Final Report

31 December 2005
(Final Revisions 13 September 2006)

Effects of Grazing on the Dakota Skipper Butterfly; Prairie Butterfly Status Surveys 2003-2005

Contract #A50630

Submitted
to

Richard J. Baker, Animal Research Coordinator
Natural Heritage and Nongame Research Program
Minnesota Department of Natural Resources
500 Lafayette Rd., Box 25
St. Paul, MN 55155

Principal Investigator

Gerald Selby
Ecological and GIS Services
1410 W. Euclid
Indianola, Iowa 50125

TABLE OF CONTENTS

ABSTRACT

A research project was conducted to examine the effects of cattle grazing on the Dakota skipper (*Hesperia dacotae* [Skinner]) (Lepidoptera: Nymphalidae) from 2003-2005. The study area included public and private properties in and around Glacial Lakes State Park, Pope County, Minnesota. The study was intended to examine the impacts of grazing intensity, duration, and timing on each of the key stages of the Dakota skipper life cycle (e.g. egg, larva, pupa, and adult). Sites representing three grazing regimes (moderate rotational, moderate open season-long, and intense open season-long) and various non-grazing regimes (short-term and long-term ungrazed) were selected to test the impacts. For each combination of grazing factors, the objectives of the study included the following: 1) examine grazing impacts on adult usage (e.g. distribution, abundance, and behavior); 2) examine grazing impacts on oviposition site selection and egg survivorship; and 3) examine grazing impacts on larval survivorship during early development (late summer to fall), diapause (winter), and late development (spring to early summer). Unfortunately, the Dakota skipper population in the study area experienced a major population crash prior to or perhaps during the 2003 field season, and did not recover enough by the end of the 3-year study to allow adequate data to be collected. Also, the rotational grazing program that was a central component of the study still had not been implemented by the end of the final field season. Some general trends were apparent from the adult butterfly data. Severe overgrazing and highly degraded prairie have predictably negative impacts on most of the prairie butterfly species, but Dakota skippers appeared to do as well in areas with intermediate grazing as they did in ungrazed areas. It was impossible to draw any conclusions about grazing impacts on the other life stages, but the study did provide an opportunity to refine the methodology that might be used for those components in future studies. The dramatic population declines for the prairie specialist skippers (Arogos and Dakota skipper, and Poweshiek skipperling) in the study area may be widespread in west-central Minnesota, but those same species appear to be doing well at sites in southwestern Minnesota. Dakota skippers also appear to be doing fairly well at Felton Prairie SNA in northern Minnesota.

INTRODUCTION

The purpose of this research project was to examine the effects of cattle grazing on the Dakota skipper (*Hesperia dacotae* [Skinner]) (Lepidoptera: Nymphalidae). An initial planning study was done to define the objectives, develop the research plan, and select the study areas (Selby 2003a). During this time, an experts' workgroup was assembled to assist with the development and implementation of the research plan, and a workgroup planning meeting was held on 9 January 2003 (see **Appendix 7** for workgroup participants and meeting summary). Based on input from the workgroup, it was determined that this study should focus on the combined impacts of grazing intensity, duration, and timing on the key stages of the Dakota skipper life cycle (e.g. egg, larva, pupa, and adult). Sites representing three grazing regimes (moderate rotational, moderate open season-long, and intense open season-long) and various non-grazing regimes (short-term and long-term ungrazed) were selected to test those impacts. They included public and private properties in and around Glacial Lakes State Park, Pope County, Minnesota (**Appendix 1, Figure 1**).

For each combination of grazing factors, the objectives of the study included the following:

1) Examine grazing impacts on adult usage (e.g. distribution, abundance, and behavior)
2) Examine grazing impacts on oviposition (egg-laying) site selection and egg survivorship
3) Examine grazing impacts on larval survivorship during early development (late summer to fall), diapause (winter), and late development (spring to early summer).

Unfortunately, the Dakota skipper population in the study area experienced a major population crash prior to or perhaps during the 2003 field season, and did not recover significantly by the end of the 3-year study. Skadsen (2001) collected baseline data along equivalent, but slightly shorter transects at Glacial Lakes State Park in 2001. During duplicate surveys of those transects he observed a total of 126 Dakota skippers, 104 Poweshiek skipperlings (*Oarisma poweshiek*), 17 regal fritillaries (*Speyeria idalia*), and two unconfirmed Arogos skippers (*Atrytone arogos*). During this study, total Dakota skipper observations during roughly equivalent transect surveys at Glacial Lakes State Park were 17 in 2003 and 12 in 2004. There were similarly low numbers at Anderson Pasture (2003 = 6; 2004 = 16), and at the other sites there was only one confirmed Dakota skipper observation at Fredrickson Pasture in 2003. The Dakota skipper population appeared to be recovering slightly in 2005. During a single set of transect surveys a total of 29 Dakota skippers was seen (Glacial Lakes State Park = 18; Anderson Pasture = 11). Poweshiek skipperlings appear to have suffered even more catastrophic losses in the area. Only four were seen during all fieldwork conducted in 2003, and none were seen in 2004 and 2005. No Arogos skippers were seen during this study, but Skadsen's results suggest that if they were present, their numbers may have already been low in 2001. Regal fritillary numbers were generally higher during this study. Total observations at all sites during equivalent transect surveys (duplicate in 2003 and 2004, and single in 2005) were 152 in 2003 (Glacial Lakes State Park = 57; Anderson Pasture = 42; Fredrickson Pasture = 30; Rutledge Pasture = 23), 263 in 2004 (Glacial Lakes State Park = 130; Anderson Pasture = 101; Fredrickson = 10; Rutledge Pasture = 22), and 51 in 2005 (Glacial Lakes State Park = 26; Anderson Pasture = 16; Fredrickson = 7; Rutledge Pasture = 2).

The low numbers of Dakota skipper and other secondary target butterfly species during the study made it difficult to collect significant grazing impact data for the adult stage, and impossible to obtain significant data for the other life stages. After the first field season, given the possibility that the population might still be low in 2004, a flexible work plan was agreed to for the 2004 field season. If the population made a significant recovery, an attempt would be made to collect data for all the life stages during that field season and in 2005 data collection would be limited to adult surveys and larval survival from the previous season. If the numbers were still low, the focus would be on collecting adult butterfly, grazing and vegetation data, and if possible, testing methodology for the other life stages. More complete data collection would be reserved for the 2005 field season. This would, of course, require that the population recovered enough in 2005 to collect that data, and would also require extending the project and funding to collect larval survival data in 2006. The Dakota skipper population did not recover in 2004, and there was evidence that the dramatic declines observed for the Dakota skipper and other secondary targets (e.g. Poweshiek skipperling and possibly Arogos skipper) were fairly widespread. Similar declines were observed in Iowa (Selby 2004), North Dakota (Royer, pers. comm. 2004), South Dakota (Skadsen, pers. comm. 2004), and Wisconsin (Borkin, pers. comm. 2004), suggesting an urgent need to document just how widespread the declines were, and to attempt to assess the factors responsible for those declines. Given the likely possibility that numbers would still be too low in 2005 for collecting grazing impact data, and the need to evaluate the extent and factors responsible for the observed declines, I recommended meeting to discuss possible changes for the final field season (2005) of the project. A meeting of the project principals (Richard Baker, MN DNR project coordinator; Robert Dana, MN DNR ecologist; Phil Delphey, FWS representative; Gerald Selby, contractor) was held on 10 January 2005. The general consensus was that the experimental component of the study should be abandoned, and that the final field season should be focused on continuing to document population trends along the established transects in the study area, and also documenting the status of the Dakota skipper and other secondary target species at other sites in Minnesota. A general revised work plan was developed and agreed to at that meeting (see email summary by Richard Baker in **Appendix 8**). I worked with Robert Dana to select and prioritize sites for the general status surveys, and with Richard Baker to finalize details for the revised work plan.

Some general trends were apparent from the adult butterfly data. Severe overgrazing and highly degraded prairie have predictably negative impacts on most of the prairie butterfly species, but Dakota skippers appeared to do as well in areas with intermediate grazing as they did in ungrazed areas. It was impossible to draw any conclusions about grazing impacts on the other life stages, but the study did provide an opportunity to refine the methodology that might be used for those components in future studies. The dramatic population declines for the prairie specialist skippers (e.g. Arogos and Dakota skipper; Poweshiek skipperling) in the study area may be widespread in west-central Minnesota, but those same species appear to be doing well at sites in southwestern Minnesota. Dakota skippers also appear to be doing fairly well at Felton Prairie SNA in northern Minnesota.

METHODS

Dakota Skipper Grazing Study

Project Development

An initial planning study was done to define the objectives, develop the research plan, and select the study areas (Selby 2003a). Objectives for the planning study included (1) review recent literature on the effects of grazing on prairie invertebrates, (2) contact project stakeholders, (3) conduct field visits to potential study sites, and (4) develop a detailed research plan. As part of the planning process, project stakeholders were contacted and an experts' workgroup was assembled to assist with the development and implementation of the research plan. A workgroup planning meeting was held on 9 January 2003 at the Morris Waterfowl Management District (WMD) office, and a consensus was reached on many of the issues related to the scope of the study, the sites to include, and logistics for conducting the study (see **Appendix 7** for workgroup participants and meeting summary).

An important first consideration in developing the project was whether to conduct an extensive study (e.g. numerous replicates per grazing regime spread across a large geographic area with a focus on the adult stage), an intensive study (e.g. a few sites concentrated in a localized area with a focus on all the life stages), or some combination of those approaches. The consensus of the workgroup was that it was important to understand the impacts of grazing on each of the Dakota skipper life stages (e.g. egg, larva, pupa, and adult). To accomplish that, it would be necessary to conduct an intensive study focused on a few sites in a relatively small geographic area. The second consideration was the types of grazing regimes to examine. All grazing systems involve varying combinations of grazing **intensity**, **duration**, and **timing**. Therefore, while it is convenient to compare "grazing regimes" as a whole, a proper understanding of the effects of those regimes on the Dakota skipper will require a careful examination of the interaction between those factors. The final consideration addressed by the workgroup was whether to examine the impacts of different types of grazers (e.g. cattle vs. bison), but the consensus was that this was beyond the scope of this study.

Based on input from the workgroup, it was determined that this study would focus on the combined impacts of grazing intensity, duration, and timing on the key stages of the Dakota skipper life cycle (e.g. egg, larva, pupa, and adult). Sites representing three grazing regimes (moderate rotational, moderate open season-long, and intense open season-long) and various non-grazing regimes (short-term and long-term ungrazed) were selected to test the impacts. Within the non-grazing regimes, other management impacts (e.g. fire history) were also evaluated. Vegetation responses to the grazing regimes were also measured and examined in relation to their impacts on the Dakota skipper at each life stage. Vegetation measurements included structure (e.g. height), nectar plant diversity and abundance, and general community composition. For each combination of grazing factors, the objectives of the study included the following:

1) Examine grazing impacts on adult usage (e.g. distribution, abundance, and behavior)
2) Examine grazing impacts on oviposition site selection and egg survivorship
3) Examine grazing impacts on larval survivorship during early development (late summer to fall), diapause (winter), and late development (spring to early summer).

Field Season Planning

Prior to the first field season (2003) I worked with local experts and landowners to get additional information on potential research sites, and also to make arrangements for getting permission to conduct research on the sites selected (see **Appendix 7** for contact information). Key expert contacts included:
- Margaret Kuchenreuther, Associate Professor of Biology, University of Minnesota, Morris
- Sara Vacek, Wildlife Biologist, USFWS, Morris Wetland Management District
- Craig Bower, District Conservationist, NRCS office, Glenwood
- Dean Schmidt, Wes-Min Resource Conservation and Development Council, Alexandria

One field season planning trip was conducted 29 April – 3 May 2003. The primary purpose of that trip was to finalize selection of sites to be included in the study, meet with key contacts and landowners, and interview a potential research assistant. Margaret Kuchenreuther met with me to discuss project details. She also introduced me to Bryan Simon, a recent graduate that she had recommended as a research assistant, and I interviewed him for the position. During that trip I also met with several other key contacts and a landowner, surveyed several properties on foot, and conducted a driving tour of the general area to look for other potential sites in and around tracts that had been recommended for the study.

I met with Craig Bower, District Conservationist at the NRCS office in Glennwood to discuss Randy Anderson's rotational grazing plan, and to get additional leads on potential landowners to work with. They were still finalizing field mapping for the paddocks, and I was also able to meet with Troy Baumgart, the technician responsible for doing the mapping and collecting GPS data for the paddock boundaries. Randy Anderson met with me at his property and gave me a driving tour of the pasture to be included in the rotational grazing system. I also surveyed a portion of his prairie pasture on my own the next day.

Other key private landowners included Mark Fredrickson and Michael Rutledge. I contacted Mark by phone and received permission to visit his property and include it in the study. His pasture was surveyed on foot to evaluate it, determine which portions should be included, and begin thinking about the survey transect design. I wasn't able to get a hold of Michael Rutledge, so I just conducted a road tour of the area in and around his property. He was contacted later and permission to include his property was obtained.

Glacial Lakes State Park was used as an ungrazed control for the study. I met with Melody Webb, park manager to discuss the project, purchased a state park user permit, and obtained a copy of relevant portions of the report for butterfly surveys conducted at the park by Dennis Skadsen in 2001 (Skadsen 2001). General field surveys were conducted to become familiar with state park survey units to be included in the study. Areas surveyed included Unit 1 (west end and area east of the parking lot), Unit 2 (west end), and Unit 4 (east end). These survey units are all ungrazed, and include both burned and unburned areas.

Other potential sites approximately 8-12 km south of the main study area were also evaluated (**Appendix 1, Figure 1**). Luverne and Mary Jo Forbord were preparing to implement a rapid rotational grazing system, and I was able to meet with them and tour their property. Other prairie immediately to the east of their farm includes a pasture with intense season-long grazing and an ungrazed USFWS WPA. There is another prairie pasture complex about four km further south. It includes the Don and Helen Berheim property (formerly Billehus tract). They had recently purchased the property and were working with the NRCS and USFWS to implement a rotational grazing system. Other prairie in the area ranged from ungrazed to intense season-long grazing. These prairie pastures presented the opportunity to examine a variety of grazing systems on a smaller scale than the Glacial Lakes State Park area, but as yet no Dakota skippers have been documented there, and overall prairie quality was much worse. Adding these areas would have required a significant increase in the capacity for the study, so they were not included. Some of those sites were targeted for later general surveys to determine if they had populations of the Dakota skipper or other prairie specialist butterflies.

Relevant GIS data were acquired from the Minnesota DNR's GIS Data Deli. Additional maps and GIS data with landowner information and FWS interests (e.g. easements, WPA's) were obtained from Sara Vacek. Data were prepared for use in the field with ArcPad software on a pocket PC with an attached WAAS capable CF GPS unit. Required permits (e.g. state park research permit and state collecting permit) were obtained, and housing arrangements were made for the months of June and July.

A one-two week trip was originally scheduled for May. The purpose of that trip was to finalize selection of the study areas and the research design within each area, set up the survey routes for the adult surveys, begin training the research assistant, and test the methodology for each of the life stages on similar butterfly species with an earlier flight (e.g. dusted skipper [*Atrytonopsis hianna*]). Full-time fieldwork was scheduled to begin early-mid June so that there would be time to complete the setup, training, and testing of the methodology before the Dakota skipper flight started. Unfortunately, there were considerable delays in the contract approval process, and it was necessary to eliminate the May trip and delay all fieldwork and hiring the research assistant until the second week in June. On 9 June I traveled to Minnesota to begin full-time fieldwork, stopping in St Paul for a final planning meeting with Rich Baker and Robert Dana. The next day was spent on employee training, setting up a computer workspace, and becoming familiar with the resources available at the university and in the town of Morris. Fieldwork began on 11 June. As a result of the delayed start, the setup was not completed until part way through the Dakota skipper flight.

Study Sites

The study area included public and private properties in and around Glacial Lakes State Park, Pope County, Minnesota (**Appendix 1, Figure 1**). It is located in the west-central portion of the state about eight km south of the town of Starbuck. Several factors were involved in the selection of this area for the study. There are extensive complexes of native prairie remnants, and previous butterfly surveys have suggested that they support a diverse assemblage of prairie-specialist butterflies, including healthy populations of Dakota skippers (Schlicht and Saunders 1995; Schlicht 1997a, 1997b, 2001; Skadsen 2001; Minnesota NHP 2003). The native prairie complexes also contain a good representation of grazing regimes and ungrazed controls. A major reason for selecting this area was the opportunity to work with a landowner that was setting up a new moderate rotational grazing program on property where good populations of Dakota skippers had been documented.

Sites representing various grazing regimes and ungrazed controls were selected for the study. Targeted grazing regimes included moderate rotational grazing and season-long grazing (intense, moderate, and light). Unfortunately, implementation of the new rotational grazing program was delayed, so grazing in that pasture system was also season-long (mostly moderate to light) throughout the study. The state park, Evenson tract, and Fish and Wildlife Service Waterfowl Production Area (WPA) were included as ungrazed controls. Study areas included in the study are described below.

Glacial Lakes State Park (Sec 13, 23, 24, T124N, R39W; Sec 19, 30, T124N, R38W)
Units in the park are ungrazed controls, and included recently burned (fall 2002, 2003, 2004; spring 2003 & 2004) and unburned prairie.

Rose Evenson Prairie (E2, Sec 30, T124N, R38W)
This ungrazed private tract is adjacent to the eastern boundary of Glacial Lakes State Park, and was included as part of the eastern transects for the park.

Randy Anderson Pasture (Sec 28, 29, 33, T124N, R38W)

This pasture was included as an example of a newly implemented rotational grazing system with four large paddocks. There were delays getting internal fencing and the watering system installed, so cattle were free ranging throughout the study, and it was an example of moderate to light intensity season-long grazing. A portion of a horse pasture adjacent to the north boundary was also included for comparison. Grazing in that pasture had been high intensity season-long through 2003, but the owner plans to incorporate it into the cattle grazing program. It was not grazed in 2004 and 2005 to allow it to recover from the past severe overgrazing.

Mark Frederickson Pasture (Sec 22, 23, T124N, R39W)

This tract was included as an example of moderate intensity season-long grazing. The actual grazing intensity varied within the site, and ranged from moderate through high.

Glacial Lake WPA (NW4, SW4, Sec 23, T124N, R39W)

This FWS unit is adjacent to the Mark Frederickson Pasture, and was included as an ungrazed control. It had been grazed prior to acquisition by FWS.

Michael Rutledge Pasture (Sec 9, 10, T124N, R39W)

This tract was included as an example of high intensity season-long grazing. The west pasture was the only one surveyed. Actual grazing intensity varied significantly within the site, and ranged from very high through moderate. The eastern pastures are divided into three units with some rotation of the herds between them, but they were not included due to time constraints.

Transect Design and Setup

Pollard transect surveys (Pollard 1977) were used as the principal sampling methodology for the adult component of the study. Transects were focused within suitable habitat, and were designed to include a good representation of the topographic relief, aspect, and slope position so that differences in grazing impacts on vegetation and preferences by skippers could be examined (**Appendix 1, Figures 2-5**). The acreage per survey unit, transect length, grazing intensity, and recent fire history are summarized in **Appendix 2, Table 1**.

Transects for each of the study areas were established in 2003. For Glacial Lakes State Park and Anderson Pasture, they were adapted from a transect design proposed by Robert Dana for those sites, and adaptations of the Glacial Lakes State Park design by Dennis Skadsen for his 2001 surveys (Skadsen 2001). For the new sites (e.g. Fredrickson Pasture, Glacial Lake WPA, and Rutledge Pasture) a similar transect design was used. A Pocket PC with an attached global positioning system (GPS) unit and ArcPad software was used for locating and navigating the proposed or existing transects, and collecting GPS data for the final waypoints (transect corners). Base map layers (e.g. 7.5 minute topographic maps [digital raster graphics – DRGs], black and white aerial photography [digital ortho photography – DOQ], and infrared aerial photography [CIR]) and feature map layers (e.g. property boundaries, transects, waypoints, etc.) were loaded on the Pocket PC, and were available as a background in the ArcPad view when navigating or collecting GPS data. It was possible to use the GPS units to navigate the transects each time a survey was done, but the transects were marked with flags (2.5x3.5" flags with 30" wires) so that during regular surveys the focus could be on observing and recording butterfly data, not GPS navigation. Transect waypoints were marked with white flags, and straight-of-ways were marked with enough orange flags to maintain constant line-of-site between flags. Unfortunately, cows have a strange fascination with flags, and maintaining the flags in the grazed pastures was a problem! The flags were removed at the end of each field season.

At Anderson Pasture there were four large survey units corresponding to the proposed rotational grazing paddocks, and one small unit that was to be excluded from grazing for erosion control (**Appendix 1, Figure 2**). At Glacial Lakes State Park and Evenson Prairie four of the five survey units surveyed by Skadsen (2001) were included (**Appendix 1, Figure 3**). A fifth short transect north of the park entrance was not included in this study, but could be added back in for general monitoring purposes in the future. A single transect covered both the Fredrickson Pasture and the adjacent WPA. It is quite long (7,928 m), and it was difficult to complete the entire route in a single survey period. The route surveyed in the WPA was modified slightly after the first year (**Appendix 1, Figure 4**). At Rutledge Pasture a single transect that provided fairly complete coverage of the pasture west of the road was proposed in 2003, but quantitative surveys were limited to the southern portion that transect, and in 2004 the transect was modified to focus the surveys in that area (**Appendix 1, Figure 5**).

Adult butterfly surveys

General surveys were conducted whenever fieldwork other than quantitative transect surveys was being done. The main purpose of those surveys was to keep a record of the active butterfly species, and a very general sense of their relative abundance. An attempt was made to record every observation for target species (e.g. Dakota skipper, Poweshiek skipperling, and to a lesser extent regal fritillary). Not all individual observations were recorded for the non-target species during general surveys, so the numbers recorded for those species should not be used to draw conclusions about their abundance.

Quantitative transect surveys were conducted along the transects using standardized protocols adapted from Pollard (1977). During the first two field seasons (2003, 2004) an attempt was made to conduct at least two complete surveys per transect during the peak portion of the Dakota skipper flight. During the third field season (2005) a single set of surveys was completed. The transects were walked at a slow steady pace, recording all observations within five meters on either side of the transect and up to ten meters in front of the surveyor. Most of the surveys were conducted by two-person teams during the first two field seasons, but the third year they were done by one person. For the two-person teams, the lead person was the observer and the second person was the data recorder. Observations by the recorder that were missed by the observer were recorded as “second observer”, and observations outside the transect area were recorded as “off transect”. These extra observations were not included as part of the regular survey results, but did provide useful information (e.g. additional scarce observations and data for the Dakota skipper). Whenever possible, data collected for the butterflies included name, sex, condition, behavior, and location. However, it was not practical to confirm the sex and condition for every observation, so these data were more complete for the target species.

Data were all recorded using a Pocket PC with an attached GPS unit and ArcPad software. Each observation was recorded as a point in a shape file. When the GPS button was activated, a georeferenced point was created and a form popped up for entering attribute data. Data fields included “name”, “sex”, “condition”, and “comments”. The date, site, and route were a part of the name for each shape file, so those fields were usually filled in later.

Butterfly nomenclature used in this report follows Opler and Warren (2003) for scientific names and NABA (2001) for English names. A species checklist was compiled for all species observed during the grazing study and the 2005 general status surveys. Systematic (follows Opler and Warren 2003) and alphabetical arrangements are included (**Appendix 6**). The lists include a comparison of the nomenclature used for scientific names by Opler and Warren (2003) and NABA (2001), and the common names used by NABA (2001).

Egg survival and hatching success

During both regular and general adult surveys, female Dakota skippers were observed closely to determine when oviposition behavior began. After observing the first ovipostion, the focus was to shift to following individual females to document the locations of as many oviposition sites as possible. When females were seen during a regular survey, the survey was suspended while observing them. This portion of the study was necessarily limited to those units where an adequate number of adult females were seen, and where subsequent observations of those females culminated in a documented oviposition. As it turned out, there were very few opportunities to observe females, and only one actual oviposition was observed during the 2003 field season. Data collected for that oviposition site included GPS coordinates, the plant species used, height above ground, and general vegetation attributes (e.g. height, composition) for the surrounding area. The specific location was marked with a nail and fender washer placed flush with the ground so that grazing activity would not be influenced. It was placed about 4 cm from the egg, and the exact distance and compass direction from the egg were recorded. A blue flag (2.5x3.5" with 21" wire) was placed about 50 cm from the nail to assist in relocating the site, and the exact distance and compass direction from the nail were recorded. The egg was monitored daily to determine its fate.

Larval survival

The plan was to use the oviposition sites where the larvae hatch for the larval survival studies. In Robert Dana's dissertation research (Dana 1989, 1991) sheet-metal barrier strips were placed around each plot and then covered with removable cages. This kept the larvae from wandering out of the area and also afforded them extra protection. Direct observation of the larvae is very difficult, if not impossible, so adult emergence in the cages the following year was used as a measure of survival. For this study, it was important not to influence the sites availability for grazing. Therefore, barrier strips and protective cages were not used, and emergence cages were not put in place until immediately before the adult emergence. As a result, the larvae were likely to wander greater distances and the probability of each larva surviving was significantly reduced. To compensate for this, the plan was to use larvae hatched from eggs laid by captive females to augment the number of larvae at each oviposition site (e.g. at least six per site), and possibly also to increase the number of larval survival plots. Emergence traps also had to be large enough to include the "wandering" area for the majority of the larvae. It was assumed that the cages should be about 1-2 m in diameter, but the distance that the larvae move is not known. One option for evaluating the distance moved by the larvae and determining the optimal cage size would be to use a series of cages with different diameters nested together.

Vegetation data

Vegetation data were collected along the adult butterfly survey routes. Vegetation measures included nectar source abundance for selected species, community type, community quality, vegetation height, and grazing intensity. Plant nomenclature used in this report follows USDA, NRCS (2005).

Nectar plant data were collected for selected plants that bloomed during the Dakota skipper flight. In 2003, the abundance of each species along the transects was recorded by either mapping individual flowering plants where occurrences were scattered, or by mapping patches and recording the patch size and number of flowering plants per patch where occurrences were dense. In 2004, the abundance of each species was represented by recording the number of individual flowering plants in the general area of each mapped point along the transect. Key species for which data were collected included, but were not limited to, purple coneflower (*Echinacea angustifolia*), hoary vervain (*Verbena stricta*), and Flodman's thistle (*Cirsium flodmanii*).

Community type and quality/disturbance, vegetation height, and grazing intensity were also recorded along the transects. Within the park, areas burned the previous fall or spring were also mapped. Grazing patterns within a pasture assigned to a given grazing regime may prove to be a significant factor. The primary objective for collecting the vegetation data was to obtain a preliminary assessment of those patterns so that they could be accounted for when interpreting the results and evaluating the design of the study. Fairly coarse categories were used to simplify the data collection in 2003. General community types included dry, mesic and wet prairie, wet meadow, and non-native (cool-season) pasture. Disturbance categories were based on the overall quality of the vegetation and included undisturbed (dominated by diverse mix of native species), moderately disturbed (moderate native diversity; moderate weedy and cool season component), and very disturbed (very low native diversity; dominated by weedy and cool season component). Grazing intensity assessments were based primarily on the height of the grazed vegetation and general categories included ungrazed (height could vary depending on community type), light (8-12"), moderate (4-8"), heavy (2-4"), and severe (0-2"). In 2004, data collection was similar but the mapping in the field and categories used were more refined. The categories per vegetation variable and the criteria used to define them are summarized in **Appendix 3, Tables 1-3**. Data were recorded by creating a GPS point and completing the attribute table each time any of the above factors changed along the transect. Those data were then used to create polyline shape files with the attributes per line segment corresponding to those for the point at the start of that line segment.

General Status Surveys

General Status Survey Sites

Additional sites outside the project area were selected for general status surveys in the 2005 field season (**Appendix 4, Figure 1**). The primary criterion used for selecting sites was the historic or potential occurrence of Dakota skippers, and a secondary criterion was the historic occurrence of other important prairie-specialist butterflies (e.g. Arogos skipper, Ottoe skipper [*Hesperia ottoe*], Poweshiek skipperling, and regal fritillary). Minnesota DNR staff (especially Robert Dana) used those criteria to select and prioritize the sites, and sites were selected for either timed wandering transect surveys or more qualitative presence/absence surveys (see site descriptions below and **Appendix 5, Table 1**). The GPS technology employed for the data collection made it possible to employ a higher standard for the surveys at all sites. Survey methods involved a directed search of a representative sample of the habitat at each site. The actual route surveyed was recorded in the GPS track log, so in addition to converting the observations for each survey to numbers per unit time, they were also converted to numbers per unit distance. Also, since all observations were recorded using the GPS unit, the distribution and abundance of all individual butterflies observed were recorded. Sites selected for each type of survey are described below.

Timed Wandering Transect Surveys (1st priority)

Felton Prairie, Clay County
Felton Prairie SNA, Clay County, T141N, R45W, Sec 5
Bicentennial Unit (SW4 Sec 5) – Clay County (includes County Open Space lands)
Blazing Star Unit (NE4 Sec 5) – The Nature Conservancy
Felton Prairie SNA (SE4 Sec 5) – MN DNR Ecological Services Scientific & Naturals Areas
County land north of the gravel pit, T141N, R45W, Sec 6 and T142N, R45W, Sec 31
Hole-in-the-Mountain Prairie, Lincoln County, T109N, R45W, SE4 Sec 19
The Nature Conservancy (original purchase; Dana [1989, 1991] study area)
Prairie Coteau SNA, Pipestone County, T108N, R44W, SE4 Sec 29 and E2 Sec 32
MN DNR Ecological Services Scientific & Naturals Area

Qualitative, Presence/Absence Surveys (1st priority)

Alexandria Moraine (central portion – high priority), Ottertail/Douglas Counties
Elmer Prairie, Douglas County, T130N, R40W, Sec 2
Private pasture; rapid rotational grazing (12 pastures with central pond for water)
Wallace Prairie, Ottertail County, T131N, R40W, Sec 35
Private prairie; not grazed; includes fire management; part of Native Prairie Bank Program (allows landowners to protect native prairie on their property through a conservation easement with the Minnesota Department of Natural Resources)
Altona WMA, Pipestone County, T108N, R46W, E2 NW4 Sec 1
Chanarambie Creek, Murray County
Carney Prairie Bank, T106N, R43W, SE4 Sec 32
Sankey Prairie, T105N, R43W, SE4 Sec 3
Chippewa Prairie, Chippewa/Swift Counties
Chippewa Prairie – The Nature Conservancy
Swift County, T120N, R43W, Sec 35; Chippewa County, T119N, R43W, Sec 1 and 12
Hole-in-the-Mountain Prairie, Lincoln County, T109N, R45W, SE4 Sec 18, NE4 Sec 19
The Nature Conservancy (more recent additions to preserve)
Mound Springs SNA – MN DNR Ecological Services Scientific & Naturals Area
Yellow Medicine County, T115N, R46W, NW4 Sec 17, N2 Sec 18 and N2 Sec 19

Qualitative, Presence/Absence Survey Sites (2nd priority)

Alexandria Moraine (northwest portion – middle priority), NW Ottertail County
Rengstorf Prairie WPA, Ottertail County, T137N, R43W, N2 Sec 4
US FWS Waterfowl Production Area; management includes grazing
Lewis Prairie, Ottertail County, T137N, R43W, Sec 3
Private pasture; grazed

Alexandria Moraine (southern portion – lowest priority), SE Pope & NW Kandiyohi Counties
Moe Woods, The Nature Conservancy, Kandiyohi County, T122N, R36W, Sec 3
Ordway Prairie, The Nature Conservancy
Pope County, T123N, R36W, Sec 19 and 30; T123N, R37W, Sec 23, 26 and 27
Kandiyohi County, T122N, R36W, Sec 1, 2, 11 and 12
Leslie Ellingson Tract (private), Kandiyohi County, T122N, R36W, NW4 Sec 5
Oakwood Hills Ranch (private), Kandiyohi County, T122N, R36W, NE4 Sec 5
Randall WPA, Kandiyohi County, T122N, R36W, NW4 Sec 9
FWS Waterfowl Production Area; aggressive burning; not grazed
Miller Hills WPA, Kandiyohi County, T122N, R35W, W2 Sec 6; T122N, R36W, E2 Sec 1
FWS Waterfowl Production Area; aggressive burning; not grazed recently
Big Stone WMA, Big Stone County, T122N, R46W, S2 Sec 18
MN DNR Wildlife Management Unit (lower priority than Bonanza Prairie SNA)
Bonanza Prairie SNA, Big Stone County, T123N, R48W, W2 Sec 20
MN DNR Ecological Services Scientific & Naturals Area (lower priority)
Chippewa Prairie, Chippewa/Swift Counties
Lac qui Parle WMA – MN DNR Wildlife Management Unit
Swift County, T120N, R43W, SW4 Sec 35; Chippewa County, T119N, R43W, Sec 2 and 11
Mound Springs, Yellow Medicine County (high quality private tracts)
Yellow Medicine County, T115N, R46W, Sec 7, 17, 18, 29, 33

RESULTS

Dakota Skipper Grazing Study

Adult butterfly surveys

Regular fieldwork for the first field season (2003) began on 11 June. The first two weeks were spent setting up the study areas, training the field assistant, and testing the methodology for collecting butterfly data. On 24 June the first Dakota skipper was seen, and regular quantitative surveys were initiated with a complete survey of Unit 3 at Glacial Lakes State Park on 28 June. Numbers appeared to be good on this survey (9 males and 1 female despite poor conditions for the last part of the survey), but rather than continuing to increase over the next few weeks as would normally be expected, they appeared to decline suddenly and dramatically. There were only 44 additional Dakota skipper observations on all subsequent surveys. Other skipper species suffered even more dramatic declines. Only four Poweshiek skipperlings were seen during all surveys throughout the field season, and no Arogos skippers were seen. Regal fritillaries were doing much better. Three hundred and twenty-one observations were recorded during general and quantitative surveys, and there were numerous additional observations during general surveys and other fieldwork that were not recorded.

My last day of fieldwork during the 2003 field season was on 28 July. During my last week we began collecting vegetation data along the transects, and then Bryan Simon completed that work after I left. He also continued to collect butterfly data, and during that time he started seeing a skipper species that was new to him. He did not get a positive ID, but based on his description and the timing of the flight, it was most likely the Pawnee subspecies of the Leonard's skipper (*Hesperia leonardus pawnee*). If this assumption is correct, based on the number of skipper observations he recorded it would appear that the Pawnee skipper did not suffer the same population decline experienced by the mid-summer species.

Fieldwork for the second field season (2004) started later due to a delayed emergence of the Dakota skippers resulting from cooler temperatures. Degree-day accumulations based on Morris weather data predicted an emergence date around 5 July (Glenwood data available later predicted a 1 July emergence). This compared to a predicted 23 June and observed 24 June emergence in 2003. Glacial Lakes State Park staff were contacted as the predicted emergence date approached to check the predictions against the actual phenology of the purple coneflowers. On 25 June Melody Webb reported that flower heads were mostly in the earliest development stages, with ray florets just starting to extend for only a very few. On 2 July another park employee reported that coneflowers along the trails were just beginning to extend their ray florets. This supported the delayed emergence predicted by the degree-day models. I traveled to Minnesota and got settled into an apartment on 5 July. The next day was cool (13^{o} C) and rainy, so it wasn't possible to do any butterfly surveys. I prepared an emergence trap and set it out at Anderson Pasture where the single larva had been released in 2003. Purple coneflowers ranged from no ray floret extension to full extension, with most intermediate. Disk florets were just starting to open in a few flowers. The plant phenology suggested that it was very close to the beginning of the Dakota skipper emergence, but no butterflies were observed due to the poor weather conditions. It was still very early in the flight, and cool weather was predicted for the next couple days, so I spent several days completing butterfly surveys for a separate project in Iowa. Regular fieldwork for this project began on 11 July.

The first two weeks of fieldwork (11-22 July) focused on adult butterfly surveys, and then the second two weeks (26 July – 5 August) focused on collecting grazing and vegetation data. Phil Delphey, Endangered Species Coordinator for the Twin Cities field office of the U.S Fish and Wildlife Service, assisted with the fieldwork for the first two weeks. Quantitative surveys for Glacial Lakes State Park and Anderson Pasture were conducted once while setting out flags, at least once as focused butterfly surveys after the flags were set out, and then once while collecting grazing and vegetation data. Surveys at the Fredrickson, WPA and Rutledge sites were more limited. Single quantitative surveys of the WPA and southern portion of Fredrickson Pasture were conducted while setting out flags, and a general survey was conducted for the northern portion of Fredrickson Pasture. Quantitative surveys at Rutledge Pasture were focused along a slight modification of the southern portion of the proposed transect. This segment included the full range of severe to light grazing at the site. Two quantitative surveys were conducted along this segment (one while setting out flags), and a general survey was conducted after completing the second quantitative survey. Surveys while setting out flags took longer, and occasionally portions of a transect were completed on separate days, but were at least, if not more, thorough than regular surveys. These surveys were at or near what should have been the peak portion of the flight. The second set of surveys should have been just past the peak, but the numbers started relatively low, and then dropped rapidly as they did in 2003. The final surveys conducted while collecting grazing and vegetation data were well past the peak for Dakota skippers, but still within the peak for regal fritillaries. Conditions were generally poor for most of those surveys and many were spread across two-three days since it took longer to collect the vegetation data.

Fieldwork for the third and final field season (2005) included one complete set of quantitative transect surveys in each of the study areas during the peak portion of the Dakota skipper flight. The predicted emergence for Dakota skippers at both Prairie Coteau SNA and at Glacial Lakes State Park was 25 June. I moved to Morris to start fulltime fieldwork on 23 June, and made a brief stop at Prairie Coteau along the way to check the actual phenology. There was very little activity, but it appeared to still be very early. Purple coneflower heads were in the early stages of development, with little or no ray floret extension. Butterfly species observed included those with an earlier flight that normally only overlap slightly with the start of the Dakota skipper flight (e.g. 'inornate' common ringlet [*Coenonympha tullia*] and long dash [*Polites mystic*]). The next day was spent getting set up to work out of my Morris apartment. Butterfly phenology in the Glacial Lakes State Park area was checked on 25 June with a brief survey of the east end of the Evenson tract. Purple coneflower head development was still fairly early. Most ray florets were just starting to extend, some were extended ¼-½ inches, and one head had full ray floret extension and disk florets just starting to open. No Dakota skippers were seen, and the most abundant butterfly species were those with a slightly earlier but overlapping flight (e.g. Melissa blue [*Plebejus melissa*] and long dash). The phenology at Prairie Coteau was checked again on 26 June. Purple coneflower ray floret extension was early for some, early-mid for most, and mid-late for a very few. Two common wood-nymphs (*Cercyonis pegala*) were seen. Their emergence normally occurs at about the same time as the Dakota skipper, suggesting that it was at or near the start of the flight at that site. Actual surveys at southern Minnesota sites were conducted 1-3 July when the flight was well under way. Then I returned to Glacial Lakes State Park to conduct one complete set of surveys for each of the grazing study areas during the peak portion of the flight.

Survey summary data tables are included in **Appendix 2**. **Appendix 2, Table 2** provides a comparison of the quantitative transect survey results for Dakota skippers, Poweshiek skipperlings, and regal fritillaries at Glacial Lakes State Park in 2001 (Skadsen surveys) and 2003-2005 (Selby surveys). Data for all butterfly species observed during the quantitative transect surveys in 2003-2005 are summarized in **Appendix 2, Tables 3-13**. Butterfly phenology corresponds more closely to degree-day accumulations than to calendar dates (Selby, unpublished dissertation research), so degree-day accumulations per survey date are included as column headings above the survey dates to facilitate comparing data between years. Data from a subset of complete quantitative transect surveys were used to examine the relationship between the abundance of selected butterfly species and the vegetation and grazing variables, and are summarized in **Appendix 2, Tables 14-26**. Data summaries for each species in those tables include the total numbers observed, average numbers per survey, average numbers per km, and average numbers per km per vegetation variable. **Appendix 2, Tables 27-29** summarize the total observations per butterfly species for each route and site during each field season. They include observations from both general surveys and quantitative transect surveys. Site maps showing the distribution of Dakota skippers and other key butterfly species during the study are found in **Appendix 1, Figures 6-11**. For Glacial Lakes State Park and Anderson Pasture there are two sets of maps. The first shows the distribution of key skipper species (**Figures 6 and 8**), and the second shows the distribution of other key species (**Figures 7 and 9**). For the Fredrickson, WPA and Rutledge sites there were very few skipper observations, so all the key species are shown on single maps per site (**Figures 10 and 11**).

The dramatic population declines for Dakota skippers and Poweshiek skipperlings at Glacial Lakes State Park since the surveys conducted by Dennis Skadsen in 2001 are illustrated in **Appendix 2, Table 2**. The phenology for the surveys conducted each year was comparable (see the degree-day accumulations) for all but a couple surveys, but the numbers obtained for the 2003-2005 surveys were all significantly lower than in 2001. The numbers for both species along transects #1 and #2 were already relatively low in 2001, and they were almost entirely absent in 2003-2005 (only a single Dakota skipper along transect #1 in 2003). Transects #3 and #4 had the best peak numbers for both Dakotas (31 & 29) and Poweshieks (18 & 36) in 2001. The best counts for Dakota skippers during this study were along transect #3 from 2003-2005 (10, 8, and 7) and Transect #4 in 2005 (11). Each year moderate numbers were observed early in the flight, but they dropped off dramatically, rather than continuing to increase as would be expected on a normal year. The only Poweshiek skipperlings seen during regular surveys were along transect #3 in 2003 (1 on each of two surveys).

At Anderson Pasture there are no 2001 survey data to compare with the results from this study. Total Dakota skipper observations each year were comparable to those in the eastern portion of Glacial Lakes State Park throughout the study (2003-2005), with higher total observations in 2004 the result of extra general surveys in Unit D while checking the emergence trap. Dakota skipper counts for the quantitative transect surveys tended to be low. Transects A and C tended to have the best results (2003 = 2 & 1; 2004 = 3 & 4; 2005 = 5 & 4), but those numbers were still too low to be very useful for any kind of statistical analyses (**Appendix 2, Tables 7-11**).

Moderately low initial numbers and abbreviated peak portions of the Dakota skipper flights in 2003-2005 made it difficult to collect data that were adequate for a statistical analysis of the impacts of grazing and other vegetation variables on the adult stage, and impossible to obtain significant data for the other life stages. However, some general patterns are apparent from a preliminary examination of the adult data. The distribution of all Dakota skipper observations at Anderson Pasture and Glacial Lakes State Park in relation to the vegetation variables mapped is illustrated in **Appendix 1, Figures 12-14**. Quantitative data for the Dakota skipper and a subset of species that represent both prairie specialists, grassland generalists, and habitat generalists are also summarized in a series of tables (**Appendix 2, Tables 14-26**). For each species, those data summaries include total numbers observed, average number per survey, average number per km, and average number per km per vegetation variable (e.g. community type, community quality rating, grazing intensity rating, and vegetation height class). Data for the distribution of all butterflies observed during those surveys were also included for comparison with the individual species. Anderson Pasture is the only grazed site with quantitative Dakota skipper data. There is a general downward trend with increasing grazing intensity (light-moderate = 1.69/km; moderate = 0.63 km; moderate-heavy = 0.41/km; heavy = 0.25/km), but there were too few observations (14in 3 surveys) for the results to have any statistical significance (**Appendix 2, Table 21**). The tawny-edged skipper is a grassland generalist, and was more abundant (45 in 3 surveys). Those numbers were still too small for statistical analysis, but there was an apparent upward trend with increasing grazing intensity (light-moderate = 0.56/km; moderate = 1.10 km; moderate-heavy = 1.07/km; heavy = 1.52/km; heavy-severe = 5.26/km; severe = 7.36/km). Overall densities of Dakota skippers were similar at Anderson Pasture (0.44/km) where overall grazing intensity was moderate and Glacial Lakes State Park (0.33/km) where there was no grazing. Tawny-edged skipper densities were much higher at Anderson Pasture (1.40/km vs. 0.38/km).

Regal fritillaries and common wood-nymphs were doing much better at all the sites (**Appendix 2, Tables 2-13**). Regal fritillaries are an important prairie specialist butterfly, and some useful information about how the adults are responding to grazing could be obtained from the study. The quantitative data do not show a clear relationship between regal fritillary abundance and grazing intensity (**Appendix 2, Tables 21-23**). Values were fairly even for different grazing intensities at Anderson Prairie (**Appendix 2, Table 21**). Higher values for light and severe grazing may simply reflect the 'chance' occurrence of one or a few individuals of this highly mobile species in grazing intensity categories that are poorly represented (0.095 and 0.136 km respectively). The distribution at Rutledge helps illustrate this. Observations at that site were fairly evenly distributed between light, light-moderate, and moderate grazing intensities, but peaked for heavy grazing (**Appendix 2, Table 22**). That peak resulted from seeing a total of three individuals in short heavily grazed transect segments within an area dominated by light to moderate grazing intensity (**Appendix 1, Figure 15**). Those data can be misleading, but it is clear from the figure that there is a strong negative response of regal fritillaries and most of the other butterfly species to the heavy-severe and severe grazing in the eastern portion of the pasture. At Glacial Lake WPA and Fredrickson Pasture regal fritillaries are less abundant in the ungrazed WPA, but show a downward trend with increasing grazing intensity within the grazed pasture (**Appendix 2, Table 23**). Their overall density is similar for Anderson Pasture (3.17/km) and Glacial Lakes State Park (3.53/km).

Wood-nymphs are a common butterfly with little conservation significance, but they emerge at the same time as the Dakota skipper, and can be useful as an indicator of flight phenology and butterfly activity during a survey. Also, while their response to grazing is likely different from that of Dakota skippers, their abundance and distribution could be used to begin formulating ideas about the effects of grazing on prairie butterflies. Initial observations suggest that even wood-nymphs have a strong negative response to severe overgrazing. This is quite apparent when the heavily grazed portions of Fredrickson Pasture are compared to the ungrazed WPA immediately to the west (**Appendix 1, Figure 10; Appendix 2, Table 23**), and when the severely overgrazed portions of Rutledge pasture are compared to portions with light-moderate grazing (**Appendix 1, Figures 15; Appendix 2, Table 22**). Their overall density at Glacial Lakes State Park (18.33/km) is nearly twice as high as at Anderson Pasture (9.51/km).

Egg survival and hatching success

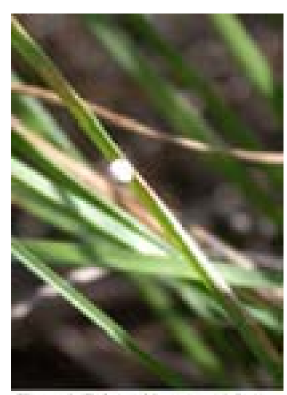


Figure 1. Dakota skipper egg (photo by Phil Delphey).

During the 2003 field season the first oviposition was observed on 11 July. A female showing moderate wing wear (condition rating = 2+) was observed in Unit D of Anderson Pasture on the way to the start of a transect survey. Skies were overcast initially and the female was fairly inactive until the sun came out. We observed her for about 30 minutes (11:55 a.m. – 12:25 p.m.) and when the sun came out she became more active and finally laid a single egg on a grass blade (probably prairie dropseed [*Sporobolus heterolepis*]) about two inches above ground level (**Figure 1**). The area where the egg was laid was mid-lower slope, dry-mesic prairie with light grazing intensity. After that we spent about 1.5

hours searching for and observing females in that general area. Six more Dakota skippers were seen during that time, including three females, but we did not see any additional oviposition behavior.

At total of 27 confirmed females were observed during the 2003 field season, and only 11 were seen after the first oviposition was observed. Extended observations were made on eight of those eleven females, but no additional ovipositions were observed. The egg from the only observed oviposition was monitored daily, but after 17 days it still had not hatched, and was most likely dead. One female was retained for captive egg-laying after first observing it in the field. It laid one egg on 20 July, which hatched on 28 July. The larva was released in the same area as the field oviposition site, and the location was permanently marked so that it could be monitored for adult immergence in 2004.

During the 2004 field season attempts were made to search for and observe females in the field whenever possible, but there were very few opportunities and no ovipositions were observed. A single female Dakota skipper was retained for captive egg laying on 14 July. Two eggs were laid during the day on 15 July, and both eggs were hatched successfully. There weren't enough larvae to obtain meaningful data on grazing impacts, so the release site was located behind the park office where survival probabilities were higher (e.g. ungrazed prairie), and where it would be more convenient to monitor for emergence the next year. The first larva hatched between 5:30 and 6:30 a.m. on 23 July. I was leaving for a weekend trip home, and stopped at the park to release it on my way through. The second egg was left with Melody Webb and the other park staff. It hatched early the next morning (24 July) and Melody released it at the same location as the first one. A second female Dakota skipper had been captured late on 22 July and was placed in a cage at the larvae release location. Melody monitored it during the day on 23 July, spraying the cage periodically to provide it with moisture, and then released it at the end of the day. The cage and vegetation inside the cage were checked thoroughly on Monday morning (26 July), but no eggs were found. That female was pretty worn, and did not look like she was still carrying very many eggs, so this was not surprising. Park staff enjoyed getting involved and showing park visitors the captive female and egg.

Larval survival

On 6 July 2004 an emergence cage was placed over the release site for the larva hatched in 2003. It was monitored daily starting on 11 July, but no adults were found in the cage. The two larvae released in 2004 were not monitored for emergence in 2005, since that component of the study had been abandoned.

There were several problems with the methodology that need to be addressed in the future. The emergence cage was a cylindrical ring cut from a large garbage can and covered with netting from old butterfly nets. The diameter of the cage (about 55 cm) was probably too small to accommodate potential movement of the larva away from the original release spot, and it was too short to accommodate the natural vegetation height. Poor visibility inside the cage also made it difficult to check. The major problem, however, was the tendency for the cattle to disturb the cage. On several occasions it appeared that cattle had stepped through the netting, leaving the cage partially to mostly open. Several modifications are recommended. Cages made entirely of netting would be more open and easier to monitor, but also even more prone to damage from cattle and severe weather. A series of cages with different diameters nested together could allow distance moved by larvae to be evaluated. It will also be necessary to prevent cattle from damaging the cages once they are in place. Solar operated electric fences around each cage might work. They might also provide a means of randomizing oviposition and larval release sites to grazed and ungrazed treatments within a single area.

Vegetation Data

My last day of fieldwork in 2003 was on 28 July. During my last week, Bryan and I began collecting nectar plant data along the transects and tested methodology for collecting the other vegetation data. After I left, Bryan finished collecting the nectar plant data. He also collected preliminary data for plant community type, plant community quality, and grazing intensity along the transects, and pulled all the flags used to mark the transects. His final day of fieldwork was 31 August. In 2004, I spent the last two weeks of the field season collecting vegetation data.

Community type, quality/disturbance, and grazing intensity were recorded along the transects, and for the park, areas burned the previous fall or spring were also noted. Grazing patterns within a pasture assigned to a given grazing regime appeared to be a significant factor. In 2003, the primary objective for collecting the vegetation data was to obtain a preliminary assessment of those patterns so that they could be accounted for when interpreting the results and evaluating the design of the study. Fairly coarse categories were used to simplify the data collection. In 2004, the objective was similar, but the mapping categories were more refined and the field mapping was more detailed. The criteria used to define the vegetation categories (e.g. plant community type, plant community quality, grazing intensity, and vegetation height) are summarized in **Appendix 3, Tables 1-3.** For the plant community types, equivalent types used by the MN NHP (Aaseng et al. 1993) are listed as a reference (**Appendix 3, Table 1**). Statistics for each of the mapping categories (e.g. meters and percent length per transect) for each site are summarized in **Appendix 3, Tables 4-12**. General vegetation and grazing patterns in relation to the distribution of selected butterfly species are also illustrated for the sites in **Appendix 1, Figures 12-15** and **Appendix 2, Tables 14-26**.

Nectar plant data were also collected for selected plants that bloomed during the Dakota skipper flight. In 2003 the abundance of each species along the transects was recorded by either mapping individual flowering plants where occurrences were scattered, or mapping patches and recording the patch size and number of plants per patch where occurrences were dense. In 2004 the abundance of each species was represented by recording the number of individual flowering plants per mapped point along the transect. Key species for which data were collected included purple coneflower (*Echinacea angustifolia*), hoary vervain (*Verbena stricta*), and Flodman's thistle. Nectar plant data for both years at Glacial Lakes State Park and Anderson Pasture are summarized in **Appendix 3, Tables 13-14**. Purple coneflowers are the primary nectar plant used by Dakota skippers and other butterflies with a similar flight, but they do not appear to be in any way limiting. The abundance of coneflowers appeared to increase dramatically for most transects from 2003 to 2004, with total numbers increasing from 7,234 to 24,566 at Glacial Lakes State Park, and from 480 to 4,186 at Anderson Pasture. The distribution of Dakota skippers and Poweshiek skipperlings in relation to the frequency of coneflowers at Glacial Lakes State Park and Anderson Pasture is illustrated in **Appendix 1, Figures 12-13**.

General Status Surveys

The general locations and survey priorities for the sites proposed for the 2005 general status surveys are illustrated in **Appendix 4, Figure 1**. Degree-day models predicted an approximate emergence date of 25 June for the Dakota skippers at both Prairie Coteau SNA and Glacial Lakes State Park. Preliminary surveys were conducted at Prairie Coteau SNA to evaluate the actual phenology and approximate emergence date for the Dakota skipper. In a brief survey on 23 June no butterfly species with a similar emergence were seen, and the developmental stages of purple coneflowers suggested that it was still early. Common wood-nymphs were seen for the first time at Prairie Coteau on 26 June, suggesting that it was at or near the start of the Dakota skipper emergence at that site. Regular surveys were delayed until 1 July to make sure the flight was well under way, and started with the southernmost sites. Maps illustrating the location and context for each site, routes surveyed, and the distribution of primary and secondary target butterfly species observed are included in **Appendix 4, Figures 2-22**. Data from those surveys are also summarized in data tables (**Appendix 5, Tables 2-4**). **Table 2** provides a summary of the maximum observation rate (expressed as observations per survey, per hour, and per km) for the target species at each site. **Tables 3-4** provide summaries of all the observations at each site. The surveys conducted at each site are described below in the approximate order (south to north) in which they were completed.

Chanarambie Creek, Murray County

Carney Prairie Bank, T106N, R43W, SE4 Sec 32
Qualitative, presence/absence surveys (1^{st} priority)
02 July 2005; 11:10 a.m. – 2:00 p.m. (2 hrs 50 min)
74-80^{o} F; 25-50% clear (hazy overcast) early becoming 100% clear
11-14 mph S-SW winds with gusts to 18 mph
Generally good survey conditions; wind was a factor on exposed slopes
Sankey Prairie, T105N, R43W, SE4 Sec 3
Qualitative, presence/absence surveys (1^{st} priority)
02 July 2005; 3:25 – 5:45 p.m. (2 hrs 20 min)
82-80^{o} F; 75-100% clear throughout
12-15 mph S-SW winds with gusts to 18 mph
Generally fair survey conditions; wind was a factor throughout; otherwise good conditions

Chanarambie Creek site and the location of the tracts surveyed are illustrated in **Appendix 4, Figure 2**. Surveys were conducted at the Carney Prairie Bank and Sankey Prairie tracts at the Chanarambie Creek site on 2 July 2005. Dakota skipper, Poweshiek skipperling, and regal fritillary populations appear to be doing fairly well on both tracts. A single fairly fresh (C1+) Arogos skipper was seen at the Sankey tract, and it is likely that more would have been seen at both tracts if additional surveys had been done about one week later.

I met with Leon Carney at about 10:00 a.m. He continues to be very interested in the prairie and, as always, was a pleasure to talk to. He drove separately to show me the way to the survey area. After talking briefly with him he left and I completed a survey from 11:10 a.m. to 2:00 p.m. This tract has high quality prairie with good habitat for Dakota skippers and the other secondary target species. Five confirmed Dakota skippers were seen. Secondary target species included six Poweshiek skipperlings and 15 regal fritillaries. Seven unconfirmed skipper observations were probably either Dakota skippers or tawny-edged skippers (*Polites themistocles*). The route surveyed and selected butterfly observations are illustrated in **Appendix 4, Figure 3**.

I called Dave Sankey to get permission to do the survey on his property, but did not actually meet with him. The Sankey tract was surveyed from 3:25 to 5:45p.m. This tract also has high quality prairie with good habitat for Dakota skippers and the other secondary target species. Seven confirmed Dakota skippers were seen. Secondary target species included one Arogos skipper, two Poweshiek skipperlings, and six regal fritillaries. The wind had an impact on the amount of butterfly activity and also made it more difficult to confirm the identification of the skippers. There were 10 unconfirmed skipper observations that were probably either Dakota or tawny-edged skippers. The route surveyed and selected butterfly observations are illustrated in **Appendix 4, Figure 4**.

Prairie Coteau SNA, Pipestone County, T108N, R44W, SE4 Sec 29 and E2 Sec 32

Timed wandering transect survey (1st priority)
23 June 2005; 6:40 – 9:00 p.m. (2 hrs 20 min) – Phenology check
87-80° F; 75-100% clear
12-14 mph S winds early; 4 mph S winds at the end
Generally good survey conditions; too late in the day for good survey results
26 June 2005; 7:10 – 9:18 p.m. (2 hrs 8 min)
Phenology check survey; included parts of Units 2, 3S, and 4S
84-79° F; 50-75% clear
6-10 mph S-SE winds with gusts to 13 mph
Generally good-fair survey conditions; too late in the day for good survey results
01 July 2005; 11:40 a.m. – 6:50 p.m. (5 hrs 10 min)
Regular survey; included Unit 34N (mostly) and northern portion of Unit 3S
69-77° F; 100% clear
4-6 mph N winds with gusts to 8 mph (most); 2-4 mph SE winds (late)
Generally good survey conditions throughout; cool temperatures were a slight factor initially
02 July 2005; 11:40 a.m. – 6:50 p.m. (5 hrs 10 min)
Brief survey to check southern portion (Unit 2) for target species
81-78° F; 75-100% clear
10-12 mph S winds with gusts to 18 mph
Generally fair survey conditions; windy and too late in the day for good survey results
13 July 2005; 9:40 a.m. – 2:00 p.m. (4 hrs 20 min)
Regular survey; included Units 2, 3S, and 4S
78-84° F; 100% clear early, 75-100% clear late
2-4 mph NE winds early and late; 6-8 mph NE winds middle
Generally good survey conditions throughout

The first two surveys (23 and 26 June) at Prairie Coteau SNA were intended primarily to evaluate the phenology and determine the optimal times for initiating regular surveys. Both surveys were too late in the day for obtaining good butterfly data. On 23 June purple coneflower heads were in the early stages of development, with little or no ray floret extension, and butterfly species observed included those with an earlier flight that normally only overlap slightly with the start of the Dakota skipper flight (e.g. 'inornate' common ringlet and long dash). On 26 June purple coneflower ray floret extension was early for some, early-mid for most, and mid-late for a very few. Two common wood-nymphs were seen, suggesting that it was at or near the start for the Dakota skipper. Routes for those surveys and selected butterfly observations are illustrated in **Appendix 4, Figure 6**).

The first regular general status survey was conducted at Prairie Coteau on 1 July. It was cool that day, and I had to wait until after 11:30 a.m. for temperatures to get warm enough. This survey focused on Unit 34N in the north portion of the SNA (**Appendix 4, Figure 7**). Once the temperatures got above 70^{o} F, there was a lot of butterfly activity. Thirty-three Dakota skippers were seen. Secondary target species included 14 Poweshiek skipperlings and 21 regal fritillaries. One mulberry wing (*Poanes massasoit*) was also seen. Thirteen unconfirmed skippers observed were probably either Dakota or tawny-edged skippers.

The purpose of the survey on 2 July was to document primary and secondary target species in the southern portion of the SNA in Unit 2 (**Appendix 4, Figure 7**). It was too late in the day to obtain good survey results, and the wind was a factor throughout. The only target species seen was a single Poweshiek skipperling.

A final survey was conducted at Prairie Coteau on 13 July. This survey was focused in the southern and central portions of the SNA in Units 2, 3S, and 4S (**Appendix 4, Figure 8**), since the previous thorough survey was focused in the north. This survey also provided a benchmark for evaluating the current phenology for the target species since they had been present in good numbers previously. Dakota skippers and Poweshiek skipperlings were still present, but in much lower numbers (four and one respectively). Twelve additional unconfirmed skipper observations were probably either Dakota or tawny-edged skippers. Regal fritillary numbers had increased significantly (118) and the Arogos skipper was present in good numbers (30). Two mulberry wings were also seen.

Prairie specialist butterflies appear to be doing quite well at Prairie Coteau SNA. Peak numbers were good for all the key primary and secondary target species. This is good news, considering the apparent dramatic population declines for these species at sites further north.

Altona WMA, Pipestone County, T108N, R46W, E2 NW4 Sec 1

Qualitative, presence/absence surveys (1st priority)
03 July 2005; 10:30 a.m. – 1:30 p.m. (3 hrs)
Regular survey; included prairie ridges south of the gravel road
74-78^{o} F; 25-50% clear (most); occasional increase in clouds, but mostly sunny conditions
2-4 mph SW winds early; 8-10 mph WNW winds middle; 4-6 mph WNW winds late
Generally good survey conditions throughout; hazy overcast skies were a slight factor

The Altona WMA was surveyed from 10:30 a.m. – 1:30 p.m. The area surveyed included the prairie ridges just south of the gravel road (**Appendix 4, Figure 10**). This tract has high quality prairie with good habitat for Dakota skippers and the other secondary target species. Twenty-four confirmed Dakota skippers were seen. Secondary target species included two Poweshiek skipperlings and 21 regal fritillaries. Based on these preliminary results, Dakota skippers and regal fritillaries appear to be doing well at the site, but the Poweshiek skipperling population may not be doing as well. It was probably still too early for Arogos skippers, and later surveys to see if it is present are recommended for the site. There were five unconfirmed skipper observations that were probably either Dakota or tawny-edged skippers.

Hole-in-the-Mountain Prairie, Nature Conservancy Preserve, Lincoln County

Original purchase (Dana [1989, 1991] study area), T109N, R45W, SE4 Sec 19
Timed wandering transect survey (1st priority)
03 July 2005; 2:15 – 7:15 p.m. (5 hrs)
Regular survey; fairly complete coverage of all but the northern portion
78-82-78° F; 25-50% clear (early); 25-50% clear (most); hazy overcast after 5:30 p.m.
8-10 mph NW winds (most); 3-5 mph NW winds late
Generally good survey conditions throughout; hazy overcast skies were a slight factor
More recent additions to preserve, T109N, R45W, SE4 Sec 18, NE4 Sec 19
Qualitative, presence/absence surveys (1st priority)
13 July 2005; 3:10 – 4:25 p.m. (1 hr 15 min)
Regular survey; focused on ridges south of access road; brief survey on north side
84-88° F; 75-100% clear
6-8 mph NE winds early; 2-4 mph NE winds late
Generally good survey conditions throughout

The 3 July survey at Hole-in-the-Mountain Prairie focused on the southern prairie ridges that were part of the original purchase where Robert Dana did his Ph.D. research (Dana 1989, 1991) (**Appendix 4, Figure 11**). These ridges continue to have high quality prairie with good habitat for Dakota skippers and the other secondary target species. Twenty-seven confirmed Dakota skippers were seen. Secondary target species included five Poweshiek skipperlings and 20 regal fritillaries. There were thirteen unconfirmed skipper observations that were probably either Dakota or tawny-edged skippers. These results are similar to those at Altona WMA, with Dakota skippers and regal fritillaries appearing to be doing well at the site, but the Poweshiek skipperling numbers somewhat lower. It was probably still too early for Arogos skippers.

The 13 July survey at Hole-in-the-Mountain Prairie focused on the northern prairie ridges that were part of the more recent acquisitions. It was focused on the ridges south of the access road, but also included a brief survey on the north side of that road (**Appendix 4, Figure 11**). Regal fritillaries were abundant (49), but no skippers were seen. Based on the Prairie Coteau SNA results, this survey should have been at the peak portion of the Arogos skipper flight, so it is significant that none were found.

Prairie specialist butterflies appear to be doing quite well in the original purchase at Hole-in-the-Mountain Prairie, but Poweshiek skipperling numbers may be somewhat lower than those for the Dakota skipper and regal fritillary. Regal fritillaries were the only target species found in the northern unit. That survey was probably too late for a definitive assessment of the status of Dakota skipper and Poweshiek skipperling populations, but should have been perfectly timed for the Arogos skipper.

Mound Springs, Yellow Medicine County

Mound Springs SNA, T115N, R46W, NW4 Sec 17, N2 Sec 18 and N2 Sec 19
Qualitative, presence/absence surveys (1st priority)
05 July 2005; 3:15 – 7:55 p.m. (4 hrs 40 min)
Regular survey; fairly complete coverage of southern portion of northern SNA unit
74-76-72° F; 100% clear;
2-4 mph N winds (most); 1-2 mph E winds late
Generally good survey conditions throughout; last part (west end) getting late in the day
13 July 2005; 5:55 – 7:05 p.m. (1 hr 10 min)
Regular survey; focused on prairie ridges in southern SNA unit
85-86° F; 75-100% clear early; 100% clear late
1-2 mph NNE winds early; 3-5 mph NE winds late
Generally good survey conditions throughout; getting too late in the day for a good survey
Mound Springs (high quality private tracts), T115N, R46W, Sec 7, 17, 18, 29, 33
Qualitative, presence/absence surveys (2nd priority)
05 and 13 July 2005 (general driving surveys to evaluate site potential only)

Surveys on 5 July were originally planned for the grazing study sites, but the forecast was for overcast skies most of the day. Skies appeared to be clearing earlier in the Mound Springs area, so a last minute trip to that area was made. Unfortunately, this meant that the surveys didn't get started until later in the day, and it wasn't possible to cover all the tracts in a single trip. The southern portion of the northern SNA Unit was surveyed (**Appendix 4, Figure 13**). The survey started in the southeastern portion (3:15 – 6:05 p.m.). Unfortunately, there is very little decent prairie in this area. Brome is dominant throughout the uplands, and there are just a few degraded prairie remnants on some of the hillsides along the drainage. One regal fritillary was seen during this portion of the survey, but no other targets were seen. There were areas along the drainage with higher quality sedge communities, and six mulberry wings were seen. It was getting late in the day for the surveys of the southwestern portion (6:05 – 7:55 p.m.). The southeastern corner was relatively flat and included fair quality wet-mesic vegetation. Further west there were some ridgelines with better quality prairie, but most of these were almost entirely overrun with leafy spurge (*Euphorbia esula*). Observations during this portion of the survey included one regal fritillary and one mulberry wing. There were very few prairie remnants throughout the area surveyed, and the small patches of prairie that were there were either highly degraded or overrun with leafy spurge. Dakota skippers, Poweshiek skipperlings, and Arogos skippers are unlikely to occur there. Better quality prairie might be found in the northeast corner of section 18 (northern part of the SNA unit west of the access road). Unfortunately, by the time the survey of the southern portion was complete, it was too late for a survey in that area.

On 13 July the southern Mound Springs SNA unit was surveyed (**Appendix 4, Figure 13**). It was fairly late (5:55 – 7:05 p.m.), but survey conditions were generally good and there was a fair amount of butterfly activity (98 total observations). There were eighteen regal fritillaries observations, but only one skipper was seen (probably Delaware skipper [*Anatrytone logan*]). This unit had more prairie along the ridgelines than the northern SNA unit, but the quality was still fairly poor, and leafy spurge was also a significant problem in the unit. The quality might improve with proper management, but there doesn't currently appear to be much potential for Dakota skippers and some of the other prairie specialist skippers.

Numerous attempts were made to track down landowner information for the private tracts, but without much success. Several DNR (Peter Buesseler, Ellen Fuge, Russ Smith, and Bob Meyer) and TNC personnel were contacted, and I eventually tracked down some potential names and one possible phone number, but did not have time to follow up on them and conduct field surveys. While in the area for the surveys of the SNA units, I did a complete road survey to evaluate the potential for the private tracts. Tracts near the SNA units (sections 17 and 18) appeared to have some potential for native prairie, but the quality was likely similar to what was in the SNA units (not very good). The best potential appeared to be in the NE4 of section 29. I was told that the owner of this tract was a Marty Grable. The prairie in this pasture appears to be somewhat degraded from grazing, but seemed to have the most potential for recovery.

Chippewa Prairie, Chippewa and Swift Counties

Chippewa Prairie Preserve, The Nature Conservancy
Swift County, T120N, R43W, Sec 35; Chippewa County, T119N, R43W, Sec 1 and 12
Qualitative, presence/absence surveys (1st priority)
Lac qui Parle WMA – MN DNR Wildlife Management Unit
Swift County, T120N, R43W, SW4 Sec 35; Chippewa County, T119N, R43W, Sec 2 and 11
Qualitative, presence/absence surveys (2nd priority)
12 July 2005; 2:25 – 7:25 p.m. (5 hrs)
Regular survey; included portions of Chippewa Prairie Preserve and Lac qui Parle WMA
86-88-84^{o} F; 50-75% clear early; 75-100% clear late
4-6 mph NE winds early; 2-3 mph NNE winds middle; 4-6 mph N winds late
Generally good survey conditions; getting too late in the day for the last part

The 12 July survey at the Chippewa Prairie site started at the northeast access to the Conservancy preserve, and included a loop that extended west to the WMA, southeast along the ridgeline in the WMA, and then north to the start along the edges of the Conservancy preserve (**Appendix 4, Figure 15**). There was a lot of butterfly activity (304 total observations), and 95 regal fritillaries were seen, but there were no other target species observations. Only three skippers were seen (one Delaware, one tawny-edged, and one unconfirmed). The prairie along the ridgeline had burned (possibly a wildfire) several years earlier, and was fairly degraded from the influx of sweetclover that resulted from that fire. The dead stalks were still quite evident. Otherwise, this prairie complex is impressive for both its size and quality. Dakota skippers, Arogos skippers, and Poweshiek skipperlings have all been documented there in the past, but were not found despite a survey under good conditions that was both intensive and extensive. Additional surveys a little earlier in the flight should be conducted in the future to confirm the status of Dakota skippers and Poweshiek skipperlings.

Bonanza Prairie SNA, Big Stone County, T123N, R48W, W2 Sec 20
Qualitative, presence/absence surveys (2nd priority; lower priority)
Big Stone WMA, Big Stone County, T122N, R46W, S2 Sec 18
Qualitative, presence/absence surveys (2nd priority; lowest priority)

Both of these sites were included as optional lower priority surveys sites, but since the optimal time for conducting surveys was only about two weeks, there wasn't time to include them.

Alexandria Moraine (south), SE Pope & NW Kandiyohi Counties

Qualitative, presence/absence surveys (2nd priority; lowest priority)
Moe Woods, The Nature Conservancy, Kandiyohi County, T122N, R36W, Sec 3
Ordway Prairie, The Nature Conservancy
Pope County, T123N, R36W, Sec 19 and 30; T123N, R37W, Sec 23, 26 and 27
Kandiyohi County, T122N, R36W, Sec 1, 2, 11 and 12
Leslie Ellingson Tract (private), Kandiyohi County, T122N, R36W, NW4 Sec 5
Oakwood Hills Ranch (private), Kandiyohi County, T122N, R36W, NE4 Sec 5
Randall WPA, Kandiyohi County, T122N, R36W, NW4 Sec 9
FWS Waterfowl Production Area; aggressive burning; not grazed
Miller Hills WPA, Kandiyohi County, T122N, R35W, W2 Sec 6; T122N, R36W, E2 Sec 1
FWS Waterfowl Production Area; aggressive burning; not grazed recently

Sites were included for surveys in three separate portions of the Alexandria Moraine (southern, central, and northern). The southern portion was the lowest priority of the three, and in the event that there wasn't time to do full surveys, it was suggested that the area simply be evaluated to see if there was Dakota skipper habitat. There wasn't time to do field surveys during the Dakota skipper flight, so a fairly complete driving tour of the area was conducted at the end of the field season on my way home (see track log **Appendix 4, Figure 16**). I did stop briefly at a few sites to take a closer look.

Alexandria Moraine (central portion – high priority), Ottertail/Douglas Counties

Qualitative, presence/absence surveys (1st priority)
Elmer Prairie, Douglas County, T130N, R40W, Sec 2
Private pasture; rapid rotational grazing (12 paddocks with central pond for water)
14 July 2005; 12:40 – 4:10 p.m. (3 hrs 30 min)
Regular survey; complete survey of the northeastern and west-central portions of the pasture
89-88° F; 75-100% clear
2-4 mph SSE winds
Generally good survey conditions throughout
Wallace Prairie, Ottertail County, T131N, R40W, Sec 35
Private prairie; not grazed; includes fire management; part of Native Prairie Bank Program
14 July 2005; 5:05 – 7:45 p.m. (2 hrs 40 min)
Regular survey; fairly complete survey (W2, E2, Sec 35)
90-87-85° F; 75-100% clear (most); 100% clear (late)
4-6 mph SSE winds
Generally good survey conditions; getting too late in the day at the end (especially return trip)

The Elmer Prairie tract was surveyed on 14 July from 12:40 – 4:10 p.m. This pasture includes 12 paddocks that radiate out from a central watering pond. The survey started at the pond and included fairly representative coverage of the prairie habitat in the northeast quarter of section 2 and a portion of the west-central portion of the section (**Appendix 4, Figure 18**). There was a lot of butterfly activity (291 total observations), and 21 regal fritillaries were seen, but there were no other target species observations. The only skippers seen were three tawny-edged skippers. This prairie is somewhat degraded from grazing, but there are areas that are very nice, and it has the potential to support populations of the target skipper species. Additional surveys should be conducted in the future that are a little earlier in the flight to confirm the status of those targets.

The Wallace Prairie tract was surveyed on 14 July from 5:05 – 7:45 p.m. This tract is part of the DNR's Native Prairie Bank Program. It is not currently grazed, and is managed with fire. The south half had been burned this year. The survey started at the southern end and included fairly representative coverage of the prairie habitat to the north end of section 35 from 5:05 – 6:50 p.m. (**Appendix 4, Figure 18**). It was getting too late in the day for good survey results on the return trip, so that portion of the survey was not as thorough. There was still quite a bit of butterfly activity (115 total observations), but only five regal fritillaries were seen, and no other target species or other skippers were seen. This is a fairly high quality prairie, and there is good potential for some of the target skipper species. Fire management could be a threat to prairie specialist butterflies that might occur there if it is too aggressive. Larvae overwintering in the leaf litter are vulnerable to fires, so it is important to only burn a portion of their habitat (e.g. about one-fourth) each year. Additional surveys should be conducted in the future that are a little earlier in the flight and in the day to confirm the status of the target skipper species.

Alexandria Moraine (northwest portion – middle priority), NW Ottertail County

Qualitative, presence/absence surveys (2nd priority; middle priority)
Rengstorf Prairie WPA, Ottertail County, T137N, R43W, N2 Sec 4
US FWS Waterfowl Production Area; management includes grazing
15 July 2005; 10:45 a.m. – 12:30 p.m. (1 hr 45 min)
Regular survey; complete survey of the northeastern portion of the WPA
76-80^{o} F; 50-75% clear early; 75-100% clear (most)
6-8 mph N winds
Generally good survey conditions throughout
Lewis Prairie, Ottertail County, T137N, R43W, Sec 3
Private pasture; grazed
Visual evaluation from the road only; not surveyed

Rengstorf Prairie WPA was surveyed on 15 July from 10:45 a.m. – 12:30 p.m. Management of this unit includes grazing. The survey included a fairly representative coverage of the prairie habitat in the northeastern portion of the unit (**Appendix 4, Figure 20**). Conditions for the survey were good, and there was a lot of butterfly activity (206 total observations). Four regal fritillaries were seen, but there were no other target species and the only skipper seen was a tawny-edged skipper. One very late flying 'inornate' common ringlet was also seen. This is a fairly high quality prairie, and there is good potential for some of the target skipper species. Additional surveys should be conducted in the future that are a little earlier in the flight to confirm the status of the target skipper species.

FWS and Nature Conservancy did not have contact information for the Lewis Prairie tract, so I was unable to get permission to survey it. Based on a visual evaluation of the prairie from the road, it appears to have good prairie and would be worth further attempts to survey it in the future.

Felton Prairie, Clay County

Qualitative, timed wandering transect surveys (1st priority)
Felton Prairie SNA, Clay County, T141N, R45W, Sec 5
Bicentennial Unit (SW4 Sec 5) – Clay County (includes County Open Space lands)
Blazing Star Unit (NE4 Sec 5) – The Nature Conservancy
Felton Prairie SNA (SE4 Sec 5) – MN DNR Ecological Services Scientific & Naturals Areas
15 July 2005; 3:10 – 7:10 p.m. (4 hrs; 3 hrs 40 min regular survey)
Regular survey; representative survey of all three SNA units
81-82^{o} F; 75-100% clear; 4-6 mph N winds early; 1-2 mph N winds late
Generally good survey conditions throughout
County land north of the gravel pit, T141N, R45W, Sec 6 and T142N, R45W, Sec 31
The County was contacted, but they were concerned about allowing me to survey in active or future quarry areas. Since it was unclear where I could survey, I did not do any field surveys on their land.

Felton Prairie SNA was surveyed on 15 July from 3:10 – 7:10 p.m. The survey included fairly representative coverage of the prairie habitat in the Bicentennial, Blazing Star, and Felton Prairie units of the SNA (**Appendix 4, Figure 22**). The regular survey actually ended at 6:50 p.m., and I arrived back at the car at 7:10 p.m. Conditions for the survey were good, and there was a lot of butterfly activity (503 total observations). Eight Dakota skippers was seen (Bicentennial = 7; Blazing Star = 1). There were also three more unconfirmed Dakota skipper observations, and two more unconfirmed skipper observations in the Bicentennial Unit. Most of the Dakota skipper observations for which sex and condition data were collected were fairly worn (C3) males. Their condition suggests that it was fairly late in the flight, but it is unusual to see such a disproportionate number of males this late in the flight. Regal fritillaries were the only other target species seen. Their numbers were surprisingly low, considering the overall amount of butterfly activity and the numbers seen recently at other similar sites (Chippewa Prairie = 95). Only eight regal fritillaries were seen (Bicentennial = 2, Blazing Star = 5; Felton Prairie = 1). There are historic records for Dakota skippers, Poweshiek skipperlings, and Arogos skippers at this site. Dakota skippers were most abundant in the northwest corner of the Bicentennial unit. An earlier survey might have done a better job of documenting their distribution and abundance, and would have been more likely to capture the occurrence of Poweshiek skipperlings if they are still present, but the timing should have been good for the Arogos skipper.

DISCUSSION

Dakota Skipper Grazing Study

Adult butterfly surveys

A quick visual analysis of the Dakota skipper distribution in relation to the other data collected would suggest a positive correlation with less intense grazing and higher quality prairie, but the numbers are too small to form strong conclusions about management impacts. Extremes cases (e.g. severe overgrazing and highly degraded prairie) have predictably negative impacts on most of the prairie butterfly species, but patterns for intermediate grazing levels are less clear. The lower skipper numbers in the western portion of Glacial Lakes State Park (transects #1 and #2) is cause for concern. A more thorough evaluation of the complete management history for the park and historic butterfly records needs to be done.

Numerous surveys under good survey conditions and in years with good Dakota skipper numbers may be needed to get adequate data. It would help to have enough field personnel so that one or two crews could be conducting adult surveys whenever weather conditions were good, and other crews could be focused on oviposition monitoring. It is also worth considering a revised survey design. Transects work well as a standard monitoring protocol, but variability along the transects and low numbers tend to make it difficult to collect data for statistical analysis of variables along and between transects. Intense standardized searches within blocks of relatively homogeneous areas are likely to produce better results (e.g. more observations per survey), and those sample units would be more amenable to statistical analysis. Those same units could also be used for examining impacts on the other life stages.

Egg survival and hatching success

The low adult numbers had an even more dramatic impact on this portion of the study. Even in a year when the Dakota skipper populations were doing well, it would be difficult to obtain enough oviposition observations for a significant sample size in each of the treatment areas. We had to observe a female about 20-30 minutes for the only oviposition we documented, and then we were unable to relocate her when she flew off. Several other females were observed for at least 15 minutes without documenting any additional ovipositions. Healthy Dakota skipper populations and several two-person teams committed to this portion of the study would be needed to obtain adequate oviposition data. The teams would need to begin observations earlier in the flight (e.g. as soon as the first females are observed), and it would be more efficient to focus their efforts within blocks of suitable habitat rather simply searching along the transects used for the adult monitoring. Eggs from caged females could also be used to augment the sample size for egg survival and hatching success. Caging the females in habitat similar to "natural" oviposition sites so that they could lay the eggs directly in the vegetation would be preferable to trying to transfer the eggs, but it might be difficult to locate all the eggs laid. An additional modification to the methodology that might help achieve better results would be to focus this portion of the study in a few areas, and then use small exclosures to randomize oviposition sites to different treatments within that area. These modifications would not only provide a better experimental design, but would make monitoring the oviposition sites much easier. Solar operated "ring" fences could be placed around randomly selected oviposition sites assigned to ungrazed treatments. They might also be used to control the duration and/or intensity of grazing for selected sites.

Larval survival

This component of the study was, of course, impacted by all of the above factors. It would be necessary to obtain a large number of eggs from captive-reared females to get the number of larvae needed for an adequate number of sample units per treatments and larvae per sample unit. The success rate for larvae hatched from eggs laid was high (100% from 3 eggs) but improved captive-rearing facilities and procedures are needed to keep adult mortality to a minimum, and increase the number of eggs laid in captivity per female. Part of the problem during this study was that captive rearing was not initiated until later in the 2003 and 2004 flights, and the two females captured were both fairly worn and had probably already laid most of their eggs. Fresh gravid females would lay more eggs and would probably survive captivity better. It would also help to have the rearing facility closer to the research site so that larvae could be transferred as quickly as possible after they hatch.

Many of the modifications recommended for the egg survival and hatching success experimental design also apply here. This portion of the study is also problematic. It is desirable to allow the cattle free access to the grazed experimental units, but once the emergence cages are in place the units are protected from grazing impacts. Therefore, the cages need to be put in place as late as possible. Since it isn't possible to allow free grazing access once the cages are in places, and since cattle damage to the emergence cages is a major problem, I recommend that solar operated "ring" fences be placed around each cage at the same time they are put out. The optimal size for the cages is unknown, since it uncertain just how far the larvae move prior to pupation. I would recommend testing the use of different diameter cages nested together to evaluate the distance moved by larvae, and the optimal size for the cages.

Vegetation and Grazing Data

Vegetation data collected in 2004 were more refined than in 2003, but were still fairly subjective. They helped to get a feel for the vegetation and grazing patterns within survey units that need to be accounted for when designing the sampling protocol and interpreting the results, but more quantitative sampling would be helpful. As with other components of this study, it would help to have additional field personnel with expertise in forage and plant community analysis so that they could be focused on collecting that data while other personnel were focused on collecting the butterfly data. Improved assessment of grazing patterns within an area would also be useful. Phil Delphey suggested the possibility of using GPS collars to track the movement of the cattle.

Overall Project Assessment and Recommendations

The dramatic Dakota skipper population declines that occurred in the Glacial Lakes State Park area during this study made it impossible to test hypotheses for the impacts of different grazing regimes on the various life stages of the Dakota skipper. However, the limited data from adult surveys did suggest some general trends. The Dakota skipper populations at Anderson Pasture (light to moderate season-long grazing) appeared to be doing about as well as the populations in the ungrazed units where their numbers were the highest. Severe grazing did appear to have a strong negative impact on Dakota skippers and other prairie specialist butterflies. A significant population recovery at the study area would need to occur for successful implementation of the current research plan.

General Status Surveys

The dramatic declines observed in this study for Dakota skippers, Poweshiek skipperlings, and possibly also Arogos skippers appeared to be fairly widespread. Similar declines were observed in Iowa (Selby 2004), North Dakota (Royer, pers. comm. 2004), South Dakota (Skadsen, pers. comm. 2004), and Wisconsin (Borkin, pers. comm. 2004). Given the likely possibility that Dakota skipper numbers would still be too low in 2005 to collect significant grazing impact data, the 2005 work plan was modified to shift resources to more widespread surveys and monitoring of key sites for Dakota skippers and Poweshiek skipperlings in Minnesota. Those surveys had mixed results. The southernmost sites (Chanarambie Creek, Prairie Coteau SNA, and Hole-in-the-Mountain Prairie) all appeared to have normal Dakota skipper numbers, and slightly reduced Poweshiek skipperling numbers. Arogos skippers were present at Chanarambie Creek (1 early observation) and doing well at Prairie Coteau, but were not seen at any other sites. The target skipper species were not found at any of the general status survey sites from Mound Springs to Alexandria Moraine (north), and Dakota skippers were the only target skipper found at Felton Prairie. Regal fritillaries were generally doing well at most of the sites, although their numbers did appear to be lower at the northern sites.

Dakota skippers, Poweshieks skipperlings and regal fritillaries were also all seen in brief visits to Prairie Coteau SNA by Scott Krych and Joyce Pickle on 3 July 2005 (pers. comm.). I visited the SNA again with them on 7 July 2005 and we saw Dakota skippers but no Poweshiek skipperlings or Arogos skippers. Survey conditions were not very good, so the negative results are not at all conclusive.

REFERENCES

Aaseng, N.E., J.C. Almendinger, R.P. Dana, B.C. Delaney, H.L. Dunevitz, K.A. Rusterholz, N.P. Sather, and D.S.Wovcha. 1993. Minnesota's native vegetation: A key to natural communities. Minnesota Department of Natural Resources Natural Heritage Program (unpublished). Version 1.5. 111 pp.

Borkin, S. 2004. Curator of Invertebrate Zoology and Director of Special Projects, Milwaukee Public Museum, Invertebrate Zoology Department, 800 West Wells Street, Milwaukee, WI 53233-1478. Personal Communication.

Dana, R.F. 1989. Biologies of the prairie skippers Hesperia dacotae and H. ottoe (Lepidoptera: Hesperiidae), and factors affecting mortality in prescribed burning of their habitat in spring. Ph.D. dissertation, University of Minnesota.

Dana, R.P. 1991. Conservation management of the prairie skippers *Hesperia dacotae* and *Hesperia ottoe*: basic biology and threat of mortality during prescribed burning in spring. Minnesota Agric. Exp. Sta. Bull. 594-1991St. Paul, MN. 63 pp.

Minnesota NHP. 2003. Element occurrence records from the Minnesota atural Heritage Program, St Paul, MN. Received February 2003.

North American Butterfly Association (NABA). 2001. Checklist & English names of North American butterflies (2nd edition). http://www.naba.org/ftp/check2com.pdf

Opler, P. A. and A. D. Warren. 2003. Butterflies of North America. 2. Scientific names list for butterfly species of North America, north of Mexico. http://www.biology.ualberta.ca/old_site/uasm//Opler&Warren.pdf

Pollard, E. 1977. A method of assessing changes in the abundance of butterflies. Biological Conservation. 12:115-134.

Royer, R. 2004 Division of Science, Minot State University, 500 University Avenue West, Minot, ND 58707. Personal Communication.

Schlicht, D.W. and M.R. Saunders. 1995. Completion of status surveys for the Dakota skipper (*Hesperia dacotae*) and the Poweshiek skipper (*Oarisma poweshiek*) in Minnesota (with additional data on the regal fritillary (*Speyeria idalia*). Unpublished report, Minnesota Department of Natural Resources, Natural Heritage and Nongame Research Program, St. Paul, MN. January 28, 1995. 22+pp.

Schlicht, D.W. 1997a. Population monitoring for prairie butterflies in Minnesota. Unpublished report, Minnesota Department of Natural Resources, Natural Heritage and Nongame Research Program, St. Paul, MN. March 30, 1997. 26+pp.

Schlicht, D.W. 1997b. Surveys for the Dakota skipper in Minnesota. Unpublished report, Minnesota Department of Natural Resources, Natural Heritage and Nongame Research Program, St. Paul, MN. November 30, 1997. 10+pp.

Schlicht, D.W. 2001. Surveys of Lepidoptera in the Glacial Lakes/Ordway landscape, Minnesota 2001. Unpublished Report, Iowa Lepidoptera Project, Center Point, IA. 1 p.

Selby, G.L. 2003a. Dakota skipper grazing project – phase 1 (research plan). Final report, Minnesota Department of Natural Resources, Natural Heritage and Nongame Research Program, St. Paul, MN. February 28, 2003. 18+pp.

Selby, G.L. 2004. Effect of grazing on the Dakota skipper butterfly. Annual progress report, Minnesota Department of Natural Resources, Natural Heritage and Nongame Research Program, St. Paul, MN. December 31, 2004. 17+pp.

Skadsen, D.R. 2001. A survey of prairie Lepidoptera in southwestern Minnesota State Parks. Unpublished Report, Minnesota Department of Natural Resources, Division of Parks and Recreation, St. Paul, MN. 61 pp.

Skadsen, D.R. 2004. Natural History Investigations, 1017 Outlet Road, Grenville, SD 57239-8350. Personal Communication.

USDA, NRCS. 2005. *The PLANTS Database*, Version 3.5 (http://plants.usda.gov). Data compiled from various sources by Mark W. Skinner. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

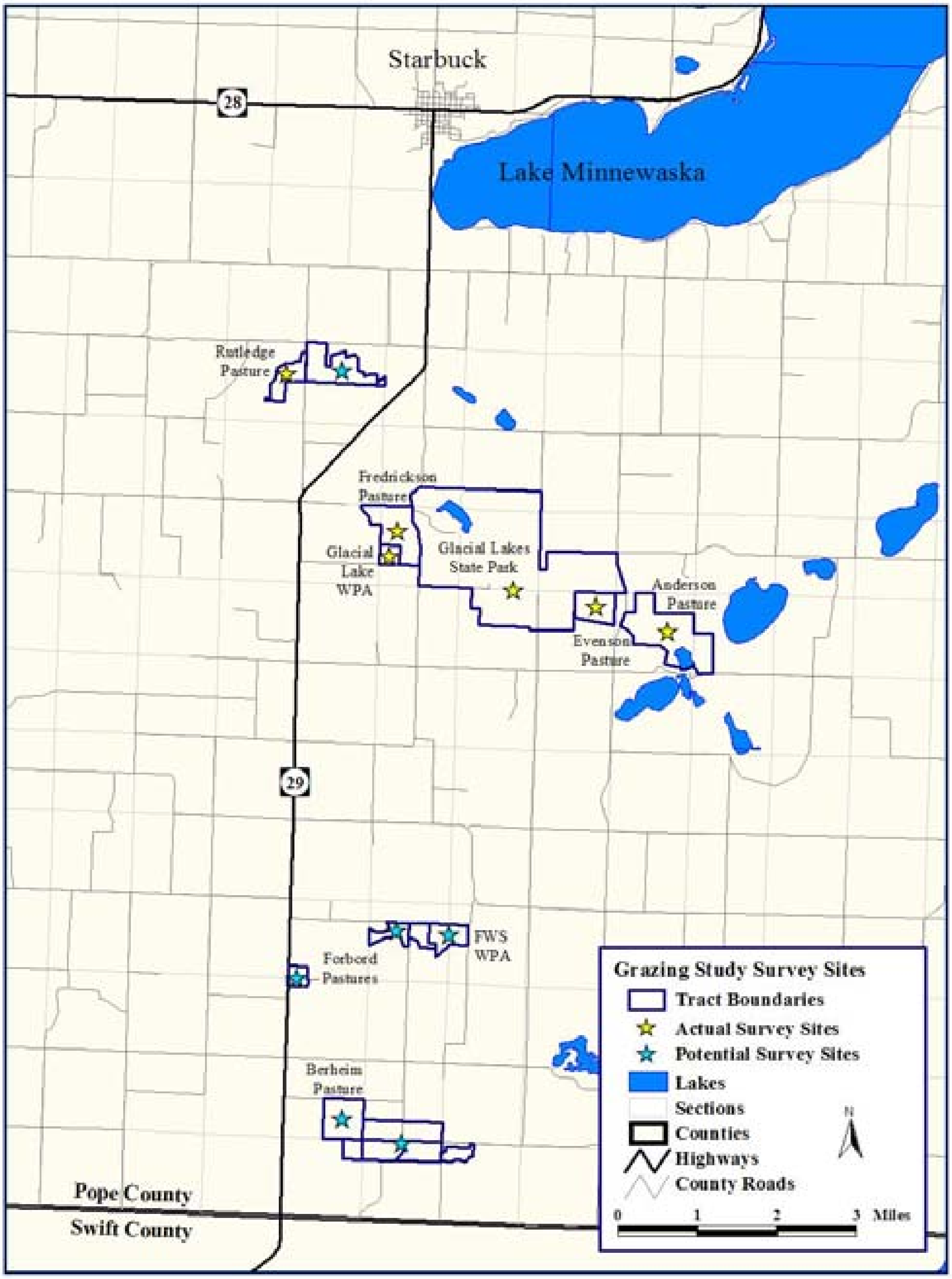
APPENDIX 1

Maps: Dakota Skipper Grazing Study Sites and Survey Results

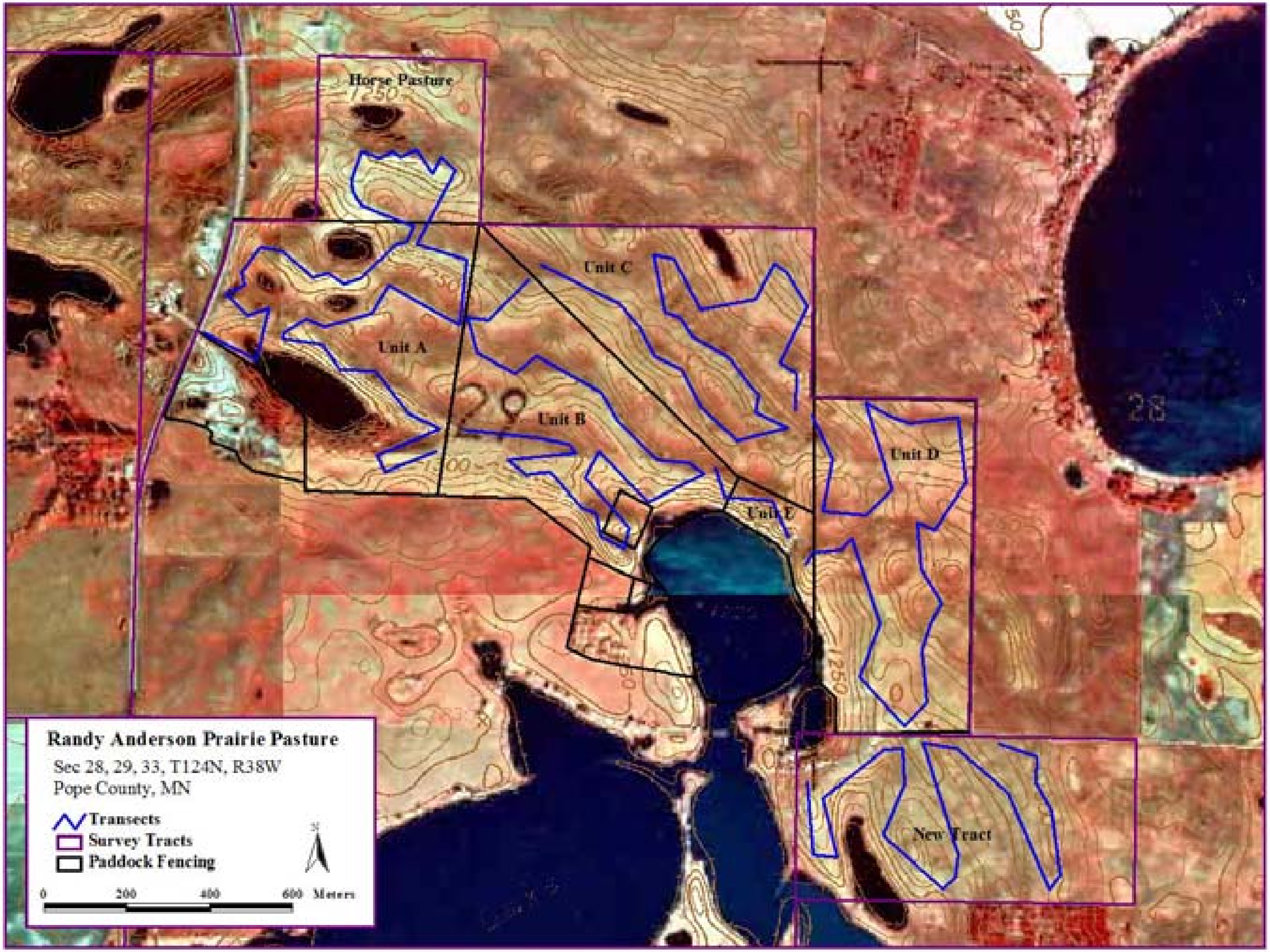
Survey Sites

Butterfly Distribution

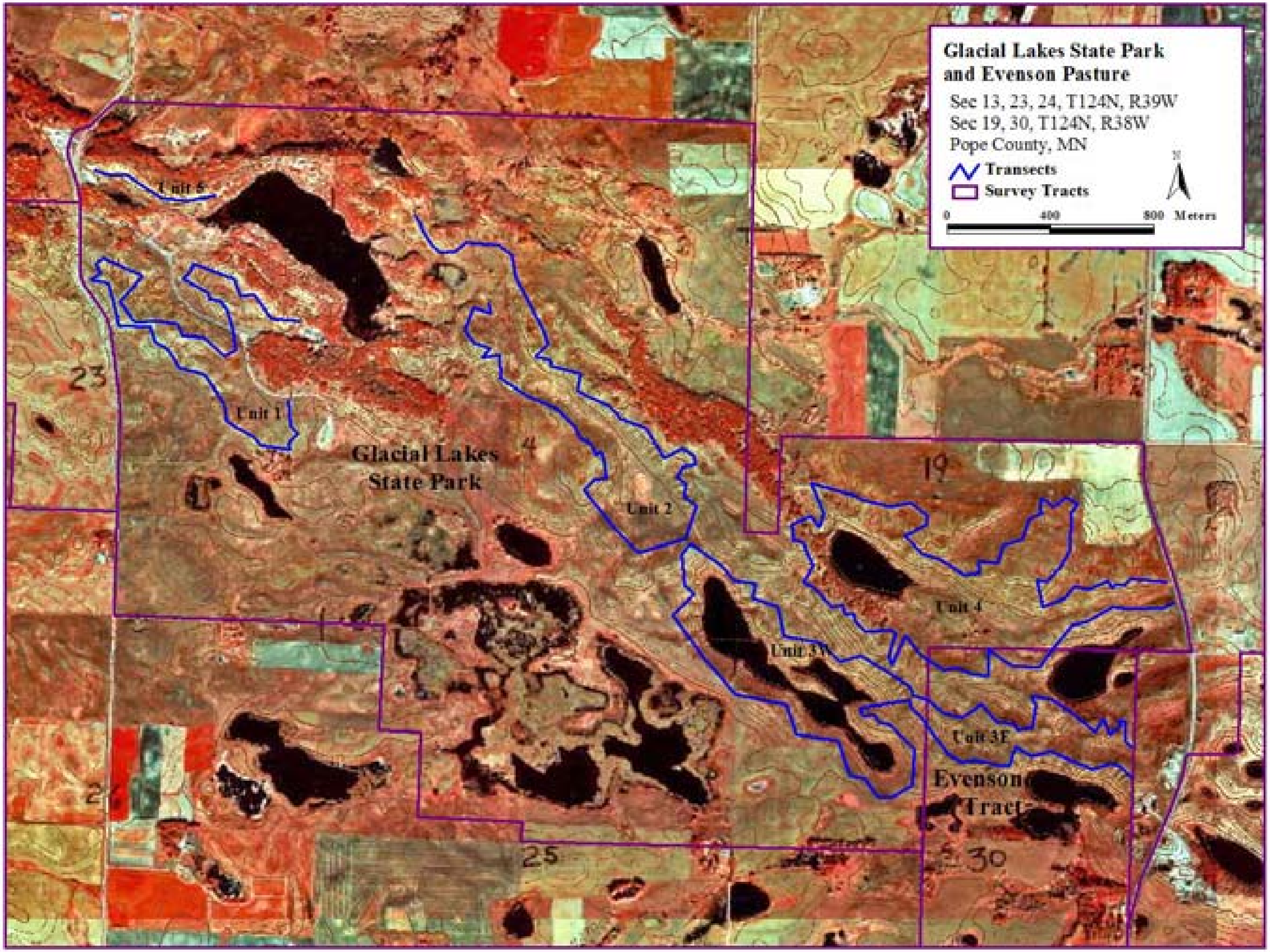
Vegetation and Grazing Intensity



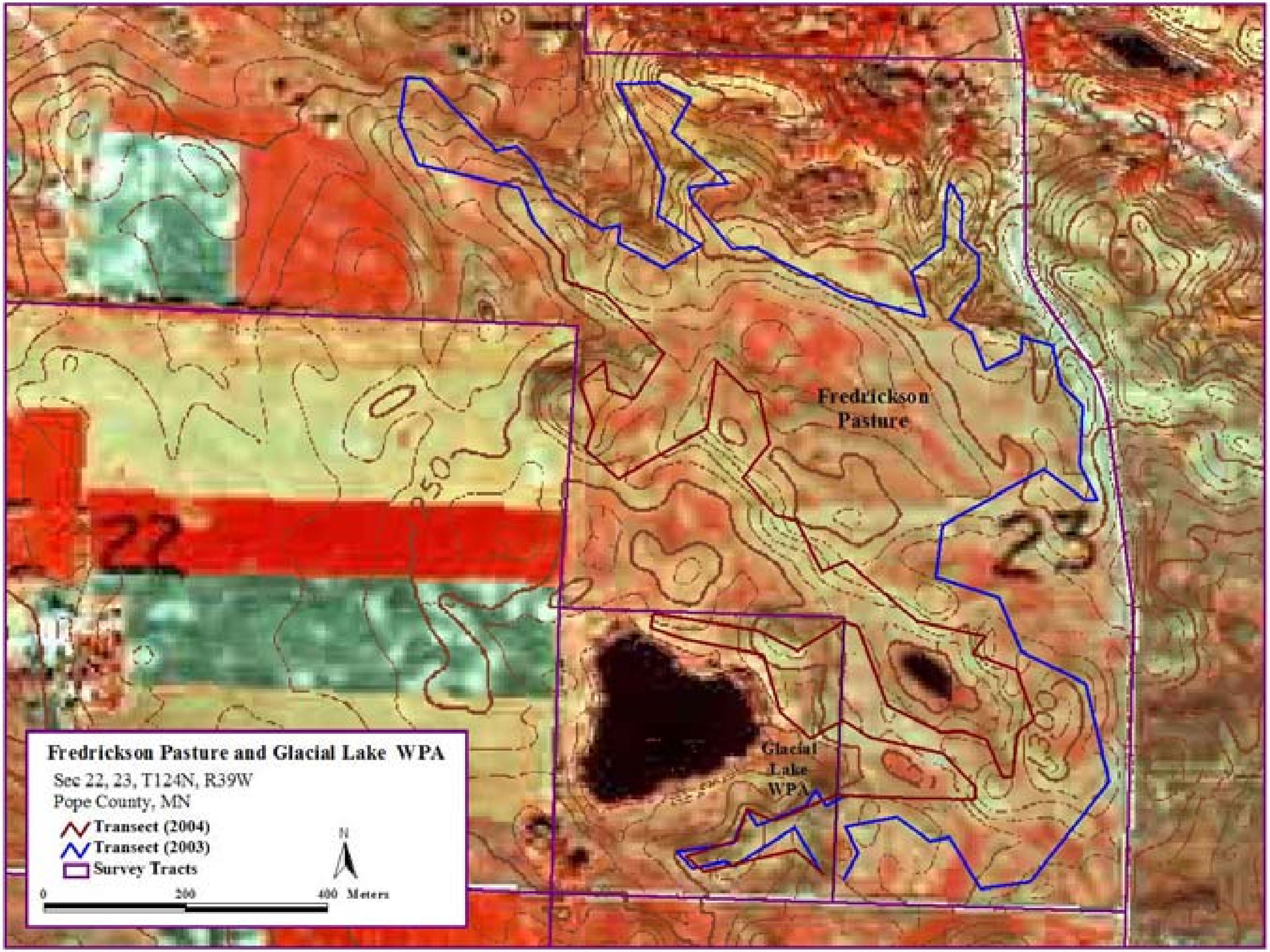
Appendix 1, Figure 1. Dakota Skipper Grazing Study Area (Actual and Potential Survey Sites).



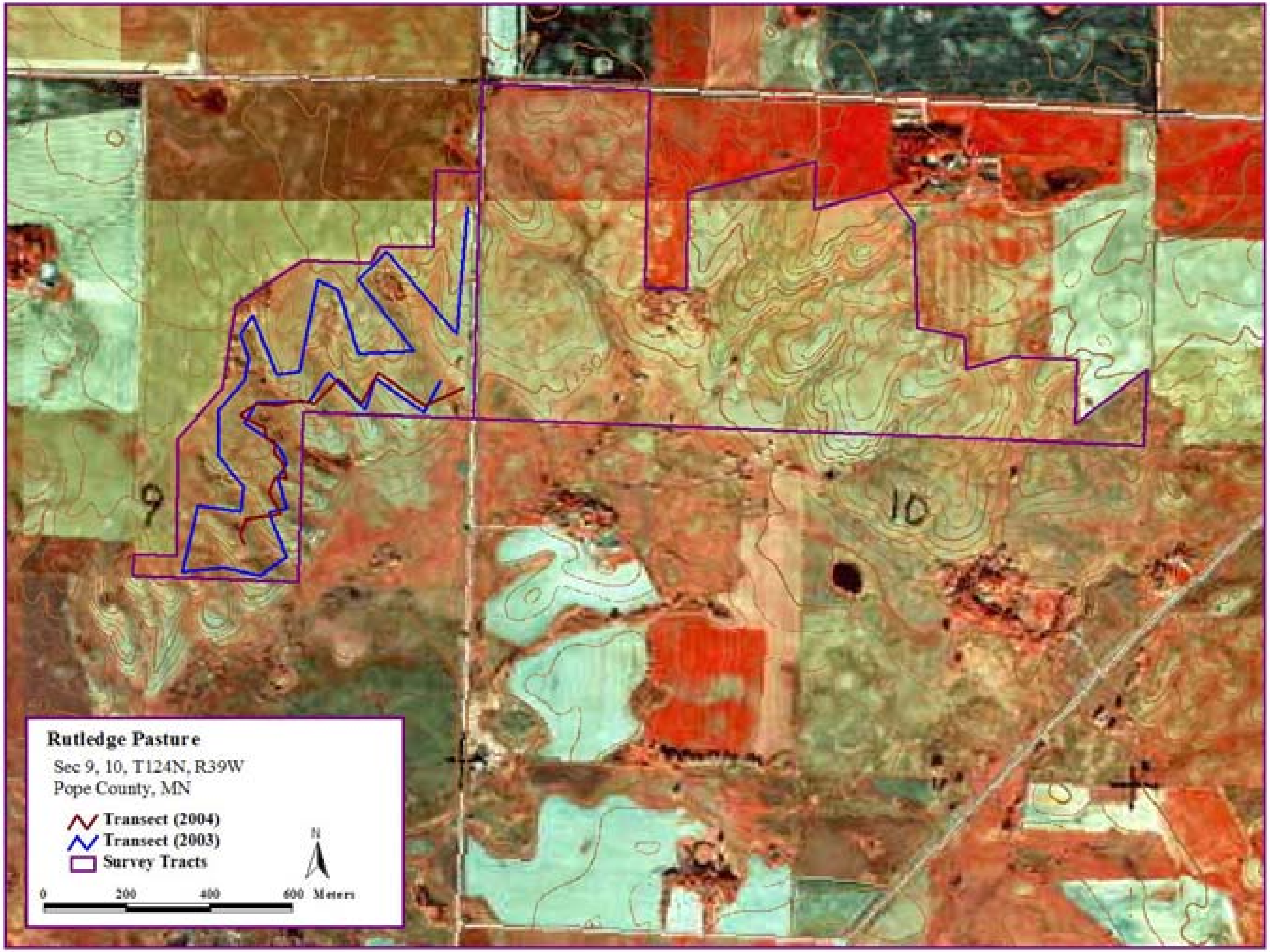
Appendix 1, Figure 2. Anderson Prairie Pasture Site (Paddock & Survey Design).



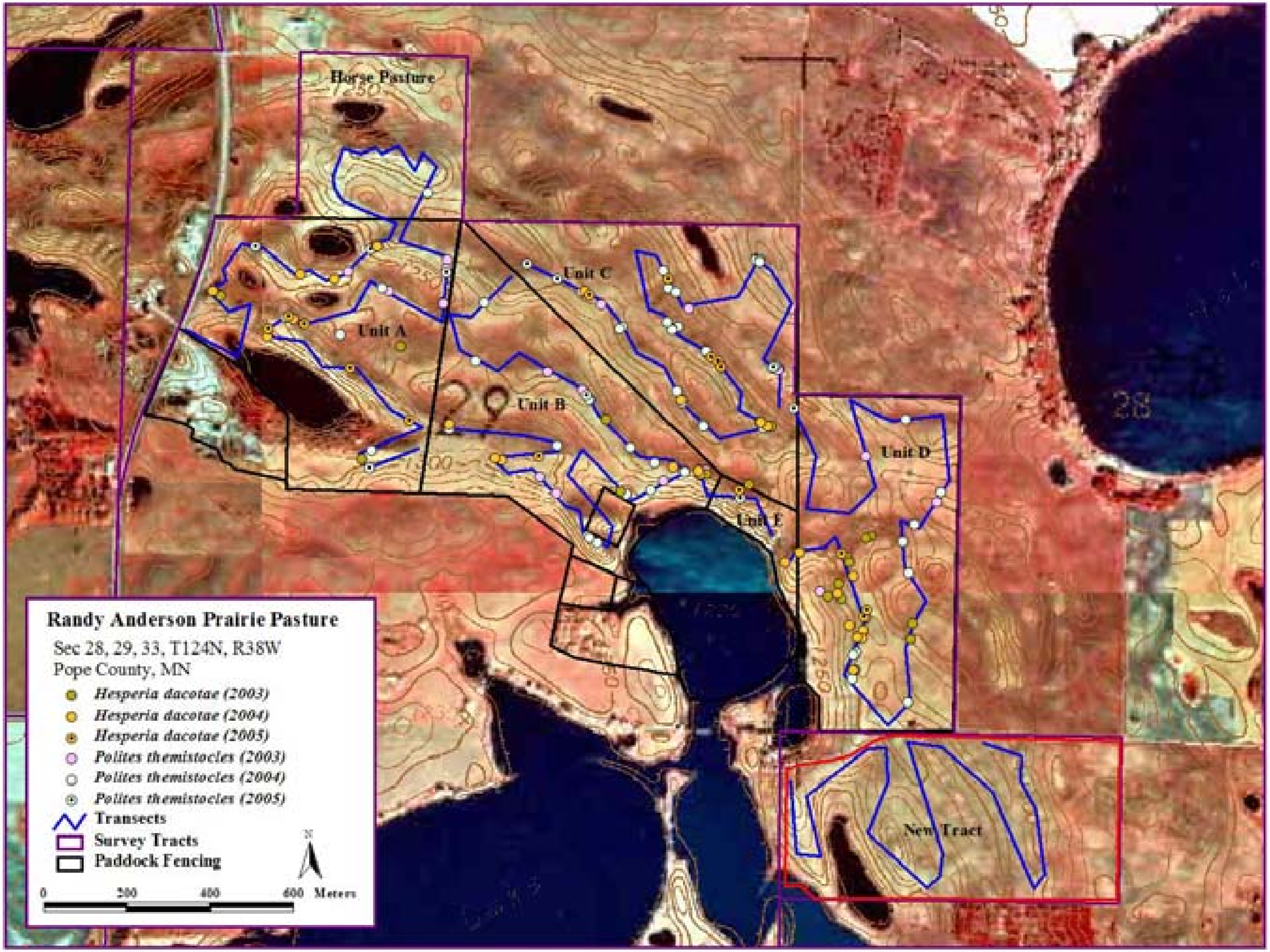
Appendix 1, Figure 3. Glacial Lakes State Park and Evenson Pasture Site (Survey Design).



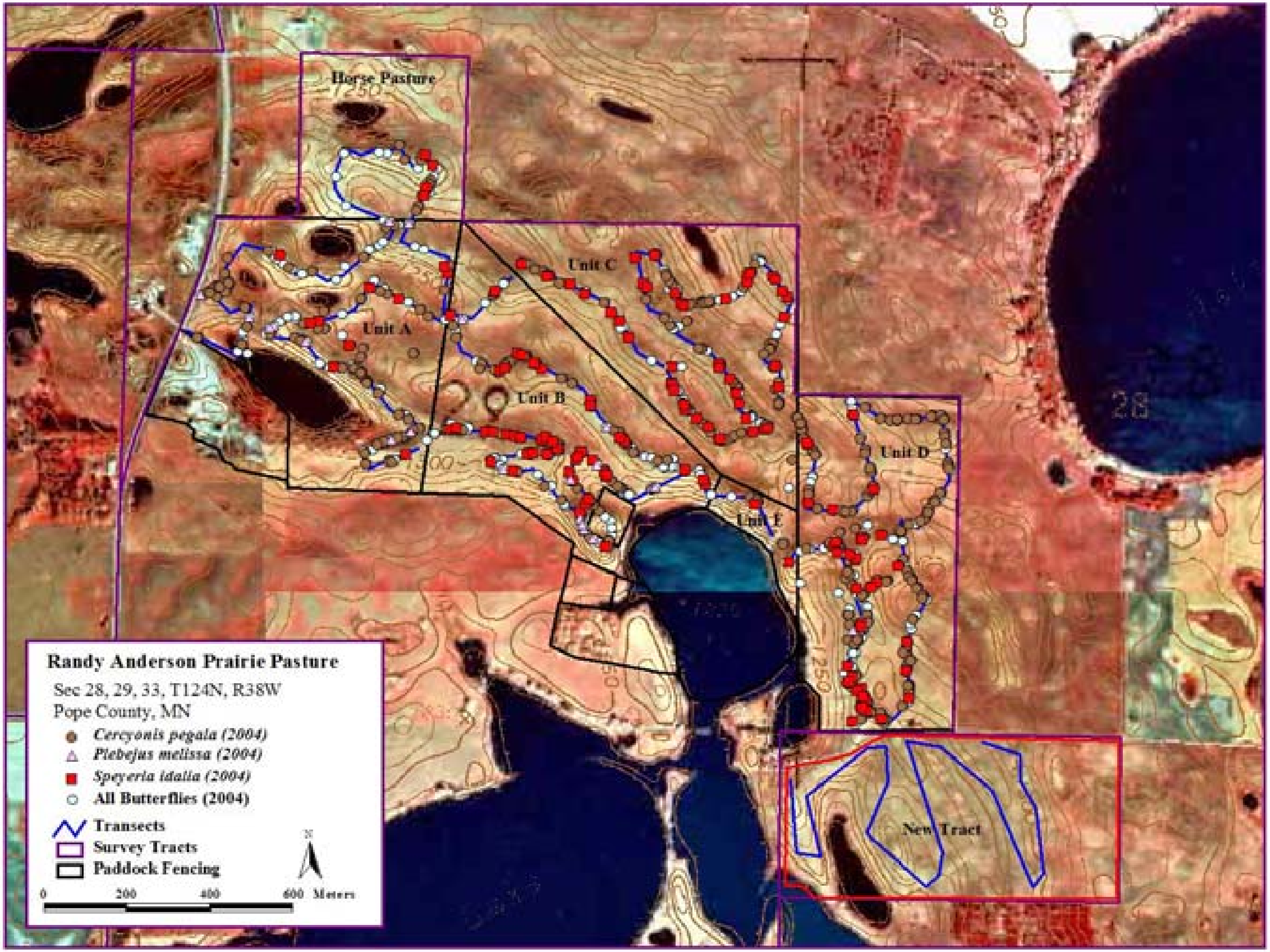
Appendix 1, Figure 4. Fredrickson Prairie Pasture and Glacial Lake WPA Sites (Survey Design).



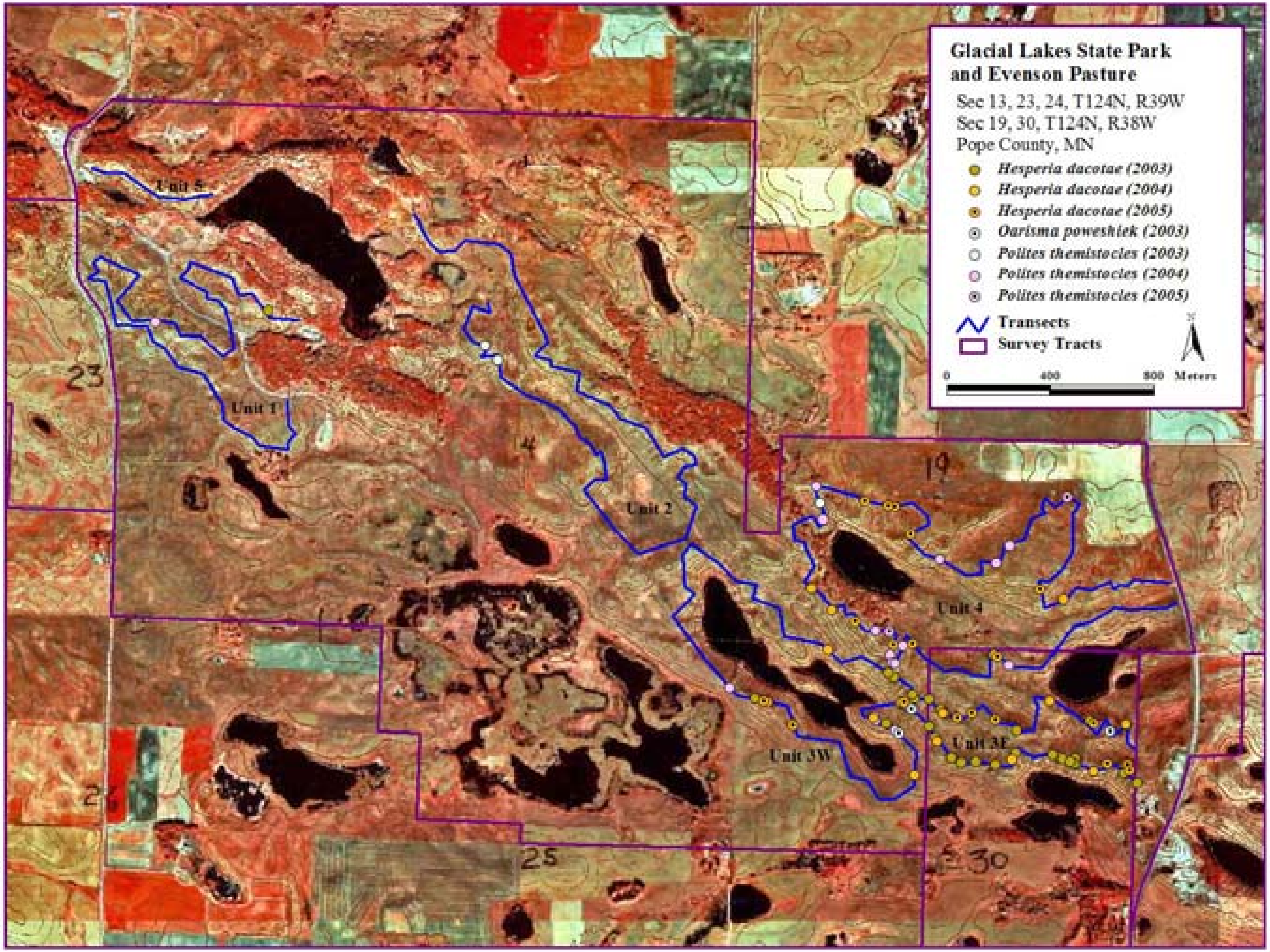
Appendix 1, Figure 5. Rutledge Prairie Pasture (Surveyed Western Pasture and Unsurveyed Eastern Pastures).



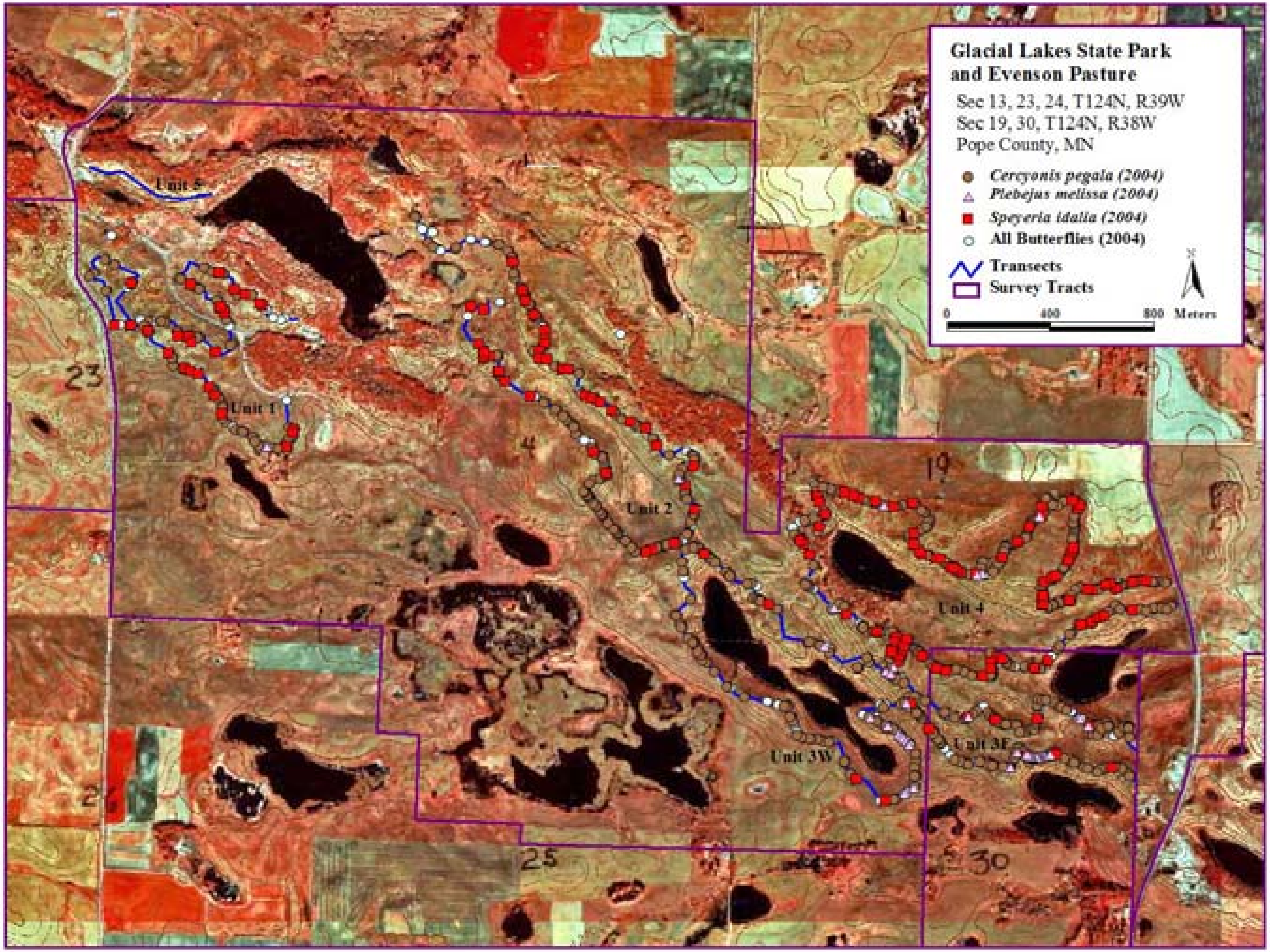
Appendix 1, Figure 6. Anderson Prairie Pasture Site (Hesperia dacotae and Polites Themistocles observatons for 2003-2004).



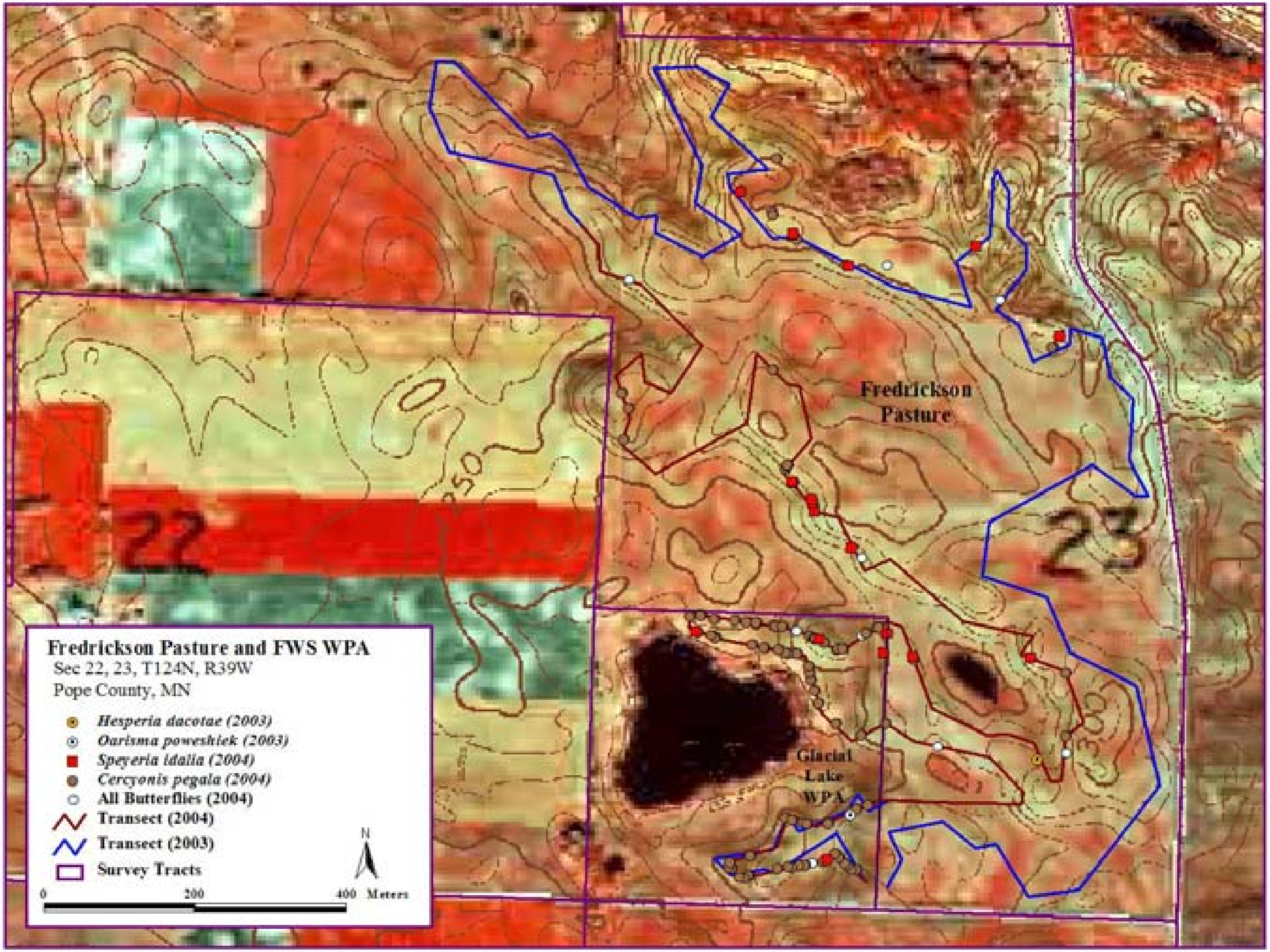
Appendix 1, Figure 7. Anderson Prairie Pasture Site (Cercyonis pegala, Plebejus melissa, and Speyeria idalia observatons for 2004).



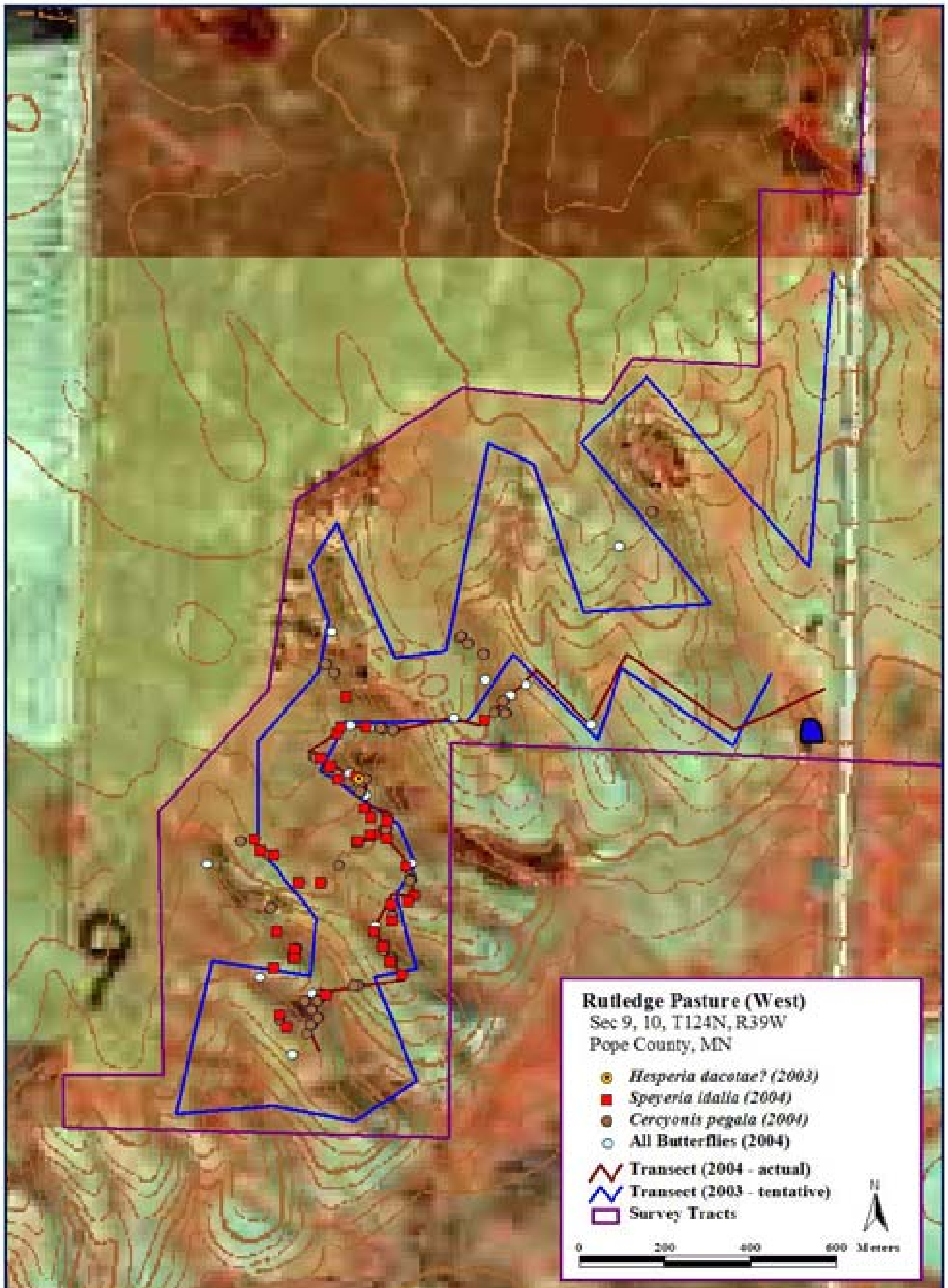
Appendix 1, Figure 8. Glacial Lakes State Park and Evenson Pasture Site (Hesperia dacotae, Oarisma poweshiek & Polites themistocles observatons for 2003-2004).



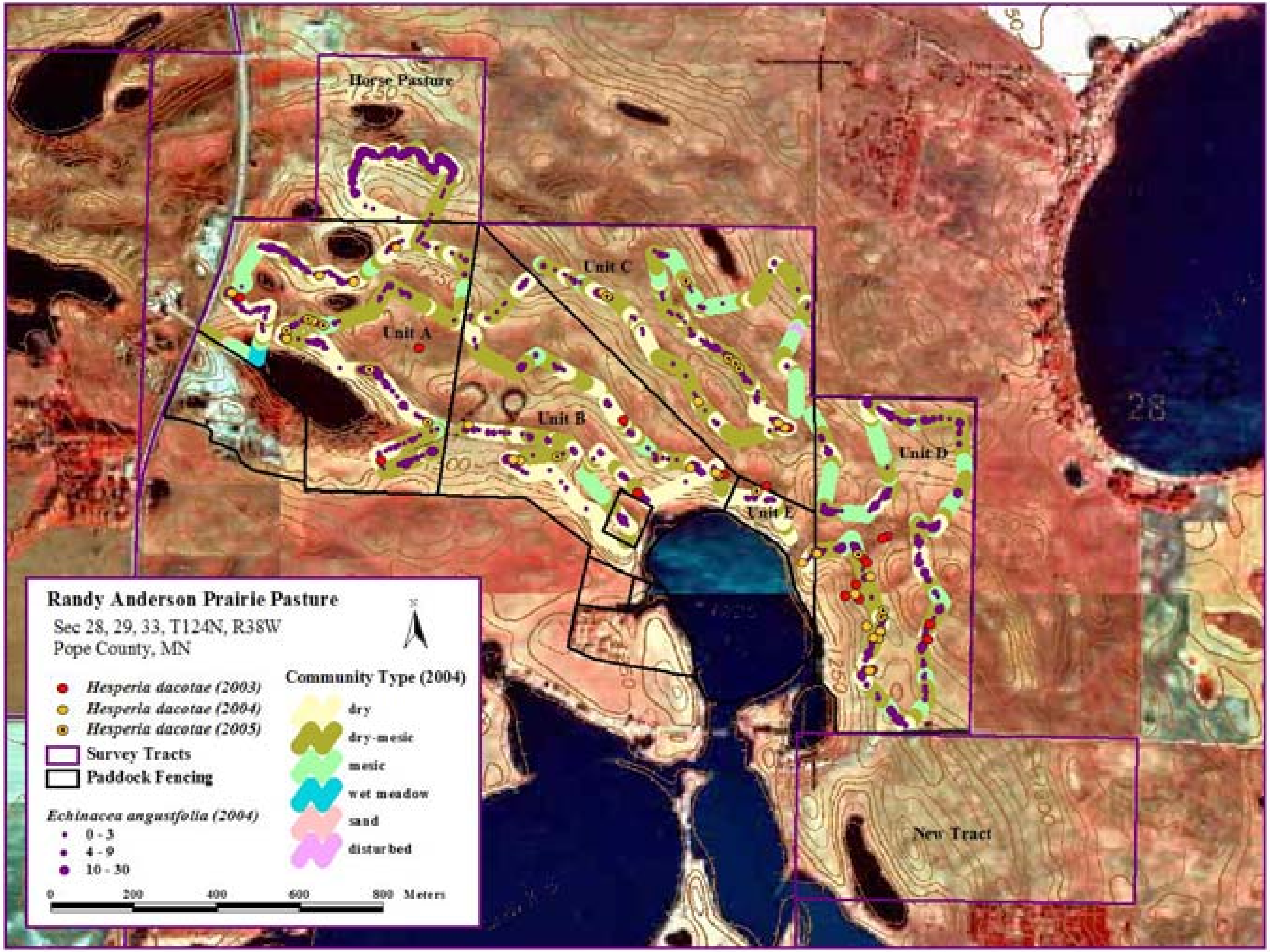
Appendix 1, Figure 9. Glacial Lakes State Park and Evenson Pasture Site (Cercyonis pegala, Plebejus melissa, and Speyeria idalia observatons for 2004).



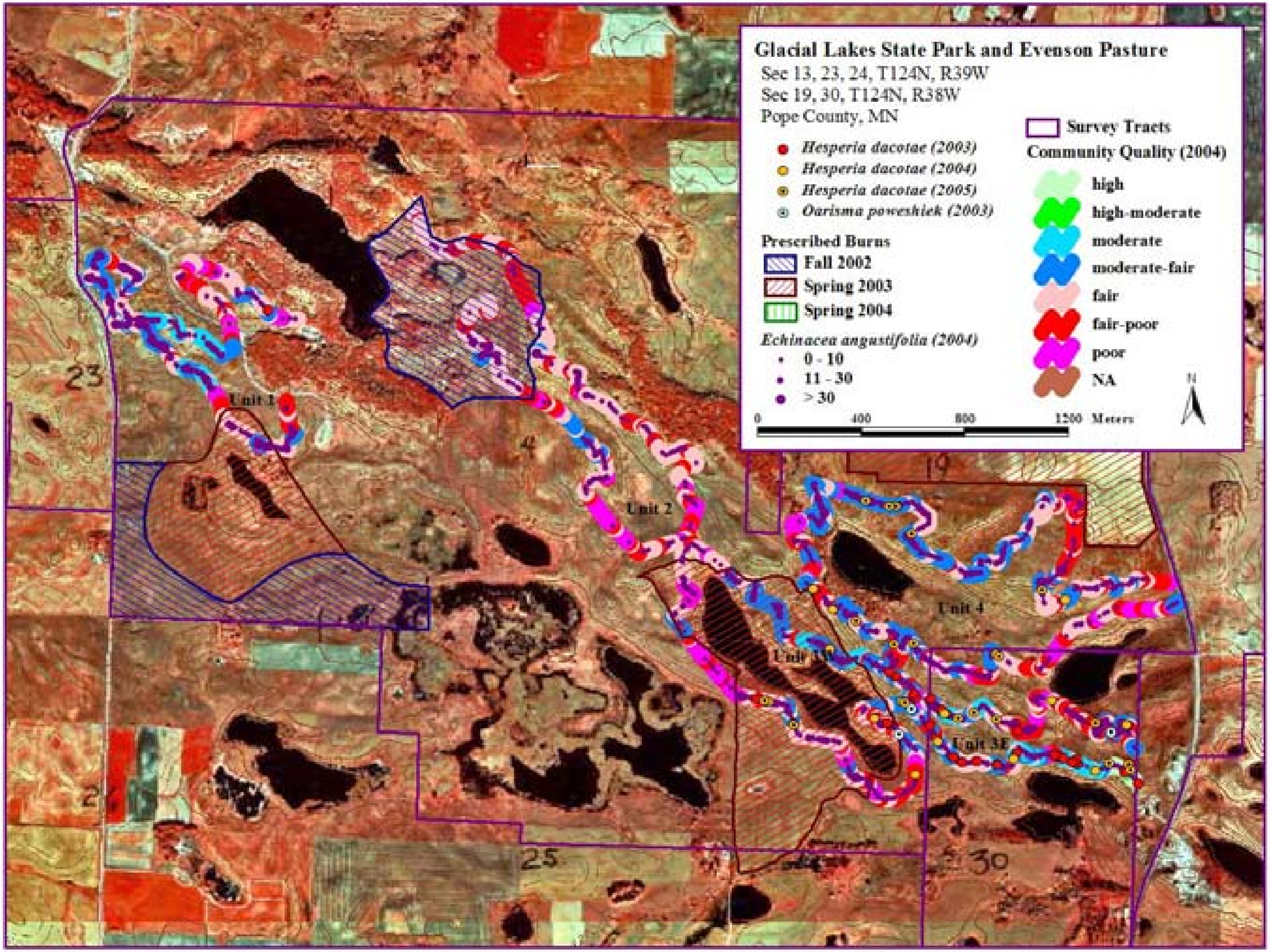
Appendix 1, Figure 10. Fredrickson Prairie Pasture and FWS WPA Sites (Selected 2003-2004 Butterfly Observations).



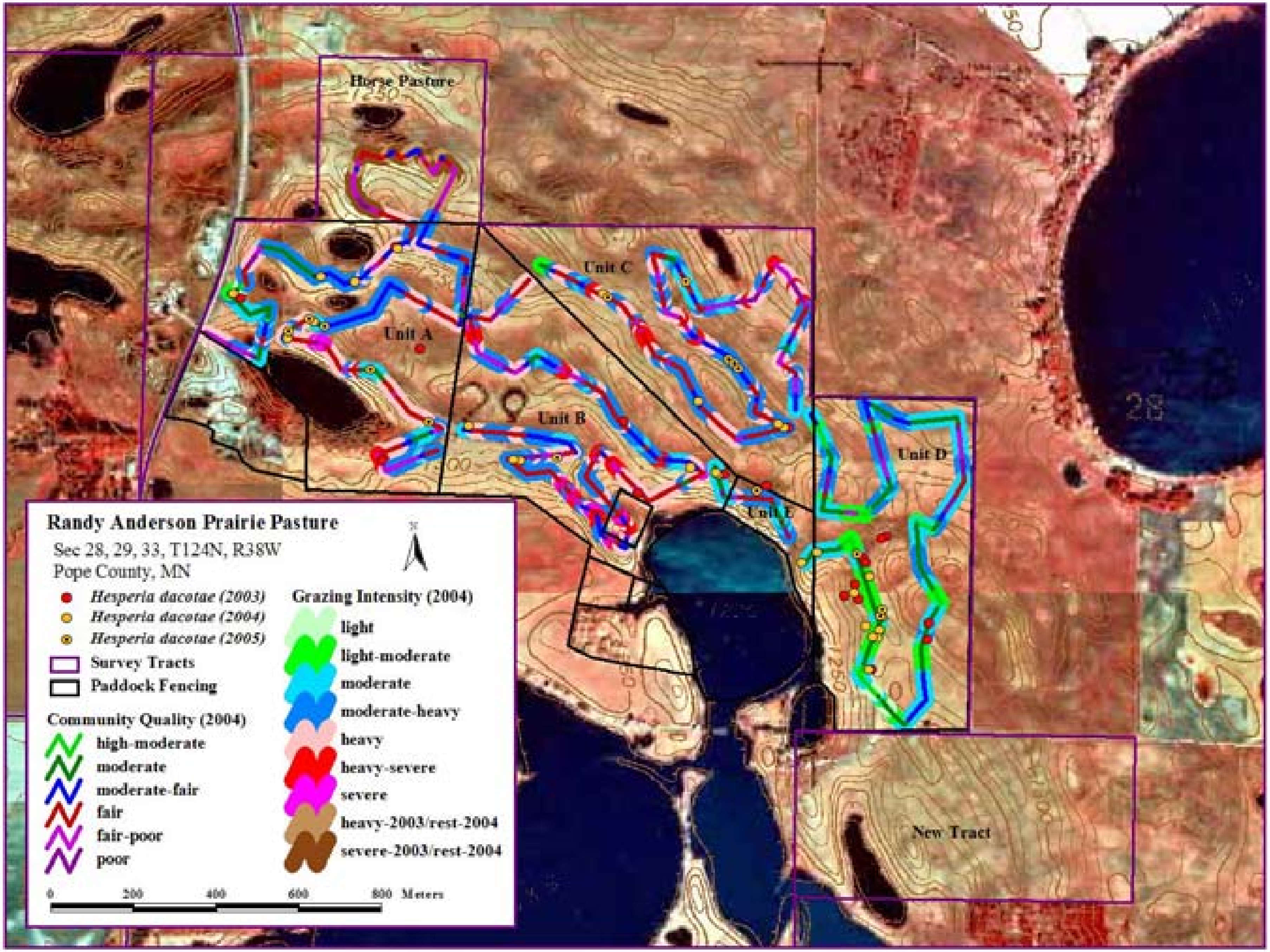
Appendix 1, Figure 11. Rutledge West Prairie Pasture (Selected 2003-2004 Butterfly Observations).



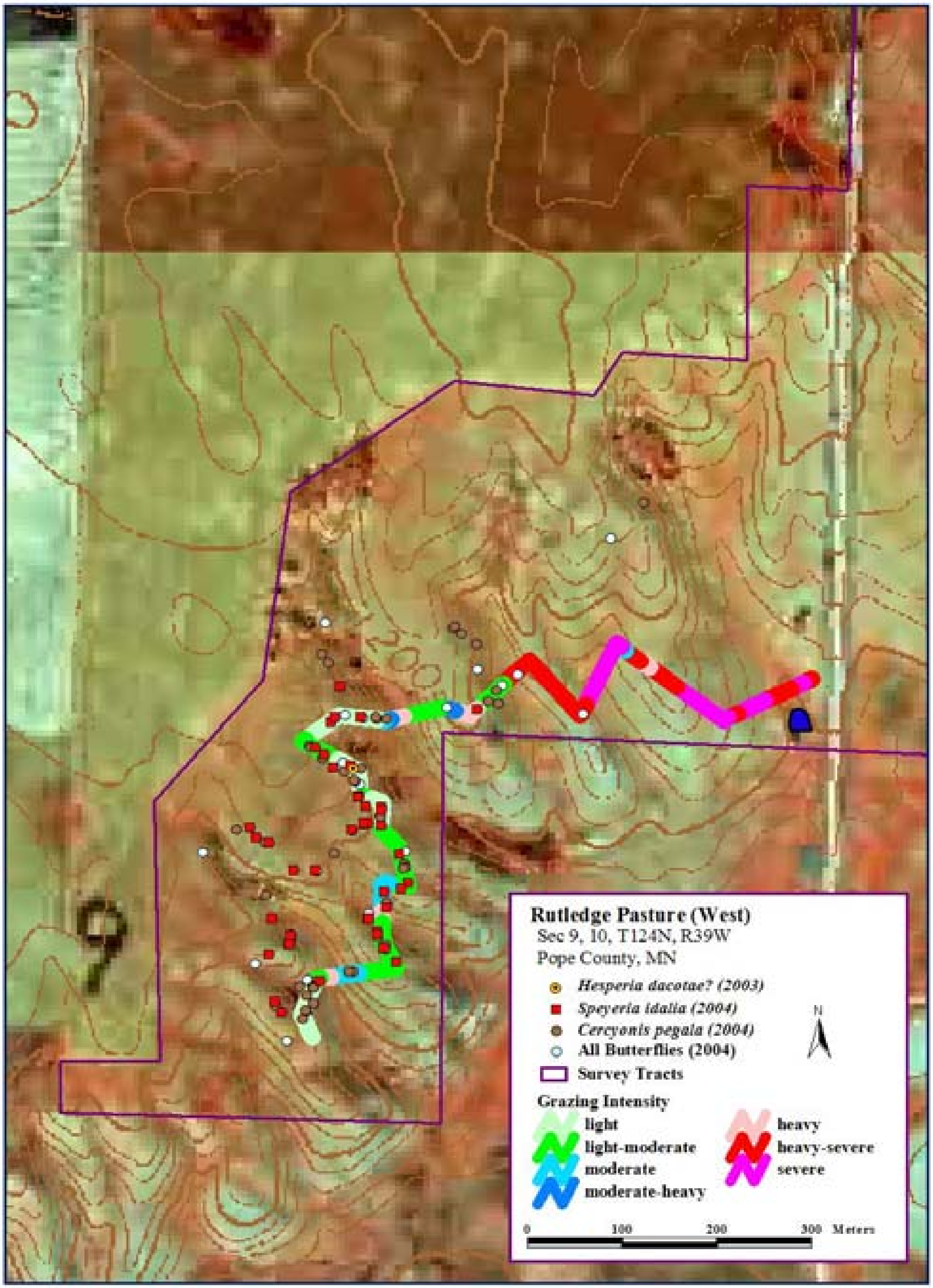
Appendix 1, Figure 12. Anderson Prairie Pasture site (2004 community type, purple coneflower frequency, and 2003-2005 Dakota skippers).



Appendix 1, Figure 13. Glacial Lakes State Park and Evenson Pasture site (2004 community quality, purple coneflower frequency, and 2003-2005 skippers).



Appendix 1, Figure 14. Anderson Prairie Pasture site (2004 community quality, grazing Intensity, and 2003-2005 Dakota skippers).



Appendix 1, Figure 15. Rutledge West Prairie Pasture (2004 grazing intensity, and selected butterfly observations).

APPENDIX 2

Tables: Dakota Skipper Grazing Study Site and Butterfly Survey Data

Survey Site Information

Quantitative Butterfly Transect Survey Results

Butterfly Observations per Vegetation/Grazing Variable

All Butterfly Observations per Survey Route

Survey Site Information

Appendix 2, Table 1. Grazing study survey sites, units and transects (unit area[1], transect length, management).

Site/Route	Area (acres)	Area (ha)	Transect Length (meters)	Transect Length (m/ha)	Grazing Intensity[2] 2003	Grazing Intensity[2] 2004	Recent Burns 2003	Recent Burns 2004
Anderson Pasture								
Unit A (total)	**91**	**37**	**3,409**	**92**	**L-S**	**L-M**	**None**	**None**
Unit A (cattle pasture)	73	30	2,708	90	L-M	L-M	None	None
Unit A (horse pasture)	18	7	701	101	H-S	None	None	None
Unit B	72	29	2,400	83	L-M	L-M	None	None
Unit C	75	30	2,206	74	L-M	L-M	None	None
Unit D	74	30	2,423	81	L-M	L-M	None	None
Unit E	9	4	288	72	L-M	L-M	None	None
Site Totals	**321**	**130**	**10,726**	**83**				
Glacial Lakes SP								
Unit 1	95	38	3,321	87	None	None	Partial[3]	Partial[4]
Unit 2	184	74	3,971	54	None	None	Partial[5]	None
Unit 3 (total)	**199**	**80**	**5,864**	**73**	**None**	**None**	**Partial[6]**	**None**
Unit 3 (Evenson)	73	29	2,220	77	None	None	None	None
Unit 3 (Park)	126	51	3,644	71	None	None	Partial[6]	None
Unit 4 (total)	**224**	**91**	**5,291**	**58**	**None**	**None**	**None**	**None**
Unit 4 (Evenson)	16	7	640	91	None	None	None	None
Unit 4 (Park)	208	84	4,651	55	None	None	None	None
Unit 5	12	5	502	100	None	None	None	None
Site Totals	**714**	**288**	**18,949**	**66**				
Fredrickson & WPA								
Fredrickson Pasture	195	79	6,686	85	M-H	M-H	None	None
Glacial Lake WPA	20	8	1,242	155	None	None	None	None
Site Totals	**215**	**87**	**7,928**	**91**				
Rutledge Pasture	90	36	3,844	107	M-S	M-S	None	None
Overall Totals	**1,382**	**558**	**41,447**	**74**				

[1] Area per survey unit in Glacial Lakes State Park is somewhat arbitrary, since unit boundaries were not defined prior to the establishment of the transects. In units with ponds/lakes, the area for the water is not included.

[2] All grazing is by cattle unless otherwise specified, and was season-long 2003-2005.
Grazing Key: L = Light; M = Moderate; H = Heavy; S = Severe

[3] 1+ hectares of the 38 hectares in unit 1 (southeast part) were burned in the spring 2003.
23 hectares of the 38 hectares in unit 1 (south & west of road) were burned in the fall 2003.

[4] 23 hectares of the 38 hectares in unit 1 (north of road) were burned in the fall 2004.

[5] 17 hectares of the 74 hectares in unit 2 (western part) were burned in the fall 2002.

[6] 20 hectares of the 51 hectares in unit 3 (Park) were burned in the spring 2003.

Quantitative Butterfly Transect Survey Results

Appendix 2, Table 2. Dakota skipper, Poweshiek skipperling, and regal fritillary observations at Glacial Lakes State Park during transect surveys by Skadsen (2001) and Selby (2003-2005).

Transect #1	**2001**			**2003**			**2004**			**2005**
Degree-days	518	644		531	620		613	678		653-666
Name	27 Jun	08 Jul	**Total**	01 Jul	08 Jul	**Total**	16 Jul	21 Jul	**Total**	11-12 Jul
Hesperia dacotae	4	5	**9**	1	0	**1**	0	0	**0**	**0**
Oarisma poweshiek	14	6	**20**	0	0	**0**	0	0	**0**	**0**
Speyeria idalia	0	6	**6**	1	19	**20**	5	17	**22**	**6**

Transect #2	**2001**			**2003**			**2004**			**2005**
Degree-days	518	644		531	620		623	689		653
Name	27 Jun	08 Jul	**Total**	01 Jul	08 Jul	**Total**	17 Jul	22 Jul	**Total**	11 Jul
Hesperia dacotae	4	5	**9**	0	0	**0**	0	0	**0**	**0**
Oarisma poweshiek	0	5	**5**	0	0	**0**	0	0	**0**	**0**
Speyeria idalia	0	0	**0**	0	8	**8**	4	28	**32**	**9**

Transect #3	**2001**			**2003**				**2004**			**2005**
Degree-days	533	657		501	597	638		581	649		582
Name	28 Jun	09 Jul	**Total**	28 Jun	06 Jul	10 Jul	**Total**	13 Jul	19 Jul	**Total**	06 Jul
Hesperia dacotae	31	31	**62**	10	4	2	**16**	8	1	**9**	**7**
Oarisma poweshiek	18	15	**33**	1	1	0	**2**	0	0	**0**	**0**
Speyeria idalia	0	11	**11**	0	4	2	**6**	2	7	**9**	**5**

Transect #4	**2001**			**2003**	**2004**			**2005**
Degree-days	533	657		715	601	678		622
Name	28 Jun	09 Jul	**Total**	**17 Jul**	15 Jul	21 Jul	**Total**	09 Jul
Hesperia dacotae	29	17	**46**	**0**	2	1	**3**	**11**
Oarisma poweshiek	36	10	**46**	**0**	0	0	**0**	**0**
Speyeria idalia	0	0	**0**	**23**	12	55	**67**	**6**

Transects #1-4 Totals	**2001**	**2003**	**2004**	**2005**
Hesperia dacotae	**126**	**17**	**12**	**18**
Oarisma poweshiek	**104**	**2**	**0**	**0**
Speyeria idalia	**17**	**57**	**130**	**26**

Appendix 2, Table 3. Quantitative butterfly survey results for Glacial Lakes State Park – Transect #1.

	T1 (2003)				T1 (2004)				T1 (2005)
Degree-days	531	620	998		612	678	800-809		653-666
Name	01 Jul	08 Jul	11 Aug	**Total**	16 Jul	21 Jul	3-4 Aug	**Total**	11-12 Jul
Blue sp.	-	-	2	**2**	-	-	-	**-**	**-**
Bol bel	-	1	-	**1**	-	-	-	**-**	**4**
Cer peg	3	120	4	**127**	29	36	13	**78**	**99**
Col sp.	-	3	2	**5**	-	3	3	**6**	**7**
Dan ple	1	4	-	**5**	-	2	1	**3**	**4**
Eno ant	-	1	-	**1**	-	-	-	**-**	**-**
Eup cla	-	5	1	**6**	-	-	-	**-**	**2**
Eup cla?	-	-	-	-	-	-	-	**-**	**1**
Hes dac	1	-	-	**1**	-	-	-	**-**	**-**
***Hes leo*?**	-	-	2	**2**	-	-	-	**-**	**-**
Nym ant?	-	-	-	**-**	-	-	-	-	**1**
Ple mel	-	-	-	**-**	-	-	1	**1**	**-**
Pol the	-	-	-	**-**	-	1	-	**1**	**-**
Sat edw?	-	-	-	**-**	-	1	-	**1**	**-**
Sat tit	-	-	-	**-**	2	1	-	**3**	**-**
Sat sp.	-	1	-	**1**	-	-	-	**-**	**-**
Spe aph	-	-	-	**-**	-	2	-	**2**	**1**
Spe ida	1	19	7	**27**	5	17	9	**31**	**6**
Spe sp.	-	5	-	**5**	1	1	-	**2**	**3**
Van ata	-	-	-	**-**	-	-	-	-	**1**
Van sp.	-	1	-	**1**	-	-	-	**-**	**-**
Totals	6	160	18	**184**	37	64	27	**128**	**129**

01 Jul 2003 (1:40 – 4:55 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Bryan
Weather: relatively good

08 Jul 2003 (10:20 a.m. – 12:50 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: fair early; fair-poor late

11 Aug 2003 (time not recorded)
Quantitative butterfly & vegetation survey
Surveyors: Bryan
Weather: not recorded

16 Jul 2004 (2:00 – 7:30 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: fair-good most; fair-poor late

21 Jul 2004 (2:25 – 4:10 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good, but hot throughout

03 Aug 2004 (1st half) (5:45 – 8:35 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-poor; late in day at end

04 Aug 2004 (2nd half) (7:45 a.m. – 3:45 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: poor early; good most

11 Jul 2005 (1:50 – 3:00 p.m.)
Quantitative survey (first part)
Surveyors: Jerry
Weather: good early; fair mid; poor late

12 Jul 2005 (10:30 a.m. – 12:20 p.m.)
Quantitative survey (last part)
Surveyors: Jerry
Weather: fair early; good most

Appendix 2, Table 4. Quantitative butterfly survey results for Glacial Lakes State Park – Transect #2.

	T2 (2003)					T2 (2004)				T2 (2005)
Degree-days	531	620	725	836		623	689	808-816		653
Name	01 Jul	08 Jul	18 Jul	28 Jul	**Total**	17 Jul	22 Jul	4-5 Aug	**Total**	11 Jul
Blue sp.	-	-	-		**-**	-	-	-	**-**	**1**
Bol bel	-	-	1	-	**1**	1	-	-	**1**	**-**
Cel neg	-	-	-	-	**-**	-	1	-	**1**	**-**
Cer peg	3	33	74	25	**135**	59	52	37	**148**	**78**
Coe tul	2	-	-	-	**2**	-	-	-	**-**	**-**
Col sp.	3	6	1	-	**10**	-	1	5	**6**	**7**
Dan ple	11	4	18	12	**45**	1	4	14	**19**	**8**
Eup cla	1	3	3	2	**9**	-	-	-	**-**	**3**
Hes dac	-	-	-		**-**	-	-	-	**-**	**-**
Lim art	-	-	-	-	**-**	-	1	-	**1**	**1**
Phy tha	-	-	-	-	**-**	-	1	-	**1**	**-**
Ple mel	-	-	-	2	**2**	-	2	1	**3**	**-**
Pol mys	2	-	-	-	**2**	-	-	-	**-**	**-**
Pol the	-	2	-	-	**2**	-	-	-	**-**	**-**
Sat eur	1	1	-	-	**2**	-	-	-	**-**	**-**
Sat lip	-	1	-	-	**1**	-	-	-	**-**	**-**
Sat sp.	-	1	-	-	**1**	-	-	-	**-**	**-**
Sat tit	-	-	-	-	**-**	1	5	-	**6**	**-**
Sat tit?	-	-	-	-	**-**	-	1	-	**1**	**-**
Skip sp.	-	-	1	-	**1**	1	-	-	**1**	**-**
Spe aph	-	1	2	-	**3**	-	7	-	**7**	**-**
Spe cyb	1	-	1	-	**2**	-	-	-	**-**	**-**
Spe ida	-	8	28	15	**51**	4	28	9	**41**	**9**
Spe sp.	-	3	12	3	**18**	-	-	-	**-**	**3**
Str mel	-	-	-		**-**	-	1	-	**1**	**-**
Van ata	-	-	1	1	**2**	-	-	-	**-**	**-**
Totals	24	63	142	60	**289**	67	104	66	**237**	**110**

01 Jul 2003 (9:15 a.m. – 12:25 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: good

08 Jul 2003 (west half only) (1:55 – 3:35 p.m.)
Quantitative survey (partial due to conditions)
Surveyors: Jerry & Bryan
Weather: fair-poor (**Sultry/Mosquitoes!**)

18 Jul 2003 (10:10 – 11:35 a.m.; 11:45 a.m. – 1:00 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: good

28 Jul 2003 (11:45 – 5:30 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Bryan (1st part); Jerry & Bryan (last part)
Weather: relatively good

17 Jul 2004 (3:15 – 9:00 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: fair-good most; poor late

22 Jul 2004 (1:05 – 3:15 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: fair early; fair-poor late

04 Aug 2004 (1st half) (5:30 – 8:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good early; fair-poor late

05 Aug 2004 (2nd half) (12:25 – 5:15 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: good

11 Jul 2005 (9:40 a.m. – 12:37 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: fair-good most

Appendix 2, Table 5. Quantitative butterfly survey results for Glacial Lakes State Park – Transect #3.

	T3 (2003)					T3 (2004)				T3 (2005)
Degree-days	501	597	638	913		581	649	765-800		582
Name	28 Jun	6 Jul	10 Jul	4 Aug	**Total**	13 Jul	19 Jul	31Jul-3Aug	**Total**	06 Jul
Blue sp.	-	-	1	16	**17**	-	1	-	**1**	**-**
Bol bel	-	-	-	-	-	-	-	-	**-**	**2**
Cer peg	-	71	51	4	**126**	57	159	31 (21/2/8)	**247**	**431**
Col sp.	1	3	1	2	**7**	-	3	-	**3**	**10**
Dan ple	1	3	3	5	**12**	-	3	8 (7/0/1)	**11**	**5**
Eup cla	1	1	2	-	**4**	1	4	7 (7/0/0)	**12**	**22**
Hes dac	10	4	2	-	**16**	8	1	1 (1/0/0)	**10**	**7**
Hes dac?	-	-	-	-	-	1	-	-	**1**	**-**
Oar pow	1	1	-	-	**2**	-	-	-	**-**	**-**
Phy tha	-	1	1	-	**2**	-	-	-	**-**	**-**
Phy tha?	-	-	-	-	-	-	-	-	**-**	**2**
Ple mel	4	1	-	8	**13**	-	6	37 (23/12/2)	**43**	**1**
Ple mel?	-	-	-	-	-	-	1	-	**1**	**-**
Pol mys	-	-	1	-	**1**	2	-	-	**2**	**-**
Pol the	-	-	-	-	-	4	2	1 (1/0/0)	**7**	**2**
Pol the?	-	-	-	-	-	-	2	-	**2**	**-**
Pyr com	-	-	-	-	-	-	1	-	**1**	**-**
Sat eur	-	-	-	-	-	-	1	-	**1**	**1**
Sat tit	-	-	-	-	-	-	3	-	**3**	**2**
Skip sp.	-	1	-	-	**1**	2	2	-	**4**	**2**
Spe aph	-	-	-	-	-	-	-	3 (3/0/0)	**3**	**-**
Spe ida	-	4	2	19	**25**	2	7	7 (7/0/0)	**16**	**5**
Spe sp.	-	-	-	1	**1**	-	-	-	**-**	**1**
Van car	-	-	-	-	-	-	-	-	**-**	**1**
Van vir	-	-	-	-	-	-	-	-	**-**	**3**
Totals	17	89	64	55	**225**	77	196	95 (70/14/11)	**368**	**497**

28 Jun 2003 (1:15 – 9:30 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good most; poor late (T3e-north)

06 Jul 2003 (1:35 – 6:55 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: good most; fair-good late

10 Jul 2003 (11:10 a.m. – 2:10 a.m.)
Quantitative survey (T3e-north rained out)
Surveyors: Jerry & Bryan
Weather: fair (T3e-south); poor (remainder)

04 Aug 2003 (time not recorded)
Quantitative butterfly/vegetation survey
Surveyors: Bryan
Weather: not recorded

13 Jul 2004 (1:00 – 6:00 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: good most

19 Jul 2004 (2:30 – 6:15 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good

31 Jul 2004 (east) (9:45 a.m. – 2:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good most; fair-poor early & late

02 Aug 2004 (west-1st part) (6:20 – 8:40 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: good

03 Aug 2004 (west-2nd part) (8:45 a.m. – 4:35 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: poor

06 Jul 2005 (12:05 – 6:20 p.m.; breaks 30 min.)
Quantitative survey
Surveyors: Jerry
Weather: good most; good-fair late

Appendix 2, Table 6. Quantitative butterfly survey results for Glacial Lakes State Park – Transect #4.

	T4 (2003)				T4 (2004)				T4 (2005)
Degree-days	715	870	947		601	678	776-778		622
Name	17 Jul	31 Jul	7 Aug	**Total**	15 Jul	21 Jul	1-2 Aug	**Total**	9 Jul
Blue sp.	-	4	5	**9**	-	-	-	**-**	**-**
Bol bel	1	-	-	**1**	-	-	-	**-**	**2**
Cer peg	111	18	2	**131**	175	109	46 (24/22)	**330**	**100**
Col sp.	3	-	-	**3**	-	1	-	**1**	**2**
Dan ple	7	4	1	**12**	-	-	8 (6/2)	**8**	**1**
Eup cla	6	-	-	**6**	2	3	5 (4/1)	**10**	**1**
Hes dac	-	-	-	**-**	2	1	-	**3**	**11**
Ple mel	5	-	2	**7**	-	2	4 (2/2)	**6**	**-**
Pol ori	-	-	-	**-**	1	-	-	**1**	**-**
Pol sp.	-	-	-	**-**	-	1	-	**1**	**-**
Pol the	1	-	-	**1**	5	3	-	**8**	**2**
Sat edw	-	-	-	**-**	1	-	-	**1**	**-**
Sat tit	3	-	-	**3**	2	8	-	**10**	**-**
Skip sp.	-	-	-	**-**	2	1	-	**3**	**3**
Spe aph	-	-	-	**-**	1	8	-	**9**	**-**
Spe ida	23	18	1	**42**	12	55	18 (9/9)	**85**	**6**
Spe sp.	7	-	-	**7**	1	-	-	**1**	**1**
Van ata	-	-	-	**-**	-	-	-	**-**	**1**
Totals	167	44	11	**222**	204	192	81 (45/36)	**477**	**130**

17 Jul 2003 (10:25 a.m. – 12:05 p.m. & 12:50 – 2:10 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: good most; poor late (T3e-north)

31 Jul 2003 (time not recorded)
Quantitative butterfly/vegetation survey
(all but east end of south leg)
Surveyors: Bryan
Weather: not recorded

07 Aug 2003 (time not recorded)
Quantitative butterfly/vegetation survey
(east end of south leg)
Surveyors: Bryan
Weather: not recorded

15 Jul 2004 (9:50 a.m. – 3:10 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: poor-fair early; fair-good late

21 Jul 2004 (10:00 a.m. – 1:45 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good, but hot

01 Aug 2004 (east part of north & south legs) (9:40 a.m. – 2:15 p.m.; 3:15 – 8:15 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good most; fair-poor early & late

02 Aug 2004 (west part) (11:35 a.m. – 5:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good

09 Jul 2005 (1:35 – 5:12 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: good-fair (wind a factor)

Appendix 2, Table 7. Quantitative butterfly survey results for Anderson Pasture – Transect A.

	2003			**2004**					**2005**
Degree-days	610	1033		570	613	663	730-748		608
Name	07 Jul	14 Aug	**Total**	12 Jul	16 Jul	20 Jul	27-29 Jul	**Total**	8 Jul
Ana log	--	--	**--**	--	--	--	--	**--**	**1**
Anc num	--	--	**--**	--	--	1	--	**1**	**--**
Blue sp.	--	--	**--**	--	--	1	1 (1/0/0)	**2**	**--**
Bol bel	12	4	**16**	1	--	--	--	**1**	**18**
Bol bel?	--	--	**--**	--	--	1	--	**1**	**--**
Cat sp.	--	--	**--**	1	--	--	--	**1**	**--**
Cer peg	15	--	**15**	19	2	35	3 (0/2/1)	**59**	**80**
Coe tul	--	--	**--**	--	--	--	--	**--**	**1**
Col sp.	2	3	**5**	--	--	2	2 (0/1/1)	**4**	**16**
Dan ple	--	--	**--**	--	--	1	1 (0/1/0)	**1**	**--**
Eup cla	12	7	**19**	5	--	15	7 (1/1/5)	**27**	**44**
Hes dac	2	-	**2**	3	--	2	--	**5**	**5**
Hes dac?	--	--	**--**	1	--	--	--	**1**	**--**
Hes leo?	--	25	**25**	--	--	--	--	**--**	**--**
Phy tha	--	--	**--**	--	--	--	--	**--**	**3**
Ple mel	1	2	**3**	--	--	3	6 (0/4/2)	**9**	**--**
Ple mel?	--	--	**--**	--	--	1	--	**1**	**--**
Pol mys	--	--	**--**	1	--	--	--	**1**	**--**
Pol ori?	--	--	**--**	--	--	1	--	**1**	**--**
Pol pec	--	--	**--**	--	--	--	--	**--**	**1**
Pol the	3	--	**3**	2	1	2	--	**5**	**5**
Pol the?	--	--	**--**	1	--	--	--	**1**	**--**
Sat eur	1	--	**1**	--	--	--	1 (1/0/0)	**1**	**--**
Sat tit	--	--	**--**	--	--	3	--	**3**	**4**
Skip sp.	1	--	**1**	--	--	--	--	**--**	**6**
Spe aph	--	--	**--**	--	--	7	--	**7**	**--**
Spe ida	5	--	**5**	3	2	6	--	**11**	**7**
Spe sp.	5	--	**5**	--	1	--	--	**1**	**5**
Van ata	1	--	**1**	--	--	--	1 (1/0/0)	**1**	**--**
Total	60	41	**101**	37	6	81	22 (4/9/9)	**146**	**196**

07 Jul 2003 (10:57 a.m. – 2:52 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Bryan
Weather: fair-poor early; fair-good most

14 Aug 2003 (time not recorded)
Quantitative butterfly/vegetation survey
Surveyors: Bryan
Weather: not recorded

12 Jul 2004 (1:40 – 5:30 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: fair early to good late

16 Jul 2004 (10:30 a.m. – 12:25 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good

20 Jul 2004 (10:00 a.m. – 12:10 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good

27 Jul 2004 (1st part) (5:00 – 8:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair early; fair-poor late ((strong winds)

28 Jul 2004 (mid) (12:15 – 3:48 & 5:35 – 8:23 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: poor

29 Jul 2004 (last part) (10:35 a.m. – 1:40 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-poor

08 Jul 2005 (2:20 – 3:55 p.m.; break 15 min.)
Quantitative survey
Surveyors: Jerry
Weather: good-fair (early); fair-poor (late)

Appendix 2, Table 8. Quantitative butterfly survey results for Anderson Pasture – Transect B.

	2003				**2004**					**2005**
Degree-days	583	610	1033		558-570	591	663	748-757		594
Name	5 Jul	7 Jul	14 Aug	**Total**	11-12 Jul	14 Jul	20 Jul	29-30 Jul	**Total**	7 Jul
Ana log	--	--	--	**--**	--	--	--	--	**--**	**1**
Bol bel	3	8	9	**20**	--	--	1	--	**1**	**11**
Cer peg	14	25	1	**40**	11 (4/7)	33	26	8 (8/0)	**78**	**31**
Col sp.	-	2	1	**3**	1 (0/1)	--	--	1 (1/0)	**2**	**11**
Dan ple	1	-	-	**1**	--	--	--	--	**--**	**--**
Eup cla	12	13	3	**28**	4 (0/4)	4	3	9 (8/1)	**20**	**14**
Lyc xan	--	--	--	**--**	--	--	--	1 (1/0)	**1**	**--**
Hes dac	1	-	-	**1**	2 (0/2)	--	--	--	**2**	**--**
Hes dac?	1	-	-	**1**	--	--	--	--	**--**	**--**
Hes leo?	-	-	18	**18**	--	--	--	--	**--**	**--**
Lim art	1	--	--	**1**	--	--	--	--	**--**	**--**
Ple mel	-	-	1	**1**	--	--	2	9 (9/0)	**11**	**--**
Ple mel?	--	--	--	**--**	--	--	--	--	**--**	**1**
Pol pek	-	1	--	**1**	--	--	--	--	**--**	**--**
Pol the	-	3	--	**3**	2 (0/2)	10	3	--	**15**	**1**
Pol the?	--	--	--	**--**	2 (0/2)	--	--	--	**2**	**--**
Sat tit	--	--	--	**--**	--	--	2	--	**2**	**--**
Skip sp.	-	1	--	**1**	4 (1/3)	3	--	--	**7**	**4**
Spe aph	--	--	--	**--**	--	5	1	1 (1/0)	**7**	**1**
Spe ida	9	6	2	**17**	2 (1/1)	10	25	10 (10/0)	**47**	**1**
Spe sp.	-	4	-	**4**	--	--	--	--	**1**	**1**
Van vir	--	--	--	**--**	--	--	--	--	**--**	**1**
Total	60	41		**101**	28 (6/22)	65	64	39 (38/1)	**196**	**78**

05 Jul 2003 (first part) (10:05 a.m. – 3:00 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good

07 Jul 2003 (3:00 – 4:55 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Bryan
Weather: fair-poor early; fair-good most

14 Aug 2003 (time not recorded)
Quantitative butterfly & vegetation survey
Surveyors: Bryan
Weather: not recorded

11 Jul 2004 (last part) (4:15 – 5:25 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good

12 Jul 2004 (first part) (4:40 – 6:50 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: good

14 Jul 2004 (12:10 – 1:55 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: fair-good

20 Jul 2004 (12:25 – 1:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry & Phil
Weather: good

29 Jul 2004 (first part) (2:20 – 7:35 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-poor

30 Jul 2004 (last part) (11:45 a.m. – 1:15 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-poor

07 Jul 2005 (4:45 – 6:30 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: fair-poor (wind and clouds a factor)

Appendix 2, Table 9. Quantitative butterfly survey results for Anderson Pasture – Transect C.

	2003			**2004**					**2005**
Degree-days	646	761		558	591	663	757		594
Name	11 Jul	21 Jul	**Total**	11 Jul	14 Jul	20 Jul	30 Jul	**Total**	7 Jul
Blue sp.	--	--	**--**	--	--	--	1	**1**	**--**
Bol bel	2	1	**3**	--	3	--	--	**3**	**8**
Cer peg	12	16	**28**	5	28	25	11	**69**	**36**
Col sp.	--	--	**--**	--	--	--	--	**--**	**4**
Dan ple	2	2	**4**	--	--	--	1	**1**	**--**
Eup cla	2	1	**3**	--	4	1	3	**8**	**5**
Hes dac	--	1	**1**	--	4	--	--	**4**	**4**
Hes dac?	--	--	**--**	--	--	--	--	**--**	**1**
Pol mys	--	--	**--**	1	2	--	--	**3**	**--**
Pol mys?	--	--	**--**	1	--	--	--	**1**	**--**
Pol pek	1	--	**1**	--	--	--	--	**--**	**--**
Pol the	--	--	**--**	--	11	9	2	**22**	**4**
Sat sp.	1	--	**1**	--	--	--	--	**--**	**--**
Sat tit	--	3	**3**	--	1	3	--	**4**	**--**
Skip sp.	1	2	**3**	1	--	1	1	**3**	**--**
Spe aph	--	1	**1**	--	3	5	1	**9**	**--**
Spe aph?	--	--	**--**	--	--	--	--	**--**	**1**
Spe ida	8	8	**16**	6	17	20	3	**46**	**1**
Spe sp.	--	--	**--**	1	2	--	--	**3**	**3**
Van vir	--	--	**--**	--	1	--	--	**1**	**--**
Total	29	35	**64**	15	76	64	23	**178**	**67**

11 Jul 2003 (first part) (3:08 – 4:28 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: fair-good

21 Jul 2003 (1:12 – 3:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Bryan
Weather: not recorded

11 Jul 2004 (5:35 – 8:20 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good early; fair-poor late

14 Jul 2004 (2:20 – 4:10 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: fair-good

20 Jul 2004 (2:00 – 3:23 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good

30 Jul 2004 (1:30 – 3:15 & 4:05 – 7:57 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-poor

07 Jul 2005 (2:05 – 4:38 p.m.; break 40 min.)
Quantitative survey
Surveyors: Jerry
Weather: good-fair (windy; more overcast late)

Appendix 2, Table 10. Quantitative butterfly survey results for Anderson Pasture – Transect D.

	2003			**2004**					**2005**
Degree-days	559	779		557&581	591	663	719-730		594
Name	03 Jul	23 Jul	**Total**	11&13 Jul	14 Jul	20 Jul	26-27 Jul	**Total**	7 Jul
Bol bel	12	4	**16**	--	1	--	--	**1**	**46**
Cer peg	15	--	**15**	21 (1/20)	47	27	15 (3+12)	**110**	**108**
Coe tul	--	--	**--**	--	--	--	--	**--**	**1**
Col sp.	2	3	**5**	--	--	--	1 (1/0)	**1**	**5**
Dan ple	--	--	**--**	--	--	--	1 (0/1)	**1**	**1**
Eup cla	12	7	**19**	3 (3/0)	3	4	--	**10**	**4**
Hes dac	2	-	**2**	2 (2/0)	1	--	--	**3**	**1**
Hes dac?	--	--	**--**	1 (1/0)	--	--	--	**1**	**--**
Hes leo?	--	25	**25**	--	--	--	--	**--**	**--**
Phy tha	--	--	**--**	--	--	1	--	**1**	**1**
Ple mel	1	2	**3**	--	--	--	--	**--**	**--**
Ple mel?	--	--	**--**	--	--	--	--	**--**	**--**
Pol mys	--	--	**--**	2 (1/1)	1	--	--	**3**	**--**
Pol ori?	--	--	**--**	--	--	--	--	**--**	**--**
Pol the	3	--	**3**	--	2	2	--	**4**	**--**
Pol the?	--	--	**--**	--	--	--	--	**--**	**--**
Sat eur	1	--	**1**	--	--	--	--	**--**	**--**
Sat tit	--	--	**--**	--	3	7	2 (0/2)	**12**	**2**
Sat tit?	--	--	**--**	--	1	--	--	**1**	**--**
Skip sp.	1	--	**1**	1 (1/0)	2	--	--	**3**	**1**
Spe aph	--	--	**--**	--	--	2	1 (0/1)	**3**	**--**
Spe ida	5	--	**5**	--	2	5	8 (4/4)	**15**	**7**
Spe sp.	5	--	**5**	1 (0/1)	--	1	--	**2**	**2**
Van vir	1	--	**1**	--	--	--	1 (0/1)	**1**	**--**
Total	60	41	**101**	31 (9/22)	63	49	29 (8/21)	**172**	**179**

03 Jul 2003 (E&N part) (9:50 a.m. – 12:40 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Bryan
Weather: good

23 Jul 2003 (11:30 a.m. – 2:50 p.m.; break 40 min.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry & Bryan
Weather: fair-good

11 Jul 2004 (last part) (2:00 – 3:20 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good

13 Jul 2004 (first part) (10:40 – 11:55 a.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: fair-good

14 Jul 2004 (4:15 – 5:50 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: fair-good

20 Jul 2004 (3:30 – 4:45 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: good but hot

26 Jul 2004 (last part) (2:35 – 4:35 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good; wind a factor

27 Jul 2004 (first part) (10:30 a.m. – 3:50 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: poor-fair; strong winds a factor

07 Jul 2005 (11:45 a.m. – 1:57 p.m.)
Quantitative survey
Surveyors: Jerry
Weather: good (wind a moderate factor)

Appendix 2, Table 11. Quantitative butterfly survey results for Anderson Pasture – Transect E.

	2003			2004					2005
Degree-days	646	761		558	591	663	719		594
Name	11 Jul	21 Jul	**Total**	11 Jul	14 Jul	20 Jul	26 Jul	**Total**	7 Jul
Cer peg	2	--	**2**	--	2	1	--	**3**	**1**
Col sp.	--	--	**--**	--	--	--	--	**--**	**1**
Dan ple	--	--	**--**	--	--	--	1	**1**	**--**
Eup cla	1	--	**1**	--	--	--	--	**--**	**--**
Hes dac	--	--	**--**	2	--	--	--	**2**	**--**
Pol the	--	--	**--**	1	1	--	--	**2**	**1**
Spe ida	1	--	**1**	1	2	--	--	**3**	**--**
Spe sp.	--	--	**--**	--	1	--	--	**1**	**--**
Total	4	--	**4**	4	6	1	1	**12**	**3**

11 Jul 2003 (first part) (2:37 – 2:52 p.m.)
Quantitative survey
Surveyors: Jerry & Bryan
Weather: fair-good
21 Jul 2003 (11:50 a.m. – 12:15 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry & Bryan
Weather: good

11 Jul 2004 (3:25 – 3:55 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good
14 Jul 2004 (11:35 – 11:50 a.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: fair-good
20 Jul 2004 (4:50 – 5:00 p.m.)
Quantitative survey
Surveyors: Jerry & Phil
Weather: good but hot
26 Jul 2004 (4:45 – 5:35 p.m.)
Quantitative butterfly & vegetation survey
Surveyors: Jerry
Weather: fair-good; windy a factor

07 Jul 2005 (11:20 – 11:35 a.m.)
Quantitative survey
Surveyors: Jerry
Weather: good (wind a moderate factor)

Appendix 2, Table 12. Quantitative butterfly survey results for Fredrickson Pasture and Glacial Lake WPA.

	2003			2004			2005		
	WPA	Fred-S		WPA	Fred-S		WPA	Fred	
Degree-days	656	656		601	634		638	638	
Name	12 Jul	12 Jul	**Total**	15 Jul	18 Jul	**Total**	10 Jul	10 Jul	**Total**
Bol bel	7	1	**8**	2	--	**2**	1	11	**12**
Cer peg	92	14	**106**	73	12	**85**	60	33	**93**
Col sp.	4	2	**6**	--	2	**2**	3	32	**35**
Dan ple	1	1	**2**	--	1	**1**	--	6	**6**
Eup cla	1	1	**2**	--	1	**1**	--	1	**1**
Hes dac	--	--	**--**	--	--	**--**	--	--	**--**
***Hes dac*?**	--	--	**--**	--	--	**--**	--	1	**1**
Oar pow	1	--	**1**	--	--	**--**	--	--	**--**
Phy tha	3	--	**3**	3	--	**3**	1	--	**1**
Phy tha?	--	--	**--**	--	--	**--**	1	--	**1**
Pol mys	1	--	**1**	--	--	**--**	--	--	**--**
Pol the	2	2	**4**	1	--	**1**	1	2	**3**
Pol the?	--	--	**--**	--	--	**--**	--	1	**1**
Sat eur	--	1	**1**	--	--	**--**	--	--	**--**
Sat tit	--	--	**--**	1	--	**1**	--	1	**1**
Skip sp.	--	1	**1**	--	--	**--**	1	2	**3**
Spe aph	--	1	**1**	--	--	**--**	--	--	**--**
Spe cyb	--	--	**--**	1	--	**1**	--	--	**--**
Spe ida	2	18	**20**	1	9	**10**	1	6	**7**
Spe sp.	--	--	**--**	--	--	**--**	1	--	**1**
Van ata	--	1	**1**	--	--	**--**	--	--	**--**
Van car	--	--	**--**	--	--	**--**	--	1	**1**
Van sp.	--	--	**--**	--	1	**1**	--	1	**1**
Total	114	43	**157**	82	26	**108**	70	98	**168**

12 Jul 2003 (11:05 a.m. – 7:30 p.m.)
Quantitative survey (WPA & Fredrickson-south)
Surveyors: Jerry
WPA (11:05 – 11:50 a.m.; 12:40 – 2:15 p.m.)
Weather: fair-good
Fred (11:55 a.m. – 12:30 & 2:20 – 7:05 p.m.)
Weather: good

15 Jul 2004 (WPA) (3:50 – 5:15 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry & Phil
Weather: fair-good

18 Jul 2004 (Fred-south) (3:05 – 8:35 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: fair early & late; fair-good middle

10 Jul 2005 (12:45 – 6:07 p.m.)
Quantitative survey (WPA & Fredrickson)
Surveyors: Jerry
WPA (12:45 – 1:30 & 1:50 – 2:25 p.m.)
Weather: good-fair (wind a factor)
Fred (1:30 – 1:50 & 2:25 – 6:07 p.m.)
Weather: good-fair (wind a factor)

Appendix 2, Table 13. Quantitative (Q) and general (G) butterfly survey results for Rutledge Pasture.

	2003	**2004**					**2005**		
Degree-days	690	649	689				622		
	15 Jul	19 Jul	22 Jul			**2004**	09 Jul		
Name	Q/G	Q	Q	G	**Total**	**Total**	Q	G	**Total**
Blue sp.	**--**	--	--	1	**1**	**1**	--	--	**--**
Bol bel	**--**	--	--	--	**--**	**--**	1	10	**11**
Cer peg	**41**	20	10	22	**32**	**52**	19	34	**53**
Col sp.	**5**	1	--	1	**1**	**2**	7	12	**19**
Cup com	**2**	--	1	--	**1**	**1**	--	--	**--**
Dan ple	**10**	--	--	--	**--**	**--**	2	4	**6**
Eup cla	**3**	--	2	1	**3**	**3**	--	1	**1**
Hes dac	**--**	--	--	--	**--**	**--**	--	--	**--**
***Hes dac*?**	**1**	--	--	--	**--**	**--**	--	--	**--**
Lim art	**--**	1	--	--	**--**	**1**	--	--	**--**
Oar pow	**--**	--	--	--	**--**	**--**	--	--	**--**
Pap pol	**--**	--	--	1	**1**	**1**	--	--	**--**
Phy tha	**1**	--	--	1	**1**	**1**	--	--	**--**
Pol the	**2**	1	--	--	**--**	**1**	--	1	**1**
Pol the?	**--**	--	1	--	**1**	**1**	--	--	**--**
Sat tit	**--**	1	--	--	--	**1**	--	--	**--**
Skip sp.	**--**	--	--	1	**1**	**1**	--	1	**1**
Spe aph	**--**	2	--	1	**1**	**3**	--	--	**--**
Spe ida	**23**	15	7	22	**29**	**44**	2	--	**2**
Spe sp.	**8**	--	1	1	**2**	**2**	--	--	**--**
Van ata	**2**	--	--	--	**--**	**--**	--	--	**--**
Total	**88**	41	22	53	**74**	**115**	31	63	**94**

15 Jul 2003 (10:15 a.m. – 1:15 p.m.)
Quantitative & General survey while laying out route
Surveyors: Jerry & Bryan
Weather: fair early; fair-good late

19 Jul 2004 (Rutl-south) (10:10 a.m. – 1:30 p.m.)
Quantitative survey while placing flags
Surveyors: Jerry
Weather: good

22 Jul 2004 (9:55 – 11:45 p.m.)
Quantitative & General survey (similar to 15 Jul 2003)
Surveyors: Jerry & Phil
Quantitative (Rutl-south) (9:55 – 10:38 a.m.)
Weather: fair-good; cool
General (10:40 – 11:45 a.m.)
Weather: good

09 Jul 2005 (9:10 a.m. – 12:30 p.m.)
Quantitative & General survey (similar to 15 Jul 2003)
Surveyors: Jerry & Phil
Quantitative (Rutl-south) (9:10 – 10:15 a.m.)
Weather: good
General (10:20 a.m. – 12:30 p.m.)
Weather: good

Butterfly Observations per Community Type

Community type abbreviations used in the tables:

D	= Dry Prairie	Sav	= Savanna (scattered trees)
Dm	= Dry-mesic Prairie	Dist	= Nonnative grassland
M	= Mesic Prairie	Dist-dm	= Nonnative grassland (dry-mesic)
Wm	= Wet Meadow	Dist-m	= Nonnative grassland (mesic)

Appendix 2, Table 14. Dakota skipper and selected other butterfly observations at Glacial Lakes State Park per plant community type during two complete sets of transect surveys in 2004.

Units 1-4	**Transect length (km)**			**18.438**	**0.792**	**9.959**	**5.960**	**0.040**	**0.051**	**1.541**	**0.095**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Community Type**						
Name	**Obs**	**Surv**	**Surv**	**Km**	**D**	**Dm**	**M**	**Wm**	**Sav**	**Dist**	**Shrub**
Bol bel	1	2	0.5	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.00
Cer peg	**676**	**2**	**338.5**	**18.33**	**17.68**	**15.82**	**23.07**	**0.00**	**0.00**	**18.81**	**0.00**
Col sp.	7	2	3.5	0.19	0.00	0.30	0.08	0.00	0.00	0.00	0.00
Dan ple	10	2	5.0	0.27	0.67	0.15	0.34	0.00	0.00	0.32	5.24
Eup cla	10	2	5.0	0.27	0.00	050	0.00	0.00	0.00	0.00	0.00
Hes dac	**12**	**2**	**6.0**	**0.33**	**0.63**	**0.45**	**0.17**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	10	2	5.0	0.27	1.89	0.25	0.17	0.00	0.00	0.00	0.00
Pol mys	2	2	1.0	0.05	0.00	0.00	0.17	0.00	0.00	0.00	0.00
Pol the	14	2	7.0	0.38	0.63	0.50	0.17	0.00	0.00	0.32	0.00
Sat tit	22	2	11.0	0.60	0.00	0.40	0.67	0.00	9.78	1.62	0.00
Skip sp.	8	2	4.0	0.22	0.00	0.20	0.34	0.00	0.00	0.00	0.00
Spe aph	18	2	9.0	0.49	0.00	0.20	1.09	0.00	0.00	0.32	0.00
Spe ida	**130**	**2**	**65.0**	**3.53**	**5.05**	**3.61**	**3.78**	**0.00**	**0.00**	**1.62**	**0.00**
All obs.[1]	**934**	**2**	**467.0**	**25.33**	**26.51**	**22.84**	**30.37**	**0.00**	**9.78**	**23.68**	**5.24**

[1]These values in Tables 14-26 include observations for all species observed during the surveys.

Appendix 2, Table 15. Dakota skipper and selected other butterfly observations at Anderson Prairie per plant community type during three complete sets of transect surveys in 2004.

Units A-E	**Transect length (km)**			**10.726**	**4.116**	**5.013**	**1.531**	**0.039**	**0.012**	**0.015**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Community Type**					
Name	**Obs**	**Surv**	**Surv**	**Km**	**D**	**D-m**	**M**	**Wm**	**Sand**	**Dist**
Bol bel	6	3	2.00	0.19	0.08	0.20	0.44	0.00	0.00	0.00
Cer peg	**306**	**3**	**102.00**	**9.51**	**5.75**	**11.17**	**14.37**	**8.47**	**0.00**	**0.00**
Col sp.	5	3	1.67	0.16	0.32	0.07	0.00	0.00	0.00	0.00
Dan ple	1	3	0.33	0.03	0.08	0.00	0.00	0.00	0.00	0.00
Eup cla	46	3	15.33	1.43	1.94	1.40	0.22	0.00	0.00	0.00
Hes dac	**14**	**3**	**4.67**	**0.44**	**0.65**	**0.40**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	5	3	1.67	0.16	0.08	0.27	0.00	0.00	0.00	0.00
Pol mys	8	3	2.67	0.25	0.08	0.07	1.09	8.47	0.00	0.00
Pol the	45	3	15.00	1.40	2.35	0.86	0.65	0.00	0.00	0.00
Sat tit	19	3	6.33	0.59	0.73	0.40	0.87	0.00	0.00	0.00
Skip sp.	12	3	4.00	0.37	0.65	0.20	0.22	0.00	0.00	0.00
Spe aph	23	3	7.67	0.71	0.16	0.80	1.74	0.00	0.00	22.81
Spe ida	**102**	**3**	**34.00**	**3.17**	**2.27**	**4.19**	**2.39**	**0.00**	**0.00**	**0.00**
All obs.	**613**	**3**	**204.33**	**19.05**	**15.87**	**20.41**	**23.07**	**25.40**	**0.00**	**22.81**

Appendix 2, Table 16. Dakota skipper and selected other butterfly observations at Rutledge Prairie per plant community type during two complete sets of transect surveys in 2004.

S Tran	**Transect length (km)**			**1.168**	**0.127**	**0.186**	**0.610**	**0.101**	**0.129**	**0.014**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Community Type**					
Name	**Obs**	**Surv**	**Surv**	**Km**	**D**	**Dm**	**M**	**Dist-dm**	**Dist-m**	**Bare**
Bol bel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cer peg	**30**	**2**	**15.0**	**12.84**	**0.00**	**5.37**	**22.12**	**0.00**	**3.88**	**0.00**
Col sp.	1	2	0.5	0.43	0.00	0.00	0.82	0.00	0.00	0.00
Dan ple	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eup cla	2	2	1.0	0.86	3.93	0.00	0.82	0.00	0.00	0.00
Hes dac	**0**	**2**	**0.0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol mys	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol the	1	2	0.5	0.43	0.00	0.00	0.82	0.00	0.00	0.00
Sat tit	1	2	0.5	0.43	0.00	0.00	0.82	0.00	0.00	0.00
Skip sp.	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spe aph	2	2	1.0	0.86	0.00	0.00	1.64	0.00	0.00	0.00
Spe ida	**22**	**2**	**11.0**	**9.42**	**0.00**	**2.69**	**15.56**	**0.00**	**7.76**	**0.00**
All obs.	**63**	**2**	**31.5**	**26.97**	**3.93**	**8.06**	**44.23**	**0.00**	**19.40**	**0.00**

Appendix 2, Table 17. Dakota skipper and selected other butterfly observations at Glacial Lake WPA and Fredrickson Pasture per plant community type and quality rating during a single transect survey of the WPA and southwest portion of the pasture in 2003.

SW Tran	**Transect length (km)**			**3.478**	**0.683**	**2.794**	**0.093**	**2.950**	**0.434**
					Average Number per Km				
					Community Type		**Community Quality**		
Name	**WPA**	**Fred**	**Total**	**Km**	**Dry**	**Mesic**	**High**	**Mod**	**Poor**
Bol bel	7	1	8	2.30	0.00	2.86	0.00	2.71	0.00
Cer peg	**92**	**14**	**106**	**30.48**	**11.70**	**35.07**	**0.00**	**35.93**	**0.00**
Col sp.	4	2	6	1.73	0.00	2.15	0.00	1.69	2.30
Dan ple	1	1	2	0.58	0.00	0.72	0.00	0.68	0.00
Eup cla	1	1	2	0.58	1.46	0.36	0.00	0.68	0.00
Hes dac	**0**	**0**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Oar pow	**1**	**0**	**1**	**0.29**	**0.00**	**0.36**	**0.00**	**0.34**	**0.00**
Ple mel	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Pol mys	1	0	1	0.29	0.00	0.36	0.00	0.34	0.00
Pol the	2	2	4	1.15	1.46	1.07	0.00	1.36	0.00
Sat tit	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Skip sp.	0	1	1	0.29	0.00	0.36	0.00	0.34	0.00
Spe aph	0	1	1	0.29	1.46	0.00	0.00	0.34	0.00
Spe ida	**2**	**18**	**20**	**5.75**	**7.32**	**5.37**	**10.78**	**5.42**	**6.91**
All obs.	**114**	**46**	**160**	**46.01**	**26.34**	**50.82**	**10.78**	**52.20**	**11.51**

Butterfly Observations per Community Quality Rating
(see also previous table)

Community quality rating abbreviations used in the tables:

H	= High	M/Mod	= Moderate	F-P	= Fair-poor
H-M	= High-moderate	F	= Fair	P	= Poor

Appendix 2, Table 18. Dakota skipper and selected other butterfly observations at Glacial Lakes State Park per plant community quality rating during two complete sets of transect surveys in 2004.

Units 1-4	**Transect length (km)**			**18.438**	**0.162**	**0.033**	**0.893**	**4.644**	**7.452**	**3.416**	**1.838**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Community Quality**						
Name	**Obs**	**Surv**	**Surv**	**Km**	**High**	**H-M**	**Mod**	**M-F**	**Fair**	**F-P**	**Poor**
Bol bel	1	2	0.5	0.03	0.00	0.00	0.00	0.00	0.00	0.10	0.00
Cer peg	**676**	**2**	**338.0**	**18.33**	**0.00**	**107.25**	**17.92**	**17.98**	**16.51**	**22.40**	**19.31**
Col sp.	7	2	3.5	0.19	0.00	0.00	0.56	0.11	0.27	0.15	0.00
Dan ple	10	2	5.0	0.27	0.00	0.00	0.00	0.00	0.40	0.29	0.54
Eup cla	10	2	5.0	0.27	0.00	000	0.00	0.43	0.34	0.15	0.00
Hes dac	**12**	**2**	**6.0**	**0.33**	**0.00**	**0.00**	**1.12**	**0.54**	**0.13**	**0.29**	**0.27**
Ple mel	10	2	5.0	0.27	0.00	0.00	0.56	0.22	0.27	0.29	0.27
Pol mys	2	2	1.0	0.05	0.00	0.00	0.00	0.00	0.13	0.00	0.00
Pol the	14	2	7.0	0.38	0.00	0.00	0.56	0.65	0.27	0.29	0.27
Sat tit	22	2	11.0	0.60	0.00	0.00	0.00	0.54	0.67	0.15	1.63
Skip sp.	8	2	4.0	0.22	0.00	0.00	0.00	0.11	0.40	0.15	0.00
Spe aph	18	2	9.0	0.49	0.00	0.00	0.00	0.86	0.27	0.73	0.27
Spe ida	**130**	**2**	**65.0**	**3.53**	**0.00**	**15.32**	**2.80**	**4.52**	**3.62**	**3.37**	**1.36**
All obs.	**934**	**2**	**467.0**	**25.33**	**0.00**	**122.57**	**24.07**	**26.16**	**23.62**	**28.98**	**24.48**

Appendix 2, Table 19. Dakota skipper and selected other butterfly observations at Anderson Prairie per plant community quality rating during three complete sets of transect surveys in 2004.

Units A-E	**Transect length (km)**			**10.726**	**0.355**	**2.167**	**2.162**	**3.666**	**1.663**	**0.711**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Community Quality**					
Name	**Obs**	**Surv**	**Surv**	**Km**	**H-M**	**Mod**	**M-F**	**Fair**	**F-P**	**Poor**
Bol bel	6	3	2.00	0.19	0.94	0.00	0.00	0.18	0.40	0.47
Cer peg	**306**	**3**	**102.00**	**9.51**	**14.07**	**12.77**	**11.56**	**6.27**	**9.82**	**7.03**
Col sp.	5	3	1.67	0.16	0.00	0.15	0.46	0.09	0.00	0.00
Dan ple	1	3	0.33	0.03	0.00	0.00	0.00	0.00	0.20	0.00
Eup cla	46	3	15.33	1.43	0.94	2.15	1.39	1.45	1.20	0.00
Hes dac	**14**	**3**	**4.67**	**0.44**	**0.00**	**1.38**	**0.62**	**0.09**	**0.00**	**0.00**
Ple mel	5	3	1.67	0.16	0.94	0.00	0.46	0.09	0.00	0.00
Pol mys	8	3	2.67	0.25	0.00	0.31	0.00	0.09	0.60	0.94
Pol the	45	3	15.00	1.40	0.94	1.08	1.85	1.64	1.40	0.00
Sat tit	19	3	6.33	0.59	3.75	0.31	0.62	0.73	0.00	0.47
Skip sp.	12	3	4.00	0.37	0.94	0.46	0.31	0.36	0.40	0.00
Spe aph	23	3	7.67	0.71	0.94	0.77	0.77	0.73	0.60	0.47
Spe ida	**102**	**3**	**34.00**	**3.17**	**2.81**	**1.54**	**3.55**	**4.36**	**2.81**	**1.88**
All obs.	**613**	**3**	**204.33**	**19.05**	**26.26**	**21.84**	**21.89**	**16.55**	**18.24**	**13.13**

Appendix 2, Table 20. Dakota skipper and selected other butterfly observations at Rutledge Prairie per plant community quality rating during two complete sets of transect surveys in 2004.

S Tran	Transect length (km)			1.168	0.151	0.291	0.125	0.086	0.204	0.311
	Total	Num	Avg/	Avg/	Average Number per Km per Community Type					
Name	Obs	Surv	Surv	Km	H-M	Mod	M-F	Fair	F-P	Poor
Bol bel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cer peg	**30**	**2**	**15.0**	**12.84**	**29.87**	**18.90**	**23.99**	**17.53**	**0.00**	**1.61**
Col sp.	1	2	0.5	0.43	0.00	0.00	0.00	5.84	0.00	0.00
Dan ple	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eup cla	2	2	1.0	0.86	0.00	1.72	0.00	0.00	2.45	0.00
Hes dac	**0**	**2**	**0.0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol mys	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol the	1	2	0.5	0.43	0.00	1.72	0.00	0.00	0.00	0.00
Sat tit	1	2	0.5	0.43	3.32	0.00	0.00	0.00	0.00	0.00
Skip sp.	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spe aph	2	2	1.0	0.86	0.00	1.72	4.00	0.00	0.00	0.00
Spe ida	**22**	**2**	**11.0**	**9.42**	**16.59**	**15.46**	**12.00**	**11.69**	**2.45**	**3.21**
All obs.	**63**	**2**	**31.5**	**26.97**	**53.10**	**41.23**	**39.98**	**35.06**	**4.89**	**8.03**

Butterfly Observations per Grazing Intensity Rating

Grazing intensity rating abbreviations used in the tables:

L	= Light	M-H	= Moderate-Heavy	S/Sev	= Severe
L-M	= Light-moderate	H	= Heavy	H-R	= Heavy/Rested
M/Mod	= Moderate	H-S	= Heavy-Severe	S-R	= Severe/Rested

Appendix 2, Table 21. Dakota skipper and selected other butterfly observations at Anderson Prairie per grazing intensity rating during three complete sets of transect surveys in 2004.

Units A-E	Length (km)			10.726	0.095	0.591	2.114	4.042	2.633	0.507	0.136	0.224	0.384
	All	Num	Avg/	Avg/	Average Number per Km per Grazing Intensity								
Name	Obs	Surv	Surv	Km	Light	L-M	Mod	M-H	Heavy	H-S	Sev	H-R	S-R
Bol bel	6	3	2.0	0.19	3.51	0.00	0.32	0.16	0.13	0.00	0.00	0.00	0.00
Cer peg	**306**	**3**	**102.0**	**9.51**	**14.04**	**18.60**	**14.98**	**8.08**	**6.71**	**6.57**	**7.36**	**10.43**	**2.61**
Col sp.	5	3	1.7	0.16	0.00	0.00	0.00	0.16	0.25	0.66	0.00	0.00	0.00
Dan ple	1	3	0.3	0.03	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.87
Eup cla	46	3	15.3	1.43	0.00	2.25	0.95	1.07	2.15	0.00	2.45	1.49	3.47
Hes dac	**14**	**3**	**4.7**	**0.44**	**0.00**	**1.69**	**0.63**	**0.41**	**0.25**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	5	3	1.7	0.16	0.00	0.00	0.16	0.25	0.00	0.66	0.00	0.00	0.00
Pol mys	8	3	2.7	0.25	0.00	0.00	0.63	0.33	0.00	0.00	0.00	0.00	0.00
Pol the	45	3	15.0	1.40	0.00	0.56	1.10	1.07	1.52	5.26	7.36	1.49	0.00
Sat tit	19	3	6.3	0.59	0.00	2.82	0.16	0.66	0.25	1.31	0.00	0.00	0.87
Skip sp.	12	3	4.0	0.37	0.00	0.00	0.47	0.41	0.13	0.66	4.91	0.00	0.00
Spe aph	23	3	7.7	0.71	0.00	1.69	1.10	0.58	0.76	0.00	0.00	0.00	0.00
Spe ida	**102**	**3**	**34.0**	**3.17**	**7.02**	**2.25**	**2.05**	**3.79**	**3.16**	**3.94**	**7.36**	**4.47**	**0.00**
All obs.	**613**	**3**	**204.3**	**19.05**	**28.08**	**30.44**	**23.18**	**17.57**	**15.70**	**19.05**	**29.44**	**19.36**	**11.29**

Appendix 2, Table 22. Dakota skipper and selected other butterfly observations at Rutledge Prairie per grazing intensity rating during two complete sets of transect surveys in 2004.

S Tran	**Transect length (km)**			**1.168**	**0.237**	**0.328**	**0.078**	**0.023**	**0.077**	**0.235**	**0.190**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Grazing Intensity**						
Name	**Obs**	**Surv**	**Surv**	**Km**	**Light**	**L-M**	**Mod**	**M-H**	**Heavy**	**H-S**	**Severe**
Bol bel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cer peg	**30**	**2**	**15.0**	**12.84**	**23.24**	**22.85**	**19.23**	**21.75**	**0.00**	**0.00**	**0.00**
Col sp.	1	2	0.5	0.43	0.00	0.00	0.00	21.75	0.00	0.00	0.00
Dan ple	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eup cla	2	2	1.0	0.86	0.00	1.52	0.00	0.00	0.00	2.12	0.00
Hes dac	**0**	**2**	**0.0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol mys	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pol the	1	2	0.5	0.43	0.00	1.52	0.00	0.00	0.00	0.00	0.00
Sat tit	1	2	0.5	0.43	2.11	0.00	0.00	0.00	0.00	0.00	0.00
Skip sp.	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spe aph	2	2	1.0	0.86	2.11	1.52	0.00	0.00	0.00	0.00	0.00
Spe ida	**22**	**2**	**11.0**	**9.42**	**14.79**	**15.24**	**12.82**	**0.00**	**19.57**	**0.00**	**0.00**
All obs.	**63**	**2**	**31.5**	**26.97**	**46.48**	**42.66**	**32.04**	**43.50**	**26.09**	**4.25**	**0.00**

Appendix 2, Table 23. Dakota skipper and selected other butterfly observations at Glacial Lake WPA and Fredrickson Pasture per grazing intensity rating during a single transect survey of the WPA and southwest portion of the pasture in 2003.

SW Tran	**Transect length (km)**			**3.478**	**1.232**	**1.239**	**0.295**	**0.712**
					Number per Km per Grazing Intensity			
Name	**WPA**	**Fred**	**Total**	**Km**	**None**	**Light**	**Mod**	**Heavy**
Bol bel	7	1	8	2.30	5.68	0.81	0.00	0.00
Cer peg	**92**	**14**	**106**	**30.48**	**74.69**	**6.46**	**16.94**	**1.41**
Col sp.	4	2	6	1.73	3.25	0.00	0.00	2.81
Dan ple	1	1	2	0.58	0.81	0.00	3.39	0.00
Eup cla	1	1	2	0.58	0.81	0.81	0.00	0.00
Hes dac	**0**	**0**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Oar pow	**1**	**0**	**1**	**0.29**	**0.81**	**0.00**	**0.00**	**0.00**
Ple mel	0	0	0	0.00	0.00	0.00	0.00	0.00
Pol mys	1	0	1	0.29	0.81	0.00	0.00	0.00
Pol the	2	2	4	1.15	1.62	0.81	0.00	1.41
Sat tit	0	0	0	0.00	0.00	0.00	0.00	0.00
Skip sp.	0	1	1	0.29	0.00	0.00	0.00	1.41
Spe aph	0	1	1	0.29	0.00	0.81	0.00	0.00
Spe ida	**2**	**18**	**20**	**5.75**	**1.62**	**10.49**	**6.78**	**4.22**
All obs.	**114**	**46**	**160**	**46.01**	**92.55**	**21.79**	**30.49**	**14.05**

Butterfly Observations per Vegetation Height Class

Vegetation height was based on the height of the grassland cover. Where shrubs were dominant, their height was variable (1-3 feet) and the dominant shrub cover (e.g. sumac) is simply noted.

Appendix 2, Table 24. Dakota skipper and selected other butterfly observations at Glacial Lakes State Park per vegetation height category during two complete sets of transect surveys in 2004.

Units 1-4	**Transect length (km)**			**18.438**	**6.052**	**11.986**	**0.329**	**0.071**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Height**			
Name	**Obs**	**Surv**	**Surv**	**Km**	**>12”**	**8-12”**	**4-8”**	**Sumac**
Bol bel	1	2	0.5	0.03	0.00	0.04	0.00	0.00
Cer peg	**676**	**2**	**338.5**	**18.33**	**19.09**	**18.27**	**10.64**	**0.00**
Col sp.	7	2	3.5	0.19	0.00	0.29	0.00	0.00
Dan ple	10	2	5.0	0.27	0.41	0.13	1.52	7.02
Eup cla	10	2	5.0	0.27	0.00	0.42	0.00	0.00
Hes dac	**12**	**2**	**6.0**	**0.33**	**0.25**	**0.38**	**0.00**	**0.00**
Ple mel	10	2	5.0	0.27	0.17	0.25	3.04	0.00
Pol mys	2	2	1.0	0.05	0.00	0.08	0.00	0.00
Pol the	14	2	7.0	0.38	0.25	0.46	0.00	0.00
Sat tit	22	2	11.0	0.60	1.16	0.33	0.00	0.00
Skip sp.	8	2	4.0	0.22	0.33	0.17	0.00	0.00
Spe aph	18	2	9.0	0.49	0.99	0.25	0.00	0.00
Spe ida	**130**	**2**	**65.0**	**3.53**	**2.31**	**4.17**	**3.04**	**0.00**
All obs.	**934**	**2**	**467.0**	**25.33**	**25.36**	**25.61**	**18.25**	**7.02**

Appendix 2, Table 25. Dakota skipper and selected other butterfly observations at Anderson Prairie per vegetation height category during three complete sets of transect surveys in 2004.

Units A-E	**Transect length (km)**			**10.726**	**1.865**	**1.909**	**4.321**	**2.407**	**0.224**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Height**				
Name	**Obs**	**Surv**	**Surv**	**Km**	**>12”**	**8-12”**	**4-8”**	**2-4”**	**0-2”**
Bol bel	6	3	2.00	0.19	0.54	0.00	0.15	0.14	0.00
Cer peg	**306**	**3**	**102.00**	**9.51**	**18.05**	**11.17**	**7.48**	**5.40**	**7.45**
Col sp.	5	3	1.67	0.16	0.00	0.00	0.15	0.42	0.00
Dan ple	1	3	0.33	0.03	0.00	0.00	0.00	0.14	0.00
Eup cla	46	3	15.33	1.43	1.07	1.05	1.70	1.52	1.49
Hes dac	**14**	**3**	**4.67**	**0.44**	**0.36**	**0.87**	**0.54**	**0.00**	**0.00**
Ple mel	5	3	1.67	0.16	0.18	0.17	0.15	0.14	0.00
Pol mys	8	3	2.67	0.25	0.71	0.35	0.15	0.00	0.00
Pol the	45	3	15.00	1.40	0.54	1.22	1.39	1.52	8.94
Sat tit	19	3	6.33	0.59	1.07	0.17	0.77	0.28	0.00
Skip sp.	12	3	4.00	0.37	0.18	0.70	0.15	0.42	2.98
Spe aph	23	3	7.67	0.71	1.25	1.22	0.62	0.14	0.00
Spe ida	**102**	**3**	**34.00**	**3.17**	**2.68**	**3.14**	**3.55**	**2.63**	**5.96**
All obs.	**613**	**3**	**204.33**	**19.05**	**27.52**	**20.78**	**17.20**	**13.71**	**26.83**

Appendix 2, Table 26. Dakota skipper and selected other butterfly observations at Rutledge Prairie per vegetation height category during two complete sets of transect surveys in 2004.

S Tran	**Transect length (km)**			**1.168**	**0.524**	**0.121**	**0.058**	**0.241**	**0.225**
	Total	**Num**	**Avg/**	**Avg/**	**Average Number per Km per Height**				
Name	**Obs**	**Surv**	**Surv**	**Km**	**>12"**	**8-12"**	**4-8"**	**2-4"**	**0-2"**
Bol bel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Cer peg	**30**	**2**	**15.0**	**12.84**	**25.78**	**12.35**	**0.00**	**0.00**	**0.00**
Col sp.	1	2	0.5	0.43	0.00	0.00	8.65	0.00	0.00
Dan ple	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Eup cla	2	2	1.0	0.86	0.95	0.00	0.00	2.08	0.00
Hes dac	**0**	**2**	**0.0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Ple mel	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Pol mys	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Pol the	1	2	0.5	0.43	0.95	0.00	0.00	0.00	0.00
Sat tit	1	2	0.5	0.43	0.95	0.00	0.00	0.00	0.00
Skip sp.	0	2	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Spe aph	2	2	1.0	0.86	1.91	0.00	0.00	0.00	0.00
Spe ida	**22**	**2**	**11.0**	**9.42**	**17.19**	**4.12**	**17.31**	**2.08**	**0.00**
All obs.	**63**	**2**	**31.5**	**26.97**	**49.66**	**16.47**	**34.61**	**6.23**	**0.00**

All Butterfly Observations per Survey Route

(see tables below)

Appendix 2, Table 27. All 2003 butterfly observations for grazing study sites per survey route for general and quantitative surveys.

	Glacial Lakes SP					Anderson Pasture						Fredrickson/WPA			Rutledge	2003
Binomial	**1**	**2**	**3**	**4**	**Total**	**A**	**B**	**C**	**D**	**E**	**Total**	**Fred**	**WPA**	**Total**	**Pasture**	**Total**
Ancyloxypha numitor	--	--	--	--	**--**	1	--	--	--	--	**1**	--	--	**--**	**--**	**1**
Atalopedes campestris	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Atrytonopsis hianna	2	--	--	--	**2**	--	--	--	--	--	**--**	--	--	**--**	**1**	**3**
Blue species	2	--	19	9	**30**	--	--	--	--	--	**--**	2	--	**2**	**--**	**32**
Boloria bellona	1	1	2	1	**5**	19	23	7	4	--	**53**	12	7	**19**	**--**	**77**
Carterocephalus palaemon	--	1	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Celastrina ladon neglecta	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Cercyonis pegala	127	140	212	131	**610**	19	40	37	24	3	**123**	33	117	**150**	**41**	**924**
Coenonympha tullia	6	3	--	--	**9**	1	--	--	1	--	**2**	--	--	**--**	**--**	**11**
Colias sp.	5	10	11	3	**29**	6	4	--	--	--	**10**	29	7	**36**	**5**	**80**
Cupido comyntas	--	--	--	--	**--**	--	--	--	1	--	**1**	--	--	**--**	**2**	**3**
Danaus plexippus	5	46	26	12	**89**	--	1	10	6	1	**18**	15	3	**18**	**10**	**135**
Echinargus isola	--	--	1	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Enodia anthedon	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Euptoieta claudia	6	9	8	6	**29**	21	31	9	7	1	**69**	10	2	**12**	**3**	**113**
Glaucopsyche lygdamus	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Hesperia dacotae	1	--	33	--	**34**	4	3	1	10	1	**19**	1	--	**1**	**--**	**54**
Hesperia dacotae?	--	--	2	--	**2**	--	1	--	1	--	**2**	--	--	**--**	**1**	**5**
Hesperia leonardus pawnee?	2	--	--	--	**2**	25	18	--	--	--	**43**	3	--	**3**	**--**	**48**
Limenitis arthemis arthemis	2	--	--	--	**2**	--	1	--	--	--	**1**	--	--	**--**	**--**	**3**
Oarisma poweshiek	--	--	3	--	**3**	--	--	--	--	--	**--**	--	1	**1**	**--**	**4**
Papilio polyxenes	--	--	--	1	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Phyciodes tharos	1	--	2	--	**3**	--	--	--	--	--	**--**	--	4	**4**	**1**	**8**
Plebejus melissa	--	3	30	7	**40**	3	1	--	8	--	**12**	6	1	**7**	**--**	**59**
Polites mystic	--	2	4	--	**6**	1	--	2	1	--	**4**	--	1	**1**	**--**	**11**
Polites peckius	--	--	--	--	**--**	--	1	2	1	--	**4**	--	--	**--**	**--**	**4**
Polites themistocles	--	2	1	1	**4**	6	5	6	3	1	**21**	3	2	**5**	**2**	**32**
Satyrium calanus?	2	1	--	--	**3**	--	--	1	--	--	**1**	--	--	**--**	**--**	**4**
Satyrium liparops	--	1	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Satyrium titus	--	1	3	3	**7**	--	--	3	4	1	**8**	--	--	**--**	**--**	**15**
Satyrodes eurydice	--	2	--	--	**2**	1	--	--	--	--	**1**	1	1	**2**	**--**	**5**
Skipper species	--	1	8	--	**9**	1	1	4	--	--	**6**	1	--	**1**	**--**	**16**
Speyeria aphrodite	--	3	2	--	**5**	--	--	1	1	1	**3**	1	--	**1**	**--**	**9**
Speyeria cybele	--	2	--	--	**2**	--	--	--	--	--	**--**	--	--	--	**--**	**2**
Speyeria idalia	28	51	48	42	**169**	7	23	24	29	5	**88**	28	13	**41**	**23**	**321**
Speyeria sp.	5	18	6	7	**36**	5	4	2	6	--	**17**	3	--	**3**	**8**	**64**
Vanessa atalanta	--	2	--	--	**2**	1	1	--	1	--	**3**	2	--	**2**	**3**	**10**
Vanessa cardui	--	--	1	--	**1**	--	--	--	--	--	**--**	2	--	**2**	**--**	**3**
Vanessa sp.	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Vanessa virginiensis	--	--	--	--	**--**	--	--	--	--	--	**--**	1	--	**1**	**--**	**1**
Totals	200	299	422	223	**1144**	121	158	109	108	14	**510**	153	159	**312**	**100**	**2066**

Appendix 2, Table 28. All 2004 butterfly observations for grazing study sites per survey route for general and quantitative surveys.

	Glacial Lakes SP					Anderson Pasture						Fredrickson/WPA			Rutledge	2004
BinomialCode	**1**	**2**	**3**	**4**	**Total**	**A**	**B**	**C**	**D**	**E**	**Total**	**Fred**	**WPA**	**Total**	**Pasture**	**Total**
Ancyloxypha numitor	--	--	--	--	--	1	--	--	--	--	**1**	--	--	--	--	**1**
Blue species	--	--	1	--	**1**	3	--	1	--	--	**4**	--	--	--	**1**	**6**
Boloria bellona	--	1	--	--	**1**	1	1	3	1	--	**6**	--	2	**2**	--	**9**
Boloria bellona?	--	--	--	--	--	1	--	--	--	--	**1**	--	--	--	--	**1**
Celastrina ladon neglecta	--	2	--	--	**2**	--	--	--	--	--	--	--	--	--	--	**2**
Cercyonis pegala	78	148	250	332	**808**	90	78	69	161	3	**401**	18	73	**91**	**52**	**1352**
Colias sp.	6	6	3	2	**17**	6	2	--	1	--	**9**	2	--	**2**	**2**	**30**
Cupido comyntas	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1**	**1**
Danaus plexippus	3	19	12	9	**43**	2	--	1	1	1	**5**	1	--	**1**	--	**49**
Euptoieta claudia	--	--	12	10	**22**	33	20	8	23	--	**84**	2	--	**2**	**3**	**111**
Hesperia dacotae	--	--	12	3	**15**	6	5	4	10	2	**27**	--	--	--	--	**42**
Hesperia dacotae?	--	--	2	--	**2**	1	--	--	2	--	**3**	--	--	--	--	**5**
Limenitis arthemis arthemis	--	1	--	--	**1**	--	--	--	--	--	--	--	--	--	**1**	**2**
Lycaena xanthoides	--	--	--	--	--	--	1	--	--	--	**1**	--	--	--	--	**1**
Papilio polyxenes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1**	**1**
Phyciodes tharos	--	1	1	1	**3**	--	--	--	1	--	**1**	--	3	**3**	**1**	**8**
Plebejus melissa melissa	1	3	44	6	**54**	11	11	--	1	--	**23**	--	--	--	--	**77**
Plebejus melissa melissa?	--	--	1	--	**1**	1	--	--	--	--	**1**	--	--	--	--	**2**
Polites mystic	--	--	2	--	**2**	2	--	3	6	--	**11**	--	--	--	--	**13**
Polites mystic?	--	--	--	--	--	--	--	1	--	--	**1**	--	--	--	--	**1**
Polite origenes	--	--	--	1	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Polite origenes?	--	--	--	--	--	1	--	--	--	--	**1**	--	--	--	--	**1**
Polite sp.	--	--	--	1	**1**	1	--	--	--	--	**1**	--	--	--	--	**2**
Polites themistocles	1	--	8	11	**20**	5	17	26	9	4	**61**	--	1	**1**	**1**	**83**
Polites themistocles?	--	--	2	1	**3**	1	2	--	--	--	**3**	--	--	--	**1**	**7**
Pyrgus communis	--	--	1	--	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Satyrium edwardsii	--	--	--	1	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Satyrium edwardsii?	1	--	--	--	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Satyrium titus	3	6	3	13	**25**	4	3	5	19	--	**31**	1	1	**2**	**1**	**59**
Satyrium titus?	--	1	--	--	**1**	--	--	--	1	--	**1**	--	--	--	--	**2**
Satyrodes eurydice	--	--	1	--	**1**	1	--	--	--	--	**1**	--	--	--	--	**2**
Skipper species	--	1	4	3	**8**	1	7	4	4	--	**16**	--	--	--	**1**	**25**
Speyeria aphrodite	2	7	3	9	**21**	9	7	10	7	--	**33**	1	--	**1**	**3**	**58**
Speyeria cybele	--	--	--	--	--	--	--	--	--	--	--	--	1	**1**	--	**1**
Speyeria idalia	31	41	16	87	**175**	14	48	49	36	3	**150**	16	4	**20**	**44**	**389**
Speyeria sp.	2	--	--	1	**3**	--	1	4	3	1	**9**	--	--	--	**2**	**14**
Strymon melinus	--	1	--	--	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Vanessa atalanta	--	--	--	1	**1**	--	--	--	--	--	--	--	--	--	--	**1**
Vanessa sp.	--	--	--	--	--	1	--	--	--	--	**1**	1	--	**1**	--	**2**
Vanessa virginiensis	--	--	--	--	--	--	--	1	1	--	**2**	--	--	--	--	**2**
Totals	128	238	378	492	**1236**	196	203	189	287	14	**889**	42	85	**127**	**115**	**2367**

Appendix 2, Table 29. All 2005 butterfly observations for grazing study sites per survey route for general and quantitative surveys.

	Glacial Lakes SP					Anderson Pasture						Fredrickson/WPA			Rutledge	2005
Binomial	**1**	**2**	**3**	**4**	**Total**	**A**	**B**	**C**	**D**	**E**	**Total**	**Fred**	**WPA**	**Total**	**Pasture**	**Total**
Anatrytone logan	--	--	--	--	**--**	1	1	--	--	--	**2**	--	--	**--**	**--**	**2**
Blue species	--	1	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Boloria bellona	5	--	2	2	**9**	19	11	8	47	--	**85**	11	1	**12**	**11**	**117**
Cercyonis pegala	123	78	475	100	**776**	80	31	36	109	1	**257**	33	60	**93**	**53**	**1179**
Coenonympha tullia	--	--	1	--	**1**	1	--	--	1	--	**2**	--	--	**--**	**--**	**3**
Colias sp.	9	7	17	2	**35**	16	11	4	6	1	**38**	32	3	**35**	**19**	**127**
Danaus plexippus	5	8	17	1	**31**	1	--	--	2	--	**3**	6	--	**6**	**6**	**46**
Euptoieta claudia	2	3	25	1	**31**	44	14	5	4	1	**68**	1	--	**1**	**1**	**101**
Euptoieta claudia?	1	--	--	0	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Hesperia dacotae	--	--	11	11	**22**	5	1	5	4	1	**16**	--	--	**--**	**--**	**38**
Hesperia dacotae?	--	--	1	--	**1**	--	--	1	--	--	**1**	1	--	**1**	**--**	**3**
Limenitis archippus	--	--	1	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Limenitis arthemis arthemis	--	2	--	--	**2**	--	--	--	--	--	**--**	--	--	**--**	**--**	**2**
Nymphalis antiopa?	1	--	--	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Phyciodes tharos	--	--	--	--	**--**	3	--	--	1	--	**4**	--	1	**1**	--	**5**
Phyciodes tharos?	--	--	2	--	**2**	--	--	--	--	--	**--**	--	1	**1**	**--**	**3**
Plebejus melissa melissa	--	--	10	--	**10**	--	--	--	1	--	**1**	--	--	**--**	**--**	**11**
Plebejus melissa melissa?	--	--	--	--	**--**	--	1	--	--	--	**1**	--	--	**--**	**--**	**1**
Polites mystic	--	--	3	--	**3**	--	--	--	--	--	**--**	--	--	**--**	**--**	**3**
Polites peckius	--	--	--	--	**--**	1	--	--	--	--	**1**	--	--	**--**	**--**	**1**
Polites themistocles	--	--	2	2	**4**	5	1	4	1	1	**12**	2	1	**3**	**1**	**20**
Polites themistocles?	--	--	--	--	**--**	--	--	--	--	--	**--**	1	--	**1**	**--**	**1**
Satyrium titus	1	--	3	--	**4**	4	--	--	2	--	**6**	1	--	**1**	**--**	**11**
Satyrodes eurydice	--	--	1	--	**1**	--	--	--	--	--	**--**	--	--	**--**	**--**	**1**
Skipper species	--	--	4	3	**7**	6	4	--	2	1	**13**	2	1	**3**	**1**	**24**
Speyeria aphrodite	1	--	--	--	**1**	--	1	--	--	--	**1**	--	--	**--**	**--**	**2**
Speyeria Aphrodite?	--	--	--	--	**--**	--	--	1	--	--	**1**	--	--	**--**	**--**	**1**
Speyeria idalia	7	9	14	6	**36**	9	1	1	7	1	**19**	6	1	**7**	**2**	**64**
Speyeria sp.	3	3	1	1	**8**	5	1	3	3	--	**12**	--	1	**1**	**--**	**21**
Vanessa atalanta	1	--	--	1	**2**	--	--	--	--	--	**--**	--	--	**--**	**--**	**2**
Vanessa cardui	--	--	2	--	**2**	1	--	--	--	--	**1**	1	--	**1**	**--**	**4**
Vanessa sp.	--	--	--	--	**--**	--	--	1	--	--	**1**	1	--	**1**	**--**	**2**
Vanessa virginiensis	--	--	3	--	**3**	1	1	--	--	--	**2**	--	--	**--**	**--**	**5**
Totals	159	111	595	130	**995**	202	79	69	190	7	**547**	98	70	**168**	**94**	**1804**

APPENDIX 3

Tables: Dakota Skipper Grazing Study Vegetation and Management Data

Appendix 3, Table 1. Classification criteria used to define plant community types and MN Natural Heritage Program community type equivalents (Aaseng et al. 1993).

Type	MN NHP Equivalents and Classification Criteria
Dry Prairie	**Dry Prairie (Central Section) Sand-gravel Subtype**. Dominated by a mix of short-grass (e.g. blue and hairy grama) and mid-grass (e.g. little bluestem, prairie dropseed, sideoats grama).
Dry-mesic Prairie	**Dry Prairie (Central Section) Hill Subtype** and drier phases of **Mesic Prairie (Central Section)**. Prairie dominated by mid-grass species.
Mesic Prairie	**Mesic Prairie (Central Section)**. Dominated by tallgrass (e.g. big bluestem, Indian grass), but with a significant mid-grass component.
Wet-mesic Prairie	Wetter phases of **Mesic Prairie (Central Section)**. Prairie dominated by tallgrass (e.g. big bluestem, Indian grass) and to a lesser extent wet prairie species such as sloughgrass.
Wet Meadow	**Wet Meadow**. Dominated by wide-leaved sedges and some grasses.
Savanna	**Dry Oak Savanna (Central Section) Sand-gravel Subtype**. Prairie with an overstory of scattered open-grown oaks.
Nonnative	Grassland dominated by nonnative species (e.g. brome, bluegrass).
Woody (shrubs)	Grassland dominated by solid patches of woody vegetation (e.g. sumac, western snowberry).
Bare Ground	Sparse to no vegetation (e.g. heavily used areas around watering holes).

Appendix 3, Table 2. Classification criteria used to define plant community types and MN Natural Heritage Program community type equivalents (Aaseng et al. 1993).

Ranking[1]	Criteria
High	Relatively undisturbed; dominated by a diverse mix of native species; insignificant weedy and cool season component
Moderate	Moderately disturbed; moderate native diversity; moderate weedy and cool season component
Fair	Highly disturbed; low native diversity; high weedy and cool season component
Poor	Severely disturbed to nonnative; very low native diversity; dominated by weedy and cool season component

[1]If the community quality appeared to fall between the above categories, intermediate categories were used (e.g. high-moderate, moderate-fair, fair-poor).

Appendix 3, Table 3. Criteria used to define vegetation height and grazing intensity rankings.

Vegetation Height Categories

Vegetation height categories were based on the overall height of the herbaceous vegetation. Heights were recorded prior to the flowering of warm season grasses and were based on the vegetative portions of the grasses. The height of sumac patches was also noted, but these are simply presented as "sumac" in the data tables. Height categories for grassland vegetation included the following: >12", 8-12", 4-8", 2-4", 0-2".

Grazing Intensity Ranking Criteria

Intensity[1]	Height[2]	Apparent grazing impact
Ungrazed	Variable	Depending on community type and historic land use
Light	8-12"	Very little evidence of disturbance from grazing impact
Moderate	4-8"	Moderate evidence of disturbance from grazing impact
Heavy	2-4"	Heavy evidence of disturbance from grazing impact
Severe	0-2"	Severe evidence of disturbance from grazing impact
Heavy/Rest	Horse pasture with heavy grazing intensity in 2003, but rested in 2004-2005	
Severe/Rest	Horse pasture with severe grazing intensity in 2003, but rested in 2004-2005	

[1]If the grazing intensity appeared to fall between these categories, intermediate categories were used (e.g. light-moderate, moderate-heavy, heavy-severe).

[2]Vegetation height per grazing intensity rating varied. Taller community types were assigned a higher intensity rating for a given vegetation height if it was justified by the apparent grazing impact.

Appendix 3, Table 4. Plant community type data per survey route in 2004 for Glacial Lakes State Park.

Comm Type	Length (meters) per Transect					Percent Length per Transect				
	1	2	3	4	All	1	2	3	4	All
Dry	77	115	506	94	792	2	3	9	2	4
Dry-mesic	1,838	2,153	3,207	2,761	9,959	55	54	55	52	54
Mesic	1,119	1,314	1,621	1,905	5,940	34	33	28	36	32
Wet-mesic	0	0	0	40	40	0	0	0	1	<1
Savanna	51	0	0	0	51	2	0	0	0	<1
Nonnative	142	379	530	490	1,541	4	10	9	9	8
Woody	85	10	0	0	95	3	<1	0	0	<1
Road	12	0	0	0	12	<1	0	0	0	~0
Total	3,324	3,971	5,864	5,291	18,450	100	100	100	100	100
% Total	18	22	32	29	100					

Appendix 3, Table 5. Plant community quality data per survey route in 2004 for Glacial Lakes State Park.

Comm Quality	Length (meters) per Transect					Percent Length per Transect				
	1	2	3	4	All	1	2	3	4	All
High	0	0	162	0	162	0	0	3	0	1
High- Mod	0	0	33	0	33	0	0	<1	0	<1
Moderate	392	0	501	0	893	12	0	9	0	5
Mod- Fair	913	216	1,477	2,039	4,644	27	5	25	39	25
Fair	1,373	2,323	2,032	1,724	7,452	41	58	35	33	40
Fair- Poor	376	988	1,002	1,051	3,416	11	25	17	20	19
Poor	260	445	657	476	1,838	8	11	11	9	10
NA	12	0	0	0	12	<1	0	0	0	~0
Total	3,324	3,971	5,864	5,291	18,450	100	100	100	100	100

Appendix 3, Table 6. Vegetation height data per survey route in 2004 for Glacial Lakes State Park.

Veg Height	Length (meters) per Transect					Percent Length per Transect				
	1	2	3	4	All	1	2	3	4	All
>12	1,329	1,664	1,716	1,343	6,052	40	42	29	25	33
08-12	1,836	2,192	4,093	3,866	11,986	55	55	70	73	65
04-08	77	115	55	82	329	2	3	1	2	2
Sumac	71	0	0	0	71	2	0	0	0	<1
NA	12	0	0	0	12	<1	0	0	0	~1
Total	3,324	3,971	5,864	5,291	18,450	100	100	100	100	100

Appendix 3, Table 7. Plant community type data per survey route in 2004 for Anderson Pasture.

Comm	Length (meters) per Transect						Percent Length per Transect					
Type	A	B	C	D	E	All	A	B	C	D	E	All
Dry	1,487	1,269	554	564	241	4,116	44	53	25	23	84	38
Dry-mesic	1,517	966	1,279	1,203	47	5,013	45	40	58	50	16	47
Mesic	353	165	358	655	0	1,531	10	7	16	27	0	14
Sedge Meadow	39	0	0	0	0	39	1	0	0	0	0	<1
Sand	12	0	0	0	0	12	<1	0	0	0	0	<1
Nonnative	0	0	15	0	0	15	0	0	1	0	0	<1
Total	3,409	2,400	2,206	2,423	288	10,726	100	100	100	100	100	100
% Total	32	22	21	23	3	100						

Appendix 3, Table 8. Plant community quality data per survey route in 2004 for Anderson Pasture.

Comm	Length (meters) per Transect						Percent Length per Transect					
Quality	A	B	C	D	E	All	A	B	C	D	E	All
High-Mod	25	0	0	330	0	355	1	0	0	14	0	3
Moderate	538	55	125	1,315	134	2,167	16	2	6	54	47	20
Mod-Fair	902	559	393	308	0	2,162	26	23	18	13	0	20
Fair	1,139	1,217	1,112	90	109	3,666	33	51	50	4	38	34
Fair-Poor	646	446	408	148	15	1,663	19	19	18	6	5	16
Poor	157	123	168	232	30	711	5	5	8	10	10	7
Total	3,409	2,400	2,206	2,423	288	10,726	100	100	100	100	100	100

Appendix 3, Table 9. Grazing intensity data per survey route in 2004 for Anderson Pasture.

Grazing	Length (meters) per Transect						Percent Length per Transect					
Intensity	A	B	C	D	E	All	A	B	C	D	E	All
Light	17	0	0	78	0	95	<1	0	0	3	0	1
Light-Mod	31	0	32	529	0	591	1	0	1	22	0	6
Moderate	296	204	226	1,242	146	2,114	9	9	10	51	51	20
Mod-Heavy	1,309	1,004	1,027	574	127	4,042	38	42	47	24	44	38
Heavy	1,061	816	741	0	15	2,633	31	34	34	0	5	25
Heavy-Sev	66	261	181	0	0	507	2	11	8	0	0	5
Severe	22	114	0	0	0	136	<1	5	0	0	0	1
Heavy/Rest	224	0	0	0	0	224	7	0	0	0	0	2
Severe/Rest	384	0	0	0	0	384	11	0	0	0	0	4
Total	3,409	2,400	2,206	2,423	288	10,726	100	100	100	100	100	100

Appendix 3, Table 10. Vegetation height data per survey route in 2004 for Anderson Pasture.

Veg	Length (meters) per Transect						Percent Length per Transect					
Height	A	B	C	D	E	All	A	B	C	D	E	All
>12	253	135	126	1,316	34	1,865	7	6	6	54	12	17
08-12	655	337	305	547	65	1,909	19	14	14	23	22	18
04-08	1,571	936	1,095	560	159	4,321	46	39	50	23	55	40
02-04	917	848	642	0	0	2,407	27	35	29	0	0	22
00-02	12	143	38	0	30	224	<1	6	2	0	10	2
Total	3,409	2,400	2,206	2,423	288	10,726	100	100	100	100	100	100

Appendix 3, Table 11. Plant community type data (left) and plant community quality data (right) per survey route in 2004 for Rutledge Pasture.

Comm Type	Length (meters)	Length (percent)
Dry	127	11
Dry-mesic	186	16
Mesic	610	52
Nonnative (dm)	101	9
Nonnative (m)	129	11
Bare Soil	14	1
Total	1,168	100

Comm Quality	Length (meters)	Length (percent)
High-Mod	151	13
Moderate	291	25
Mod-Fair	125	11
Fair	86	7
Fair-Poor	204	17
Poor	311	27
Total	1,168	100

Appendix 3, Table 12. Grazing intensity data (left) and vegetation height data (right) per survey route in 2004 for Rutledge Pasture.

Grazing Intensity	Length (meters)	Length (percent)
Light	237	20
Light-Mod	328	28
Moderate	78	7
Mod-Heavy	23	2
Heavy	77	7
Heavy-Severe	235	20
Severe	190	16
Total	1,168	100

Veg Height	Length (meters)	Length (percent)
>12	524	45
08-12	121	10
04-08	58	5
02-04	241	21
00-02	225	19
Total	1,168	100

Appendix 3, Table 13. Nectar plant data per survey route in 2003 and 2004 for Glacial Lakes State Park.

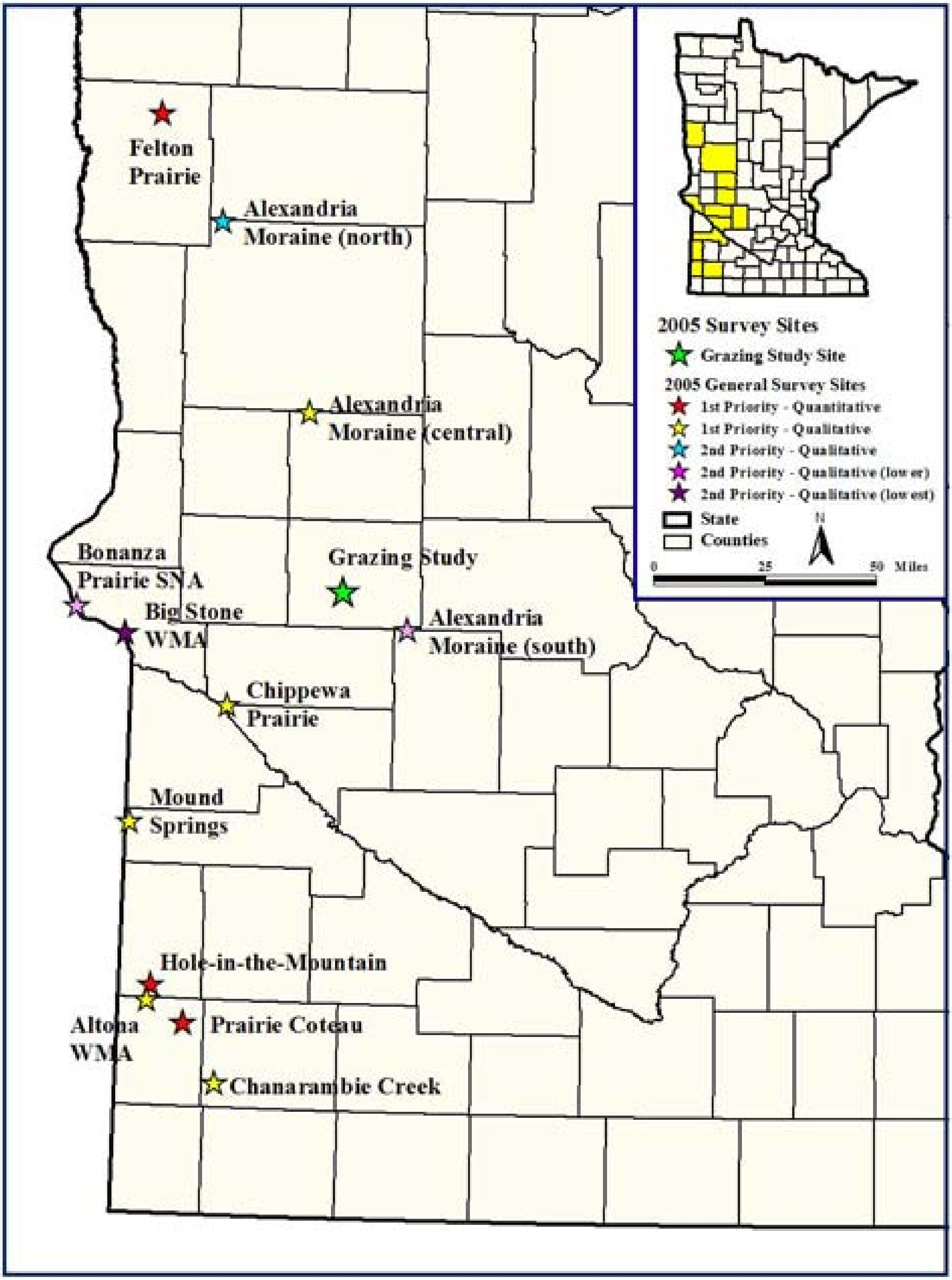
	2003 (# Inflorescence per Transect)					2004 (# Inflorescence per Transect)				
Species	1	2	3	4	All	1	2	3	4	All
Cirs flod	64	57	209	83	413	132	290	770	374	1,566
Echi angu	1,447	1,015	3,689	1,083	7,234	6,904	1,826	9,463	6,363	24,566
Verb stri	0	84	124	427	635	0	161	143	382	686

Appendix 3, Table 14. Nectar plant data per survey route in 2003 and 2004 for Anderson Pasture.

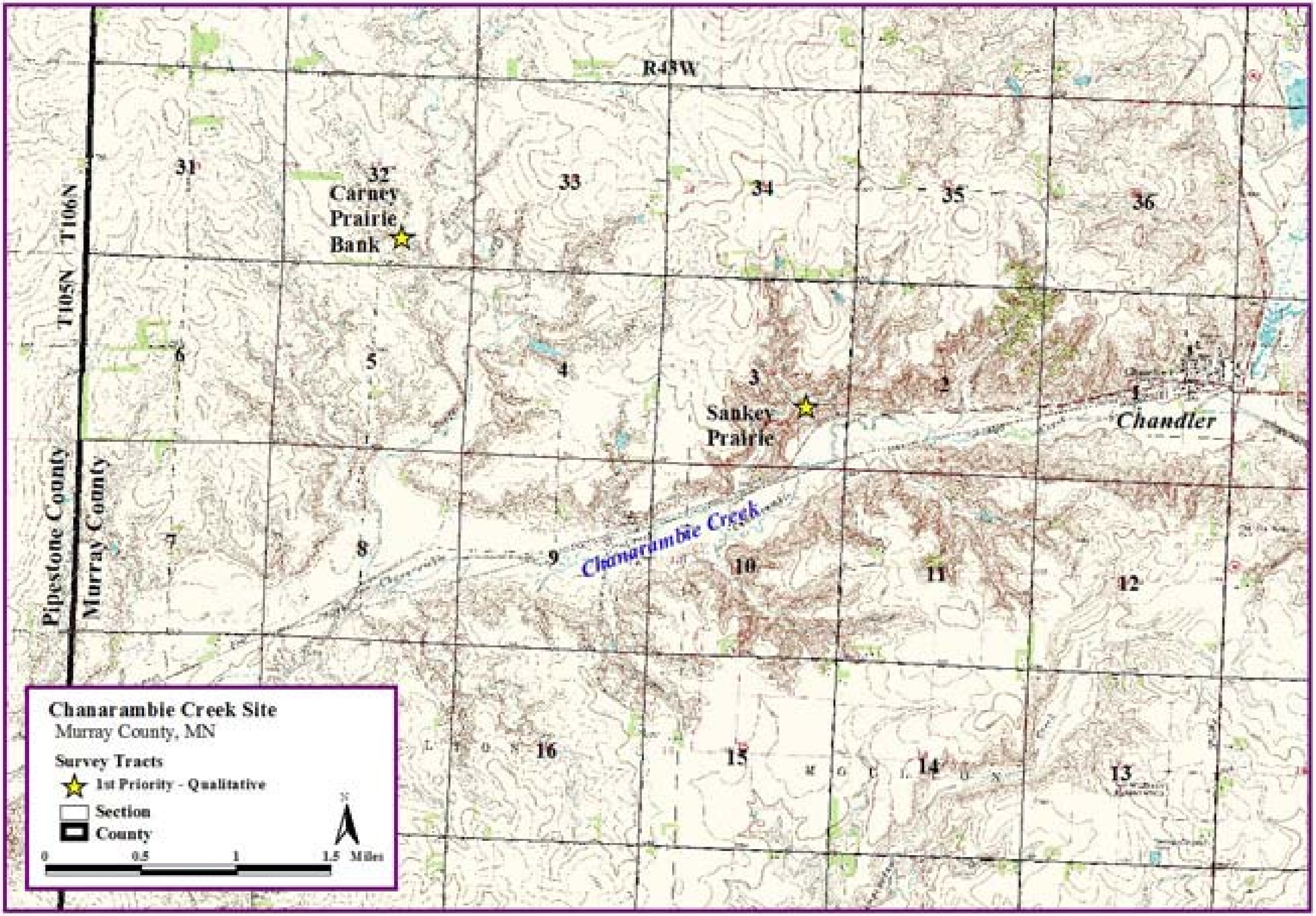
	2003 (# Inflorescence per Transect)						2004 (# Inflorescence per Transect)					
Species	A	B	C	D	E	All	A	B	C	D	E	All
Cirs flod	39	53	76	98	8	274	193	294	237	55	9	788
Echi angu	130	78	92	172	8	480	2,171	467	424	1,063	61	4,186
Verb stri	657	156	23	166	1	1,003	359	313	21	108	2	803

APPENDIX 4

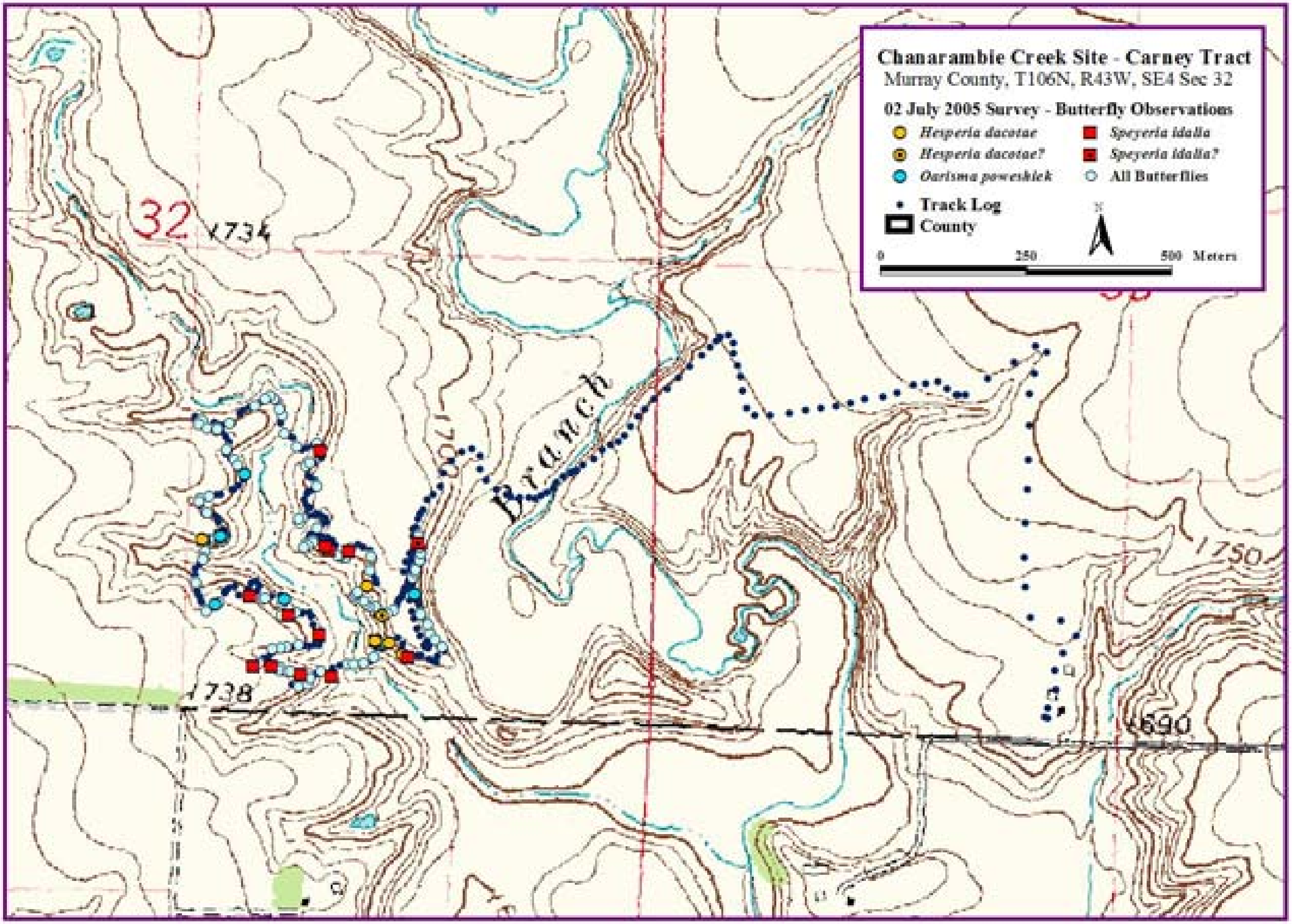
Maps: General Status Survey Sites and Butterfly Survey Data



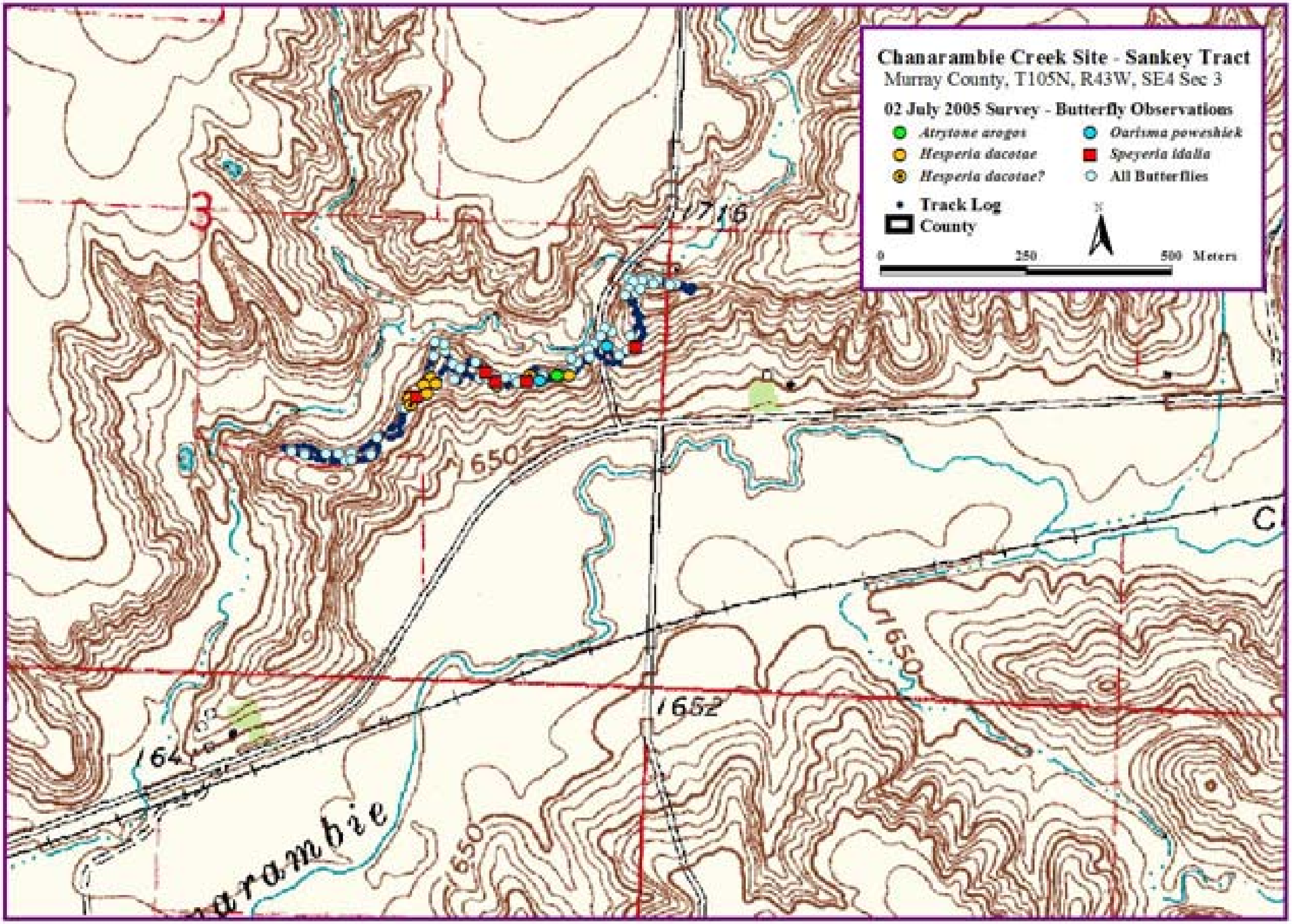
Appendix 4, Figure 1. Dakota skipper grazing study and 2005 general status survey sites.



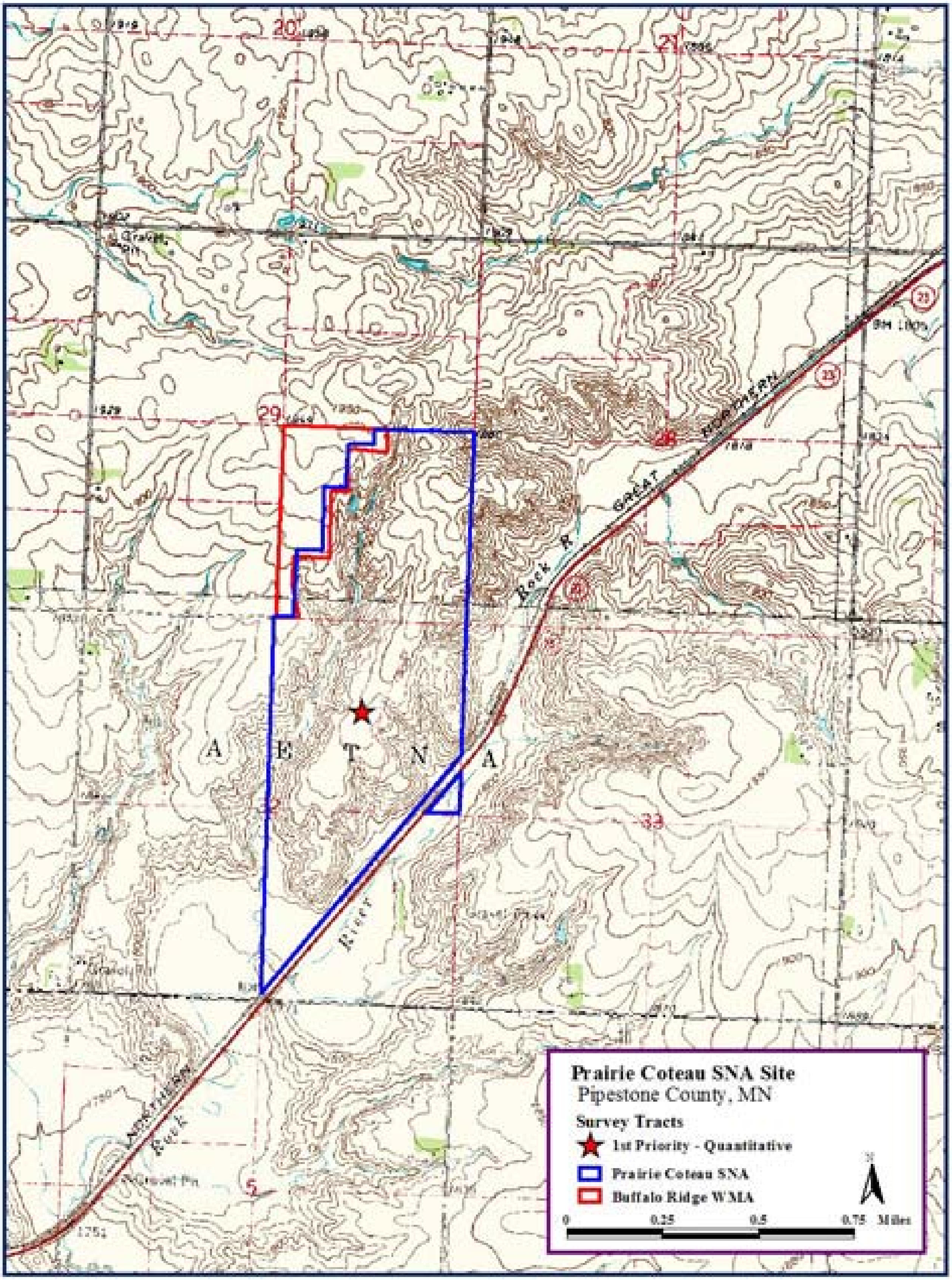
Appendix 4, Figure 2. Chanarambie Creek site.



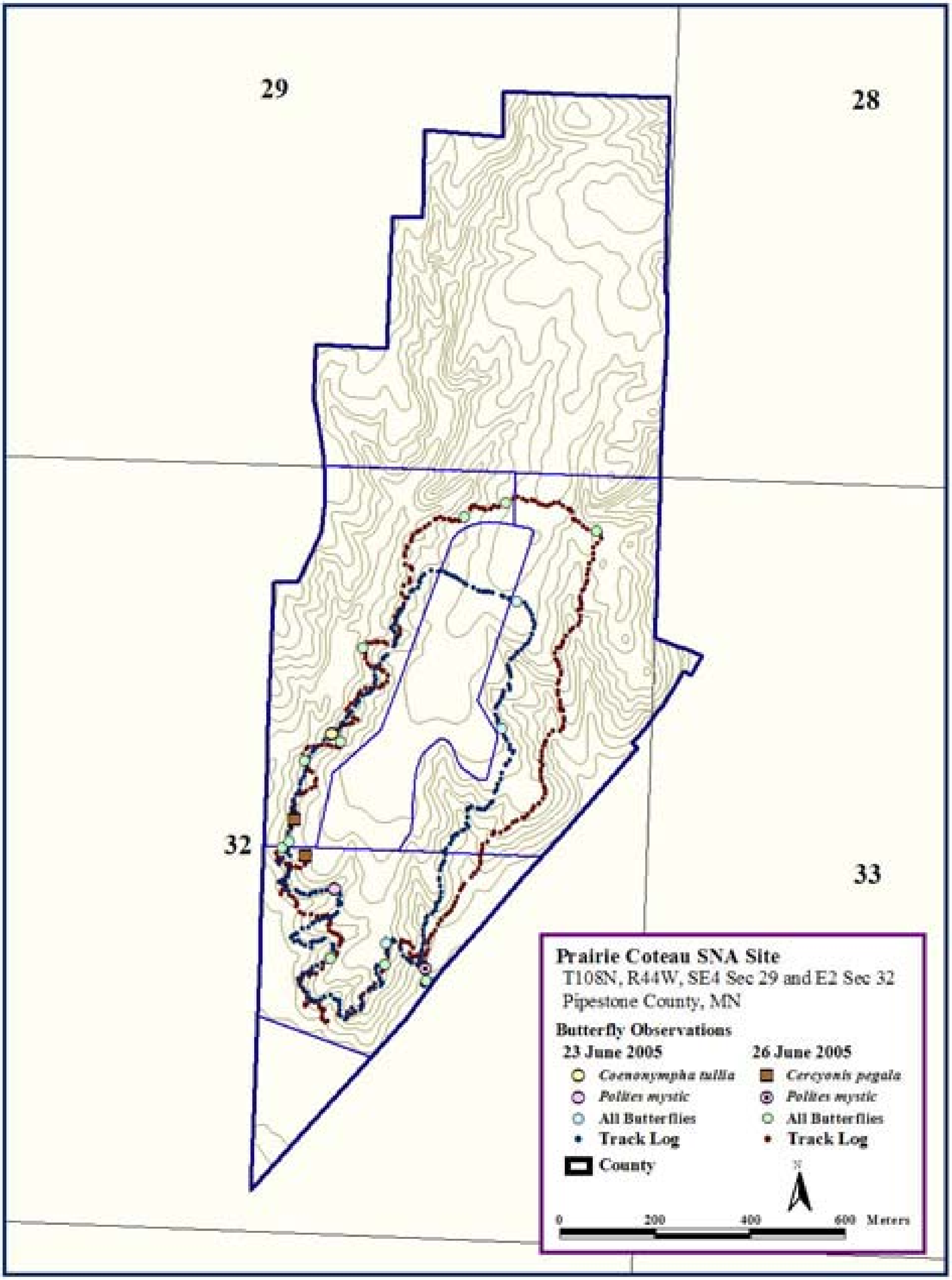
Appendix 4, Figure 3. Chanarambie Creek site, Carney Prairie Bank tract survey - 02 July 2005.



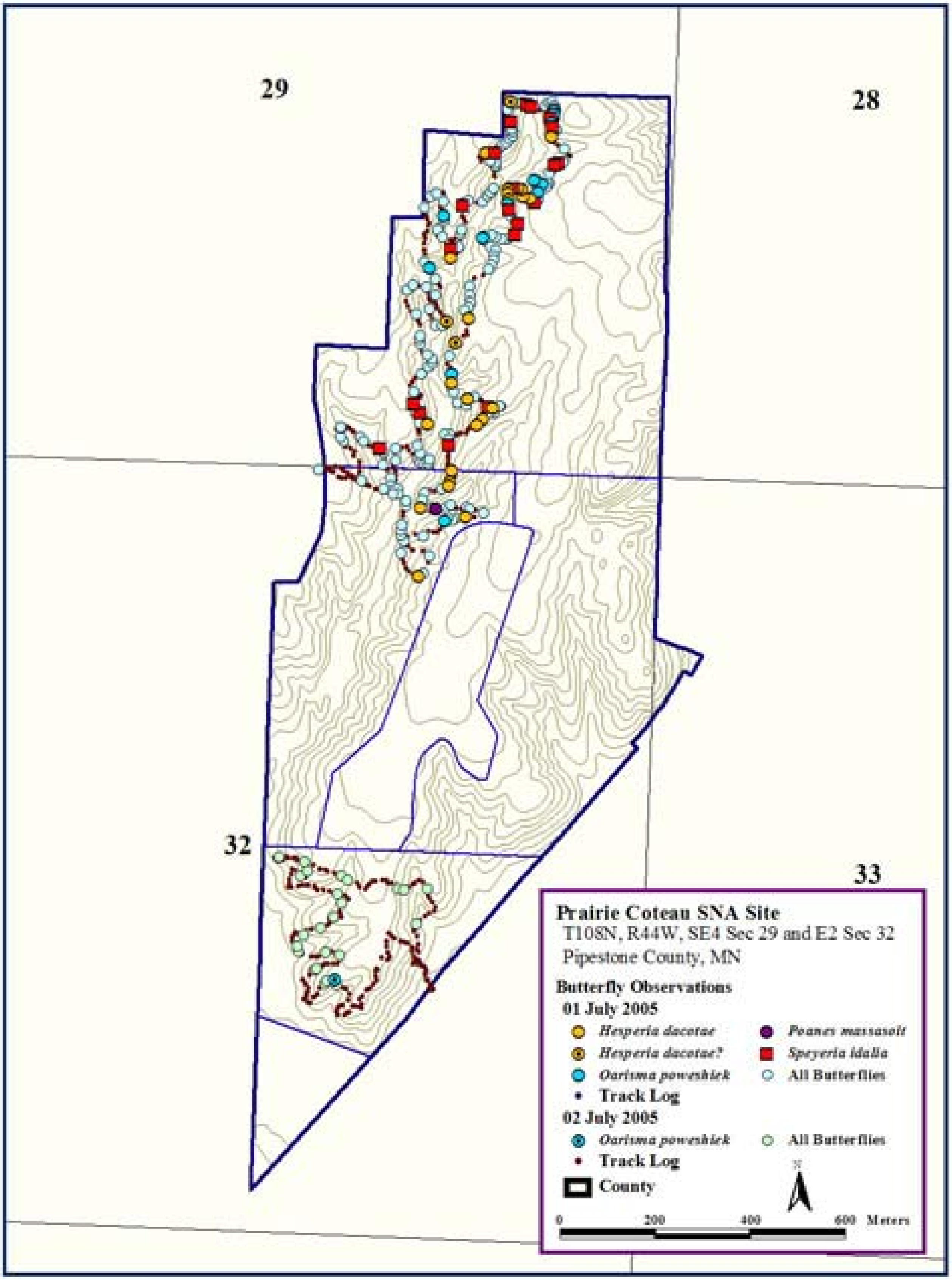
Appendix 4, Figure 4. Chanarambie Creek site, Sankey Prairie tract survey - 02 July 2005.



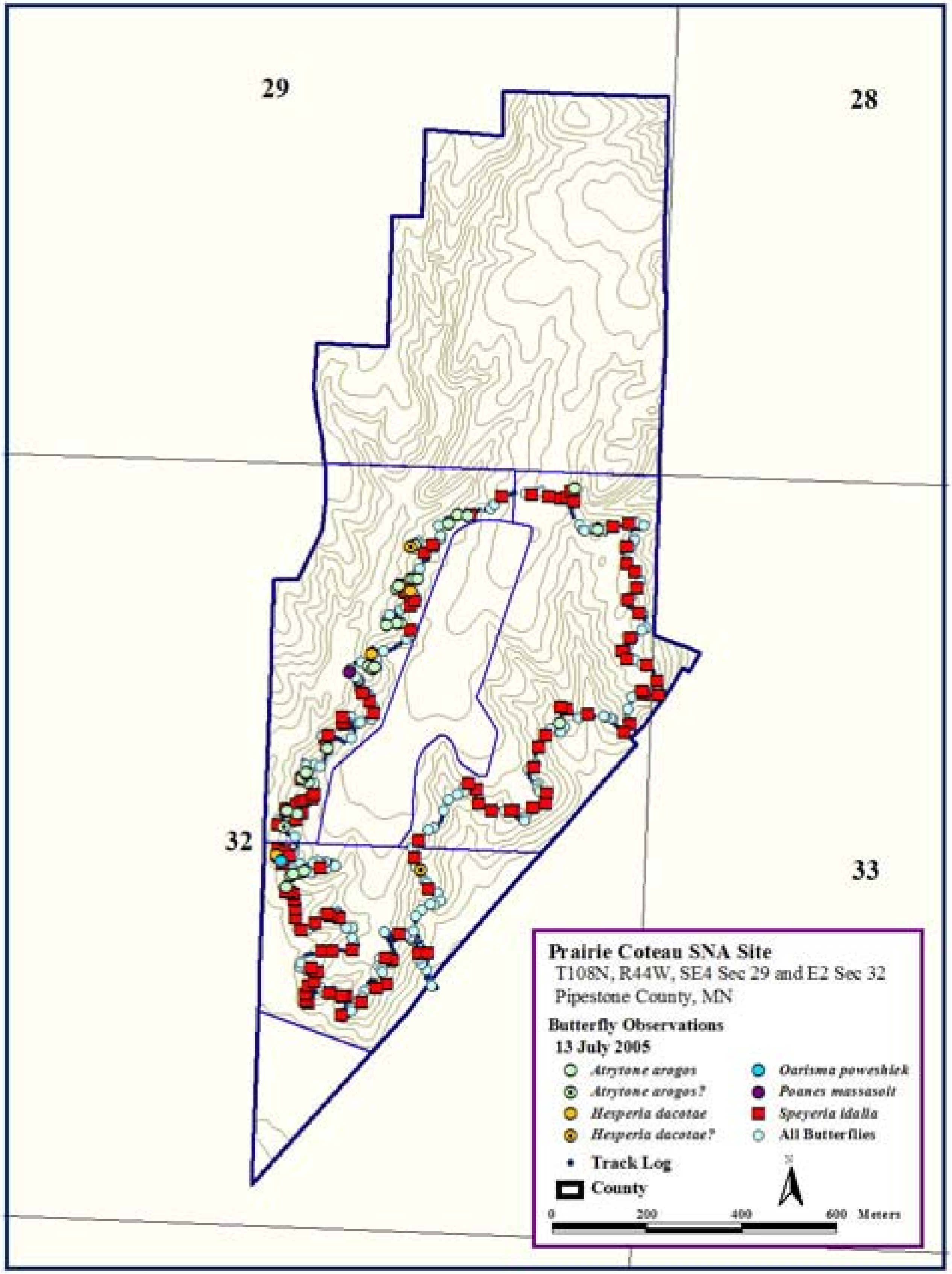
Appendix 4, Figure 5. Prairie Coteau SNA site.



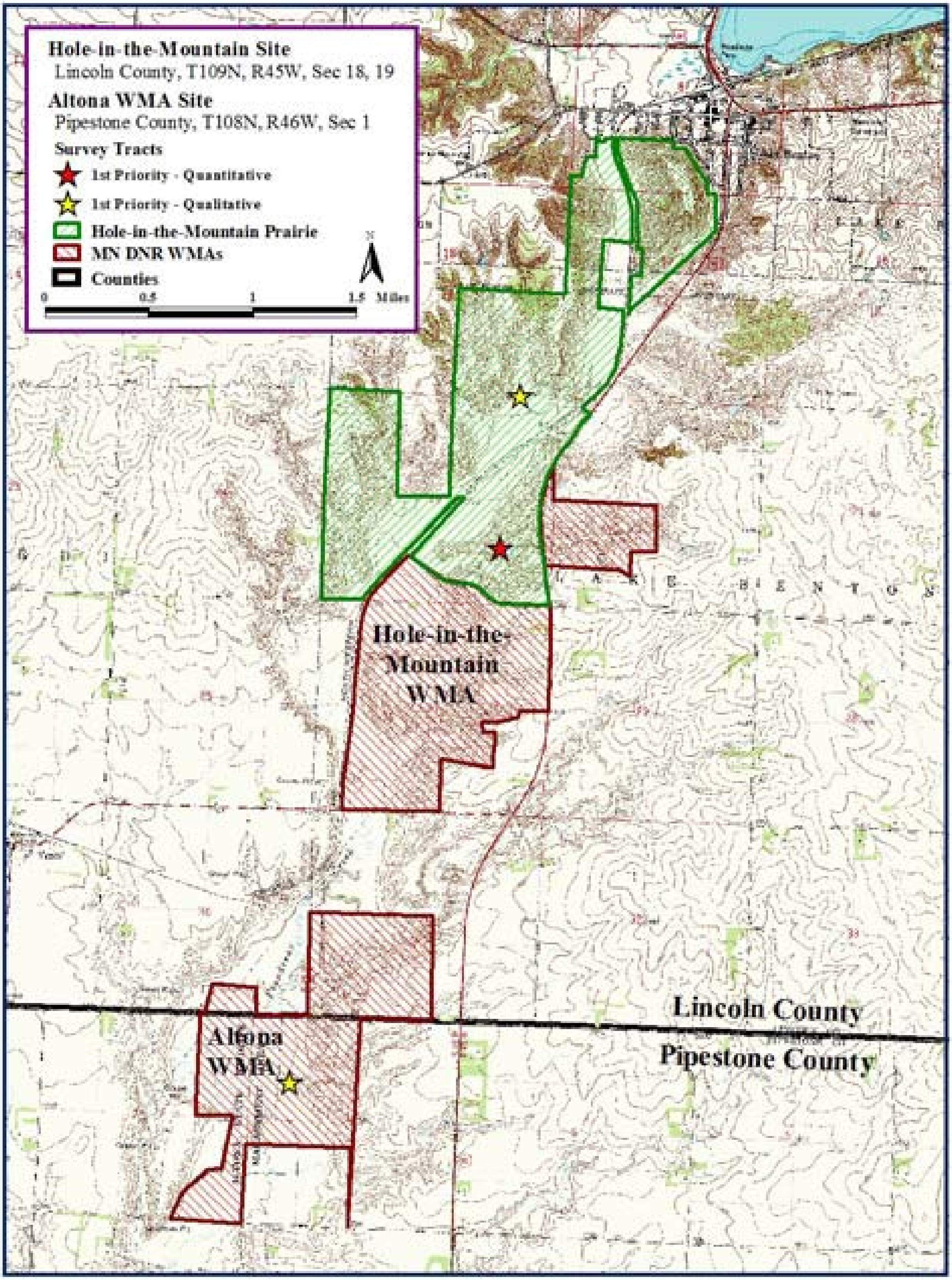
Appendix 4, Figure 6. Prairie Coteau SNA surveys - 23 and 26 June 2005.



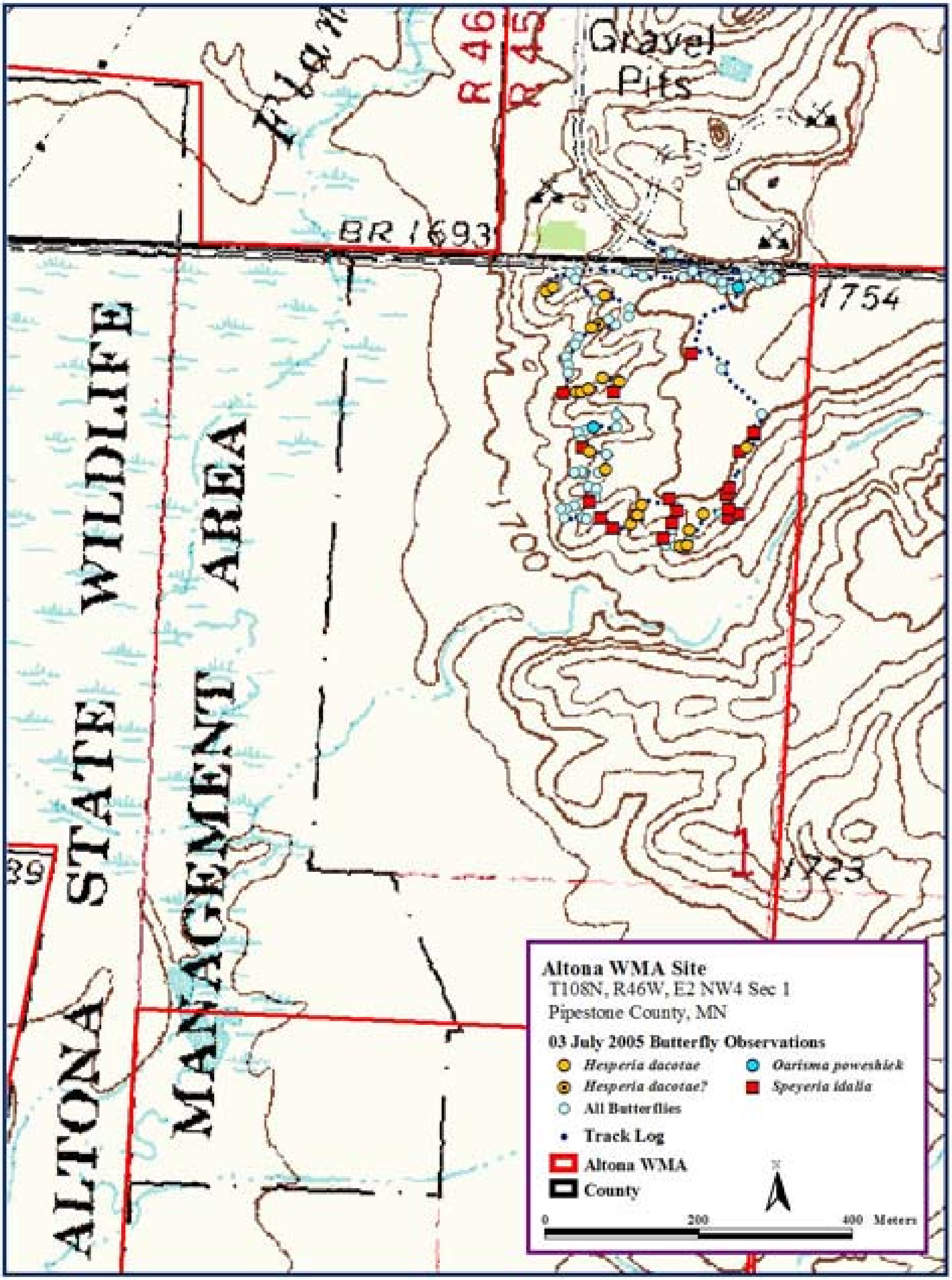
Appendix 4, Figure 7. Prairie Coteau SNA surveys - 01 and 02 July 2005.



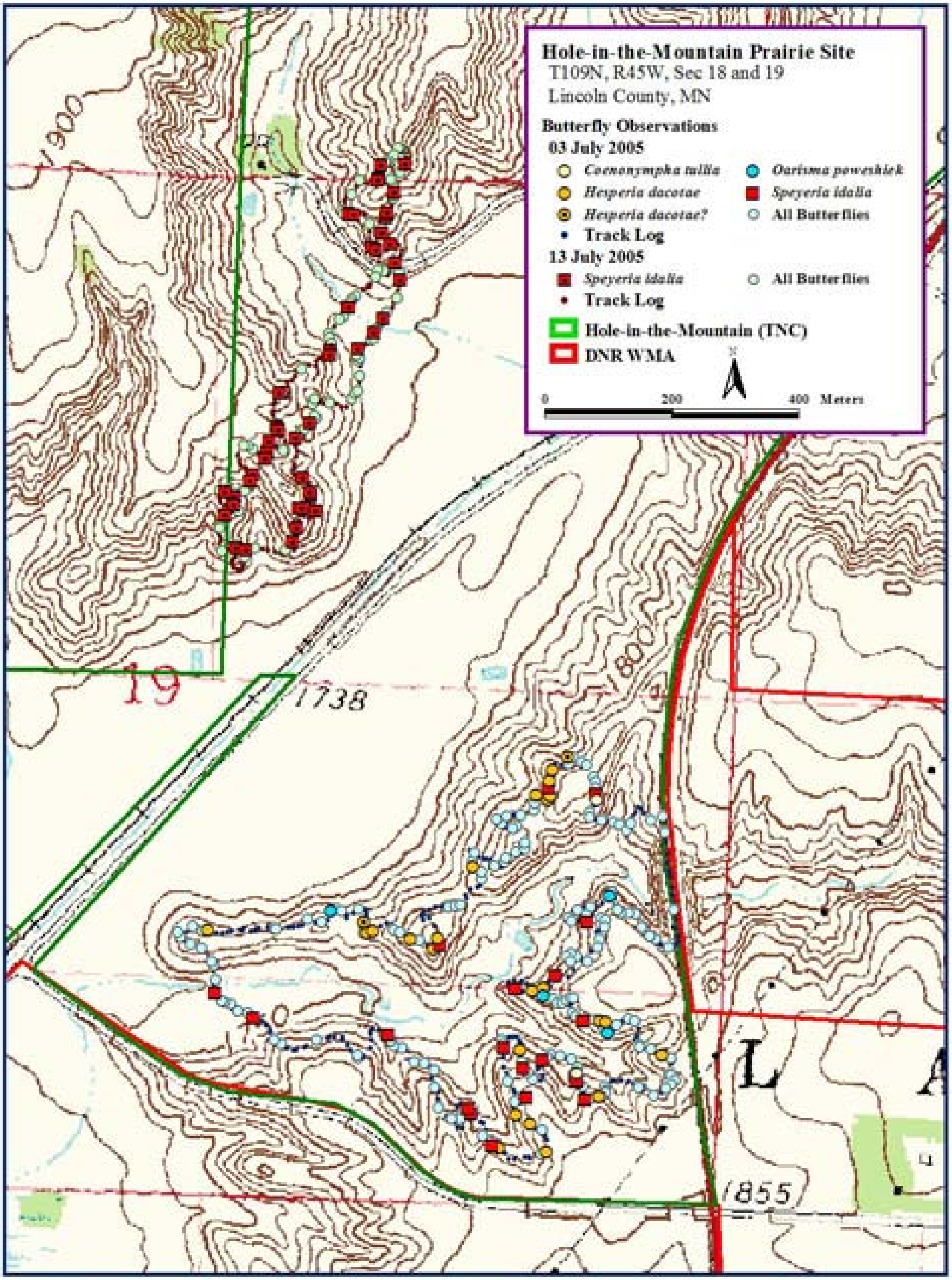
Appendix 4, Figure 8. Prairie Coteau SNA surveys - 13 July 2005.



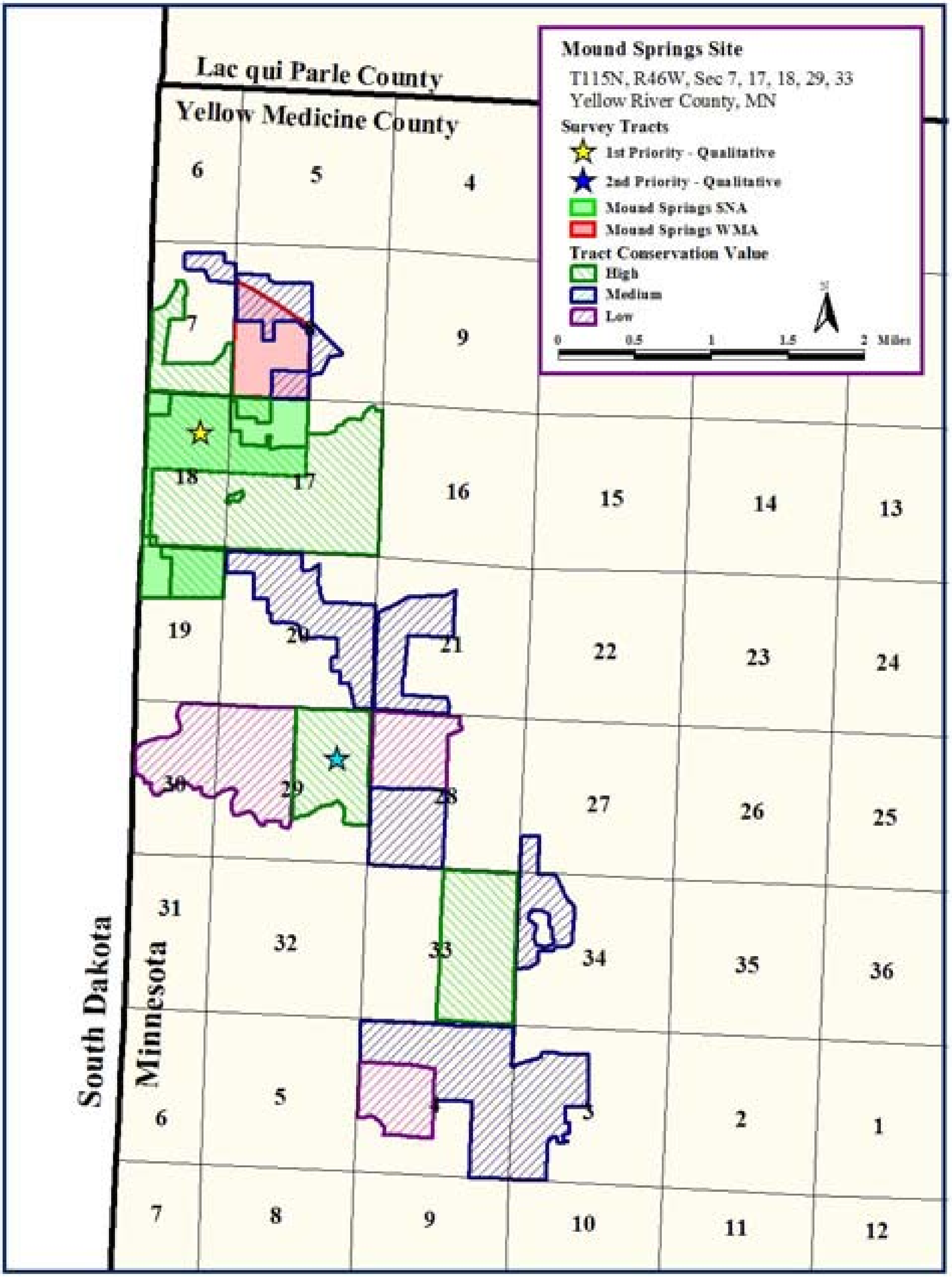
Appendix 4, Figure 9. Hole-in-the-Mountain Prairie and Altona WMA sites.



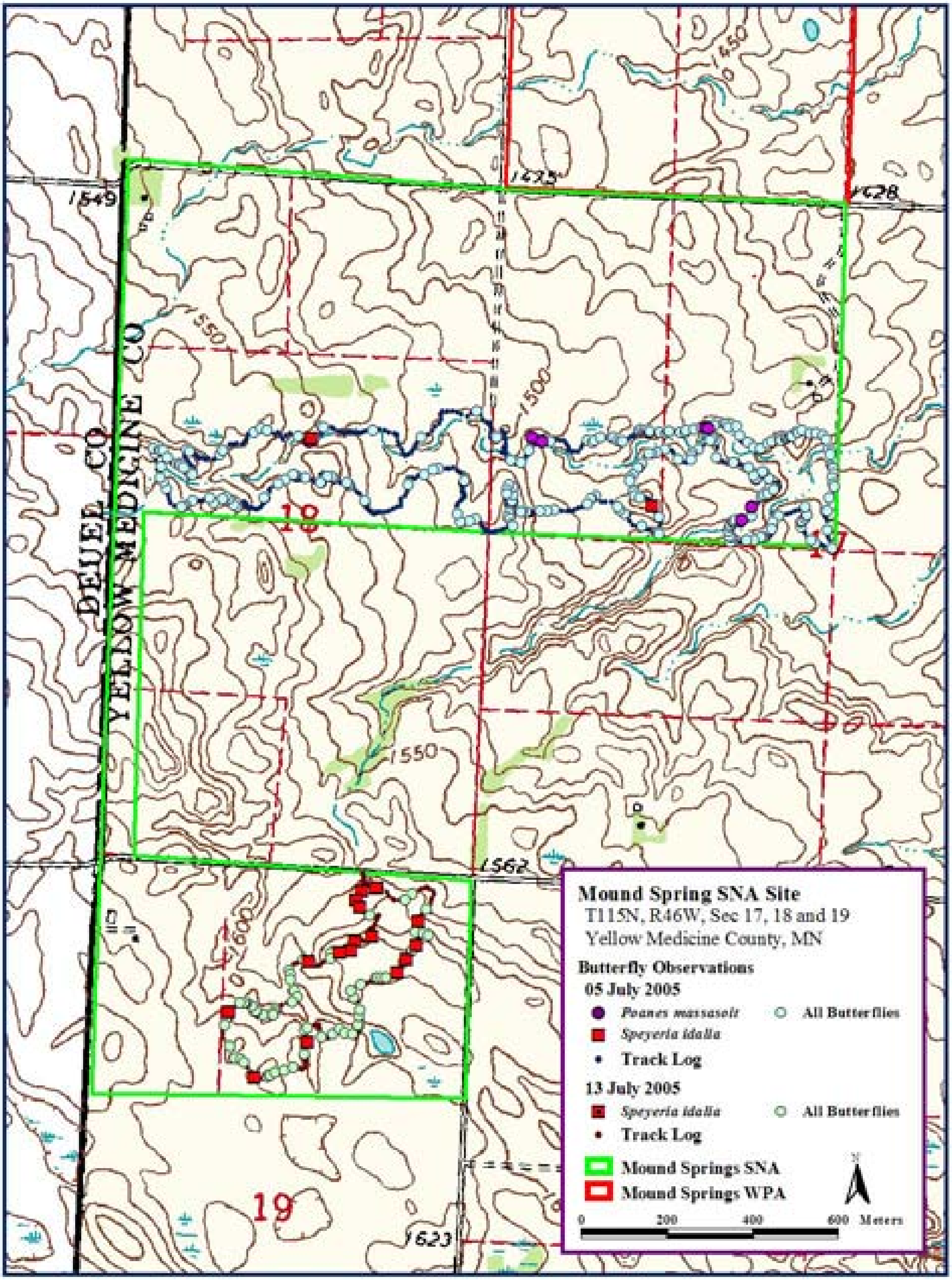
Appendix 4, Figure 10. Altona WMA survey - 03 July 2005.



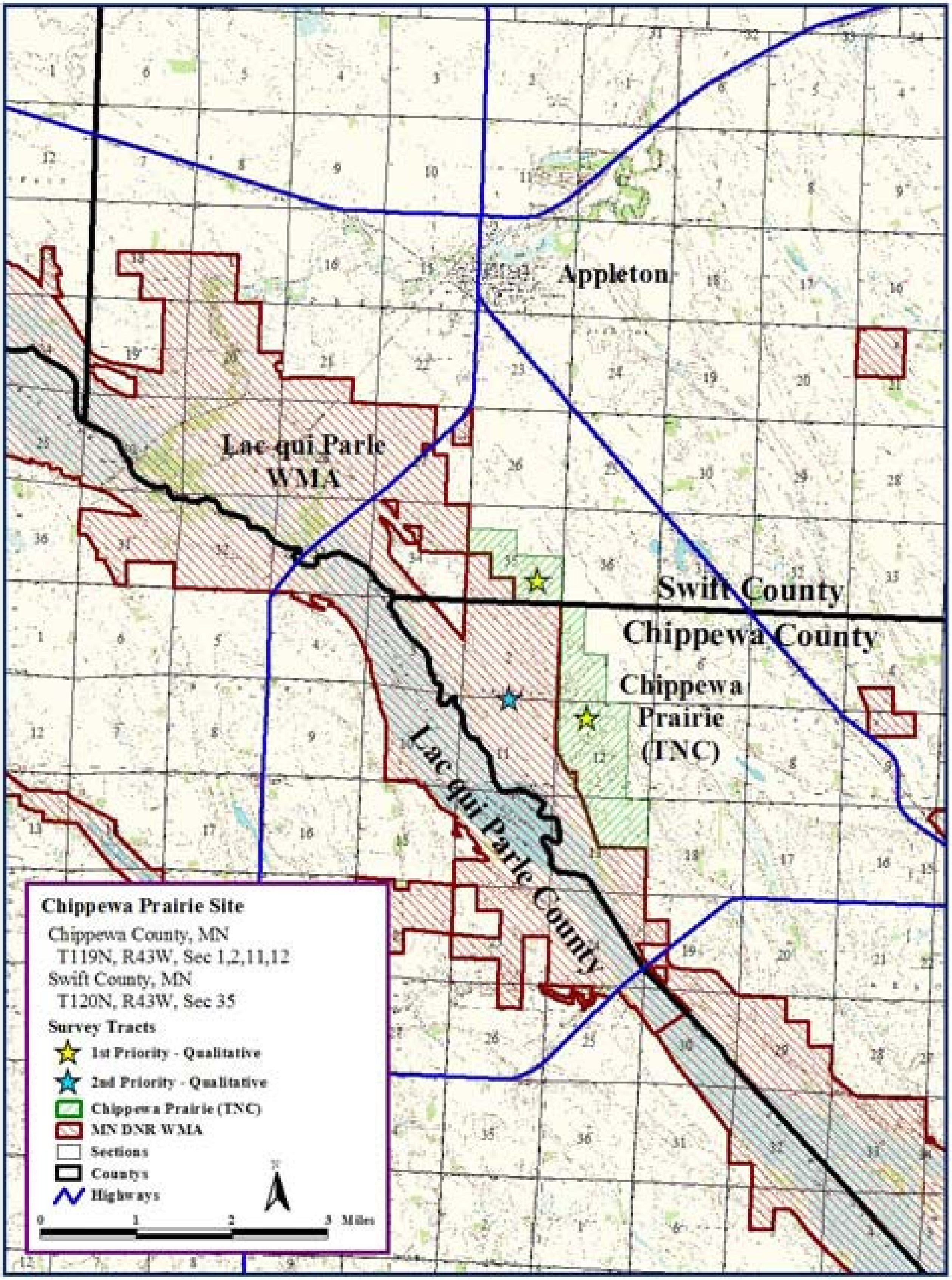
Appendix 4, Figure 11. Hole-in-the-Mountain Prairie surveys - 03 and 13 July 2005.



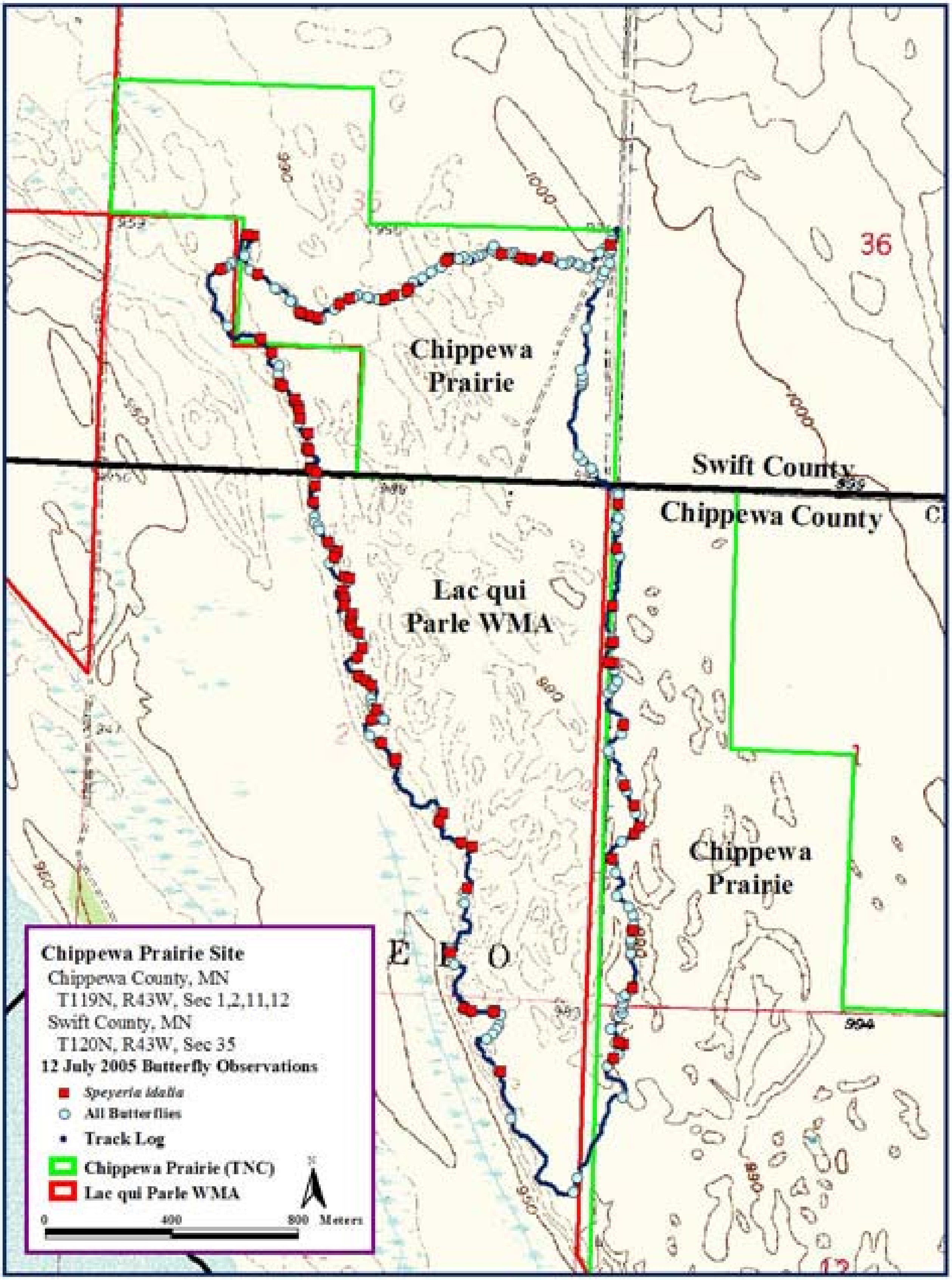
Appendix 4, Figure 12. Mound Springs site.



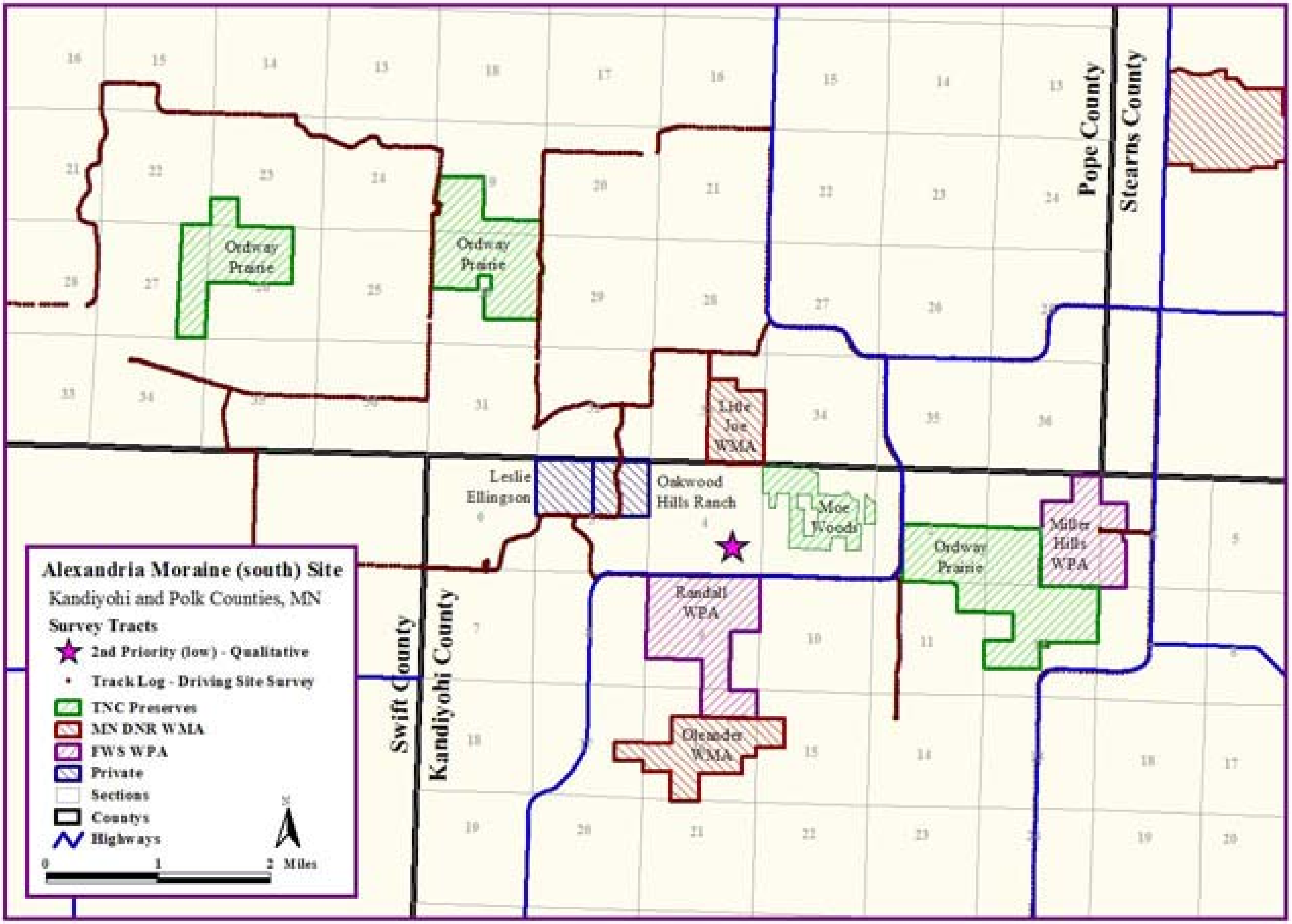
Appendix 4, Figure 13. Mound Springs surveys - 05 and 13 July 2005.



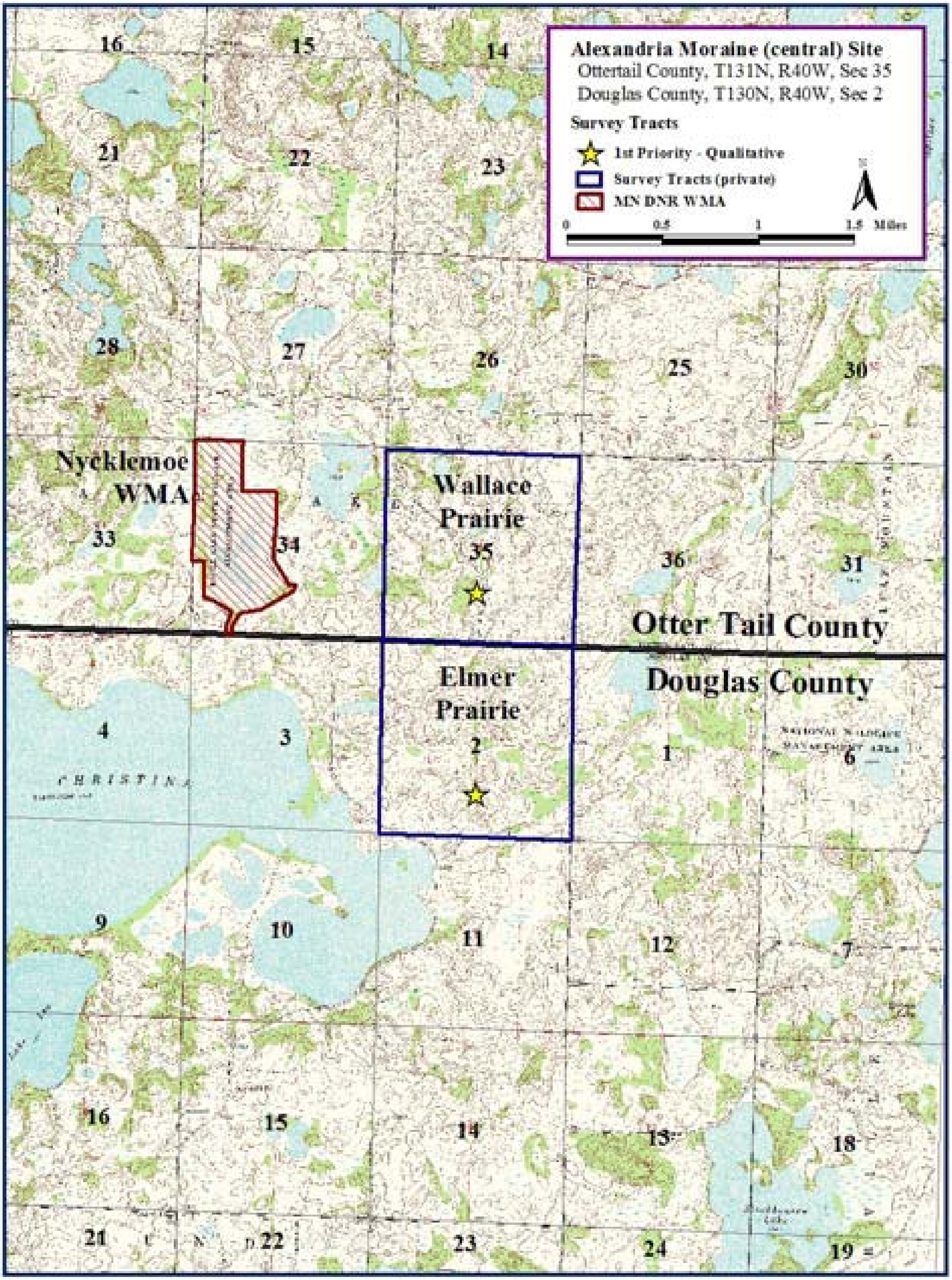
Appendix 4, Figure 14. Chippewa Prairie site.



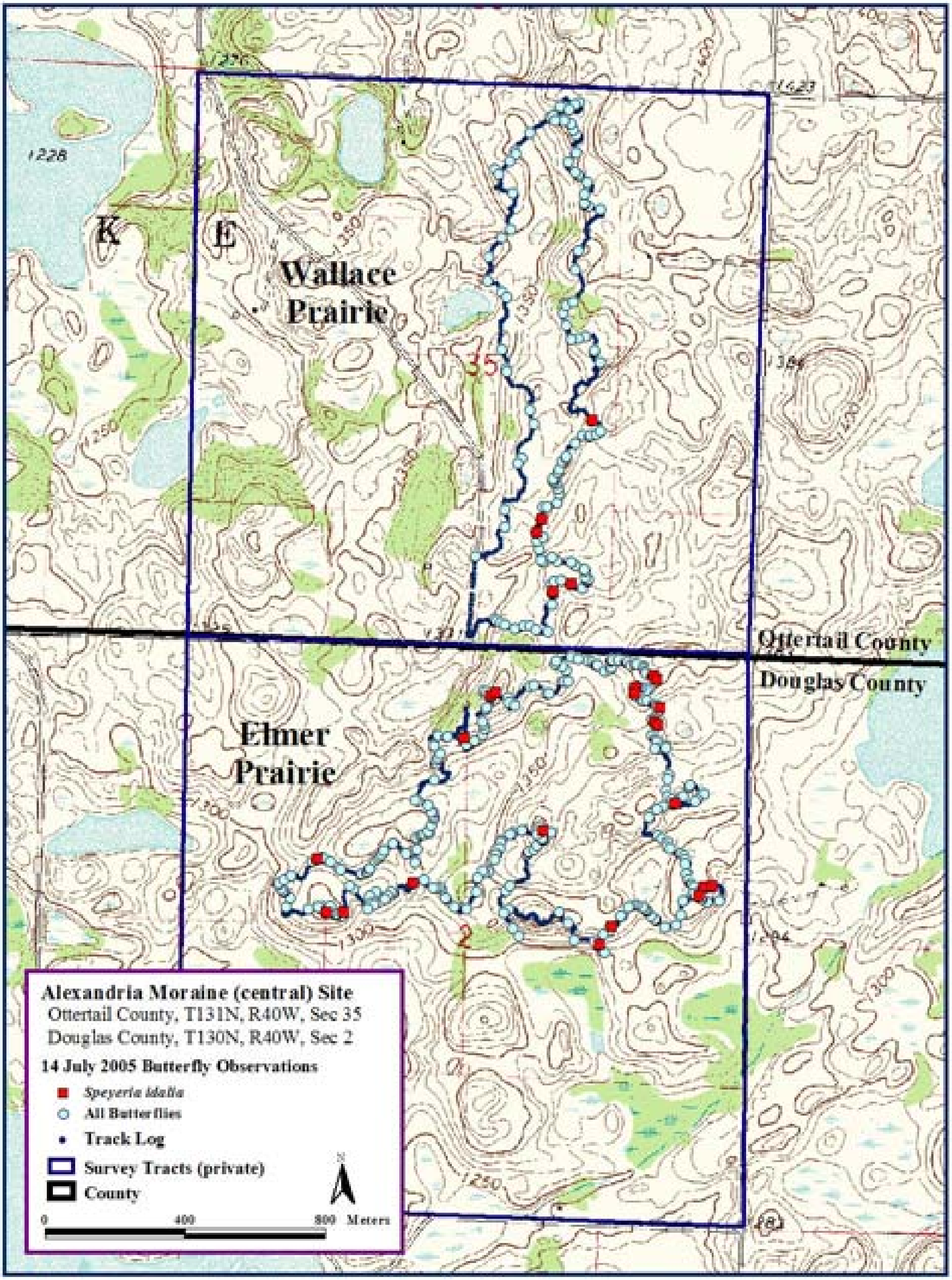
Appendix 4, Figure 15. Chippewa Prairie survey - 12 July 2005.



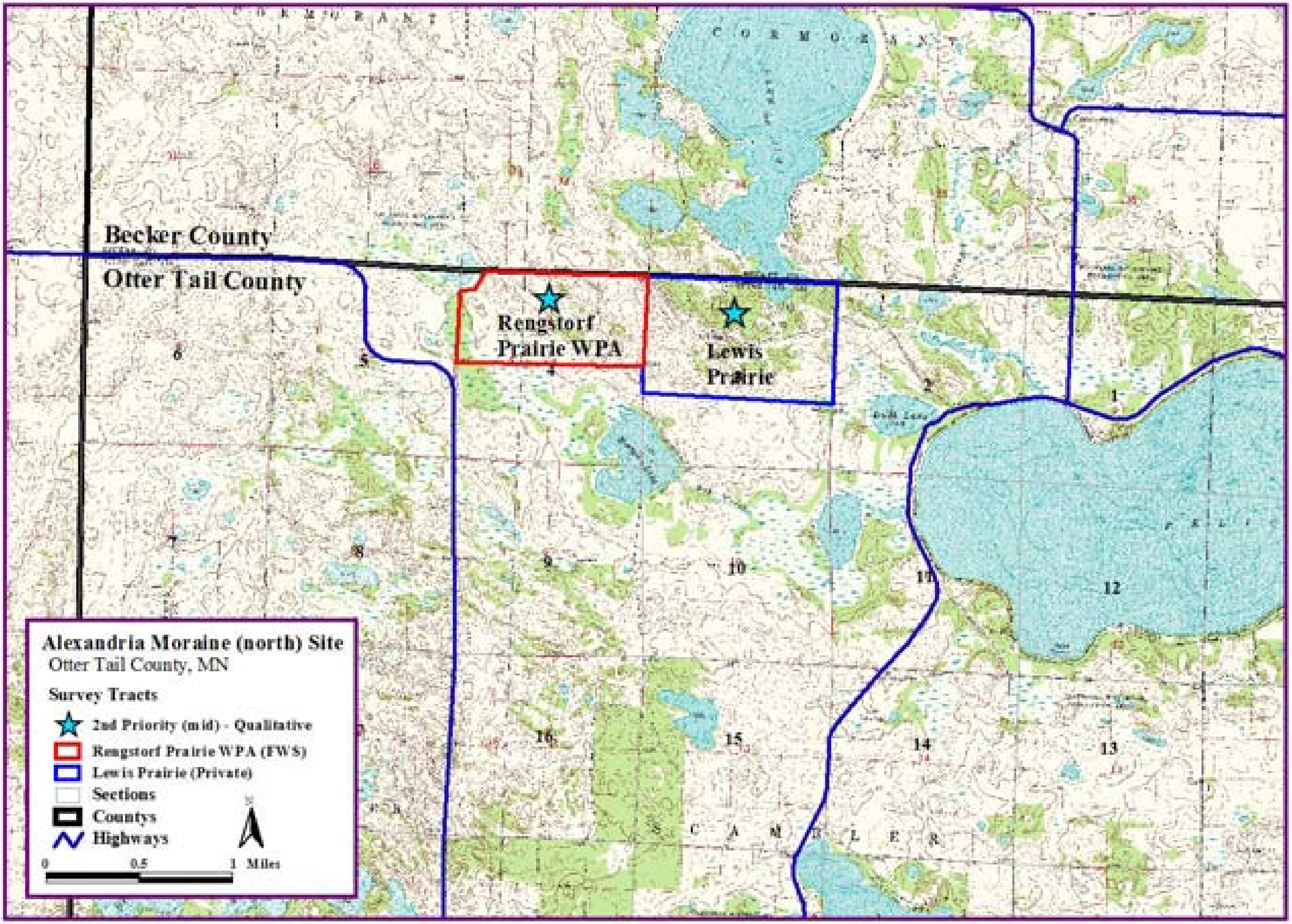
Appendix 4, Figure 16. Alexandrai Moraine (south) site.



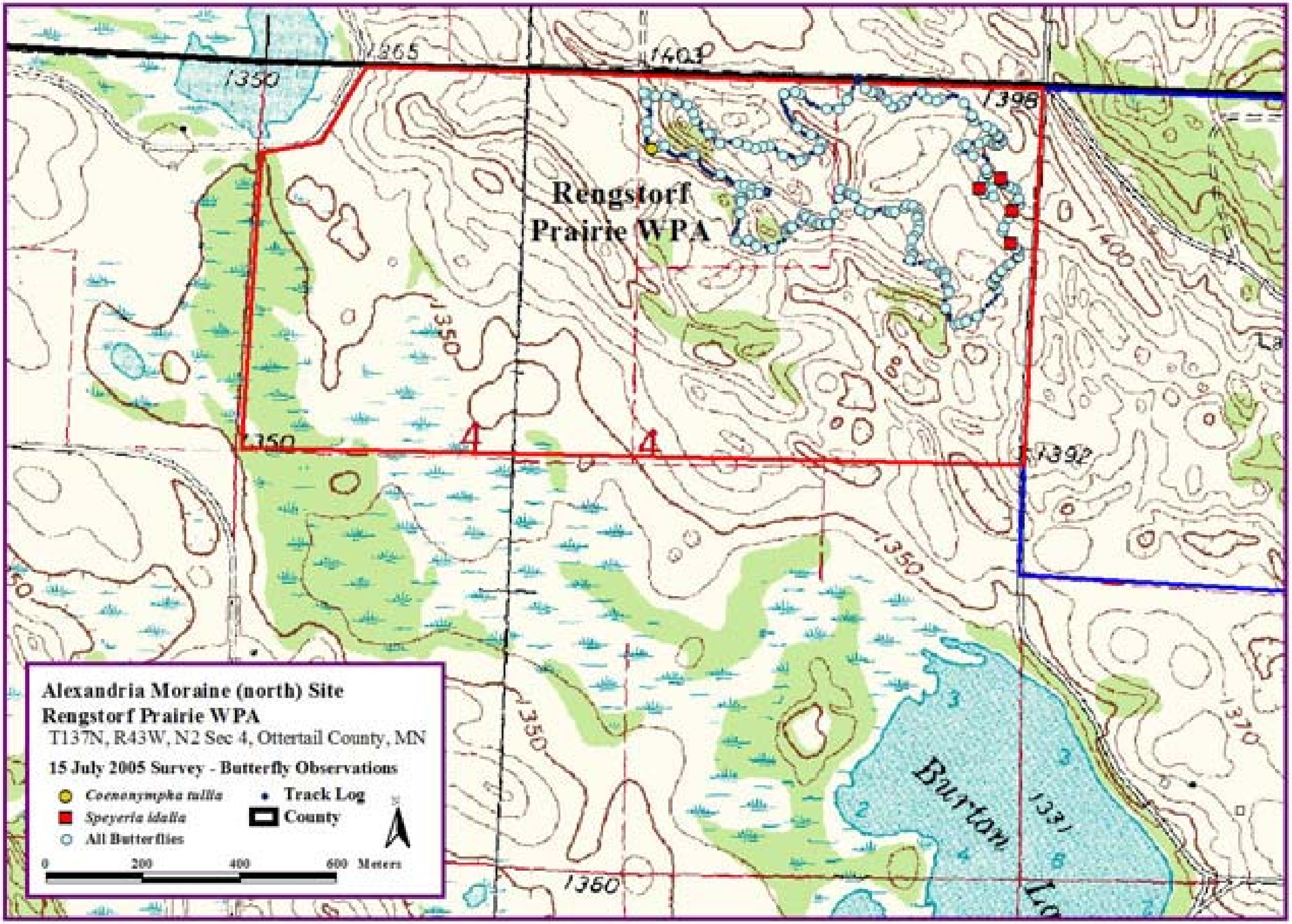
Appendix 4, Figure 17. Alexandria Moraine (central) site.



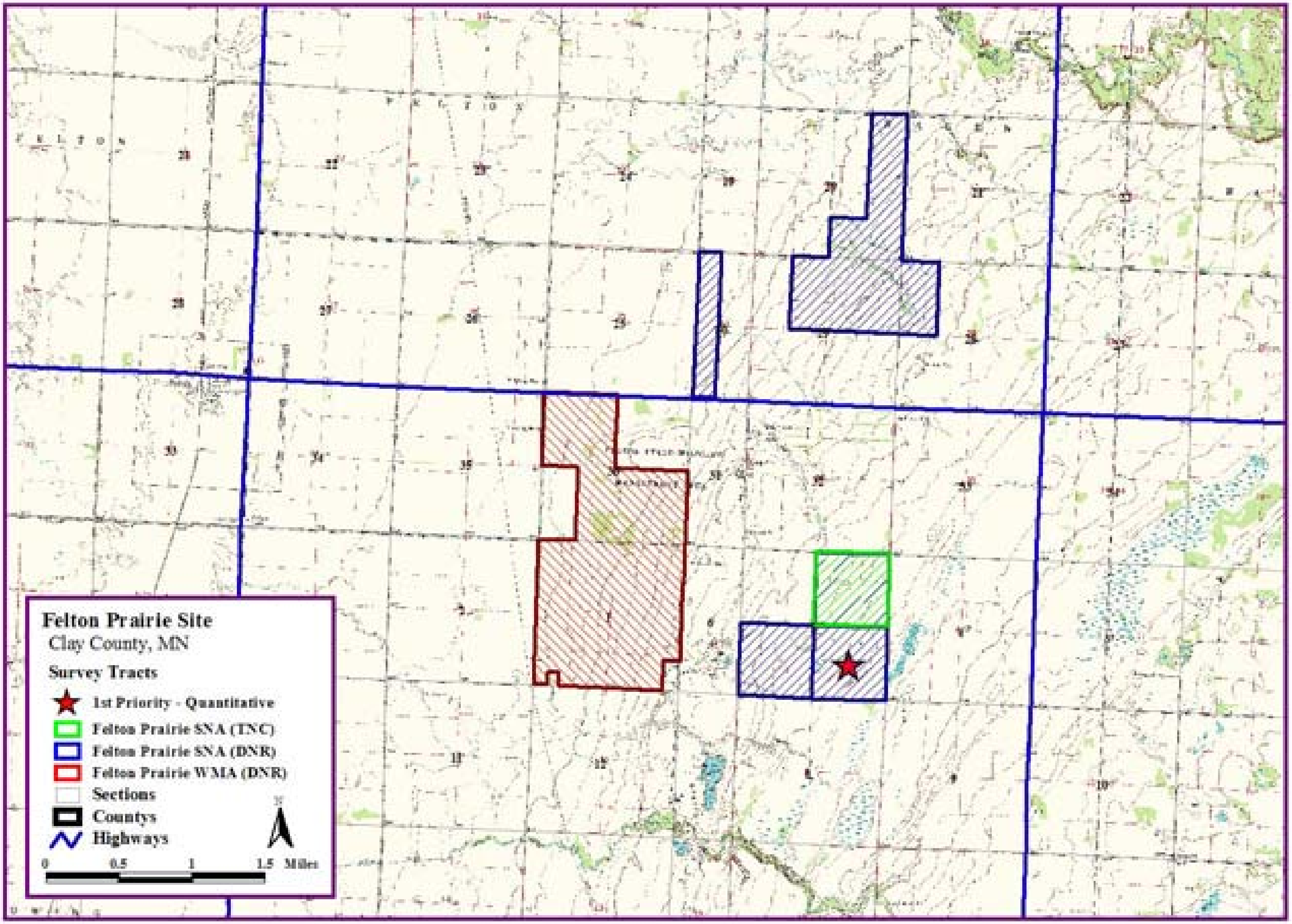
Appendix 4, Figure 18. Alexandria Moraine (central) survey - 14 July 2005.



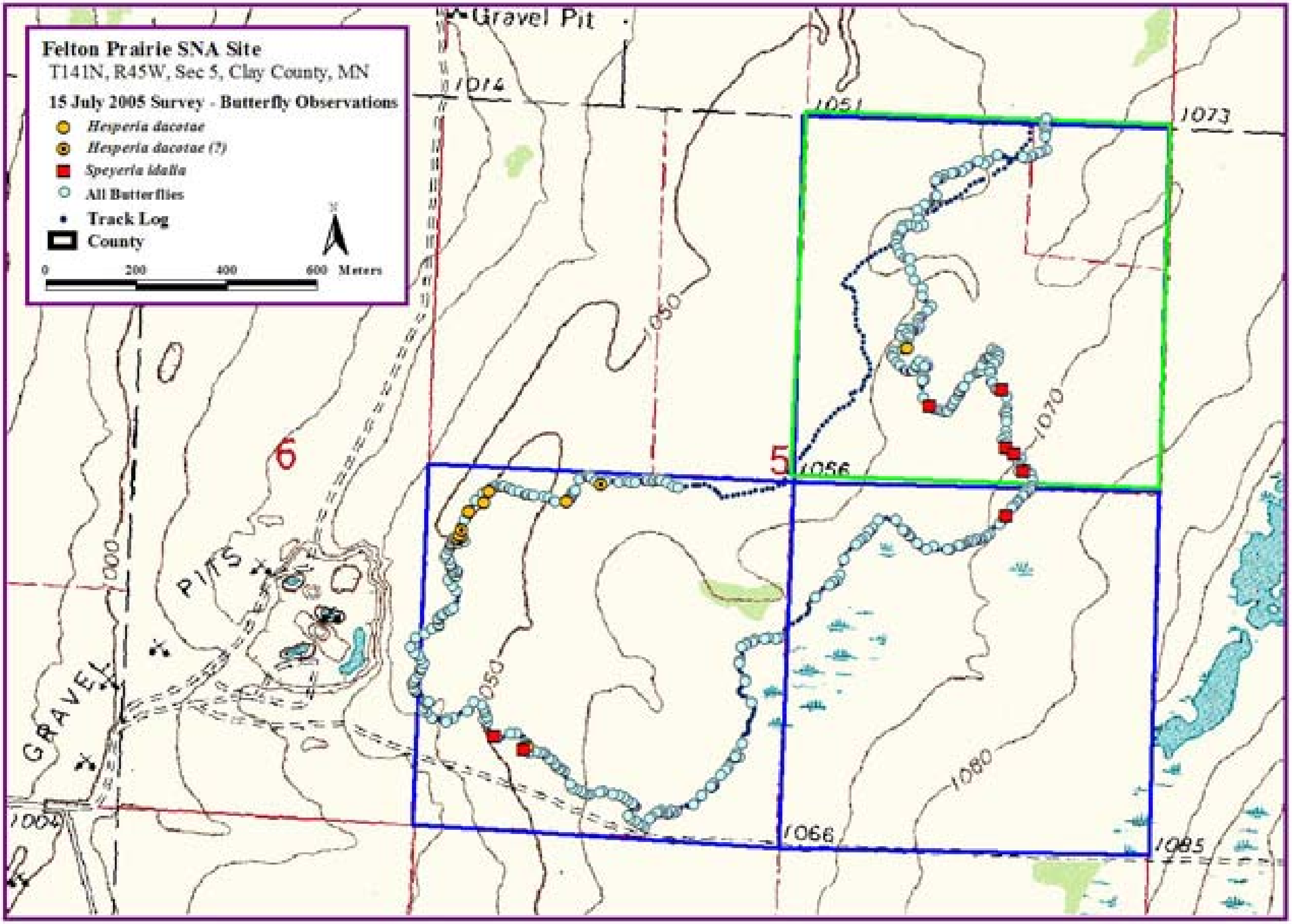
Appendix 4, Figure 19. Alexandrai Moraine (north) site.



Appendix 4, Figure 20. Alexandria Moraine (north). Rengstorf Prairie WPA survey - 15 July 2005.



Appendix 4, Figure 21. Felton Prairie site .



Appendix 4, Figure 22. Felton Prairie survey - 15 July 2005.

APPENDIX 5

Tables: General Status Survey Butterfly Survey Data

Appendix 5, Table 1. Survey priority/type and historic target species records (denoted by an X) per general status survey site (arranged approximately south to north).

		Survey	Survey	Historic Target Records[2]				
Site Name	**County**	**Priority**	**Type[1]**	**Aa**	**Hd**	**Ho**	**Op**	**Si**
Chanarambie Creek Sites								
Carney Prairie	Murray	1	QS	--	X	--	X	X
Sankey Prairie	Murray	1	QS	--	X	--	X	X
Prairie Coteau SNA	Pipestone	1	TS	X	X	X	X	X
Altona WMA	Pipestone	1	QS	--	--	--	--	--
Hole-in-the-Mountain								
Original purchase (south)	Lincoln	1	TS	X	X	X	X	X
Newer additions (north)	Lincoln	2	QS	X	X	--	X	X
Mound Springs Sites								
Mound Springs SNA	Yellow Medicine	1	QS	--	--	--	--	--
Private tracts	Yellow Medicine	2	QS	--	--	--	--	--
Chippewa Prairie								
Chippewa Prairie (TNC)	Chippewa/Swift	1	QS	X	X	--	X	X
Lac Qui Parle WMA	Chippewa/Swift	2	QS	X	X	--	X	X
Alexandria Moraine (S)								
Miller Hills WPA	Kandiyohi	3	QS	--	--	--	--	X
Randall WPA	Kandiyohi	3	QS	--	--	--	--	--
Ellingson Prairie	Kandiyohi	3	QS	--	--	--	X	--
Oakwood Hills Ranch	Kandiyohi	3	QS	--	--	--	--	--
Ordway Prairie (TNC)	Kandiyohi/ Pope	3	QS	X	--	--	X	X
Alexandria Moraine (C)								
Elmer Prairie	Douglas	1	QS	--	--	--	--	--
Wallace Prairie	Otter Tail	1	QS	--	--	--	--	--
Alexandria Moraine (N)								
Lewis Prairie	Otter Tail	2	QS	--	--	--	--	--
Rengstorf Prairie (WPA)	Otter Tail	2	QS	--	--	--	--	--
Felton Prairie								
Felton Prairie SNA								
Blazingstar Prairie (TNC)	Clay	1	TS	--	X	--	X	X
Bicentennial Prairie (County)	Clay	1	TS	X	X	--	X	X
Felton Prairie (DNR)	Clay	1	TS	X	X	--	X	X
North of gravel pit (County)	Clay	1	TS	--	X	--	X	X

[1]TS = timed wandering transect surveys
QS = qualitative presence/absence surveys
[2]Aa = *Atrytone arogos*
Hd = *Hesperia dacotae*
Ho = *Hesperia ottoe*
Op = *Oarisma poweshiek*
Si = *Speyeria idalia*

Appendix 5, Table 2. Target species[1] observations during 2005 general status surveys (expressed as observations per survey, hour and km).

		Obs/Survey					Obs/Hour					Obs/Km			
Site Name	**Date**	**Aa**	**Hd**	**Op**	**Si**	**Hrs**	**Aa**	**Hd**	**Op**	**Si**	**Km**	**Aa**	**Hd**	**Op**	**Si**
Chanarambie Creek Sites															
Carney Prairie	02 Jul	--	5	6	15	2.83	0.00	1.76	2.12	5.29	2.890	-----	1.73	2.08	5.19
Sankey Prairie	02 Jul	1	7	2	6	2.17	0.46	3.23	0.92	2.77	2.249	0.44	3.11	0.89	2.67
Prairie Coteau SNA															
Prairie Coteau (north)	01 Jul	--	33	14	21	7.17	-----	4.60	1.95	2.93	4.754	-----	6.94	2.94	4.42
Prairie Coteau (south)	13 Jul	30	4	1	118	4.33	6.92	0.92	0.23	27.23	6.329	4.74	0.63	0.16	18.64
Altona WMA	03 Jul	--	24	2	21	3.00	-----	8.00	0.67	7.00	2.148	-----	11.17	0.93	9.78
Hole-in-the-Mountain															
Original purchase (south)	03 Jul	--	27	5	20	5.00	-----	5.40	1.00	4.00	4.356	-----	6.20	1.15	4.59
Newer additions (north)	13 Jul	--	--	--	49	1.28	-----	-----	-----	38.18	2.272				21.56
Mound Springs Sites															
Mound Springs SNA (north)	05 Jul	--	--	--	2	4.67	-----	-----	-----	0.43	6.337	-----	-----	-----	0.32
Mound Springs SNA (south)	13 Jul	--	--	--	18	1.20	-----	-----	-----	15.00	2.201	-----	-----	-----	8.18
Chippewa Prairie															
Chippewa Prairie (TNC)	12 Jul	--	--	--	42	2.80	-----	-----	-----	15.00	5.579	-----	-----	-----	7.53
Lac Qui Parle WMA	12 Jul	--	--	--	53	2.20	-----	-----	-----	24.09	4.799	-----	-----	-----	11.04
Chippewa Prairie (totals)	**12 Jul**	**--**	**--**	**--**	**95**	**5.00**	-----	-----	-----	**19.00**	**10.378**	-----	-----	-----	**9.15**
Alexandria Moraine (C)															
Elmer Prairie	14 Jul	--	--	--	21	3.45	-----	-----	-----	6.09	6.988	-----	-----	-----	3.01
Wallace Prairie	14 Jul	--	--	--	5	2.62	-----	-----	-----	1.91	5.495	-----	-----	-----	0.91
Alexandria Moraine (N)															
Rengstorf Prairie (WPA)	15 Jul	--	--	--	4	1.75	-----	-----	-----	2.29	3.591	-----	-----	-----	1.11
Felton Prairie SNA															
Blazingstar Prairie (TNC)	15 Jul	--	1	--	5	1.27	-----	0.79	-----	3.95	1.860	--	0.54	--	2.69
Bicentennial Prairie (County)	15 Jul	--	7	--	2	0.45	-----	15.56	-----	4.44	0.788	--	8.89	--	2.54
Felton Prairie (DNR)	15 Jul	--	--	--	1	1.93	-----	-----	-----	0.52	2.859	--	--	--	0.35
Felton Prairie (totals)	**15 Jul**	**--**	**8**	**--**	**8**	**3.65**	-----	**2.19**	-----	**2.19**	**5.507**	**--**	**1.45**	**--**	**1.45**

[1]Aa = *Atrytone arogos*
Hd = *Hesperia dacotae*
Op = *Oarisma poweshiek*
Si = *Speyeria idalia*

Appendix 5, Table 3. 2005 butterfly surveys at other Minnesota sites (Chanarambie Creek, Prairie Coteau SNA, and Hole-in-the-Mountain Prairie).

	Chanarambie Creek			**Prairie Coteau SNA**						**Hole-in-the-Mountain Prairie**			
	02 Jul	**02 Jul**		**23 Jun**	**26 Jun**	**01 Jul**	**02 Jul**	**13 Jul**		**03 Jul**	**03 Jul**	**13 Jul**	**TNC**
Binomial	**Carney**	**Sankey**	**Total**	**2/3S/4S**	**2**	**3S/34N**	**2**	**2/3S/4S**	**Total**	**Altona**	**TNC-S**	**TNC-N**	**Total**
Anatrytone logan	--	--	**--**	--	--	--	--	1	**1**	**1**	1	--	**1**
Atrytone arogos	--	1	**1**	--	--	--	--	30	**30**	**--**	--	--	**--**
Atrytone arogos?	--	--	**--**	--	--	--	--	1	**1**	**--**	--	--	**--**
Blue species	1	--	**1**	--	--	2	--	--	**2**	**--**	2	--	**2**
Boloria bellona	1	1	**2**	--	--	9	--	3	**12**	**3**	6	--	**6**
Boloria bellona?	--	--	**--**	--	--	4	--	--	**4**	**--**	--	--	**--**
Boloria sp.	--	--	**--**	--	--	6	--	--	**6**	**--**	--	--	**--**
Cercyonis pegala	91	49	**140**	--	2	145	16	214	**377**	**60**	192	55	**247**
Coenonympha tullia	--	--	**--**	1	--	--	--	--	**1**	**--**	2	--	**2**
Colias sp.	12	10	**22**	1	4	22	6	28	**61**	**30**	23	20	**43**
Cupido comyntas	--	--	**--**	--	1	--	--	--	**1**	**--**	--	--	**--**
Danaus plexippus	1	2	--	--	1	6	--	12	**19**	**1**	3	7	**10**
Euptoieta claudia	--	--	**--**	--	1	4	--	1	**6**	**--**	--	1	**1**
Echinargus isola	--	--	**--**	--	--	--	--	1	**1**	**--**	--	--	**--**
Hesperia dacotae	5	7	**12**	--	--	33	--	4	**37**	**24**	27	--	**27**
Hesperia dacotae?	1	4	**--**	--	--	5	--	2	**7**	**1**	2	--	**2**
Junonia coenia	--	--	**--**	1	--	1	--	--	**2**	**--**	--	--	**--**
Junonia coenia?	--	--	**--**	--	1	--	--	--	**1**	**--**	--	--	**--**
Limenitis archippus	--	--	**--**	--	1	--	--	--	**1**	**--**	--	--	**--**
L.arthemis astyanax	--	1	**1**	--	--	--	--	--	**--**	**--**	--	--	**--**
Plebejus melissa	--	--	**--**	--	--	1	--	1	**2**	**--**	2	--	**2**
Plebejus melissa?	--	--	**--**	--	--	--	--	--	**--**	**--**	1	--	**1**
Lycaena hyllus	--	--	**--**	--	--	2	--	--	**2**	**--**	--	--	**--**
Oarisma poweshiek	6	2	**8**	--	--	14	1	1	**16**	**2**	5	--	**5**
Papilio polyxenes	--	--	**--**	--	--	1	--	1	**2**	**3**	1	--	**1**
Poanes massasoit	--	--	**--**	--	--	1	--	2	**3**	**--**	--	--	**--**
Polites mystic	1	--	**1**	1	1	2	--	--	**4**	**1**	4	--	**4**
Polites themistocles	1	--	**1**	--	--	10	1	3	**14**	**9**	5	--	**5**
Polite themistocles?	1	--	**1**	--	--	--	--	--	**--**	**--**	--	--	**--**
Satyrium titus	--	--	**--**	--	--	1	--	--	**1**	**--**	--	--	**--**
Satyrodes eurydice	7	--	**7**	--	--	24	--	2	**26**	**14**	1	--	**1**
Skipper species	7	10	**17**	--	--	13	4	12	**29**	**5**	13	--	**13**
Speyeria aphrodite	--	--	**--**	--	--	9	--	2	**11**	**--**	1	1	**2**
Speyeria cybele	--	--	**--**	--	--	3	--	--	**3**	**1**	--	--	**--**
Speyeria idalia	15	6	**21**	--	--	21	--	118	**139**	**21**	20	49	**69**
Speyeria idalia?	1	--	--	--	--	--	--	--	**--**	**--**	--	--	**--**
Speyeria sp.	11	2	**13**	--	--	39	--	13	**52**	**2**	3	2	**5**
Vanessa atalanta	--	--	**--**	--	1	1	--	--	**2**	**--**	--	2	**2**
Vanessa cardui	--	--	**--**	--	--	2	--	--	**2**	**--**	--	--	**--**
Vanessa sp.	--	--	**--**	1	1	--	--	--	**2**	**1**	1	1	**2**
Vanessa virginiensis	--	2	**2**	--	--	--	--	--	--	**--**	1	--	**1**
Totals (1,772)	162	97	**259**	5	14	381	28	452	**880**	**179**	316	138	**454**

Appendix 5, Table 4. 2005 butterfly surveys at other Minnesota sites (Mound Springs, Chippewa Prairie, Alexandria Moraine, and Felton Prairie).

	Mound Springs SNA			Chippewa Prairie			Alexandria Moraine Sites: Central			Alexandria Moraine Sites: North	Felton Prairie SNA			
	05 Jul	13 Jul		02 Jul	12 Jul		14 Jul	14 Jul		15 Jul	15 Jul	15 Jul	15 Jul	
Binomial	**SNA-N**	**SNA-S**	**Total**	**TNC**	**WMA**	**Total**	**Elmer**	**Wallace**	**Total**	**WPA**	**SE4**	**SW4**	**NE4**	**Total**
Anatrytone logan	2	--	**2**	1	--	**1**	--	--	**--**	**--**	--	--	--	**--**
Blue species	--	--	**--**	1	--	**1**	--	--	**--**	**--**	**--**	--	--	**--**
Boloria bellona	1	--	**1**	1	2	**3**	1	1	**2**	**--**	--	15	16	**31**
Cercyonis pegala	177	69	**246**	132	24	**156**	81	31	**112**	**112**	45	183	137	**365**
Chlosyne nycteis?	--	--	**--**	--	--	**--**	--	1	**1**	**--**	--	--	--	**--**
Coenonympha tullia	--	--	**--**	--	--	**--**	--	--	**--**	**1**	--	--	--	**--**
Colias sp.	30	6	**36**	13	16	**29**	114	29	**143**	**43**	3	21	7	**31**
Danaus plexippus	2	4	**6**	1	8	**9**	20	7	**27**	**7**	2	4	13	**19**
Euptoieta claudia	--	--	**--**	1	--	**1**	15	16	**31**	**14**	--	--	--	**--**
Hesperia dacotae	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	7	1	**8**
Hesperia dacotae?	--	--	**--**	--	--	**--**	--	--	**--**	**--**	--	3	--	**3**
Nymphalis antiopa	--	--	**--**	--	--	**--**	--	1	**1**	**--**	--	--	1*	**1**
Papilio polyxenes	--	--	**--**	--	--	**--**	1	--	**1**	**--**	--	2	1	**3**
Phycoides tharos	--	--	**--**	1	--	**1**	6	--	**6**	**9**	6	3	10	**19**
Poanes massasoit	7	--	**7**	--	--	**--**	--	--	**--**	**--**	--	--	--	**--**
Polites themistocles	1	--	**1**	1	--	**1**	3	--	**3**	**1**	--	--	--	**--**
Satyrium titus	1	--	**1**	--	--	**--**	5	3	**8**	**--**	--	--	--	**--**
Satyrodes eurydice	22	--	**22**	--	--	**--**	--	--	**--**	**1**	--	--	8	**8**
Skipper species	--	1	**1**	1	--	**1**	--	--	**--**	**--**	--	2	--	**2**
Speyeria aphrodite	--	--	**--**	--	--	**--**	7	4	**11**	**10**	--	--	--	**--**
Speyeria idalia	2	18	**20**	42	53	**95**	21	5	**26**	**4**	1	2	5	**8**
Speyeria sp.	3	--	**3**	--	6	**6**	16	5	**21**	**3**	1	1	1	**3**
Vanessa cardui	--	--	**--**	--	--	**--**	--	3	**3**	**--**	--	--	--	**--**
Vanessa sp.	--	--	**--**	--	--	**--**	1	4	**5**	**1**	--	1	1	**2**
Vanessa virginiensis	--	--	**--**	--	--	**--**	--	5	**5**	**--**	--	--	--	**--**
Totals (1765)	248	98	**346**	195	109	**304**	291	115	**406**	**206**	58	244	201	**503**

APPENDIX 6

Dakota Skipper Grazing Study and General Status Surveys
Butterfly Checklists

Dakota Skipper Grazing Study (2003-2005)
Butterfly Checklist – Systematic Arrangement

Systematic arrangement follows Opler and Warren (2003)
Scientific names include Opler and Warren (2003), and NABA (2001) for comparison
Common names follow NABA (2001)
* Designates nomenclature differences between Opler and Warren (2003), and NABA (2001)
** Designates target species that were not observed during study
*** Designates species observed only at additional status survey sites

Opler & Warren (2003)	NABA (2001)	
Binomial	**Binomial**	**Common Name**
<u>Superfamily Hesperioidea</u>		
Family Hesperiidae		
Subfamily Hesperiinae		
Anatrytone logan	*Anatrytone logan*	Delaware Skipper
Ancyloxypha numitor	*Ancyloxypha numitor*	Least Skipper
Atalopedes campestris	*Atalopedes campestris*	Sachem
*Atrytone arogos****	*Atrytone arogos*	Arogos Skipper
Atrytonopsis hianna	*Atrytonopsis hianna*	Dusted Skipper
Hesperia dacotae	*Hesperia dacotae*	Dakota Skipper
Hesperia leonardus	*Hesperia leonardus*	Leonard's Skipper
*Hesperia ottoe***	*Hesperia ottoe*	Ottoe Skipper
Oarisma poweshiek	*Oarisma poweshiek*	Poweshiek Skipperling
*Poanes massasoit****	*Poanes massasoit*	Mulberry Wing
Polites mystic	*Polites mystic*	Long Dash
Polites origenes	*Polites origenes*	Crossline Skipper
Polites peckius	*Polites peckius*	Peck's Skipper
Polites themistocles	*Polites themistocles*	Tawny-edged Skipper
Subfamily Heteropterinae		
Carterocephalus palaemon	*Carterocephalus palaemon*	Arctic Skipper
Subfamily Pyrginae		
Pyrgus communis	*Pyrgus communis*	Common Checkered-Skipper
<u>Superfamily Papilionioidea</u>		
Family Lycaenidae		
Subfamily Lycaeninae		
Tribe Polyommatini (Blues)		
*Celastrina neglecta**	*Celastrina ladon neglecta*	'Summer' Spring Azure
*Cupido comyntas**	*Everes comyntas*	Eastern Tailed-Blue
*Echinargus isola**	*Hemiargus isola*	Reakirt's Blue
Glaucopsyche lygdamus	*Glaucopsyche lygdamus*	Silvery Blue
*Plebejus melissa**	*Lycaeides melissa*	Melissa Blue
Tribe Lycaenini (Coppers)		
*Lycaena hyllus****	*Lycaena hyllus*	Bronze Copper
Lycaena xanthoides	*Lycaena xanthoides*	Great Copper

Butterfly Checklist (Systematic Arrangement – continued)

Opler & Warren (2003)	NABA (2001)	
Binomial	**Binomial**	**Common Name**
<u>Superfamily Papilionioidea (continued)</u>		
Tribe Eumaeini (Hairstreaks)		
Satryium calanus	*Satryium calanus*	Banded Hairstreak
Satryium edwardsii	*Satryium edwardsii*	Edwards' Hairstreak
Satryium liparops	*Satryium liparops*	Striped Hairstreak
Satryium titus	*Satryium titus*	Coral Hairstreak
Strymon melinus	*Strymon melinus*	Gray Hairstreak
Family Nymphalidae		
Subfamily Danainae		
Danaus plexippus	*Danaus plexippus*	Monarch
Subfamily Heliconiinae		
Boloria bellona	*Boloria bellona*	Meadow Fritillary
Euptoieta claudia	*Euptoieta claudia*	Variegated Fritillary
Speyeria aphrodite	*Speyeria aphrodite*	Aphrodite Fritillary
Speyeria cybele	*Speyeria cybele*	Great Spangled Fritillary
Speyeria idalia	*Speyeria idalia*	Regal Fritillary
Subfamily Limenitidinae		
Limenitis archippus	*Limenitis archippus*	Viceroy
*Limenitis arthemis**	*Limenitis arthemis arthemis*	White Admiral
*Limenitis arthemis** ***	*Limenitis arthemis astyanax*	Red-spotted Purple
Subfamily Nymphalinae		
Chlosyne nycteis (?)***	Chlosyne *nycteis*	Silvery Checkerspot
Junonia coenia	*Junonia coenia*	Common Buckeye
*Nymphalis antiopa****	*Nymphalis antiopa*	Mourning Cloak
Phyciodes tharos	*Phyciodes tharos*	Pearl Crescent
Vanessa atalanta	*Vanessa atalanta*	Red Admiral
Vanessa cardui	*Vanessa cardui*	Painted Lady
Vanessa virginiensis	*Vanessa virginiensis*	American Lady
Subfamily Satyrinae		
Cercyonis pegala	*Cercyonis pegala*	Common Wood-Nymph
Coenonympha tullia	*Coenonympha tullia inornata*	'Inornate' Common Ringlet
Enodia anthedon	*Enodia anthedon*	Northern Pearly-eye
Satyrodes eurydice	*Satyrodes eurydice*	Eyed Brown
Family Papilionidae		
Subfamily Papilioninae		
Papilio glaucus	*Papilio glaucus*	Eastern Tiger Swallowtail
Papilio polyxenes	*Papilio polyxenes*	Black Swallowtail
Family Pieridae		
Subfamily Coliadinae		
Colias eurytheme	*Colias eurytheme*	Orange Sulphur
Colias philodice	*Colias philodice*	Clouded Sulphur

Dakota Skipper Grazing Study (2003-2005)
Butterfly Checklist (Alphabetical Arrangement)

Scientific names include Opler and Warren (2003), and NABA (2001) for comparison
Common names follow NABA (2001)
Species Code – 1st three letters of genus and species names; used for recording field data
* Designates nomenclature differences between Opler and Warren (2003), and NABA (2001)
** Designates target species that were not observed during study
*** Designates species observed only at additional status survey sites

	Opler & Warren (2003)	**NABA (2001)**	
Code	**Binomial**	**Binomial**	**Common Name**
Analog	*Anatrytone logan*	*Anatrytone logan*	Delaware Skipper
Ancnum	*Ancyloxypha numitor*	*Ancyloxypha numitor*	Least Skipper
Atacam	*Atalopedes campestris*	*Atalopedes campestris*	Sachem
Atraro	*Atrytone arogos****	*Atrytone arogos*	Arogos Skipper
Atrhia	*Atrytonopsis hianna*	*Atrytonopsis hianna*	Dusted Skipper
Bolbel	*Boloria bellona*	*Boloria bellona*	Meadow Fritillary
Carpal	*Carterocephalus palaemon*	*Carterocephalus palaemon*	Arctic Skipper
Celneg	*Celastrina neglecta**	*Celastrina ladon neglecta*	'Summer' Spring Azure
Cerpeg	*Cercyonis pegala*	*Cercyonis pegala*	Common Wood-Nymph
Chlnyc	*Chlosyne nycteis* (?)***	*Chlosyne nycteis*	Silvery Checkerspot
Coetul	*Coenonympha tullia**	*Coenonympha tullia inornata*	'Inornate' Common Ringlet
Coleur	*Colias eurytheme*	*Colias eurytheme*	Orange Sulphur
Colphi	*Colias philodice*	*Colias philodice*	Clouded Sulphur
Cupcom	*Cupido comyntas**	*Everes comyntas*	Eastern Tailed-Blue
Danple	*Danaus plexippus*	*Danaus plexippus*	Monarch
Echiso	*Echinargus isola**	*Hemiargus isola*	Reakirt's Blue
Enoant	*Enodia anthedon*	*Enodia anthedon*	Northern Pearly-eye
Eupcla	*Euptoieta claudia*	*Euptoieta claudia*	Variegated Fritillary
Glalyg	*Glaucopsyche lygdamus*	*Glaucopsyche lygdamus*	Silvery Blue
Hesdac	*Hesperia dacotae*	*Hesperia dacotae*	Dakota Skipper
Hesleo	*Hesperia leonardus*	*Hesperia leonardus*	Leonard's Skipper
Hesott	*Hesperia ottoe*	*Hesperia ottoe*	Ottoe Skipper
Juncoe	*Junonia coenia*	*Junonia coenia*	Common Buckeye
Limarc	*Limenitis archippus*	*Limenitis archippus*	Viceroy
Limart	*Limenitis arthemis**	*Limenitis arthemis arthemis*	White Admiral
Limart	*Limenitis arthemis* * ***	*Limenitis arthemis astyanax*	Red-spotted Purple
Lychyl	*Lycaena hyllus****	*Lycaena hyllus*	Bronze Copper
Lycxan	*Lycaena xanthoides*	*Lycaena xanthoides*	Great Copper
Nymant	*Nymphalis antiopa****	*Nymphalis antiopa*	Mourning Cloak
Oarpow	*Oarisma poweshiek*	*Oarisma poweshiek*	Poweshiek Skipperling
Papgla	*Papilio glaucus*	*Papilio glaucus*	Eastern Tiger Swallowtail
Pappol	*Papilio polyxenes*	*Papilio polyxenes*	Black Swallowtail
Phytha	*Phyciodes tharos*	*Phyciodes tharos*	Pearl Crescent
Plemel	*Plebejus melissa**	*Lycaeides melissa*	Melissa Blue
Poamas	*Poanes massasoit****	*Poanes massasoit*	Mulberry Wing

Butterfly Checklist (Alphabetical Arrangement – continued)

	Opler & Warren (2003)	NABA (2001)	
Code	**Binomial**	**Binomial**	**Common Name**
Polmys	*Polites mystic*	*Polites mystic*	Long Dash
Polori	*Polites origenes*	*Polites origenes*	Crossline Skipper
Polpec	*Polites peckius*	*Polites peckius*	Peck's Skipper
Polthe	*Polites themistocles*	*Polites themistocles*	Tawny-edged Skipper
Pyrcom	*Pyrgus communis*	*Pyrgus communis*	Common Checkered-Skipper
Satcal	*Satyrium calanus* (?)	*Satyrium calanus*	Banded Hairstreak
Satedw	*Satyrium edwardsii*	*Satyrium edwardsii*	Edwards' Hairstreak
Satlip	*Satryium liparops*	*Satryium liparops*	Striped Hairstreak
Sattit	*Satyrium titus*	*Satyrium titus*	Coral Hairstreak
Sateur	*Satyrodes eurydice*	*Satyrodes eurydice*	Eyed Brown
Speaph	*Speyeria aphrodite*	*Speyeria aphrodite*	Aphrodite Fritillary
Specyb	*Speyeria cybele*	*Speyeria cybele*	Great Spangled Fritillary
Speida	*Speyeria idalia*	*Speyeria idalia*	Regal Fritillary
Strmel	*Strymon melinus*	*Strymon melinus*	Gray Hairstreak
Vanata	*Vanessa atalanta*	*Vanessa atalanta*	Red Admiral
Vancar	*Vanessa cardui*	*Vanessa cardui*	Painted Lady
Vanvir	*Vanessa virginiensis*	*Vanessa virginiensis*	American Lady

APPENDIX 7

Dakota Skipper Grazing Study
Workgroup Participants, Other Contacts,
and Planning Meeting Summary

Workgroup Participants

Rich Baker	MN DNR rich.baker@dnr.state.mn.us	(651) 297-3764
Robert Dana	MN DNR robert.dana@dnr.state.mn.us	(651) 297-2367
Steve Delehanty	USFWS steve_delehanty@fws.gov	(320) 589-1001
Phil Delphey	USFWS phil_delphey@fws.gov	(612) 725-3548 ext 206
Lisa Gelvin-Innvaer	MN DNR, Nongame lisa.gelvin-innvaer@dnr.state.mn.us	(507) 359-6033
Katie Goodwin	USFWS Morris WMD katie_Goodwin@fws.gov	(320) 589-4971 R.O.S.
Katie Haws	MN DNR katie.haws@dnr.state.mn.us	(218) 755-2976
Laura Hubers	USFWS Waubay WMD laura_hubers@fws.gov	(605) 947-4521
Margaret Kuchenreuther	U of MN Morris, Associate Professor kuchenma@cda.mrs.umn.edu	(320) 589-6335
Bruce Lenning	MN DNR bruce.lenning@dnr.state.mn.us	(218) 755-2976
Jerry Selby	Ecological & GIS Services, Owner jselby@mchsi.com	(515) 961-0718
Dennis Skadsen	Day Conservation District Project Coordinator dennis-skadsen@sd.nacdnet.org	(605) 345-4661 ext 124
Sara Vacek	USFWS Morris WMD, Wildlife Biologist sara_vacek@fws.gov	(320) 589-4973
Brett Wehrle	Big Stone NWR, Refuge Manager Brett_Wehrle@fws.gov	(320) 273-2191
Tim Whitfeld	MN DNR tim.whitfeld@dnr.state.mn.us	(651) 296-5359

Other Contacts (Experts and Landowners)

Experts

Craig Bower	NRCS, Glenwood, MN, District Conservationist	320-634-5143
Dean Schmidt	Wes-Min RC&D Council, Alexandria	320-763-3191
Melody Webb	Glacial Lakes State Park, Manager	320-239-2860

Landowner Contacts

Randy Anderson	320-239-2579
Mark Frederickson	320-239-4213
Michael & Sharon Rutledge	320-239-4187
Rose Evenson	320-239-2578
Don & Helen Berheim	320-842-4466
Luverne & Mary Jo Forbord	320-239-4054

Planning Meeting Summary
Friday – January 9, 2003
11:00 a.m. – 2:00 p.m.

Planning Meeting Attendees

Rich Baker, MN DNR
Steve Delehanty, USFWS
Phil Delphey. USFWS
Lisa Gelvin-Innvaer, MN DNR, Nongame
Katie Goodwin, USFWS Morris WMD
Laura Hubers, USFWS Waubay WMD
Margaret Kuchenreuther, U of MN Morris, Associate Professor
Bruce Lenning, MN DNR
Jerry Selby, Ecological and GIS Services, Private Consultant
Dennis Skadsen, Day Conservation District Project Coordinator
Sara Vacek, USFWS Morris WMD, Wildlife Biologist

Project Background (Rich Baker)

Chuck Kjos (Phil Delphey's predecessor at the FWS) and Robert Dana (MN DNR) have played an important role in developing the project, and will be important partners in its implementation. The seed money for the project came from left over funding for a monitoring project. Dennis Schlicht was hired to set up and conduct monitoring at representative sites over a three-year period. It soon became apparent that it was going to be difficult to get good, cost effective results from the monitoring, and a decision was made to use the remaining money ($25,000) to look at the effects of grazing on the Dakota skipper. Bridgette Olson had an additional $20,000 for the project, bringing the total funds to $45,000. They tried to get a professor or team of professors with expertise in entomology and range management to sponsor a graduate student to do the project, but were unable to get anybody. In the summer of 2002 Jerry Selby's position as Director of Science at the Nature Conservancy of Iowa was cut, and he became available for doing consulting work. He worked with the Dakota skipper and other prairie butterflies at Prairie Coteau for his Ph.D. research, and has continued to work with prairie butterflies and issues related to their management during his 9-year tenure at the Conservancy. Jerry will be assuming responsibility for managing the Dakota skipper grazing study. Phase 1 of the project consists of 1) conducting a literature review, 2) contacting stakeholders, 3) conducting field visits, and 4) developing a research plan. It will be completed by the end of February.

Research Design

Most of the meeting focused on the development of the research design. Key factors discussed included 1) grazing regimes, 2) practical considerations in attempting to apply experimental treatments, 3) measures used to monitor the effects on the Dakota skipper, and 4) study sites to be included in the study. An additional issue discussed was the availability of surveyors to participate in the study. Participants were very helpful, and over the coarse of the meeting a consensus emerged on many of the key issues. Key points are summarized below.

Grazing regimes

All grazing systems involve varying combinations of grazing **intensity**, **duration**, and **timing**. Therefore, while it is convenient to compare "grazing regimes" as a whole, a proper understanding of the effects of those regimes on the Dakota skipper will require a careful examination of the interaction between those factors.

Two broad categories of grazing regimes include the following:
1) **Open season-long grazing** (May – October). Dairy farmers commonly use this regime. Ranchers also commonly bring in cattle from some distance for season-long grazing. This regime is typical of many South Dakota sites ranging from hundreds to thousands of acres. Duration and timing are relatively fixed for this method, but adjusting the stocking rates can vary intensity.
2) **Prescribed grazing**. This regime generally involves fencing to divide the site into different pastures, and rotating the cattle through the pastures. Intensity, duration and timing can all be varied, resulting in numerous combinations of those factors.

As indicated above, prescribed grazing regimes can assume numerous variations. They can include the following:
1) **Cool season/warm season**. This system takes advantage of the seasonality of cool season and warm season grasses, rotating cattle to the paddocks where the grasses are actively growing (e.g. cool season in spring and fall, and warm season during the summer). An attempt is usually made to regulate the intensity of grazing by setting the number of Animal Units (AU's) per time period allowed. This system is good for cattle production, but could be worse for the overall prairie health since areas are grazed whenever they are actively growing.
2) **Savory (intensive/rapid rotational)**. This system represents an extreme form of rotational grazing in which each paddock is grazed intensively for a few days, and then allowed to rest for up to 30 days. Fencing, labor moving cattle and water supplies are issues limiting the use of this method. Ideally, the timing of grazing should also be varied. Dean Elmer is using this method. He has twelve paddocks about 35-40 acres in size. Two paddocks are in CRP and not grazed. The other ten are grazed for three days and then rested for thirty days. Margaret has conducted vegetation studies at his property, and already has exclosures set up.

Randy Anderson, who owns land adjacent to Glacial Lakes State Park, plans to implement an intermediate rotational grazing program. He has indicated that he would allow his property to be included in the Dakota skipper grazing study.

Several additional points related to grazing were made by participants.
- In the southern plains there is a focus on grass production, with cattle production as a byproduct. In the northern plains the focus tends to be on cattle production, with grass production as a byproduct. This subtle difference has a profound effect on how rangeland is managed.
- Public land could play a key role in the study, as there are more options for manipulating the management.
- It is important to consider new versus established grazing systems.

- It is important to measure the effects on vegetation (esp. forb diversity). Does rotational grazing lead to unique habitat types? What is the effect on nectar plants? What is the effect of trampling?
- Slope position may be a factor, since grazing tends to be concentrated on flat uplands and minimized on steep slopes. Steep slopes might serve as refugia.
- Bison grazing (selective for grasses) versus cattle grazing (selective for forbs) should be considered.
- Focusing on the grazing systems most likely to be used in an area can narrow the focus of the study.
- Haying might favor Dakota skippers by keeping the vegetation stature low.

Measures of Grazing Effects

Effects of grazing can occur at various stages of the Dakota skipper life cycle (adult, larvae, pupae or egg). Adult abundance is commonly used as an indirect measure of the combined effects on all the life stages because it is the easiest to measure. It is, however, inadequate for separating out the stage at which an effect occurs, and adult movement can confound the results. It was the consensus of the group that it was critically important to separate out the effects on each life cycle stage.

Life stages that need to be considered include the following:
1) **Egg**. Oviposition height could be an issue related to grazing height, and oviposition species selection could be an issue related to grazing preferences. Vegetation height, character and persistence are all factors that could contribute to egg survival and hatching success.
2) **Larvae**. Larval effects can occur during early development (late summer to fall), diapause (winter), and late development (spring to early summer). When larvae are actively feeding vegetation composition, quality and height, trampling, and fire are among the factors that could effect their survival. Over wintering larvae might be affected by compaction of the soil and the presence/absence of an insulating layer of vegetation. Dakota and Ottoe skipper larvae extend their shelters below the ground surface to over winter. This helps protects them from extreme winter conditions and from fire, but the ability to burrow might be negatively impacted by compaction.
3) **Pupae**. Trampling or removal of protective vegetation could affect the survival of pupae.
4) **Adults**. Vegetation structure and nectar sources are key factors for adult survival. In a prairie landscape adult movement to more suitable habitats can mitigate negative effects in one area, but for isolated populations this may not be an option.

It was apparent that to adequately address the above issues the study would need to include the following:
1) **Monitor adult populations**. Relative population estimates should be obtained using a standardized monitoring protocol. Vegetation data (e.g. composition, structure, nectar plants) should also be collected.
2) **Monitoring egg survival**. A sample of eggs should be selected by careful observation of ovipositing females. Oviposition height, species selection and other vegetation attributes should be noted. Each egg should be followed to determine whether it survives to successfully hatch. Elimination of eggs by grazing or other factors would be key observations.

3) **Monitoring larval survival**. Survival of larvae is difficult to observe directly. Larval survival would need to be measured indirectly by observing egg-laying to obtain a sample of larvae, confining the larvae to known locations, and then using emergence traps to determine the number of larvae that survive to the adult stage. Robert Dana should be consulted to refine the methodology.

Practical Considerations and Site Selection for the Study

An important consideration in the site selection process is whether to conduct an extensive study including numerous replicates of each grazing regime spread across a large geographic area, an intensive study focused on a few sites in a localized area, or some combination of those approaches. Advantages of an extensive study are greater replication per grazing regime and better representation of geographic variation. Results are likely to have broader applications than those from a few sites in a localized area. Disadvantages are limitations to the types and quality of data that can be collected. An extensive study would necessarily be limited to using one or a few quick surveys of adult populations to measure grazing effects. The data collected per site would not be very robust, and adult populations might not be the best measure if grazing affects other life stages. Advantages of an intensive study are the greater types and quality of data that can be collected. Given limited resources, an intensive localized study is the only way to examine the life stages at which grazing effects are occurring. Disadvantages of an intensive study are little or no replication per grazing regime, and limited representation of geographic variation. The results might be specific to that particular area.

For this study there was a consensus that it was important to understand the impacts of grazing on each life stage of the Dakota skipper, and therefore that the focus should be an intensive study. Extensive surveys would be included only if time permitted. There was a consensus that the study should be focused in and around Glacial Lakes State Park. Grazing regimes on surrounding property include rotational grazing (Randy Anderson property), and moderate and intensive season-long grazing. Within the park and WPA's additional grazing regimes and ungrazed controls can be included. It might also be possible to examine burn effects, since units will include a burn history.

Inclusion of South Dakota sites would also provide valuable information, but is probably beyond the scope of this study. Dennis indicated that there are areas where all types of grazing, haying and burning are represented within a 50-mile area. The pros and cons of focusing the study at Glacial Lakes State Park versus a 50-mile area in SD need to be considered before making a final decision on the location for the intensive study area. It might be possible to at least arrange for extensive surveys in SD, but these sites tend to be very connected, which could confound the effects of grazing if adult numbers are the only index used to measure them. Jerry will work with Dennis to determine the value of these sites to the study, and the logistics of including them.

There was some discussion of the value of looking at isolated versus connected sites. It was suggested that it is most critical to understand the effects in isolated sites, since recolonization cannot be counted on for recovery from negative impacts of grazing.

Jerry will be working with landowners and local experts to develop the site selection process. He will also begin pulling together GIS data for the potential study areas.

Potential Participants in Study

For the intensive study it will be necessary to have assistants to collect all the data needed on each study area. The most convenient and cost-effective solution would be to hire students from the UM Morris. Jerry will work with Margaret on this. If there aren't enough UM Morris students available he will consider other options. Additional assistance could come from working group members but since they all have other obligations their assistance should not be depended on. Work done by Dennis and Gary Marone in SD could also contribute to the study, and Jerry will work with them to coordinate efforts.

Field Visits

Following the meeting the group went on a quick road trip to see the areas in-and-around Glacial Lakes State Park that might be included in the study. It was extremely cold and windy so we did not take the time to hike on any of the tracts.

APPENDIX 8

Dakota Skipper Grazing Study
Revised 2005 Field Season Work Plan

28 January 2005 Email from Rich Baker
Summarizing Decisions at 10 January 2005 Meeting

Phil/Robert/Jerry,

Thanks to each of you for taking the time to meet on January 10th to discuss the future of our Dakota Skipper Grazing project. The purpose of this email is to provide the following summary of our discussion and agreements:

1) We agreed that low Dakota skipper population numbers continue to conspire against the grazing component of this project. The very low numbers observed during the 2003 and 2004 field seasons have prevented Jerry from conducting the experimental manipulations that were intended to allow us to assess the effects of grazing on the species.

2) At the same time, Jerry's efforts are valuable in documenting the severe decline being experienced by several prairie lepidoptera on the study sites. We agreed that Jerry's documentation will be useful in assessing the status of these species and in developing management responses to the observed trends.

3) Given points 1 and 2, and the fact that Jerry is currently funded for only one more field season, we agreed that it is not reasonable to attempt to initiate the originally planned experimental manipulations at this point, and this aspect of the project will be abandoned. Instead, the final (2005) field season will be devoted to further Dakota skipper surveying and monitoring in order to continue to document the species' population trends in areas where transects have been established, and to document presence/absence of the species in other areas as time permits. Data will be collected on other prairie lepidoptera as opportunity allows, but the focus of the project will remain the Dakota skipper.

In light of the above decision, it is agreed by Phil (representing FWS as the funding agency) and me (as project coordinator), and by Jerry (contractor) and me, that the final field season of the project will be devoted to the following activities:

1) Monitoring during the 2005 field season will include conducting at least two quantitative surveys on all project transects. Additional timed wandering transects will be conducted at Hole-In-The-Mountain Prairie, at Prairie Coteau, and (if skipper numbers are sufficient to warrant the effort) at Felton Prairie.

2) As time allows, surveys during the 2005 field season will include conducting qualitative, presence/absence surveys at sites outside the project study area (e.g., Chanarambie Creek valley sites, SNAs), to be determined by Jerry in cooperation with myself, Robert, and other project partners.

3) As a result of this refocusing of the project, the project final report (due on or before 12/31/05) will place new emphasis on an analysis of the relationship between dependent variables derived from survey and monitoring results (perhaps transformed to gross classes such as "none," "few," and

"many") and such independent variables as weather, management history, and habitat characteristics.

4) Finally, Jerry will include efforts to coordinate rangewide with other prairie lepidoptera survey and monitoring projects, and will initiate efforts to raise additional funds (e.g., by developing a USDA, National Research Initiative proposal) to continue the project.

This email will serve as formal documentation of the modification of all agreements associated with the project. Please contact me if you have any questions or concerns about this email.

With Regards,

Rich

<><><><><><><><><><><><><><><><><><><><><><><><><>
Richard J. Baker
Animal Research Coordinator / Zoologist
Minnesota Natural Heritage and Nongame Research Program
Division of Ecological Services
Minnesota Department of Natural Resources
500 Lafayette Rd., Box 25
St. Paul, MN 55155
Phone: 651/297-3764
Fax: 651/296-1811
E-mail: richard.baker@dnr.state.mn.us
<><><><><><><><><><><><><><><><><><><><><><><><><>