FINAL REPORT - DECEMBER 1990

Project Title: An Ecological Study of the Plant/Butterfly Associations and their Response to Management, at the Prairie Coteau Scientific and Natural Area (SNA), Pipestone County, Minnesota

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I. INTRODUCTION

A study of rare prairie-obligate butterflies has been conducted during the summers of 1988, 1989 and 1990 at Prairie Coteau Scientific and Natural Area, Pipestone County, Minnesota. During the 1990 field season the project was expanded to include surveys at additional sites in southwest Minnesota including Hole-in-the-Mountain Preserve in Lincoln County, Pipestone National Monument in Pipestone County, Blue Mound State Park in Rock County, and Chanarambie Creek in Murray and Pipestone Counties. This work is part of a four-year study which will be completed in 1991. The principal objectives of the study are to 1) examine the occurrence and distributional patterns of rare butterflies in relation to plant community associations and environmental factors such as soils, topography, aspect and available moisture; 2) examine the relationship between the phenology of important nectar and food plants, and the flight periods for the prairie-obligate butterfly species; 3) examine the response of the rare butterflies and their associated nectar and food sources to management practices such as fire and grazing; 4) continue to test the population monitoring methodology at Prairie Coteau and apply it to other sites; and 5) document the butterfly and plant species which occur at each study site.

Fieldwork at Prairie Coteau in 1990 consisted of (1) setting up new transects and flagging ten meter intervals along the transects for more accurate geo-referencing of the data, (2) population counts of all species of butterflies, (3) distribution mapping and behavioral observations for selected prairie-obligate butterflies, and (4) collecting preliminary vegetation data. Hesperia dacotae (Skinner) continues to be the focus of the study, but other

prairie-obligate species for which distribution and behavioral data are being collected include Atrytone arogos iowa (Scudder), Atrytonopsis hianna hianna (Scudder), Clossiana selene (Denis & Schiffermuller), Coenonympha tullia inornata, Glaucopsyche lygdamus (Doubleday), Hesperia leonardus pawnee Harris, Hesperia ottoe W.H. Edwards, Lycaeides melissa melissa, Oarisma poweshiek (Parker), Polites mystic, and Speyeria idalia (Drury).

The primary purpose of fieldwork at the other sites was to document the presence of rare butterflies at those sites, and to set up transects for population monitoring at Hole-in-the-Mountain Preserve. Species lists were compiled for each site, and the number and distribution of selected prairie-obligate species were recorded.

II. SITE DESCRIPTION

Prairie Coteau consists mostly of glacial till hill prairie, with small inclusions of gravel prairie, and mesic blacksoil prairie (unpublished DNR report). Most of the prairie is restricted to the steep slopes of the large rolling hills. Flat upland areas have either been converted to cropland, or have been degraded by past grazing. The drainageways and low-lying areas include mesic prairie and sedge meadow, but are fairly weedy in many cases. For the surveying and monitoring the area has been divided into five units based on the proposed management units (see Figure 1). (1) Unit 1 includes low-lying sedge meadow and disturbed fields on the south end of the original purchase (NW1/4, SE1/4 Sec 32). No monitoring was done here since there was no suitable habitat for H. dacotae. (2) Unit 2 includes upland prairie on the

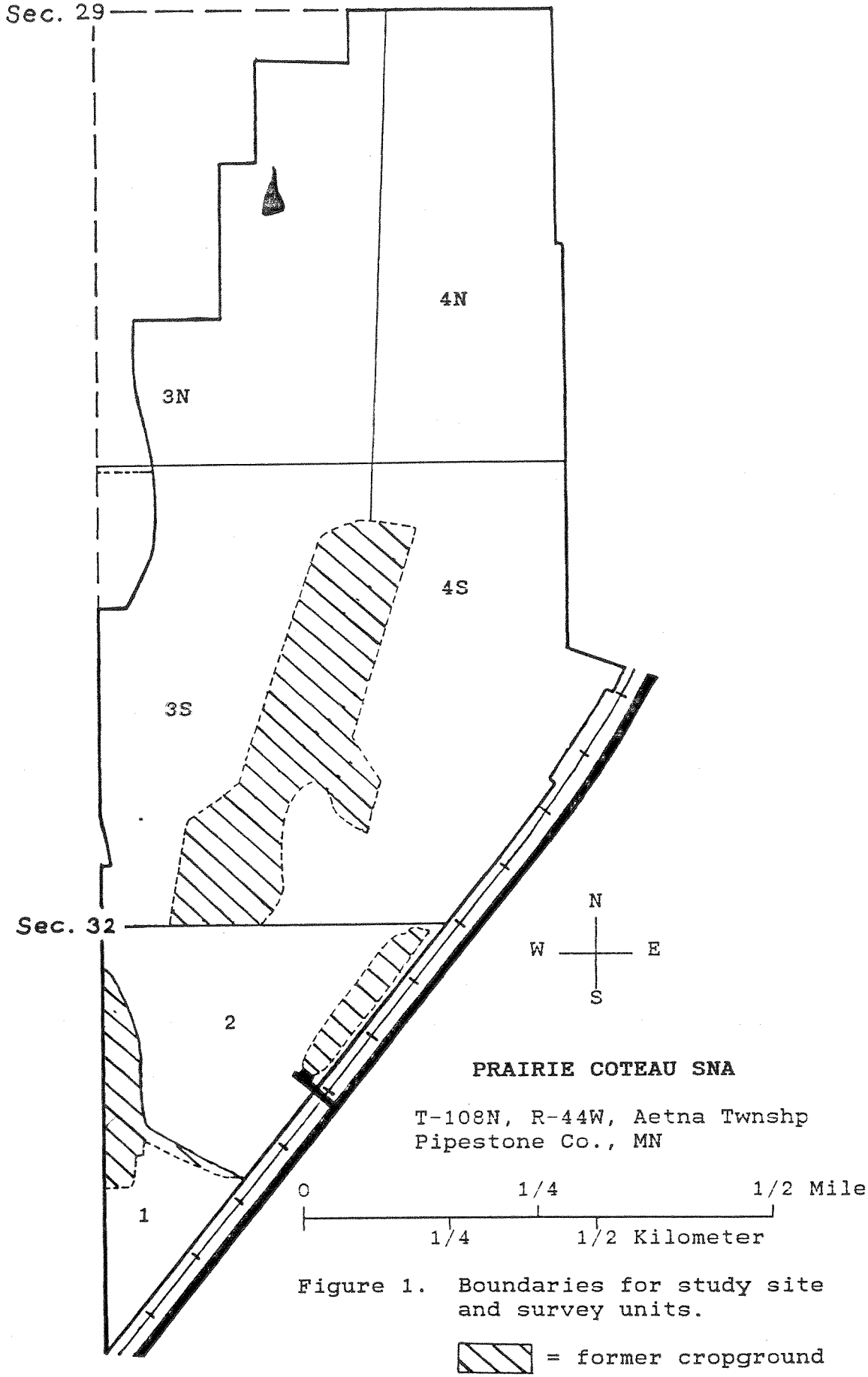


Figure 1. Boundaries for study site and survey units.

north end of the original purchase (NW1/4, SE1/4 Sec 32). (3) The south half of unit 3 (W1/2, NE1/4 Sec 32) was treated as a separate monitoring unit (3S). It has a sedge meadow valley running north and south through the middle, with upland prairie ridges on either side. This area was degraded by recent grazing, but is recovering and has a good population of H. dacotae. (4) The south half of Unit 4 (E1/2, NE1/4 Sec 32) was also treated as a separate monitoring unit (4S). It includes a combination of steep upland prairie ridges and somewhat disturbed valleys and draws. Much of the prairie is in good shape, and this area has a good population of H. dacotae. (5) The northern halves of units 3 and 4 were treated as one monitoring unit (3&4N). Unit 3N is similar to 3S, but with steeper topography and better quality prairie. Much of unit 4N is degraded, flat upland, with suitable habitat restricted to the slopes on the eastern edge of the unit, and on neighboring property to the east. The cropground in units 3S and 4S (see Figure 1) was not surveyed, but the transects were set up in 1989 and 1990 so they could be extended to include these area in the future.

Hole-in-the-Mountain Preserve and Chanarambie Creek are very similar to Prairie Coteau, with the prairie restricted mostly to steep slopes of glacial till deposits. Hole-in-the-Mountain Preserve is owned by the Minnesota Chapter of The Nature Conservancy and prairie in the Chanarambie Creek area is still privately owned. Pipestone National Monument and Blue Mound State Park have prairie associated with Sioux Quartzite outcrop areas.

III. METHODS

Transect Design at Prairie Coteau

Within each of the four monitoring units transects were selected which crossed the area in an east/west direction. For the 1988 and 1989 surveys each quarter section was divided into eight rectangular subunits and two different designs were used in which the transect endpoints within each rectangular subunit were selected at random (see Figures 2 and 3). In 1990 the routes were again redesigned to simplify geo-referencing the data for use in a GIS analysis. The same rectangular subunits were used, but the transects run due east/west across the middle of each unit (see Figure 4). County roads, fencelines, and 7.5 minute series U.S.G.S topographic maps were used to establish the location of the section and quarter section boundaries. The transects were located by measuring 100 meter (aerial distance) intervals starting 50 meters from the northern and southern boundaries of each quarter section. The actual distance between transects should have been 100.58 meters, based on 804.67 meters per half mile, but the measured distance between quarter section lines was closer to 800 meters. Starting at the west boundary of each quarter section, the ground distance along each transect was measured and orange flags were used to mark the ten meter intervals. Fifty meter intervals were marked with white flags which were labeled with the distance along the transect. The transect routes were drawn on topographic maps and the 50 meter intervals were labeled. These maps were then attached to the survey forms for recording distribution data. The ground distances along the transects will be converted to aerial distances for use in the GIS analysis.

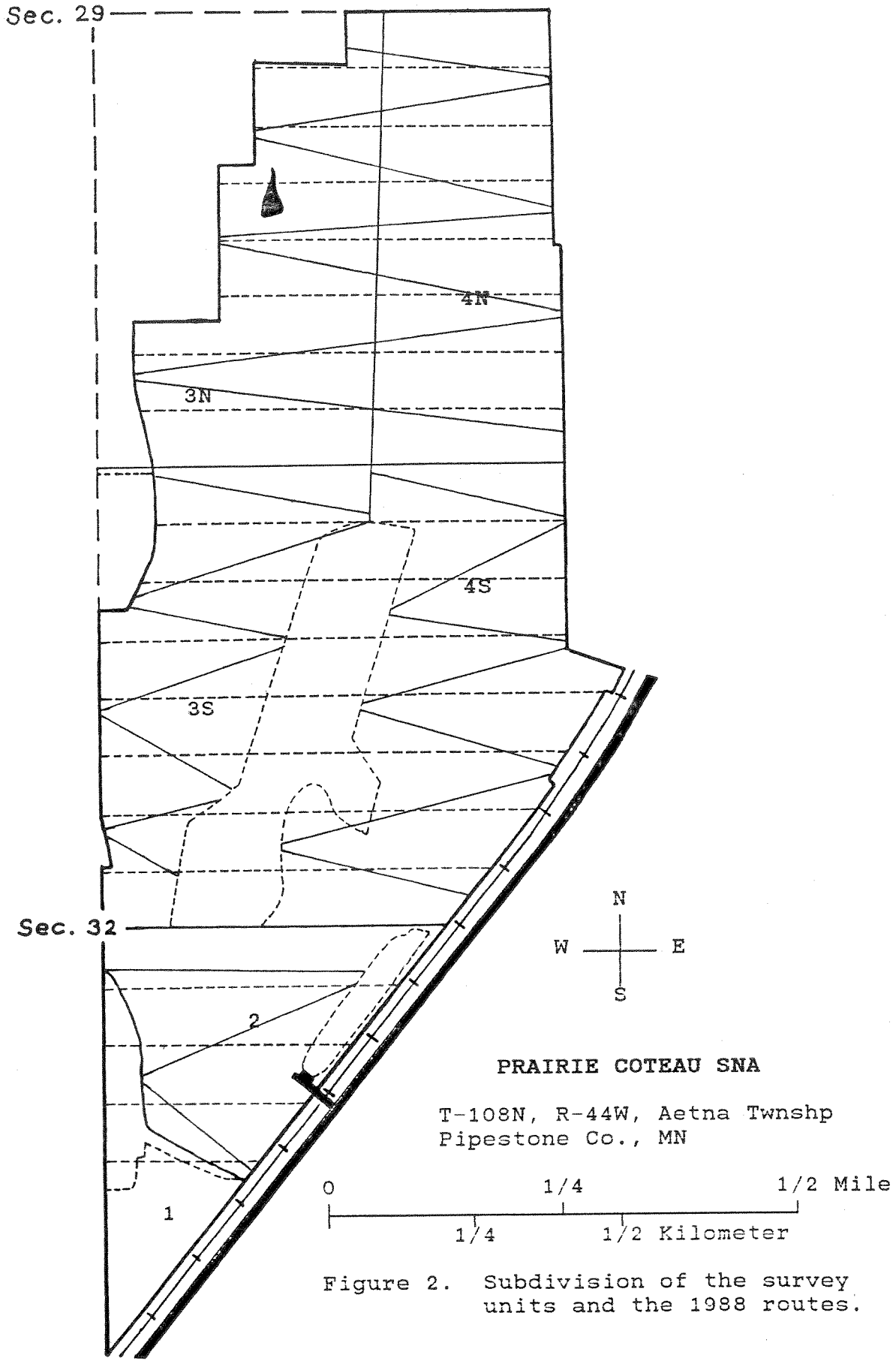


Figure 2. Subdivision of the survey units and the 1988 routes.

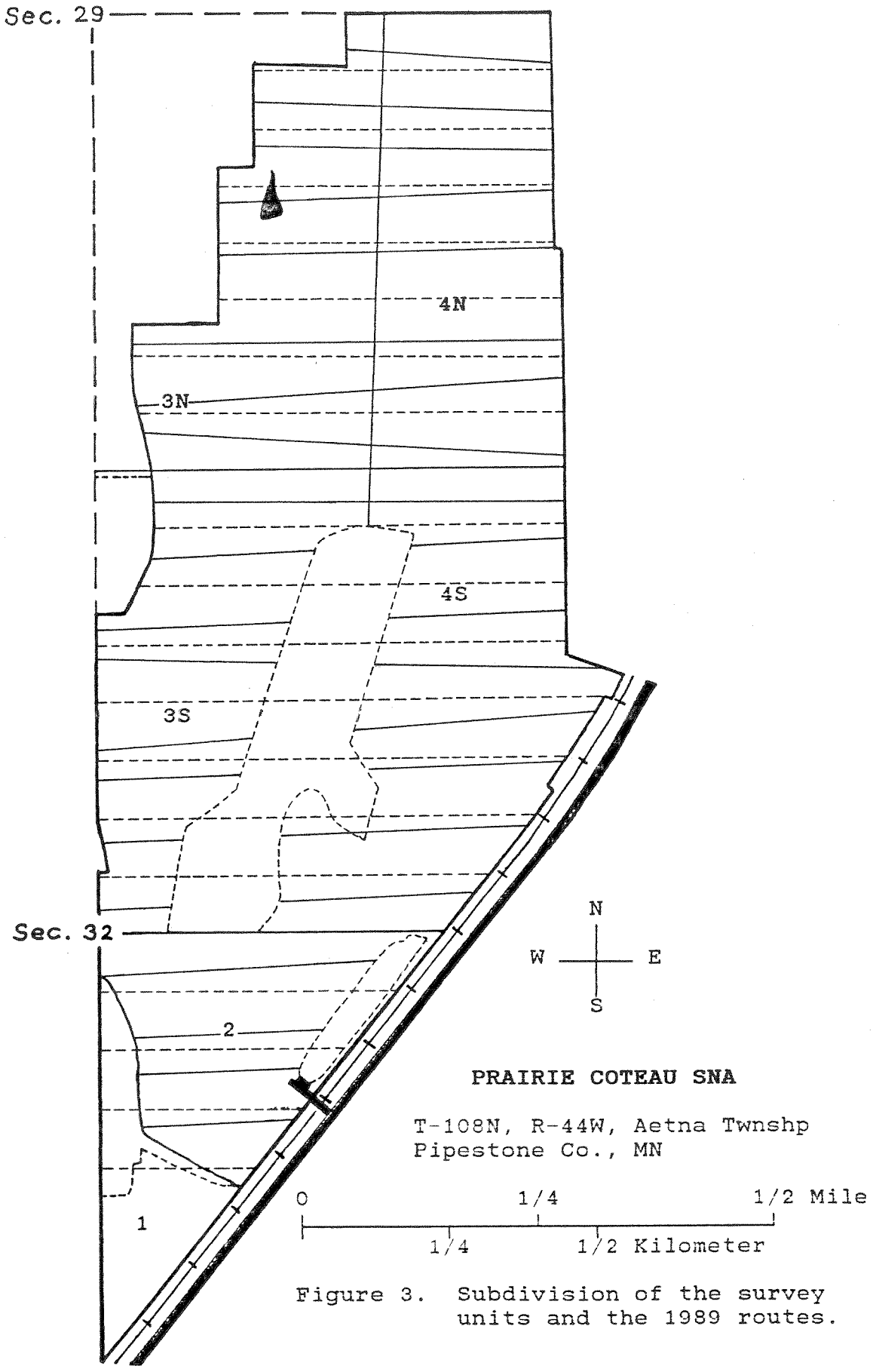


Figure 3. Subdivision of the survey units and the 1989 routes.

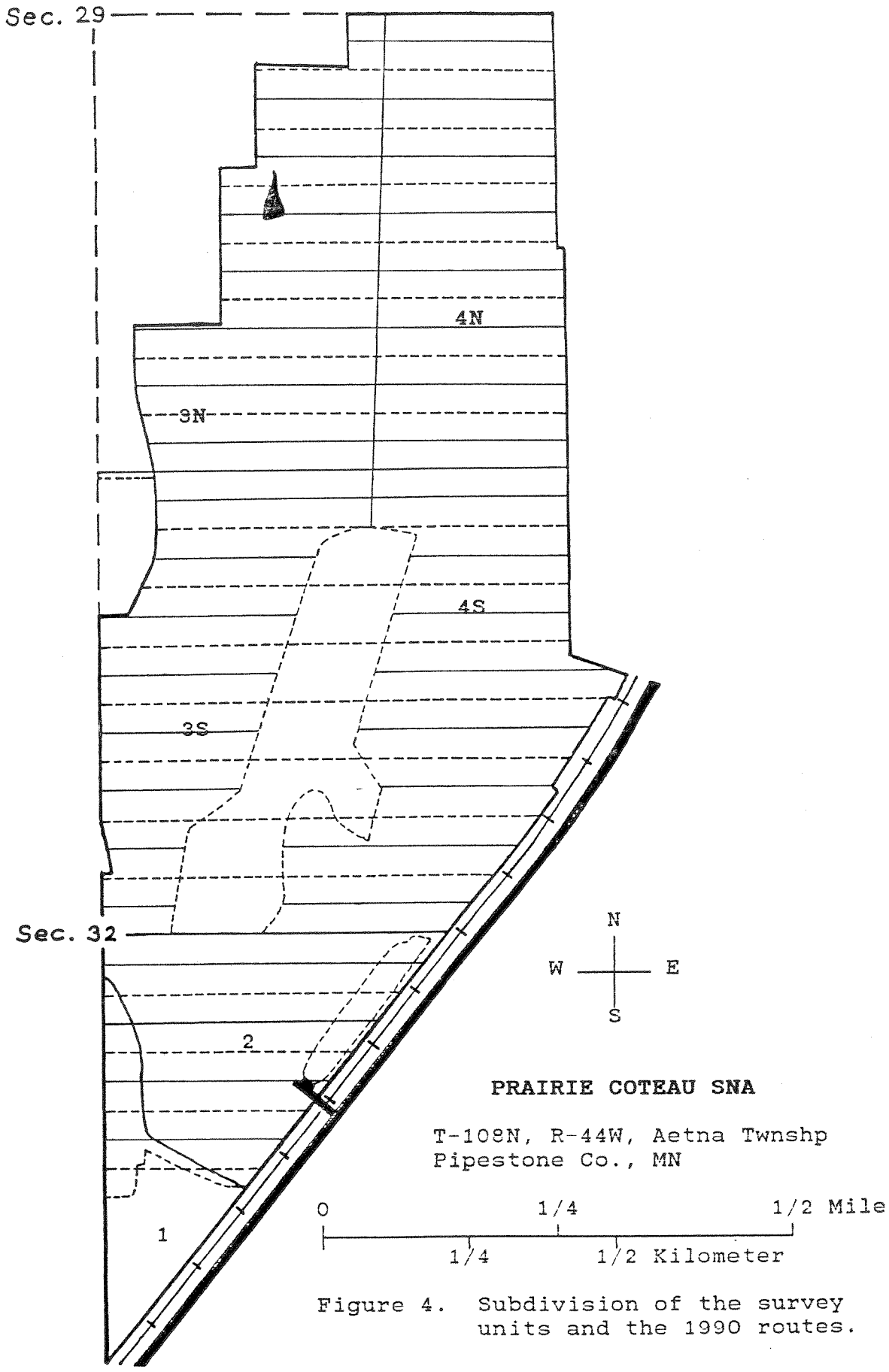


Figure 4. Subdivision of the survey units and the 1990 routes.

Setting up the transects took a considerable amount of time, limiting the amount of data collection in some of the areas. There are still 4 transects in area 3&4N that need to have the 10 meter intervals measured and flagged. These will be finished and flags will be replaced where needed in the spring of 1991 before other fieldwork begins. For permanent marking of the transects I propose using metal fenceposts to mark the endpoints, and metal conduit to mark the 50 meter intervals along the transects. Permanent marking of the 10 meter intervals would be desirable if intensive studies are continued at the site, but is not very practical or aesthetically appealing.

Population Monitoring at Prairie Coteau

Standardized survey forms were used for recording the population monitoring data (see Appendix 1). In 1990 the numbers for all species observed were recorded, and for selected prairie-obligate species the sex, condition rating, distribution, and behaviors were also recorded. For the condition rating a scale of 1 to 4 was used, where 1 is no wing wear and 4 is very worn. Additional information recorded on the forms included the date and time period for the survey, time period for individual transects, temperature, wind speed, and cloud cover.

Transects were walked at a relatively steady pace, recording all individuals observed within five meters of either side of the transect. An attempt was made to catch and release each butterfly for which sex and condition data were collected. For the skippers this worked quite well for isolated observations of perching individuals, but when several individuals were observed at the same time it was difficult to capture each one, and if they were observed in flight it was even more difficult. This seemed to pose the greatest problem

during the early part of the flight period when there was more flight activity. For S. idalia it was not practical to capture each individual because their flight was much less localized. Complete sex and condition data were obtained for H. dacotae, since it was the focus of the monitoring, but data for the other species were not always complete because it was difficult to capture each individual, and sexual dimorphism was less pronounced in some species.

Species were targeted for population monitoring in each of three flight periods: (1) late May to late June - A. h. hianna, C. t. inornata, L. m. melissa (also has second flight between H. dacotae and H. l. pawnee); (2) late June to late July - A. a. iowa, H. dacotae, H. ottoe, O. poweshiek, and S. idalia; and (3) late August through September - H. l. pawnee, and S. idalia. Population data were collected throughout the early and middle flight periods, but the late flight period began earlier than expected and was well underway when the fieldwork was done.

In 1988 unit 4S was selected for regular surveys at the same time (early afternoon) each day at intervals during the flight period for H. dacotae. Other units were surveyed as time permitted, with most other work being done in unit 2. In 1989 surveys were conducted every day throughout the flight period for H. dacotae. Units 4S and 2 were selected for regular surveys on alternate days. Unit 4S was surveyed once a day in the early afternoon as it had been in 1988. Surveys in unit 2 were replicated five times per day so that the effect time of day had on the counts could be examined. The other units (3S and 3&4N) were each surveyed twice.

Fieldwork at Prairie Coteau in 1990 was conducted on 4 May, 23 May through 30 July, 11-16 August, and 30 August through 10 September. The goal was to survey each area twice per week during the peak portion of each flight period, and to survey one area at least once per week throughout the flight season. Surveys were conducted approximately twice per week throughout the A. h. hianna and H. dacotae flight periods in areas 2 and 4S, and during the peak portion of the H. dacotae flight period in area 3S. Some surveys were missed during the H. dacotae flight period due to rain. One survey was conducted between the H. dacotae and H. l. pawnee flight periods in area 4S, and during the H. l. pawnee flight period surveys were conducted in areas 2, 3S and 4S, but the flight appeared to have ended early and very few individuals were seen. There wasn't time to conduct regular surveys in area 3&4S, and weather conditions were poor during some of the surveys, so good data were not obtained for that area. Additional surveys in May would provide more information about species such as G. lygdamus which have an earlier flight than A. h. hianna.

Distribution Mapping at Prairie Coteau

In conjunction with the population monitoring surveys, the distributions for selected prairie-obligate species were mapped. For each survey the location of every individual observed along the transect was marked on a topographic map, using a unique symbol for each species. As measurements along the transects were completed locations could be recorded to the nearest 10 m^2 quadrat. Species for which distribution data were collected in 1990 included A. a. icwa, A. h. hianna, C. selene, C. t. inornata, G. lygdamus, H. dacotae, H. L. pawnee, H. ottoe, L. m. melissa, O. poweshiek, P. mystic, and S. idalia. Distributions were also recorded for species such as Polites themistocles

(Latreille), which are not restricted to prairies but are often sympatric with the prairie-obligate species and utilize the same nectar plants.

Composite dot distribution maps have been used in previous years for summarizing the data, but this year the data will be summarized as numbers per 10 m^2 along the transects. For data collected before transect measurements were completed it will be necessary to assign occurrences to quadrats based on the mapped location, so there will be some error since the placement of symbols was not exact. These data will be computerized and computer generated maps of the relative density of butterflies along the transects will be produced. When these data are combined with vegetation and environmental data for the site in a Geographic Information System (GIS), it should be possible to predict the relative densities of the butterfly species throughout the site and generate maps for them. The distribution data have not been computerized so they will be included in a later report.

Vegetation Data at Prairie Coteau

Vegetation work is still in the preliminary stages. Plant species have been recorded throughout this and previous field seasons, and the flowering phenology of important nectar sources has been noted. The number of inflorescence stalks of Echinacea angustifolia, Liatris aspera, and Liatris punctata per 10 m^2 quadrat were recorded for the first transect in area 2. Some quantitative data were collected along the third transect in area 2 using ten meter square releve samples. Some unknowns still need to be identified before the data can be analyzed. The above data will be summarized in a later report.

GIS Applications at Prairie Coteau

During the winter I will begin computerizing some of the layers of information for GIS applications. These will include soils, topography, CIR aerial photos, and butterfly data along the transects.

Fieldwork at Other Sites

Hole-in-the-Mountain Preserve, Lincoln County, MN. General surveys were conducted during the flight periods for A. h. hianna and H. dacotae, but most of the time was spent setting up transects, so no quantitative surveys along the transects were conducted. The layout for the transects was similar to the one at Prairie Coteau except the transects run in a north/south direction. Placement of the transects was more difficult since there were very few north/south or east/west reference points to work from. Dates for work at Hole-in-the-Mountain Preserve include:

A. h. hianna flight period - 11 June (extensive general survey)

H. dacotae flight period - 27 June, 4,10,11 July (work on transects)
- 22 July (brief general survey)

General surveys were conducted at each of the other sites. Species lists were compiled and for the prairie-obligate species the number of individuals observed and their approximate location were recorded. Survey dates for each site were as follows:

Pipestone National Monument, Pipestone County, MN

A. h. hianna flight period - 10 June
H. dacotae flight period - 1 July
H. l. pawnee flight period - 4 September

Blue Mound State Park, Rock County, MN

H. dacotae flight period - 20 July
H. l. pawnee flight period - 2 September

Chanarambie Creek Site, Murray County, MN

Wes Stevens Property (middle N1/2 Sec 8, T-105N, R-43W)

G. lygdamus flight period - 3 May
H. dacotae flight period - 7 July

Carney's Prairie (SE1/4 Sec 32, T-106N, R-43W)
Moulton Prairie - Sankey Tract (NE1/4 SE1/4 Sec 3, T-105N, R-43W)

H. dacotae flight period - 7 July

IV. RESULTS

Population Monitoring at Prairie Coteau

A total of 43 butterfly species were recorded from Prairie Coteau in 1988 and 1989. New species documented in 1990 include Basilarchia archippus archippus (Viceroy), Poanes massasoit (Mulberry Marsh Skipper), and Vanessa virginiensis (American Painted Lady). This brings the total number of species documented at the site to 46. A summary of the species observed each year and the time periods during which they were observed is shown in Figure 5. The time periods during which fieldwork was conducted are included to assist in interpreting the data. Coverage of the flight season was more complete in 1990 than in previous years, but there are still gaps in May and August.

In 1989 individuals of A. h. hianna were observed as early as 24 May, but in 1990 the first individuals were observed 28 May. The first individuals of H. dacotae were observed on 25 June in 1990, which was very similar to the main hatch in 1989 which occurred on 26 June. Peak counts for both years in area 4S were on 2 July, so it appears that although the A. h. hianna flight was later in 1990 than in 1989, the H. dacotae flights were very similar.

Figure 5. 1988 & 1989 BUTTERFLY OCCURENCE RECORDS FOR PRAIRIE COTEAU

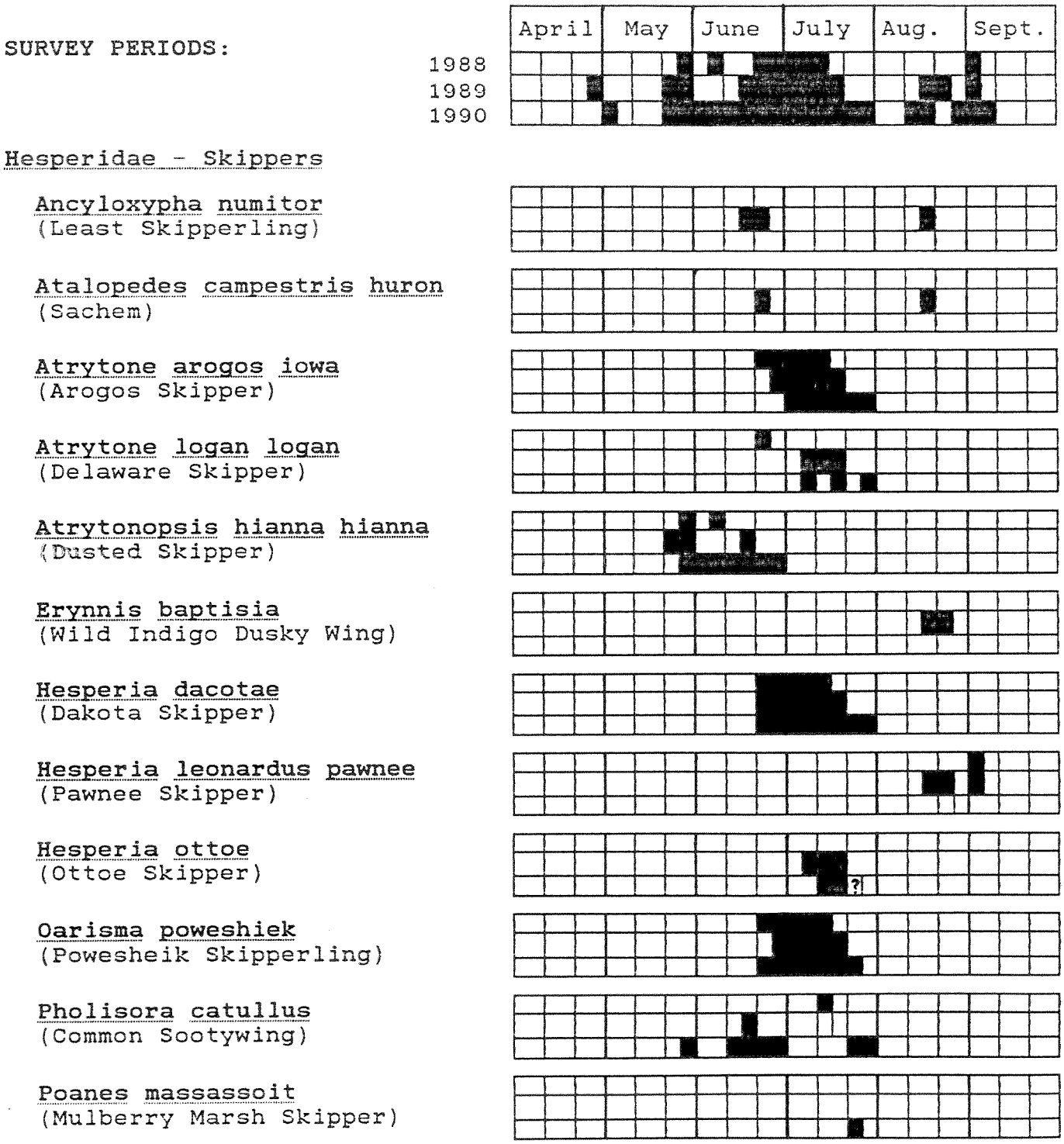
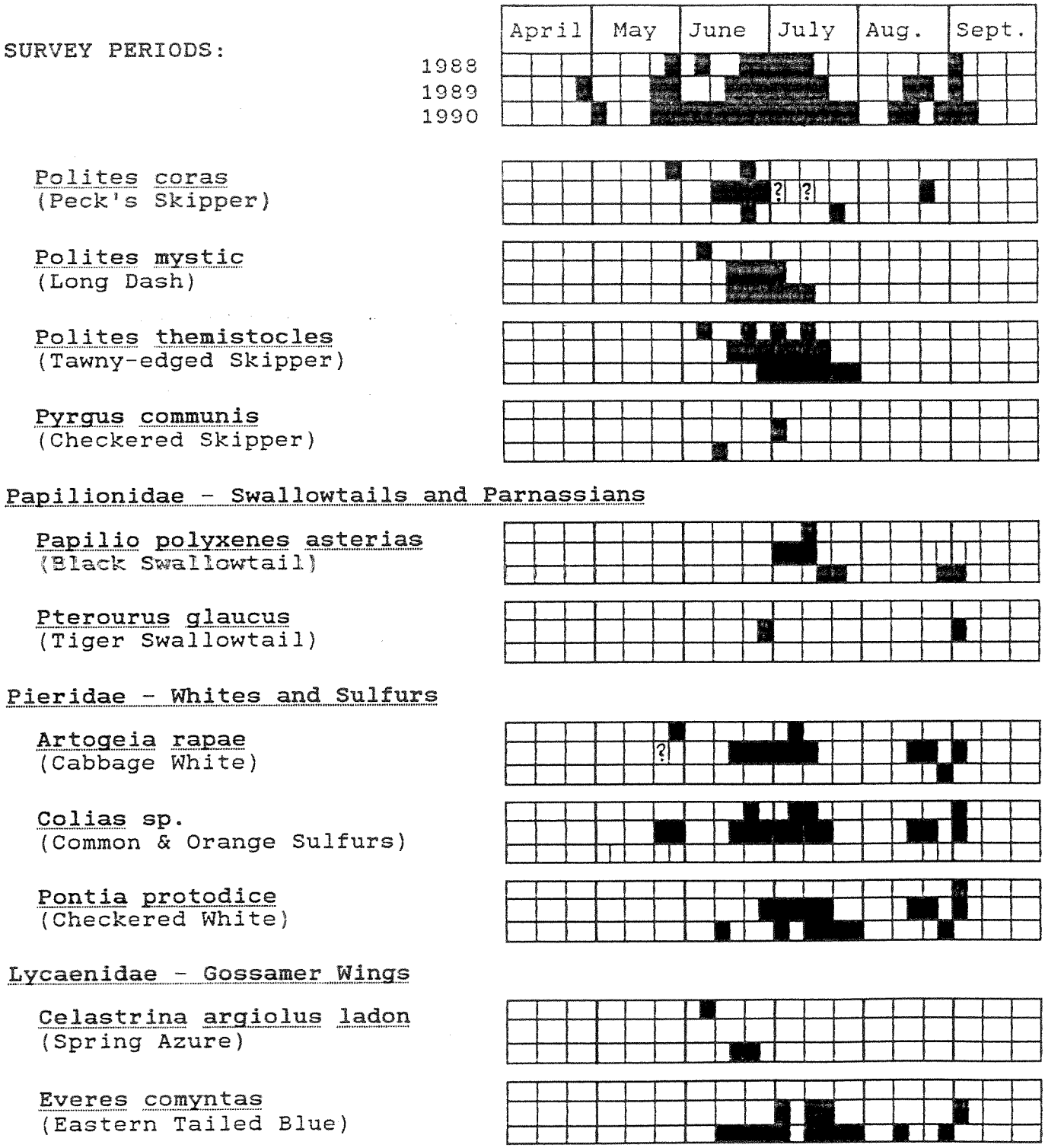


Figure 5. (cont.)



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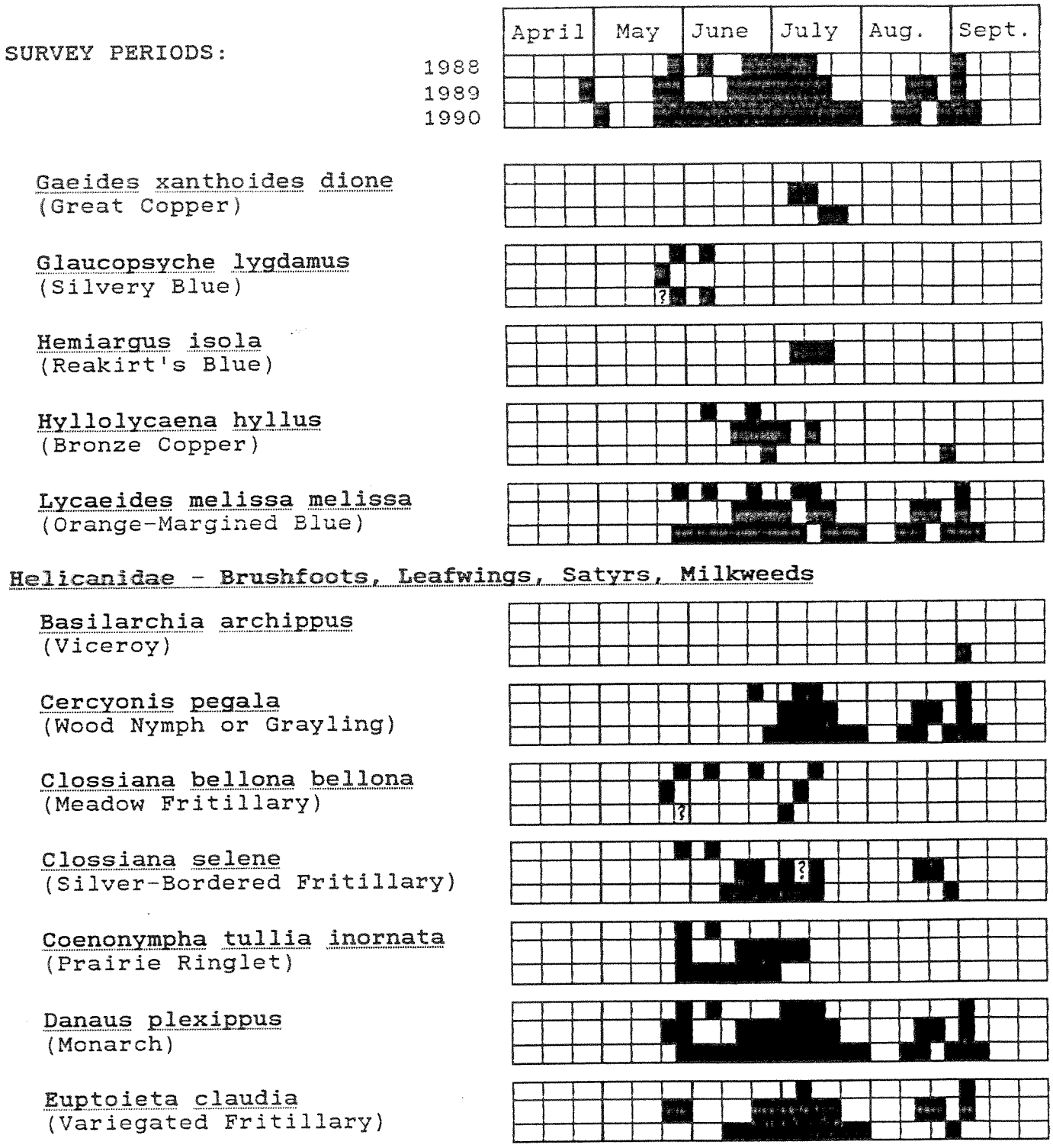

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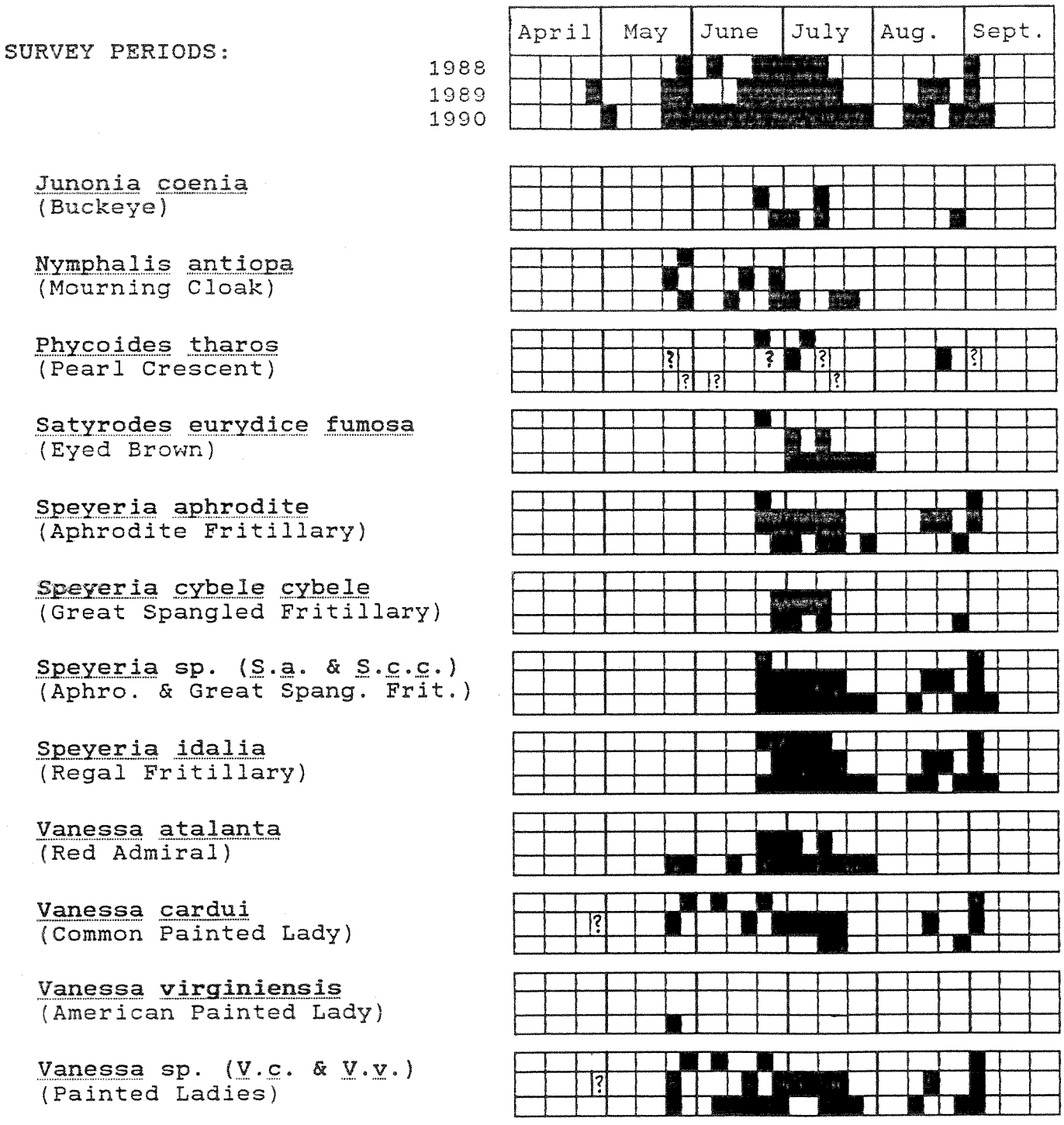

Sightings for H. ottoe were still very low, with only three individuals (one unconfirmed) observed. No observations of H. l. pawnee had been made as of 16 August. I had to be gone from the area from 17 August through 29 August, and when fieldwork was resumed it appeared that the major portion of the flight was over. In 1989 the flight had begun by 19 August, but there were still numerous individuals observed as late as 1-3 September. Data for butterfly counts in areas 2, 3S, and 4S are summarized in Tables 1-3. Only those species which occurred regularly along the transects have been included, and they have been arranged to reflect their phenology. Names have been abbreviated to the first three letters of the genus and species. A more complete summary of data collected for prairie-obligate species (e.g. sex ratios, condition rating, and distribution) will be presented in a later report.

Table 1. 1990 butterfly surveys in area 2.

Date	Gla lyg	Atr hia	Coe tul	Lyc mel	Pol mys	Hes dac	Oar pow	Pol the	Atr aro	Spe ida	*Spe sp.	Cer peg	*Col sp.	Dan ple
5-29		3	1											
5-30	1	4	2										5	2
5-31	1		1										3	
6-6		1	1										2	
6-9		6	25	1									1	1
6-12		4	55	7									8	3
6-19		1	15	15									6	3
6-22			4	4									2	
6-26		1	8	1	1						2	3	3	4
6-29			1	1		4	6			2	1	2	8	2
7-2				2		15	24	2	1	7	4	6	23	2
7-5					1	14	32	4	1	11	7	44	35	6
7-12						3	22	3	6	18	6	26	33	6
7-16						7	9	1	17	48	9	54	40	10
7-23						1		2	5	42	9	25	27	8
8-30				2						7	1	20	186	38

*Spe sp. includes S. aphrodite and S. cybele
Col sp. includes C. philodice and C. eurytheme

Table 2. 1990 butterfly surveys in area 4S.

Date	Gla lyg	Atr hia	Coe tul	Lyc mel	Pol mys	Hes dac	Oar pow	Pol the	Atr aro	Hes ott	Spe ida	*Spe sp.	Cer peg	*Col sp.	Dan ple
6-6		27	49	1										3	4
6-8		15	29	1										2	3
6-9	1	26	131	8										4	3
6-12		21	146	10										13	4
6-20		1	22	3	2										1
6-25			28	14	3	9					1			3	5
6-29			6	14	4	29	24	5			7	8	1	10	16
7-2				2	2	55	28	6			22	11	9	26	8
7-5				3	1	22	50	18	1		44	28	59	51	6
7-13						10	22	12	23	1	69	37	68	52	17
7-16				2		5	12	18	22	1	83	51	76	63	20
7-23				3		2	1	8	16	1	113	24	44	36	41
7-28				8		1		2	16		72	15	27	27	30
8-11				40							37	1	19	24	8
8-30				7							17	1	12	131	35
9-5				1							8	1	6	57	53

*Spe sp. includes S. aphrodite and S. cybele
Col sp. includes C. philodice and C. eurytheme

Table 3. 1990 butterfly surveys in area 3S.

Date	Coe tul	Lyc mel	Pol mys	Clo sel	Hes dac	Oar pow	Pol the	Atr aro	Spe ida	*Spe sp.	Cer peg	*Col sp.	Dan ple	Hes len
6-20	15	9		5									3	
6-26	16	22	11	19	5		5		1	2		4	6	
6-30	7	9	16	18	39	29	12		6	21	5	19	10	
7-3		2	5	3	28	33	7	3	15	20	8	16	11	
7-6		3	2	6	22	34	3	4	23	43	21	43	10	
7-13			2	1	8	9	3	19	34	53	38	50	10	
7-17						1	1	10	31	32	14	22	15	
8-31		11							11	3	22	282	70	2

*Spe sp. includes S. aphrodite and S. cybele
Col sp. includes C. philodice and C. eurytheme

The population for each species increases to a peak and then decreases again as the flight period progresses. Some species, such as L. m. melissa, have two flight periods. For counts to be meaningful it is important to know what portion of the flight curves they represent. Sex ratio and condition rating data have been collected for H. dacotae during each of the field seasons for use as indices for estimating the portion of the flight curve. The males emerge first and peak sooner than the females, so there is strong relationship between the sex ratio (expressed here as per cent females) and the portion of the flight period. The condition of the butterflies deteriorates with age so the average condition rating is also correlated with the portion of the flight period. Both of these indices can also be plotted together with the per cent peak population and then used to determine the appropriate adjustment factor for converting counts to their expected values at the peak portion of the flight period.

As a first attempt to quantify these relationships, weighted least squares linear regressions were done for the sex ratio and condition rating data for H. dacotae in area 4S for each year. The output for the regressions is summarized in Tables 4 and 5. Plots of the data and best fit lines are included in Figures 6 and 7. Fairly complete data were obtained for the H. dacotae flight period in 1989 and 1990 so the portion of the flight curve is known for each survey. In 1988 the flight was already in progress when surveys were started and appeared to be at or past the peak, so the portion of the flight curve for each survey is not known. For the regressions and plots 24 June was used as day zero since this was the first day for which data were available. The flight periods for 1989 and 1990 appeared to be the same, so the data for those two years were combined and regressions for the combined

data were also done (see Tables 4 and 5). The actual relationships might not actually be linear, and a sigmoid (logistic) curve might fit the data better. It will be necessary to use two equations to describe the population curve, a positive logistic equation up to the peak population, and a different negative logistic equation after that. Population data for H. dacotae in area 4S for 1988-1990 are included in Figure 8. Fitting of appropriate curves to the data will be done and included in a later report.

Table 4. Weighted least squares regressions for per cent females of H. dacotae vs. day in area 4S.

Year	1988	1989	1990	89&90
Constant	40.9491	3.8929	18.7347	10.6408
Std Err of Y Est	11.7163	9.1941	5.1789	9.7941
R Squared	0.6983	0.8412	0.8702	0.7836
No. of Observations	76	244	131	375
Degrees of Freedom	74	242	129	373
X Coefficient	3.7008	4.3001	2.3209	3.5300
Std Err of Coef.	0.2828	0.1201	0.0789	0.0960

Table 5. Weighted least squares regressions for condition rating of H. dacotae vs. day in area 4S.

Year	1988	1989	1990	89&90
Constant	1.6783	0.6629	0.7017	0.6788
Std Err of Y Est	0.1972	0.1563	0.0873	0.1441
R Squared	0.8554	0.8705	0.9563	0.8921
No. of Observations	76	244	131	375
Degrees of Freedom	74	242	129	373
X Coefficient	0.0996	0.0824	0.0707	0.0785
Std Err of Coef.	0.0048	0.0020	0.0013	0.0014

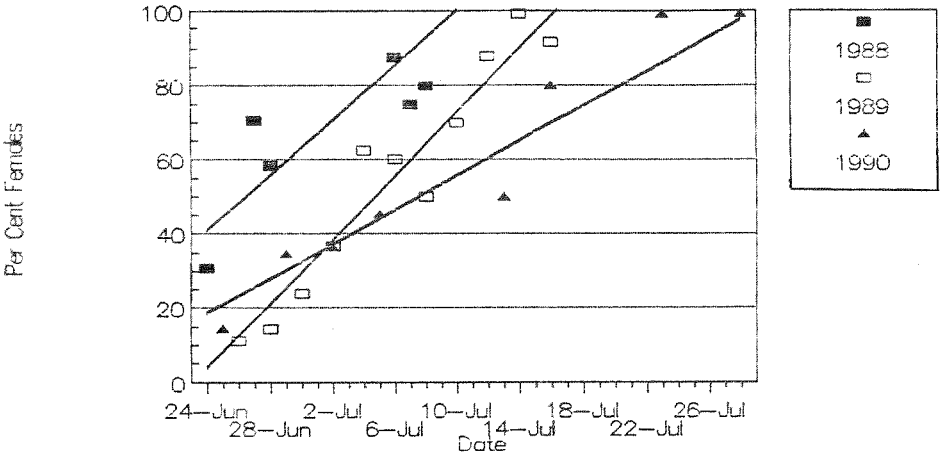

Figure 6. Per cent females vs. date for H. dacotae in area 4S for 1988, 1989, and 1990.

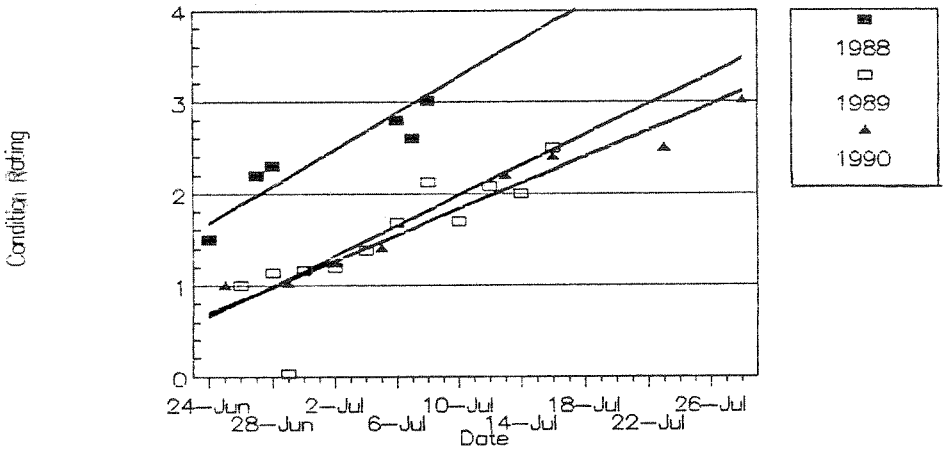

Figure 7. Average condition rating vs. date for H. dacotae in area 4S for 1988, 1989, and 1990.

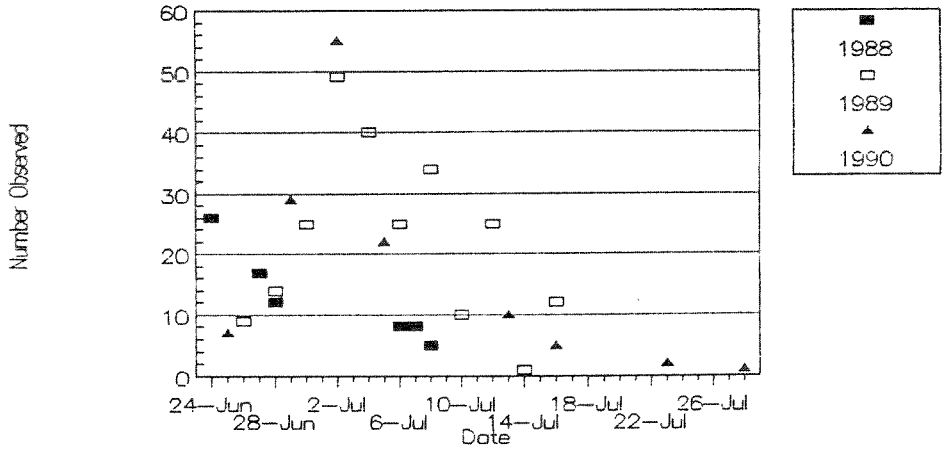

Figure 8. Number H. dacotae vs. date in area 4S for 1988, 1989, and 1990.

Fieldwork at other sites

A summary of the species observed at each of the other sites is given below. For those species for which quantitative data were collected, the number of individuals observed is also included. Several tracts were surveyed in the Chanarambie Creek Site, so the occurrences for each tract are listed separately.

Table 6. Butterfly occurrences at Hole-in-the-Mountain Preserve.

Species	June 11	June 27	July 4	July 10	July 22
Atrytone arcgos iowa			X	X	X
Atrytonopsis hianna hianna	2				
Cercyonis pegala		X	X	X	X
Clossiana bellona bellona				X	
Coenonympha tullia inornata	49	X			
Colias sp.	X		X	X	X
Danaus plexippus	X	X	X	X	X
Euptoieta claudia	X				
Everes comyntas	X			X	X
Hesperia dacotae		?	X	X	
Hesperia ottoe				X	
Lycaeides melissa melissa	11	X	X		
Nymphalis antiopa				X	
Oarisma poweshiek		X	X	X	
Pholisora catullus	X				
Polites themistocles				X	
Satyrodes eurydice fumosa			X		
Speyeria idalia		X	X	X	X
Speyeria sp.		X		X	
Vanessa atalanta		X			
Vanessa virginiensis			X		

Table 7. Butterfly occurrences at Pipestone National Monument.

Species	10 June	1 July	4 Sept.
Artogeia rapae			X
Cercyonis pegala		25	
Coenonympha tullia inornata	3		
Colias sp.	X	19	X
Danaus plexippus	X		X
Euptoieta claudia			X
Everes comyntas		3	X
Gaeides xanthoides dione		2	
Harkenclenus titus		1	
Lycaeides melissa melissa	1	1	X
Carisma poweshiek		14	
Polites coras			X
Pontia protodice		1	X
Speyeria idalia		2	X
Speyeria sp.		2	
Vanessa atalanta	X	3	

Table 8. Butterfly occurrences at Blue Mound State Park.

Species	20 July	2 Sept.
Artogeia rapae		X
Asterocampa celtis celtis		?
Asterocampa clyton clyton	?	
Atrytone arogos iowa	2	
Atrytone logan logan	X	
Celastrina argiolus ladon		X
Cercyonis pegala	X	
Colias sp.	X	X
Danaus plexippus	X	X
Euptoieta claudia	X	
Everes comyntas	X	X
Hemiargus isola	1	
Hyllolycaena hyllus		X
Papilio polyxenes		?
Polites coras		X
Pontia protodice	X	X
Pyrgus communis		X
Speyeria aphrodite	X	X
Speyeria cybele	?	
Speyeria idalia	100's	9
Speyeria sp.	X	
Vanessa atalanta		X
Vanessa sp.	X	
Vanessa cardui		X

Table 9. Butterfly occurrences at Chanarambie Creek.

Tract/Species		
Wes Stevens Property	3 May	2 Sept.
Atrytone arogos iowa		1
Atrytone logan logan		1
Cercyonis pegala		24
Colias sp.		25
Danaus plexippus		1
Everes comyntas		1
Gaeides xanthoides dione		2
Glaucopsyche lygdamus	X	
Lycaeides melissa melissa		1
Oarisma poweshiek		5
Polites mystic		1
Speyeria idalia		10
Speyeria sp.		11
Carney's Prairie	2 Sept.	
Cercyonis pegala	X	
Colias sp.	X	
Gaeides xanthoides dione	X	
Hesperia dacotae	10	
Oarisma poweshiek	5	
Speyeria idalia	many	
Speyeria sp.	X	
Moulton Prairie - Sankey Tract	2 Sept.	
Atrytone arogos iowa	2	
Cercyonis pegala	X	
Colias sp.	X	
Danaus plexippus	X	
Hesperia dacotae	13	
Lycaeides melissa melissa	1	
Oarisma poweshiek	3	
Speyeria idalia	4	
Speyeria sp.	X	

IV. SUMMARY

Setting up new transects and measuring distances along them took a considerable amount of time, but the advantages of being able to accurately reference data from points on the ground to points in other sources of information such as aerial photos, topographic maps, and soil maps are worth the extra effort. The major problem may be that the level of accuracy of the other information sources may be less than that for the data collected along the transects. Displacement in the aerial photos will also need to be accounted for.

Assigning data to 10 m^2 quadrats also facilitates mathematical analysis of the distribution pattern of different butterfly species in relation to each other and to other environmental factors. In the 1991 field season it will not be necessary to map occurrences in the field since their location can be recorded to the nearest 10 m^2 quadrat. Other information, such as number of inflorescence stalks for nectar plants, vegetation releve data, slope, aspect and position, can also be recorded to the nearest 10 m^2 quadrat. The transects will be set up before the 1991 flight season begins so that the entire field season can be devoted to data collection.

A total of 46 butterfly species have been documented at Prairie Coteau from 1988-1990. Population monitoring was expanded in 1990 to include counts of all species observed along the transects, and distribution data were collected for A. arogos, A. h. hianna, C. selene, C. t. inornata, G. lygdamus, H. dacotae, H. l. pawnee, H. ottoe, L. m. melissa, O. poweshiek, P. mystic, and S. idalia. Condition, sex, and behavioral data were also collected for each

of those species. Populations of these species were found throughout the survey areas. With the exception of H. ottoe, there continue to be good populations of prairie-obligate butterflies at Prairie Coteau.

Preliminary attempts at quantifying the relationship of sex ratios and condition ratings to the portion of the flight curve have been attempted for the three years data using weighted least squares linear regressions. The regression lines for the condition rating were quite similar for 1989 and 1990, but the slope was slightly steeper in 1989. The slope of the regression line for 1988 was even greater. For the regressions of per cent females there was a large difference in slopes for the 1989 and 1990 data. The intercepts for the 1988 data for both regressions are quite different from the intercepts for the 1989 and 1990 data. This is due to the fact that the flight period was earlier in 1988. If the slopes for the lines were the same, the difference in the flight periods would be the number of days between equal y values. These differences in slopes may reflect real differences in the flight period from year to year, making it more difficult to use condition ratings and sex ratios as indices. The shape of the population curve itself may also vary from year to year, making it difficult to develop a single model for the curve. Other curves will be tested (e.g. logistic) to see if they fit the data better, and best fit curves will also be tested for the population data.

Variability in all of the parameters makes exact quantification of the above relationships difficult. Population counts fluctuate considerably within a given portion of the flight period, and there is also variation in the observed sex ratios and condition ratings, so even if the relationship between

the population curve and the sex ratio and condition rating were known, an incorrect adjustment might be made. Some factors that affect the population counts include temperature, wind and cloud cover. While these can be used to explain some of the variations in the data, it is difficult to quantify their effect. The condition rating is subjective, so even though those data seem less variable than the sex ratio data, it might be expected that the slope for the regression line would be different for each observer. By using both indices it is possible to check to see if they both indicate the same portion of the flight period. Temperature data is also being examined to determine the relationship between accumulated degree days and the phenology of the butterflies.

There will always be a significant amount of uncertainty associated with single counts due to the many factors that can effect them. For the best results surveys should be conducted during the peak portion of the flight period since the variability in all of the parameters decreases with an increase in sample size. Overcast skies, strong winds, and cool or excessively hot temperatures are all factors which can reduce the activity of the butterflies.

Significant occurrences of prairie-obligate butterflies were found at each of the other sites that were surveyed. Surveys were not done for every flight period at all of the sites, and some of the surveys were not done during the peak portion of a flight. More complete surveys can be expected to identify more prairie-obligate species at each site. Survey routes were established at Hole-in-the-Mountain Preserve, but more work needs to be done to finish setting up the transects.

Butterfly distribution and vegetation data for Prairie Coteau still need to be analyzed. These will be presented, along with preliminary GIS applications, in a report in March 1991.

A proposal is being submitted to continue the work at Prairie Coteau for one more summer. Having the transects in place at the beginning of the season should make it possible to obtain more complete data throughout the flight season in each of the survey areas. It will also be possible to do more extensive vegetation work.