A STUDY OF RUFFED GROUSE DRUMMING SITES IN NORTHERN MICHIGAN

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A STUDY OF RUFFED GROUSE DRUMMING SITES

IN NORTHERN MICHIGAN

By

Walter Lawrence Palmer

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

DEPARTMENT OF FISHERIES AND WILDLIFE

1961

Approved Peter I. Tack

ABSTRACT

Forty ruffed grouse (Bonasa umbellus L.) spring courtship sites were studied in 1959. Sites consisted of drumming logs and surrounding vegetation, and had been located on the Rifle River Area, Ogemaw County, Michigan, during a nine-year period from 1951 to 1959.

I recorded log dimensions, azimuth of log axis, species of log whenever possible, and distances from the drumming position to the nearest end of the log. Vegetation surrounding the logs was studied quantitatively and qualitatively by utilizing a series of quadrats and transects.

Logs averaged about 12 inches high, 13 inches wide, and almost 20 feet long. Logs used most often were larger in diameter than those used infrequently, but length did not appear to be important. Almost three-fourths of the logs were white pine (Pinus strobus) and about half of the remaining logs were other coniferous species. The drumming location was usually about five feet from the larger end of the log.

Vegetation except in the 0-2 feet tall size class, was usually more dense immediately surrounding the logs than elsewhere in the habitat. In the 0-2 feet tall size class, fewer stems were tallied near the logs than elsewhere.

No significant vegetational differences were found between logs used several years as compared with logs used less frequently.

All forty drumming logs were located in lowland vegetation types, but usually were near a lowland-upland type boundary. Although 44 woody plant species were tallied on the sites, speckled alder (Alnus rugosa), red-osier dogwood (Cornus stolonifera), willows (Salix spp.), balsam fir

(*Abies balsamea*), and mountain holly (*Nemopanthus mucronata*) were most common.

The Rifle River Area had not been lumbered for several years, and had an excessive deer (*Odocoileus virginianus*) population. Much of the area contained merchantable or near-merchantable stands of large-toothed aspen (*Populus grandidentata*) and trembling aspen (*P. tremuloides*) which could be harvested. Results of vegetation analyses suggested that plants which are not palatable to deer are the only species reproducing successfully, and therefore these supply the undergrowth necessary for the establishment of drumming sites.

Although no quantitative grouse population data are available for comparison, it is possible that the combined effect of inadequate timber harvest, and the excessive deer population have reduced the grouse carrying capacity of this area by reducing the percentage of the area suitable for grouse territories.

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A THESIS

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INTRODUCTION

The ruffed grouse (Bonasa umbellus L.) is an important game bird in Michigan, second only to the ring-necked pheasant (Phasianus colchicus L.) in average annual kill. The kill exceeds a half-million birds during peaks of abundance, and recently has totalled approximately a third of a million birds (Ryel and Eberhardt, 1960). Improved highways, faster cars, shorter work weeks, and competition for hunting areas in southern Michigan farmland, have been responsible for an increasing interest in northern Michigan grouse hunting.

Male grouse usually select individual territories during their first fall and winter, and keep them throughout life (Eng, 1959). Once these territories are established, males become quite sedentary and probably spend all their time within an area less than a quarter-mile in radius (Palmer, 1956; Eng, 1959). Some slightly elevated object within the territory is selected on which they perform the courtship drumming act. The elevated object is usually a log, but other objects such as boulders or hummocks may be used (Edminster, 1957; Frank, 1947; Bump, Darrow, Edminster and Crissey, 1947). The drumming sound is produced by moving the wings forcefully downward and forward.

Previous Investigations

Edminster (1947) described typical cover used for drumming in New York State. He found that birds preferred young, second growth woodland, predominantly hardwood, but where a fair scattering of conifers, especially young conifers, was present. He also found that mature woodlands, solid coniferous stands, open slashings, and brushland seem to be avoided.

Dorney (1959) in Wisconsin noted that males did not select territories in habitat devoid of forest undergrowth less than 6 feet tall.

Eng (1959) attempted the first detailed analysis of vegetation near drumming logs, but did not compare this vegetation with that elsewhere in the habitat.

Since cover, soils, and other ecological factors in northern Michigan differ considerably from the areas in which Eng's Minnesota study took place, his data are not readily applicable here.

Present Conditions in Northern Lower Michigan

Virgin forests in northern lower Michigan were cut during the middle and late nineteenth century. The logging was followed by extensive fires, which were not adequately controlled until about 1920. Much of the present-day forest cover dates from this period. As a result, large areas exist, which have pole-sized or larger trees, where undergrowth is scanty. This situation is especially apparent on poorer soils. In many areas excessive numbers of browsing deer (Odocoileus virginianus) have also helped to reduce plant reproduction. Because of these two factors, it seemed possible that the availability of suitable drumming cover is declining in this region. This in turn may be a factor affecting the abundance of ruffed grouse in Michigan.

Since males are the most sedentary segment of the population, (Palmer, 1956; Eng, 1959) I thought that a study designed to evaluate drumming sites would provide valuable information necessary for management of areas for ruffed grouse production. Although grouse are polygamous, and it is possible that cover requirements of cocks and hens differ,

especially during the nesting season, generally the two sexes require similar habitat types.

THE STUDY AREA

During a nine year grouse population study from 1951 to 1959, forty drumming logs were located and studied on the Rifle River Area, Ogemaw County, Michigan. This 4318-acre area is largely forest, and several distinct forest cover types are present. (Table I)

TABLE 1

Cover types, and percentage of the 4318-acre

Rifle River Area, Michigan

Type	Percentage of total area
Upland Aspen	40.6
Northern swamp hardwoods	15.7
Upland grasses	12.3
Lowland willows and alder	9.4
Lakes	7.9
Northern swamp conifers	7.3
Lowland grass or sedges	4.5
Upland oak	2.1
Upland conifers	.2
	100.0

LOCATING AND RECORDING DRUMMING LOG USE

I located drumming males each spring using the stalking method (Frank, 1947). The method involved walking slowly through an area listening for drumming. When I heard a grouse drum, I approached it carefully. The bird usually flushed at close range, and a search of the area disclosed the drumming log, which could be identified by the presence of several fecal droppings. Some males however, did not flush, but instead hopped down from the log and walked away, often unnoticed thus making locating of the log much more difficult.

By live-trapping and banding birds, and also by checking areas repeatedly it was apparent that some birds used more than one log. It appeared that there was a direct correlation between the birds' tendency to walk or run away upon being approached and the number of logs on which it drummed. In other words, grouse which performed on only one log apparently had a strong attachment for that log and an unwillingness to leave, and I postulated that this attachment was probably a reflection of the site's quality. The logs studied to my knowledge, were used by only one male each spring.

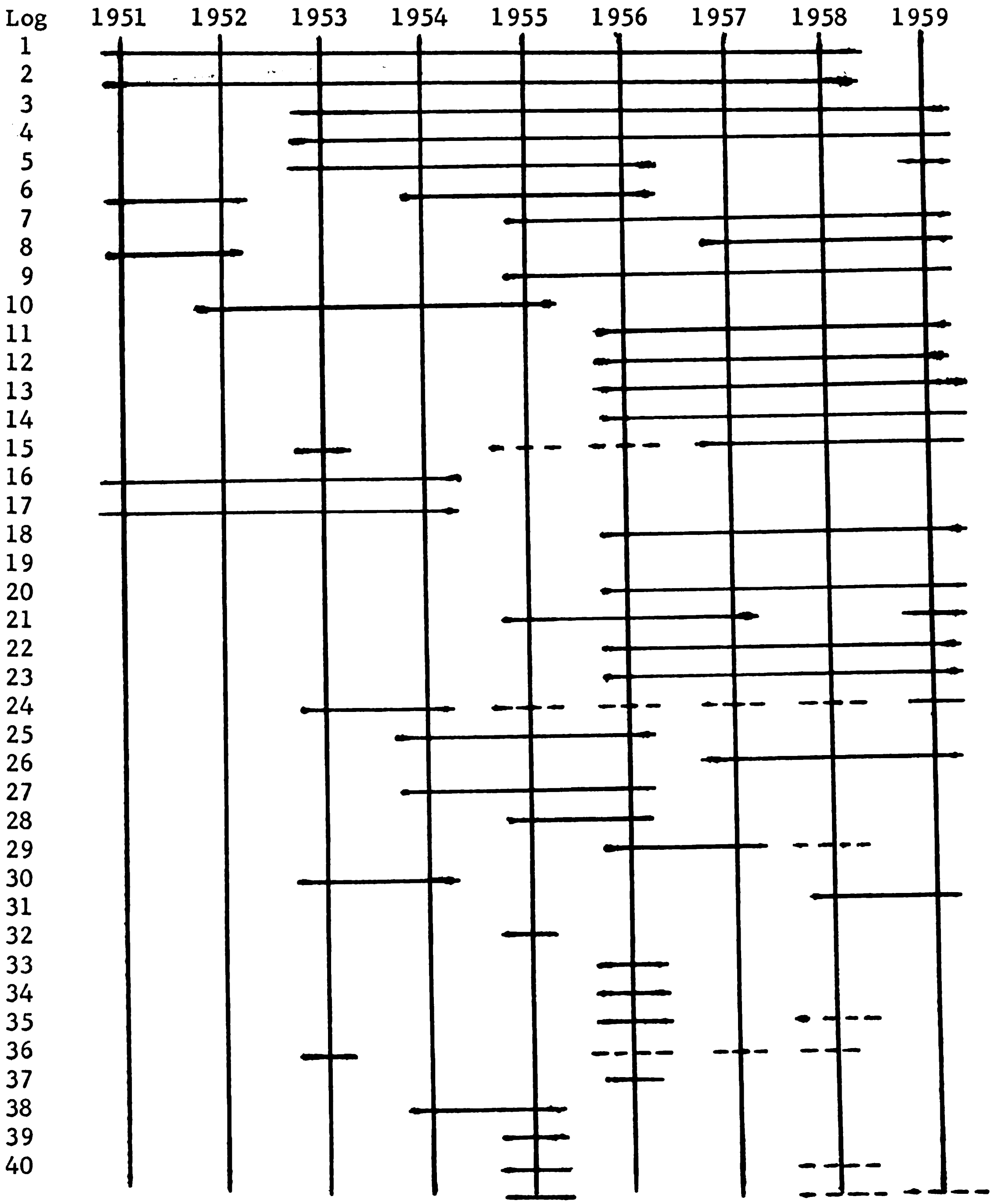
Once drumming logs were located, I attempted to check them in subsequent years to ascertain whether they were being used. Thus, I had a continuous record of use for most of the 40 logs for up to 8 years time (Figure 1).

DIMENSIONS, TYPES AND DIRECTIONS OF DRUMMING LOGS

I revisited each of the forty drumming logs during the summer of 1959 and secured the following information:

Figure 1. Record of use of 40 ruffed grouse drumming logs, 1951-1959, Rifle River Area, Michigan.

Solid lines represent years logs were definitely used, the left end being the year each was located. Dashed lines indicate years logs were not checked for use, and years with no lines indicate logs were not used.



1. Log height and width to the nearest one-half inch.
2. Length to the nearest half foot.
3. Species of log or, if very decayed, whether it was a conifer or hardwood.
4. Azimuth of log axis.
5. Distance of drumming position to nearest end of the log.

Log width varied from 8 to 21 inches with a mean of 13 inches. Height varied from 7 to 21 inches with a mean of 11.9 inches and length ranged from 5.5 to 44 feet and average 19.8 feet (Figure 2).

Logs were then tabulated according to the number of years each had been used and observed, and a ratio was computed between the sum of the number of years used by the sum of the number of years observed. The resultant ratio was therefore an estimated probability of use in each size class for any given year (Tables 2 and 3).

Using this method of analysis, I assumed that if log diameter was one factor affecting selection the estimated probability of use for each size class would be lowest in the smaller size classes and approach unity in the larger log sizes. It appears that this was indeed true, because the probability of use in the largest diameter class was considerably larger than in the smallest class.

Thus if logs are at least 7 inches in diameter the probability of use in any year increases directly with a further increase in log size.

Log length showed little correlation with frequency of use, although I expected that longer logs would tend to be larger in diameter and therefore should be correlated with use. Although the two larger length

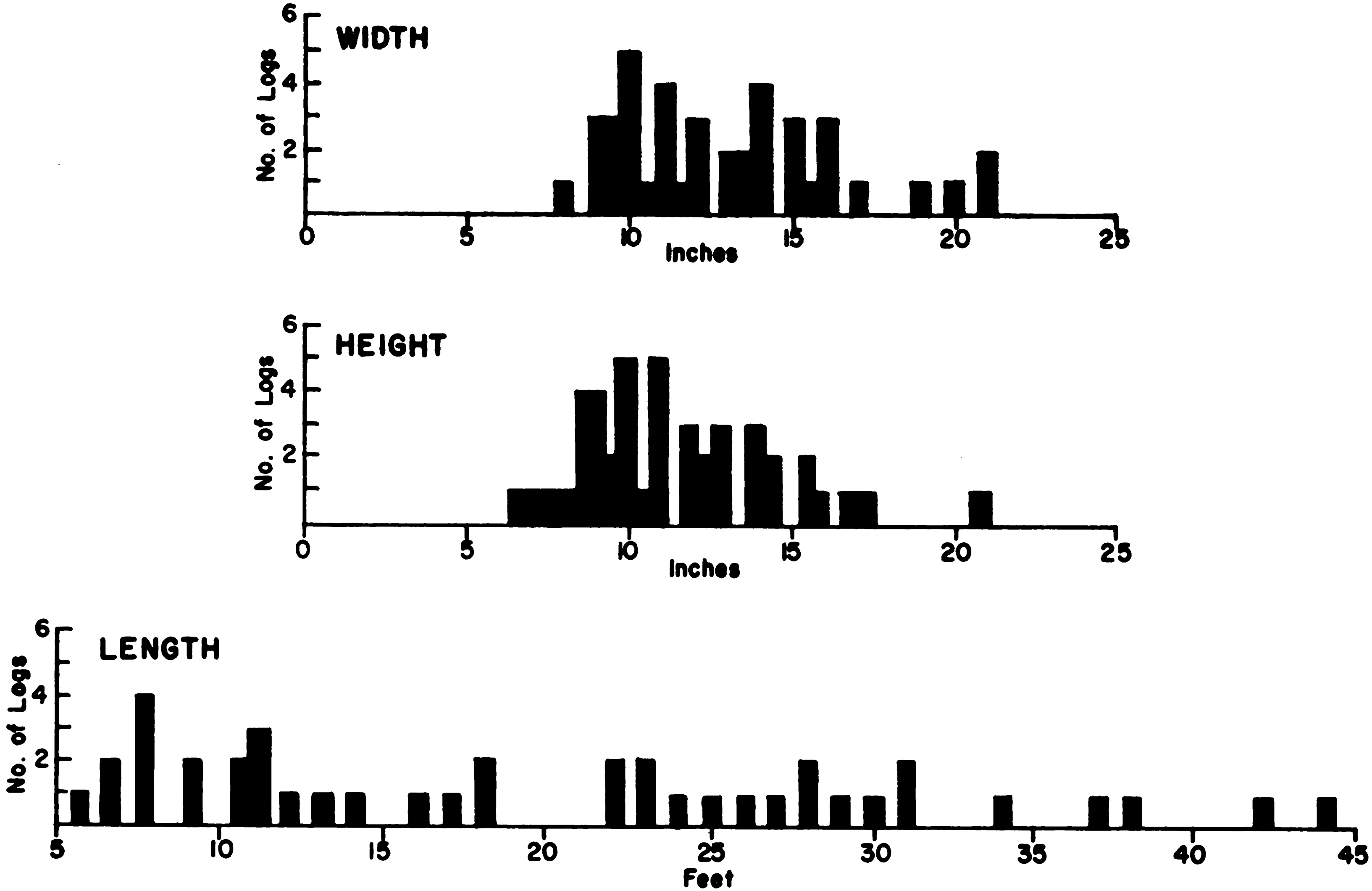


Fig. 2 Plotted frequency distribution of width, height, and length of 40 ruffed grouse drumming logs on the Rifle River Area, Michigan.

TABLE 2

The relationship between the number of years 40 ruffed grouse drumming logs were used and observed by arbitrary diameter classes, and the computed probability of use in any one year by size classes.

LOG DIAMETER CLASS

No. of Log	7-9.5" Class		10-12.5" Class		13-15.5" Class		16"+ Class	
	Years used	Years observed	Years used	Years observed	Years used	Years observed	Years used	Years observed
1	2	5	4	4	7	7	8	9
2	2	7	1	5	4	5	5	9
3	3	6	1	5	4	4	3	3
4	1	4	1	4	4	4	4	4
5	2	2	3	3	4	9		
6	3	6	5	5	5	9		
7			4	4	1	4		
8			4	4	4	8		
9			2	3	4	4		
10			1	3	5	7		
11			4	4	1	4		
12			5	5				
13			4	9				
14			8	9				
15			7	7				
16			4	5				
17			1	4				
18			1	3				
19			2	6				
Totals	13	30	62	92	43	65	20	25

$\frac{\text{Years used}}{\text{Years observed}} = .433$

$\frac{\text{Years used}}{\text{Years observed}}$ $P_2 = .674$

$\frac{\text{Years used}}{\text{Years observed}}$ $P_3 = .662$

$\frac{\text{Years used}}{\text{Years observed}}$ $P_4 = .800$

TABLE 3

The relationship between the number of years 40 ruffed grouse drumming logs were used and observed by arbitrary length classes, and the computed probability of use in any one year by size classes.

LOG LENGTH CLASSES

No. of Logs	5 - 15 feet		15.5-25 feet		25.5-35 feet		35.5 feet +	
	Years used	Years observed	Years used	Years observed	Years used	Years observed	Years used	Years observed
1	1	4	1	3	4	4	3	6
2	2	6	4	5	8	9	4	9
3	1	4	7	7	5	5	8	9
4	5	7	3	6	2	3	3	3
5	2	2	2	7	4	4		
6	1	4	4	8	2	5		
7	4	4	4	4	5	5		
8	1	4	1	5	4	4		
9	3	3	1	5	7	7		
10	4	4			4	4		
11	1	3						
12	5	9						
13	5	9						
14	4	9						
15	4	4						
16	1	4						
17	4	5						
Totals	48	85	27	50	45	50	18	27

Years used / Years observed =.565	Years Used / Years observed =.540	Years used / Years observed =.900	Years used / Years observed =.667

classes were more apt to be used than the smaller classes, the difference was not consistent. Since none of the 40 logs studied was less than 5.5 feet this appears to be a minimum length requirement, but additional length apparently is not critical.

Species and types of logs used, and drumming location selected on logs

Thirty-four of the 40 logs were old, decayed conifers of which at least 26 were white pine (Pinus strobus). It was sometimes impossible to identify species. In most cases logs were either fallen trunks or had been saw-logs left behind when the virgin stands of timber were cut many years ago. Freshly fallen, wind-thrown trees, mostly large-toothed aspen (Populus grandidentata) were sometimes used, and birds invariably drummed near the butt end of these logs, apparently to take advantage of the added concealment of the exposed roots. On most logs in fact, birds seldom drummed from near the center or mid-point, but seemed to prefer a position about 5 feet from the large end.

Log directions

I recorded azimuth readings to determine whether grouse preferred logs lying in a particular direction. Twenty-eight or 70 per cent of the logs lay in a southwest to northeast direction i.e. between 0°-90° and 180°-270°. I did not take a random sample of directions of non-drumming logs for reasons to be explained in the following section of this report, but I would expect to find most logs lying in this general direction due to the effects of the prevailing winds. This is strictly speculation of course, and therefore the proposition of grouse selecting logs on the basis of direction cannot be settled at present.

ANALYSES OF VEGETATION

Early in the study I gave some thought to comparing vegetation near drumming and non-drumming logs. As I have previously mentioned however, the distinction between these two classes of logs is not always clear-cut. For example, most cocks select only one log on which to drum and I speculated that these are prime sites. The 40 logs I studied were of this type. On the other hand, some birds skip from one log to another, and may use four or five logs. These logs must be classed as drumming logs. Finally, logs with no evidence of use would be classed as non-drumming logs, but bias could be introduced if such logs had been used in the past and were not detected.

The ultimate objective of this study was to ascertain the characteristics of prime drumming sites so that habitat improvement practices could be directed toward perpetuation or creation of favorable habitat. Because of the difficulties and magnitude of a study involving non-drumming as well as drumming logs outlined above, and also because of the desirability of learning the requisites of the best sites, I decided to study the characteristics of the best sites only.

I experimented with several sampling methods which would enable me to ascertain these characteristics, and at the same time be able to make comparisons of site characteristics with vegetation adjacently or in the vicinity of sites. The sampling design had to meet these additional requirements: (1) vegetation had to be sampled adequately so that the data could withstand statistical treatment and, (2) the design had to be easily used in the field.

Eng (1959) used two methods to measure vegetation, the "closest tree method" described by Cottam and Curtis (1956) to study tree density and composition, and for smaller vegetation he used four milacre quadrats surrounding the logs. With these two methods, he was able to specify characteristics of flora near logs, but was not able to compare this with vegetation elsewhere in the habitat.

I suspected that vegetation within a few feet of the drumming bird might be less dense than nearby, because birds must have space in which to move their wings, and because the presence of the log might decrease the abundance of stems. Therefore, I used a series of 5 one-quarter milacre quadrats at the log. One of these (Number 5 in Fig. 3) was used to measure vegetation immediately surrounding the drumming location, and quadrats 1-4 were used to measure vegetation adjacently. Four quadrats of the same size were located 66 feet from the log, one in each cardinal direction. Quadrats were used primarily to sample the smaller vegetation.

To sample larger vegetation, I used a system of four, hundreth-acre transects (6.6 x 66 feet) laid out from the drumming location, one in each cardinal direction. (Fig. 4.) Each transect was later divided into "near" and "far" halves to determine whether plant density and composition varied between these portions.

In both sampling methods I tallied only woody vegetation, with more than half the stem diameter in the sampling unit, and stems were grouped into the following size classes: 0-2 feet tall, 2-5 feet tall, 5-8 feet tall, between 8 feet tall and 3 inches diameter at breast height, 3-6 inches dbh, 6-9 inches dbh, and 9 inches dbh and larger. All of these classes were used while tallying stems on quadrats, whereas to save time

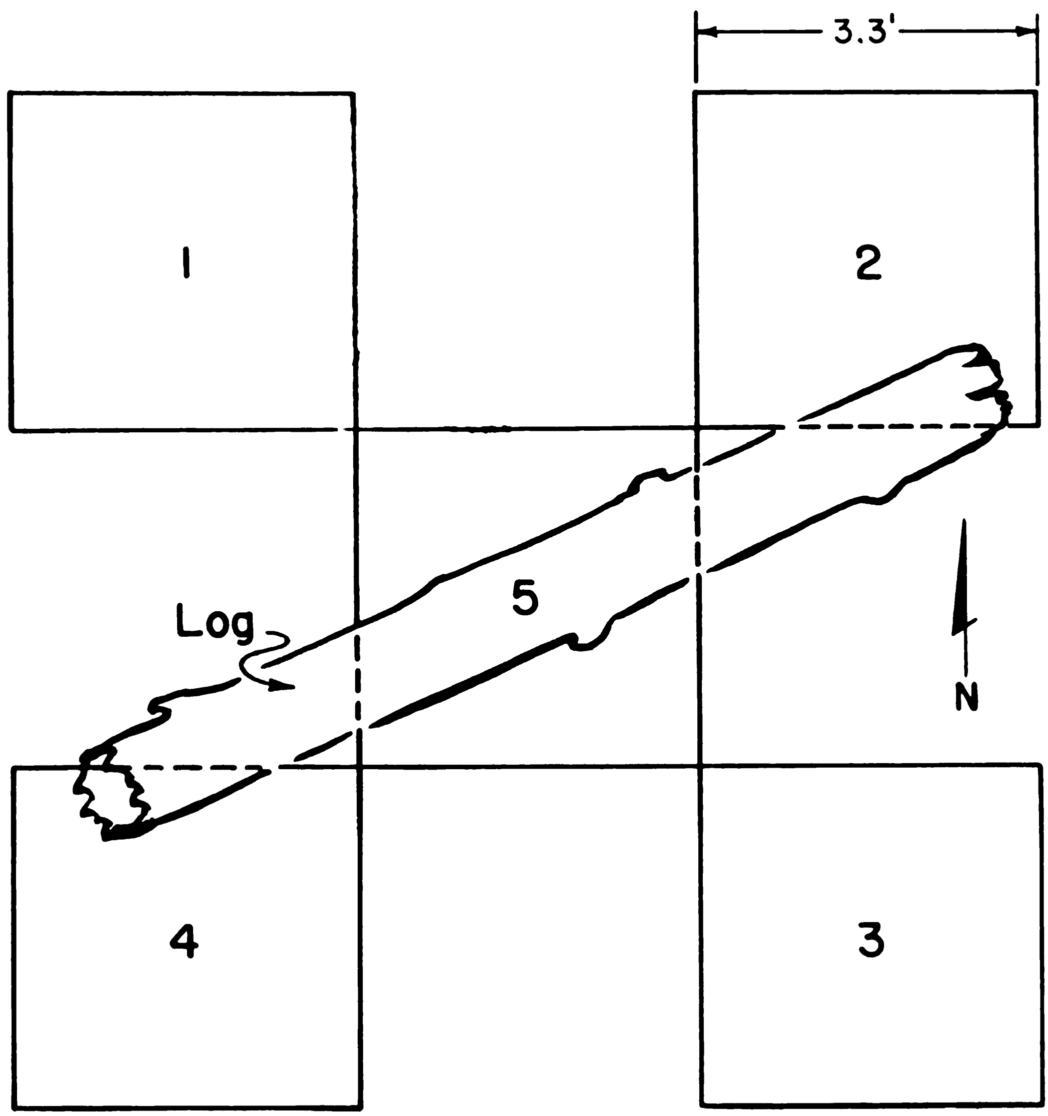


Fig. 3 Sketch of quadrat vegetation sampling design used "near" the drumming log. Each quadrat is one-quarter milacre in size. Log is hypothetical.

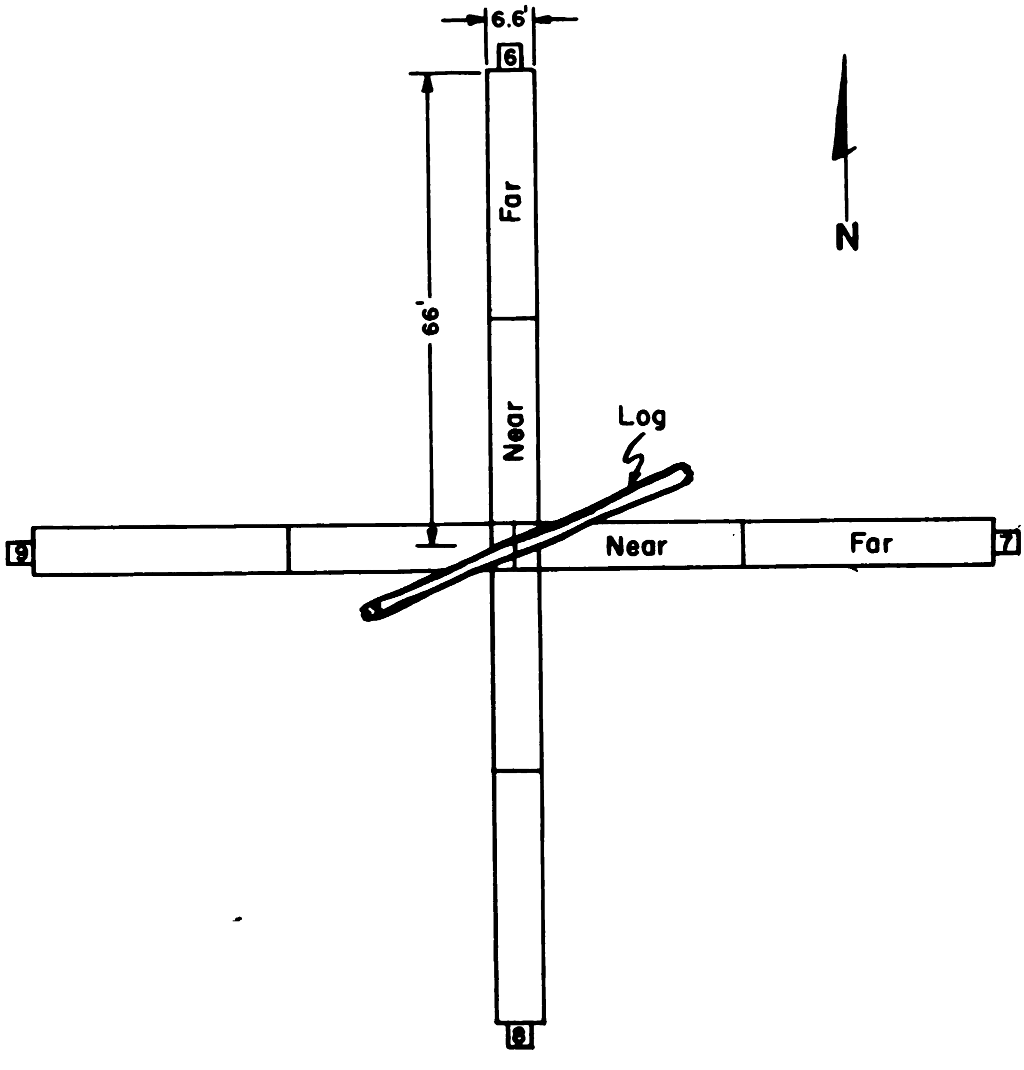


Fig. 4 Sketch of transect vegetation sampling design with "far" quadrats. Each transect is one-hundredth acre in size. Quadrats 6, 7, 8, and 9 are counterparts of quadrats 1, 2, 3, and 4.

the first two classes were omitted on the transects.

Working Procedure

I developed an orderly method of securing the needed information at each drumming location. First, I measured and recorded log size. After this I noted its general state of decay and attempted to determine species. When this was not possible, I recorded whether it had been a deciduous or coniferous species. The azimuth was then recorded and I measured the distance from the drumming location to the nearest end.

When these properties were recorded, Quadrat 5 was centered over the drumming location and laid out using a wire frame measuring 3.3 feet on a side, and with the sides in north-south and east-west directions. With this quadrat in place, I marked each corner with small sticks which later served as corners for Quadrats 1, 2, 2, and 4. Stems were then tallied on Quadrats 1-5. When herbaceous cover was very dense, it was necessary to further divide the quadrats into portions to facilitate counting.

After completing these quadrats I imbedded a jack knife in the log, placed a looped end of a white cord over the knife handle, and laid out each transect, staking the far end of the cord. I then tallied vegetation along one side and then another of the transect using the same 3.3 foot wire to delimit the outer margin of the transect that was used to lay out the quadrats. After completing each transect, its corresponding distal quadrat was laid out and tallied.

Plant Density Analysis

I converted total numbers of woody stems of all species tallied on quadrats and transects to equivalent numbers of stems per acre to determine

average densities in each size class necessary for establishment of male courtship territories (Tables 4, 5, and 6).

TABLE 4

Number of woody stems tallied by size classes on nine one-quarter milacre quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan

	Number of woody stems tallied Quadrat Number									
Size Class	1	2	3	4	5	6	7	8	9	Total
0-2 ft.	80	76	127	97	91	167	140	168	214	1160
2-5 ft.	60	38	80	61	21	43	42	60	79	484
5-8 ft.	24	17	24	17	8	22	22	20	20	174
8 ft.-3 in. dbh	62	40	71	33	9	30	20	19	22	306
3-6 in. dbh	9	3	4	4	2	3	1	0	6	32
6-9 in. dbh	3	0	1	0	0	1	0	0	0	5
9 in. + dbh	1	0	0	1	0	1	1	0	0	4
Total	239	174	307	213	131	267	226	267	341	2165

TABLE 5

Number of woody stems tallied on "near" and "far" **halves** of one-hundreth acre transects near 40 ruffed grouse drumming logs, Rifle River Area, Michigan

	North Transect		East Transect		South Transect		West Transect		
Size Class	Near	Far	Near	Far	Near	Far	Near	Far	Total
5-8 ft.	290	266	277	242	313	199	321	242	2150
8 ft. to 3in.dbh	646	490	624	488	688	424	632	481	4473
3-6 in. dbh	59	60	70	37	68	52	58	44	448
6-9 in. dbh	14	13	10	7	11	7	11	11	84
9 in. + dbh	7	12	3	5	3	6	6	12	54
Total	1016	841	984	779	1083	688	1028	790	7209

TABLE 6

Converted average number of woody stems per acre by size classes encountered on quadrats and transects located near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Size Class	Average number of stems per acre
Quadrats	
Less than 5 feet tall	
0-2 ft. tall	12889
2-5 ft. tall	5378
More than 5 feet tall	
5-8 ft. tall	1933
8 ft. tall-3 in. dbh	3400
3-6 in. dbh	478
6-9 in. dbh	56
9 in. dbh	44
Transects	
Less than 5 feet tall	
No sample taken	
More than 5 feet tall	
5-8 ft. tall	1344
8 ft. tall-3 in. dbh	2796
3-6 in. dbh	280
6-9 in. dbh	53
9 in. + dbh	34

Comparison of plant densities "near" and "far" from drumming logs

My first analysis consisted of determining whether vegetation "near" the log (quadrats 1-4 and "near" halves of transects) differed basically from vegetation a distance from the log (quadrats 6-9 and "far" halves of transects). To do this I used the matched pairs method described by Goulden (1952) whereby numbers of stems on paired groups of sampling units ("near" and "far") were compared for each log. Comparisons were made by each size class. This method removed the heterogeneitty in plant composition and density due to inherent differences between log sites. (Tables 7, 8, 9, 10, 11, 12, 13, 14.) Values of t obtained and results of analyses are presented in Table 15.

TABLE 7

Comparison of woody plant density in the 0-2 foot tall size class on matched pairs of quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	Number of Stems Quadrats 1-4	Number of Stems Quadrats 6-9	d Quadrats 1-4 minus Quadrats 6-9
1	6	18	-12
2	14	10	4
3	17	11	6
4	9	20	-11
5	9	27	-18
6	5	6	- 1
7	4	21	-17
8	5	12	- 7
9	18	4	14
10	0	11	-11
11	23	7	16
12	22	23	- 1
13	4	6	- 2
14	11	14	- 3
15	7	137	-130
16	16	11	5
17	4	9	- 5
18	10	8	2
19	7	4	3
20	9	14	- 5
21	6	7	- 1
22	1	11	-10
23	11	48	-37
24	11	14	- 3
25	8	6	2
26	3	18	-15
27	12	20	- 8
28	48	24	24
29	10	10	0
30	2	9	- 7
31	6	3	3
32	10	21	-11
33	7	13	- 6
34	3	16	-13
35	0	31	-31
36	12	10	2
37	0	15	-15
38	12	24	-12
39	10	15	- 5
40	8	8	0

$\Sigma d = -316$

$\Sigma d^2 = 22646$

$\frac{(\Sigma d)^2}{40} = 2496.4$

$\bar{d} = 7.9$

$s_{\bar{d}} = \frac{22646-2496.4}{40 \times 39} = 3.5939$

$t = \frac{7.9 - 0}{3.5939}$

$= 2.198$

TABLE 8

Comparison of woody plant density in the 2-5 foot size class on matched pairs of quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan

Log Number	Number of Stems Quadrats 1-4	Number of Stems Quadrats 6-9	d Quadrats 1-4 minus Quadrats 6-9
1	0	5	- 5
2	1	0	1
3	20	4	16
4	1	1	0
5	5	3	2
6	11	9	2
7	9	6	3
8	8	8	0
9	12	12	0
10	6	9	- 3
11	13	12	1
12	7	2	5
13	3	5	- 2
14	4	16	-12
15	7	5	2
16	18	20	- 2
17	20	13	7
18	3	0	3
19	1	7	- 6
20	0	3	- 3
21	1	3	- 2
22	3	0	3
23	1	0	1
24	1	0	1
25	2	0	2
26	3	4	- 1
27	23	8	15
28	10	12	- 2
29	2	2	0
30	1	3	- 2
31	0	1	- 1
32	0	0	0
33	4	5	- 1
34	1	8	- 7
35	23	3	20
36	7	16	- 9
37	7	7	0
38	0	1	- 1
39	0	6	- 6
40	1	4	- 3

$\Sigma d = 16$ $\bar{d} = .40$

$\Sigma d^2 = 1424$ $t = .42$

$s_{\bar{d}} = .954$

$\frac{(\Sigma d)^2}{40} = 6.4$

TABLE 9

Comparison of woody plant density in the 5-8 foot size class on matched pairs of quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	Number of Stems Quadrats 1-4	Number of Stems Quadrats 6-9	d Quadrats 1-4 minus Quadrats 6-9
1	1	0	0
2	0	2	- 2
3	0	1	- 1
4	0	4	- 4
5	7	0	7
6	1	3	- 2
7	3	2	1
8	1	0	1
9	6	5	1
10	0	3	- 3
11	10	10	0
12	0	2	- 2
13	1	0	1
14	8	9	- 1
15	2	4	- 2
16	11	0	11
17	5	10	- 5
18	0	0	0
19	0	0	0
20	1	0	1
21	0	0	0
22	0	1	- 1
23	0	0	0
24	1	1	0
25	2	0	2
26	6	6	0
27	1	0	1
28	2	2	0
29	1	0	1
30	0	0	0
31	3	3	0
32	0	0	0
33	0	1	- 1
34	0	0	0
35	6	1	5
36	3	4	- 1
37	0	7	- 7
38	0	0	0
39	0	2	- 2
40	0	1	- 1

$\Sigma d = -3$ $\quad \bar{d} = .075$ $\quad t = .163$

$\Sigma d^2 = 331$

$\frac{(\Sigma d)^2}{40} = .225$ $\quad s_{\bar{d}} = .46$

TABLE 10

Comparison of woody plant density in the 8'-3" dbh size class on matched pairs of quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	Number of Stems Quadrats 1-4	Number of Stems Quadrats 6-9	d Quadrats 1-4 minus Quadrats 6-9
1	3	0	3
2	1	1	0
3	9	5	4
4	0	0	0
5	2	0	2
6	2	4	- 2
7	4	1	3
8	1	7	- 6
9	12	2	10
10	2	4	- 2
11	4	6	- 2
12	4	0	4
13	0	1	- 1
14	3	6	- 3
15	12	2	10
16	5	0	5
17	3	3	0
18	8	2	6
19	0	0	0
20	3	2	1
21	11	0	11
22	1	1	0
23	19	1	18
24	3	0	3
25	3	2	1
26	6	2	4
27	4	0	4
28	6	1	5
29	9	0	9
30	4	0	4
31	4	3	1
32	3	16	-13
33	1	1	0
34	5	0	5
35	4	1	3
36	23	9	14
37	7	4	3
38	15	0	15
39	0	3	- 3
40	0	1	- 1

$\Sigma d = 115$ $\bar{d} = 2.875$

$\Sigma d^2 = 1627$ $t = 3.154$

$\frac{(\Sigma d)^2}{40} = 330.6$ $s_{\bar{d}} = .912$

TABLE 11

Comparison of woody plant density in the 3-9" dbh size class on matched pairs of quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	Number of Stems Quadrats 1-4	Number of Stems Quadrats 6-9	d Quadrats 1-4 minus Quadrats 6-9
1	0	0	0
2	3	0	3
3	0	0	0
4	0	0	0
5	0	0	0
6	1	1	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	1	- 1
11	0	0	0
12	1	1	0
13	1	2	- 1
14	0	0	0
15	0	0	0
16	0	1	- 1
17	0	0	0
18	0	0	0
19	1	0	1
20	2	0	2
21	0	0	0
22	0	1	- 1
23	0	0	0
24	1	0	1
25	1	0	1
26	1	0	1
27	0	1	- 1
28	0	0	0
29	0	0	0
30	2	0	2
31	3	0	3
32	1	0	1
33	1	1	0
34	1	1	0
35	1	0	1
36	0	0	0
37	1	0	1
38	1	0	1
39	0	1	- 1
40	1	0	1

$\Sigma d = 13$ $\quad \bar{d} = .325$

$\Sigma d^2 = 41$ $\quad t = 2.117$

$\frac{(\Sigma d)^2}{40} = 4.225$ $\quad s_{\bar{d}} = .154$

TABLE 12

Comparison of woody plant density in the 5-8 foot class on matched pairs of transects near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	"Near" Transects	"Far" Transects	d "Near" minus "Far"
1	21	39	-18
2	12	20	- 8
3	5	6	- 1
4	19	20	- 1
5	27	32	- 5
6	8	44	-36
7	40	40	0
8	25	24	1
9	85	71	14
10	41	38	3
11	77	60	17
12	29	34	- 5
13	58	26	32
14	75	57	18
15	41	29	12
16	124	18	106
17	78	52	26
18	17	5	12
19	15	10	5
20	3	2	1
21	5	3	2
22	11	15	- 4
23	7	3	4
24	7	8	- 1
25	26	13	13
26	40	40	0
27	48	3	45
28	32	39	- 7
29	11	24	-13
30	8	10	- 2
31	7	7	0
32	3	0	3
33	9	3	6
34	9	20	-11
35	61	47	14
36	36	41	- 5
37	46	25	21
38	26	5	21
39	3	10	- 7
40	6	6	0

$\Sigma d = 252$

$\Sigma d^2 = 19576$

$\frac{(\Sigma d)^2}{40} = 1587.6$

$\bar{d} = 6.3$

$s_{\bar{d}} = 3.396$

$t = 1.855$

TABLE 13

Comparison of woody plant density in the 8'-3" dbh class on matched pairs of transects near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	"Near" Transects	"Far" Transects	d "Near" minus "Far"
1	42	45	- 3
2	67	44	23
3	65	24	41
4	45	44	1
5	52	46	6
6	15	42	-27
7	44	42	2
8	80	44	36
9	207	130	77
10	72	81	- 9
11	225	151	74
12	104	61	43
13	136	69	67
14	136	57	79
15	73	40	33
16	214	68	146
17	49	20	29
18	43	24	19
19	26	34	- 8
20	72	9	63
21	17	24	- 7
22	46	49	- 3
23	6	8	- 2
24	34	22	12
25	56	47	9
26	70	52	18
27	78	38	40
28	92	74	18
29	20	75	-55
30	26	33	- 7
31	15	22	- 7
32	35	21	14
33	35	29	9
34	28	39	-11
35	110	75	35
36	79	94	-15
37	49	34	15
38	36	33	3
39	18	17	1
40	20	25	- 5

$\Sigma d = 754$ $\quad \bar{d} = 18.85$

$\Sigma d^2 = 63756$ $\quad t = 3.345$

$\frac{(\Sigma d)^2}{40} = 14212.9$ $\quad s_{\bar{d}} = 5.635$

TABLE 14

Comparison of woody plant density in the 3-9" class on matched pairs of **transects** near 40 ruffed grouse drumming logs, Rifle River Area, Michigan.

Log Number	"Near" Transects	"Far" Transects	d "Near" minus "Far"
1	2	1	1
2	16	16	0
3	5	1	4
4	9	9	0
5	1	2	- 1
6	0	0	0
7	10	1	9
8	4	3	1
9	0	2	- 2
10	3	2	1
11	2	0	2
12	8	10	- 2
13	3	2	1
14	0	2	- 2
15	4	3	1
16	1	9	- 8
17	4	6	- 2
18	7	6	1
19	10	5	5
20	24	13	11
21	14	7	7
22	19	12	7
23	2	4	- 2
24	9	4	5
25	13	15	- 2
26	1	4	- 3
27	2	3	- 1
28	13	7	6
29	4	3	1
30	5	15	-10
31	19	5	14
32	19	8	11
33	2	7	- 5
34	12	6	6
35	3	2	1
36	12	11	1
37	8	5	3
38	11	3	8
39	25	15	10
40	1	2	- 1

$\Sigma d = 76$ $\qquad \bar{d} = 1.9$

$\Sigma d^2 = 1166$ $\qquad t = 2.348$

$\frac{(\Sigma d)^2}{40} = 144.4$ $\qquad s_{\bar{d}} = .809$

TABLE 15

Values of t obtained by analyses of stem densities on quadrats 1-4 compared to quadrats 6-9 and "near" halves of transects compared to "far" halves surrounding 40 ruffed grouse drumming logs by arbitrary size classes using the matched pairs technique.*

Size Class	$\bar{d}$	t value	Remarks
Quadrats			
0-2 feet tall	-7.9	2.198	Significant difference in stem density on near and far quadrats. More stems on far quadrats.
2-5 feet tall	.40	.42	No significant difference in stem density between near and far quadrats.
5-8 feet tall	.075	.163	No significant difference in stem density between near and far quadrats.
8 feet tall-3 inches dbh	2.875	3.154	Significant difference in stem density on near and far quadrats. More stems tallied on near quadrats.
3-9 inches dbh	.325	2.117	Significant difference in stem density on near and far quadrats. More stems tallied on near quadrats.
Transects			
5-8 feet tall	6.30	1.855	No significant difference in stem density between near and far halves of transects.
8 feet tall-3 inches dbh	18.85	3.345	Significant difference in stem density on near and far transects. More stems were tallied on near transects.
3-9 inches dbh	1.90	2.348	Significant difference in stem density on near and far transects. More stems were tallied on near transects.

* The t value for 39 degrees of freedom at the 5 per cent level is 2.02.

It is apparent from these analyses that drumming ruffed grouse require a dense layer of undergrowth. The understory stratum in this study area is typified by alder runs or dogwood clumps. In the two size classes smaller than the 8 foot-3 inch dbh class I was not able to show differences in stem densities adjacent to the logs as compared to several feet from the logs. In the 0-2 foot tall size class I found significantly fewer stems immediately surrounding the log than elsewhere.

These findings at first appear contradictory, but the analyses are reasonable when the history of land use and the pressure of a large deer population are considered. The woody plants in the 0-2 foot tall size class represent young reproduction. It is probable that deer populations have little influence on the abundance of stems in this class. The next two size classes however, are subject to constant browse pressure by deer. Therefore the understory stratum throughout the Rifle River Area has been reduced or eliminated in some cases. The 8 foot to 3 inch dbh class is beyond the reach of deer. I made a comparison of the prevalence of deer food and non-deer food plants tallied during the study (Table 16) and the results illustrate how deer have affected plant composition. Non-deer food plants are those which deer usually refuse to eat even when subjected to extreme hardship (Duvendeck, 1952).

TABLE 16

Number of stems of woody deer food plants and non-deer food plants tallied by size classes on 360 quadrats near 40 ruffed grouse drumming logs, Rifle River Area, Michigan

Size Class	Deer Food Plants	Non-deer Food Plants
0-2 feet tall	656	493
2-8 feet tall	143	526
8 feet to 3 inches dbh	30	274

Plant Composition

All 40 logs were located in a lowland vegetative type. Thirty-seven woody plant species were tallied on the 360 quadrats. These 37, as well as 7 additional species were found on the transects. A check list is presented in the Appendix. Nomenclature is from Fernald (1950).

Many species were usually represented on the sampling units i.e. at least one stem occurred. This was particularly true in the smallest size class (Table 17). In this size class, 8 different species occurred in more than 5 per cent of the quadrats. Fewer species were encountered in the larger classes and these few plants therefore assumed more relative importance. In fact, in the 8 feet tall to 3 inch dbh class only 4 species occurred regularly. These included speckled alder (*Alnus rugosa*), balsam fir (*Abies balsamea*), black ash (*Fraxinus nigra*), and willows (*Salix* spp.). Alder, moreover, was tallied much more frequently than the others, and it occurred on 21 per cent of the quadrats.

Alder not only occurred frequently, but it also supplied the necessary density of stems which perhaps was more important (Table 18). In the very important tall shrub class (8 feet tall to 3 inches dbh) 73 per cent of the woody stems tallied were speckled alder.

Plant Densities Compared by Number of Years Logs were Used.

Calendar years when ruffed grouse used the 40 drumming logs were plotted (Fig. 1), and the number occurring in each years-of-use class is presented in Table 19.

TABLE 17

Number of quadrats in which at least one stem of the 37 plant species occurred and the computed relative frequency of each species by size classes.*

Species	Size Class 0-2'	2-8'	8'-3"	3-6"	6-9"	9"+
Alder	76(21.1)	138(38.3)	77(21.4)			
Red-osier	56(15.6)	29(8.1)	1(.3)			
Black ash	38(10.6)	12(3.3)	12(3.3)			
Black currant	30(8.3)	6(1.7)				
Mountain holly	29(8.1)	27(8)(7.5)	4(1.1)			
Balsam fir	29(8.1)	9(2.5)	15(4.2)	14(3.9)	2(.6)	
Gray dogwood	30(8.3)	11(3)(3.1)				
Trembling aspen	10(2.8)	2(.6)	2(.6)	4(1.1)	1(.3)	1(.3)
Nannyberry	18(5.0)	7(1.9)	3(.8)			
Red oak	16(4.4)	2(.6)				
Red maple	25(6.9)	4(1.1)	1(.3)			
Blueberry	11(3.1)					
Willow	6(1.7)	16(4.4)	10(2.8)			
Chokeberry	11(3.1)	8(2.2)	2(.6)			
Silky dogwood	7(1.9)					
White cedar	2(.6)	3(.8)	4(1.1)	2(.6)		
Ninebark	1(.3)					
Leatherleaf	2(.6)	1(.3)				
White spruce	5(1.4)	4(1.1)	2(.6)			
White birch			2(.6)	2(.6)		
High-bush cranberry	1(.3)					
Juneberry	2(.6)					
Black cherry	7(1.9)					
Hawthorn	5(1)(1.4)					
Honeysuckle	3(.8)					
Large-tooth aspen	1(.3)					
Hazelnut	7(1.9)					
Larch			1(.3)		2(.6)	
Balsam poplar		1(.3)	1(.3)	1(.3)		
Slippery elm	1(.3)	1(.3)				
American elm	2(.6)	1(.3)				
White ash	1(.3)					
Prickly ash	1(.3)	1(.3)				
Meadow-sweet	1(.3)	1(.3)				
White pine	1(.3)					
White oak	1(.3)					
Hemlock					1(.3)	
Unknown	3(.8)				1(.3)	

* Figures in parenthesis are percentages. The relative frequency is computed by dividing the number of quadrats in which the species was tallied by the total number of quadrats (360).

TABLE 18

Total stems and relative density of woody plant species occurring on 360 quadrats near 40 ruffed grouse drumming sites.[1]

Species	Size Class 0-2'	2-5'	5-8'	8'-3"	3-6"	6-9"	9"+	Total stems
Alder	186(16.0)	234(47.4)	106(60.6)	223(73.1)				750
Red-osier	160(13.7)	52(10.5)	1(.6)					213
Blueberry	131(11.2)							131
Balsam fir	91(7.8)	3(.6)	6(3.4)	26(8.5)	17(54.8)	2(40)		145
Gray dogwood	88(7.6)	21(4.2)	3(1.7)	1(.3)				113
Black ash	73(6.3)	16(3.2)	2(1.1)	12(3.9)	5(16.1)		1(25)	109
Mountain holly	60(5.2)	79(15.9)	16(9.1)	7(2.3)				162
Black currant	55(4.7)	8(1.6)						63
Nannyberry	52(4.5)	9(1.8)	12(6.9)	4(1.3)				77
Red maple	48(4.1)	4(.8)		1(.3)				53
Leatherleaf	32(2.7)	30(6.0)						62
Meadow-sweet	26(2.2)	5(1.0)						31
Chokeberry	21(1.8)	7(1.4)	5(2.9)	2(.7)				35
Silky dogwood	17(1.5)							17
Red oak	18(1.5)	3(.6)						21
Trembling aspen	14(1.2)	1(.2)	1(.6)	2(.7)	4(12.9)	1(20)	1(25)	24
Black cherry	16(1.4)			1(.3)				17
Willow	12(1.0)	10(2.0)	17(9.7)	15(4.9)				54
Hawthorn	8(.7)							8
White spruce	7(.6)	3(.6)	3(1.7)	2(.7)			1(25)	16
Hazelnut	7(.6)							7
Honeysuckle	4(.3)							4
Large-tooth aspen	4(.3)							4
Prickly ash	4(.3)	2(.4)						6
Juneberry	3(.3)							3
American elm	3(.3)	1(.2)						4
White cedar	2(.2)	1(.2)	3(1.7)	5(1.6)	2(6.5)			13
Ninebark	1(.1)							1
Highbush cranberry	1(.1)							1
Slippery elm	2(.2)	1(.2)						3
White ash	1(.1)							1
White pine	1(.1)							1
White oak	1(.1)							1
Hemlock							1(25)	1
Larch			1(.6)		2(6.5)			3
Balsam poplar		2(.4)		1(.3)	1(3.2)			4
White birch				2(.7)	2(6.5)			4
Unknown	16(1.4)	3(.6)						19
Totals	1165	496	175	305	31	5	4	2181

[1] Figures in parentheses represent relative density, which is the percentage of total stems recorded by species by size classes.

TABLE 19

Number of drumming logs occupied by male ruffed grouse during 8 calendar years, Rifle River Area, Michigan

	Number of years occupied							
	1	2	3	4	5	6	7	8
Number of logs	9	5	4	13	5	0	2	2

In addition to size being a factor responsible for perennial selection in some cases, I suspected that plant densities near the logs might differ between logs used varying lengths of time.

Analysis of variance was used to test whether there was a relationship between stem density and the frequency of log use (by years). Tests were performed by the various size classes (Tables 20, 21, 22 and 23). F values obtained in analyses of all size classes were less than the required value for 5, 34 degrees of freedom at the 5 per cent level of 2.49. Thus the analyses suggested there was no relationship between stem density and frequency of log use.

From analyses of log size and vegetation density therefore, it is concluded that grouse require logs and surrounding vegetation of certain specifications. If these specifications are met, the preference for some logs from year to year cannot be explained at this time. Some other factors such as population size, or perhaps a spatial relationship exists between one site to another in the total environment which overshadows minor vegetational differences at the different sites.

TABLE 20

Analysis of variance of density of woody vegetation in the 0-2 foot height class on quadrats 1-4 by numbers of years 40 ruffed grouse drumming logs were occupied, Rifle River Area, Michigan

	Number of years logs were used by grouse					
	1	2	3	4	5	7 and 8
				8		
	6	23	16	11	10	0
	14	22	4	11	7	12
Number of	17	4	10	0	3	10
woody stems	9	11	0	7	0	8
tallied in	9	7		6	12	
each year class	5			9		
	4			48		
	5			2		
	18			6		
				3		
				12		
				10		
Ave. No. Stems	9.7	13.4	7.5	10.2	6.4	7.5

Estimate of "between" year class variance = 32.66
Estimate of "within" year class variance = 75.56

$$F = \frac{32.7}{75.6} = .43$$

TABLE 21

Analysis of variance of density of woody vegetation in the 2-8 foot height class on quadrats 1-4 by numbers of years 40 ruffed grouse drumming logs were occupied, Rifle River Area, Michigan

	Number of years logs were used by grouse					
	1	2	3	4	5	7 and 8
	12	7	6	1	23	1
Number of	12	3	4	12	1	1
woody stems	18	1	3	9	1	4
tallied in	1	10	1	9	3	29
each year	9	12		29	7	
class	1			25		
	0			3		
	20			2		
	1			24		
				0		
				0		
				12		
				4		
Ave. No. Stems	8.2	6.7	3.5	10.0	7.0	8.8

Estimate of "between" year class variance = 30.10
Estimate of "within" year class variance = 79.54

$$F = \frac{30.10}{79.54} = .38$$

TABLE 22

Analysis of variance of density of woody vegetation in the 8'-3" dbh class on quadrats 1-4 by numbers of years 40 ruffed grouse drumming logs were occupied, Rifle River Area, Michigan.

	Number of years logs were used by grouse					
	1	2	3	4	5	7 and 8
Number of	4	5	8	1	23	7
stems tallied	3	4	5	11	4	0
by year classes	9	0	2	4	1	0
	0	3	3	3	5	15
	1	12		19	3	
	1			6		
	2			4		
	12			4		
	2			9		
				6		
				3		
				0		
				3		
Ave. No. Stems	3.8	4.8	4.5	5.6	7.2	5.5

Estimate of "between" year class variance = 8.7 $F = \frac{8.7}{29.6} = .29$

Estimate of "within" year class variance =29.6

TABLE 23

Analysis of variance of density of woody vegetation in the 3-9" dbh class on quadrats 1-4 by numbers of years 40 ruffed grouse drumming logs were occupied, Rifle River Area, Michigan.

	Number of years logs were used by grouse					
	1	2	3	4	5	7 and 8
Number of	1	1	0	0	0	1
woody stems	1	1	0	0	1	1
tallied by	1	0	0	0	1	0
year classes	3	0	0	1		1
	0	0		0	1	
	0			0		
	0			3	1	
	0			2		
	0			0		
				1		
				2		
				1		
				1		
Ave. No. Stems	.67	.4	0	.85	.8	.75

Estimate of "between" year class variance = 2.65 $F = .12$

Estimate of "within" year class variance =22.45

DISCUSSION

During this population study various investigations of grouse ecology enabled me to become familiar with habitat quality in many parts of notthern lower Michigan.

Although foresters are guided by multiple-use policies, in many areas mature or near-mature stands of aspen, oak, and jack pine are not being lumbered adequately, at least from a game standpoint. In many cases stands of pole-size or larger trees are characterized by scanty undergrowth, and in some areas the situation has become critical because of excessive browse removal by deer (Fig. 5, 6, 7).

In some counties over-numerous deer have been a problem for as long as 30 years (Jenkins and Bartlett, 1959). Lowland flora is composed largely of woody plants, which are unpalatable to deer, such as speckled alder, white spruce, balsam fir, and a few other species.

Upland areas where these conditions exist such as on the Rifle River Area probably are not supporting maximum numbers of ruffed grouse.

In most of Michigan ruffed grouse are underhunted. Beaause of this and also because habitat improvement specifically for ruffed grouse is expensive, we must rely on standard forestry practices to maintain or create ideal grouse habitat. Only on intensively used lands, such as our game areas in southern Michigan, can intensively directed management be justified. Thus it is doubly important to reduce or maintain deer populations at a sufficiently low level so that habitat quality is maintained at a level suitable for maximum grouse production concomitant with other land uses.

Fig. 5 The upland aspen type with scanty understory occurs abundantly in northern lower Michigan.

Fig. 6 A jack pine forest near Luzerne, Oscoda County, Michigan. This vegetation type is also abundant in northern lower Michigan. Both types illustrated represent poor ruffed grouse habitat and could be noticeably improved.

Fig. 7 The "edge" between upland and lowland aspen types. Note the development of the lowland understory, composed almost entirely of speckled alder. Forest age and deer browsing pressure have eradicated the understory stratum in the upland.

SUMMARY

Forty ruffed grouse drumming logs and the nearby vegetation were studied in 1959. Minimum size of logs and plant density requirements were ascertained.

Logs were occupied by grouse for varying numbers of years. Logs used several years tended to be larger in diameter than those used infrequently, but there was little correlation between use and length of logs. Log directions occurred most often in a sourthwesterly - northeasterly direction, but it was not determined whether this was due to prevailing winds or whether grouse prefer this direction. Birds selected drumming locations near one end of the log, and usually this was the large or "butt" end. More than three-fourths of the logs were old conifers, of which most were white pine.

No consistent differences in plant densities were noted near logs used almost perennially as compared to logs used infrequently. Vegetation surrounding logs was also compared to vegetation elsewhere in the habitat, and comparisons were made by arbitrary size classes. Plants in the smallest size class (0-2 feet tall) were less numerous near the logs than elsewhere. In the larger size classes, particularly the 8 feet tall to 3 inch dbh class, plants were much more numerous near the log.

All logs were located in lowland vegetation types. The presence of all logs in lowland types suggests that the upland types are not suitable for the establishment of courtship sites. This unsuitability was probably due to a paucity of undergrowth, resulting from an advanced forest age and also perhaps from an overabundance of deer. Lowland types were

satisfactory as courtship sites, because plants growing there were unpalatable to deer and therefore escape serious browsing and can reproduce. Very few plant species supplied practically all of the necessary density, although 44 different species were tallied. Speckled alder (*Alnus rugosa*) was undoubtedly the most important single plant species.

Ecological conditions on the Rifle River Area are believed to be representative of many areas in Michigan, and if maximum ruffed grouse production is desired, deer numbers must be reduced and lumbering rotations shortened. In some areas, more intensive habitat improvement measures may be necessary than can be supplied by the removal of mature trees, but the least expensive means to create or maintain habitat quality is through deer herd reduction.

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APPENDIX

Check list of woody plants tallied near 40 grouse drumming logs. Nomenclature from Fernald, 1950.

Balsam fir (Abies balsamea)
Hemlock (Tsuga canadensis)
White spruce (Picea glauca)
Larch (Larix laricina)
White pine (Pinus Strobus)
Red pine (Pinus resinosa)
White cedar (Thuja occidentalis)
Willow (Salix spp.)
Trembling aspen (Populus tremuloides)
Large-tooth aspen (Populus grandidentata)
Balsam poplar (Populus balsamifera)
American hazel (Corylus americana)
White birch (Betula papyrifera)
Yellow birch (Betula lutea)
Swamp birch (Betula pumila)
Speckled alder (Alnus rugosa)
White oak (Quercus alba)
Red oak (Quercus rubra)
Slippery elm (Ulmus rubra)
American elm (Ulmus americanum)
Rock elm (Ulmus Thomasi)
Black currant (Ribes americanum)
Ninebark (Physocarpus opulifolia)
Meadow-sweet (Spiraea alba)
Chokeberry (Pyrus melanocarpa)
Juneberry (Amelanchier huronensis)
Hawthorn (Crataegus sp.)
Pin cherry (Prunus pennsylvanica)
Black cherry (Prunus serotina)
Choke cherry (Prunus virginiana)
Prickly ash (Xanthoxylum americanum)
Mountain holly (Nemopanthus mucronata)
Red maple (Acer rubrum)
Red-osier dogwood (Cornus stolonifera)
Gray dogwood (Cornus racemosa)
Silky dogwood (Cornus obliqua)
Leatherleaf (Chamaedaphne calyculata)
Blueberry (Vaccinium sp.)
White ash (Fraxinus americana)
Black ash (Fraxinus nigra)
Honeysuckle (Lonicera canadensis)
Nannyberry (Viburnum lentago)
High-bush cranberry (Viburnum trilobum)
Elderberry (Sambucus canadensis)