STATE OF MINNESOTA

Office Memorandum

DEPARTMENT OF NATURAL RESOURCES
Section of Wildlife
Nongame Wildlife Program

DATE: December 8, 1992

TO: Zona DeWitt
Legislative Reference Library

FROM: Richard Baker, Nongame Research Specialist RAB

PHONE: 7-3764

SUBJECT: Final Report Submitted for Contractual Work

The enclosed report has been submitted to fulfill the obligations of a contract between the Department of Natural Resources and The University of Minnesota.

Contract #: 29000-56307;58366
Duration: 6/16/91 - 6/15/92

Title: "***The Status of the Karner Blue Butterfly and its Associated Plant Resources in Minnesota, 1991***"

Please feel free to contact me if you have any questions.

encl.

THE STATUS OF THE KARNER BLUE BUTTERFLY (*Lycaeides melissa samuelis*: Lycaenidae) AND ITS ASSOCIATED PLANT RESOURCES IN MINNESOTA, 1991

Final Report to

U.S. Fish and Wildlife Service
Minnesota Department of Natural Resources
The Nature Conservancy

March 1, 1992

Cynthia P. Lane
Graduate Program in Conservation Biology
University of Minnesota
St. Paul, Minnesota

TABLE OF CONTENTS

LIST OF TABLES, FIGURES, AND MAPS

ABSTRACT

In Minnesota, the state threatened Karner blue butterfly, *Lycaeides melissa samuelis*, is currently found in only one area in the southeastern portion of the state. A study was initiated to estimate population sizes and the distribution of the butterfly. Populations were found to be very low, with only 75 total individuals sighted. Since food resources are believed to be one of the limiting factors for Karner blue survival, the distribution and abundance of common lupine (*Lupinus perennis*), the sole larval food source, was also studied. The sites containing the butterfly did not vary significantly in their lupine cover, and the one site where Karner blues were not found had the significantly greatest lupine cover. Butterflies were found to be associated with areas with less than 5% canopy cover. This may be due to increased quantity or quality of the food resource in these areas.

ACKNOWLEDGEMENTS

Special thanks go to the managers and staff (Jon Cole, Bob Tangen, Mike Tenney, Steve Ellringer and Gary Nelson) at the Whitewater Wildlife Management Area. They provided not only living and working space, but a multitude of assistance in many ways.

David Andow and Rich Baker provided advice throughout the course of the study. Rich provided excellent scientific advice as well as the much appreciated moral support of a graduate students first field season. Dave's creative advice and vast expertise was invaluable, as was the use of lab space and supplies - all were greatly appreciated.

The project would not have been possible without funding from the U.S. Fish and Wildlife Service, The Nature Conservancy, and the Minnesota Department of Natural Resources' Nongame Wildlife Program.

INTRODUCTION

The purpose of this project is to study the only known populations of the Karner Blue butterfly remaining in Minnesota (Cuthrell 1990). Since loss and degradation of habitat are believed to be the major forces resulting in reduced Karner Blue populations (Schweitzer 1989), a major goal of this project is to develop a management plan for the improvement of its habitat in Minnesota. In order to develop an effective management scheme, both the natural history of the butterfly and its rare oak savanna habitat will need to be better understood.

An initial survey was conducted in 1990 to determine the current status of the Karner Blue butterfly in Minnesota (Cuthrell 1990). Only two sites were found that currently support butterfly populations. The sites are within one mile of each other in the Whitewater Wildlife Management Area (WMA). The Cedar Creek Natural Area, where the Karner Blue had historically been found, no longer appears to contain populations of the butterfly. Because the 1990 state survey was designed to search for the Karner Blue at as many sites as possible during the field season, no effort was made to further document either the distribution of habitat or the size and distribution of the butterfly populations at the Whitewater sites.

Out of concern for the Karner Blue butterflies declining numbers in Minnesota and across its range, a four year study was initiated in 1991. The goals for this first year were to: 1) derive estimates of Karner Blue population size and distribution, 2) document current distributions and estimate percent cover of lupine, 3) document behavioral and habitat requirements for the butterfly, and 4) determine the structure and species composition of oak savanna in existing and potential Karner Blue habitat in the Whitewater WMA.

BACKGROUND INFORMATION: THE KARNER BLUE BUTTERFLY IN MINNESOTA

KARNER BLUE TAXONOMY

The butterfly was first described by W.H. Edwards as Rusticus scudderi (Edwards 1861). Nabokov (1943) revised the group in the 1940's and renamed the butterfly Lycaeides melissa samuelis, Nabokov (common name: Karner Blue). He later concluded the Karner Blue was a separate species versus a subspecies of Lycaeides melissa, however this revision was never published (Nabokov 1975).

LIFE HISTORY

The Karner Blue is bivoltine throughout its range. The first brood begins with the hatching of eggs that have overwintered from the fall of the previous year, (Dirig and Cryan, 1975, Dirig 1976). The larvae feed on Lupinus perennis (lupine), the only known larval food plant, for approximately three weeks, at which time they pupate on lupine or nearby litter (Schweitzer 1989). Pupae normally take seven to eleven days before eclosing (Dirig 1976). The first flight period is typically from late May to mid-June (Schwietzer, 1989). In Minnesota the second flight period is from mid to late July through mid August (Cuthrell, 1990, pers obs.). The average life span of adults is five days and the males typically emerge before the females (Schweitzer 1989).

DISTRIBUTION

Historically, the Karner Blue butterfly occurred in a narrow band from New York to Minnesota, north to Ontario and south to Ohio and Illinois (Opler and Krizek 1984). It is now extirpated from Illinois, Ohio, Ontario, Pennsylvania and Massachusetts (Schweitzer, 1989).

HABITAT

Across its range, Lycaeides melissa samuelis is typically found in small, open in pine barrens, pine prairies, oak savannas and beach dunes where lupine is present (Savignano 1990, Opler and Krizek 1984). In Minnesota, the remaining populations of the Karner Blue butterflies are found in southeastern Minnesota in an region known as the "driftless area". This area is believed to have escaped glacial overriding, (Ojakangas and Matsch, 1982). However, melt from nearby glaciers deposited thick outwash in the Whitewater River valley (Hobbs 1984). The Plainfield sand soil type found in this areas may have been deposited as glacial outwash or may have been wind blown into its present location and then cut by glacial melt or heavy rains (Hobbs, pers. comm.). The entire Whitewater River valley area is dissected by rivers and intermittent streams which have created flat valley floors and steep ridges that may vary in elevation by as much as 150 meters. The microclimates created by this unique topography allow a wide variety of species to survive in the area, including some plant species typically found in northern Minnesota (Table 8). It is on the areas with Plainfield sand soil type that most of the Karner Blue habitat, known as oak savanna, is found.

Oak savanna covered 10%, or approximately 2,200,000 Ha, of Minnesota at time of settlement (Nuzzo 1986). It is an early successional community maintained by fire and grazing animals. Currently, due to cultivation, development and fire suppression, as little as 500 hectares remain in the state (Nuzzo 1986).

The Minnesota Department of Natural Resources, Natural Heritage Program, describes oak savanna as a community with canopy cover of 10 to 70% with trees growing in clumps or singly (Almendinger 1991). The herb layer, especially in openings, typically consists of prairie species.

In the Whitewater WMA, the oak savanna is placed in the sand - gravel subtype (Almendinger 1991). The dominant tree species is black oak (Quercus velutina) and occasionally jack pine (Pinus banksiana). Common shrubs are chokecherry (Prunus virginiana) and hazelnut (Corylus americana). In the herb layer, lupine (Lupinus perennis), horsemint (Monarda punctata), flowering spurge (Euphorbia corollata) and June grass (Koeleria macrantha) are often found. Several rare or endangered plants are also found in the area, including: fame flower (Talinum rugospermum), goat's rue (Tephrosia virginiana), spiderwort (Tradescantia ohiensis), false foxglove (Aureolaria pedicularia) and knotweed (Polygonum tenue) (Curtis 1959, pers. obs.). In addition to supporting populations of rare plants and the Karner Blue, some sites in the WMA also contain the state threatened Ottoe Skipper (Hesperia ottoe) (Cuthrell 1990).

Vegetational features unique to oak savanna, and necessary for Karner Blue survival, are its larval and adult food resources. The sole known food plant for the larvae is Lupinus perennis. Adults feed on the nectar of various flowering plants such as: Monarda punctata, Campanula rotundifolia, Gnaphalium obtusifolium and Euphorbia corollata (pers. obs.). There may be other vegetational aspects of the oak savanna in this area that are factors in Karner Blue survival but are yet to be documented, (e.g. trees for roosting.

As with the much-studied Checkerspot butterfly (Euphydras editha, the variety of microclimates created by the steep slopes of differing aspect may prove to be important for butterfly survival under certain climatic conditions (Weiss, et al 1988).

ANT MUTUALISM

Several Lycaenid butterflies have been suggested to have a mutualistic relationship with certain ant species (Atsatt 1981). The larvae of Lycaeides melissa samuelis benefit from their association with ants by receiving reduced predation (Savignano 1990).

The larvae have special organs which provide benefits to the attending ants. The dorsal nectary organ is used to secrete nectar which may provide food for the ants (Savingnano 1990).

Whether this mutualistic relationship between the Karner Blue and various ant species occurs in Minnesota, is yet to be demonstrated.

NATURAL ENEMIES

There is insufficient information available to determine whether natural enemies play an important role in Karner Blue survival. Savignano recorded parasitism levels for larvae of less than 10% at study sites in the New York State Pine Bush Reserve (Savignano 1990). In that study, no parasites were ever isolated from field collected eggs, and only 1 pupae, of the 5 collected, was parasitized (Savignano 1990). Various predators have been recorded for the adults and larvae, but no studies have specifically researched the predators or quantified their impact. More research on the effects of natural enemies on Lycaeides melissa samuelis is needed to assess the degree to which parasites or predators impact Karner Blue populations.

METHODS

LUPINE DISTRIBUTION AND ABUNDANCE SURVEY

Initially, soil maps and aerial photography were reviewed to determine potential sites for lupine. Sources indicated that lupine would most likely be found in areas with a Plainfield Sand soil type (Robert Dana pers. comm.). These areas were located on U.S.D.A. quad maps using the Winona County soil survey and then compared with infrared aerial photos. Areas appearing to be relatively open oak savanna on Plainfield Sand were selected for this years lupine survey.

After systematically searching for lupine in the selected areas, eight sites where lupine was most abundant were chosen as 1991 study sites. One of these sites is the historic site for Karner Blues in the WMA (See map 1 for site names and locations).

In order to quantify the lupine at each site, a percent cover study was done. A grid of 20 meter X 20 meter points was stepped off on north-south/east-west transects in each of the eight sites. The Historic and Cuthrell south sites were divided into 2 and 3 sample areas, respectively. At each point, a 2 meter X 2 meter square plot was laid out. Data taken for each plot included a visual estimate of percent lupine cover, the number of flowering stems and fruiting stems, and an estimate of canopy cover. Data was collected at a total of 1345 plots.

To determine the relationship between stem number and percent cover, data were collected at one hundred one-meter square plots at the Lupine Valley and Burnt Oaks sites. Percent cover was estimated and stems counted at each plot (See figure 1).

KARNER BLUE DISTRIBUTION AND ABUNDANCE

No Karner Blue butterflies were sighted during the first flight period. Upon the first Karner Blue sighting during the second flight period, systematic surveys were begun in the eight study sites. Each site was searched by walking a zig-zag pattern over the areas with, and in close proximity to, lupine. These "general surveys" were done two to three times per site.

In doing the general surveys, the Karner Blue was found in five of the eight sites. In order to establish population estimates and indices, transect surveys (Pollard 1977, Thomas 1983), were set up at Historic and Cuthrell south, the two sites appearing to have higher populations of butterflies. The transect path was drawn on an aerial infrared photograph and then transferred to the site as accurately as possible. The transect path was chosen to include various vegetation types within the sites. Flags were placed every 25 meters using a "Hip-chain" distance measurer and butterfly observations were recorded to the nearest flag. The Historic site transect was 2300 meters long, and the Cuthrell South site transect was 3000 meters long. Surveys were walked at a slow and steady pace and any butterflies within 4 meters to either side or ahead were recorded. Surveys were restricted to the times of day and weather conditions suggested by Pollard (1977). If possible sex and wing wear were noted. Wing wear was rated from 1 (perfect condition) to 3 (very worn). Each transect was walked four times between July 29 and August 12.

During the transect surveys, breaks were taken to make observations of selected individual Karner Blues. Notes were taken on roosting, nectaring and oviposition sites as well as the flight distance and time spent/activity/plant. Plants in bloom and other butterflies seen in the area were also noted. A total of 27 individuals were observed in this fashion over a total time of approximately 3 hours.

KARNER BLUE HABITAT

Releve data were collected at seven of the study sites following the methods described in "A handbook for collecting releve data in Minnesota" (Almendinger 1987). The sites were divided into habitat sub-types, and releves were used to describe these areas. The habitat sub-types were chosen based on readily distinguishable features that were noted during the Karner Blue surveys. A total of 53 releves were done with eleven located in the Historic site and thirteen located in the Cuthrell South site. The plot location within each habitat sub-type was based on where the Karner Blue butterflies had been observed and on the portion appearing most representative of the type. Several releves were also placed in locations where no butterflies were found. Nomenclature used for plant species follows that of Ownbey an Morley (1991) or Gleason and Cronquist (1991).

Karner Blue habitat was classified into seven subtypes, as follows:

OAK SAVANNA (CLOSED) (OS): Terraced areas above sand banks and valley floors. Sandy terraces with an average slope of 13°, ranging from 2°-20°. Dominated by Quercus velutina with canopy cover up to 50-75%. Occasional portions of openings included.

OAK SAVANNA OPENING (OO): Openings within the oak savanna sub-type. Less than 15% canopy cover, dominated by 1-3 meter tall herbaceous vegetation.

SANDY BANK (SB): Steep, unstable, banks with slopes averaging from 30° to 43°, and approximately 10-30% of surface consisting of exposed Plainfield sand. Aspect may be from south, southwest, west, northwest or northeast. Dominated by 1-3 meter tall herbaceous vegetation.

VALLEY FLOOR (VF): Almost flat, with slopes rarely greater than 5°. Usually open, with less than 5% canopy cover. Dominated by 1-3 meter tall herbaceous vegetation.

OAK SAVANNA-CUT (0C): 5-10 acre patches clear cut 7-12 years ago. Quercus velutina sprouting back from the crown ("grubs") at ground level with approximately 10-30 stems/plant. Canopy cover may reach 50-75%. Mostly flat or slightly sloping, up to 5°. Ground layer vegetation dominated by Carex pennsylvanica in areas with dense canopy cover.

OAK SAVANNA-CUT OPENING (CO): Open areas within the cut savanna sub-type. Dominated by 1-3 meter tall herbaceous vegetation.

OAK SAVANNA-BURNED (OB): Burned April 1, 1985 and April 6, 1990. No upper stems of trees survived these burns and all that remains are standing and fallen burned snags.

Releve data were analyzed using ordination and classification techniques. The "Decorana" program for detrended correspondence analysis (DCA) was used to ordinate sample and species scores (Hill 1979a). A polythetic divisive technique of classification was applied to the data using the "Twinspan" program (Hill 1979b).

LOCATION OF MELISSA BLUE BUTTERFLIES

The Tuey Sand Savanna site is located thirty miles southwest of the Whitewater area. Cuthrell (1990) had recorded the Melissa Blue butterfly (Lycaeides melissa melissa) at this site in 1990. The Melissa Blue butterfly was located and notes were taken on the morphology of the males and females.

RESULTS AND DISCUSSION

LUPINE DISTRIBUTION AND ABUNDANCE

There is a strong correlation between stem number and percent cover estimates (figure 1). The correlation appears to be most reliable at lower percentages and stem numbers. However, there may be variation between sites due to varying plant vigor and resulting stem size. In general, the stem size in the Burnt Oak site appeared larger than those in the Lupine valley site. Therefore, percent cover estimates at different sites can give an estimate of abundance within a site, but may be correlated with different stem numbers and levels of plant vigor at different sites.

Lupine distribution in the sites appears to be patchy with higher densities in openings and sparser coverage in more forested areas. The percent cover estimates per site in Table 1 represent averages for the areas, and include plots with no lupine as well as to dense patches of lupine in open areas. Average percent cover values for the sites are not significantly different, with the exception of the Lupine valley site, which had an average percent cover of 8.602% (confidence interval = $\pm$ 2.082).

KARNER BLUE DISTRIBUTION AND ABUNDANCE

The results of the general surveys are shown in Tables 2 and 3. The Historic and Cuthrell South sites appear to have the greatest numbers of butterflies. The number of individuals counted during the general surveys ranged from 3-5 in the Historic Site and from 2-13 in the Cuthrell South site. In the three other sites where Karner Blues were found, numbers of individuals recorded ranged from 1-4 per day. Due to time spent at other sites searching for butterflies and walking transects, the Turkey Valley, Fabel Ravine and Hidden Valley sites were only surveyed 2-3 times and the numbers of butterflies in these sites is uncertain. Three sites in which lupine is abundant were also surveyed for the Karner Blue butterfly but none were found (Table 3). Again further searching is recommended in these areas next season.

In conducting the transect surveys, slightly higher numbers of butterflies were recorded than in the general surveys (Tables 2 and 3). Higher Karner Blue numbers may be due to transect counts having been done during the peak of the flight period. Wind varied little between various survey dates for the two sites (0-5mph). However, temperature and cloud cover ranged from 20 -32 C and from less than 50% clear sky to 80-100% clear sky. Temperature and solar radiation effect the mobility of insects and on cooler, cloudier days fewer butterflies may have been recorded (Clench 1967).

Population indices were calculated for the transect surveys using methods described by Thomas (1983):

$$P = \frac{100\ N\ A}{L}$$

where

P = population index

N = number of butterflies counted

L = length of transect

A = size of flight area

The average population index for the Cuthrell South site was twice as great as that for the Historic Site (3.30 versus 1.31 respectively). From this data it appears that the Cuthrell South site has greater population numbers than the Historic or other Karner Blue sites. The greatest numbers of butterflies were counted in late July and it seems likely that the peak of the second flight period was at this time.

The preferred nectar plant for the Karner Blue butterflies observed was Monarda punctata (Horsemint), (Table 5). Both males and females were recorded nectaring on Horsemint an average of 92% of the total observations. Whether this represents a preference for Monarda punctata as a nectar source or is due to a greater abundance of this plant in the sites is uncertain. A list of all plant species identified in the study sites can be found in table 8. Table 9 is a list of all butterfly species observed.

In general, females flew more frequently than males, but the average distance flown by males was over 3 times that of the females (Table 6 and 7).

KARNER BLUE HABITAT

Assuming a relationship between presence of Karner Blue butterflies and the vegetational composition of a site, patterns should emerge using ordination and classification techniques. Using ordination methods, two distinct groups emerged. These groups consist of plots located in the oak savanna habitat sub-types and those located in all other habitat sub-types (see figure 2). This division represents a gradient along axis 1 from high to low canopy cover. All plots in which Karner Blues have been found are clustered in the group with low canopy cover.

Results from the classification techniques show similar patterns As the dendrogram in figure 3 shows, there is a split between most of the oak savanna plots (high canopy cover) and other habitat sub-types. Two-thirds of the plots containing Karner Blue butterflies are found in the fourth division, and the remaining one-third in division five.

In order to describe canopy cover for sites with and without butterflies, the average percent cover was calculated for both. All tree species in the 4-5 (2-10 meter) height class or greater were included. The sites with Karner Blues had a much lower average canopy cover (2.67%) than did the sites with Karner Blues (32.91%).

The similar patterns found using both methods of analysis suggest that sites with low canopy cover may be critical habitat for Karner Blue butterfly survival.

MANAGEMENT RECOMMENDATIONS

Based on the results of this study, there are several sites in the Whitewater Wildlife Management Area that should be considered for Karner Blue habitat management. Most importantly, the sites known to contain Karner Blues must be protected. In the 1991 study season, a timber harvest boundary was moved approximately 50 feet to provide protection to areas with lupine and Karner Blue butterflies. Other sites with Karner Blue butterflies and large lupine populations must be the focus of similar habitat management and protection.

Within these areas, it appears that the butterflies would benefit from the creation of clearings. These may be created by cutting and/or girdling oaks in areas with dense canopies. To maintain openings, prescribed burning or herbicide applications may be effective in suppressing undesirable woody or herbaceous species. Other management considerations are described by Lawrence and Cook (1989).

Many of these suggestions may also be applicable to Minnesota sites, however, differences in topography, vegetation, etc., will require that restoration studies be conducted to test various methods in Minnesota before being used for management.

There is much potential for restoration of habitat in Minnesota. Management of oak savanna would provide habitat for the Karner Blue butterfly, but for many state listed species as well. In order to create openings that are an optimal size and composition, further study is needed. In particular, specific aspects of the openings critical for the Karner Blue survival need to be quantified.

REFERENCES

Almendinger, John C. 1991. A Key to Natural Communities of Minnesota. Natural Heritage Program, Minnesota Department of Natural Resources.

Atsatt, P.R. 1981. Lycaenid butterflies and ants: selection for enemy-free space. Am. Nat. 118(5):638-654.

Clench, H. K. 1967. Temporal dissociation and population regulation in certain hesperiine butterflies. Ecology 48(6):1000-1006.

Curtis, John T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press, Madison.

Cuthrell, David L. 1990. Status of the Karner Blue butterfly, Lycaeides melissa samuelis Nabokov, in Minnesota 1990. Report submitted to the Minnesota Nongame Wildlife Program.

Dirig, Robert and J. Cryan. 1975. Endangered Pine Bush Lepidoptera: the fragile ecology of the Karner Blue and Buck Moth. Privately Published, 13pp.

Dirig, R. 1976. Karner's famous blue butterfly. Pp. 197-219 in Rittner, D. (ed.) Pine Bush: Albany's Last Frontier. Pine Bush Historic Preservation Project, Albany, N.Y.

Edwards, W.H. 1861. Descriptions of certain species of diurnal Lepidoptera, found with the limits of the United States and of British America. Proc. Acad. Nat. Sci. Philadelphia 13:160-164.

Forman, R.T.T. and Godron, M. 1986. Landscape Ecology. Wiley, New York.

Gleason, Henry A. and Arthur Cronquist. 1991. Manual of Vascular Plants of the Northeastern United States and Adjacent Canada, 2nd edition. The New York Botanical Garden, New York.

Hill, M. O. 1979a. Decorana: A Fortran program for detrended correspondence analysis and reciprocal averaging. Cornell University, Ithaca, New York.

Hill, M. O. 1979b. Twinspan: A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Cornell University, Ithaca, New York.

Hobbs, Howard. 1984. Geologic atlas of Winona county, Minnesota. County Atlas Series, Atlas C-2, Plate 3 of 8, Surficial Geology.

Lawrence, W. S. and Andrea Cook. 1989. The status and management of Karner Blue (Lycaeides melissa samuelis) populations in the Allegan State Game area, Michigan. A report to The Nature Conservancy, Michigan Field Office.

Nabokov, V. 1943. The Neararctic forms of Lycaeides Hub. (Lycaenidae, Lepidoptera). Psyche 50:87-99.

Nabokov, V. 1975. Novelist as Lepidopterist. The New York Times Magazine, July 27, 1975, p.46.

Nuzzo, Victoria A. 1986. Extent and status of midwest oak savanna: presettlement and 1985, Natural Areas Journal 6(2):6-36.

Ojakangas, Richard W. and Charles L. Matsch. 1982. Minnesota's Geology University of Minnesota Press, Minneapolis.

Opler, P.A. and G. Krizek. 1984. Butterflies East of the Great Plains, The John Hopkins University Press,Baltimore.

Ownby, Gerald B. and Thomas Morley. 1991. Vascular Plants of Minnesota: A Checklist and Atlas. University of Minnesota, Minneapolis.

Pollard, E. 1977. A method for assessing changes in the abundance of butterflies. Biol. Conserv. 12:115-134.

Savignano, Dolores Anne. 1990. Field investigations of a facultative mutualism between Lycaeides melissa samuelis Nabokov (Lycaenidae), the Karner Blue butterfly, and attendant ants. Ph.D. dissertation, University of Texas, Austin.

Schweitzer, Dale. 1989. Fact sheet for the Karner Blue Butterfly with special reference to New York. The Nature Conservancy, internal document.

Thomas, J.A. 1983. A quick method for estimating butterfly numbers during surveys. Biol. Cons. 27:195-211.

Weiss, Stuart B., Dennis D. Murphy and Raymond White. 1988. Sun, slope, and butterflies: topographic determinants of habitat quality for Euphydras editha (Nymphalidae). J. Lepid. Soc. 28(2):103-107.

TABLE 1. Lupine percent cover estimates.

SITE NAME	% COVER (CONFIDENCE INTERVALS)
Trout valley	4.11 ± 1.70
Lupine valley	8.60 ± 2.08
Burnt oaks	2.99 ± 0.93
Historic 1	3.20 ± 0.86
Historic 2	2.30 ± 1.06
Cuthrell south 1	2.72 ± 0.98
Cuthrell south 2	5.87 ± 1.74
Cuthrell south 3	3.31 ± 2.51
Turkey valley	5.62 ± 2.21
Hidden valley	2.93 ± 1.01
Fabel ravine	2.91 ± 0.73

KARNER BLUE SURVEY

TABLE 2. Sites containing Lycaeides melissa samuelis. TYPE: GS = general survey; TS = transect survey; SKY: percentage of sky without clouds; COND: condition rating- 1 = no wing wear, 2 =medium wing wear, 3 = very worn wings; REL: releve and habitat sub-type codes (see text).; TOT: total butterflies seen/day.

HISTORIC SITE

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL	TOT.
GS	7/17	1:20-3:00	27 C	5-10MPH	50%	M	1	1125	HS5-VF	
						M	1	1325	HS4-SB	
						M	1	1325	HS4-SB	
										3
GS	7/23	9:00-11:45	25 C	0-5MPH	80-100%	M	1	525	HS6-VF	
						M	2	800	HS7-VF	
						M	1	1125	HS5-VF	
						M	1	1325	HS4-VF	
						F	(UD)	800	HS7-SB	
										5
TS	7/29	10:50-1:45	20 C	0-5	50%	M	1	800	HS7-VF	
						M	1	1325	HS4-SB	
						F	1	2150	HS10-SB	
										3
TS	7/31	11:00-2:33	29 C	0-5	50-80	M	2	975	OSO	
						M	1	1750	HS9-OSO	
						M	1	1750	HS9-OSO	
						M	1	2050	SB	
										4
TS	8/5	10:20-3:20	24 C	0-5	50%	F	1	1125	HS5-VF	
						M	1	1425	OS	
						M	3	1750	HS9-OSO	
										3
TS	8/12	2:45-4:30	32 C	0-5	50-80%	NONE FOUND				

TABLE 2: continued, Cuthrell South site.

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL.	TOT
GS	7/16	4:05-5:30	30 C	UD	50-80%	M	1	-	OSC	
						M	1	-	OSC	
										2
GS	7/22	1:55-3:10	32 C	0-5MPH	80-100%	F	1	-	-	
						M	1	-	-	
						UD	2	-	-	
						M	1	-	-	
						M	1	550	CS11-OSC	
						M	1	550	CS11-OSC	
						M	1	-	-	
						F	1	-	-	
						M	1	-	-	
						F	1	2700	CS7-SB	
						M	1	-	-	
						M	1	2650	CS4-VF	
						M	1	2150	CS3-SB	
										13
TS	7/30	10:20-2:05	24 C	0-5MPH	80-100%	F	1	600	-	
						F	UD	1450	CS1-SB	
						M	1	2100	CS2-VF	
						M	2	2100	CS2-VF	
						M	1	2125	CS3-SB	
						M	1	2300	-	
						F	2	2325	-	
						F	1	2375	CS8-VF	
						M	1	2600	CS4-VF	
						M	2	2600	CS4-VF	
						M	1	2625	-	
						M	1	2725	-	
						M	1	3000	CS5-0S0	
						F	1	3000	CS5-OSO	
										14
TS	8/1	10:45-2:12	25 C	0-5MPH	50%	F	1	1675	CS10-OSO	
						M	1	2075	CS2-VF	
						M	1	2075	CS2-VF	
						F	1	2400	SB	
						M	2	2650	CS4-VF	
						M	1	2825	-	
						F	1	2900	SB	
						M	2	2900	SB	
						M	1	3000	CS5-OSO	
						M	2	3000	CS5-OSO	
						M	1	3000	CS5-OSO	
										11
TS	8/9	11:15-1:30	25 C	0-5MPH	80-100%	F	2	1800	-	
						M	2	2100	CS2-VF	
										2
TS	8/13	10:05:2:35	25 C	0-5MPH	80-100%	M	1	2400	-	
						M	2	2400	-	
						F	2	2975	CS5-VF	
										3

TABLE 2: continued, Cuthrell South site.

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL.	TOT
GS	7/16	4:05-5:30	30 C	UD	50-80%	M	1	-	OSC	
						M	1	-	OSC	
										2
GS	7/22	1:55-3:10	32 C	0-5MPH	80-100%	F	1	-	-	
						M	1	-	-	
						UD	2	-	-	
						M	1	-	-	
						M	1	550	CS11-OSC	
						M	1	550	CS11-OSC	
						M	1	-	-	
						F	1	-	-	
						M	1	-	-	
						F	1	2700	CS7-SB	
						M	1	-	-	
						M	1	2650	CS4-VF	
						M	1	2150	CS3-SB	
										13
TS	7/30	10:20-2:05	24 C	0-5MPH	80-100%	F	1	600	-	
						F	UD	1450	CS1-SB	
						M	1	2100	CS2-VF	
						M	2	2100	CS2-VF	
						M	1	2125	CS3-SB	
						M	1	2300	-	
						F	2	2325	-	
						F	1	2375	CS8-VF	
						M	1	2600	CS4-VF	
						M	2	2600	CS4-VF	
						M	1	2625	-	
						M	1	2725	-	
						M	1	3000	CS5-0S0	
						F	1	3000	CS5-OSO	
										14
TS	8/1	10:45-2:12	25 C	0-5MPH	50%	F	1	1675	CS10-OSO	
						M	1	2075	CS2-VF	
						M	1	2075	CS2-VF	
						F	1	2400	SB	
						M	2	2650	CS4-VF	
						M	1	2825	-	
						F	1	2900	SB	
						M	2	2900	SB	
						M	1	3000	CS5-OSO	
						M	2	3000	CS5-OSO	
						M	1	3000	CS5-OSO	
										11
TS	8/9	11:15-1:30	25 C	0-5MPH	80-100%	F	2	1800	-	
						M	2	2100	CS2-VF	
										2
TS	8/13	10:05:2:35	25 C	0-5MPH	80-100%	M	1	2400	-	
						M	2	2400	-	
						F	2	2975	CS5-VF	
										3

TABLE 2: continued.

TURKEY VALLEY

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND	POS	REL	TOT
GS	7/18	4:05-5:0	32 C	0-10MPH	80-100%	M	1	-	TV2-SB	
GS	8/9	9:50-10:50	26 C	0-5MPH	80-100%		NONE FOUND			

FABEL RAVINE

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND	POS	REL	TOT
GS	7/19	10:40-12:15	30 C	0-5MPH	80-100%	M	1	-	-	
						M	1	-	-	
										2
GS	7/24	11:00-2:05	23 C	0-20MPH	50-80%	F	1	-	FR3-OSO	
						F	1	-	FR3-OSO	
						M	2	-	FR3-OSO	
										3
GS	8/7	10:00-12:30	18 C	0-5MPH	50%	F	1	-	FR3-OSO	

HIDDEN VALLEY

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND	POS	REL	TOT
GS	7/19	12:20-1:00	32 C	0-5MPH	50-80%	M	1	-	HV1-SB	
						M	1	-	HV1-SB	
										2
GS	7/24	2:15-3:30	25 C	0-15MPH	50%	M	1	-	HV1-SB	
						M	2	-	HV1-SB	
						M	1	-	HV2-SB	
						M	1	-	HV2-SB	
										4

TABLE 3. Sites where <u>Lycaeides melissa samuelis</u> was not found.

LUPINE VALLEY

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL.
GS	7/18	1:00-2:05	30 C	0-10MPH	80-100%		NONE FOUND		
GS	7/23	2:00-2:45	31 C	0-5MPH	50-80%		NONE FOUND		
GS	8/1	3:50-4:25	32 C	0-5MPH	50%		NONE FOUND		

TROUT VALLEY

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL.
GS	7/18	10:25-10:45	27 C	0-5MPH	80-100%		NONE FOUND		
GS	7/23	3:30-4:00	31 C	0-10MPH	50-80%		NONE FOUND		

BURNT OAKS

TYPE	DATE	TIME	TEMP.	WIND	SKY	SEX	COND.	POS.	REL.
GS	7/23	12:20-12:50	30 C	0-12MPH	80-100%		NONE FOUND		
GS	7/18	8:55-9:40	25 C	0-5MPH	80-100%		NONE FOUND		

TABLE 4. Population indices for Lycaeides melissa samuelis in Historic and Cuthrell South study sites.

$$\text{POPULATION INDEX} = \frac{100\ N\ A}{L}$$

N = number of butterflies counted
L = lenghth of transect
A = size of flight area

SITE	DATE	NUMBER (N)	AREA(A)	LENGHTH (L)	INDEX
Historic	7/29	3	9.3 Ha	2300 meters	1.213
	7/31	5	"	"	2.022
	8/5	5	"	"	2.022
	8/12	0	"	"	0
Cuthrell South	7/30	14	13.2 Ha	3000 meters	6.160
	8/1	11	"	"	4.840
	8/9	2	"	"	0.880
	8/13	3	"	"	1.320

INDIVIDUAL OBSERVATION SUMMARIES:

TABLE 5 - Adult Nectar Plants

Percent nectaring/plant species =

$$\frac{\text{times each sex observed nectaring on a specific plant}}{\text{total times observed nectaring}}$$

NECTAR PLANT	MALES		FEMALES	
	# OBS.	%	#OBS.	%
Monarda punctata	21	91.30	14	93.33
Campanula rotundifolia	0	-	1	6.67
Gnaphalium obtusifolium	1	4.30	0	-
Euphorbia corollata	1	4.30	0	-
Total	23		15	

TABLE 6 - Flight frequency

Flight Interval=

$$\frac{\text{Total minutes observed}}{\text{Number of flights observed}}$$

	MALES	FEMALES
Total minutes observed	76.51	108.65
Number of flights observed	55	52
Flight frequency	1.4/min.	2.1/min.

TABLE 7 - Average flight distance

Flight Distance=

$$\frac{\text{Total Distance (meters)}}{\text{Number of flights observed}}$$

	MALES	FEMALES
Number of flights obs.	41	39
Total distance	204.72	58.3
Average flight distance	4.99	1.49

TABLE 8. Butterfly species in Lycaeides melissa samuelis butterfly habitat. Species recorded by David Cuthrell (1990) and Cynthia Lane (1991).

SPECIES NAME	COMMON NAME
Amblyscirtes vialis	Roadside skipper
Ancyloxypha numitor	Least skipperling
Artogeia rapae	Cabbage white
Asterocampa celtis	Hackberry butterfly
Asterocampa clayton	Tawny emperor
Atrytone delaware	Delaware skipper
Basilarchia arthemis	Red-spotted purple
Basilarchia archippus	Viceroy
Celastrina ladon	Spring azure
Cercyonis pegala	Wood nymph
Charidryas gorgone	Gorgone crescentspot
Colias eurytheme	Common sulfur
Colias philodice	Orange sulfur
Danaus plexippus	Monarch
Enodia anthedon	Pearly eye
Epargyreus clarus	Silver-spotted skipper
Erynnis baptisiae	Wild indigo skipperling
Erynnis juvenalis	Juvenal's duskywing
Erynnis persius	Persius duskywing
Euphyes ruricola	Dun skipper
Everes comyntas	Eastern tailed blue
Harkenclenus titus	Coral hairstreak
Hemiargus isola	Reakirt's Blue
Heraclides cresophontes	Giant swallowtail
Hesperia leonardus	Leonardus skipper
Lycaena phlaeas	American copper
Megisto cymela	Little wood satyr
Nymphalis antiopa	Mourning cloak
Papilio polyxenes	Black swallowtail
Phyciodes tharos/morpheus	Pearly crescentspot
Poanes hobomok	Hobomok skipper
Polites origines	Crossline skipper
Polites thenistodes	Tawny-edged skipper
Polygonia comma	Comma
Polygonia progne	Gray comma
Pontia protodice	Checkered white
Pterourus glaucus	Tiger swallowtail
Pyrisitia lisa	Little yellow
Satyrium edwardsii	Edward's hairstreak
Speyeria cybele	Great spangled fritillary
Strymon melinus	Gray hairstreak

Thorybes bathyllus	Southern cloudywing
Vanessa atalanta	Red admiral
Vanessa cardui	Painted lady
Wallengrenia egeremet	Northern broken dash

TABLE 9. Plant species of Lycaeides melissa samuelis study sites in oak savanna, Whitewater Wildlife Management area, Minnesota.

SCIENTIFIC NAME	COMMON NAME
HERBS	
Achillea millefolium L.	Common Yarrow
Ambrosia artemisiifolia L.	Rag Weed
Amorpha canescens Pursh	Lead Plant
Amphicarpaea bracteata (L.) Fern.	Hog Peanut
Anenome cylindrica Gray	Thimbleweed
Anenome virginiana L.	Thimbleweed
Antennaria plantaginifolia (L.) Richards.	Pussytoes
Aquilegia canadensis L.	Columbine
Arabis canadensis L.	Sicklepod
Arabis glabra (L.) Bernth.	Tower-Mustard
Aralia nudicaulis L.	Wild Sarsaparilla
Artemisia campestris L.	Wormwood
Artemisia ludoviciana Nutt.	Prairie Sage
Asclepias syriaca L.	Common Milkweed
Asclepias tuberosa L.	Butterfly Milkweed
Asparagus offincinalis L.	Garden Asparagus
Aster ericoides L.	Heath Aster
Aster oblongifolius Nutt.	Aromatic Aster
Aster oolentaniensis Riddell	Azure Aster
Aster sericeus Vent.	Silky Aster
Aureolaria pedicularia (L.) Raf.	False Foxglove
Campanula rotundifolia L.	Harebell
Chenopodium desiccatum (leptophyllum) Nels.	Narrowleaved Goosefoot
Chimaphila umbellata (L.) Bart.	Pipsissewa
Conyza canadensis (L.) Cronq.	Horseweed
Coreopsis palmata Nutt.	Stiff Tickseed
Delphinium virescens Nutt.	Prairie Larkspur
Desmodium glutinosum (Muhl. ex Willd.) Wood	Tick-Trefoil
Erigeron annuus (L.) Pers.	Daisy Fleabane
Eupatorium rugosum Houtt.	White Snake root
Euphorbia corollata L.	Flowering Spurge
Frageria vesca L.	Strawberry
Frageria virginiana Duchesne	Strawberry
Froelichia floridana (Nutt.) Moq.	Cottonweed
Galium boreale L.	Northern Bedstraw
Gnaphalium obtusifolium L.	Sweet Everlasting
Goodyera pubescens (Willd.) R. Br.	Rattlesnake Plantain
Hackelia deflexa (Wahlenb.)Opiz	Stickseed
Hedyotis lonifolia (Gaetrn.) Hook.	Longleaved Houstonia

Helianthemum bicknelli Fern.	Rockrose
Helianthemum canadense (L.) Michx.	Frostweed
Helianthus occidentalis Riddell	Western Sunflower
Hieracium kalmii L.	Hawkweed
Hieracium scabrum Michx.	Hawkweed
Hypericum canadense	St. John's Wort
Lechea stricta Leggett	Pinweed
Lechea tenuifolia Michx.	Pinweed
Lepidium densiflorum Shrad.	Pepper Grass
Lespidisa capitata Michx.	Bush Clover
Liatris aspera Michx.	Rough Blazing Star
Lithospermum caroliniense (Walt.) MacM.	Hairy Puccoon
Lithospermum canescens (Michx.) Lehm.	Hoary Puccoon
Lupinus perennis L.	Lupine
Lysimachia ciliata L.	Fringed Loosestrife
Melilotus alba Medic.	White Sweet Clover
Melilotus officinalis (L.) Pallas	Yellow Sweet Clover
Mollugo verticillata L.	Carpetweed
Monarda fistulosa L.	Wild Bergamont
Monarda punctata L.	Horsement
Oenothera clelandii Dietr., Raven and Wagner	Evening Primrose
Oxalis dillenii Jacq.	Wood Sorel
Parietaria pensyvanica Muhl. ex Willd.	Pellitory
Pedicularis canadensis L.	Lousewort
Petalostemon purpureum (Vent.)Rydb.	Purple Prairie Clover
Physalis virginiana Mill.	Ground Cherry
Polygonum convolvulus L.	Black Bindweed
Polygonum scandens L.	Climbing False Buckwheat
Polygonum tenue Michx.	Knotweed-rare
Potentilla arguta Pursh	Tall Cinquefoil
Prenanthes alba L.	White lettuce
Pteridium aquilinum (L.) Kuhn	Braken Fern
Pyrola eliptica Nutt.	Shinleaf
Ratibida pinnata (Vent.) Barnh.	Yellow Coneflower
Rhus radicans L.	Poison Ivy
Rosa sp.	Wild Rose
Rudbeckia hirta L.	Coneflower
Rumex acetosella L.	Sheep Sorel
Saponaria officinalis L.	Soapwort
Scrophularia lanceolata Pursh	Figwort
Smilacina racemosa (L.) Desf.	False Spikenard
Smilacina stellata (L.) Desf.	Star-flowered F. S. S.
Smilax hispida Torr.	Greenbrier
Solanum ptycanthum Dunal ex DC	Nightshade
Solidago canadensis L.	Goldenrod
Solidago nemoralis Ait.	Gray Goldenrod

Solidago ptarmicoides (Nees) Boivin	White Aster
Solidago sciaphila Steele	
Talinum rugospermum Holz.	Fameflower
Tephrosia virginiana (L.)Pers.	Hoary Pea
Teucrium canadense L.	American Germander
Tradescantia ohiensis Raf.	Spiderwort
Verbascum thapsus L.	Common Mullein
Viola pedata L.	Bird Foot Violet
Viola pedatifida G. Don	Bird Foot Violet

GRASSES AND SEDGES

Andropogon gerardi Vitman	Big Bluestem
Aristida tuberculosa Nutt.	Triple-awned Grass
Bouteloua hirsuta Lag.	Gramma Grass
Bromus kalmii Gray	Brome Grass
Bromus inermis Leyss.	Smooth Brome
Carex pennsylvanica Lam.	Sedge
Cyperus lupulinus (Spreng.) Marcks	Nut Grass
Cyperus schweinzi Torr.	Nut Grass
Digitaria ischaemum (Schreb.) Muhl.	Crab Grass
Eragrostis spectabilis (Pursh) Steud.	Tumble Grass
Koeleria macrantha (Ledeb.) Schultes	June Grass
Leptoloma cognatum (Schultes) Chase	Fall Witch Grass
Panicum virgatum L.	Switch Grass
Poa pratensis L.	Kentucky Blue Grass
Setaria viridis (L.)Beauv.	Bristly Foxtail
Schizachyrium scoparium (Michx.) Nash.	Little Bluestem
Sorghastrum nutans (L.) Nash	Indian Grass

WOODY PLANTS

Celastrus scandens L.	Climbing Bittersweet
Ceanothus americanus L.	New Jersey Tea
Cornus alternifolia L.	Pagoda Dogwood
Cornus foemina Mill.	Gray Dogwood
Corylus americana Walt.	American Hazelnut
Gaylussacia baccata (Wang.) K. Koch	Black Huckleberry
Lonicera tatarica L.	Tatarian Honeysuckle
Parthenosissus inserta (Kerner0 Fritsch	Virginia Creeper
Physocarpus opulifolius (L.) Maxim.	Common Ninebark
Populus deltoides Marsh.	Cottonwood
Populus tremuloides Michx.	Quaking Aspen
Ribes sp.	Current/Gooseberry
Rubus flagellaris Willd.	Dewberry
Rubus occidentalis L.	Black Raspberry
Quercus alba L.	White Oak
Quercus rubra L.	Red Oak

Quercus velutina Lam.	Black Oak
Vaccinium sp.	Blueberry
Zanthoxylum americanum Mill.	Prickly Ash

EVERGREENS

Pinus banksiana Lamb.	Jack Pine
Juniperus communis L.	Ground Juniper
Juniperus virginiana L.	Eastern Red Cedar

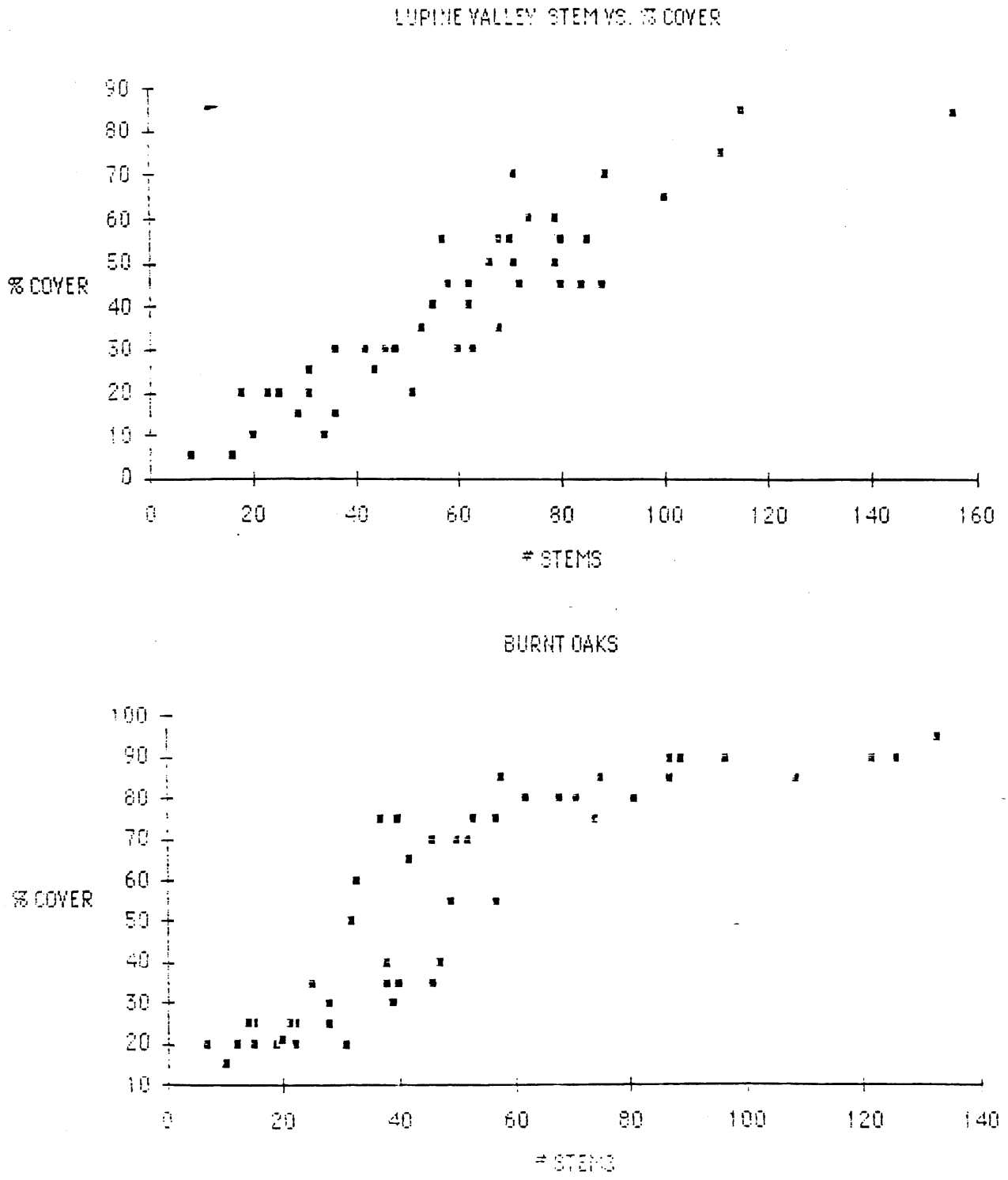


FIGURE 1. Comparison of number of stems and percent cover estimates of Lupinus perennis. Lupine valley and Burnt oaks study sites.

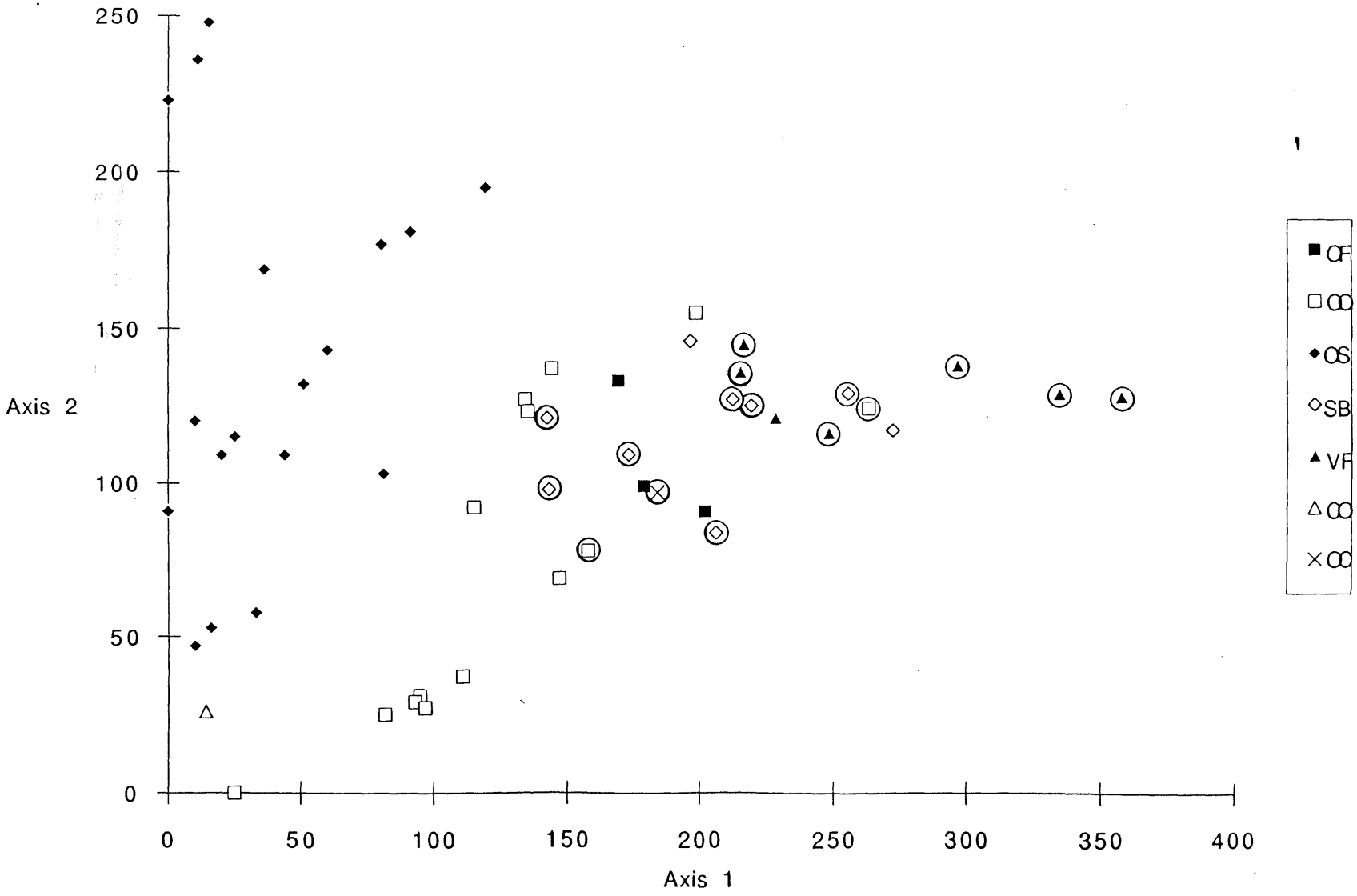


FIGURE 2. Detrended correspondence analysis (DCA) ordination of sample plots. ◯ = plots containing Karner Blue butterflies.

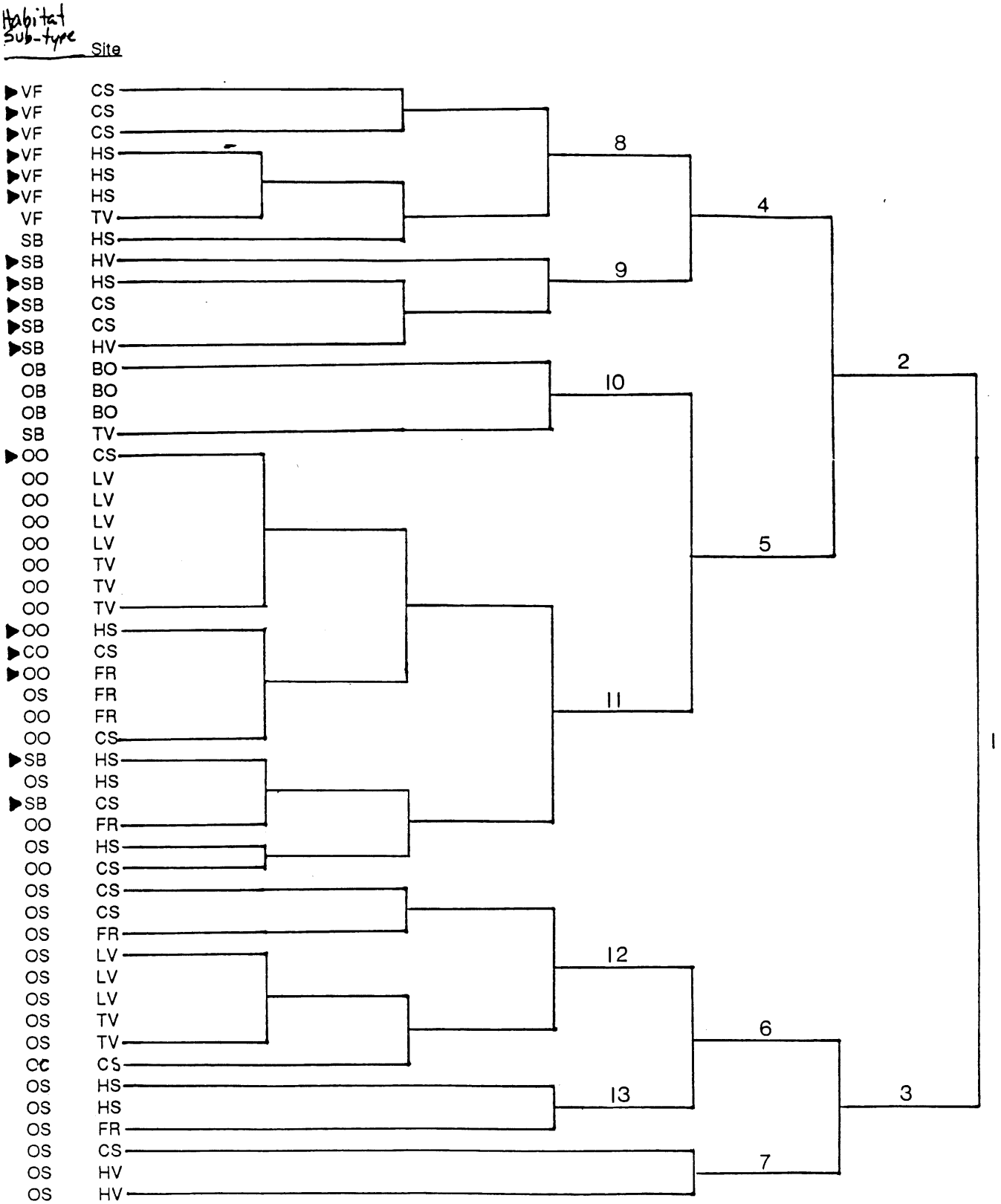
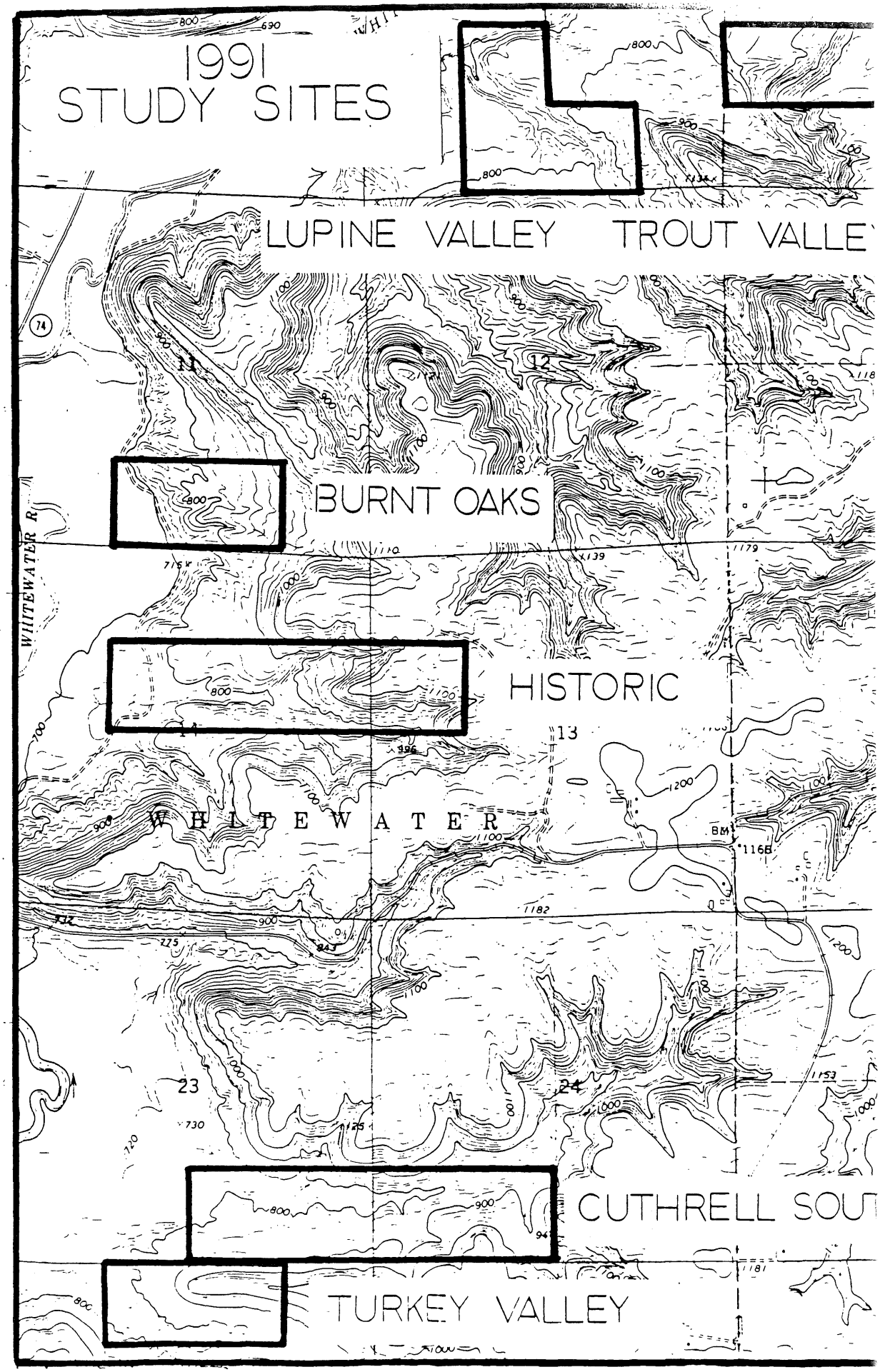


FIGURE 3. Dendrogram displaying the classification of 53 releve plots in Lycaeides melissa samuelis study sites. ▶ = sites with butterflies. See text for habitat sub-type and site codes.



WHITE WATER WILDLIFE MANAGEMENT AREA - MAP 1

1991
STUDY SITES
MAP 1-CONT.