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Division of Ecological Services
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AVIAN DIVERSITY, ABUNDANCE AND CONSERVATION ON A LARGE PRAIRIE LANDSCAPE RESERVE IN NORTHWESTERN MINNESOTA

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Jeanne Irene Holler

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This is to certify that I have examined this copy of a master's thesis by
Jeanne Irene Holler

and have found that it is complete and satisfactory in all aspects,
and that any and all revisions required by the final
examining committee have been made.

James L. D. Smith
Name of Faculty Advisor

Signature of Faculty Advisor

Date

GRADUATE SCHOOL

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ABSTRACT

Tallgrass prairie is one of the most endangered ecosystems in North America, the Midwest, and Minnesota, only 0.4-0.8% of Minnesota's native grassland remains in small, scattered patches. North American grassland-associated bird species have also decreased in abundance, showing steeper and more widespread declines than any other group of birds. This study examined the potential contribution of a large (3,238 ha) native prairie landscape reserve (Rothsay Prairie Landscape Unit) in northwestern Minnesota to conservation of avian biodiversity. Objectives were to: 1) determine the distribution and abundance of bird species occurring on the Rothsay Prairie Landscape Unit (Rothsay Unit); 2) determine if there was an association between habitat structure, vegetative community type, or management regime and the presence of bird species using the area; and 3) identify management options to maximize abundance and distribution of prairie avifauna present in the study area, emphasizing species designated as Conservation Concern in Minnesota in 1989.

In May - July 1989, three-minute point counts were repeated six times at 155 listening stations centered in 100 m fixed radius circular plots across the study area to determine bird presence and breeding status. Habitat data were also collected to examine the association between bird presence and habitat characteristics. ArcView® GIS software was employed to compare vegetative community types in each plot to the entire study area and to extrapolate Rothsay Unit community types to the remainder of reserve habitat in Northern Tallgrass Prairie Ecoregion.

During the1989 field season 11,631 bird observations of 76 different species were recorded on the study area. Fifty-seven species (75%) were considered breeding birds on the Rothsay Unit, including 81% of 21 Conservation Concern Species. Two-thirds (32) of the breeding species were grassland dependent species. Twenty-seven breeding species (47%) were abundant or common. Breeding bird distribution ranged from six widely distributed (documented in > 100 plots), nine moderately distributed, 17 (30%) restricted, and 25 (44%) local species. The absolute and ecological density of breeding pairs ranged from 11 to 102 prs/km~ and 0.2 to 58 prs/km2, respectively.

The bird observation plots were a representative sample of the proportion of vegetative community types on the Rothsay Unit ($X^2_7 = 5.0$, $p < 0.005$). Results from a forward step-wise multiple regression showed statistically significant linear associations between 16 bird species and a number of habitat variables. Grass height was associated with the most bird species (i.e., ten), followed by land use, which was associated with seven species. Tree cover was not associated positively or negatively with any species.

The Rothsay Unit, one of the largest contiguous areas of native prairie in Minnesota, has significance for conservation of native prairie/grassland avifauna and native prairie habitats in Minnesota and the ecoregion. To ensure future viability of the Rothsay Unit as a prairie landscape reserve for the conservation of native plant and bird communities, efforts should: include private stakeholders, occur at the regional/ ecosystem level, adopt an interdisciplinary approach for effective management, and explore expansion of the Rothsay Unit to create a larger prairie conservation area.

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INTRODUCTION

Native tallgrass prairie once covered over 85,480 km2 (221,400 mi2) of central North America, stretching from Canada to Texas and from the eastern Dakotas to Indiana (Runkel and Roosa 1989, Samson and Knopf 1994, Samson et al. 1998), including a majority of the native vegetation present in the Northern Tallgrass Prairie Ecoregion (McNab and Avers 1994) (Figure 1). Today tallgrass prairie is one of the most endangered ecosystems in North America, the Midwest, and Minnesota. With losses throughout its range of 82.6% to more than 99% (Samson et al. 1998), it has the greatest decline reported for any major ecosystem in North America (Vickery et al. 1999). The Nature Conservancy (TNC) ranks mesic and wet tallgrass prairie community types in the Northern Tallgrass Ecoregion, where declines in all tallgrass prairie community types range from 99.2% to 99.9% (Samson et al. 1998), as globally imperiled (Faber-Langendoen 1996, Grossman et al. 1998).

In Minnesota, approximately one-third of the land (about 7.3 million hectares/18 million acres) was tallgrass prairie at the time of settlement by people of European descent (Figure 2). Currently, Minnesota's prairie community types are considered to be the plant communities most reduced and at risk (U.S. Fish and Wildlife Service 1998). Only 0.8%0.4% of Minnesota's native grassland remains (Samson and Knopf 1994, Samson et al. 1998) and, as elsewhere, it exists in small, scattered patches. Typically, these occur along roadsides and railroad rights-of-way, in old cemeteries, or on lands unprofitable to cultivate because they are too wet, rocky, or steep. Prior to European settlement, these lands were kept open by fire, both wildfire and fires set by American

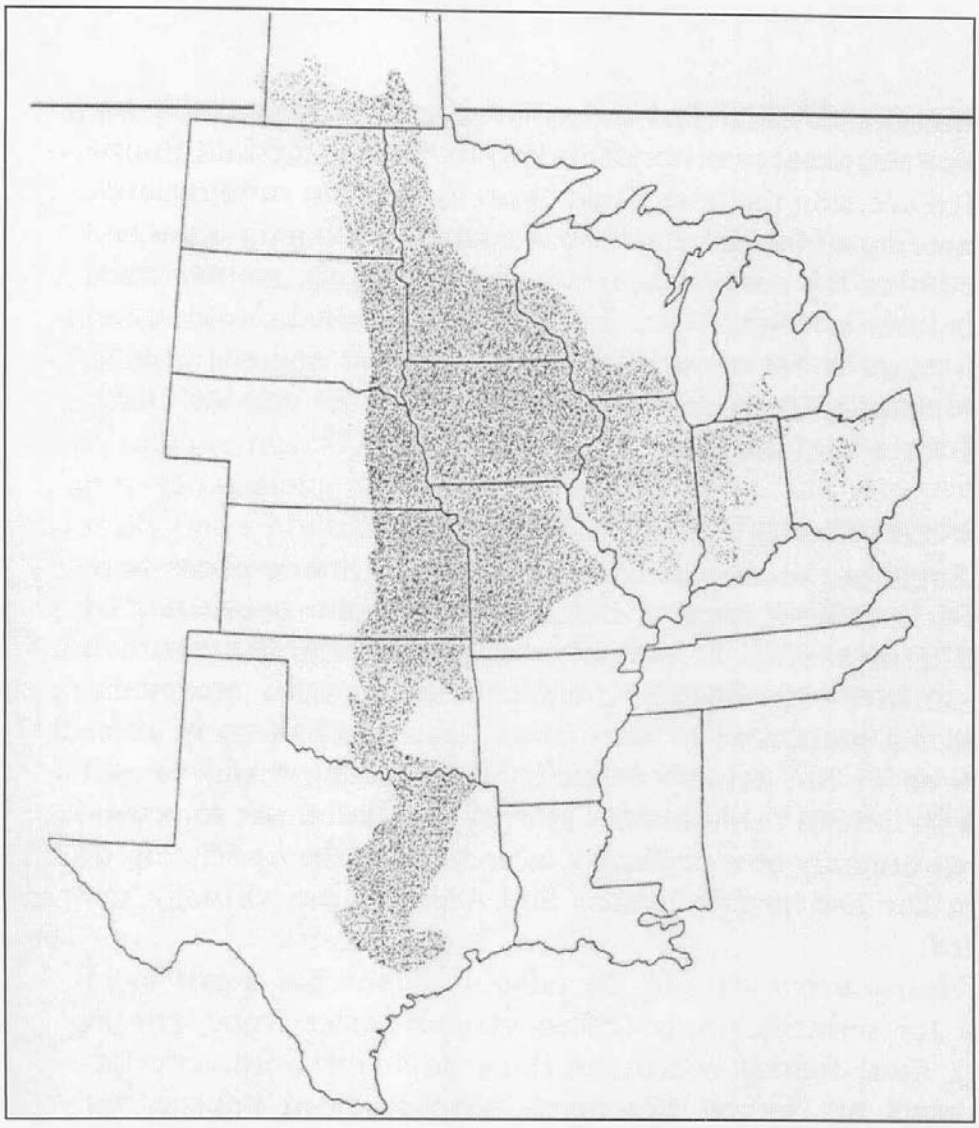


FIGURE 1. Approximate extent of tallgrass prairie at the time of European settlement (Runkel and Roosa 1992).

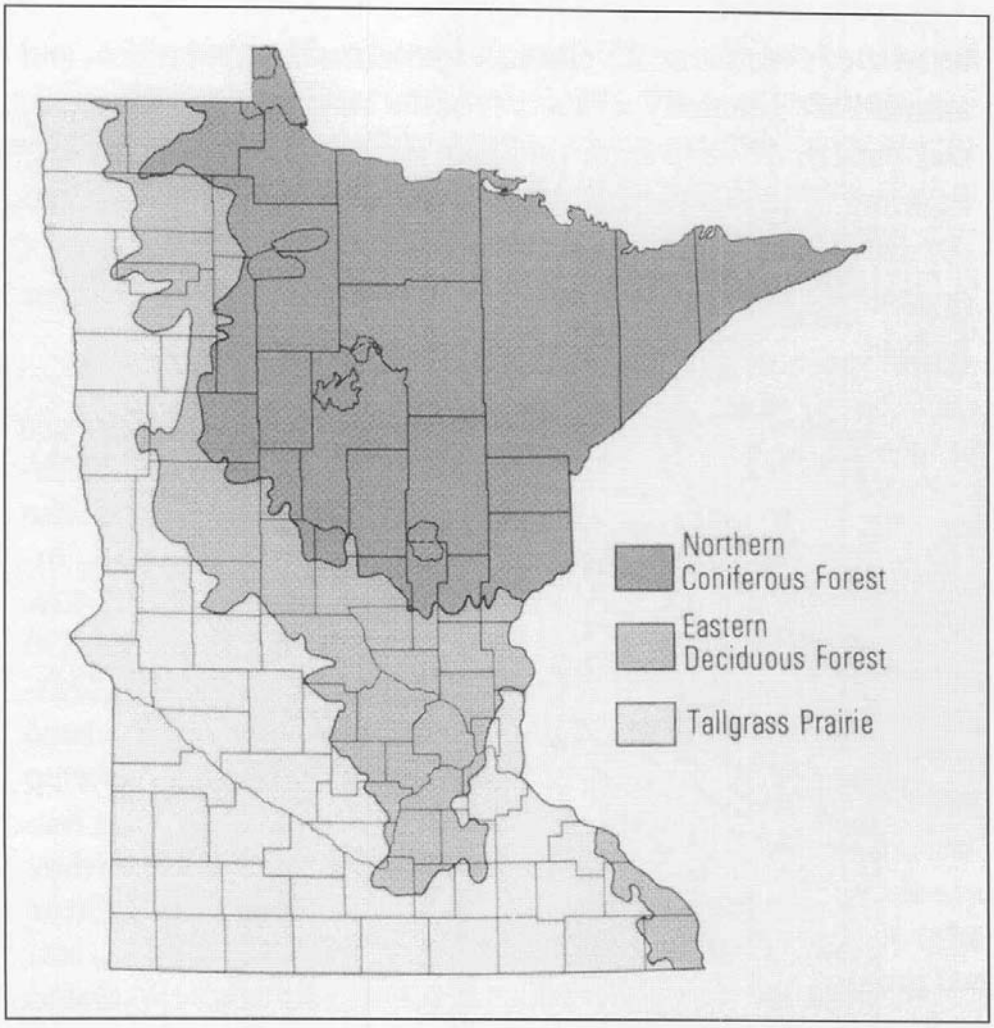


FIGURE 2. Vegetation of Minnesota at time of European settlement generalized into three major biomes (Coffin and Pfannmuller 1988).

Indians, and heavy grazing by large indigenous herbivores. Today, both influences have been lost. Exotic grasses were introduced and are used as primary forage for domesticated herbivores now present in North America and fire-suppression is widely endorsed on private lands.

In addition, the ecological integrity of grassland ecosystems and native tallgrass prairie in the United States (U.S.) and the Northern Tallgrass Prairie Ecoregion is still declining (Samson et al. 1998, TNC 1998, U.S. Fish and Wildlife Service 1998, Vickery et al. 1999). Prairie continues to be converted to other uses and remaining remnants are becoming more scattered and fragmented (TNC 1998, U.S. Fish and Wildlife Service 1998). In addition to conversion, there are threats to native prairie in the form of pesticide drift from adjoining lands, invasive species, and recreational use (TNC 1998).

Significant loss, fragmentation and degradation of native grasslands in North America resulted in a decline in wildlife species dependent on native grasslands for all or a portion of their life cycle. Many of the native prairie wildlife species have vanished. For example, naturally occurring populations of elk *(Cervus elaphus)* and bison *(Bison bison),* large native grassland herbivores, were virtually eliminated from their original tallgrass prairie range. Native herds of both species were extirpated from Minnesota by the end of the nineteenth century (Nordquist and Birney 1988). North American bird species associated with prairie also experienced significant declines (Green 1988, Knopf 1994, Sauer et a1.1997), that are steeper and more widespread than any other group of birds (Knopf 1994). Grassland species show the most consistent decreases of any group of birds monitored by the Breeding Bird Survey (BBS); fewer than 30% currently have increasing populations. Those areas showing increasing trends tend to be small and

localized (Sauer et al. 1997). At the turn of the millennium, prairie avifauna account for 71% of Minnesota's endangered bird species, 16% of its threatened bird species, and 33% of Special Concern bird species (Minnesota Department of Natural Resources 1996). Minnesota Department of Natural Resources (MNDNR) states that over 40% of Minnesota's rare species depend on tallgrass prairie habitat (MNDNR no date).

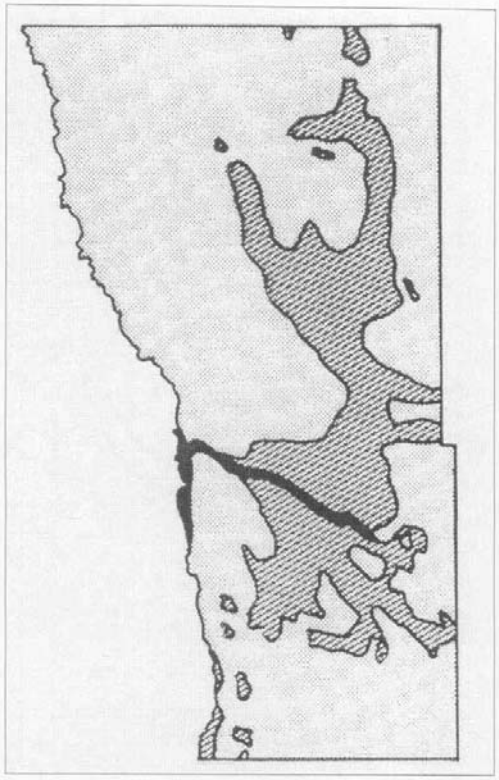
Loss and degradation of native tallgrass prairie and decline of associated wildlife is illustrates a larger problem, loss of biological diversity in North America and worldwide. Biological diversity is the variety and variability among living organisms and the ecological complexes in which they occur (McNeely et al. 1990). For many reasons, encompassing many values, maintenance of biological diversity is intricately entwined with growth, development, and survival of human populations (e.g., Ehrlich and Ehrlich 1981, Wilson 1984, Soule 1985, Noss and Harris 1986, McNeely et al. 1990, Meadows 1990, Council on Environmental Quality 1993, Holdgate 1996). Loss of biological diversity is currently occurring at a rate greater than what would be expected if it was due to natural events (Jeffries 1997). A resultant concern for the implications and consequences of this loss led to an intensified effort to conserve the remaining viable remnants of ecosystems and restore those lost.

A major problem in the conservation of many ecosystems is the limitations imposed by size. In the case of the native prairie ecosystem, this problem is especially difficult due to the small scattered nature of its remnant patches. Small parcels of any ecosystem can provide for the protection and management of many plant species and animals that are relatively sedentary and/or require relatively small areas for their continued existence (Terbough 1975, Pyle et al. 1981, Simberloff and Gotelli 1984,

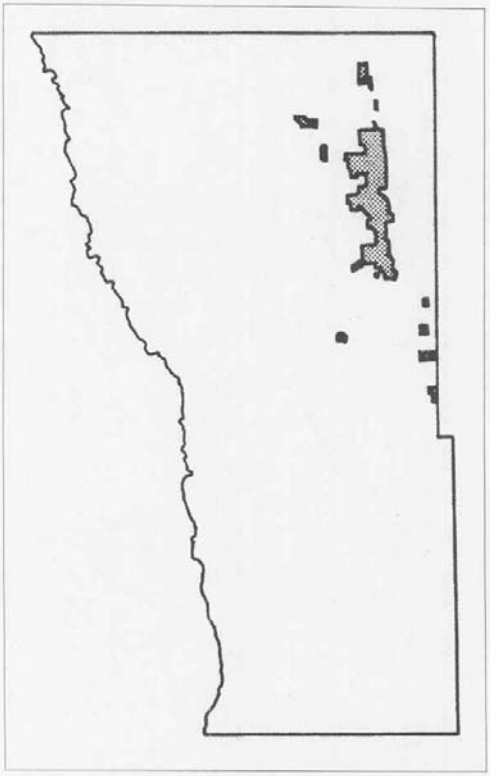
Robinson 1986). TNC also argues that these small parcels are "essential for the long-term viability of biodiversity in the region", because "although, not likely viable over the long-term, these remnants functionally serve as a valuable storehouse for restoration efforts" (TNC 1998).

However, these small tracts are not effective for conserving species with large home ranges, more wide-ranging species such as many birds, and/or sparsely distributed species (Terbough 1974, 1975; Diamond 1975; Soule et al. 1979; Frankel and Soule 1981). They also do not afford adequate protection for plants and animals that are considered area sensitive or "interior" species. These are organisms that are habitat specialists and require large continuous blocks of a vegetative community or habitat type to maintain viable populations. Their productivity often declines along the "edge" where habitats grade into each other (Samson 1980; Johnson and Temple 1986, 1990; Soule 1986; Herkert 1991, 1994; Askins 1993; Meffe and Carroll 1994). Rare species may also be excluded from these small parcels if they only exist in very small isolated populations that are outside boundaries of reserves (Higgs and Usher 1980).

Conservation of large remnant areas of ecosystems may ameliorate many problems mentioned above. One of the largest areas of contiguous native tallgrass prairie remaining in Minnesota is located in Wilkin County near the town of Rothsay. Prior to European settlement, at least 90% of Wilkin County was covered by native prairie (Figure 3). The majority of the native prairie that remains in Wilkin County today (Figure 3) is located within this prairie remnant near Rothsay, Minnesota (MNDNR 1988, 1998). This area, designated as the "Rothsay Prairie Landscape Unit" (Rothsay Unit), by the MNDNR, is approximately 3,240 hectares (8,000 acres) in size and consists of a mosaic of wet prairie,



Extent of native tallgrass prairie in Wilkin County, Minnesota in the 1850s - prior to European settlement. (Light gray areas represent dry prairie and savanna, medium gray areas represent wet prairie, and black indicates floodplain forest).



Extent of native prairie habitat remaining in Wilkin County, Minnesota in 1998. (Gray indicates native prairie. The large contiguous block of native prairie is the Rothsay Landscape Unit).

FIGURE 3. Natural Communities of Wilkin County, Minnesota at the time of European settlement and in 1998 (MNDNR 1998).

mesic prairie, and prairie wetland communities in private and public ownership. Minnesota's Natural Heritage Program reported in 1987 and 1999 (Dana, pers comm) that the Rothsay Unit was one of the few places left in North America large enough to support the rare habitats, flora, and fauna characteristic of the Northern Tallgrass Prairie Ecosystem.

Insights into contributions that the Rothsay Unit can make to the conservation of biological diversity may be gained through a detailed survey of the area's flora and fauna. As part of Minnesota's County Biological Survey, the vegetation of this area was surveyed and categorized into vegetative community types in 1987. In addition, a cursory survey of birds and small mammals was conducted in 1988. As of 1989, however, no detailed study of the wildlife using the area had been undertaken. A characterization of the birds utilizing the Rothsay Prairie Landscape Unit had the potential to aid in understanding the value of managing a large parcel of native prairie in Minnesota. In addition, several prairie-related avian species of conservation concern were thought to occur in or near the Rothsay Unit due to historical records and/or their reported breeding range. These Conservation Concern Species fell into three categories: 1) species that had been. given Special Concern status by the state of Minnesota (MNDNR 1986); 2) species that had been listed as birds of management concern by the U.S. Fish and Wildlife Service (USFWS) (USFWS 1987); or 3) species that satisfied conditions of both 1) and 2). The future of these species was considered tenuous due to their dependence on vulnerable or restricted habitats, population declines, or existence of only remnant populations (USFWS 1989); or because their habitat requirements were very specific or unique, or the species was very rare in Minnesota (MN State Statute 84.0895). These

species and their status accorded by federal (USFWS) and state (Minnesota) governments in 1989 are listed in Table 1.

Under contract with Minnesota's Nongame Wildlife Program, a detailed study of the birds present on the Rothsay Prairie Landscape Unit was designed and undertaken in 1989. The goal of this research was to characterize the avifauna present within the native prairie near Rothsay, Minnesota, and ultimately identify management options to enhance the prairie avifauna on the area. The specific objectives of this research were to:

(1) determine the distribution and abundance of bird species occurring on the Rothsay Prairie Landscape Unit.

(2) determine if there was an association between habitat structure, vegetative community type, or management regime and the presence of bird species using the area.

(3) identify management options to increase abundance and/or distribution of prairie avifauna present in the study area, emphasizing species designated as Special Concern in Minnesota (in 1989).

STUDY AREA

The study area for this research consisted of the "Rothsay Prairie Landscape Unit" (Rothsay Unit) as designated by the MNDNR Natural Heritage Program (Figure 3). According to the Minnesota Ecological Classification System (ECS) (MNDNR 1996a), this area falls within the Prairie Parkland Province, Red River Valley Section, and the Red River Prairie Subsection of Minnesota (Figure 4). The Prairie Parkland Province includes the majority of the area in Minnesota that was tallgrass prairie prior to settlement by people of European descent. The Red River Prairie Subsection is the only subsection

within the Red River Valley Section of the ECS. It is the northern-most subsection of four subsections within the Prairie Parkland Province. It is bounded on the east by the eastern extent of continuous tallgrass prairie vegetation pre-European settlement, on the north and west side by the Minnesota boundary with Canada and North Dakota, respectively, and on the south by the southern extent of till plain and glacial Lake Agassiz. The lake plain of Glacial Lake Agassiz is the major landform in this subsection, a level area with silty, sandy and lacustrine soils. Old beach ridges form minor, but important landforms. The Rothsay Unit lies within the beach ridge area of this subsection.

TABLE 1. Conservation Concern Species associated with the tallgrass prairie ecosystem and their state and federal status in 1989 in Minnesota.

SPECIES	**SPECIES STATUS**	
	State[1]	**Federal[2]**
American bittern *(Botaurus lentiginosus)*	SC	MC
greater prairie-chicken *(Typanuchus cupido)*	*SC*	-- [3]
greater sandhill crane (Gnus *canadensis)*	*SC*	-- [3]
Henslow's sparrow *(Ammodramus henslowd)*	SC	MC
marbled godwit *(Limosa fedoa)*	*SC*	- -[3]
northern harrier *(Circus cyaneus)*	---[3]	MC
Nelson's sharp-tailed sparrow *(Ammodramus nelsoni)*	*SC*	-- [3]
short-eared owl *(Asio fammeus)*	*SC*	-- [3]
upland sandpiper *(Bartramia longicauda)*	*SC*	-- [3]
Wilson's phalarope *(Phalaropus tricolor)*	*SC*	-- [3]
yellow rail *(Coturnicops noveboracensis)*	SC	-- [3]

[1] MNDNR 1986 (SC - Special Concern; T - threatened; E - endangered)
[2] USFWS 1987 (MC - Species of Management Concern)
[3] Not Listed

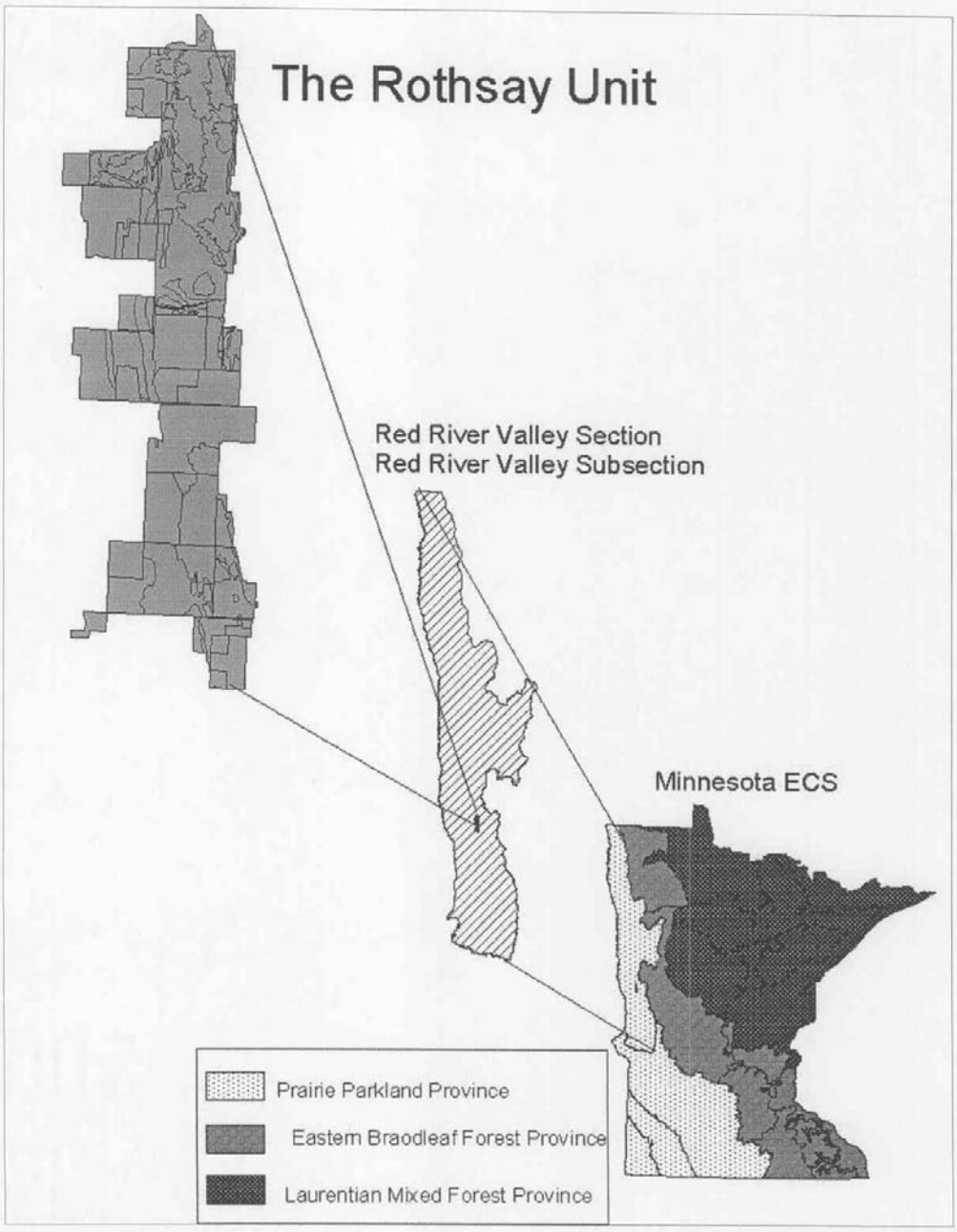


FIGURE 4. Relationship of the Rothsay Unit, Wilkin County, northwestern Minnesota to Minnesota's Ecological Classification System (ECS).

The Rothsay Unit is located in Wilkin County, Minnesota about 3.2 km (2 miles) west of the town of Rothsay in portions of Tanberg, Akron and Prairie View townships. Its boundaries, delineated by the MNDNR, are determined by natural community types. The Rothsay Unit averages about 2.4 km (1 %2 miles) east to west and is about 14.4 km (9 miles) north to south. It is bounded on the south by Wilkin County Road 20 and bisected north to south by Wilkin County Road 26, but no other roads cross through it. It encompasses Rothsay Wildlife Management Area owned by MNDNR, and Anna Gronseth and Town Hall Prairies owned by TNC, comprising about half of its area. The other half of the Rothsay Unit is under private ownership and used for hay production or cattle grazing (Figure 5).

METHODS

Study Design

To determine bird presence and breeding status, three-minute point counts (Hilden et al. 1991, Ralph et al. 1993) were performed at listening stations centered in 100 m fixed radius circular plots placed systematically (every 400 m) along transects that traversed the study area. Point counts began after a two-minute "cool down" period following the arrival of the observer on a plot, allowing the plot to return to pre-observer conditions. These methods generally follow those outlined for open grassland and scrubland environments (e.g., Cyr et al. 1995, Rotenberry and Knick 1995). A separation distance of 400 m between listening stations was used to eliminate double-counting of

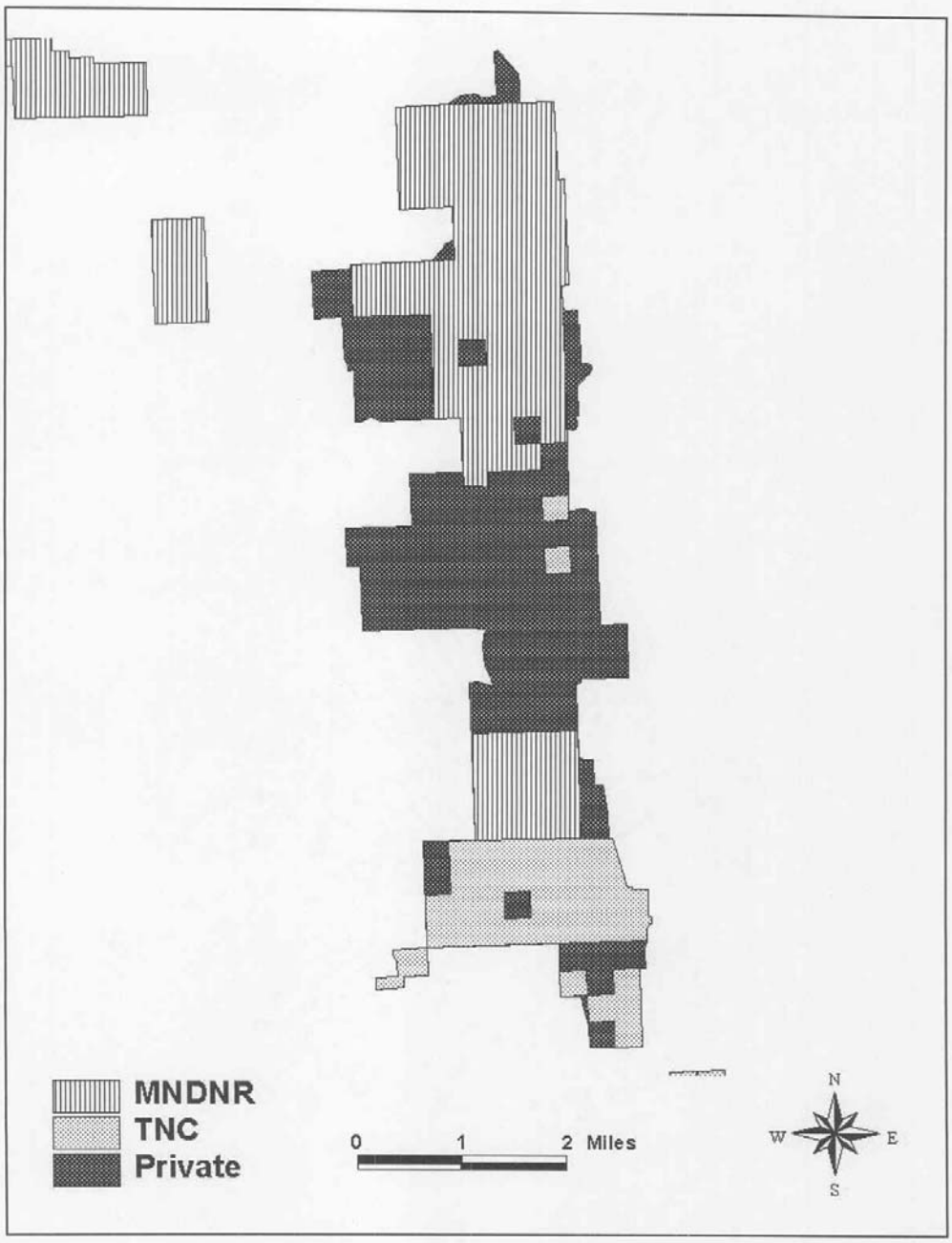


FIGURE 5. Ownership patterns at Rothsay Unit, northwestern, Minnesota.

birds in adjacent plots. This gave a 200 m effective separation distance between adjacent plots.

Transects were placed across the study area to maximize coverage of the study area, roughly represent the distribution of the vegetative community types on the site, and allow reasonable vehicular access to starting points. A vegetation community type map (Dana 1989a) was used as a base map upon which the proposed plot/transect placements were configured, using the cardinal directions for the direction of travel along each transect from its starting point, to facilitate replication.

Length of transects was determined by; 1) the amount of observation time available in a morning, and 2) the estimated time it would take to travel between stations on foot and gather data at each station. Observations began approximately'/2 hour before sunrise and continued into the midmorning hours to approximately 1000 when bird song dramatically decreased (Eliason, pers comm; Pfannmuller, pers comm). These logistical considerations resulted in the establishment of a maximum of 16 plots along each transect, with a maximum length of a transect 6.4 km (4 miles).

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The number of transects that could be laid out across the study area was based on; 1) the number of times a plot needed to be surveyed in order to detect all breeding birds present, 2) the effective field season length, and 3) an estimate of the number of field days that may be lost due to poor weather conditions. Two observers conducted point counts and we repeated visits to plots to increase the probability of encountering rare birds and to detect birds throughout the season. Based on a review of recorded breeding seasons and actual breeding records of the birds expected to be encountered on the site (Janssen 1987, Eliason, pers comm; Pfannmuller, pers comm), surveys were conducted from mid-May through June. Ten transects, totaling 155 circular plots were established on the study area (Table 2, Figure 6) to be visited six times.

Potential breeding birds were identified by the presence of singing males, individuals carrying food, individuals carrying nest material, and adult or immature birds. Breeding status on the study area was inferred from birds exhibiting these behaviors through the bulk of the breeding season (see bird results section for more details). Breeding status was confirmed when nests or young were located during point counts and additional sampling undertaken for species of conservation concern, or during plot setup and vegetation sampling. Bird observations not meeting these criteria and/or those only recorded as flying over the study site were considered nonbreeding records. Species only recorded flying over the Rothsay Unit were not considered for breeding status because they showed no direct use of the study site. Transects and stations were marked on U.S. Geological Survey topographic 7.5 minute quadrangle maps and 1980 aerial photographs of the study area (approximate scale: 1 mile = 3 1/4") as they were established. These plot

locations and their associated data were subsequently placed into a Geographic Information System (GIS) using ArcView® and ArcInfo® software.

TABLE 2. Summary of transects where breeding birds were surveyed using point counts at plots located at 400m intervals on the Rothsay Unit in 1989

TRANSECT NAME	PLOTS	OWNERSHIP
Town Hall (T)	T-1 through T-15	TNC and Private Individuals
Anna Gronseth (G)	G-1 through G-16	TNC and Private Individuals
Aetna (A)	A-1 through A-15	Aetna Insurance Co. and Private individuals (Aetna tract purchased by TNC in 199% and transferred to MNDNR)
Ouse (O)	O-3 through O-6, 0-10 through 0-19	Private Individuals
WMA (W)	W-1 through W-3, W-6 through W-18	MNDNR and Private Individuals
Ralph & Roberta (R)	R-1 through R-12, 0-1, O-2, 0-7, O-8	Private Individuals
Dow South (DS)	DS-1 through DS-15	Private Individuals and MNDNR
Dow (north) (D)	D-1 through D-16	Private Individuals and MNDNR
Fen (F)	F-1 through F-15	MNDNR
Ladwig (L)	L-1 through L-16	MNDNR

Bird and Environmental Data Collection

Data collection began 30 minutes before sunrise and continued until the transect was completed. The survey was not conducted if it was raining or if winds exceeded 20 mph. After arriving at a plot, the observer used two minutes to collect information on the environmental conditions at the plot. The following data were recorded; 1) transect name, 2) plot number, 3)

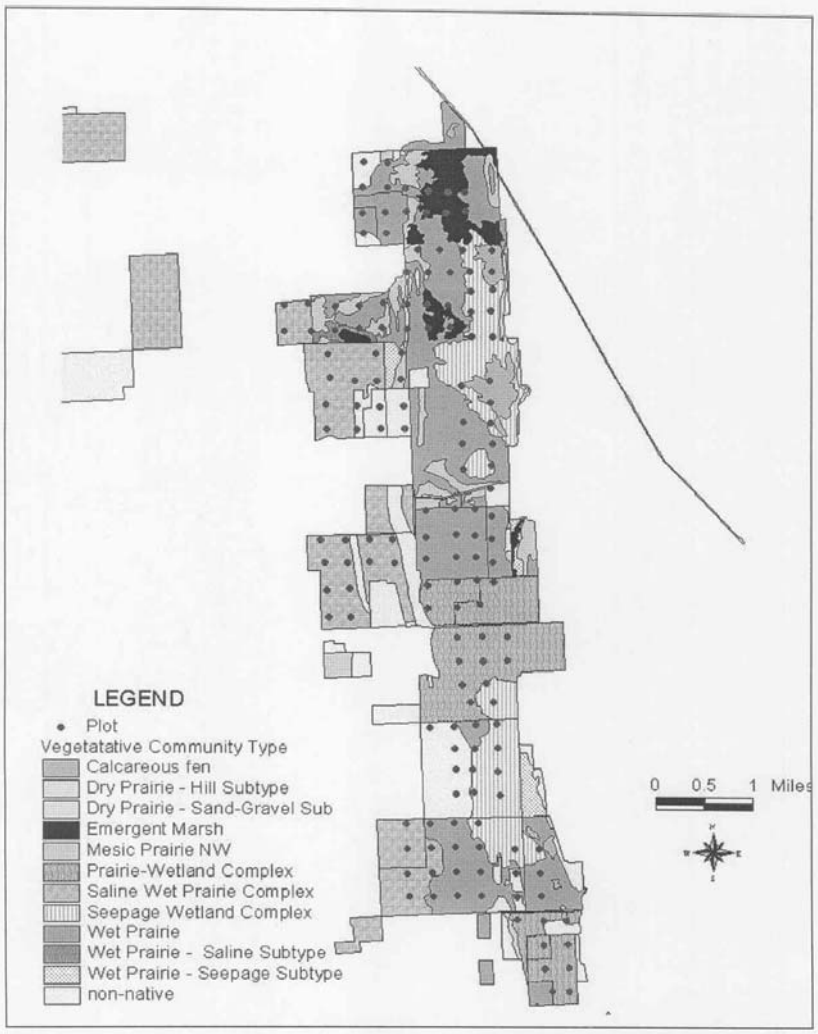

FIGURE 6. Bird Plot Locations on the Rothsay Unit, northwestern Minnesota, 1989.

observer, 4) date, 5) time, 6) cloud cover, 7) air temperature, 8) wind speed, and 9) wind direction. Cloud cover was placed into the following categories; clear, clear with fog, mostly clear (high clouds or < 15% clouds), partly cloudy (20-50% clouds), mostly cloudy (> 50% clouds, but not totally overcast), overcast, light rain/mist, and rain. Air temperature was measured with a pocket field thermometer. Wind speed was measured with a hand-held wind gauge. Wind direction was recorded in 45° categories with the aid of a compass.

Beginning two minutes after reaching the plot, every bird seen or heard within the plot during a three-minute time interval was recorded. For each individual bird in the plot, the following data were recorded; 1) species, 2) sex (all singing birds were recorded as males), 3) activity at the time it was observed and throughout the three minute interval (e.g., singing, calling, foraging, etc.), 4) basis of identification (i.e., vocalization, field markings, or both), and 5) estimated location of the bird in the plot. Birds flying over the plot within the 3-minute interval were also recorded.

Nine and a half transects on the study area were visited six times during the field season. The other half of one transect (i.e., plots L-9 through L-16) was visited four times during the season. Two observers alternately ran the transects forward and backward to facilitate the observation of those bird species that stop singing very early in the day.

Additional Bird Sampling Methods for Original 1989 Conservation Concern Species

Although there were no species in Minnesota listed as threatened or endangered by the State or Federal government on the Rothsay Prairie Landscape Unit in 1989, there were species designated as conservation concern by federal and state natural resource agencies (Table 1). In addition to point counts, extended sampling for these species

consisted of recording any sighting, sign or vocalization; 1) from the listening stations inside the plot, but before or after the 3-minute interval, 2) from the stations, but outside the plot before, during, or after the 3-minute timed interval, 3) along the transects, 4) on the study area but not on the transects, 5) outside the study area anywhere within 3.2 km (2 mi.) of the Rothsay Unit.

In addition, evening drives through the study area were performed to survey for short-eared owls foraging during their evening active period (Roberts 1936, Clark 1975, Johnsgard 1979). A formalized night survey, using broadcast vocalizations (Gibbs and Melvin 1993) to elicit territorial defense calls of sharp-tailed sparrows and yellow rails, was conducted on 2 June 1989 ('/z hour prior to sunset - midnight) in the portion of the study site considered to have the best habitat for Nelson's sharp-tailed sparrows and yellow rails (Anna Gronseth Nature Conservancy Preserve). These two species are considered erratic singers, primarily nocturnal (Johnsgard 1979, Ekert 1983, Coffin and Pfannmuller 1988), and known to occupy similar habitats (Hanowski and Niemi 1986). The Gronseth Preserve had been noted in the past as habitat for both of these species (Ekert 1983, Janssen 1987) and both species had been encountered at plot G-1 prior to this date during the field season during evening plot setup and early morning data collection. Call broadcasts were also used on the evening of 6 June 1989 at and adjacent to plot G-1. Due to the lack of response by any Conservation Concern Species, logistical considerations, and presumed rarity of the species sampled with this method, the night survey was discontinued after these two trials.

Habitat Data Collection

In addition to collecting information on the abundance and distribution of birds on the Rothsay Unit, habitat data were collected on the study area. Habitat measurements were recorded within each circular plot at the beginning and end of the season. These included; l) average grass height, 2) grass density, 3) percent of plot covered by grass, 4) percent of plot covered by trees, 5) percent of plot covered by shrubs, 6) distance to nearest woody vegetation (i.e., edge) from the sampling station in each quadrant of the plot, 7) type of nearest edge/woody vegetation (e.g., single tree or shrub, grove of trees, clump of several shrubs, etc.), and 8) height of woody vegetation. In addition, the percent of plot covered by forbs was measured at the end of the season.

Ocular estimates were made of percent coverage of the plot by grasses, forbs, shrubs, and trees. Grass height was measured to the nearest 0.1 m in four random locations within the plot and these measurements were averaged. If the grass was <0.5 m high, its height was estimated to the nearest centimeter. Density of grass was measured using Robel's method (Robel et al. 1970) at a randomly chosen location in each quadrant of the plot. These measures were averaged to give a final measure of average grass density for the entire plot. Distance to the nearest woody vegetation was paced if it fell within the plot and its height estimated. If the nearest woody vegetation was outside the plot boundaries, ocular estimates were used to determine the distance to the woody vegetation and its height.

In addition to measuring or estimating structural components of the habitat within a plot, each plot was visited and categorized into vegetative community types (Dana 1989b) according to Minnesota's Preliminary Community Classification System

(Wendt 1984). The three dominant grasses and forbs within each plot were also recorded.

Data Analysis

Bird records were separated into potential breeders and nonbreeders using criteria described earlier. Potential breeder records were examined for their occurrence within plots or location of a nest or young on the study area. Those records located within plots were further examined to determine their breeding status on the Rothsay Unit based on the temporal patterns of their detections.

Breeding Status

Based on temporal patterns through the season, potential breeding bird records were further categorized into four species groups relative to the Rothsay Unit: breeder, visitor, visitor/potential breeder, and migrant. A bird was categorized as a breeder on the study site if it met the following criteria; 1) it was recorded on the study plots after 1 June by the regular sampling method, 2) as a 1989 Conservation Concern Species it was recorded on the study plots after 1 June by the regular and extended sampling method, or 3) a nest or young was located anywhere on the study site.

A species was considered a visitor to the study site if known to breed in the vicinity based on historical records and literature, and if it was recorded on the site only when flying over a plot, without any nest or young recorded. It was considered that some visitor species may also be potential breeding birds not adequately sampled in this study. Because of the emphasis of this study on grassland nesting birds, limited deep emergent marsh or larger forested areas (e.g., farmstead woodlots, fencerows) were sampled. The

natural history and records of birds classified as visitors was reviewed to determine if a categorization of visitor/potential breeder would apply. For example, the American kestrel was categorized as a visitor/potential breeder based on the fact that its nesting sites (cavities in trees within a matrix of open grassland areas) are available on the Rothsay Unit, but essentially unsampled by this study's methodology. This, coupled with additional evidence that nests of these species were found in the vicinity (within 1.6 - 3.2 km (1-2 miles) of the study site). In contrast, great egret, great blue heron and black-crowned night-heron remained categorized as visitors because their nest sites (many dead trees in or near standing water to serve as a rookery for colony nesting) were not available on the Rothsay Unit.

The migrant classification was applied to a bird on the site if it was recorded on the site prior to 1 June. The breeding status of incidental bird observations recorded during plot setup and/or habitat data collection procedures was also assigned following the above procedure. The categorization system above was utilized for the classes of visitor and migrant. Because none of these birds was recorded by the regular sampling method, those species recorded after 1 June were considered to be potential breeding birds.

Those species considered breeding birds on the Rothsay Unit were used for the remaining analyses. Relative abundance, distribution across the site, and density of breeding pairs were estimated for each breeding bird species.

Relative Abundance

Relative abundance of breeding birds on the Rothsay Unit was determined by an analysis of the frequency of birds recorded throughout the season. Species effectively sampled by point counts were divided into four abundance groups following Janssen (1987). These categories were; 1) abundant, 2) common, 3) uncommon, and 4) rare. The term abundant refers to birds with season counts of more than 250 individuals. Common was the term used for bird species with 26 to 250 records for the season. Birds with 6 to 25 seasonal records were categorized as uncommon. Finally, the term rare was used to describe species with <5 records for the season. Abundance rankings for species not effectively sampled by point count methodology were derived from examination of regular and extended sampling records, incidental records, and a review of their natural history.

Spatial Distribution

Each breeding species was assigned a distribution class based on the total number of plots in which a breeding species had potential breeding records. The classification system also took into account records from the extended sampling methods for the 1989 Conservation Concern Species. The categories assigned were; widespread, moderate, restricted, or local and followed breaks that occurred in the data. Widespread species occurred in > 65% (i.e., 100 plots) of the 155 study plots. Moderately distributed species were those that were recorded in 33 - 51% of the study plots (i.e., 50 - 79 plots); while restricted species were recorded in 16 to 29 plots (10 - 19%). Narrowly distributed species on the site, occurring at <10 (i.e., 6%) plots were classified as local. This

categorization scheme was applied to those birds adequately sampled by point count methodology and the 1989 Conservation Concern Species using their observations from both the regular and extended sampling methods. For birds not adequately sampled by the point count method, distribution rankings were determined based on qualitative data (derived from a review of their natural history requirements and habits), and nonbreeding and incidental records.

Density of Breeding Pairs

The density of breeding pairs was calculated in two ways; one considered the distribution of birds to be uniform across the area, and one assumed the distribution of birds to be influenced by a preference for certain habitats based on their life history requirements. Regardless of the method used, each individual breeding record occurring in a plot was used as a surrogate for a breeding pair. I used the maximum number of breeding records from one round of sampling all plots (designated as weeks 1 - 6) to represent the minimum number of breeding pairs on the site.

I calculated minimum absolute density by dividing the number of breeding records (now considered a pair) for a species by the area sampled:

$$\text{Minimum Absolute Density} = \frac{\text{(Maximum number of breeding records in a week)}}{\text{(Total area of all study plots)}}$$

or:

$$\text{Minimum Absolute Density} = (\text{MAX } b) / [155 (\text{II } r^2)]$$

where MAX b is maximum number of breeding records for one round of sampling, and r equals the radius of each circular plot in kilometers (0.01 km).

Next, I calculated the minimum ecological density of breeding pairs within suitable habitat as:

$$\text{Minimum Ecological Density} = \frac{\text{(Maximum \# breeding records in a week)}}{\text{(Total area of plots in which a species was recorded)}}$$

or:

$$\text{Minimum Ecological Density} = (\text{MAX b}) / [\text{N (II r2)}]$$

where MAX b is the maximum number of breeding records for a week, N equals the number of plots within which a breeding record for a bird was documented, and r equals the radius of each circular plot in kilometers (0.01 km).

Habitat Structural and Vegetation Community Variables

The habitat structural measures described earlier were collected as a means of quantifying the habitat, for the ultimate goal of examining associations between bird presence and the habitat in which they were recorded. That is, to see if habitat variables could account for the differential distribution of species across the Rothsay Unit. The structural habitat variables recorded for the Rothsay Unit in the field were entered in a database that described the plots and was appended to the bird occurrence information. The non-numeric habitat variables of land use, edge type and wetness, were categorized into ordinal groups to express an ecological context for data analysis purposes and also

appended to the bird observation data. Wetness was given a code for wet (1) or not wet (0). Land use and edge type were changed into a range of numbers, in which the lowest numbers are indicative of least hostile and higher numbers indicated increasing threat to grassland nesting avian species. Edge types in order from least to most hostile were; single shrub, single scattered shrubs, shrubs along a ditch, shrub clusters, single tree, single dead tree, single trees, dead trees, tree-shrub cluster, trees along a ditch, ditch, tree-shrub grove, tree cluster, farmstead, tree grove. Land use categories in order from least to most hostile were: idle, burned, hayed, grazed, and plowed.

These habitat variables were evaluated in conjunction with the maximum weekly frequencies of a bird species using forward step-wise multiple linear regression analysis (Johnson and Wichern 1988) to explore any relationship(s) that may have existed between the measured habitat variables and a bird species' use of the area. Specifically, multiple linear regression was used to predict the response of the dependent variable (in this case each bird species) from a collection of independent "predictor" variables (in this case the habitat measures). It produced a linear model of the relationship by inputting, in a stepwise fashion, the variables that explain a significant proportion of the dependent variable's variation starting with the independent variable which explains the largest significant proportion of the variation. It tests the null hypothesis that no linear relationship exists between a species' occurrence and the habitat variables. If the null hypothesis is rejected, the R-square statistic reports the amount of variability that can be explained by this relationship. The statistical package for personal computers SPSS® 9.0 was used for this analysis (Norusis 1998). Each Conservation Concern Species having > 9 records and other species with > 29 records as a maximum weekly count was used as

the dependent variable when performing a forward step-wise multiple regression with the measured habitat variables.

In addition, the vegetative community types assigned to each plot in the field by Dana (1989) were used to determine the relative abundance of these communities sampled and how the sample reflected the entire study area. A statistical comparison of how representative the plots were of the entire study area was accomplished using a chi-square test. This statistic, tested the null hypothesis that there was no difference between the proportion of vegetative community types in the study area and in the study plots.

Further, the point count stations and associated bird records were entered into ArcView® GIS software and analyzed in association with several other digital coverages, including one from the Minnesota Natural Heritage Program (MNDNR 1998) that spatially identified the vegetative community types on the area. First, a summary of the total area in each vegetative community type on the Rothsay Unit was derived from this digital coverage. Then, a 100 m radius buffer was placed around each point count station to identify the plots and create a plot coverage. Using the newly created plot coverage, as an overlay on the MNDNR community type coverage, the various vegetative community types (covertypes) associated with each plot were identified. This was summarized and compared to the total area for each covertype across the entire area.

The GIS was also employed to extrapolate Rothsay Unit vegetation covertypes to the remainder of reserve habitat in Minnesota and the greater ecoregion by comparing it to other digital coverages available from the USFWS (1998) and TNC (1998) that had been developed for their recent tallgrass prairie initiatives. This analysis allowed a

comparison of the number of occurrences and amount of Rothsay Unit's vegetation covertypes to that on other "managed areas". It illustrates the availability of these habitats for prairie avifauna beyond the boundaries of the Rothsay Unit. Managed areas are those areas owned by a conservation organization, agency or private landowner under some active management and/or perpetual agreement to be maintained for natural resource conservation. Although it is estimated that 95% of the remaining native prairie in this same area is privately owned (USFWS 1998), the analysis was limited to managed areas outside the Rothsay Unit because no information was available for unmanaged sites.

Incorporation of New Information

Since this bird survey was conducted in 1989, the list of prairie avian species of conservation concern that have regional breeding distribution records that include the Rothsay Unit has grown (Table 3). All 1989 Conservation Concern Species are still of concern in 1999 for at least one agency or organization (see Table 3) however, the list has increased from 11 to 21 species. Many recent data sources were consulted to arrive at a 1999 list of Conservation Concern Species. These are included in the legend for Table 3. The latin names for the Conservation Concern Species in this table and the full species list for the Rothsay Unit are found in Appendix A.

TABLE 3. Conservation Concern Species in the Tallgrass Prairie Ecosystem in 1999.

SPECIES	CONSERVATION CONCERN SPECIES STATUS							
	State[1]	Federal[2]	TNC - (National)[3]	TNC - (Ecoregion)[4]	BBS (Regional)[5]	BBS (Minnesota)[6]	PIF - Region 40[7]	Audubon Society[8]
American bittern*		MC	G4	x	na	-*	x	
black-billed cuckoo				x	-***	0	x	
bobolink		MC	G5	x	-*	-	x	x
clay-colored sparrow				x	-	+	x	x
diskcissel		MC	G5	x	-	-	x	x
grasshopper sparrow		MC		x	-**	-***	x	
greater prairie-chicken*	SC		G4	x	na	na	x	
Henslow's sparrow*	E	MC	G3G4	x	na	na		
Le Conte's sparrow				x	na	+		
marbled godwit*	SC		G5	x	na	na	x	
marsh wren				x	-**	-	x	
northern harrier*		MC	G5	x	-	-*		
savannah sparrow					-	-		

TABLE 3. (cont.)

SPECIES	CONSERVATION CONCERN SPECIES STATUS							
	State[1]	Federal[2]	TNC - (National)[3]	TNC - (Ecoregion)[4]	BBS (Regional)[5]	BBS (Minnesota)[6]	PIF - Region 40[7]	Audubon Society[8]
sandhill crane*			G5	x	na	na		
sedge wren		MC		x	-	+	x	
Nelson's sharp-tailed sparrow*	SC		G5	x	na	na	x	x
short-eared owl*	SC		G5	x	na	na		
upland sandpiper*		MC	G5	x	-	-		
western meadowlark				x	-***	-***		
Wilson's phalarope*	T		G5	x	na	na	x	
yellow rail*	SC	MC	G4	x	na	na	x	

* original species of conservation concern for study (1989)
[1] MNDNR 1996b (SC - Special Concern; T - threatened; E - endangered)
[2] USFWS 1995a (MC - Species of Management Concern)
[3] TNC National rank (G5 - secure; G4 - apparently secure; G3 - vulnerable; G2 - imperiled; G1 - critically imperiled; NR - not rated)
[4] TNC Northern Tallgrass Prairie Ecoregion rank, Chapman et al. 1998 (x - Species of Conservation Interest)
[5] BBS Regional Population Trend,1966-1995, Black Prairie Ecoregion, Sauer et al. 1996. (- negative; + positive; * significant at 0.10; ** significant at 0.05; *** significant at 0.001; na- not available)
[6] BBS Minnesota Population Trend, 1966-1995, Sauer et al. 1996.(- negative; + positive; * significant at 0.10; ** significant at 0.05; ***significant at 0.01; na- not available)
[7] Physiographic Region 40 - Fitzgerald et al 1998 (x - Partners in Flight Priority Species)
[8] Audubon Society Watch List (x - listed)

RESULTS

Birds

Over the course of the 1989 field season 9,847 bird observations of 74 different species were recorded on the study area. Of these observations, 9,667 were potential breeding bird records. The regular sampling method accounted for 7,963 of the potential breeding bird records; 7,883 occurred within the study plots. Another 180 observations were birds that flew over the plots (flyovers) during the regular sampling method, including 14 species only recorded as flyovers. The extended sampling focused on the 1989 Conservation Concern Species that occurred within the overall framework of the regular sampling (i.e., those observations recorded during travel between plots and records outside of plots' 100 m radii, but heard from the sampling station), accounted for an additional 1,784 potential breeding bird records. This portion of the extended sampling added the following records for Conservation Concern Species: 318 marbled godwits, 151 upland sandpipers, 72 greater prairie chickens, 25 Wilson's phalaropes, 32 northern harriers, 23 American bitterns, 1 Henslow's sparrow, and the only Nelson's sharp-tailed sparrow record to the database.

The extended sampling for Conservation Concern Species outside the regular sampling framework (i.e., observations of these species recorded during plot setup, evening drives, and vegetation sampling) was responsible for other records of these species, including the only records of a short-eared owl and yellow rails on the study site. The short-eared owl was a single record, observed on 16 May 1989. Two yellow rails were recorded on 10 and 12 May 1989 at the same location. Another yellow rail was observed on 14 May in a different location. All detections of yellow rails and

short-eared owls were recorded while setting up plots. The records for these two species brings the total species recorded on the Rothsay Unit to 76.

Different temporal patterns for species were exhibited (Table 4), based on their detections from both the regular and extended sampling methods within the regular sampling framework, as well as the extended sampling outside the regular sampling framework for yellow rail and short-eared owl.

Based on the temporal patterns of the 76 species with potential breeding records during the regular and extended sampling method (Table 4), breeding status was assigned. Fifty-seven species (75%) were considered breeding birds on the Rothsay Unit (Table 5). This included 7 (67%) of the 11 species considered conservation concern in 1989, and 17 (81 %) of the 21 species considered conservation concern in 1999. Breeding was confirmed for 31 (54%) of the 57 birds classified as breeding birds on the Rothsay Unit. In addition to breeding birds, two (2) species were classified as visitors/potential breeders, including the yellow rail, a 1989/1999 Conservation Concern Species; nine (9) were categorized as visitors; and nine (9) as migrants, including Nelson's sharp-tailed sparrow and short-eared owl, two species of conservation concern in 1989 and 1999.

TABLE 4. Weekly counts* of bird records on the Rothsay Unit, in northwestern Minnesota, 1989.

	Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	
Species Name	**22-28 May**	**29 May-4 June**	**5-11 June**	**12-18 June**	**19-25 June**	**26 June-2 July**	
alder flycatcher	0	4	4(5)	5	0	3	16 (17)
American bittern	1(5)	1(8)	1(4)	0(8)	0(1)	0	3 (26)
American coot	0	0	1 **6/6/89**	0	0	0	1
American goldfinch	10(16)	7(12)	5(16)	12(18)	13(17)	5(13)	52(92)
American kestrel	0	0	0(1) **6/4/89**	0	0	0	0(1)
American robin	3	10	0	6	3(5)	5	27(29)
Baltimore oriole	2	1(3)	0	1	0	0	4(6)
barn swallow	0(20)	0(18)	0(4)	0(18)	0(14)	0(11)	0(85)
black-billed cuckoo	0	0	0(1)	0	2	2	4(5)
black-crowned night-heron	0	0	0 (1)	0	0(3)	0(3)	0(7)
blue-winged teal	0(3)	0	0	0(4)	0	0(1)	0(8)
bluejay	0	0	0	1 **6/13/89**	0	0	1
bobolink	243 (249)	229 (246)	188 (198)	150 (164)	164 (176)	151 (169)	1125 (1202)
Brewer's blackbird	21(24)	29(36)	16(20)	30(39)	21(27)	21(27)	138(173)
brown-headed cowbird	28(52)	30(54)	29(57)	41(78)	35(71)	23(71)	186(383)
Canada goose	0(4)	0	0	0	0	0	0(4)
clay-colored sparrow	43	54	48	63	54	55	317
cliff swallow	0(7)	0(18)	0(2)	0(3)	0(15)	0(15)	0(60)

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Species Name	**22-28 May**	**29 May-4 June**	**5-11 June**	**12-18 June**	**19-25 June**	**26 June-2 July**
common grackle	0(5)	0(2)	0	0	1(3)	0(21)	1(31)
common snipe	2(9)	1(7)	0(3)	1(3)	0(7)	0	4(29)
common yellowthroat	79(80)	94	99	88	110	89	559(560)
dickcissel	0	0	0	0	3	3(4)	6(7)
double-crested cormorant	0	0	0(1)	0	0(3)	0	0(4)
eastern bluebird	0	2	0	0	1	0	3
eastern kingbird	2(3)	6(7)	1(2)	2	2	2(4)	15(20)
eastern phoebe	0	0	0	0	1 **6/15/89**	0	1
European starling	0	**6/2/89**	0	0	0	0	1
golden-winged warbler	0	1 **5/31/89**	0	0	0	0	1
grasshopper sparrow	36(37)	50	61	49	65	64	325(326)
gray catbird	1	3	4	1	2	1	12
great blue heron	0(4)	0(2)	0(2)	0	0(2)	0	0(10)
great egret	0(4)	0(1)	0(2)	0	0	0(1)	0(8)
great horned owl	0	1 **5/31/89**	0	0	0	0	1
greater prairie chicken	0(16)	0(9)	0(24)	0(16)	0(8)	1	1(73)
green heron	0	0(1) **5/29/89**	0	0	0	0	0(1)
Henslow's sparrow	1	1(2)	0	1	2	1	6(7)
horned lark	4(6)	1	0(1)	0	0	0(1)	5(9)
house wren	2	1	1	1	0	1	6
killdeer	5(9)	8(11)	14(16)	13(17)	12(19)	6(16)	58(88)

Species Name	Week 1 22-28 May	Week 2 29 May-4 June	Week 3 5-11 June	Week 4 12-18 June	Week 5 19-25 June		Week 6 26 June-2 July
least flycatcher	1	5	1	4	5	4	20
Le Conte's sparrow	12(13)	20	25	18	21	22	118(119)
mallard	3(40)	7(50)	5(27)	0(26)	1(20)	0(16)	16(179)
marbled godwit	47(140)	34(118)	26(107)	4(43)	3(22)	0(2)	114(432)
marsh wren	3	11	15	13	8	7	57
mourning dove	8(15)	10(11)	12(18)	13(25)	11(21)	10(23)	64(113)
northern harrier	3(6)	0(5)	3	1(9)	1(8)	0(9)	8(40)
northern pintail	0(1)	0(4)	0(1)	0(2)	0	0	0(8)
orchard oriole	1 **5/27/89**	0	0	0	0	0	1
purple martin	0	0	**6/4/89**	0	0	0	0(1)
red-eyed vireo	0	1 **5/31/89**	0	0	0	0	1
red-tailed hawk	0	1	0(1)	(1)	0	(1)	1(4)
red-winged blackbird	194 (217)	186 (218)	191 (211)	239 (268)	170 (193)	171 (208)	1151 (1315)
ring-billed gull	0	0(1) **5/29/89**	0	0	0	0	0(1)
ring-necked pheasant	1(2)	1(12)	0(8)	1(12)	0(9)	1(4)	4(47)
rose-breasted grosbeak	1 **5/22/89**	0	0	0	0	0	1
savannah sparrow	212	203	197	271	272	282	1437
sedge wren	119	140	132	134	164	149	838
Nelson's sharp-tailed sparrow	0	0(1) **5/29/89**	0	0	0	0	0(1)
short-eared owl	0	0	0	0	0	0	0(1) **5/17/89**
song sparrow	22	31	30	35	32	50	200
sora	0(1)	0	2	0	1	0	3(4)

Species Name	Week 1 22-28 May	Week 2 29 May-4 June	Week 3 5-11 June	Week 4 12-18 June	Week 5 19-25 June		Week 6 26 June-2 July
swamp sparrow	20	34	40	38	53	52	237
tree swallow	2(4)	2(6)	0(1)	0(3)	0	0(5)	4(19)
upland sandpiper	7(19)	7(26)	6(24)	10(29)	4(45)	10(52)	44(195)
veery	2	4	4	5(6)	1(2)	3	19(21)
vesper sparrow	0(2) **5/22,23**	0	0	0	0	0	0(2)
Virginia rail	1	0	1(2)	0	0	0	2(3)
Western meadowlark	98(102)	75(79)	96	86(91)	79(83)	64(70)	498(521)
willow flycatcher	1	3	10	8	8	8	38
Wilson's phalarope	2(8)	4(14)	1	0(1)	2(3)	0(7)	9(34)
wood duck	0	0	0	0	0(1) **6/19/89**	0	0(1)
yellow rail	0	0	0	0	0	0	0(5) **5/10,12 &14**
yellow warbler	9	10	13	15	8	9	64
yellow-breasted chat	1 **5/27/89**	1 **6/1/89**	0	0	0	0	2
yellow-headed blackbird	1(2)	7(8)	0(9)	16(26)	4(8)	13(32)	41(85)
northern flicker	1	0	0(2)	0(1)	1(2)	0	0(6)

* Numbers are the records from within the plots as sampled by the regular sampling method. Numbers in parentheses are total records from the regular and extended sampling methods, including flyovers. Dates shown in bold italics are for those birds with a single potential breeding record for the season and the records of short-eared owl and yellow rail which were outside the regular framework.

TABLE 5. Potential breeding species recorded during regular and extended sampling and their assigned Breeding Status on the Rothsay Unit, northwestern Minnesota, in 1989.

SPECIES	BREEDING STATUS[3]
alder flycatcher	breeder
American bittern[1,2]	breeder
American coot	breeder*
American goldfinch	breeder
American kestrel (flyover during regular sampling)	visitor/potential breeder
American robin	breeder*
Baltimore oriole	breeder
barn swallow (flyover during regular sampling)	breeder*
black-billed cuckoo[2]	breeder*
black-crowned night-heron (flyover during regular sampling)	visitor
bluejay	breeder
blue-winged teal (flyover during regular sampling)	breeder*
bobolink[2]	breeder*
Brewer's blackbird	breeder*
brown-headed cowbird	breeder*
Canada goose (flyover during regular sampling)	breeder*
clay-colored sparrow[2]	breeder*
cliff swallow (flyover during regular sampling)	breeder*
common grackle	breeder
common snipe	breeder*
common yellowthoat	breeder
dickcissel[2]	breeder

SPECIES	BREEDING STATUS[3]
double-crested cormorant (flyover during regular sampling)	visitor
eastern bluebird	breeder
eastern kingbird	breeder*
eastern phoebe	breeder
European starling	breeder
golden-winged warbler	migrant
grasshopper sparrow[2]	breeder
gray catbird	breeder*
great blue heron	visitor
great egret (flyover during regular sampling)	visitor
great horned owl	visitor
greater prairie chicken[1,2]	breeder*
green heron (flyover during regular sampling)	visitor
Henslow's sparrow"'	breeder
horned lark	breeder
house wren	breeder
killdeer	breeder*
least flycatcher	breeder
Le Conte's sparrow[2]	breeder
mallard	breeder*
marbled godwit [1,2]	breeder*
marsh wren[2]	breeder
mourning dove	breeder*
northern harrier [1,2]	breeder*
northern pintail (flyover during regular sampling)	breeder*
orchard oriole	migrant
purple martin (flyover during regular sampling)	visitor

SPECIES	BREEDING STATUS[3]
red-eyed vireo	migrant
red-tailed hawk	breeder
red-winged blackbird	breeder*
ring-billed gull (flyover during regular sampling)	migrant
ring-necked pheasant	breeder
rose-breasted grosbeak	migrant
savannah sparrow[2]	breeder*
sedge wren[2]	breeder
Nelson's sharp-tailed sparrow[1,2] (recorded during extended sampling)	migrant
short-eared owl[1,2] (only recorded during extended sampling)	migrant
song sparrow	breeder*
sora	breeder*
swamp sparrow	breeder*
tree swallow	breeder
upland sandpiper[1,2]	breeder*
vesper sparrow	migrant
Virginia rail	breeder
western meadowlark[2]	breeder*
willow flycatcher	breeder*
Wilson's phalarope[1,2]	breeder*
wood duck (flyover during regular sampling)	visitor
yellow rail[1,2] (only recorded during extended sampling)	visitor/potential breeder

SPECIES	BREEDING STATUS[3]
yellow warbler	breeder*
yellow-breasted chat	migrant
yellow-headed blackbird	breeder
northern flicker	breeder

[1] 1989 Conservation Concern Species
[2] 1999 Conservation Concern Species
[3] * denotes breeding confirmed by presence of nest or young during the regular and extended sampling, plot setup, while walking between plots, or while performing vegetation measures.

Incidental Records

During plot setup and vegetation sampling procedures incidental to the regular and extended sampling methods, 43 additional bird species were detected (Table 6). The majority of these species (29 or 67%) were classified as migrants, based on their detection prior to June 1. These incidental records also identified seven species classified as visitors, and an additional seven species that are potential breeding birds on the Rothsay Unit. Additional information will be required to be more certain of the status of these potential breeders, all of which are not well sampled by point count methodology.

TABLE 6. Incidental bird species records and Breeding Status on Rothsay Unit, northwestern Minnesota, 1989.

SPECIES	BREEDING STATUS
American crow	visitor
*American wigeon	migrant
*American woodcock	potential breeder
*bank swallow	migrant
black-capped chickadee	migrant
*American black duck	migrant
brown thrasher	visitor
cedar waxwing	visitor
chestnut-collared longspur	migrant
chimney swift	migrant
*Cooper's hawk	visitor
*downy woodpecker	potential breeder
eastern wood-pewee	visitor
*Forster's tern	migrant
*Franklin's gull	migrant
great crested flycatcher	migrant
*greater yellowlegs	migrant
*green-winged teal	migrant
*hairy woodpecker	potential breeder
house sparrow	potential breeder
*Hudsonian godwit	migrant
Lapland longspur	migrant
lark bunting	migrant
*least bittern	potential breeder
*American golden-plover	migrant
*lesser yellowlegs	migrant
common nighthawk	migrant
*northern shoveler	migrant
northern waterthrush	migrant
*osprey	visitor

palm warbler	migrant
*pied-bill grebe	potential breeder
rock dove	potential breeder
*northern rough-winged swallow	migrant
*snow goose	migrant
*solitary sandpiper	migrant
*Swainson's hawk	visitor
Tennesee warbler	migrant
warbling vireo	migrant
western kingbird	migrant
white-throated sparrow	migrant
Wilson's warbler	migrant
yellow-romped warbler	migrant

* not well sampled by point count methodology

Abundance

Relative abundance of the breeding bird species identified for the Rothsay Unit is summarized in Table 7, which presents the frequencies of breeding bird records and their abundance classification. Twenty-seven species (47%) of the breeding birds recorded at the Rothsay Unit were classified as abundant or common. An additional 15 species were rated as uncommon and another 15 ranked as rare. Six of the eight categorized as abundant are 1999 Conservation Concern Species. The highest rank for a 1989 Conservation Concern Species was common. Four 1989 Conservation Concern Species fell into this category, including two, northern harrier and greater prairie chicken upgraded from uncommon and rare, respectively, based on extended sampling observations. Three 1989 conservation species were classified as uncommon, including American bittern, which was upgraded from rare. Of the four remaining species considered Conservation Concern Species only in 1999, two were classified as common, one as uncommon, and one as rare. The rankings for the 1989 Conservation Concern Species were determined with the inclusion of additional information gained from the extended sampling methods.

Spatial Distribution

The distribution of breeding birds on the Rothsay Unit is summarized in Table 8. The extended sampling data were utilized for the distribution classification of the 1989 Conservation Concern Species. A comparison of data for the 1989 Conservation Concern Species based on the regular and extended sampling processes shows the impact of the extended sampling procedure on the distribution class of these species (Table 9).

TABLE 7. Frequency and Abundance classification of breeding birds observed on the Rothsay Unit, northwestern Minnesota, 1989.

SPECIES (in order of frequency)	FREQUENCY	PERCENT of observations	ABUNDANCE CLASSIFICATION[1]
savannah sparrow[3]	1437	18.26	abundant
red-winged blackbird	1151	14.63	abundant
bobolink[3]	1125	14.30	abundant
sedge wren[3]	838	10.65	abundant
common yellowthroat	559	7.10	abundant
western meadowlark[3]	498	6.33	abundant
grasshopper sparrow[3]	325	4.13	abundant
clay-colored sparrow[3]	317	4.03	abundant
swamp sparrow	237	3.01	common
song sparrow	200	2.54	common
brown-headed cowbird	186	2.36	common
Brewer's blackbird	138	1.75	common
Le Conte's sparrow	118	1.50	common
marbled godwit[2,3]*	114	1.45	common
mourning dove[3]	64	0.81	common
yellow warbler	64	0.81	common
killdeer*	58	0.74	common
marsh wren	57	0.72	common
American goldfinch	52	0.66	common
upland sandpiper[2,3]*	44	0.56	common

SPECIES (in order of frequency)	FREQUENCY	PERCENT of observations	ABUNDANCE CLASSIFICATION[1]
yellow-headed blackbird	41	0.52	common
willow flycatcher	38	0.48	common
American robin	27	0.34	common
least flycatcher	20	0.25	uncommon
veery	19	0.24	uncommon
alder flycatcher	16	0.20	uncommon
mallard*	16	0.20	uncommon
eastern kingbird	15	0.19	uncommon
gray catbird	12	0.15	uncommon
Wilson's phalarope[2,3]*	9	0.11	uncommon
northern harrier[2,3]*	8	0.10	common
Baltimore oriole	6	0.08	uncommon
dickcissel[3]	6	0.08	uncommon
Henslow's sparrow [2,3]*	6	0.08	uncommon
house wren	6	0.08	uncommon
horned lark	5	0.06	rare
black-billed cuckoo3	4	0.05	rare
common snipe*	4	0.05	rare
ring-necked pheasant*	4	0.05	rare
tree swallow*	4	0.05	uncommon
American bittern [2,3]*	3	0.04	uncommon
eastern bluebird	3	0.04	rare
sora*	3	0.04	uncommon
Virginia rail*	2	0.03	uncommon
northern flicker*	2	0.03	rare
American coot*	1	0.01	rare

SPECIES ABUNDANCE (in order of frequency) CLASSIFICATION[1]	FREQUENCY	PERCENT of observations	
blue jay	1	0.01	rare
common grackle	1	0.01	rare
eastern phoebe	1	0.01	rare
European starling	1	0.01	rare
greater prairie chicken [2,3] *	1	0.01	
	common		
red-tailed hawk*	1	0.01	rare
barn swallow*	0	0.00	
	common		
blue-winged teal*	0	0.00	rare
Canada goose*	0	0.00	rare
cliff swallow*	0	0.00	
	common		
northern pintail*	0	0.00	rare
TOTAL	7868	100.00	---

[1] Abundance Classification, following Janssen (1987)
abundant: > 250 season records
common: 26-250 season records
uncommon: 6-25 season records
rare: < 5 season records

[2] 1989 Conservation Concern Species

[3] 1999 Conservation Concern Species

* Species not effectively sampled by point count methodology

TABLE 8. Number of plots a breeding bird was recorded on and their Spatial Distribution Classification on the Rothsay Unit, northwestern Minnesota, 1989.

SPECIES (in decreasing order of spatial distribution)	NO. of PLOTS[3]	PERCENT of plots	SPATIAL DISTRIBUTION
savannah sparrow[2]	131	84.5	widespread
bobolink[2]	123	79.4	widespread
western meadowlark [2]	115	74.2	widespread
common yellowthoat	106	68.4	widespread
sedge wren[2]	103	66.5	widespread
red-winged blackbird	100	64.5	widespread
clay-colored sparrow[2]	79	51.0	moderate
marbled godwit[1,2]*	77	49.7	moderate
grasshopper sparrow[2]	73	47.1	moderate
brown-headed cowbird	60	38.7	moderate
upland sandpiper[1,2]*	60	38.7	moderate
song sparrow	59	38.1	moderate
swamp sparrow	58	37.4	moderate
greater prairie chicken[1,2]*	50	32.3	moderate
Le Conte's sparrow[2]	50	32.3	moderate
mourning dove	29	18.7	restricted
northern harrier[1,2]*	25	16.1	restricted
American bittern[1,2]*	23	14.8	restricted
American goldfinch	22	14.2	restricted
willow flycatcher	22	14.2	restricted
Brewer's blackbird	20	12.9	restricted
yellow warbler	19	12.3	restricted
marsh wren[2]	18	11.6	restricted
American robin	16	10.3	restricted
Wilson's phalarope[1,2]*	16	10.3	restricted
gray catbird	10	6.5	local
alder flycatcher	9	5.8	local

SPECIES (in decreasing order of spatial distribution)	NO. of PLOTS[3]	PERCENT of plots	SPATIAL DISTRIBUTION
killdeer*	9	5.8	restricted
mallard*	9	5.8	restricted
eastern kingbird	8	5.2	local
veery	8	5.2	local
least flycatcher	7	4.5	local
dickcissel[2]	5	3.2	local
horned lark	5	3.2	local
yellow-headed blackbird	5	3.2	local
black-billed cuckoo[2]	4	2.6	local
common snipe*	4	2.6	restricted
house wren	4	2.6	local
ring-necked pheasant*	4	2.6	local
Baltimore oriole	3	1.9	local
tree swallow*	3	1.9	local
Henslow's sparrow[1,2]*	2	1.3	local
red-tailed hawk*	2	1.3	local
Virginia rail*	2	1.3	restricted
northern flicker*	2	1.3	local

SPECIES (in decreasing order of spatial distribution)	NO. of PLOTS[3]	PERCENT of plots	SPATIAL DISTRIBUTION
American coot*	1	0.6	local
blue jay	1	0.6	local
common grackle	1	0.6	local
eastern bluebird	1	0.6	local
eastern phoebe	1	0.6	local
European starling	1	0.6	local
sora*	1	0.6	restricted
barn swallow*	n/a	-	local
blue-winged teal*	n/a	--	restricted
Canada goose*	n/a	--	restricted
cliff swallow*	n/a	--	local
northern pintail*	n/a	--	local

[1] 1989 Conservation Concern Species
[2] 1999 Conservation Concern Species
[3] n/a - not applicable (no records from in plots, breeding confirmed outside of plots)
* not effectively sampled by point counts

TABLE 9. Comparison of the 1989 distribution data and classification for 1989 Conservation Concern Species based on the regular sampling and regular sampling method augmented by extended sampling on the Rothsay Unit, northwestern Minnesota.

SPECIES	REGULAR SAMPLING METHOD ALONE		REGULAR AND EXTENDED SAMPLING	
	NO. of PLOTS	DISTRIBUTION	NO. of PLOTS	DISTRIBUTION
American bittern	3	local	23	restricted
greater prairie chicken	1	local	50	moderate
Henslow's sparrow	2	local	2	local
marbled godwit	38	restricted	77	moderate
northern harrier	5	local	25	restricted
upland sandpiper	15	restricted	60	moderate
Wilson's phalarope	4	local	16	restricted

The six most widely distributed breeding bird species on the site; 1) savannah sparrow, 2) bobolink, 3) western meadowlark, 4) common yellowthroat, 5) sedge wren, and 6) red-winged blackbird, were documented in > 100 plots (65%). Their distribution on the study area was classified as widespread. It is notable that 4 of these (savannah sparrow, bobolink, western meadowlark, and sedge wren) are 1999 Conservation Concern Species. Nine breeding species (16% of total) were considered moderately distributed across the Rothsay Prairie Landscape Unit; 1) clay-colored sparrow, 2) marbled godwit, 3) grasshopper sparrow, 4) brown-headed cowbird, 5) upland sandpiper, 6) song sparrow, 7) swamp sparrow, 8) greater prairie chicken and 9) Le Conte's sparrow. Three of these are 1989/1999 Conservation Concern Species and three more are considered Conservation Concern Species in 1999 only. Seventeen (30%) species had restricted distribution, including three 1989/1999 Conservation Concern Species, an

additional 1999 Conservation Concern Species, and seven species not effectively sampled by point counts that were upgraded from local. The remaining 25 species (44%) were classified as local. This included one 1989/1999 Conservation Concern Species (Henslow's sparrow), two 1999 Conservation Concern Species (black-billed cuckoo and dickcissel), and five species not effectively sampled by point counts.

Density of Breeding Pairs

The density of breeding pairs (Table 10) was calculated using each species' maximum number of breeding records detected in a week. Density of breeding pairs is a measure that is comparable between species on a site and within a species across calculation methods and/or in comparison to other sites. Factors, such as territory size and other differing life history requirements (e.g., area sensitivity) that are not taken into account by these calculations, confound interspecies comparisons when evaluating habitat suitability or population viability. On the Rothsay Unit, some species (e.g., yellowheaded blackbird) exhibited a close association with some vegetative community types, as evidenced by large differences between absolute and ecological density. Other species (e.g., savannah sparrow), with essentially the same breeding pair densities across the two methods, appeared to be uniformly distributed across habitats.

TABLE 10. Summary of the minimum absolute and ecological densities of breeding pairs of birds on the Rothsay Unit, northwestern Minnesota, 1989.

SPECIES (in descending order of minimum ecological density)	DENSITY OF BREEDING PAIRS Ecological Density (prs/km^2)	Absolute Density (prs/km^2)	SPECIES (in descending order of minimum absolute density)
yellow-headed blackbird	102	58	savannah sparrow
ring-necked pheasant'	96	50	bobolink
red-winged blackbird	76	49	red-winged blackbird
common snipe*'	72	34	sedge wren
savannah sparrow	69	23	common yellowthoat
killdeer*+	67	20	Western meadowlark
eastern bluebird	64	13	grasshopper sparrow
sora*	64	13	clay-colored sparrow
tree swallow*'	64	11	swamp sparrow
bobolink	63	11	upland sandpiper*'
sedge wren	51	10	song sparrow
Brewer's blackbird	48	10	marbled godwit*
common yellowthoat	33	8	brown-headed cowbird
American coot*	32	7	Baltimore oriole
blue jay	32	6	Brewer's blackbird
common grackle	32	5	Le Conte's sparrow
eastern phoebe	32	5	greater prairie chicken*'
European starling	32	4	killdeer*+
Henslow's sparrow +	32	3	yellow-headed blackbird

SPECIES (in descending order of minimum ecological density)	DENSITY OF BREEDING PAIRS Ecological Density (prs/km^2)	Absolute Density (prs/km^2)	SPECIES (in descending order of minimum absolute density)
swamp sparrow	29	3	marsh wren
grasshopper sparrow	28	3	yellow warbler
Wilson's phalarope*+	28	3	Wilson's phalarope*+
upland sandpiper*+	28	3	American goldfinch
Western meadowlark	27	3	mourning dove
song sparrow	27	2	ring-necked pheasant*+
marsh wren	27	2	American robin
horned lark	25	2	willow flycatcher
clay-colored sparrow	25	2	common snipe*+
yellow warbler	25	2	northern harrier*+
eastern kingbird	24	2	American bittern*+
least flycatcher	23	1	eastern kingbird
brown-headed cowbird	22	1	tree swallow*+
Baltimore oriole	21	1	alder flycatcher
American robin	20	1	least flycatcher
veery	20	1	veery
marbled godwit*	19	1	gray catbird
dickcissel	19	1	horned lark
American goldfinch	19	1	dickcissel
alder flycatcher	18	1	mallard

SPECIES (in descending order of minimum ecological density)	DENSITY OF BREEDING PAIRS Ecological Density (prs/km^2)	Absolute Density (prs/km^2)	SPECIES (in descending order of minimum absolute density)
black-billed cuckoo	16	0.4	black-billed cuckoo
house wren	16	0.4	eastern bluebird
Le Conte's sparrow	16	0.4	Henslow's sparrow +
red-tailed hawk	16	0.4	house wren
Virginia rail*	16	0.4	sora*
northern flicker	16	0.2	American coot*
greater prairie chicken'	15	0.2	blue jay
willow flycatcher	14	0.2	common grackle
mourning dove	14	0.2	eastern phoebe
gray catbird	13	0.2	European starling
northern harrier*'	11	0.2	red-tailed hawk
American bittern'	11	0.2	Virginia rail*
mallard	11	0.2	northern flicker
barn swallow*+	??	??	barn swallow*+
blue-winged teal*+	??	??	blue-winged teal*+
Canada goose*+	??	??	Canada goose*+
cliff swallow'	??	??	cliff swallow*+
northern pintail*+	??	??	northern pintail*+

* not effectively sampled by point count methodology
+ density based on extended sampling
?? cannot be calculated because sampling was outside of plots

Habitat

The number of plots within each vegetation community type was compared to the community types for the entire Rothsay Unit (Table 11). There were ten covertypes originally identified for the study area (MNDNR 1998). These were collapsed into eight by combining wet prairie-saline subtype with saline-wet prairie complex, and wet prairie-seepage subtype with seepage-wetland complex. Wet prairie and wet prairie-wetland complexes characterized the majority of the study site, comprising 72.8% or 2731.1 hectares. An additional 6.1 % (224.9 hectares) of the study area was comprised of mesic prairie. Two wetland types, emergent marsh (4.4% or 164.7 hectares) and calcareous fen (2.4% or 88.4 hectares), rounded out the native plant communities present on the Rothsay Unit. Approximately 498.6 hectares (13.4%) of the study area was non-native vegetation. Distribution of plots among vegetative community types did not differ significantly from the composition of covertypes on the Rothsay unit (Table 11, $X^2_7 = 5.0$, $p < 0.005$).

TABLE 11. Summary of vegetative community types (covertypes) within bird plots and on the entire Rothsay Unit, northwestern Minnesota, 1989.

COVERTYPE	HECTARES in STUDY AREA	NUMBER of PLOTS	% of STUDY AREA	% PLOTS
Mesic Prairie	224.9	4	6.1	2.6
Wet Prairie	1075.6	47	29.0	30.3
Saline - Wet Prairie Complex	618.0	30	16.7	19.4
Wet Prairie - Seepage Wetland Complex	507.9	22	13.7	14.2
Prairie - Wetland Complex	529.5	21	14.3	13.5
Calcareous Fen	88.4	4	2.4	2.6
Emergent Marsh	164.7	9	4.4	5.8
Non-native	498.6	18	13.4	11.6
TOTAL	3707.7	155	100.0	100.0

An extrapolation of the covertypes on the Rothsay Unit to the managed lands to the greater ecoregion was accomplished where data were available (TNC 1998, USFWS 1998). This comparison (Table 12), limited to the managed units in Iowa and Minnesota within the Northern Tallgrass Prairie Ecoregion, was summarized by the areal extent of the covertypes and the number of separate parcels containing each vegetative community. Based on these data, the Rothsay Unit includes the second largest wet-mesic prairie, cordgrass wet prairie, and reed marsh in this portion of the ecoregion. It also contains 3 (23%) of the 13 managed occurrences of saline-wet prairie in this area, and another 10 occurrences in unmanaged private ownerships. The Rothsay Unit also accounts for 53% of the managed area of calcareous fen community type in the ecoregion.

Association of Birds with Measured Habitat Variables

Results from the forward step-wise multiple regression (Table 13) showed statistically significant linear associations between 16 bird species and a number of habitat variables. Two species, savannah sparrow and song sparrow, were associated with four habitat variables. Five species were associated with three habitat variables, and the remaining species were associated with two or less. Further, certain habitat variables were associated with many birds. Grass height was associated with the most bird species (i.e., ten). This was followed by land use which was associated with seven species. Tree cover was not associated positively or negatively with

TABLE 12. Native vegetative community types at the Rothsay Unit, northwestern Minnesota, compared to other Managed Areas in Minnesota and Iowa within physiographic region 40.

COMMUNITY TYPE (MNDNR CLASSIFICATION)[1]	**Total Hectares at Rothsay**[2] (no. of parcels)	**Managed Hectares at Rothsay**[2]	**Hectares in ManagedUnits in Minnesota & Iowa** [3]	**Managed Parcels in Rothsay with this habitat** [2]	**Managed Parcels in Minnesota & Iowa** [3]	**Managed Parcels in Minnesota & Iowa without areas** [3]
CALCAREOUS FEN	88.4 (8)	84.8	159	6	32	11
WET PRAIRIE	1,075.6 (20)	811.8	2,603	15 (includes 2nd largest cordgrass wet prairie)	155	49
SALINE WET PRAIRIE - COMPLEX	618.0 (10)	173.9	36	3	13	8
SEEPAGE WET PRAIRIE - COMPLEX	507.9 (9)	427.6	1,256	6 (includes 2nd largest reed marsh)	not available[4]	not available[4]
PRAIRIE-WETLAND COMPLEX	529.5 (6)	102.4		2	not available[4]	not available[4]
WET-MESIC PRAIRIE*		238.8	1,396	2 (includes 2nd largest wet-mesic prairie)	53	
MESIC PRAIRIE	224.9 (23)	204.3	6,643	18	329	51
EMERGENT MARSH	164.7 (5)	158.8	12,646	4	117	0
GRAND TOTAL	3,209.0	2,202.4	24,740	54	710	63

* TNC classification - these hectares are not added into the total hectares at Rothsay because they are included elsewhere in MNDNR (MNDNR) classification system

[1] MNDNR 1993

[2] MNDNR 1998 (converted to hectares)

[3] USFWS (1998) and TNC (1998) (converted to hectares)

[4] these figures are not available due to a non-parallel match between the MNDNR's classification system which is the most accurate for the Rothsay Unit and TNC and USFWS classificatim system used for the Minnesota and Iowa managed lands.

TABLE 13. Results of forward step-wise multiple regression for Conservation Concern Species having ≥10 observations and other species having ≥ 49 records and habitat variables on the Rothsay Unit, northwestern Minnesota, 1989.

			Betas for Habitat Variables													
Species	n	constant	grass dens.	grass ht.	grass cover	forb cover	shrub cover	no qtr. shrub	no qtr. trees	wet-ness	dist. nearest edge	edge type	land use	f	p-value	R^2
bobolink	243	3.110		-1.62							0.001		-0.374	7.88	0.000	0.150
clay-colored sparrow	63	0.475						.155					-0.174	23.80	0.000	0.259
grasshopper sparrow	65	0.755		-0.564				-0.084					0.104	18.08	0.000	0.272
LeConte's sparrow	25	0.758		-0.313									-0.128	6.51	0.000	0.108
marsh wren	15	-0.060	0.026											14.82	0.000	0.099
marbled godwit	47	0.189						-.155					0.217	10.34	0.00	0.133
western meadowlark	98	0.823		-0.562				-0.084					3.240	19.92	0.000	0.308
savannah sparrow	282	0.901		-2.134	0.023					0.866	0.001			26.40	0.000	0.441
sedge wren	164	0.723		1.298				0.167				-0.216		21.48	0.00	0.325
upland sandpiper	10	-0.114	0.054										0.010	7.83	0.006	
non - conservation Concern Species																
Brewer's	30	-0.052	0.049										0.221	7.03	0.009	

blackbird										
brown-headed cowbird	41 0.030	-0.026	0.470						4.29	0.040
swamp sparrow	53 0.270	-0.276	0.845						50.26	0.000
common yellowthroat	110 0.314	-0.341	0.771	0.007	0.132				21.89	0.000
song sparrow	50 0.000	-0.091 0.361	0.651	0.010	0.123	-0.0004			18.96	
red-winged blackbird	239 0.049	0.330		0.034					7.02	0.009

any species. The greatest amount of variation (44%) in a species' distribution could be explained by the relationship derived from this regression analysis was savannah sparrow (R-square = 0.441). The smallest R-square was 0.030 for brown-headed cowbird.

Association of Birds with Vegetative Community Types

A diversity of use of the different vegetative community types (i.e., habitats) was exhibited by breeding birds at the Rothsay Unit (Table 14). Several species (e.g., yellowheaded blackbird) were strongly associated with a few vegetative covertypes, as 88% of its occurrences were observed in the prairie-wetland complex community type on Rothsay. Other species (e.g., red-winged blackbird) utilized many covertypes in more equal proportions, suggesting less strong ties to a particular habitat type. These differential distributions of birds across the site suggest that some species exhibit strong habitat preferences on the Rothsay Unit. The sample size for some species, however, is too small to make reasonable and sound inferences. For these species, this type of treatment should be viewed with caution.

TABLE 14. Vegetative community covertypes where breeding birds were found on the Rothsay Unit, northwestern Minnesota, 1989.

COMMUNITY TYPE / SPECIES	Mesic Prairie		Wet Prairie		Seepage - Wetland Complex		Saline - Wet Prairie Complex		Prairie-Wetland Complex		Calcareous Fen		Emergent Marsh		Non- Native		Total
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	
alder flycatcher	0	0.0	1	6.3	9	56.3	0	0.0	1	6.3	0	0.0	1	6.3	4	25.0	16
American bittern[1,2]	0	0.0	0	0.0	0	0.0	0	0.0	1	33.3	0	0.0	1	33.3	1	33.3	3
American coot	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	1
American goldfinch	0	0.0	10	19.2	21	40.4	0	0.0	5	9.6	3	5.8	3	5.8	10	19.2	52
American robin	0	0.0	7	25.9	5	18.5	1	3.7	11	40.7	0	0.0	0	0.0	3	11.1	27
Baltimore oriole	0	0.0	1	16.7	0	0.0	0	0.0	3	50.0	0	0.0	0	0.0	2	33.3	6
barn swallow	1	1.1	43	50.1	6	7.1	18	21.2	8	9.4	4	4.7	0	0.0	5	5.8	85
black-billed cuckoo[2]	0	0.0	1	25.0	1	25.0	1	25.0	0	0.0	0	0.0	0	0.0	1	25.0	4
blue jay	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1
blue-winged teal	0	0.0	2	25.0	0	0.0	1	12.5	2	25.0	2	25.0	0	0.0	1	12.5	8
bobolink[2]	40	3.6	420	37.3	47	3.4	292	24.3	157	14.0	13	1.2	20	1.8	136	12.1	1125
Brewer's blackbird	0	0.0	44	31.9	0	0.0	3	2.2	82	59.4	0	0.0	7	5.1	2	1.4	138
brown-headed cowbird	3	1.6	69	37.1	51	27.4	7	3.8	29	15.6	10	5.4	3	1.6	14	7.5	186
Canada goose	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	1
clay-colored sparrow[2]	21	6.6	110	34.7	107	32.8	5	1.6	14	4.4	7	2.2	9	2.8	44	13.9	317
cliff swallow	0	0.0	18	30.0	0	0.0	9	15.0	33	55.0	0	0.0	0	0.0	0	0.0	60
common grackle	2	6.1	3	9.1	22	66.7	0	0.0	5	15.2	0	0.0	1	3.0	0	0.0	33
common snipe	0	0.0	2	50.0	1	25.0	0	0.0	1	25.0	0	0.0	0	0.0	0	0.0	4
common yellowthoat	18	3.2	155	27.7	161	28.3	25	4.3	60	10.7	27	4.8	43	7.7	70	12.5	559
dickcissel[2]	0	0.0	0	0.0	0	0.0	0	0.0	2	33.3	0	0.0	0	0.0	4	66.7	6

COMMUNITY TYPE / SPECIES	Mesic Prairie		Wet Prairie		Seepage - Wetland Complex		Saline - Wet Prairie Complex		Prairie-Wetland Complex		Calcareous Fen		Emergent Marsh		Non- Native		Total
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	
eastern bluebird	0	0.0	3	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3
eastern kingbird	0	0.0	1	6.7	0	0.0	0	0.0	11	73.3	0	0.0	0	0.0	3	20.0	15
eastern phoebe	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	1
European starling	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	1
grasshopper sparrow[2]	13	4.0	53	16.3	6	0.9	147	45.2	43	13.2	0	0.0	0	0.0	63	19.4	325
gray catbird	1	8.3	4	33.3	3	25.0	0	0.0	2	16.7	0	0.0	0	0.0	2	16.7	12
greater prairie chicken[1,2]	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	1
Henslow's sparrow[1,2]	0	0.0	4	66.7	2	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6
horned lark	0	0.0	2	40.0	0	0.0	2	40.0	0	0.0	0	0.0	0	0.0	1	20.0	5
house wren	0	0.0	0	0.0	1	16.7	0	0.0	1	16.7	0	0.0	0	0.0	4	66.7	6
killdeer	0	0.0	48	82.8	0	0.0	0	0.0	10	17.2	0	0.0	0	0.0	0	0.0	58
least flycatcher	0	0.0	1	5.0	4	20.0	2	10.0	2	10.0	0	0.0	0	0.0	11	55.0	20
Le Conte's sparrow[2]	6	5.1	66	55.9	1	0.0	18	11.0	8	6.8	0	0.0	4	3.4	15	12.7	118
mallard	0	0.0	7	43.8	2	12.5	4	25.0	0	0.0	0	0.0	0	0.0	3	18.8	16
marbled godwit[1,2]	1	0.9	18	15.8	0	0.0	75	64.9	16	14.0	0	0.0	0	0.0	4	3.5	114
marsh wren[2]	0	0.0	6	10.5	9	15.8	0	0.0	7	12.3	1	1.8	29	50.9	5	8.8	57
mourning dove	1	1.6	18	28.1	21	32.8	1	1.6	8	12.5	3	4.7	1	1.6	11	17.2	64
northern flicker	1	16.7	2	33.3	0	0.0	1	16.7	2	33.3	0	0.0	0	0.0	0	0.0	6
northern harrier[1,2]	0	0.0	2	25.0	1	12.5	0	0.0	0	0.0	0	0.0	0	0.0	5	62.5	8
northern pintail	0	0.0	1	12.5	0	0.0	7	87.5	0	0.0	0	0.0	0	0.0	0	0.0	8
red-tailed hawk	0	0.0	1	25.5	0	0.0	0	0.0	2	50.0	0	0.0	0	0.0	1	25.0	4
red-winged blackbird	10	0.9	342	29.7	160	13.3	149	12.3	225	19.5	12	1.0	128	11.1	125	10.9	1151

COMMUNITY TYPE / SPECIES	Mesic Prairie		Wet Prairie		Seepage - Wetland Complex		Saline - Wet Prairie Complex		Prairie-Wetland Complex		Calcareous Fen		Emergent Marsh		Non- Native		Total
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	
ring-necked pheasant	0	0.0	0	0.0	3	75.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	4
savannah sparrow[2]	34	2.4	386	26.9	39	2.0	511	34.9	279	19.4	14	1.0	11	0.8	163	11.3	1437
sedge wren[2]	12	1.4	302	36.0	227	26.7	42	3.3	59	7.0	52	6.2	65	7.8	79	9.4	838
song sparrow	3	1.5	42	21.0	97	48.5	9	4.5	16	8.0	4	2.0	10	5.0	19	9.5	200
sora	0	0.0	3	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3
swamp sparrow	0	0.0	42	17.7	82	34.6	1	0.4	15	6.3	26	11.0	56	23.6	15	6.3	237
tree swallow	0	0.0	1	25.0	0	0.0	0	0.0	1	25.0	0	0.0	0	0.0	2	50.0	4
upland sandpiper[1,2]	0	0.0	25	56.8	0	0.0	2	4.5	15	34.1	0	0.0	0	0.0	2	4.5	44
veery	0	0.0	1	5.3	11	57.9	0	0.0	0	0.0	0	0.0	0	0.0	7	36.8	19
Virginia rail	0	0.0	1	50.0	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0	0	0.0	2
western meadowlark[2]	8	1.6	127	25.5	11	1.6	159	31.9	121	24.3	4	0.8	2	0.4	66	13.3	498
willow flycatcher	4	10.5	10	26.3	13	34.2	1	2.6	3	7.9	2	5.3	0	0.0	5	13.2	38
Wilson's phalarope[1,2]	0	0.0	7	77.8	0	0.0	2	22.2	0	0.0	0	0.0	0	0.0	0	0.0	9
yellow warbler	0	0.0	15	23.4	26	40.6	1	1.6	4	6.3	2	3.1	0	0.0	16	25.0	64
yellow-headed blackbird	1	2.4	4	9.8	0	0.0	0	0.0	36	87.8	0	0.0	0	0.0	0	0.0	41
NUMBER of PLOTS	4	2.6	47	30.3	22	13.5	30	18.7	21	13.5	4	2.6	9	5.8	18	11.6	155

[1] 1989 Conservation Concern Species

[2] 1999 Conservation Concern Species

no. number of bird records for that species recorded in the vegetation community type

% percent of total bird records for that species recorded in the vegetation community type

DISCUSSION

Bird and Habitat Results

Two-thirds (32) of the species breeding on the Rothsay Unit in 1989 were closely tied to grasslands (Table 15). This included 22 species from Minnesota's prairie bird classification systems (Oring 1979, MNDNR no date), another eight specified as facultative grassland species by Illinois' classification (Szafoni et al. no date), and two more (northern pintail, eastern bluebird) identified as grassland dependent (i.e., require grasslands during their breeding cycle) by Sample and Mossman (1997) in Wisconsin. Sixteen Conservation Concern Species, 13 classified as abundant or common on the site, are included on this list. In addition to these species, which are strongly connected to prairie and grasslands, six more species either commonly occur in grasslands (Sample and Mossman 1997) or are considered "grassland part-timers" (Szafoni et al. no date). The remaining 19 (33%) species breeding on the Rothsay Unit are not considered grassland birds.

The large number and diversity of grassland and prairie birds breeding on the Rothsay Unit is noteworthy, because many grassland birds are considered to have a high degree of habitat specialization and will disappear from a site relatively quickly when the vegetation changes (Askins 1993). The diversity of grassland bird species on the Rothsay Unit is probably due to at least three factors. First, many of the vegetative community types on the study area are interspersed; botanists (MNDNR 1998) classify these as complexes. Interspersion creates structural as well as vegetative covertype diversity.

TABLE 15. Summary of the relationship of birds breeding on the Rothsay Unit, northwestern Minnesota, in 1989, to native prairie and grassland habitats based on various classification systems.

Species Name	Habitat Association Classification Systems				
	Minnesota[3]	Wisconsin[5]	Illinois[6]	Great Plains[7]	BBS[8]
Conservation Concern Species					
*American bittern[1,2]	LC	-	eL	W	
black-billed cuckoo[2]		-	-	eW	w
bobolink[2]	MPP	RO	O	pG	G
clay-colored sparrow[2]	G4	R	-	eG	
dickcissel[2]	G4	RO	O	eG	G
grasshopper sparrow[2]	MPS	RO	O	pG	G
*greater prairie chicken[1,2]	MPS	RO	O	eG	G
*Henslow's sparrow [1,2]	G4	RO	O	eaG	G
Le Conte's sparrow[2]	WPP	RO	-	eG	G
*marbled godwit[1,2]	MPS	-	-	eG	W
marsh wren[2]	WPP	-	-	pL	W
*northern harrier[1,2]	WPS	RO	O	pG	G
savannah sparrow[2]	MPP	RO	O	pG	G
sedge wren[2]	G[4]	RO	O	eaL	G
*upland sandpiper[1,2]	MPP	RO	O	eG	G
western meadowlark[2]	MPP	RO	O	wG	G
*Wilson's phalarope[1,2]	WPS	R		-	eLW
Non-conservation Concern Species					
alder flycatcher		C	-	-	S
*American coot		-	-	pL	

American goldfinch		C	F	pW	S
American robin		LC	P	PW	U
Baltimore oriole		LC	-	pW	-
*barn swallow		C	P	-	-
blue jay		LC	-	eaW	U
*blue-winged teal		R	F		pLW
Brewer's blackbird	G[4]	R	-	wG	-
brown-headed cowbird	MPS	R	P	PW	-
*Canada goose		LC	-	pL	W
*cliff swallow		LC		-	-
common grackle		C	P	eaW	U
*common snipe	WPS	LC	-	nL	W
common yellowthroat		C	F	pL	S
eastern bluebird		R	-	eaW	-
eastern kingbird		C	P	eaW	-
eastern phoebe		LC	-	eaW	-
European starling		LC	-	-	U
gray catbird		LC	-	eaW	S
horned lark		RO	F	pG	G
house wren		LC	-	pW	S
*killdeer	MPS	C	F	pL	-
least flycatcher		-	-	eaW	W
*mallard		C	F	pL	W
mourning dove		C	F	PW	U
*northern pintail		R	-	pL	W

*red-tailed hawk		R	P	pW	-
red-winged blackbird	WPP	C	F	pL	W
*ring-necked pheasant		R	F	-	G
song sparrow		C	F	pW	S
*sora	WPS	LC	P	pL	W
swamp sparrow	WPS	C	F	nL	W
*tree swallow		LC	-	-	-
veery		-	-	nW	W
*Virginia rail		LC	-	pL	W
willow flycatcher		C	-	pW	S
yellow warbler		LC	-	pW	S
yellow-headed blackbird		LC	-	wL	W
*northern flicker		-	P	PW	-

* Not well sampled by point count methodology
' 1989 Conservation Concern Species
2 1999 Conservation Concern Species
3 Oring 1979. WPP = wet prairie primary species, WPS = wet prairie secondary species, MPP = mesic prairie primary species, MPS = mesic prairie secondary species, - = not categorized.
4 considered to be a grassland bird by MNDNR (undated list), but not on Oring's list
5 Sample and Mossman 1997. RO = Require grasslands during their breeding cycle and are considered Obligate grassland species, R = Require grasslands during their breeding cycle, C = birds that Commonly occur in grasslands, LC = species that occur Less Commonly in grasslands, - = not listed.
6 Szafoni et al., n.d. O = prairie obligate species (breed primarily or exclusively in prairie), F = facultative prairie species (breed preferentially in other habitats, but will also breed in prairie), P = "part-timers" (breed elsewhere but use prairie for certain activities such as foraging), - = not categorized.
7 Johnsgard 1978. Grassland birds that are a (endemic), w (western), p (pandemic), or ea (Eastern) in their distribution within habitats: G (grasslands), L (limnic), or W (woodlands and forests), - = not categorized.
8 Sauer et al. 1996. G = grassland breeding species, W = wetland-open water breeding species, w = woodland breeding species, S = successional shrub breeding species, U = urban species, - = not categorized.

Second, structural diversity within each vegetation covertype was present on the Rothsay Unit due to the existence of different land uses and management practices. Therefore, even though a large portion of the area was classified as wet prairie community types (73.6%) there was structural diversity present because some of the native prairie was hayed in late July/early August, grazed, left idle, and other areas periodically burned. Resulting spatial diversity in vegetation structure benefits species that require diverse habitat structure to meet various life requirements. For example, the greater prairiechicken, congregates on traditional "dancing" or "booming" grounds (leks) for courtship displays each year in the early spring as long as the habitat remains suitable. The requisites for these booming grounds are open areas with short cover. Burned, mowed, matted down, and plowed sites can fulfill these conditions and are used by the greater prairie-chicken in Minnesota (Svedarsky 1979, Minnesota Prairie Chicken Society 1985, Coffin and Pfannmuller 1988). Nesting and brood-rearing habitat, in contrast, is described as more dense, taller, undisturbed cover and is generally located within a mile of the booming grounds (Svedarsky 1979, Minnesota Prairie Chicken Society 1985, Coffin and Pfannmuller 1988).

A third reason that the grassland bird community on the Rothsay Unit possesses high diversity is because it is a large enough patch of continuous prairie to support many of these species (Samson 1980; Johnson and Temple 1986; Herkert 1991, 1995; Vickery 1993). The abundance and wide distribution of many Conservation Concern Species (e.g., bobolink; western meadowlark; sedge wren; savannah, clay-colored, grasshopper and Le Conte's sparrow; marbled godwit; greater prairie chicken; upland sandpiper and northern harrier) across the Rothsay study area supports this hypothesis. This area may

serve as a refugium for these regionally declining species. The Rothsay Unit may be one of the few areas in Minnesota and central North America large enough to support viable populations of these species within its boundaries. My research did not address population viability, but I suggest that assessing the level of productivity of the breeding birds and viability of their populations on the Rothsay Unit as an important future study.

Limitations of Point Count Sampling Method

Paramount to understanding and interpreting bird observations from this study is the inherent shortcomings of point count methodology to effectively sample birds that do not use vocalizations for territory defense and/or advertisement, or are soft or erratic singers. At least six general types of birds fall within this category; secretive marsh birds, waterfowl, shorebirds, woodpeckers, raptors, and gallinaceous birds (Ralph et al. 1992). Although some individuals within these bird groups are recorded with this methodology based on sightings rather than song, these orders are underestimated and generally overlooked completely using point counts. In addition, nocturnal and crepuscular birds have low probability of detection during point counts because their active singing times end as data collection begins. Despite these limitations, point counts were chosen as the method to obtain information about the widest cross-section of birds expected on the stud, site (i.e., songbirds). For the original birds of special interest at the time the study was designed (i.e., the 1989 Conservation Concern Species) an extended sampling method was developed to help overcome these shortcomings. Additional sampling methods developed for species not effectively sampled by point counts is required to obtain a more complete characterization of all birds on the Rothsay Unit. For example, taped call playbacks could be used to survey secretive marsh birds (USFWS 1999). The

success of the extended sampling procedures undertaken in this study illustrates the effectiveness of additional sampling methods for gaining more information on species with the potential to be underestimated by point count methodology.

Breeding Status

Fifty-seven (75%) of 76 species recorded in this study were considered breeding birds. This included seven (67%) of 11 original 1989 Conservation Concern Species and 17 (81%) of the 21 Conservation Concern Species in 1999. All but eight of the 57 breeding species were recorded during four or more weeks out of six weeks of data collection. One 1989 Conservation Concern Species, the sandhill crane, was never recorded in this study, although conversations with local residents and wildlife biologists revealed this species was a migrant that left the site prior to my arrival on 1 May 1989. Classifications for the remaining 1989 species were: yellow rail, potential breeder; short-eared owl and Nelson's sharp-tailed sparrow, migrants.

Bird records collected outside the regular sampling method were also summarized The :majority of these species (67%) were classified as migrants. Although not a focus of this study, these migratory records help provide a more complete picture of the contribution that the Rothsay Unit makes to bird populations outside the breeding season. Use of the Rothsay Unit by fall and early spring migrants was not documented. Breeding status for species recorded informally during the breeding season (i.e., after 1 June) can only be suggested because they were not detected by my sampling method.

Seven potential breeding species were identified through informal record keeping before, during, and after the

sampling conducted in this study. Interestingly, all seven species, are not well sampled by point counts. Therefore, these species may have been present throughout the breeding season, yet undetected using point counts. Different sampling methods are required to determine the breeding status of these species on the Rothsay Unit and would also facilitate a better understanding of the 22 species detected during the regular sampling method that are not well sampled by point counts.

Abundance and Spatial Distribution

The breeding species identified on the study site exhibited a variety of spatial distributions and levels of abundance across the site. The eight species classified as abundant had either widespread (75% of the species) or moderate (25%) distributions. The 15 uncommon and 15 rare species had either local or rare distributions. These species were: classified as narrowly distributed based on three factors. First, the horned lark, an early nesting species, performs much of its territorial display and defense prior to mid-May (Janssen 1987) which was outside my sampling time frame. Second, 14 of these birds are woodland/shrubland nesting species. They showed limited spatial distribution due to the paucity of suitable breeding habitat on the Rothsay Unit. Third, half the 30 breeding birds with a small number of observations and restricted distribution are species not well sampled by point counts.

The remaining 19 species, classified as common, showed a wider range of differences in their spatial distribution. Three had local distribution, nine (47%) had restricted and seven (37%) had moderate distributions. The three locally distributed species included barn and cliff swallows, both of which have limited breeding sites on the Unit; and the yellow-headed blackbird, which was detected in only five plots; 88%

of its occurrences were in the prairie-wetland complex habitat on the Rothsay Unit. The nine common species with restricted spatial distribution included one species, the marsh wren, which is considered a primary species of wet prairies in Minnesota (Oring 1979).

The category of "common species" included the largest proportion (57%) of 1989 special concern species (all four of which are not well sampled by point counts). This category also included three species considered secondary prairie inhabitants in Minnesota, two considered prairie facultative species in Illinois, and three associated more closely with woodland or successional-shrub habitat.

Density of Breeding Pairs

A comparison of the minimum ecological and absolute density of breeding pairs for a species corroborates the spatial distribution classification system developed for this study. The yellow-headed blackbird and savanna sparrow provide two excellent examples. The density of breeding pairs for yellow-headed blackbird in suitable habitat (ecological density) was 102 pairs/km2, the highest reported for any species by this method. This is in contrast to breeding pair density for the entire area (absolute density), where this species ranked 20' (3 pairs/km2). The large difference in breeding pair density estimates resulted fromn yellow-headed blackbird occurrence in large numbers, but on only five plots. The estimated breeding pair density for the savannah sparrow remained consistent, independent of the calculation method. The savannah sparrow ranked first (58 pairs/km2) in absolute density and fifth (69 pairs/km^2) for ecological density, suggesting it was more widely distributed and abundant. Savannah sparrows were recorded on 131 of 155 plots and had the highest frequency of occurrence on the study area.

Breeding pair density data allow geographic and temporal comparisons within species. As one of the largest intact areas of native prairie remaining in Minnesota, the Rothsay Unit potentially supports one of the best complements of tallgrass prairie birds regionally. Therefore, densities on the Rothsay Unit could possibly be used as a measure of the potential value of other sites to grassland bird conservation. The potential of a site could then be used in management and/or policy decisions needed to identify and prioritize areas for protection. Additional research spanning more than one field season at the Rothsay Unit and comparative studies at several other prairie sites in Minnesota and the greater region are needed to test the validity of using breeding pair density to identify other important sites for grassland birds.

Habitat Availability

Distribution and pair density data evoke questions regarding habitat availability on the Rothsay Unit. For example, if a species is more widely distributed, is this due to life history factors (i.e., it is a habitat generalist) or does the Rothsay Unit provide more suitable habitat for this species than elsewhere. Habitat data were collected to answer questions regarding the associations of bird species on the Rothsay Unit and vegetation community types (habitats) in which they occurred. I found the distribution of the vegetative community types within the plots was statistically similar to the entire Rothsay Unit. Therefore, species effectively sampled by points counts and the 1989 Conservation Concern Species data augmented by the extended sampling method, the differences seen for bird abundance and distribution from this study should reflect the amount of suitable habitat. A formal habitat preference analysis (Nue et al. 1974; Alldredge and Ratti 1986, 1992) could provide further insight into this topic.

Relationship of Vegetation Variables to Bird Occurrence

Individual vegetation variables were significantly associated with presence of some bird species; but, generally, these characteristics were not strong predictors of bird distribution or abundance, either singly or in combination. Features of prairie habitats important to birds may be selected at a larger scale than what was measured in this study. Recent literature suggests that size and context (i.e., surrounding land use and type) of prairie landscapes are important habitat characteristics for bird conservation areas (Fitzgerald et al. 1998). These authors proposed a model for grassland bird conservation areas, incorporating these landscape attributes. Their model is currently being tested for its efficacy in supporting healthy populations of prairie avifauna (Donovan et al. 1998). The Rothsay Unit could provide a useful study site for this research.

Extrapolation of Rothsay Unit's Vegetation Covertypes to Ecoregion

GIS analysis allowed an extrapolation of Rothsay Unit vegetation covertypes to the remainder of reserve habitat in Minnesota and the greater ecoregion. This descriptive analysis underscored the contribution that the Rothsay Unit makes to all managed areas in Iowa and Minnesota within the Northern Tallgrass Prairie Ecoregion relative to vegetation community types. For example, the Rothsay Unit contains about 84.8 hectares (56%) of calcareous fen out of 159 hectares within all managed areas. It also contains about 811.8 hectares of wet prairie in 15 separate parcels, accounting for 27% of this community type in the managed lands in the ecoregion, including the second largest wet-mesic prairie parcel (239 hectares) and the second largest cordgrass wet prairie (182 hectares) in the ecoregion (TNC 1998). Total wet prairie in managed areas in Minnesota

and Iowa within the Northern Tallgrass Prairie Ecoregion approximates 2,603 hectares, which occurs in 208 separate parcels. On average, 12.5 hectares of wet prairie community types would occur per parcel, although outside the Rothsay Unit a 207-hectare wet cordgrass prairie and ;a 285-hectare wet-mesic prairie parcel exist (TNC 1998). Many of the remaining 204 areas of wet prairie are small fragments of natural habitat existing in a matrix of agricultural and sometimes rural residential land uses. The situation is similar for other natural community types present on the Rothsay Unit. Because information is incomplete, this analysis cannot be extended to the estimated 75% of native prairie remnants that are privately owned. These prairie parcels under private ownership, including about half the Rothsay Unit, have neither conservation support nor legal protection to prevent future loss.

Conservation and Management Implications

The Rothsay Unit, one of the largest intact areas of contiguous native prairie in Minnesota, has implications to the broader picture of the conservation of native prairie and grassland avifauna and native prairie habitats in Minnesota and the ecoregion.

New Initiatives

Many new conservation initiatives for the tallgrass prairie ecosystem have been developed recently. As a testimony to the threatened nature of the native communities contained within the Northern Tallgrass Prairie Ecoregion, The Midwest Regional Chapter of TNC focused on this ecoregion in its first ecoregional conservation plan (TNC 1998). TNC selected several areas, including the Rothsay Unit, as representative conservation sites (TNC 1998) to meet the Conservancy's conservation goal of ensuring

"the long-term survival of all viable native species and community types through the design and conservation of portfolios of sites within ecoregions." Criteria for choosing these sites were based on their biological viability (i.e., their potential for long-term sustainability of certain natural community and species conservation targets), biodiversity value (higher quality occurrences of conservation targets and larger continuous blocks were favored), efficiency of the action, and complementary (i.e., if they could augment existing managed areas).

This same year, the USFWS published a final Environmental Impact Statement for the establishment of a Northern Tallgrass Prairie Habitat Preservation Area (USFWS 1998) "as a means of working with individuals, groups, and governmental entities to permanently preserve tracts of northern tallgrass prairie. The purpose of this action is to preserve, restore and manage a portion of the remaining critical northern tallgrass prairie habitat and associated habitats at widespread locations throughout the historic range of the northern tallgrass prairie area of western Minnesota and northwestern Iowa." This project ranks fourth nationally out of 176 USFWS land. management/acquisition projects for the upcoming FY2001 budget proposal (R. Cole, pers comm). Realizing the importance of this effort, the "Dakota Tallgrass Prairie Project" was initiated in 1999 by the USFWS to accomplish many of the same goals for the tallgrass prairie ecosystem in North and South Dakota (C. Mowry, pers comm).

Specific to prairie avifauna, the Partners in Flight network (a consortium of hundreds of public and private organizations and individuals dedicated to maintaining healthy bird populations in the U.S. and throughout the Western Hemisphere), recognized the importance of the tallgrass prairie ecosystem, by selecting this ecoregion for its first

bird conservation plan (Fitzgerald et a1.1998). This plan, the first of its kind in the U.S., identified migratory birds of highest conservation priority within the Northern Tallgrass Prairie Ecoregion and recommended strategies for their conservation.

In addition, TNC (Chapman et al. 1998) identified important sites for bird conservation in the Northern Tallgrass Prairie Ecoregion as a step down implementation plan for its broader ecoregional planning effort. In this document, the Rothsay Unit was selected as an important bird conservation area within the Northern Tallgrass Prairie Ecoregion. Since my study was conducted in 1989, TNC has increased land protection in this ,area. In 1995 they purchased 259 ha (640 acres) and transferred it to the MNDNR for inclusion in the Rothsay Wildlife Management Area. Through additional acquisition, TNC has increased the size of their own Anna Gronseth and Town Hall Prairie Preserves to 542 ha (1,340 acres) and 81 ha (200 acres), respectively. Other landowners in the area have enrolled native tallgrass prairie into Minnesota's Prairie Bank Program which gives landowners a tax break for leaving the prairie intact (B. Winter pers comm).

Ecosystem Approach

A common thread that runs through these conservation initiatives for tallgrass prairie and its associated wildlife species, is the recognition of need for an ecosystem approach and involvement of private citizens for successful implementation. Many conservation organizations and agencies have shifted from single species management to conservation of healthy functioning plant communities. Even when individual species are identified as conservation targets, it is recognized that it is not "appropriate to focus conservation actions (including management and research activities) on these species to the exclusion of all others" and "there is little doubt that the habitats used by these

assemblages should be high priorities for management and protection" (USFWS 1995a). The ecosystem approach recognizes the need to look beyond borders of managed areas and statutory boundaries of states and countries to conserve natural entities that do not "respect" these anthropocentric divisions of the land. This approach is currently embraced by most federal and state agencies, national and local conservation organizations, and academia. Secretary of Interior Bruce Babbitt captured this new thinking when he stated in 1994: "We need a new approach: one that encourages us to think ahead and plan for the future; one that encourages us to look at whole ecosystems and not just tiny parcels of land,; one that stresses compromise and balance between people and nature." (Klatt and Neal 1996).

Involvement of Local Stakeholders and Partners

The current prairie initiatives also stress the need to engage and involve the general public, especially those in possession of 75-95% of the remaining natural plant communities in the Northern Tallgrass Prairie Ecoregion (TNC 1998, USFWS 1998). For example, the USFWS stated that the Northern Tallgrass Prairie Habitat Protection Area will be "a non-traditional type of resource preservation effort, one that uses multi[ple] levels of involvement, protection and preservation techniques. Emphasis will be on permanent protection of prairie resources through a variety of means. The first choice will be working with private landowners and partnerships to ensure permanent protection" (USFWS 1998). This was reiterated by TNC in its Ecoregional Planning in the Northern Tallgrass Prairie Ecoregion document when it stated: "It is clear that successful implementation of the ecoregion design will be largely dependent upon the

participation and support of private landowners" (TNC 1998). There are many federal, state, local, and private habitat restoration and preservation mechanisms that can be used to accomplish these goals (USFWS 1998). These programs are available to secure the future of privately owned native prairie on the Rothsay Unit and elsewhere.

Restoration of Habitats and Surrogate Grasslands

In general these conservation initiatives lack consideration of prairie restoration efforts and the value of "surrogate grasslands" (Sample and Mossman 1997) . Instead, these documents focus on identification and conservation of remaining natural remnants. This approach overlooks many areas managed for the conservation of natural resources that include restoration of natural habitat as a management goal. A number of restoration efforts have been conducted for many years. The management of Waterfowl Production Areas in the prairie pothole region of the U.S. by Wetland Management Districts of the USFWS, begun in the 1960s, is a strong example of these efforts.

When attempting to extrapolate natural community types on the Rothsay Unit to the larger ecosystem using present datasets and GIS coverages, it was not possible to identify previously restored habitats, even those existing on managed areas. While protection of remaining viable remnants of native prairie should be a priority in any prairie conservation effort, there is also merit in the restoration of habitat for the future values it can provide. Restoration efforts can create connections between extant habitats. Without restoration efforts there may be few areas capable of supporting viable populations of species that require larger areas such as birds and large mammals.

Within the Rothsay Unit there are opportunities for prairie restoration. There are approximately 500 hectares of non-native vegetation in the form of pastures, crop fields

and :hayfields. Additionally, within 1.6 km (1 mile) of the Rothsay Unit there are four other parcels containing native prairie. If the buffer around the Rothsay Unit is extended to 111.2 km (7 miles), there are a total of 20 such parcels and eight additional managed areas with restoration potential (Figure 7). Prairie restoration of the intervening lands will provide links between these sites and increase the effective area of the Rothsay Unit. These links can also provide an important corridor for less mobile prairie species to facilitate immigration/emigration and genetic exchange between potentially isolated populations. The Nature Conservancy began to recognize this potential and benefit to link natural lands in their ecoregional plan when they included the Atherton Wildlife Management Area in their Rothsay Conservation Unit (TNC 1998).

In addition to prairie restoration, maintenance and/or enhancement of surrogate grassland areas should also be actively pursued as a strategy for the conservation of prairie avifauna. Surrogate grasslands (Sample and Mossman 1997) are habitats similar to native grasslands that have largely replaced prairie through much of the historic range and can mimic the structure found on the prairie. They regularly include agricultural habitats such as hayfields, old fields, pastures, row cropped areas, and set-aside acres. Surrogate grasslands can also be found at airports, golf courses and parks and are important to the maintenance of grassland bird communities (Sample and Mossman 1997).

While it is fortunate that the Rothsay Unit provides diverse habitat for many prairie birds in its present condition, it is important to note that the existence of healthy bird populations, even on this large block of native prairie, is augmented by adjacent non-native habitats that create the ecological context within which the Rothsay Unit lies.

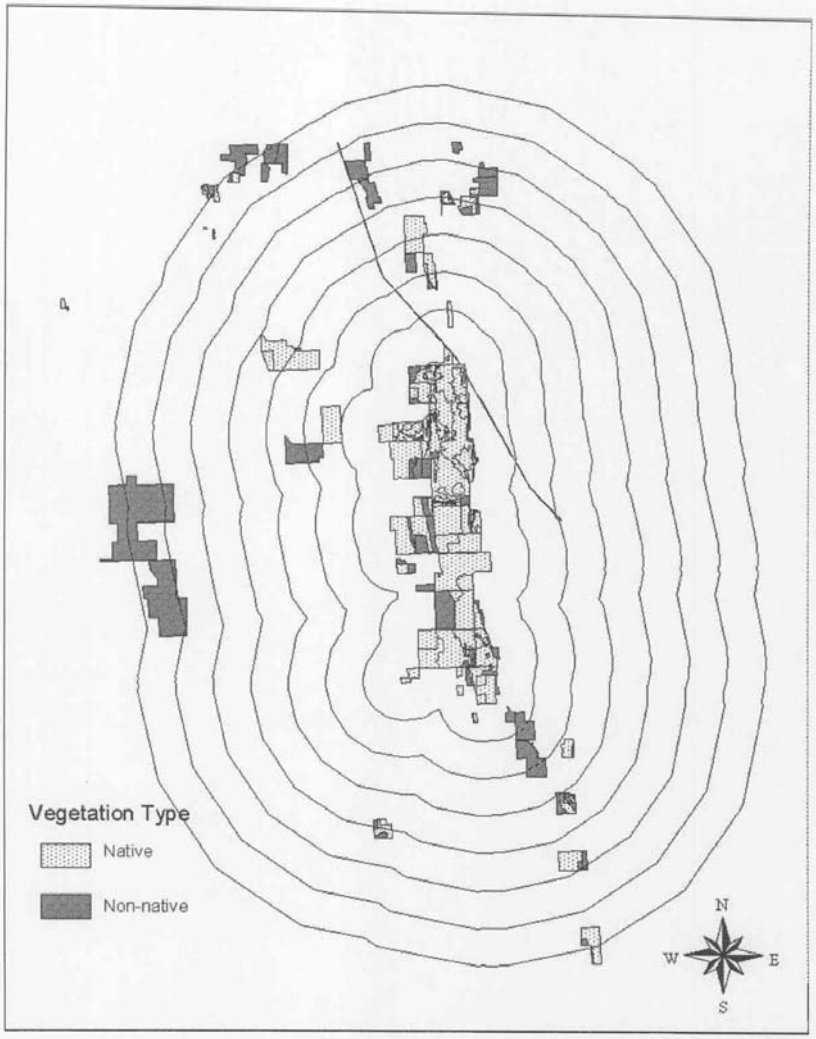

FIGURE 7. The Rothsay Unit and its relationship to other managed areas in Wilkin County, Minnesota within seven 0.6 km (1 mi.) buffers.

Many of the grassland birds breeding on the Rothsay Unit use adjacent "surrogate prairie grassland areas" to meet certain aspects of their life requirements (e.g., foraging, courtship, rearing young, roosting, resting and even nesting).

The Conservation Reserve Program (CRP), a U.S. Department of Agriculture set-aside program that compensates farmers to remove certain areas from production, can serve as surrogate grasslands when established to permanent cover plantings. There were 32,877 hectares (81,240 acres) of lands enrolled in CRP in Minnesota alone from 1986 to 1993 that have been planted to native grassland vegetation for permanent cover and an additional 550,668 hectares (1,360,700 acres) planted to introduced grass permanent cover (Minnesota Department of Agriculture 1997). The importance of CRP lands to maintenance and enhancement of grassland birds has recently been documented (Sample and I.VIossman 1990, Kantrud et al. 1993, Reynolds et al. 1994, Johnson and Igl 1995, Patterson and Best 1996). However, the long-term future for these lands is uncertain because they are enrolled into the program under ten-year contracts and may be again "lost: to the plow" if a contract is not renewed by the federal government or the landowner. For example, after 1999, only 3,820 (11.6%) of the 32,877 hectares of the native grass plantings will still be under contract, unless renewed (Minnesota Department of Agriculture 1997).

Although Sample and Mossman (1990), promote surrogate grasslands, they also understand the inherent challenge of short-term set-aside programs. These sites can serve as ecological traps, or population "sinks" where local mortality is greater than local productivity (Pulliam and Danielson 1991, Meffee and Carroll 1994). This occurs when areas attract breeding birds to nest, but terminate production prematurely when the area is

hayed, mowed, or cropped before eggs hatch and young fledge. For these areas and all other private landholdings to effectively participate in a program aimed at prairie and prairie bird conservation, it will take active engagement and education of landowners by resource agencies and organizations. A program similar to the "Safe Harbor" concept (USFWS 1999), used in endangered species management, may prove a viable management option for grassland conservation. The Safe Harbor program encourages landowners to adopt management practices that will benefit threatened and endangered species, but also allows the landowner to return the area to pre-management condition without penalty. A program such as this on private lands to benefit grassland birds (e.g., delaying mowing or rotational grazing) may be a strategy to increase the contribution private lands can make to prairie conservation. While the landowner incentive for Safe Harbor agreements is assurance that additional regulatory restrictions from the Endangered Species Act will not be imposed, a monetary incentive may be required to enlist landowners to harbor grassland bird species, which are without any legal "clout". Monetary incentive programs or technical assistance programs focused on rewarding "grassland bird friendly" agricultural practices, such as conservation tillage could also prove helpful in increasing the benefit of these surrogate grasslands to grassland birds (Warburton and Kilmstra 1984, Basore et al. 1986). Long term conservation of native plant and bird communities on the Rothsay Prairie Landscape Unit will require tugging on many of the common threads described for the recent ecosystem-wide tallgrass prairie initiatives. To ensure future viability of the Rothsay Unit as a prairie landscape reserve, conservation efforts should:

- Include private stakeholders.

  The first priority should be to avoid further loss of large privately owned tracts of native tallgrass prairie in this area through innovative partnerships.

- Occur at regional/ecosystem level

  Planning should include reintroduction of as many historical natural disturbance regimes as possible (e.g., fire, grazing) to increase diversity of structure and reestablish natural patterns and processes. The present patchwork of habitat structure and successional stages was critical to the diversity of birds using the area.

- Adopt an interdisciplinary approach for effective management

  The goals of avian conservation cannot exist in a vacuum. They must be integrated with other goals existing on the prairie and surrogate grassland areas (e.g., agriculture, range management, soil conservation)

- Explore expansion of the existing Rothsay Landscape Unit to create a larger native tallgrass prairie conservation area.

  Expansion will be facilitated through restoration of intervening non-native areas, effectively linking existing native prairie tracts of all ownership types through innovative partnerships.

SUMMARY AND CONCLUSIONS

The study site for this research, consisted of 3,238 hectares of native prairie near Rotlisay, Minnesota, and represents an opportunity to accomplish the goals of conservation for single species, suites of species, and plant communities on a landscape scale. My research focused on the bird community in the Rothsay Unit, and identified a minimum of 57 breeding species in 1989, including many declining grassland bird species and 18 species of conservation concern. Although abundance and spatial distribution of these species varied across the site, significant differences as related to measured habitat variables were able to explain < 45% of this variation. An assessment of larger landscape and vegetation covertype attributes may provide more insight into the reasons behind these differences.

The Rothsay Unit is an important model for the renewed interest in supporting larger efforts to conserve ecosystem integrity, biological health and diversity in the Northern Tallgrass Prairie Ecoregion (Chapman et al. 1998, TNC 1998, USFWS 1998, USFWS 1999). This study demonstrated that the Rothsay Unit provides nesting habitat for many declining grassland bird species; it also supports vegetation communities of conservation interest (Grossman et al. 1994, MNDNR 1998, TNC 1998). Recognizing the conservation value of the Rothsay Unit, TNC recently identified a "conservation area" including the Rothsay Unit as a priority area for the conservation of tallgrass prairie plant communities and birds in a new planning initiative for the Northern Tallgrass Prairie Ecoregion (Chapman et al. 1998, TNC 1998). As one of the largest remaining remnants of tallgrass prairie in Minnesota, the Rothsay Unit may also support other taxa of animals and plants in decline and larger scale ecosystem functions yet to be identified. It is the

existence of large remnants of native habitat, like the Rothsay Unit, that provides hope for conservation and restoration of ecosystems now largely lost or degraded. However, we cannot achieve this goal without restoration of the landscape on a larger scale and integration of community-based conservation efforts.

APPENDIX A

LATIN NAMES FOR BIRDS OBSERVED ON THE
ROTHSAY PRAIRIE LANDSCAPE UNIT
MAY- JULY 1989

latin names, based on the American Ornithologists' Union Checklist of North American Birds, seventh edition.
http://pica.wru.umt.edu/AOU/birdlist.HTML ©1999 AOU, last updated 30 September 1998

Appendix A - Latin names for birds observed on Rothsay Unit, 1989

SPECIES	Latin name
alder flycatcher	Empidonax alnorum
American bittern[1,2]	Botaurus lentiginosus
American black duck	Anas rubripes
American coot	Fulica amencana
American crow	Corvus brachyrhynchos
American golden-plover	Pluvialis dominica
American goldfinch	Carduelis tristis
American kestrel	Falco sparverius
American robin	Turdus migratorius
American wigeon	Anas americana
Arnerican woodcock	Scolopax minor
Baltimore oriole	Icterus galbula
bank swallow	Riparia riparia
barn swallow	Hirundo rustica
black-billed cuckoo[2]	Coccyzus erythropthalmus
black-capped chickadee	Poecile atricapillus
black-crowned night-heron	Nycticorax nycticorax
blue jay	Cyanocitta cristata
blue-winged teal	Anas discors
bobolink[2]	Dolichonyx oryzivorus
Brewer's blackbird	Euphagus cyanocephalus
brown thrasher	Toxostoma rufum
brown-headed cowbird	Molothrus ater
Canada goose	Branta canadensis
cedar waxwing	Bombycilla cedrorum
chestnut-collared longspur	Calcarius ornatus
chimney swift	Chaetura pelagica
clay-colored sparrow[2]	Spizella pallida

SPECIES	Latin name
cliff swallow	Petrochelidon pyrrhonota
common grackle	Quiscalus quiscula
common nighthawk	Chordeiles minor
common snipe	Gallinago gallinago
common yellowthoat	Geothlypis trichas
Cooper's hawk	Accipiter cooperii
dickcissel[2]	Spiza americana
double-crested cormorant	Phalacrocorax auritus
downy woodpecker	Picoides pubescens
eastern bluebird	Sialia sialis
eastern kingbird	Tyrannus tyrannus
eastern phoebe	Sayornis phoebe
eastern wood pewee	Contopus virens
European starling	Sturnus vulgaris
Forster's tern	Sterna forsteri
Franklin's gull	Larus pipixcan
golden-winged warbler	Vermivora chrysoptera
grasshopper sparrow'	Ammodramus savannarum
gray catbird	Dumetella carolinensis
great blue heron	Ardea herodias
great egret	Ardea alba
great horned owl	Bubo virginianus
great-crested flycatcher	Myiarchus crinitus
greater prairie chicken[1,2]	Tympanuchus cupido
greater yellowlegs	Tringa melanoleuca
green heron	Butorides virescens
green-winged teal	Anas crecca
hairy woodpecker	Picoides villosus

Appendix A - Latin names for birds observed on Rothsay Unit, 1989

SPECIES	Latin name
Henslow's sparrow[1,2]	Ammodramus henslowii
horned lark	Eremophila alpestris
house sparrow	Passer domesticus
house wren	Troglodytes aedon
Hudsonian godwit	Limosa haemastica
killdeer	Charadrius vociferus
Lapland longspur	Calcarius lapponicus
lark, bunting	Calamospiza melanocorys
Le Conte's sparrow[2]	Ammodramus leconteii
least bittern	Ixobrychus exilis
least flycatcher	Empidonax minimus
lesser yellowlegs	Tringa flavipes
mallard	Anas platyrhynchos
marbled godwit [1,2]	Limosa fedoa
marsh wren[2]	Cistothorus palustris
mourning dove	Zenaida macroura
Nelson's sharp-tailed sparrow[1,2]	Ammodramus nelsoni
northern flicker	Colaptes auratus
northern harrier[1,2]	Circus cyaneus
northern pintail	Anas acuta
northern rough-winged swallow	Stelgidopteryx serripennis
northern shoveler	Anas clypeata
northern waterthrush	Seiurus noveboracensis
orchard oriole	Icterus spurius
osprey	Pandion haliaetus
palm warbler	Dendroica palmarum
pied-bill grebe	Podilymbus podiceps

Appendix A - Latin names for birds observed on Rothsay Unit, 1989

SPECIES	Latin name
purple martin	Progne subis
red-eyed vireo	Vireo olivaceus
red-tailed hawk	Buteo j amaicensis
red-winged blackbird	Agelaius phoeniceus
ring-billed gull	Larus delawarensis
ring-necked pheasant	Phasianus colchicus
rock dove	Columba livia
rose-breasted grosbeak	Pheucticus ludovicianus
savannah sparrow[2]	Passerculus sandwichensis
sedge wren[2]	Cistothorus platensis
short-eared owl[1,2]	Asio flammeus
snow goose	Chen caerulescens
solitary sandpiper	Tringa solitaria
song sparrow	Melospiza melodia
sora	Porzana carolina
Swainson's hawk	Buteo swainsoni
swamp sparrow	Melospiza georgiana
Tenmesee warbler	Vermivora peregrina
tree swallow	Tachycineta bicolor
upland sandpiper [1,2]	Bartramia longicauda
vecry	Catharus fuscescens

SPECIES	Latin name
vesper sparrow	Pooecetes gramineus
Virginia rail	Rallus limicola
warbling vireo	Vireo gilvus
western kingbird	Tyrannus verticalis
western meadowlark [2]	Sturnella neglecta
white-throated sparrow	Zonotrichia albicollis
willow flycatcher	Empidonax traillii
Wilson's phalarope[1,2]	Phalaropus tricolor
Wi son's warbler	Wilsonia pusilla
wood duck	Aix sponsa
yellow rail[1,2]	Coturnicops noveboracensis
yellow warbler	Dendroica petechia
yellow-breasted chat	Icteria virens
yellow-headed blackbird	Xanthocephalus xanthocephalus
yellow-rumped warbler	Dendroica coronata

[1] 1989 conservation concern species
[2] 1999 conservation concern species

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ADDENDUM - Bird Use of the Rothsay Unit by Land Use Category

As a result of discussions during my thesis defense it was decided that the following table summarizing the land use types where breeding birds were found on the Rothsay Unit would be included here as an addendum.

TABLE X. Land use categories where breeding birds were found on the Rothsay Unit, northwestern Minnesota, 1989.

LAND USE CATEGORY / SPECIES	Burned		Grazed		Hayed		Idle		Plowed		Total
	no.	%	no.	%	no.	%	no.	%	no.	%	
alder flycatcher	0	0.0	0	0.0	1	6.3	15	93.8	0	0.0	16
American bittern[1,2]	0	0.0	0	0.0	1	33.3	2	66.7	0	0.0	3
American goldfinch	0	0.0	4	7.7	0	0.0	48	92.3	0	0.0	52
American robin	0	0.0	12	44.4	1	3.7	14	51.9	0	0.0	27
black-billed cuckoo[2]	0	0.0	1	25.0	1	25.0	2	50.0	0	0.0	4
bobolink[2]	3	0.3	106	9.4	197	17.5	807	71.7	12	1.1	1125
Brewer's blackbird	46	33.3	81	58.7	2	1.4	9	6.5	0	0.0	138
brown-headed cowbird	0	0.0	25	13.4	5	2.7	156	83.9	0	0.0	186
clay-colored sparrow[2]	0	0.0	10	3.2	7	2.2	300	94.6	0	0.0	317
common snipe	0	0.0	1	25.0	0	0.0	3	75.0	0	0.0	4
common yellowthoat	0	0.0	41	7.3	22	3.9	495	88.6	1	0.2	559
dickcissel[2]	0	0.0	0	0.0	0	0.0	6	100.0	0	0.0	6
Eastern kingbird	0	0.0	6	40.0	1	6.7	8	53.3	0	0.0	15
grasshopper sparrow[2]	3	0.9	29	8.9	162	49.8	118	36.3	13	4.0	325
gray catbird	0	0.0	2	16.7	0	0.0	10	83.3	0	0.0	12
greater prairie chicken[1,2]	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	1
Henslow's sparrow[1,2]	0	0.0	0	0.0	0	0.0	6	100.0	0	0.0	6
horned lark	0	0.0	2	40.0	2	40.0	0	0.0	1	20.0	5
house wren	0	0.0	1	16.7	0	0.0	5	83.3	0	0.0	6
killdeer	0	0.0	56	96.6	0	0.0	2	3.4	0	0.0	58
least flycatcher	0	0.0	2	10.0	2	10.0	16	80.0	0	0.0	20
LeConte's sparrow[2]	0	0.0	10	8.5	2	1.7	106	89.8	0	0.0	118
mallard	0	0.0	0	0.0	4	25.0	12	75.0	0	0.0	16
marbled godwit[1,2]	0	0.0	31	27.2	75	65.8	8	7.0	0	0.0	114
marsh wren[2]	0	0.0	5	8.8	2	3.5	50	87.7	0	0.0	57
mourning dove[2]	0	0.0	11	17.2	3	4.7	50	78.1	0	0.0	64
Northern harrier[1,2]	0	0.0	0	0.0	0	0.0	8	100.0	0	0.0	8
red-winged blackbird	0	0.0	236	20.5	54	4.7	861	74.8	0	0.0	1151

LAND USE CATEGORY / SPECIES	Burned		Grazed		Hayed		Idle		Plowed		Total
	no.	%	no.	%	no.	%	no.	%	no.	%	
ring-necked pheasant	0	0.0	0	0.0	0	0.0	4	100.0	0	0.0	4
rose-breasted grosbeak	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	1
savannah sparrow[2]	27	1.9	237	16.5	453	31.5	700	48.7	20	1.4	1437
sedge wren[2]	0	0.0	60	7.2	12	1.4	763	91.1	3	0.4	838
song sparrow	0	0.0	14	7.0	11	5.5	175	87.5	0	0.0	200
sora	0	0.0	0	0.0	0	0.0	3	100.0	0	0.0	3
swamp sparrow	0	0.0	3	1.3	4	1.7	230	97.0	0	0.0	237
tree swallow	0	0.0	2	50.0	0	0.0	2	50.0	0	0.0	4
upland sandpiper[1,2]	0	0.0	39	88.6	2	4.5	3	6.8	0	0.0	44
veery	0	0.0	1	5.3	0	0.0	18	94.7	0	0.0	19
Virginia rail	0	0.0	0	0.0	0	0.0	2	100.0	0	0.0	2
Western meadowlark[2]	7	1.4	131	26.3	155	31.1	196	39.4	9	1.8	498
willow flycatcher	0	0.0	4	10.5	2	5.3	32	84.2	0	0.0	38
Wilson's phalarope[1,2]	0	0.0	4	44.4	2	22.2	3	33.3	0	0.0	9
yellow warbler	0	0.0	12	18.8	1	1.6	51	79.7	0	0.0	64
yellow-breasted chat	0	0.0	0	0.0	0	0.0	2	100.0	0	0.0	2
yellow-headed blackbird	0	0.0	40	97.6	0	0.0	1	2.4	0	0.0	41
NUMBER OF PLOTS	2	1.3	21	13.5	27	17.4	103	66.5	2	1.3	155

[1] 1989 conservation concern species

[2] 1999 conservation concern species

no. number of bird records for that species recorded in the land use category

% percent of total bird records for that species recorded in the land use category