrub and trees and eroded guilds are well represented, with 24 of 29 confirmed breeding species from these groups occurring within this topographic segment.

Ravine 3 had the strongest representation of birds from the shrub and tall shrub/tree guilds (Table 25). Several species occurred in more than 1 habitat type within a ravine as long as suitable woody nesting cover was nearby: Mourning Dove, American Crow, Gray Catbird, Spotted Towhee, Lark Sparrow, Brewer's Blackbird and American Goldfinch. The American Crow preferred trees over shrubs for nesting.

Eroded habitats were well represented, especially in Ravine 8 (Table 25). Nest sites on cliffs and eroded slopes were not available elsewhere in the SNWA. Ledges on rock outcrops and cavities in softer clay cliffs are frequent nest sites for raptors (Banasch and Barry, 1998). Large stick nests made by raptors were evident on steep slopes or rocky outcrops in a number of ravines. Most were vacant, but a Golden Eagle nest, containing a single chick, was discovered in 1995. (See Banasch and Barry [1998] for a thorough treatment of raptors.)

Table 23. *Regional diversity* in Ravines/Slopes in CFB Suffield National Wildlife Area, 1994-1995.

Ravine	*Unique*	National *at risk*	Provincial *at risk*	*Rare*	*Declining* (significantly)
1	0	0	0	5	9 (7)
3	4	0	0	19	41 (26)
4	2	1	1	16	21(15)
5	1	0	0	7	15 (12)
5/6	0	0	0	5	7 (5)
6	6	0	0	10	22 (17)
7	2	1	1	7	20 (16)
8	1	0	0	7	20 (17)
11	1	0	0	4	2 (2)
13	2	1	1	6	12 (10)
14	2	0	0	3	4 (3)
15	2	0	0	8	13 (8)
20	3	0	0	5	21 (17)
20/21	2	0	0	1	11 (8)
21	3	0	0	3	16 (11)
22	1	0	0	1	6 (6)
27	2	0	0	8	13 (10)
Murphy's Horn	2	0	0	7	10 (9)
Mean	2	0.2	0.2	6.8	14.6 (11.1)

Suitable nesting conditions for Cliff Swallow were limited to a few cliff faces with a variety of exposures, that were available in only some SNWA ravines. Active nest building and occupancy occurred at only 2 of the 11 sites in 4 ravines (5, 7, 8, and 13) where we found nest structures of

this species. Active nests made up only 21.4% of the total 763 nest structures seen. Old, unoccupied nest structures were found in all 4 ravines, and included the largest colony (221 nests in ravine 5).

Table 24. *Regionally unique* species and some *rare, at risk* and *declining* breeding[1] species common in Ravines/Slopes, CFB Suffield National Wildlife Area, 1994-1995.

Species	Nest Guild	Ravines found in
Regionally Unique		
Prairie Falcon	Eroded	4, 6
Lark Sparrow	Ground/shrub	3-5, 6-8, 11, 13-15, 20, 22, 27, M. Horn
Regionally Rare		
Golden Eagle	Eroded	1, 4, 8, 15, 27, M. Horn
Rock Wren	Eroded	1, 3-5, 5/6, 6-8, 11, 13, 15, 20, 27, M. Horn
Say's Phoebe	Eroded	1, 3-5, 5/6, 6-8, 11, 13, 15, 27, M. Horn
Violet-green Swallow	Eroded	3-5, 5/6, 6-8, 11, 13, 27, M. Horn
Northern Rough-winged Swallow	Eroded	7, 15
Lazuli Bunting	Shrub	ravine north of Sherwood Forest
Spotted Towhee	Ground/shrub	3-5, 5/6, 6-8, 13, 20, 21
Declining		
Cliff Swallow	Eroded	3-5, 7, 8, 13, M. Horn
Mourning Dove	Tree	3-5, 6-8, 13, 15, 20/21, 27 M. Horn
Eastern Kingbird	Shrub	3, 4, 7 ,8, 13, 20, 20/21, 21, 27
American Crow	Tree	1, 3, 6-8, 13, 15, 20, 20/21, 21
Gray Catbird	Tree	3. 6-8, 20
Brown Thrasher	Shrub	3-5, 6-8, 21, 27, M. Horn
Clay-colored Sparrow	Grass	3-5, 6, 8, 13, 21, 22, M. Horn
Brewer's Blackbird	Shrub	3-5, 7,8, 13, 15, 20, 20/21
Western Meadowlark	Grass	1, 3, 5, 5/6, 7-8, 11, 13-15, 20, 20/21, 22, 27, M. Horn
American Goldfinch	Shrub	1,3, 5, 6-8, 15, 20, 20/21, 21,27

[1] Confirmed or expected to breed in Ravine/Slopes.

Table 25. Number of species by avian guild in surveyed Ravines/Slopes, CFB Suffield National Wildlife Area 1994-1995.

Ravine No.	Grassland	Shrub	Tall trees	Eroded	Wetland	River	Guild index
1	2	1	3	4		2	3
3	4	9	22	4	4	5	8
4	3	7	5	6	2	5	5.5
5	2	6	3	4	2	2	4
5/ 6	1	2	2	3		2	2.5
6	5	7	10	5	3	4	6
7	4	8	9	6	2	2	5
8	3	8	6	7	2	3	5
11		1		4			1.5
13	2	5	4	5	1		4
14	1	1			1	3	2
15	1	3	6	4		4	4
20	4	8	8	1	2	3	4.5
20/ 21	2	5	7			1	3
21	3	6	6		2		3
22	1	2	1		1	1	2.5
27	2	5	5	4	1	5	5
M.Horn	2	3	3	6		2	3
Mean	2.3	4.8	5.6	3.5	1.3	2.4	4

4.2.2.4 Introduced Species

Ravines/Slopes were the preferred habitat of Gray Partridge and Rock Dove. A third introduced bird–European Starling–was also common. They occurred in 4, 3 and 7 of 18 surveyed sites, respectively.

The Russian-thistle (*Salsola kali*), introduced from Eurasia, is a significant element in some grassland and ravine habitats. Macdonald (1997, p.86) describes the situation where "dried, dead bushy stems of the previous years tended to accumulate in the river ravines, locally forming 2 m deep billowing carpets". Native plants, including shrubs, and birdlife are all but eliminated in these circumstances. This is particularly evident in the North Block.

4.3 Wetlands

4.3.1 Wetland Characteristics

A total of 33 sites of 8 wetland types were surveyed during 1994 through 1996. The number of sites sampled per type varied (Table 26). The size of wetlands surveyed varied, with North Block wetlands (A and Y pond numbers) smaller on average (2.10 ha) than South Block (F and CB pond numbers) wetlands (5.16 ha) (Table 26). More than half the South Block wetlands were very small, but 4 large wetlands (>10 ha) raised the average. The surveyed wetlands were located within 7 ecosections (13 ecosites). In 1995, many wetlands were dry or nearly dry; however, in 1994 and 1996 water levels were higher.

4.3.2 Wetlands Birds

Encounter rates ranged from 0.00 to 6.25 species/min. (Table 26). The overall encounter rate for Wetlands (n=33) was 0.34 species/5 min. (Table 26). We recorded 48 wetland bird species on surveys. An additional 7 wetland species (Red-necked Grebe, Tundra Swan, Sandhill Crane, Lesser Yellowlegs, Solitary Sandpiper, Sedge Wren and Nelson's Sharp-tailed Sparrow) were recorded incidentally. Five species with historic records (American Bittern, Snow Goose, American Black Duck, Least and Pectoral Sandpiper) brought the species total to 60. Nineteen species, mostly migrants or summer visitants, were uncommon (5 or less seen) within wetlands. One wetland–Old Channel Lake–harboured most of the uncommon species.

Table 26. Physical characteristics and survey statistics for surveyed wetlands, CFB Suffield National Wildlife Area 1994-1996.[1]

Pond No.[2]	Type[3]	Ecosite	Size (ha)	Duration (min)	Species	Species/5 min
A4	SAB	G3.1	4.32	22	1	0.23
A5	SAB	G3.1	9.72	106	10	0.47
A6	SBA	G3.1	0.17	4	5	6.25
A8	SAB	E1.6	0.48	28	6	1.07
A9	SAB	E1.6	3.34	65	15	1.15
A15	TBA	G3.4	0.18	2	1	2.5
A17	USB	F1.1	0.62	19	1	0.26
Y9	STP	F2.4	0.02	5	1	1
Y10	STP	F1.3	0.06	9	2	1.11
CB32	SBA	M1.1	1.78	8	5	3.13
CB41	STP	M1.1	2.2	25	6	1.2

Pond No.[2]	Type[3]	Ecosite	Size (ha)	Duration (min)	Species	Species/5 min
CB43	SBA	M1.1	12.59	152	15	0.49
CB63	MDC	M1.3	8.07	221	19	0.43
CB65	SBA	M1.3	0.36	6	2	1.67
CB68	SBA	M1.3	0.46	4	3	3.75
CB103	SBA	M1.3	16.95	192	16	0.42
CB148	SBA	G3.8	0.79	17	7	2.06
CB149	DUG	G3.9	0.13	2	0	0
CB157	DUG	F3.2	0.15	16	4	1.25
CB158	MSC	G2.11	48.47	1803	44	0.12
CB186	TBA	G3.8	0.4	6	1	0.83
CB195	DUG	M1.5	3.5	27	9	1.67
F17	DUG	G3.10	0.16	5	2	2
F18	STP	G3.10	18.62	28	9	1.61
F22	DUG	G3.10	0.16	62	8	0.65
F23	DUG	G3.10	0.24	4	1	1.25
F27	MDC	G3.10	0.21	5	1	1
F34	MDC	G3.10	1.93	6	1	0.83
F39	TBA	M1.3	0.08	3	0	0
F40	SBA	M1.3	0.14	2	0	0
F52	MDC	G3.10	2.23	16	1	0.31
F53	MDC	G3.10	1.5	6	0	0
F54	MDC	G3.10	2.75	7	1	0.71

[1] (A. Didiuk, unpubl. CWS data).
[2] letters refer to military areas (A=Amiens, CB=Fish Creek and Casa Berardi, F=Falcon, Y=Ypres).
[3] Pond type: SAB=saline basin; SBA=seasonal basin; TBA=temporary basin; USB=upper spring basin; STP=stock pond; MSC=meander scar; MDC=minor drainage channel; DUG=dugout. See Adams et al. 1998 for pond type and Adams et al. 1997 for ecosite definitions.

4.3.2.1 Local Diversity

Fifteen of 60 Wetlands species were encountered in no other portion of the SNWA, but most species were not confined to Wetlands (only 15 species were strictly aquatic). Species richness for each wetland site surveyed averaged 5.97 species with a range of 0 (4 sites) to 44 species

(Table 27). Old Channel Lake, the largest and most physically complex of all the sites, had the most species (44 during surveys, 49 if incidental species are included).

Of the 8 types of wetlands surveyed, meander scar had the most species (Table 27). The only example–Old Channel Lake–had 49 of 56 inventoried Wetlands species. Stock pond wetlands were the next most diverse, followed by seasonal basin wetlands and minor drainage channels. Wetland birds were most represented within ecosite G2, followed by M1 and G3 (Table 28). Wetlands in fluvial sites had few (1-3) species.

Table 27. Occurrence of birds by wetland type, CFB Suffield National Wildlife Area, 1994-1996.

Wetland type[1]	SAB	SBA	TBA	USB	STP	MDC	DUG	MSC
No. of sites	4	8	3	1	4	6	6	1
No. of species	18	22	2	1	24	21	18	49
% inventoried wetland birds	32.7	40	3.6	1.8	43.6	38.2	32.7	89.1

[1] Wetland type acronyms: SAB= saline basin, SBA=seasonal basin, TBA=temporary basin USB=upper spring basin, STP=stock pond, MDC=minor drainage channel, DUG=dugout, MSC=meander scar.

Table 28. Number of wetland bird species in relation to ecosections in CFB Suffield National Wildlife Area, 1994-1996.

	E1	F1	F2	F3	G2	G3	M1
No. Sites	2	2	1	1	1	16	10
No. Species	17	3	1	10	49	24	27
% of wetland birds	30.9	5.5	1.8	18.2	89.1	43.6	49.1

4.3.2.2 Regional Diversity

Wetlands supported 10 *regionally unique* species, but only 4 were confirmed or expected breeding species (American Avocet, Willet, Marbled Godwit and Wilson's Phalarope). There were no national *species at risk*, and the only provincial *at risk* species (Trumpeter Swan) was an uncommon summer visitant. Thirteen Wetlands species were *regionally rare*. Only 3 of these species were expected to breed (Cinnamon Teal, Virginia Rail, Spotted Sandpiper). Thirty-four species were declining at some scale, 14 significantly. Forty-two species contributed to *regional diversity* in 1 or more categories but many were uncommon. Some wetland types held more species of regional importance (Table 29). Few birds were found in wetlands in the fluvial landforms (Table 30).

Table 29. Elements of *regional diversity* by wetland type, CFB Suffield National Wildlife Area, 1994-1996.

Number of species that were:	Wetland type[1] SAB n=2	SBA n=1	TBA n=1	USB n=1	STP n=1	MDC n=1	DUG n=3	MSC n=1
Unique	4	4	0	0	3	4	4	10
Provincial *species at risk*	0	0	0	0	0	0	0	1
Regionally rare	2	1	0	0	4	1	0	11
Declining	12	15	2	1	18	16	12	29
Declining significantly	6	6	1	1	7	8	6	11
Contributing to *regional diversity*	13	16	2	1	19	17	12	37

[1] Wetland type acronyms: SAB=saline basin, SBA=seasonal basin, TBA=temporary basin, USB=upper spring basin, STP=stock pond, MDC=minor drainage channel, DUG=dugout, MSC=meander scar.

Table 30. Wetland elements of *regional diversity* by ecosection, CFB Suffield National Wildlife Area, 1994-1996.

No. of species that were:	E1 n=2	F1 n=2	F2 n=1	F3 n=1	G2 n=1	G3 n=16	M1 n=10
Unique	4			1	10	4	4
Provincial *species at risk*					1		
Rare	1				11	4	2
Declining	12	2	1	5	29	16	19
Declining significantly	6	2	1	4	11	6	8
Contributing to *regional diversity*	12	2	1	5	37	18	20

4.4 Riparian

4.4.1 Riparian Habitat Characteristics

Sherwood Forest is the largest and most varied "woods" (tree-dominated). The 4 wooded sites varied from 9 to 51 ha (Table 31). The North Block contained the largest riparian shrub area-

NE Amiens. Shrub and shrub/tree sites varied in size from 8 to 100 ha. All Riparian areas combined had 33 ecosites and 19 VCTs. Individual sites had 2 to 9 ecosites and 2 to 8 VCTs.

Table 31. Riparian site characteristics, CFB Suffield National Wildlife Area.

Riparian site	Location	Riparian type	Size[1] (ha)	Ecosites	Vegetation cover type[2]
Riverbend Woods	Fish Creek	Woods	9	F2.2, G2.22	Barren-mid/tall shrubs, trees-tall/mid shrubs.
Bull Pen Woods	Fish Creek	Woods	24	F2.4, G1.6, G2.17, G2.22, G2.23, G2.3	Barren, barren-mid/tall shrubs, tall/ mid/low shrubs, mid/low shrubs, mid/ low shrubs-grassland, trees-tall/mid shrubs.
Dugway Forest	Fish Creek	Woods	11	F2.13, G2.21, G2.25	Barren-mid/tall shrubs, trees-grassland, tall/mid/low shrubs.
Sherwood Forest	Ypres	Woods	51	F2.5, F2.6, F2.7, G2.2, W3	Sedge-forb wetlands, upland grassland, tall shrubs-grassland, trees-grassland, trees-tall/mid shrubs, tall trees.
Farmstead	Fish Creek	Shrubs/ trees	8	F3.2, G1.6, G1.7, G2.14, G2.3, G2.5, W8, W9, W1	Unclassified wetlands, dugouts, sedge-forb-wetlands, disturbed grassland, tall/mid/low shrubs, shrubs-trees-grassland, upland grassland, saline grassland.
Fish Creek peninsula	Fish Creek	Shrubs/ trees	21	F2.13, G2.22	Barren, barren-mid/tall shrubs, trees-tall/mid shrubs.
NE Amiens	Amiens	Shrubs/ trees	100	F2.1, F2.4, G1.5	Barren-trees, shrubs-trees-grassland.
Old Channel Lake Area	Fish Creek	Shrubs	16.5	G1.3, G1.8, G2.11, W3	Forb, upland grassland, tall shrubs-grassland.
Frog Ponds	Fish Creek	Shrubs		F2.11, G2.5,	Grassland-mid/low shrubs, tall shrubs-grassland.
Ypres	Ypres	Shrubs	60	F1.1, F1.2, F1.3, F2.1, F2.4, F2.9, F2.10, G1.3, G2.5	Ravine wetlands, barren, barren-mid/tall shrubs, upland grassland, grassland-mid/low shrubs, mid/low shrubs-grassland.
S Whitco	Ypres	Shrubs	56	F1.1, F2.1, F2.2, F2.9	Barren-mid/tall shrubs, grassland-mid/low shrubs, mid/low shrubs-grassland, tall shrubs-grassland, trees-grassland.

4.4.2 Riparian Birds

A total of 154 bird species were recorded during the inventory. Most (146) were counted on surveys and 8 of these species were from incidental records. Many (68) were species seen 5 times or less. Ypres, SWhitco and NE Amiens, which were visited once, had few species but higher encounter rates than all other sites except the Farmstead (Table 32). Tree-dominated sites had more species and more survey time spent but low encounter rates. The relative abundance of breeders and migrants varied by site, with tree-dominated sites having more species in all status categories (Table 32). Eleven Riparian species were aquatic, 41 were aqua-terrestrial species and 102 were terrestrial species.

Table 32. Survey times, species and status for riparian habitats, CFB Suffield National Wildlife Area, 1994-1996[1].

Location	Duration (min.)	Number species	Number summer residents	Number permanent residents	Number migrants	Number summer visitors
Riverbend Woods	1100	75	43	10	18	4
Bullpen Woods	1693	81	51	8	18	4
Dugway Forest	2514	85	48	7	22	8
Sherwood Forest	3098	124	69	10	36	9
Farmstead	140.	38	24	3	10	1
Fish Creek Peninsula	282	32	25	3	4	0
NE Amiens	90	13	9	1	3	0
Old Channel Lake Area	1716	48	29	4	13	0
Frog Ponds	725	59	43	3	10	3
Ypres	55	11	9	1	0	1
S Whitco	95	11	9	1	1	0

[1] Includes Gray-cheeked Thrush from 1997 (Jocelyn Hudon, Provincial Museum of Alberta, personal communication).

4.4.2.1 Local Diversity

Thirty-five of 154 species of birds found in Riparian habitats were not seen in any other topographic segment of the SNWA. The number of species per riparian area surveyed ranged from 11 to 124 species, with a mean of 49.0 species per site (Table 32). Sherwood Forest clearly had the greatest number of species. Within the shrub/tree and shrub categories, South Block sites had more species than those in the North Block. Tree-dominated sites had more than three times the number of mean species per site (91.5) compared to shrub/tree and shrub areas (30.3).

Overall, the size of a site was not related to the number of species encountered (Tables 31 and 32). Within tree-dominated sites, species richness increased as the frequency of cattle access and grazing pressure decreased: Riverbend Woods (annual grazing, 6.6 acres/cow, 75 species); Bull Pen Woods (grazing almost annual, 6.6 acres/cow, 81 species); Dugway Forest (>10 years between grazing events, 3.4 acres/cow, 86 species); and Sherwood Forest (>40 years since grazed, 124 species). The season of grazing had some influence as well (Bull Pen and Dugway are grazed in the fall only). The number of shrub- and cavity-nesting species varied, but not in strict accordance with cattle use: Riverbend Woods (20), Bull Pen Woods (19), Dugway Forest (22) and Sherwood Forest (26).

Riparian growth along the South Saskatchewan River, immediately south of Trumpeter Trail, was fire-killed in 1992 (Adams et al. 1997). Root boles were burned below ground level, leaving large 1-m diameter by 1.5 to 2.5-m deep holes in the ground, but scattered shrub growth had started to return by 1995. No shrub- or tree-nesting birds were present.

4.4.2.2 Regional Diversity

Fifteen species recorded in Riparian habitats were *regionally unique,* but virtually all were summer visitants or species breeding in adjacent Upland, Ravines/Slopes or Wetlands. There were 4 national *species at risk* recorded (Ferruginous Hawk, Long-billed Curlew, Sprague's Pipit and Loggerhead Shrike). Each was seen at only 1 or 2 riparian locales verging on the Upland, and there was no evidence or liklihood of them breeding in the Riparian zone. The summer visitant Trumpeter Swan, considered *at risk* provincially, was observed on the river. Fifty-eight of the species recorded in Riparian habitats were *regionally rare,* but 36 were migrants or summer visitants. About half (31) of *rare* species were seen at 2 or fewer riparian locations. Ninety-six native Riparian species are *declining* (54 significantly).

Tree-dominated sites contributed the majority of regionally important species in all categories (Table 33). Within woods sites the number of species contributing to *regional diversity* increased as the amount of grazing pressure decreased. However, regionally important species made up a lower proportion of species in tree-dominated areas. The few species in the relatively unpopulated Ypres, NE Amiens and South Whitco sites were almost all important to *regional diversity*.

Many of the 121 Riparian species contributing to *regional diversity* were migrants (36) or summer visitants (10) and many others were uncommon (seen less than 5 times). Only a small proportion of the summer residents recorded in Riparian areas probably bred there (Table 34). Most of these species nest in trees or cavities with only the Spotted Sandpiper nesting on the ground. Although Bank Swallows were recorded in 6 sites, they only bred at Frog Ponds. Barn Swallows nested on man-made structures near Riparian sites.

4.4.2.3 Introduced Species

There are 5 introduced species in or near SNWA riparian sites: Gray Partridge, Ring-necked Pheasant, Rock Dove, European Starling and House Sparrow. For the latter 2 species, it is the preferred habitat with starlings being the most common species in Riparian sites (Table 35; Appendix 2). Few native cavity-nesting Tree Swallows and no Mountain Bluebirds were seen at individual sites.

4.5 Brood Parasitism/Productivity

We found 40 songbird nests in the SNWA with complete clutches or hatched young. Only 1 nest was parasitized by Brown-headed Cowbird. This provides a rough estimate (2.5%) of parasitism in the SNWA. We have no estimates of predation rates.

Table 33. Elements of *regional diversity* in Riparian sites, CFB Suffield National Wildlife Area, 1994-1996.

Species that were:	RW[1]	BPW	DF	SF	F	FCP	NEA	OCLA	FP	Y	SW
Unique	5	4	6	10	1	3	1	2	4	1	1
National *species at risk*			1	2				2			
Provincial *species at risk*			2	1				1			
Rare	26	24	30	41	9	8	5	11	13	7	3
Declining	49	57	57	79	20	24	10	32	40	6	9
Declining significantly	34	39	34	45	16	19	6	24	23	6	5
Contributing to *regional diversity*	60	67	69	93	24	28	12	39	46	11	10
% of species Contributing	75.0	82.7	81.2	75.0	63.2	87.5	92.3	81.3	78.0	100	90.9

Tree dominated site abbreviations: RW (Riverbend Woods); BPW (Bull Pen Woods); DF (Dugway Forest); and SF (Sherwood Forest). Shrub /tree site abbreviations: F (Farmstead); FCP (Fish Creek Peninsula); and NEA (North East Amiens). Shrub site abbreviations: OCLA (Old Channel Lake Area); FP (Frog Ponds); Y (Ypres); and SW (South Whitco).

Table 34. Breeding species contributing to *regional diversity* in Riparian sites, CFB Suffield National Wildlife Area, 1994-1996.

Species	Nest guild	Sites found in
Regionally rare		
Spotted Sandpiper	Ground	RW, BPW, DF, SF, FCP, NEA
Yellow-bellied Sapsucker	Cavity	BPW, DF, SF
Red-naped Sapsucker	Cavity	RW, SF
Downy Woodpecker	Cavity	RW, BPW, DF, SF
Hairy Woodpecker	Cavity	DF, SF
Declining		
Common Goldeneye	Cavity	DF, SF
American Kestrel	Cavity	All except S. Whitco and Ypres
Western Kingbird	Tree	RW, DF, F, FP
Black-billed Magpie	Tree	All except NE Amiens, OCLA, S Whitco, Ypres
Tree Swallow	Cavity	RW, BPW, DF, SF
Bank Swallow	Eroded	BPW, DF, SF, OCLA, FP
Brown Thrasher	Shrub	All except NE Amiens, Ypres
Common Yellowthroat	Shrub	All except NE Amiens, S Whitco
Song Sparrow	Shrub	All except FCP, OCLA, SW, Y
Common Grackle	Shrub	SF, SW

Tree dominated site abbreviations: RW (Riverbend Woods); BPW (Bull Pen Woods); DF (Dugway Forest); and SF (Sherwood Forest). Shrub / Tree site abbreviations: F (Farmstead); FCP (Fish Creek Peninsula); and NEA (North East Amiens). Shrub site abbreviations: OCLA (Old Channel Lake Area); FP (Frog Ponds); Y (Ypres); and SW (South Whitco).

Table 35. Number of Tree Swallows and European Starlings, CFB Suffield National Wildlife Area, 1994-1996.

Site	Tree Swallows	European Starlings
Riverbend Woods	7	76
Bull Pen Woods	4	214
Dugway Forest	19	299
Sherwood Forest	2	104

4.6 SNWA Totals and Status

One hundred and ninety-four species were encountered during the inventory or present historically (Appendix 2). We determined, confirmed or updated the status of all bird species (Table 36; Appendix 1). Sixty-four species, most of them migrants, had not previously been reported within the SNWA. There were a substantial number (>1600) of incidental records.

The 4 records of Common Poorwill, heard by David Gummer and others, represent a range extension (Appendix 3, Map 1). The status of Turkey Vulture, recorded historically and incidentally (Stevens 1972; AEC staff), and Sedge Wren, heard once, is still undetermined.

The number of species per Upland count was much lower than species per Ravines/Slopes, Wetlands or Riparian site (Figure 14). The contribution to the total number, and to status categories, by various topographic segments is unequal (Table 37). The dunes and grasslands of the Upland harbour the only winter residents and visitants in the SNWA. The Riparian segment dominated the migrant, summer visitant and 2 resident categories. The contribution of species by segment is more even in terms of which habitat is *preferred* (bracketed numbers in Table 37). Many species were seen fewer than 5 times in any segment (Table 37). Each segment also contributes species found no where else on the SNWA.

Table 36. Summary of 194 bird species recorded on CFB Suffield National Wildlife Area by their seasonal occurrence and breeding status.

Seasonal occurrence	Number (new)	Breeding confirmed (updated)	Breeding expected (updated)	Historic only	Incidental only
Permanent resident[1]	13 (2)[2]	9	4 (2)		
Summer resident	96 (9)	74 (6)	22 (3)		2
Summer visitant	19 (11)		2 (2)	1	4
Winter resident	1				1
Winter visitant	1			1	
Migrant	62 (41)			7	8
Status unknown	2 (1)				2
Total	194 (64)	83 (6)	28 (7)	9	17

[1]For status definitions see Appendix 1.
[2] Number of new species in each category in brackets.

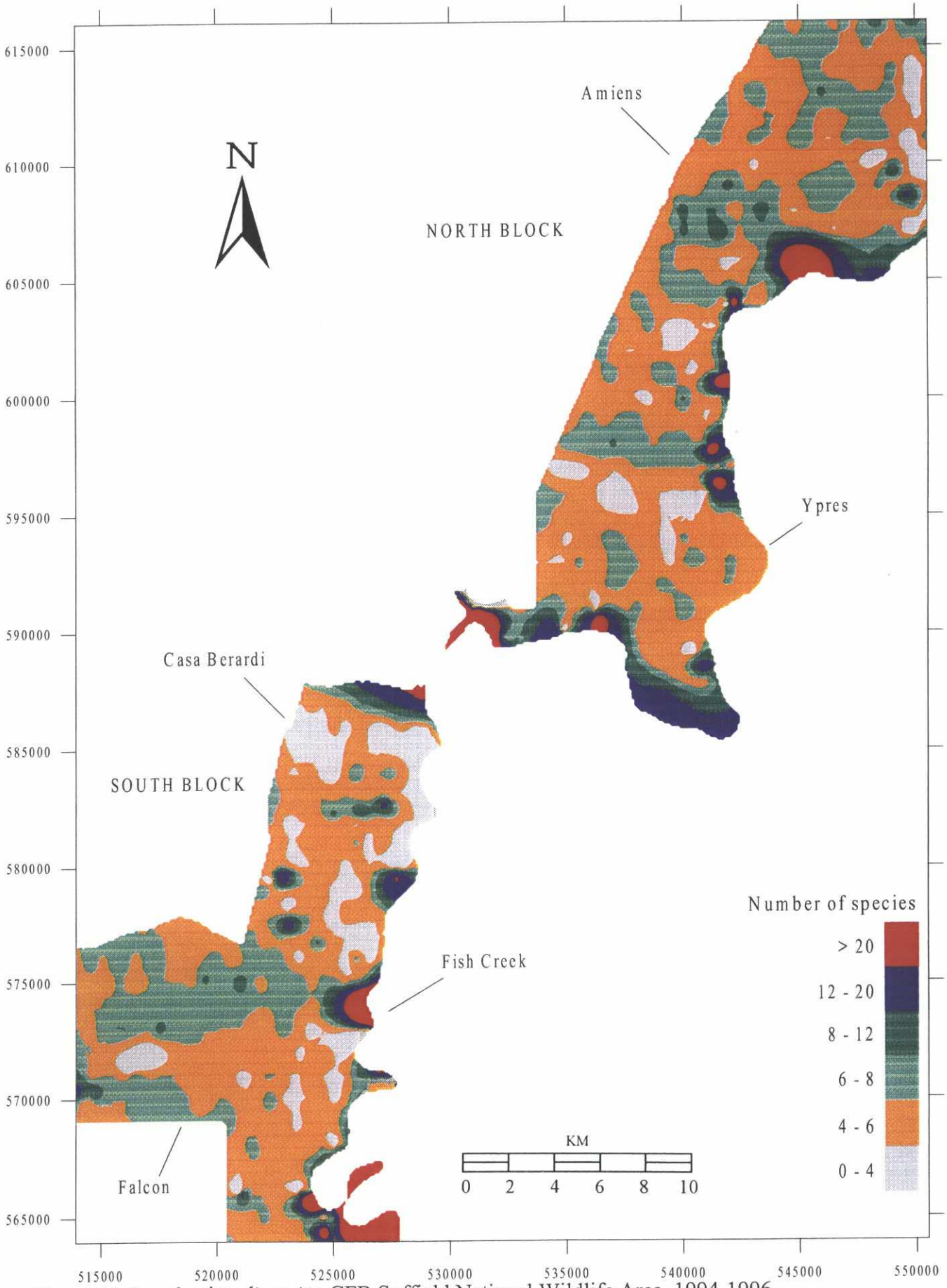


Figure 14. Local avian *diversity*, CFB Suffield National Wildlife Area, 1994-1996.

Table 37. Summary of species by topographic segment of CFB Suffield National Wildlife Area.

Number of:	Upland	Ravines/ Slopes	Wetlands	Riparian
Species	101 (40)[1]	96 (26)	60 (53)	154 (75)
New species	7 (3)	22 (5)	12 (10)	53 (46)
Permanent resident	10 (4)	9 (3)		13 (6)
Summer resident	79 (27)	64 (18)	33 (29)	81 (22)
Summer visitant	4 (1)	9 (2)	10 (9)	12 (7)
Winter resident	1 (1)			
Winter visitant	1 (1)			
Status unknown	1 (1)		1 (1)	
Migrants	5 (5)	14 (3)	16 (14)	48 (40)
Breeding	89 (31)	75 (22)	33 (29)	95 (29)
Species seen $\leq$ 5 times	42 (11)	55 (9)	24 (18)	68 (36)
Species seen only in 1 segment	15	2	15	35

[1]bracketed figure is number that *prefer* this habitat

4.7 Water Levels

In June 1995, a flood inundated riverside habitats with water, debris and silt. Many Riparian sites (Riverbend Woods, Bull Pen Woods, Frog Ponds, Fish Creek Peninsula, Dugway Forest and Sherwood Forest) and the mouths of many ravines were flooded. The mean depth of silt deposited in Dugway Forest was 24.8 cm (range 15-38 cm).

5.0 DISCUSSION

5.1 Data Limitations

5.1.1 Number/Timing of Visits

Our inventory may be incomplete for a number of reasons. We visited tree-dominated Riparian sites and Old Channel Lake multiple times, but most of the Upland, Ravines/Slopes and Wetlands sites were visited only once. In Upland we compensated for single visits by visiting multiple sites within each ecosite or VCT. Petit et al. (1995) suggest $\geq$15 point sampling stations are needed to characterize the avifauna. Coverage of 3 terrestrial ecosections and some VCTs (7) was insufficient by this standard.

The timing of counts may not have been ideal for large upland shorebirds, which are best surveyed prior to clutch completion or hatching (Redmond et al. 1981; Kalas and Byrkjedal 1984). Most surveys were conducted early in the day which is inappropriate for birds active at night or in the evening. In Ravines/Slopes, Wetlands and Riparian surveys, the extended period of sampling may have partially compensated for the inappropriate time of day. Not all sites were visited during migration so migrant use of the SNWA is underestimated–particularly for Upland, Ravines/Slopes and temporary Wetlands. The large proportion of migrants encountered in Riparian sites is a reflection of both our visitation schedule and the attractiveness of these sites for migrants (Table 37). Since we only spent 1 winter survey day in the SNWA we underestimated winter resident and winter visitant numbers.

5.1.2 Moisture Conditions

Moisture conditions in 1994/1995 were good. Bird species composition, abundance of breeding species, and responses by birds to disturbance (fire or grazing) may change under drier conditions (Dale 1984; George et al. 1992).

5.1.3 Comparability Among Upland Counts

We found significant between-year differences in abundance for a few species (Sprague's Pipit, Vesper and Grasshopper Sparrow, and Lark Bunting). One of the 3 Upland observers participated only in 1995. The different mix of observers in the 2 years could have contributed to between-year differences in species' abundance since observer abilities to recognize and enumerate birds differ (Bart and Schoultz 1984; Dawson et al. 1995). A far greater mix of habitats were surveyed in 1995 and sampling additional habitats will influence which birds are encountered. Grassland birds are notorious for substantial between-year variation (Wiens and Dyer 1975; Dale 1984; Prescott and Wagner 1996), often by an order of magnitude. Sprague's Pipit increased on the SNWA and enjoyed a rare increase throughout the region between 1994 and 1995 (BBS annual indices). The significant increase in the number of Vesper Sparrows recorded was due entirely to increases in the counts of 1 observer but the apparent increase in local population size may also reflect improvement in shrub cover resulting from 2 years of post-fire or post-feral horse grazing recovery. We found Grasshopper Sparrows increased between 1994 and 1995 on the SNWA, but they were stable in the region, based on BBS. The first year of our study (1994) was an irruption year when Lark Buntings expanded beyond the core of their range in all parts of prairie Canada (confirmed by BBS annual indices) and they were much more common (23.3% of point counts) than in the following year (11.5%) on the SNWA. With so few significant differences, and some explained by region-wide trends, we pooled both years results.

Not all sample sites were completely visible to the observers. This had no discernable effect on our ability to detect birds, so we compared frequency of occurrence on point counts from all parts of the Upland.

Using the 23 points examined in both years, we found 9 of 20 structural variables differed significantly between 1994 and 1995. These results are consistent with known high year-to-year variability in habitat values (Dale 1983). The vegetation structure values depicted in our maps (Appendix 4), like the bird abundance (Appendix 3), contain year-to-year variability.

5.1.4 Comparability of Upland to Ravines/Slopes, Wetlands and Riparian

Encounter rates (birds/5 minutes in columns 3-5 in Appendix 2) derived from Ravines/Slopes, Wetlands and Riparian surveys are not directly comparable to the frequency values derived from the Upland point counts (column 2) for 2 reasons. First, time and effort were devoted to verifying breeding for bird species encountered during the timed walk counts. This has the effect of reducing the rate of bird sightings on timed walk surveys (2.5 times as many species/5 minutes on ravine point counts as on ravine timed walks). Second, occurrence on Upland point counts was expressed as frequency (percent of point counts where they occurred) and 1 to many birds of a given species might be present at the same point. Frequency was appropriate for making comparisons among point counts because equal effort was expended on areas of equal size. Ravines/Slopes, Wetlands and Riparian areas varied in size, shape and the time spent, and few sites were visited so frequency would not be a very meaningful means of comparing them.

5.1.5 Assessing Fire and Grazing Effects

Our measures took into account the fire or grazing **history**, not just current management practices. This is an important consideration when making comparisons to other studies, or when planning management procedures. Some species respond very differently to habitat currently being grazed or burned than they would several years after application (Maher 1973; Pylypec 1991; Madden 1996).

Our tests examined the influence of fire and grazing history as they have been applied. We were unable to apply a true experimental design since grazing had been applied in a controlled manner in only some portions (which translated into a limited number of ecosections or VCTs) of the SNWA. Feral horse grazing was uneven in distribution. The Graze sample was dominated by E1 and G3 with other ecosections making minor contributions. In terms of VCTs, the major contribution to the Graze sample is from upland grassland, grass/low shrub while shrub-dominated VCTs are scarcely represented. Since neither fire nor grazing happens equitably across ecosections or VCTs, the combination of these disturbances also occurred on a skewed distribution of sites. The Burned and Grazed combination occurred disproportionally, often in E1 and the shrub/tree vegetation class (there was no pristine habitat sampled in this VCT), with the fire influence mainly from 1987. Much of the shrub grows on dunes, which were over-represented in the Burned and Grazed category, thereby influencing the apparent avian response. Therefore our tests in the Upland were complicated by the soil type, topography and vegetation layers to which the treatment(s) was applied.

We have a very limited amount of data to assess the influence of fire and grazing on the other topographic segments. Without replicates our discussion relies on the scientific literature.

5.2 Inventory/Status

Incidental records provided our only information for 17 species, in a cross-section of status categories, and confirmed breeding for many more (Table 36). Historical records provided the only evidence for 9 species and, in additional cases, provided more cogent evidence of status than our records. Almost a third of the 194 species were migrants, while 111 were confirmed or expected breeders. The updated species list (Appendix 1) is considerably larger than those in Crease (1990), Patriquin and Skinner (1992) and Karasiuk (1976), and the species status has been determined, confirmed or upgraded. Species lists for coarse vegetation categories (grassland, sandhills, shrubs/grasslands, coulees, riparian) in Karasiuk (1976) have been largely confirmed, although we found many species occur in multiple vegetation categories. Our study has expanded those lists, particularly for the non-breeding season, and provided information on the relative abundance of species and their response to variability within ecosections and VCTs.

We encountered 64 new species with no previous records for the SNWA. Several (Downy Woodpecker, Brown Creeper, Townsend's Solitaire, Dark-eyed Junco) were listed in Patriquin and Skinner (1992), but those records were from Ralston or other parts of CFB Suffield outside the SNWA. The White-throated Sparrow was attributed to Crease (1990) in error by Patriquin and Skinner (1992).

New species were mainly migrants or summer visitants, but some breeding or expected breeding species were added to the SNWA list. For example, Violet-green Swallows were not mentioned by Karasiuk (1976) or Crease (1990). They were absent from Spring and White Rock Coulee (east of the SNWA) in the early 1970s but have since increased along the South Saskatchewan River (Cleve Wersler, Sweetgrass Consultants Ltd, pers. commun.). Future surveys may provide breeding evidence for some summer visitant species. Northern Mockingbird, seen once in Amiens during our study, bred at nearby Bindloss in 1990 (Koes and Taylor 1990). A pair of Lazuli Buntings exhibited nest building/courtship behaviour, which suggested breeding. Lazuli Bunting is rare and local in distribution, and irregular in abundance from year to year (Greene et al. 1996), particularly across its southern Alberta breeding range (Pinel et al. 1993). Records near Medicine Hat have increased, and Lazuli Bunting is now considered regular in occurrence there, with breeding confirmed (Anonymous N.D.; Semenchuk 1992; Sherrington 1997; Dennis Baresco, Grasslands Naturalists, pers. commun.).

The proximity of other biomes near SNWA influences the occurrence of some species. The following montane and coniferous species, all breeders or probable breeders in the Cypress Hills 80 km to the south-southeast (Mitchell 1924; Salt and Salt 1976; Semenchuck 1992), have been recorded at SNWA: Red-naped Sapsucker, Townsend Solitaire, MacGillivray's Warbler, and both Red and White-winged Crossbill. Kondla (1978, p. 111) reports Red Crossbills are "quite regular in cottonwoods stands of southern [Alberta] river valleys during summer."

The previously known breeding range of Common Poorwill reached as far north as the Cypress Hills (Csada and Brigham 1992), but they have been heard along the Red Deer River northwest of Bindloss, Alberta (Wayne Smith and Cleve Wersler, unpub. data), and in the Great Sand Hills in Saskatchewan during 1993 (K. Wang, M.C. Kalcounis, D.B. Bender, D.L. Gummer, and R.M. Brigham, unpub. data). This nocturnal species is found in semi-arid regions with high rolling grasslands (Csada and Brigham 1992), and it nests on sparsely vegetated ground. Given the 4 observations in the SNWA (Map1, Appendix 3), and others at a similar latitude in Saskatchewan, Common Poorwill may exist in significant numbers on the SNWA.

Status for a few species remains undetermined. One of these, the Turkey Vulture, breeds locally in Alberta's boreal, parkland (Semenchuk 1992) and grassland biomes (Alberta Environmental Protection 1996). In Saskatchewan, the situation is similar (Smith 1996). It is a probable breeder in the Medicine Hat area (Semenchuk 1992), but definitely breeds in the central Red Deer River valley (Alberta Environmental Protection 1996). Stevens (1972) reported this species within CFB Suffield. With less than 100 breeding pairs in Alberta (Alberta Environmental Protection 1996), observations of this species in SNWA will continue to be limited and its status questionable. Sedge Wren, another species of uncertain status, was heard once in appropriate breeding habitat, but the date (23 May) was consistent with migration. Alberta Atlas records were restricted to the Southern Boreal Forest and Parkland biomes, and a record from Cereal was considered extralimital (Semenchuk 1992). There is a probable breeding record from an adjacent portion of Saskatchewan (Smith 1996).

The only comparable inventory in the Prairies is from the Matador International Biological Program site in southwest Saskatchewan (Maher 1973, 1974). Matador's species lists and breeding records are based on incidental observations from 1967 to 1971. The SNWA has slightly more permanent (Matador -10/SNWA -13), summer (92/96) and winter residents (0/1) as well as summer visitants (16/19), but Matador has more winter visitants (7/1) and migrants (73/60). Further surveys will increase the SNWA species list and improve our knowledge of all bird species, particularly migrants and wintering birds.

5.3 Avian Diversity

5.3.1 Local Diversity

The total number of species (194) is similar to the 198 at Matador, Saskatchewan (Maher 1973, 1974) and better than the 133 encountered in a less intensive inventory of McIntyre Ranch, Alberta (Hudon et al. 1996).

5.3.1.1 Contribution by Topographic Segment

At any given point, Upland *local diversity* is low (Figure 14) while Riparian, Ravines/Slopes and Wetlands areas are species rich. The disparate size and shape of Ravines/Slopes, Wetlands

and Riparian sample polygons, and the long time spent in them compared to the 5-minute visit to each 100-m radius Upland plots, tends to exaggerate the real differences in *local diversity*.

Local diversity can also be measured by looking at species per segment. The multiple visits to Riparian sites yielded the most species of any segment (Figure 15), while the Wetlands held less than a third of the total 194 species. Wetlands, Riparian and Ravines/Slopes habitats make up a small proportion of the SNWA landbase (Figure 16), but contribute many breeding species (Figure 17) and total species (Figure 15). The Upland segment contributes fewer species in proportion to its representation in the landbase since few species are detected at any given point.

Riparian provided the most migrant species on an unadjusted basis and according to which segment was preferred (Table 37). For breeding species, the unadjusted pattern was very different from the preferred segment pattern. Superficially, it might appear that Riparian (68 breeding species) was far more important for breeding species than Wetlands (33). But each topographic segment is *preferred* by very similar numbers of breeding species (Table 37, Figure 18). This is a more meaningful view of the relative importance of segments to breeding species. Only species that occur regularly in a study area should be used to determine species richness for a site (Remsen 1994). There were situations where a breeding species was seen once or twice in a segment but their appearance did not reflect breeding or even a substantial or biologically meaningful use of the area. Examples of this are Sprague's Pipit and Long-billed Curlew, which were heard once or twice on Riparian counts, or Rock Wrens or Say's Phoebe heard on Upland counts near a ravine.

Each segment contributed a few to many species encountered nowhere else in the SNWA (Table 37). Some species (particularly shrub nesters like Black-billed Magpie, Spotted Towhee, Lark Sparrow) were most common in Ravine and Riparian habitat but considerable numbers occurred in lower densities in Ypres and Amiens in the Upland. Additional species nested in 1 habitat but fed or roosted in another. Examples of these are waterfowl species associated with Wetlands but nesting in Upland, or Common Nighthawks that nest in Upland but often feed on insects near water and roost in Riparian areas. This underlines the importance of the presence of all 4 segments within the SNWA in maintaining a large variety of birds. Some species are present only because of the juxtaposition of the different habitats or physical features, while breeding populations of other species are more viable because of several suitable segments.

Upland

Low numbers of species per point in Upland is typical of results found elsewhere in grasslands and shrub-steppes (Wiens and Dyer 1975; Cody 1968; Ryan 1986). In grasslands, more species at any given spot is <u>not</u> better, since it usually means inappropriate (non-grassland) species are present (Graul 1980).

Upland did have the second highest species total and contributed 15 species found nowhere else on the SNWA. The large extent of the Upland provides adequate habitat for large numbers of each species that breeds there. Sharp-tailed Grouse, present on 3.5% of point counts, had a total

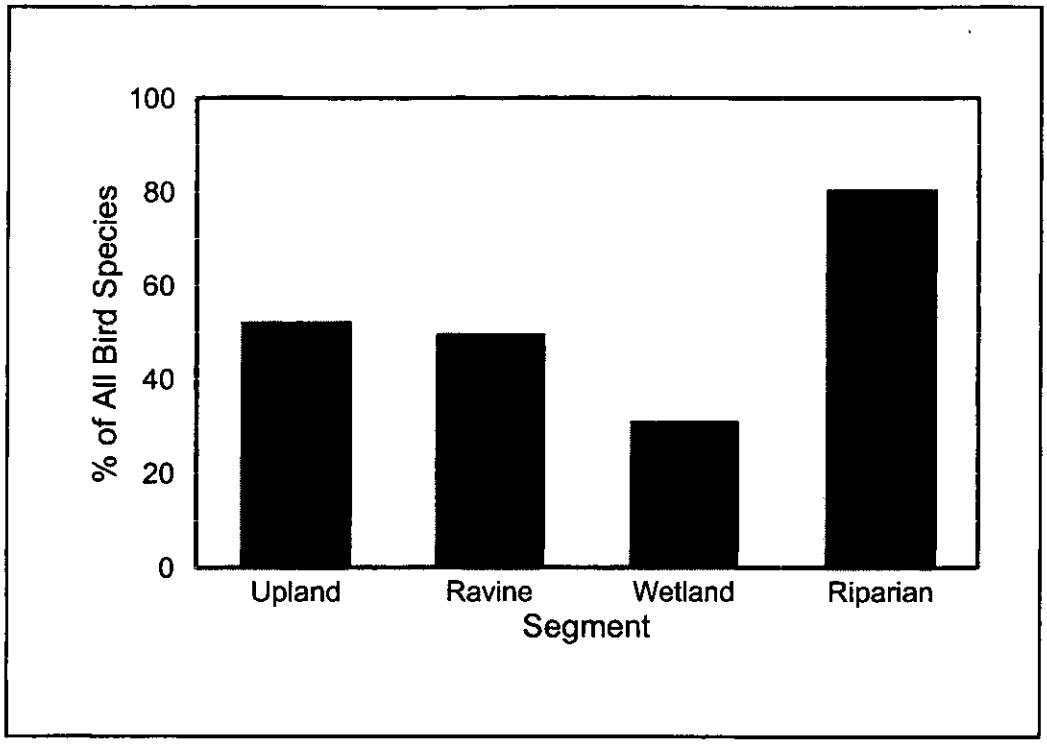


Figure 15. Proportion of all bird species seen on CFB Suffield National Wildlife Area, by topographic segment. Many species were seen in more than 1 segment.

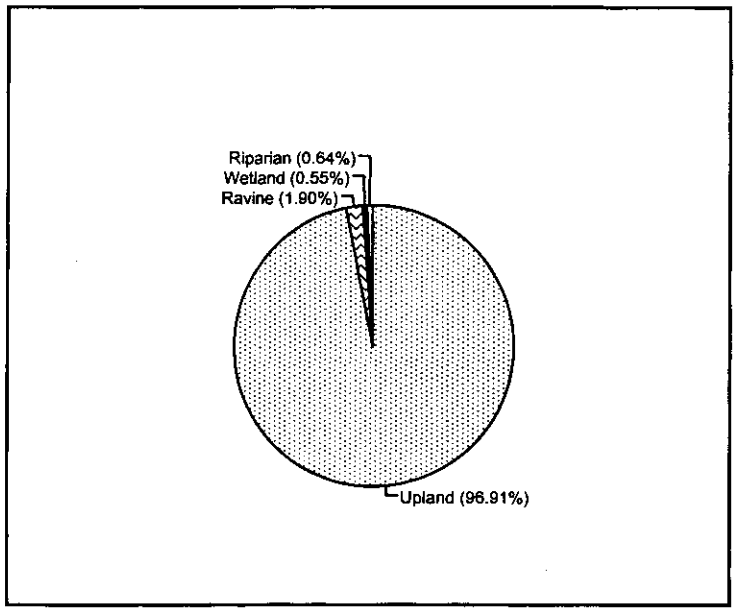


Figure 16. Proportion of CFB Suffield National Wildlife Area in each topographic segment.

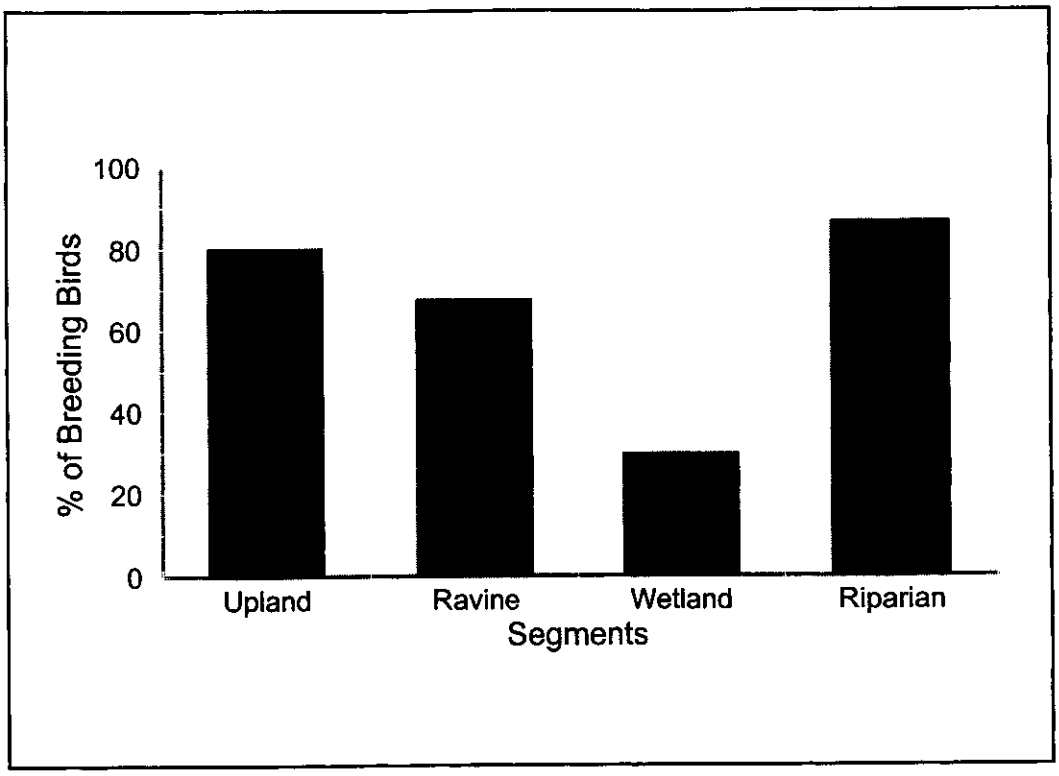


Figure 17. Proportion of breeding bird species seen on CFB Suffield National Wildlife Area, by topographic segment. Many species were seen in more than 1 segment.

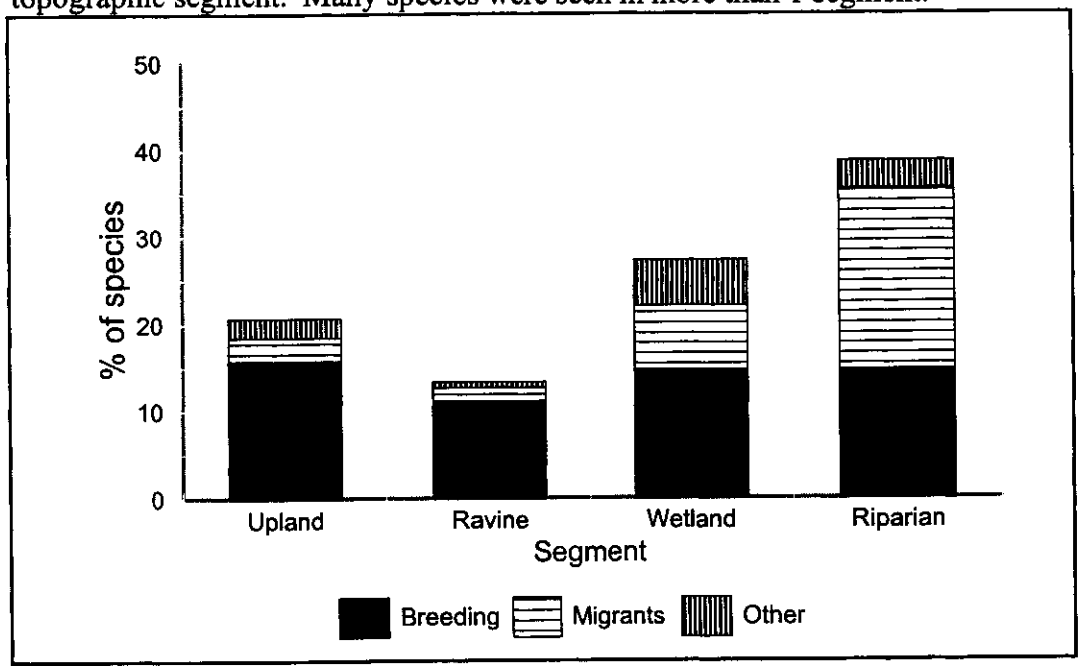


Figure 18. Proportion of breeding, migrant and other species that preferred each topographic segment on CFB Suffield National Wildlife Area.

of 581 individuals reported in the Upland over the 2 year study. It was the twenty-third most frequently encountered species in the Upland and was still recorded in greater numbers than any breeding Ravines/Slopes, Wetlands or Riparian species. Very few breeding species that preferred Upland were uncommon there (Ring-necked Pheasant, Black-billed Cuckoo, Long-eared Owl and Common Poorwill). Most uncommon species were migrants or from adjacent segments.

Frequency of occurrence of Brown-headed Cowbirds (Appendix 2) is a quarter of that in the prairies as a whole. Observed nest parasitism on the SNWA (2.5%) is similar to low rates from pre-settlement/early settlement periods (Friedmann and Kiff 1985), and to nearby Remount pasture (0 of 78 nests, O'Grady et al. 1996) and Matador, Saskatchewan (none of 480 nests, Maher 1973). Both the SNWA and Matador are large grasslands with little shrub, fencing or cattle to provide perches needed by cowbird females searching for potential host nests. Elsewhere, nest parasitism by Brown-headed Cowbirds increased with a decrease in size of grassland patches (Davis 1994) or distance to edge of patches (Johnson and Temple 1990). Parasitism rates for altered landscapes include: 88% (Clay-colored Sparrow) on remnant Saskatchewan prairie (Fox 1961); 15.5% of Lark Bunting nests in Kansas (Hill 1976); 14 to 43% (6 species) at Manitoba sites (Davis 1994); and 38% of Clay-colored Sparrows in a North Dakota study (Romig and Crawford 1995).

We are unable to assess productivity directly within the SNWA, without further study. Owing to its size and the largely untilled lands around it, the SNWA has high potential for productivity. Elsewhere it has been show that rates of nest predation may relate to patch size with larger patches showing higher survival rates (Johnson and Temple 1990). Small patches can have decreased productivity for a multitude of reasons. Some species avoid nesting near edges (Delisle and Savidge 1996). Edge habitat may also attract predators or provide perches from which they can hunt. Surrounding land use influences productivity in fragments. A Minnesota study, conducted in an intensively used landscape, found productivity rates too low for long-term survival of populations (Johnson and Temple 1990). Human activities alter landscape structure and function and increase the amount of edge habitat in agricultural landscapes. This leads to high densities of small nest predators (rodents) buoyed by artificial food supply (waste grain) and the absence of top level predators (Bayne and Hobson 1997).

The almost complete absence of skunks and ground squirrels (Reynolds et al. 1999) and the open nature of SNWA grasslands are probably positive influences on avian productivity. Skunks can be responsible for high rates of nest loss (Vickery et al. 1992). Mammals are common nest predators for grassland birds (Greer and Anderson 1989). Many mammalian predators minimize time in open grassland where they are susceptible to predation (Johnson and Temple 1990) and often utilize shrubs for cover so nests near shrubs are more susceptible to predation (With 1994).

Ravines/Slopes

Relative to its small area within the SNWA, the Ravines/Slopes segment supports a high

number of species (Figures 14-16). The total number of species encountered was almost double that from surveys conducted in 30 draws in North Dakota (Faanes 1984) and 2 draws in Saskatchewan (Driver 1992).

Although only 2 species were seen exlusively in SNWA Ravines, the avifauna there was unique as many additional species were largely confined there and only recorded occasionally on surveys of other segments. The eroded slope guild (9 species) was largely restricted to this segment because cliffs, rock ledges, rock overhangs, rock outcrops, rock rubble slopes and clay banks/cliffs occurred almost entirely within the South Saskatchewan River corridor.

Many shrub and tree nesting species (19) were also found in Riparian or woody portions of the Upland so Ravines/Slopes make an important contribution to maintaining their SNWA breeding populations. In addition to sharing populations with other SNWA segments, many species (>40) used habitats on both sides of the river. Proximity to other adjacent habitats can influence species richness values for a given site (Remsen 1994). This connectedness between otherwise isolated habitat patches is characteristic of the South Saskatchewan River corridor of the SNWA and increases the value of this habitat complex to birds and other wildlife species.

More than half the species overall (55) and a third of species preferring Ravines/Slopes were uncommon (seen $\leq$5 times). About half the species in the North Dakota and Saskatchewan studies were uncommon in ravine habitat (Faanes 1984; Driver 1992).

Although breeding species predominated in all ravines (Table 22), at least 14 species used Ravine habitat during migration. Most migrant songbirds are attracted to the best-developed woody growth for shelter, food and water. Migrant songbirds probably do not differentiate between the tree/shrub cover found in ravines and nearby Riparian woodlands. However, the smaller physical extent of ravine tree/shrub habitats probably limits their holding capacity for migrants because of restrictions in preferred habitat, food, water and escape cover in comparison to larger riparian areas. The notable exception is Ravine 3, which has tree/shrub growth for nearly half its length and tended to attract and hold a variety of migrants. Migrant accipiters (e.g., Sharp-shinned Hawk), attracted to the concentrations of migrant passerines, are further evidence of the value of ravine complexes for birds during their spring and fall passage.

Wetlands

The total number of species in the Wetlands (60) was the lowest of any segment, but the Wetlands also covers the smallest extent (Figure 14) and, with the exception of Old Channel Lake, was not extensively surveyed (Table 26). Most of the species (53) used wetlands preferentially, and 15 species were found only in Wetlands. More than half the Wetlands species were breeding. Old Channel Lake accounted for much of the Wetlands *local diversity* in the SNWA. Forty percent of Wetlands species were uncommon and numbers of most species were low, so SNWA wetlands, alone, do not sustain significant bird populations.

Riparian

Thirty-five species found nowhere else on the SNWA used Riparian. This small topographic segment had the most total species, breeding species and migrants (Figures 15 and 17). No other vegetation community in the Great Plains supports more breeding birds than riparian habitats (Knopf et al. 1988). Migrant, breeding and wintering birds all make use of resources in riparian habitats for migratory stopovers, nesting or seasonal survival (Szaro 1980).

When we look only at species by their preferred habitat (Figure 18) Riparian's contribution to breeding species is about the same as other segments. Almost half the Riparian species and half the species preferring it are uncommon. Eleven breeding species are uncommon and for most species, the number using Riparian is too low to sustain populations (122 species had fewer than 50 individuals recorded). Therefore, Riparian's contribution to maintaining these species is low. Riparian sites are small wooded islands of habitat where natural population fluctuation could lead to local extinction (Finch 1991). Finding mates in small forests may also be problematic for small populations and thereby hinder productivity (Finch 1991). Riparian shares populations of many shrub- and tree- nesting species with Ravines/Slopes and portions of the Upland, and similar habitats along the South Saskatchewan River.

With about a third of Riparian birds being migrants, it appears the segment is almost as important as a migration stopover for migrants as it is as nesting habitat for breeding species. Rivers provide natural corridors for birds to follow during migration. The habitats adjacent to rivers are stepping stones for migrants needing food and rest. Riparian forests are important to migrant birds as refuelling stops during their annual migrations (Sprunt 1975). The number of birds during migration tends to be greater in riparian habitats than during the breeding season (Knopf et al. 1988). The presence of spring and/or fall migrants creates temporary increases in *local diversity*.

5.3.1.2 Topography and Cover

The greater physical diversity available in the Riparian, Ravines/Slopes and Wetlands topographic segments provides suitable habitat for more species than did the Upland (Figure 14). Ravines had 19 VCTs and Riparian had 33 ecosites and 19 VCTs (Table 31, Appendix 5). Eight of a possible12 wetland types surrounded by 13 ecosites were surveyed. All of this topographic and vegetative diversity occurred in less than 5% of the SNWA landbase. In contrast, the extensive Upland held less than twice as many ecosites (55) and 21 VCTs. Upland sample points usually had only 1 ecosite or VCT. Breeding bird diversity rises with increasing vegetation complexity (Balda 1975). The structural simplicity of the Upland dictates that relatively few species can be accommodated here as has been found elsewhere in grasslands and shrubsteppes (Wiens and Dyer 1975; Cody 1968; Ryan 1986). Grasslands make up 17% of the North American landscape but contribute only 5% of bird species (Knopf 1994).

Upland

Local diversity per point values in Upland are similar for all VCTs (Table 6) and most ecosections (Table 4), with the exception of G3 which was extremely well sampled and showed higher species richness. A large polygon of G3 was changed (post analysis) to M1, so this difference should be viewed with caution as it might not exist with reanalysis of the corrected data set.

Those ecosections (Table 3) with more samples had more species (except M1 which had similar or fewer species than the much less well sampled F2, G1 and G2). Most well-sampled ecosections and VCTs had species found no where else in the Upland (Tables 3 and 5), showing that variation in soil, slope and vegetation cover contributes to *local diversity*. The upland grassland was the most distinctive VCT with fully 16% of its species confined to it.

No single ecosection or VCT met the needs of all species (Tables 13 and 15) and each species chose slightly different habitat features (Figure 12). Correlations showed that the more residual cover and living native cover that existed, and the more variable that cover was, the more species were present. Multiple regression indicated the greater variation there was in vegetation structure, and the more habitat layers (grass and shrub) there were, the more species there were present at any given point. Variation in vegetation height and thickness, presence or absence of shrub, and the relative contribution of live and old cover over the SNWA Upland is critical to the area's ability to support the number of bird species that occur there.

Ravines/Slopes

SNWA Ravines support a diverse bird fauna from several distinct guilds associated with 6 primary habitat types. Ravines with the greatest habitat diversity support the greatest number of species (Figure 13). This is due to: the uniqueness of some of the habitats (e.g., rock outcrops, cliffs, eroded clay banks, steep rock-strewn slopes); the close proximity of many different habitat types to each other, which creates a great number of contact zones or edge habitats that are often highly attractive to many wildlife species; the presence of water attracting wildlife in an otherwise arid landscape; high ravine walls that provide shelter from sun, wind and rain; and cover from predators provided by topography and vegetation.

Orientation of ravines (Table 21) varies widely with the greatest similarity usually occurring among neighbouring ravines. The orientation and depth of a ravine were important factors in determining how much exposure there is to direct sun, wind, and rain along its various reaches. In the SNWA, this directly influenced vegetation along the ravine course with grasses being favoured in drier, more exposed sites and woody vegetation favoured in wetter, more sheltered sites. The vegetation, in turn, influenced which and how many bird species were present. Roy (1996, p.17-18) describes the ravine habitats in his study area in southwestern Saskatchewan along the South Saskatchewan River in some detail, noting the lusher vegetation on north- and east-facing slopes which is dependent upon the ravine's orientation and depth.

Wetlands

The number of species per wetland varied with size, physical complexity and permanence (wetland type), and surrounding topography and habitat (ecosection) (Tables 27 and 28). Old Channel Lake, a large, permanent waterbody with a variety of vegetation types along its margin (Adams et al. 1998), accounted for 89.1% of Wetlands species inventoried on the SNWA (Table 27). Permanent stock ponds (including Heggie's Lake), some with well-developed marginal vegetation, were second in terms of *local diversity*.

Riparian

Tree-dominated woods had notably more species and migrants than shrub/trees or shrub sites (Table 32). The size of the site and number of VCTs or ecosites did not appear to be related to the number of species in SNWA Riparian sites, although small patch size, irregular shape, and habitat patchiness is thought to be important to increasing *local diversity* (Tubbs 1980). Within shrub/tree and shrub sites, the South Block areas had more species than North Block sites.

5.3.1.3 Grazing and Fire

Upland

Some degree of grazing, either in the past or present, increased the number of species per point (non-significantly) in most ecosections and all VCTs. Well-sampled Low intensity grazing areas virtually always had more species than the few pristine areas. High-intensity grazing was rare, but it did appear to increase species number in G3. Some studies indicate species richness is unaffected by grazing (Cody 1968; Dale 1984), or increases with grazing (Maher 1973; Wiens 1973), while other studies indicate the opposite (Kantrud 1981).

The response of individuals species to grazing varied, sometimes by ecosection (Table 16). Studies elsewhere show soil (Kantrud and Kologiski 1982) and moisture (Ryder 1980) can alter the degree, and even direction, of response of individual species. Results vary from year to year depending on moisture, and as populations fluctuate independent of grazing (Wiens and Dyer 1975). Because of the variable response by individual species, *local diversity* in the Upland as a whole depended on a variety of grazing conditions. The large paddocks used in the PFRA grazing system contribute to uneven grazing and were a factor in creating the habitat variety.

Fire significantly decreased *local diversity* overall, but differences were not significant for individual ecosections or VCTs (Tables 9 and 10). The 2 apparent exceptions (G2, low shrubs-grassland) are based on very small sample sizes in Fire=high. Other studies in Canada and Montana have found fire initially reduced species richness (Maher 1973), or reduced the abundance of many species (Maher 1973; Huber and Steuter 1984; Bock and Bock 1987; Driver 1987; Pylypec 1991). Several of these studies document at least partial recovery for some bird species over a period of 2 or more years (Maher 1973; Pylypec 1991). In North Dakota, soil

and moisture conditions result in rapid shrub proliferation in the absence of fire. This made the habitat unattractive for grassland birds. Under these conditions, fire reduced the amount of shrub and increased the number of bird species (Madden 1996).

As with grazing, individual species respond differently to fire depending on whether they prefer short or moderate cover and/or whether they need shrubs (Table 17), so no single disturbance regime maintains good numbers of all species and a variety of fire history helps to maintain the complete suite of grassland birds.

Riparian

The number of species in woods increased with a decrease in the frequency of cattle access and/or a decrease in grazing pressure. Forest size and physiognomy differed among these sites independent of grazing, thereby potentially influencing species composition and abundance, but grazing does appear to decrease *local diversity*.

Species nesting in shrubs or old trees were most abundant in sites with the least grazing influence (Sherwood and Dugway Forests). Understory vegetation loss occurs with cattle grazing (Hopkins et al. 1986; Taylor 1986). Saunders (1988) predicted a 6% loss of species if 50% of riparian shrubs were thinned in her study area along the Red Deer River. In riparian habitats in Oregon, as grazing increased, bird species number decreased (Taylor 1986). In that study shrub height and volume, as well as the number of birds recorded, all increased significantly as the amount of time since the last grazing increased.

Where fire has occurred in Riparian sites (Casa Berardi) the above-ground woody vegetation was removed. Since most common breeding Riparian species nest in shrubs or trees (Table 34), *local diversity* was greatly reduced in those sites.

5.3.2 Regional Diversity

The SNWA is important to the future of a substantial proportion of the bird species in this region. The 111 species breeding in the SNWA represents about 69.8% of the 159 bird species with 1 or more breeding or probable breeding records within the grassland portion of Alberta (Semenchuk 1992). It is about 42.7% of the bird species whose breeding range includes the southern portion of 1 or more prairie province (Godfrey 1986).

Most species *unique* to the prairie provinces (22) are present at Suffield (Table 38). Six of 8 national *species at risk* possible in Alberta (COSEWIC 1999) breed in the SNWA. More than a third (68) of the species in the SNWA are *rare,* and 116 of the 194 species recorded there are currently *declining* at some scale of measurement. For 65 of those species, the decline is statistically significant and for another 10 species it is biologically significant (0.051 to 0.10). As a group, grassland birds are declining significantly across North America (Peterjohn and Sauer 1993), in U.S. prairie states (Igl and Johnson 1997) and in Canada (Downes and Collins

1996). Providing permanent, breeding, or migratory habitat for the 145 species in 1 or more of these categories is a worthwhile contribution to *regional diversity* (Table 38). Each topographic segment contributes habitats important in maintaining the fauna of the region.

Table 38. Summary of elements of *regional diversity* by topographic segment of CFB Suffield National Wildlife Area.

No. of species that are:	SNWA	Upland	Ravines/ Slopes	Wetlands	Riparian
Unique	22	**17 (10)**[1]	11 (3)	10 (9)	15 (0)
National *Species at risk*	6	**6 (6)**	3 (0)	0 (0)	4 (0)
Provincial *Species at risk*	6	**5 (5)**	3 (0)	1 (1)	4 (0)
Rare	68	22 (11)	29 (13)	13 (9)	**56 (35)**
Declining	116	67 (29)	61 (14)	34 (30)	**95 (43)**
Declining significantly	65	43 (20)	36 (9)	14 (12)	**54 (24)**
Contributing to *regional diversity*	145	78 (34)	76 (22)	42 (34)	**121 (55)**
% Species contributing	74.7	77.2 (85.0)	79.2 (84.6)	70.0 (64.2)	78.6 (73.3)
% Breeding species contributing	81.1	80.9 (93.5)	80.0 (81.8)	78.8 (79.3)	80.0 (69.0)

[1]Bracketed figure is number that *prefer* this habitat, bolded figures show the segment with greatest contribution

5.3.2.1 Contribution by Topographic Segment

Upland

Most Upland breeding species contribute to *regional diversity* (93.5% of species preferring Upland) and are associated with grassland or grassland/shrub habitats. Upland shelters the majority of the SNWA's breeding *regionally unique* species and all the federal *species at risk.* Conserving *regionally unique* species is important for maintaining *regional, national and international diversity*, and some feel it should be a management priority (Samson and Knopf 1994). The value of the Upland for *regional diversity* is made even greater because all but 3 of the 17 *unique* species are declining elsewhere in their range, based on the BBS, while there is reason to believe they are highly productive on the SNWA and evidence that Brown-headed Cowbird parasitism rates are much lower than in the majority of the prairie.

The 25 most common Upland species all contribute to *regional diversity* and, because of the large geographic extent of the segment, occur in good numbers. Most species are present in far greater frequency than in the prairies as a whole (Table 11). Exceptions are the Marbled Godwit and Clay-colored Sparrow. The former is present on the SNWA in a frequency about equal to the prairies as a whole. Marbled Godwit needs wetlands, particularly wetland complexes (Ryan et al. 1984) and situations where wetlands make up greater than 5% of the

habitat (Gratto-Trevor 1997). In the SNWA, wetlands are a relatively scarce element. Clay-colored Sparrow occurs in lower frequency on the SNWA Upland (Table 11) than in the prairies. Clay-colored Sparrows need shrubs, which are scarce in many parts of the Upland. However, the Upland is not the only place within the SNWA that this species occurs, and overall healthy numbers of this species are maintained on the SNWA.

The SNWA represents an important refugium where healthy population levels of species important to *regional diversity* (particularly *regionally unique* species and *species at risk)* are maintained. The sheer size of the grassland block represented by a combination of the SNWA, the remainder of CFB Suffield and neighboring intact grasslands such as the Remount Community pasture all contribute to its value.

Ravines/Slopes

A substantial proportion (81.8%) of breeding species preferring this segment contribute to *regional diversity*. Ravines/Slopes contribute several breeding *regionally unique* species (Prairie Falcon and Lark Sparrow) but mainly it contains *rare* and *declining* species (Table 23). Ravine habitats and associated plant and animal species are found in only a restricted part of the Prairies. Within Alberta, badland habitats and landforms are estimated to comprise less than 0.25% of the total landscape (Ian Campbell, University of Alberta, personal communication to Ross Dickson). Roy (1996) notes that although eroded land systems, including ravines associated with the South Saskatchewan River valley, comprise less than 3% of his southwestern Saskatchewan study area, they are "vitally important wildlife habitat". The presence of this rare habitat in the SNWA, and its maintenance of the eroded slopes species guild, which is unusual in the region, makes a major contribution to *regional diversity*.

Some sites contribute little to *regional diversity* (Table 23), and most species in Ravines/Slopes are uncommon (Table 37). The proximity to other such sites and populations across the river, both upstream and downstream, increases the value of this habitat for uncommon bird species.

Wetlands

Apart from the river and Old Channel Lake, wetlands are not a dominant feature of the SNWA habitat and many species found in them were uncommon (Table 37). A low proportion of Wetlands species contribute to *regional diversity* (Table 38). Few of the *regionally unique* or *rare* species found in the Wetlands actually breed there. Wetlands also harbour some *declining* species.

Riparian

Although Riparian has the most species of any topographic segment, it has the lowest proportion of breeding species contributing to *regional diversity* (Table 38). Riparian habitats

are important as stopover sites for species moving north to breed in parkland and boreal forests and many of the regionally important species in Riparian are migrants.

No species that prefers Riparian is *at risk* or *regionally unique* (Table 38). High species richness is often associated with a low number of characteristic species (Kerr 1992). Riparian vegetation makes up less than 1% of the Great Plains landscape. Many Riparian species are *declining* or *regionally rare*, so the SNWA contributes to *regional diversity* by maintaining a portion of their populations within its boundaries. As with Ravines/Slopes species, the close proximity of other similar areas across and along the river makes the SNWA sites more valuable in maintaining populations.

Diversity outside the SNWA is indirectly affected by SNWA Riparian habitat which acts as a corridor to encourage species mixing, colonization and recolonization. Undesirable non-native species, like the European Starling, can bring competition and displace native species to new locales within a region. Riparian habitats may also have a genetic influence by facilitating contact with isolated or separate but related species (Knopf and Samson 1994).

5.3.2.2 Topography and Cover

Upland

No single ecosection supported good numbers of all species that were important to *regional diversity* (Table 12). The poorly sampled fluvial ecosections appear to make a smaller contribution while G1, even with a relatively small sample, is a major contributor to Upland *regional diversity*. G3 supports the most *unique*, *rare* and *declining* species, and E1 the most *at risk* species. Ecosites dominated by crested wheat grass had extremely low *regional diversity*.

Individual species, important to *regional diversity*, showed associations with particular ecosections (Table13). Only E1, G2, G3 and M1 were sampled well enough to make any meaningful conclusions. The 3 national non-raptor *species at risk* show definite, but different, preferences. The Long-billed Curlew was absent from F2 and F3 and most common in M1. The post-breeding flocks of Long-billed Curlew seen in M1 and M2 were comparable to large groups reported in Remount Pasture (Wershler 1991) and elsewhere in the prairies (Dickson and Beyersbergen 1998). Sprague's Pipit was encountered in all ecosections, but most frequently in M1 and G3. This species was found on a variety of soil types in North Dakota but was most common on typic and aridic borolls (Kantrud and Kologiski 1982). The Loggerhead Shrike was most common in E1. The area between Bindloss and Iddesleigh just north of the military base ("Shrike Alley") is the highest known concentration area of Loggerhead Shrikes in the province, and supports about 36% of the provincial population (Prescott and Collister 1993). The sandhills area (E1) of the SNWA represents a substantial block of largely suitable habitat (habitats containing short to moderate grass cover for hunting and shrubs for nests - Telfer 1992) in close proximity to this population core.

E1 appears largely unsuited for species requiring open low grassland (McCown's Longspur,

Horned Lark, Chestnut-collared Longspur), or moderately well-covered grassland (Baird's Sparrow, Sprague's Pipit). However, for those needing heterogeneous cover (Grasshopper Sparrow) or who are shrub obligates or edge species (Brewer's Sparrow, Clay-colored Sparrow, Vesper Sparrow), this is good habitat. Grassland birds were most common in glacial or morainal ecosections. G3 has enough variation in cover height to accommodate both the short, open cover grassland birds and those needing moderate and heterogeneous cover. Cover height must vary, within an ecosection, to maximize the number of species it can maintain (Figure 12).

Most grassland-dominated VCTs (except disturbed grasslands) have a high component of *regionally unique, species at risk, rare* and *declining* species (Table 14). Of the 4 well-sampled vegetation types, shrubs-trees-grassland contributes the fewest species to *regional diversity*. Which species contribute to *regional diversity* varies by VCT (Table 15). Half the *regionally unique, rare* or *declining* species prefer grasslands of some type, but the remainder prefer some type of shrub VCT.

Species at risk also show varied affinities. Long-billed Curlews showed strongest affinities to moist grassland, disturbed grassland (disturbance here refers to soil disturbance) and upland grassland. Sprague's Pipit was common in all grassland-dominated VCT. Loggerhead Shrike occurs in 3 VCTs, and only 2 with any regularity. Its strongest affinity is to grassland-tall/mid/low shrubs (n=10, frequency=30%, not in Table 15). This is consistent with its need for shrubs for nesting and hunting perches (Telfer 1992; Prescott and Collister 1993). One of the strongest elements in habitat selection by Loggerhead Shrike is normally the presence of the shrub thorny buffaloberry (*Shepherdia argentea*) and this is true at Shrike Alley just north of the base (Prescott and Collister 1993). However, due to fires this shrub species has been virtually extirpated from the SNWA (Adams et al. 1997), so shrikes must use other shrubs such as choke cherry (*Prunus virginiana*).

Uniform cover type, height and thickness throughout the Upland would not support the full suite of *regionally unique* species (Figure 12). The mix of structure among VCTs (Table 19), and the variation within VCTs of vegetation thickness and height, is responsible for the outstanding *regional diversity* in the Upland. Variation in vegetation structure provides places for species requiring specific habitat, such as short or sparse cover, moderate cover, and tall, thick vegetation (Figure 12). Areas with habitat conditions suitable for virtually all habitat specialists also satisfy generalists, and management to maintain heterogeneity of cover is ideal (Graul 1980; Ryan 1986; Grumbine 1994; Samson and Knopf 1994).

Ravines/Slopes

Most *declining, regionally unique* or *rare* species nested in shrubs, trees or eroded slopes (Table 24) so the presence of these primary habitats is important to *regional diversity* (Figure 13). Only Ravines 3 and 6 make a high contribution of *unique* species and no ravines are of much importance for *species at risk.* Ravines 3, 4 and 6 have the highest number of *regionally rare* species. *Declining* species are best represented in 3, 4, 6, 7, 8 and 20 - the ravines with the greatest number and variety of habitats (Figure 13, Table 22).

Wetlands

Meander scar (Old Channel Lake) contained all the inventoried Wetlands species contributing to *regional diversity* except Red-necked Grebe and Common Goldeneye (Table 29). Stock ponds were a distant second, while temporary and upper spring basins add little to *regional diversity.* G2, which contains Old Channel Lake, stands out as the ecosection supporting the most regionally important species (Table 30).

Riparian

Breeding species contributing to regional diversity were mostly shrub- or tree- (particularly cavity) nesting species (Table 34). Although there are more regionally important species in tree-dominated sites, the proportion of contributing species per site is higher in some shrub and shrub/tree sites than in any tree-dominated Riparian site.

5.3.2.3 Grazing and Fire

Upland

Vegetation height and litter depth were lower in portions of Falcon and Casa Berardi where historic grazing pressure was highest (Figure 9; Appendix 4, Maps 2 and 4). Our tests showed shrubs were most common in Burn Only and lowest in Graze Only, while thickness of cover near the ground (Hits/1st DM) was greatest in Graze Only and Pristine sites.

Since each bird species chooses different combinations of structural characteristics their response to fire and grazing, that shape habitat, varies as well (Figure 12). In some cases the response to grazing and/or fire varied by ecosection. An extensive survey in North Dakota also found different responses to grazing by soil types (Kantrud and Kologiski 1982).

The positive response of Sprague's Pipit and Baird's Sparrow to increased grazing (Table 16) is in sharp contrast to results elsewhere (Owens and Myres 1973; Maher 1973; Kantrud and Kologiski 1982; Dale 1984; Anstey et al. 1995), and from earlier work at Suffield (Karasiuk et al. 1977). It also appears to contrast with their preference for areas with high grass cover (Figure 12). Our test was of grazing history based on a small sample size for Graze=High. Our test used only birds recorded within the 100-m circles so birds could have been present outside of additional points. The distribution maps were based on records both inside and outside of 100-m circles and the maps for these 2 species (Appendix 3, Maps 6 and 10) when compared to grazing intensity (Figure 9) would indicate both the species avoided heavy grazing. Throughout the SNWA these species almost never coincide with heavy grazing. Sprague's Pipit and Baird's Sparrow, prefer intermediate cover (Dale 1983; 1991; Madden 1996; Robbins and Dale 1999), and showed a strong tendency to avoid fire and utilize Graze Only sites (Tables 17 and 18). Habitat usually becomes attractive to both species 2 to 3 years after fire (Maher 1973, Pylypec 1991, Madden 1996). However, since shrub dominated the Burn Only and Burned and Grazed

samples and both species tend to avoid shrub (Dale 1983, Madden 1996) this may have influenced their apparently strong negative response to past fire in the SNWA.

Lark Bunting and Clay-colored, Brewer's and Vesper Sparrows all achieved greatest abundance in Graze=Low (Table 16), Fire=Low (Table 17) and Burned and Grazed sites (Table 18). In Nebraska, Lark Bunting used burned areas grazed by bison (Griebel et al. 1998). In all likelihood, the response of all these species reflects their tolerance of grazing (Best 1972; Owens and Myres 1973; Kantrud 1981; Kantrud and Kologiski 1982; Dale 1984; Arnold and Higgins 1986; Prescott et al. 1998) and an overwhelming preference for some shrub (Best 1972; Knapton 1978; Castrale 1983; Arnold and Higgins 1986; With and Webb 1993), even when it is burned. Their complete or partial acceptance of a degree of shrub removal (Best 1972; Wiens et al. 1986; Driver 1987; Pylypec 1991) has been demonstrated in other studies, but total removal is not tolerated (Best 1972; Pyrah and Jorgensen 1974; Castrale 1983; Arnold and Higgins 1986; Bock and Bock 1987). In the SNWA, shrub removal by fire appears to be incomplete in many cases, and a considerable period of time for possible shrub recovery had passed between the occurrence of fire and our avian sampling. Elsewhere, early season fires often occur with environmental conditions similar to those associated with partial burns (Kruse et al. 1983), and shrub is often skipped in fires because of the lack of understorey fuel (Kruse and Piehl 1986).

Horned Lark and Chestnut-collared Longspur both prefer low cover (Maher 1973; Ryder 1980; Kantrud 1981; Dale 1983), and showed positive responses to Graze=High and Fire=High. Positive responses to grazing by both species are common (Owens and Myres 1973; Maher 1973; Kantrud and Kologiski 1982; Dale 1984). Burning favours Chestnut-collared Longspur (Maher 1973; Huber and Steuter 1984) and Horned Larks (Driver 1987). Chestnut-collared Longspur preferred (n.s.) the Burned and Grazed sample in spite of it being dominated by shrubs, which they avoid.

Grasshopper Sparrow exhibited a significantly negative response to fire (Table 17) and a preference for Pristine (Table 18). Elsewhere their numbers were reduced by fire for from 1 (Huber and Steuter 1984) to several years (Bock and Bock 1987). Negative responses to grazing, especially in drier portions of their range, have been demonstrated before (Wiens 1973; Karasiuk et al. 1977; Kantrud and Kologiski 1982).

Western Meadowlark exhibited a significantly negative response to fire (Table 17) and preferred Graze=Low (Table 16) and Graze Only (Table 18). Meadowlarks declined for 1 (Maher 1973) to a few years after fire in Saskatchewan (Pylypec 1991). In Nebraska, they preferred grazed to burned and grazed sites (Griebel et al. 1998), and many studies shown they tolerate grazing (Owens and Myres 1973; Maher 1973; Karasiuk et al. 1977; Dale 1984) in prairie Canada.

Upland Sandpiper (Appendix 3, Map 4) appeared to respond negatively to fire except in the sand hills of Amiens. The positive response by Upland Sandpiper is consistent with results in South Dakota where shrub encroachment can be a problem for this species (Huber and Steuter 1984). Sharp-tailed Grouse were noted (Appendix 3, Map 3) in portions of the sand hills touched by fire. Huber and Steuter (1984) and Kruse and Higgins (1990) indicated Sharp-tailed

Grouse benefit from fire. Sexton and Gillespie (1979) noted that mating display areas are rejuvenated by fire. McCown's Longspur were almost completely confined to grassland touched by fire (Map 11).

Although burning and grazing wetland edges may not benefit waterfowl species, it is desirable for some upland nesting shorebirds such as Willet and Marbled Godwit that were not included in our tests (Ryan et al. 1984; Ryan and Renken 1987). These species require both low and moderate upland cover for feeding, nesting and brood rearing, so a mixture of cover heights is ideal.

Certainly no single grazing intensity (Table 16), fire intensity (Table 17) or combination of these disturbances (Table 18) maintains all *regionally unique, species at risk* or *declining* species. A rotation grazing system simultaneously provides space for species with different needs (Prescott et al. 1993). Patchy grazing and burning creates habitat suitable for the needs of all species. We found species from both extremes of the grassland habitat spectrum–Burrowing Owl and McCown's Longspur (very short cover) and Savannah Sparrow (tall homogeneous grass)–and all the intermediate stages in the mosaic of disturbance regimes within the Upland.

Riparian

The number of species contributing to *regional diversity* increased as cattle use of tree-dominated sites decreased (Riverbend Woods, Bull Pen Woods, Dugway Forest, Sherwood Forest). The proportion of species per site contributing to *regional diversity* did not vary in proportion to measures of grazing pressure (only 75% of Sherwood Forest species contributed).

All shrub- and tree-nesting birds were absent from the Riparian site in Casa Berardi that burned in 1992, and *regional diversity* was much reduced.

5.3.3 Conclusion

Each segment had some species found nowhere else on the SNWA (Table 37) and all portions of the SNWA make important contributions to *local diversity*. Each segment also contributes different elements of *regional diversity* (Table 38). Upland makes its greatest contribution to both *local* and *regional diversity* for breeding species, most of which are present in good numbers and productive conditions over the large extent of this segment, while Riparian areas provide habitat suitable for the majority of migrants. The inclusion of all the topographical segments in the SNWA is also important to *diversity* because many species used multiple segments. All habitats, combined, form a diverse unit - the SNWA. Any single habitat or segment could not support the full range of species we encountered. Kunin (1997) documented the importance to diversity of an elongated shape in large reserves. The size, length and continuity of the SNWA block allows for considerable variation of soil, elevation, slope and aspect, a condition associated with high diversity (Burnett et al. 1998). The diversity of birds at the McIntyre Ranch in southern Alberta was assumed to be the result of complex topography

(Hudon et al. 1996). This physical diversity, coupled with variable treatment (grazing and fire) of Upland increases the SNWA's value in maintaining both *local* and *regional diversity*. Disturbance in Riparian areas appears to decrease *local diversity*.

The continuity of the SNWA with similar surrounding habitats (CFB Suffield, Remount Pasture, public and private lands across the river and upstream and downstream segments of the South Saskatchewan River) further contributes to ecosystem function and thus *diversity*.

6.0 MANAGEMENT ISSUES AND RECOMMENDATIONS

6.1 Management Issues

Despite its relative isolation and protection, the SNWA is vulnerable to environmental changes and disturbance factors from past and present human activities that affect habitats and birds. Sensitivity to these activities varies by species. For small specialized populations, these disturbances could potentially result in local extinction within the SNWA. Some of these disturbances occur on the SNWA, while others occur outside the area. Some are related to military activities on the range, others to secondary activities on DND property, and still others emanate from lands not administered by DND.

6.1.1 Grazing

Consideration of historic conditions is important to modern management considerations (Ryan 1986). Modern agricultural practices increase grazing capacity but place the needs of cattle first. On national lands, the fauna may potentially have primary consideration (Buttery and Shields 1975). Native grassland controlled by public agencies is increasingly important for maintaining wildlife as more private land is destroyed or degraded (Kruse and Bowen 1996).

6.1.1.1 Upland

Because individual species differ in their response to grazing and the resulting changes in vegetation, the key to maintaining *local* and *regional diversity* is to have variation in the height and thickness of vegetation. These conditions are created on the SNWA by variation in soil, moisture and vegetation type (ecosections and VCTs), conservative stocking rates, and by *unequal and uneven disturbance* applied to existing habitats. These disturbances occur over an area of sufficient size to allow even rare habitat configurations to exist in frequencies adequate to support species preferring the extremes (Burrowing Owl and McCown's Longspur need intense annual grazing, annual grazing on poor soil, or a combination of grazing and fire; Savannah Sparrow requires no or light grazing with good soil moisture).

With some areas undisturbed for periods of time and some areas grazed annually (over the range of soil and moisture conditions) as well as the whole spectrum of intermediate conditions,

sufficient habitat for all *regionally unique, at risk, rare* and *declining* species is currently provided. Such management may seem at odds with the most efficient grazing management schemes, which advocate equal and maximum sustainable cover removal. However, even a good management system creates a patchy landscape (Robertson et al. 1991) and certainly patch grazing is best for the avifauna because it most closely approximates the irregular and uneven cover removal of pre-European settlement. Current management with conservative stocking rates and large pastures in a rest-rotation system with a limited number of water supply sites achieves this.

In addition to creating habitat attractive to birds, this type of management also provides areas of rest and deferment where productivity may be higher (Buttery and Shields 1975; Bowen and Kruse 1993). Spring/early summer grazing results in reduced nest densities of Upland Sandpiper compared to no or late season grazing in the Northern Great Plains (Bowen and Kruse 1993). Pastures with low stocking rates also had higher nest densities than those with high stocking rates. Other studies found reduced Upland Sandpiper and Long-billed Curlew nest success associated with grazing (Kirsch and Higgins 1976; Redmond and Jenni 1986). Hendricks and Reinking (1994) documented 16% of artificial nests were trampled by cattle. In the Remount Pasture, just north of the SNWA, 2.6% of Chestnut-collared Longspur nest failures were due to cattle trampling (O'Grady et al. 1996). In Alberta parkland, some species exhibit higher nest success during July grazing compared to June grazing treatments (Prescott et al. 1998). Success of Clay-colored Sparrow nests declined with increased grazing activity around them (Prescott et al. 1998). In that study, 4.7 and 22.2% of nest failures of Clay-colored Sparrow and Vesper Sparrow, respectively, were due to cattle. The highest nest destruction occurs when cattle first enter a pasture and exploratory movements are high (Paine et al. 1997), so minimizing the number of moves between pastures, as is done in the SNWA, is beneficial to avian productivity.

6.1.1.2 Ravines/Slopes

Ravines used by cattle suffer increased rate of gully formation (Ryder 1980), breakage of shrubs and trees, trampling of wetlands and margins, overgrazing in selected areas where palatable forage is available, and increased bank erosion in heavy use and soft soil areas. Bird species requiring shrub, tree and wetland habitats are the most influenced. The presence of cattle may attract more Brown-headed Cowbirds and result in more nest parasitism. Reduced vertical diversity of vegetation in grazed woody habitats increased natural nest predation and the negative effects of grazing persisted for years following removal of the cattle, indicating habitats are slow to recover and grazing may negatively impact bird populations for a longer period of time than just the year during which cattle are present (Ammon and Stacey 1997).

6.1.1.3 Wetlands

Numerous studies have shown that waterfowl productivity is negatively affected by grazing (Braun et al. 1978). Cattle trampling is evident in SNWA's wetlands (Adams et al. 1998). This

can potentially destroy bird habitat in small wetlands and contribute to nest loss and decreased productivity. Some species (Marbled Godwit and Willet) prefer grazed wetlands (Ryan et al. 1984; Ryan and Renken 1987), so a mix of disturbance regimes is ideal.

6.1.1.4 Riparian

Although grazing can be compatible with avian breeding in riparian habitat, it depends on the season and grazing pressure (Sedgwick and Knopf 1987). The effects of livestock grazing are "magnified" in riparian areas (Fleischner 1994). Heavy grazing allows plant species to invade, thus preventing natural riparian succession from taking place (Garry Trottier, CWS, pers. commun.). Forested areas need a diversity of flora including a canopy made up of several layers, to provide vertical and horizontal diversity (McKee et al. 1995) to accommodate the broad range of habitat needs of riparian bird species.

6.1.2 Fire

6.1.2.1 Upland

Our research seems to indicate the current combination of irregular grazing and fire disturbance maintains sufficient variation in vegetation structure for the full suite of grassland *regionally unique* birds. Additional research during a drought period would be necessary to confirm this.

Burning can affect productivity, so the timing and frequency of fires is critical to maintaining bird populations. Upland Sandpipers in North Dakota had the highest nest success in sites that were either left undisturbed or burned every 3 years (Kirsch and Higgins 1976). Active nests were prone to immediate destruction. The number of nests destroyed during a fire varied with the intensity of the fire. Skips (areas missed by fire) resulted in some nests proceeding to natural completion, so nest loss may not be total (Higgins 1986; Kruse and Piehl 1986). Skips are often used by re-nesting birds (Kruse et al. 1983). Productivity of shorebirds and passerines initiating nests immediately after a burn was lower than 1 year post-burn (Vickery et al. 1992).

There is little documentation on the combined effects of grazing and burning on productivity. Some species initiated fewer nests in burned/grazed areas (Kruse and Bowen 1996). Literature on productivity in each treatment separately has been presented earlier and indicates substantial short-term negative effects and long-term positive effects on avian reproduction. The productivity evidence also favours uneven management from year to year and from place to place to prevent continuous occurrence of negative effects and allow time for the more positive influences of these disturbances to occur.

6.1.2.2 Ravines/Slopes

Shrubs and trees are sensitive to fire. They may either be damaged or killed depending upon the frequency and intensity of the burn(s). Accumulated dead material, including broken stems, branches and russian-thistle plants increases the potential for fire to have a long-lasting impact on ravine shrubs and trees. The majority of common Ravines/Slopes birds were shrub- or tree-nesting species (Tables 24 and 25) so the loss or damage of woody cover can be expected to have a negative impact.

6.1.2.3 Wetlands

The effect of fire on seasonal wetlands is not well known but it can result in a loss of dried vegetation during the late summer (Adams et al. 1998). This can lead to a loss of potential avian nesting habitat and cover for the following spring breeding season.

6.1.2.4 Riparian

Most common breeding riparian species nested in either trees or shrubs (Table 34). Shrub and tree habitats are sensitive to fire. One or more hot fires can remove the majority of above-ground growth and even kill many of the plants. While native plant species often are fire adapted to some degree, frequent burning may kill weakened species or slow their recovery.

6.1.3 Introduced Plants

Although our own data from the SNWA were limited, introduced plants have the potential to powerfully influence Upland bird species composition. Crested wheat grass is structurally different from native grasses, having fewer standing dead stalks, more litter, greater average height and less variability in height (McCanny et al. 1996). Its planting within the SNWA has been discontinued, but it appears in narrow strips and in a few patches in the Upland and on some river flats. Our data showed reduced *local* and *regional diversity* on the few Upland sample sites containing pure crested wheat grass. The single species in these sites–the Grasshopper Sparrow–is known to use crested wheat grass (Prescott et al. 1993; Prescott and Wagner 1996; Davis and Duncan 1999). The sandy soils of Suffield create a large complex of native cover in ideal condition for this species, as demonstrated by its high occurrence in the SNWA (Table 11), so crested wheat grass is certainly not needed to maintain this bird on the SNWA.

Negative responses to introduced vegetation by grassland birds have been documented elsewhere. Marbled Godwit and Willet prefer native grassland (Ryan et al. 1984; Ryan and Renken 1987). Sprague's Pipit shows a clear aversion for crested wheat grass, and Baird's Sparrow demonstrates a mixed response with aversion most likely to occur where the crested wheat grass appears within areas of largely native vegetation such as in the SNWA (Prescott et

al. 1993; Anstey et al. 1995; Sutter et al. 1995; Sutter 1996; Prescott and Wagner 1996; Prescott and Bilyk 1996; Davis and Duncan 1999). Chestnut-collared Longspur and Clay-colored Sparrow also exhibit a negative response to crested wheat grass (Davis and Duncan 1999).

Brome is uncommon on the SNWA and mainly confined to roadsides and the river valley (Macdonald 1997). In Manitoba, several grassland birds including Sprague's Pipit and Baird's Sparrow avoided non-native grasses, particularly smooth brome grass (Wilson and Belcher 1989). Later studies in Saskatchewan and North Dakota confirmed a strong aversion to idle brome grass (Dale 1991, 1992; Madden 1996; Dale et al. In Review) while Davis (1994) found these birds used grazed brome in Manitoba.

Accumulation of Russian-thistle in ravines can choke out shrubs and indirectly diminish numbers of shrub-associated birds. The situation is exacerbated, at least in part, by past overgrazing by horses in the SNWA since overgrazed upland sites continue to produce abundant new thistles that blow into adjacent ravines.

6.1.4 Introduced Birds

The European Starling is abundant in Riparian and some lower Ravines/Slopes habitats of the SNWA– wherever trees grow. Originally introduced at New York in 1890, starlings arrived in Alberta in 1934 (Ehrlich et al. 1988; Semenchuk 1992). Starlings displace native bird species that nest in cavities (Kerpez and Smith 1990). Species that excavate their own cavities like woodpeckers are least affected by starlings, but secondary cavity nesters that use abandoned nest sites–Tree Swallows, Violet-green Swallows, Mountain Bluebirds–fare poorly against the starling which overwinter or arrive each spring several weeks ahead of native species. Starlings are colonial, where enough nest sites are available, such as in the riparian woodlands of the SNWA. In these locations the starling can usurp nearly all suitable nest sites, leaving few for other species (Table 35). Starlings may be multibrooded in the SNWA, further limiting nesting by other species. Since tree habitats are so rare in SNWA, the potential influence of the European Starling on other migratory bird populations may be even greater.

House Sparrows are present on the SNWA only in close proximity to buildings and people (e.g., PFRA and Gate 24 buildings). Introduced to North America in 1850-1867, the House Sparrow arrived in Alberta in 1898 (Houston 1978). It requires human environments (agricultural and urban) to survive. In the SNWA it may occasionally appear in places like military buildings, riparian woodlands, ravine cliffs, raptor nests and Cliff Swallow colonies.

6.1.5 Water Levels

Riparian habitats adjacent to the South Saskatchewan River are subjected to periodic flood events. Floods potentially cause disruption to birds during the nesting season, but bring needed nutrients, soil and moisture to sustain riparian ecosystems.

A permanent rise in river water level would devastate small, structurally diverse Riparian sites and decrease the number of species in the SNWA (Figure 14). Several uncommon and locally distributed species would likely be permanently lost from the avifauna of the SNWA.

Old Channel Lake, the largest of SNWA's wetlands, comprises about 19% of the wetland habitat surveyed in SNWA (Adams et al. 1998) and has high *local* and *regional diversity* value (Tables 27 and 29). This waterbody is managed for waterfowl and agriculture benefits and is sustained with water drawn from the South Saskatchewan River (Adams et al. 1998). Depending on the timing, increased water levels may threaten nests of some wetland species. Ducks Unlimited established islands in the western portion of the lake to provide nesting and loafing sites. The water level is sometimes lowered artificially by mechanical pumping to provide irrigation to nearby hay land. Drawdown results in mudflats and food resources attractive to shorebirds. The effect of this drawdown on nesting and brood-rearing wetland species is unknown and probably varies depending on timing.

6.1.6 Precipitation Cycles

6.1.6.1 Upland

Our studies occurred in good moisture conditions but drought will modify the spectrum of vegetation height and thickness and alter the relative abundance of various species (Figure 12). Decreased cover will result in increasing populations of low cover specialists (Horned Lark, McCown's and Chestnut-collared Longspur) and reduction of birds requiring moderate to heavy cover (Sprague's Pipit, Baird's Sparrow). This is supported by casual observations of a British soldier during 1990 when the prairies were still recuperating from drought. Crease (1990) records the McCown's Longspur as common (more common than Chestnut-collared), makes no mention of Baird's or Grasshopper Sparrow, and notes Sprague's Pipit as infrequent on the Suffield prairie. These results are very different from our findings in 1994 and 1995. A predicted shift in species composition at SNWA during dry conditions is also supported by large declines in Sprague's Pipit, Baird's Sparrow, Chestnut-collared Longspur and Western Meadowlark, during a drought at the Milk River Natural Area–Kennedy Coulee Ecological Reserve (Wersler and Smith 1996).

Whether species simply decrease or are eliminated from the community during drought depends on the range's ability to produce cover even during drought (range condition). Cover (exclusive of brush) generally increases with range condition scores (Tiedeman et al. 1991), thus providing at least some suitable habitat for moderate and high cover specialists even under poor moisture conditions. In North Dakota, pastures in good to excellent condition were able to sustain prairie bird species during drought conditions, while a large component of the grassland bird community disappeared from range in poor to good condition (George et al. 1992). A number of grassland birds are positively correlated with good range condition–Vesper Sparrow (George et al. 1992), Sprague's Pipit, Baird's Sparrow and Chestnut-collared Longspur (Anstey et al. 1995).

By no means is all of the SNWA considered to be in excellent condition (Chu 1993). The SGAC has proposed conservative grazing management (when compared to rates recommended in provincial guidelines). It will be difficult for the range to continue to recover and maintain good to excellent condition during future dry periods unless conservative management continues. Even with careful management, the range condition may not improve (Laycock 1991) in portions that have deteriorated below a threshold (Friedel 1991). Based on research in southern Alberta, a temporary rest period may be needed to rejuvenate some sites (Willms et al. 1990).

6.1.6.2 Wetlands

Prairie wetlands are dynamic because of temporal changes in precipitation and climatic conditions. Depending on the water depth and drainage regime, wetlands can be permanent or temporary in nature. Permanent waterbodies offer more dependable food, shelter and nesting resources for birds, while temporary wetlands are less reliable as they can disappear seasonally or periodically if evaporation and drainage exceeds precipitation and inflow.

Temporary and seasonal basins are the most common form of wetland in SNWA, making up about 73% of the 294 wetlands examined (Adam et al. 1998). These wetlands are valuable to the bird community, both in wet and dry periods. During wet periods they provide temporary staging sites for migratory species, and food and nesting resources for breeding wetland species. Seasonal or periodic dry periods can result in a shift in avifaunal use from waterbirds to species that nest in a variety of upland habitats (Hubbard 1982). Managing for shorebirds requires a diversity of habitats (Helmers 1992). Protecting such a diversity of habitats at SNWA is important for attracting wetland species and providing nesting and brood habitats.

6.2 Recommendations

Our suggestions relate to the non-raptor avifauna and may not necessarily be ideal for management of flora or other faunal groups. We do advocate using natural (uneven and unequal) disturbance regimes, consistent with current ecosystem management. Our suggestions are intended to maintain current native species, particularly those important to *regional diversity,* since the SNWA has potential to be key to their long term survival. We do not advocate measures to artificially raise the number of species.

6.2.1 Future Research/Monitoring

- Dates of fires in the SNWA could be assessed. If early to mid-summer fires predominate this may be of management concern because of reproductive losses for some *regionally unique* or *at risk* species that do not complete their nesting until August (Dickson and Dale 1999). June and July fires will result in partial to complete nest losses (Higgins 1986; Kruse and Piehl 1986), which is undesirable. Early summer fires would have

occurred historically (but less frequently than August/September fires based on Rowe's [1969] assessment of lightning fires in southern Saskatchewan). Late season fires will negatively affect habitat attractiveness for some birds in the following spring (Higgins 1986). This a less serious consequence than reproductive losses unless it occurs annually.

- Continued periodic monitoring and/or a directed research project within the Upland segment of the SNWA could be used to gather information on changes in the bird community associated with drought, and for the sandhills portion, with prolonged protection from grazing.

- The relationships between grazing systems, range condition and bird abundance and productivity could be explored within the SNWA. The relationship between grazing and nest success varies geographically, with local year-to-year variability in predator and bird communities, and probably also varies with stocking rates and paddock sizes (Prescott et al. 1998), so management should be based on site-specific research over several years.

- Examining productivity and nest parasitism rates within SNWA could further document the high value of the SNWA, which has a potentially important role to play as a refugium where the full suite of prairie bird species can exist and reproduce successfully and potentially act as a source for repopulating sink areas (sites where reproduction is below replacement levels) in the more fragmented and intensively used landscape surrounding it (Gates and Gysel 1978).

- Night surveys using playback to elucidate the distribution of Common Poorwill within the SNWA could confirm the importance of the area for a scarce species.

- Monitoring the shrub guild (Gray Catbird, Brown Thrasher, Common Yellowthroat, Yellow-breasted Chat, Spotted Towhee, and Song Sparrow) in Riparian areas would give an indication of habitat quality and recovery from grazing in sites fenced since the conclusion of our inventory.

- Ungulate populations, including elk (*Cervus elpahus* –introduced after the conclusion of our study), need to be monitored to assess population trends. Ungulates browse on herbage and woody vegetation and this has been shown to affect birds (Casey and Hein 1983). The relationship between ungulate browse consumption and its effect on bird habitats, populations, and productivity might be examined at SNWA.

- Periodic monitoring of the extent of introduced plants, and bird response to them, would be an important element of long-term management of the area. Anecdotal data from SNWA and findings elsewhere indicate introduced vegetation is a potential problem for some *regionally unique* and *at risk* bird species. Since crested wheat grass is no longer used in reseeding pipeline rights of way and wellsites the only remaining issue is the

degree to which existing crested wheat grass will invade native grassland adjacent to it. Crested wheat grass does not spread rapidly but it does gradually invade surrounding habitats. Smooth brome is not currently an issue on the SNWA, but if the valley is protected from all disturbance by fire and grazing, brome may spread and become a more important issue.

- Further study is needed to determine the timing, frequency and degree of water input and draw-downs at Old Channel Lake and the effect on breeding habitats, nests and young. Efficient management of this lake, in consultation with Ducks Unlimited and the CWS, could provide seasonal feeding habitat for migrant shorebirds as well as attractive and relatively safe breeding habitat for waterfowl, waders, and marsh passerines.

- A research project focused on roads and their effect on birds populations could provide insights for managing of the road system, now and in the future. Although no tests were conducted on how roads affect bird distribution and mortality, we did observe road kills. Common Nighthawks and young birds of many species appeared particularly vulnerable. Research elsewhere shows roads may depress densities of some bird species for hundreds of meters (van der Zande et al. 1980). This may be due to actual mortality, disturbance, interference with territorial song, or alteration of habitat directly or because of dust.

6.2.2 Management

6.2.2.1 Upland

Conservation of grassland species is dependant on preservation of highly productive core areas (Curnutt et al. 1996) such as the SNWA, and management with natural (uneven and unequal) disturbance regimes (Ryan 1986; Grumbine 1994; Samson and Knopf 1994). More than 75% of grassland habitat in Canada has been ploughed and losses continue. A further 6% (570,000 ha) of native prairie was broken during the period 1991-96 (Statistics Canada 1997). The grazing intensity applied to much of the remaining grassland is high and subject to market-related fluctuations (Gayton 1991). Small blocks of grassland in Alberta have poorer range condition than large blocks (Smoliak et al. 1985). The SNWA is an important refugium for grassland birds, but maintenance of the entire suite of bird species is dependent on a mosaic of grassland and grassland/shrub habitats and disturbance regimes being present.

- Artificial attempts to increase *local diversity* in grassland by adding trees are detrimental to grassland species (and therefore to *regional diversity*), and should not be attempted (Graul 1980; Samson and Knopf 1994).

- Planting isolated trees or placing nesting platforms for raptors should not occur near Sharp-tailed Grouse dancing grounds (Graul 1980).

- We caution against increases in the number of cattle per acre. An overall increase in

stocking rate will virtually eliminate Sprague's Pipit and Grasshopper and Baird's Sparrow, as has been shown in historic studies at Suffield (Karasiuk et al. 1977) and elsewhere (Owens and Myres 1973; Anstey et al. 1995).

- Maintaining a large proportion of the PFRA pasture in excellent range condition is an important management goal if all grassland *regionally unique* and *at risk* and *declining* species are to be retained in good numbers even during dry periods.

- In addition, continued use of large pastures and few water sources, and the rest-rotation grazing system in Casa Berardi, Fish Creek and Falcon, will ensure range use remains uneven and the Upland will include a small proportion of both heavy use and rested sites. This will maintain a mosaic of varied habitat conditions necessary to accommodate the habitat requirements of many species, and will contribute to continued high *local* and *regional diversity*.

- Ideally some watering sites should be shifted periodically to avoid continued heavy use of the same site. This could be done by fencing the wetland and moving water to troughs with nose or solar powered pumps. Trough sites could then be shifted every few years.

- Fire intervals of greater than 4 years are recommended (Kirsch et al. 1978), with longer intervals in dry areas (10-25 years was natural fire interval in arid grasslands–Bragg 1995). Annual or frequent burning can be harmful since recovery may take several years and fires in arid areas can critically reduce litter, which is not beneficial for either plants or birds (Kruse and Higgins 1990). Some parts of the SNWA may now burn more frequently than recommended because of their proximity to military exercises. If it is feasible to occasionally shift the location of military exercises adjacent to the SNWA, it might bring the disturbance regime closer to a natural frequency.

- Eradication of large patches of crested wheat grass followed by restoration, where possible, (Wilson et al. 1997), and a continued policy of not seeding this grass will benefit birds (Graul 1980). Management practices favouring the natural disturbance regime (periodic fire and/or grazing) may be the optimum approach to promoting native flora (Planty-Tabacchi et al. 1996).

- The need for new roads should be critically evaluated (van der Zande et al. 1980), and the current policy of discouraging creation of trails continued.

- An inventory and re-evaluation of fences could be done and unnecessary fences removed. Our observations and literature review showed large pastures encouraged uneven cover removal. Our studies showed this increased both *local* and *regional diversity*. Fencing also has negative impacts on mammals and birds by causing death or entanglement (Braun et al. 1978).

6.2.2.2 Ravines/Slopes

- We recommend continued exclusion of cattle from ravines to minimize erosion (Ryder 1980).

- The majority of birds using the South Saskatchewan River corridor freely pass back and forth across the river. Managing both sides of the river in concert may reduce populations fluctuations and prevent local extinctions within the SNWA. Riparian and Ravine habitat in Koomati could also be protected from cattle grazing to maximize benefits. Along the remainder of the SNWA river habitat, conservation efforts would involve co-management and cooperation with other government agencies and private landowners.

6.2.2.3 Wetlands

- Excluding cattle from areas with high wetland densities as well as key seasonal, semi-permanent and permanent wetlands (Old Channel Lake) may decrease waterfowl reproductive losses.

- Because some species find grazed wetlands more attractive, a mix of grazing intensity impacts on semi-permanent and other wetland types within the SNWA will accommodate needs of all species.

6.2.2.4 Riparian

- Cattle should continue to be excluded from all riparian areas, particularly those which have suffered damage (Tubbs 1980). Recovery can be as short as 1-7 years (Behnke 1979; see Tubbs 1980 for references) but in cases of severe damage riparian succession may never reach its natural climax state (Garry Trottier, CWS, pers. comm.). Cattle exclusion will also help maintain acceptably low levels of Brown-headed Cowbird parasitism (Laymon 1987), and protect tree snags needed by cavity nesting species (McKee et al. 1995). This cattle exclusion policy should be revisited if smooth brome or other introduced vegetation increases in the Riparian zone.

- Identification of a Riparian management zone may help protect this sensitive habitat as small changes in avian habitat could negatively influence bird community composition (Croonquist and Brooks 1993). Contingency protocols outlining measures to prevent fires and promptly suppress those threatening riparian forests could be developed.

- Artificial nest structures erected for Canada Geese along the South Saskatchewan River should be removed. Placement of artificial nesting structures on the SNWA for conservation or management of any bird species is unnecessary at this time, as there are

sufficient natural nesting sites for all native species on the SNWA. Nest structures should only be used as part of an approved recovery plan for a *species at risk* (e.g., raptors–see Banasch and Barry 1998 for such recommendations), or as part of research programs designed to help resolve conservation/management questions.

- European Starling is the most abundant Riparian species, and it may be limiting the distribution and productivity of native birds. It is difficult to recommend any specific management options for controlling them. All methods tried in North America have failed to curb the advance and productivity of this persistent species (Cabe 1993). Continued prohibition of livestock feedlots and use of range by wintering livestock may limit the starling's food supply thereby limiting starling numbers in the SNWA.

- Since House Sparrows are usually found around buildings, it would be best to minimize putting up buildings within the SNWA. Without human construction this species is not expected to be persistant in natural habitats on the SNWA and should not be in conflict with native birds.

- We recommend DND continue to use its position as a stakeholder on the South Saskatchewan River to prevent developments that alter water levels. A permanent rise in the water level would inundate rare and locally distributed habitats along the river corridor including riparian gallery forests, maple tree stands, plains cottonwood stands, shrub lands, spring and wetland complexes, and ravine tree and tall shrub complexes, which together form some of the most biologically rich habitats of the SNWA (Figure 14). Permanent lowering of levels as a result of stabilization at points upstream or downstream from the SNWA would also preclude natural regeneration of plains cottonwood stands and other plant communities unique to southeastern Alberta river systems. Stabilization of other river reaches in Alberta (the Oldman River) and Saskatchewan (including the South Saskatchewan River above the Gardiner Dam) have already altered natural riparian and riverine ecosystems, and diminished their capacity to regenerate and sustain themselves (Bradley et al. 1991).

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8. APPENDICES

APPENDIX 1. Species Names, Status and Trend.

Species Names[1]	Status[2]	COSEWIC (1999)[3]	Alberta Rating[4]	Breeding Bird Survey Trend 1966-96; 1980-96 % Decline/Year (significance value)[5]
Common Loon *Gavia immer*	M	Not at Risk	Green	
Pied-billed Grebe *Podilymbus podiceps*	SR, B		Yellow A	Canada 31 yr. -2.7 (0.01), Canada 17 yr. -5.9 (0.06) Continent 31yr. -0.5 (0.67)
Horned Grebe *Podiceps auritus*	M		Yellow A	Canada 31 yr. -3.3 (0.03), Canada 17 yr. -6.2 (<0.005) Continent 31 yr. -3.1 (0.05), Continent 17 yr. -5.0 (0.02)
Red-necked Grebe *Podiceps grisegena*	M	Not at Risk	Yellow A	Canada 17 yr. -0.7 (0.64), Continent 17 yr. -0.3 (0.83)
Eared Grebe *Podiceps nigricollis*	SR, B		Green	Canada 17 yr. -0.7 (0.91), Ecoregion 31 yr. -7.3 (0.46) Ecoregion 17 yr. -1.2 (0.89)
Western Grebe *Aechmophorus occidentalis*	M		Yellow B	Continent 17 year -1.8 (0.32)
American White Pelican *Pelecanus erythrorhynchos*	SV	Not at Risk delisted 1987	Yellow B	
Double-crested Cormorant *Phalacrocorax auritus*	SV	Not at Risk	Yellow B	
American Bittern[6] *Botaurus lentiginosus*	SR, b		Yellow A	Canada 31 yr. -2.2 (0.07), Continent 31 yr. -2.2 (0.02) Ecoregion 31 yr. -1.1 (0.83)
Great Blue Heron *Ardea herodias*	SV		Yellow B	Canada 31 yr. -0.6 (0.81)
Black-crowned Night-Heron *Nycticorax nycticorax*	SV		Yellow B	Canada 17 yr. -9.8 (0.05)
Turkey Vulture *Cathartes aura*	?		Yellow B	
Snow Goose *Chen caerulescens*	M		Green	Outside BBS Coverage
Canada Goose *Branta canadensis*	SR, B		Green	
Trumpeter Swan *Cygnus buccinator*	SV	Not at Risk delisted 1996	Blue	Outside BBS Coverage
Tundra Swan *Cygnus columbianus*	M		Green	Outside BBS Coverage
Gadwall *Anas strepera*	SR, b		Green	
American Wigeon *Anas americana*	SR, B		Green	Canada 31 yr. -1.6 (0.09), Canada 17 yr. -1.5 (0.38) Continent 31 yr. -1.0 (0.20), Ecoregion 31 yr. -0.8 (0.70)
American Black Duck[7] *Anas rubripes*	SV		Green	Canada 31 yr. -1.1 (0.56), Continent 31 yr. -1.3 (0.42)
Mallard *Anas platyrhynchos*	SR, B		Green	Canada 17 yr. -0.1 (0.95)

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Blue-winged Teal *Anas discors*	SR, B		Green	Canada 31 yr. -1.0 (0.33), Canada 17 yr. -2.9 (0.02) Continent 31 yr. -1.0 (0.27)
Cinnamon Teal *Anas cyanoptera*	SR, b		Green	Continent 17 yr. -0.8 (0.71)
Northern Shoveler *Anas clypeata*	SR, B		Green	
Northern Pintail *Anas acuta*	SR, B		Green	Canada 31 yr. -6.4 (<0.005), Canada 17 yr. -1.7 (0.40) Continent 31 yr. -4.8 (<0.005), Ecoregion 31 yr. -2.5 (0.27)
Green-winged Teal *Anas crecca*	SR, b		Green	
Canvasback *Aythya valisineria*	SR, b		Green	Canada 31 yr. -2.4 (0.13), Canada 17 yr. -2.1 (0.10) Continent 31 yr. -1.5 (0.14)
Redhead *Aythya americana*	SR, b		Green	
Ring-necked Duck *Aythya collaris*	M		Green	
Lesser Scaup *Aythya affinis*	SR, b		Green	Canada 17 yr. -0.2 (0.87)
Surf Scoter *Melanitta perspicillata*	M		Green	Outside BBS Coverage
Bufflehead *Bucephala albeola*	M		Green	
Common Goldeneye *Bucephala clangula*	SR, B WV[7]		Green	Canada 31 yr. -1.9 (0.43), Canada 17 yr. -0.9 (0.74) Continent 31 yr. -1.8 (0.43), Continent 17 yr. -0.5 (0.83)
Common Merganser *Mergus merganser*	SR, B		Green	
Red-breasted Merganser *Mergus serrator*	M		Green	Continent 31 yr. -3.2 (0.35)
Ruddy Duck *Oxyura jamaicensis*	SR, B		Green	Canada 17 yr. -0.7 (0.79)
Osprey *Pandion haliaetus*	M		Yellow B	
Bald Eagle *Haliaeetus leucocephalus*	M	Not at Risk	Yellow B	
Northern Harrier *Circus cyaneus*	SR, b	Not at Risk	Yellow A	Canada 31 yr. -0.7 (0.31), Canada 17 yr. -3.2 (<0.005), Continent 31 yr. -0.6 (0.21), Continent 17 yr. -0.7 (0.38) Ecoregion 31 yr. -0.7 (0.49), Ecoregion 17 yr. -1.5 (0.11)
Sharp-shinned Hawk *Accipiter striatus*	M	Not at Risk	Green	Canada 17 yr. -5.2 (0.32)
Cooper's Hawk *Accipiter cooperii*	M	Not at Risk delisted 1996	Yellow B	Canada 17 yr. -21.3 (0.02)

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Broad-winged Hawk *Buteo platypterus*	M		Yellow B	Canada 17 yr. -4.8 (0.10), Continent 17 yr. -3.8 (0.01)
Swainson's Hawk *Buteo swainsoni*	SR, B		Yellow A	Canada 17 yr. -2.1 (0.27), Ecoregion 17 yr. -0.8 (0.72)
Red-tailed Hawk *Buteo jamaicensis*	SR, B	Not at Risk	Green	
Ferruginous Hawk *Buteo regalis*	SR, B	Vulnerable	Blue	
Rough-legged Hawk[8] *Buteo lagopus*	M, WV	Not at Risk	Green	Outside BBS Coverage
Golden Eagle *Aquila chrysaetos*	PR, B	Not at Risk	Yellow B	
American Kestrel *Falco sparverius*	SR, B		Green	Canada 31 yr. -0.1 (0.93), Canada 17 yr. -1.9 (0.01) Continent 31 yr. -0.1 (0.75), Continent 17 yr. -1.4 (<0.005) Ecoregion 17 yr. -2.3 (0.53)
Merlin *Falco columbarius*	PR, B		Green	
Gyrfalcon[8] *Falco rusticolus*	M		Green	Outside BBS Coverage
Prairie Falcon *Falco mexicanus*	SR, B		Yellow A	
Gray Partridge *Perdix perdix*	PR, B		Green	Canada 17 yr. -0.2 (0.93), Continent 17 yr. -2.7 (0.08)
Ring-necked Pheasant *Phasianus colchicus*	PR, b		Yellow A	Canada 31 yr. -0.8 (0.37), Canada 17 yr. -0.3 (0.85) Continent 31 yr. -1.0 (0.01), Continent 16 yr. -0.6 (0.23)
Sharp-tailed Grouse *Tympanuchus phasianellus*	PR, B		Yellow A	Canada 31yr. -6.5 (0.01), Canada 17 yr. -5.4 (0.28)
Virginia Rail *Rallus limicola*	SR, b		Undeterm.	
Sora *Porzana carolina*	SR, b		Green	
American Coot *Fulica americana*	SR, B	Not at Risk	Green	Canada 31 yr. -1.1 (0.15), Canada 17 yr. -2.5 (0.18) Continent 31 yr. -0.4 (0.56), Continent 17 yr. -0.3 (0.87)
Sandhill Crane *Grus canadensis*	M		Yellow B	
Killdeer *Charadrius vociferus*	SR, B		Green	Canada 31 yr. -2.5 (<0.005), Canada 17 yr. -4.3 (<0.005) Continent 31 yr. -0.4 (0.01), Continent 17 yr. -1.5 (<0.005) Ecoregion 31 yr. -2.2 (0.01), Ecoregion 17 yr. -1.6 (0.17)
American Avocet *Recurvirostra americana*	SR, B		Yellow B	Ecoregion 31 yr. -2.0 (0.59)
Greater Yellowlegs *Tringa melanoleuca*	M		Green	Outside BBS Coverage

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Lesser Yellowlegs *Tringa flavipes*	M		Green	Canada 31 yr. -5.8 (<0.005), Canada 17 yr. -16.0 (<0.005) Continent 31 yr. -6.0 (<0.005), Continent 17 yr. -16.1 (<0.005)
Solitary Sandpiper *Tringa solitaria*	M		Green	Outside BBS Coverage
Willet *Catoptrophorus semipalmatus*	SR, B[7]		Yellow B	Canada 31 yr. -1.6 (0.01), Canada 17 yr. -1.6 (0.09) Continent 31 yr. -0.5 (0.30), Ecoregion 31 yr. -0.7 (0.54)
Spotted Sandpiper *Actitis macularia*	SR, b		Green	Canada 31 yr. -0.5 (0.56), Canada 17 yr. -2.0 (0.12) Continent 31 yr. -0.7 (0.30), Continent 17 yr. -1.6 (0.07)
Upland Sandpiper *Bartramia longicauda*	SR, B		Yellow A	Canada 17 yr. -0.7 (0.78), Continent 17 yr. -0.9 (0.24)
Long-billed Curlew *Numenius americanus*	SR, B	Vulnerable	Blue	Canada 17 yr. -1.2 (0.70), Continent 31 yr. -1.4 (0.21) Continent 17 yr. -2.0 (0.10), Ecoregion 31 yr. -0.2 (0.94) Ecoregion 17 yr. -2.2 (0.40)
Marbled Godwit *Limosa fedoa*	SR, b		Green	Canada 31 yr. -0.2 (0.80), Canada 17 yr. -0.5 (0.84)
Semipalmated Sandpiper *Calidris pusilla*	M		Green	Outside BBS Coverage
Least Sandpiper[7] *Calidris minutilla*	M		Green	Outside BBS Coverage
Baird's Sandpiper *Calidris bairdii*	M		Green	Outside BBS Coverage
Pectoral Sandpiper[7] *Calidris melanotos*	M		Green	Outside BBS Coverage
Dowitcher (sp.)				Outside BBS Coverage
-Short-billed *Limnodromus griseus*	M		Green	
-Long-billed *Limnodromus scolopaceus*	M		Green	
Common Snipe *Gallinago gallinago*	SR, b		Green	Canada 31 yr. -0.3 (0.55), Canada 17 yr. -0.8 (0.25) Continent 31 yr. -0.2 (0.53), Continent 17 yr. -1.2 (0.02)
Wilson's Phalarope *Phalaropus tricolor*	SR, B		Green	Canada 31 yr. -0.5 (0.68), Canada 17 yr. -0.5 (0.90) Continent 31 yr. -1.6 (0.05), Continent 17 yr. -1.7 (0.25) Ecoregion 31 yr. -0.3 (0.87), Ecoregion 17 yr. -2.0 (0.59)
Franklin's Gull *Larus pipixcan*	SV		Green	
Ring-billed Gull *Larus delawarensis*	SV		Green	
California Gull *Larus californicus*	SV		Green	Continent 31 yr. -1.3 (0.64), Continent 17 yr. -3.4 (0.16)
Common Tern *Sterna hirundo*	SR, B[7]	Not at Risk	Green	Canada 31 yr. -0.5 (0.92), Continent 31 yr. -0.7 (0.89)
Black Tern *Chlidonias niger*	SR, B[7]	Not at Risk	Yellow A	Canada 31 yr. -3.5 (0.04), Canada 17 yr. -1.9 (0.23) Continent 31 yr. -3.1 (0.04)

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Rock Dove *Columba livia*	PR, b		Green	Canada 17 yr. -1.4 (0.30), Continent 17 yr. -1.6 (<0.005) Ecoregion 17 yr. -1.8 (0.56)
Mourning Dove *Zenaida macroura*	SR, B		Green	Continent 31 yr. -0.3 (0.02), Continent 17 yr. -0.7 (<0.005)
Black-billed Cuckoo *Coccyzus erythropthalmus*	SR, b		Undeterm.	Canada 31 yr. -0.5 (0.64), Canada 17 yr. -2.3 (0.10) Continent 31 yr. -1.2 (0.02), Continent 17 yr. -3.2 (<0.005) Ecoregion 31 yr. -3.7 (0.33), Ecoregion 17 yr. -9.0 (0.06)
Great Horned Owl *Bubo virginianus*	PR, B		Green	Canada 31 yr. -1.8 (0.46), Canada 17 yr. -5.2 (0.08) Continent 17 yr. -1.8 (0.07)
Snowy Owl[8] *Nyctea scandiaca*	WV, M[9]	Not at Risk	Green	Outside BBS Coverage
Burrowing Owl *Athene cunicularia*	SR, B	Endangered	Red	Ecoregion 31 yr. -9.7 (0.07), Ecoregion 17 yr. -12.8 (0.03)
Long-eared Owl *Asio otus*	SR, B		Green	
Short-eared Owl *Asio flammeus*	SR, B[9]	Vulnerable	Blue	Canada 31 yr. -12.9 (<0.005), Canada 17 yr. -14.2 (0.16) Continent 31 yr. -2.8 (0.14), Continent 17 yr. -0.8 (0.79) Ecoregion 31 yr. -1.7 (0.77), Ecoregion 17 yr. -4.1 (0.51)
Common Nighthawk *Chordeiles minor*	SR, B		Green	Canada 31 yr. -2.1 (0.03), Canada 17 yr. -3.7 (0.04) Continent 31 yr. -1.2 (0.01), Continent 17 yr. -3.0 (<0.005)
Common Poorwill *Phalaenoptilus nuttallii*	SR, b	Indeterminate	Undeterm.	Continent 17 yr. -0.2 (0.91)
Belted Kingfisher *Ceryle alcyon*	SR, b		Green	Canada 31 yr. -3.6 (<0.005), Canada 17 yr. -4.1 (<0.005), Continent 31 yr. -2.2 (<0.005), Continent 17 yr. -2.4 (<0.005)
Yellow-bellied Sapsucker *Sphyrapicus varius*	SR, b		Green	Canada 31 yr. -1.6 (0.09), Continent 31 yr. -0.6 (0.38)
Red-naped Sapsucker *Sphyrapicus nuchalis*	SV, b		Green	
Downy Woodpecker *Picoides pubescens*	PR, b		Green	Continent 31 yr. -0.2 (0.34), Continent 17 yr. -1.1 (<0.005)
Hairy Woodpecker *Picoides villosus*	PR?, b		Green	
Northern Flicker *Colaptes auratus*	SR, B		Green	(Yellow-shafted) Canada 31 yr. -1.6 (<0.005), Canada 17 yr. -1.3 (<0.005) Continent 31 yr. -2.8 (<0.005), Continent 17 yr. -2.6 (<0.005)
Pileated Woodpecker *Dryocopus pileatus*	SV		Yellow B	
Olive-sided Flycatcher *Contopus cooperi*	M		Green	Canada 31 yr. -3.7 (<0.005), Canada 17 yr. -2.9 (0.01) Continent 31 yr. -3.9 (<0.005), Continent 17 yr. -3.5 (<0.005)
Western Wood-Pewee *Contopus sordidulus*	SR, B		Green	Canada 31 yr. -0.6 (0.48), Canada 17 yr. -0.8 (0.40) Canada 31 yr. -1.5 (<0.005), Continent 17 yr. -1.1 (0.02)
Alder Flycatcher *Empidonax alnorum*	M		Green	

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Least Flycatcher *Empidonax minimus*	SR, B		Green	Canada 31 yr. -0.4 (0.39), Canada 17 yr. -0.6 (0.24) Continent 31 yr. -0.8 (0.02), Continent 17 yr. -0.6 (0.08)
Say's Phoebe *Sayornis saya*	SR, B		Green	
Western Kingbird *Tyrannus verticalis*	SR, B		Green	Continent 17 yr. -0.1 (0.76)
Eastern Kingbird *Tyrannus tyrannus*	SR, B		Green	Canada 31 yr. -0.4 (0.31), Canada 17 yr. -2.9 (<0.005) Continent 31 yr. -0.7 (<0.005), Continent 17 yr. -1.2 (<0.005)
Loggerhead Shrike *Lanius ludovicianus*	SR, B	Threatened (prairie popul.)	Yellow A	Canada 31 yr. -10.1 (<0.005), Continent 31 yr. -3.6 (<0.005) Continent 17 yr. -1.8 (<0.005)
Northern Shrike *Lanius excubitor*	M		Green	Outside BBS Coverage
Blue-headed Vireo *Vireo solitarius*	M		Green	
Warbling Vireo *Vireo gilvus*	SR, B		Green	
Red-eyed Vireo *Vireo olivaceus*	M		Green	
Black-billed Magpie *Pica pica*	PR, B		Green	Canada 31 yr. -0.9 (0.09), Canada 17 yr. -0.6 (0.25) Continent 31 yr. -1.2 (<0.005)
American Crow *Corvus brachyrhynchos*	SR, B		Green	Canada 17 yr. -0.1 (0.83), Ecoregion 17 yr. -2.7 (0.10)
Horned Lark *Eremophila alpestris*	SR, B		Green	Canada 31 yr. -2.2 (<0.005), Canada 17 yr. -3.3 (<0.005) Continent 31 yr. -1.3 (<0.005), Continent 17 yr. -2.0 (<0.005) Ecoregion 31 yr. - 0.5 (0.16), Ecoregion 17 yr. -1.4 (<0.005)
Tree Swallow *Tachycineta bicolor*	SR, b		Green	Canada 17 yr. -0.8 (0.18), Continent 17 yr. -0.3 (0.48)
Violet-green Swallow *Tachycineta thalassina*	SR, B		Green	
Northern Rough-winged Swallow *Stelgidopteryx serripennis*	SR, B		Green	Canada 31 yr. -0.9 (0.65), Canada 17 yr. -2.3 (0.07) Continent 17 yr. -1.4 (0.07)
Bank Swallow *Riparia riparia*	SR, B		Green	Canada 31 yr. -1.8 (0.11), Canada 17 yr. -3.4 (0.08) Continent 31 yr. -1.3 (0.12), Continent 17 yr. -2.3 (0.05) Ecoregion 17 yr. -4.9 (0.53)
Cliff Swallow *Petrochelidon pyrrhonota*	SR, B		Green	Ecoregion 17 yr. -1.1 (0.81)
Barn Swallow *Hirundo rustica*	SR, B		Green	Canada 31 yr. -1.6 (<0.005), Canada 17 yr. -4.2 (<0.005) Continent 31 yr. -0.3 (0.02), Continent 17 yr. -2.2 (<0.005)
Black-capped Chickadee *Poecile atricapillus*	PR, B		Green	
Red-breasted Nuthatch *Sitta canadensis*	SV, M		Green	

APPENDIX 1. Species Names, Status and Trend.

Species Names[1]	Status[2]	COSEWIC (1999)[3]	Alberta Rating[4]	Breeding Bird Survey Trend 1966-96; 1980-96 % Decline/Year (significance value)[5]
Brown Creeper *Certhia americana*	M		Yellow B	Continent 17 yr. -0.4 (0.77)
Rock Wren *Salpinctes obsoletus*	SR, B		Yellow B	Continent 31 yr. -1.4 (0.01), Continent 17 yr. -1.8 (0.02)
House Wren *Troglodytes aedon*	SR, B		Green	
Sedge Wren *Cistothorus platensis*	?	Not at Risk	Yellow B	
Marsh Wren *Cistothorus palustris*	SR, B		Yellow B	
Ruby-crowned Kinglet *Regulus calendula*	M		Green	Canada 31 yr. -1.2 (0.06), Continent 31 yr. -0.8 (0.19)
Mountain Bluebird *Sialia currucoides*	SR, B		Green	
Townsend's Solitaire *Myadestes townsendi*	M[7]		Green	Canada 31 yr. -0.2 (0.92), Canada 17 yr. -2.2 (0.01) Continent 17 yr. -2.1 (<0.005)
Gray-cheeked Thrush *Catharus minimus*	M		Green	
Swainson's Thrush *Catharus ustulatus*	M		Green	Canada 31 yr. -0.2 (0.59), Canada 17 yr. -1.0 (0.09) Continent 31 yr. -0.3 (0.41), Continent 17 yr. -0.8 (0.08)
Hermit Thrush *Catharus guttatus*	M		Green	
American Robin *Turdus migratorius*	SR, B		Green	
Varied Thrush *Ixoreus naevius*	M		Green	Canada 17 yr. -0.1 (0.93), Continent 17 yr. -0.8 (0.44)
Gray Catbird *Dumetella carolinensis*	SR, B		Green	Canada 31 yr. -1.3 (<0.005), Canada 17 yr. -1.7 (<0.02) Continent 31 yr. -0.3 (0.03)
Northern Mockingbird *Mimus polyglottos*	SV		Green	Canada 17 yr. -0.5 (0.90), Continent 31 yr. -0.9 (<0.005)
Brown Thrasher *Toxostoma rufum*	SR, B		Yellow A	Canada 31 yr. -2.8 (<0.005), Canada 17 yr. -2.1 (0.02) Continent 31 yr. -1.2 (<0.005), Continent 17 yr. -1.2 (<0.005)
European Starling *Sturnus vulgaris*	PR?, B		Green	Canada 31 yr. -2.0 (<0.005), Canada 17 yr. -3.8 (0.02) Continent 31 yr. -1.1 (<0.005), Continent 17 yr. -1.3 (<0.005)
American Pipit *Anthus rubescens*	M		Green	Outside BBS Coverage
Sprague's Pipit *Anthus spragueii*	SR, B	Threatened	Blue	Canada 31 yr. -7.1 (<0.005), Canada 17 yr. -8.0 (<0.005) Continent 31 yr. -4.7 (<0.005), Continent 17 yr. -4.5 (0.09) Ecoregion 31 yr. -2.5 (0.59)
Cedar Waxwing *Bombycilla cedrorum*	SR, B		Green	

APPENDIX 1. Species Names, Status and Trend.

Species Names[1]	Status[2]	COSEWIC (1999)[3]	Alberta Rating[4]	Breeding Bird Survey Trend 1966-96; 1980-96 % Decline/Year (significance value)[5]
Tennessee Warbler *Vermivora peregrina*	M		Green	Canada 17 yr. -5.3 (0.07), Continent 17 yr. -5.1 (0.08)
Orange-crowned Warbler *Vermivora celata*	M		Green	Canada 31 yr. -0.8 (0.43), Continent 31 yr. -0.9 (0.18)
Yellow Warbler *Dendroica petechia*	SR, B		Green	
Yellow-rumped Warbler *Dendroica coronata*	M		Green	
Palm Warbler *Dendroica palmarum*	M		Green	
Blackpoll Warbler *Dendroica striata*	M		Yellow B	Canada 31 yr. -1.7 (0.75), Canada 17 yr. -10.6 (<0.005) Continent 31 yr. -2.4 (0.67), Continent 17 yr. -10.6 (<0.005)
Black-and-White Warbler *Mniotilta varia*	M		Yellow B	
American Redstart *Setophaga ruticilla*	M		Green	Canada 31 yr. -0.4 (0.44), Canada 17 yr. -0.8 (0.18) Continent 31 yr. -0.4 (0.32), Continent 17 yr. -0.4 (0.37)
Ovenbird *Seiurus aurocapillus*	M		Green	Canada 17 yr. -1.1 (<0.005)
Northern Waterthrush *Seiurus noveboracensis*	M		Green	Canada 17 yr. -0.2 (0.77), Continent 17 yr. -0.2 (0.80)
MacGillivray's Warbler *Oporornis tolmiei*	M		Green	Canada 31 yr. -0.1 (0.92), Canada 17 yr. -0.6 (0.47) Continent 31 yr. -0.3 (0.57), Continent 17 yr. -0.3 (0.59)
Common Yellowthroat *Geothlypis trichas*	SR, B		Green	Canada 31 yr. -0.7 (0.07), Canada 17 yr. -1.0 (0.02), Continent 31 yr. -0.3 (0.02), Continent 17 yr. -0.7 (<0.005) Ecoregion 31 yr. -0.2 (0.92)
Wilson's Warbler *Wilsonia pusilla*	M		Green	Canada 31 yr. -1.3 (0.33), Canada 17 yr. -2.5 (0.23) Continent 31 yr. -0.6 (0.30), Continent 17 yr. -2.0 (0.03)
Canada Warbler *Wilsonia canadensis*	M		Yellow B	Canada 31 yr. -2.1 (0.10), Canada 17 yr. -3.5 (<0.005) Continent 31 yr. -2.1 (0.03), Continent 17 yr. -3.1 (<0.005)
Yellow-breasted Chat *Icteria virens*	SR, B	Not at Risk (prairie popul.)	Yellow B	Continent 31 yr. -0.3 (0.24)
Spotted Towhee *Pipilo maculatus*	SR, B		Green	
American Tree Sparrow *Spizella arborea*	M		Green	Outside BBS Coverage
Chipping Sparrow *Spizella passerina*	SR, b		Green	Canada 31 yr. -0.4 (0.31), Canada 17 yr. -0.2 (0.73) Continent 31 yr. -0.2 (0.33)
Clay-colored Sparrow *Spizella pallida*	SR, B		Yellow A	Canada 31 yr. -1.2 (<0.005), Canada 17 yr. -1.0 (0.06) Continent 31 yr. -1.1 (<0.005), Continent 17 yr. -0.5 (0.25) Ecoregion 31 yr. -0.2 (0.85)
Brewer's Sparrow *Spizella breweri*	SR, B		Yellow B	Continent 31 yr. -3.7 (<0.005), Continent 17 yr. -3.0 (<0.005)

APPENDIX 1. Species Names, Status and Trend.

Species Names[1]	Status[2]	COSEWIC (1999)[3]	Alberta Rating[4]	Breeding Bird Survey Trend 1966-96; 1980-96 % Decline/Year (significance value)[5]
Vesper Sparrow *Pooecetes gramineus*	SR, B		Green	Canada 31 yr. -0.1 (0.81), Continent 31 yr. -0.8 (0.01)
Lark Sparrow *Chondestes grammacus*	SR, B		Yellow B	Continent 31 yr. -3.2 (<0.005), Continent 17 yr. -1.8 (0.02)
Lark Bunting *Calamospiza melanocorys*	SR, B		Green	Canada 31 yr. -5.2 (0.34), Continent 31 yr. -0.9 (0.26)
Savannah Sparrow *Passerculus sandwichensis*	SR, B		Green	Canada 31 yr. -0.4 (0.26), Canada 17 yr. -0.4 (0.30) Continent 31 yr. -0.6 (0.02), Continent 17 yr. -0.2 (0.42)
Grasshopper Sparrow *Ammodramus savannarum*	SR, B		Yellow B	Canada 31 yr. -1.8 (0.41), Canada 17 yr. -4.2 (0.02) Continent 31 yr. -3.6 (<0.005), Continent 17 yr. -2.1 (<0.005) Ecoregion 31 yr. -1.5 (0.53)
Baird's Sparrow *Ammodramus bairdii*	SR, B	Not at Risk delisted 1996	Yellow A	Canada 31 yr. -0.7 (0.70), Continent 31 yr. -1.6 (0.29) Continent 17 yr. -1.1 (0.53)
Nelson's Sharp-tailed Sparrow *Ammodramus nelsoni*	SV	Not at Risk	Green	Canada 31 yr. -1.9 (0.64), Continent 31 yr. -0.2 (0.97)
Fox Sparrow *Passerella iliaca*	M		Green	Canada 31 yr. -0.4 (0.85), Canada 17 yr. -1.6 (0.28) Continent 17 yr. -0.5 (0.55)
Song Sparrow *Melospiza melodia*	SR, b		Green	Canada 31 yr. -1.5 (<0.005), Canada 17 yr. -0.5 (0.11) Continent 31 yr. -0.6 (<0.005), Ecoregion 31 yr. -16.1 (0.14)
Lincoln's Sparrow *Melospiza lincolnii*	M		Green	
Swamp Sparrow *Melospiza georgiana*	M		Green	
White-throated Sparrow *Zonotrichia albicollis*	M		Green	Canada 31 yr. -1.1 (<0.005), Canada 17 yr. -1.2 (0.02) Continent 31 yr. -1.1 (<0.005), Continent 17 yr. -1.1 (0.01)
Harris's Sparrow *Zonotrichia querula*	M		Green	Outside BBS Coverage
White-crowned Sparrow *Zonotrichia leucophrys*	M		Green	Continent 31 yr. -1.7 (<0.005)
Dark-eyed Junco *Junco hyemalis*	M		Green	**Slate-colored race** Canada 31 yr. -1.8 (<0.005), Canada 17 yr. -2.0 (<0.005) Continent 31 yr. -1.5 (<0.005), Continent 17 yr. -1.6 (<0.005)
McCown's Longspur *Calcarius mccownii*	SR, B		Green	Canada 31 yr. -3.9 (0.27), Canada 17 yr. -4.0 (0.43) Ecoregion 31 yr. -0.3 (0.91)
Lapland Longspur[8] *Calcarius lapponicus*	M[9]		Green	Outside BBS Coverage
Chestnut-collared Longspur *Calcarius ornatus*	SR, B		Green	Canada 17 yr. -1.1 (0.57), Continent 31 yr. -0.1 (0.90) Continent 17 yr. -1.1 (0.33)
Snow Bunting *Plectrophenax nivalis*	WR, M		Green	Outside BBS Coverage
Rose-breasted Grosbeak *Pheucticus ludovicianus*	M		Green	Canada 31 yr. -1.3 (0.09), Canada 17 yr. -4.7 (<0.005) Continent 31 yr. -0.5 (0.17), Continent 17 yr. -2.7 (<0.005)

APPENDIX 1. Species Names, Status and Trend.

Species Names[1]	Status[2]	COSEWIC (1999)[3]	Alberta Rating[4]	Breeding Bird Survey Trend 1966-96; 1980-96 % Decline/Year (significance value)[5]
Lazuli Bunting *Passerina amoena*	SV, b		Green	
Red-winged Blackbird *Agelaius phoeniceus*	SR, B		Green	Canada 31 yr. -0.9 (0.01), Canada 17 yr. -2.0 (<0.005) Continent 31 yr. -1.0 (<0.005), Continent 17 yr. -1.3 (<0.005) Ecoregion 31 yr. -2.2 (0.01), Ecoregion 17 yr. -0.5 (0.41)
Western Meadowlark *Sturnella neglecta*	SR, B		Yellow A	Canada 31 yr. -2.0 (<0.005), Canada 17 yr. -1.5 (<0.005) Continent 31 yr. -0.6 (0.01), Continent 17 yr. -0.3 (0.15)
Yellow-headed Blackbird *Xanthocephalus xanthocephalus*	SR, B		Green	Canada 17 yr. -0.5 (0.59), Continent 17 yr. -0.8 (0.18) Ecoregion 31 yr. -1.2 (0.47), Ecoregion 17 yr. -1.6 (0.34)
Rusty Blackbird[6] *Euphagus carolinus*	M		Green	Canada 31 yr. -8.4 (0.07), Canada 17 yr. -7.6 (0.01) Continent 31 yr. -8.4 (0.09), Continent 17 yr. -7.6 (0.01)
Brewer's Blackbird *Euphagus cyanocephalus*	SR, B		Green	Canada 31 yr. -0.9 (0.14), Canada 17 yr. -1.5 (0.16) Continent 31 yr. -3.8 (0.09), Continent 17 yr. -2.0 (<0.005)
Common Grackle *Quiscalus quiscula*	SR, b		Green	Canada 31 yr. -1.6 (<0.005), Canada 17 yr. -0.7 (0.27) Continent 31 yr. -1.6 (<0.005), Continent 17 yr. -2.0 (<0.005)
Brown-headed Cowbird *Molothrus ater*	SR, B		Green	Canada 31 yr. -1.7 (<0.005), Canada 17 yr. -2.0 (<0.005) Continent 31 yr. -1.1 (<0.005), Continent 17 yr. -0.8 (<0.005)
Baltimore Oriole *Icterus galbula*	SR, B		Green	Canada 17 yr. -2.7 (<0.005), Continent 31 yr. -0.2 (0.27), Continent 17 yr. -1.7 (<0.005), Ecoregion 31 yr. -3.6 (0.02) Ecoregion 17 yr. -1.3 (0.40)
Purple Finch *Carpodacus purpureus*	SV?		Undeterm.	Canada 31 yr. -2.3 (<0.005), Canada 17 yr. -3.9 (<0.005) Continent 31 yr. -1.8 (<0.005), Continent 17 yr. -2.0 (0.07)
Red Crossbill *Loxia curvirostra*	SV		Green	
White-winged Crossbill *Loxia leucoptera*	SV		Green	Canada 31 yr. -2.6 (0.61), Continent 31 yr. -2.7 (0.59)
Pine Siskin *Carduelis pinus*	SV		Green	Canada 31 yr. -0.5 (0.54), Canada 17 yr. -1.6 (0.16) Continent 31 yr. -0.7 (0.33), Continent 17 yr. -1.8 (0.07)
American Goldfinch *Carduelis tristis*	SR, b		Green	Canada 31 yr. -0.5 (0.28), Continent 31 yr. -0.8 (<0.005)
House Sparrow *Carduelis tristis*	PR, B		Green	Canada 31 yr. -2.5 (<0.005), Canada 17 yr. -3.5 (<0.005) Continent 31 yr. -2.2 (<0.005), Continent 17 yr. -3.8 (<0.005) Ecoregion 17 yr. -0.2 (0.86)

[1] Names
Species English names, scientific names and order of listing follow all decisions of the Committee on Classification and Nomenclature of the American Ornithologists' Union, which have been published in the AOU Check-list, seventh edition (American Ornithologists' Union 1998). Common names in **Bold** are for species considered *regionally unique* (see page 26)

[2]Status codes were based on historical and incidental data in addition to survey data (1994-1995).
PR - permanent resident
SR - summer resident
SV - summer visitant
WR - winter resident
B - breeding confirmed
b - breeding not confirmed, but expected

WV - winter visitant
M - migrant
? - status undetermined

[3] COSEWIC (The Committee on the Status of Endangered Wildlife In Canada 1999).

A list of Canadian wildlife species at risk is determined and reviewed annually by COSEWIC. This committee is comprised of federal, provincial and territorial officials, as well as representatives from conservation organizations.

COSEWIC Status Codes.
Endangered: A species threatened with imminent extinction or extirpation in Canada.
Threatened: A species likely to become endangered in Canada if limiting factors are not reversed.
Vulnerable: A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Indeterminate: A species for which there is insufficient scientific information to support status designation.
Not at risk: A species that has been evaluated and found to be not at risk.
BLANK - Where this column is empty, it indicates that no evaluation has been attempted.

[4] Alberta Rating. Alberta Environmental Protection (1996).

The status of Alberta wildlife is published every 5 years and assists provincial government agencies in developing wildlife management and conservation programs. The word "risk" in the following definitions indicates the "risk of extirpation" within Alberta.

Alberta Rating Codes:

Red List: Species are at risk (populations have declined to non-viable levels).
Blue List: Species may be at risk (populations are vulnerable because of non-cyclical declines, OR information is limited for species suspected of being at risk).
Yellow List: Sensitive species currently not believed to be at risk but may require special management.
    Yellow A: Concern because of long-term declines.
    Yellow B: Naturally rare with clumped breeding distributions.
Green List: Species not considered to be at risk.
Status Undetermined: Not known to be at risk, but data are limited.

[5] Breeding Bird Survey (BBS) Trend for 1966-96 and 1980-96. Sauer et al. (1998).

Data are presented for species **whose annual population trend is NEGATIVE** for either of two time periods at one to 3 scales: national (Canada), continent (survey-wide within North America), and local (ecoregion). Suffield NWA is within the Glaciated Missouri Plateau ecoregion. Exact P values to indicate statistical significance are shown within parentheses. To read this information for Pied-billed Grebe, for example, the overall Canadian population is estimated to have declined at a statistically significant rate of 2.7% per year between 1966 and 1996. During that same period when all routes in Canada and the United States (i.e., Continent) were analyzed together, the population is estimated to have declined by 0.5% per year, but the trend is either too small or too variable to be significant. A number of species breed outside of Continental Breeding Bird Survey coverage. This is indicated by the phrase "not covered by BBS". **Where this column is blank, it indicates the trend is positive** (significantly or not-significantly).

[6] Stevens (1972).

[7] Crease (1990).

[8] Reynolds and Armbruster (1971).

[9] Banasch and Barry (1998).

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Common Loon				**0.0017**[3]	**0.08**
Pied-billed Grebe	0.13		**0.0203**		1.34
Horned Grebe			**0.0169**	0.0004	1.02
Red-necked Grebe			**I**[4]	I	**0.33**
Eared Grebe	0.13		**1.7517**		0.58
Western Grebe			**0.0118**	0.0035	**0.25**
American White Pelican	0.27	**0.2101**	0.0642	0.0466	**0.34**
Double-crested Cormorant		I	0.0034	**0.0048**	**0.38**
American Bittern [5]		**0.0027**	H		2.29
Great Blue Heron		0.0027	**0.0490**	0.0039	0.64
Black-crowned Night-Heron			**0.0101**		**0.20**
Turkey Vulture	**I, H**[5]				**<0.01**
Snow Goose[6]			**H**		Out
Canada Goose	0.94	**1.5823**	0.8159	0.1386	1.81
Trumpeter Swan			**0.0051**	0.0004	Out
Tundra Swan			**I**		Out
Gadwall	T 0.27	I	**0.4037**	0.0086	3.32
American Wigeon	0.27	0.0085	**0.1740**	0.0121	2.86
American Black Duck [6]			**H**		Out
Mallard	0.4	0.0342	**0.6470**	0.0237	14.09
Blue-winged Teal	T 0.13	I	**0.4949**	0.0220	6.16
Cinnamon Teal			**0.0321**	0.0004	**0.08**
Northern Shoveler	0.27	I	**0.4662**	0.0168	4.03
Northern Pintail	T 0.54	0.0093	**0.3328**	0.0112	4.92
Green-winged Teal	0.13		**0.2162**	0.0026	1.23
Canvasback			**0.0574**	0.0009	0.98
Redhead	0.13		**0.3142**	0.0004	1.17
Ring-necked Duck			**0.0963**		**0.12**
Lesser Scaup	0.13		**0.3581**	0.0091	2.83
Surf Scoter				**I**	Out

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SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Bufflehead			**0.0034**	0.0009	**0.25**
Common Goldeneye			0.0034	**0.0039**	**0.11**
Common Merganser	T 0.13	0.0041		**0.0052**	**0.03**
Red-breasted Merganser				**0.0013**	Out
Ruddy Duck	0.13		**0.1503**		1.34
Osprey		**0.0014**		0.0004	**<0.01**
Bald Eagle				**0.0004**	**<0.01**
Northern Harrier	**1.62**	0.0176		0.0104	2.93
Sharp-shinned Hawk		0.0075		**0.0043**	**0.06**
Cooper's Hawk				**0.0009**	**0.12**
Broad-winged Hawk				**0.0013**	**0.03**
Swainson's Hawk	**0.27**	0.0041		0.0017	3.81
Red-tailed Hawk	**T 0.27**	0.0052		0.0039	3.94
Ferruginous Hawk	**0.54**			0.0004	**0.38**
Rough-legged Hawk [7]	**H**				Out
Golden Eagle	0.27	**0.0281**		0.0013	**0.02**
American Kestrel	0.4	0.0549		**0.0389**	1.10
Merlin	**0.81**	0.0149		0.1999	**0.18**
Gyrfalcon [7]	**H**				Out
Prairie Falcon	I	**0 0027**		0.0009	**0.04**
Gray Partridge	0.13	**0.0160**		0.0022	1.16
Ring-necked Pheasant	**0.13**			0.0004	2.44
Sharp-tailed Grouse	**3.51**			0.0009	0.57
Virginia Rail			**0.0017**		**0.02**
Sora		0.0051	**0.0422**	0.0009	7.10
American Coot	0.13	0.0010	**1.9274**	0.0017	6.23
Sandhill Crane			**I**		Out
Killdeer	1.08	0.0136	**0.0980**	0.0135	16.32
American Avocet	T 0.13		**0.1064**	0.0043	0.97
Greater Yellowlegs			**0.0051**	0.0004	Out

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Lesser Yellowlegs			I	**0.0022**	0.52
Solitary Sandpiper		I	I	**0.0009**	Out
Willet	2.29	0.0023	**0.1926**	0.0125	5.46
Spotted Sandpiper		0.0072	0.0034	**0.0104**	**0.49**
Upland Sandpiper	**22.4**	0.0050		0.0009	1.89
Long-billed Curlew	**12.55**	0.0014		I	2.39
Marbled Godwit	6.21	0.0075	**0.1706**	0.0030	6.22
Semipalmated Sandpiper			**0.0034**		Out
Least Sandpiper [6]			**H**		Out
Baird's Sandpiper			**0.0152**	0.0004	Out
Pectoral Sandpiper [6]			**H**		Out
Dowitcher (sp.)			**0.1182**		
- Short-billed			**H**[6]		Out
- Long-billed					Out
Common Snipe	0.13		**0.0017**	0.0004	5.84
Wilson's Phalarope	T 0.13	I	**0.0895**		1.28
Franklin's Gull			**0.0101**		4.55
Ring-billed Gull	0.13	0.0014	**0.0051**	0.0017	7.0
California Gull		0.0026	**0.0051**		0.76
Common Tern			**0.0186**	0.0017	0.59
Black Tern			**0.0084**		4.90
Rock Dove	0.13	**0.0491**		0.0078	4.05
Mourning Dove	**10.66**	0.0882		0.0289	16.24
Black-billed Cuckoo	**0.27**			0.0004	1.85
Great Horned Owl	**T 0.13**	0.0039		0.0130	0.90
Snowy Owl [7]	**H**				Out
Burrowing Owl	**I**				**0.07**
Long-eared Owl	**I**			0.0004	**0.02**
Short-eared Owl	**I**	0.0014			**0.47**
Common Nighthawk	**2.7**	0.0052		0.0393	**0.21**

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Common Poorwill	**I**				**N/A**
Belted Kingfisher		**0.0162**		0.0013	**0.05**
Yellow-bellied Sapsucker		0.0021		**0.0022**	**0.33**
Red-naped Sapsucker		0.0010		**0.0009**	**N/A**
Downy Woodpecker		0.0021		**0.0052**	**0.21**
Hairy Woodpecker				**0.0009**	**0.29**
Northern Flicker	0.13	0.0236		**0.0332**	3.03
Pileated Woodpecker				**0.0004**	**0.03**
Olive-sided Flycatcher				**I**	**0.02**
Western Wood-Pewee		0.0010		**0.0039**	0.95
Alder Flycatcher				**0.0013**	1.50
Least Flycatcher	0.54	0.0176		**0.0213**	9.20
Say's Phoebe	0.13	**0.1138**		0.0017	**0.10**
Western Kingbird	0.27	I		**0.0100**	4.12
Eastern Kingbird	**5.4**	0.0494		0.0402	10.24
Loggerhead Shrike	**2.43**			0.0026	0.99
Northern Shrike				**I**	Out
Blue-headed Vireo				**0.0017**	**0.02**
Warbling Vireo	0.27	0.0010		**0.0082**	7.70
Red-eyed Vireo				**0.0017**	4.77
Black-billed Magpie	7.02	0.0970		**0.1088**	14.82
American Crow	2.16	**0.0539**		0.0112	40.72
Horned Lark	**62.08**	0.0812		0.0272	44.28
Tree Swallow	T 0.13			**0.0138**	5.36
Violet-green Swallow	0.13	**0.2283**		0.0043	**<0.01**
Northern Rough-winged Swallow	0.13	**0.0182**		0.0074	**0.10**
Bank Swallow	T 0.27			**0.0324**	1.05
Cliff Swallow	0.4	**1.4145**		0.0004	1.85
Barn Swallow	0.27	0.0028		**0.0073**	16.61

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Black-capped Chickadee	0.13	0.0102		**0.0121**	1.08
Red-breasted Nuthatch		0.0037		**0.0112**	**0.05**
Brown Creeper				**0.0004**	**N/A**
Rock Wren	0.54	**0.1243**		0.0009	**<0.01**
House Wren	1.62	0.0682		**0.1023**	23.53
Sedge Wren			**I**		**0.41**
Marsh Wren			**0.0591**	0.0009	0.55
Ruby-crowned Kinglet				**0.0138**	**0.07**
Mountain Bluebird	0.13	**0.0891**			1.26
Townsend's Solitaire				**I**	**N/A**
Gray-cheeked Thrush		I		**I**	Out
Swainson's Thrush		0.0201		**0.0147**	**0.11**
Hermit Thrush				**0.0004**	**0.17**
American Robin	0.27	0.0103		**0.0756**	15.87
Varied Thrush		**0.0010**			Out
Gray Catbird		**0.0137**		0.0073	3.04
Northern Mockingbird	**I**				**N/A**
Brown Thrasher	3.51	**0.0744**		0.0380	2.34
European Starling	1.35	0.1207		**0.3613**	10.49
American Pipit		0.0062		**0.0099**	Out
Sprague's Pipit	**54.12**	0.0031		0.0004	3.75
Cedar Waxwing	0.27	0.0102		**0.0920**	1.72
Tennessee Warbler				**0.0246**	**0.12**
Orange-crowned Warbler		0.0102		**0.0484**	**0.06**
Yellow Warbler	0.81	0.0377		**0.0911**	11.41
Yellow-rumped Warbler (Myrtle)		0.0179		**0.2543**	**0.06**
Palm Warbler				**0.0022**	Out
Blackpoll Warbler		0.0010		**0.0086**	Out
Black-and-White Warbler				**0.0009**	**0.02**
American Redstart				**0.0004**	**0.08**

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Ovenbird				**0.0017**	**0.30**
Northern Waterthrush				**0.0013**	Out
MacGillivray's Warbler				**0.0009**	N/A
Common Yellowthroat	0.81	0.0630	**0.1419**	0.0402	4.07
Wilson's Warbler				**0.0078**	Out
Canada Warbler	**T 0.13**				Out
Yellow-breasted Chat		0.0010		**0.0056**	**0.02**
Spotted Towhee	9.18	**0.0960**		0.0497	**0.26**
American Tree Sparrow		**0.0082**		0.0013	Out
Chipping Sparrow		0.0155		**0.0768**	2.37
Clay-colored Sparrow	**19.57**	0.0471		0.0363	36.11
Brewer's Sparrow	**20.78**			0.0043	**0.11**
Vesper Sparrow	**51.14**	0.0137		0.0078	32.56
Lark Sparrow	2.7	**0.2087**		0.0117	**0.17**
Lark Bunting	**15.52**	0.0049		0.0039	3.03
Savannah Sparrow	**3.64**			0.0186	32.27
Grasshopper Sparrow	**64.51**				0.72
Baird's Sparrow	**22.81**				3.48
Nelson's Sharp-tailed Sparrow			**I**		**0.19**
Fox Sparrow				**0.0004**	Out
Song Sparrow	0.13			**0.0108**	14.02
Lincoln's Sparrow		0.0068		**0.0341**	**0.46**
Swamp Sparrow				**0.0048**	**0.05**
White-throated Sparrow		0.0010		**0.0345**	1.04
Harris's Sparrow				**0.0013**	Out
White-crowned Sparrow		0.0102		**0.0773**	Out
Dark-eyed Junco				**0.0099**	**0.05**
McCown's Longspur	**4.99**				1.42
Lapland Longspur [7]	**H**				Out
Chestnut-collared Longspur	**24.02**				6.47

APPENDIX 2. Avian Frequency of Occurrence on CFB Suffield National Wildlife Area and in the Prairies.

SPECIES NAME	Frequency (%) Upland [1]	Birds/5 min. Ravines/Slopes	Birds/5 min. Wetlands	Birds/5 min. Riparian	Frequency (%) BBS by stop [2]
Snow Bunting	**I**				Out
Rose-breasted Grosbeak				**0.0022**	1.01
Lazuli Bunting		**I**			**<.01**
Red-winged Blackbird	0.81	0.1105	**0.5498**	0.0298	44.47
Western Meadowlark	**97.84**	0.3210		0.0466	52.94
Yellow-headed Blackbird	0.40	I	**1.0891**	0.0017	9.17
Rusty Blackbird [6]	**H**				**<.01**
Brewer's Blackbird	4.99	**0.0949**		0.0812	17.0
Common Grackle				**0.0017**	3.84
Brown-headed Cowbird	6.75	**0.0803**		0.0307	26.14
Baltimore Oriole	0.27			**0.0138**	8.31
Purple Finch				**0.0009**	**0.06**
Red Crossbill				**0.0039**	Out
White-winged Crossbill				**I**	**<0.01**
Pine Siskin	T 0.67	**0.0335**		0.0056	**0.16**
American Goldfinch	2.02	**0.0827**		0.0233	9.18
House Sparrow				**0.0009**	16.98

[1] Frequency is % occurrence inside or outside of 100 m radius on 741 point counts in SNWA Upland 1994-1995. "T" indicates species was recorded only during travel between point counts.

[2] Downes, C., Canadian Wildlife Service, unpublished data. Breeding Bird Survey route data (1968 - 1995) from the prairie provinces. Frequency expressed in % of all prairie stops on which species recorded. "N/A" indicates species not recorded on prairie BBS. "Out" indicates the species breeds mainly (>90%) outside the area covered by prairie BBS. If frequency is in **Bold,** then species is *regionally rare* (page 26).

[3] The segment with the frequency or encounter rate in **Bold** is the *preferred* segment for that species. See page 26 for a description of how this was determined.

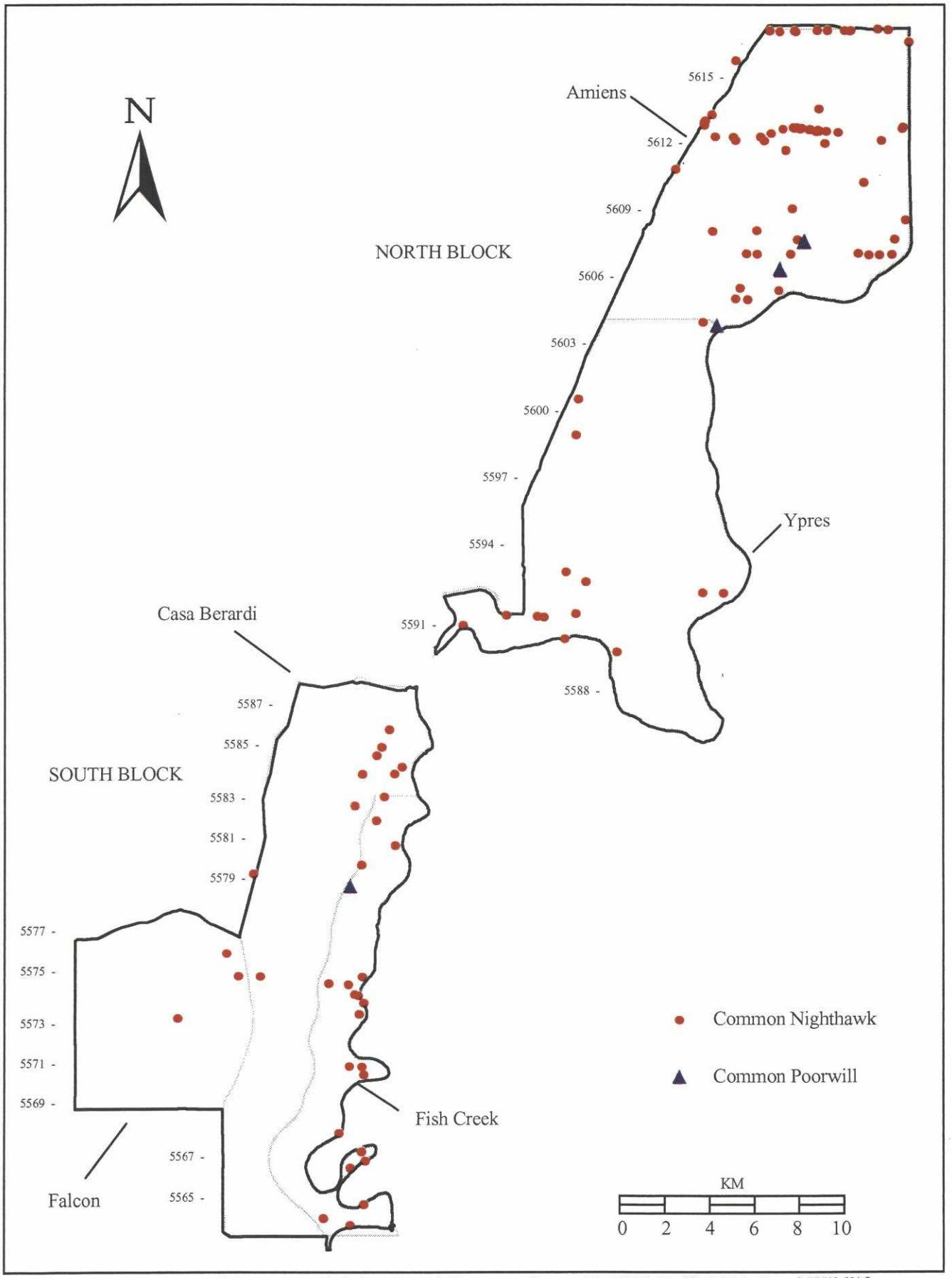
[4] Incidental records ("I") are non-survey data from 1994 - 1996 within the SNWA , and historical records ("H") are included where there is no survey record for a segment of the SNWA. The source is provided in footnote form.

[5] Stevens (1972).

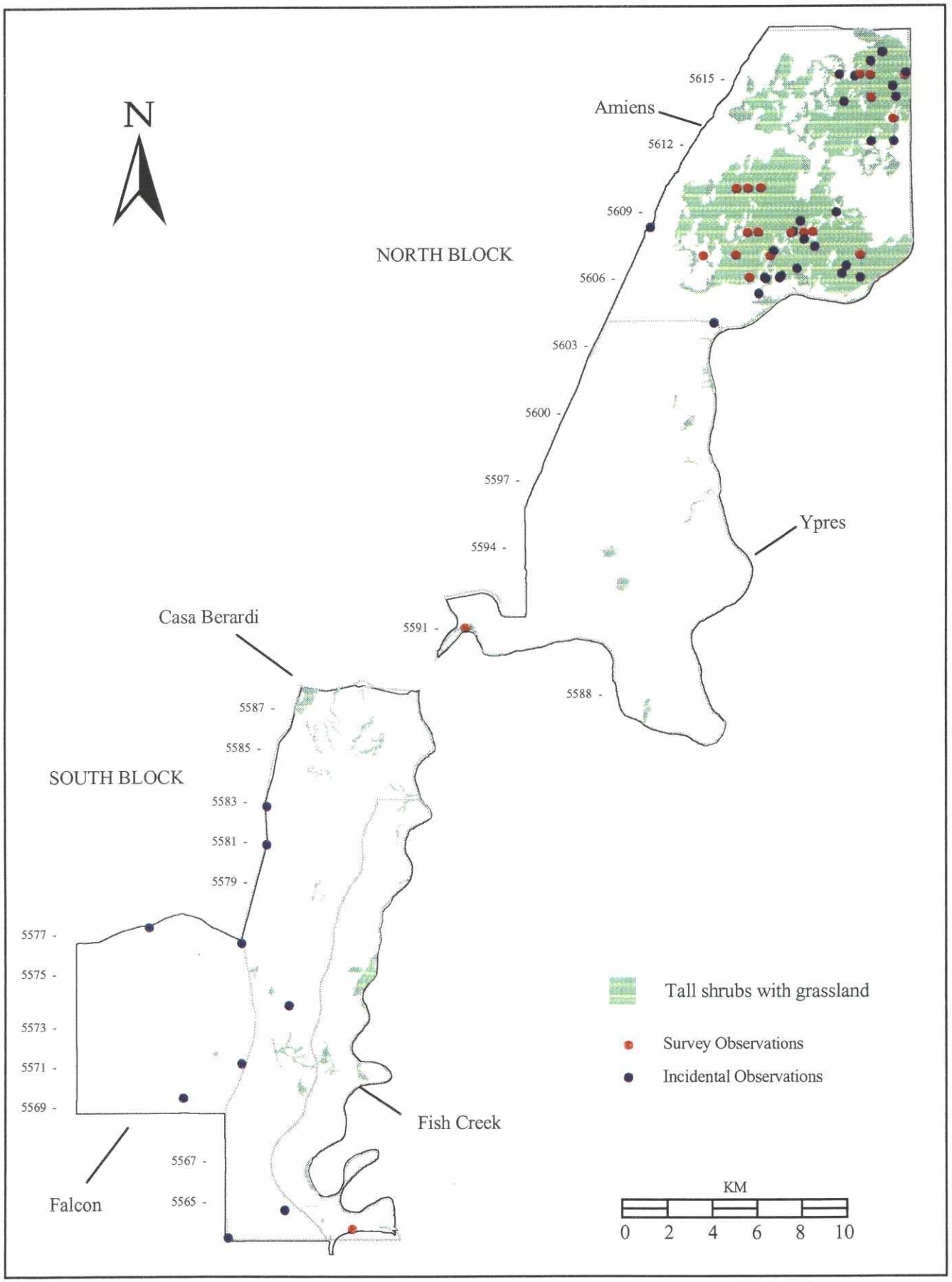
[6] Crease (1990).

[7] Reynolds and Armbruster (1971).

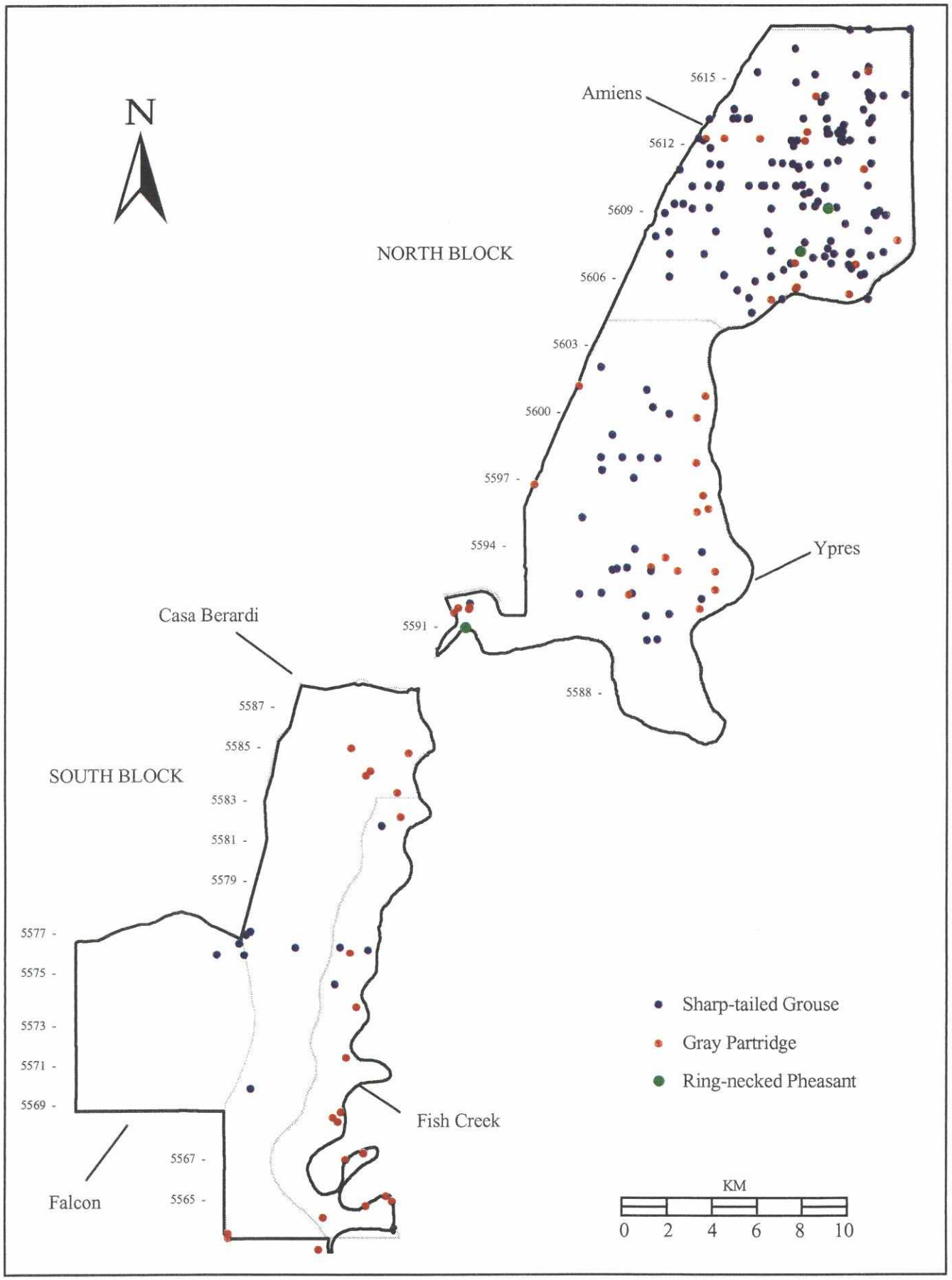
APPENDIX 3. Distribution of Selected Bird Species on CFB Suffield National Wildlife Area, 1994-1995.



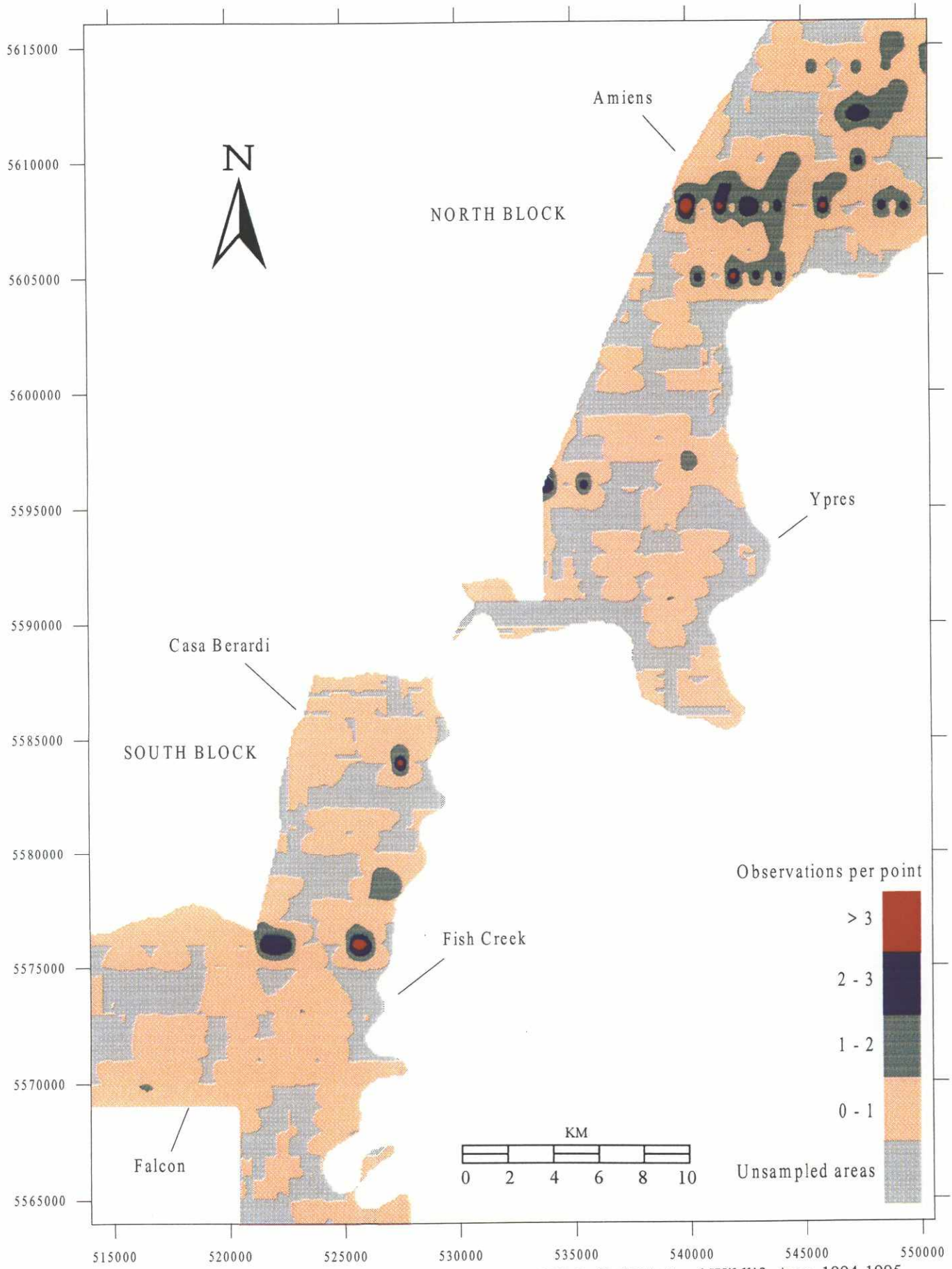
Map 1. Observations of Common Nighthawk and Common Poorwill, CFB Suffield National Wildlife Area, 1994-1995.



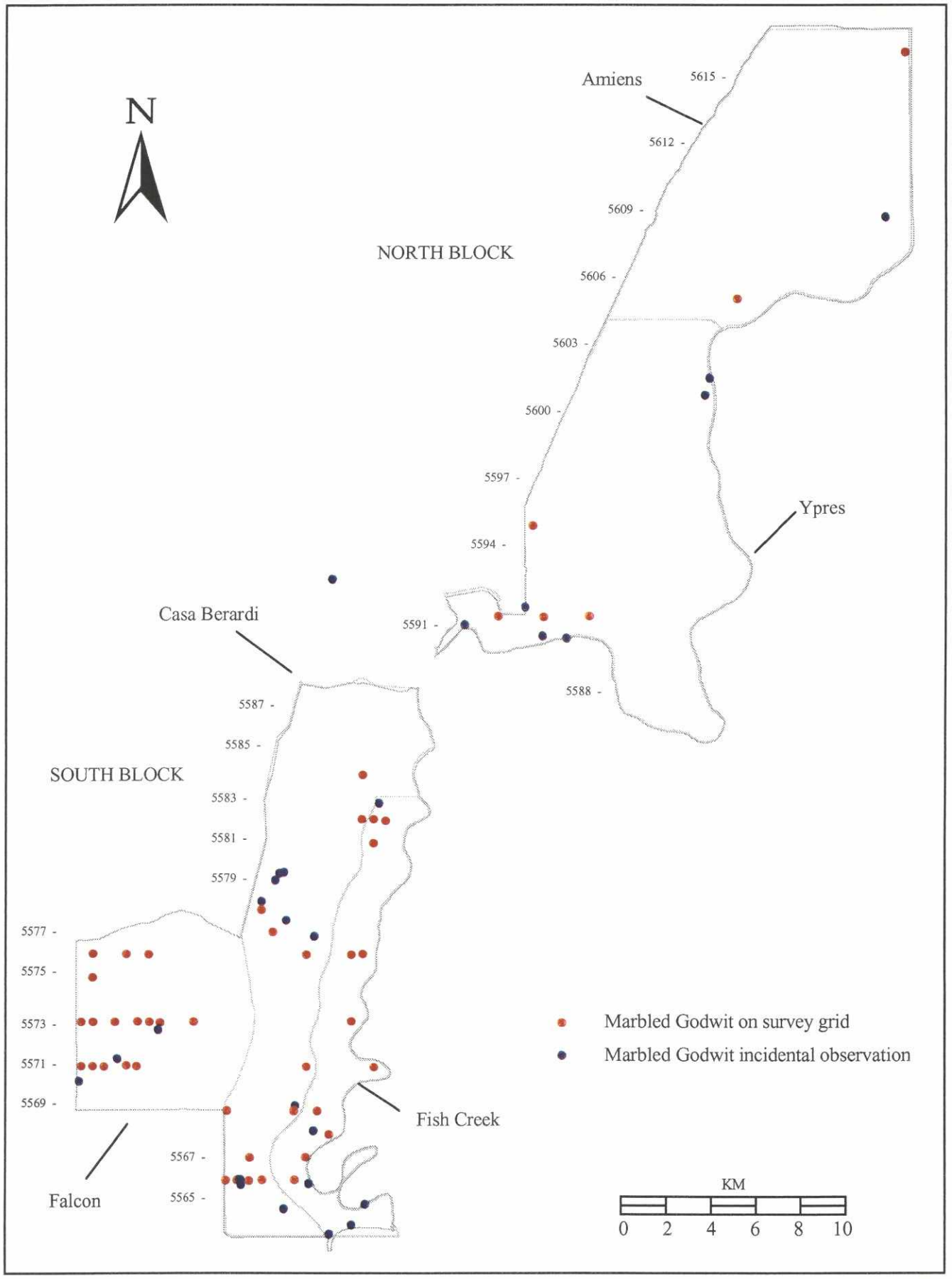
Map 2. Observations of Loggerhead Shrike, CFB Suffield National Wildlife Area, 1994-1995. (Vegetation data from Adams et al. 1997).



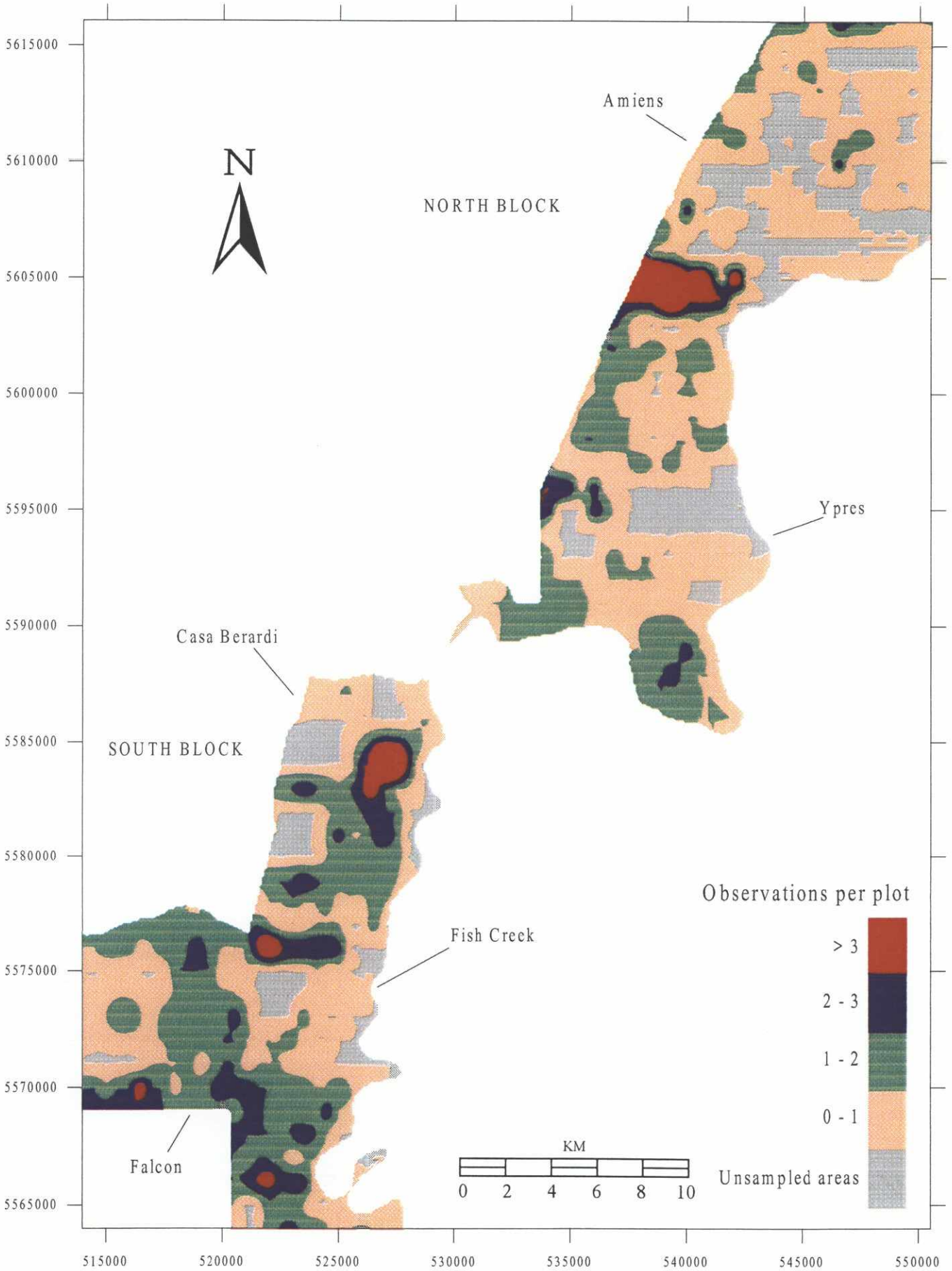
Map 3. Observations of non-migratory game birds, CFB Suffield National Wildlife Area, 1994-1995.



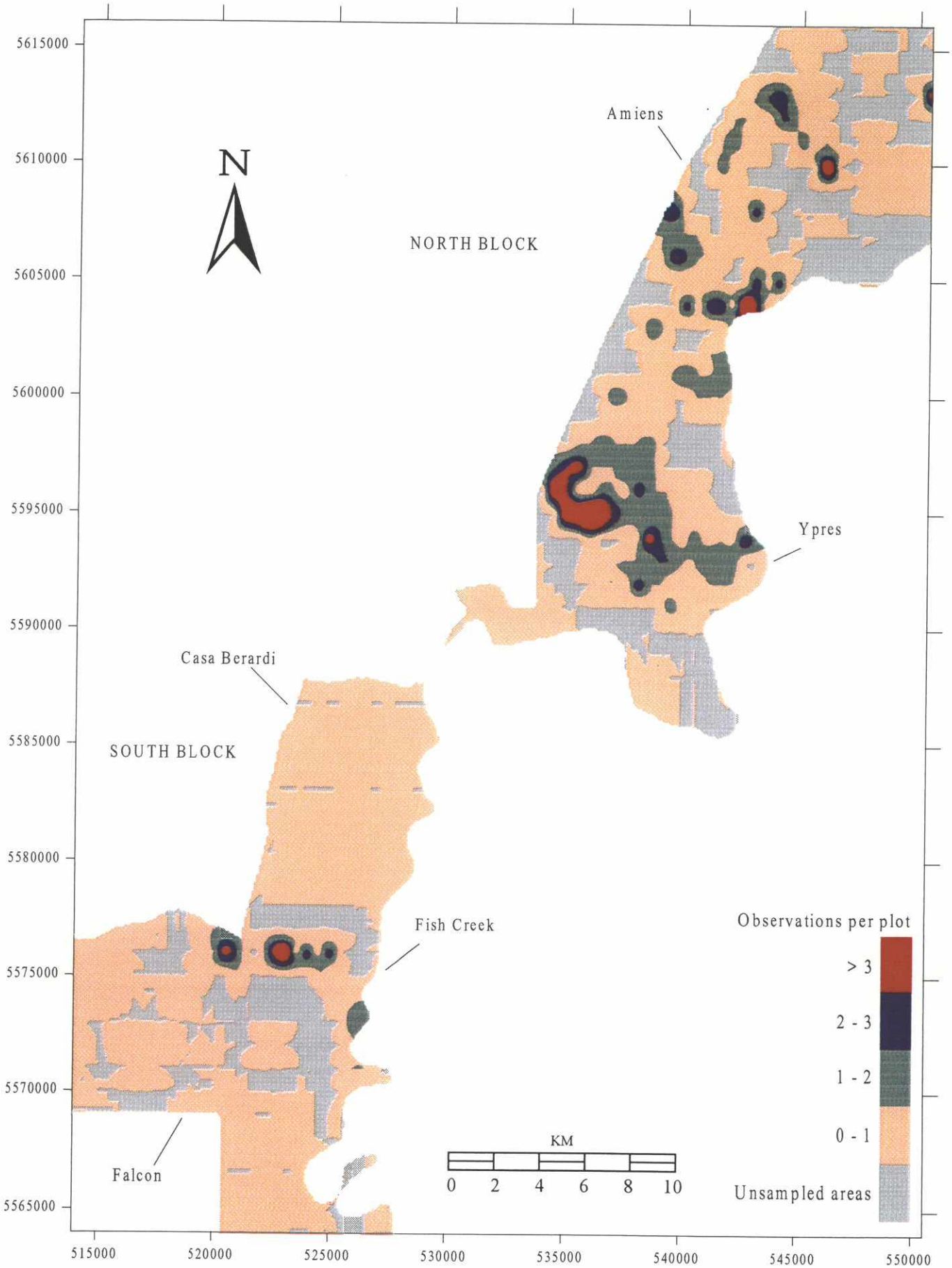
Map 4. Relative abundance and distribution of Upland Sandpiper, CFB Suffield National Wildlife Area, 1994-1995.



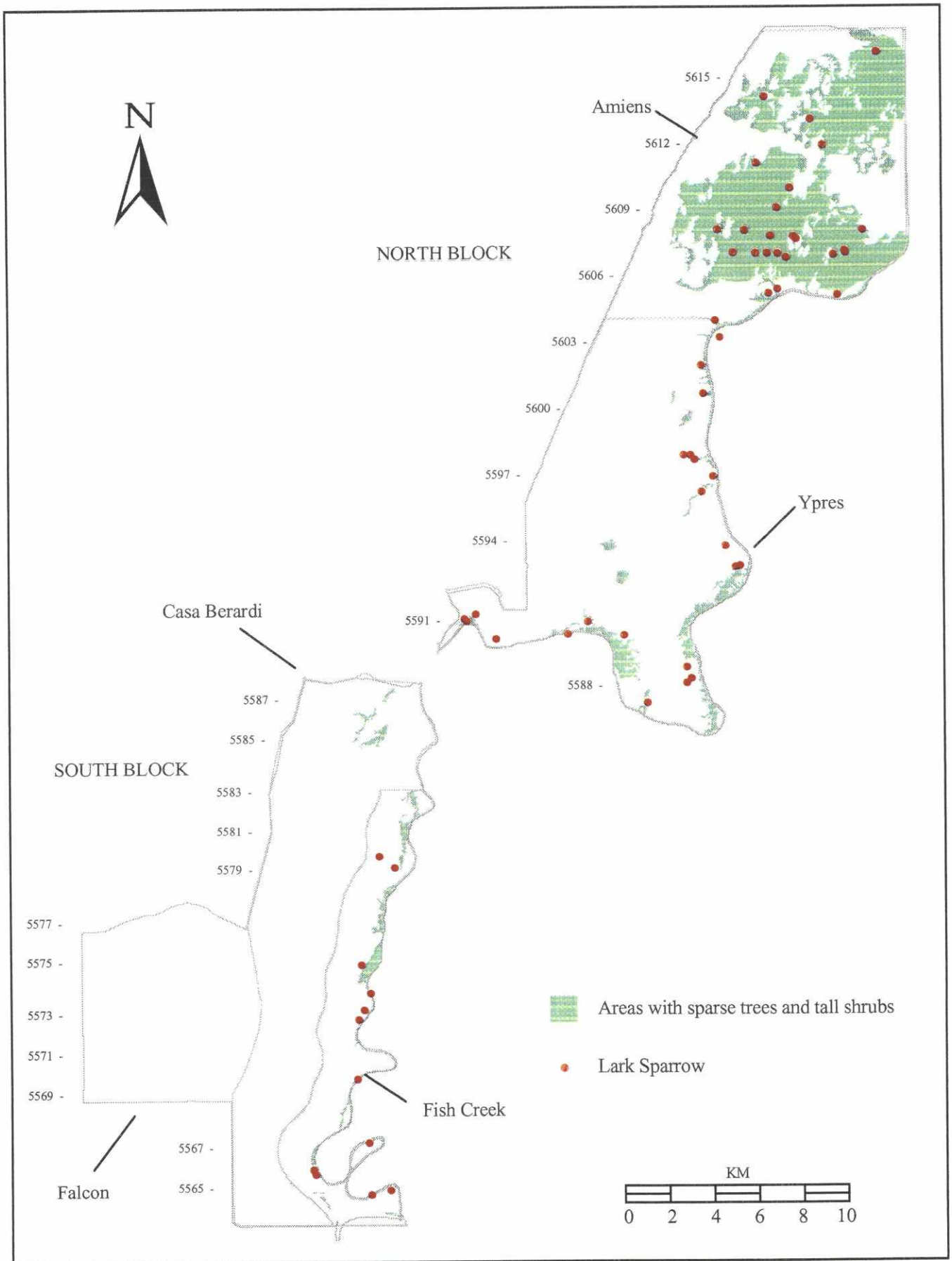
Map 5. Observations of Marbled Godwit, CFB Suffield National Wildlife Area, 1994-1995.



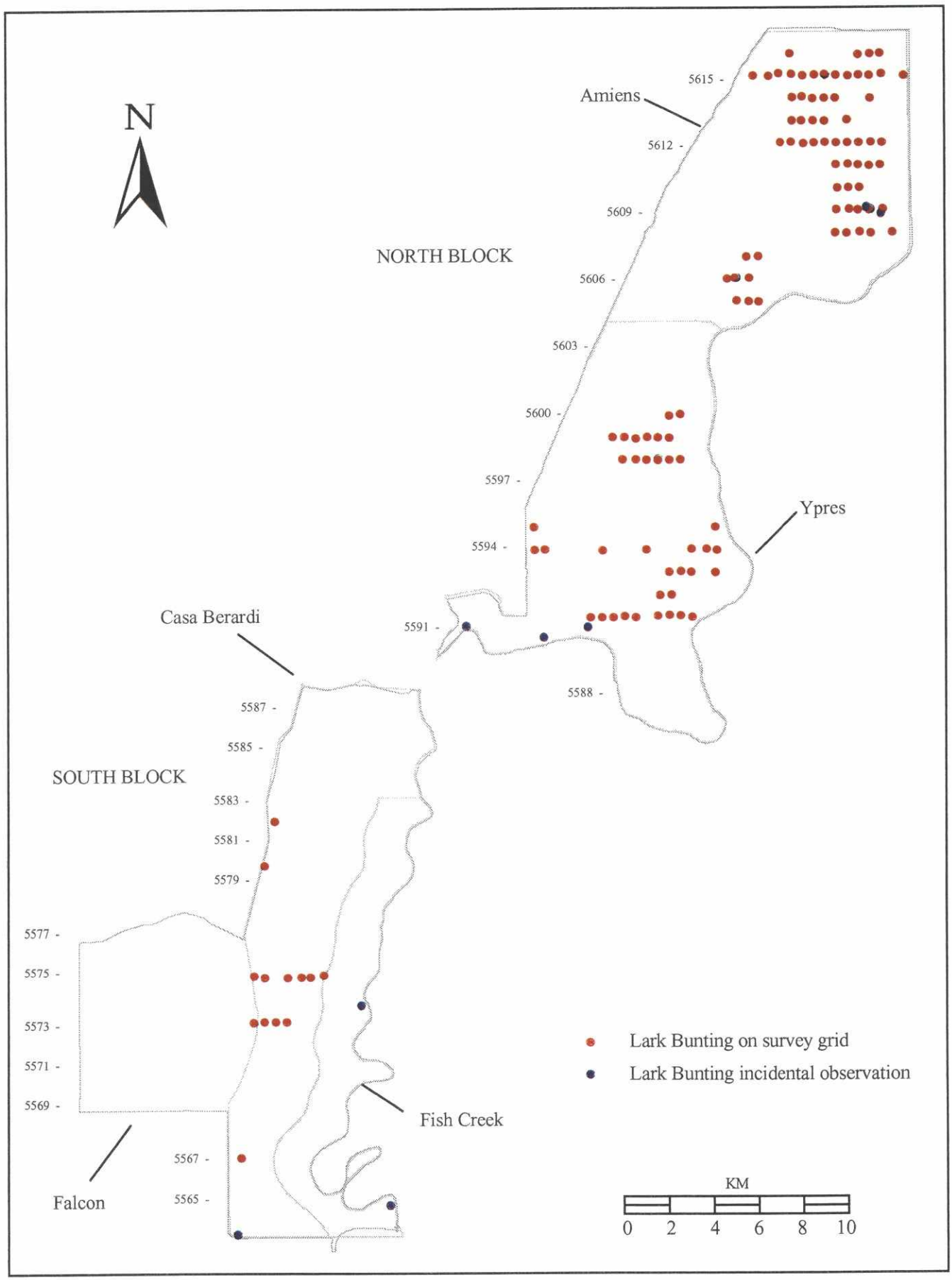
Map 6. Relative abundance and distribution of Sprague's Pipit, CFB Suffield National Wildlife Area, 1994-1995.



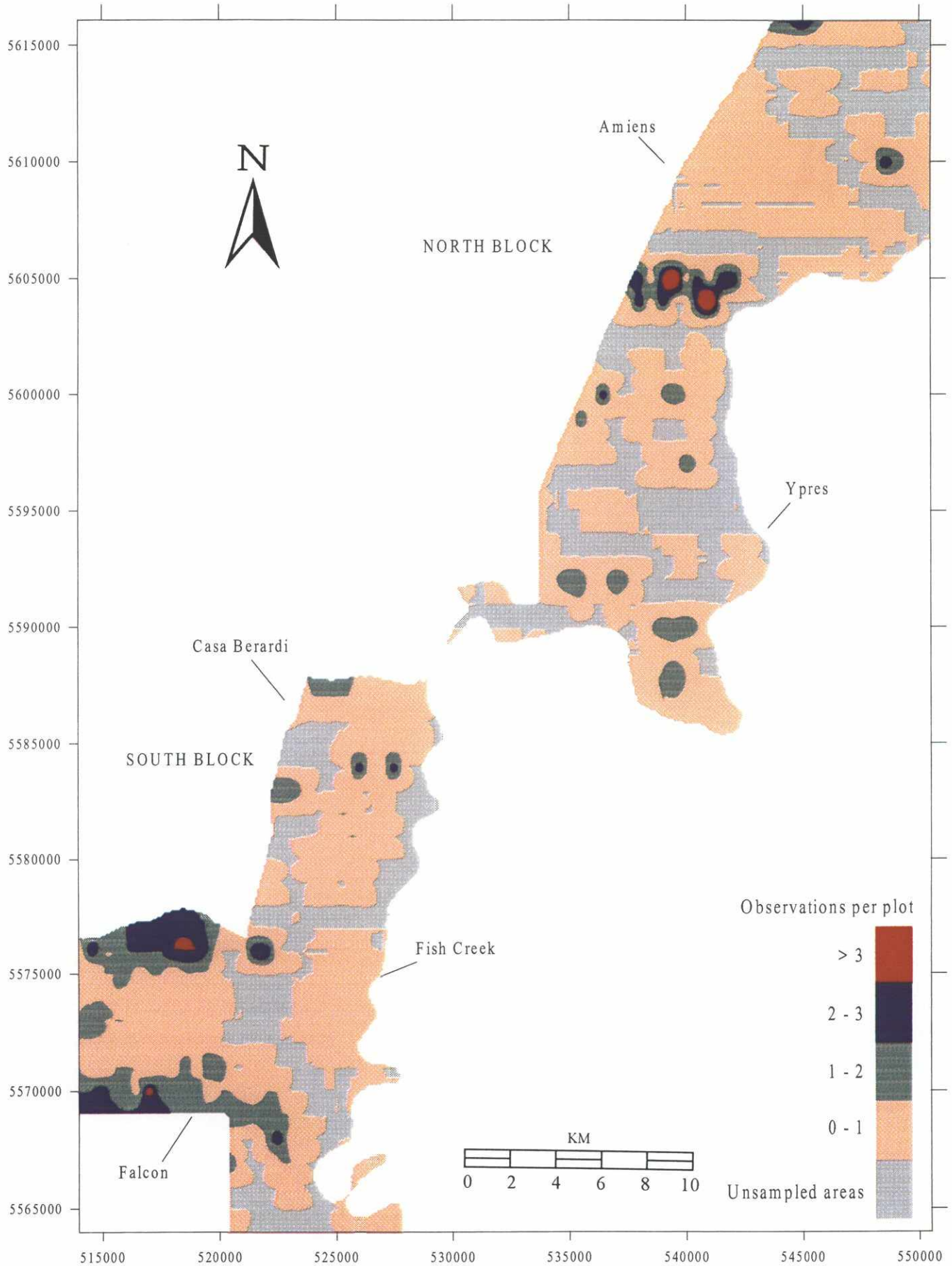
Map 7. Relative abundance and distribution of Brewer's Sparrow, CFB Suffield National Wildlife Area, 1994-1995.



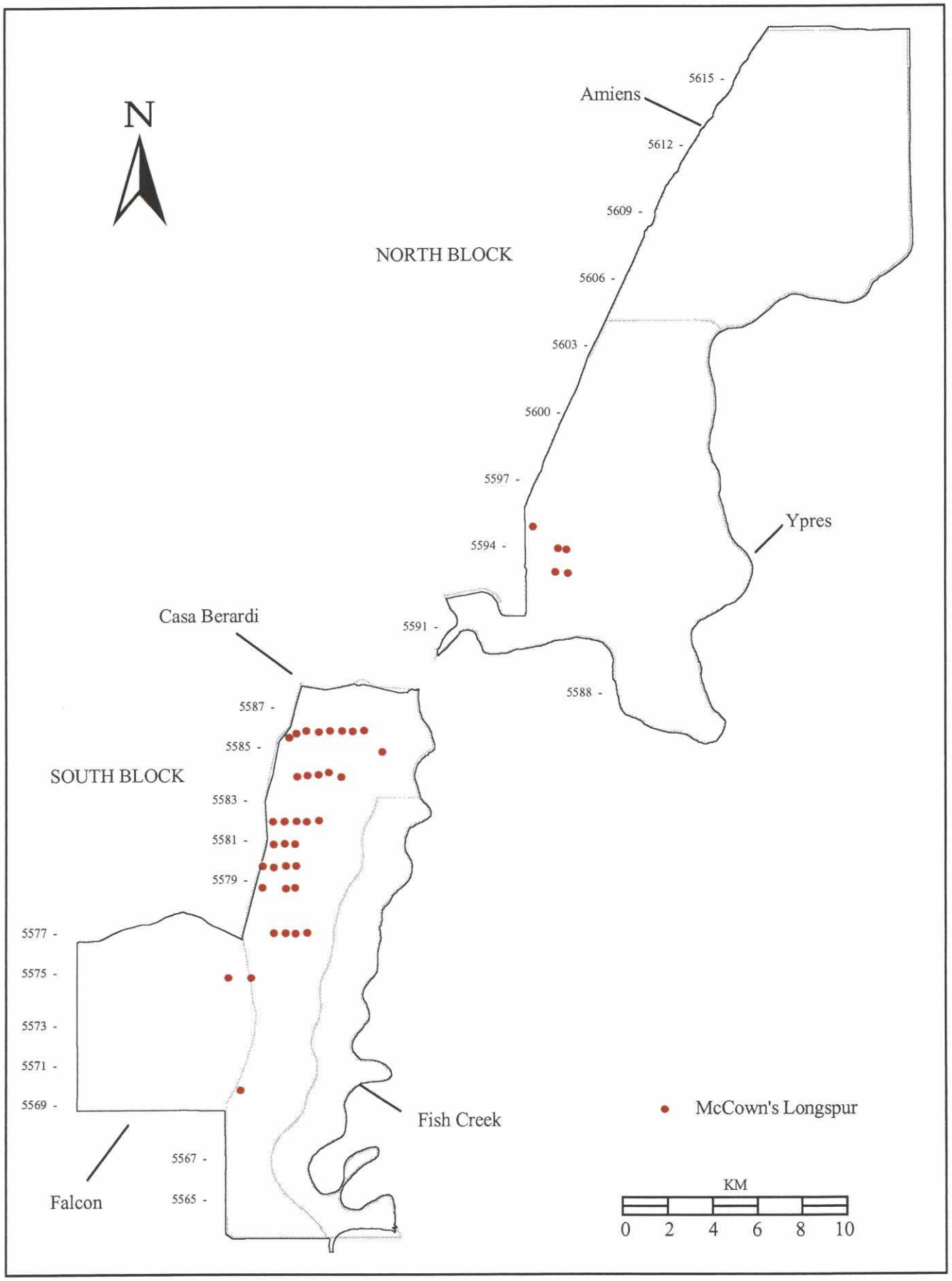
Map 8. Observations of Lark Sparrow, CFB Suffield National Wildlife Area, 1994-1995. (Vegetation descriptions modified from Adams et al. 1997).



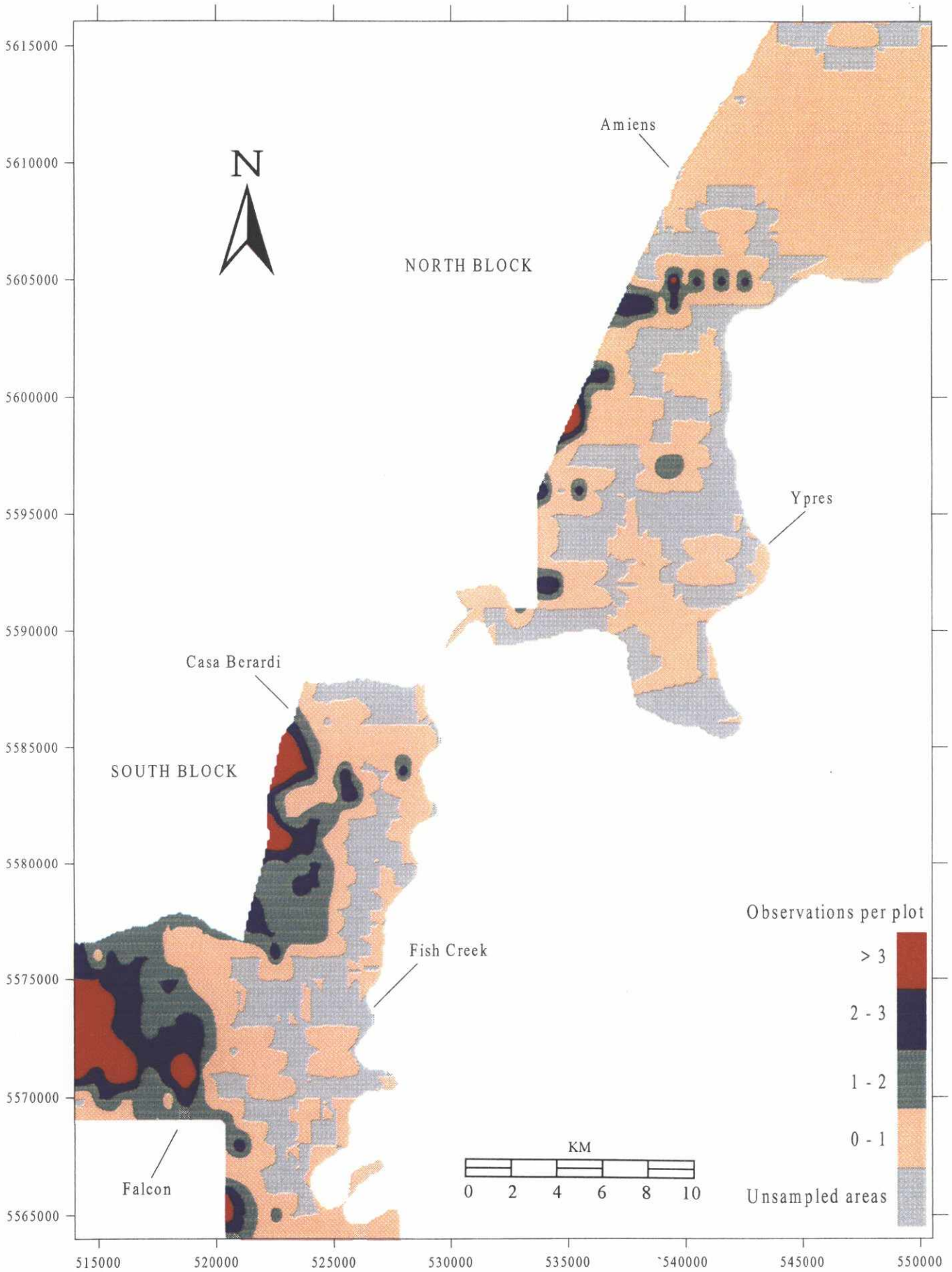
Map 9. Observations of Lark Bunting, CFB Suffield National Wildlife Area, 1994-1995.



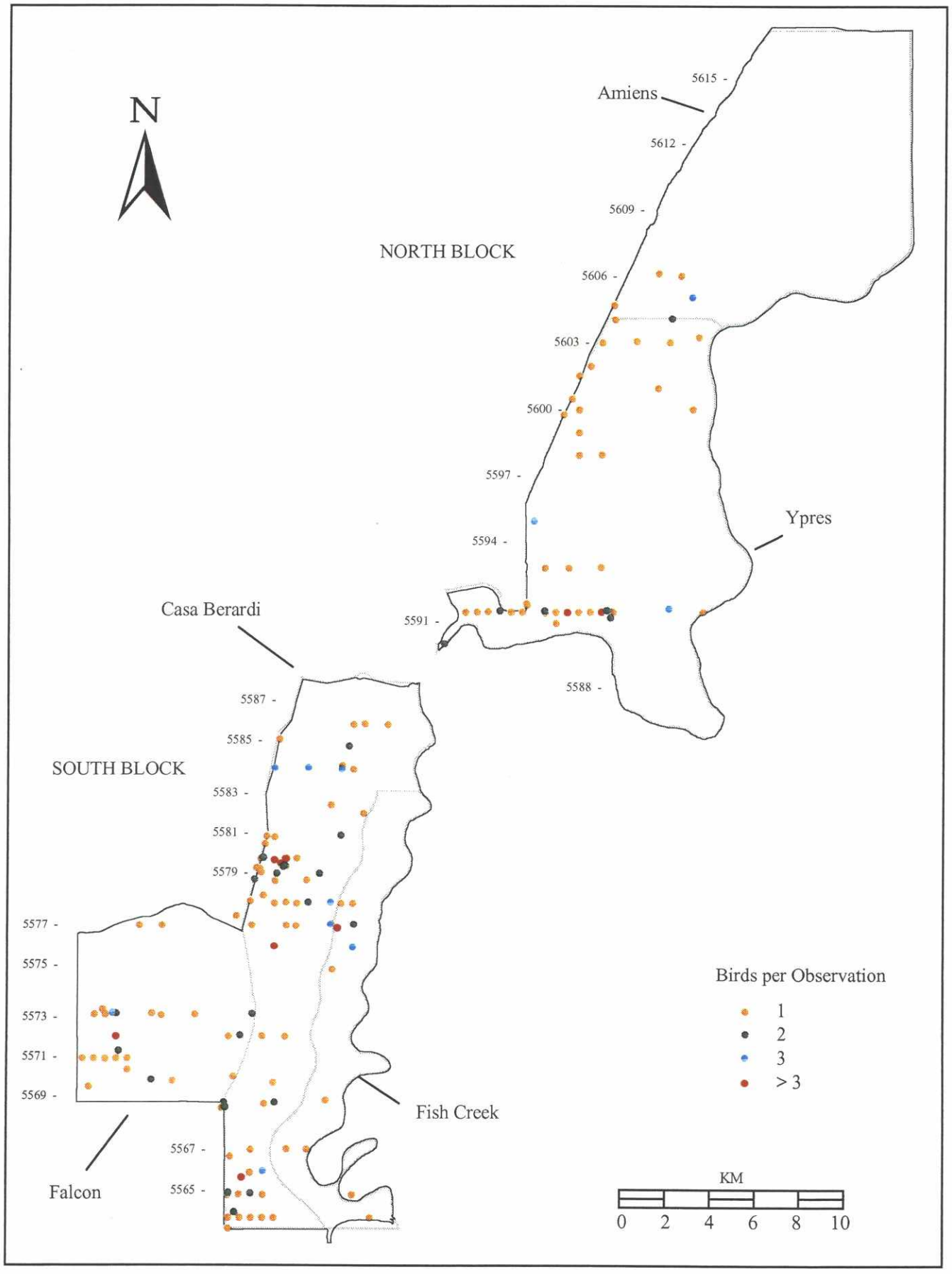
Map 10. Relative abundance and distribution of Baird's Sparrow, CFB Suffield National Wildlife Area, 1994-1995.



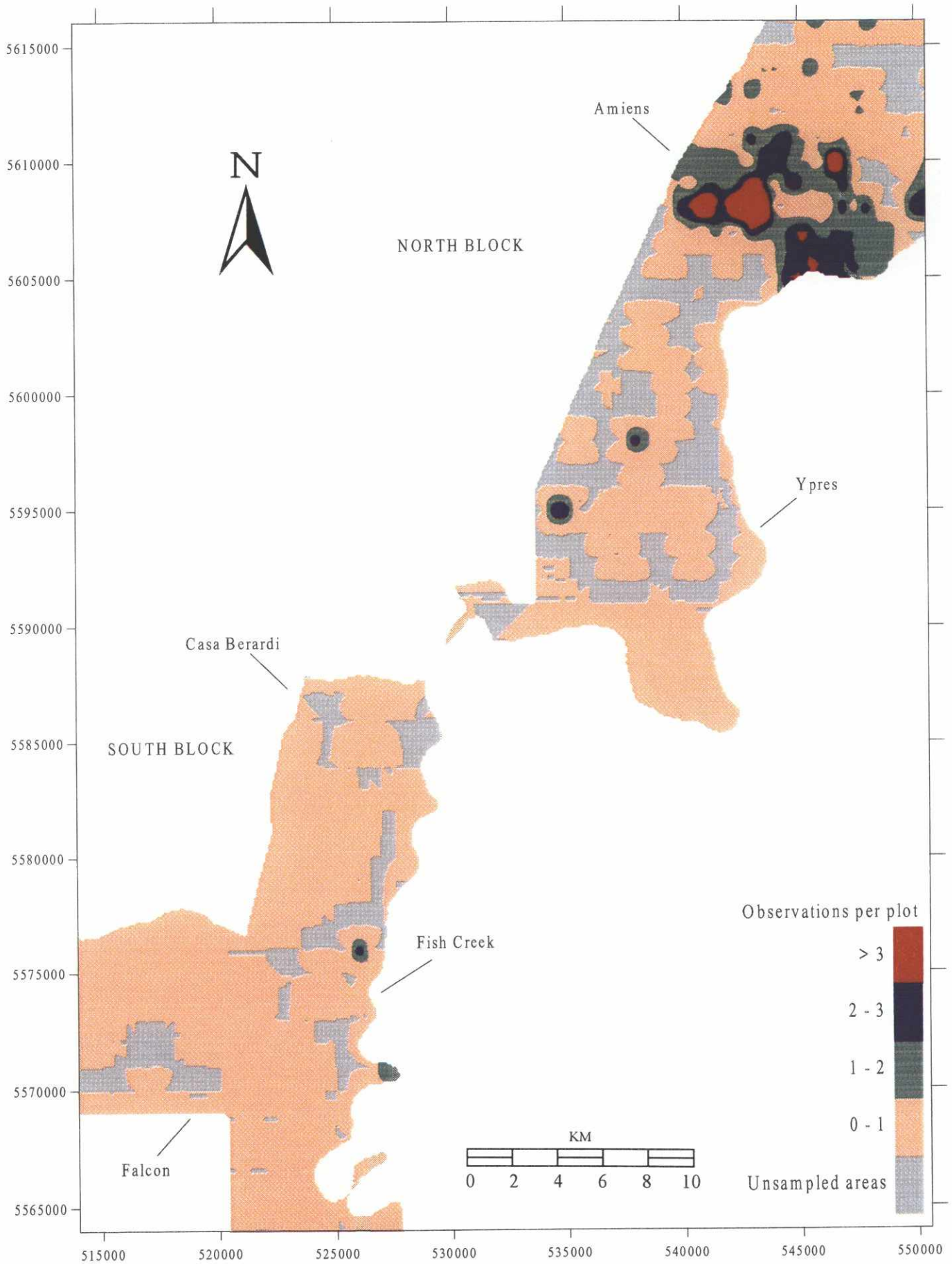
Map 11. Observations of McCown's Longspur, CFB Suffield National Wildlife Area, 1994-1995.



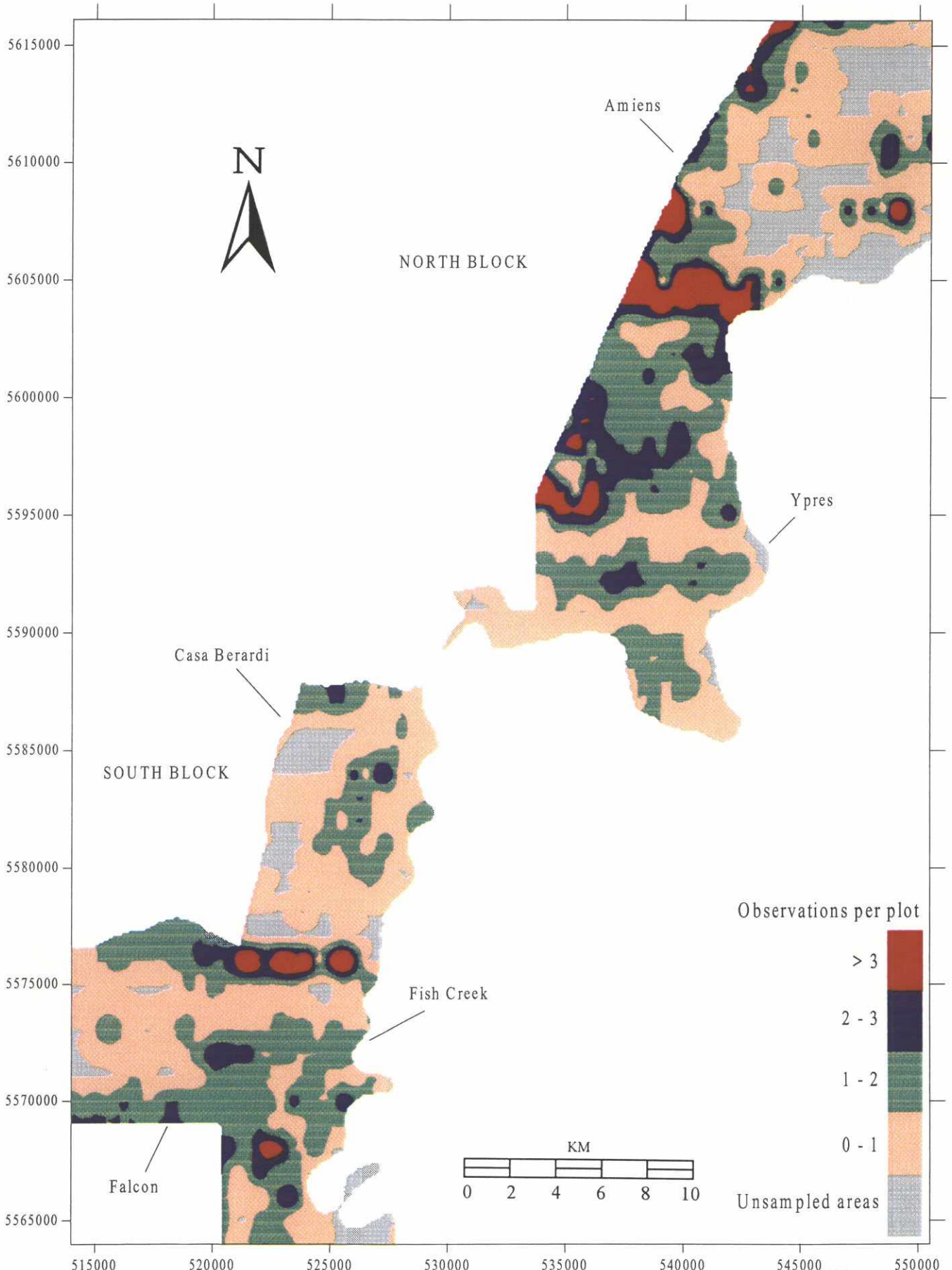
Map 12. Relative abundance and distribution of Chestnut-collared Longspur, CFB Suffield National Wildlife Area, 1994-1995.



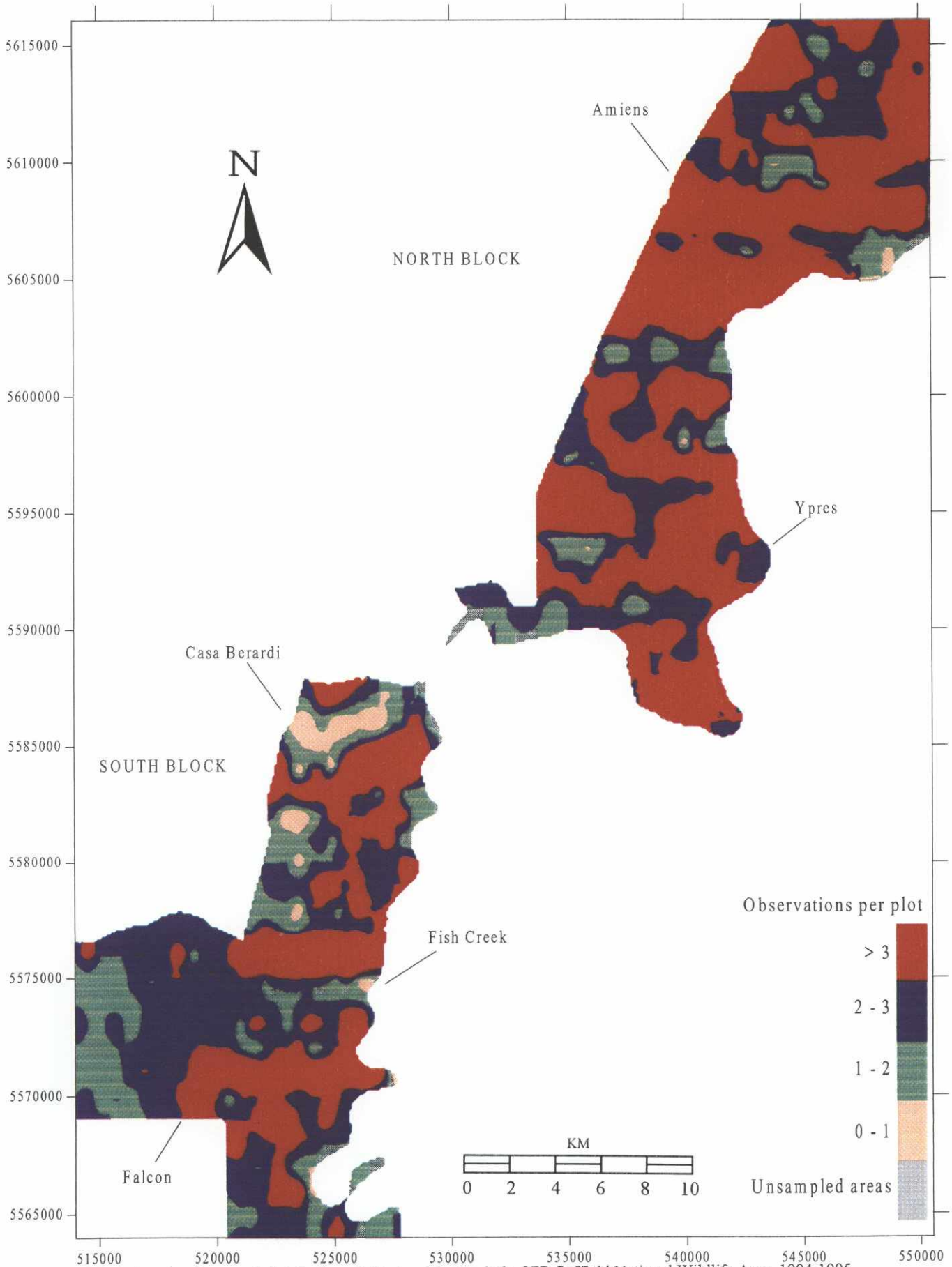
Map 13. Observations of Long-billed Curlew, CFB Suffield National Wildlife Area, 1994-1995.



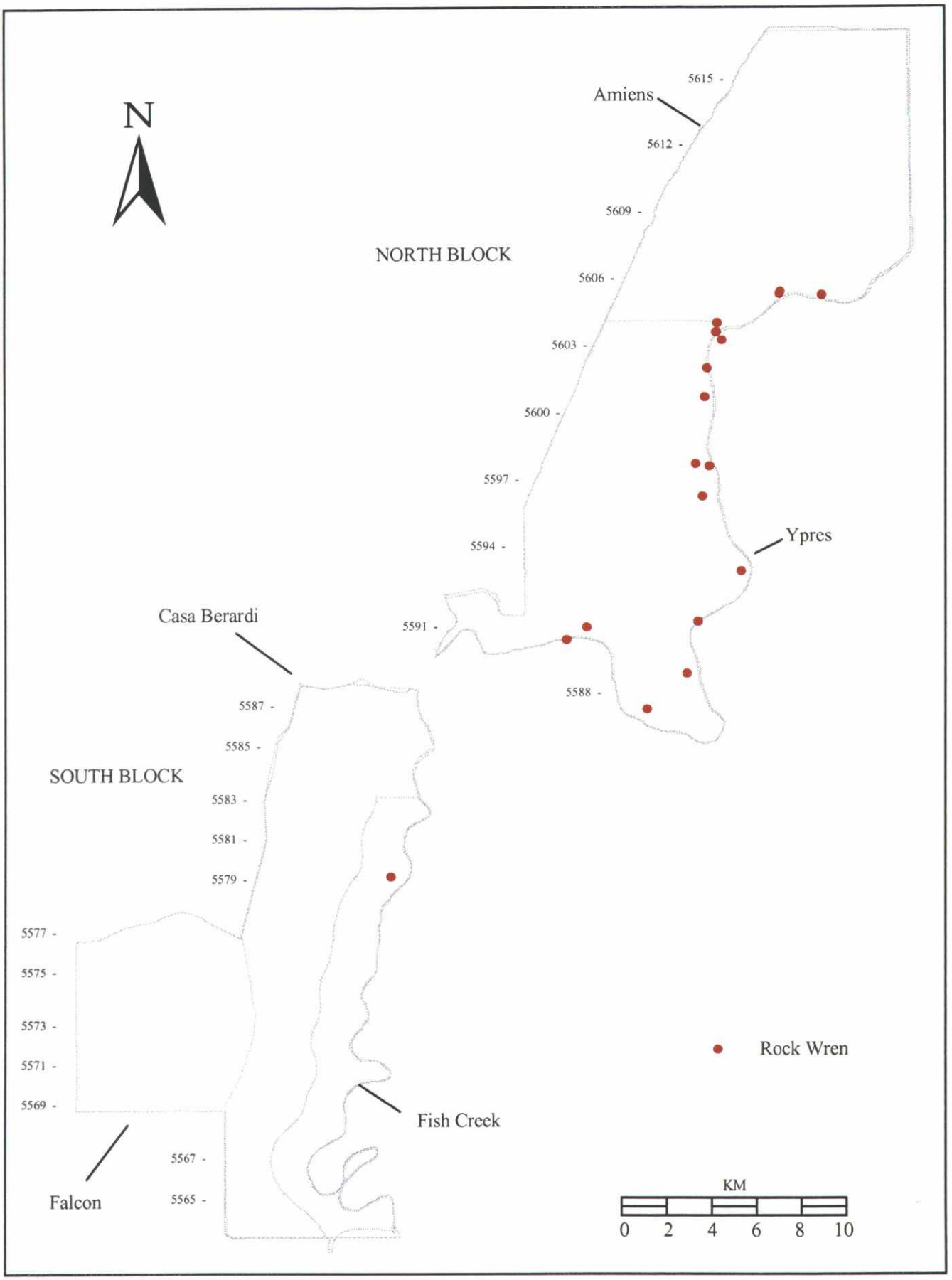
Map 14. Relative abundance and distribution of Clay-colored Sparrow, CFB Suffield National Wildlife Area, 1994-1995.



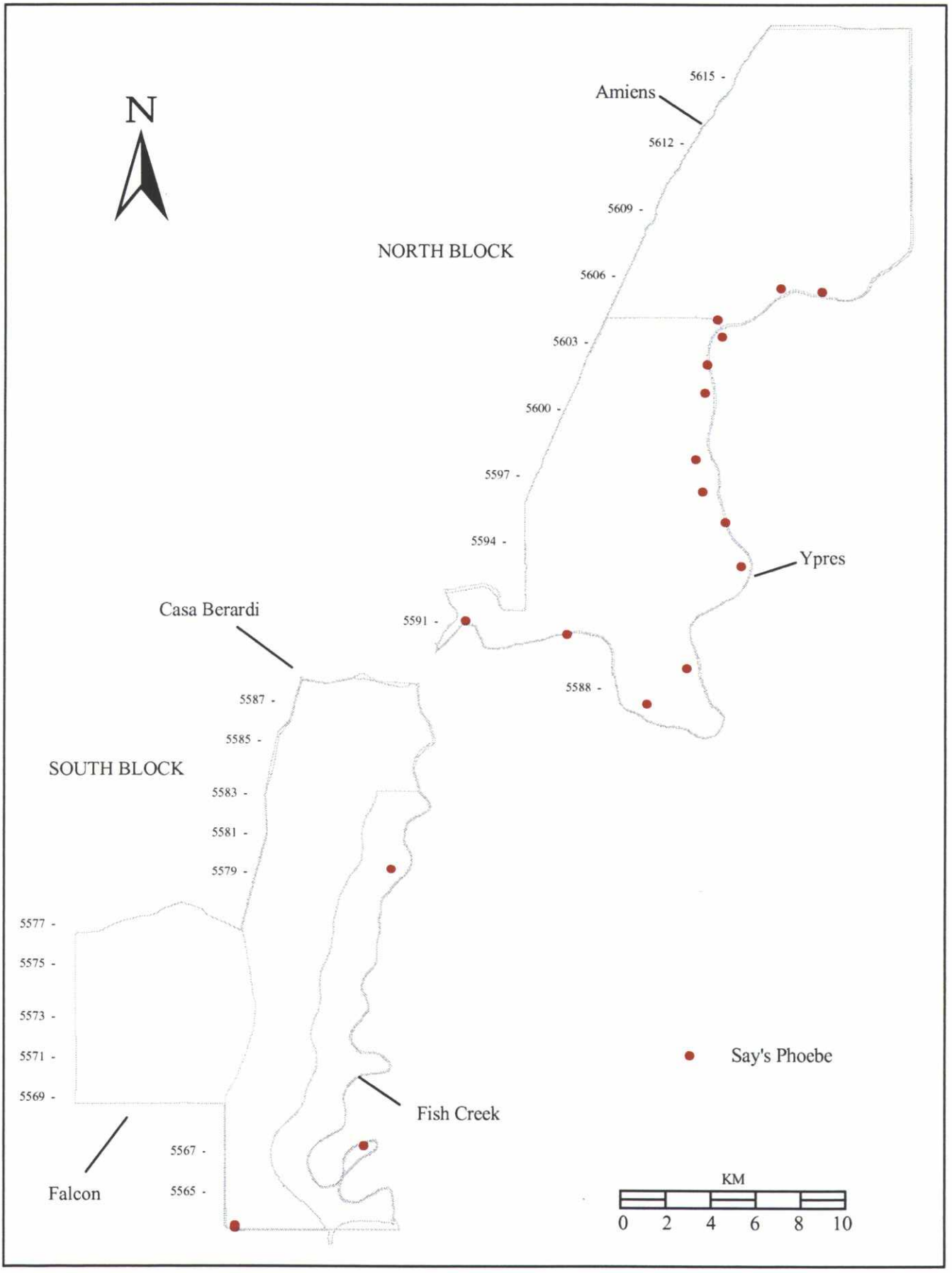
Map 15. Relative abundance and distribution of Grasshopper Sparrow, CFB Suffield National Wildlife Area, 1994-1995.



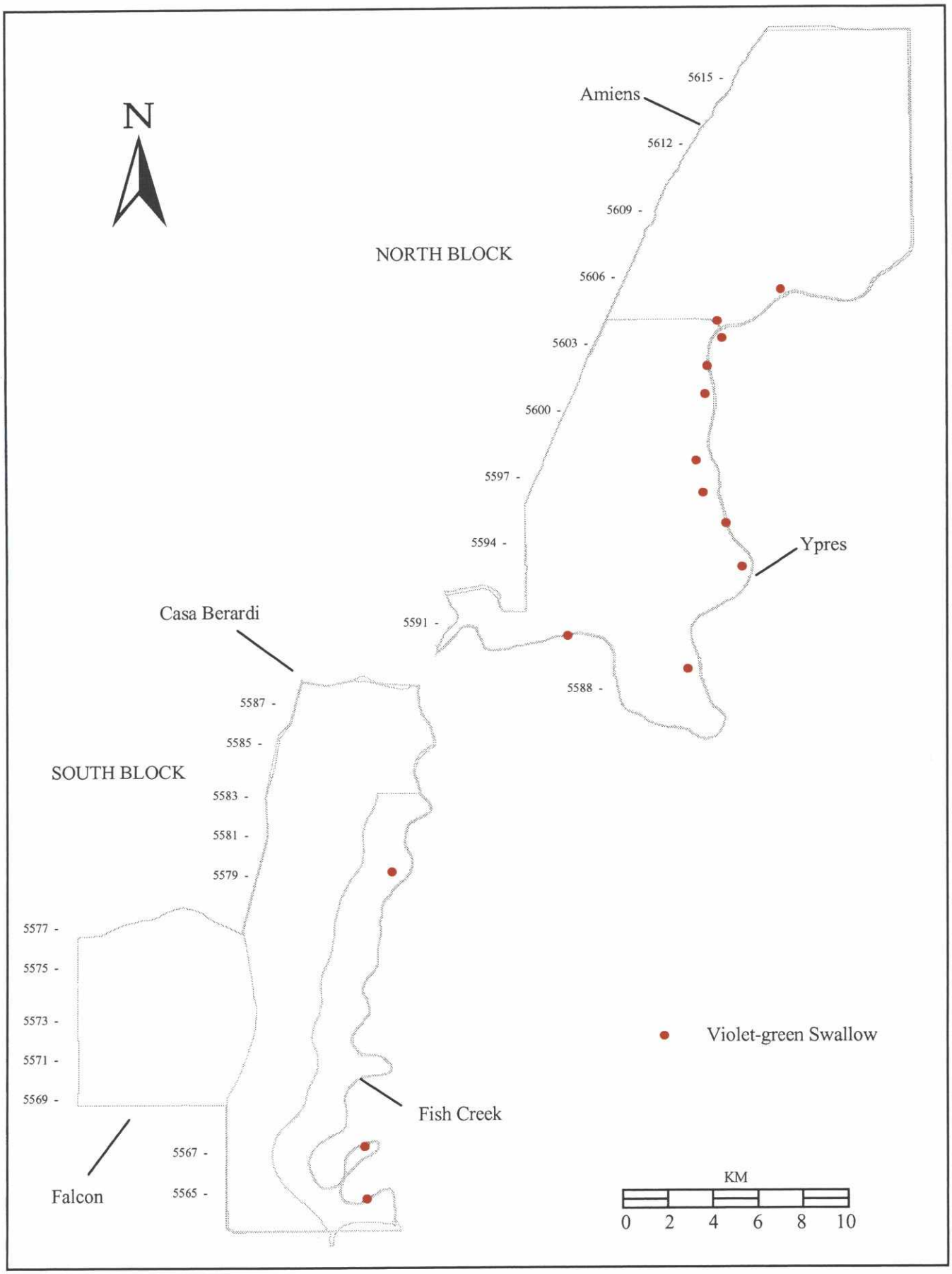
Map 16. Relative abundance and distribution of Western Meadowlark, CFB Suffield National Wildlife Area, 1994-1995.



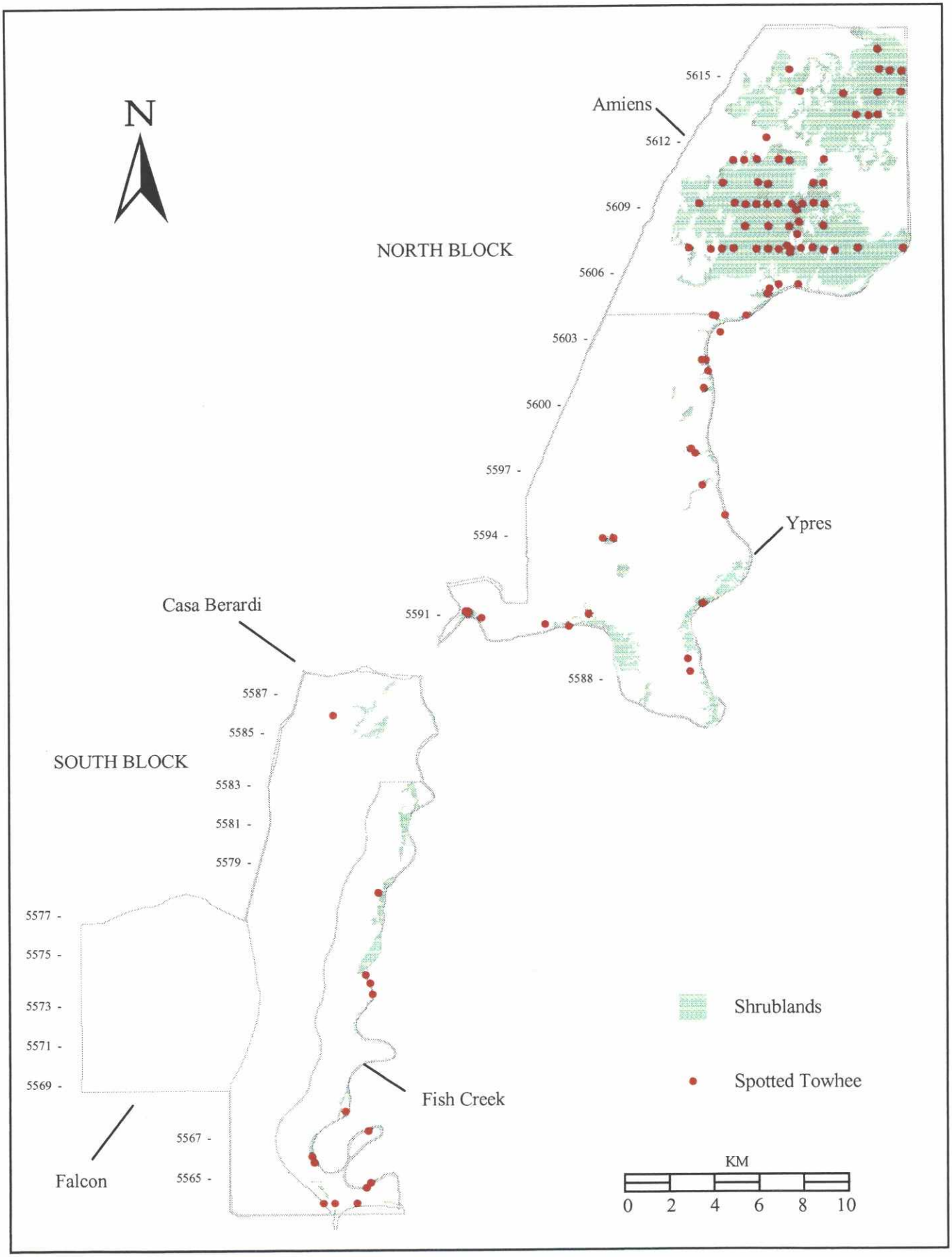
Map 17. Observations of Rock Wren, CFB Suffield National Wildlife Area, 1994-1995.



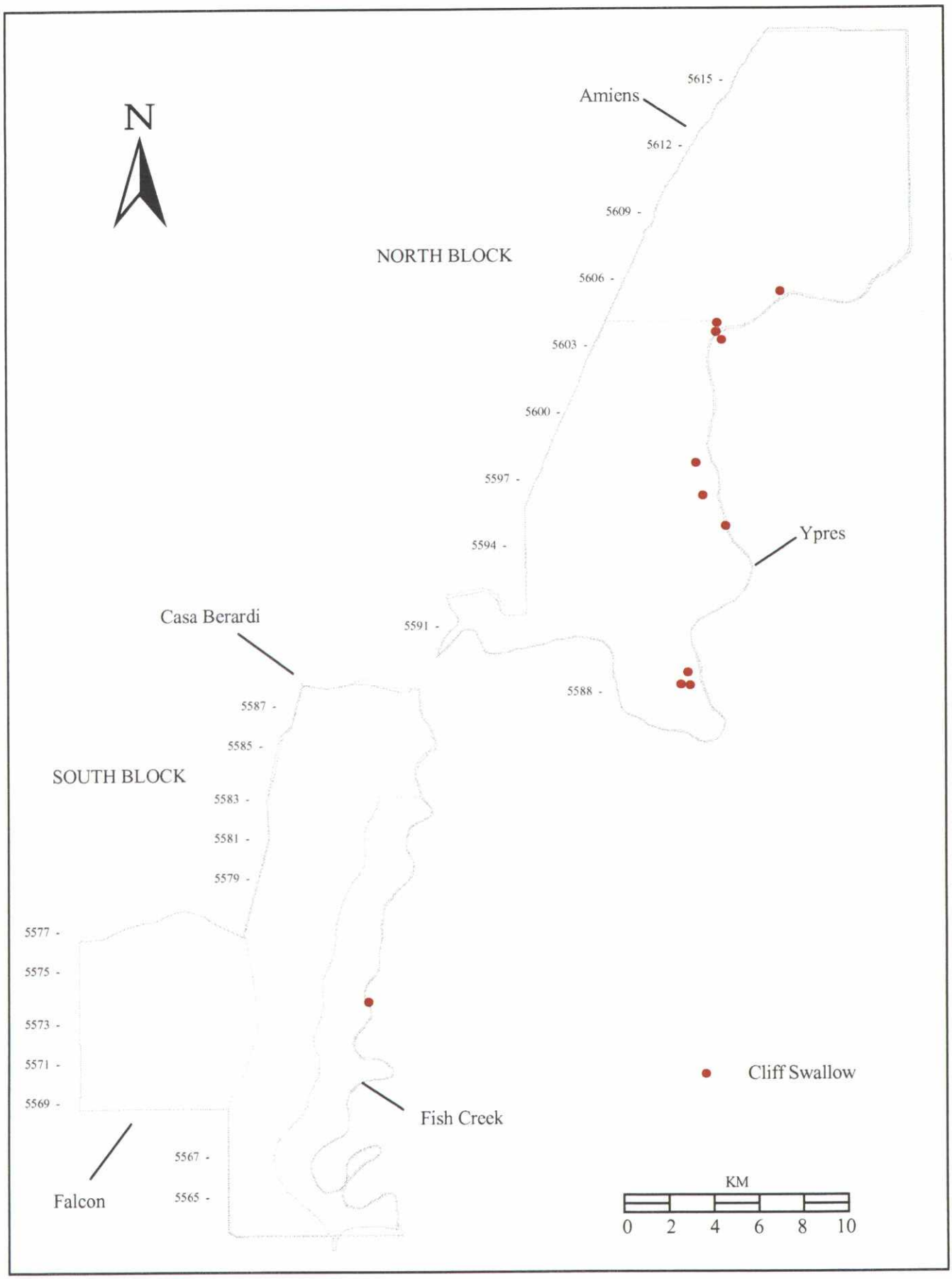
Map 18. Observations of Say's Phoebe, CFB Suffield National Wildlife Area, 1994-1995.



Map 19. Observations of Violet-green Swallow, CFB Suffield National Wildlife Area, 1994-1995.

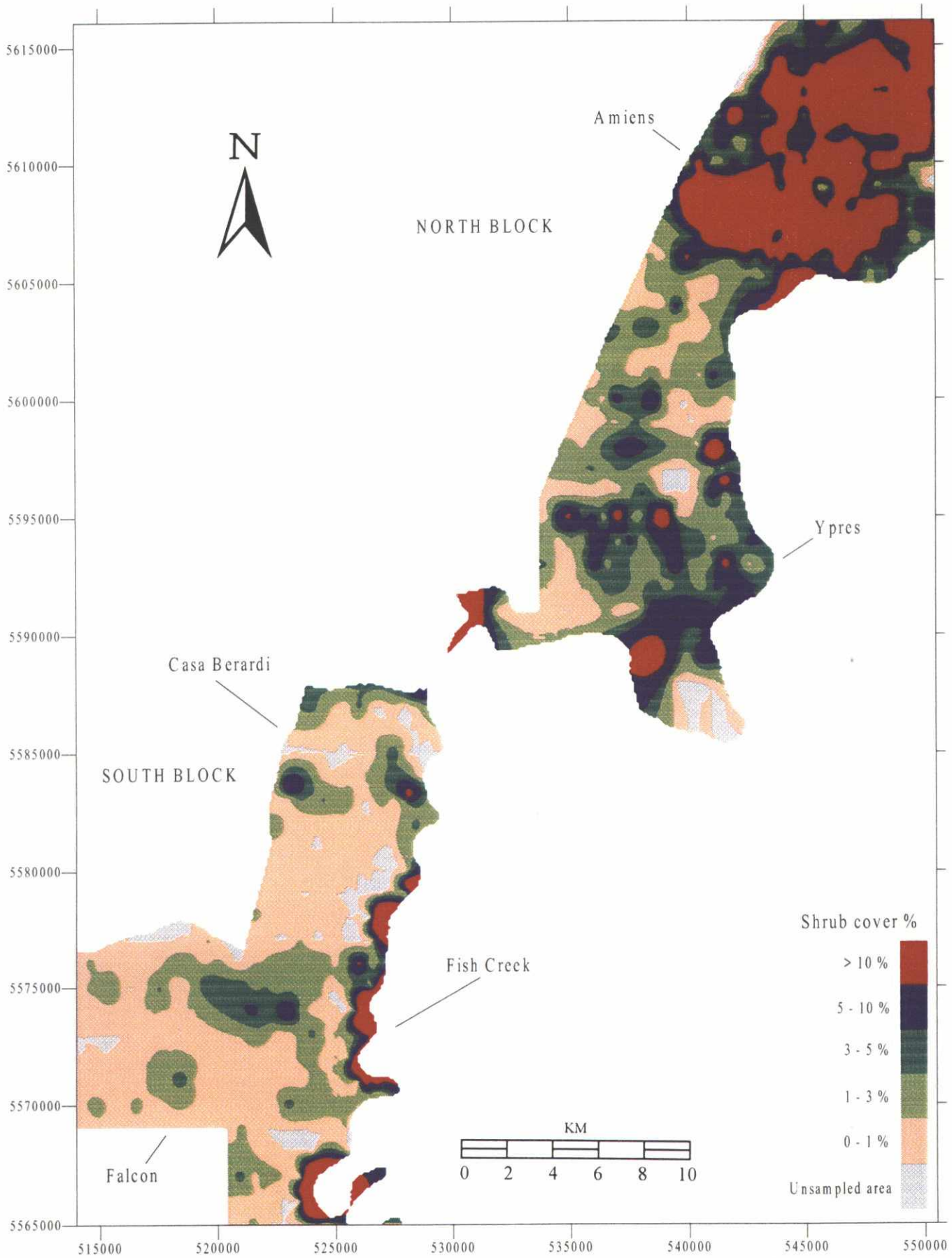


Map 20. Observations of Spotted Towhee, CFB Suffield National Wildlife Area, 1994-1995. (vegetation descriptions modified from Adams et al. 1997).

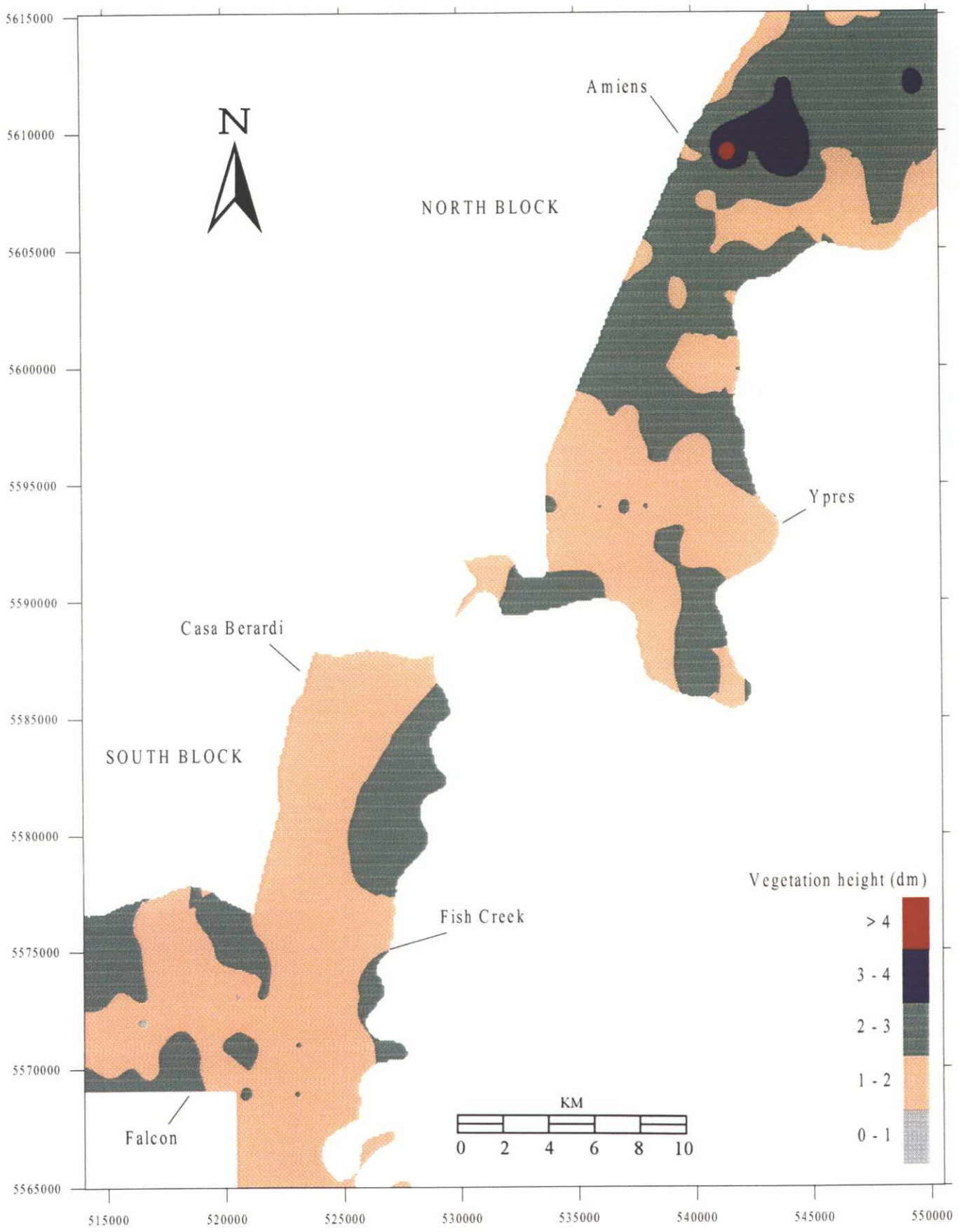


Map 21. Observations of Cliff Swallow, CFB Suffield National Wildlife Area, 1994-1995.

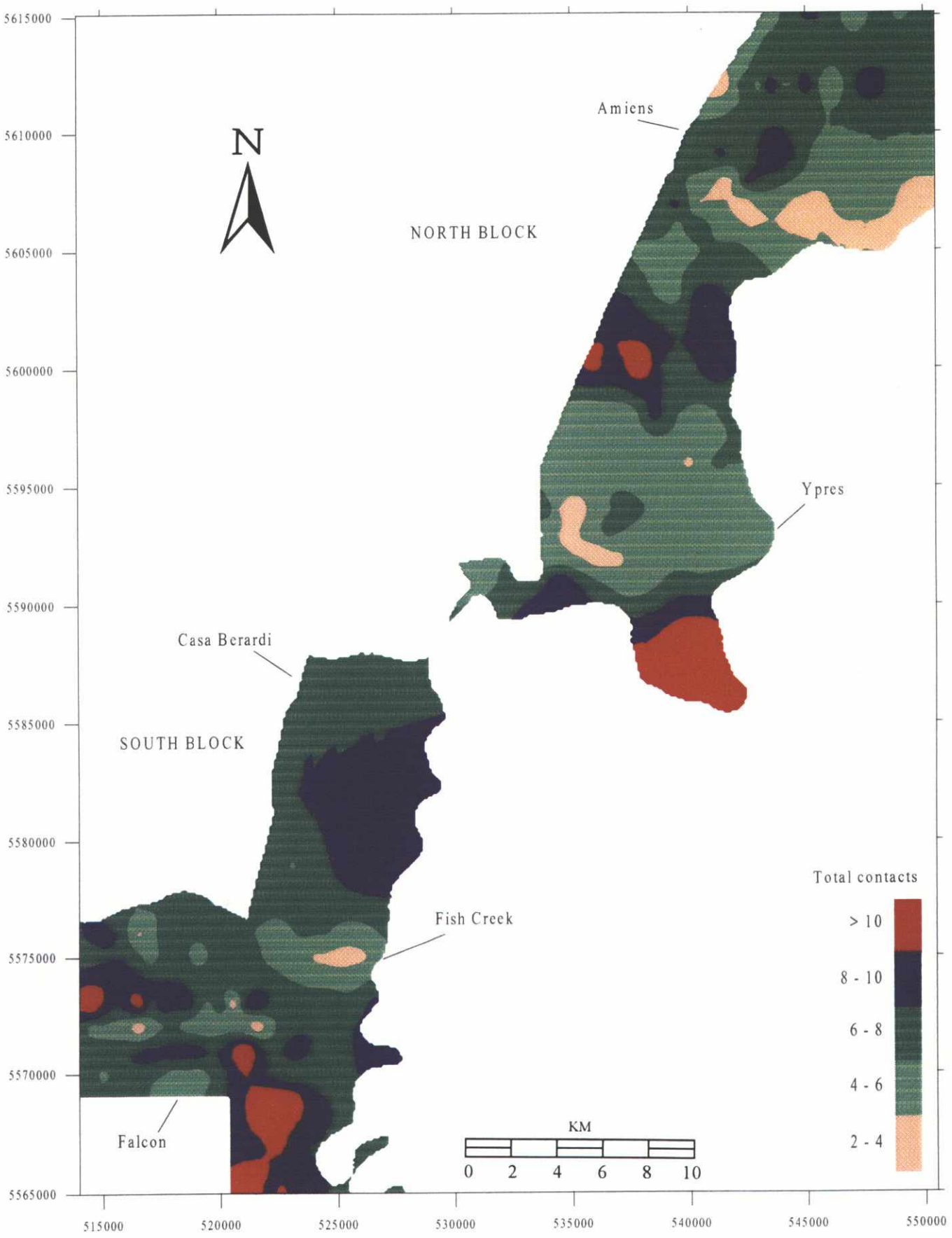
APPENDIX 4. Values of Selected Vegetation Structure Variables Within CFB Suffield National Wildlife Area.



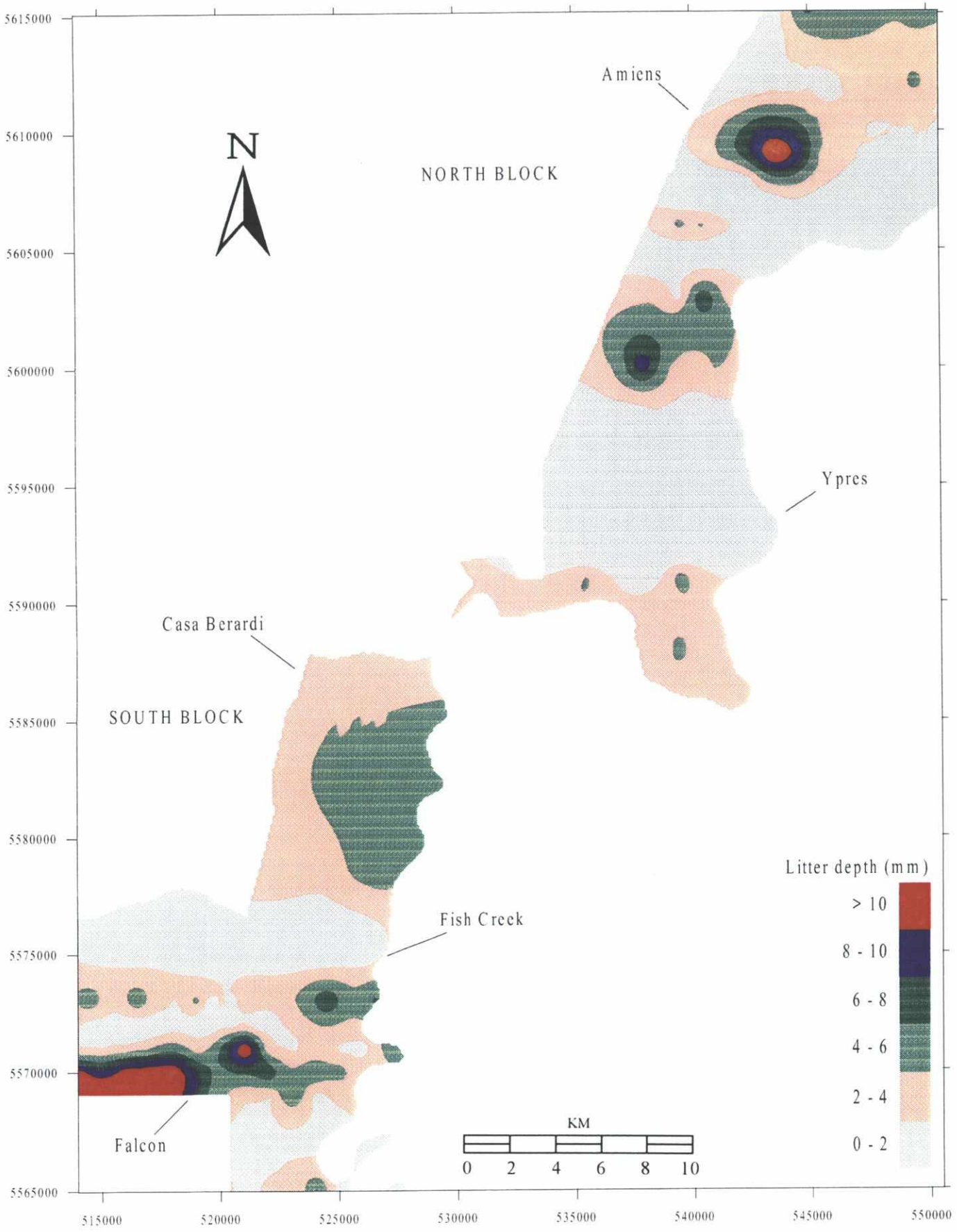
Map 1. Shrub cover (%) in the CFB Suffield National Wildlife Area (data from Adams et al. 1997).



Map 2. Mean vegetation height (last DM), CFB Suffield National Wildlife Area, 1994-1995.



Map 3. Total vegetation contacts, CFB Suffield National Wildlife Area, 1994-1995.



Map 4. Litter depth (mm), CFB Suffield National Wildlife Area, 1994-1995.

APPENDIX 5. Vegetation Cover Types, Primary Habitat Types and Special Features Found Within Ravines of the South Saskatchewan River Corridor on CFB Suffield National Wildlife Area.

Ravine Number	1	2	3	4	5	5/6	6	7	8	9
Vegetation Cover Type										
Dugouts (W)[1]					0.26					
Ravine Wetlands (W)			S[2]	S	S	P[3]	P	1.65	0.94	
Sedge-forb wetlands (W)				0.26	1.72					
Trees tall/mid shrubs (T)	5.01	3.42	10.48							
Shrubs-trees-grassland (T)				0.32	1.01		P			
Tall-mid-low-shrubs (S)								4.72	2.45	
Tall shrubs-grassland (S)			P	2.02	2.8	26.12		3.62	9.4	
Mid/low shrubs (S)	P	1.27		1.19					4.76	
Mid/low shrub-grassland (S)										
Low shrubs-grassland (S)					1.9			33.55	21.49	P
Meadow-low shrubs (S)										
Grassland-tall/mid/low-shrubs (S)	P							4.86	1.52	
Grassland-mid/low shrubs (G)	P		P				P	17.54		2.82*[4]
Upland grassland (G)									18.33	
Seeded grassland (G)										
Saline grassland (G)										
Barren (E)			P	P		20.0*	P	P/C[5]	P/C	
Barren/grass (E)								11.5		
Barren-mid/tall shrubs (S)[6]							8.1	6.92*	6.92*	
Total Area (ha)	5.01	4.69	10.48	3.79	7.69	46.12	8.1	84.36	65.81	2.82
No. Veg. Cover Types	4	2	5	6	6	3	5	9	9	2
No. Habitats	3	2	5	4	3	3	4	4	4	2

APPENDIX 5. (continued)

Ravine Number	10	11	12	13	14	15	16	17	18
Vegetation Cover Type									
Dugouts (W)									
Ravine Wetlands (W)				P	P				
Sedge-forb wetlands (W)									
Trees tall/mid shrubs (T)									
Shrubs-trees-grassland (T)									
Tall-mid-low-shrubs (S)									
Tall shrubs-grassland (S)									
Mid/low shrubs (S)									
Mid/low shrub-grassland (S)									
Low shrubs-grassland (S)	P			31.6*	25.9*				
Meadow-low shrubs (S)									
Grassland-tall/mid/low-shrubs (S)						22.2			
Grassland/mid/low/shrubs (G)	5.5	10.3	5.57			C/P			
Upland grassland (G)									
Seeded grassland (G)									
Saline grassland (G)									
Barren (E)				C/P	C/P				
Barren/grass (E)									
Barren-mid/tall shrubs (S)		P	P				30.0*	35.0*	25.0*
Total Area (ha)	5.5	10.3	5.57	31.6	25.9	22.2	30	35	25
No. Veg. Cover Types	2	2	2	3	3	2	1	1	1
No. Habitats	2	2	2	3	3	2	1	1	1

APPENDIX 5 (continued)

Ravine Number	19	20	19/20	21	22	23	24	25	26
Vegetation Cover Type									
Dugouts (W)		0.13		P					
Ravine Wetlands (W)		2.97			P	2.08			
Sedge-forb wetlands (W)			P			4.10			
Trees tall/mid shrubs (T)			P						
Shrubs-trees-grassland (T)									
Tall-mid-low-shrubs (S)									
Tall shrubs-grassland (S)									6.13
Mid/low shrubs (S)									
Mid/low shrub-grassland (S)			22.27				5.0	2.02	
Low shrubs-grassland (S)		8.7							
Meadow-low shrubs (S)							10.65		
Grassland-tall/mid/low-shrubs (S)			P					7.98	
Grassland/mid/low/shrubs (G)		1.0		14.81	20.0*	59.25	62.04*	5.0*	
Upland grassland (G)									
Seeded grassland (G)								5.0*	
Saline grassland (G)									
Barren (E)		2.70							
Barren/grass (E)			P						26.44
Barren-mid/tall shrubs (S)	20*	12.36		2.43*	0.5*		0.5*		
Total Area (ha)	20.0	27.86	22.27	17.24	20.5	65.43	78.19	20.0	32.57
No. Veg. Cover Type	1	6	5	3	3	3	4	4	2
No. Habitats	1	4	5	3	3	2	2	2	2

APPENDIX 5 (continued)

Ravine Number	27	28	29	30	A	B	Total area of VCT (ha)
Vegetation Cover Type							
Dugouts (W)							0.39
Ravine Wetlands (W)							7.64
Sedge-forb wetlands (W)							6.08
Trees tall/mid shrubs (T)		3.57					22.48
Shrubs-trees-grassland (T)							1.33
Tall-mid-low-shrubs (S)							7.17
Tall shrubs-grassland (S)							50.09
Mid/low shrubs (S)							7.22
Mid/low shrub-grassland (S)							29.29
Low shrubs-grassland (S)						8.69	131.83
Meadow-low shrubs (S)	2.68						13.33
Grassland-tall/mid/low-shrubs (S)					18.22	27.42	82.18
Grassland-mid/low shrubs (G)	P				5.17	44.35	253.39
Upland grassland (G)							18.33
Seeded grassland (G)							5.0
Saline grassland (G)					5.82		5.82
Barren (E)	C/P						22.70
Barren/grass (E)			7.85		58.65	23.62	128.06
Barren-mid/tall shrubs (S)		4.0*	4.0*	7.85	5.98	10.97	180.53
Total Area (ha)	2.68	7.57	11.85	7.85	93.84	115.05	972.86
No. Veg.Cover Types	3	2	2	1	5	5	
No. Habitats	3	2	2	1	3	3	

[1] Vegetation Cover Types are followed by a reference to a broader habitat classification in parentheses: W=wetland; G=grassland; S=shrub land; T=tree; E=eroded/barren.

[2] "S" refers to small but significant quantities of water, springs or seeps found in the ravine at the time of the survey. These are critical for birds and are used for drinking and bathing.

[3] " P" indicates the presence of a feature/Vegetation Cover Type not included in the area totals because it is too small or is on the edge of the ravine.

[4] An asterisk (*) indicates the numbers are estimated due to Vegetation Cover Types being shared between two adjacent ravines.

[5] "C" indicates the presence of significant rock outcrops in the form of caves (rock overhangs) and/or cliffs along the ravine corridor.

[6] The VCT "Barren/mid-low shrub" class is composed of significant portions of both components of barren ground and shrub habitat and analysis and discussions reflect this reality.