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HABITAT ANALYSIS AND MANAGEMENT
CONSIDERATIONS FOR RUFFED GROUSE
ON A MULTIPLE USE AREA IN MICHIGAN.

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HABITAT ANALYSIS AND MANAGEMENT CONSIDERATIONS FOR
RUFFED GROUSE ON A MULTIPLE USE AREA IN MICHIGAN

By
Alfred Berner
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A THESIS

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ABSTRACT

HABITAT ANALYSIS AND MANAGEMENT CONSIDERATIONS FOR RUFFED GROUSE ON A MULTIPLE USE AREA IN MICHIGAN

By

Alfred Berner

Observations of ruffed grouse and measurements of grouse habitat were made during all seasons for two years in aspen, lowland hardwood, and upland northern hardwood types on glacial moraines in Wexford County, Michigan on the Manistee National Forest. Areas containing the necessary diversity for grouse were centered around drainage areas where there was a gradual transition from a poorly-drained lowland soil to a well-drained upland soil. These transition zones which had a high degree of vegetative diversity and were dominated (in most cases) by trembling aspen, were the focal point of the brood range. The aspen type appeared to be important because of the food the larger aspen provided, and because of the diverse, moderately dense shrub and herbaceous layers that were maintained under the aspen canopy.

Grouse management should be limited primarily to the transition zone, and should consist of clear cutting 5-10 acre blocks or 300-600 foot wide strips of aspen in 40-50

Alfred Berner

years rotations (on medium sites) and 10-year cycles to maintain even-aged stands in different age classes in close proximity to each other. Ten per cent of 20-acre coverts should be kept in small, permanent, shrub openings which would supply needed food and cover species for broods. Upland sites should be maintained as all-aged stands for sawtimber production and to benefit upland wildlife species, particularly the recently re-introduced wild turkey, squirrels, and deer. All multiple use interests should benefit from this type of management plan.

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INTRODUCTION

Until recently, most of our publicly owned forest lands in the Lake States were managed with only minimal regard for interests other than forestry. However, with the advent of the multiple use concept, recreation, wildlife and esthetics have attained an equally important role in management considerations.

As the multiple use concept becomes increasingly influential on the management plans of our federal and state forests, the critical need for multiple use wildlife management plans becomes evident. Management of ruffed grouse (Bonasa umbellus) habitat is of primary concern since grouse need youthful forest types, which are, in general, difficult to maintain without a conflict of interest.

In 1965, Michigan State University and the North Central Forest Experiment Station of the United States Forest Service initiated a cooperative study on ruffed grouse. The objectives of this study were: (1) to measure and describe the habitat components used by grouse; (2) to describe sites with good grouse habitat productivity; and (3) to formulate a habitat management plan for ruffed grouse which can be integrated with other forest practices and interests.

STUDY AREA

Location

The study area chosen was section 4-T21N-R12W, which is located in the northern portion of the Manistee National Forest, in Wexford County, Michigan. The area was chosen for its diversity and because of its similarity to most of the surrounding sections.

Physiography

The topography of the square mile study area (640 acres) is characterized by hilly glacial moraines, which range in elevation from 1,000 to 1,200 feet (Figure 1). Approximately 75 per cent of the area has 0 to 5 degree slope; the remaining 25 per cent varies from 6 to 60 degree slope.

Approximately 92 per cent of the study area is covered by well-stocked stands of aspen and northern hardwoods. The remaining 8 per cent is comprised of 3 per cent poorly-stocked stands, 4 per cent openings and 1 per cent roads and trails (see Figures 2 and 3, in back pocket). The five general vegetation types present are: (1) Lowland Hardwoods (LH), characterized by tree species such as American elm

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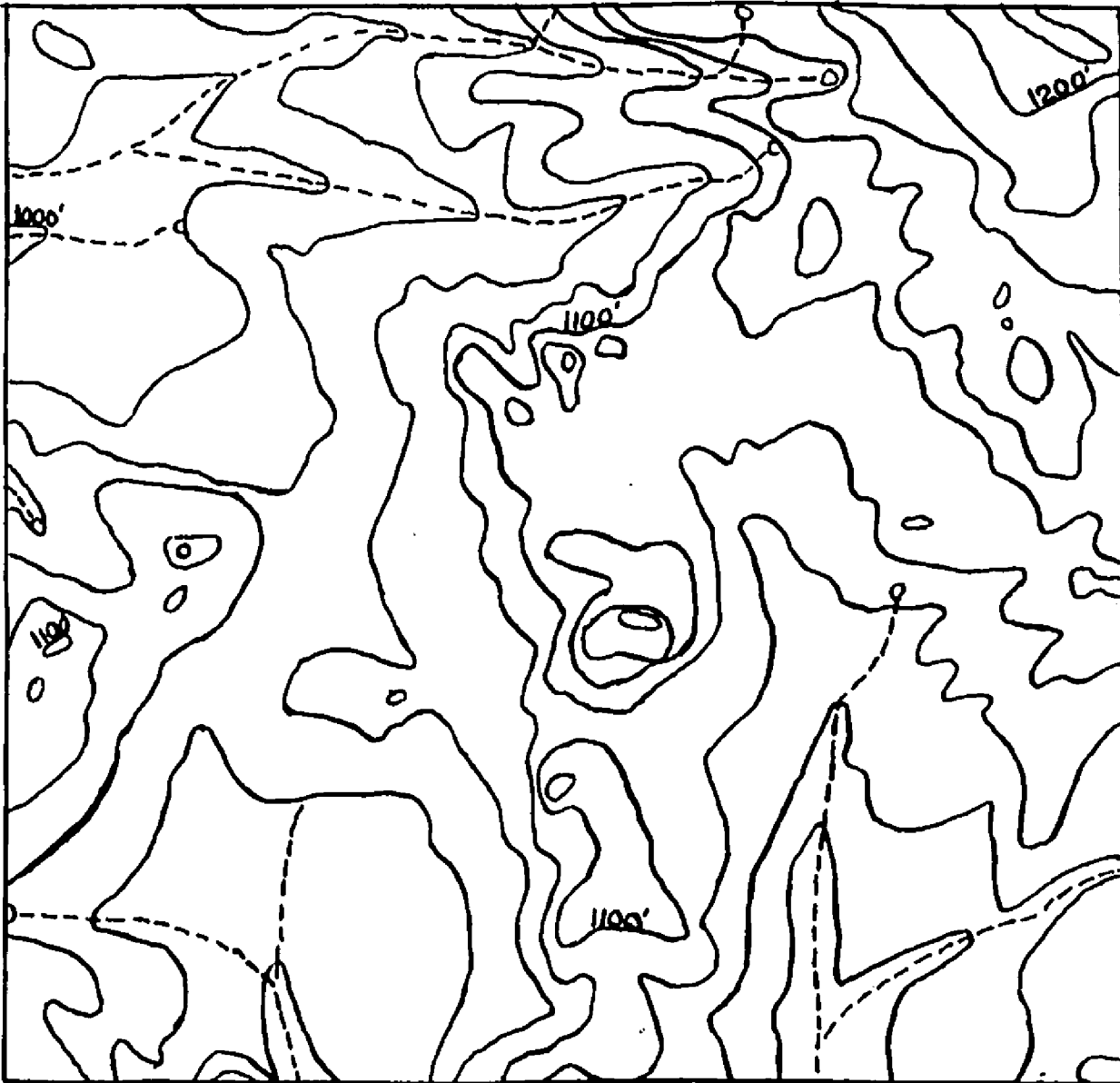


Figure 1. Topographic map of the square mile study area. Contour intervals are 20 feet; dash lines are for streams and small circles are for springs. (Scale 1 in = 910 feet.)

(Ulmus americana), black ash (Fraxinus nigra), red maple (Acer rubrum), and blue beech (Carpinus caroliniana); (2) Aspen (A), dominated by trembling aspen (Populus tremuloides), and big-tooth aspen (Populus grandidentata) in the overstory or understory; (3) Aspen-Hardwood Mixture (A-H), dominated by hardwoods such as sugar maple (Acer saccharum), black cherry (Prunus serotina), and white ash (Fraxinus americana) with some aspen present; (4) Upland Northern Hardwoods (UH), characterized by sugar maple, basswood (Tilia americana), hophornbeam (Ostrya virginiana), white ash, red oak (Quercus rubra) and black cherry; and (5) Openings (O), characterized by large amounts of various grasses and herbs, and/or shrubs, but with less than 50 per cent of the area covered by trees of such species as black cherry, basswood, rock elm (Ulmus thomasi) and aspen.

The two principal soil series present, Blue Lake and Kalkaska, differ only slightly in their structural composition (Webber per comm 1968).¹ The Blue Lake Series contains a finer sand, particularly in the lower B horizon, which gives these soils a higher water holding capacity than those of the Kalkaska Series. The higher water capacity is usually reflected by the presence of mesic vegetation in the uplands. Also modifying the soils and vegetation is the presence of a claypan layer which aids in maintaining a high water table.

¹Soils Specialist for the Soil Conservation Service in the Traverse City-Cadillac-Manistee area.

This clay layer is evident under several of the springs that arise within the study area. All seven springs arise between the elevations of 1,060 and 1,120 feet (Figure 1).

Seasonal Climatic Conditions

Climatological standard normals obtained from the United States Weather Bureau at Cadillac, Michigan, 18 miles east of the study area, were calculated for the years of 1928-1957. The average yearly temperature for this 30-year period was 43.1° F., mean maximum 53.3° F., and mean minimum 32.8° F. The average annual precipitation for the same period of time was 30.8 inches, of which 8.4 inches were in the form of 60.3 inches of snow.

Seasonal standard normals for the same 30-year period were calculated per three-month period and were determined as follows: Winter, January-March, had an average temperature of 21.6° F., a mean maximum of 30.1° F., and a mean minimum of 12.8° F. The average precipitation for this three-month period was 5.51 inches in the form of 39.8 inches of snow. The spring months of April-June had an average temperature of 52.2° F., a mean maximum of 64.1° F., and a mean minimum of 40.2° F. The average precipitation for three months was 8.89 inches of which 0.65 inches were in the form of 4.7 inches of snow. The summer months of July-September had the highest average temperature which was 63.6° F., mean maximum 75.9° F. and mean minimum 51.3° F.

Average rainfall was calculated to be 9.01 inches for the three-month period. Fall, October-December, had an average temperature of 34.9° F., a mean maximum of 42.9° F., and a mean minimum of 26.7° F. The average precipitation was 7.42 inches of which 2.2 inches was in the form of 15.8 inches of snow.

METHODS

Mapping

For descriptive purposes and to study the influence of interspersation and juxtaposition of vegetation types on grouse use, the landmarks, vegetation types and site zones of the area were mapped. This mapping was accomplished using a 1956 United States Forest Service type map, 1965 aerial photographs, a 1964 Geologic Survey topographic map, and ground reconnaissance. Distinctions between vegetation types were made on the basis of variations in the species, density, and size class of the woody plants. Site zones were determined from the topographic map, a preliminary soil survey map, and a general ground survey conducted by a soils specialist.

Type Analysis

A detailed analysis of the mapped vegetation types was obtained by a series of nested plots and line intercepts (Figure 4). The plots and lines were used to obtain estimates of various descriptive parameters (Table 1). In general, the number of plots in each type was approximately

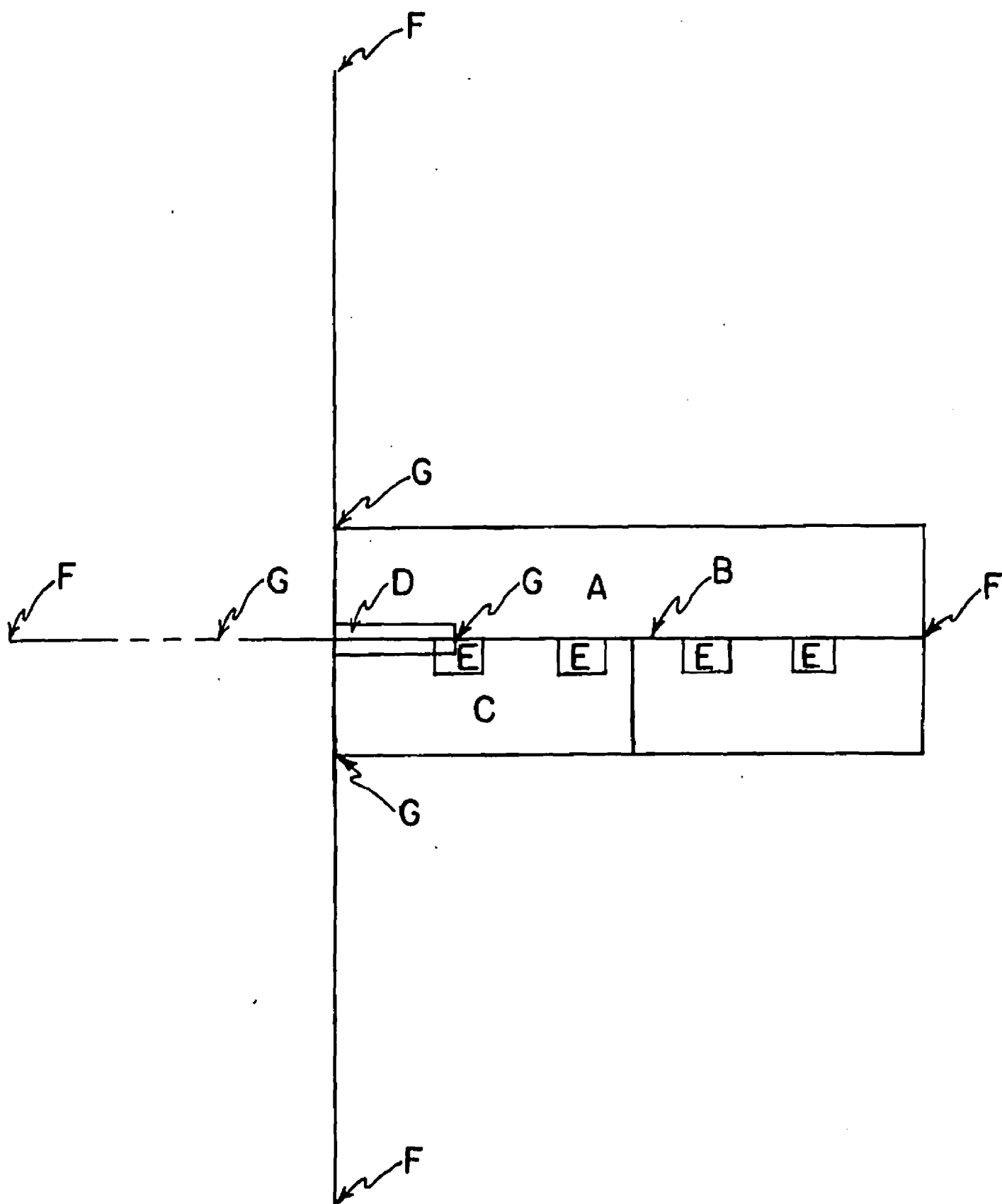


Figure 4. Diagram of nested plot system and line intercepts used to sample the parameters. Plot and line sizes and descriptive parameters are given in Table 1.

Table 1. Listing of plot and line intercept sizes, and the corresponding descriptive parameters sampled by that plot or line.

Plot or line	Number of plots or lines	Size of plot or line	Descriptive Parameters
A	1	50'x 20'	Species composition and stem density of trees over 1" dbh. broken down into four size categories: 1-4"; 5-8"; 9-12"; and 13+" dbh.
B ₁	1	50'	Species composition and percent of canopy cover. 3 size categories: dominant, sub-canopy, and understory.
B ₂	1	50'	Height of canopy cover in the 3 size categories listed for B ₁ .
C	1	25'x 10'	Species composition and stem density per acre of saplings and shrubs over 1' in height. 3 size categories: 1-3' in height; 3-10' in height; and 10' in height to 1" dbh.
D	1	10'x 2'	Species composition and stem density of herbaeaceous ground cover and woody species less than 1' in height.
E	4	4'x 3'	Percent of ground cover between 8" and 36" in height.
F	4	10'	*Density profile readings of ground cover between 0 and 18" in height.
G	4	50'	*Density profile readings of the understory and ground cover between 0 and 6' in height.

* For further explanation of this measurement refer to methods section of this paper.

proportional to its area. Plots were located along one or more lines which were established randomly in the type.

One descriptive parameter that needs clarification is the density profile. The density profile is an innovation of the method of cover measurement described by Wight (1938) (Figure 5). In my study, however, the 6-foot density board was placed 50 feet from the observer (the mean flushing distance of a grouse [Bump et al. 1947]), and the observer recorded the per cent category of obstruction ($0-33\% = 0$; $33-66\% = 0.5$; $66-100\% = 1$) for each 1-foot interval. By this method, I obtained an estimate of the average per cent of obstruction due to cover for each of the six, 1-foot intervals (Figure 7). When graphed, these points gave a density profile for that particular vegetation type.

The same general procedure was used to estimate the density profile of the ground cover layer. In this case, however, an 18-inch high density board was placed 10 feet from the observer (Figures 6 and 8).

Symbols for Type Mapping

For type mapping purposes, the series of symbols used by the United States Forest Service in 1956 were modified to denote certain characteristics of the vegetation types which were apparently important to grouse. These modifications allowed for notations which indicated the per cent categories of ground cover between the height of 8 to 36

Figure 5. The 6-foot density board in use. (Readings would be: $1' = 0.5$; $2' = 0.5$; $3' = 0$; $4' = 0$; $5' = 0.5$; and $6' = 0.5$).

Figure 6. The 18-inch density board in use. (Readings would be: $0'' = 1$; $3'' = 0$; $6'' = 0.5$; $9'' = 0$; $12'' = 0$; and $15'' = 0$).

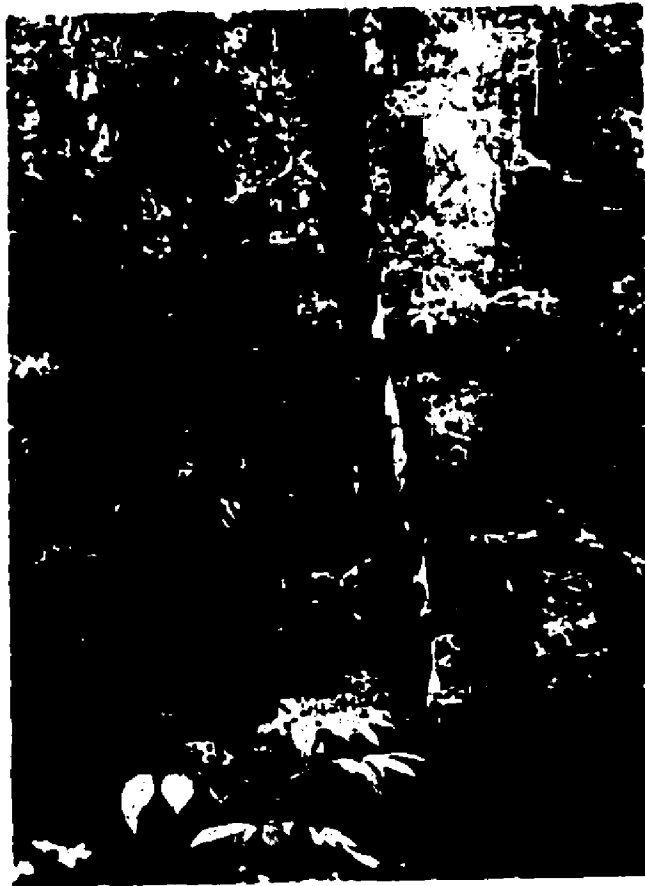


Figure 5



Figure 6

Figure 7. Illustration of how the 6' density board was used and what portion of the cover was measured.

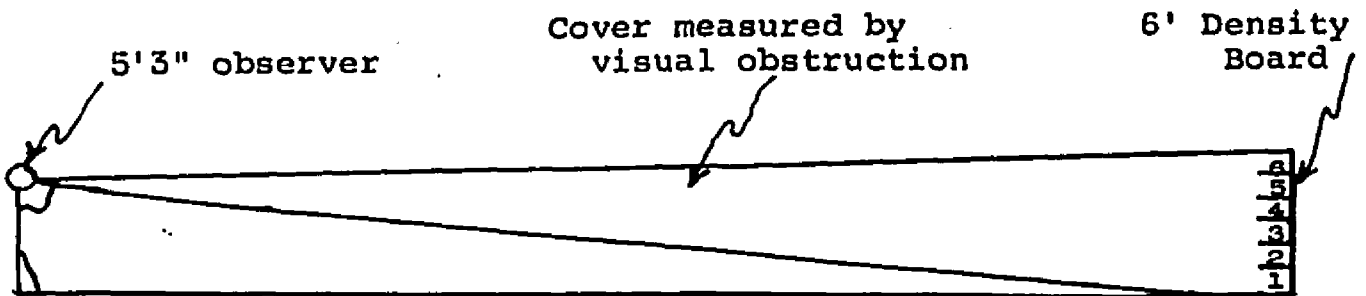
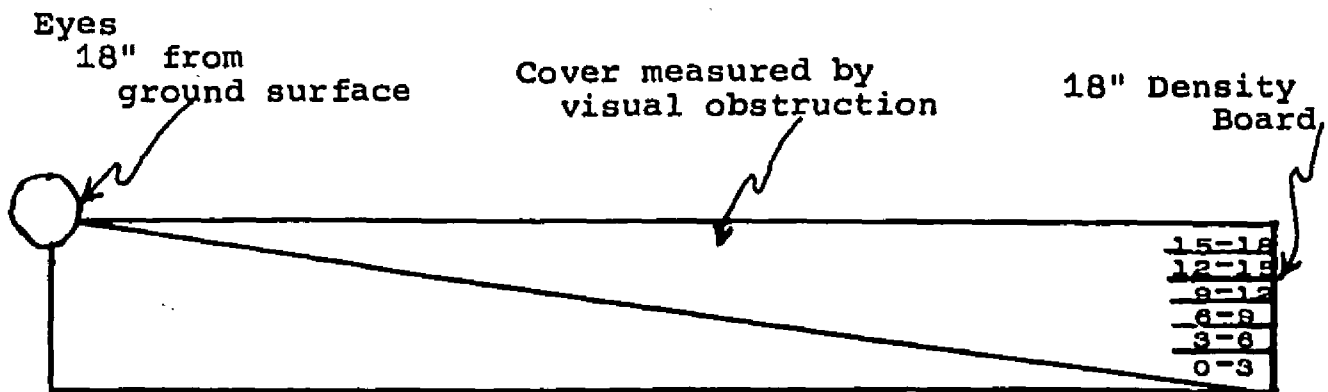


Figure 8. Illustration of how the 18" density board was used and what portion of the cover was measured.



inches, and the stem density categories of shrubs and saplings, as well as the species composition group, density and dominant size class of the overstory. For an explanation of the symbols used, see Table 2 accompanying the overlays in the back pocket.

Determination of Grouse Use

In order to determine the vegetation types, and site zones used by grouse, observations of grouse use were made by seasonal searches of the quarter sections (160 acres). Each quarter section was searched an equal number of times during the first year. During the second year, due to the extremely few observations, the northeast quarter section was searched only once in each season. The remaining quarter sections were searched an average of five times each (3-6). The concentrated searching of a given area was the method found most useful by Bump (ibid.). A pointing dog was used at all times, except when drumming counts were being made. Flushes and drumming counts were used to obtain population estimates. No attempt was made to locate nests due to the limited time and manpower available.

Analysis of Data

For the purpose of analysis, all observations were plotted on the study area map, and summarized according to season, type of sign, vegetation type and site zone.

These data were then statistically analyzed using the One-Way Analysis of Variance and Duncan's New Multiple Range Test to detect differences in the descriptive parameter means of the vegetation type used by grouse at various seasons. Chi-square analysis was used to detect seasonal differences in the grouse use of the three site zones and the five general vegetation types.

In the final analysis of the observational data, the functional grouse range of the study area was calculated by encircling 95 per cent of the observations in each of the three areas of concentrated grouse use (see Figures 9 and 10 in back pocket). Vegetation types and site zone composition of the three areas were then analyzed in relation to grouse use. In the text to follow, the phrase Transition Zone Management Unit will be synonymous with Grouse Habitat Compartment.

The areas of the various vegetation types and site zones were calculated by the use of a planimeter.

RESULTS

Grouse Population Estimates

During the course of this study, spring populations were estimated by use of spring drumming counts (Petraborg et al. 1953; Gullion 1966c), and fall populations by noting flushes of individuals and broods during the summer (Bump, ibid.). In the fall of 1966, I estimated that there were 60 to 70 grouse; an ecological density of about one grouse per 5 acres (Table 3). Drumming counts during the following spring indicated a breeding population of 22 birds. Due to the absence of three broods and a lower mean brood size (4.8 instead of 6.1), the fall population of 1967 was estimated to be 40 to 50 birds; an ecological density of about one grouse per 7.9 acres. This reduction in the fall population apparently did not have any appreciable effect on the following spring population since it remained essentially stable at 20 grouse. Preliminary observations in the summer of 1968, after the termination of the study, indicated that the fall population would be between 50 and 60 birds.

The mean spring breeding population density of one grouse per 16.7 ± 0.7 acres remained quite stable during

Table 3. Estimations of the grouse populations in the spring and the fall of the two-year study.

Grouse Habitat Compartments	Population Estimates										
	Spring		Broods			Fall			Spring	Broods	Fall
	Year		Year			Year			Average	Average	Average
	1967	1968	1966	1967	1968	1966	1967	1968			
1 (NW)	8	8	**19(3)	* 11(2)	11(2)	25	18	18	8	13.7(2.3)	20.3
2 (SE)	6	4	12(2)	3(1)	13(2)	17	8	17	5	9.3(1.7)	14.0
3 (SW)	8	8	18(3)	11(2)	13(2)	25	17	20	8	14.0(2.3)	20.6
Total	22	20	49	25	37	67	43	55	21	37.0(6.3)	55.3

* The total number of different broods observed.

** The total number of chicks in the broods observed.

the two-year study. The fall ecological density, however, fluctuated 30 per cent from its mean of one grouse per 6.1 acres (one per 5 to one per 7.9).

Detailed Analysis of the Vegetation

Twenty vegetation types were sampled using 306 plots. The smallest type mapped required 4 plots and the largest 37; the average was 15. Estimates of the descriptive parameters listed in Table 1 were calculated for each of the vegetation types from the plot data (Tables 4 and 5). Tree species most commonly present on the study area, in order of abundance and frequency, were: sugar maple, trembling aspen, black cherry, basswood, rock elm, white ash, red oak, beech (Fagus grandifolia), red maple, hophornbeam and juneberry (Amelanchier laevis). The understory was composed primarily of saplings of trembling aspen, sugar maple, juneberry, white ash, hophornbeam, black cherry and red oak, and of a shrub layer of blackberry (Rubus allegheniensis), maple-leaf viburnum (Viburnum acerifolium), red raspberry (Rubus idaeus), gooseberry (Ribes cynosbati), witch hazel (Hamamelis virginiana), and honeysuckle (Lonicera involucrata). The dominant herbs were bracken fern (Pteridium aquilinum), violets (Viola spp.), various grasses, goldenrod (Salidago spp.), club mosses (Lycopodium spp.), strawberry (Fragaria virginiana), hawkweeds (Hieracium spp.) and buttercups (Ranunculus spp.). Complete listings of the identified plants are given in Tables 14, 15 and 16 in the Appendix.

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Table 4. Estimations of the overstory descriptive parameters for each of the 20 vegetation types.

	Vege- tation Types	Trees									DO
		Density Stems/acre					Canopy Cover Per cent				
		1-4"	5-8"	9-12"	13+	Total	DOM	SubC	UND.ST.	Total	
Lowland Hardwoods	H5*	541	183	118	12	853	55.4	29.4	47.8	129.6	52
	H6	932	244	13	--	1189	42.5	37.1	51.5	131.1	43
	A2H2	260	46	---	--	306	12.7	----	47.4	60.1	33
	A2H2	258	58	9	--	325	30.8	18.6	19.6	69.0	44
	A3H3	442	97	29	5	573	24.6	36.8	50.0	114.4	44
	A3H3	425	131	43	12	610	64.5	6.5	31.0	102.0	50
	A3H4	632	107	11	--	751	37.8	11.2	58.3	107.3	42
	A4H3	558	135	52	13	758	57.8	25.9	31.9	115.6	41
	A4H4	1080	110	23	--	1214	54.0	11.0	50.5	115.6	41
	A6H2	1674	70	2	--	1746	19.7	----	78.2	97.9	46
Upland Aspen- Hardwood Mixtures	H3A1	213	96	---	--	309	31.7	39.5	17.3	88.5	41
	H3A3	507	97	21	4	679	46.4	16.1	27.5	90.0	41
	H4A2	307	122	35	9	473	49.0	36.5	30.5	116.0	41
	H3	225	87	35	4	349	40.2	12.5	11.6	64.3	41
	H4	408	220	49	4	681	76.0	19.4	38.4	133.8	51
	H5	550	241	82	4	878	72.5	16.8	51.9	141.2	51
	H6	696	192	43	--	931	68.8	21.2	36.6	126.6	51
	H1&A1	15	6	2	1	25	6.6	----	1.2	7.8	41
	H2&A2	68	35	21	13	137	19.4	8.0	1.0	28.4	41
	H3A2	49	185	27	9	270	20.6	19.2	6.8	46.6	51
Open- ings											

* Refer to Table 2 for interpretation of vegetation types.

s for

over e ST. Total	Canopy Cover Height			Saplings & Shrubs			
	DOM	SubC.	UND.ST	Density Stems/acre			Total
				1-3"	3-10"	10"-1'	
129.6	51.6	36.0	23.2	3675	35	180	3890
131.1	43.0	34.7	14.8	4094	1080	540	5714
60.1	33.0	----	9.6	5153	5476	923	11552
69.0	44.6	33.1	19.6	2448	2865	209	5522
114.4	48.2	34.7	11.8	5411	3463	731	9650
102.0	50.5	35.0	16.3	5973	1439	44	7455
107.3	41.0	33.5	13.0	5313	4312	1694	11319
115.8	46.8	32.4	13.0	5064	1580	350	6995
115.8	42.1	33.3	15.1	5622	3315	862	9799
97.9	40.1	----	14.6	4161	2582	635	7378
88.5	43.6	34.8	10.1	5133	1276	174	6583
90.0	46.5	31.8	16.2	3170	582	437	4189
116.0	46.2	36.0	13.4	4382	1903	188	6473
64.3	42.3	35.1	17.3	2618	174	---	2792
133.8	55.5	50.3	25.2	3200	100	62	3362
141.2	59.2	50.4	29.1	3500	50	243	3793
126.8	51.0	28.0	10.4	1200	200	96	1496
7.8	47.7	----	18.0	4568	66	---	4636
28.4	48.0	35.0	29.0	6307	292	21	6620
46.8	50.0	32.3	11.2	13144	1276	224	14644

Table 5. Estimations of the understory descriptive parameters for each of the 20 vegetation types.

Vegetation Types	Understory						Ground Cover								
	Density Profile						Density Profile								
	One-foot Intervals						Three-inch Intervals								
	1	2	3	4	5	6	D*	E*	0-3	3-6	6-9	9-12	12-15	15-18	
H5	87.5	49.5	35.0	22.5	20.0	22.5	4.9	43.9	77.5	45.0	32.5	22.5	17.0	20.0	
	**55.0	40.0	33.3	28.3	25.0	23.3									
H6	88.8	72.5	52.5	47.5	45.0	43.7	3.2	28.2	63.8	37.5	27.5	15.0	15.0	12.5	
	42.3	27.8	14.5	12.3	10.0	10.0									
A2H2	100.0	100.0	98.7	98.4	91.9	92.5	3.5	82.0	98.4	92.5	86.9	81.3	83.8	87.9	
	71.7	55.8	45.0	33.3	28.3	27.5									
A2H2	99.2	98.3	90.8	79.2	62.8	51.7	3.1	7.4	93.4	82.5	73.4	66.6	59.2	59.2	
A3H3'	96.2	93.1	87.6	78.8	75.0	70.0	2.8	38.3	86.9	65.6	53.1	47.5	38.1	38.1	
	49.2	27.5	20.0	20.0	20.9	23.4									
A3H3	90.6	84.4	75.0	46.9	28.2	34.4	2.9	51.6	78.1	75.0	56.3	40.6	43.8	43.8	
A3H4	99.3	95.0	90.0	85.8	79.9	80.0	3.4	55.0	98.3	91.7	84.2	74.2	66.7	64.2	
	69.2	55.9	48.3	40.0	34.2	36.7									
A4H3	98.5	90.0	68.8	50.0	42.5	52.5	5.3	48.4	93.7	88.2	72.5	62.5	51.5	50.0	
	45.0	30.0	24.2	21.7	20.9	21.7									
A4H4	95.8	90.0	76.7	64.2	49.2	50.7	6.9	57.1	93.3	85.7	80.0	66.7	55.0	53.3	
	57.5	33.3	25.9	24.2	21.7	21.7									
A6H2	100.0	96.7	93.4	84.1	72.5	82.5	2.6	67.9	100.0	88.4	74.2	65.8	59.2	57.5	
	52.7	40.7	32.0	30.0	29.3	29.3									
H3A1	95.8	87.5	72.9	56.2	54.2	47.9	3.4	55.8	97.9	95.8	86.2	81.1	75.0	64.6	
H3A3	95.0	89.2	70.9	55.0	40.9	35.9	4.0	65.3	91.7	86.7	80.9	68.3	60.9	53.5	
	56.0	24.7	20.0	18.0	16.0	21.3									
H4A2	70.9	55.8	42.5	52.5	40.8	40.8	1.4	21.0	48.3	27.5	17.5	16.7	13.3	7.5	
	45.7	34.0	23.3	20.7	21.3	21.3									
H3	54.4	27.5	15.6	13.1	16.2	22.5	3.7	11.8	33.8	8.8	7.5	2.5	8.1	8.8	
	25.0	14.2	10.8	6.3	7.5	7.5									
H4	64.0	50.0	41.5	36.0	33.1	32.9	1.2	19.0	38.0	23.0	15.0	12.0	9.0	7.0	
	33.3	18.0	15.3	14.7	15.3	16.0									
H5	66.2	55.0	43.7	38.5	36.0	34.1	1.0	11.9	35.0	20.0	14.0	11.0	8.0	7.0	
H6	68.0	63.0	57.5	52.5	48.5	46.2	1.0	8.8	30.0	10.0	7.5	5.0	3.0	3.0	
Ha&A1	67.6	33.5	16.0	14.2	17.0	17.2	5.4	25.9	83.1	60.0	38.0	29.8	18.6	10.0	
Ha&A2	63.8	39.1	23.7	16.9	19.4	29.4	5.4	36.7	83.1	61.1	44.4	37.4	26.9	21.2	
H3A2	85.0	65.0	32.5	27.5	25.0	32.5	7.1	35.5	92.5	75.0	47.5	45.0	32.5	30.0	

*Letters correspond with those in Table 1 which describes the parameters measured.

**Understory density profile readings for type in winter.

The principal vegetation constituents of the study area were (Tables 4, 5, and 6; Figure 3 in back pocket): (1) well-stocked, pole-sized upland northern hardwoods, with little or no ground cover (less than 20%) between 8 and 36 inches and very little understory cover under 6 feet in height, covered 58.4 per cent of the area; (2) pole-sized aspen-hardwood mixtures, with a moderately dense shrub and sapling layer and spotty ground cover (20-30%), covered 11.3 per cent; (3) mature aspen, with moderate ground cover (40-50%) and a moderately dense shrub and sapling layer, comprised 1.4 per cent; (4) pole-sized aspen, with moderately dense ground cover (50-70%) and a dense shrub and sapling layer, comprised 2.9 per cent; (5) sapling aspen, with moderately dense to dense ground cover and a dense shrub and sapling layer, covered 15 per cent; (6) small openings, roads, and poorly stocked stands (those with less than 250 stems per acre over 1-inch dbh or less than 50% canopy cover); with dense shrub borders or patches and spotty ground cover, comprised 8.2 per cent; and (7) the remainder of the area, 2.8 per cent, was covered by lowland hardwoods which had moderate sedge and shrub cover.

The three Grouse Habitat Compartments present on the study area varied in size from 92 to 124 acres, and included 52 per cent of the total area (Tables 7 and 8; Figure 9 in back pocket). The most common tree species present in these Compartments, in order of abundance and frequency, were:

Table 6. The area in acres of each of the 20 vegetation types on the study area (see Figure 3 in back pocket).

Vegetation Types	Quarter Sections							
	NW $\frac{1}{4}$				NE $\frac{1}{4}$			
	Forties				Forties			
	NW	NE	SE	SW	NW	NE	SE	SW
H5	0.1	----	----	1.9	----	----	----	----
H6	3.7	1.2	----	1.0	----	----	----	----
Total	3.8	1.2	0.0	2.9	0.0	0.0	0.0	0.0
A2A2	4.9	3.1	----	7.2	----	----	----	----
A2H2	0.2	----	----	3.3	----	----	----	----
A3H3	2.2	2.4	----	----	7.3	----	----	0.2
A3H3	----	----	5.6	----	----	----	----	----
A3H4	----	----	----	----	----	----	----	----
A4H3	4.8	----	----	4.0	----	----	----	----
A4H4	----	1.3	----	----	4.7	----	----	0.5
A6H2	8.9	7.9	----	----	0.8	----	----	----
Total	21.0	14.7	5.6	14.5	12.8	0.0	0.0	0.7
H3A1	----	10.0	0.4	----	2.7	----	----	0.1
H3A3	----	----	----	----	----	----	----	----
H4A2	----	11.0	----	----	7.0	----	----	----
Total	0.0	21.0	0.4	0.0	9.7	0.0	0.0	0.1
H3	3.0	0.4	8.7	6.2	----	0.8	4.7	6.3
H4	3.3	1.6	11.6	15.8	4.7	19.5	25.9	12.2
H5	7.6	----	13.4	----	12.0	19.5	9.3	14.9
H6	----	----	----	----	----	----	----	----
Total	13.9	2.0	33.7	22.0	16.7	39.8	39.9	33.4
H+A1	0.6	----	----	0.1	----	----	----	5.7
H+A2	----	0.1	----	----	----	----	----	----
H3A2	----	----	----	----	----	----	----	----
Roads	0.7	1.0	0.3	0.5	0.8	0.2	0.1	0.1
Orchard	----	----	----	----	----	----	----	----
Total	1.3	1.1	0.3	0.6	0.8	0.2	0.1	5.8

SE $\frac{1}{4}$				SW $\frac{1}{4}$				Total Acres Per Type	Total Acres per Type in Grouse Habitat Compartments
Forties				Forties					
NW	NE	SE	SW	NW	NE	SE	SW		
----	3.0	0.5	1.9	----	----	----	----	7.4	7.4
----	----	----	----	0.3	----	0.2	3.8	10.2	10.2
0.0	3.0	0.5	1.9	0.3	0.0	0.2	3.8	17.6	17.6
----	----	----	----	0.8	----	----	1.3	17.3	17.3
----	----	----	----	----	----	----	----	3.5	3.5
----	----	1.3	----	----	0.5	----	----	13.9	10.6
----	----	----	----	----	11.5	0.6	4.2	21.9	19.4
----	----	----	----	6.9	2.0	6.4	8.0	23.3	23.3
----	----	----	----	----	----	----	----	8.8	8.2
6.2	3.4	0.2	0.9	----	----	----	----	17.2	12.5
----	----	----	----	----	----	----	----	17.6	17.6
6.2	3.4	1.5	0.9	7.7	14.0	7.0	13.5	123.5	112.4
----	----	----	----	0.7	1.7	----	----	15.6	12.9
----	0.2	20.3	1.1	----	----	----	----	21.6	21.6
----	----	----	----	7.2	3.2	----	6.8	35.2	25.6
0.0	0.2	20.3	1.1	7.9	4.9	0.0	6.8	72.4	60.1
----	----	----	----	----	----	----	----	30.1	10.0
7.4	9.8	4.0	----	23.6	3.5	----	7.4	150.3	54.2
24.9	22.1	5.7	31.5	----	9.6	17.1	1.0	188.6	26.2
----	----	----	----	----	4.8	----	----	4.8	4.8
32.3	31.9	9.7	31.5	23.6	17.9	17.1	8.4	373.8	95.2
1.0	----	3.5	----	----	1.1	11.6	4.9	28.5	25.0
0.3	1.5	4.2	4.4	----	1.5	2.3	2.2	16.5	16.5
----	----	----	----	----	----	0.9	----	0.9	0.9
0.2	----	0.3	0.2	0.5	0.6	0.2	0.4	6.1	5.0
----	----	----	----	----	----	0.7	----	0.7	0.7
1.5	1.5	8.0	4.6	0.5	3.2	15.7	7.5	52.7	48.1

Table 7. The area of each of the five general vegetation types for the entire study area and for the three Grouse Habitat Compartments (see Figures 2, 3, and 9 in back pocket).

Study Area Quarter Sections	Total Acres	General Vegetation Types									
		Lowland Hardwoods		Aspen		Aspen-Hardwood Mixtures		Upland Hardwoods		Openings	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
NW $\frac{1}{4}$	160.0	7.9	4.9	55.8	34.9	21.4	13.4	71.6	44.7	3.3	1.6
NE $\frac{1}{4}$	160.0	0.0	0.0	13.5	8.4	9.8	6.2	129.8	81.1	6.9	4.3
SE $\frac{1}{4}$	160.0	5.4	3.4	12.0	7.5	21.6	13.5	105.4	65.9	15.6	9.7
SW $\frac{1}{4}$	160.0	4.3	2.7	42.2	26.4	19.6	12.2	67.0	41.9	26.9	16.8
Total	640.0	17.6	2.8	123.5	19.3	72.4	11.3	373.8	58.4	52.7	8.2

Grouse Habitat Compartments											
1 (NW)	117.0	7.9	6.8	54.6	46.7	23.1	19.7	27.4	23.4	4.1	3.5
2 (SE)	92.2	5.4	5.9	12.5	13.5	21.6	23.4	35.4	38.4	17.3	18.8
3 (SW)	124.1	4.3	3.5	45.3	36.5	15.4	12.4	32.4	26.1	26.7	21.5
Total	333.4	17.6	5.3	112.4	33.7	60.1	18.0	95.2	28.6	48.1	14.4

Table 8. The number of plant species recognized in each of the five general vegetation types and the three site zones while sampling.

Species	General Vegetation Types					Total	Site Zones		
	LH	A	A-H	UH	O		LZ	TZ	UZ
Trees Total	12.0	22.0	15.0	17.0	10.0	22	12.0	22.0	15.0
Average/Types	11.0	10.3	11.0	9.8	5.0		11.0	10.2	10.3
Shrubs Total	7.0	14.0	10.0	9.0	10.0	15	7.0	14.0	10.0
Average/Types	6.5	7.9	7.3	4.5	6.0		6.5	7.7	5.5
Herbs Total	43.0	63.0	48.0	32.0	38.0	80	43.0	65.0	38.0
Average/Types	23.5	25.6	24.0	14.0	19.7		23.5	25.8	16.8
Total Types	62.0	99.0	73.0	58.0	58.0	117	62.0	101.0	63.0
Average/Types	41.0	43.9	42.3	27.9	28.7		41.0	43.9	32.3
*Diversity Index	0.47	0.73	0.84	0.42	0.42		0.47	0.81	0.50

* Diversity Index = $\frac{\text{Cumulative number of Species}}{\sqrt{\text{Number of individuals}}}$: Species composition and number of individuals for all cover types were estimated on the basis of 15 plots using a species area curve.

Table 9. The area of each of the three site zones for the three Grouse Habitat Compartments and for the entire study area (see Figures 2 and 9 in back pocket) .

Grouse Habitat Compartments	Total Acres	Habitat Zones					
		Lowland		Transition		Upland	
		Acres	Percent	Acres	Percent	Acres	Percent
1 (NW $\frac{1}{4}$)	117.0	13.2	11.3	69.4	59.3	34.4	29.6
2 (SE $\frac{1}{4}$)	92.2	5.8	6.3	41.5	45.0	44.9	48.7
3 (SW $\frac{1}{4}$)	124.1	8.2	6.6	50.7	40.9	65.2	52.5
Total	333.4	27.2	8.2	161.6	48.5	144.5	43.4
Total Study Area	640.0	28.6	4.5	165.3	25.8	446.2	69.7

trembling aspen, sugar maple, black cherry, basswood, American elm, black ash, white ash and juneberry. The understory was composed primarily of saplings of trembling aspen, black cherry, white ash, hophornbeam, and juneberry, and a shrub layer of blackberry, red raspberry, gooseberry, witch hazel, maple-leaf viburnum, honeysuckle and red-osier dogwood (Cornus stolonifera). The principle herbs were bracken fern, goldenrod, violets, sedges (Carex spp.), strawberry, grasses and buttercups (Appendix: Tables 17 through 23).

The principal vegetation constituents of the grouse coverts were (Tables 6 and 7): (1) small openings, roads, and poorly stocked stands (Figures 11 and 12) which comprised 14.4 per cent of their area; (2) sapling aspen growth (Figures 12 and 13) which comprised 25.9 per cent of the vegetation; (3) aspen-hardwood mixtures and mature and pole-sized aspen (Figures 14 and 15), upland hardwoods (Figure 16), and lowland hardwoods (Figure 17) which comprised, respectively, 25.8, 28.6 and 5.3 per cent of the Grouse Habitat Compartments.

From the species lists of the 20 vegetation types, I found that 99 of the 117 species identified in the plots occurred in the aspen types. The other four general types had noticeably fewer total species (Table 8). The mean number of species occurring in the eight aspen types, however, was not significantly different from that of the lowland hardwoods or that of the aspen-hardwood mixtures. But, these three means were significantly different from those of the

Figure 11. An opening (turnaround) and a sapling aspen type used extensively by broods. Ground cover: Bracken-Goldenrod, 50-60%, cover between 8-36" in height.

Figure 12. Sapling aspen and an opening used by broods for dusting and feeding. Ground cover: rubus, sumac, and grasses, 30-40%, cover between 8-36" in height.



Figure 11



Figure 12

Figure 13. Upland sapling aspen and pole size hardwood mixture used extensively by broods and adults the entire year (Tables 4 and 5: A3H3). Ground cover: brackens and shrubs 38%, cover between 8-36" in height.

...

Figure 14. Transition zone aspen-hardwood mixture used by drummers and for nesting (Tables 4 and 5: H4A2). Ground cover: shrubs and brackens, 21% cover between 8-36" in height.



Figure 13



Figure 14

Figure 15. A stand of aspen, of sufficient size for pulp, used by adults and broods. Ground cover: bracken, goldenrod, and shrubs 40% between 8-36" in height.

Figure 16. Upland hardwoods which were generally avoided by grouse except in winter. Note lack of ground cover (Tables 4 and 5: H5).



Figure 15



Figure 16

Figure 17. A lowland hardwood type similar to that used by drumming males in the spring and broods in early summer. Ground cover: goldenrod and sedges, 40-50%, cover between 8-36" in height.

Figure 18. A typical drumming site on the study area. Moderately cut area of an aspen-hardwood mixture (Tables 4 and 5: H2A3).



Figure 17



Figure 18

upland hardwoods and open types (Appendix: Tables 25-31; 0.05 level).

The diversity indices of the five types and the three zones (Table 8) indicated that the aspen and aspen-hardwood types were significantly more diverse than the lowland hardwood, upland hardwood and openings, and the (Appendix: Table 33; 0.01 level) transition zone significantly more diverse than the lowland and upland zones (Appendix: Table 34; 0.01 level).

Interspersion of Vegetation Types

For comparison, the degree of interspersion of cover types for the total study area and for each of the Grouse Habitat Compartments was determined by calculating the mean number of cover types per forty acres (Figures 3 and 9 in back pocket). The mean for the total area was 5.5 types per 40 acres (88/16), whereas, the mean for the three compartments was 9.8 types per forty. Compartment 3 (SW $\frac{1}{4}$) had the highest degree of interspersion with 11.3 types per forty (35/3.1) and compartment 2 (SE $\frac{1}{4}$) the lowest with 7.4 types per forty (17/2.3). Compartment 1 also had a high degree of interspersion with 10.3 types per forty (30/2.9).

Site Zonal Composition

From delineation and area determinations it was found that 69.8 per cent of the total area could be classified as an upland site (Table 9 in back pocket). The transition

zone, which contained the imperfectly to moderately well-drained soils, existed in a relatively narrow strip (less than 900 feet) between the lowland and upland zones (see Figure 9 in back pocket). This zone occupied 25.8 per cent of the area. Lowlands, along the streams and seepage areas occupied the remaining 4.5 per cent.

Zonal composition data of the Grouse Habitat Compartments, which included 97 per cent of the total lowland and transition area, and only 32.4 per cent of the upland zone, indicate that the lowland and transition zones were the nuclei of the grouse habitats on the study area.

Analysis of Seasonal Grouse Use

In analyzing grouse use in relation to the zonal composition of the entire study area, I found that the transition zone was used significantly more than expected at all seasons, whereas, the upland zone was used significantly less at all seasons except winter (Table 10 series of "+" on left side of transition zone numbers and "-" on left of upland zone numbers). The lowland zone was frequented significantly more than expected during the fall, winter and spring, but used randomly during the remaining seasonal categories. When zonal composition of the Grouse Habitat Compartments was analyzed in relation to grouse use, the previous trend of the avoidance of the upland zones was negated in all but two exceptions (Table 10) (lack of significance on right side of most numbers).

Table 10. The number of observations made in the three site zones for the seven seasonal categories.

Seasonal Observational Categories	Zones			Total Observations
	Lowland	Transition	Upland	
Drummers	*+ ₇ +**	+ ₁₁	- ₁ -	19
Spring Flushes	3	+ ₂₃	- ₄ -	30
Summer Flushes	4	+ ₂₀	- ₁₄	38
Summer Brood Flushes	3	+ ₁₉	- ₈	30
Summer Dusting Signs	1-	+ ₅₈	- ₄₂	101
Fall Flushes	+ ₁₁	+ ₄₃	- ₃₈	92
Winter Roosts and Flushes	+ ₁₃	+ ₄₆	74	133
Total	42	220	181	443

Chi-square Analysis

- * Left side of number
 + Significantly more than random
 - Significantly less than random
- ** Right side of number
 + Significantly more than random
 - Significantly less than random
- Using composition of the total study area.
- Using composition of the Grouse Habitat Compartments

Descriptions of the habitat preferred by grouse at various seasons and by the different sexes were obtained by: (1) averaging the descriptive parameter estimates of the types in which the observations were made; (2) statistically analyzing results from procedure 1 (Tables 4 and 5); (3) statistically analyzing grouse use in relation to general type and zonal compositions of the Grouse Habitat Compartments; and (4) literature research.

Drummers (Spring)

Data gathered from observations made in the months of April and May indicated that drummers used only three general cover types (lowland hardwoods, aspen and aspen-hardwood mixtures; Table 11). Vegetation types, in which drumming logs were located, were well-stocked stands of pole-size trees which had a moderately dense shrub and sapling layers (Tables 12 and 13; Figures 3 and 10 in the back pocket; and Figures 18 and 19). Generally, these types developed moderate ground cover (30-40%) by the end of May. All drumming sites, with one exception, were located in the lowland and transition zones, where most of the preferred cover types were located (Table 10). The one exception occurred in an sapling aspen type on an upland site, which was structurally similar to sites used and located in the transition zone (Figure 19). This use of upland sites also has been demonstrated in Alberta (Rusch, 1967), Iowa (Porath, 1967)

Table 11. The number of observations of grouse made in the five general vegetation types for the seven seasonal categories.

Seasonal Observational Categories	General Vegetation Types					Total Observations
	Lowland Hardwoods	Aspen	Aspen-Hardwood Mixtures	Upland Hardwoods	Openings	
Drummers	*+8***	5	+6	-0-	-0-	19
Spring Flushes	+3	+18+	+8	-1-	0-	30
Summer Flushes	+5	+16	+12	-5	0	38
Summer Brood Flushes	2	+19	4	-0-	5	30
Summer Dusting Signs	1	+45+	+21	-9-	25	101
Fall Flushes	+11+	+36	+29+	-13-	3-	92
Winter Roosts and Flushes	8	30	+40+	-41	14	133
Total	38	169	120	69	47	443

Chi-square Analysis

*Left side of number

+ Significantly more than random
- Significantly less than random

} Using composition of
the total study area.

**Right side of number

+ Significantly more than random
- Significantly less than random

} Using composition of the
Grouse Habitat Compartments.

Table 12. Means of the overstory descriptive parameters of the types frequented by grouse at various seasons.

Seasonal Category						Trees			
	Stems per Acre					Average Per cent of Canopy Cover			
	1-4"	5-8"	9-12"	13+	Total	DOM	SUBC	UST	Total
Spring Drummers	659	161	34.3	4.8	864	45.8	30.6	42.9	129.3
Spring Flushes	844	124	24.6	3.3	996	44.6	22.4	47.8	114.8
Summer Flushes	720	132	24.8	3.9	887	42.5	22.7	45.6	110.8
Summer Brood Flushes	562	93	22.8	4.5	685	32.4	16.3	42.0	90.7
Summer Dusting Sign	506	79	16.5	2.9	611	29.4	12.9	34.5	76.8
Fall Flushes	563	136	29.4	4.7	734	45.1	26.3	41.7	113.1
Winter Roosts Flushes & Tracts	445	131	34.7	5.0	633	48.2	19.9	34.5	102.6

Average Height of: Canopy Cover			Saplings & Shrubs			
			Stems/acre			Total
DOM	SUBC	UST	1-3'	3-10'	10'-1"	
46	35	15	4364	1603	461	6428
44	30	14	4757	2470	564	7781
46	31	13	4291	1856	481	6624
45	25	15	5039	2492	655	8186
45	20	16	4566	1906	438	6911
47	34	15	4427	2008	474	6909
48	35	19	4070	1252	327	5649

Table 13. Means of the understory descriptive parameters of the types frequented by grouse at various seasons.

Seasonal Category	Understory						Ground Cover							
	Average						Average							
	Density Profile						Density Profile							
	One-foot Intervals						Three-inch Intervals							
	1	2	3	4	5	6	D*	E*	0-3	3-6	6-9	9-12	12-15	15-18
Spring Drummers	**48.2	29.9	21.2	18.9	17.5	18.3	3.5	37.4	72.0	52.1	42.1	33.1	28.6	25.5
	87.6	73.3	57.6	51.4	44.5	43.5								
Spring Flushes	**50.2	31.8	24.0	22.0	21.0	21.3	3.8	42.2	76.5	61.3	51.9	43.9	37.1	34.3
	88.2	79.4	67.6	60.0	51.9	53.1								
Summer Flushes	87.2	77.9	66.5	58.3	51.5	51.9	2.9	41.8	74.5	58.9	48.7	41.0	35.9	32.9
	**48.8	31.7	24.8	22.0	21.1	22.4								
Summer Brood Flushes	90.7	80.2	70.5	61.8	55.9	57.0	3.8	47.9	88.1	73.8	61.2	52.5	46.0	43.5
	**50.8	32.6	26.3	23.3	22.9	24.6								
Summer Dusting Sign	85.6	73.3	62.4	55.0	49.9	50.5	3.8	47.3	84.1	70.0	58.3	50.6	44.1	40.5
	**47.9	29.8	23.3	20.8	20.5	21.8								
Fall Flushes	82.1	71.1	59.8	54.5	50.2	49.8	2.7	33.2	66.8	49.3	39.6	33.6	28.3	25.2
	**45.9	28.9	22.3	20.6	20.6	21.5								
Winter Roosts	**44.0	26.0	20.5	18.2	17.7	19.4	3.0	36.3	66.6	50.7	41.3	34.8	29.7	26.5
Flushes & Tracks	78.6	63.3	52.9	45.9	41.0	41.0								

*Letters correspond with those in Table 1 which describes the parameters measured.

**Understory density profile readings for types in winter.

Figure 19. A drumming site in an upland aspen type (Tables 4 and 5: A3H3).

Figure 20. Upland-transition border where a sapling aspen type adjoins an aspen-hardwood type. Only grouse nest found was 100 feet from this opening along the U-T border (Tables 4 and 5: H4A2 (left); A3H4 (right)).



Figure 19

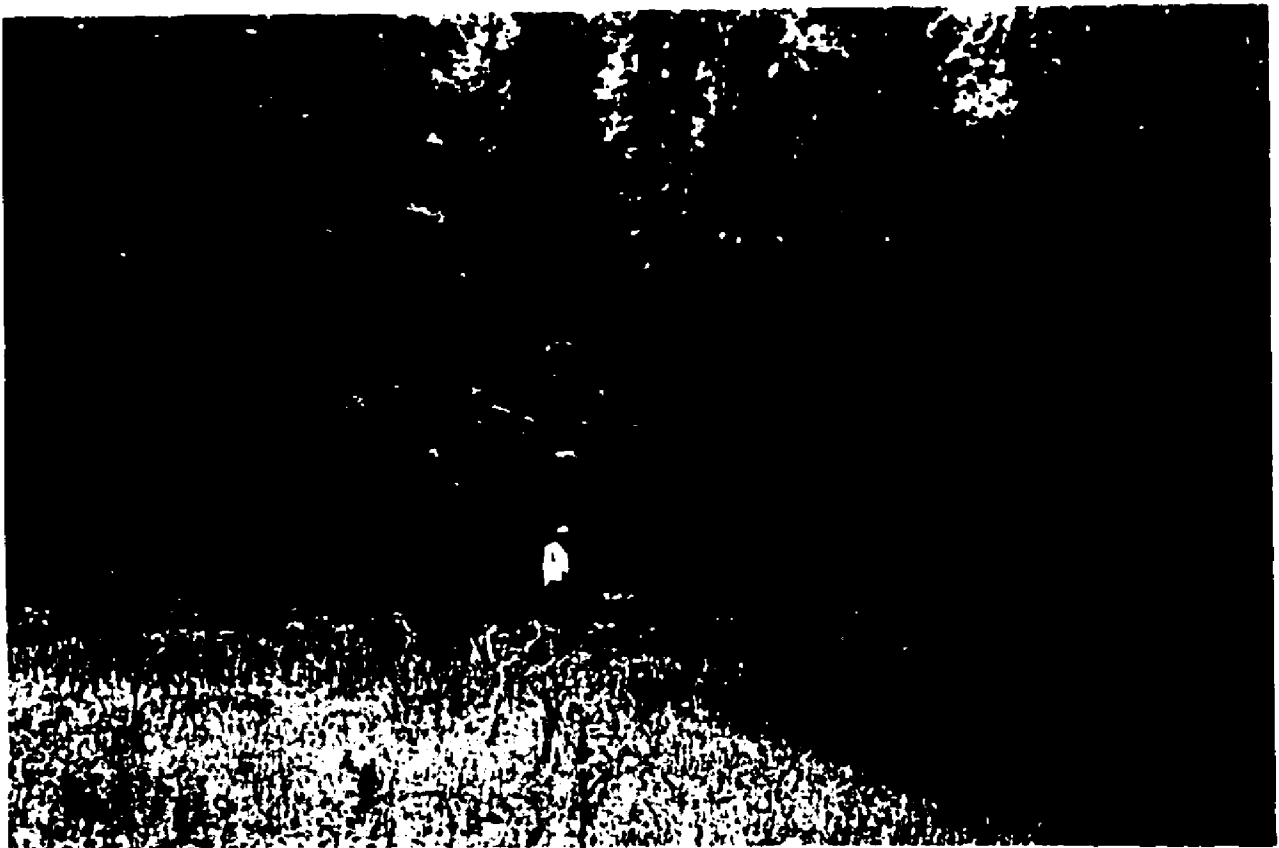


Figure 20

and Missouri (Lewis et al. 1968). The structural composition of these drumming sites was very similar to those described by Palmer (1963). The preferred zonal location of these drumming males bears a close resemblance to areas in Minnesota described by Gullion (1968). Also, most drumming sites in northern Wisconsin and Michigan were in lowland or in the lowland edges where adequate sapling and shrub structure was present (Dorney 1959; Palmer 1963).

A special consideration of good drumming areas was pointed out by Gullion (per. comm. with Moulton 1968). He stated that one requirement at Clouquet is that mature aspen or other food source be within 100 yards of the drumming log. During some Aprils in Minnesota, most male grouse lived entirely on male aspen catkins. After the aspen catkins were gone, willow catkins and red maple flowers were used (Gullion 1967).

Nesting (Spring)

As previously mentioned in methods, no attempt was made to locate nests. However, all spring flushes were noted and at least 50 per cent were assumed to be females. These data indicated that females used aspen and aspen-hardwood mixtures and the transition zone more than expected (Tables 10 and 11). These types were characterized by high densities of 1 to 4-inch trees and moderately dense ground cover (42%) (Tables 12 and 13). During the fall of 1968 while hunting,

I found an abandoned grouse nest next to a slash pile along the border of a sampling aspen type and an aspen-hardwood mixture which was in the upper transition zone and about 100 feet from an opening (Figure 20).

Brander (1967) and Gullion (1968) indicated that female grouse in Minnesota were drawn to the aspen types by drummers and/or by the food source (aspen buds) which were found primarily there. Bump (op. cit.) found that grouse in New York preferred to nest in types with moderate ground cover and within 100 feet of an opening. The female grouse in New York, Wisconsin, and Minnesota all appeared to prefer to nest in pole-size stands next to some object (ibid.; Gullion 1967; Moulton 1968). These data, therefore, indicated that grouse nest in pole-size aspen or hardwood stands near openings and a mature aspen source.

Adults (Summer)

Adult males and females, without broods, frequented cover types very similar in structure to those used by drumming males in the spring (Tables 12 and 13). These data indicated that the males remained, to some degree, in the area of their drumming centers. However, the adults appeared to be more mobile in the summer than in the spring (Tables 10 and 11). Site zones were used randomly during the summer, whereas, the upland zone was apparently avoided in the spring.

Broods (Summer)

Females with broods used youthful types with ground cover and understory layers significantly denser than those preferred by adult grouse at any other time of the year (Tables 12 and 13). These differences in density were particularly evident in the number of saplings, and percent of ground cover between 8 and 36 inches in height and both the ground cover and understory density profiles (Appendix: Tables 25 and 19 through 24; Graphs 1 through 4). Although sapling aspen types were used more than expected and upland hardwoods less than expected, the site zones were used randomly (Tables 10 and 11). In most cases, the openings frequented by broods were along the upland-transition border in or adjacent to aspen types (Figures 13, 21 and 22). The phrase "youthful and diverse," used by Bump (ibid.) to describe brood habitat in New York, is also appropriate in this situation.

During their first two weeks of life, the chicks spent most of their time in openings and types near the nest site or on the way to the lowlands (Mounton 1968). From mid-June to early August, broods appeared to spend much of their time in the lowlands (Figure 17) and youthful portions of the transition zone (Figures 14, 23 and 24) with intermittent trips to the upland zone for dusting and insects. Most of the dusting occurred in roads, turnarounds, small openings, and types adjacent to these various openings (Figures 13, 14

Figure 21. An east-west elongated opening (600' long x 75'-150' wide) in a sapling aspen type and used extensively by broods. Ground cover: rubus, grasses, goldenrod and hawkweeds; 30-40% cover between 8-36" in height.

Figure 22. Transition zone sapling aspen type produced by clear cutting 10 years ago, and used by grouse throughout the year (Tables 4 and 5: A6H2).

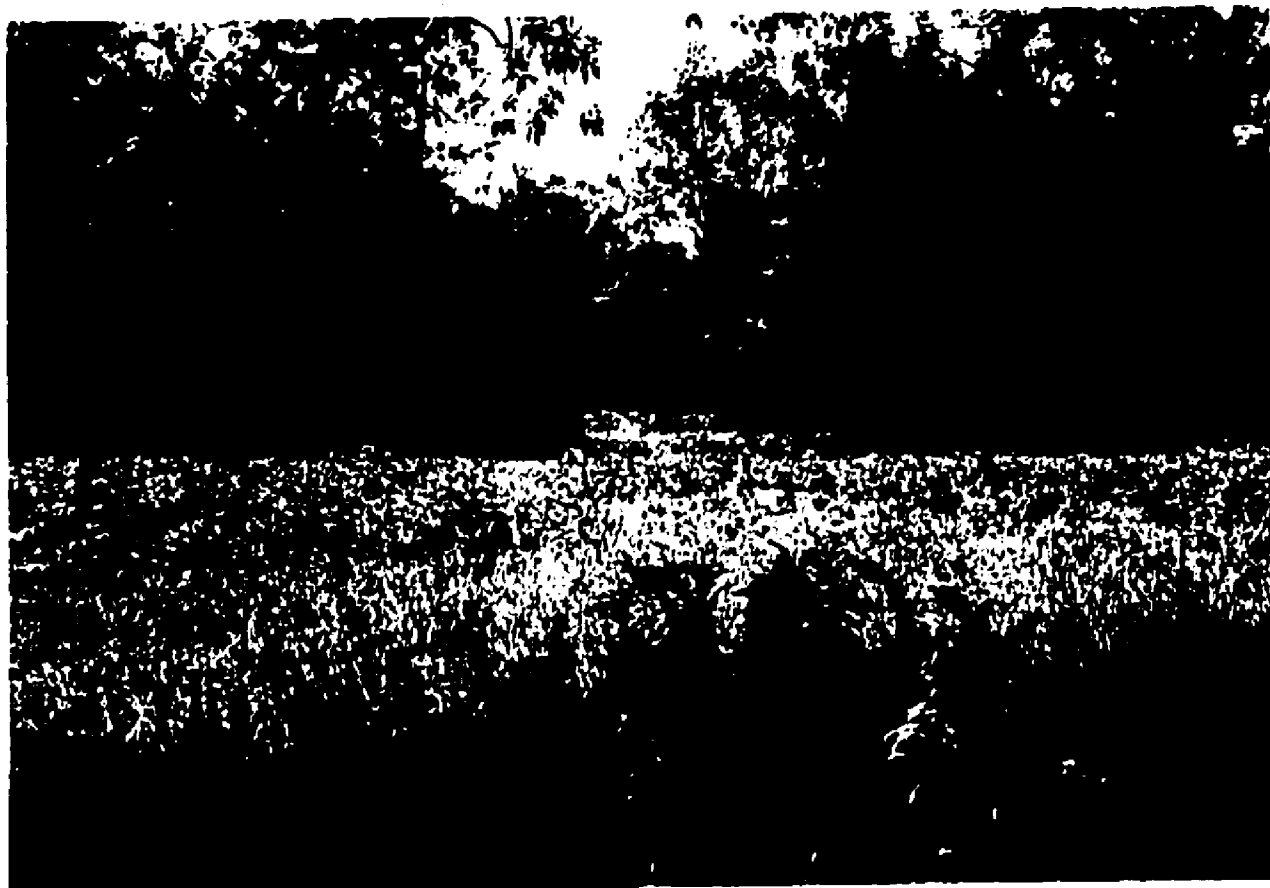


Figure 21



Figure 22

Figure 23. Transition zone sapling and pole-size aspen stand produced by cutting 12 years ago, and used by grouse throughout the year (Tables 4 and 5: A4H4).

Figure 24. Pole-size, upland hardwoods used extensively for winter roosting in times of deep snow (Tables 4 and 5: H4).



Figure 23



Figure 24

and 22). Later in the summer and early fall (mid-August to early October), they restricted most of their activities to the openings along the upland-transition border and to other youthful types where there was a profusion of blackberry, black cherry, sumac, and hawthorn (Crataegus spp.). Sharp (1963) also noted the importance of openings to broods, particularly in poorer coverts. Bump (op. cit.) and Rossman et al. (1965) reported similar seasonal movements by broods.

Adults (Fall)

In fall, grouse began to frequent types structurally similar to those used by drummers in the spring and adults in the summer. However, grouse in the fall used types with significantly less ground cover than types used by adults in summer (Appendix: Tables 18-25). Also, it was found that they were using the lowland hardwoods and aspen-hardwood mixtures more than random (Table 11). This trend indicated that the grouse had begun to frequent types preferred for winter roosting, and that males had begun localizing in drumming centers. The latter phenomenon has been documented by Gullion (1966a) from intensive studies on drumming males in Minnesota.

Adults (Winter)

Probably the most drastic change in the structural composition of the grouse habitat occurred in the winter,

when grouse on the study area exhibited a more than random use of pole-size stands of upland hardwoods and aspen-hardwood mixtures and mature stands of aspen (Figures 24, 25 and 26). The mean sapling and shrub density and the mean understory density profile of winter cover were the lowest of all seven observational categories (Tables 12 and 13). These parameter means were significantly different from those of broods, dusting, fall and spring flushes (Appendix: Tables 13, 14, 15, 16, and 25; Graph 3). Although all general types were used, aspen-hardwood mixtures were used significantly more and sapling aspen types significantly less than random. However, when the two years were considered separately, the data indicated that during the winter with 12 inches or more of powder snow (1966-67) the grouse roosted more than expected in the uplands (Figure 24). In the winter with less than 12 inches of snow (1967-68), they roosted primarily in the lowland and transition zones (Figures 25 and 26). Some possible reasons for the preferential use of the mature stands during the winter were the large supply of available buds of such species as aspen, black cherry, hophornbeam and junberry, and the deeper snows with few obstructions.

Bump (op. cit.) emphasizes the importance of conifers in the winter habitat; Dorney (op. cit.) and Rusch (op. cit.), on the other hand, found that they were not important in Wisconsin, and Alberta, Canada, respectively. And, Gullion

Figure 25. Upland pole size, aspen-hardwood mixture used extensively for winter roosting (Tables 4 and 5: H4A2).

Figure 26. Transition zone pole size aspen-hardwood mixture used for winter roosting during times of shallow snow (Tables 4 and 5: H3A3).



Figure 25



Figure 26

and Marshall (1968) found indications that large conifers, particularly pines (Pinus spp.), were detrimental to the life expectancy of grouse. I found, on an adjacent area where coniferous cover was available, that grouse roosted exclusively in the hardwoods when sufficient powder snow existed, but showed a substantial use of conifers during times of shallow or crusting snow.

DISCUSSION

Data gathered on grouse use of the various vegetation types and site zones indicated that grouse concentrated in areas of high plant species diversity, with special structural characteristics, and with a high degree of interspersion. Major types that possessed a high degree of species diversity and the apparent preferred structural characteristics were, in most cases, lowland hardwoods, aspen and aspen-hardwood mixtures. Various combinations of these three much used types, plus the two also important but less used types (upland hardwoods and openings), composed the three basic habitat units observed. The first unit was composed of mixtures of sapling and pole-size aspen or aspen-hardwood stands with scattered openings. These structural conditions had been produced by recent heavy cutting of aspen for pulp, and were preferred by broods and grouse in the spring. Usually, these were located in the lowland and transition zones where the aspen types were most prevalent. The second unit, which was used by drummers in the spring and by adults in the summer and fall, was composed also of sapling and pole-size mixtures of aspen and aspen-hardwood stands, but was the result of light to medium cutting of aspen.

The last, which was made up of pole-size or mature stands of hardwoods or aspen, was used primarily for winter roosting.

The best interspersion of cover types was localized in areas dominated by aspen and aspen-hardwood types, and centered around the lowland-transition-upland sequence (see Figures 3, 9 and 10 in back pocket). The interspersion present was, in most cases, the direct or indirect result of the cutting of aspen for pulp. Turnarounds, trails and roads created by the logging were used intensively by broods. This was particularly true of roads and turnarounds in or adjacent to the sapling aspen types.

The key elements of the Grouse Habitat Compartments, which were obviously available in these locations, were a high diversity of plants, youthful structure and high interspersion of cover types. These elements were just as obviously lacking in the surrounding upland hardwoods which were not generally frequented by grouse. The principal reasons for the abundance of these desirable elements in one and the lack in another, stemmed from three basic factors: (1) site variations; (2) stand structural effects; (3) past and present forest practices.

Site Variations

On the study area, the situation illustrated in Figure 28 exists around many of the moist areas, which range from

seepage slopes to stream valleys. The soils in many of these situations form drainage sequences which have a variety of micro-environmental conditions within a short distance (less than 300 feet). Ecotones often develop in this area. Species diversity is usually greatest in these transition zones because they offer suitable sites for the survival of both upland and lowland plant species (Wilde 1958; Table 8). Lowland and upland tree species that do invade the transition zones usually do not develop a commercially, desirable form due to the off-site condition for these species (ibid.).

Structural Effects

The most diverse stands are those dominated by aspen as well as those located on the lowland or transition sites (Table 8). The same high degree of diversity that occurs in aspen stands on transition sites also occurs in an aspen stand on an upland site. This indicates that the canopy disturbance caused by the removal of aspen pulp results in an increase of the structural and species diversity in the stand. Rowe (1956) has found that the shrub and herbaceous diversity decreases as aspen stands convert to spruce. A similar effect could result in the conversion of these aspen stands to pole-size hardwoods; as indicated by the fact that pole-size hardwood stands have significantly less diversity in the understory than does pole-size aspen stands (27.9 as compared to 42 species).

Figure 27. Schematic illustration of water influence on soils, grouse use of zones, and plant species common in each zone on the study area.

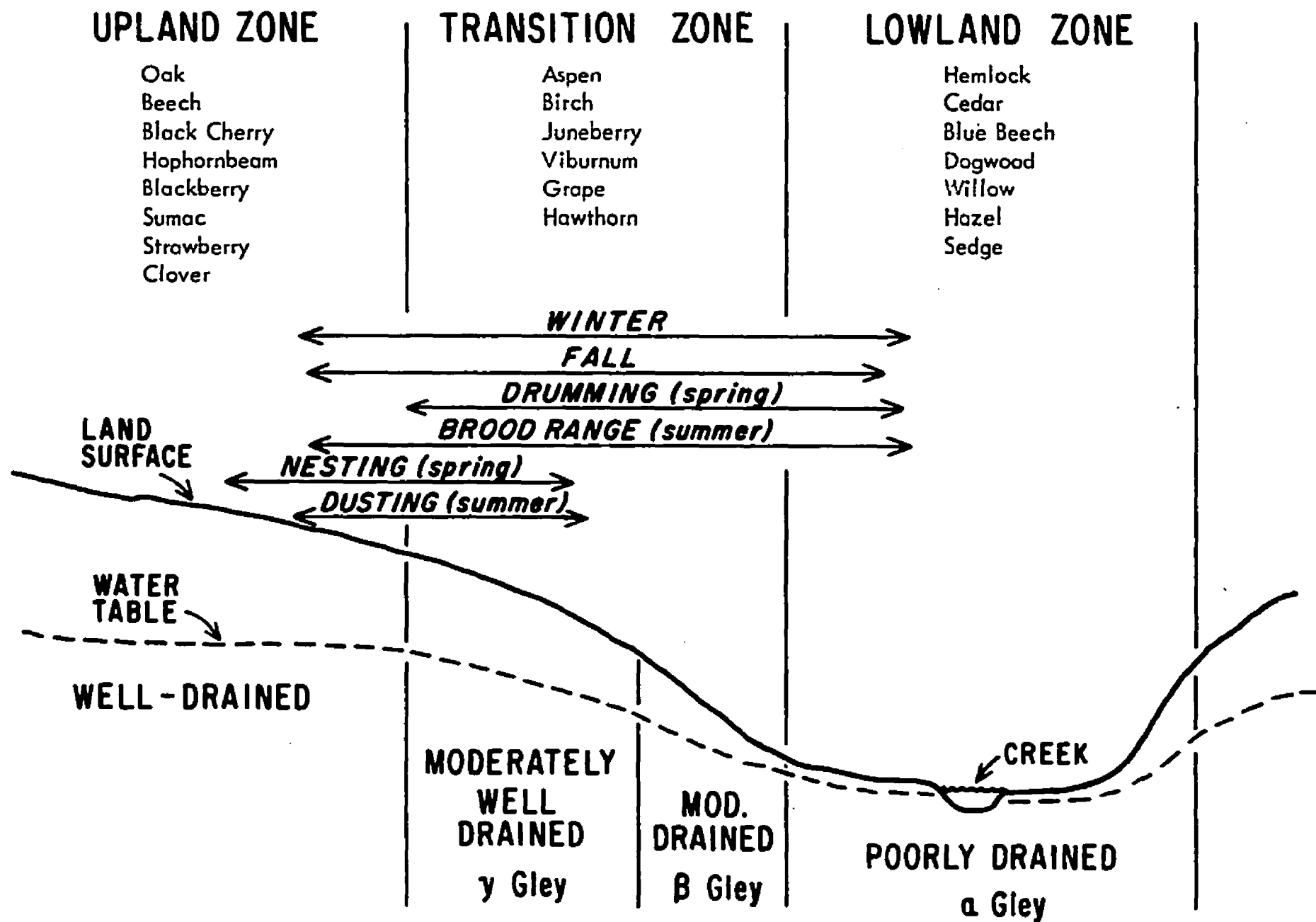


Figure 27

Forest Management Practices

Because of the wood production considerations, a forest plan for the study area must include two basic considerations: (1) management methods for the sawtimber production of the quality lowland and upland hardwoods; and (2) management methods for pulp production in the transition zone. The silvicultural practices chosen for this area will influence the successional sequence of types and also of the associated wildlife.

In most cases after certain stand improvement treatments, the quality hardwoods of sawtimber size would be managed as all-aged stands by various modifications of the selection method (Hawley and Smith 1954; Cooley, per conver. 1968).² The modifications most likely to be used in the management of stands on the area would be: (1) single-tree selection method; or (2) group selection method. Probably the preferred of these two methods, for timber production, ease of logging and for wildlife management, would be the group selection method. The single tree selection method, however, would be more esthetically desirable but very little diversity would result. The cutting rotation of hardwoods would be 80 to 100 years with 10 to 20 year cutting cycles (ibid.).

²J. Cooley, 1968. Silviculturist with the North Central Forest Experiment Station on the Michigan State University Campus at East Lansing, Michigan.

Management of the transition zone is not as easily formulated as that of the upland zone. This is due to the possibility of maintaining either aspen or hardwoods for pulp production on these sites. In order to make this choice, a critical evaluation of the ecology of these two possible stands and of their effects on other multiple use interests is needed.

Trembling aspen is a shade intolerant tree species which grows well on sites ranging from imperfectly to well-drained. It has a rapid growth rate (Appendix: Table 24) and is considered a soil improver after fire, particularly with regards to its role in redistribution of nitrogen to the surface layers (Fowells 1965). The shading and soil improvement provided by aspen stands make them seed beds for the more shade tolerant tree and shrub species. However, the canopy of aspen is somewhat thinner than that of comparable stands of conifers or hardwoods, and thereby, allows for the development of moderate ground cover, shrub and sapling layers. The cutting rotation varies from 35 to 55 years depending on site conditions but this is still considerably shorter than the 60 to 80 year rotation used in the management of hardwoods for pulp. In both cases, the stands could be perpetuated by clear cutting, but due to its prolific sprouting, aspen is particularly adapt to this silvicultural method. At present, however, the aspen stands on the study area are not being clear-cut. This practice is allowing the aspen

stands to be converted to hardwoods at a rather rapid rate.

As mentioned in results and above, aspen is important to grouse in all of its various stages of development. The mature aspen are used extensively as a food source (Brown 1946; Bump op. cit.; Gullion 1966b), the pole-size for nesting (Bump, ibid.; Gullion 1967), and the sapling for drumming and brood cover. Its rapid growth rate and prolific sprouting make aspen an ideal species for pulp production. Because of relatively constant disturbance associated with commercial aspen stands, preferred plant species, structural diversity, and type interspersions can be maintained without special effort. Therefore, from the viewpoint of esthetics and wildlife management, aspen would be more desirable because of the diversity produced in an otherwise homogeneous situation which would develop if hardwoods were dominant also in the transition zone. Recreational value of the area would likewise increase. Forest production would suffer very little, if any, since good pulp production would be maintained and logging would be made easier and more practical by clear cutting of aspen (White 1968).

Management Implications

The influence of available water on site quality has been investigated and discussed by many foresters (White 1958; Wilde 1958). Likewise, the quality of site has been evaluated in terms of its influence on the growth of various

plant species, particularly trees. The importance of water and site as indicators of potential ruffed grouse habitat is illustrated by Figures 2, 9 and 10 in the back pocket. Wertz (1966) also found that site was a good indicator of areas that should have specific consideration in wildlife management of multiple use lands. Reiske (1966) emphasized the importance of soils in determining management plans for multiple use area using present silvicultural practices.

The single most important covert of the grouse habitat, as related to the fall population, is the brood range. This is because the areas frequented by broods are the most diverse and also contains many of the yearly requirements of the adults. Therefore, if good brood range is present, it seems apparent that adults can easily survive in the same conditions; however, the reverse is not necessarily true. Broods are probably less capable of coping with undesirable environmental pressures than are adults.

The primary factors to be considered in the management of an area for grouse are its size, and the composition, interspersion and juxtaposition of the cover types. The minimal size of a Transition Zone Management Unit (Grouse Habitat Compartment), as affected by the economics of present logging procedures, appears to be 80 acres. The management unit should have at least four, but preferably five, cover types per coverts (20 acres). Composition of the four basic cover types are: (1) 5-10 per cent of the

area in scattered small openings which have dense shrub borders or food bearing species; (2) 25-35 per cent in sapling aspen types produced by medium to heavy cutting and less than 20 years of age; (3) 15-20 per cent in sapling and pole-size mixtures of aspen-hardwood stands produced by light to medium cutting of pulp; (4) 25-35 per cent in pole-size or mature aspen more than 20 years of age. If possible, these coverts should be adjacent to lowland and upland hardwood areas.

The following management plan for the study area was derived from this study and the literature. The narrow lowland zones should be managed as all-aged stands of hardwoods if commercially valuable, but left undisturbed if not. For the improvement of these areas for wildlife, esthetic values and wood production, hemlock (Tsuga canadensis) and yellow birch (Betula lutea) should be encouraged where possible. In some instances the planting of small clumps of spruce (Picea glauca) (less than 20' in diameter) would increase the cover value for grouse and snowshoe hare (Lepus americanus) as well as increasing the esthetics of these areas.

The upland hardwoods should be managed as all-aged stands for sawtimber. The principal wildlife species that should be considered in these areas are the wild turkey (Meleagris gallopavo), fox squirrel (Sciurus niger), gray squirrel (Sciurus carolinensis), white-tailed deer

(Odocoileus virginianus) and the many species of small mammals and birds common to that forest type. Along a 300-foot strip surrounding all Transition Zone Management Units, tree species that provide food for grouse (black cherry, hophornbeam, juneberry and red oak) should be encouraged; particularly those trees on the edge of openings in these areas. This practice will not only benefit the grouse but also many of the wildlife species mentioned above.

Small openings should make up at least 5 per cent but preferably 10 per cent of the total area. This includes roads, trails, turnarounds, powerlines and poorly stocked stands as well as the typical forest openings. To minimize the necessity of producing openings for wildlife, the logging trail and turnaround network should be planned with this need in mind. Openings should be located primarily in aspen or aspen-hardwood mixtures in the upper half of the transition zone and/or in the upland hardwoods adjacent to an aspen type. Where wildlife openings are lacking, openings 100-200 feet in diameter, or east-west elongated openings 50-100 feet wide should be developed. Elongated openings were observed to be used more extensively by broods than were round openings. McCaffery et al. (1967) in Wisconsin found that deer also preferred elongated forest openings. When openings were smaller than the above dimensions many of the desirable plant species tended to be shaded out; larger openings were too dry for good shrub development. Openings

located in the vicinity of the upland-transition border would be accessible to wildlife in the upland hardwoods as well as wildlife in the transition zone area. All trails used only for logging should be blocked from public vehicle travel and should be kept clear of sapling growth, but not shrubs, by the use of selective herbicides. To add diversity when needed, these trails can be seeded to clover which provides food for various wildlife. Access roads should be widened so that a shrub border can be established and maintained. Circular openings should be kept clear of tree growth with the exception of scattered individuals of juneberry, hawthorn, and black cherry.

Forty-five per cent or more of the Transition Zone Management Unit should be in stands of aspen or aspen-hardwood mixtures. Stands dominated by aspen should be maintained by clear cutting; whether on a transition or upland site. A cutting rotation of 40-50 years with 10-year cutting cycles should be used if possible. The hardwoods in the aspen-hardwood mixtures should be on a 60-80 year rotation with 10 to 20 year cutting cycles. The pockets of aspen in these mixtures should be maintained and enlarged whenever possible. Pulp should be cut in 5-10 acre blocks or 300-600 foot wide strips.

All stands on transition sites and aspen stands on upland sites should be clear-cut for pulp wood. However, scattered small groups of individuals of juneberry,

hophornbeam, black cherry and white spruce or hemlock should be left standing to add structural and species diversity to these areas. These stems should total less than 20 square feet of basal area per acre (Moulton 1968).

Figure 28 gives a possible cutting schedule for the various stands in the three Transition Zone Management Units on the study area. With clear cutting on a rotation of 40-50 years, the aspen areas would yield, on the average, a minimum of 15 cords per acre (per. comm. Cooley 1968). Theoretically, if managed as outlined, this 180-acre area would have a minimal sustained yield of 2,700 cords of aspen pulp per rotation. Also, there would be substantial amounts of hardwood pulp produced.

Therefore, maximum utilization of this area would be best realized by partitioning the study area into two major management units. Upland sites would be classed as Upland Zone Management Units. These would be managed for sawtimber production and as habitat for wild turkeys, squirrels and deer. The transition sites and adjacent lowland and upland areas would be classed as Transition Zone Management Units. They would be managed for pulp production and as habitat for ruffed grouse, snowshoe hare, deer and woodcock (philohela minor) (Sheldon 1967), and maintained to provide a diversity of vegetation which would be biologically and esthetically advantageous.

Figure 28. Possible cutting schedule for the various stands in the three Transition Zone Management Units.

Legend



Lowland Hardwoods



Maintained Shrub Openings



Maintained Poorly Stocked Stands



Maintained Turnarounds for Logging



Maintained Openings or Poorly Stocked Stands after the removal of Planted Red Pine



Red Pine Plantations



Additional Logging Trails



Strip of Upland Hardwoods where Food Tree Species should be encouraged

A

Aspen cut for Pulp

H

Hardwoods cut for Pulp

A-H

Aspen and Hardwoods cut for Pulp

Dates are the approximate Year for Pulp Cut



N

Scale

1 inch = 918.2 feet

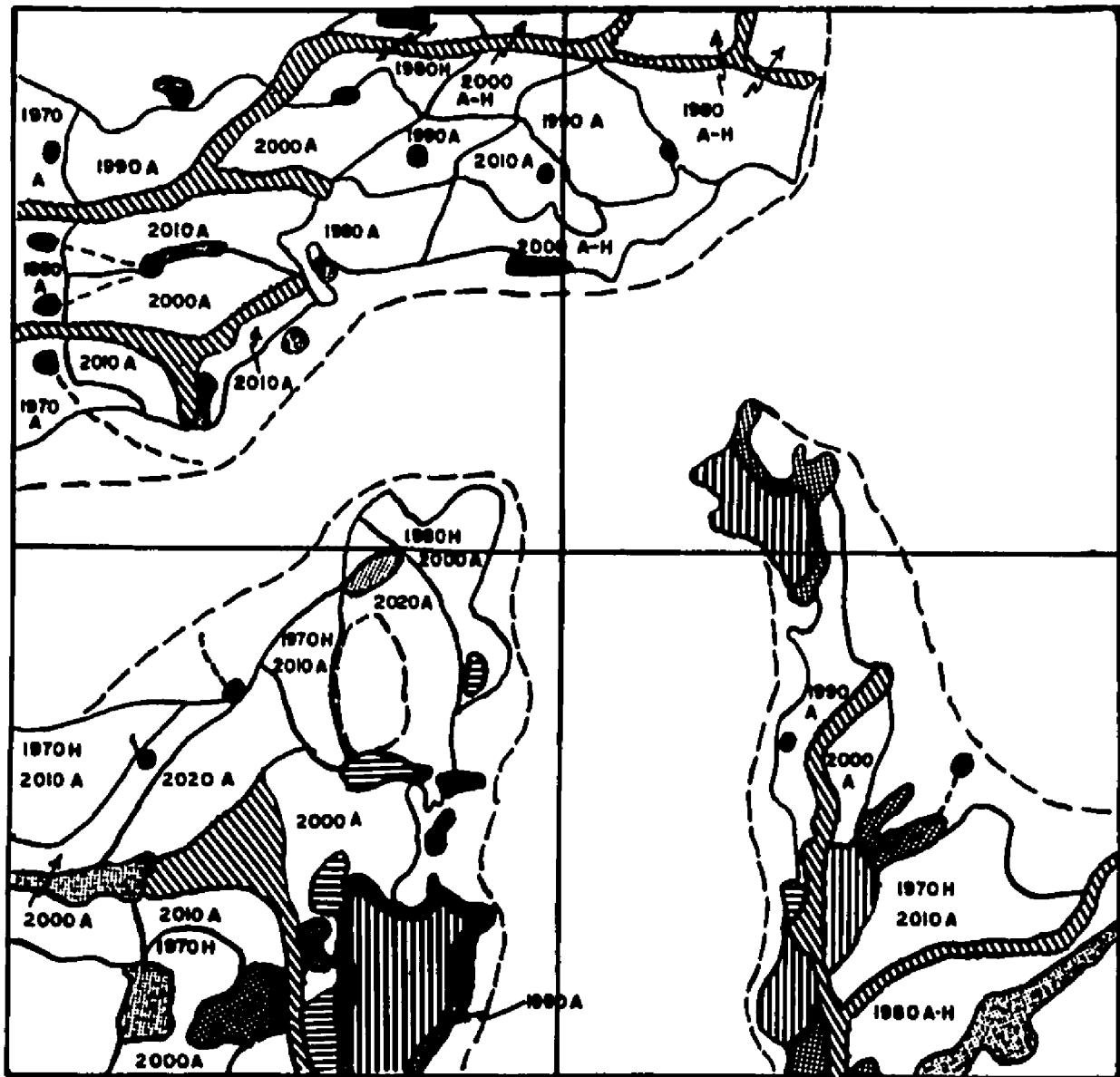


Figure 28

SUMMARY AND CONCLUSIONS

With the advent of the multiple use concept, the need for a multiple use, ruffed grouse habitat management plan became evident. In 1965, a study was initiated to measure and describe the cover types on sites with productive ruffed grouse populations and to formulate a management plan that would be in harmony with other forest practices.

The vegetation used by grouse was measured and described during the period June 20, 1966, to June 20, 1968. The breeding population was estimated, from spring drumming counts, to be between 18 and 22 grouse (one grouse per $16.7 \pm$ acres of habitat). Fall populations varied from one grouse per 5 acres of habitat in 1966 to one grouse per 7.9 acres in 1967. The mean fall population for the three years was one grouse per 6.1 acres of habitat.

There were 20 structural variations of 5 general vegetation types (lowland hardwoods, aspen, aspen-hardwood mixtures, upland hardwoods and openings) on 3 different sites (lowland = poorly drained; transition = imperfectly to moderately well-drained; and upland = well-drained). Estimates of various descriptive parameters for each of the 20 types were obtained from 306 plots. Species diversity was

greatest in the transition zone and in aspen stands. Lowland-transition-upland sequence areas also were characterized by the highest degree of interspersions and structural diversity.

During the two-year study, 443 observations of grouse use were made. These observations were summarized into seven seasonal observational categories and listed according to the general type and site-zone location. Differences in the means of a particular descriptive parameter of the types preferred by grouse at the various seasons were analyzed statistically using the One-Way Analysis of Variance and the Duncan's New Multiple Range Test. To detect differences in the use of the five general types and the three site zones, Chi-square Analysis was used. Ninety-five per cent of the observed grouse use was concentrated in 52 per cent of the total area in locations where the three site zones were present and where there was a predominance of aspen types. These areas had high degrees of interspersions (averaged 9.8 cover types per forty acres) and large amounts of structural diversity, which was due primarily to the cutting of aspen for pulp. Although over 58 per cent of the study area was covered by upland hardwoods, only 25.5 per cent of these hardwoods were used by grouse with any consistency. Lowland hardwoods, aspen and aspen-hardwood mixtures, on the other hand, were used randomly or more than randomly at all seasons.

These data resulted in the following conclusions as to the structural and zonal preference of grouse at various seasons:

(1) Drumming males used the lowland and transition sites more than expected but used upland sites when vegetation provided the proper structural characteristics. These characteristics were best described by Palmer (1963).

(2) Types frequented by grouse during the spring were on transition sites with high densities of 1 to 4-inch trees and density profiles similar to that used by broods.

(3) In the summer, males and females (without broods) occupied types similar in structure to those used by drumming males, but used the site zones randomly.

(4) Cover types used by females with broods had dense understory layers and moderately dense ground cover layers, between 8 and 36 inches in height. These types usually occurred on lowland and transition sites or in cut aspen stands on upland sites. Areas with these characteristics and with scattered small openings were used more intensively.

(5) After October 1st, the grouse used the site zones randomly. Cover types frequented the most were similar to those used by drummers in the spring and adults in the summer.

(6) For winter roosting, pole-size stands of upland hardwoods and aspen-hardwood mixtures were used. During times of deep snow the upland sites were preferred, but during shallow snow the transition and lowland zones were used more than expected. Conifers were used noticeably only during times of shallow or crusting snow.

From these results and the literature, I have formulated the following management plan for similar areas in multiple use forests:

(1) Use the drainage patterns and soil drainage sequences (catenas) as indicators of potential sites of manageable grouse habitats.

(2) Partition the areas into two management units: Transition Zone Unit and the Upland Zone Unit.

(3) Manage Upland Zone Management Units, which are upland sites, for wild turkey, squirrels and deer using the area primarily for the production of sawtimber. This could possibly be accomplished by managing these sites as all-aged stands using the group selection method.

(4) Manage Transition Zone Units, which are areas including lowland and transition sites and portions of the upland sites, for snowshoe hare, deer, woodcock and grouse using the area primarily for the production of aspen and for hardwood pulp.

(5) Transition Zone Management Units should be composed of at least four adjoining, 20-acre coverts with the following composition: (a) at least 5 but preferably 10 per cent of the area in openings; this includes roads, trails, turn-arounds, powerlines and poorly stocked stands; (b) 25-35 per cent in sapling aspen types produced by medium to heavy aspen cuttings less than 20 years old; (c) 15-20 per cent in sapling and pole-size mixtures of aspen-hardwood stands

produced by light to medium cuttings of pulp; and (d) 25-35 per cent pole-size or mature aspen more than 20 years old. If possible, these small coverts should be adjacent to low-land and upland hardwood areas.

Special Considerations

(1) Openings should be located primarily along the upland-transition border. Trail and turnaround networks used for logging should be planned with this in mind. Openings should be kept clear of sapling growth and have dense shrub borders of blackberry, sumac, viburnum, hazel or dogwood. Individuals of such tree species as black cherry, hawthorn, juneberry and hophornbeam should be permitted in openings not used in the road network. East-west elongated openings 50-100 feet wide should be developed where needed.

(2) Aspen stands should be clear-cut and maintained in aspen by not allowing more than 20 square feet of basal area to remain. Small groups or individuals of the tree species mentioned above should be left standing. Stands should be cut in 5 to 10-acre blocks or 300 to 600 foot wide strips on a 40-50 year rotation with 10-year cycles.

(3) Along a 300-foot strip in the upland hardwoods adjacent to the transition sites, tree species that provide food for grouse and other wildlife should be encouraged.

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LITERATURE CITED

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APPENDIX

APPENDIX

Table 14. The tree species identified from the plot data.

Common Name	Scientific Name*
Red Maple	Acer rubrum
Sugar Maple	Acer saccharum
Juneberry	Amelanchier laevis
Yellow Birch	Betula lutea
White Birch	Betula papyrifera
Blue Beech	Carpinus caroliniana
Hawthorn	Crataegus spp.
Beech	Fagus grandifolia
White Ash	Fraxinus americana
Black Ash	Fraxinus nigra
Hophornbeam	Ostrya virginiana
Big-tooth Aspen	Populus grandidentata
Trembling Aspen	Populus tremuloides
Pin Cherry	Prunus pensylvanica
Black Cherry	Prunus serotina
Domestic Apple	Pyrus malus
Pin Oak	Quercus ellipsoidalis
Red Oak	Quercus rubra
Sassafras	Sassafras albidum
Basswood	Tilia americana
American Elm	Ulmus americana
Rock Elm	Ulmus thomasi

Table 15. The shrub species identified from the plot data.

Common Name	Scientific Name*
Alternate-leaf Dogwood	Cornus alternifolia
Red-Osier Dogwood	Cornus stolonifera
Witch Hazel	Hamamelis virginiana
Spice Bush	Lindera benzoin
Fly Honeysuckle	Lonicera involucrata
Virginia Creeper	Parthenocissus quinquefolia
Gooseberry	Ribes cynosbati
Black Current	Ribes lacustre
Winged Sumac	Rhus copallina
Staghorn Sumac	Rhus typhina
Blackberry	Rubus allegheniensis
Red Raspberry	Rubus idaeus
Willow	Salix spp.
Red Elderberry	Sambucus pubens
Maple-leaf Viburnum	Viburnum acerifolium

*Petrides (1958) was used for identification and scientific names.

Table 16. Herbaceous species and woody species under 1-foot in height identified from the plot data.

Common Name	Scientific Name*	
Maidenhair Fern	<i>Adiantum pedatum</i>	
Canada Anemone	<i>Anemone canadensis</i>	
Wood Anemone	<i>Anemone quinquefolia</i>	
Pussy Toes	<i>Antennaria rosea</i>	
Wild Columbine	<i>Aquilegia canadensis</i>	
Burdock	<i>Arctium minus</i>	
Jack-in-the-Pulpit	<i>Arisaema triphyllum</i>	
Ginger	<i>Asarum canadense</i>	
Milkweed	<i>Asclepias</i> spp.	
Asters	<i>Aster</i> spp.	3
Sedges	<i>Carex</i> spp.	2
Bull Thistle	<i>Cirsium vulgare</i>	
Bunchberry	<i>Cornus canadensis</i>	
Wild Carrot	<i>Daucus carota</i>	
Wood Fern	<i>Dryopteris spinulosa</i>	
Horsetails	<i>Equisetum Arvense</i>	
Strawberry	<i>Fragaria virginiana</i>	
Bedstraw	<i>Galium</i> spp.	2
Wintergreen	<i>Gaultheria procumbens</i>	
Avens	<i>Geum vernum</i>	
Hepatica	<i>Hepatica americana</i>	
Hawkweeds	<i>Hieracium</i> spp.	3
St. John's Wort	<i>Hypericum perforatum</i>	
Jewel-weed	<i>Impatiens biflora</i>	
Blue Lettuce	<i>Lactuca biennis</i>	
Wood Nettle	<i>Laportea canadensis</i>	
Club Mosses	<i>Lycopodium</i> spp.	3
Canada Mayflower	<i>Maianthemum canadense</i>	
Mint	<i>Mentha arvensis</i>	
Partridge Berry	<i>Mitchella repens</i>	
Wild Bergamot	<i>Monarda fistulosa</i>	
Water Cress	<i>Nasturtium officinale</i>	
Phlox	<i>Phlox divaricata</i>	
Ground Cherry	<i>Physalis heterophylla</i>	
Plantain	<i>Plantago major</i>	
Bracken Fern	<i>Pteridium aquilinum</i>	
Buttercups	<i>Ranunculus</i> spp.	2
Dewberry	<i>Rubus flagellaris</i>	
Sheep Sorrel	<i>Rumex acetocella</i>	
continued		

*Gleason and Cronquist (1963) was used for identification and scientific names.

Table 16 - continued

Common Name	Scientific Name	
Goldenrod	Salidago spp.	2
Solomon Seal	Smilacian stellata	
Dandelion	Taraxacium officinale	
Foamflower	Tiarella cordifolia	
Starflower	Trientalis borealis	
Clover	Trifolium hybridum & pratense	
Trillium	Trillium erectum	
Bellwort	Uvalaria perfoliata	
Muellein	Verbasium thapsus	
Violets	Viola spp.	3
Grasses		5
Unknowns		17

Table 17. The ranking of the dominant tree, sapling and shrub species of the types used by drumming males in the spring.

$\frac{2}{H4_2A3^C}^*$		
Trees	Saplings	Shrubs
1. Sugar Maple	1. Trembling Aspen	1. Red Raspberry
2. Trembling Aspen	2. Sugar Maple	2. Blackberry
3. American Elm	3. Ash	3. Witch Hazel
4. Basswood	Black Cherry	4. Gooseberry
5. Black Cherry	4. Hophornbeam	M. L. Viburnum
6. Ash	5. Red Maple	5. Honeysuckle
7. Hophornbeam	6. Juneberry	6. Willow
8. Red Maple	7. Red Oak	Dogwood
Juneberry		Winged Sumac
Big-tooth Aspen		7. 5-Leaf Ivy

Table 18. The ranking of the dominant tree, sapling, and shrub species of the types in which grouse were flushed in the spring.

$\frac{2}{A4_2H3^C}$		
Trees	Saplings	Shrubs
1. Trembling Aspen	1. Trembling Aspen	1. Blackberry
2. Sugar Maple	2. Ash	2. Red Raspberry
3. Black Cherry	3. Black Cherry	3. M. L. Viburnum
4. Ash	4. Juneberry	4. Winged Sumac
5. Hophornbeam	5. Sugar Maple	5. Witch Hazel
6. Elm	6. Hophornbeam	6. Gooseberry
7. Basswood	7. Red Oak	7. Honeysuckle
8. Red Maple		
9. Beech		

*Refer to Table 2 in back pocket for explanation.

Table 19. The ranking of the dominant tree, sapling and shrub species of the types used by males and females, without broods, in the summer.

${}^2A_4{}_2H_3^C$		
Trees	Saplings	Shrubs
1. Trembling Aspen	1. Trembling Aspen	1. Blackberry
2. Sugar Maple	2. Juneberry	2. Winged Sumac
3. Black Cherry	3. Black Cherry	3. Gooseberry
4. Basswood	4. Ash	4. Red Raspberry
5. Ash	5. Hophornbeam	5. M. L. Viburnum
6. Elm	6. Sugar Maple	6. Witch Hazel
7. Juneberry	7. Red Maple	7. Willow
8. Big-tooth Aspen	8. Red Oak	8. Honeysuckle
9. Hophornbeam		9. Dogwood
10. Red Maple		10. Staghorn Sumac

Table 20. The ranking of the dominant tree, sapling and shrub species of the types used by females with broods.

${}^2A_4{}_2H_3^C$		
Trees	Saplings	Shrubs
1. Trembling Aspen	1. Trembling Aspen	1. Blackberry
2. Sugar Maple	2. Juneberry	2. Red Raspberry
3. Black Cherry	3. Black Cherry	3. Winged Sumac
4. Elm	4. Hophornbeam	4. Willow
5. Ash	Ash	Gooseberry
6. Red Maple	5. Red Pine	5. Staghorn Sumac
7. Juneberry	6. Red Maple	6. Dogwood
8. Apple	Sugar Maple	7. M. L. Viburnum
9. Basswood	7. Red Oak	Witch Hazel
10. Hophornbeam	8. Elm	8. Honeysuckle
11. Big-tooth Aspen		5-Leaf Ivy

Table 21. The ranking of the dominant tree, sapling and shrub species of the types used by broods for dusting.

${}^2A_4{}_2H_2^C$		
Trees	Saplings	Shrubs
1. Trembling Aspen	1. Trembling Aspen	1. Blackberry
2. Sugar Maple	2. Juneberry	2. Red Raspberry
3. Black Cherry	3. Black Cherry	3. Winged Sumac
4. Apple	4. Ash	4. Staghorn Sumac
5. Juneberry	5. Red Pine	5. Gooseberry
6. Basswood	6. Hophornbeam	6. M. L. Viburnum
7. Ash	7. Red Maple	7. Willow
8. Rock Elm	8. Sugar Maple	8. Witch Hazel
9. Red Maple	9. Elm	9. Dogwood
10. Hophornbeam	Red Oak	10. Honeysuckle
11. Big-tooth Aspen		
12. Beech		

Table 22. The ranking of the dominant tree, sapling and shrub species of the types used by grouse in the fall.

${}^3H_3{}_2A_3^B$		
Trees	Saplings	Shrubs
1. Sugar Maple	1. Trembling Aspen	1. Blackberry
2. Trembling Aspen	2. Black Cherry	2. Red Raspberry
3. Black Cherry	3. Ash	3. M. L. Viburnum
4. Basswood	4. Juneberry	4. Gooseberry
5. Ash	5. Hophornbeam	5. Winged Sumac
Elm	6. Red Pine	6. Witch Hazel
6. Hophornbeam	7. Red Oak	7. Willow
7. Red Maple	8. Sugar Maple	8. Honeysuckle
8. Apple	9. Red Maple	9. Dogwood
Beech	10. Elm	10. Staghorn Sumac
9. Juneberry		11. Apple
Big-Tooth Aspen		

Table 23. The ranking of the dominant tree, sapling and shrub species of the types used by grouse in the winter.

$\begin{matrix} 3 \\ H3 \\ 2 \\ A3 \\ B \end{matrix}$		
Trees	Saplings	Shrubs
1. Sugar Maple	1. Trembling Aspen	1. Blackberry
2. Trembling Aspen	2. Ash	2. Red Raspberry
3. Black Cherry	3. Juneberry	3. M. L. Viburnum
4. Basswood	4. Black Cherry	4. Gooseberry
5. Elm	5. Hophornbeam	5. Winged Sumac
6. Ash	6. Sugar Maple	6. Witch Hazel
7. Juneberry	7. Red Maple	7. Staghorn Sumac
8. Big-tooth Aspen	8. Red Oak	8. Willow
9. Red Maple	9. Red Pine	9. 5-Leaf Ivy
10. Pin Oak	10. Elm	10. Dogwood
		11. Honeysuckle

Table 24. The diameters and age of 15 trembling aspen trees. All trees were located in transition zones on the study area. Linear regression formula for the data is also given.

Tree Number	d.b.h.	Age in years
1	3.7	17
2	4.6	19
3	5.0	22
4	5.2	24
5	5.5	25
6	6.5	26
7	6.2	27
8	6.3	28
9	6.8	29
10	6.8	29
11	6.8	29
12	6.5	30
13	7.2	32
14	7.6	33
15	8.8	40
$\bar{x} = 6.23$ inches	Slope : $\bar{y} = 0.6 + 4.38(x)$	
$\bar{y} = 27.3$ years		

- Graph I: Density profiles of ground cover of types used by grouse in winter (7), and spring (2), and by drummers (1). The curves were calculated using summer cover values.
- Graph II: Density profiles of ground cover of types used by grouse in fall (6), and summer (3), and by broods (4), and for dusting (5).
- Graph III: Density profiles of understory cover of types used by grouse in winter (7), and spring (2), and by drummers (1). The left set of curves were those calculated using winter density profiles values, and the right set using summer cover values.
- Graph IV: Density profiles of understory cover of types used by grouse in fall (6), and summer (3), and by broods (4), and for dusting (5).

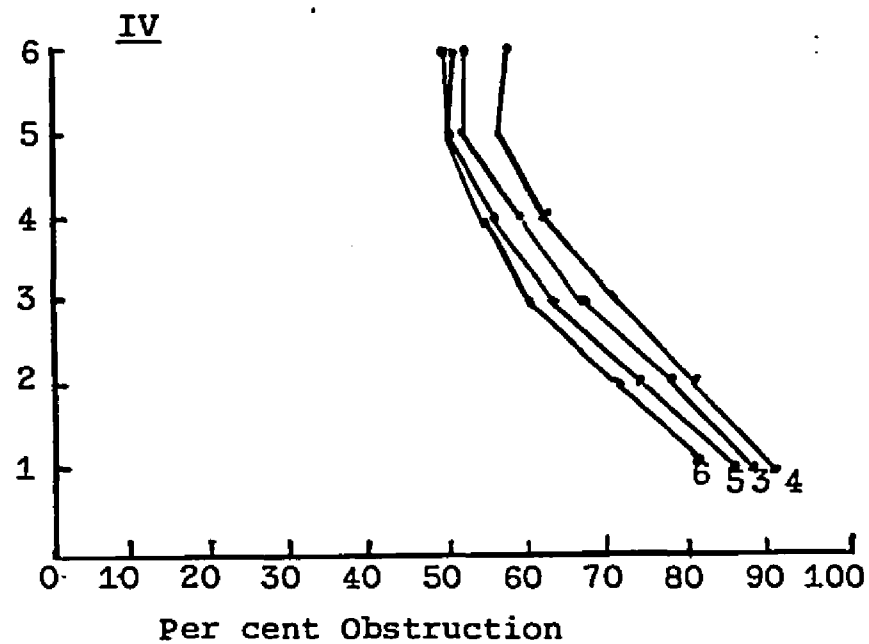
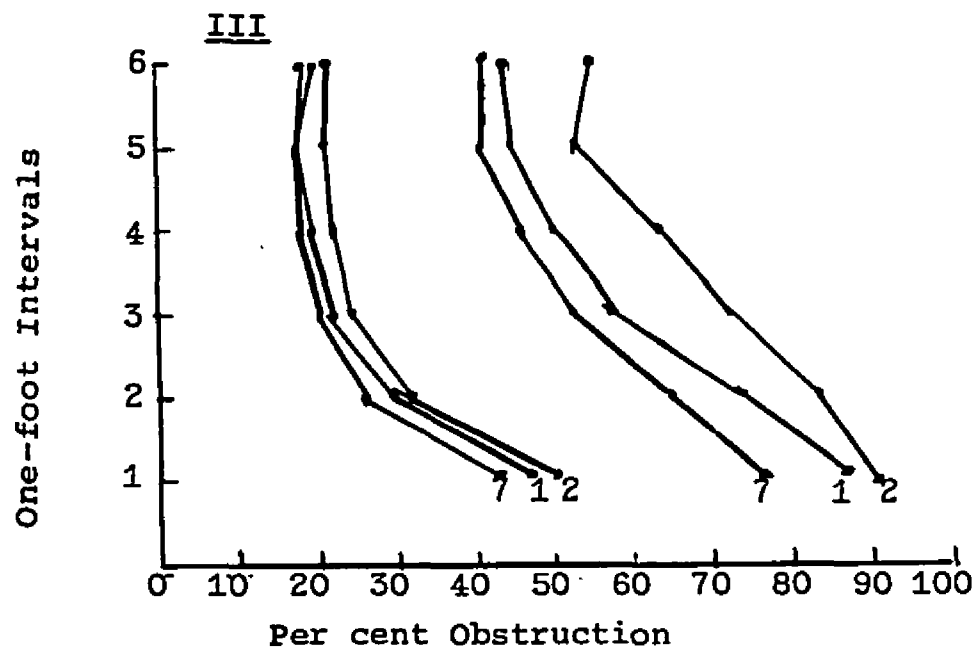
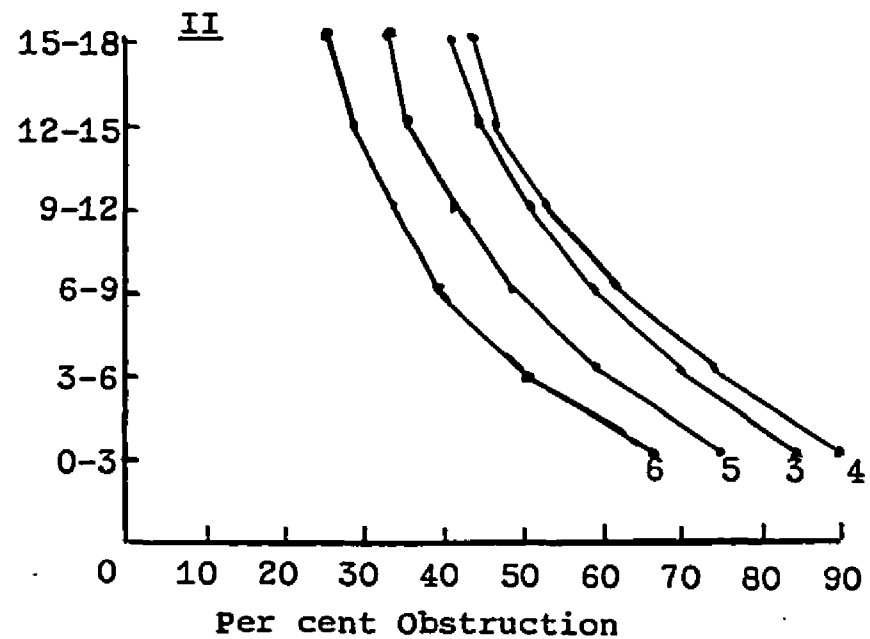
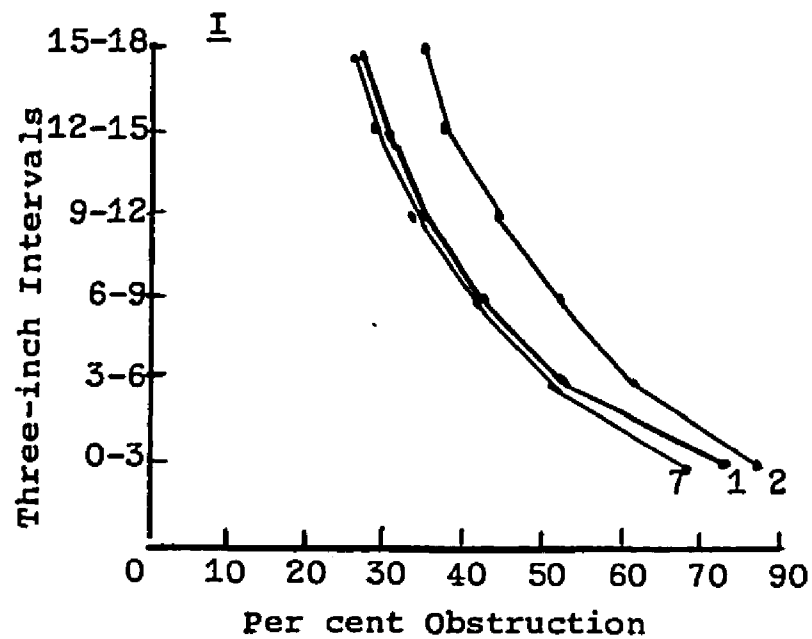


Table 25. Tables 25-1 through 25-30 significance of particular descriptive parameter means between various seasonal observational categories, and levels of significance (+ = 0.05; ++ = 0.01).

- | | |
|---------------------------|--------------------------------|
| *1. = Drummers | 5. = Summer Dusting Signs |
| 2. = Spring Flushes | 6. = Fall Flushes |
| 3. = Summer Flushes | 7. = Winter Roosts and Flushes |
| 4. = Summer Brood Flushes | |

Tables 25-31 through 25-34 give the general vegetation types which have significantly higher average number of plant species, and give the levels of significance.

- | | |
|------------------------------|----------------------|
| **LH = Lowland Hardwoods | ***LZ = Lowland Zone |
| A = Aspen | TZ = Transition Zone |
| AH = Aspen-Hardwood Mixtures | UZ = Upland Zone |
| UH = Upland Hardwoods | |
| O = Openings | |

1

	1	2	3	4	5	6	7
*1							
2							
3							
4	+						
5	++						
6	+						
7	++	+					

2

	1	2	3	4	5	6	7
1							
2							
3							
4	++	++	++			++	++
5	++	++	++			++	++
6							
7							

3

	1	2	3	4	5	6	7
1							
2							
3							+
							+
						++	++
6							
7							

4

	1	2	3	4	5	6	7
1							
2							
3							
4						++	++
5							
6							
7							

5

	1	2	3	4	5	6	7
1							
2							
3							
4	+						
5	+	++	++				
6	++						
7	+	++	++				

6

	1	2	3	4	5	6	7
1							
2							
3							
4	++	+	+			+	++
5	++	++	++			++	++
6							
7							

7

	1	2	3	4	5	6	7
1							
2							
3							
4	++					++	
5	++	++	++			++	++
6							
7	++					++	

8

	1	2	3	4	5	6	7
1							
2							
3							
4							
5			++	++			
6							
7			++	++			

9

	1	2	3	4	5	6	7
1							
2							
3							
4	++	++	++			++	
5	++	++	++	+		++	++
6							
7						+	

10

	<u>Height Dominant</u>						
	1	2	3	4	5	6	7
1							
2					+	++	
3							
4						++	
5					+	++	
6							
7							

11

	<u>Height Sub-Canopy</u>						
	1	2	3	4	5	6	7
1							
2							
3							
4					++	++	
5	++	++	++		++	++	
6							
7							

12

	<u>Height Understory</u>						
	1	2	3	4	5	6	7
1							+
2							++
3				+			++
4							++
5							++
6							++
7							

13

	<u>Saplings: 1-3 ft.</u>						
	1	2	3	4	5	6	7
1				+			
2							
3				++			
4							
5				+			
6				++			
7	++		++	++	+		

14

	<u>Saplings: 3-10 ft.</u>						
	1	2	3	4	5	6	7
1							
2							
3							
4							
5							
6							
7	++	++	+	+	+		

15

	<u>Saplings: 10ft.1in dbh</u>						
	1	2	3	4	5	6	7
1							
2							
3							
4							
5				+			
6							
7	++		++				

16

	<u>Saplings: Total</u>						
	1	2	3	4	5	6	7
1				+			
2							
3				+			
4							
5				+			
6				+			
7	++		++	++	++		

17

	<u>Herbs/sq. ft.</u>						
	1	2	3	4	5	6	7
1							
2							
3	+				+		
4							
5							
6	++		++	++			
7	+				++		

18

	<u>% Ground Cover (8-36")</u>						
	1	2	3	4	5	6	7
1							
2							
3							
4							
5							
6	+	+	++	++			
7			+	++			

19 % Obstruction 1 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

20 % Obstruction 2 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

21 % Obstruction 3 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

22 % Obstruction 4 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

23 % Obstruction 5 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

24 % Obstruction 6 ft.

	1	2	3	4	5	6	7
1							
2							
3		++		++			
4							
5		++		++			
6		++		++			
7		++		++			

25 % Obstruction 0-3 in.

	1	2	3	4	5	6	7
1							
2							
3							
4							
5				++			
6				++			
7		++	++	++			

26 % Obstruction 3-6 in.

	1	2	3	4	5	6	7
1							
2							
3							
4							
5				++			
6				++			
7		++	++	++			

27 % Obstruction 6-9 in.

	1	2	3	4	5	6	7
1							
2							
3							
4							
5				++			
6				++			
7		++	++	++			

28 % Obstruction 9-12 in.
 1 2 3 4 5 6 7

1
 2
 3
 4
 5 ++
 6 ++
 7 ++ ++ ++

29 % Obstruction 12-15 in.
 1 2 3 4 5 6 7

1
 2
 3
 4
 5 ++
 6 ++
 7 ++ ++ ++

30 % Obstruction 15-18 in.
 1 2 3 4 5 6 7

1
 2
 3
 4
 5 ++
 6 ++
 7 ++ ++ ++

31 No. of Species
 LH A A-H UH O

**LH
 A
 AH
 UH + ++ ++
 O + ++ ++

32 No. of Species
 LZ TZ UZ

***LZ
 TZ
 UZ + ++

33 Diversity Indice
 LH A A-H UH O

LH ++ ++
 A
 A-H
 UH ++ ++
 O ++ ++

34 Diversity Indice
 LZ TZ UZ

LZ ++
 TZ
 UZ ++

Figure 2: (Black) Map of the roads, trails and streams on the study area. The grid denotes the 16 forties on the section.

Streams = -----

Roads and trails = _____

Figure 3: (Green) Vegetation type map of the study area. Refer to Table 2 for explanation of the symbols used. (up)

Figure 9: (Blue) Map showing the locations of the three site zones and the three Grouse Habitat Compartments on the area. (right)

Lowland Zone = ==

Transition Zone = - - - - -

Upland Zone = — — — — —

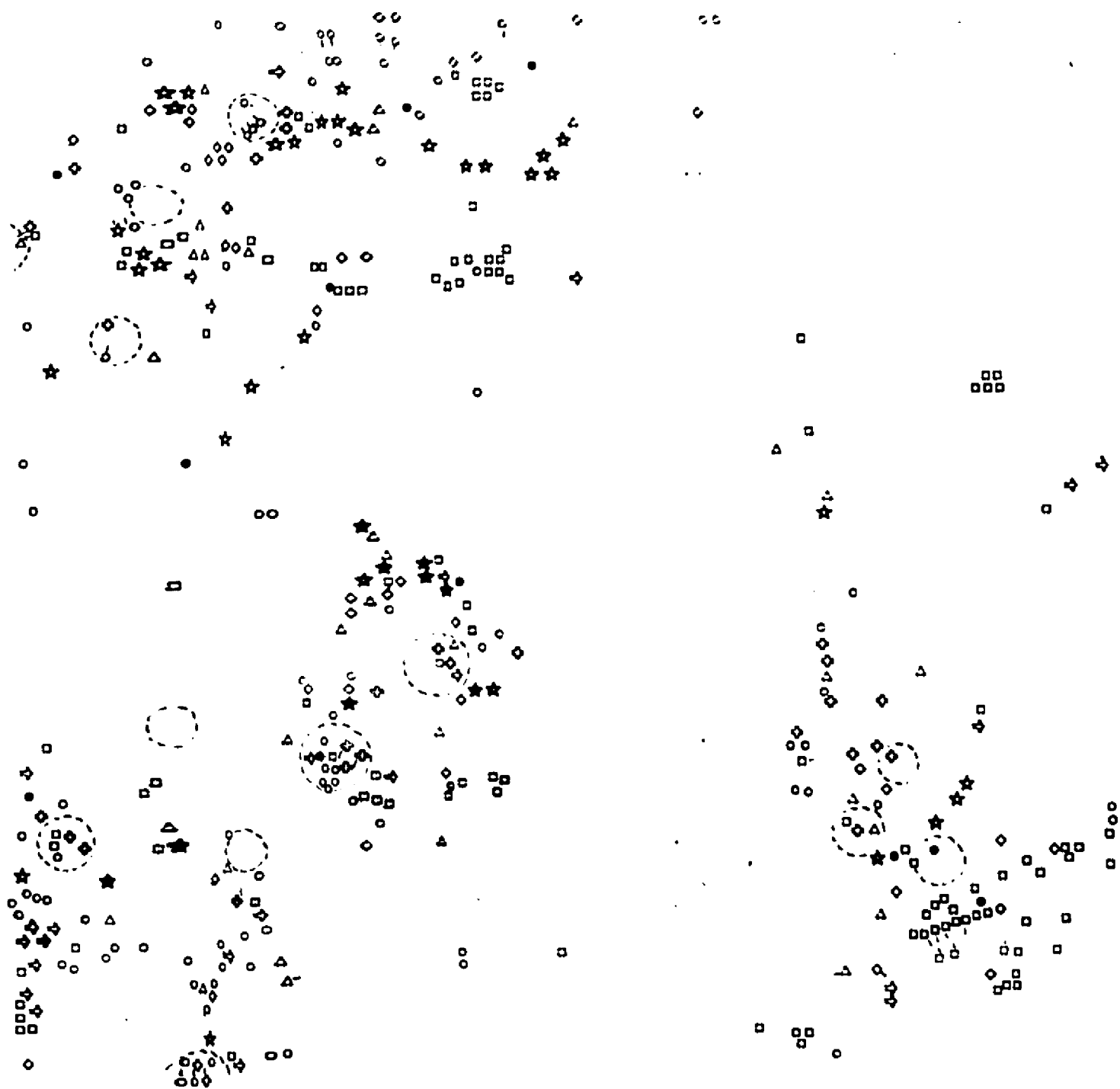
Grouse Habitat Compartment = - - - - -

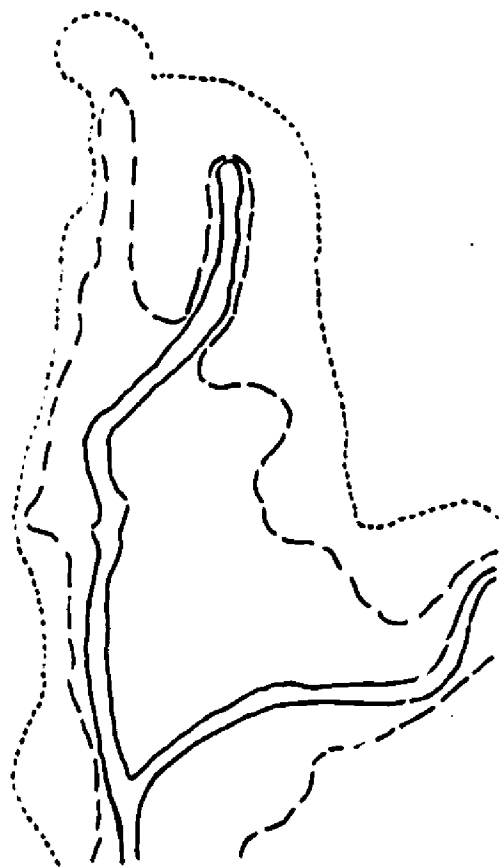
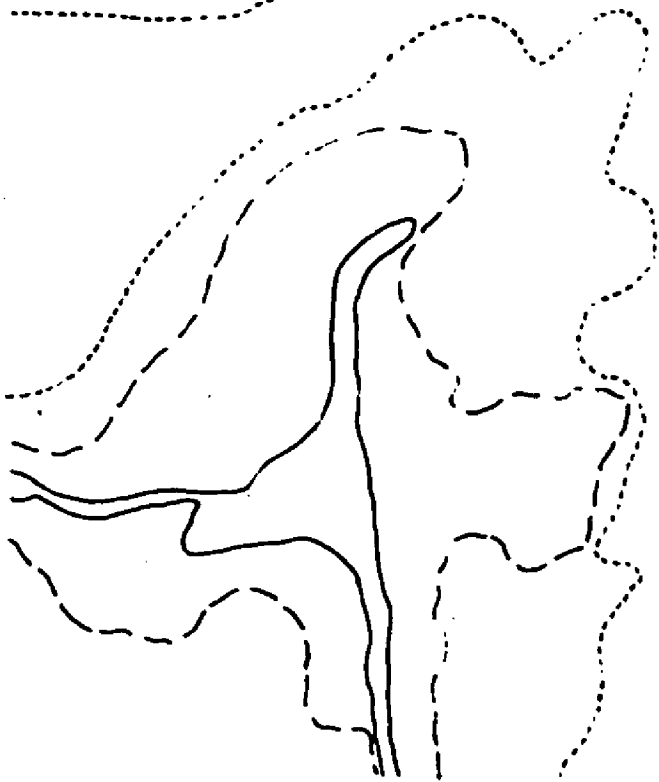
Figure 10. (Red) Map showing the locations of the various seasonal observations in relation to cover types, site zones and landmarks. (down)

Drumming Center	=	⊙	Adults-Fall	=	○
Flush-Spring	=	⊕	Roost-Winter	=	□
Adult-Summer	=	◇	Track-Winter	=	✕
Brood-Summer	=	△	Flush-Winter	=	●
Dusting Sign-Summer	=	★			

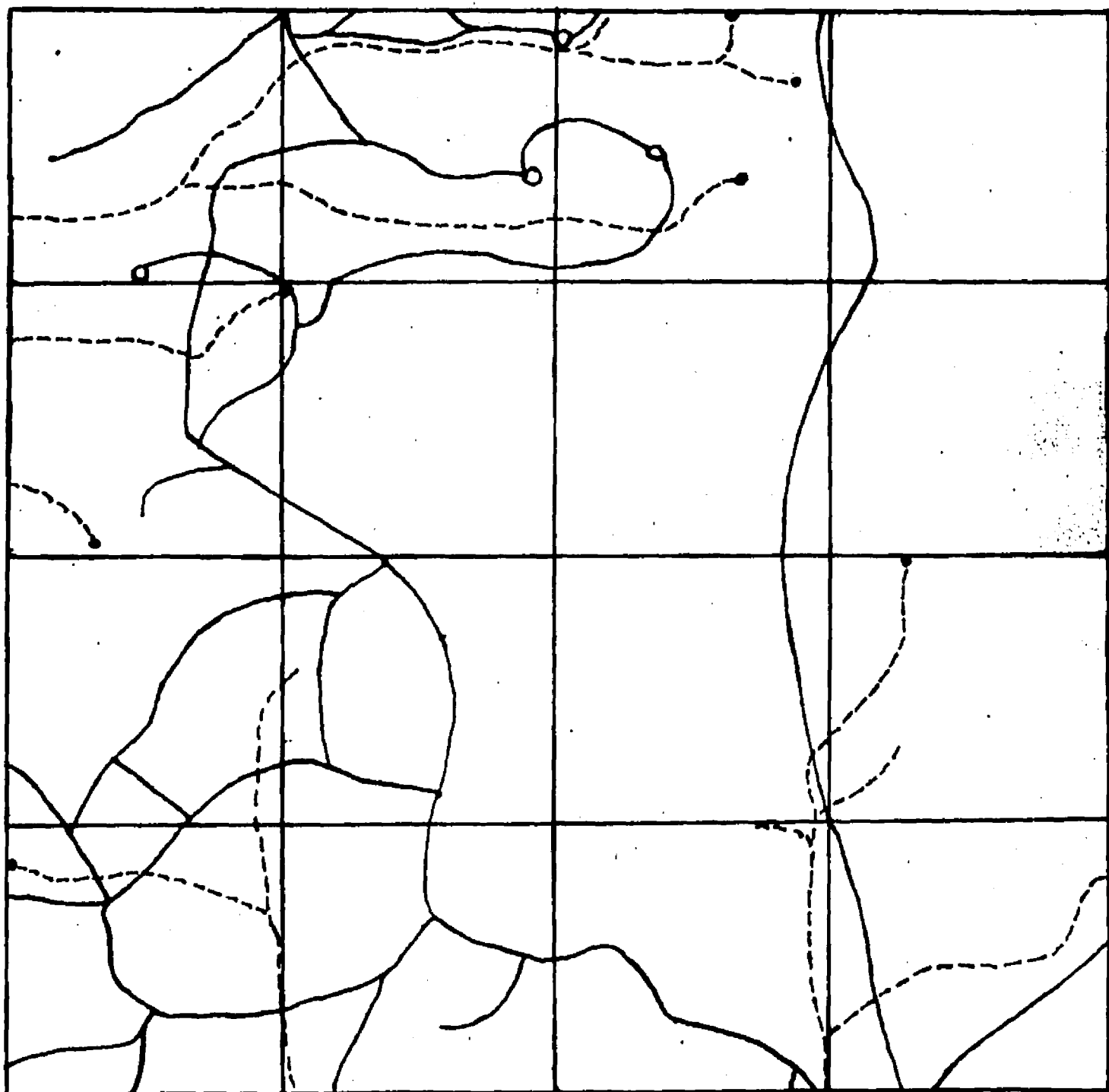
SCALE = 1 inch equals 1056 feet.

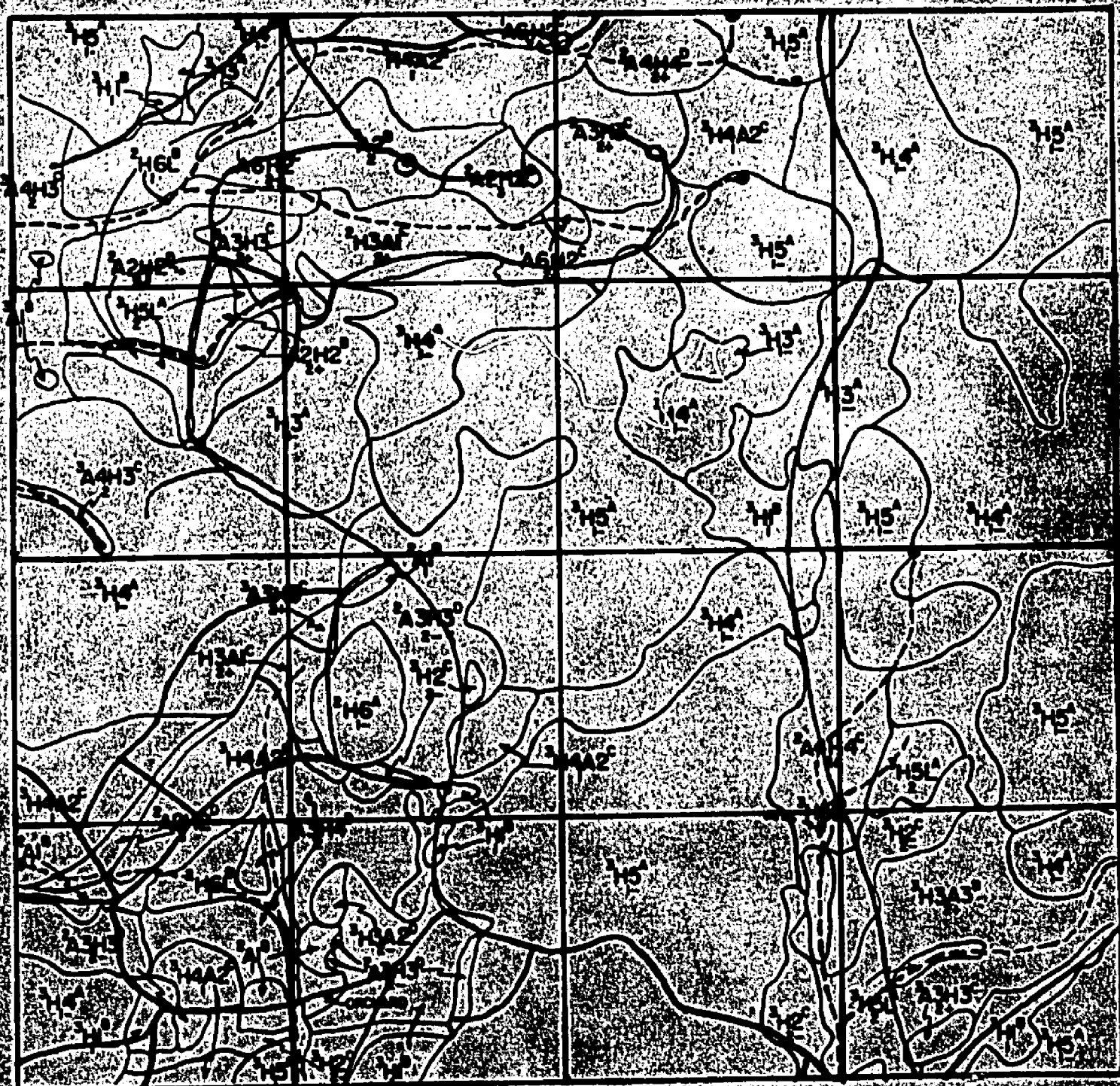
1
N

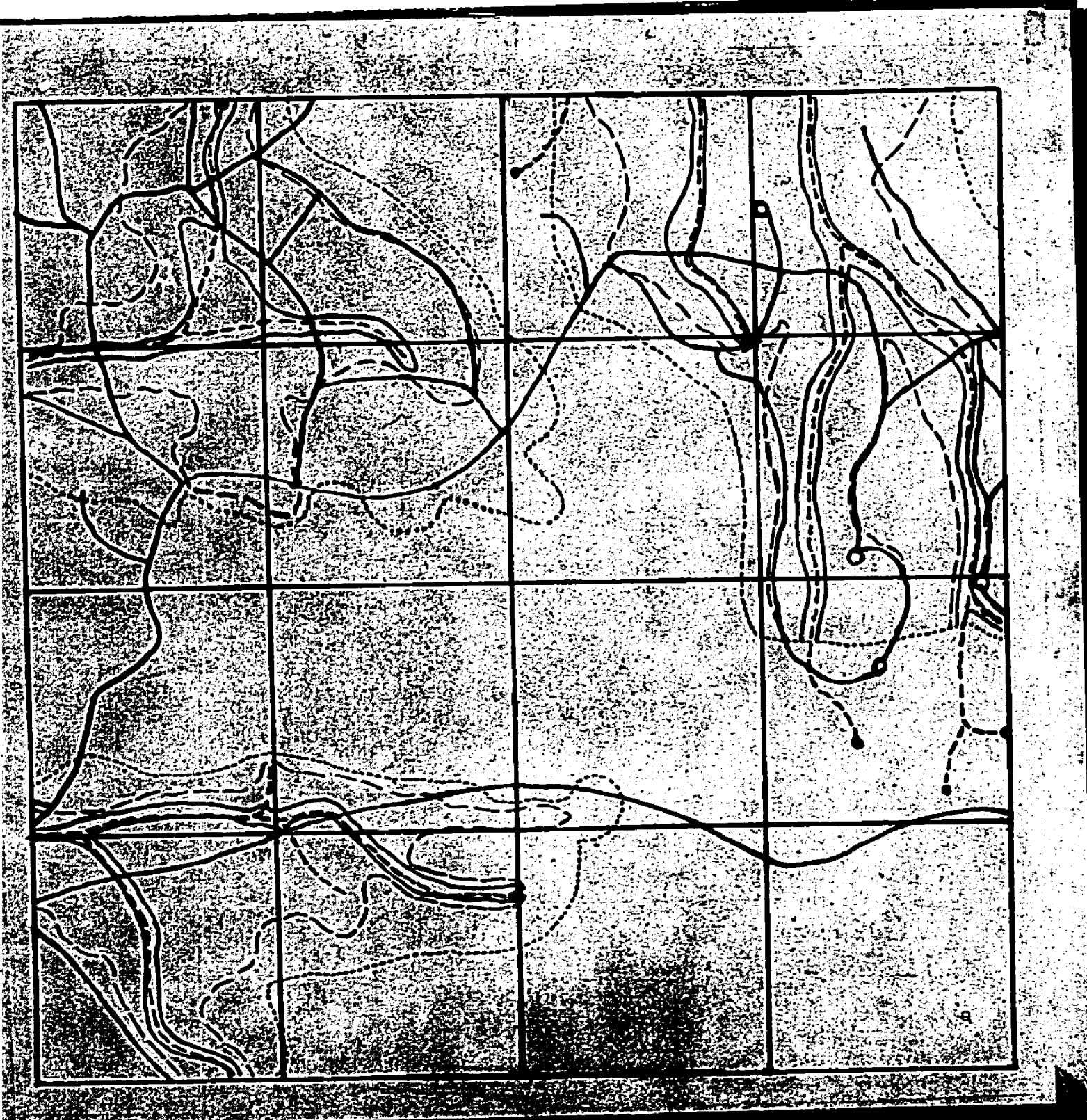












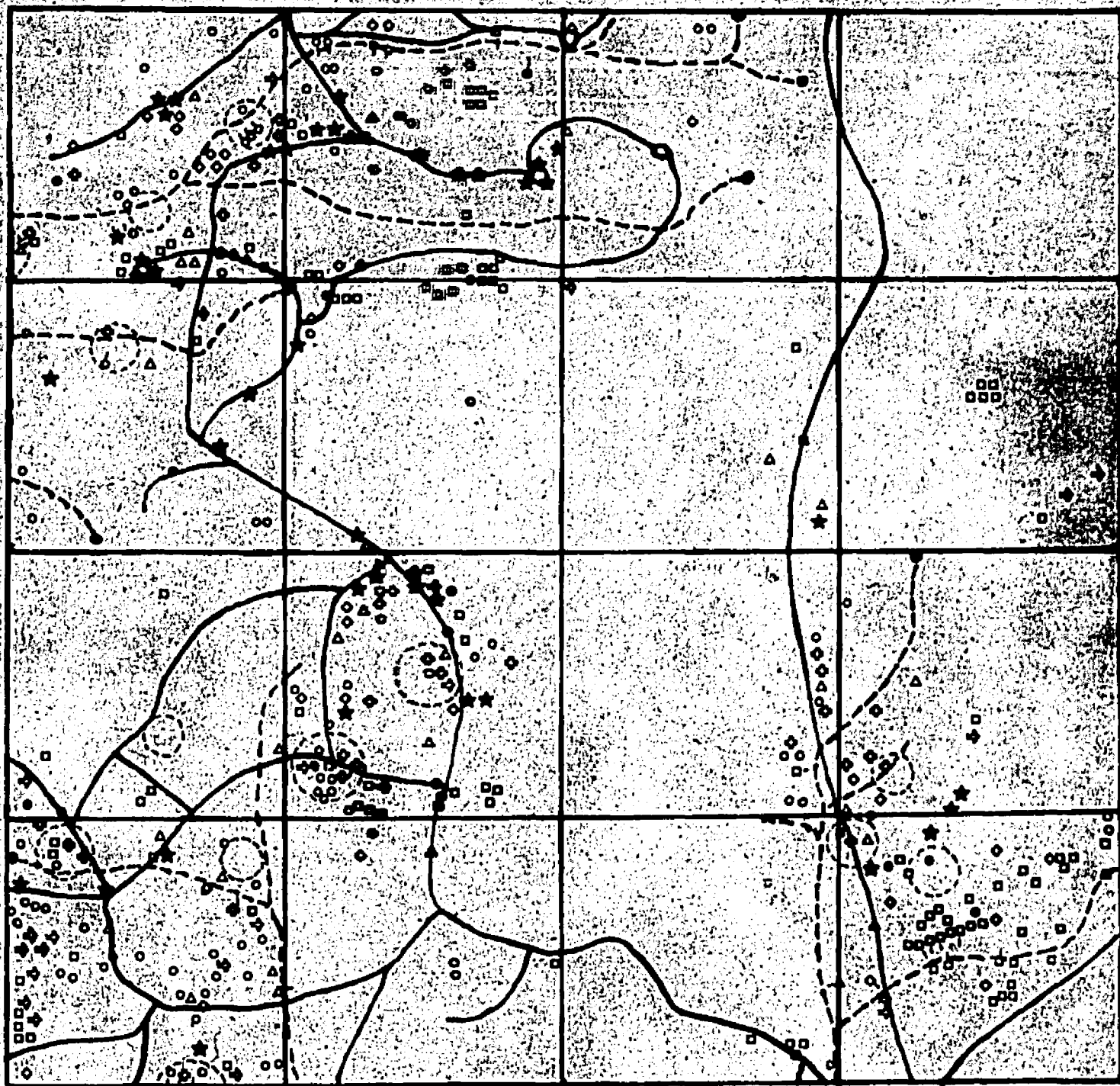
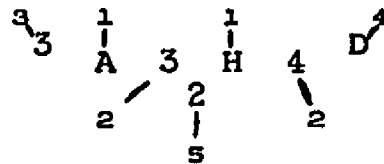


Table 2. Explanation of symbols used for type mapping purposes.

Example:



CANOPY COVER

¹ <u>Species Classification</u>	² <u>Density Category</u>
H ^L = Lowland hardwoods	1 = 0-50 stems/acre
A or A-H = Aspen dominated	2 = 51-200
H-A = Aspen-hardwood mixture	3 = 201-400
H = Upland hardwoods	4 = 401-675
C = Conifers	5 = 676-900
	6 = 900+

³ <u>Size Classes</u>
1 = 90%+ in 1-4" dbh
2 = 95%+ in 1-8"
3 = 90%+ in 1-12"
4 = 10%+ in 12.5"+

UNDERSTORY

GROUND COVER

⁴ <u>Density Category</u>	⁵ <u>% Cover Between 8 & 36"</u>
A = 0-4000 stems/acre	1- = 0-19%
B = 4000-6000	1 = 20-29%
C = 6000-8000	2- = 30-39%
D = 8000+	2 = 40-49%
	2+ = 50-69%
	3 = 70-100%

Explanation of above example:

Aspen-hardwood mixture; 90% stems in 1-12" dbh size class; Aspen 201-400 stems & upland hardwoods 401-675 stems/acre; Understory 8,000 stems/acre; Ground cover 40-49%.