Potential reintroduction of the Dakota skipper (*Hesperia dacotae*) into south-eastern Manitoba

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Abstract

The Dakota skipper, *Hesperia dacotae* (Skinner), is a rare butterfly, now confined to isolated areas of mixed and tall-grass prairie in Manitoba, Saskatchewan and several northern U.S. states. Due to conversion of prairie into agricultural cropland, the population of this butterfly has declined dramatically and it is currently classified as a threatened species under the Manitoba Endangered Species Act. Vegetation surveys were completed to assess the floral composition at the Tall-Grass Prairie Preserve (TGPP) near Tolstoi, Manitoba, where the skipper was previously recorded but has been absent since 2000, and in the southern Interlake, where a small population still exists. This study examined the link between the abundance of larval food plants and adult host plants, the presence of the Dakota skipper and the feasibility of re-introducing the Dakota skipper into the TGPP. There was a significant difference in herbaceous and shrub composition between the TGPP and the Interlake plots. There were differences in species richness, species diversity and relative abundance of vegetation between the two areas. Currently, re-introduction of the Dakota skipper may not be feasible in the TGPP. However future research and examination of different management techniques in prairie habitats may make reintroduction of the Dakota skipper in the TGPP feasible.

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Introduction

The Dakota skipper (*Hesperia dacotae* (Skinner, 1991)) is a rare butterfly found as 19 or 20 separate, isolated populations in southern Manitoba. A few scattered populations also occur in southeast Saskatchewan, eastern North and South Dakota, and western Minnesota (COSEWIC, 2003). The Dakota skipper is a habitat-specialist and an obligate resident of native tall-grass prairie, itself, an endangered ecosystem. Extant populations of Dakota skippers are associated with wet-to-mesic tall-grass prairie in Manitoba (COSEWIC, 2003). The Dakota skipper is one of many unique species within tall-grass prairie ecosystems which are threatened by the expansion of agriculture and urban sprawl (Cochrane and Delphey, 2002). In Manitoba, the Dakota skipper has been found in two disjunct regions. These are located in southwest Manitoba, and the Interlake region (COSEWIC, 2003). Historically, they have also been found at the Tall-Grass Prairie Preserve in the southeast portion of the province, however Manitoba Conservation indicated that they have been extirpated from the area in recent years (COSEWIC, 2003).

Fragmentation of Dakota skipper habitat is of concern as populations have become spatially and genetically isolated from one another causing them to be more vulnerable to habitat disturbance (Britten and Glasford, 2002). A primary cause of fragmentation has been the conversion of natural prairie habitat to cropland. The Dakota skipper is dependent on an association of native prairie plants to provide nectar and larval food resources (Klassen *et al*., 1989). This dependency has made the Dakota skipper susceptible to anthropomorphic disturbance, which may have significantly degraded its remaining habitat (Cochrane and Delphey, 2002).

To date, there has been minimal research on the life history and ecology of the Dakota skipper (Webster, 2003). Data is needed regarding longevity and reproductive success of the Dakota skipper in isolated populations. We need to assess opportunities for its re-introduction into locations where it is no longer found.

Study objective

This study surveyed existing Dakota skipper sites in the Interlake region for larval host plants and adult nectar sources in addition to sites in the TGPP where the Dakota skipper is no longer found. The link between vegetative composition and presence or absence of *H. dacotae* was examined. I tested the null hypothesis that the plant communities in the two areas were similar and therefore the TGPP may support viable populations of the Dakota skipper in the future.

The second objective of the study was to determine presence or absence of the Dakota skipper in the TGPP and the Interlake, while recording other butterflies species that were located in the same habitat during the Dakota skipper flight period.

Literature review

Biology

The Dakota skipper is a member of the Subfamily Hesperiinae (branded skippers), Family Hesperiidae, Order Lepidoptera (Klassen *et al.*, 1989). Skippers are distinguishable from other butterflies and moths by various morphological characteristics and behaviour. Unlike butterflies, skippers possess antennae that are hooked at the distal end, at rest wings are held at a 45 degree angle, and the body size is quite large compared to the wing area (Layberry *et al*., 1998). They are diurnally active as adults, but nocturnal as larvae and cannot cover their hind wings with forewings (Triplehorn and Johnson, 2005). Dakota skippers (like most skippers) often fly rapidly, just above the ground, with many short stops on the ground or vegetation (Scott, 1986). The skipping flight motion is quite pronounced, hence the name skippers.

Like all butterflies, the Dakota skipper passes through four development stages of complete metamorphosis (Scott, 1986). These stages include egg, larva, pupa, and adult. This skipper has one generation per year in Manitoba (Klassen *et al*., 1989; Swengel, 1996). Male and female Dakota skippers overwinter as fourth-instar larvae. The larvae pupate in early June (Klassen *et al*., 1989) and the adults emerge from the pupae in late June to early July. Males emerge from pupae before females and both sexes remain on wing for approximately three weeks (Swengel, 1999). In Manitoba, adult Dakota skippers have been recorded from June 23 – July 14 (Klassen *et al*., 1989). Females lay approximately 250 eggs by attaching them to blades of grass (COSEWIC, 2003). It takes seven to twenty days for the eggs to hatch and then larvae begin to feed. During July to September Dakota skipper larvae feed at night and return to a silken tube near the ground during the day (Klassen *et al.*, 1989). Larvae overwinter in the silken tube (Klassen *et al*., 1989).

The eggs are laid in a gleaming, semi-translucent white mass (COSEWIC, 2003). Mature larvae range from 19 – 22 mm in length. Larvae have unique distinguishable ventral pits on the head capsule and the prothoracic shield, thoracic legs, and spiracles are black with the remainder of the body integument light brown to flesh coloured (COSEWIC, 2003).

The adult Dakota skipper has a wingspan of 21 - 29 mm (COSEWIC, 2003). Males are a tawny orange colour (Figure 1.). The dorsal surface of the wings is tawny orange with a brownish border on the forewing. The forewing has a distinct centrally located dark, raised mark called a stigma that contains scent scales that release pheromones to attract mates (Layberry *et al*., 1998). The ventral surface of the wings in the male is brownish orange, with a poorly developed semicircle of paler spots on the hind wing. Females vary in colour from buff to brown. There are multiple small, whitish spots on the forewing of the female (Figure 1.). Females lack the stigma on the dorsal surface of the forewing. The dorsal surface of the hindwing may also have occasional white spots. The Dakota skipper is often confused with *Polites mystic* (W.H. Edwards, 1863) because of their similar colouration, habitat requirements, and their overlapping flight period (COSEWIC, 2003). Other species utilizing similar habitat include *Hesperia ottoe* (W.H. Edwards, 1866), *Hesperia leonardus pawnee* (Dodge, 1874), and *Hesperia assiniboia* (Lyman, 1892) (Layberry *et al*., 1998).

Figure 1. Photograph of male (top) and female (bottom) Dakota skipper from COSEWIC Assessment and Status Report of Dakota Skipper.

Habitat requirements of Dakota skippers

The Dakota skipper is an obligate resident of the wet-to-mesic tall-grass prairie in Manitoba (COSEWIC, 2003). The Dakota skipper has been found in dry-mesic prairie dominated by midheight grasses (Britten and Glasford, 2002). They seem especially abundant in areas with low-rolling hills (Dana, 1997). The extant populations survive at sites of open prairie with small groves of aspen (*Populus tremuloides* Michx.) and bur oak (*Quercus macrocarpa* Michx) (COSEWIC, 2003). Often these sites have alternating sections of wet and dry areas, each with its own distinct vegetation (Cochrane and Delphey, 2002). Lower, wetter areas are dominated by sedge species (*Carex spp.*), rushes (*Juncus spp.*), and spike rushes (*Eleocharis spp.*) (COSEWIC, 2003). Higher, dryer areas are often dominated by bluestem grasses, such as little bluestem (*Schizachyrium scoparium* (Michx.) Nash), big bluestem (*Andropogon gerardii* Vitman), Kentucky bluegrass (*Poa pratensis* L.) and various herbs including the wood lily, (*Lilium philadelphicum* L.), smooth camas (*Zigadenus elegans* Pursh.), harebell (*Campanula rotundifolia* L.), and black-eyed susan (*Rudbeckia serotina* Nutt.) (Cochrane and Delphey, 2002; COSEWIC, 2003). Shrubs may include shrubby cinquefoil (*Potentilla fruticosa* L.), and rose species (*Rosa spp*) (COSEWIC, 2003). Past research has commonly found the Dakota skipper on higher, drier sites where bunch grasses (Poaceae) are prevalent (COSEWIC, 2003).

Larval host plants include little bluestem, Kentucky bluegrass, panic grass (*Panicum spp.*), grama grass (*Bouteloua spp.*), and three-awn grass (*Aristida spp.*) (Klassen *et al*., 1989). Adult Dakota skippers are dependent on plants that produce large amounts of nectar to provide energy and water, especially for females to achieve maximum fecundity (Dana, 1997). Adults have been observed perching on and feeding on smooth camas, black-eyed susan, wood lily, and harebell (Scott, 1986; Klassen *et al.*, 1989; COSEWIC, 2003).

Status of Dakota skippers

Dakota skipper populations have declined in proportion to loss of the tall grass prairie habitat in North America. Skipper populations are isolated and considered threatened in Canada (Layberry *et* al., 1998; COSEWIC, 2003). Prior to 2001, six isolated populations were known in Manitoba. In 2002, only two populations remained, with the largest located in the Interlake region (Webster, 2003). As of November 2003, the Dakota skipper was listed as threatened by Committee of the Status of Endangered Wildlife in Canada with a global population of 28,500 - 40,500 individuals (COSEWIC, 2003). Currently, the Dakota skipper is listed as threatened under the Manitoba

Endangered Species Act, considered threatened in Minnesota, extirpated in Illinois and Iowa, and a candidate species with low priority, pending petition, under the old Category 2 status of the US-ESA (current information is minimal to make proper assessment and listings at this time) (Britten and Glasford, 2002; Vaughan and Shepherd, 2005).

Population size is determined largely by the presence of larval and adult food host plants which in turn may be reflective of the method by which sites are managed. The Dakota skipper is susceptible to habitat changes and therefore is not frequently found in areas that have been severely disturbed, and where critical resources such as food host plants have been destroyed (Swengel, 1998; Webster, 2003). Threats to adults and larvae include conversion of habitat into non-grassland, grazing, haying, controlled burning, succession, exotic species, and habitat fragmentation (COSEWIC, 2003). It is thought that *Hesperia dacotae* seldom flies more than 100 kilometres from home range sites, thus it is unlikely that they can easily re-colonize sites after local populations have been extirpated (Swengel, 1996).

In Manitoba, there has been an apparent extirpation of the Dakota skipper from the TGPP in south-eastern Manitoba. In 1987, low numbers of the Dakota skipper were found near Tolstoi adjacent to the TGPP (Westwood, 2006, person. comm.). Despite extensive searches throughout the area between 1992-2004, no subsequent individuals have been recorded (Borkowski, 2006, person. comm.). Webster (2003) surveyed for the Dakota skipper in the area of the TGPP in 2002 and did not find any individuals. We also surveyed the north and south block of the TGPP for the skipper in 2005. Webster (2003) reported someone finding the skipper in 2000 however, no voucher specimens or collector's name are available to corroborate this (COSEWIC, 2003). There is a lack of data on the long-term population trends of the Dakota skipper in Manitoba (Webster, 2003).

Tall-grass, mixed-grass and short grass prairie in Manitoba

Tall-grass prairie is considered the most biologically diverse and productive type of grassland present in North America (Nature Conservancy of Canada, 2001). It is the eastern-most prairie in North America, and extends north-westward into southern Manitoba and southward into Texas (Samson and Knopf, 1994; Whiles and Charlton, 2006). Tall-grass prairie is characterized by dense grasses, numerous species of wildflowers, and nutrient rich, black chernozem soils (Joyce and Morgan, 1989). They are adapted to extreme climates i.e. hot summers and cold winters. Climates are described as a boreal continental regime with mean July temperatures of approximately 19.6°C and mean January temperatures of approximately -18.8°C. Precipitation may reach 600 mm of rain between May and August (Westwood and Borkowski, 2004). Tall-grass prairie has evolved through an interaction of a drying climate, grazing by ungulates, and fire (Gibson and Hulbert, 1987; Howe, 1994). In Manitoba and the northern United States, the tall grass prairie vegetation is found on poorly-drained lacustrine parent material, with a thin organic surface layer (Westwood and Borkowski, 2004; Hamilton, 2005). The tall-grass prairie is bordered by deciduous forests to the east, aspen parkland to the north, and mixed-grass prairie in the south and west (Joyce and Morgan, 1989).

The name tall-grass prairie is derived from the dominant tall grasses that sometimes reach 2 metres in height (Hamilton, 2005). Characteristic plants include big bluestem, little bluestem, blazingstar (*Liatris spp.*), prairie clover (*Petalostenum spp.*), lilies *(Lilium spp.*)*,* willow *(Salix spp.*)*,* and poplar (*Populus spp.*) (Joyce, 2000; Westwood and Borkowski, 2004).

Three herbaceous strata can be found in the tall grass prairie, each characterized by relatively high species diversity (Whiles and Charlton, 2006). The tallest vegetation is characterized by bunch grasses (ex. Indiangrass (*Sorghastrum spp.*), panic grass, bluestems (ex. big bluestem), and forbs (ex. sunflower *(Helianthus spp.))* (Whiles and Charlton, 2006). The intermediate level contains the most diversity including shorter upright grasses and forbs such as beardstongue (*Penstemon spp.*)*,* milkweed (*Asclepias spp.*)*,* purple coneflowers (*Echinacea spp.*)*,* and prairie coneflowers *(Ratibida spp.*)*,* aster (*Aster spp.*), and prairie clover (*Dalea spp.*). The lowest level is characterized by recumbent species such as violets *(Viola spp.*)*,* and grama grasses (*Bouteloua spp.*) (Whiles and Charlton, 2006). The roots of many grass species extend deep (3-5 metres) into the soil to access seasonally scarce moisture and act in stabilizing the ground by binding the soil (Whiles and Charlton, 2006).

Mixed grass prairie is a blend of both tall and short grass prairie species that are adapted to a wide range of temperatures and precipitation (Reaume, 1993; Hamilton, 2005). Common grasses include wheatgrass (*Agropyron spp.)*, and speargrass (*Stipa spp.)* (Hamilton, 2005). Short grass prairie is adapted to drought and high temperatures. Grasses seldom reach more than 50 cm in height and the root system is quite shallow. Species include buffalo grass (*Buchloe spp.*) and grama grass (Hamilton, 2005). Short grass prairie is found in western parts of the prairies from southern Alberta to northern Texas, North Mexico, and into eastern Montana (Reaume, 1993; Samson and Knopf, 1994).

Materials and methods

Study areas in Manitoba

Study area 1: The Tall-grass Prairie Preserve

In Manitoba, the tall grass prairie once covered 6,000 km^2 and reached its northern extent (Joyce and Morgan, 1989). Currently, less than one percent of the original tall-grass prairie remains in the province (Joyce and Morgan, 1989). Less than 0.01 % is now protected in parks and preserves (Samson and Knopf, 1994). In 1989, the Manitoba Critical Wildlife Habitat Program began securing tall grass prairie in the Tolstoi-Gardenton area for a prairie preserve. The major partners in the program were Manitoba Conservation, Canadian Wildlife Service, the Manitoba Naturalists Society, the Manitoba Habitat Heritage Corporation, World Wildlife Fund, the Nature Conservancy of Canada and Wildlife Habitat Canada. There are currently over 2,000 hectares of tall-grass prairie protected by the TGPP in southern Manitoba (MB Conservation, 2006).

The TGPP in Manitoba has remained largely undeveloped due to presence of stone and boulders in the soil deposited after the last ice age (Lubiansky, 2006). The stony soil and extensive swampy ground and aspen groves have helped deter agricultural development (MB Conservation, 2006). The primary historical land use in the TGPP area has been cattle grazing.

Prairie ecosystems were naturally subjected to wildfires, grazing, and droughts which slowed the invasion of trees, shrubs, and undesirable plant species from crowding out the dominant native grass species (Vogl, 1974; Gibson and Hulbert, 1987). Fire has been the dominant process in maintaining the openness of prairie and savanna (Swengel, 1998) as well as allowing faster decomposition of dead and decaying vegetation by recycling nutrients, allowing the release of nutrients back into the ground (Vogl, 1974). Native tall-grass prairie species have extensive root systems and they are adapted to survive fire better than woody species, which are commonly killed (Vogl, 1974; Swengel, 1998). In the TGPP, managers carry out prescribed burns in the spring or fall depending on the weather. This is intended to mimic natural disturbance in the prairie and also to provide various grazing regimes for cattle (Borkowski, 2006). Burning is known to increase the productivity of grassland species, but in absence of other kinds of disturbance (such as grazing), it may be seen as ineffective and sometimes even deleterious to certain invertebrates, animals, and plants (Vogl, 1974).

Study area 2: The Interlake prairie Lundar, Manitoba

The area from Lake Winnipeg west to Lake Manitoba was once considered to be mixed-grass prairie and aspen woodland; however bluestem-dominated grasslands suggest tall-grass prairie remnants (Hamilton, 2005). The remnants of tall-grass and mixed-grass prairie, in the Interlake where populations of the Dakota skipper can presently be found, are most commonly used for hay production. These sites are privately owned and are usually hayed once annually. In the past, the Dakota skipper has been found more often in areas that have been mowed in late summer and fall, rather than on unmowed sites (McCabe, 1981; Swengel, 1999). The absence of standing dead grass, low shrub density, and an abundance of nectar flowers distinguishes mowed sites and unmowed sites (SARA, 2006).

Diversity measurements and habitat assessment

A diversity index is a mathematical measure of the diversity of species in a particular region (Magurran, 1988). Diversity measures combine information about the variety of species found in a habitat with their relative abundances (Magurran, 1988). Diversity indices may provide more information about community composition than just species richness (i.e., the number of species present), and measures of relative abundances of different species can provide critical information on rareness or commonness (Magurran, 1988). Diversity indices allow biologists to quantify diversity and allow for species comparisons between different habitats. Both alpha and beta diversity can be used to quantify the amount of vegetative variation in the sites. Alpha diversity measures the diversity of an area whereas the β diversity measures the change of diversity between areas at a landscape level (Whittaker, 1972).

The Shannon diversity index (H) is an alpha index commonly used to characterize plant species diversity in a community. Shannon's index utilizes the number of species and their relative abundance in a sample (Beals *et al*., 2000). The proportion of species i relative to the total number of species is calculated (p_i), and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The total product is summed for the species, and multiplied by -1 (Beals *et al.*, 2000).

$$H = -\sum_{i=1}^{S} p_i \ln p_i$$

Shannon's evenness (E_H) index can be calculated by dividing H by H_{max} (where H_{max} is equal to the natural logarithm of the total number of species (species richness) ($\ln S$)). Evenness is measured on a scale of 0 to 1, with values near 1 explaining more even abundance of each species (Beals *et al.*, 2000). $E_H = H / H_{max} = H / \ln S$

Sorenson's quantitative index (Magurran, 1988) is a similarity coefficient used to produce values for β diversity. β diversity is a measure of how similar habitats are in the terms of the variety of species found in them by taking into account their abundance (Magurran, 1988)

Field procedures of the two study areas

Site selection

Three study sites were selected during May 2005 from within each study area (TGPP and Interlake) (Figure 2.). Each site in the Interlake area was located based on past surveys of the areas completed by Webster (2003). The three sites in the Interlake were those with the highest recorded number of the Dakota skippers recorded in previous surveys as revealed by Webster (2003) (COSEWIC, 2003) (Figure 3.). Sites in the TGPP were based on typical Dakota skipper habitat and locations visually comparable to Interlake sites. One plot was randomly established within each site. The plots were approximately 300 x 300 metres in size.

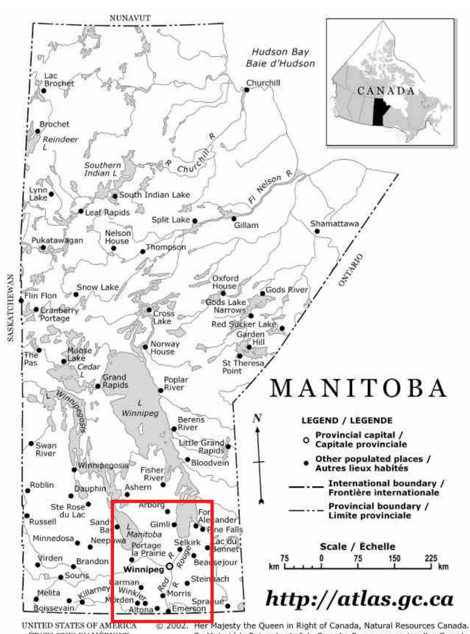

Figure 2. Map of Manitoba (Natural Resources of Canada, 2002)

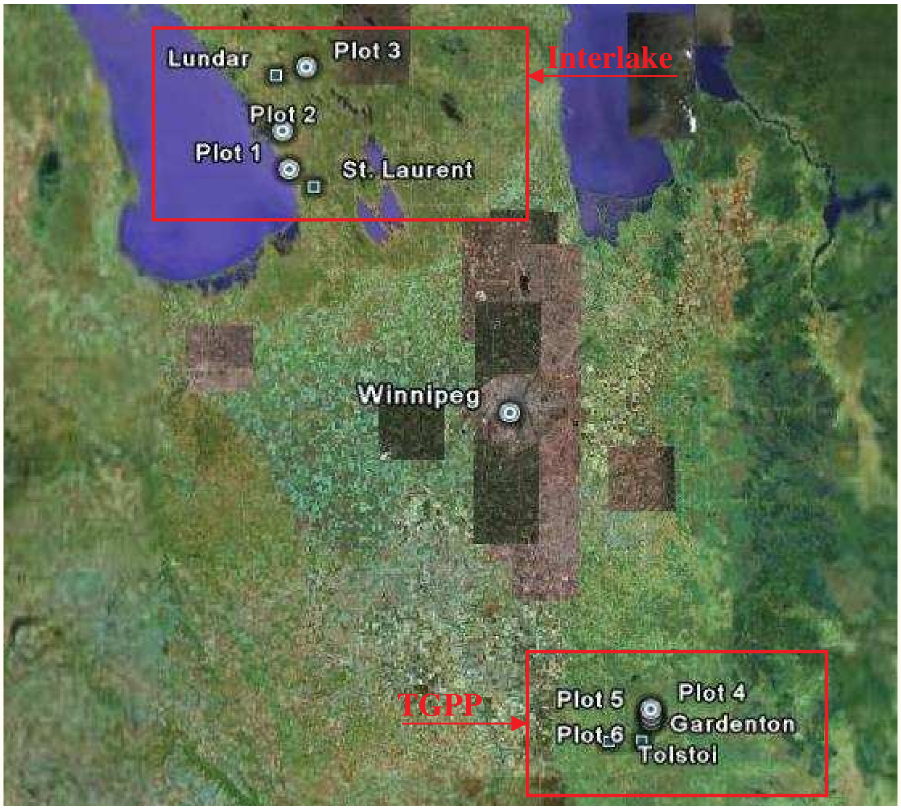

Figure 3. Study area showing TGPP and Interlake areas (*one cm represents 20.38 km*) (Google Earth, 2005)

At each site, within a plot, two, 250 metre transects were established. Transects were marked at each 50 metre interval. The two transects lay in an east/west or north/south direction. A geographic positioning system (GPS) was used to locate and record the zero metre mark for each plot transect (Figure 4.):

Plot 1 (Hydro site):	East/west 50°27.937' 097°58.267'
	North/south 50°27.812' 097°58.214'
Plot 2 (Oak point site):	East/west 50°33.284' 098°00.903'
	North/south 50°33.173' 098°00.956'
Plot 3 (Lundar site):	East/west 50°42.596' 097°55.065'
	North/south 50°42.663' 097°55.017'

Figure 4. Interlake sites: Plots denoted by circle within sites (*one cm represents 10.56 km*) (Google Earth, 2005)

The sites at the TGPP were selected within the north block of the preserve (Appendix 2.) by locating areas that closely resembled the Interlake sites in terms of vegetation. A GPS unit was used to identify the location of each plot (Figure 5.):

Plot 4	East/west & North/south	49°10.346’ 096°40.654’
Plot 5	East/west & North/south	49°09.446’ 096°40.440’
Plot 6	East/west & North/south	49°08.567’ 096°40.525’

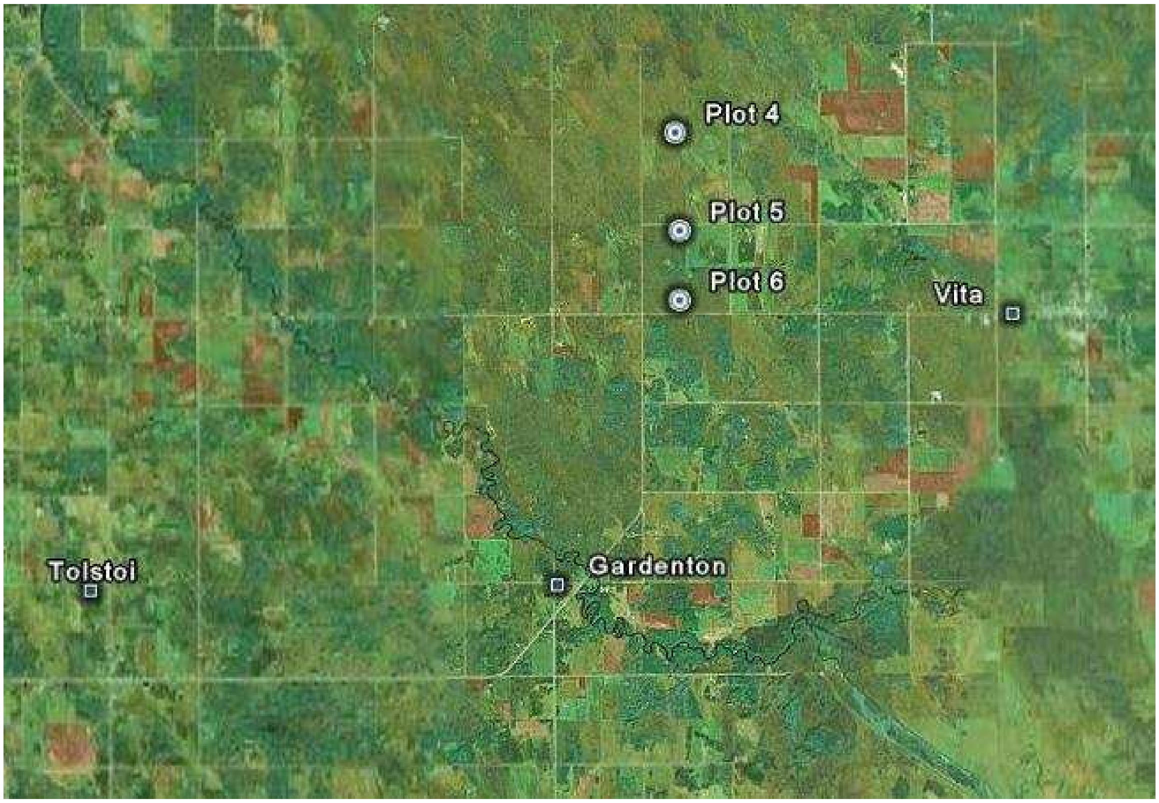

Figure 5. Tall Grass Prairie Preserve sites: plots denoted by circle within sites (*one cm represents 1.4 km*) (Google Earth, 2005)

Vegetation surveys

Sampling of the vegetation took place between June and August 2005. Each transect in the six plots were sampled once in June, July, and August. Plot 4 in the TGPP, was not sampled in July due to time constraints. Three quadrat sizes were used to sample herbaceous plants (herbs), shrubs, and trees respectively. The quadrat for herbs was 1x1 m, the quadrat for shrubs measured was 2x2 m, and the quadrat for trees was 5x5 m. At each 50 metre mark along the transect, two 1x1 quadrats, one 2x2 quadrat, and one 5x5 quadrat were placed on each side of the marker. A random number table was used to generate the distances from the marker to place each quadrat up to 10 metres away from the marker. Along each transect, a total of 24 1x1 quadrats, 12 2x2 quadrats, and 12 5x5 quadrats were established. The same plots and transects were examined throughout the summer. Interlake plots were sampled for herbs, shrubs, and trees in all three months. At the TGPP, herbs were sampled in all three months and shrubs and trees only in June. However, for vegetative composition comparison, the data collected for June shrubs and trees were incorporated with July and August species data at the TGPP. Plant identity for each species and their percent cover values were recorded for each quadrat. Plant identification was based on (Scoggan, 1957; Johnson *et al.*, 1995; Looman, 1979; Kershaw, 2003; Vance, 1984; Moore, 2003). When identification was not possible in the field, samples were collected, pressed, and identified in the laboratory.

Butterfly survey

Surveys for the Dakota skipper were implemented during the first three weeks of July 2005, based on historic flight period information. All the areas surrounding the transects in the TGPP and Lundar plots were surveyed using a sweep net. The area around each transect was traversed by a collector for 30-60 minute intervals between 10 am and 4 pm. Butterflies were either collected or identified on the wing. Manitoba Conservation provided permission to collect 1 female and 1 male Dakota skipper at each plot to confirm identification as they are very difficult to identify during flight or perching. Specimens collected were later pinned in the laboratory for identification and sexing.

Statistical analysis

Comparisons were made between the plots within the Interlake area (Plots 1-3) and within the TGPP area (Plots 4-6) and a comparison was made between the two areas. The percent cover of each plant species was calculated for each transect within each plot. The mean percent cover for each plant species in both transects was then calculated per plot. A master list of all plant species found in June, July, and August was created to compare presence of species in all transects at each plot in the two areas. Mean percent cover of plant species was used to rank abundance between the Interlake and TGPP areas.

Diversity indices

Diversity indices were calculated for each transect and the pooled mean was calculated for each plot and area. This allowed a comparison between the plots within sites in the Interlake (Plot 1-3) and sites in the TGPP (Plot 4-6), and also between the TGPP and Interlake areas. Species richness, Shannon's diversity and Shannon's evenness (Magurran, 1988) were compared between plots in one area using one-way analysis of variance (ANOVA) and between the two areas using an independent t-test. The level of significance was set at $P \geq 0.05$. Fisher's Least Significant Difference (LSD) post-hoc test was used to test for differences between means when the ANOVA was significant. ANOVA's and a t-test's were also used to compare percent cover of larval and adult food plant species between sites and the areas using SPSS 11.0 (SPSS, 2001).

Species richness is a measure of the number of different species within a specified area (Kempton, 1979). The higher the value the more species are found in the community. Shannon's diversity measures the overlap between the presence of different species and weighs them by their abundance. A larger value indicates more diversity within the community. This diversity index is useful when using percent cover data (Pielou, 1975). Shannon's evenness is a measure of how equally abundant species are represented in the sample (Magurran, 1988). As the evenness value approaches 1, the more the species are equal in abundance within the community.

Cluster analysis

β diversity values were calculated between plots using Sorenson's quantitative index (Magurran, 1988). The Sorenson's values were placed in a matrix using Systat11 (Systat, 2004). The matrix was used in hierarchical cluster analysis where similar plots are placed closer together in the cluster and dissimilar plots farther away.

Results

Statistical methods

Vegetation ranking of individual species based on mean percent cover for the June, July, and August sampling periods are shown in Tables 1-3. In June, *Carex spp.* was one of the most numerous taxon encountered in both the TGPP and Interlake, as well as *Grass spp.* (Table 1.). Shrub species were also more common in the TGPP (Table 1.).

Table 1: Ranked mean percent plant cover for the June sampling period, the Interlake and TGPP plots (Plots 1-3 & 4-6 pooled).

Species name	Interlake	Species name	TGPP
Grass spp.	12.70	*Carex spp.*	23.33
Potentilla anserina	8.08	*Grass spp.*	13.45
Juncus balticus	8.00	*Potentilla fruticosa*	9.01
Antennaria neglecta	6.40	*Juncus balticus*	8.67
Thalictrum venulosum	5.53	*Salix spp.*	6.15
Poa pratensis	5.47	*Betula pumila*	6.03
Carex spp.	4.68	*Corylus americana*	4.14
Eleocharus spp.	4.44	*Melilotus alba*	3.75
Rosa spp.	2.57	*Populus tremuloides*	3.75
Galium boreale	2.18	*Cirsium arvense*	3.53
Taraxacum spp.	2.15	*Platanthera praeclara*	3.19
Hypoxis hirsuta	2.12	*Eleocharus spp.*	2.94
Plantago eriopoda	2.04	*Rosa spp.*	2.87
Antennaria microphylla	2.00	*Galium boreale*	2.69
Unknown	1.78	*Poa spp.*	2.57
Trigochin maritime	1.73	*Cornus stolonifera*	2.30
Deschampsia caespitosa	1.71	*Fragaria virginiana*	1.89
Grindelia squarrosa	1.59	*Deschampsia caespitosa*	1.68
Arctostaphylos uva-ursi	1.25	*Juncus dudleyi*	1.67
Medicago sativa	1.25	*Elaeagnus commutata*	1.45
Typha latifolia	1.25	*Hypoxis hirsuta*	1.36
Salix spp.	1.13	*Potentilla anserina*	1.36
Zizia aptera	1.12	*Carex sartwellii*	1.27
Ambrosia psilostachya	1.08	*Petalostenum purpureum*	1.17
Betula pumila	1.08	*Poa pratensis*	1.14
Populus tremuloides	1.08	*Cornus alba*	1.03
Stachys palustrus	1.08	*Populus balsmifera*	1.00
Poa spp.	1.06	*Quercus macrocarpa*	0.96
Plantago spp.	1.00	*Sanicula marilanda*	0.96
Psoralea esculenta	0.97	*Unknown*	0.92

Table 1. continued

Species name	Interlake	Species name	TGPP
Juncus spp.	0.91	*Pedicularis spp.*	0.83
Helianthus maximilianii	0.58	*Carex buxbaumi*	0.65
Poa juncifolia	0.58	*Antennaria neglecta*	0.50
Sphenopholis	0.58	*Sisyrinchium montanum*	0.46
Elaeagnus commutate	0.54	*Rubus pubescens*	0.33
Carex lenticularis	0.53	*Carex utricularis*	0.31
Sisyrinchium montanum	0.49	*Viola nephrophylla*	0.31
Amelanchier alnifolia	0.42	*Zizia aptera*	0.28
Scirpus lacustris	0.41	*Carex bebbii*	0.25
Comandra umbellata	0.39	*Juncus alpinus*	0.25
Agropyron spp.	0.36	*Thalictrum spp.*	0.25
Anemone spp.	0.33	*Achillea millefolium*	0.24
Astragalus agrestis	0.33	*Betula glandulifera*	0.22
Cirsium spp.	0.33	*Vicia spp.*	0.20
Polygonum amphibium	0.33	*Agropyron spp.*	0
Lathyrus palustris	0.28	*Ambrosia psilostachya*	0
Hordeum jubatum	0.27	*Amelanchier alnifolia*	0
Ranunculus abortivus	0.27	*Anemone spp.*	0
Dodecatheon pauciflorum	0.25	*Antennaria microphylla*	0
Lysimachia thrysflora	0.25	*Arctostaphylos uva-ursi*	0
Rudbeckia hirsuta	0.25	*Astragalus agrestis*	0
Melilotus officinales	0.23	*Carex lenticularis*	0
Castilleja spp.	0.22	*Castilleja spp.*	0
Betula glandulifera	0	*Cirsium spp.*	0
Carex bebbii	0	*Clover spp.*	0
Carex buxbaumi	0	*Comandra umbellata*	0
Carex sartwellii	0	*Dodecatheon pauciflorum*	0
Carex utricularis	0	*Grindelia squarrosa*	0
Cirsium arvense	0	*Helianthus maximilianii*	0
Cornus alba	0	*Hordeum jubatum*	0
Cornus stolonifera	0	*Juncus spp.*	0
Corylus americana	0	*Lathyrus palustris*	0
Fragaria virginiana	0	*Lysimachia thrysflora*	0
Juncus alpinus	0	*Melilotus officinales*	0
Juncus dudleyi	0	*Plantago eriopoda*	0
Melilotus alba	0	*Plantago spp.*	0
Pedicularis Canadensis	0	*Poa juncifolia*	0
Pedicularis spp.	0	*Polygonum amphibium*	0
Petalostenum purpureum	0	*Psoralea esculenta*	0
Platanthera praeclara	0	*Ranunculus abortivus*	0
Populus balsmifera	0	*Rudbeckia hirsuta*	0
Potentilla fruticosa	0	*Scirpus lacustris*	0
Quercus macrocarpa	0	*Sphenopholis*	0
Rubus pubescens	0	*Stachys palustrus*	0
Sanicula marilanda	0	*Taraxacum spp.*	0
Thalictrum spp.	0	*Thalictrum venulosum*	0
Vicia spp.	0	*Trigochin maritima*	0

Table 1. continued

Species name	Interlake	Species name	TGPP
Viola nephrophylla	0	*Typha latifolia*	0

In July, Carex spp. was more dominant in the Interlake plots (Table 2.). Poa pratensis was more abundant in the Interlake plots (Table 2.). It should be noted that another *Poa spp*. (which could not be identified to species) was present in both the Interlake and TGPP. The shrub *Potentilla fruticosa* covered the most area in the TGPP.

Table 2. Ranking of mean percent cover for the July sampling period for the Interlake and TGPP plots (Plots 1-3 pooled and plot 4-6 pooled).

Species name	**Interlake**	**Species name**	**TGPP**
Grass spp.	16.43	*Potentilla fruticosa*	9.01
Carex spp.	14.12	*Melilotus alba*	6.67
Antennaria microphylla	7.88	*Salix spp.*	6.15
Juncus balticus	5.33	*Betula pumila*	6.03
Juncus spp.	4.40	*Corylus americana*	4.14
Betula pumila	3.60	*Populus tremuloides*	3.75
Poa pratensis	3.56	*Cirsium spp.*	3.33
Helianthus maximilianii	3.21	*Rosa spp.*	2.87
Deschampsia caespitosa	2.86	*Cornus stolonifera*	2.30
Eleocharus spp.	2.61	*Calamagrostis spp.*	2.16
Salix spp.	2.46	*Deschampsia caespitosa*	2.04
Rhus radicans	2.25	*Lysimachia quadriflorum*	1.81
Galium boreale	2.25	*Agrostis spp.*	1.50
Typha latifolia	2.17	*Elaeagnus commutata*	1.45
Antennaria neglecta	2.12	*Poa spp.*	1.08
Koeleria cristata	2.08	*Cornus alba*	1.03
Hordeum jubatum	2.07	*Populus balsmifera*	1.00
Sonchus arvensis	2.05	*Quercus macrocarpa*	0.96
Grindelia squarrosa	2.04	*Lysimachia thrysflora*	0.63
Trigochin maritima	1.95	*Zizia aptera*	0.56
Thalictrum spp.	1.86	*Glyceria striata*	0.42
Zizia aptera	1.60	*Koeleria cristata*	0.38
Potentilla anserina	1.55	*Apocynum cannabinum*	0.38
Rosa spp.	1.37	*Calamagrostis neglecta*	0.32
Melilotus alba	1.28	*Prunella vulgaris*	0.30
Achillea Millefolium	1.23	*Betula glandulifera*	0.22
Smilacina racemosa	1.17	*Viola nephrophylla*	0
Polygonum amphibium	1.17	*Typha latifolia*	0
Arctostaphylos uva-ursi	1.17	*Trigochin maritima*	0
Medicago lupulina	1.08	*Thalictrum venulosum*	0
Glycyrrhiza lepidota	0.99	*Thalictrum spp.*	0
Rudbeckia serotina	0.98	*Taraxacum spp.*	0
Calamagrostis neglecta	0.96	*Spartina gracilis*	0
Melilotus sativa	0.95	*Sonchus arvensis*	0

Table 2. continued

Species name	Interlake	Species name	TGPP
Taraxacum spp.	0.91	*Solidago canadensis*	0
Populus tremuloides	0.87	*Smilacina racemosa*	0
Elaeagnus commutata	0.83	*Sherpherdia canadensis*	0
Dalea candida	0.75	*Salicornia sp.*	0
Agropyron spp.	0.72	*Rudbeckia serotina*	0
Erigeron spp.	0.71	*Rhus radicans*	0
Plantago eriopoda	0.67	*Ranunculus abortivus*	0
Ambrosia psilostachya	0.61	*Potentilla anserina*	0
Sherpherdia canadensis	0.58	*Polygonum amphibium*	0
Phragmites australis	0.58	*Poa pratensis*	0
Hieraceum umbellatum	0.54	*Plantago eriopoda*	0
Bromus spp.	0.52	*Phragmites australis*	0
Salicornia sp.	0.50	*Petalostenum purpureum*	0
Ranunculus abortivus	0.50	*Pedicularis spp.*	0
Aster ericoides	0.49	*Panicum spp.*	0
Thalictrum venulosum	0.47	*Melilotus sativa*	0
Panicum spp.	0.47	*Medicago lupulina*	0
Solidago canadensis	0.42	*Lobelia spicata*	0
Pedicularis spp.	0.42	*Lobelia kalmii*	0
Prunella vulgaris	0.41	*Lathyrus spp.*	0
Betula spp.	0.39	*Juncus spp.*	0
Anemone spp.	0.33	*Juncus balticus*	0
Agropyron albicans	0.31	*Hordeum jubatum*	0
Agropyron smithii	0.27	*Hordeum brachyantherum*	0
Petalostenum purpureum	0.25	*Hieraceum umbellatum*	0
Lysimachia thrysflora	0.25	*Helianthus maximilianii*	0
Lathyrus spp.	0.25	*Grindelia squarrosa*	0
Hordeum brachyantherum	0.25	*Grass spp.*	0
Dodecatheon pauciflorum	0.25	*Glycyrrhiza lepidota*	0
Comandra umbellata	0.25	*Galium boreale*	0
Cirsium spp.	0.25	*Erigeron spp.*	0
Viola nephrophylla	0.22	*Eleocharus spp.*	0
Lobelia spicata	0.22	*Dodecatheon pauciflorum*	0
Lobelia kalmii	0.22	*Dalea candida*	0
Camus spp.	0.21	*Comandra umbellata*	0
Spartina gracilis	0.20	*Carex spp.*	0
Quercus macrocarpa	0	*Camus spp.*	0
Potentilla fruticosa	0	*Bromus spp.*	0
Populus balsmifera	0	*Betula spp.*	0
Poa spp.	0	*Aster ericoides*	0
Lysimachia quadriflorum	0	*Arctostaphylos uva-ursi*	0
Glyceria striata	0	*Antennaria neglecta*	0
Corylus americana	0	*Antennaria microphylla*	0
Cornus stolonifera	0	*Anemone spp.*	0
Cornus alba	0	*Amelanchier alnifolia*	0
Calamagrostis spp.	0	*Ambrosia psilostachya*	0
Betula glandulifera	0	*Agropyron spp.*	0

Table 2. continued

Species name	Interlake	Species name	TGPP
Apocynum cannabinum	0	*Agropyron smithii*	0
Amelanchier alnifolia	0	*Agropyron albicans*	0
Agrostis spp.	0	*Achillea millefolium*	0

In August, *Carex spp.* and *Grass spp.* once again dominated both areas (Table 3.).

Table 3. Ranking of mean percent cover for the August sampling period for the Interlake and TGPP plots (Plots 1-3 pooled and plot 4-6 pooled).

Species Name	Interlake	Species Name	TGPP
Grass spp.	24.71	*Grass spp.*	36.47
Carex spp.	14.31	*Potentilla fruticosa*	9.01
Juncus spp.	13.52	*Carex spp.*	8.98
Typha latifolia	9.61	*Salix spp.*	6.15
Andropogon gerardii	4.46	*Betula pumila*	6.03
Calamagrostis spp.	4.30	*Corylus americana*	4.14
Schizachyrium scoparium	3.51	*Populus tremuloides*	3.75
Sonchus arvensis	3.25	*Juncus spp.*	3.28
Poa spp.	3.23	*Fragaria virginiana*	3.07
Potentilla anserina	3.22	*Cirsium spp.*	3.03
Poa pratensis	2.90	*Melilotus alba*	2.92
Trigochin maritima	2.74	*Rosa spp.*	2.87
Aster ericoides	2.73	*Calamagrostis spp.*	2.41
Deschampsia caespitosa	2.45	*Cornus stolonifera*	2.30
Grass 2 DP	2.40	*Lysimachia quadrifolia*	2.19
Cirsium spp.	2.30	*Agrostis spp.*	1.93
Thalictrum spp.	2.27	*Deschampsia caespitosa*	1.51
Solidago nemoralis	2.24	*Elaeagnus commutata*	1.45
Parnassia palustris	2.18	*Juncus balticus*	1.36
Helianthus maximiliani	2.09	*Petalostemum purpureum*	1.33
Muhlenbergia asperifolia	2.00	*Pedicularis lanceolata*	1.17
Zizia aptera	1.93	*Calamagrostis canadensis*	1.15
Potamogeton spp.	1.92	*Viola nephrophylla*	1.12
Unknown	1.83	*Zizia aptera*	1.08
Eleocharus spp.	1.75	*Calamagrostis neglecta*	1.04
Salix spp.	1.72	*Cornus alba*	1.03
Rosa spp.	1.58	*Populus balsamifera*	1.00
Prunus virginiana	1.58	*Poa spp.*	1.00
Populus tremuloides	1.58	*Hieracium spp.*	1.00
Taraxacum spp.	1.53	*Galium boreale*	0.99
Solidago ptarmicoides	1.47	*Spartina gracilis*	0.96
Glycyrrhiza lepidota	1.39	*Quercus macrocarpa*	0.96
Antennaria neglecta	1.29	*Potentilla anserina*	0.89
Agropyron spp.	1.24	*Rubus spp.*	0.83
Scirpus lacustris	1.22	*Solidago canadensis*	0.56
Stachys palustris	1.10	*Solidago ptarmicoides*	0.54
Galium spp.	0.97	*Solidago spp.*	0.50
Elaeagnus commutata	0.97	*Lathyrus spp.*	0.45
Aster spp.	0.92	*Senecio spp.*	0.42
Muhlenbergia richardsonii	0.83	*Petasites spp.*	0.42
Hordeum jubatum	0.83	*Lobelia kalmii*	0.42

Table 3. continued

Species name	Interlake	Species name	TGPP
Elymus spp.	0.83	*Galium spp.*	0.42
Bromus spp.	0.82	*Aster simplex*	0.42
Grass 2 CJ	0.74	*Anemone canadensis*	0.39
Spartina gracilis	0.69	*Helianthus spp.*	0.33
Solidago spp.	0.64	*Zizia aurea*	0.31
Polygonum amphibium	0.61	*Zizia spp.*	0.25
Symphoricarpos spp.	0.58	*Sanicula marilandia*	0.25
Melilotus alba	0.58	*Platanthera praeclara*	0.25
Grindelia squarrosa	0.58	*Hierochloe odorata*	0.25
Prunella vulgaris	0.56	*Glycyrrhiza lepidota*	0.25
Rudbeckia serotina	0.53	*Betula glandulifera*	0.22
Aster laevis	0.51	*Unknown*	0
Galium boreale	0.50	*Typha latifolia*	0
Prairie clover spp.	0.42	*Triglochin maritima*	0
Achillea millefolium	0.42	*Thalictrum spp.*	0
Lycopus uniflorus	0.33	*Taraxacum spp.*	0
Smilacina racemosa	0.29	*Symphoricarpos spp.*	0
Medicago sativa	0.29	*Stachys palustris*	0
Helianthus spp.	0.28	*Sonchus arvensis*	0
Betula pumila	0.28	*Solidago nemoralis*	0
Liatrus ligulistylis	0.25	*Smilacina racemosa*	0
Comandra umbellata	0.25	*Scirpus lacustris*	0
Amelanchier alnifolia	0.25	*Schizachyrium scoparium*	0
Allium spp.	0.25	*Rudbeckia serotina*	0
Lobelia kalmii	0.21	*Prunus virginiana*	0
Zizia spp.	0	*Prunella vulgaris*	0
Zizia aurea	0	*Prairie clover spp.*	0
Viola nephrophylla	0	*Potamogeton spp.*	0
Solidago canadensis	0	*Polygonum amphibium*	0
Senecio spp.	0	*Poa pratensis*	0
Sanicula marilandia	0	*Parnassia palustris*	0
Rubus spp.	0	*Muhlenbergia richardsonii*	0
Quercus macrocarpa	0	*Muhlenbergia asperifolia*	0
Potentilla fruticosa	0	*Medicago sativa*	0
Populus balsamifera	0	*Lycopus uniflorus*	0
Platanthera praeclara	0	*Liatrus ligulistylis*	0
Petasites spp.	0	*Hordeum jubatum*	0
Petalostemum purpureum	0	*Helianthus maximiliani*	0
Pedicularis lanceolata	0	*Grindelia squarrosa*	0
Lysimachia quadrifolia	0	*Grass 2 DP*	0
Lathyrus spp.	0	*Grass 2 CJ*	0
Juncus balticus	0	*Elymus spp.*	0
Hierochloe odorata	0	*Eleocharus spp.*	0
Hieracium spp.	0	*Elaeagnus commutata*	0
Fragaria virginiana	0	*Comandra umbellata*	0
Elaeagnus commutata	0	*Bromus spp.*	0
Corylus americana	0	*Aster spp.*	0

Table 3. continued			
Species name	**Interlake**	**Species name**	**TGPP**
Cornus stolonifera	0	*Aster laevis*	0
Cornus alba	0	*Aster ericoides*	0
Calamagrostis neglecta	0	*Antennaria neglecta*	0
Calamagrostis canadensis	0	*Andropogon gerardii*	0
Betula glandulifera	0	*Amelanchier alnifolia*	0
Aster simplex	0	*Allium spp.*	0
Anemone canadensis	0	*Agropyron spp.*	0
Agrostis spp.	0	*Achillea millefolium*	0

A total of 204 plant species were found within all plots.

Table 4. ANOVA and t-test results for sites (Plot 1-6) and area (Interlake and TGPP) comparison (mean ± SEM) for all plant species and selected plant species sampled in 2005.

Plots[1]	Species richness	Shannon's diversity	Shannon's evenness	*Poa pratensis*[3]	*Schizachyrium scoparium*[3]	*Panicum spp.*[3]	*Camus spp.*[4]	*Rudbeckia serotina*[4]
June								
1	22.50 ± 1.50b[2]	2.76 ± 0.07	0.89 ± 0.00	2.78 ± 0.55	-	-	-	0.75 ± 0.75
2	17.00 ± 2.00a	2.52 ± 0.01	0.90 ± 0.04	9.29 ± 5.00	-	-	-	0.00 ± 0.00
3	18.00 ± 1.00a	2.52 ± 0.13	0.87 ± 0.06	4.34 ± 0.67	-	-	-	0.00 ± 0.00
4	23.00 ± 0.00b	2.78 ± 0.13	0.89 ± 0.05	3.42 ± 1.92	-	-	-	0.00 ± 0.00
5	17.50 ± 0.50a	2.36 ± 0.14	0.83 ± 0.06	0.00 ± 0.00	-	-	-	0.00 ± 0.00
6	18.00 ± 1.00a	2.47 ± 0.11	0.86 ± 0.03	0.00 ± 0.00	-	-	-	0.00 ± 0.00
$F_{5,11}$	5.06	2.52	0.00	2.41	-	-	-	1.00
P	0.037	0.146	0.833	0.157	-	-	-	0.489
Interlake	19.17 ± 1.28	2.60 ± 0.06	0.89 ± 0.02	5.47 ± 1.80	-	-	-	0.25 ± 0.25
TGPP	19.50 ± 1.15	2.53 ± 0.10	0.86 ± 0.02	1.14 ± 0.87	-	-	-	0.00 ± 0.00
t_{10}	-0.19	0.56	1.03	2.16	-	-	-	1.00
P	0.850	0.590	0.326	0.056	-	-	-	0.341
July								
Plots 1	33.00 ± 3.00c	2.95 ± 0.15	0.85 ± 0.03	3.40 ± 1.40b	-	0.67 ± 0.67	0.00 ± 0.00	-
2	22.50 ± 0.50b	2.72 ± 0.21	0.87 ± 0.06	4.33 ± 0.76b	-	0.75 ± 0.75	0.00 ± 0.00	-
3	19.00 ± 4.00ab	2.46 ± 0.22	0.84 ± 0.01	2.94 ± 0.27b	-	0.00 ± 0.00	0.63 ± 0.63	-
5	11.50 ± 0.50a	2.22 ± 0.22	0.91 ± 0.08	0.00 ± 0.00a	-	0.00 ± 0.00	0.00 ± 0.00	-
6	12.50 ± 0.50a	2.22 ± 0.12	0.88 ± 0.03	0.00 ± 0.00a	-	0.00 ± 0.00	0.00 ± 0.00	-
$F_{4,9}$	14.77	3.03	0.33	7.75	-	0.75	1.00	-
P	0.006	0.128	0.850	0.023	-	0.597	0.486	-
Interlake	24.83 ± 2.96	2.71 ± 0.12	0.85 ± 0.02	3.56 ± 0.49	-	0.47 ± 0.30	0.21 ± 0.21	-
TGPP	12.00 ± 0.41	2.22 ± 0.10	0.89 ± 0.08	0.00 ± 0.00	-	0.00 ± 0.00	0.00 ± 0.00	-
t_8	3.46	2.84	0.29	5.79	-	1.26	0.80	-
P	0.009	0.022	0.275	› 0.001	-	0.243	0.447	-
August								
Plots 1	29.50 ± 3.50	2.75 ± 0.18	0.82 ± 0.03	2.79 ± 1.46b	5.87 ± 5.87	-	-	0.80 ± 0.80
2	29.00 ± 2.00	2.91 ± 0.20	0.86 ± 0.04	3.47 ± 0.14b	4.67 ± 1.67	-	-	0.00 ± 0.00
3	24.00 ± 4.00	2.79 ± 0.13	0.88 ± 0.01	2.45 ± 1.81b	0.00 ± 0.00	-	-	0.80 ± 0.00
4	24.00 ± 1.00	2.49 ± 0.26	0.79 ± 0.08	0.00 ± 0.00a	0.00 ± 0.00	-	-	0.00 ± 0.00
5	19.00 ± 3.00	2.42 ± 0.36	0.82 ± 0.08	0.00 ± 0.00a	0.00 ± 0.00	-	-	0.00 ± 0.00
6	19.50 ± 1.50	2.35 ± 0.08	0.79 ± 0.04	0.00 ± 0.00a	0.00 ± 0.00	-	-	0.00 ± 0.00
$F_{5,11}$	2.71	1.07	0.54	7.34	1.22	-	-	0.80
P	0.129	0.459	0.741	0.015	0.403	-	-	0.588
Interlake	27.50 ± 1.84	2.82 ± 0.08	0.85 ± 0.02	2.90 ± 0.42	3.51 ± 1.94	-	-	0.53 ± 0.34
TGPP	20.83 ± 1.35	2.42 ± 0.12	0.80 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	-	-	0.00 ± 0.00
t_{10}	2.92	2.74	1.50	6.86	1.81	-	-	1.58
P	0.015	0.021	0.164	› 0.001	0.100	-	-	0.145

[1] Plots 1-3 – Interlake, plot 4-6 – TGPP
[2] Means in columns followed by different letters are significantly different, Fisher's Least Sample Difference LSD Test (p≥0.05)
[3] Larval host plant
[4] Adult nectar source plant

There were no differences between the Interlake and TGPP for species richness, Shannon's diversity, and evenness for all species in the June sample period (Table 4). Plots 1 (Interlake) and 4 (TGPP) had significantly higher species richness but there was no difference in Shannon's diversity and evenness between any of the plots in June (Table 4). There was also no difference in June between the TGPP and Interlake for species richness, Shannon’s diversity, and Shannon’s evenness, for *Poa pratensis* (larval food plant) or *Rudbeckia serotina* (adult nectar source) (Table 4).

There was a significant difference between the Interlake and TGPP in July for species richness, Shannon's diversity, and *Poa pratensis*. Plots 1-3 at Interlake had more species than the plots in the TGPP (Table 4). There was no significant difference with respect to Shannon's diversity, Shannon's evenness, *Panicum spp.*, or *Camus spp.* between plots.

In August, differences were observed between the Interlake and the TGPP for species richness, Shannon's diversity, and *Poa pratensis* (Table 4). Shannon's evenness was not different between plots or areas. Again, *Poa pratensis* was more abundant in the Interlake area than in the TGPP area (Table 4).

The cluster analyses are based on β diversity measures used to develop a matrix using Sorensen’s quantitative coefficients for the June, July, and August sampling periods.

The June cluster shows a close relatedness between plots 1, 2, and 3 (Interlake). There is also a close clustering of plots 5 and 6 (TGPP) suggesting a high degree of overlap between plant species in the plots (Table 5).

Table 5. June matrix of Sorensen's coefficients (β diversity)

Plots	1	2	3	4	5	6
1	1.00	-	-	-	-	-
2	0.32	1.00	-	-	-	-
3	0.44	0.43	1.00	-	-	-
4	0.32	0.31	0.46	1.00	-	-
5	0.30	0.30	0.40	0.43	1.00	-
6	0.32	0.30	0.40	0.45	0.64	1.00

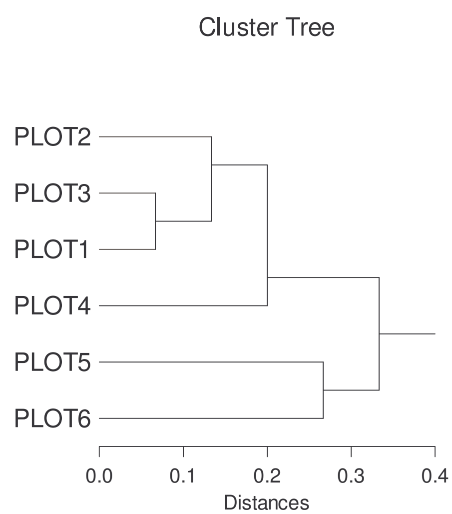

Figure 5. June cluster analysis using Sorenson's quantitative index, Plots 1-3 – Interlake, plots 4-6 – TGPP.

In July, there was a high degree of overlap between species in plots 1 & 2 (Table 6) but there is less overlap between all of the other plots. There still is a clear clustering of the Interlake plots separate from the TGPP plots (Table 6).

Table 6. July matrix of Sorensen's coefficients (β diversity)

Plots	1	2	3	5	6
1	1.00	-	-	-	-
2	0.39	1.00	-	-	-
3	0.42	0.35	1.00	-	-
5	0.09	0.08	0.24	1.00	-
6	0.07	0.09	0.19	0.44	1.00

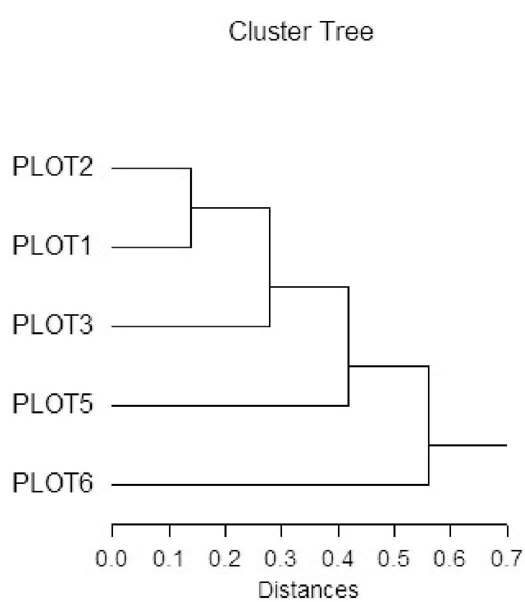

Figure 6. July cluster analysis using Sorenson's quantitative index, Plots 1-3 – Interlake, plots 5-6 – TGPP.

The August sampling period shows a high degree of overlap between the Interlake plots (Table 7). Plot 1, 2, and 3 are close in relation to each other, however, plots 4, 5, and 6 are further away from each other (Table 7). This suggests a smaller degree of overlap of plant species within the TGPP plots and a weak correlation between the Interlake and the TGPP.

Table 7. August matrix of Sorensen's coefficients (β diversity)

Plots	1	2	3	4	5	6
1	1.00	-	-	-	-	-
2	0.52	1.00	-	-	-	-
3	0.39	0.39	1.00	-	-	-
4	0.39	0.34	0.41	1.00	-	-
5	0.37	0.35	0.38	0.53	1.00	-
6	0.32	0.29	0.36	0.61	0.59	1.00

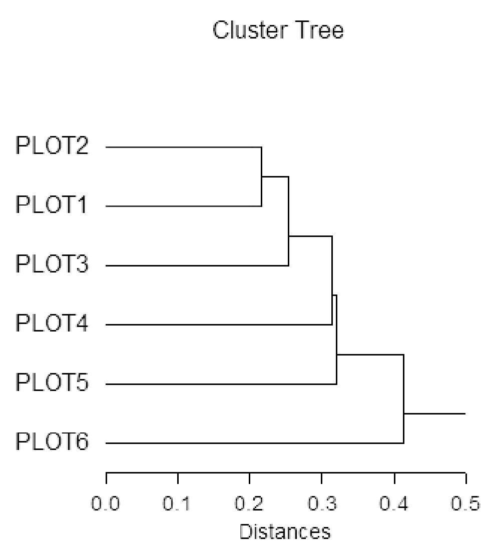

Figure 7. August cluster analysis using Sorenson's quantitative index, Plots 1-3 – Interlake, plot 4-6 – TGPP.

Butterfly collections

Eight individual Dakota skippers were observed and/or collected in plot 2 and 3 of the Interlake plots during the flight period for Dakota skippers. No Dakota skippers were observed or collected in the TGPP or in plot 1 of the Interlake. A list of other butterfly species collected in the Interlake and TGPP is shown in Appendix 3.

Table 8. Number and locations of Dakota skippers identified in 2005

Date	Plot	Number	Sex
12-Jul-05	3	3	F
12-Jul-05	2	1	M
13-Jul-05	2	1	F
13-Jul-05	3	1	M
14-Jul-05	3	1	F
22-Jul-05	3	1	F

Discussion

Rankings: Abundance of shrubs in TGPP

Rankings illustrated the structural difference between the two sites. The TGPP had a higher shrub composition versus the Interlake. This was visibly obvious in the field, where the TGPP had shrubs dispersed throughout the prairie. The Interlake plots had aspen and poplar groves, but few shrubs throughout the interconnecting prairie areas.

Rankings: Overabundance of few species in TGPP

Several plant species dominated in the TGPP, whereas plant species were represented more evenly in the Interlake. For example, percent cover of *Carex spp.* in the TGPP in June was 23.33%, with the next most abundant group being *Grass spp.* at almost half (13.45%). The most abundant plant group in the Interlake was *Grass spp.* at 12.70%. The second most abundant plant species was *Potentilla anserina* at 8.08%. Management practices, climate, or physiographic factors may influence the plant distribution in the two areas. Sedges were the most abundant species in TGPP and it appeared that the TGPP was wetter than the Interlake area where grasses predominated. Further studies into the influence of climate on tall-grass prairie vegetation should be completed for the study areas.

Rankings: Low abundance of adult and larval food host plants in TGPP

A higher abundance of larval and adult food plants, an important aspect of the species niche, in the Interlake could support a Dakota skipper population to a greater degree than those found in the TGPP. There was a significant difference in the abundance of larval and adult food host plants between the TGPP and Interlake. The Interlake had higher cover of larval and adult food plants compared to the TGPP. In

August, the mean percent cover of *Poa pratensis* was 2.9% in the Interlake and zero in the TGPP. This trend continued with *Schizchryrium scoparium* (3.51% and zero in the Interlake and TGPP respectively) and *Rudbeckia serotina* (0.53% and zero in the Interlake and TGPP respectively).

Diversity higher in Interlake area

In all three months species richness, diversity, and evenness increased in the Interlake plots. *Poa pratensis*, a larval food plant, was more abundant in the Interlake than in the TGPP.

Management effects on vegetative composition

Further research should focus on the effect of management type on the vegetative composition. Parts of TGPP are subject to spring and fall prescribed burns on approximately a three-year cycle (Borkowski, 2006, pers. comm.) (Appendix 1), however, the Interlake sites are not subject to burning but rather subject to fall haying (COSEWIC, 2003, landowner contacts). Kucera and Koelling (1964) reported that if burning was omitted over a five-year period, with no additional management practices, there was a general deterioration in the native prairie community. There is a general belief among many scientists, that without fire, woody plant species will move in to prairie systems and the open grassland will disappear (Vogl, 1974). Prairie species are assumed to be fire-adapted because natural fires maintained the historical prairie landscape (Swengel, 1998). Without fire, the habitat would change to a degree that may be unsuitable to many grassland dependent species (Swengel, 1998).

Webster (2003) expressed the possibility that a prescribed burn in the year 2000 in combination with an unscheduled wildfire may have contributed to the extirpation of the

Dakota skipper from the TGPP. Timing of these prescribed fires, their size and intensity are extremely important in conserving the grassland biodiversity (Gibson and Hulbert, 1987). If burns are too frequent or are too large, there is a possibility that rare butterflies may be extirpated (Swengel, 1998). Panzer and Schwartz (2000) refute this statement and claim that management by burning can in fact protect several species that would otherwise be lost by the invasion of woody plants and non-native species. Swengel (1999) found that there was there was high mortality of rare butterfly species in spring and late summer burns because they either kill the adults in spring or the eggs and larvae in late summer or fall. Some protection from haying may be available to the larvae of Dakota skippers in late summer and fall because they are located in their silken tube at the base of bunch grasses (Dana, 1991). However, they are still above the ground, so intense ground fires can still cause mortality (Swengel, 1996). It has been proposed that haying in fall may potentially be the best management activity to preserve Dakota skipper habitat (McCabe, 1981) but haying or mowing before or during the adult flight period would remove critical food plants (Webster, 2003).

The northern portion of the TGPP was sampled for butterflies and Dakota skippers in this study. I collected extensively for butterflies in the southern block as well (all vegetation surveys took place in the Interlake only) (Appendix 2). Historical data indicates the presence of the Dakota skipper in the southern limits of the preserve, however no Dakota skippers were found. Perhaps further research could include a vegetation survey of the southern portion of the preserve.

Cluster analysis of landscape

The cluster analyses showed that the plots selected in the study were a good representation of the prairie being sampled. They also showed that the Interlake and the TGPP were significantly different in terms of overlap of plant species between plots.

The cluster analyses provided a landscape level overview of vegetative composition. The distance between clusters signified the degree of overlap of plant species between the plots. Each sample period had a fairly large overlap of species within the Interlake plots, and within the TGPP plots. The cluster analysis showed that plots 1-3 and plots 4-6 were quite similar. Thus we can be fairly confident that Interlake plots were similar. Also the Dakota skipper was collected in plots 2 and 3 in the Interlake. Similarly, each of the TGPP plots were similar, once again confirming our sample design targeted similar areas of habitat. However, cluster distances between the Interlake and TGPP area was larger, indicating lesser overlap between species and highlighting the differences in the two broad habitat types.

Butterfly survey

Butterfly surveys during the summer of 2005 from the beginning to middle of July were completed in both the TGPP and Interlake plots. Eight Dakota skippers were identified during the adult flight period in two of the three Interlake plots but none were found in plot one of the Interlake or in the north and south block of the TGPP. Examples of other skippers found in both the Interlake and TGPP areas included; *Polites mystic* (W.H. Edwards, 1863), *Polites coras* (Cramer, 1775), *Polites themistocles* (Latreille, 1824), *Thymelicus lineola* (Ochsenheimer, 1808), and *Oarisma garita* (Reakirt, 1866). These species often fly in association with the Dakota skipper. If these species are found in both areas, this raises the question as to why the Dakota skipper was not. The vegetation surveys suggest that differences between plant species abundance and diversity between the two sites may contribute to the absence of the Dakota skipper in the TGPP. A closer examination of management approaches in the future could perhaps provide a stronger link between vegetation and skipper presence or absence.

Limitations of study

One potential source of error in this study included difficulty with the identification of the certain plant and butterfly species. The process of identifying a grass species proved challenging, and dependent on the sample period during the summer. Grasses in flower were much easier to identify to genus or species level. The percent cover determination for some species was difficult (especially some grasses and sedges) as without laboratory confirmation, certain grasses and *Carex* spp. could not be identified in the field. Several plant species were assigned a number and could not be identified.

Butterfly survey and identification was another limitation in our study. Skippers are very fast fliers and certain skipper species look very similar. Actual collection is needed to correctly identify certain species, thus they must be returned to the laboratory for further taxonomic study before identity can be confirmed. Most other butterfly species could be identified on the wing, due to distinct wing characteristics.

There appeared to be an increase in the number of plant species found throughout the summer. This may be attributed to our knowledge of plant identification increasing with practice, and the influence of seasonality on types of plant species that grow at different times of the year. This may have affected our results in providing more accurate identification later in the summer when most grass species are flowering. This is important to note because the main larval food plants of Dakota skipper include grasses which are easier to identify in late summer compared to early summer during our first sample period.

Several improvements could be made to strengthen this study. The butterfly survey for both the TGPP and the Interlake plots could have been implemented earlier, perhaps at the end of June. Due to time constraints, vegetation survey activity took up all of June and Dakota skipper sampling started at the beginning of July. Plot 4 in the TGPP was not sampled in July due to lack of time and reduced the number of degrees of freedom in July t-tests and provided one less plot in July Sorenson's analysis.

Although transects in the Interlake plots were located with the GPS, the fact that they were situated on private property means they could be destroyed by land use conversion or difficult to relocate if access were denied in the future. GPS could be used to re-locate the transects, but GPS is only accurate to within a few metres and re-established transects could be off by a few metres from original ones. Visual cues in combination with GPS and a compass were used to relocate the transects.

We did not measure potentially important environmental data including soil nutrient analysis, soil moisture levels, historical climate, and elevations of the plots. These factors may have varying effects on the composition of vegetation located at both sites. Understanding the link between certain physical features of the sites may further help us understand the biology of the Dakota skipper in the study sites.

Conclusions

1. Reintroduction of the Dakota skipper into the Tall-Grass Prairie Preserve may not be feasible at this time due to the lack of suitable habitat and low density of larval and adult host plants.
2. Plant composition of the TGPP and the Interlake is significantly different, there is evidence that a few species are quite dominant in the TGPP and there are more shrubs within the TGPP.
3. Larval and adult food plants are more abundant in the Interlake.
4. Butterfly species normally associated with the Dakota skipper are present in both areas.
5. Haying may be more conducive to Dakota skipper survival. Interlake plots were all hayed in the late summer or fall.
6. Further research should focus on the influence of management on Dakota skipper populations and the effects of soil, climate, and physiographic factors on the vegetative composition of the Interlake and TGPP areas.

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Appendix 1.

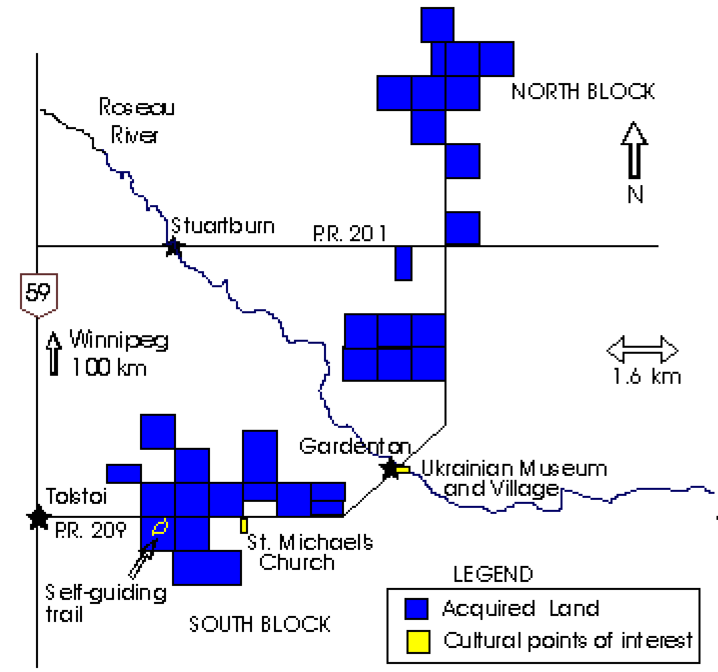
Summary of Burn Management at Tall Grass Prairie Preserve 1992 – 2005

	Spring	Section	Comments	Fall	Section	Comments
1992	Field Station (area west of land)	SW34-1-6E		Doyle (east half)	N½NW33-1-6E	
1993	Bernice and Rose lease	SW31-1-6E		Doyle (west half)	N½NW33-1-6E	
	Field Station/Sklar	S½SW34-1-6E				
*	Saranchuk	E½NE35-2-6E	extent unknown			
*	Rose	W½NW36-2-6E	extent unknown			
*	Dignam	E½NW36-2-6E	extent unknown			
*	Starbuck	NE36-2-6E	extent unknown			
1994	Grazing Project	29-1-6E				
*	Gooi	NW24-2-6E				
*	Glenlawn	SW24-2-6E				
*	Pelletieri et al.	SE26-2-6E	extent unknown			
1995 *	Matz	NE30-1-6E	prescribed followed by wildfire			
*	M.Kulyk	NW30-1-6E				
*	Starbuck	NE36-2-6E	extent unknown			
*	Rose/Dignam	NW36-2-6E	extent unknown, some damage to 1st lvs. of WPFO			
*	Tencha	SW36-2-6E	extent unknown			
1996	Bale	E½NW14-2-6E		Antonyshyn	SE4--2-6E	
				Field Station	SW34-1-6E	unsuccessful
1997	Doyle	N½NW33-1-6E		Field Station	SW34-1-6E	60 acres (snowed out)
	Loewen	33-1-6E				
	MNS	S½32-1-6E				

Appendix 1. continued						
1998	Bale	E½NW14-2-6E		Grazing Project	29-1-6E	
	Field Station	SW34-1-6E				40 acres of sedge meadows
	Matz	NE30-1-6E		Starbuck	NE36-2-6E	NE corner
*	Machnee	NW32-1-6E				
*	MNS	S½32-1-6E	all but southeast portion of SE32			
*	Doyle	N½NW33-1-6E				
*	Krashewski	SE31-1-6E	all but north 1/5 or so	Lee		up to drainage ditch
*	Loewen	SE33-1-6E	NW corner			
*	Loewen	N½SW33-1-6E				
*	Loewen	S½NW33-1-6E				
1999	No fires					
2000	Glenlawn	SW24-2-6E	wildfire	Antonyshyn	SE4-2-6E	Prescribed
	Tencha	SW25-2-6E	wildfire	Field Station	SW34-1-6E	Prescribed
	Gooi	NW24-2-6E	wildfire			
2001	Grazing Project	29-1-6E	incomplete (skipped Excl. B)	Bale	E½NW14-2-6E	
	Matz	NE30-1-6E	incomplete burn	Loewen	SE33-1-6E	Wildfire
				Loewen	N½SW33-1-6E	Wildfire
				Doyle	NW33-1-6E	Wildfire
				Machnee	NW32-1-6E	Wildfire
2002 Apr. 10	Machnee	NW32-1-6E	wildfire - 160acres			
	Krashewski	SE31-1-6E	wildfire - 70 acres			
Apr-20	Rybuck	SE6-2-6E	wildfire - 90 acres			
	Tencha	SW25-2-6E	wildfire - 100 acres			
Apr.20-22	WMA		wildfrie - 960 acres			
Apr.23	Saranchuk	SW36-2-6E	prescribed			
	Starbuck	NE36-2-6E	prescribed			
	Tencha	SW36-2-6E	prescribed			

Appendix 1. continued						
	Dignam	E½NW36-2-6E				
May-16	Pelletieri et al	SE26-2-6E	prescribed			
	Simms	NE26-2-6E	prescribed			
	LGD	NW26-2-6E	prescribed			
	Saranchuk	NE26-2-6E	prescribed			
	Saranchuk	SE2-3-6E	prescribed			
May-22	Pajonk	SE24-2-6E	prescribed			
	Glenlawn	SW24-2-6E	prescribed			
	Saranchuk	NE23-2-6E	prescribed			
	Pajonk	NW13-2-6E	wildfire - 160 acres			
	Pajonk	NE13-2-6E	wildfire - 160 acres			
	Richards	SW18-2-7E	wildfire - 160 acres			
	Kischuk	SE18-2-7E	wildfire - 160 acres			
	Gooi	NW24-2-6E	prescribed			
2003 May-16	Old field station	SW34-1-6E	prescribed			
	Antonyshyn	SW4-2-6E	prescribed			
May-02	DCGC	NE22-2-6E	prescribed			
	Kischuk	NW7-2-7E	wildfire - 160 acres			
	Batte	SE12-1-6E	wildfire - 160 acres			
	Batte	NE12-1-6E	wildfire - 160 acres			
2004	INFO PENDING					
2005	Lee	NE31-2-7E	wildfire on sw portion	Sighn	NE21-2-6E	presecribed - approx 60 acres
	Antonyshyn	SW4-2-6E	wildfire			

Appendix 2. Tall-grass prairie preserve



Appendix 3. List of other butterflies caught in the Interlake in 2005 during Dakota skipper flight period

Date	Plot #	Species name	Quantity	Sex	Condition
05-Jul-05	1	*Coenonympha tullia*	5	0	0
05-Jul-05	1	*unknown*	1	0	0
05-Jul-05	2	*Nyphalis milberti*	1	1	1
05-Jul-05	2	*Nyphalis milberti*	3	0	0
05-Jul-05	2	*Thymelicus lineola*	unknown	0	0
05-Jul-05	2	*Danaus plexippus*	1	0	0
05-Jul-05	2	*Oarisma garita*	1	1	1
05-Jul-05	2	*Phyciodes sp.*	1	0	0
05-Jul-05	2	*unknown*	2	0	0
05-Jul-05	3	*Coenonympha tullia*	unknown	0	0
05-Jul-05	3	*unknown*	1	0	0
05-Jul-05	3	*Thymelicus lineola*	1	0	0
07-Jul-05	2	*Cercyonis pegala*	1	0	0
07-Jul-05	2	*unknown*	1	0	0
07-Jul-05	2	*Phyciodes tharos*	1	0	0
07-Jul-05	3	*Vanessa sp.*	2	0	0
07-Jul-05	3	*Coenonympha tullia*	unknown	0	0
07-Jul-05	3	*Coenonympha tullia*	1	2	1
07-Jul-05	3	*Thymelicus lineola*	unknown	0	0
07-Jul-05	3	*Pieris sp.*	1	0	0
07-Jul-05	3	*Phyciodes tharos*	1	0	1
07-Jul-05	3	*Phyciodes sp.*	unknown	0	0
12-Jul-05	3	*Thymelicus lineola*	unknown	0	0
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	1
12-Jul-05	3	*Thymelicus lineola*	1	1	2
12-Jul-05	3	*Coenonympha tullia*	unknown	0	0
12-Jul-05	3	*Coenonympha tullia*	1	1	1
12-Jul-05	3	*Coenonympha tullia*	1	1	1
12-Jul-05	3	*Cercyonis pegala*	unknown	0	0
12-Jul-05	3	*Limenitis archippus*	1	0	0
12-Jul-05	3	*Limenitis archippus*	1	1	2
12-Jul-05	3	*Euptoieta claudia*	1	0	0
12-Jul-05	3	*Phyciodes morpheus*	1	2	2
12-Jul-05	3	*Phyciodes morpheus*	1	2	3
12-Jul-05	3	*Cercyonis pegala*	1	1	1

Condition
1 – Poor
2 – Good
3 – Excellent

Sex
0 – Unknown
1 – Male
2 – Female

Appendix 3.
Continued

Date	Plot #	Species name	Quantity	Sex	Condition
12-Jul-05	3	*Cercyonis pegala*	1	1	1
12-Jul-05	3	*Cercyonis pegala*	1	1	1
12-Jul-05	3	*Cercyonis pegala*	1	1	1
12-Jul-05	3	*Satyrodes eurydice*	1	2	2
12-Jul-05	3	*Satyrodes eurydice*	1	1	3
12-Jul-05	3	*Lycaena dorcas*	1	0	0
12-Jul-05	2	*Cercyonis pegala*	unknown	0	0
12-Jul-05	2	*Cercyonis pegala*	1	1	2
12-Jul-05	2	*Cercyonis pegala*	1	1	1
12-Jul-05	2	*Cercyonis pegala*	1	1	3
12-Jul-05	2	*Vanessa atalanta*	1	2	3
12-Jul-05	2	*Phycoides morpheus*	1	2	2
12-Jul-05	2	*Colias philodice*	1	1	1
12-Jul-05	2	*Vanessa atalanta*	1	0	0
12-Jul-05	1	*Cercyonis pegala*	1	1	1
12-Jul-05	1	*Thymelicus lineola*	1	2	1
12-Jul-05	1	*Thymelicus lineola*	1	2	2
13-Jul-05	3	*Coenonympha tullia*	unknown	0	0
13-Jul-05	3	*Cercyonis pegala*	unknown	0	0
13-Jul-05	3	*Thymelicus lineola*	unknown	0	0
13-Jul-05	3	*Phyciodes sp.*	unknown	0	0
13-Jul-05	2	*Cercyonis pegala*	unknown	0	0
13-Jul-05	2	*Thymelicus lineola*	unknown	0	0
13-Jul-05	2	*Vanessa atalanta*	1	0	0
13-Jul-05	2	*Colias sp.*	unknown	0	0
13-Jul-05	2	*Pieris sp.*	unknown	0	0
13-Jul-05	2	*Phyciodes sp.*	unknown	0	0
13-Jul-05	1	*Vanessa atalanta*	1	0	0
13-Jul-05	1	*Cercyonis pegala*	unknown	0	0
13-Jul-05	1	*Danaus plexippus*	1	0	0
14-Jul-05	3	*Vanessa atalanta*	1	0	0
14-Jul-05	3	*Limenitis arthemis*	1	0	0
14-Jul-05	3	*Coenonympha tullia*	unknown	0	0
14-Jul-05	3	*Erynnis sp.*	1	0	0
14-Jul-05	3	*Thymelicus lineola*	unknown	0	0
14-Jul-05	3	*Phyciodes sp.*	unknown	0	0
14-Jul-05	3	*Colias sp.*	unknown	0	0
14-Jul-05	3	*Pieris sp.*	unknown	0	0
14-Jul-05	3	*Colias eurytheme*	1	2	1
14-Jul-05	3	*Lycaena dorcas*	1	2	1
14-Jul-05	3	*Cercyonis pegala*	unknown	0	0

Appendix 3.
Continued

Date	Plot #	Species name	Quantity	Sex	Condition
14-Jul-05	2	*Vanessa atalanta*	2	0	0
14-Jul-05	2	*Vanessa virginiensis*	1	2	1
14-Jul-05	2	*Cercyonis pegala*	unknown	0	0
14-Jul-05	2	*Colias sp.*	1	0	0
14-Jul-05	2	*Pieris sp.*	1	0	0
14-Jul-05	2	*unknown*	1	0	0
14-Jul-05	1	*Cercyonis pegala*	unknown	0	0
14-Jul-05	1	*Colias sp.*	1	0	0
14-Jul-05	1	*Danaus plexippus*	1	0	0
22-Jul-05	3	*Cercyonis pegala*	unknown	0	0
22-Jul-05	3	*Phyciodes sp.*	unknown	0	0
22-Jul-05	3	*Coenonympha tullia*	unknown	0	0
22-Jul-05	3	*Colias sp.*	unknown	0	0
22-Jul-05	3	*Limenitis archippus*	1	0	0
22-Jul-05	3	*Pieris sp.*	unknown	0	0
22-Jul-05	3	*Nyphalis antiopa*	1	0	0
22-Jul-05	3	*Satyrodes eurydice*	1	0	0
22-Jul-05	3	*Speyeris ap.*	1	0	0
22-Jul-05	3	*Hesperiidae*	1	0	0
22-Jul-05	2	*Cercyonis pegala*	unknown	0	0
22-Jul-05	2	*Thymelicus lineola*	unknown	0	0
22-Jul-05	2	*Danaus plexippus*	5	0	0
22-Jul-05	2	*Colias philodice*	unknown	0	0
22-Jul-05	2	*Colias interior*	unknown	0	0
22-Jul-05	2	*Pieris sp.*	unknown	0	0
22-Jul-05	2	*Phyciodes sp.*	1	0	0
22-Jul-05	2	*Satyrodes eurydice*	1	0	0
22-Jul-05	1	*Cercyonis pegala*	unknown	0	0
22-Jul-05	1	*Colias sp.*	unknown	0	0
22-Jul-05	1	*Pieris sp.*	unknown	0	0

Appendix 3. continued

List of other butterflies caught in the TGPP in 2005 during Dakota skipper flight period

Skippers
Polites mystic
Polites themistocles
Polites coras
Oarisma garita
Thymelicus lineola
Epargyreus clarus
Ancyloxpha numitor
Euphyes ruricola

Butterflies
Lycaena dorcas
Lycaena helloides
Satyrodes eurydice
Coenonympha tullia
Cercyonis pegala
Colias philodice
Boloria selene
Nymphalis antiopa
Speyeria cybele
Phyciodes morpheus