Operations Manual, Terrestrial Studies
May 23, 1977

1. INTRODUCTION

To fully acquaint yourself with the original changes, amendments and reasons leading to the current sampling carried on by the terrestrial portion of the Regional Copper-Nickel Study, interested persons should read the Original Terrestrial Proposal (summer 1976) and the First Review (June 8, 1976). For those interested in program status and plans for next year, this overview will cover the required ground.

The terrestrial staff is charged with characterizing the vegetation, mammal, bird and insect flora and fauna in northeastern Minnesota, specifically the area likely to be impacted by copper-nickel development. Sampling operations during the 1976 season, were confined to the "Minesite" area.

With these tasks before us, we had to select and specialize in much smaller categories within these four broad topics listed above. The process of specializing in itself requires a decision making process. This is a preliminary report of the findings of the 1976 field season.

The terrestrial staff was organized in April (1976) and conducted intensive field work until mid-October of this year. Each section contains only data which could be analyzed and a partial literature review conducted from mid-October to the present (December 10). We have indluced samples of the type of data currently in our files that will be compiled, analyzed and summarized during the winter of 1976-1977.

The intent of this paper is to provide adequate information to compare and constructively criticize our basic approach and the type of data currently being collected in the terrestrial biology program.

2. THEORY BEHIND SITE SELECTION AND THE NUMBER OF SITES SAMPLED FOR VEGETATION, SMALL MAMMALS, NONGAME BIRDS AND INSECTS DURING 1976

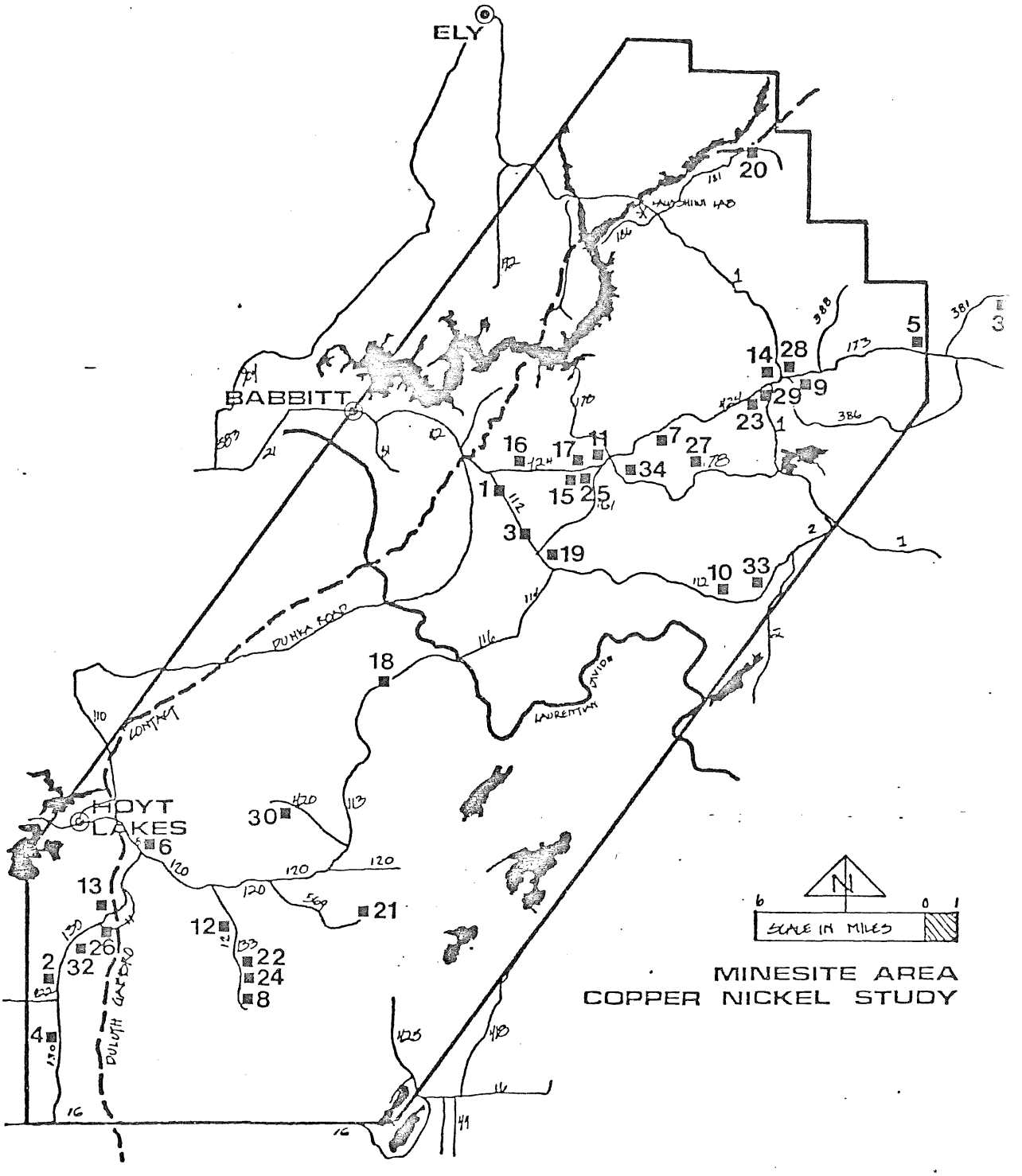
The term site is used in the terrestrial biology program to define the physical area where various field activities such as small mammal trapping, bird census, insect sampling, florectic surveys and quantitative vegetation data are conducted. Due to the highly disturbed nature of much of the vegetation in the study region, a single site is often not large enough or homogeneous enough to meet the needs of all sampling programs. If the reader keeps this problem of varing numbers of sites used for each type of sampling in mind, sample sizes discussed during this overview will be clear.

After on-site field examinations of the forest types and existing road systems on the study area were completed in May (1976), the following decisions relative to site selection were made:

1) Only homogeneous and readily accessible sites would be selected, because additional time required to walk long distnaces to sites would only reduce efficiency.

2) Sites should be chosen on the basis of their representation of vegetation communities. The original 22 sites (site nos. 1-22, inclusive) represent the major plant community types found on the study area (Table SS-1, P). The number of sites located in each cover type are not proportional to the percent cover of that type on the Minesite. A total of 34 sites (Table SS-1; P- ; Figure SS-1, P-) were needed to provide representative plant community types and the area requiremenhs for small mammal trapping during the 1976 season. Ad additional 36 sites (Table BT-1, P-) were required for non-game bird census. Thus

Figure SS-1 Location of 34 sites selected for study during 1976



different sites were located and sampled by terrestrial biology during the spring, summer and fall sampling period in 1976;

3) Sites should be compatable with needs of other Copper-Nickel studies to facilitate coordination. The original 22 sites are used jointly by the terrestrial group and plant pathology study;

4) Sampling in 1977 should consider disturbed habitat types. Although a large proportion of the area consists of distrubed cover types (recent clear cuts, coniferous plantations and aspen regeneration) and forest with mixtures of coniferous and deciduous species, most sites selected and sampled during 1976 were homogeneous forest types predominated by a single species (e.g. trembling aspen, paper birch, black spruce, etc.) The emphasis for the 1977 field season is to select sites in disturbed and forestry cover types to complement data from 1976.

Sampling sites were located throughout the study area to provide a regional characterization for the terrestrial study. Each site number and location is noted no maps and discussed in separate sections of this report.

A considerable number of changes had to be made from the original terrestrial proposal relative to the actual size of each site (Proposal for the Terrestrial Biology Section of the Regional Environmental Impact Study; Summer-1976, internal Copper-Nickel publication). This proposal for establishing permanent sites was written with only a limited knowledge of the biological and administrative factors existing for the area. The original proposal for site establishment reads as follows:

> "Two plots will be located in each habitat type, one to the north and one to the south of the Laurentian Divide. Plots will contain 40 acres, a 20 acre area used for sampling and a 20 acre buffer zone surrounding the core area for added protection against future disturbances (mainly logging). The corners and sides of these two areas (core and buffer) will be marked with 5 foot long aluminum or steel conduit driven into the ground 12-18 inches and properly labeled."

The main limiting factor to establishing these 40 acre (16.2 hectares) sites was the highly disturbed nature (natural and man-caused) of cover types. Large, uniform plant communities sought for our studies are uncommon over much the area, with the exception of black spruce swamps and recently logged or planted areas. In addition, the U.S. Forest Service (USFS) was not receptive to permanent plots on Federal lands.

As a result of these biological and administrative problems, all sites utilized during the 1976 field season are temporary in nature. Guarantees have been obtained from the respective governing agencies (State, Counties and USFS) to protect our sites for two years during the current study.

If permanent sites are established for re-examination during future studies, these sites will be established during 1977. In all likelihood, they will be located on State owned lands.

The remainder of this paper includes the literature reviewed to date, the methods and technqiues used to obtain field data, sample sizes and results, based on the data analyzed to date. Preliminary projections for the 1977 field season are are also included. Results, conclusions and projections are based on only a fraction of the data collected during 1976 and are subject to changes and modifications.

Table SS-1.

1976 terrestrial site descriptions. These sites were used for all sampling with the exception of nongame bird census.

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
1	Mature Jack Pine Stand	On USFS Road #112 SE of Babbitt	10	346	T.60N. R.12W. Sec. 15 NE¼ SE¼	Federal
				347	T.60N. R.12W. Sec. 14 E½ NW¼ SW¼	
2	Mature Jack Pine Stand	On USFS Road #130 SE of Hoyt Lakes	21		T.57N. R.14W. Sec. 7 SE¼ NE¼ NE¼	Federal
				739	T.57N. R.14W. Sec. 7 E½ SE¼ NE¼	
				740	T.57N. R14W. Sec. 8 SW½ NW¼ SE¼ N½ SW¼ SE¼	
3	Mature Red Pine Stand	On USFS Road #112 SE of Babbitt	10	371	T.60N. R.12W. Sec. 23 S½ NW¼ SE¼ NW¼ SW¼ SE¼	Federal
4	Mature Red Pine Stand	On USFS Road #130 SE of Hoyt Lakes	21	757	T.57N. R.14W. Sec. 18 NE¼ SE¼ SE¼ N½ SW¼ SE¼	Federal
5	Mature Black Spruce Stand	On USFS Road #173 SE of August Lake	7	257	T.61N. R.10W. Sec. 26 N½ SE¼ NE¼	Federal
6	Mature Black Spruce Stand	On USFS Road #569 SE of Hoyt Lakes	17	628	T.58N. R.14W. Sec. 15 E½ SE¼ SW¼ SW¼ SW¼ SE¼	Federal
7	Mature Paper Birch Stand	On USFS Road #424 2 mi east of Stony River	11	327	T.60N. R.11W. Sec. 9 E½ NE¼ NW¼	Nonfederal
8	Mature Paper Birch Stand	On USFS Road #128 Skibo Lookout	22	746	T.57N. R.13W. Sec. 8 SE¼ SW¼	Federal
				764	T.57N. R.13W. Sec. 17 N½ NE¼ NW¼	

Table SS-1. (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
9	Mid-Aged Trembling Aspen Paper Birch Mixed Stand	On USFS Road #386 NW of Shamrock Lake	7	278	T.61N. R.10W. Sec. 32 SE¼ SE¼ NW¼ SE¼ S½ SE¼ NE¼	Federal
				279	T.61N. R.10W. Sec. 33 W½ SW¼ NW¼ W½ NW¼ SW¼ W½ SW¼ SW¼	
10	Mid-Aged Trembling Aspen Paper Birch Stand	On USFS Road #112 W of Hwy. 2	16	456	T.59N. R.11W. Sec. 1 N½ SE¼ SW¼ SW¼ NW¼ SE¼ NE¼ NW¼ SE¼ NW¼ NE¼ SE¼	Federal
11	Mature Trembling Aspen Stand	On USFS Road #178 W of Stony River	11	325	T.60N. R.11W. Sec. 7 SE¼ SE¼ *More than 640 acres in Sec. 7	Federal
12	Mid-Aged Trembling Standonly Scattered Paper Birch	On USFS Road 128 N of Skibo Vista	22	728	T.57N. R.13W. Sec. 5 SW¼ SW¼	Nonfederal
				746		
13	Pole Trembling Aspen Stand	On USFS Road #130 (just west of St. Louis River)	17	699	T.58.N. R.14W. Sec.33 S½ NE¼ NW¼ SE¼ NW¼ NW¼ N½ SW¼ NW¼	Nonfederal
14	Mid-Aged Tamarack Stand, Scattered Black Spruce	On USFS Road #424, 5 mi west of Hwy. 1	7	277	T.61N. R.10W. Sec 31 NE¼ SE¼ NW¼	Federal
15	Young Tamarack	On USFS Road #424 Approx. 1.25 mi. W of 1431 Intersection	11	349	T.60N. R.11W. Sec. 18 N½ NW¼ SW¼ S½ SW¼ NW¼ *More than 640 acres in Sec. 18	Federal

Table SS-1. (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
16	Mid-Aged Tamarack-Black Spruce Stand (Co-Dominant in Canopy)	On USFS Road #424, 1.5 mi. E of Junc. w/USFS Road #112	10	324	T.60N. R.12W. Sec. 12 N½ NE¼ NW¼	Federal
17	Mature White Cedar Stand	On USFS Road #424, .5 mi. W of Junc. w/USFS Road #1431	11	349	T.60N. R.11W. Sec. 18 N½ SE¼ NE¼ *More than 640 acres in Sec. 18	Federal
18	Mature Trembling Aspen with Dense Fir Understory	On USFS Road #116, Between 2 RR Crossings	15	493	T.59N. R.12W. Sec. 18 S½ SE¼ NE¼ N½ NE¼ SE¼ *More than 640 acres in Sec. 18	Federal
19	Approx. 6 yr old Red Pine-Jack Pine Plantation	On USFS Road #112 ½ mi. E of Junc. w/USFS Road #1431	10	396	T.60N. R.12W. Sec. 25 SE¼ SW¼ E½ SW¼ SW¼	Federal
20	1972 Clearcut	On Spruce Road 1.9 mi. N of Hwy. 1	2	107	T.62N. R.11W. Sec. 26 SE¼ NW¼ N½ NW¼ SW¼	Federal
21	Grassland-Skibo Mill	End of USFS Road #569 approx. 2.5 mi. beyond area where road runs along E side of RR right-of-way	18	708	T.58.W. R.13W. Sec. 36 NW¼ SW¼ SW¼	Nonfederal
22	Alder-Willow Swamp	Along USFS Road #128 Just S of Intersection w/129, before road takes sharp bend SW	22	746	T.57N. R.12W. Sec. 8 NE¼ NW¼ NW¼	Federal
				747	T.57N. R.12W. Sec. 5 SE¼ SW¼ SW¼	Nonfederal

Table SS-1. (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
23	Mid-aged Tamarack Black Spruce Mixture	On south side of USFS Road #424 about ¼ mi. W. of junc. w/Hwy. 1	7	277	T.61N. R.10W. Sec. 31 NW¼ NW¼ SE¼ SW¼ SW¼ NE¼	Federal
24	Alder-Willow Swamp	On USFS Road #128 about ¼ mi N of plot #8	22	746	T.57N. R.13W. Sec. 8 NE¼ NW¼ SW¼	Nonfederal
25	Ash	On USFS Road #424 S side of Road ½ mi. W of junc. with USFS #1431	11	349	T.60N. R.11W. Sec. 18 SE¼ SE¼ NW¼ *Sec. 18 more than 640 acres)	Federal
26	Red Pine Stand	On USFS Road #790 (Dead End) off of USFS Road #130 SE of Hoyt Lakes	17	699	T.58N. R.14W. Sec. 33 NW¼ SW¼	Federal
27	Paper Birch Stand	On USFS Road #178 about 2 mi. W of Hwy 1	11	354	T.60N. R.11W. Sec. 13 SW¼ NW¼	Federal
28	Black Spruce Stand	At triangle ¼ mi E of junc. of USFS Road #173 and Hwy 1	7	278	T.61N. R.10W. Sec. 81 NE¼ SE¼ NE¼	Federal
29	Trembling Aspen Stand	At junction of USFS Road #424 & Hwy 1	7	277	T.61N. R.10W. Sec. 7 E½ SW¼ NE¼	Federal
30	Black Spruce Stand	On USFS Road #420	18	610	T.58N. R.13W. Sec. 10 NW¼ SW¼ SE¼ *Sec. 10 more than 640 acres	Federal

Table SS-1. (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
31	1975 Clearcut	On USFS Road #381	8	212	T.61N. R.9W. Sec. 17 NE¼ NE¼	Federal
32	Red Pine Stand	On USFS Road #130	21	722	T.57N. R.14W. Sec. 5 NE¼ NW¼ N½ SE¼ NW¼ NW¼ NW¼ NE¼	Federal
33	Paper Birch Stand	1.75 mi. W of Hwy 2 on USFS Road #112			T.59N. R.10W. Sec. 6 N½ NE¼ NW¼	
34	Trembling Aspen Stand	On USFS Road #178, 0.9 mi. E of junc. with USFS Road #424	11	350	T.60N. R.11W. Sec. 17 SE¼ SW¼ NW¼ SW¼ SE¼ NW¼	Nonfederal

3. REGIONAL VEGETATION STUDY

3.1. Introduction

Vegetation studies during the summer of 1976 included four aspects: phenological records, floristic survey, collection of herbarium voucher specimens, and quantitative sampling.

Plant collections were made throughout the area, both on and off of designated sites. The floristic survey was confined to sites 1-34, which are designated either as "primary plant community" plots or as census areas for small mammals and insects. Quantiative data were collected from all 36 transects used for singing male, nongame bird census and from 10 primary plots. Pars of several other bird transects overlap primary plots. Table V-12 shows the status of sampling in each study site as of October 1, 1976.

4. PHENOLOGY

4.1. Introduction

During the 1976 field season, seasonal changes in leaf emergence, flowering, leaf color change, and leaf fall were measured.

The phenology study was undertaken for a number of reasons: 1) the need to understand the dates of leaf-out, flowering, leaf color change and leaf fall in order to learn the functional limits of our field season; 2) phenology may show relationships to other aspects of the terrestrial study. Leaf presence or absence may be one of the proximate

Table V-12 (cont.) Field work completed, summer 1976.

● Completed
○ Partially completed

Primary community SITE 1-22; supplimentary SITE s 24-34

Plot Numbers	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33	34
Releve	●	●	●	●	●	●	●	●	●	●	●	●	●			
Followup visit	●		●		●	●	●		●				●			
Stand history		●									○					
VEG. QUADRAT/					○	○	○		●		●		●			●
Bird transects					●	●	●			●			●			
Pitfall traps	●	●		●												
Insect net TINS	●	●	●	●	●											
Mist nets																
Mammal tr. grid								B	B	BC	B	C		C	C	C
Mapped									●						●	
Duff & soil DEPTH								●	●	●	●	●		●	●	●

17

Table V-12 Field work completed, summer 1976.

● Completed
○ Partially Completed

Primary community ~~plots~~ SITE 1-22; supplimentary ~~plots~~ SITE 24-34

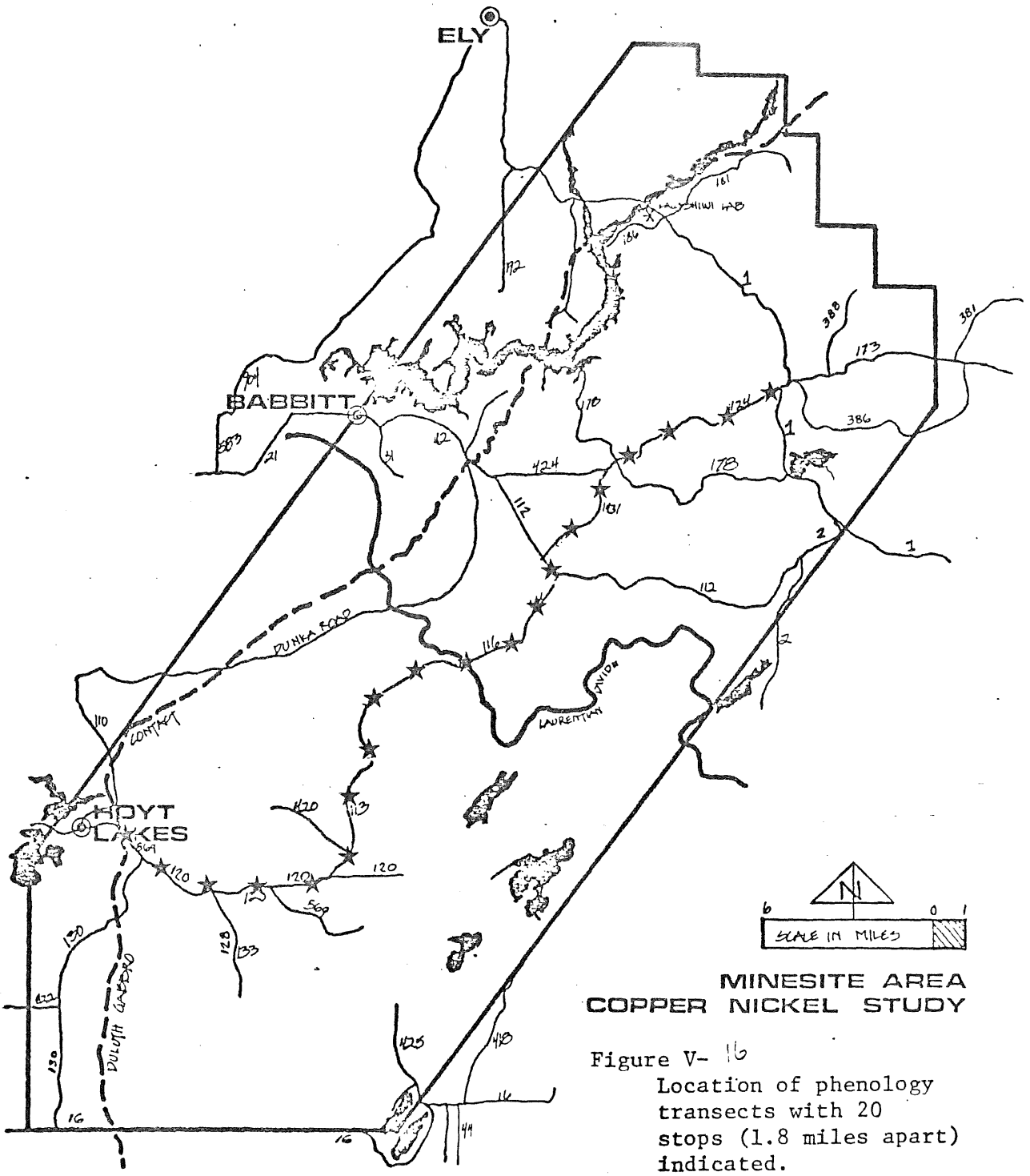
~~Plot~~ SITE Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Releve	●	●			●	●		●	●	●	●	●		●	●	●	●
Followup visit	●	●				●					●	●					●
Stand history	○		●	○		○		○			●	●					
VEG. QUADRAT ~~Plots~~	○	○		○		●	●		●		●	○			○	○	○
Bird transects	●	●		●		●						●			●	●	●
Pitfall traps		●		●	●		●		●		●			●	●		●
Insect net ~~sing~~	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Mist nets		●				●					●		●		●		●
Mammal tr. grid	ABC	ABC	ABC	A	A	AB	A	ABC	ABC	ABC	A		ABC	I	I	I	I
Mapped	○									●							
Duff & soil DEPTH ~~Clip~~	●	●	●	●	●	●	●	●	●	●	●		●				

factors determining small mammal movements. In addition, flowering and fruiting contribute to food supplies of forest consumers. Birds may select more dense habitats during periods of molting. Ground dwelling birds and mammals depend on leaf litter for nesting materials. The emergence of some terrestrial insects (Aspen tortrix) is coordinated closely with leaf emergence. Leaf fall in this area is one of the major contributors of alochthinous input to streams. The leaf fall becomes a large part of organic input into the soil and a major food source for soil organisms; 3) the amount of light penetrating the overstory changes drastically when leaf emergence closes the canopy; 4) the phenology study complements the nosie study because leaf sounds are a major source of natural forest sounds.

Phenology data was collected in spring to date leaf emergences and flowering, and in fall to date color change and leaf fall. A study of phenology in northern Minnesota was completed by Ahlgren (1957). Ahlgren selected five individual trees from each of 19 species in a variety of habitats and measured factors such as stem and bud expansion. Our emphasis was on the more readily observed changes taking place, such as percent leaf out.

4.2. Methods

Sampling stations were set up on a road route that runs the length of the study area. Twenty stations at 1.8 mile intervals were established along this route. Station placement was systematic without selection for specific vegetation types or structures, thus reducing bias in



MINESITE AREA
COPPER NICKEL STUDY

Figure V- 16
Location of phenology transects with 20 stops (1.8 miles apart) indicated.

site selection and producing a more representative sampling of the entire study area.

Phenology data on 11 species of deciduous trees and shrubs that were relatively common on most sites were recorded. The trees included: Populus tremuloides, Populus balsmifera, Populus grandidertata, Fraxinus nigra, Betula papyrifera, and Larix laricina. The shrubs included: Alnus crispa, Alnus rugosa, Corulus cornuta, Cornus stolonifera and Acer spicatum. The phenology of dominant tree and shrub species at each site (10 individuals of each species when possible) was recorded each time the transect was run. The spring phenology study was repeated every three days from May 13 to June 1. A visual observation was made with the occasional help of binoculars. Trees were counted as leafed out when over 50 percent of the inital leaves had erupted from the bud. Generally a whole tree leafed out at one time. Unknown factors influenced the trees next to the road because these trees appeared to be under more stress than trees away from the road. Therefore, all observations were of trees between 10 and 50 m from roads.

Both spring and fall phenology data is represented in Figure V-15. Examples of field data sheets during each period are shown in Table V-13 and V-14.

The autumn phenology study began August 17 and continued at weekly intervals through October. Autumn color change and leaf fall were recorded. These processes were much lower than spring leaf eruption. These data have been converted to total percent to relate directly to spring data and are shown in Figure V-15.

The total number of trees observed at the 20 stops was 417. The single most common species was Populus tremuloides. Figure V-15 portrays leaf emergence for the 11 species in May and leaf fall for the same species in Autumn. The sample size for Populus tremuloides was large enough to show differences in the phenology between trees north and south of the Laurentian divide. The timing of the seasonal changes was complicated in 1976 by the drought which caused low soil moisture during leaf emergence, color change and in fall. Spring temperatures and soil moisture have been shown to be major factors in the timing of flowering (Lindsey and Newman 1956). Using temperature data from the meteorology project and this year's phenology data, more precise predictions of flowering may be made. These evaluations (excluding the included results of leaf out and leaf fall), await final analysis of data.

4.3. Conclusion

The phenology study completed during the 1976 field season has given us a relatively simple system for determining seasonal changes throughout the study area. With several years of data we may be able to show definite trends from north to south, and perhaps east to west if time and money allow expansion of the phenology study. This year's phenology data has already proved useful for scheduling sound measurements for the noise program. These data will also be useful in planning sampling periods for the plant pathology program. Finally, the terrestrial study will use phenology data when interpreting results from the non-game bird and small mammal census information.

Table V-13.

~~Table IV~~ ~~Spring phenology data sheet.~~ An example of the spring phenology data sheet.

Date: Nov 21, 1976 Observer: Shubat Spring phenology

Stop No.	Species	No. of Individuals	Leaf Out	Flower	Notes
4	Larix	10	100%	0%	leaf 1½ cm. grouse drum. Chamedaphne, Andromeda Blooming
2	Alnus rugosa	10	100%		10% Alnus fl present but not mature
	Cornus stolonifera	10	100%		fl buds
	Betula papyrifera	10	100%		Black and white warbler
	frax. nigra	10	0%		

Table V-14. An example of the fall phenology data sheet.

Table 13-

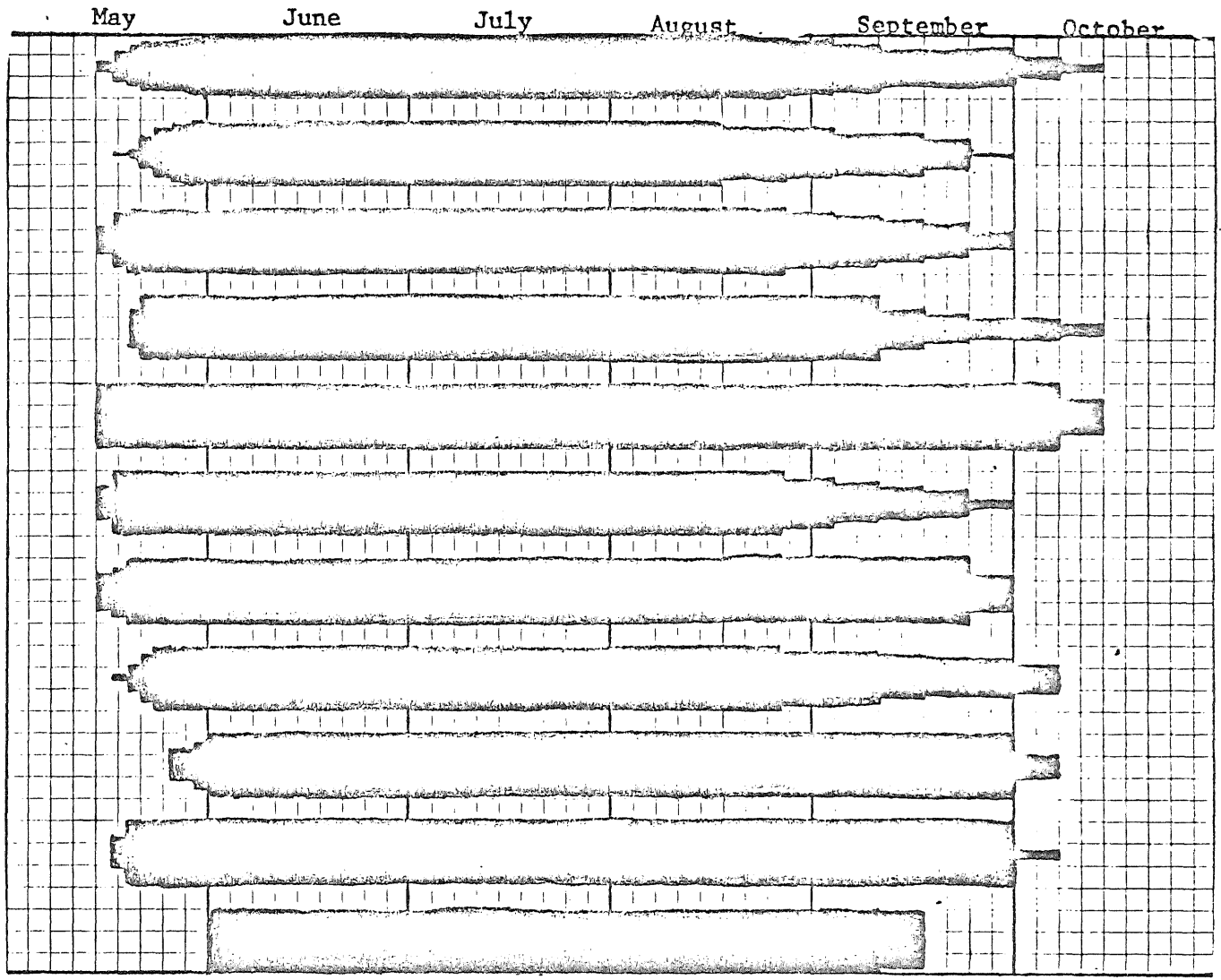
Fall phenology data sheet.

Date: September 17, 1976 Observer: Shubat Fall phenology

Stop No.	Species	No. of Individuals	Leaf Turn					Leaf Fall				
			+	25%	50%	75%	100%	+	25%	50%	75%	100%
1	Larix	10	10									
2	Cornus stolonif	10	8	2								
	Alnus rugosa	10	10									
	Betula papyrif	10	1	2	5	2		1	7	1		1
	fraxinus nigra	10					10		9		1	

Figure V-15
1976 spring and fall phenology record.

Species	Sample Size
Populus tremuloides	119
Betula papyrifera	77
Alnus rugosa	51
Alnus crispa	30
Larix laricina	21
Corylus cornuta	50
Cornus stolonifera	18
Populus balsamifera	19
Populus grandidentata	20
Acer spicatum	7
Fraxinus nigra	10



4.4. References

Ahlgren, C.E. 1957. Phenological observation of nineteen native tree species in northeastern Minnesota. Ecology 38(4): 622-628.

Lindsey, A.A. and J.E. Newman. 1956. Use of official weather data in spring time-temperature analyses of an Indiana phenological record. Ecology 37: 812-823.

5. FLORISTIC (RELEVÉ) STUDY

5.1. Introduction

The 1976 floristic study was conducted using the Kuchler (1967) modification of the Braun-Blanquet floristic releve method (1932). Kuchler's system provides a record of vegetation structure by height classes, growth form and coverage. Braun-Blanquet's system provides a record of species presence and an estimate of abundance. Releves were completed for 27 sites (Table V-12, P).

5.2. Methods

When conducting a releve, a plot within each site was selected which best represented the species and structure of the given stand. A 60 m diameter circle around the point was searched and all species encountered were either identified in the field or the laboratory with help of a compound microscope. Each species was recorded on a standard data sheet (Table V-17), using appropriate coverage, height classes, sociability and life form classifications (Table V-18 and V-19). We used the Curter field key to difficult Wisconsin genera as an aid to field identification.

Species were recorded by both scientific name and a four digit code assigned by Dr. E.J. Cushing of the University of Minnesota for all Minnesota plant species. The code numbers allow us to coordinate our data with a much larger set of releves completed in 1972 by a University of Minnesota mapping project operating primarily in the northern portions of the study area.

5.3. Results

Table V-20 list all species encountered during the 1976 floristic survey, the number of sites at which the species was encountered, and the percent occurrence. This table, along with Figure V-21, were constructed from field releve data sheets.

5.4. Conclusion

Figure V-21 shows the range of cover types and number of species in each. Species numbers range from 58 in a mature white cedar stand to 13 in a young tamarack stand. Table V-20 shows percent occurrence varying between 81 percent for Rubus pubescens (Raspberry), to 3.7 percent (single occurrence) for a relatively rare plant such as Botrychium virginianum (Grape Fern), 72.5 percent of the 229 species occurred on five or fewer sites.

5.5. References

Braun-Blanquet. 1932. Plant Sociology; The Study of Plant Communities (English Translation), McGraw-Hill, New York. pp 22-53.

Kuchler. 1967. Vegetation Mapping, Ronald press. pp 190-191, p 449.

Shimwele. 1971. Description and Classification of Vegetation. University of Washington Press, Seattle. pp 186-188.

Table V-17.

Sample of data sheet using the Keuchler-Braun-Blanquet releve method.

Location NE¼ NW¼ SE¼ S18T57N R14W
Plot 4 Red pine plantation
July 15, 1976
Observers: Shubat and Sather
Notes: large stumps about 25 inches in diameter present litter layer pine needles about 60 percent soil dry

		code #
E6-7i		
	Pinus resinosa	3.2 ( )
D5-6r		
	Betula papyrifera	+.1 ( )
	Populus tremuloides	+.1 ( )
E2-3r		
	Abies balsamea	r.1 ( )
	Picea mariana	r.1 ( )
D2-3r		
	Populus tremuloides	+.1 ( )
	Salix cf bebbiana	+.1 ( )
	Lonicera canadensis	+.1 ( )(F)
	Rosa acicularis	1.1 ( )
	Ribes cf triste	+.1 ( )
	Corylus cornuta	+.1 ( )
	Acer rubrun	+.1 ( )
	Cornus stolinifera	+.1 ( )
	Ribes cf odoratum	+.1 ( )(F)
H1-2p		
	Aster macrophyllus	3.2 ( )
	Vaccinium myrtilloides	1.2 ( )
	Rubus pubescens	2.2 ( )(F)
	Pyrola elleptica	+.2 ( )(B)
	Diervilla lonicera	1.2 ( )(B)
	Aralia nudicaulis	+.2 ( )
	Solidago juncea	r.1 ( )
	Trientalis borealis	+.1 ( )
	Cornus canadensis	+.2 ( )(F)
	Fragaria virginiana	+.1 ( )
	cf Oryzopsis sp.	+.1 ( )
	Osmunda claytoniana	r.1 ( )
H1-2p (contd.)		
	Maianthemum canadense	+.2 ( )
	Viola sp.	+.2 ( )
	Aquilegia canadensis	r.1 ( )
	Galium triflorum	r.1 ( )
	Dryopteris sp.	r.1 ( )
	Epilobium augustifolium	+.2 ( )
	Corallorbiza macaluta	+.2 ( ) (B&F)
	Anemone quinquefolia	+.2 ( )
	Streptopus roseus	+.2 ( )
	Petasites palmata	+.2 ( )
	Achillea millefolium	+.2 ( )
	grass cf Poa sp.	+.1 ( )
L1-2r		
	Calliergonella schreberi	
	Dicranum sp.	
	Marasmius rotula	

↑ all these periods are not periods but "joiners" therefor r.1 should be r·1

Table V-18.

Key to Braun-Blanquet's floristic system.

A. List species by Scientific name

B. List code number of species

C. Cover-degree/abundance (applies to category A)

- r. single occurrence
- + occasional, cover <5%
- 1. plentiful, cover <5%
- 2. very numerous, cover 5-25%
- 3. any number of individuals, cover 25-50%
- 4. any number of individuals, cover 50-75%
- 5. any number of individuals, cover 75-100%

D. Sociability (applies to category A, list directly after category C)

1. growing singly
2. grouped, few individuals
3. large group, many individuals
4. small colonies, extensive patches, broken mat
5. extensive mat

E. Flowering condition

- bu budding
- bl blooming
- fr fruiting
- v vegetative

Example: small patch of blooming Dandelions in a yard

Tavaxacum officinale 5127 +.2 bl

r

more dot up +.2

Table V-19.

Key to Kuchler's physiognomic system of life form categories.

A. Woody Plants and ground cover

- B Broadleaf evergreen
- D Broadleaf deciduous
- E Needleleaf evergreen
- N Needleleaf deciduous
- O Aphyllous (without leaves)
- S Semideciduous
- M Mixed
- G Graminoids
- H Forbs
- L Lichens

B. Height class (applies to category A)

- 8. >35m
- 7. 20-35m
- 6. 10-20m
- 5. 5-10m
- 4. 2-5m
- 3. 0.5-2m
- 2. 0.1-0.5m
- 1. <0.1m

C. Coverage (applies to category A, not to any particular species)

- c. continuous (>75%)
- i. interrupted (50-75%)
- p. parkline, patchy (25-50%)
- r. rare (5-25%)
- b. barely present, sporadic (1-5%)
- a. almost absent, extremely scarce (<1%)

Example: Stand with 15 meter open aspen canopy, continuous shrub layer and herb layer of mainly forbs with some grasses, includes

D6i
D3c
H1i
G1b

Table V-20.
Vascular plant species identified while conducting releves on 27 different sites from May-August, 1976. (Species Listed Alphabetically by Genus)

Scientific Name	Common Name	Sites Species Occured On (Max. No. = 27) Number	Percent
Abies balsamea	balsam fir	12	44.4
Acer spicatum	mountain maple	10	37.0
Acer rubrum	red maple	1	3.7
Achillea millefolium	yarrow	7	25.9
Actaea pachypoda	white baneberry	4	14.8
Actaea rubra	red baneberry	4	14.8
Agropyron repens		1	3.7
Alnus crispa	green alder	8	29.6
Alnus rugosa	speckled alder	10	37.0
Amelanchier sp.	juneberry	13	48.1
Anaphalis margaritacea	pearly everlasting	8	29.6
Andromeda glaucophylla	bog rosemary	5	18.5
Anemone quinquefolia	wood anemone	16	59.2
Anethum graveolens		1	3.7
Apocynum androsaemifolium	dogbane	15	55.6
Aralia hispida	bristly sarsaparilla	4	14.8
Aralia nudicaulis	sarsaparilla	13	48.1
Arenaria macrophylla	large-leaf sandwort	1	3.7
Aster macrophyllus	large-leaf aster	18	66.7
Aster umbellatus	flat-top aster	3	11.1
Athyrium filix-femina	lady fern	9	33.3
Aquilegia canadensis	columbine	1	3.7
Barbarea vulgaris	common wintercress	2	7.4
Betula papyrifera	paper birch	12	44.4
Betula pumila v. glandulifera	dwarf birch	7	25.9
Botrychium matricariaefolium	matricary grape fern	1	3.7
Botrychium multifidum	leathery grape fern	1	3.7
Botrychium virginianum	common grape fern	1	3.7
Calamagrostis canadensis		1	3.7
Calamagrostis inexpansa	bluejoint grass	4	14.8
Calla palustris	wild calla	2	7.4
Caltha palustris	marsh marigold	5	18.5

Table V-20. (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Campanula uliginosa	swamp bell	3	11.1
Carex adusta	sedge	3	11.1
Carex brunnescens	sedge	1	3.7
Carex crawfordii	sedge	1	3.7
Carex disperma	sedge	2	7.4
Carex gracillima	sedge	1	3.7
Carex houghtonii	sedge	3	11.1
Carex interior	sedge	2	7.4
Carex intumescens	sedge	1	3.7
Carex lacustris	lake-bank sedge	1	3.7
Carex leptalea	sedge	2	7.4
Carex lupulina	sedge	1	3.7
Carex pauciflora	sedge	1	3.7
Carex paupercula	sedge	3	11.1
Carex sp.		9	33.3
Carex stricta	sedge	1	3.7
Carex trisperma	sedge	3	11.1
Chamaedaphne calyculata	leatherleaf	5	18.5
Chelone glabra	turtlehead	2	7.4
Chenopodium sp.		1	3.7
Chimaphila umbellata	pipsissewa	3	11.1
Chrysanthemum leucanthemum	daisy	3	11.1
Cirsium arvense	canada thistle	7	25.9
Clematis verticillaris	purple clematis	1	3.7
Clintonia borealis	Clinton's lily	13	48.1
Comptonia peregrina	sweet fern	2	7.4
Coptis groenlandica	goldthread	10	37.0
Corallorhiza maculata	coral root	9	33.3
Cornus canadensis	bunchberry	20	74.1
Cornus rugosa	round-leaf dogwood	4	14.8
Cornus stolonifera	red-osier dogwood	8	29.6
Corydalis aurea	gold corydalis	2	7.4
Corydalis sempervirens	pink corydalis	3	11.1
Corylus cornuta	beaked hazel	15	55.6
Cryptotaenia canadensis		1	3.7
Cynoglossum boreale	northern houndstongue	2	7.4

Table V-20 . (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Diervilla lonicera	bush honeysuckle	15	55.6
Dracocephalum parviflorum	dragonhead	2	7.4
Drosera rotundifolia	sundew	2	7.4
Dryopteris cristata	crested shield fern	6	22.2
Dryopteris spinulosa	spinulose wood fern	5	18.5
Epilobium angustifolium	fireweed	13	48.1
Epilobium leptophyllum	thin-leaf willow herb	4	14.8
Equisetum cf. arvense	field horsetail	1	3.7
Equisetum cf. fluviatile	water horsetail	4	14.8
Equisetum cf. palustre	marsh horsetail	1	3.7
Equisetum sylvaticum	forest horsetail	5	18.5
Erigeron canadensis	common fleabane	1	3.7
Eupatorium maculatum		4	14.8
Eupatorium perfoliatum		1	3.7
Fraxinus nigra	black ash	2	7.4
Fragaria virginiana	strawberry	16	59.2
Galeopsis tetrahit	hemp nettle	1	3.7
Galium asprellum	rough bedstraw	1	3.7
Galium labradoricum	smooth bedstraw	3	11.1
Galium trifidum	3-parted bedstraw	3	11.1
Galium triflorum	sweet bedstraw	16	59.2
Gaultheria hispidula		4	14.8
Gaultheria procumbens		2	7.4
Geocaulon lividum		1	3.7
Geranium bicknellii	common geranium	1	3.7
Geum aleppicum v strictum	avens	3	11.1
Glyceria canadensis	rattlesnake grass	2	7.4
Glyceria striata	fowl mannagrass	1	3.7
Goodyera repens		1	3.7
Gymnocarpium dryopteris	oak fern	5	18.5
Habenaria hyperborea v. huronensis	northern rein orchid	3	11.1
Halenia deflexa	spurred gentian	1	3.7
Hypericum virginicum	Marsh St. Johnswort	1	3.7
Impatiens capensis	jewelweed	1	3.7
Iris versicolor	wild iris	6	22.2

Table V-20. (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Juncus bufonius	toad rush	1	3.7
Kalmia polifolia	bog laurel	4	14.8
Lactuca pulchella	blue lettuce	2	7.4
Larix laricina	tamarack	5	18.5
Lathyrus japonicus	beach pea	1	3.7
Lathyrus ochroleucus	early sweet pea	10	37.0
Lathyrus venosus	wild sweet pea	2	7.4
Ledum groenlandicum	labrador tea	12	44.4
Linnaea borealis	twinflower	9	33.3
Lobelia inflata	Indian tobacco	2	7.4
Lonicera canadensis	fly honeysuckle	13	48.1
Lonicera hirsuta	hairy climbing honeysuckle	8	29.6
Lonicera oblongifolia	swamp fly honeysuckle	7	25.9
Lonicera villosa		1	3.7
Lychnis alba	white cockle	2	7.4
Lycopodium annotinum	stiff clubmoss	2	7.4
Lycopodium clavatum	running clubmoss	2	7.4
Lycopodium complanatum	ground cedar	5	18.5
Lycopodium lucidulum	shining clubmoss	2	7.4
Lycopodium obscurum	ground pine	8	29.6
Lycopus uniflorus	water horehound	4	14.8
Lysimachia ciliata	fringed loosestrife	2	7.4
Maianthemem canadense	false lily-of-the-valley	16	59.2
Melampyrum lineare	cow-wheat	5	18.5
Mentha arvensis	sweet mint	1	3.7
Menyanthes trifoliata		1	3.7
Mertensia paniculata	northern lungwort	2	7.4
Mitella nuda	northern miterwort	11	40.7
Moneses uniflora	one-flowered pyrola	5	18.5
Monotropa uniflora	Indian-pipe	3	11.1
Myrica gale	sweet gale	1	3.7
Onoclea sensibilis	sensitive fern	3	11.1
Oryzopsis asperifolia	mountain rice	4	14.8
Oryzopsis sps.		6	22.2
Osmunda claytoniana	interrupted fern	2	7.4
Osmunda regalis	royal fern	4	14.8

Table V-20 . (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Parnassia palustris	grass-of-Parnassus	1	3.7
Petasites palmatus	sweet coltsfoot	9	33.3
Petasites vitifolius	grape-leaf coltsfoot	1	3.7
Phleum pratense	timothy	4	14.8
Physalis grandiflora	great-flowered ground-cherry	2	7.4
Picea glauca	white spruce	2	7.4
Picea mariana	black spruce	14	51.8
Pinus banksiana	jack pine	4	14.8
Pinus resinosa	red pine	4	14,8
Pinus strobus	white pine	1	3.7
Plantago major	plantain	2	7.4
Poa pratensis	Kentucky bluegrass	5	18.5
Polygala paucifolia	fringed polygala	5	18.5
Polygonum cilinode	bindweed	3	11.1
Polypodium virginianum	polypody	1	3.7
Populus balsamifera	balsam poplar	1	3.7
Populus grandidentata	large tooth aspen	1	3.7
Populus tremuloides	quaking aspen	16	59.2
Potentilla norvegica	rough cinquefoil	3	11.1
Potentilla palustris	marsh cinquefoil	6	22.2
Potentilla recta	sulphur cinquefoil	3	11.1
Prunus pensylvanica		1	3.7
Prunus sp.		6	22.2
Prunella vulgaris		2	7.4
Pteridium aquilinum	braken fern	11	40.7
Pteretis struthiopteris	ostrich fern	1	3.7
Pyrola asarifolia	pink shinleaf	2	7.4
Pyrola elliptica	white-flowered shinleaf	8	29.6
Pyrola minor		3	11.1
Pyrola secunda	one-sided pyrola	8	29.6
Pyrola verens	pyrola	2	7.4
Ranunculus acris	meadow buttercup	1	3.7
Ribes glandulosum	skunk currant	6	22.2
Ribes hirtellum	swamp gooseberry	8	29.6
Ribes hudsonianum	northern black currant	2	7.4
Ribes odoratum		1	3.7

Table V-20. (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Ribes triste	red swamp currant	2	7.4
Rorippa hispida	yellowcress	1	3.7
Rosa acicula	prickly rose	15	55.6
Rosa arkansana		1	3.7
Rosa blanda		1	3.7
Rubus acaulis	arctic raspberry	1	3.7
Rubus idaeus v strigosus	raspberry	14	51.8
Rubus pubescens	dewberry	22	81.5
Rumex acetosella	sheep sorrel	3	11.1
Rumex crispus	curly dock	4	14.8
Salix bebbiana	beaked willow	12	44.4
Salix cf bebbianax pedicellaris	interbreed	9	33.3
Salix pedicellaris	bog willow	4	14.8
Salix petiolaris	willow	3	11.1
Salix cf. pyrifolia	balsam-willow	2	7.4
Sanicula marilandica	sanicle snake root	2	7.4
Sarracenia purpurea	pitcher plant	3	11.1
Scirpus sp.		1	3.7
Senecio pauperculus v. balsamitae	common ragwort	1	3.7
Smilacina trifoliata		7	25.9
Smilax herbacea	smooth carrion	1	3.7
Smilax sp.		1	3.7
Solidago sp.	goldenrod	5	18.5
Solidago juncea	early goldenrod	1	3.7
Sonchus arvensis	sow thistle	1	3.7
Sonchus asper	sow thistle	1	3.7
Sorbus americana	mountain ash	5	18.5
Spiraea alba	meadowsweet	2	7.4
Stellaria calycantha	northern chickweed	2	7.4
Streptopus roseus	twisted stalk	8	29.6
Taraxacum officinale		2	7.4
Thalictrum sp		2	7.4
Thelypteris palustris		2	7.4
Thuja occidentalis	white cedar	3	11.1

Table V-20. (contd.)

Scientific Name	Common Name	Sites Species Occurred On (Max. No. = 27) Number	Percent
Trientalis borealis	starflower	17	63.0
Trifolium pratense		2	7.4
Trifolium repens		2	7.4
Unidentified grass sp.		9	33.3
Vaccinium angustifolium	late sweet blueberry	15	55.6
Vaccinium myrtilloides	velvet-leaf blueberry	13	48.1
Vaccinium oxycoccos	small cranberry	6	22.2
Verbascum thapsus		11	40.7
Viburnum rafinesquianum	downy arrow-wood	7	25.9
Vicia americana	American vetch	14	51.8
Viola adunca	hooked blue violet	1	3.7
Viola incognita	swamp white violet	3	11.1
Viola cf. novae-anglinae	New England violet	1	3.7
Viola pallens	early sweet violet	5	18.5
Viola pubescens	downy yellow violet	1	3.7
Viola renifolia	kidney-leaf violet	5	18.5
Viola selkirkii	long-spurred violet	4	14.8
Viola sororia	downy blue violet	1	3.7
Viola sp.		2	7.4
Zizia aptera	heart-leaf alexander	1	3.7

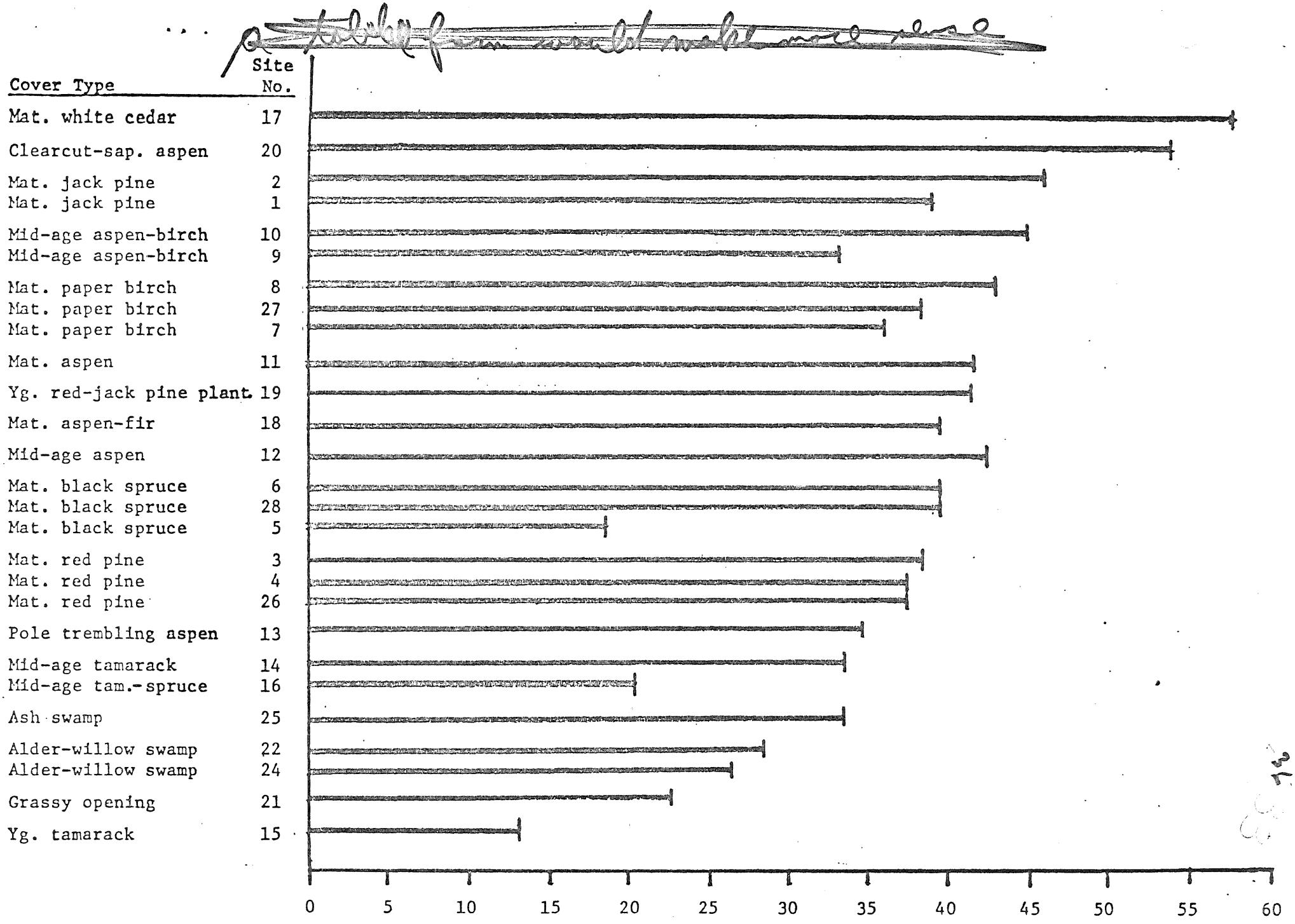


Figure No. TB-V-21

Number of plant species present (tree, shrub, and herbaceous) per site and cover type (Determined from releves.)

6. PREPARATION OF THE HERBARIUM

6.1. Introduction

A herbarium collection was made during 1976 to provide vocher specimens of many of the vascular platn species occurring on the study area. When possible, three speciments of each species were collected. We also collected all "unknown" species from the primary plant community sites (sites 1022, incl.) and small mammla trapping grids. "Unknowns" were collected in various stages of growth.

Repeated collections were made for several difficult taxa. For example, 15 individual plants of the genus Amelanciar were tagged during bloom so leaves could be collected and identified at maturity.

6.2. Methods

Triplicate specimens were collected from May 5--August 30, 1976. When possible, plants were gathered at anthesis (blooming) to simplify identification. Smaller plants were often collected with roots. On larger woody plants, we included leaves, stems, flowers, and/or seeds, but not roots.

Rare plants--We sought expert advice concerning the collection of rare plant species such as Arathusa bulbosa (orchids) and Trileum.

Dr. Thomas Morely, University of Minnesota (author of Spring flora of Minnesota) and Dr. Paul Monson, curator of the OLGA Herbarium at University of Minnesota, Duluth, were individually consulted and suggested

that voucher specimens of rare plants are important because their identification will allow for their protection.

Both Drs. Morely and Monson suggested that a portion of the plant that identified that species should be collected. Usually this means collecting the flower along with other important vegetative structures and leaving the roots intact. This procedure was followed when collecting all rare plants.

6.3. Maintaining plants specimens in the field

To maintain specimens in a relatively fresh state during hot days, plants were kept in a Coleman ice chest and cooled with commercially available "ice pacs." After plants were gathered, they were placed in large plastic bags with a label indicating date and location, then placed in the cooler. This method protected specimens over a 10-14 hour period.

6.4. Identification and mounting

Identification of plant species was completed in the laboratory. Most identifications were made with the aid of 10 x magnifying lens, but some instances a 30 power disecting scope was necessary. Appropriate taxonomic references were chosen for the taxon in question. A list of references used is appended.

Separate collection numbers were assigned for each taxon. For example, three specimens of Viola ronifolca collected at the same location on the same date have the same number. Individuals from that location

collected on a different date are assigned a different number. Collection numbers were assigned by the order in which they were identified. For each specimen the following information was recorded: scientific name, reference, common name, date of collection, county, habitat type, plot number, location by quarter-section, township and range, family, collector, identifier, taxonomic references used, blooming condition, and number of individuals included in the collection number.

As an aid to rapid field identification we prepared a portable herbarium for difficult taxa. Specimens were placed on a 4x6 card, annotated with features for field identification, and covered with a piece of 4x6 clear contact paper.

Plants were pressed individually using standard botanical techniques. The labeling and mounting of specimens is being completed at the University of Minnesota at Duluth (UMD). The labels were printed by UMD and an example is shown in Table V- The order of information on the label follows tradition, with the addition of information such as common names and our site numbers and description. The information appears as follows; scientific name, authority, family, county, state, plot number-name, technical location, date and collection number (see Table V- All labels were typed then reproduced for the duplicate speciments.

We have a cooperative agreement with the Olga Lakela herbarium and Dr. Monson to supply one specimen of each of our plant species to the herbarium at UMD. In return, we have use of their facilities to mount plants and serve as reference source. Finally, Dr. Monson has also agreed to supply taxonomic assistance by verifying identifications.

figure V-10 Herbarium label

Minnesota Environmental Quality Council
Regional Copper-Nickel Study

Viola renifolia Greg.

Violaceae

St. Louis County, Minn.

Plot #19 clearcut 1970, red pine & jack pine plantation

SE¼, SW¼, T60N, R12W

6/29/76

Nancy Sather 173 *Deborah Shubat*

6.5. Results

A list of the herbarium species collected in 1976 is provided in Table
Mounting of specimens will be complete December 15, 1976. At that time, one copy of each species will be filed in the Olga lakela herbarium, with the remainder of the specimens being kept at the Kawishiwi lab. The final disposition of the plant collection (upon completion of the project) has not yet been determined.

In a few plant groups (e.g. willow and birch) there is hybridization between species. This sometimes makes the individual species difficult to recognize. Our collection includes a wide range of examples of species and hybrids for these questionable groups. These specimens will help solve some of next summer's taxonomic problems.

6.6 Conclusion

The collection and preparation of the herbarium species represents a very substantial amount of the work time for the vegetation study was allocated to collection and preparation of the Herbarium Specimens in the 1976 field season. With an emphasis on new sites in disturbed vegetation types in 1977, these will be much less time slotted to the collection and preparation of herbarium specimens. In 1977, 1976 sites will be revisited for vegetational analysis not complete this year and to collect "unknowns" that were not in bloom.

By December 15, 1976, we will have approximately 800 specimens in our herbarium collection at Kawishiwi labs. These represent 226 species in 46 families.

Table V- " .

DNR Cu-Ni terrestrial, plant collection as of August 20, 1976.

Species	Common Name	Collection Numbers
Acer spicatum	mountain maple	16, 77
Achillea millefolium	yarrow	83, 93
Actaea pachypoda	white baneberry	103
Actaea rubra	red baneberry	59
Alnus crispa	green alder	17
Anaphalis margaritacea	pearly everlasting	247
Amelanchier Bartramiana	northern juneberry	5
Amelanchier spp.	juneberry spp.	7, 27-41 collection
Anemone canadensis	canada anemone	45
Anemone quinquefolia	wood anemone	18
Andromeda glaucophylla	bog rosemary	42, 185
Antennaria neglecta	pussyfoot	81
Apocynum androsaemifolium	dogbane	90
Arctostaphylas uva-ursi	bearberry	332
Aralia hispida	bristly sarsaparilla	152, 290
Aralia nudicaulis	sarsaparilla	44
Arenaria macrophylla	large-leaf sandwort	124
Arethusa bulbosa	swamp-pink	134
Aster ciliolatus		333
Aster macrophyllus	large-leaf aster	247
Aster puniceus	swamp blue aster	334
Aster simplex	white panicled aster	344
Aster umbellatus	flat-top aster	297, 342
Athyrium felix-femina	lady fern	132, 172
Aquilegia canadensis	columbine	60

Table V-[illegible]. (cont.)

Species	Common Name	Collection Numbers
Barbarea vulgaris	common wintercress	117
Betula pumila v. glandulifera	dwarf birch	139
Botrychium matricarifolium	matricary grape fern	201
Botrychium multifidum	leathery grape fern	203
Botrychium virginianum	common grape fern	171
Brassica rapa	field mustard	20
Bromus ciliatus	forest bromegrass	329
Calamagrostis inexpensa	blue jointgrass	325
Calla palustris	wild calla	64
Caltha palustris	marsh marigold	25
Campanula uliginosa	swamp bell	274, 305
Carex adusta	sedge	111, 316
Barex brunnescens	sedge	73, 74, 170
Carex crawfordii	sedge	299
Carex disperma	sedge	294
Carex gracillima	sedge	106
Carex Houghtonii	sedge	70, 162
Carex interior	sedge	105, 168, 291
Carex intumescens	sedge	50
Carex leptalea	sedge	113, 285
Carex lupulina	sedge	280
Carex pauciflora	sedge	292
Carex paupercula	sedge	112, 161
Carex projecta	sedge	322
Carex stricta	sedge	259
Carex trispermo	sedge	235
Carex vesicaria	sedge	262

Table V- 1 . (cont.)

Species	Common Name	Collection Numbers
Carex lacustris	lake-bank sedge	258, 263
Castilleja coccinea	Indian paintbrush	122
Chamaedaphne calyculata	leatherleaf	1
Chelone glabra	turtlehead	304
Chimaphila umbellata	pipsissewa	218
Chrysanthemem leucanthemum	daisy	61
Cicuta maculata	water hemlock	249
Cirsium arvense	canada thistle	229
Clematis verticellaris	purple clematis	310
Clintonia borealis	Clinton's lily	54
Comptonia peregrina	sweet fern	67
Coptis groenlandica	goldthread	237
Corallorhiza maculata	coral root	86, 220
Cornus canadensis	bunchberry	57, 251
Cornus rugosa	round-leaf dogwood	79
Cornus stolinifera	red-osier dogwood	56, 228
Corydalis aurea	gold corydalis	85
Corydalis semmervirens	pink corydalis	89
Corylus americana	American hazel	239
Corylus cornuta	beaked hazel	15, 217
Cynoglossum boreale	northern houndstongue	78, 138
Diervilla lonicera	bush honeysuckle	119
Dracocephalum parviflorum	dragonhead	115
Drosera rotundifolia	sundew	243
Dryopteris cristata	crested shield fern	146, 195
Dryopteris spinulosa	spinulose wood fern	109, 202, 254

Table V- . (cont.)

Species	Common Name	Collection Numbers
Epilobium angustifolium	fireweed	120
Epilobium glandulosum	common willow herb	335, 347
Epilobium leptophyllum	thin-leaf willow herb	267, 268
Equisetum cf. arvense	field horsetail	190
Equisetum cf. fluviatile	water horsetail	192
Equisetum cf. palustre	marsh horsetail	137
Equisetum sylvaticum	forest horsetail	99, 308
Erigeron canadensis	common fleabane	156
Erigeron strigosus	daisy fleabane	183, 248
Eriophorum gracile	cottongrass	49
Eriophorum spissum	cottongrass	48
Fragaria virginiana	strawberry	53
Galeopsis tetrahit	hemp nettle	298
Galium asprellum	rough bedstraw	271
Galium labradoricum	smooth bedstraw	43
Galium trifidum	3-parted bedstraw	257, 275
Galium triflorum	sweet bedstraw	76
Geranium bicknellii	common geranium	66, 159
Geum aleppicum v strictum	avens	199
Glyceria canadensis	rattlesnake grass	260
Glyceria striata	fowl mannagrass	319
Goodyera tesselata	greater lattice leaf	336
Gymnocarpium dryopteris	oak fern	136, 200
Habenaria hyperborea v. huronensis	northern rein orchid	206
Halenia deflexa	spurred gentian	293

Table V- . (cont.)

Species	Common Name	Collection Numbers
Hieracium aurantiacum	orange hawk weed	301
Hieracium canadense	common hawk weed	118
Hypericum perforatum	St. Johnswort	125
Hypericum virginicum	Marsh St. Johnswort	272
Impatiens capensis	jewelweed	242
Iris versicolor	wild iris	82
Juncus bufonius	toad rush	281
Juniperus communis	low juniper	331
Kalmia polifolia	bog laurel	283
Lactuca pulchella	blue lettuce	197
Lactuca sp.	lettuce	178
Lathyrus japonicus	beach pea	227
Lathyrus ochroleucus	early sweet pea	72
Lathyrus venosus	wild sweet pea	98
Ledum groenlandicum	labrodor tea	52
Linnaea borealis	twinflower	62
Lobelia inflata	Indian tobacco	289, 303
Lonicera canadensis	fly honeysuckle	151
Lonicera hirsuta	hairy climbing honeysuckle	96, 123
Lonicera oblongifolia	swamp fly honeysuckle	140, 169
Luzula acuminata	common woodrush	3
Lynchis alba	white cockle	91
Lycopodium annotinum	stiff clubmoss	14
Lycopodium clavatum	running clubmoss	11, 179
Lycopodium complanatum	ground cedar	26, 148, 219

Table V-[illegible] . (cont.)

Species	Common Name	Collection Numbers
Lycopodium lucidulum	shining clubmoss	149
Lycopodium obscurum	ground pine	13, 188
Lycopus uniflorus	water horehound	210, 211, 265, 276
Lysimachia ciliata	fringed loosestrife	126, 222, 256
Maianthemem canadense	false lily-of-the valley	55
Melampyrum lineare	cow-wheat	238, 288
Melilotus alba	white sweet clover	255
Mentha arvensis	sweet mint	266
Mertensia paniculata	northern lungwort	71
Mitella nuda	northern miterwort	147, 181, 284
Moneses uniflora	one-flowered pyrola	88, 204, 245
Monotropa uniflora	Indian-pipe	221
Myrica gale	sweet gale	
Oenothera biennis	evening primrose	121
Onoclea sensibilis	sensitive fern	264
Oryzopsis asperifolia	mountain rice	77
Osmunda claytoniana	interrupted fern	177
Osmunda regalis	royal fern	135
Parnassia palustris	grass-of-Parnassus	302
Petasites palmatus	sweet coltsfoot	2, 128
Petasites vitifolius	grape-leaf coltsfoot	300
Phleam pratense	timothy	102
Physalis grandiflora	great-flowered ground-cherry	101
Plantago major	plantain	189
Poa pratensis	Kentucky bluegrass	234

Table V-11 . (cont.)

Species	Common Name	Collection Numbers
Polygala paucifolia	fringed polygala	19
Polygonum cilinode	bindweed	110
Polypodium virginianum	polypody	12
Potentilla norvegica	rough cinquefoil	65, 184
Potentilla palustris	marsh cinquefoil	336
Potentilla recta	sulphur cinquefoil	100
Pteretis struthiopteris	ostrich fern	160
Pyrola asarifolia	pink shinleaf	87, 145
Pyrola elliptica	white-flowered shinleaf	205, 253
Pyrola secunda	one-sided pyrola	182, 196
Pyrola virens	pyrola	307, 309
Ranunculus acris	meadow buttercup	63
Ribes glandulosum	skunk currant	67
Ribes hirtellum	swamp gooseberry	133, 306
Ribes hudsonianum	northern black currant	225, 269
Ribes triste	red swamp currant	186
Rorippa hispida	yellowcress	154
Rosa acicularis	prickly rose	58
Rubus acaulis	arctic raspberry	141
Rubus idaeus v strigosus	raspberry	68, 80, 180
Rubus parviflorus	thimpleberry	130
Rubus pubescens	dewberry	153
Rudbeckia serotina	brown eyed susan	131
Rumex acetosella	sheep sorrel	92, 144
Rumex crispus	curly dock	
Salix bebbiana	beaked willow	317

Table V- . (cont.)

Species	Common Name	Collection Numbers
Salix cf. bibbianaX pedicellaris	interbreed	157
Salix candida	sage leafed willow	346
Salix pedicellaris	bog willow	176, 278, 318
Salix petiolaris	willow	175, 310, 279
Salix cf. pyrifolia	balsam-willow	286
Sanicula marilandica	sanicle	127
Sarracenia purpurea	pitcher plant	114
Scirpus atrocinctus	bulrush	
Senecia pauperculus v. balsamitae	common ragwort	150, 158
Smilax herbacea	smooth carrion flower	104
Solidago cf. canadensis	small flowered goldenrod	343
Solidago cf. gigantea	greater goldenrod	341
Solidago graminifolia	grass-leaf goldenrod	287
Solidago juncea	early goldenrod	252
Solidago rigida	stiff goldenrod	345
Solidago uliginosa	swamp goldenrod	348
Sonchus arvensis	sow thistle	261
Sonchus asper	sow thistle	155
Sorbus americana	mountain ash	84, 95
Spiraea alba	meadowsweet	230
Stellaria calycantha	northern chickweed	240
Streptopus roseus	twisted stalk	330
Thelypteris palustris		142, 207
Trientalis borealis	starflower	46
Vaccinium angustifolium	late sweet blueberry	108, 143

Table V- . (cont.)

Species	Common Name	Collection Numbers
Vaccinium myrtilloides	velvet-leaf blueberry	51
Vaccinium oxycoccos	small cranberry	107, 244
Viburnum rafinesquianum	downy arrow-wood	69, 75
Virburnum trilobum	highbush cranberry	250
Vicia americana	American vetch	116
Viola adunca	hooked blue violet	23, 165
Viola conspersa	American dog-violet	22
Viola incognita	swamp white violet	166, 223, 224, 327
Viola cf. novae-angliae	New England violet	167
Viola pallens	early sweet violet	164, 174, 231, 277, 326
Viola pubescens	downy yellow violet	21, 129
Viola renifolia	kidney-leaf violet	24, 241
Viola selkirkii	long-spurred violet	163, 187, 232
Viola sororia	downy blue violet	173
Zizia aptera	heart-leaf alexander	198

6.7. References

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7. QUANTITATIVE VEGETATION SAMPLING

7.1. Choice of Sampling Methods

Four criteria were used in the choice of a quantitative sampling method: field efficiency; adequacy in describing small mammal and avian habitats; conventionality of methods; and replicability of sampling procedures. The goal of sampling was the collection of raw data that could generate the following descriptions of each stand:

1) density of trees, shrubs and herbs
2) frequency of trees, shrubs and herbs
3) some measure of dominance for tree and shrub species
4) a structural description of the stand
5) ability to estimate timber volume if desired

Several methods of quantitative analysis were reviewed. A complete list of literature consulted is presented in the bibliography. Those methods that we considered seriously are discussed below.

Plotless Method--plotless methods are noted for their field efficiency (Lindsay, Barton and Miles, 1958). The point-centered quarter method (Cottam and Curtis, 1956) was used by Ohman and Ream (1971) in their studies of the Boundary Waters Canoe Area. We rejected this method because it is only applicable if species are randomly distributed. It tends to overestimate the density of regularly dispersed populations such as plantations (Cottam and Curtis, 1956; E.J. Cushing, per. comm., 1976). The Bitterlick variable-radius method (Grosenbaugh, 1958) is

commonly used by foresters for timber estimates. It was rejected because it depends on good visibility, does not provide an estimate of frequency, and requires a large number of sample points to minimize the standard error for density (Lindsay, Barton and Miles, 1958). We also considered the method of habitat description utilizing one-tenth acre circular plots as determined by a Biltmore stick (James and Shugart, 1970). This method was developed for rapid description of bird habitats but is not well accepted by plant ecologist. It was rejected because of its unconventionality and dependence on visibility.

Square plots were chosen to study tree species because they are the most conventional plot shape in wooded areas (Kershaw, 1964, p 32; Shimwell, 1971, p 4; Greig-Smith, 1964, p 28-29). The customary plot size used in most studies in 10 meters on a side or larger. We chose to use plots 15 m on a side to coordinate with plots used for small mammal studies. Choice of an appropriate plot size is related to both the size and distribution of the plants being sampled. Mueller-Dombois and Ellenburg (19) recommend plots 200-500 m^2 for adequate representation of tree species but only 100 m^2 for estimates of density. Castro and Cain (1959) recommend 100 m^2 for estimates of tree frequency. Variance in the mean density is affected by both plot size and patchiness (Greig-Smith, 1964). Kershaw (1964) points out that "The measure of the variance of the data is at a maximum when the size of the quadrat is approximately equal to the mean area of the groups of individuals." Since patchiness varies between species and within-species in different communities,

it is best to standardize plot sizes. Our guideline in this choice was to make certain that plot size for each structural category was large enought to contain a reasonable number of individuals.

Rectangular plots were chosen for sampling high shrubs because they simplified field work. In this case a 2x15 m plot was used. Releve studies suggested that within vegetation type the tall shrub layer was more variable than overstory and herb layers. Clapham (1932) demonstrated that the variance between rectangular strips was less than that between square plots of the same area. Colonies of a single species tend to be circular and rectangular plots have a higher probability of crossing several clumps.

Within each stand, plots were located randomly using a grid system and a table of random numbers (Greig-Smith, 1964). Comparison between stands is only possible if there is a way to measure the variance within stands, and the only way to assure this is to use random locations (E.J. Cushing, personal communication).

We chose a sampling frequency which would sample 6 percent of the total grid or transect. Mueller-Dombois and Ellenburg (1974) suggest use of the ratio of the standard error of the mean to the mean as a guide in choosing sample size. An appropriate sample size would be reached when the ratio stabilized. We used this test to see if there was any benefit in doubling the number of herb quadrats in each 15m x 15m plot. For site 27 we found no trends in the variance of mean density for major herb species when we compared four samples withon one 15 x 15 m plot

with four samples from four separate plots. There were alos no trends when four samples were compared with eight. The ratio of the standard error of the mean to the mean showed no significant change. Therefore we determined a sample size of four to be adequate. Although herb plots did not represent the entire flora of the stand, we found 16 species in four samples, 20 speices in eight samples and 27 species by the Braun-Blanquet releve. The discrepancy is easily accounted for by the patchiness of the herb layer.

Our method of sampling foliage-height was chosen mainly on the basis of expediency. We rejected line transects used to record profile diagrams by Richards (1936 cited in Shimswell, 1971) and structural diagrams methods (Dansereau, 1957). The amount of time required for sampling and analysis would have been too great and the data would require conversion into numerical form for storage. The system we chose is a modification of a method for recording foliage intersection along a plumbline (Rov, 1975), and a method of recording cover for game birds used by Porter in studies of wild turkeys (Porter, 1976).

7.2. Method

Field procedure--the same sampling methods were used in mammal study areas and bird census transects but the method of locating the random plots differs.

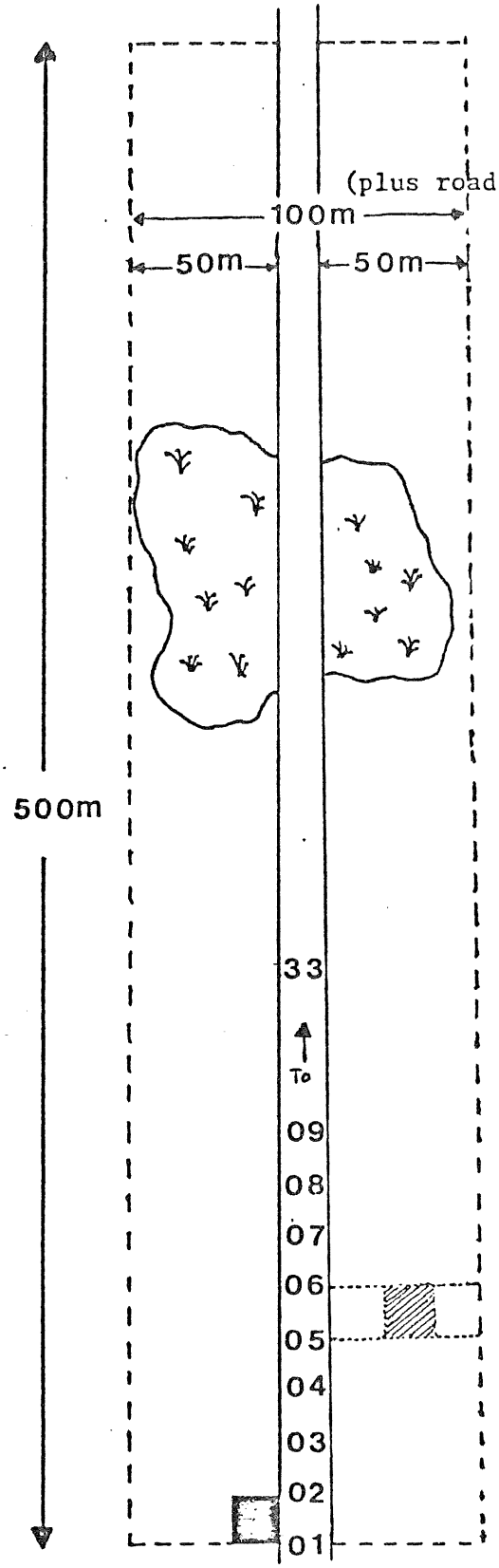
To locate plots along bird census transects three digit numbers were drawn from a table of random numbers. The first two digits were used to determine the distance along the transect and the third digit determined

the tiir distance (1, 2, or 3) from the road. Inapplicable numbers were discarded. To make the selection of numbers more rapid, redundancy was allowed in the third digit. Numbers 1, 4 and 7 designate the plot nearest the road, 2.5 and 8 points 15 m from the road, and 3, 6 and 9 the plots located 30 m from the road. Six random locations were drawn for each side of the road. The total of 12 samples per transect gives a sampling frequency for the 5ha bird transects of 6 percent. See Figure V-1 for a diagram of how quadrats are located along bird transects. Since bird census areas did not always lie in homogeneous vegetation types the number of quadrats located in a given cover type were determined by stratified random sampling. In figure A for example, the swampy area comprises about 15 percent of the total area and would be allotted two samples, one on each side of the road.

Since small mammal trapping was conducted within homogeneous vegetation types, the choice of plot locations could be completely random. The areas were gridded at 15 m intervals to provide 64 trapping stations. Each station was considered a possible point of origin for corner A, the bottom right corner of a vegetation study plot (Figure V-2). Since some stands were assymmetrical, trap locations were numbered with reference to the random numbers used to locate them (Figure V-3). Once the sampling stations were located, they were recorded on the data sheets by their correct trap numbers.

The cross-hatched plot is located by drawing the random number 23. It is recorded as trap location 42. Random numer 31 would be disregarded even though trap number 03 exists because it would generate a plot lying outside the gridded area.

Figure V- 1 Location of random plots on bird transects.



= Swampy area

The blackend plot is represented by random numbers 011, 014, and 017.

The crosshatched plot (second tier from road baseline) is represented by random numbers 052, 055, and 058.

All numbers ending in 0 would be discarded (ex. p10, 100, and 230).

Any number with the first two digits larger than 33 is inapplicable.

Figure V- Aerial view showing construction of vegetation plot.

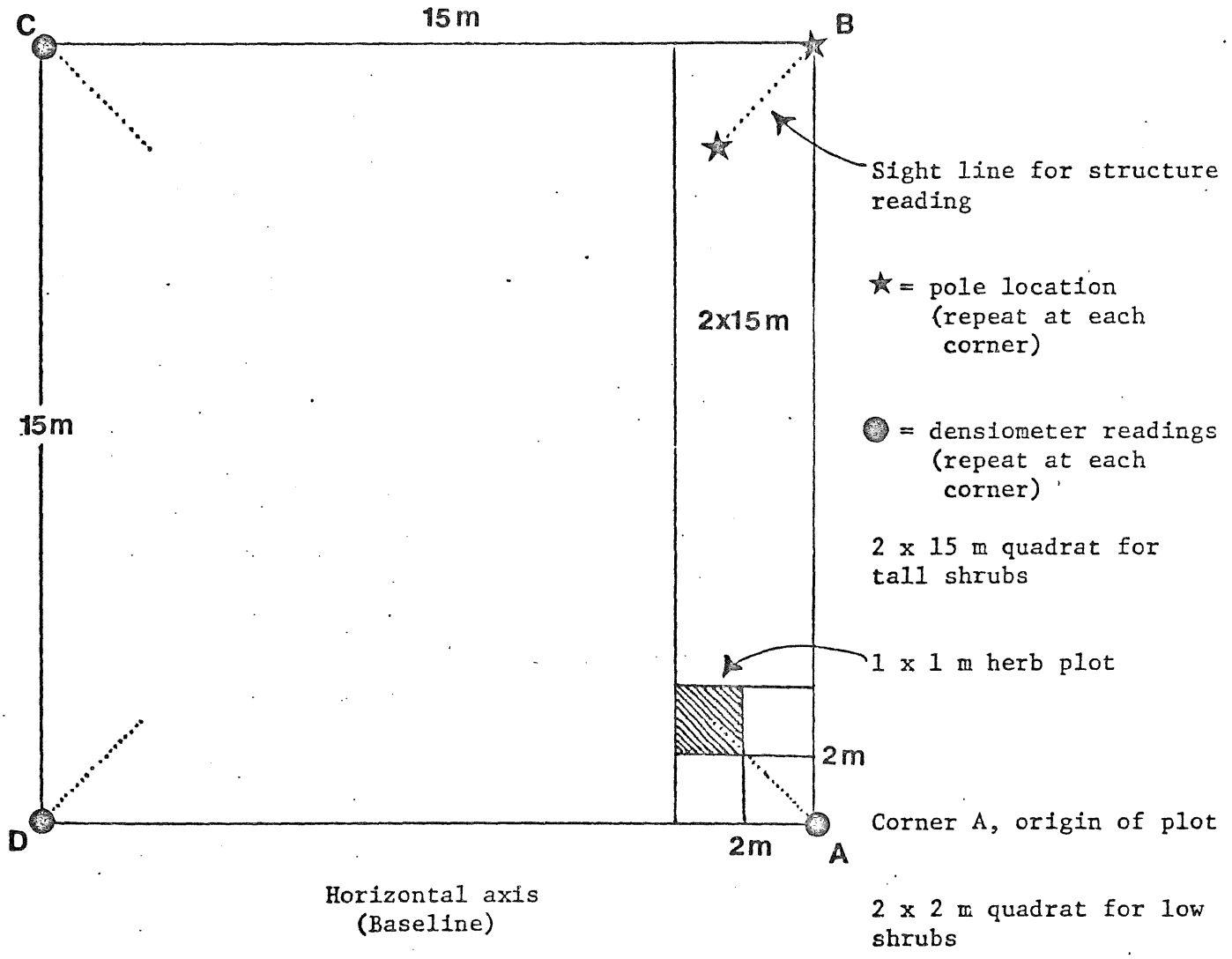
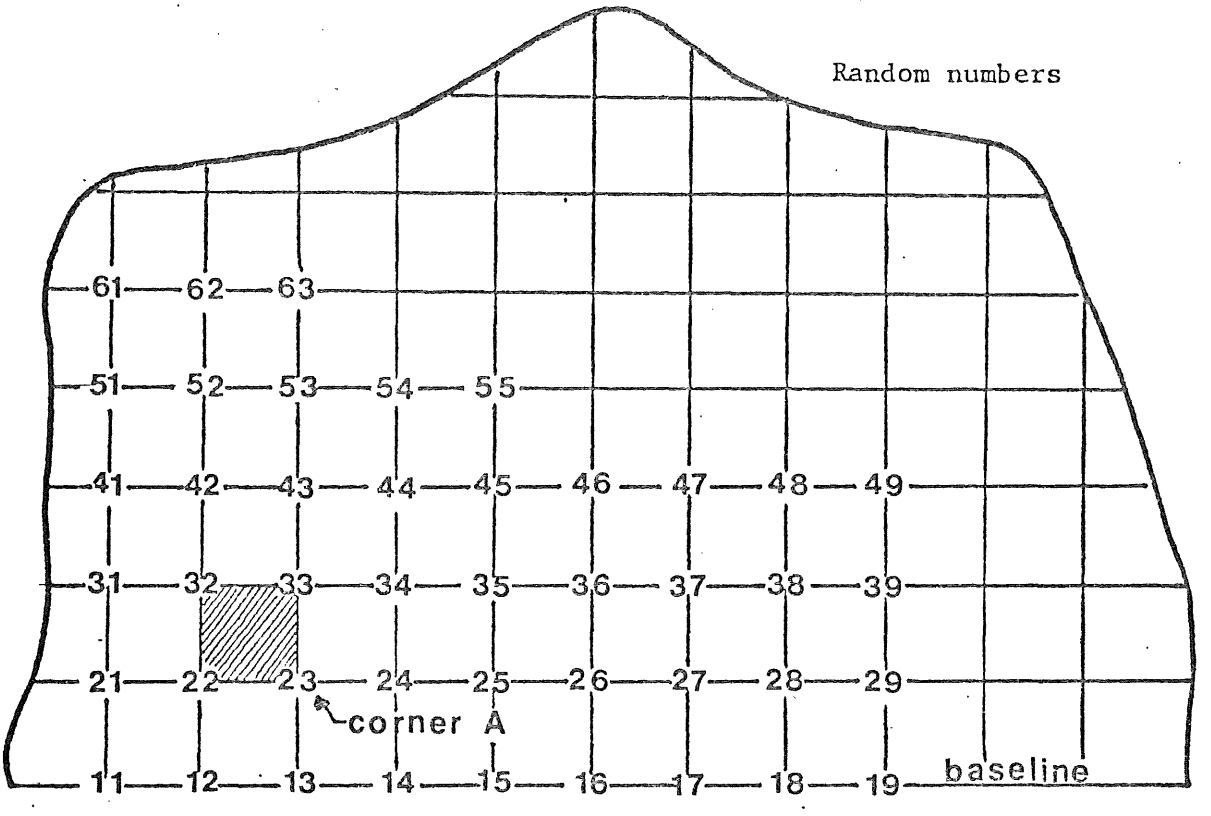
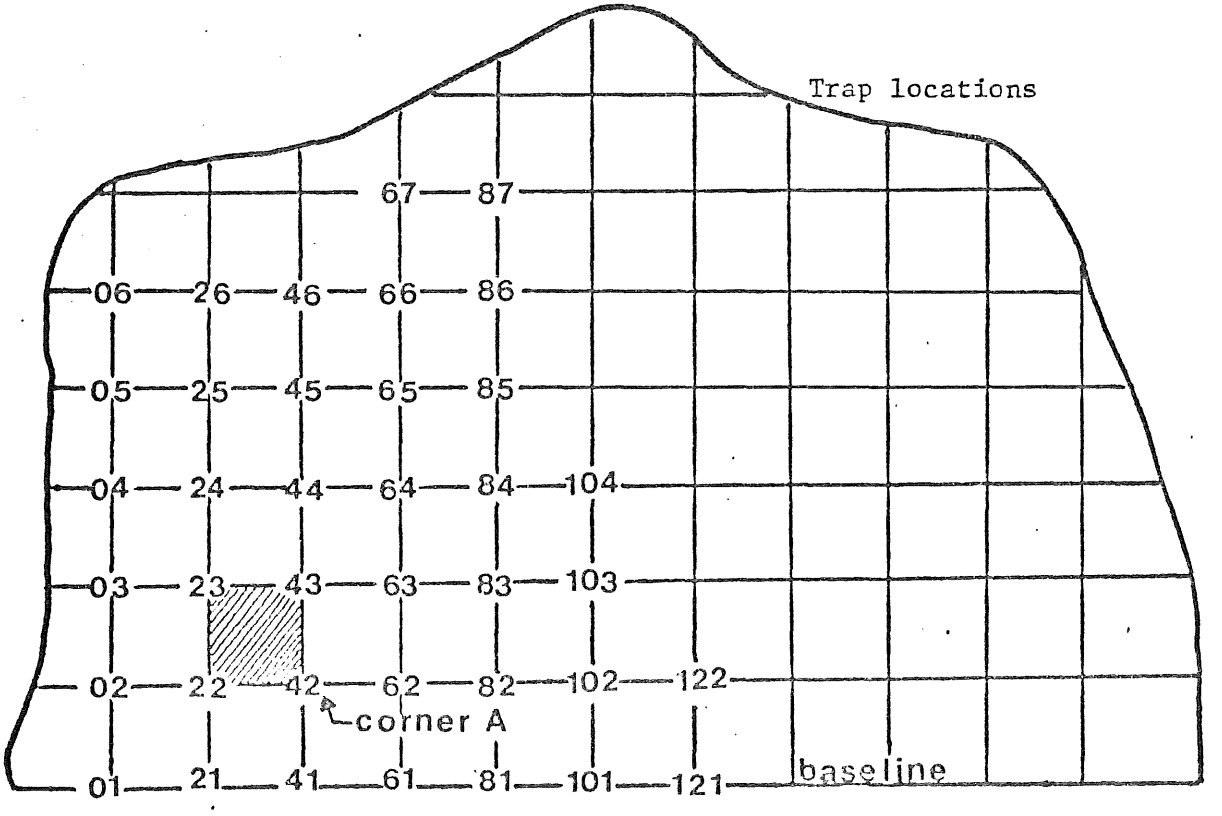


Figure V- 3 Location of random vegetation plots on small mammal trapping grid (see text for explanation).





Plots were located in the field by proceeding to the appropriate trap numbers on small mammal grids, or by measuring the appropriate distance back from the assigned station along bird transects. The 15 x 15 m plot was placed behind and to the left of corner A, the point of origin of all vegetation plots (Figure V-2).

A 60 m rope marked at 15 m intervals was used to delimit the plot. At corner A, a 2 x 2 m plot for sampling low shrubs was enclosed by using a calibrated chalk line or calibrated cane poles (Figure V-2). The outer two sides were coimcident with the corner of the 15 x 15 m plot. The inner corner of the 2 x 2 plot was marked off into a 1 x 1 m quadrat for sampling of herbs (Figure V-2). Its inner edge was marked by a calibrated chalkline.

The location of herb quadrats was chosen to avoid trampled vegetation between trap stations.

Proceeding from the corner of origin (A) to corner B, a belt transect 2 x 15 m long was used for identifying and counting tall shrubs. The entire 15 x 15 m plot was used for measuring and counting trees greater than 3" DBH. All individuals were recorded by speices. Instructions actually used in the field were as follows;

Instructions for tallying plants

1) Count all upright forbs within the 1 sq. m quadrat. Consider each stem to be a separate plant. (Disregard the possibility that they are all attached underground). Examples of "separate plants" are illustrated below:

Figure V- Separate plants

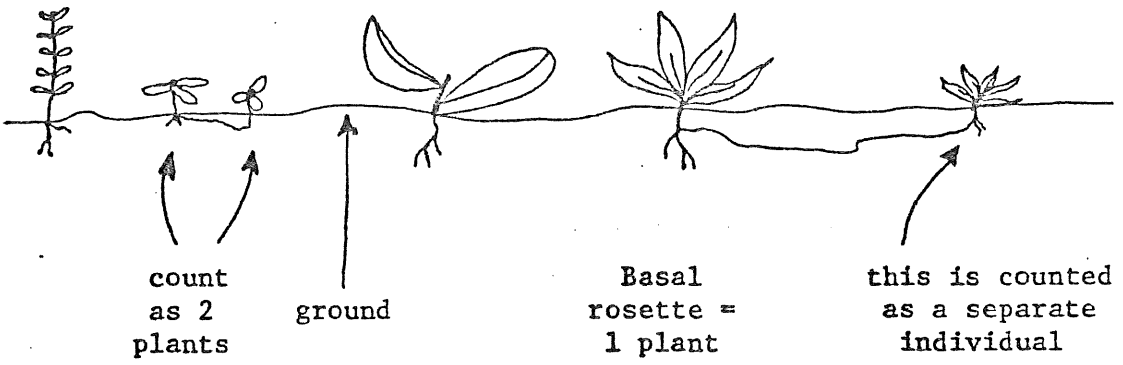


Figure V-4. Separate plants.

2) After counting the individuals of upright species, estimate the cover of all grasses (considered together), all sedges (considered together), small repent species (such as Gaultheria Hispidula or Vaccinium oxycoccos), mosses, lichens, and bare rock or ground. Use the gridded clear acetate overlay as a guide to coverage and estimate the number of 5 x 5 cm squares covered by each class of cover (Figure V-5).

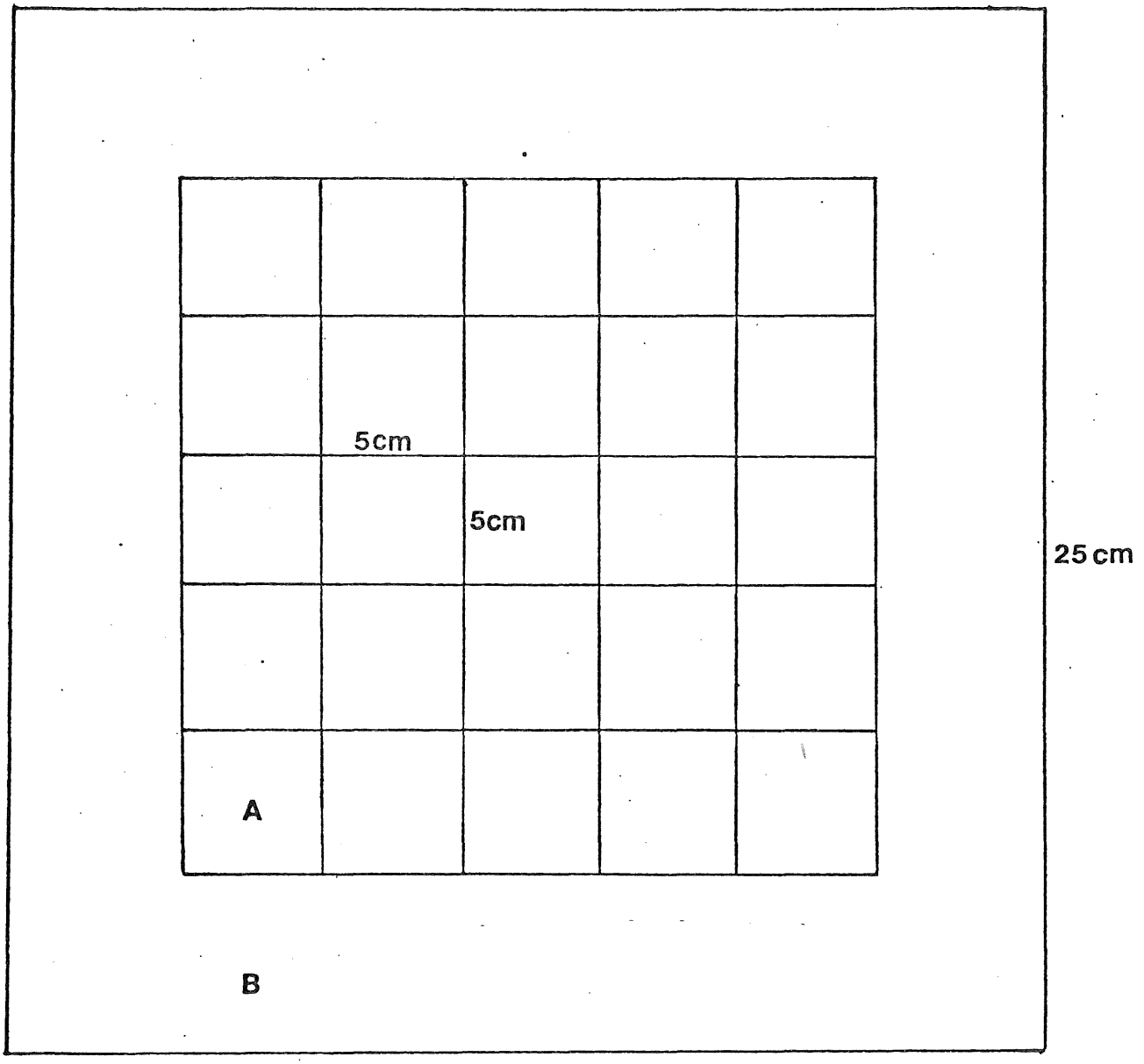
3) Seedlings of tree species less than ankle height should be treated as herbs. Ignore this size "trees" in all but the 1 x 1 plot.

4) Count all individuals of low shrubs in the 2 x 2 m quadrat. Any individual of a woody species between ankle height and waist height should be considered a "low shrub" and counted in this sample area.

5) Species with woody stems should be tallied as low shrubs if they reach more than 25 cm (around ankle height). If their height is less, tally them as herbs on the 1 x 1 plot. Example: Most Vaccinium angustifolium plants will be short enough to count as herbs, some exceptional individuals may take on a bush-like growth from about 40 cm tall. The latter type would be counted as low shrubs in the 2 x 2 plot. If they occur in the 1 x 1 portion of that plot, their counting would be deferred until low shrubs were counted. Additional species that may overlap these two size classes are:

Rubus pubescens
Rubus idaeus
Divervilla lonicera
Lonicera spp.
Ribes spp.

Figure V- 5 Clear acetate grid for estimating percent coverage of grasses, sedges and trailing herbaceous species.



A – The transparent center of the grid board is marked in 5 cm x 5 cm squares. 1 square = 0.25% of the m^2 herb plot; 400 squares = 1 m^2 or 100% cover.

B – The grid was mounted on a masonite board for added rigidness.

Not . None of these species which are all non-woody were counted as tall shrub, even if they were tall enough.

Examples of tall herbs that were never counted as shrubs:

Aster spp.
Eupatorium spp.
Solidago spp.
Apocunum androsasmifolium
Pteridium aquilinum
Thalictrum diolcum

6) Whenever a tree or tall shrub species is waist height (1m) or less, tally it as a low shrub. County such individuals in the PxP m quadrat only. Example: the stand has many Corylus stems 10 high. Tally them in the 2 x 2 plot. Where they occur in the 15 x 2 plot, ignore them.

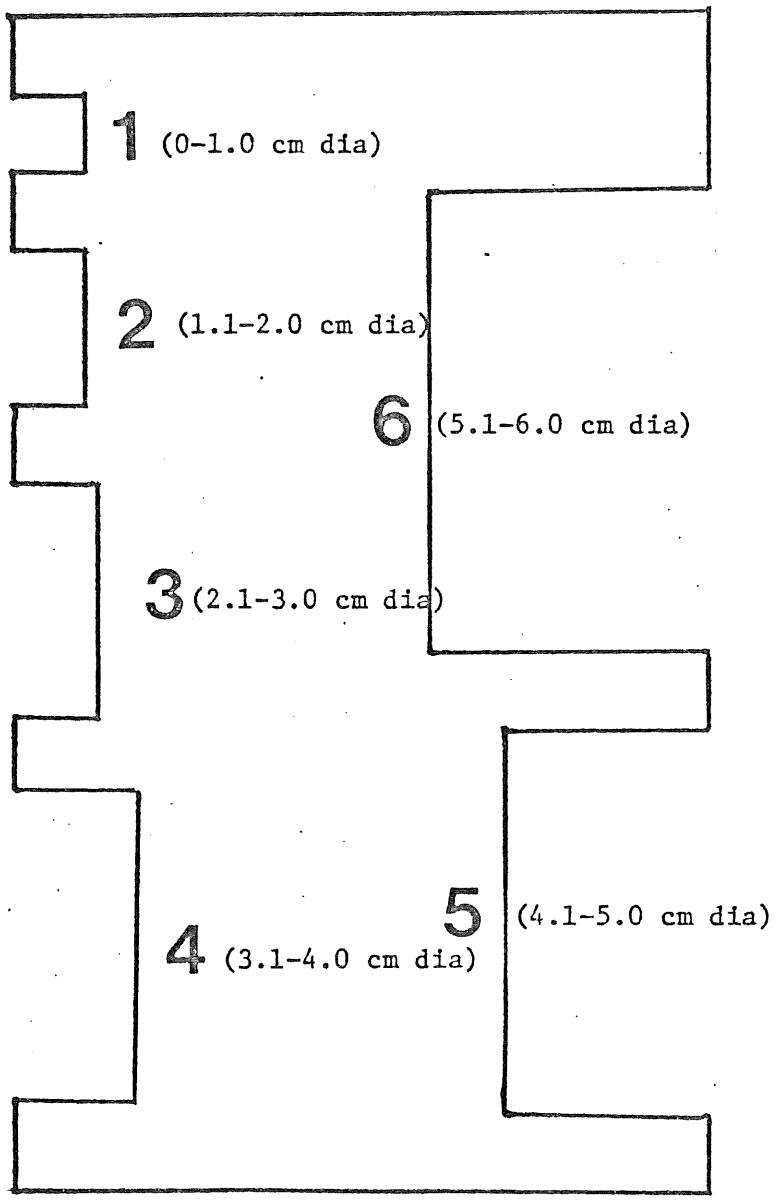
7) Using the outside rope and a 2 m long stick to define the area to be sampled, proceed along the 2 x 15 m belt from the 2 x 2 quadrat counting tall shrubs. Tally these by diameter class. with reference to a gage calibrated at 1 cm intervals (Figure V-6). Diameters should be measured (or estimated) at a height of 15 cm above ground. Count all stems of every shrub and list the shrubs by species. Trees less than 7.5 cm DBH should be included in this count, but shrubs less than knee height should be ignored. Individuals less than 7.5 cm DBH but greater than 7 cm at a height of 15 cm should be recorded in this size class with a note of their measured diameter at 15 cm above the ground.

8) Whenever a species of "low shrub" attains heights greater than 0.5 m (knee height), tally it as a tall shrub. Example: Betula pumila glandulosa often occurs in the same stand in both height classes. Tally the waist high ones in the 4 x 4 m plot and the taller ones (only) in the 15 x 2 plot.

9) After completing the shrub count, proceed back towards the original corner counting and measuring all trees greater than 7.5 cm DBH. Mark each tree or clump of trees after they have been counted if necessary. Marking materials can vary, according to the species under consideration, but they must not be permanent markers. Measuring may be done with a DBH tape or with a calipers calibrated in cm. Measure to the nearest ½ cm.

After tallies were completed in the series of nested plots average canopy height, average shrub height and average degree and aspect of slope were recorded for the plot.

Figure V- 6 Size class gauge (in cm) for tall shrubs.

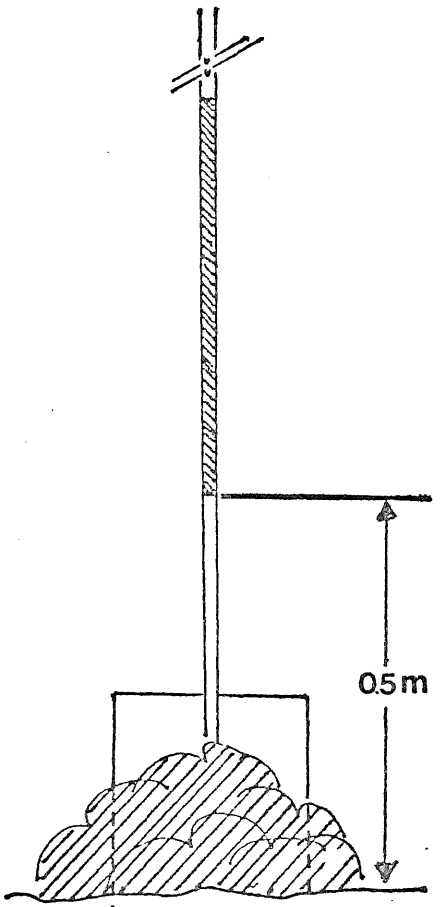


Because of the importance of foliage height diversity to avian populations, two slightly different structural records were made at each corner of the plot. Using a bamboo pole calibrated at half-meter intervals, the height class and species of foliage intercepting the pole was recorded. The pole had to actually tough the foliage when it was held vertically. After measuring interceptions, the pole was used to estimate the height of the lowest canopy foliage. In the lowest four vegetation height classes (0.10 to 2.0 cm, by 0.5 m intervals), foliage readings were taken having one investigator move a grided piece of cardboard, 25 cm x 25 cm, up the pole at 0.25 m intervals. The other observer located himself at a distance of 2 m (Figure V-7), and estimated whether 50 percent or more of the 25 cm area was obscured by foliage. The area was viewed from the same height above the ground. All interceptions of 50 percent or more were recorded as + and all interceptions less than 50 percent were recorded as -. Species were not recorded.

The entire procedure was then repeated with the observer and poleperson exchanging positions. See Figures V-7 and V-8 for illustrations of methods and equipment for recording structure. Some of the structure results are shown in Figure V-9.

Equipment used for quantitative vegetation sampling included:

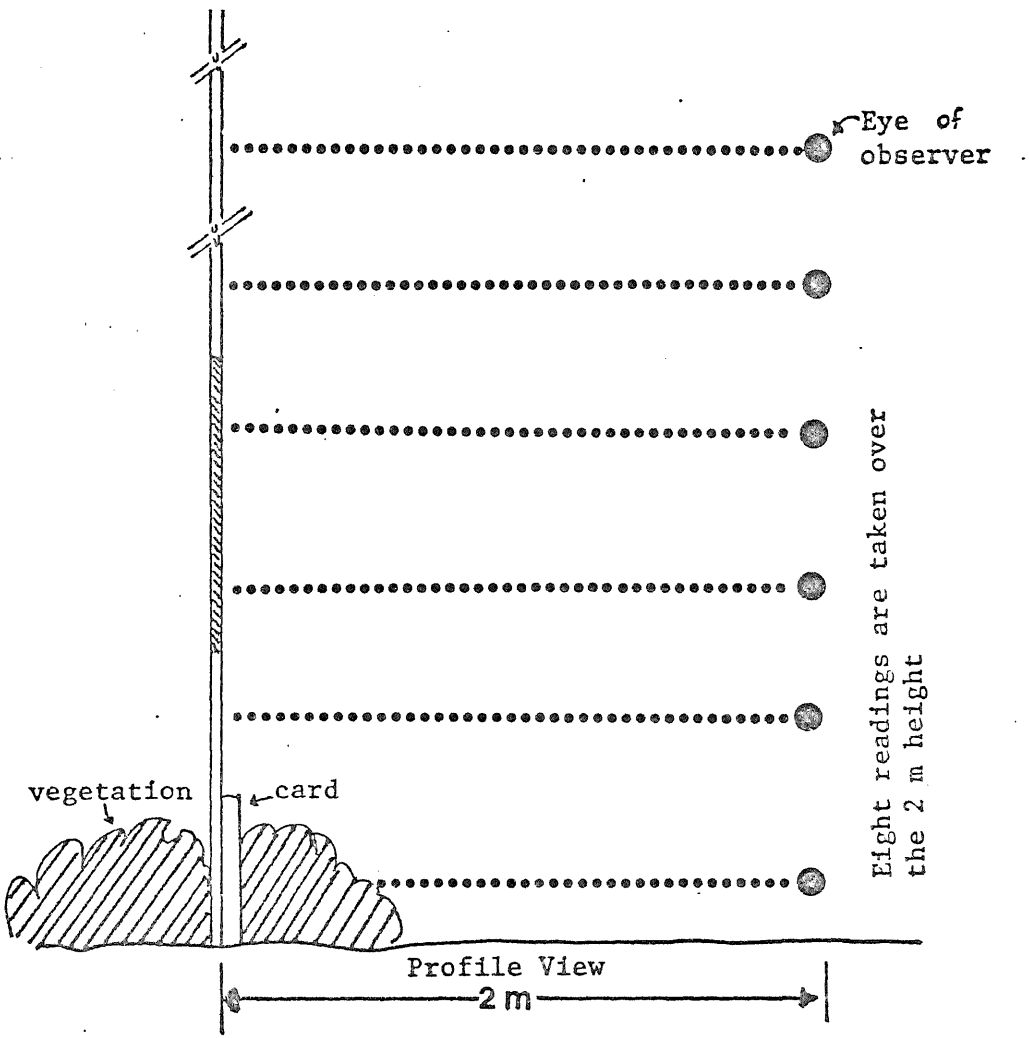
1) yellow plastic rope 60 m long, calibrated at 15 m intervals with shower curtain hooks in the corners.
2) compass-guide to quadrat boundary, slope aspect and degree
3) densiometer
4) cane pole calibrated a ½ meter intervals--structure
5) 25 cm x 25 cm white paper--structure
6) 4 meter string calibrated at 1 m intervals--delimit 2 x 2 plot
7) 2 meter string calibrated at 2 meter--delimit 1 x 1 plot
8) 6 stakes to hold strings in place



View Facing Card

25 x 25 cm card showing > 50% obstruction by vegetation (recorded as a "+")

Figure V- 11 Recording the vegetation cover between the observer and the pole.



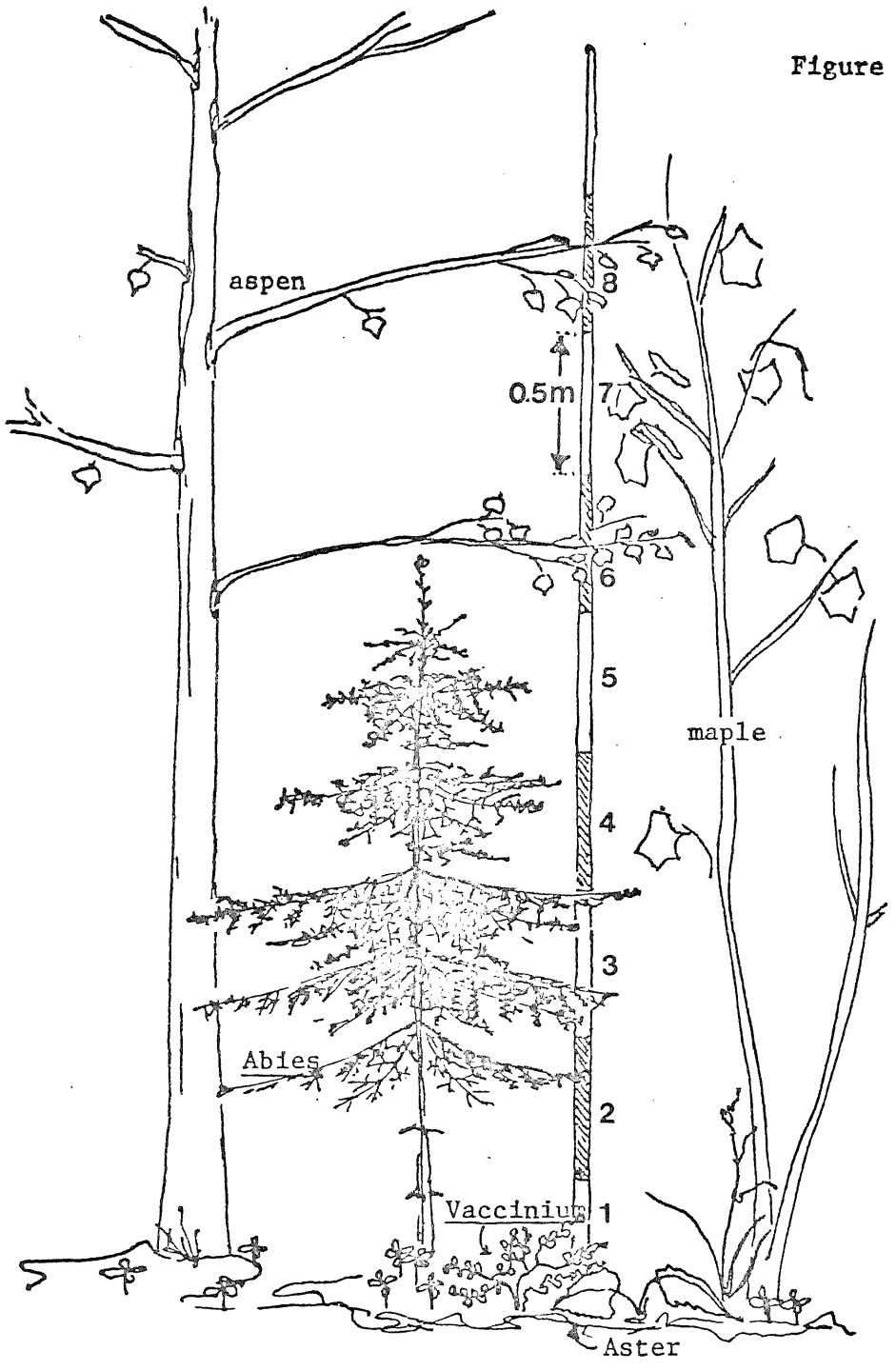


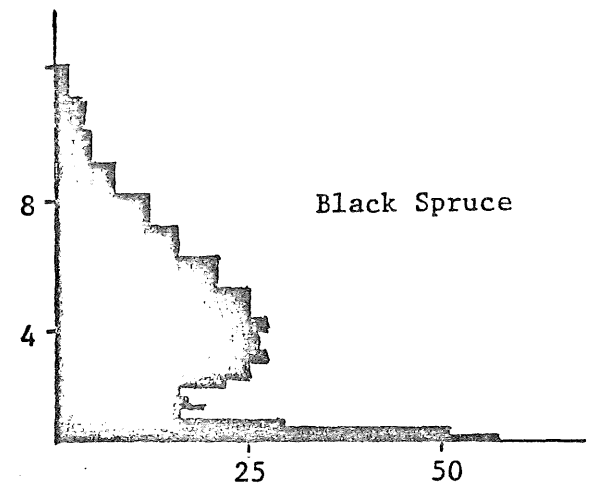
Figure V- 8 Pole intersept method for measuring vertical structure of the vegetation

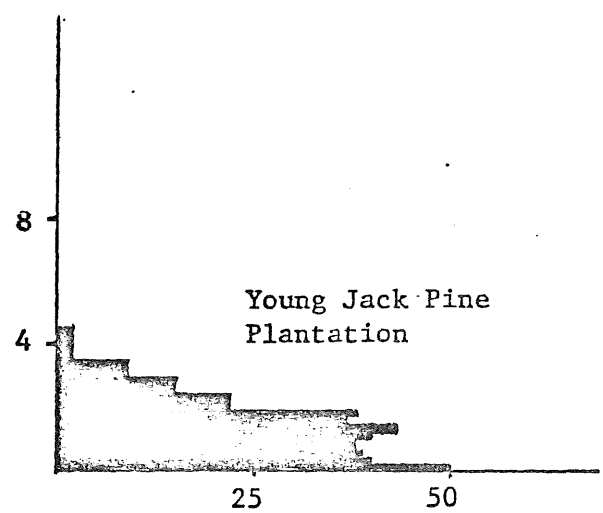
Sample Data Sheet

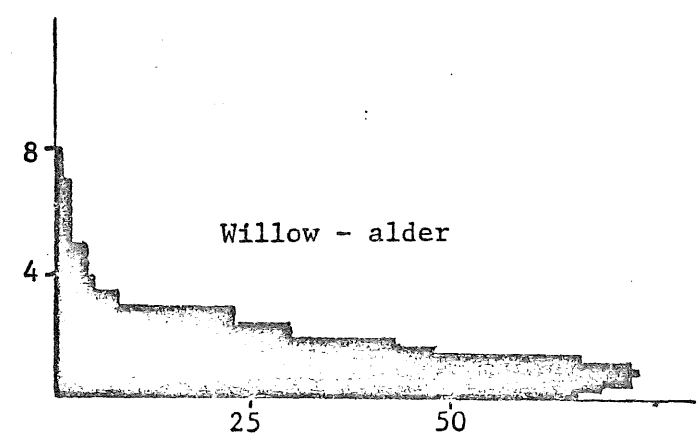
1 half meter	2	3	4	5	6	7	8
Aster mas. Vaccinium ang.	Abies bals.	Abies bals.			Populus trem. (aspen)		

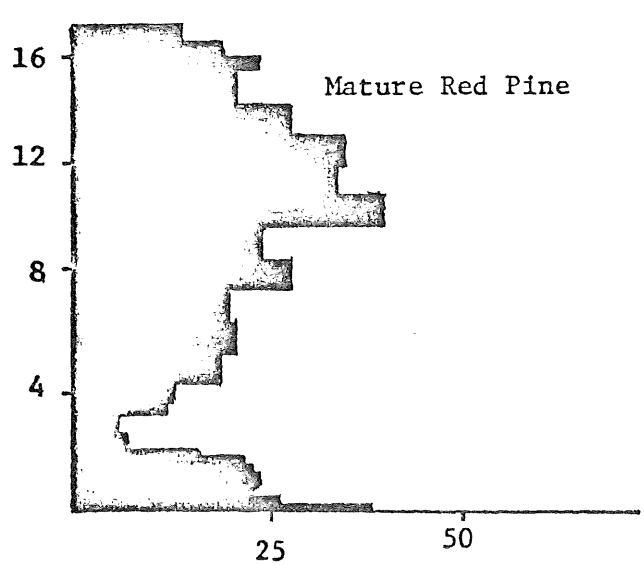
Note: the maple is not recorded because it does not actually touch the pole.

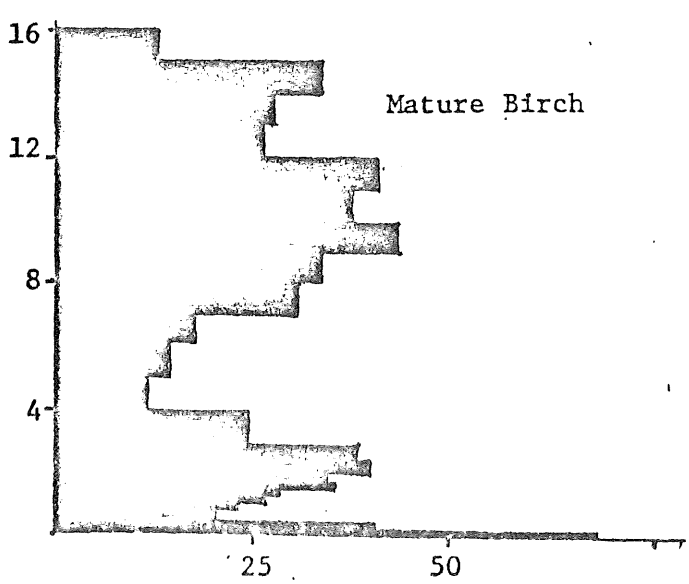
Figure V-
Foliage height profiles of five cover types. Determined from quantitative vegetation studies along bird transects.











9) clear acetate grid, 25 cm on a side--cover estimation for mosses, etc.
10) diameter gage for shrubs
11) calipers--tree DBH
12) clipboard
13) data sheets
14) matches, extra string, extra curtain hooks, indelible marker (for repairs and replacements of boundary markers)
15) colored chalk--to mark counted trees
16) 2 meter long pole--delimit width of tall shrub quadrat
17) table of random numbers--in case some predetermined points are inapplicable

Modifications were made in equipment and field procedures as the season progressed. These alterations included: changes in plant collection and drying; and many modifications in equipment and procedures expediting quantitative sampling.

Our original equipment for quantitative sampling included a bamboo pole 2 m long for determining the width of the 15 x 2 m belt for tall shrubs. It was found that this distance could be judged as well with the cane pole used for structural determinations. Experienced observers could judge the distance by knowing the span of their arms. The calibrated 4 m and 2 m chalk lines for establishing the 2 x 2 and 1 x 1 quadrats also proved extraneous. These plots could also be delimited by use of the calibrated cane pole. Both the clear acetage grid and shrub measurement gage proved more useful as reference tools in cases wehre questions arose than as standard equipment. Observers quickly learned to estimate shrub size in the 1, 2, and 3 cm size classes and percentage of cover within the $1m^2$.

"Low shrubs" were originally defined as those less than .5 m or below the knee. This proved unfeasible because of the number of ericaceous

shrubs between knee height and waist height in boggy areas. Such shrubs are low shrub species and form continuous mats. Therefore, we decided to change the boundary between "low shrubs" and "tall shrubs" to 1 m (waist height).

We found it unfeasible to county deadfall within the 15 x 15 m plot. Only dead standing trees were recorded. Our original plans included a record of slope degree and aspect as each corner of the plot. Because of microrelief, it was more meaningful to record these parameters for the plot as a whole.

7.3. Recommendations for the 1977 Field Season

1) Regular collection of plants by all members of the terrestrial team. Newly blooming and strange plants would be collected wherever team members were working throughout the season. This would free the plant biologists for quantitative study throughout the season. One day a week could be devoted to herbarium work.

2) Formalized intraterrestrial communication system so that all members are aware of ongoing aspects of the project and can share each others' plans and ideas; this would allow more feedback and input from all team members. Perhaps this communication system could take the form of obligatory weekly or bi-weekly team meetings.

3) If there are additional study sites, they need to be located earlier.

4) Quantitative sampling should begin earlier in the season.

5) Investigate the possibility of adapting the Braun-Blanquet releve system to provide repeatable data. Modifications might include use of the densiometer to quantify coverage, standardization of area covered and

possible incorporation of m^2 herb plots at regular intervals to quantify cover estimates. More extensive survey of the area would be possible with these modifications. We would also be able to obtain a better understanding of the variability within each of the canopy types shown on the Minesite vegetation map.

7.4. Consultants and Personnel

Drs. Paul Monson and Thomas Morley provided advice about taxonomic references, herbarium labels, herbarium procedures and methods of collecting rare plants. Dr. Monson also provided the facilities of the Olga Lakela Herbarium at the University of Minnesota, Duluth Branch and herbarium labels and other mounting equipment. Dr. E.J. Cushing critically reviewed original field plans.

The following members of the terrestrial team participated in vegetation studies during the 1976 field season:

phenology: Deborah Shubat
plant collection and releves: D. Shubat, N. Sather, D. Bruce
Quantitative sampling: D. Shubat, L. Pfannmuller, G. Niemi, N. Sather, D. Bruce, G. Seim, D. Garin, J. Jaeger and R. Huempfner

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8. IDENTIFICATION OF MOSSES

8.1. Introduction

Bryophytos (mosses and their allies) are inconspicuous but common species in many plant communities.

In 1976 we initiated a study that will produce a species list of mosses on 22 sites (sites no. 1-22 included, Table TB- , Figure TB-). The reasons for identifying moss species as a part of the regional characterization for this study is best explained by Steere (1970):

> "Bryophytes (mosses and allies) are unusually sensitive among plants to variations in the substratum upon which they live, not only in moisture, but in acidity, alkalinity, the presence of certain metallic ionic, and other factors." ..."The very close relationship of bryophytes to the soil, rocks, and barks upon which they grow, because of their lack of roots, combined with their sensitivity to the environment, cause them to be excellent indicators of the nature of the environment..."

Other researchers (Stacklette 1967, p. 614) have recognized that certain species of mosses may be "...a local indicator of mineral enrichment,..." This moss-mineral association was noted for a number of elements in Alaska (Shacklette 1965).

8.2. Methods

The complications with the taxonomy of mosses prompted us to contract-out this portion of the study. Ms. Rae Barkley, currently employed by the Bell Museum of Natural History, University of Minnesota, Minneapolis Campus, was contracted to collect and identify moss species from 22 sites on the Minesite area. The entire contract (transportation, lodging, supplies, collecting, and identification) amounts to $500.00.

Ms. Barkley traveled to the study area twice during 1976 and spent approximately 30 minutes on each site during each field trip. Mosses were collected from as many substrates as possible, placed in individual paper bags, numbered and dated. Samples were air dried and identified in the Twin Cities by using binocular and compound microscopes.

8.3. Results

A species list of mosses for each of the 22 sites will be completed by mid-January, 1977. Over 350 samples are being classified, representing approximately 100 species. Questionable specimens will be checked by Dr. Howard Crum of the University of Michigan, Ann Arbor and his graduate student, Mr. Bill Buck.

The species list will provide baseline data at 22 locations throughout the study area (Figure TB-).

Moss specimens will be stored at the University of Minnesota, St. Paul Campus, under the care of Dr. Clifford Wetmore. These specimens will be added to the existing collection.

8.4. Conclusions

No conclusions or comparisons between habitats can be made at this time.

8.5. References

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9. SMALL MAMMAL CENSUS

9.1. Introduction

The major purpose for this census of small mammals (mice, voles, shrews and squirrels) was to obtain population, species diversity and biomass estimates for different forest habitats commonly found in northeastern

Minnesota. Small mammals are generally censused by using either snap traps or live traps. After considering time distances involved in travelling to the various sites, and available manpower and resources, we decided to census with snap traps. Snap traps were used in a grid arrangement. This method provides data which can yield population estimates.

Another purpose for the census is to provide a way of ranking plant communities by comparing the richness of small mammal species and total numbers of individuals among the different forest types. In addition, some small mammals will be analyzed for levels of heavy metal body burdens.

9.2. Methods

We trapped during four periods: Period A, June 22-28; Period B, July 27-August 2; and Period C, August 31-September 6 and August 5-11, 1976. Twelve sites, representing six different forest types, were trapped during each period. The trapping was equally distributed between deciduous (two trembling aspen, two paper birch and two mixed trembling aspen-paper birch) and coniferous types (two red pine, two jack pine and two black spruce). In most cases, based on the availability of suitable habitat, one grid was located north and the other south of the Laurentian Divide.

During the August 5-11 trapping period, four different forest types were trapped (one tamarack, one 1-2 m tall tamarack, one mixed tamarack-black spruce, and one white cedar). A total of 40 different grids were trapped during the 1976 field season at 24 different sites (Figure SM-1).

9.2.1. Grids

When there was sufficient homogeneous habitat, a square grid of 8 x 8 stations (64 traps) was established. In other areas, as many traps as possible were fit into the site allowing at least a 15 m buffer zone between outermost trap lines and other cover types or roads. Most trapping grids included 50 or more traps.

The interval between each station along both rows and columns was 15 m. Each station was located using a compass line for direction and split-image range finder for distance. A 9-gage, 50 cm long steel stake was used to mark each station. The stake also held traps securely in place and was looped at one end to hold a numbered plastic marking flag.

9.2.2. Trapping

Each grid station contained a single Museum Special snap trap. Traps were baited with peanut butter and rolled oats. Prebaiting (traps unset) was conducted for two days. Traps were then set and checked once a day for five consecutive days thereafter.

Each mammal trapped was placed in a plastic whirl-top bag at the trap station, with a label containing the trap number, date, species (if known), site number, and researcher's initials. Specimens were kept on ice the remainder of the day and frozen upon return to the laboratory.

9.2.3. Laboratory Studies

A number of factors are beind studied in the laboratory. These include: 1) aging all specimens; 2) sexing and determining reproductive condition;

3) positive taxonomic identification; 4) fresh frozen weight of each specimen; 5) hair samples are being saved to store in the biological archives; 6) museum specimens were made for uncommon species; 7) stomach contents are preserved in alcohol from all species. This work is currently being conducted by Dr. Elmer Birney, Betsy Batten, and Dr. Birney's laboratory technician. Dr. Birney is the Curator of Mammals at the Bell Museum of Natural History, University of Minnesota, Minneapolis Campus and is under contract to conduct these determinations. The total contract is $1000.00 and would include as many as 2000 specimens for both 1976 and 1977. This work could not be done as accurately, or in the same time frame, by members of the terrestrial staff.

Stomach contents are being saved with the hope that we can find an interested person to identify these materials for a food studies paper especially for shrews. The hair samples being collected will be saved in the biological archives for possible future analysis for heavy metals.

9.3. Results and Discussion

9.3.1. Trapping Period A, C and Intermediate Period

Data from these three periods are not yet available. Specimens must still be examined in the laboratory by Dr. Elmer Birney and his staff. These results should be available by mid-winter 1977.

9.3.2. Trapping Period B

Most of the data from trapping period B is presently available. A few individuals of Sorex sps. must still be positively identified. A number

of individuals of other species must be reexamined and there may be minor changes in species numbers in future reports from those presented here. Gunderson and Beer (1953) state that Soxex cinereos, the most common species during trapping period B, cannot be separated from the pigmy shrews (Microsorex) on the basis of external characteristics. However, they can be distinguished by dental characters. We have tentatively identified, as they suggest, all of the small, long-tailed shrews of nearly uniform brownish color as Soxex cinereous until laboratory studies are complete.

The numbers and percentages of each species trapped in period B are given in Table SM-1, with the scientific and common names for each species given in Table SM-2. For trapping period B, a total of 492 small mammals were collected. Sorex cinereus (cinereous shrew) and Clethrionomys gapperi (red-backed vole) accounted for 60.8 percent of the total animals collected. These two species, along with Peronyscus maniculatus (white-footed mouse) and Blariva brevicanda (short-tailed shrew), accounted for 85.4 percent of the total. Figure SM-1 graphically shows that these four species are much more abundant than the others on our forested plots on the Minesite area.

As shown in Table SM-1, a total of 12 known species (excluding 1 juvenile snowshoe hare) were collected. Site 27B (paper birch) contained the highest number of species (9), while site 2B (jack pine) contained the lowest number (3). An average of just under six species (5.75) were trapped per site. The largest number of individuals collected on a

single grid was at site 29B (trembling aspen), with 72. The lowest number was at site 3B (red pine), with 17. The average number of individuals collected/site was 41.

Since the number of traps varied for certain site, the grid areas trapped varied. Because of this, it is not accurate to compare actual numbers for all sites. It is better to express the numbers as densities (individuals/hectare) thus compensating for differences in grid areas.

Grid areas were calculated as the area inside the grid arrangment plus the area of a 7.5 m wide fringe around the grid. Since traps in the grid were arranged 15 m apart, each trap was assumed to have an effective trapping area of a square, 15 ms on a side. Thus, to have equal trapping areas for each trap, a 7.5 m wide fringe area was added to the traps on the edge of the grid arrangement.

The number of traps at each site ranged from 46 to 64 traps, with an average of 58 traps per site. With these variables grid arrangements, the area of the grids ranged from 1.04 to 1.44 hectares, with an average of 1,30 hectares per site.

With the numbers shown in Table SM-1 and the grid areas calculated for each site, densities of herbivores and insectivores for each site were calculated and shown in Figure SM-3. Please refer to this figure during the following discussion. Insectivores were defined as all shrew species (Sorex and Blaria),with herbivores included the rest of the species. Only on sites 13B (pole size trembling aspen), 28B (black spruce), and 6B (mature black spruce) did the densities of insectivores

exceed the densities of herbivores. No insectivores were collected on site 3B (mature red pine).

Biomass per area for herbivores and insectivores is shown in Figure SM-6. Biomass was calculated by adding the weights for each individual trapped. Only on site 13B (pole trembling aspen) did the biomass per area of insectives exceed the biomass per area of herbivores. It is important to remember the pronounced weight differences of individuals of different species. For example, Sorex cinereus averages less than 5 g each, the smaller herbivores average about 20 gs, with chipmunks and flying squirrels averging more than 75 grams. Even though Sorex cineus was the most common species collected (155 individuals caught), its relatively low weight reduces its influence on biomass estimates. In turn, the relatively high weights of chipmunks and flying squirrels (only 37 total individuals collected) strongly influenced biomass estimates.

As stated previously, one major reason for the census of small mammals was to obtain population estimates for different forest habitats. The analysis method used on the data was the lease squares regression as described in Zippin (1956) and Grodrzinski et al. (1966). An example of linear regression analysis is shown in Figure SM-5. Y values are the number of small mammals trapped per day and x values are the cumulative number of small mammals previously caught. Grodzinski et al. (1966) states that the resulting graph yields the number of rodents caught after removal of a definite number of animals from the population.

By calculating the equation of linear regression, $y = -ax + b$, it is possible to calculate the intersection point of the straight line $y = -ax + b$ with the axis of abscissal. This intersection point equals the estimated population size for the study area. As shown in Figure SM-5, the estimated population size for site 10B was 48. With a grid area of 1.44 Ha, the estimated population density for site 10B was 33 individuals/hectare.

The estimated densities for 12 sites is shown in Figure SM-6. Figure SM07 (densities of actual individuals caught) is presented to show how estimated densities from linear regression compare to actual numbers of individuals collected. As shown in Figure SM-6 the trembling aspen sites (29B and 13B) had estimated populations much higher than other forest types. Also, the mixed aspen-birch sites (9B and 10B) had much lower estimated populatons than either the birch or aspen sites alone. The average population estimates for all deciduous types (using regression) was 81 individuals/hectare while the average for all coniferous types was only 35 individuals/hectare (Figure SM-7). The average number of individuals collected during the five day period was 39/hectare for the deciduous types and 26/hectare for the coniferous types (Figure SM-6). From these data, it appears that the deciduous forest on the study area contain considerably higher densities of small mammals than the coniferous types studied.

Grodzinski et al. (1966) states that the reliability of the estimates obtained by regression depends on the correctness of the following

premises: 1) all the individuals in the populatio have a uniform change of being caught, 2) there is either no, or very little, immigration and emigration of individuals during the capture period, 3) variations in numbers due to mortality or reproduction are slight during the capture period, and 4) capture conditions are similar throughout the whole of the capture period. One method to determine reliability of the estimates is by calculating confidence limits for the population estimates at each site. At this time there are questions concerning the proper method needed to assess these confidence limits. More work is needed before these limits can be calculated and reported.

9.4. Conclusion

Since the results of this report are based on limited data from just one trapping period, the trends observed must be assumed to be preliminary. Much additional information concerning small mammals in the Minesite area will be reported as soon as the data are available and analyzed.

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Table SM-1.

Numbers and percentages of small mammal species caught by site and cover types.
(Trapping period B July 29 - August 2, 1976

	Cover Type and Site Number																			
	(27B) Paper Birch		(8B) Paper Birch		(9B) Mid-aged Aspen-Birch		(10B) Mid-aged Aspen-Birch		(29B) Trembling Aspen		(13B) Pole Aspen		(28B) Black Spruce		(6B) Black Spruce		(26B) Red Pine		(3B) Red Pine		(2B) Jack Pine		(1B) Jack Pine		Totals	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sorex cinereus	3	8.1	14	23.7	3	9.7	11	26.8	11	15.3	38	70.4	33	53.2	18	81.8	3	10.2			15	32.6	6	27.3	155	31.
Clethrionomys gapperi	11	29.7	28	47.5	4	12.9	18	43.9	12	16.7	3	5.6	17	27.4	1	4.5	7	24.1	6	35.3	30	65.2	7	31.8	144	29.
Peromyscus maniculatus	6	16.2	10	16.9	12	38.7	6	14.6	28	38.9					1	4.5	16	55.2	3	17.6			1	4.5	83	16.
Blarina brevicauda	2	5.4	5	8.5	5	16.1	4	9.8	15	20.8	3	5.6	2	3.2			1	3.4					1	4.5	38	7.
Eutamias minimus	3	8.1							3	4.2			1	1.6					4	23.5			5	22.7	16	3.
Tamias striatus	4	10.8			4	12.9	1	2.4	2	2.8									1	5.9					12	2.
Microtus pennsylvanicus											3	5.6	5	8.1	2	9.1									10	2.
Glaucomys sabrinus	2	5.4					1	2.4					2	3.2			1	3.4	2	11.8			1	4.5	9	1.
Zapus hudsonicus			2	3.4							2	3.7					1	3.4	1	5.9	1	2.2			7	1.
Napeozapus insignis	4	10.8			3	9.7																			7	1.
Unknown	1	2.7							1	1.4			2	3.2									1	4.5	5	1.
Sorex arcticus (?)											4	7.5													4	0.
Sorex sps. (?)											1	1.9													1	0.
Lepus americanus	1	2.7																							1	0.
Totals	37	99.9	59	100.0	31	100.0	40	99.9	72	100.1	54	100.2	62	99.9	22	99.9	29	99.8	17	100.0	46	100.0	22	99.8	492	99.

Table SM-2.

Scientific and common names* of small mammal species trapped in period B (July 29 - August 2, 1976).

Scientific Name	Common Name
Sorex cinereous	Cinereous shrew
Clethrionomys gapperi	Red-backed vole
Peromyscus maniculatus	Deer or white-footed mouse
Blarina brevicanda	Short-tailed shrew, mole shrew
Entamias minimus	Least chipmunk
Tamias striatus	Eastern chipmunk
Microtus pennsylvanicus	Common meadow mouse, Pennsylvania meadow mouse
Glaucomys sabrinus	Northern flying squirrel
Zapus hudsonicus	Meadow jumping mouse
Napeozapus insignis	Woodland jumping mouse
Sorex arcticus	Saddle-backed shrew, Richardson shrew
Lepus americanus	Varying hare, Snowshoe rabbit

* Gunderson, H.L. and J.R. Beer (1953).

Figure SM-1 Sites on which small mammals were trapped during 1976 (trapping period A,B,C and intermediate)

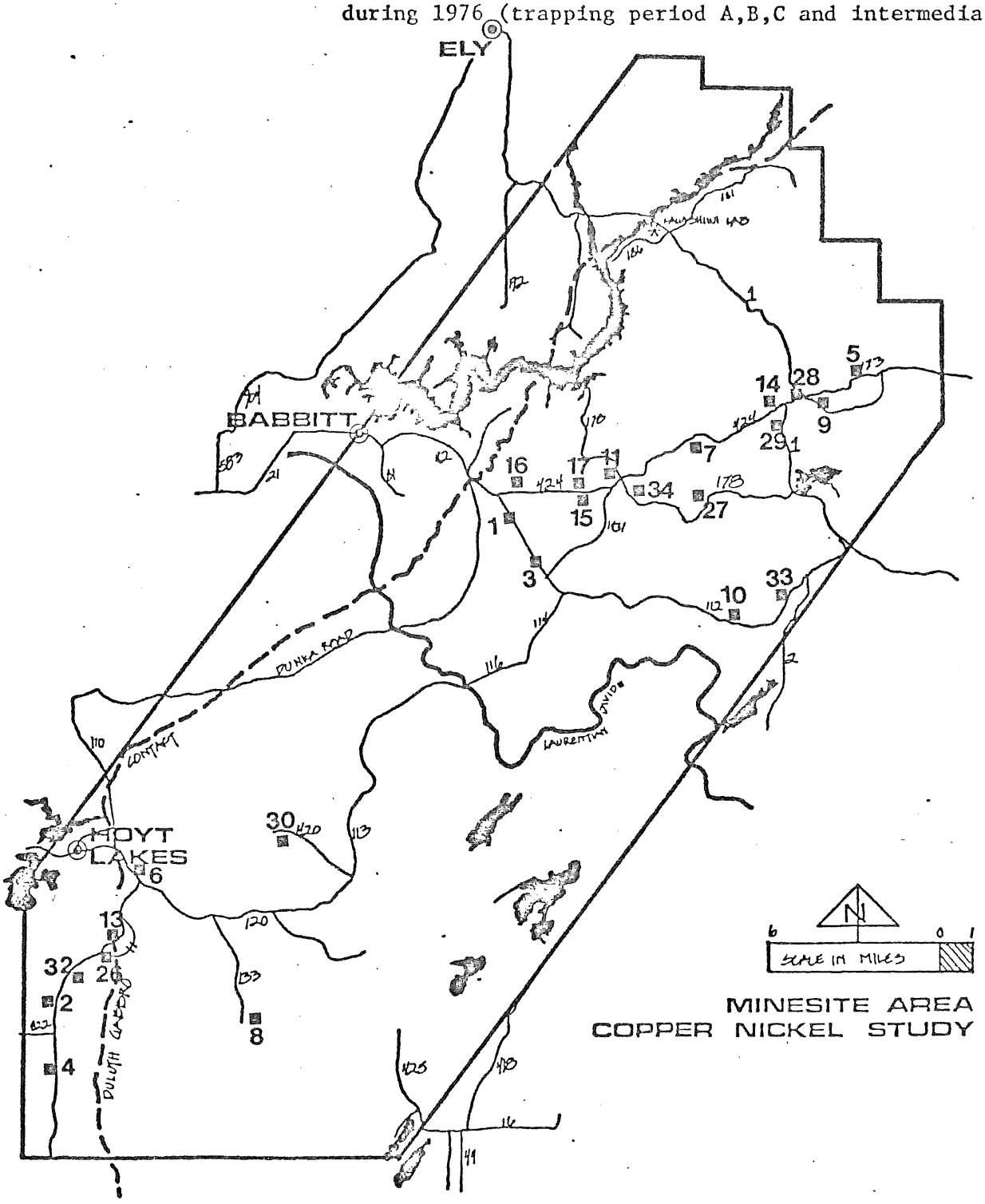


Figure SM-1
Total numbers of small mammals of each species trapped on 12 sites during trapping period B (July 29 - August 2, 1976).

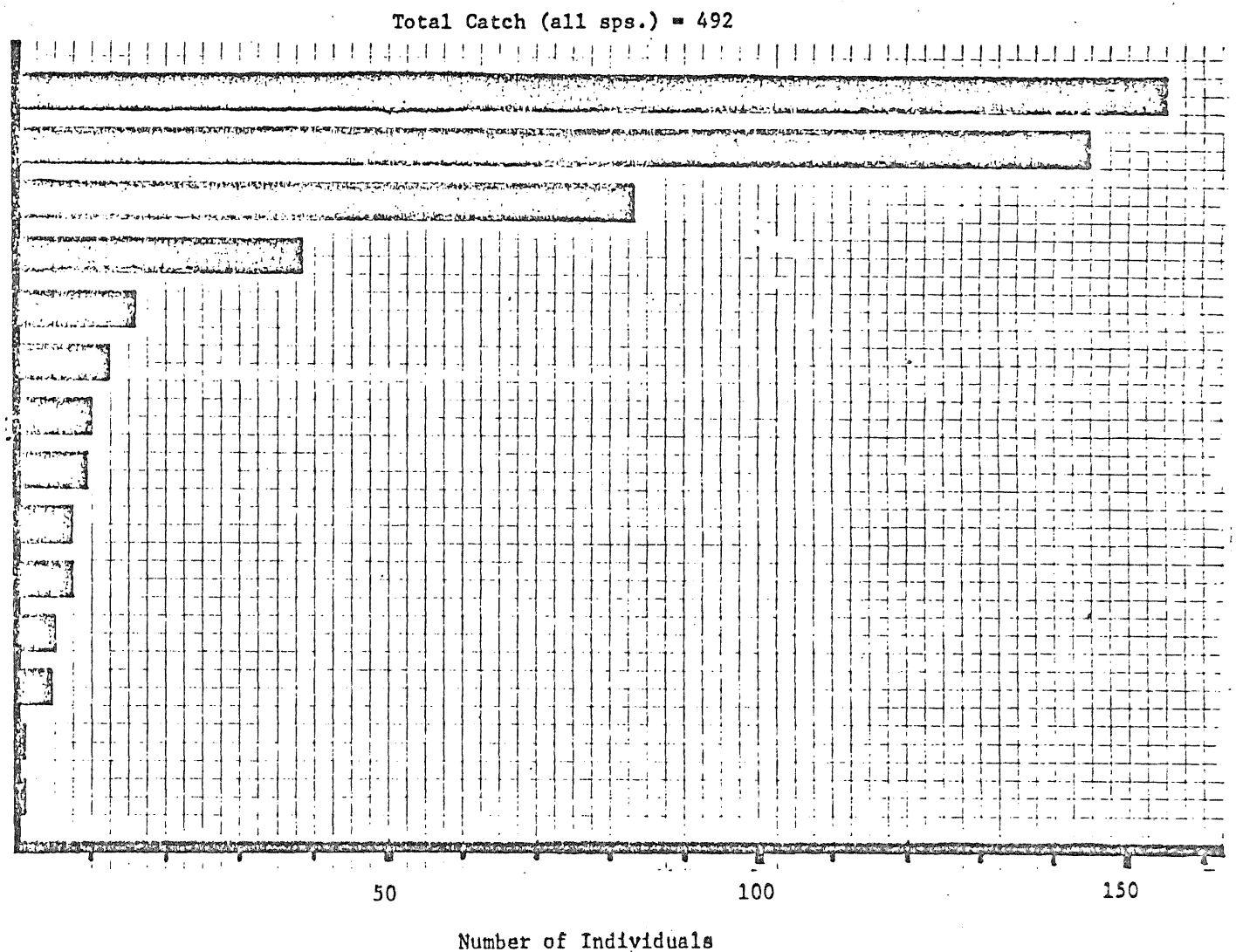


Figure SM-3.
Densities of herbivores and insectivores
by site and cover type.
(Trapping period B, July 29 - August 2, 1976)

Cover Type	Site No.
Paper Birch	(27B)
Mature Paper Birch	(8B)
Mid-aged Aspen-Birch	(9B)
Mid-aged Aspen-Birch	(10B)
Trembling Aspen	(29B)
Pole Trembling Aspen	(13B)
Black Spruce	(28B)
Mature Black Spruce	(6B)
Red Pine	(26B)
Mature Red Pine	(3B)
Mature Jack Pine	(2B)
Mature Jack Pine	(1B)

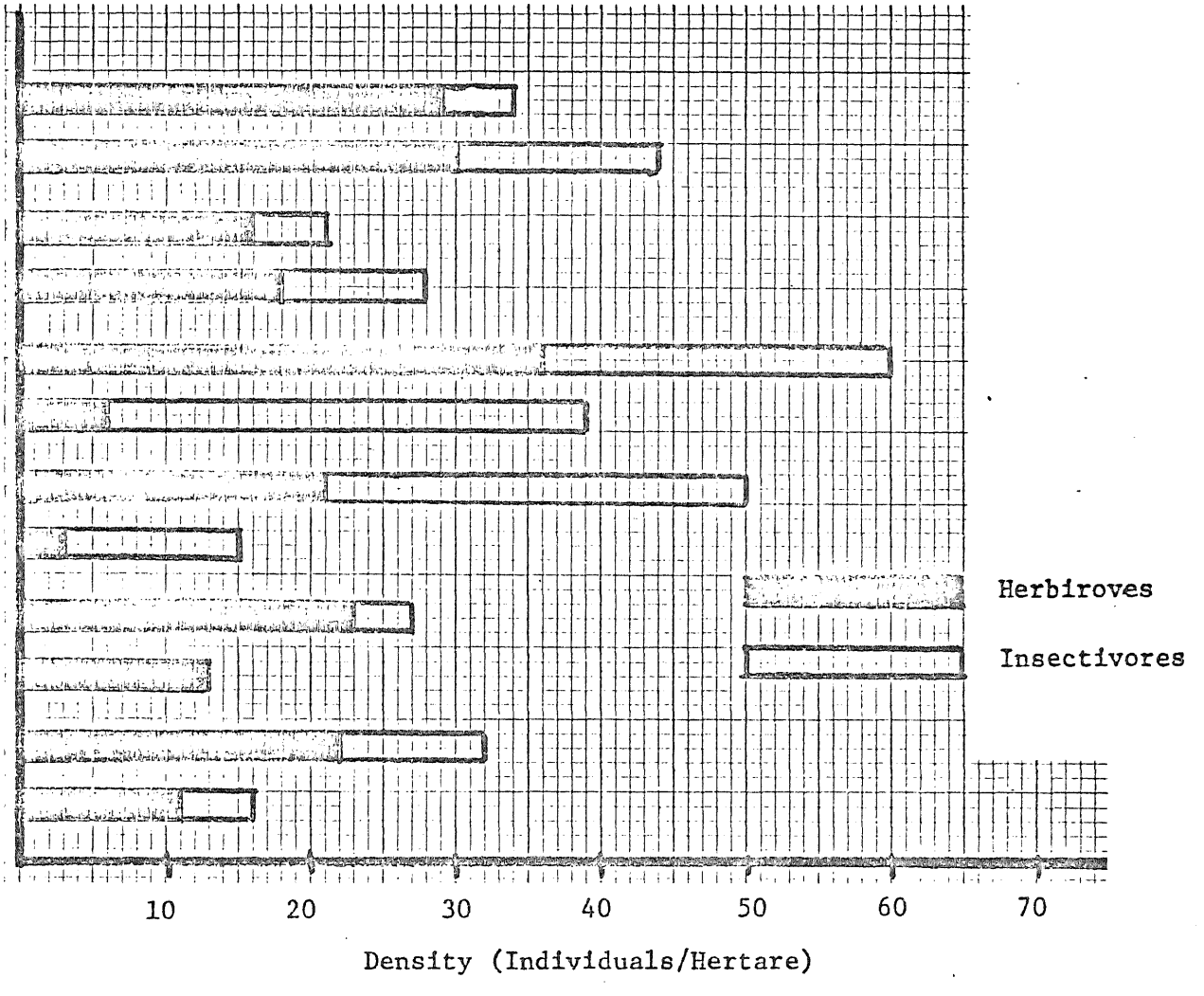


Figure SM-4.
Biomass/area for herbivores and Insectivores for each site and cover type.
(Trapping period B July 29 - August 2, 1976)

Cover Type	Site No.
Paper Birch	(27B)
Mature Paper Birch	(8B)
Mid-aged Aspen-Birch	(9B)
Mid-aged Aspen-Birch	(10B)
Trembling Aspen	(29B)
Pole Trembling Aspen	(13B)
Black Spruce	(28B)
Mature Black Spruce	(6B)
Red Pine	(26B)
Mature Red Pine	(3B)
Mature Jack Pine	(2B)
Mature Jack Pine	(1B)

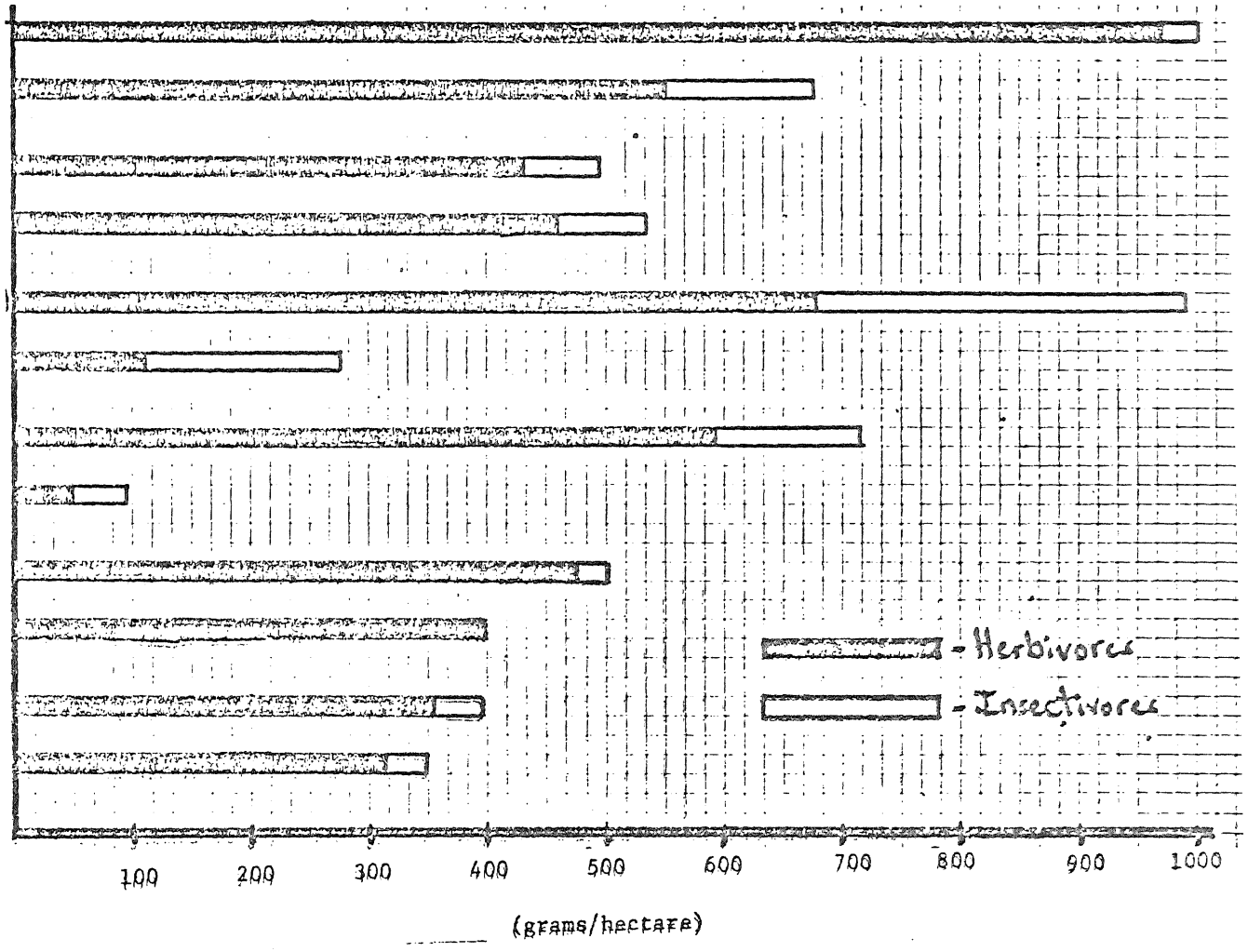


Figure SM-5.
Example of method used in determining estimated populations using linear regression.
(Trapping period B, July 29 - August 2, 1976)

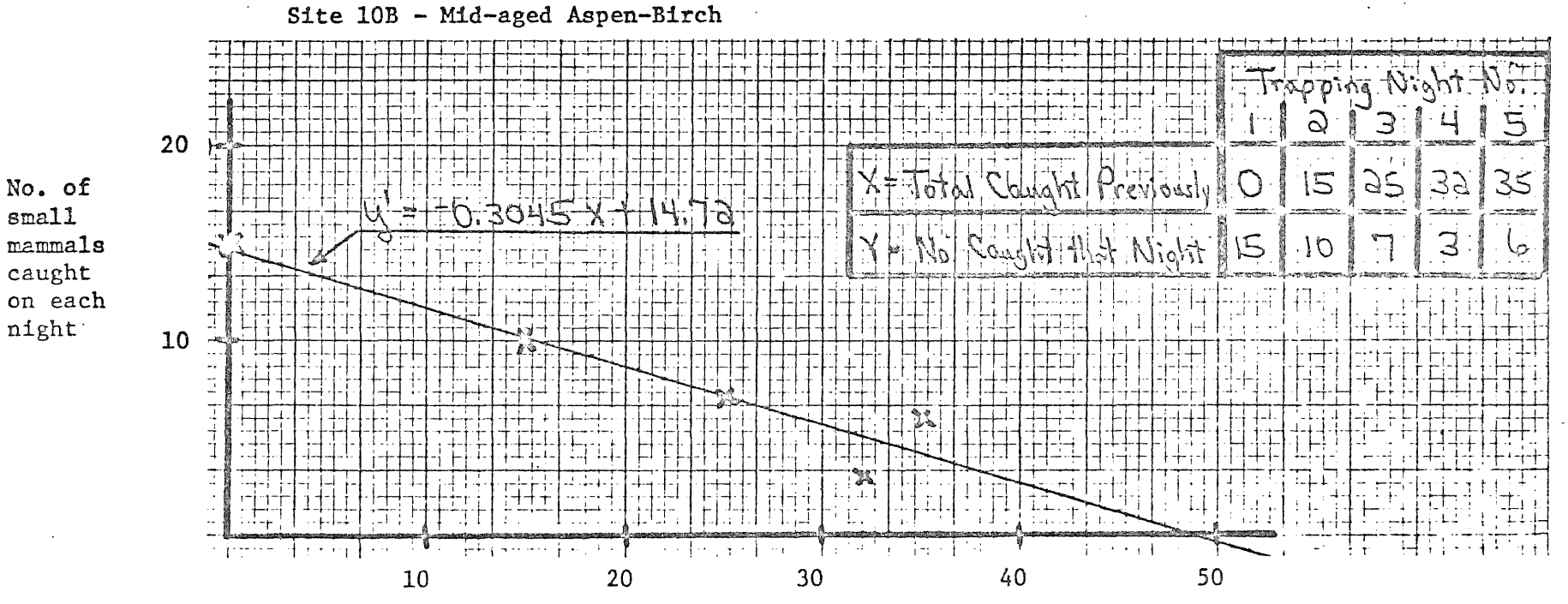


Figure SM-6.
Estimated total populations (all species) as calculated from linear regression by site number and cover type. (Trapping period B, July 29 - August 2, 1976)

Cover Type	Site No.
Paper Birch	(27B)
Mature Paper Birch	(8B)
Mid-aged Aspen-Birch	(9B)
Mid-aged Aspen-Birch	(10B)
Trembling Aspen	(29B)
Pole Trembling Aspen	(13B)
Black Spruce	(28B)
Mature Black Spruce	(6B)
Red Pine	(26B)
Mature Red Pine	(3B)
Mature Jack Pine	(2B)
Mature Jack Pine	(1B)

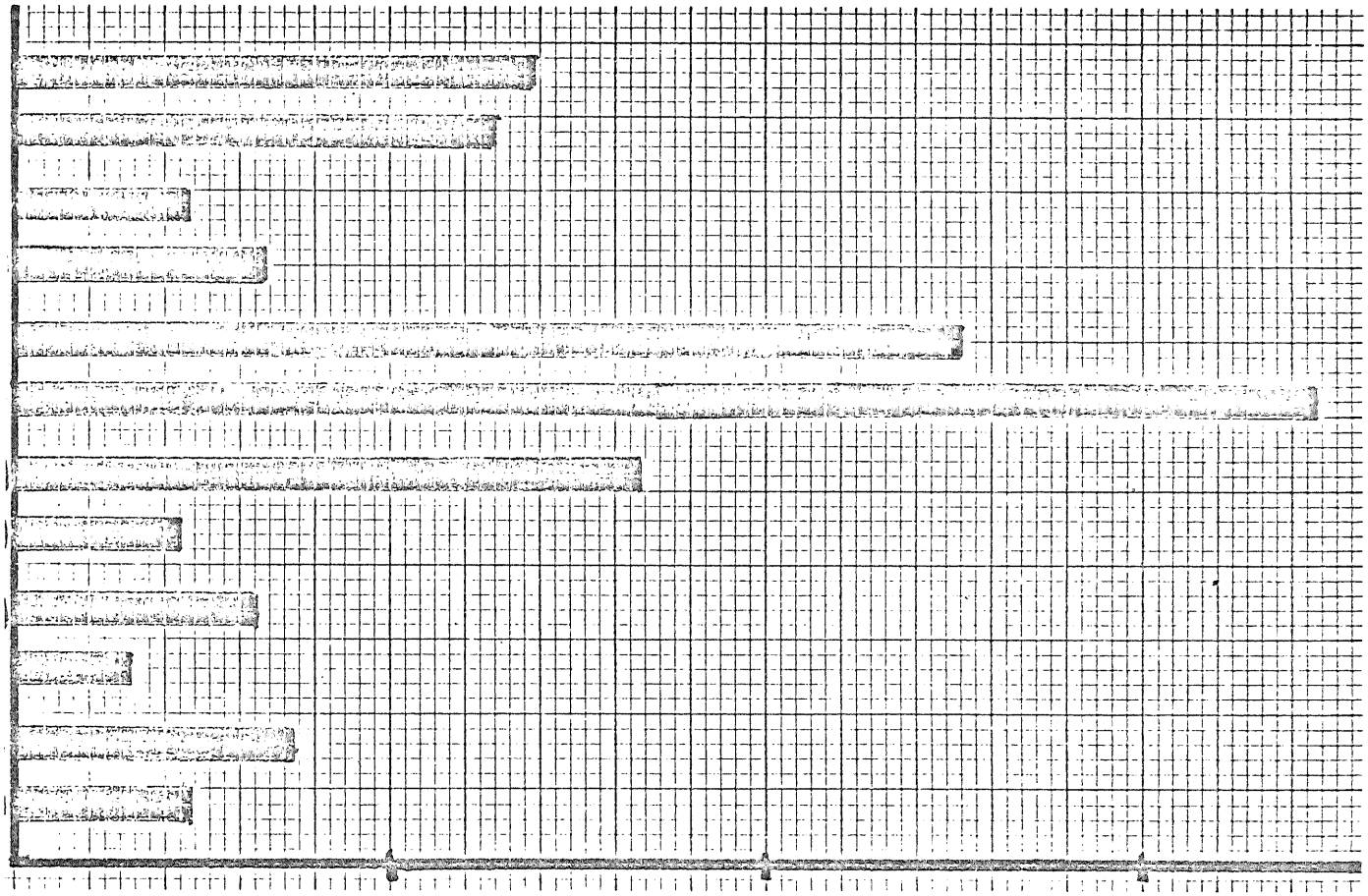


Figure SM-6.
Densities of total individuals caught per site.
(Trapping period B July 29 - August 2, 1976)

Cover Type	Site No.
Paper Birch	(27B)
Mature Paper Birch	(8B)
Mid-aged Aspen-Birch	(9B)
Mid-aged Aspen-Birch	(10B)
Trembling Aspen	(29B)
Pole Trembling Aspen	(13B)
Black Spruce	(28B)
Mature Black Spruce	(6B)
Red Pine	(26B)
Mature Red Pine	(3B)
Mature Jack Pine	(2B)
Mature Jack Pine	(1B)

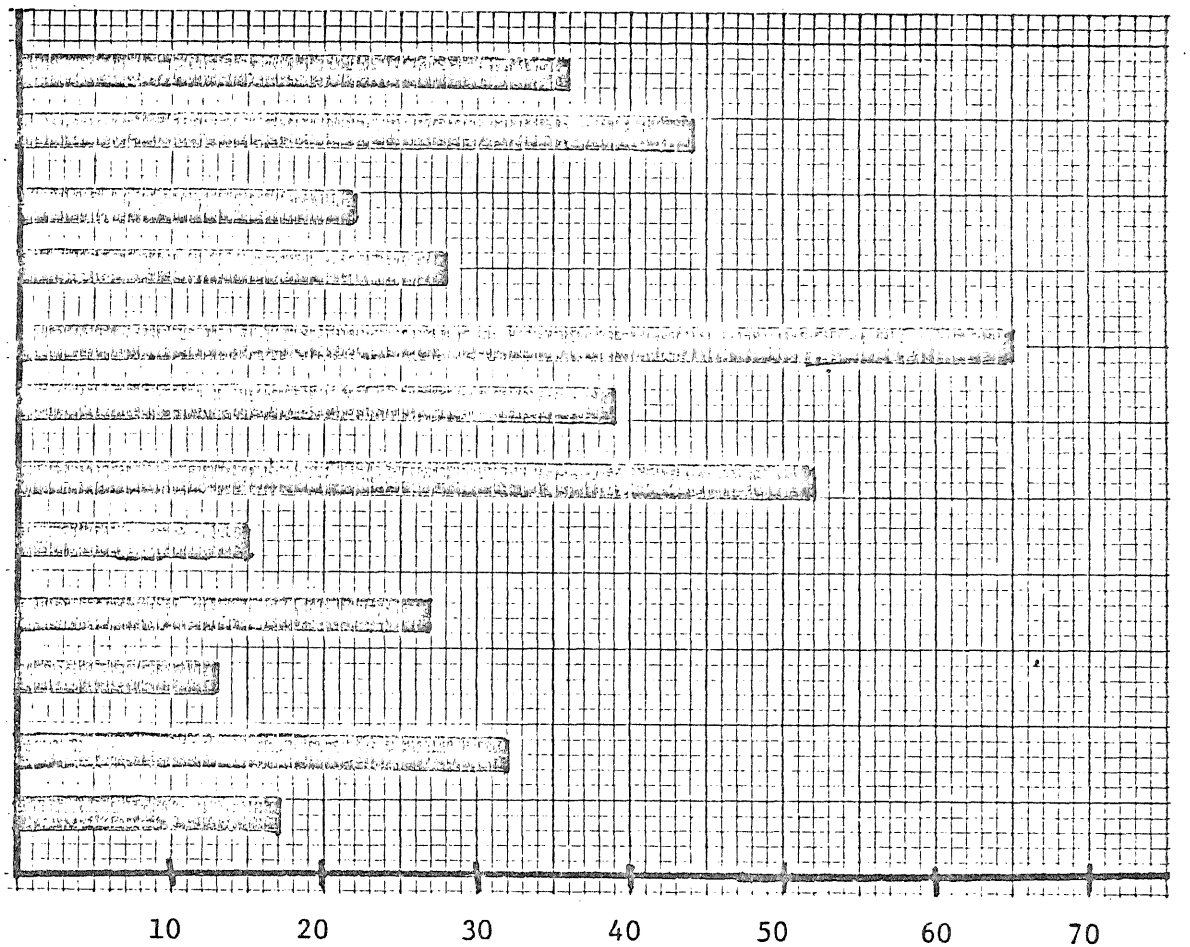


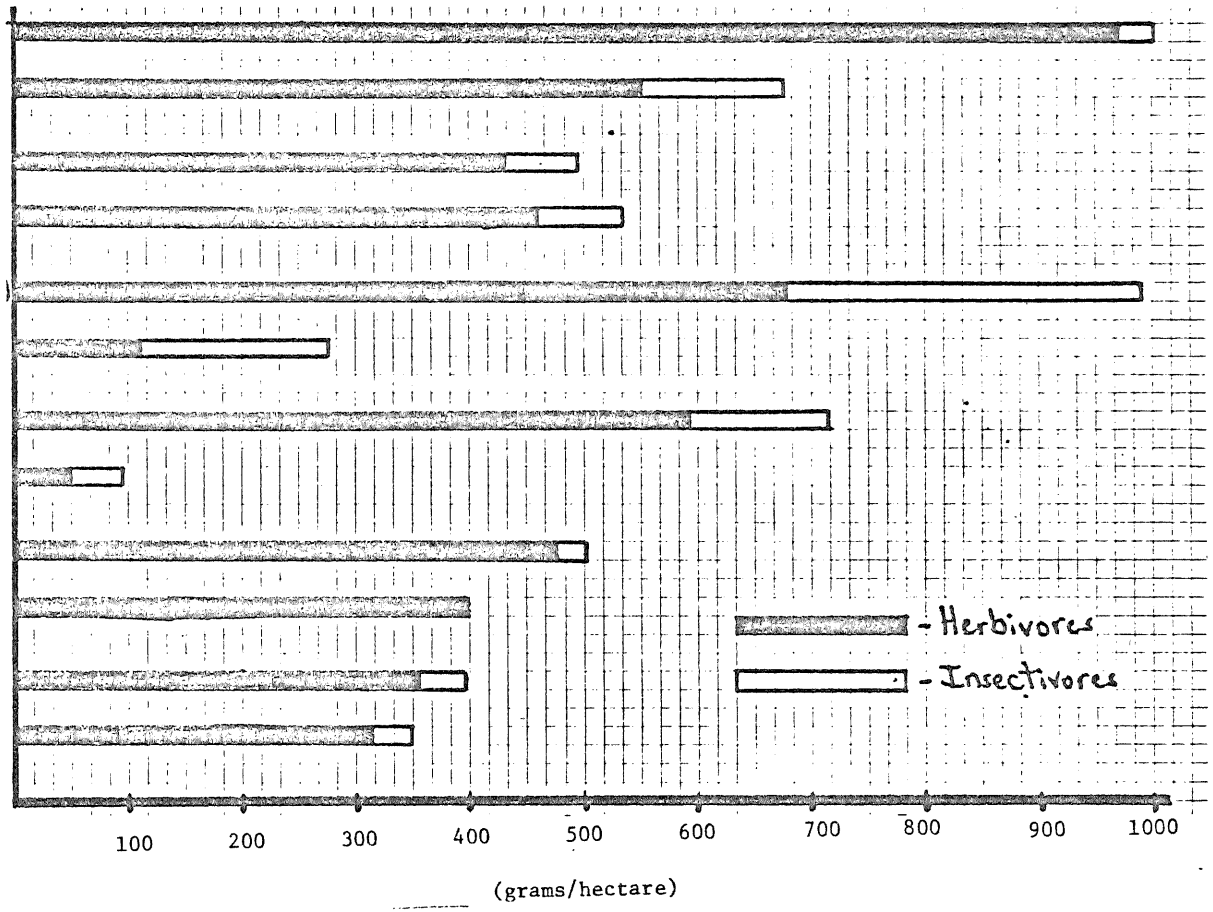
Table SM-1.

Numbers and percentages of small mammal species caught by site and cover types.
(Trapping period B July 29 - August 2, 1976

	Cover Type and Site Number													
	(27B) Paper Birch		(8B) Paper Birch		(9B) Mid-aged Aspen-Birch		(10B) Mid-aged Aspen-Birch		(29B) Trembling Aspen		(13B) Pole Aspen		(28B) Black Spruce		(6B) Black Spruce		(26B) Red Pine		(3B) Red Pine		(2B) Jack Pine		(1B) Jack Pine		Totals	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sorex cinereus	3	8.1	14	23.7	3	9.7	11	26.8	11	15.3	38	70.4	33	53.2	18	81.8	3	10.2			15	32.6	6	27.3	155	31.5
Clethrionomys gapperi	11	29.7	28	47.5	4	12.9	18	43.9	12	16.7	3	5.6	17	27.4	1	4.5	7	24.1	6	35.3	30	65.2	7	31.8	144	29.3
Peromyscus maniculatus	6	16.2	10	16.9	12	38.7	6	14.6	28	38.9					1	4.5	16	55.2	3	17.6			1	4.5	83	16.9
Blarina brevicauda	2	5.4	5	8.5	5	16.1	4	9.8	15	20.8	3	5.6	2	3.2			1	3.4					1	4.5	38	7.7
Eutamias minimus	3	8.1							3	4.2			1	1.6					4	23.5			5	22.7	16	3.3
Tamias striatus	4	10.8			4	12.9	1	2.4	2	2.8									1	5.9					12	2.4
Microtus pennsylvanicus											3	5.6	5	8.1	2	9.1									10	2.0
Glaucomys sabrinus	2	5.4					1	2.4					2	3.2			1	3.4	2	11.8			1	4.5	9	1.8
Zapus hudsonicus			2	3.4							2	3.7					1	3.4	1	5.9	1	2.2			7	1.4
Napeozapus insignis	4	10.8			3	9.7																			7	1.4
Unknown	1	2.7							1	1.4			2	3.2									1	4.5	5	1.0
Sorex arcticus (?)											4	7.5													4	0.8
Sorex sps. (?)											1	1.9													1	0.2
Lepus americanus	1	2.7																							1	0.2
Totals	37	99.9	59	100.0	31	100.0	40	99.9	72	100.1	54	100.2	62	99.9	22	99.9	29	99.8	17	100.0	46	100.0	22	99.8	492	99.9

Figure SM-8.
Biomass/area for herbivores and Insectivores for each site and cover type.
(Trapping period B July 29 - August 2, 1976)

Cover Type	Site No.
Paper Birch	(27B)
Mature Paper Birch	(8B)
Mid-aged Aspen-Birch	(9B)
Mid-aged Aspen-Birch	(10B)
Trembling Aspen	(29B)
Pole Trembling Aspen	(13B)
Black Spruce	(28B)
Mature Black Spruce	(6B)
Red Pine	(26B)
Mature Red Pine	(3B)
Mature Jack Pine	(2B)
Mature Jack Pine	(1B)



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10. NONGAME BIRD CENSUS

10.1. Introduction

The nongame bird census is designed to define the variables of habitat structure that are related to the distribution of breeding birds within northeastern Minnesota. Recent studies (MacArthur and MacArthur, 1961; Weins 1969; Shugart and Patten, 1972; Anderson and Shugart, 1974) have documented the correlation structural featues of vegetation and habitat selection by birds. Structural features are thought by MacArthur (1961) to convey information regarding the ultimate factors (e.g. nest sites, food and shelter) necessary for the birds survival. The field methods used to realize this objective included a quantitative analysis of both the avifauna and flora present along 35 road transects within the Minesite area. These methods will provide a characterization of habitat types by the composition of their bird communities and provide a means for assessing the potential impact of various aspects of mining technology.

10.2. Materials and Methods

10.2.1. Road Transects

Census transects, similar to those used by Kendeigh (1956), were established at 35 different sites (Figure BT-1 and Table BT-1). Each was 500 m long and marked with plastic flagging at 50 m intervals. Thirty-four of the transects were established along roads or logging trails. Transect B34 (the 1975 clear-cut) was established along an EW ling through the middle of the clear-cut. All bird sounds and sightings, within 100 m of either side of the transect, were recorded on a data sheet by their approximate location within each 50 m x 50 m area (figure PT-2). Codes were used to indicate whether the bird was sighted and/or heard singing or calling.

Morning census periods began at sunrise and lasted four-five hours. Heavy rain was the only environmental condition that prevented the transects from being censused. Two separate transects were run simultaneously by two individuals. The route was covered twice, with 20 minutes spent walking each leg of the transect (40 minute census/ 1 transect/1 morning). The 35 transects were sectioned into four different census loops, with eight to 10 transects per loop. One of the four loops was censused each morning. Each site was visited six to eight times during the breeding season (June and early July), including one evening census at each site. The order in which each transect was censused in the morning was systematically rotated to avoid bias due to timing of the census period relative to sunrise.

The 35 transects were selected to represent different habitat types found within northeastern Minnesota. Because vegetation is naturally variable and the study area disturbed by logging, fewer than one-third of the transects included a homogeneous stand of predominantly one species throughout the 10ha area.

10.2.2. Mist Netting

MIst nets were used to capture nongame bird species in July and early August on 11 of the census transects (Figure BT-3). Three to six, 12 m nets were erected in areas where the understory could be easily cleared away. The nets were raised at sunrise and lowered between 10:00 a.m. and noon. All birds caught in the nets were banded with official U.S. Fish and Wildlife Service bands, with sex, age and species recorded (Figure BT-4). Birds were banded in mist-nets during two separate three-day periods. Nets in the northern portion of the study area were run July 19-21, 1976 while nets in the south were run August 2-4, 1976. Our primary interest was to observe whether mist-netting would collect birds on the transects that were not previously recorded during the census period. Net locations were selected to cover as many habitat types as possible.

Quantitative vegetation data were collected on 12, 15 m x 15 m plots along each of the 35 bird transects. Materials and methods are described in the vegetation section (p.

10.3. Results and Discussion

10.3.1. Results from Censuses along Road Transects

10.3.1.1. General Species List and Observations

We ran a total of 87 transects during the months of June and July. Table BT-2 is a list of all species along with a summary of the number of transects on which each species was recorded and the total number of observations per species. Twenty-one species are commonly recognized as being rare or very rare in the Superior National Forest (Green, 1971) and 27 as being uncommon. These species comprised 12.8 percent of the observations made in June and 20.9 percent of the observations made in July. In addition, one species, Vermivora chrysoptera (Golden-winged Warbler), has not been previously recorded as a breeding bird in the Superior National Forest (Green and Janssen, 1975). This species was observed on four transects in June (7 observations) and two transects (2 observations) during July.

Many commonly observed species (for example Oporornis philadelphia (Morning Warbler), Dendroica pensylvanica (Chestnut-sided Warbler), Turdus migratorius (American Robin)) are very abundant in areas that have been recently disturbed by logging and/or burning (Niemi, 1976). Such areas are characteristic of a large portion of northeastern Minnesota. The most abundant bird encountered during the summer census period was Seierus aurocopillus (Oven Bird). Other studies (Anderson and Shugart, 1974) indicate that Oven Birds select habitats with open

canopy, subcanopy layers and dense understory. This structural profile is characteristic of many of the successional stages following disturbance.

Figures BT-5 and BT-6 illustrate the distribution of observations among the major bird families. During both June and July, the families Parulidae (Wood Warbler) and Fringillidae (Grosbeaks, Finches, Sparrows and Buntings) contributed the largest number of observations (68.4 percent in June, 48.96 percent in July). The smaller number of observations made during July largely results from the transects being censused less frequently. In addition, birds are also less conspicuous during July becuase many adults have completed the breeding cycle and have begun molting. However, there are some exceptions. For example, the family Paridae (Chickadees) were observed three times as often during July as compared to June.

10.3.1.2. Preliminary Results for 12 Transects Selected for Uniformity of Habitat

The majority of transects included more than one habitat type. However, 12 of the 35 transects are homogeneous and were selected in order that preliminary generalizations about bird communities and habitat could be made. The following results include only those birds seen or heard within 50 m of either side of the transect (total area of 5ha) during the month of June.

Figure BT-7 illustrates the total number of species observed along each of the 12 transects. The 1975 clear-cult (Site B-34) is structurally the least diverse of the habitats and has fewer species than any other

transec+ The number of species ranges from a low of eight in the clear-cut to a high of 27 found along the alder-willow transect (site B35 a & b). Two of the transects are also unique in containing a large number of uncommon species. On the black spruce transect (Site B29) 35.4 percent of the observations were of nine rare and uncommon speices and on the 1975 clear-cut (site B34) 32.0 percent of the observations were of five rare and uncommon speices. These percentages are significatnly higher than the average of 12.8 percent for all 35 transects.

The total number of breeding paris of birds was calculated using the summation method developed by Palmgren, 1930, referenced in Emlen, 1971). The methods used for obtaining population estimates will be discussed in a later section. The total number of breeding paris of birds per transect is illustrated in Figure BT-8.

Population estimates range from a low of 14 breeding, pairs in the 1975 clear-cut (site B34) to a high of 64 breeding pairs in the alder-willow (site B35 a & b). The relative contribution of the three major bird families (when greater than 10 percent) to the total population is also shown. On all but one of the transects (the mature aspen, site B14) the families Parulidae, Fringillidae and Verionidae contribued 50 percent or more of the total population. Mature aspen was unique in that 16 percent of the population consisted of woodpeckers. Table BT-3 summarizes all these results for each of the 12 transects.

One major point made by these results is that the two most wet-soiled transects, black spruce (B29) and alder-willow (B35 a-b), support both

larger numbers of species and larger breeding populations than any other transect.

10.3.2. Methods Used to Obtain Population Estimates

The use of transects to characterize different habitat types by the composition of their bird communities allows relative population estimates to be calculated. The assumption is that singing males represent breeding pairs of birds. This assumption however, is not always correct. Transient and non-breeding resident males may also be heard singing and unmated males may sing more than mated males (Best, 1975). In addition, with some species, like Zonothicia albricollis (White-throated Sparrow), the female may also sing regularly (Bent, 1968). Therefore, the methods used in this study for obtaining population estimates must not be interpreted as yielding absolute population counts, but only relative estimates.

Three method will be used to calculate population estimates for each transect. First, the summation method (Palmgren, 1930 in Emlen, 1971), uses the largest number of observations/40 minute census period recorded in June, as the population estimate. Only the observations of singing birds within 50 m of the transect will be counted. For example, at site B31 (mixed upland) three ovenbirds were heard on June 14, one on June 17, four on June 23 and six on June 28. The maximum number, six, will then be used as the population estimate for the 5 ha transect. Bird densities however, are commonly expressed as the number of breeding pairs per 100 acres, therefore the summation method yields a density of 49 ovenbirds. The results for other species observed on Site B31 are listed in Table BT-4.

The second and third population estimates are calculated using the territory mapping method (Williams, 1936; Robbins, 1970). This method attempts to delimit bird territories by mapping the distribution of observations accumulated during the entire census. The first step in analyzing the data is to compile a composite map for each species. All observations are mapped on one data form and are distinguished according to the census morning on which they were recorded (Figure BT-9-14). An attempt is then made to delimit those observations belonging to a single individual. Population estimate II requires a minimum of two recorded observations to map a territory and population estimate III requires a minimum of three recorded observations. Fractions of territories (e.g. one half of a territory) result when some of the observations defining a territory are more than 50 m from the transect. The interpretational variability of the mapping method has been recently discussed by Best (1975). Population estimates derived from the mapping method are listed in Table BT-4.

For transect B31, the three population estimates are extremely variable. This variability largely results from the small number of censuses conducted along each transect. It has not yet been determined which of the above methods will be used in the final analysis.

10.3.3. Mist-netting

Results from the mist-netting periods are summarized in Tables BT-5 and BT-6. After completion of the two trapping periods, it was felt that the amount of time and effort required to yield information additional to

that obtained from the census transects could not be justified. Mist-nets will not be used in 1977.

10.4. Conclusion

At present, data analysis has included the compilation of summary information regarding the abundance of each of the bird species observed on the 35 census transects. Composite maps for obtaining population estimates by the mapping method have also been completed for all transects. Future analysis will include the calculation of population and biomass estimates (or a similar statistic) to determine the habitat parameters important to the distribution of breeding birds.

10.5. References

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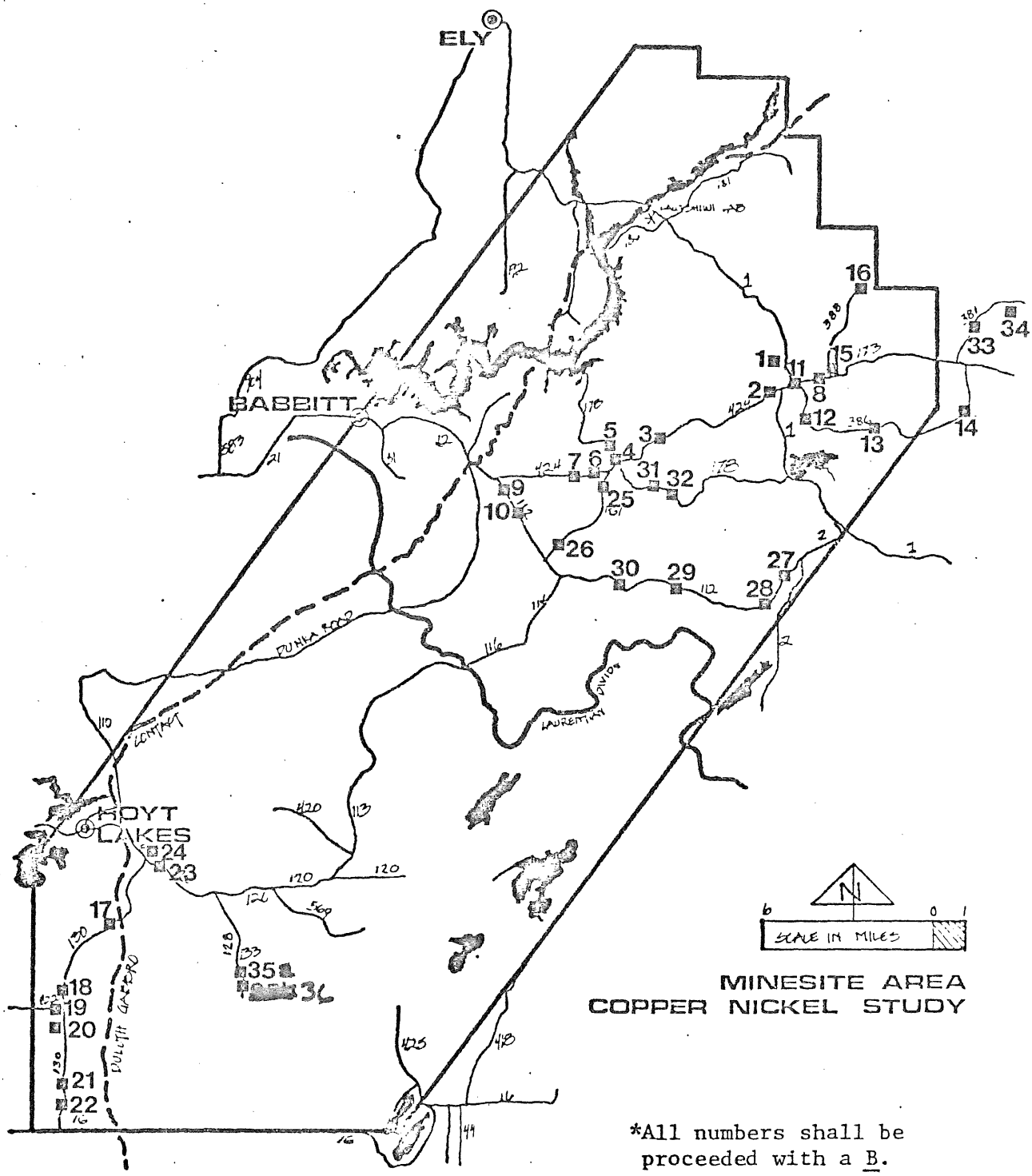
11. STATUS OF THE BALD EAGLE AND OSPREY ON THE MINESITE AREA AND IN THE SUPERIOR NATIONAL FOREST

11.1. Introduction

Data for our study on the distribution and status of the Haliaeetus leucocephalus (Bald Eagle) and Pandion haliaetus (Osprey) were obtained principally from three sources: 1) all eagle and osprey observed by members of the terrestrial team and other groups working for the Copper-Nickel Study were recorded on a standard observation form; 2) active nesting sites of these two species obtained from the Minnesota Department of Natural Resources (MDNR); and 3) summary of data on reporduction for eagles and ospreys in the Superior National Forest from the United States Forest Service (USFS). The terrestrial team has not conducted a special field

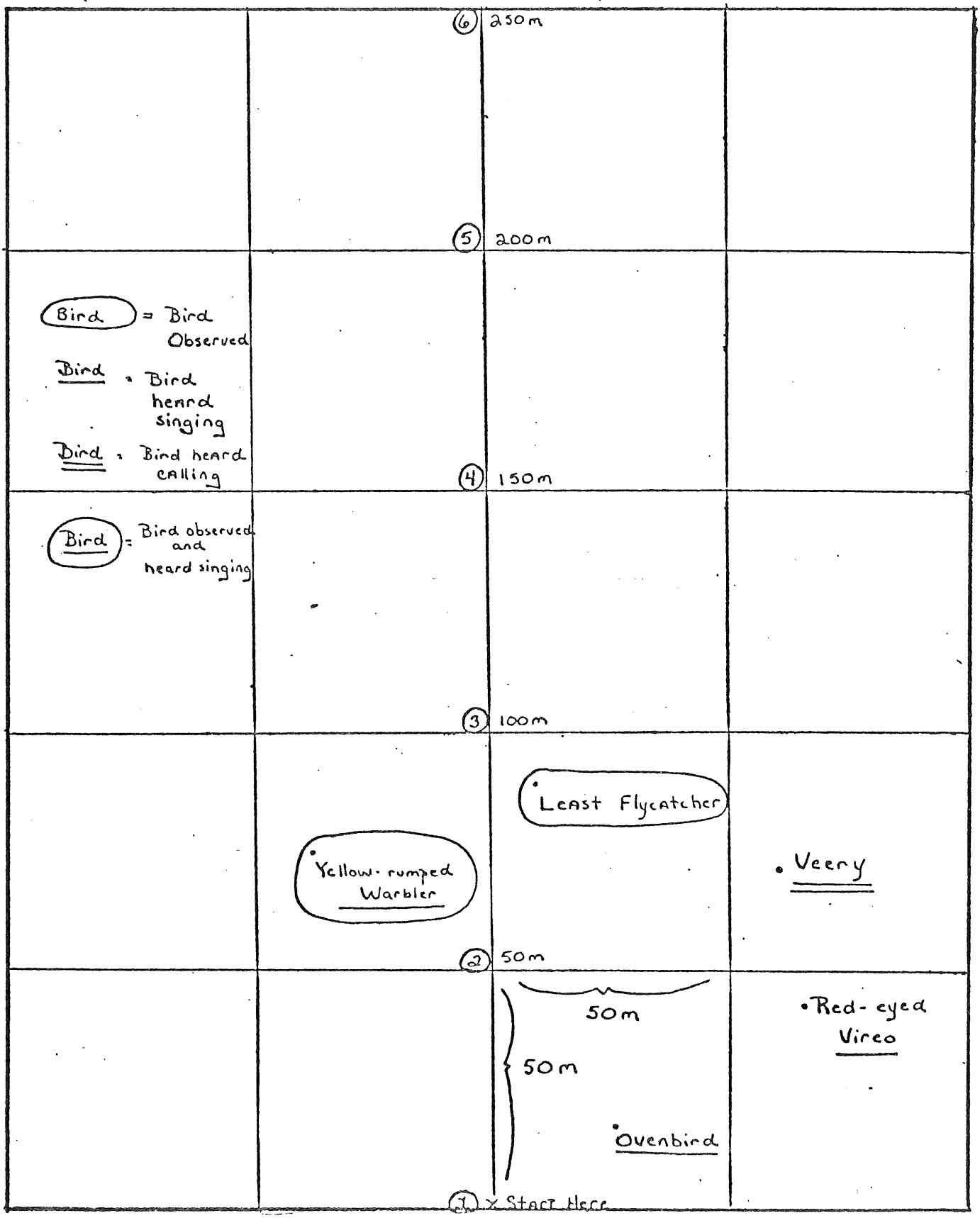
Figure BT-1.

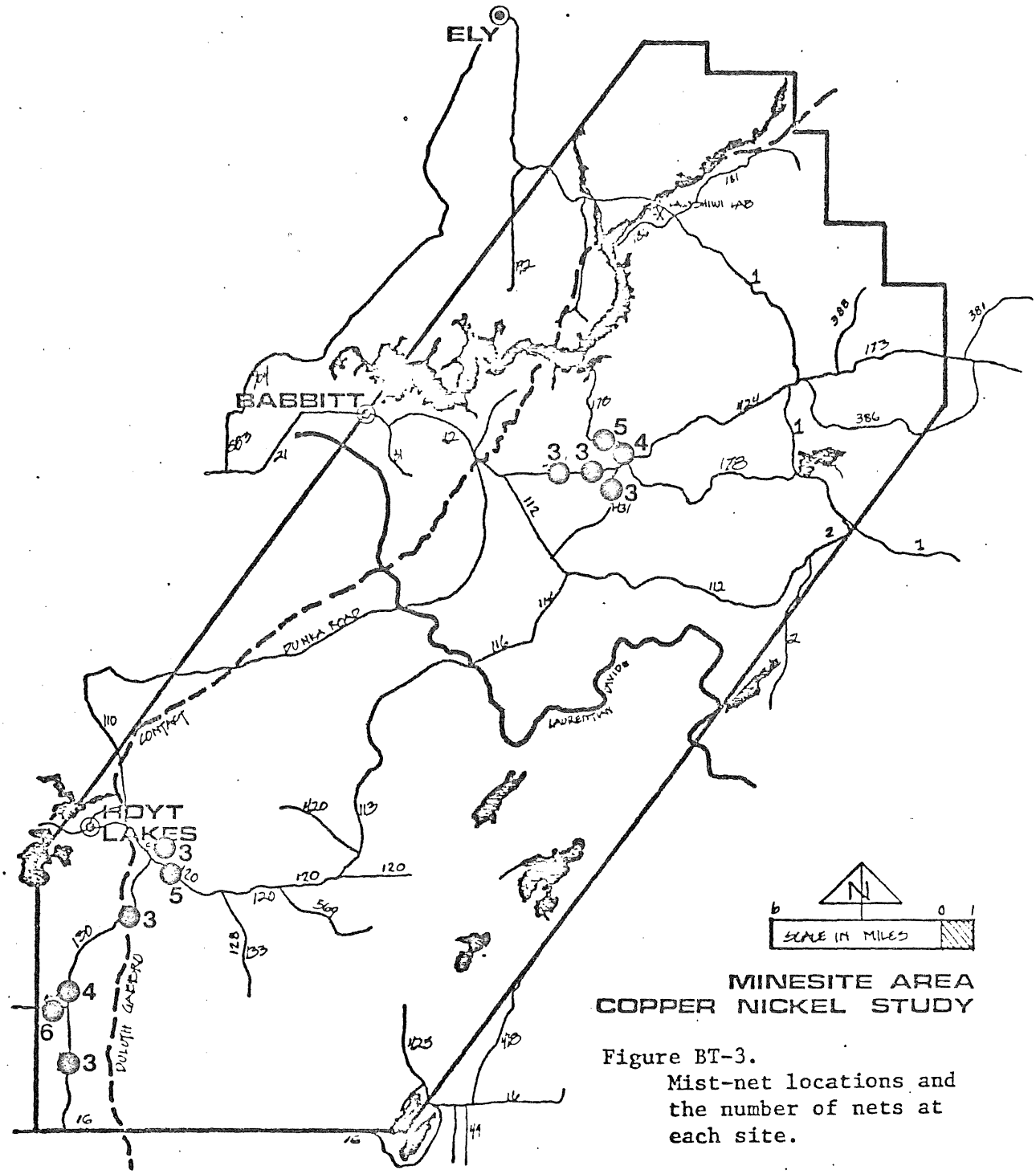
Map locations of the 36 bird transects.



*All numbers shall be proceeded with a B.

Figure BT-
Sample data sheet for nongame bird census.





MINESITE AREA
COPPER NICKEL STUDY

Figure BT-3.
Mist-net locations and the number of nets at each site.

Figure BT-4.
Sample data sheet for banding nongame birds.

Bird-Banding Data Record

Location:

Date:

Bander:

Time nets raised:

Time nets lowered:

Sky:

Wind:

Temperature:

Remarks:

Band No.	Common Name	Band Size	Age	Sex	Remarks

Figure BT- 5 Percent of total number of recorded observations (2997) for major bird families during the month of June.

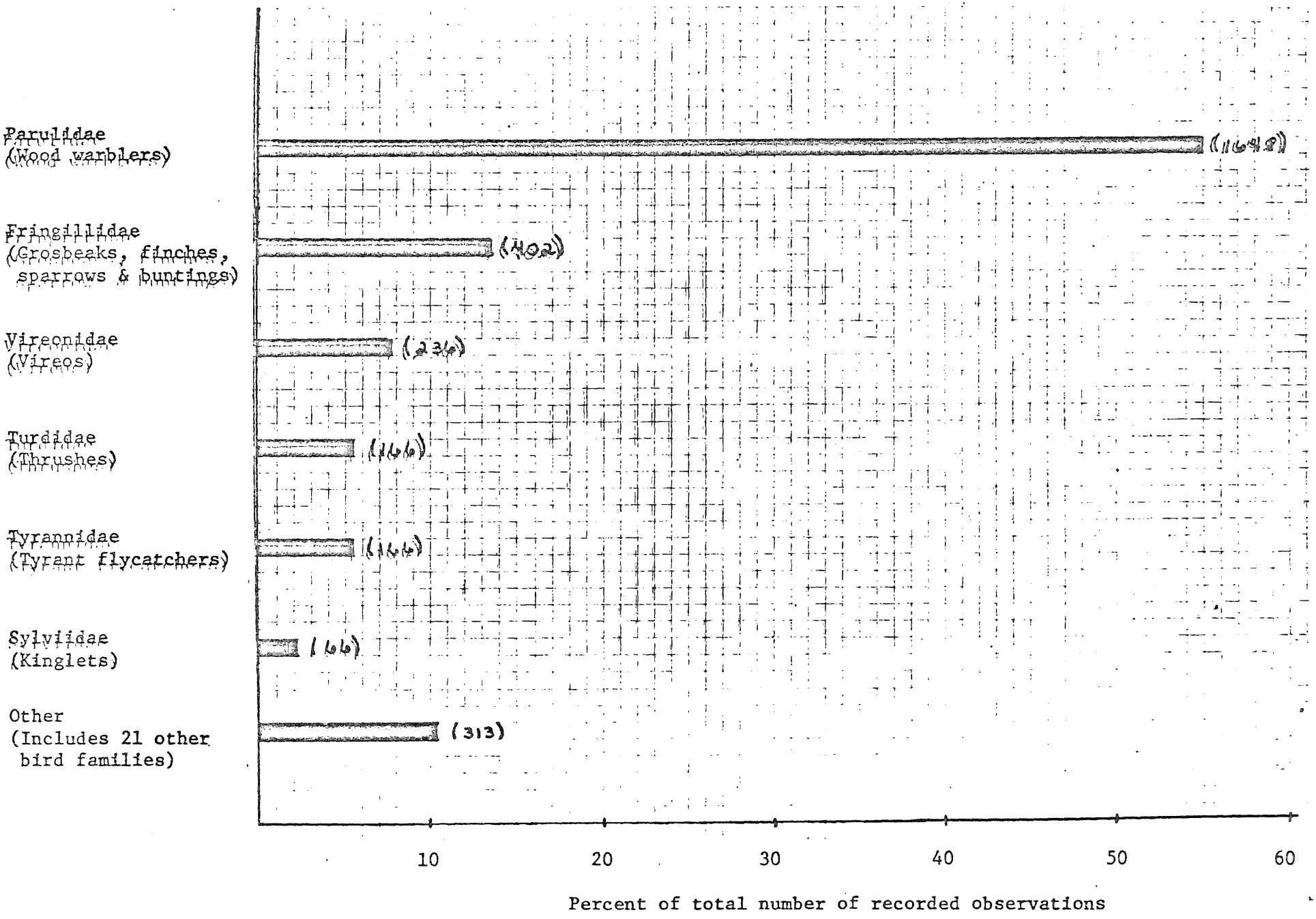


Figure BT-
Percent of total number of recorded observations (1395)
for major bird families during the month of July

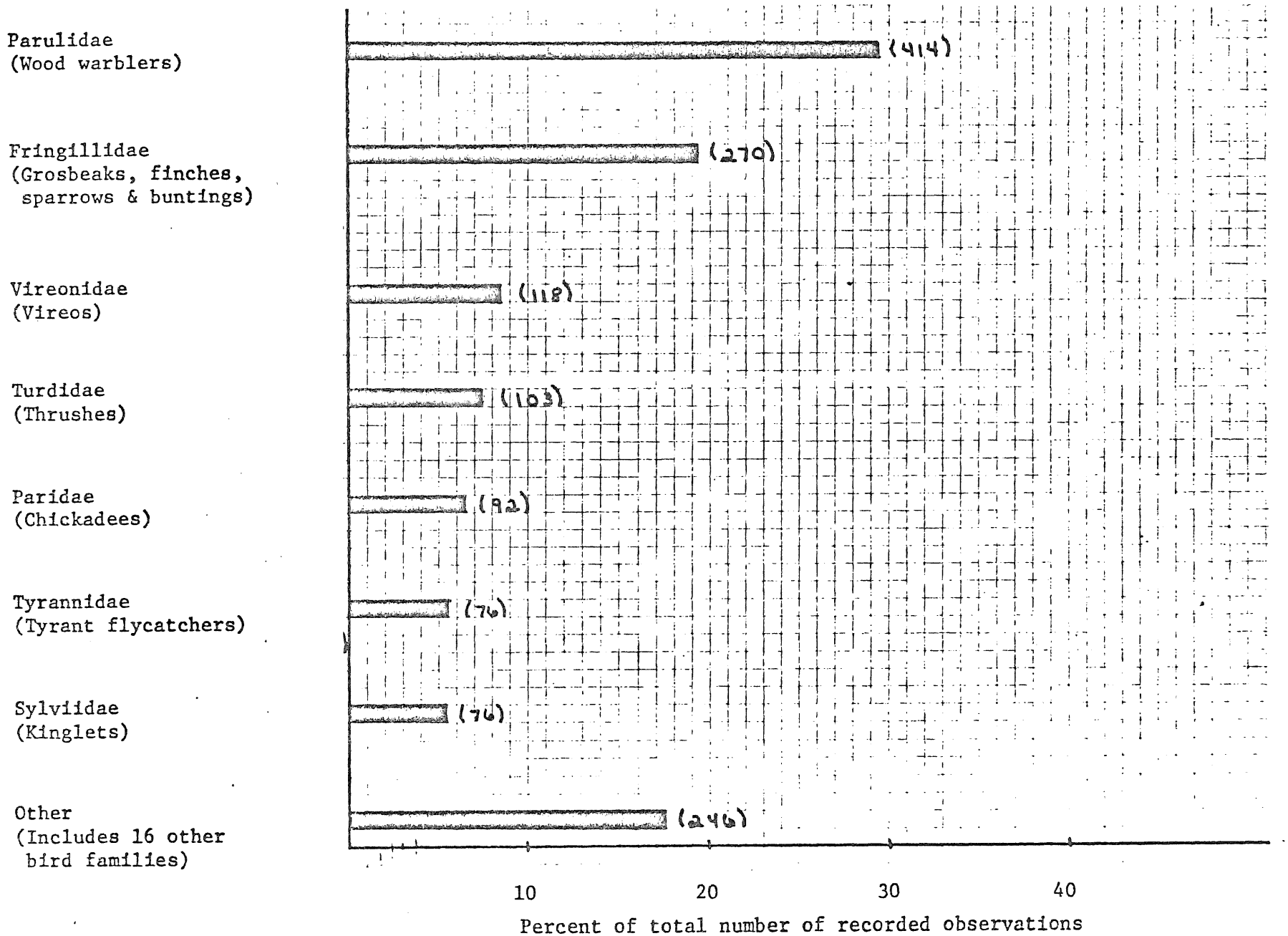


Figure BT-

Number of Species Recorded along 12 Different Road Transects Chosen for Uniformity of Habitat

Transect Cover Types	Transect No.
Alder-Willow	(B35a & b)
Black Spruce	(B29)
Mature Aspen	(B14)
Young Jack Pine	(B26)
Clear Cut	(B1)
Red Pine	(B10)
Mixed Upland	(B15)
Pole Aspen	(B17)
Jack Pine	(B18)
Tamarack	(B7)
Mixed Aspen	(B12)
1975 Clear Cut	(B34)

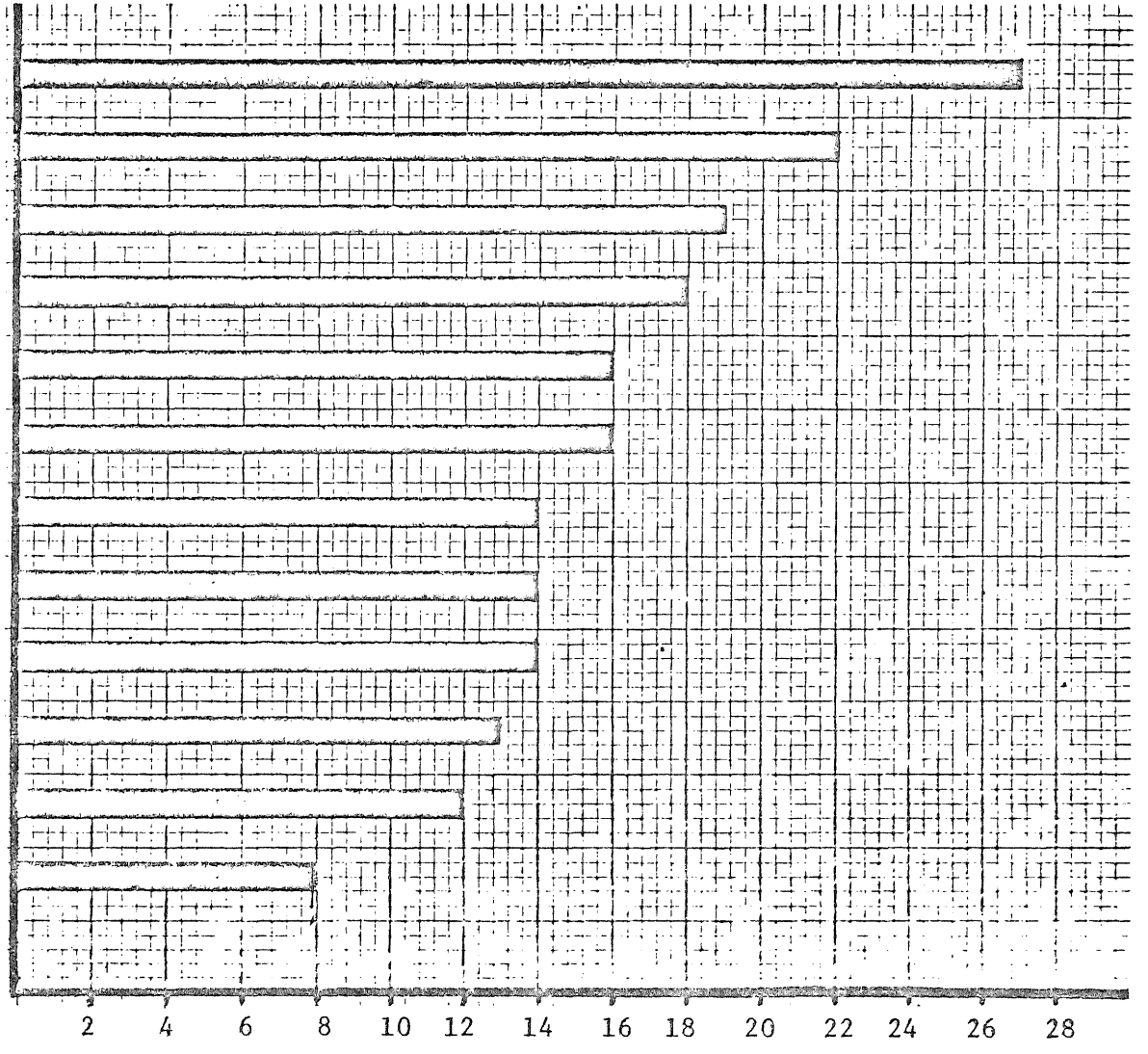


Figure BT-

Total Number of Breeding Pairs of Birds along 12 Different Road Transects chosen for Uniformity of Habitat

Transect Cover Types	Transect No.
Alder-Willow	(B35a & b)
Black Spruce	(B29)
Pole Aspen	(B17)
Young Jack Pine	(B26)
Tamarack	(B7)
Mature Aspen	(B14)
Jack Pine	(B18)
Mixed Upland	(B15)
Clear Cut	(B1)
Mixed Aspen	(B12)
Red Pine	(B10)
1975 Clear Cut	(B34)

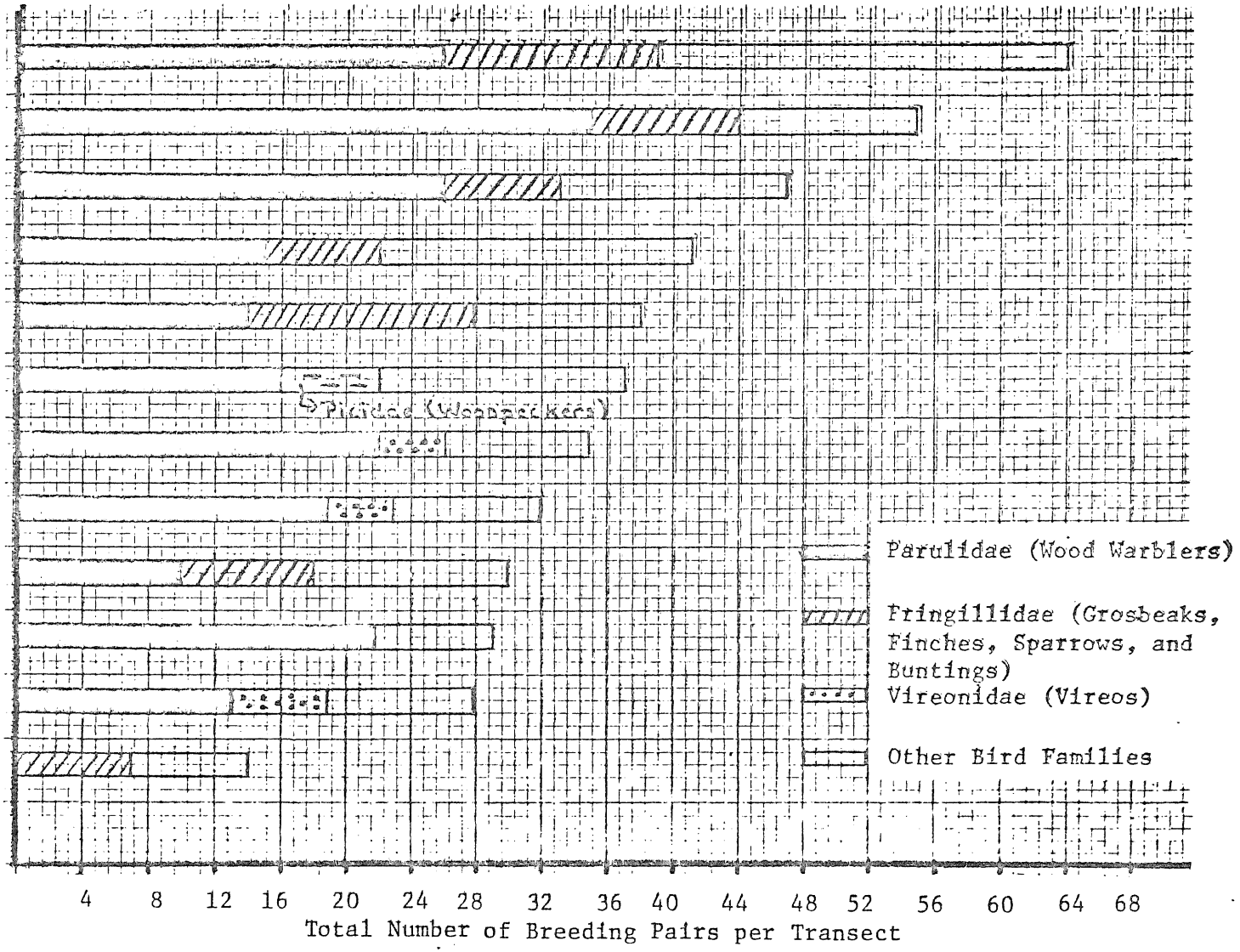


Figure BT .
Composite map and Territory map for Seiurus aurocapillus (ovenbird) on transect B31.

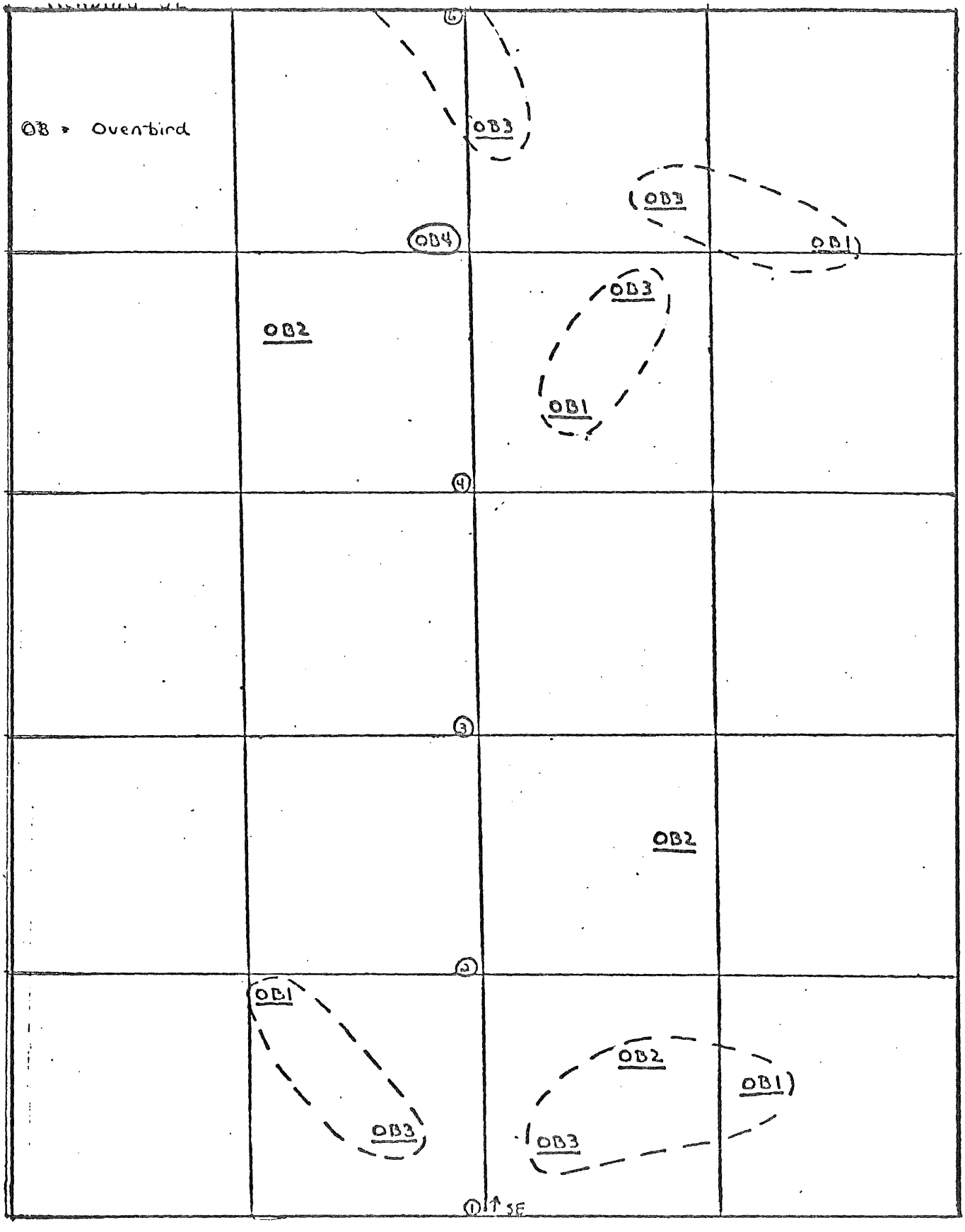


Figure BT-9. (cont.)

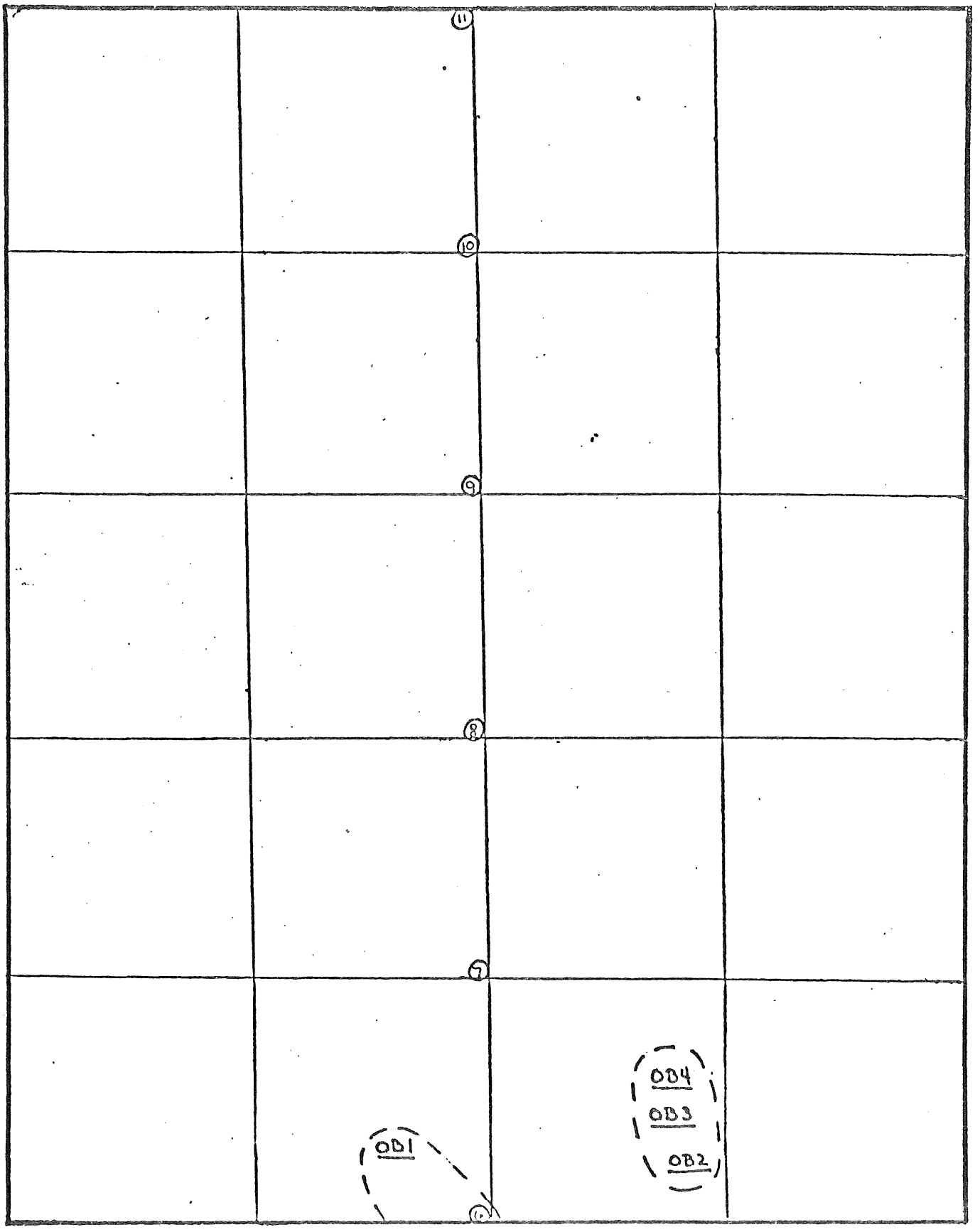


Figure BT-
Composite map and territory map for Vireo olivaceus (Red-eyed Vireo) on transect B31.

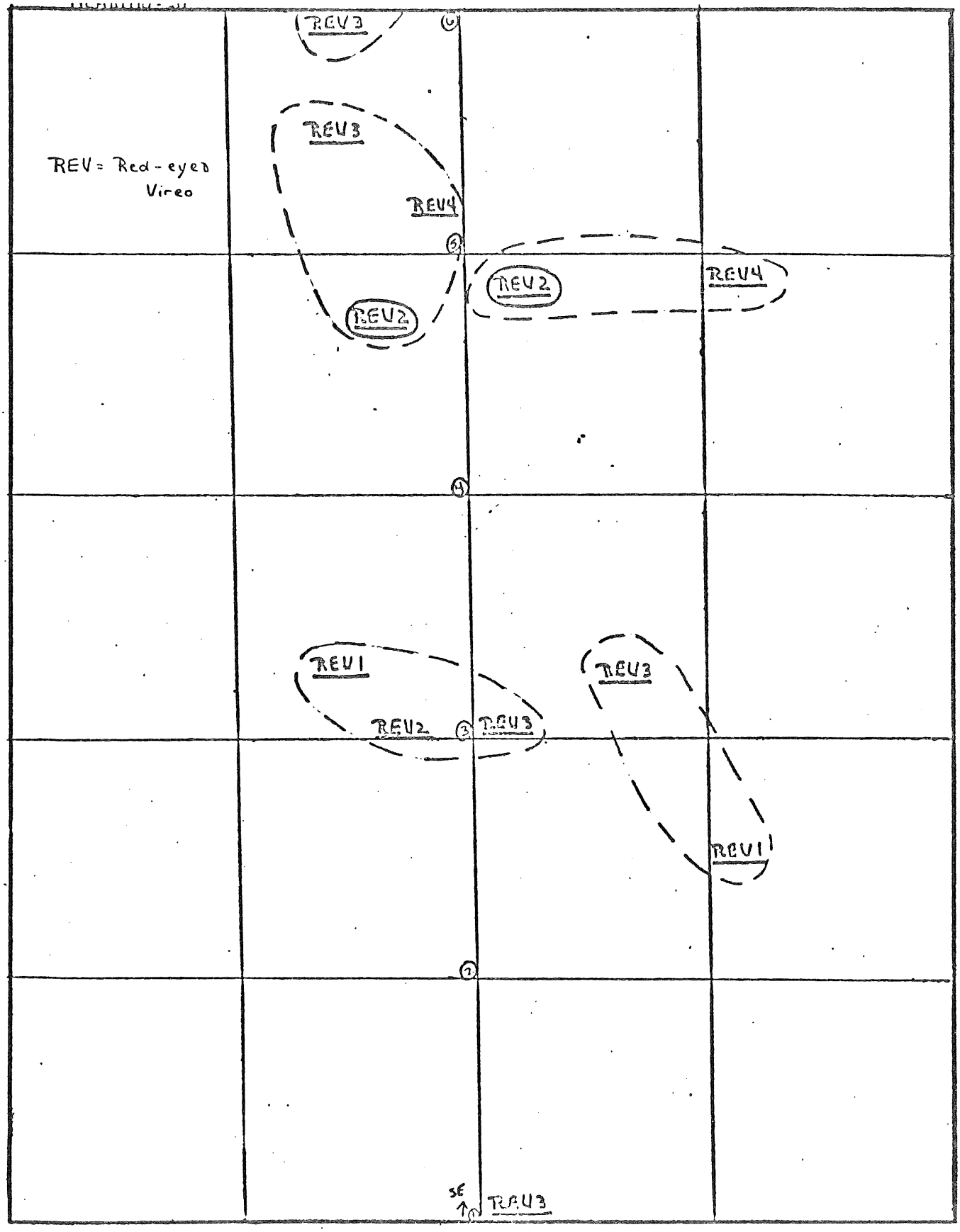


Figure BT- 2. (cont.)

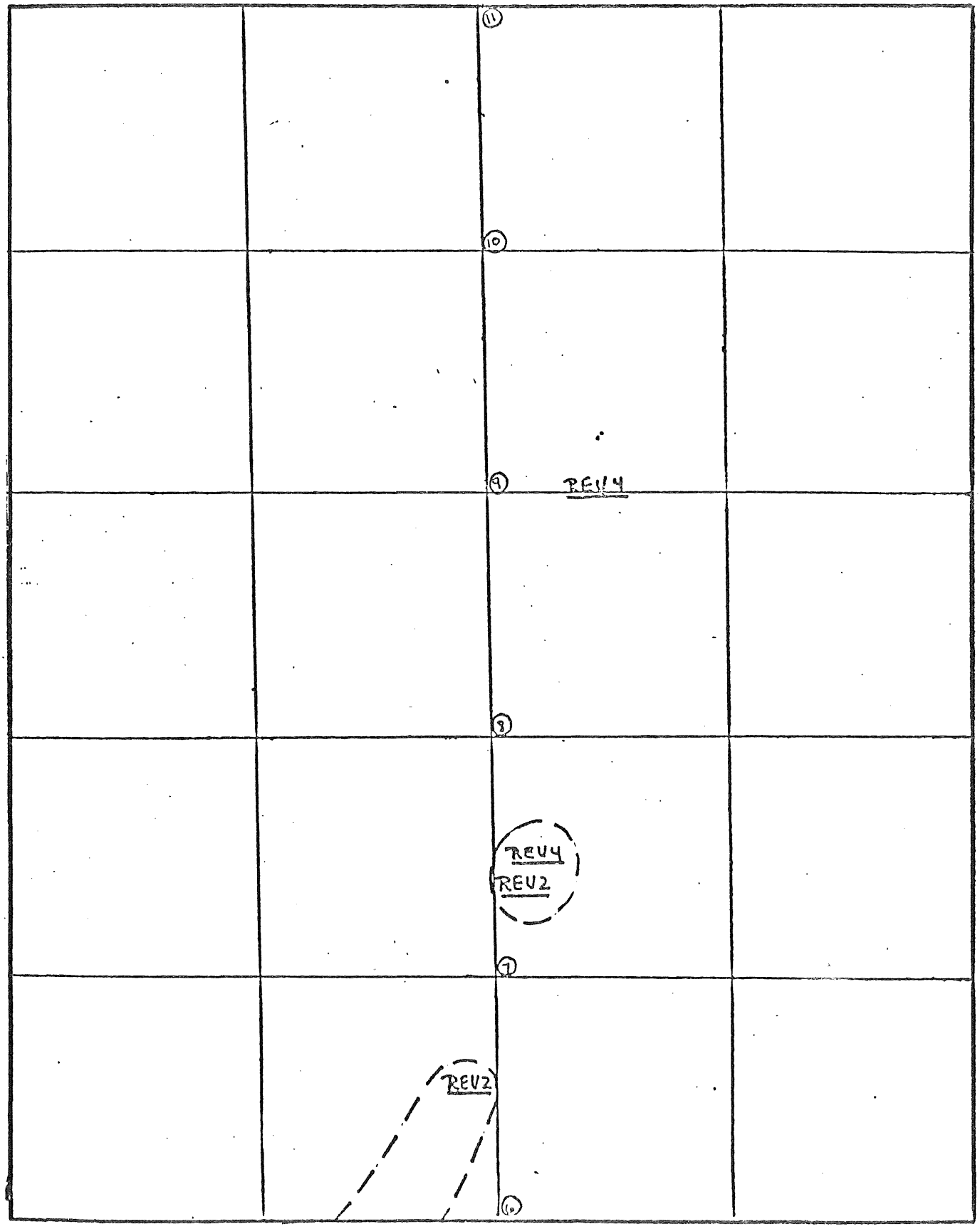


Figure BT .
Composite map and Territory map for Dendroica pensylvanica (Chestnut-sided Warbler) on transect B31.

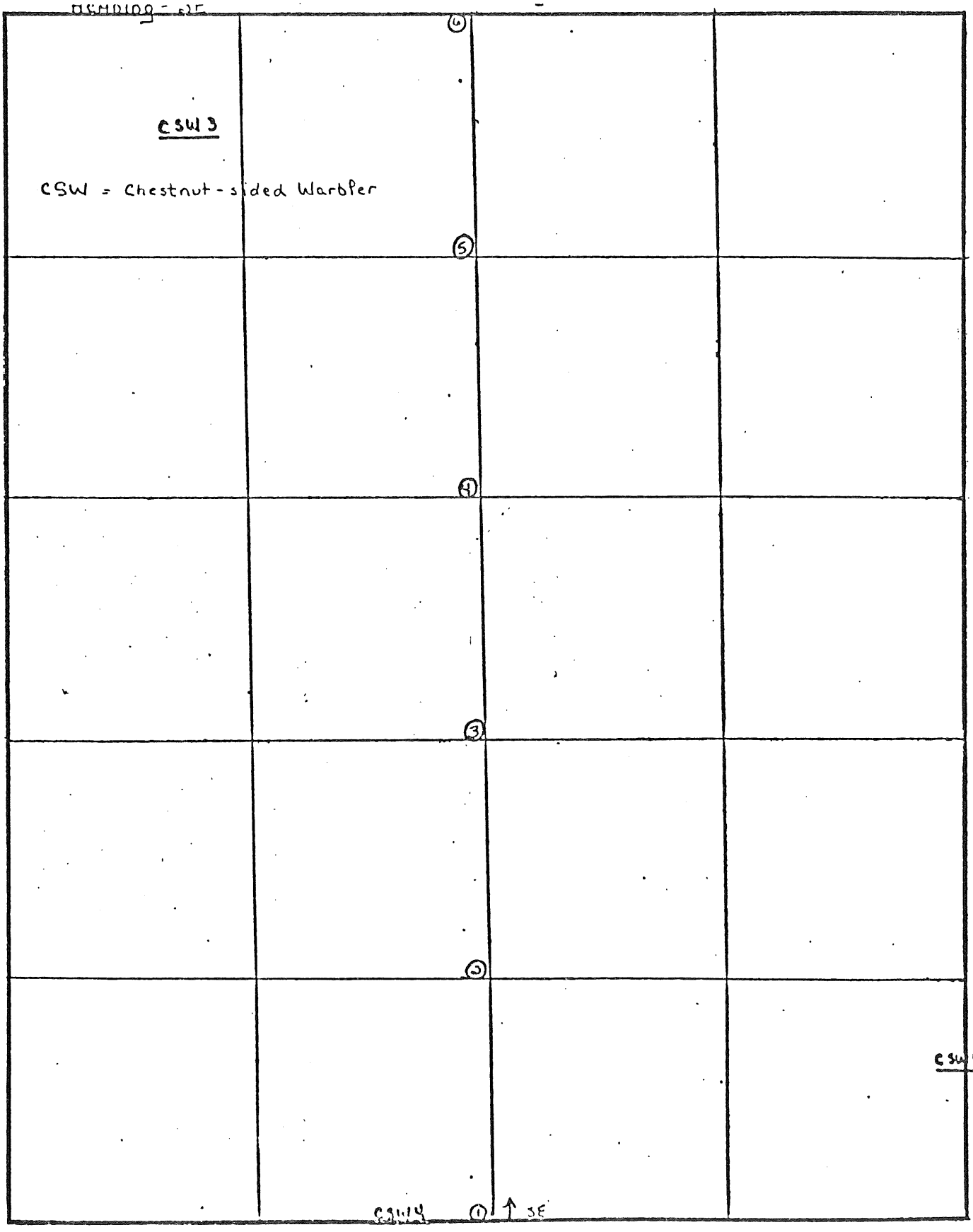


Figure BT . (cont.)

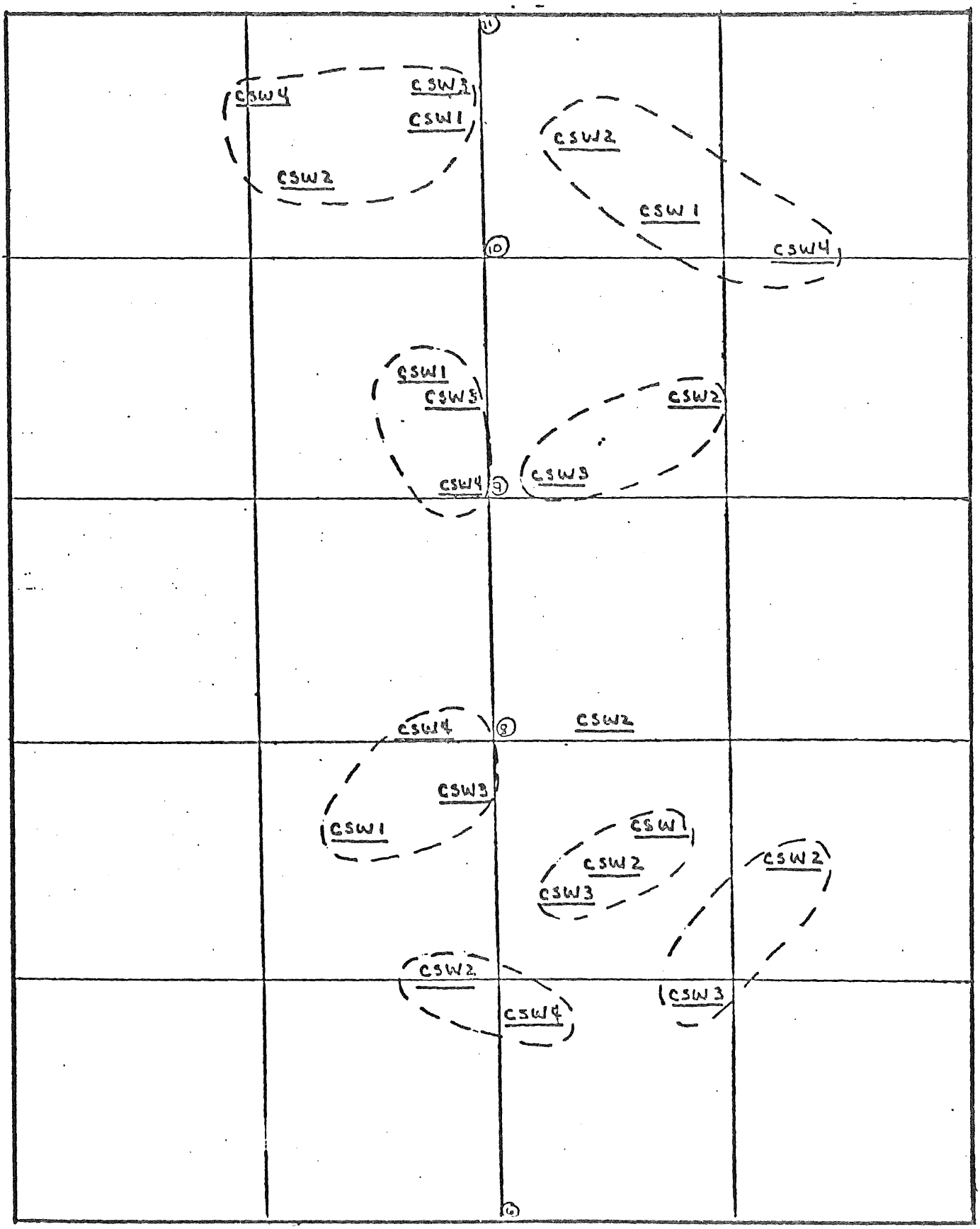


Figure BT .
Composite map and territory map for Empidonax minimus (Least Flycatcher) on transect B31.

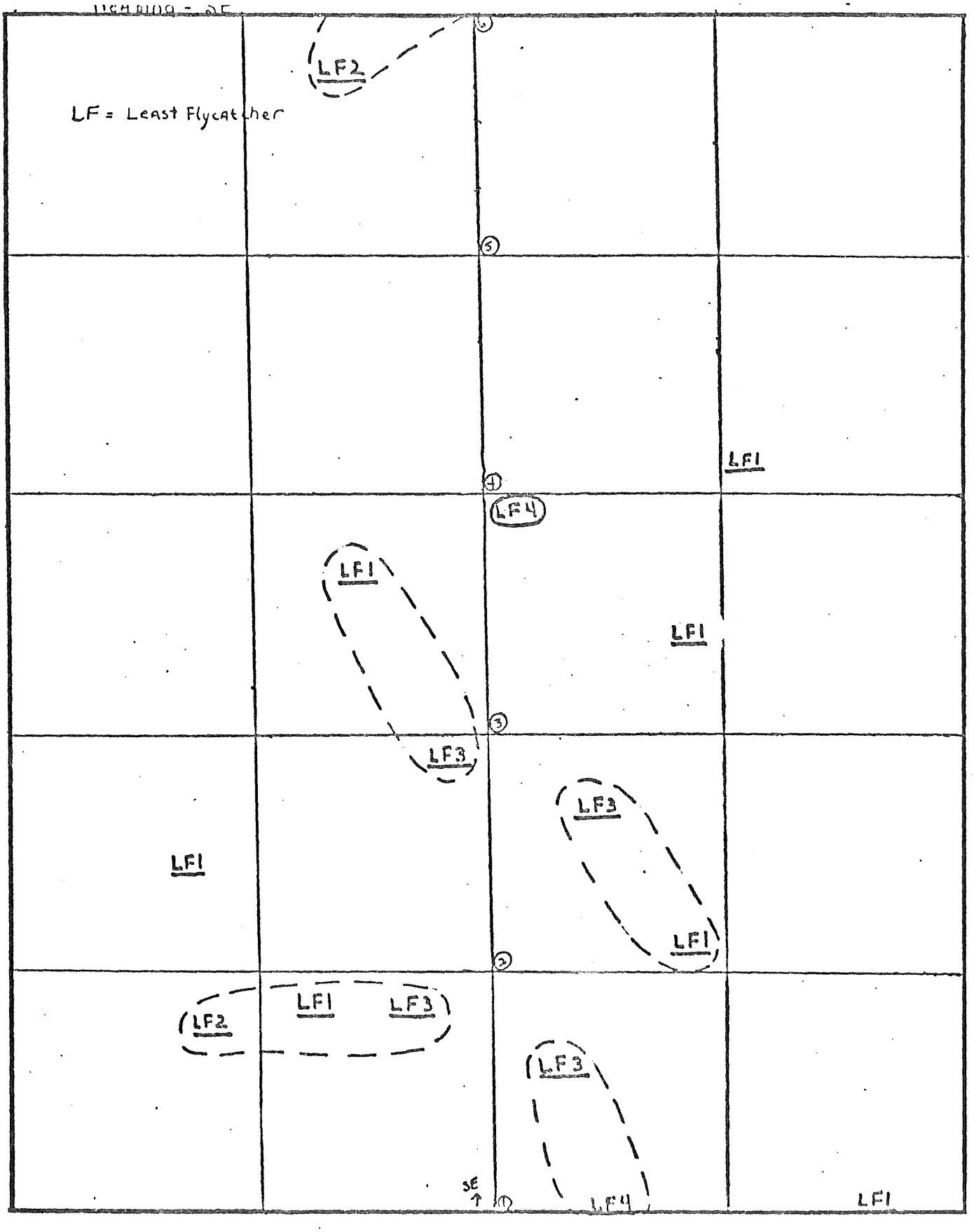


Figure BT-[illegible] (cont.)

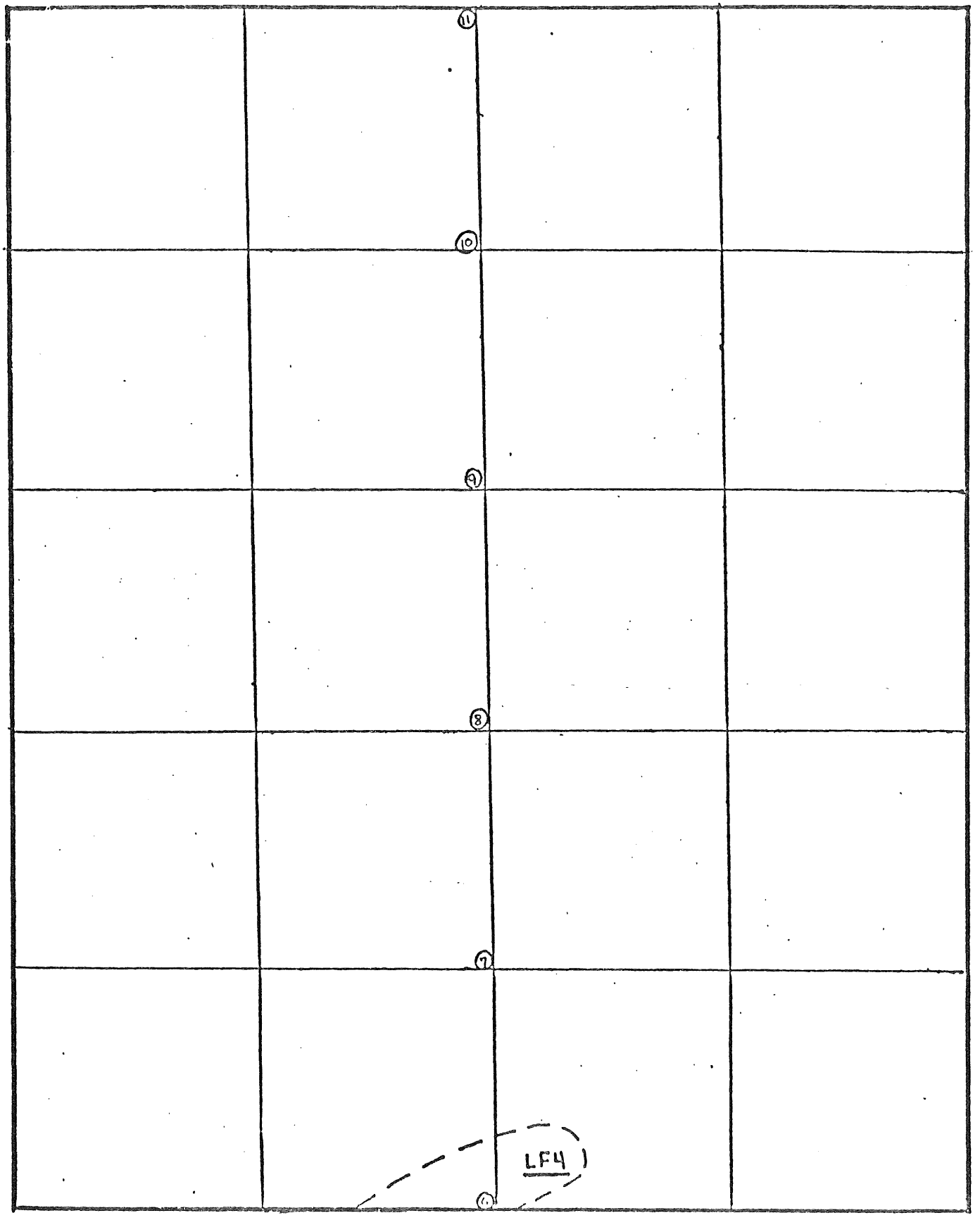


Figure BT-
Composite maps and territory maps for Wilsonia canadensis (Canada Warbler), Oporornis philadelphia (Mourning Warbler), Dendroica fusca (Blackburian Warbler), and Sphyrapicus varius (Yellow-bellied Sapsucker) on transect B31.

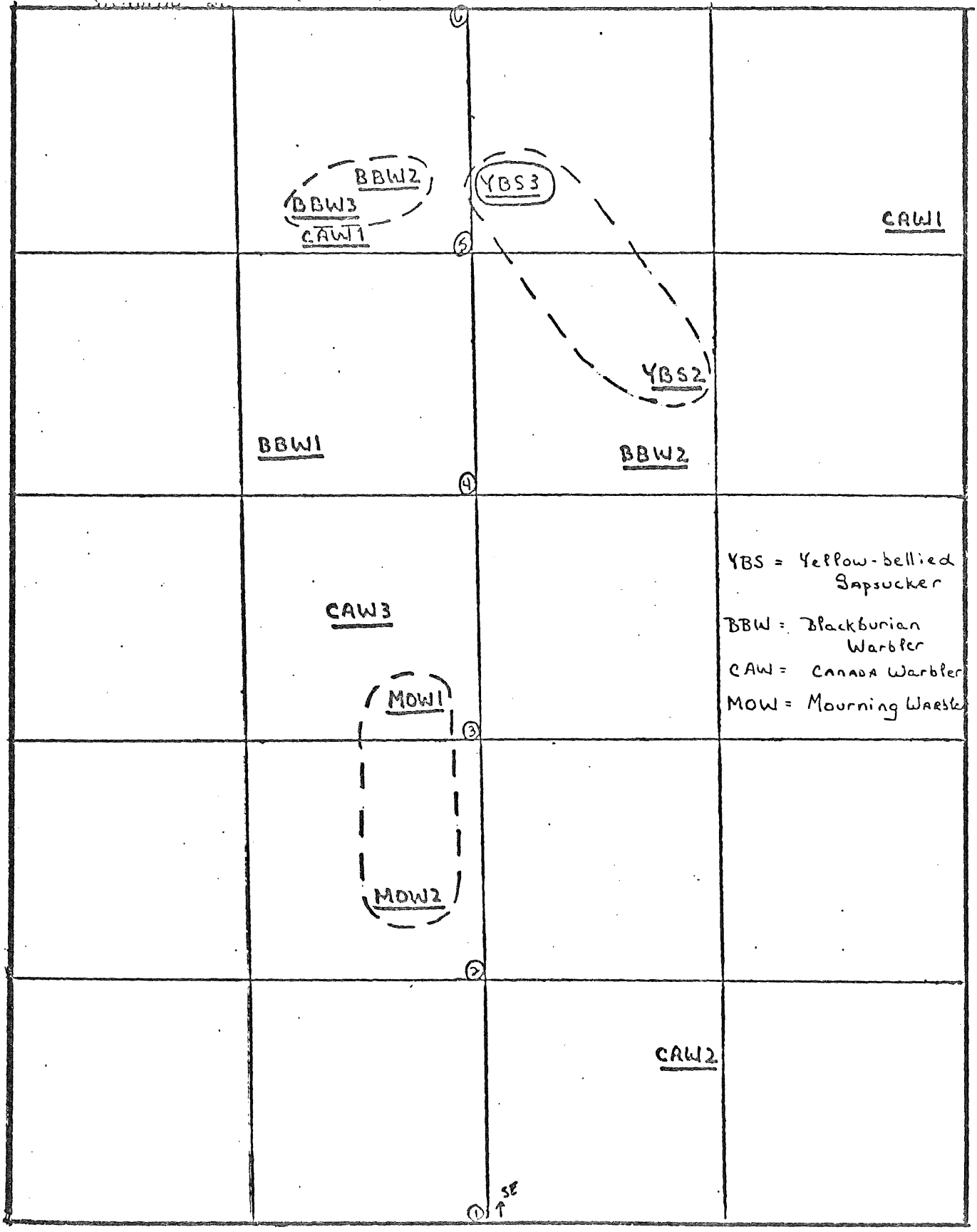


Figure BT- ? . (cont.)

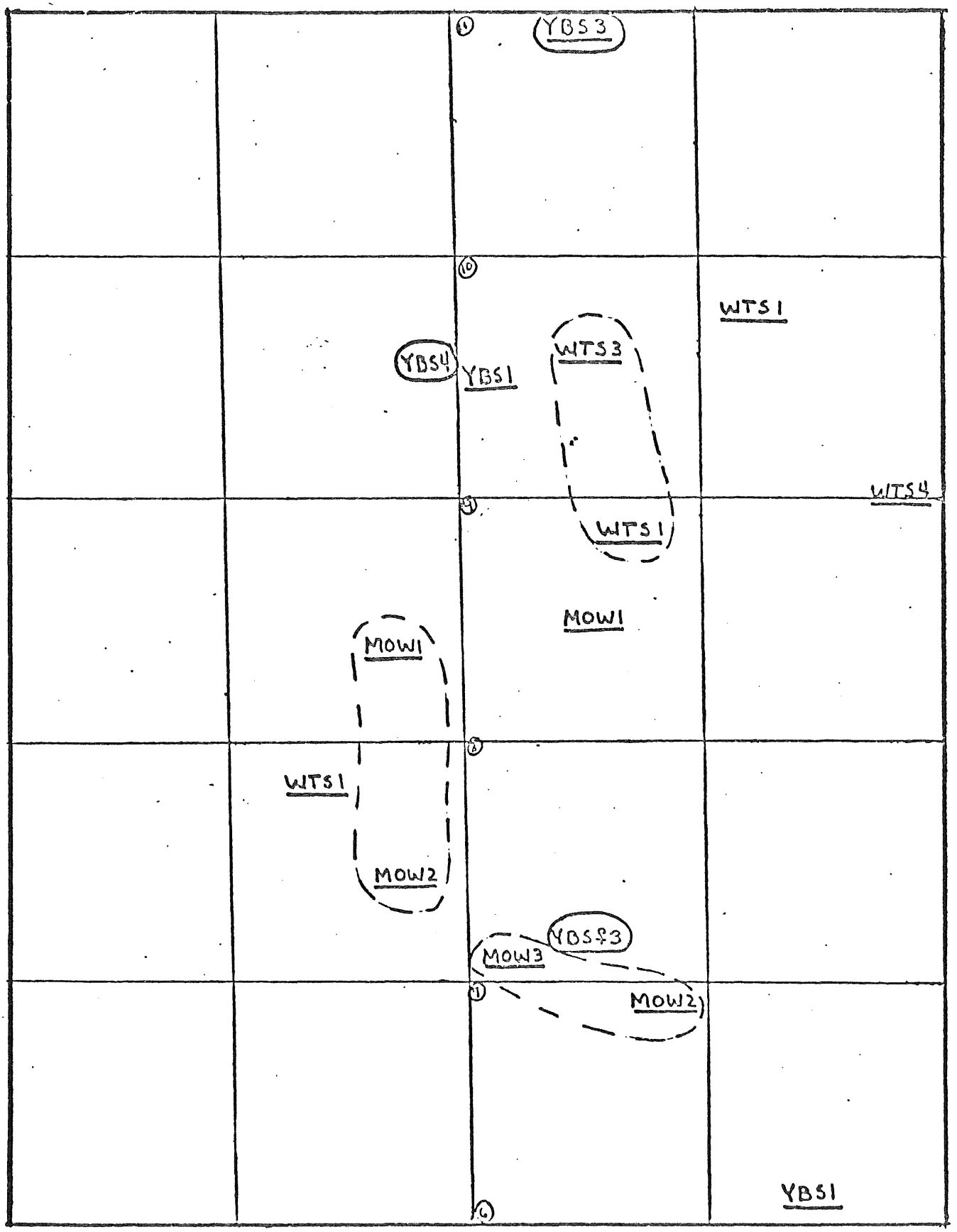


Figure BT-
Composite map and territory map for bird species uncommon on transect B3.

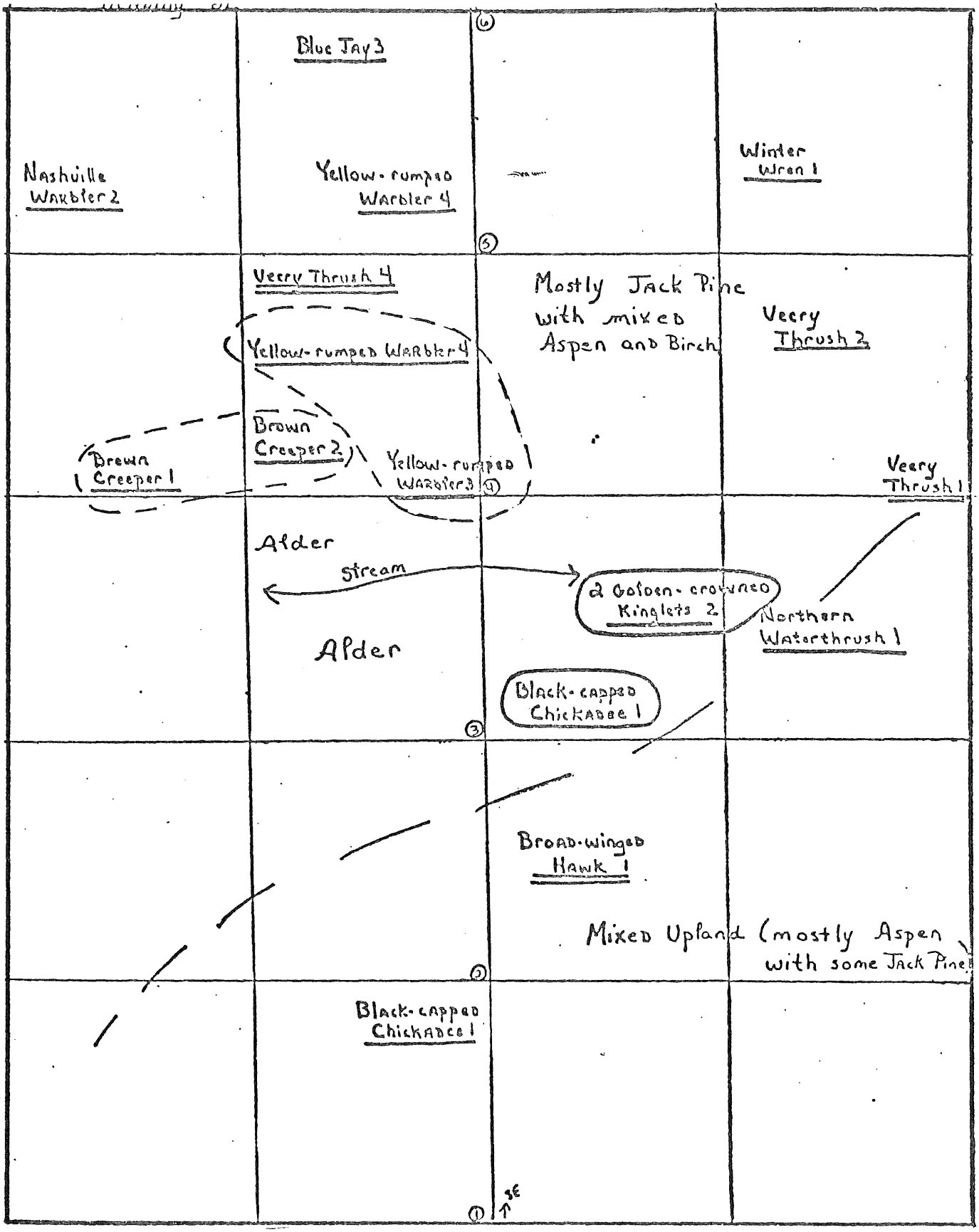


Figure BT- - . (cont.)

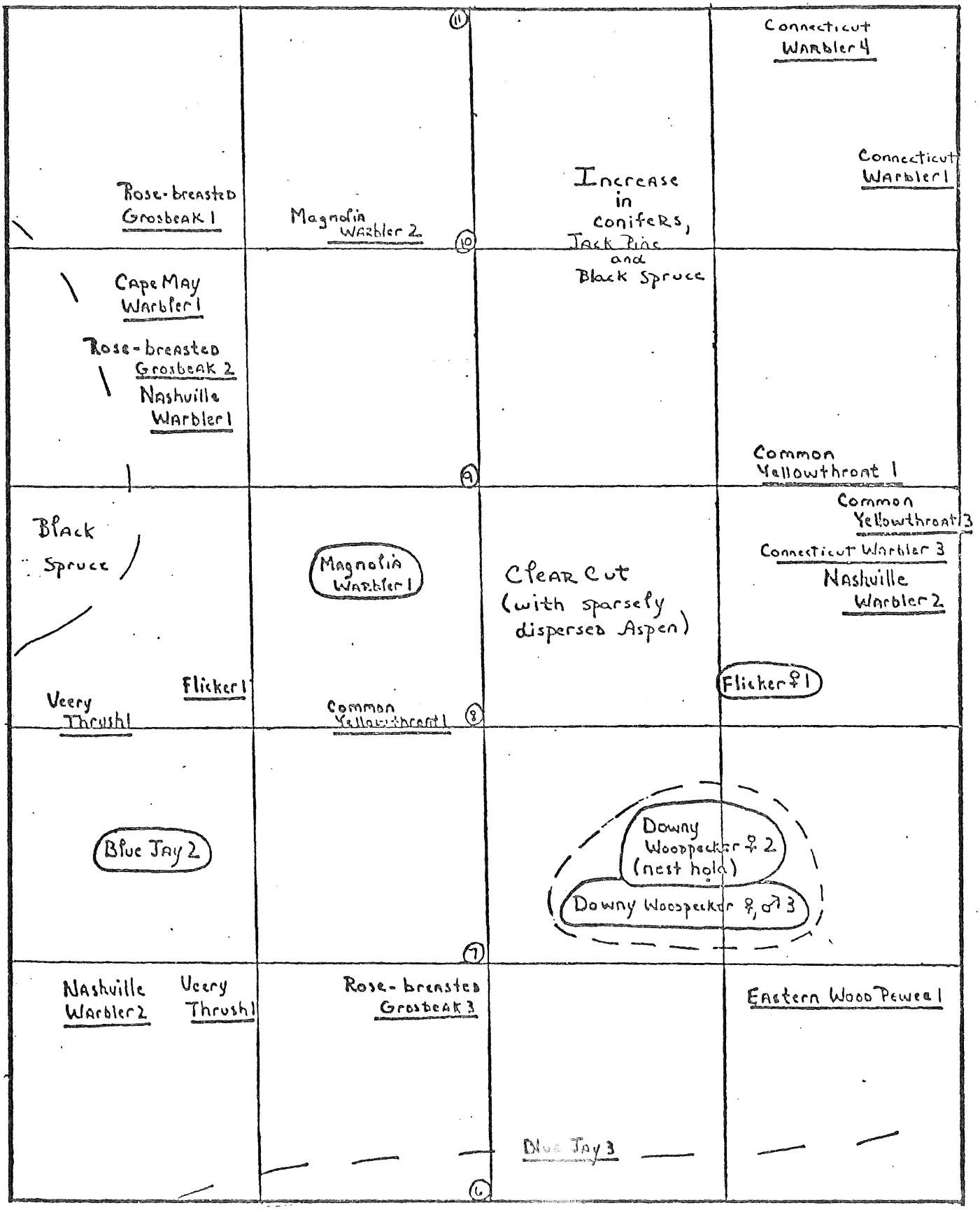


Table BT-1

Technical description of bird transects for the 1976 field season.

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
B1	Clear Cut	On Hwy #1, approx. 1.5 mi. N of Junc. w/USFS Road #424	7	253	T.61N., R.10W. Sec. 30. NE¼	Federal
B2	Young Tamarack and Black Spruce	On USFS Road #424, .2 mi. SW of Junc. w/Hwy#1	7	277	T.61N., R.10W. Sec.31	Federal
B3	Mixed Upland and Mixed Lowland	On USFS Road #424, at Junc. w/USFS Road #428	11	327	T.60N., R.11W. Sec. 9 NE¼ and NW¼	Federal and Non-Federal
B4	Mature Aspen	On USFS Road #178, NW of Junc. w/USFS Rd#424	11	325	T.60N., R.11W. Sec. 7 SE¼	Federal and Non-Federal
B5	Mature Jack Pine	On USFS Road #178, .5 mi. NW of Junc. w/USFS Road #424	11	325	T.60N., R.11W. Sec. 7 NE¼ and SE¼	Federal and Non-Federal
B6	White Cedar	On USFS Road #424, .8 mi. W of Junc. w/USFS Road #1431	11	349	T.60N., R.11W. Sec.18 NW¼	Federal
B7	Tamarack	On USFS Road #424 approx. 1 mi. W of Junc. w/USFS Road #1431	10	348	T.60N., R.12W. Sec.13 NE¼	Federal
B8	Mid-aged Jack Pine Plantation	On USFS Road #173, approx. .2 mi. W of Junc. w/USFS Rd. #386	7	255	T.61N., R.10W. Sec.28 SW¼	Federal
B9	Mature Jack Pine Plantation	On USFS Road #112, approx. .3 mi. SE of Junc. w/USFS Rd. #424	10	346 347	T.60N., R.12W. Sec.23 Sec. 15, SE¼ Sec. 14, SW¼	Federal

Table BT-1 (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
B10	Red Pine Plantation	On USFS Road #112, approx. 1.5 mi. SE of Junc. w/USFS Road #424	10	371	T.60N., R.12W. Sec. 23, SE¼	Federal
B11	Black Spruce	On USFS Road #173, E of Junc. w/Hwy #1	7	277	T.61N., R.10W. Sec. 31, NE¼	
				278	Sec. 32, NW¼	
B12	Mixed Aspen	On USFS Road #386, approx. 1 mi. SW of Junc. w/USFS Road #173	7	278	T.61N., R.10W. Sec. 32, SE¼	Federal
			12	[illegible]	T.60N., R.10W. Sec. 5, NE¼	
B13	Mixed Upland and Young Red Pine Plantation treated w/2,4,5-D	On USFS Road #386, approx. 3.5 mi. W of Junc. w/USFS Road #173	12	310	T.60N., R.10W. Sec. 3, SE¼	Federal
B14	Mature Aspen	On USFS Road #386, approx. 2 mi. SW of Junc. w/USFS Rd. #173	Undesig-nated	Undesig-nated	T.60N., R.9W. Sec. 6, NW¼ & NE¼	Federal
B15	Mixed Aspen	On USFS Road #388, N of Junc. w/USFS Road #173	7	255	T.61N., R.10W. Sec. 28 NE¼ and SE¼	Federal
B16	Mature Red Pine	On USFS Road #388, approx. 4 mi. N of Junc. w/USFS Rd. #173	7	184	T.61N., R.10W. Sec. 10 NE¼ and SE¼	Federal
B17	Pole Aspen	On USFS Road #130, approx. 3 mi. S of Junc. w/USFS Road #569	17	699	T.58N., R.14W. Sec. 33, NW¼	Non-Federal
B18	Jack Pine Plantation	On USFS Road #130, approx. .1 mi. N of Junc. w/780	21	739	T.57N., R.14W. Sec. 7, NE¼	Federal
				740	Sec. 8, NW¼	

Table BT-1 (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
B19	White Cedar	On USFS Road #1822, W of Junc. w/USFS Road #130	21	739 757	T.57N., R.14W. Sec. 7, SE¼ Sec. 18, NE¼	Federal
B20	Red Pine Plantation	On old logging road, W of USFS Road #130, approx. .5 mi. S of Junc. w/USFS Road #1822	21	757	T.57N., R.14W. Sec. 18, SE¼	Federal
B21	Mixed Lowland	On USFS Road #130, approx. 2.2 mi. S of Junc. w/USFS Road #1822	21	794	T.57N., R.14W. Sec. 29, NW¼ and SW¼	Federal
B22	Ash Lowland	On USFS Road #130, 3 mi. S of Junc. w/USFS Road #1822	21	811 812	T.57N., R.14W. Sec. 31, NE¼ Sec. 32, NW¼	Federal
B23	White Birch	On USFS Road #569, .5 mi. SW of Junc. w/USFS Road #130	17	652 653	T.58N., R.14W. Sec. 22, NE¼ Sec. 23, NW¼	Federal
B24	Black Spruce	On USFS Road #569, at Junc. w/USFS Road #130	17	628	T.58N., R.14W. Sec. 15, SW¼ and SE¼	Federal
B25	Cut and Burn Area	On USFS Road #1431, approx. .3 mi. S of Junc. w/USFS Road #424	11	349 373	T.60N., R.11W. Sec. 18, SE¼ Sec. 19, NE¼	Federal
B26	Young Jack Pine Plantation	On USFS Road #1431, approx. .6 mi. NE of Junc. w/USFS Road #112	10	372 396	T.60N., R.12W. Sec. 24, SE¼ Sec. 25, NE¼	Non-Federal
B27	White Birch	On USFS Road #112, approx. 1 mi. SW of Junc. w/Hwy #2	12	427	T.60N., R.10W. Sec. 31, SE¼	Federal

Table BT-1 . (contd.)

Site No.	Cover Type	General Location	Map No.	Square Mile No.	Technical Description of Plot #	Ownership
B28	Mixed Aspen	On USFS Road #112, approx. 2 mi. SW of Junc. w/Hwy #2	16	456	T.59N., R.11W. Sec. 1, SE¼	Federal
B29	Black Spruce	On USFS Road #112, approx. 4 mi. W of Junc. w/USFS Road #114	11	424 454	T.60N., R.11W. Sec. 34, SW¼ T.59N., R.11W. Sec. 3, NW¼	Federal and Non-Federal
B30	Mixed Upland	On USFS Road #112, approx. 2 mi. W of Junc. w/USFS Road #114	11	422	T.60N., R.11W. Sec. 32, SW¼	Federal
B31	Mixed Upland (w/cut)	On USFS Road #178, approx. 1.5 mi. SW of Junc. w/USFS Road #424	11	351	T.60N., R.11W Sec. 16, SW½	Federal and Non-Federal
B32	Mixed Upland (w/some Black Spruce Lowland)	On USFS Road #178, approx. 2 mi. SW of Junc. w/USFS Road #424	11	351 375	T.60N., R.11W. Sec. 16, SE¼ Sec. 21, NE¼	Federal and Non-Federal
B33	Old Burn (w/Mixed Upland)	On USFS Road #381, approx. 1 mi. NE of Junc. w/USFS Road #173	8	235 236	T.61N., R.9W. Sec. 19, NE¼ Sec. 20, NW¼	Federal
B34	1975 Clear Cut	On USFS Road #381, approx. 2.5 mi. NE of Junc. w/USFS Road #173	8	212	T.61N., R.9W. Sec. 17, NE¼	Federal
B35a	Aldᵉᵉ-Willow Lowland	On USFS Road #128, approx. 3 mi. S of Junc. w/USFS Road #569 (250 m long)	22	728 746	T.57N., R.13W. Sec. 5, SW¼ Sec. 8, NW¼	Federal and Non-Federal
B35b	Aldᵉᵉ-Willow Lowland	On USFS Road #128, approx. 3.5 mi. S of Junc. w/USFS Road #569 (250m long)	22	746	T.57N., R.13W. Sec. 8, NW¼ and SW¼	Non-Federal

Table TB-3.

List of bird species observed or heard along 35 different transects during the spring breeding season (June & July) of 1976.

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)		No. and % of Observations per Species (Sound and/or Sight)	
		June No. (0.0%)	July No. (0.0%)	June No. (0.00%)	July No. (0.00%)
Botaurus lentinosus	***American bittern	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Buteo jamaicensis	***red-tailed hawk	1 (2.9)	1 (2.9)	3 (0.10)	1 (0.07)
Buteo platypterus	broad-winged hawk	6 (17.1)	5 (14.3)	9 (0.30)	5 (0.36)
Circus cyaneus	**marsh hawk	0 (0.0)	1 (2.9)	0 (0.00)	1 (0.07)
Pandion haliaetus	***osprey	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Falco sparverius	**American kestrel	7 (20.0)	5 (14.3)	8 (0.27)	8 (0.57)
Charadrius vociferus	**killdeer	1 (2.9)	1 (2.9)	3 (0.10)	1 (0.07)
Philohela minor	***American woodcock	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Capella gallinago	**common snipe	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Tringa solitaria	**solitary sandpiper	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Coccyzus erythropthalmus	***black-billed cuckoo	1 (2.9)	3 (8.6)	1 (0.03)	6 (0.43)
Aegolius acadieus	**saw-whet owl	1 (2.9)	0 (0.0)	1 (0.03)	0 (0.00)
Chordeiles minor	common nighthawk	1 (2.9)	3 (8.6)	0 (0.00)	3 (0.22)
Archilochus colubris	***ruby-throated hummingbird	5 (14.3)	4 (11.4)	7 (0.23)	11 (0.79)
Megaceryle alcyon	***belted kingfisher	3 (8.6)	0 (0.0)	4 (0.13)	0 (0.00)

For description of astericks, see footnote at end of table.

Table 1B- . . (cont.)

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)				No. and % of Observations per Species (Sound and/or Sight)			
		June		July		June		July	
		No.	(0.0%)	No.	(0.0%)	No.	(0.00%)	No.	(0.00%)
Colaptes auratus	common flicker	10	(28.6)	11	(31.4)	15	(0.50)	18	(1.29)
Dryocopus pileatus	**pileated woodpecker	2	(5.7)	1	(2.9)	4	(0.13)	1	(0.07)
Sphyrapicus varius	yellow-bellied sapsucker	10	(28.6)	9	(25.7)	24	(0.80)	12	(0.86)
Dendrocopos villosus	***hairy woodpecker	4	(11.4)	4	(11.4)	6	(0.20)	4	(0.29)
Dendrocopos pubescens	***downy woodpecker	5	(14.3)	13	(37.1)	7	(0.23)	19	(1.36)
Picoides arcticus	**black-backed three-toed woodpecker	0	(0.0)	1	(2.9)	0	(0.00)	1	(0.07)
Tyrannus tyrannus	***eastern kingbird	3	(8.6)	1	(2.9)	6	(0.20)	1	(0.07)
Myiarchus crinitus	*great crested flycatcher	1	(2.9)	0	(0.0)	1	(0.03)	0	(0.00)
Empidonax flaviventris	***yellow-bellied flycatcher	8	(22.9)	7	(20.0)	24	(0.80)	7	(0.50)
Empidonax alnorum	alder flycatcher	6	(17.1)	3	(8.6)	17	(0.57)	14	(1.00)
Empidonax minimus	least flycatcher	18	(51.4)	10	(28.6)	100	(3.34)	47	(3.37)
Contopus virens	***eastern wood pewee	5	(14.3)	4	(11.4)	15	(0.50)	6	(0.43)
Nuttallornis borealis	***olive-sided flycatcher	2	(5.7)	2	(5.7)	3	(0.10)	1	(0.07)
Iridoprocne bicolor	tree swallow	9	(25.7)	3	(8.6)	27	(0.90)	4	(0.29)
Perisoreus canadensis	***gray jay	4	(11.4)	5	(14.3)	10	(0.33)	15	(1.08)
Cyanocitta cristata	blue jay	15	(42.9)	13	(37.1)	38	(1.27)	20	(1.43)

For description of astericks, see footnote at end of table.

Table B- . . (cont.)

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)				No. and % of Observations per Species (Sound and/or Sight)			
		June		July		June		July	
		No.	(0.0%)	No.	(0.0%)	No.	(0.00%)	No.	(0.00%)
Corvus corax	common raven	2	(5.7)	3	(8.6)	7	(0.23)	3	(0.22)
Corvus brachyrhynchos	common crow	0	(0.0)	2	(5.7)	0	(0.00)	7	(0.50)
Parus atricapillus	black-capped chickadee	13	(37.1)	21	(60.0)	26	(0.87)	77	(5.52)
Parus hudsonicus	**boreal chickadee	3	(8.6)	7	(20.0)	5	(0.17)	15	(1.08)
Sitta carolinensis	**white-breasted nuthatch	0	(0.0)	1	(2.9)	0	(0.00)	1	(0.07)
Sitta canadensis	red-breasted nuthatch	7	(20.0)	16	(45.7)	13	(0.43)	30	(2.15)
Certhia familiaris	**brown creeper	4	(11.4)	2	(5.7)	9	(0.30)	2	(0.14)
Troglodytes aedon	**house wren	1	(2.9)	1	(2.9)	2	(0.07)	2	(0.14)
Troglodytes troglodytes	winter wren	8	(22.9)	4	(11.4)	10	(0.33)	7	(0.50)
Dumetella carolinensis	**gray catbird	1	(2.9)	1	(2.9)	4	(0.13)	7	(0.50)
Toxostoma rufum	*brown thrasher	3	(8.6)	0	(0.0)	6	(0.20)	2	(0.14)
Turdus migratorius	American robin	24	(68.6)	24	(68.6)	66	(2.20)	44	(3.16)
Catharus guttatus	***hermit thrush	14	(40.0)	16	(45.7)	24	(0.80)	26	(1.87)
Catharus ustalatus	Swainson's thrush	2	(5.7)	4	(11.4)	5	(0.17)	6	(0.43)
Catharus fuscescens	veery	18	(51.4)	12	(34.3)	71	(2.37)	27	(1.94)
Regulus satrapa	***golden-crowned kinglet	14	(40.0)	16	(45.7)	49	(1.64)	71	(5.09)
Regulus calendula	***ruby-crowned kinglet	8	(22.9)	3	(8.6)	17	(0.57)	5	(0.36)

For description of astericks, see footnote at end of table.

Table TB-[illegible] (cont.)

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)				No. and % of Observations per Species (Sound and/or Sight)			
		June		July		June		July	
		No.	(0.0%)	No.	(0.0%)	No.	(0.00%)	No.	(0.00%)
Bombycilla cedrorum	cedar waxwing	12	(34.3)	9	(25.7)	24	(0.80)	22	(1.58)
Vireo solitarius	solitary vireo	3	(8.6)	2	(5.7)	3	(0.10)	2	(0.14)
Vireo olivaceus	red-eyed vireo	29	(82.9)	24	(68.6)	225	(7.51)	115	(8.24)
Vireo philadelphicus	**Philadelphia vireo	2	(5.7)	1	(2.9)	8	(0.27)	1	(0.07)
Mniotilta varia	black-and-white warbler	20	(57.1)	11	(31.4)	52	(1.74)	28	(2.01)
Vermivora chrysoptera	golden-winged warbler	4	(11.4)	2	(5.7)	7	(0.23)	2	(0.14)
Vermivora ruficapilla	Nashville warbler	28	(80.0)	21	(60.0)	240	(8.01)	49	(3.52)
Parula americana	***parula warbler	2	(5.7)	2	(5.7)	4	(0.13)	3	(0.22)
Dendroica petechia	**yellow warbler	2	(5.7)	1	(2.9)	3	(0.10)	1	(0.07)
Dendroica magnolia	magnolia warbler	10	(28.6)	7	(20.0)	22	(0.73)	19	(1.36)
Dendroica tigrina	***cape may warbler	9	(25.7)	1	(2.9)	27	(0.90)	2	(0.14)
Dendroica caerulescens	**black-throated blue warbler	0	(0.0)	1	(2.9)	0	(0.00)	1	(0.07)
Dendroica coronata	yellow-rumped warbler	20	(57.1)	10	(28.6)	49	(1.64)	19	(1.36)
Dendroica virens	***black-throated green warbler	8	(22.9)	7	(20.0)	21	(0.70)	17	(1.22)
Dendroica fusca	blackburian warbler	15	(42.9)	6	(17.1)	59	(1.97)	7	(0.50)
Dendroica pensylvanica	chestnut-sided warbler	28	(80.0)	16	(45.7)	254	(8.48)	51	(3.66)
Dendroica castanea	***bay-breasted warbler	4	(11.4)	1	(2.86)	5	(0.17)	2	(0.14)

For description of astericks, see footnote at end of table.

Table TB- . (cont.)

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)				No. and % of Observations per Species (Sound and/or Sight)			
		June		July		June		July	
		No.	(0.0%)	No.	(0.0%)	No.	(0.00%)	No.	(0.00%)
Seiurus aurocapillus	ovenbird	25	(71.4)	21	(60.0)	520	(17.38)	67	(4.80)
Seirus noveboracensis	***northern waterthrush	2	(5.7)	0	(0.0)	4	(0.13)	0	(0.00)
Oporornis agilis	**Connecticut warbler	7	(20.0)	1	(2.9)	23	(0.77)	3	(0.22)
Oporornis philadelphia	mourning warbler	31	(88.6)	18	(51.4)	169	(5.64)	32	(2.30)
Geothlypis trichas	common yellowthroat	20	(57.1)	21	(60.0)	145	(4.84)	94	(6.74)
Wilsonia canadensis	Canada warbler	15	(42.9)	9	(25.7)	41	(1.37)	14	(1.00)
Setophaga ruticilla	American redstart	1	(2.9)	2	(5.7)	3	(0.10)	3	(0.22)
Agelaius phoeniceus	red-winged blackbird	2	(2.9)	3	(8.6)	12	(0.40)	9	(0.65)
Quiscalus quisacula	***common grackle	1	(2.9)	1	(2.9)	1	(0.03)	20	(1.43)
Molothrus ater	brown-headed cowbird	4	(11.4)	2	(5.7)	15	(0.50)	3	(0.22)
Piranga olivacea	***scarlet tanager	6	(17.1)	1	(2.9)	7	(0.23)	2	(0.14)
Pheucticus ludovicianus	rose-breasted grosbeak	20	(57.1)	6	(17.1)	38	(1.27)	12	(0.87)
Passerina cyanea	**indigo bunting	1	(2.9)	0	(0.0)	1	(0.03)	0	(0.00)
Hesperiphona vespertina	***evening grosbeak	7	(20.0)	3	(8.6)	15	(0.50)	7	(0.50)
Carpodacus purpureus	purple finch	4	(11.4)	3	(8.6)	5	(0.17)	4	(0.29)
Spinus tristis	***American goldfinch	3	(8.6)	3	(8.6)	6	(0.20)	9	(0.65)

For description of astericks, see footnote at end of table.

Tab TB-[illegible] (cont.)

Scientific Name	Common Name	No. and % of Transects Where a Species was Present (35 Different Transects)				No. and % of Observations per Species (Sound and/or Sight)			
		June		July		June		July	
		No.	(0.0%)	No.	(0.0%)	No.	(0.00%)	No.	(0.00%)
Junco hyemalis	***dark-eyed junco	9	(25.7)	3	(8.6)	15	(0.50)	4	(0.29)
Spizella passerina	chipping sparrow	12	(34.3)	10	(28.6)	24	(0.80)	22	(1.58)
Zonotrichia albicollis	white-throated sparrow	22	(62.9)	28	(80.0)	119	(3.97)	110	(7.89)
Melospiza lincolnii	**Lincoln's sparrow	8	(22.9)	4	(11.4)	18	(0.60)	5	(0.36)
Melospiza georgiana	swamp sparrow	10	(28.6)	12	(34.3)	85	(2.83)	54	(3.87)
Melospiza melodia	song sparrow	17	(48.6)	11	(31.4)	76	(2.54)	42	(3.01)
					Total Observations	2997	(99.74)	1395	(100.04)

Footnote: According to Grün[e.c.] (1971), the following definitions of abundance are "based on how often a knowledgeable birder would see or hear a bird if he were actively looking for birds over a wide range of area within the Superior National Forest for every day of the summer."

* very rare - not found every year
** rare - found one to four times a summer
*** uncommon - found once a week to ten days

Table BT-

Summary information for 12 different road transects chosen for uniformity of habitat: percent distribution of number of breeding pairs among bird families, total number of breeding pairs, and the total number of species along each transect.

Bird Families	Clear Cut #1	1975 Clear Cut #34	Alder-Willow #35a-35b	Mixed Aspen #12	Mature Aspen #14	Mixed Upland #15	Pole Aspen #17	Red Pine #10	Jack Pine #18	Young Jack Pine #26	Black Spruce #29	Tamarack #7	Range of % Vales	Mean of % values (per transect)
Falconidae	3.3	7.1										2.6	0-7.1	1.1
Charadriidae		14.3											0-14.3	1.2
Scolopacidae		7.1											0-7.1	.6
Trochipidae			4.7		2.7								0-4.7	.6
Alcedinidae	3.3												0-3.3	.3
Picidae	6.7		1.6	3.4	16.2			3.6		4.9	1.8		0-16.2	3.2
Tyrannidae			4.7		2.7	3.1	10.6	3.6	2.9	4.9	1.8	5.3	0-10.6	3.3
Hirundinidae	3.3	14.3	1.6							7.3		5.3	0-14.3	2.7
Coruidae	6.7				2.7	3.1				2.4	3.6		0-6.7	1.5
Sittidae					2.7								0-2.7	.2
Certhiidae									5.7				0-5.7	.5
Troglodytidae	6.7									4.9	1.8		0-6.7	1.1
Mimidae			4.7							4.9			0-4.9	.8
Turdidae	3.3	7.1	12.5	3.4	10.8	3.1	10.6	14.3	5.7	2.4	1.8	2.6	1.8-14.3	6.5
Sylviidae						9.4					9.1		0-9.4	1.5
Bombycillidae			3.1	3.4	5.4					7.3		5.3	0-7.3	2.0
Vireonidae	6.7		3.1	3.4	8.1	12.5	6.4	21.4	11.4	7.3		5.3	0-21.4	7.1
Parupidae	33.3		40.6	75.9	43.2	59.4	55.3	46.4	62.9	36.7	63.6	36.8	0-75.9	46.2
Icteridae			1.6						5.7				0-5.7	.6
Fringillidae	26.7	50.0	20.3	3.4	5.4	9.4	14.9	10.7	5.7	17.1	16.4	36.8	0-50.0	18.1
Paridae			1.6	6.9			2.1						0-6.9	.9
Total # breeding pairs (all species/ 5 ha.)	30	14	64	29	37	32	47	28	35	41	55	38	14-64	37.5
Total # species	16	8	27	12	19	14	14	16	14	18	22	13	8-27	16.1

Table BT-

Population estimates for bird transect 31 for the month of June.

I. Summation Method
II. Territory Mapping--a minimum of 2 recorded observations are necessary
III. Territory Mapping--a minimum of 3 recorded observations are necessary

Species	I. Maximum No. of Breeding Pairs Observed on Transect	I. Maximum Number of Breeding Pairs per 100 acres	II. Number of Territories on the Transect	II. Number of Territories per 100 acres	III. Number of Territories on the Transect	III. Number of Territories per 100 acres
Ovenbird	6	49	5.17	42	1.67	14
Chestnut-sided warbler	6	49	7.17	58	4.67	38
Red-eyed vireo	5	40	5	40	2	16
Least flycatcher	4	32	4.67	38	.67	5
Blackburian warbler	3	24	1	8		
Yellow-bellied sapsucker	3	24	1	8		
Mourning warbler	3	24	3	24		
White-throated sparrow	2	16	1	8		
Yellow-rumped warbler	2	16	1	8		
Brown creeper	1	8	.5	4		
Downy woodpecker	1	8	1	8		
Canada warbler	1	8				
Black-capped chickadee	2	16				
Broad-winged hawk	1	1				
Magnolia warbler	1	8				
Common yellowthroat	1	8				
Tree swallow	1	8				
Veery	1	8				
Golden-crowned kinglet	2	16				
Blue jay	2	16				
Rose-breasted grosbeak	1	8				
Total Number	49	387	30.51	246	9.01	73

Table BT - 5

Numbers and ages of bird species collected
in mist-nets during period I. July 19, 1976 - July 21, 1976.

Species	Mature Aspen #4 (4 nets)			Jack Pine #5 (5 nets)			Cut Area #25 (3 nets)			White Cedar #6 (3 nets)			Tamarack #7 (3 nets)			Total Numbers per Species		
	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown
American kestrel							1									1	0	0
Black-billed cuckoo							1									1	0	0
Yellow-bellied flycatcher										1						1	0	0
Alder flycatcher									1							0	0	1
Least flycatcher	1			1												2	0	0
Black-capped chickadee				1												1	0	0
Boreal chickadee													1			1	0	0
House wren							1									1	0	0
Brown thrasher								1								0	1	0
American robin							1									1	0	0
Swainson's thrush	2	1					1	1								3	2	0
Veery	1															1	0	0
Ruby-crowned kinglet										2						2	0	0
Red-eyed vireo	1															1	0	0
Nashville warbler						1										0	0	1
Chestnut-sided warbler	2									2						4	0	0
Ovenbird	2	1		1												3	1	0
Common yellowthroat							2			1						3	0	0
Canada warbler	2	1				1										2	1	1
Rose-breasted gorsbeak	1						2			1						4	0	0
American goldfinch	1															1	0	0
White-throated sparrow				4		2	4	1		1						9	1	2
Lincoln's sparrow							1	1								1	1	0
Swamp sparrow										2						2	0	0
Song sparrow							1	1	1				2			3	1	1
Total numbers/habitat	13	3	0	7	0	4	15	5	2	10	0	0	3	0	0			

Table BT-

Numbers and ages of bird species collected in mist-nets during period II, August 2, 1976 - August 4, 1976

Species	White Birch #23 (5 nets)			Black Spruce #24 (3 nets)			Pole Aspen #17 (3 nets)			Jack Pine #17 (3 nets)			White Cedar #19 (6 nets)			Mixed Lowland #21 (3 nets)			Total Numbers per Species		
	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown	Adult	Immature	Unknown
Broad-winged hawk										1									1	0	0
Gray jay				1	1														1	1	0
Black-capped chickadee							2	3	3										2	3	3
Brown creeper													1						1	0	0
Hermit thrush		1					4												4	1	0
Veery								1					1						1	1	0
Red-eyed vireo							1	1											1	1	0
Black-and-white warbler							2	2											2	2	0
Golden-winged warbler							2	2											2	2	0
Nashville warbler		1					2	1											2	2	0
Yellow-rumped warbler																1			1	0	0
Chestunut-sided warbler								5											0	5	0
Ovenbird							1						2						3	0	0
Connecticut warbler														1					0	1	0
Mourning warbler								1					2	2					2	3	0
Common yellowthroat														1					0	1	0
Canada warbler				1			1												2	0	0
White-throated sparrow							4	2					4	1	1				8	3	1
Total numbers/habitat	0	2	0	2	1	0	19	18	3	1	0	0	10	5	1	1	0	0			

research concerning these species, but has gathered observation data and will rely on information from the secondary sources listed above.

11.2. Methods

Bald eagles and ospreys observed during normal field activities were recorded on a standard data form (Table

11.3. Results

Only positive observations of bald eagles and ospreys from knowledgeable persons were recorded. The five eagles and two ospreys recorded during the 1976 season are presented in Table R-1 by date and number seen, and locations are shown on Figure R-1. Nesting areas were obtained from Fred Thurnhorst of the MDNR (Figure R-2). Exact nexting sites have not been shown on Figure R-2 to prevent disturbance of these areas.

Although observations of these species were uncommon in 1976, the distribution of these sitings (Figure R-1) were in the immediate area of nests (Figure R-2). Apparently, eagles nesting in the Seven Beaver Lake area (Figure R-2, far south location) do not venture to the west far enough to be seen along Forest Road No. 113 or 120. Conclusions about eagle and osprey distribution away from nesting sites would be little more than guesses with the minimal data available.

The remainder of this section is a direct quote from information provided by Karl Siderits, a Superior Forest Biologist, USFS (Bald eagle-Osprey status report, 1976 Superior National Forest, Duluth, Minnesota 55801) on the number and breeding success of bald eagles and osprey from 1973-

1976 on the entire Superior National Forest. Table numbers have been changed to follow in sequence with this paper.

> "This report is a summary of the 1976 bald eagle and osprey census on the Superior National Forest. Records of census flights date back to 1961 although the intensive checking and record keeping began in 1973. Data from 1961-1975 has been summarized by James Mattson and Al Grewe, North Central Forest Experiment Station, Research Note NC-198, 1976. To date, nesting information is available on 194 eagle and osprey nests. The bald eagle census flights are made between April 10-25 and the fledgling census from June 23-July 3. Osprey census flights are May 18-25 and July 26-August 6. A majority of the eagle and osprey nests are in the Boundary Waters Canoe Area. A helicopter was used on several of the flights. Accuracy of the census is much better with this slow flying aircraft. Considerable information was obtained on the nest tree size, shape, etc. We observed less idsturbance to the birds than when using fixed winged aircraft. As soon as the necessary observation on the birds was completed, we were able to leave the area quickly. With fixed-wing aircraft, a complete pass fairly close to the nest must be made, and usually at 70 mph. We collected information onthe reaction of the birds to the helicopter to use in analyzing the effect of this aircraft to nesting activity in subsequent years."

11.4. Bald Eagle

> "Twelve eagle nests were found and six nests were lost through blowdown this year. Two new territories were added to increase the census to 51 territories. A total of 67 known nests are on the Superior. This was a stable year for eagle nesting and nest success although nesting activity has decreased greatly on the eastern one-third of the Forest. Of eight eagle territories on the Tofte and Gunflint Ranger Districts, only one territory was active and no young were produced. This decrease has been evident since 1973." (See Table R-2)

> Two active nests, where incubating eagles were present, in spring were lost through a blowdown and a possible black bear predation of the young in the other. A conservation officer observed a bear in the nest in mid-June."

11.5. Osprey

> "Evidently, the "early" spring in northern Minnesota did not change the nesting dates of the eagles or osprey. One hundred percent of the active osprey territories were successful in raising young this year. This is an extremely encouraging census on the Superior. Normally, 40 to 50 percent of the active territories are successful in raising young. On the Chippewa National Forest, located 100 miles west of the Superior National Forest, nest success was 48 percent. Six more osprey territories (9 nests) were found this year and six were lost through blowdowns. There are 34 known territories (38 nests) included in the osprey census." (See Table R-2)

12. DATA ON RAPTORS OTHER THAN BALD EAGLES AND OSPREYS

12.1. Hawks

The distribution and relative abundance of raptors in northeastern Minnesota will be based mainly on observations of these species while carrying on normal field activities. These observations have not yet been compiled, but are expected to show that the most commonly seen species are Buted platypterus (broad-winged hawk), and Falco sparverius (sparrow hawk). These observation data will be presented in the future.

12.2 Owls

Adequate and inexpensive censusing techniques have not been developed for most raptors. However, several species of owls, especially the barred owl and great horned owl, respond to call-back tape recordings during the breeding season in February and March. This technique can be used to census a strip up to 3.2 km (1.6 km on each side of the road) along any road system. Literature is being searched, but we

feel that a census route for barred and great horned owls should be established during the nesting season in 1977.

13. WATERFOWL

13.1. Water Areas Used by Ducks and Geese

The numbers of waterfowl (the term is used here to refer to both ducks and geese) have decreased throughout North America in recent years ( ). This is especially true of such duck species as Aythya valisineria (canvas back), Aythya americana (redhead), and Aix sponsa (wood duck). The daily bag limit on these species in the Mississippi Flyway has varied from a closed season to one per day.

Although the rocky shores and low fertility lakes of northeastern Minnesota are not prime breeding habitat for most species of waterfowl, there is a need for a gneralized waterfowl survey during the present study. Ponds, rivers and lakes that may serve as temporary nesting areas during spring and fall migration are espeically important and should be located.

The methods used during this study to evaluate waterfowl use of the area have been largely qualitative and based on observation. However, some quantification using aerial surveys was completed during October, with more planned for the 1977 field season.

13.2. Methods

We are using a number of sources of information to characterize water areas used by waterfowl within the region;

Table R-1

Bold eagle and osprey observation by Copper-Nickel staff members during 1976*
*(See Figure R-1 for map location).

*Location Numbers	Date	Species	Numbers Seen
1	7-19	bald eagle	1
2	7-21	bald eagle	1
3	9-1	bald eagle	1
4	9-22	bald eagle	1
5	11-7	bald eagle	1
6	6-21	osprey	1
7	4-25	osprey	1

Table R-2.

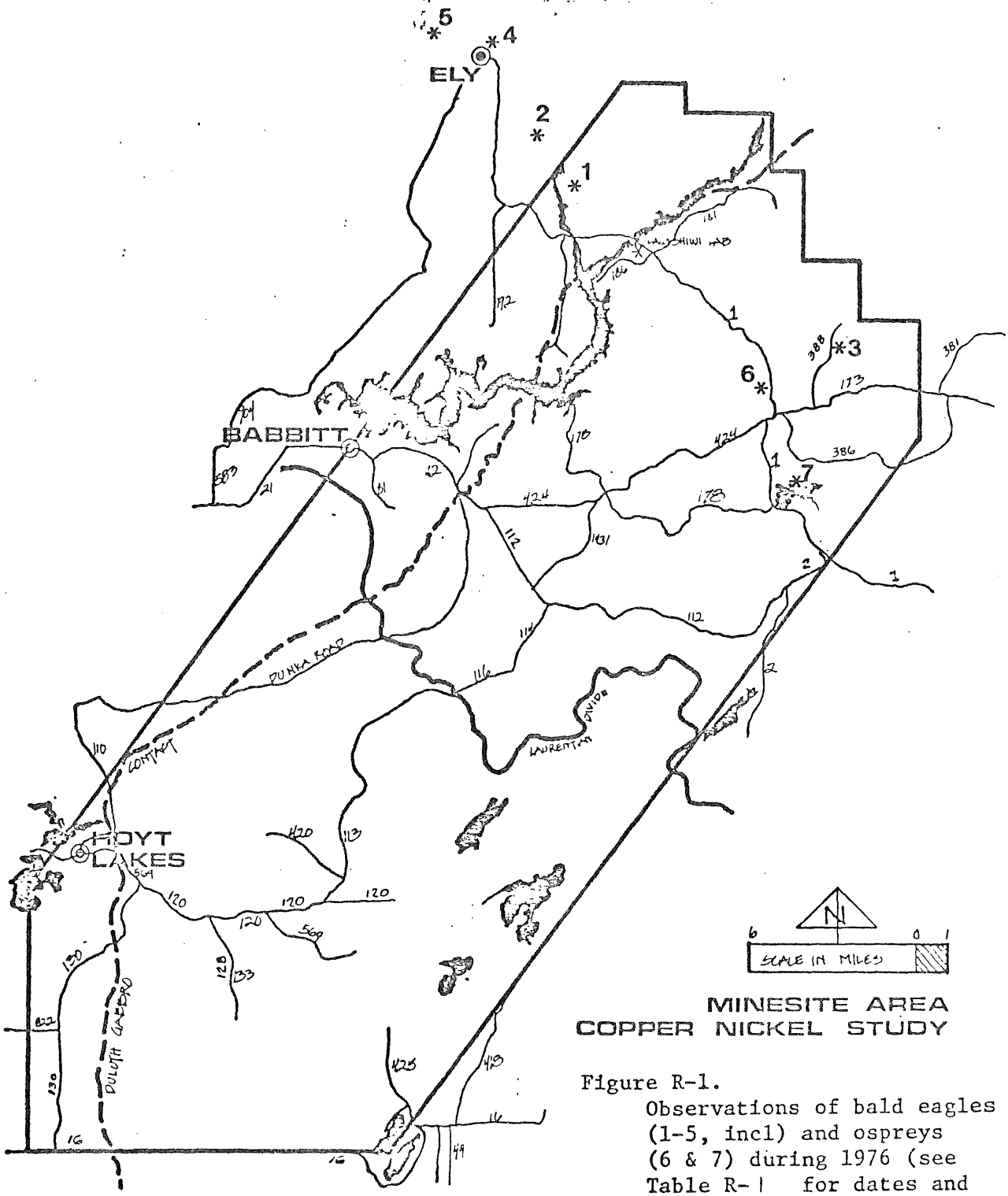
Bald eagle and osprey nesting data.
(This table includes data from USFS tables 1 and 2)

BALD EAGLE NESTING DATA

Year	Known Territories	Observed Territories	Active Territories No.	Active Territories %	Successful Territories No.	Successful Territories %	Number of Young	Average Brood Size at Fledging	Young/ Active Territory
1973	51	48	31	64	18	58	23	1.3	0.7
1974	61	47	28	65	14	50	18	1.3	0.6
1975	75	55	32	58	23	72	35	1.5	1.1
1976	52	52	26	50	20	76	29	1.5	1.1

OSPREY NESTING DATA

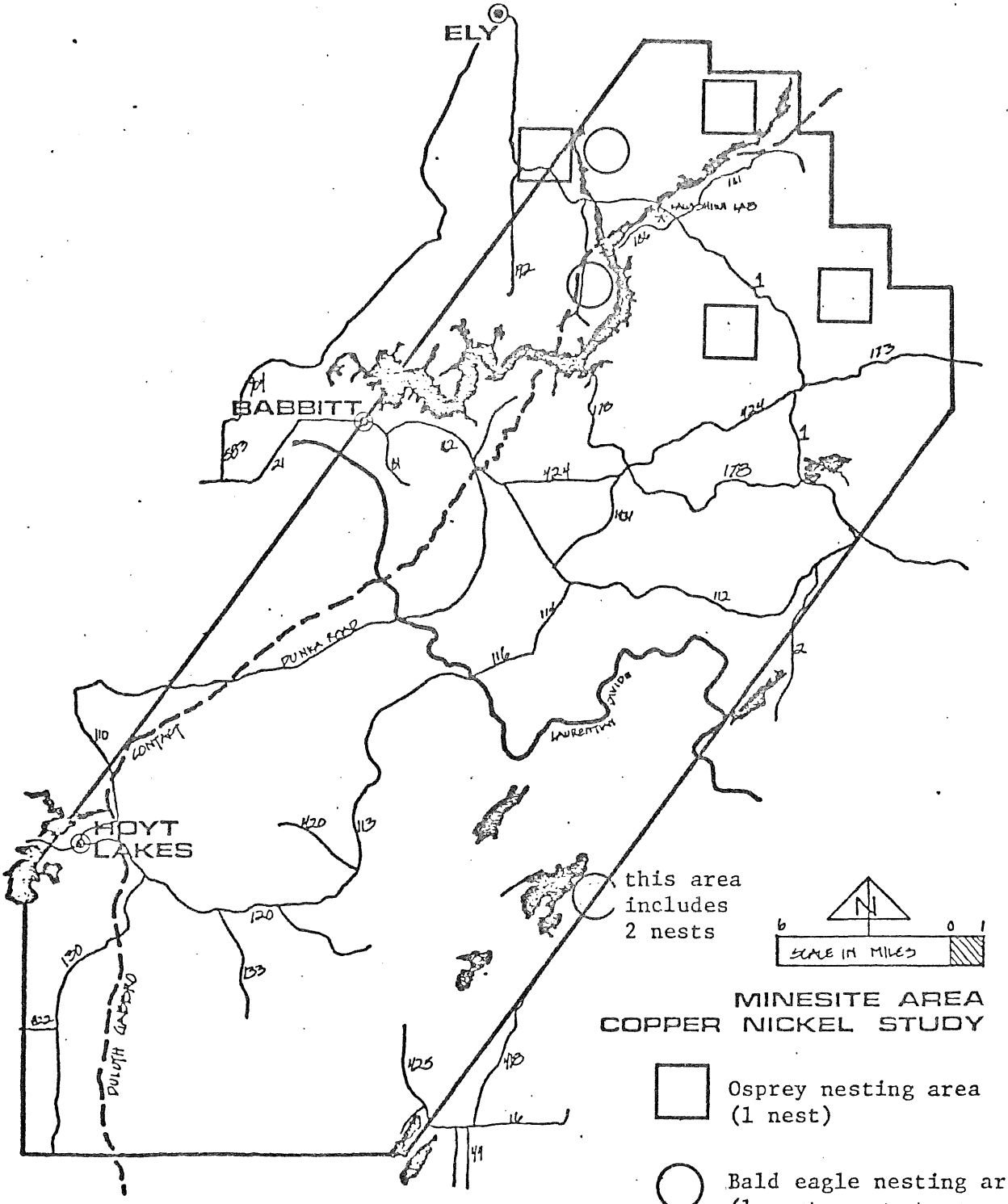
Year	Known Territories	Observed Territories	Active Territories No.	Active Territories %	Successful Territories No.	Successful Territories %	Number of Young	Average Brood Size at Fledging	Young/ Active Territory
1973	47	29	15	52	6	40	9	1.5	0.6
1974	49	36	24	67	12	50	22	1.8	0.9
1975	40	34	25	73	10	40	15	1.5	0.6
1976	34	34	21	62	21	100	32	1.5	1.5



MINESITE AREA
COPPER NICKEL STUDY

Figure R-1.
Observations of bald eagles (1-5, incl) and ospreys (6 & 7) during 1976 (see Table R-1 for dates and numbers seen).

Figure R-2.
Known nest locations for Haliaeetus leucocephalus (bald eagle) and Pandion Haliaetus (osprey).



(Information from Fred Thunhorst, Ely-Winton Game Manager, MDNR).

1) Observations of waterfowl by staff of the fisheries and terrestrial studies while conducting other field activities;

2) lake locations that are known to be used by waterfowl, at least seasonally, obtained from professional biologists employed by the MDNR and USFS;

3) informal conversations with local sportsmen concerning waterfowl hunting areas;

4) flights with the USFS to locate water areas that may serve as migration "stop-overs."

All of these techniques are primarily aimed at characterizing the important of the region during spring and fall migration. Estimates of breeding densities of selected species will almost entirely rely on the literature, which we anticipate may be limited for this area.

13.3. Results

13.3.1. Waterfowl Observations

All waterfowl observed by the terrestrial team were recorded as to species, size of flock, location, date and other parameters noted on Data Form A (P-). These observations will be summarized to provide location data, a species list and the relative frequency of occurrence of species in future papers. Duck species most commonly seen in 1976 (mainly during spring migration) were Mergus merganser (common merganser), Bucephala clangula (Common goldeneye), Aythya affinis (lesser scaup), and Bucophala albeola (bufflehead). Fewer numbers of Anas platyrhynchos (mallard) and Anas rubripes (black duck) were seen. We are not aware of geese using any river, stream, pond or lake in the region.

In addition to our observations, members of the fisheries study recorded waterfowl observed during stream, river and lake surveys. These data are being compiled and are not yet available. We may be able to estimate the relative numbers and frequency of waterfowl/species/mile of stream from their data. Although this data is based on an unknown number of reflushes as a survey proceeds, it will probably be the best data available on the number of waterfowl using small bodies of water in the region.

Fred Thunhorst (area Game Manager, Winton, MDNR) and Carl Sideritz (Biologist for Superior National Forest, USFS) were asked to identify lakes used by waterfowl in the study region. Thunhorst stated that Slate and Bald Eagle lakes are used by waterfowl (Figure W-1, Nos. 3 and 4). The seasonal use pattern of these two lakes is not presently known. Sideritz indicated that limited waterfowl hunting occurs on Long Lake (Figure W-1, No. 5). Conversations with local sportsmen indicate that the majority of the duck hunting in the area is done on Burntside and Shagawa Lakes (Figure W-1, Nos. 1 and 2). We have noticed a concentration of mainly diving ducks at the Birch Lake Dam. Attempts will be made to visit the four accessable sites (Figure W-1, Nos. 1, 2, 4, & 6), and any other accessible lakes that we are informed of as many times as possible during the spring and fall migrations, and several times during the summer.

13.3.2. Aerial Survey

An aerial survey of lakes and rivers was to be initiated in early October to locate and quantify migrating concentrations of waterfowl.

A member of the terrestrial staff was to accompany regularly scheduled flights conducted by the USFS with float equipped aircraft and flown over much of the study area. A combination of problems plagued this portion of the project; 1) interagency coordination problems between the MDNR and the USFS prevented us from making late September and early October Flights; 2) fire danger placed heavy demands on available space in aircrafts; 3) weather conditions suspended many flights; 4) ice-up on many lakes may have forced waterfowl south, out of the region. Two flights were made late in October.

13.3.3. October 22 Flight

This flight covered only a small portion of the study area, but provided a long flight over water areas within the BWCA (Figure W-2). The take-off and landing pattern did not allow us to view waterfowl we knew were present on the east end of Shagawa Lake. No ducks were seen on Burntside Lake on this day.

Since the flight was not conducted especially for our waterfowl survey, the altitude flown at was often at what we considered to be the limit for observing water fowl present on the surface of lakes. Also, some of the smaller lakes and rivers were completely covered with ice, while most lakes were open and had no ice present. The temperature was 22^{o}F and the flight began at 0800 hours with overcast skies. The only water-fowl seen during the entire 120 km flight were at Hoise Bay (Figure W-2). Approximately 100 ducks (species unknown) were seen on the surface of the water at that location. As mentioned earlier, the altitude may have prevented waterfowl sightings on some lakes.

13.3.4. October 30 Flight

This flight extended to and along the Canadian Border to north of Grand Marais, and then back to Ely (Figure W-3). The total flight was about 275 km, began at 1400 hours with clear skies and a temperature of 45°F.

Similar problems occurred on the second flight also, with a varying but usually higher than desired altitude, combined with additional icing problems. By this date, only large lakes were open, with the rest completely ice covered. No waterfowl were seen during the flight.

Although the two flights made in October to survey lakes used by migrating waterfowl provided data on only one area outside of the main study area, they have a great deal of potential if modifications are made. We need to make earlier and more frequent flights, with the main emphasis the Minesite area. We also need to fly at a lower altitude to observe all waterfowl concentrations. The proper altitude will be determined from the literature.

We plan to continue to use previously scheduled Forest Service flights if these modifications can be implemented. If problems arise, we suggest that money be budgeted for spring and fall flights which would be conducted solely for the purpose of waterfowl survey work.

13.4. Conclusion

The distribution and frequency of waterfowl species in northeastern Minnesota will be determined by; 1) routine observations during normal field duties; 2) more intensive ground and water searches on accessible

lakes known to be used by waterfowl; 3) and aerial surveys over and ad-acent to the Minesite area in the spring and fall to determine if, and how many, migrating waterfowl use the area. This phase will depend on cooperation with the USFS or budgeting for specific survey flights.

Our findings are preliminary and subject to change at this time, but this year's data allow us to make some generalizations about northeastern Minnesota by waterfowl (ducks and geese);

1) geese probably rarely nest in the area, and were not observed using lakes or river during the spring or fall migration;
2) only six lakes are known to be used by ducks to any degree, and mainly during migration (Figure W-1);
3) breeding densities are and probably will remain unknown, but are expected to be low due to the low fertility of the water in the region (with the exception of Shagawa Lake), the rocky shorelines of river and lakes, and the absence of marshes and cattail or bullrush-ringed bays that provide excellent breeding habitat farther north and west in Minnesota and Canada.
4) the area probably provides a very small number of ducks and an even smaller number of geese to the state and flyway populations each year.

Additional field work must be done if we are to modify or place more confidence in these four statements for the final regional assessment.

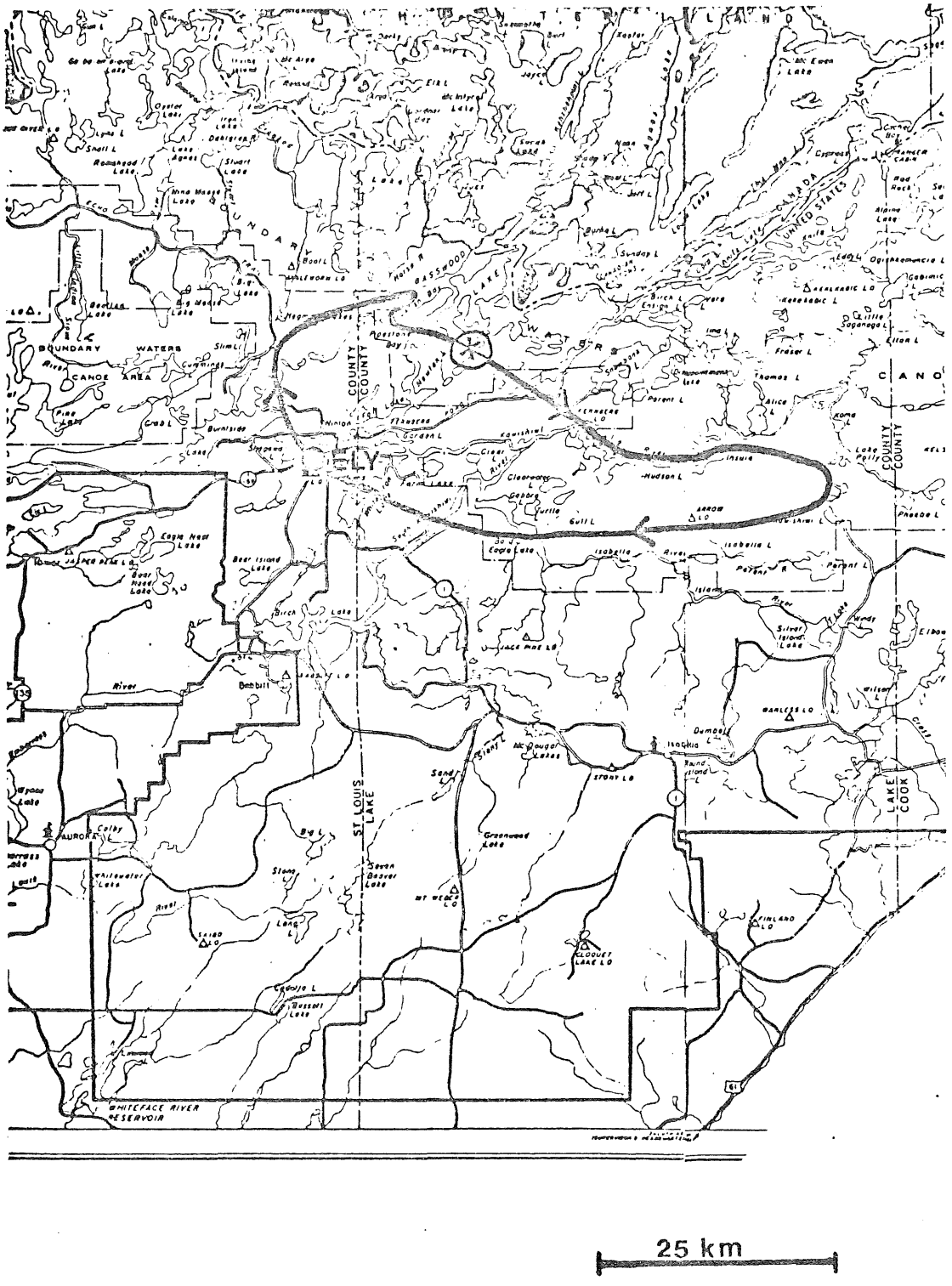


Figure W-2.
Aerial waterfowl survey--October 22, 1976.
(X Hoist Bay--100 waterfowl were observed, species unknown)

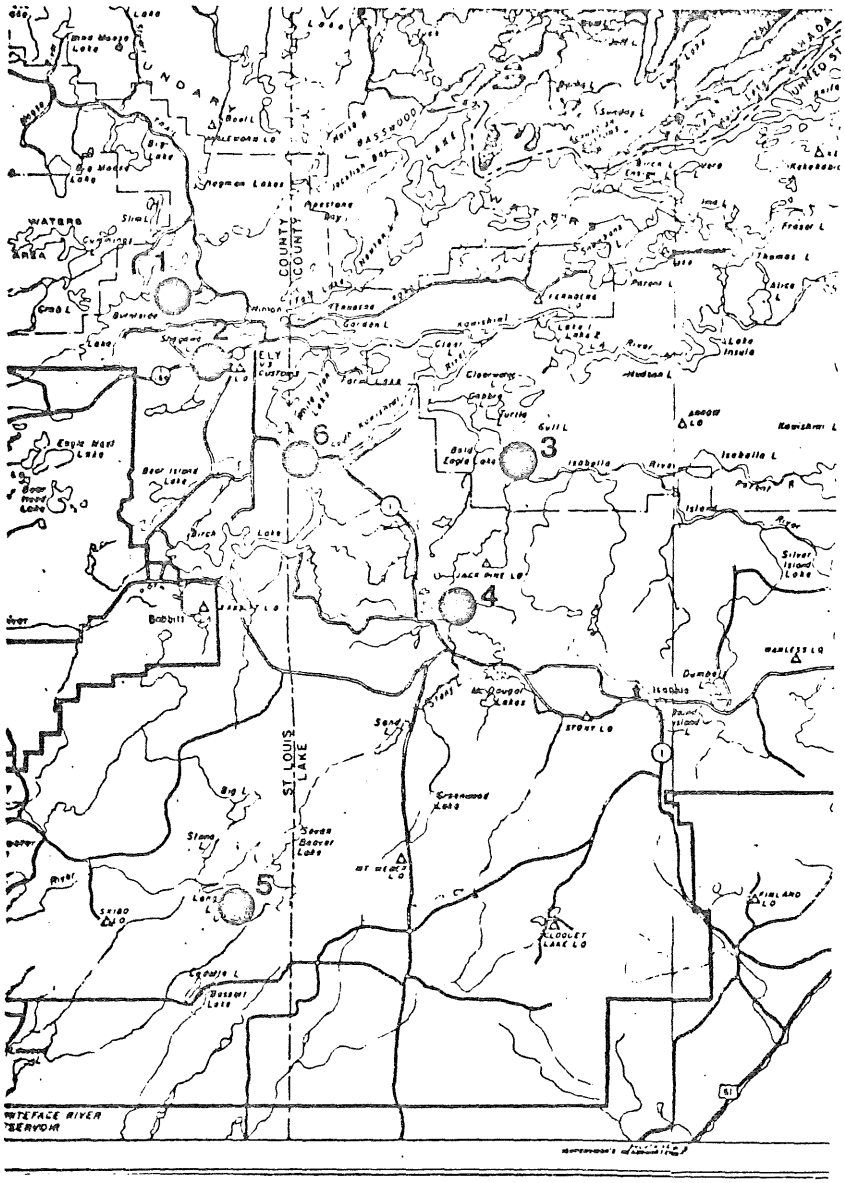


Figure W-1.
Waterfowl lakes within the Minesite area
(1-Burntside, 2-Shagawa, 3-Bald Eagle,
4-Slate, 5-Long, 6-Birch Lake Dam)

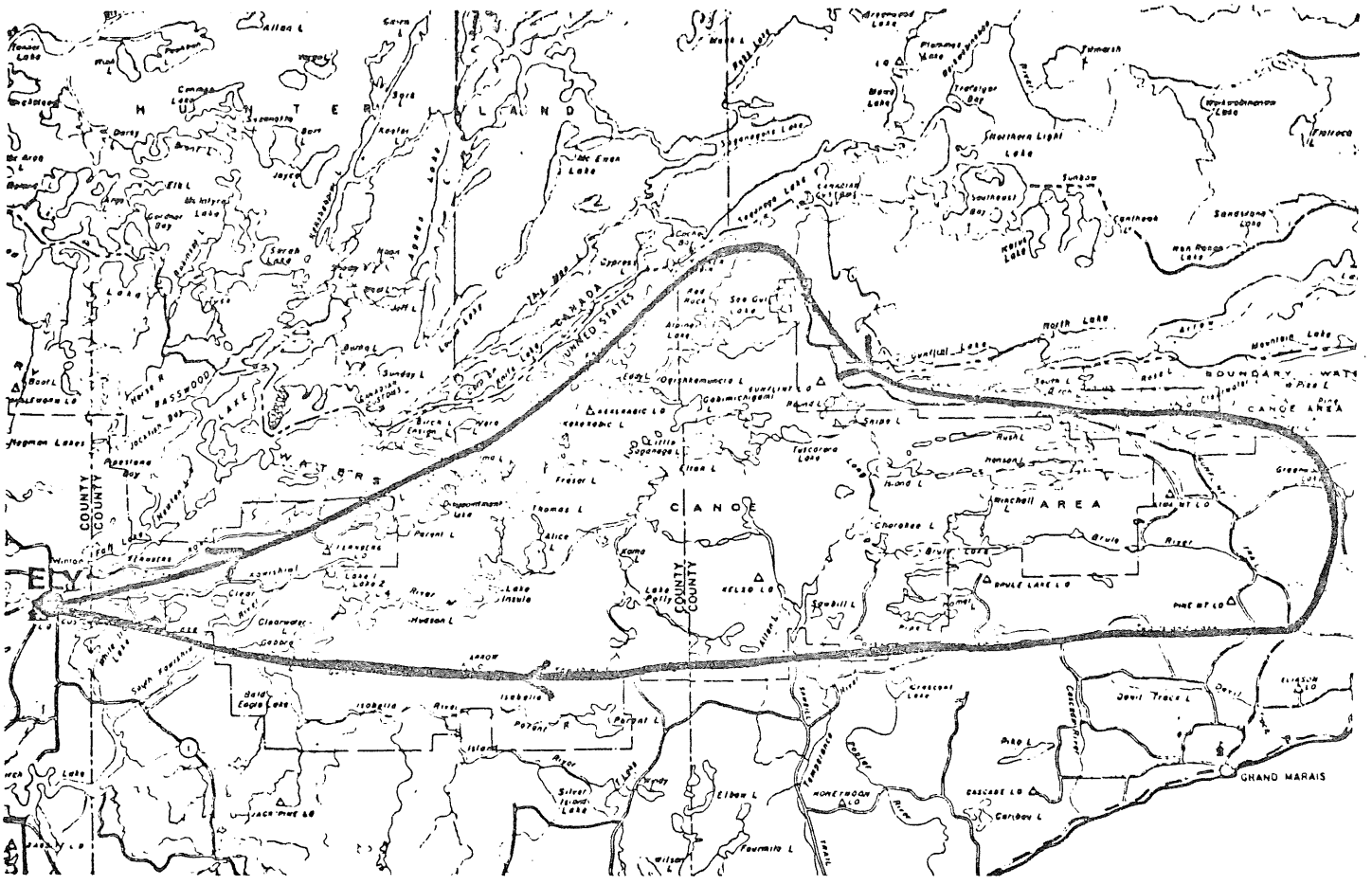


Figure W-3.
Aerial waterfowl survey--October 30, 1976.
(No waterfowl observed)

14. HUNTING AS A RECREATIONAL ACTIVITY ON THE MINESITE AREA

> Man has been primarily a hunter during most of his time on earth. Modern sport hunting, performed properly, reenacts a drama as old as man himself. In this day and age when many rely upon others to provide their sustenance through the killing of animals, hunting serves to keep man in closer touch with environmental realities and enliven his interest in his heritage as part of nature. (Portion of the Wildlife Society's policy statement on Sport Hunting.)

15. DEER HUNTER SURVEY

15.1 Introduction

Each November over 300,000 hunters take to the forest and farmlands of Minnesota in pursuit of the white-tailed deer. Within the boundries of the Minesite area, deer hunting is probably the single most important form of terrestrial recreation. This is based on the number of persons involved and total man-days spent in the field.

We investigated existing methods used by the MDNR to census hunters and hunting pressure and concluded that we required a more specific technique to delineate hunter concentration on specific portions of the study area.

Traditional methods currently used on a state-wide basis include the following (Karns, 1971); 1) hunter report cards voluntarily required of all license holders; 2) telephone census of randomly picked hunters to determine, among other things, the hunting success ratio. Other methods used (hunter check stations and pellet counts) or under

investigation (summer track census and examination of does killed by vehicles to determine reproductive conditions) are techniques used to determine the survivability, size, age structure, and condition of the deer herd, and are not direct statistics on hunting pressure for a given area.

15.2 Methods

The deer hunter survey we devised had five principle goals; 1) to determine the number of vehicles (which was then expanded to the number of hunters) per mile of selected forest roads throughout the study area to provide hunter density estimates; 2) since hunters try to maximize their success, we assumed that hunter densities would provide another indirect method of assessing relative deer numbers on various portions of the study area; 3) to provide data for evaluating the potential loss of certain parcels of land to mining operations on the regional deer population; 4) to determine the proportion of "local" to "non-local" hunters to evaluate whether the potential loss of certain areas would affect recreation for residents only, or hunters from the entire state; 5) finally, the method had to fall within the limited manpower of their project.

Nineteen routes were established from the far northwestern portion of the study area to the extreme southeast (Figure D-1). Each route was established along accessible (improved gravel) USFS or county roads. In all, 164 km of roads were censused in a period of 6-7 hours for three consecutive days, with a total trip of 272 km required to return to base.

Hunters were censused on opening weekend (November 13 and 14) and the first Monday (November 15) of the state's rifle season. The number of vehicles observed and hunter density estimates are thus the maximum expected for the area. The 19 routes were censused from north-south on the 13th and 15th, and from the south-north on the 14th to reduce any time bias that may be present.

The main census technique employed was to record license plate numbers from all vehicles observed. For each observation, the following information was recorded; road number, square mile number, license plate number, time seen, odometer reading and whether the vehicle was stopped (parked with no person(s) nearby) or moving (Table D-1). Locense numbers will be checked with the state to determine where each vehicle was registered for the breakdown of "local" and "non-local" hunters. Each vehicle parked was considered to be that of a deer hunter's, since use the the study area during summer and fall was very limited. We then calculated the number of cars/kilometer/route for the three days of the census, with an average for all three days.

The actual density of hunter per km and per hectare was determined by: 1) calculating the number of hunters per vehicle. This was done by counting hunters per moving vehicle and asking persons seen hunting near roads the size of their hunting party (person/vehicle); 2) calculating the number of hunters per hectare. Mech (1971) has estimated that the average distance hunters are willing to deer hunt from an access road in the Superior National Forest is one-quarter mile. The

area hunted was calculated by multiplying the length of each route (to the nearest 0.1 km) x 80.4 hectares (the area of a rectangular 1000 m long x one half mile, 804 m, wide).

In addition, when hunters were encountered near their vehicle they were asked whether they had hunted the area before or if this was the first time, and how they would rank the area as to deer seen per hunting effort (Table D-1).

A total of six man days (2 persons for 3 days) was required to complete this hunter survey.

15.3 Results

White-tailed deer are associated with early successional forest, primarily represented on the study area by the aspen community type. An area of approximately 115 square miles (29,500 hectares) adjacent to and south of the St. Louis River to County Road 16 contains the largest continuous aspen type on the study area. This area is represented on Figure D-1 by the land adjacent to and south of FR 120. The area has a variety of size and age classes and represents what we consider to be the most productive deer habitat on the Minesite area.

Roads that provide access to this area that were censused during this survey are FR 420, 120 569, 128, 130 and County Road 16 (Talbes D-2 and D-3). These roads were generally far above average with regard to vehicles/km (Talbe D-2) and estimated hunters/100 h (Talbe D-3). The only northern route that was used extensively was FR 181 (known

as the Spruce Road, Figure D-1). This area is not as diverse and does not have nearly the aspen resources as the southern area. However, habitat adjacent to FR 181 is some of the best deer habitat available in the northern portion of the area. The nearness of this road to Ely may also explain the high hunter density.

The northern area, represtned by FR 181, 173, 424, 178 and 1120 (Route 5), have a large portion of the forest in coniferes (20-30 year old red and jeck pine plantation and natural, extensive areas of black spruce) and a generally maturing forest type. The contral portion of the area (FR 112 (Route 8), 1431, 114, 116 and 113) have been heavily cut over and is either growing back to pine plantations, or a slow growing, shrub forest type.

Deer hunters encountered on the roads or near their vehicles were interviewed to determine whether they had hunted on the area before, or whether this was the first time on the area. A total of 54 different persons were interviewed. Eleven of these (20.4 percent) used the area for the first time, while the large majority (43, 79.6 percent) had hunted here before.

When asked to compare the area as good, fair or poor for deer hunting, 62 responses were divided as follows: 1) good (17, 27.4 percent); 2) fair (22, 35.5 percent); 3) poor (23, 37/1 percent). The majority of the "good" responses (12 of the 17) were on the southern one-fifth of the area.

License plate numbers have not yet been checked through the State to allow us to determine the proportion of "local" vs. "non-local" deer hunters on the area. The results of this check will be presented in future papers.

15.4 Conclusion

A deer hunter survey conducted during the first three days of the 1976 season (November 13, 14 and 15) provided information on the distribution and intensity of deer hunting on the Minesite area. The frequency of hunters was related to the distribution of the aspen ecosystem on the study area. Most hunters were encountered in the southern one-fifth of the area, with hunter densities in this area five to ten times that found along most northern and central census routes (Tables D-2 and D-3).

Few portions of the Minesite area currently have the potential for supporting a reasonable size deer herd (and the recreation associated with it) as does the southern one-fifth of the study area. This southern area of approximately 115 square miles (29,500 hectares) currently provides the majority of this form of recreation on the study area.

15.5 References

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Mech, L.D. 1971. Wolves, coyotes and does. In The white-tailed deer in Minnesota Symp. Proc., Edited by M.M. Nelson. Minn. Dept. Nat. Resour., St. Paul, Minn., p. 19-22.

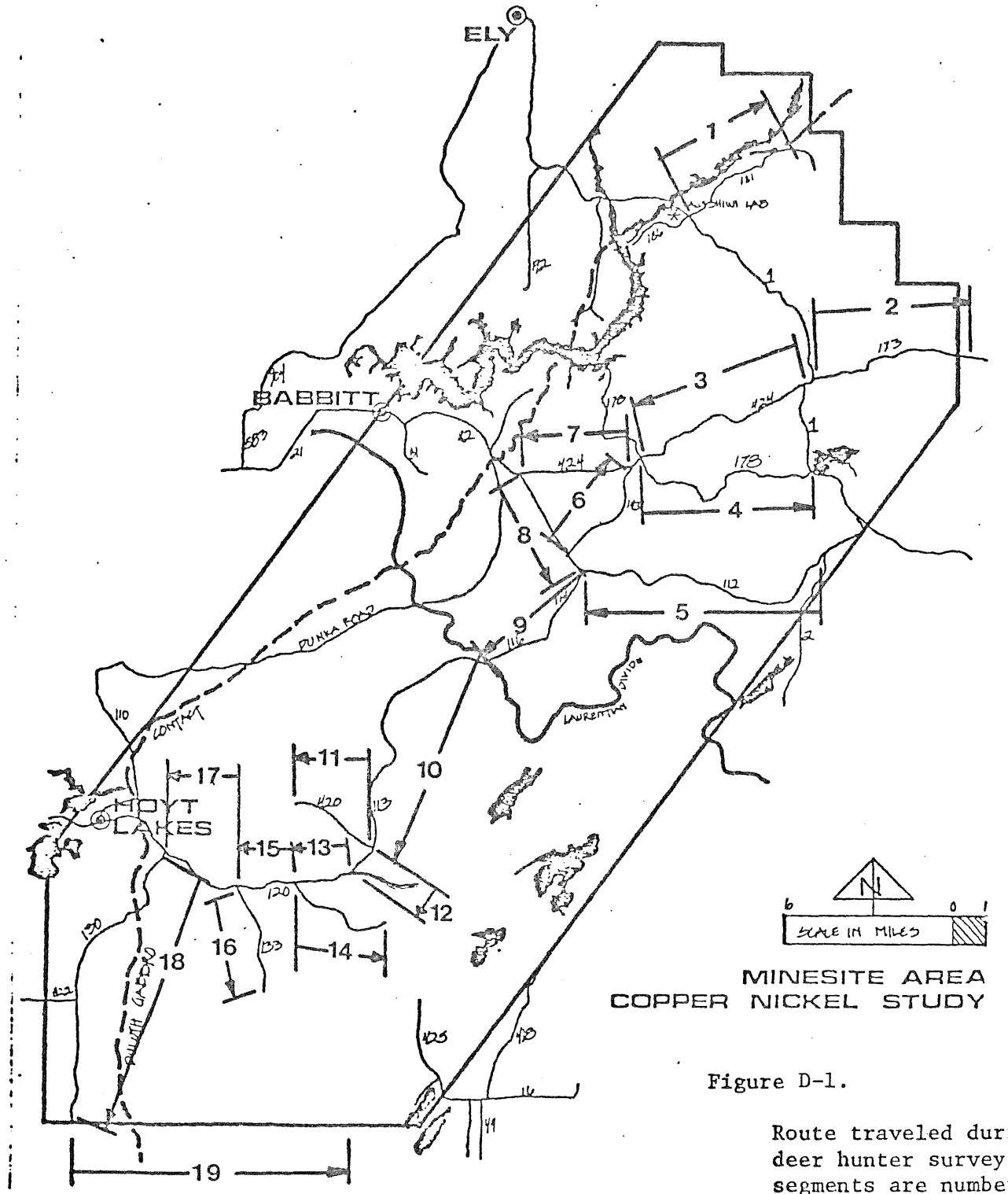

Figure D-1.

Route traveled during 1976 deer hunter survey. Route segments are numbered separately, along with the direction they were driven.

Table D-1. Deer hunter survey form.

TERRESTRIAL BIOLOGY
REGIONAL COPPER-NICKEL STUDY

BIG-GAME HUNTER CENSUS

SEASON__________ DATE__________ ODOMETER READINGS: START______
FINISH______
TOTAL MILES______

Road No.	Sq. Mile No.	Vehicle License No.	Time (Military)	Odometer Readings (000.00)	Vehicle: Stopped	Vehicle: Moving	Success: Deer	Success: Bear	Success: Moose	No. of Hunters In or Near Vehicle	Use of Area: First Time	Use of Area: Used Before	Hunter Eval. of Area: Good	Hunter Eval. of Area: Fair	Hunter Eval. of Area: Poor
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Table D-2.

The number of deer hunter vehicles[a] per kilometer by route number and date for the 1976 season.

Road No.[b]	Route No.[c]	Route Length(km)	Nov. 13 (cars/km)	Nov. 14 (cars/km)	Nov. 15 (cars/km)	Average for 3 days (cars/km)
FR181	1	8.2	4.4*	1.2	1.6*	2.4*
FR173	2	9.9	0.8	0.0	0.2	0.3
FR424	3,7	16.6	1.4	0.6	0.3	0.8
FR178	4	12.5	1.5	0.2	0.6	0.8
FR112	5,8	22.2	0.9	0.8	0.7	0.8
FR1431	6	6.2	1.2	0.4	0.4	0.7
FR114,116	9	8.3	0.9	0.9	0.3	0.7
FR113	10,12	16.8	1.1	0.6	0.1	0.6
FR420	11	5.6	1.8	1.4	0.9*	1.4
FR120	13,15,17	11.8	1.5	2.0*	1.3*	1.6*
FR569	14	6.1	3.4*	3.4*	0.8	2.5*
FR128	16	7.2	6.4*	5.3*	2.1*	4.6*
FR130	18	16.5	2.2*	3.7*	1.7*	2.5*
County Road 16	19	16.0	3.4*	4.5*	1.1*	3.0*
Totals & AVERAGES	19 routes	163.9 km	2.2 cars/km	1.8 cars/km	0.9 cars/km	1.6 cars/km

a only parked vehicles used in these calculations.

b FR is the Forest Road number designated by the USFS.

c see Figure D-1 for location of route in study area.

* Routes at or above the average.

Table D-3.

The number of deer hunters per 100 hectare by route number and date for the 1976 season.

Road No.	Route No.	Area of Route in Hectares[a]	Nov. 13 (hunters/100H)[b]	Nov. 14 (hunters/100H)[c]	Nov. 15 (hunters/100H)[d]	Average for 3 days (hunters/100H)[e]
FR181	1	659.3	1.40*	0.38	0.41*	0.73*
FR173	2	796.0	0.21	0.00	0.04	0.08
FR424	3,7	1334.6	0.22	0.09	0.04	0.12
FR178	4	1005.0	0.31	0.04	0.10	0.15
FR112	5,8	1784.9	0.10	0.09	0.07	0.09
FR1431	6	498.5	0.51	0.17	0.14	0.27
FR114,116	9	667.3	0.28	0.28	0.08	0.21
FR113	10,12	1350.7	0.17	0.09	0.01	0.09
FR420	11	450.2	0.84*	0.65*	0.34*	0.61*
FR120	13,15,17	948.7	0.33	0.44	0.23*	0.33
FR569	14	490.4	1.46*	1.46*	0.28*	1.07*
FR128	16	578.9	2.32*	1.92*	0.62*	1.62*
FR130	18	1326.6	0.35	0.58*	0.22*	0.38
County Road 16	19	1286.4	0.55	0.73*	0.15	0.48*
Totals AVERAGES	19 routes	13177.5 hectares	0.65 hunters/100H	0.49 hunters/100H	0.19 hunters/100H	0.44 hunters/100H

a area calculated by route length(km) x 80.4 hectares (the area of a rectangel 1000m long x one-half mile, 804m wide). An average in area between routes was not subtracted.
b 2.1 hunters/vehicle from Nov. 13 sample.
c 2.1 hunters/vehicle from Nov. 14 sample.
d 1.7 hunters/vehicle from Nov. 15 sample.
e 2.0 hunters/vehicle from Nov. 13, 14, and 15 sample, averaged.
* Routes at or above the average.

CHEMICAL ANALYSIS
PREPARATION OF SAMPLES

1. Each field site has been sampled in the following way.

   A. One sample bag of material was collected at each of 12 stations for:

      1) organic soil
         0-5cm
         5-10cm
         55-60cm

      2) mineral soil
         0-5cm
         5-10cm
         litter

      3) shrubs (1 or 2 sps)

      4) trees (1 or 2 sps)

   (When two shrub species and/or two tree species were sampled at the same site, twelve samples were collected from each species.)

   B. Four bags, each containing a different herb species were collected and pooled in the field from six different stations at each site.

2. All vegetation samples (leaves and needles), along with all organic litter and organic forest mat (mosses) material are oven dried at 60°C for 48 hours. Mineral soil (0-5 and 5-10cm) is air dried for 5 days.

3. Set out the 12 bags of 0-5cm soil, 12 of 5-10cm soil, 12 of litter, 12 or 24 bags of tree leaves, and 12 or 24 bags of shrub leaves from 1 site on a table. All bags (1-12) of the same soil depth and vegetation are lined up in numerical order from left to right and in rows behind each other.

Select random numbers to pool the 12 samples into 3 groups of 4 samples each.

For example:

Pooled Sample #1	Pooled Sample #2	Pooled Sample #3
includes sampling station 1,8,9,12	includes sampling station 4,6,7,11	includes sampling station 2,3,5,10

All of pooled sample #1 (whether tree, shrub, litter or soil) will include material from the same four stations so the soil chemistry can be compared to the vegetation chemistry. The same holds true for pooled samples #2 and #3.

4. Tree and Shrub. Work with one pooled sample at a time. Take pooled sample #1 (stations 1,8,9, and 12) for the tree species, weight out 2 gm samples (or an appropriate lesser amount if 2gm are not in each bag) from each station (to nearest 0.1 gm) and place in one bag (8 grams total of vegetative material before grinding).

A. If the tree sampled is a conifer, remove all needles from the twigs; saving only needles and discarding twigs, cones, buds, etc. Take needles from terminal and lateral twigs alike, sampling some needles from most twigs (not just stripping several twigs bare) until you have removed 2 grams.

B. For deciduous tree and herb species, take the entire leaf and attached petiole discarding any other plant parts (twigs, buds). If some leaves have been eaten by insects or are discolored from the remainder of the sample, use only those leaves that are properly colored and entire. If the entire sample is in "poor shape," pick the best leaves and note on separate data sheet this problem.

C. Grind entire 8 gram sample from pooled sample #1, mix and fill a clasp envelope full of the mixture. This should be at least 3-4 grams of material. Close the envelope with the clasp and place a piece of "magic-mending" tape across the flap. Do not glue the flap down. Print "code" number on envelope (see separate memo from Bill Patterson). Record the numbers from the stations pooled, plot number, weight of sample from each station, etc. on separate data sheet.

Repeat above procedure for the remaining pooled sample #2 and #3 for each species.

5. Soil. Combining the same four stations to form a pooled sample as done for trees and shrubs for the same site, proceed as follows:

A. Mineral Soil

Mineral soils are not ground in the mill. Place a piece of paper on the counter top, then the 2mm X 2mm screen, dumping the mineral soil on top of the screen. Using a rolling pin, roll the soil until all clumps are broken up. Discard peddles, roots, etc. left on the screen. Weigh out approximately 5 grams of screened soil for each stations sampled. The total pooled sample #1 from the 4 stations should weigh approximately 20 grams. Put in envelope as earlier.

B. Organic Litter

Weigh the entire litter sample from each station first. Record these weights on a separate data sheet. These weights will be used to estimate the weight of the litter layer for the forest floor.

Pass the litter sample from one station through a screen, but discard only pebbles remaining on the screen. Leaves and twigs are added to the finer material passed through the screen. Weigh out 2 grams of the sieved material plus leaves and twigs. Discard the remaining material. Grind the 8 gram sample, put in envelope as noted earlier.

Note: screening of the litter material is necessitated solely by the undesireability of grinding pebbles.

C. Organic Material

Weigh the entire sample from each station as above (5B). This material does not have to be passed through a screen. Weigh out 2 grams from each station and grind 8 gram pooled sample. Put in envelope as noted earlier.

6. Herbs. There are only 4 bags of herbs (each containing a different species) per site. These were collected from 6 stations and pooled in the field. "Crunch" up the entire sample from 1 bag (1 species) within the bag, using gloves and stirring the sample with your hand. Take portions of this mixed sample and grind until you have enough to fill the envelope (4-5 grams).