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Sharp-Tailed Grouse Nesting and Brooding Habitat in Southwestern North Dakota

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SHARP-TAILED GROUSE NESTING
AND BROODING HABITAT IN
SOUTHWESTERN NORTH DAKOTA

BY

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AND BROODING HABITAT IN

SOUTHWESTERN NORTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Head, Department of Wildlife and Fisheries Sciences — Date

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SHARP-TAILED GROUSE NESTING AND BROODING HABITAT

IN SOUTHWESTERN NORTH DAKOTA

Abstract

STANLEY C. KOHN

The habitat of nesting and brooding sharp-tailed grouse (*Pedioecetes phasianellus*) was studied 1 April to 25 August 1973 and 1974. The objective of the study was to determine the quality and quantity of vegetation at nest and brood locations of sharp-tailed grouse in relation to available vegetation within pastures. Five range sites, lowland draw, rolling grassland, upland grassland, rocky outcropping, and claypan were studied.

Thirty-four females were trapped on dancing grounds and equipped with radio transmitters. Seventeen nests were located by monitoring the movements of transmitter-equipped hens and 26 nests were located through use of a cable-chain drag. Height of vegetation was measured at nest sites, at sites where broods were located, and in pastures and range sites with the visual obstruction pole. Species composition, relative frequency, and relative density of vegetation were measured at nest and brood locations using the inclined-point quadrat-method.

Regrowth, tame, and native vegetation types were utilized most frequently by nesting and brooding sharptail hens. Most nests and broods were found in the rolling grassland range-site. Most nesting sharptails were observed in pastures under a deferred-rotation grazing system. Average visual obstruction reading (VOR) was greater than 2.0 at 40 of 43 sharptail nests and at least 3.0 for over

75 percent of the brood locations. Vegetation height declined as distance from the nest and brood sites increased to 7 m. Height of vegetation at nest sites was significantly different (P<0.01) at varying distances and directions from the site. Vegetation height at nest and brood locations was correlated to the overall-average vegetation height in rolling grassland range site within pastures during 1973 and 1974.

Native grasses occurred most frequently at nesting and brooding areas. Woody plant species were more frequently utilized by broods than nesting hens. Wolfberry (Symphoricarpos occidentalis) was the only woody species found at nest sites.

Use of cover by sharptail broods depended upon time of day, habitat available, climatic factors, and amount of disturbance. Hens with broods were found in short-growing vegetation immediately after sunrise and in taller vegetation later in the morning. Relative frequency and density of plant species at nest sites changed at various distances from the sites in 1974.

Hens nesting in a particular habitat type were usually surrounded by additional vegetation of the same type. Percentages of the various habitats within 0.4 km of the nest site indicated hens were nesting in areas where one habitat type contained over 50 percent of the area.

A significant difference (P<0.01) in vegetation height was found between pastures and between range sites within pastures in 1973 and 1974. Most pastures sampled in 1974 had taller vegetation than 1973 after the vegetative growing period. Most pastures had taller vegetation in the fall of the year than in the spring.

Grasslands on the Gorham area could be managed for grazing and sharptail habitat by measuring and evaluating cover in range sites as well as in pastures. A management program that increased the average height of vegetation in pastures (minimum VOR of 1.5 within pastures) in the spring would provide taller vegetation for nesting hens and good brooding areas in the summer.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Sharp-tailed grouse (*Pedioecetes phasianellus* Linn.) occupy a number of habitats in North America (Evans 1968). These habitats include the climax sagebrush of the northern desert shrub area, occupied by the Columbian sharp-tailed grouse (*P. p. columbianus*); the subclimax brush in the grasslands east of the Rocky Mountains and in the parklands of the Rockies, occupied by the plains sharptail (*P. p. jamesi*); the oak-savannah and logged or burned areas farther east inhabited by the prairie sharptail (*P. p. compestris*); and the openings of the boreal forest occupied by the northern sharptail (*P. p. phasianellus*); and other boreal forest races (Aldrich 1963).

The plains sharp-tailed grouse of North Dakota have been virtually eliminated in the eastern part of the state (Johnson 1964). The sharptail population in the western part of the state declined in the early part of the century, because of the conversion of grasslands to cultivated crops and other human economic interests (Johnson 1964). The loss of habitat for the sharp-tailed grouse in that part of the state continues today both from conversion of grasslands to cropland, and from the utilization of the vegetation for grazing by domestic livestock.

The North Dakota Game and Fish Department, the U. S. Forest Service, and the Cooperative Wildlife Research Unit at South Dakota

State University initiated the present study. The objective was to determine the quality and quantity of vegetation at nest sites and brood locations of sharp-tailed grouse in relation to available vegetation within pastures.

STUDY AREA

The Gorham Study Area, in northern Billings County, includes ıll or parts of sections 7-9, 16-21, and 28-33, Township 143 North, Range 100 West. More than half of the 4,608 ha is under U. S. Forest Service control; grazed as a cow-calf operation. Many discrete pasture systems are in use on both public and private lands within the Gorham area (Appendix A). For a detailed description of climate, geology, and soils refer to Bernhoft (1969) and Christenson (1970).

Native vegetation occupies over 50 percent of the area (Table 1). The planting of introduced pasture grasses was common 15-20 years ago. However, native vegetation has invaded those tame-grass areas. This egrowth vegetation comprises over 440 ha of the study area. Another 40 ha of native vegetation were plowed and planted to crested heatgrass (*Agropyron cristatum*). Crested wheatgrass, a cool season pecies, is a substitute for native vegetation for grazing in early pring and/or fall.

Most tame hay fields were plantings of a yellow sweetclover (*Melilotus officinalis*) and smooth brome (*Bromus inermis*) mixture; ne remaining fields were sweetclover and some alfalfa (*Medicago ativa*). All of the tame hay was mowed and baled in late July. Most nall grain was wheat (*Triticum aestivum*) and common barley (*Hordeum ulgare*).

Woody vegetation was confined to low wet areas, slopes of hills, aws, creek bottoms, and farm plantings. Wolfberry (*Symphoricarpos* :cidentalis), buffaloberry (*Shepherdia argentea*), juneberry

Table 1. Land use on 4,664 ha of the Gorham study area, 1973-74.

Land use	Number of hectares	Percentage of total
Native vegetation grazed	2457.	53.
Regrowth vegetation grazed	445.	10.
Crested wheatgrass grazed	436.	9.
Tame hay baled[a]	429.	9.
Small grains (agriculture)	361.	8.
Woody vegetation[b]	350.	8.
Tame grass baled	94.	2.
Shelterbelts	34.	tr
Summer fallow	21.	tr
Idle areas	13.	tr
New grass plantings	11.	tr
Open water	7.	tr
Marsh	6.	tr

[a]Sweetclover - smooth brome mixture.

[b]Excluding shelterbelts.

(Amelanchier alnifolia), choke cherry (Prunus virginiana), and prairie wild rose (Rosa arkansana) provided the majority of the woody cover on the upland hillsides and along most lowland draws and creeks. Deciduous trees occurred adjacent to draws and creeks. The shelterbelt plantings on the area were less than 2 hectares in size.

Five range sites as classified by the U. S. Forest Service on the Custer National Grasslands were identified on the area. The lowland draw range site included drainages, intermittent streams, and brushy draws and incised drainages. The community supported a postclimax vegetation dominated by woody species such as green ash (Fraxinus pennsylvanica), prairie wild rose, wolfberry and buffaloberry often mixed with a variety of forbs and a few grasses.

Rolling grassland range site was the true prairie climax and occupied more than half of the Gorham area. This site is composed of gently sloping uplands with clayey, sandy, and glacial soils. The upland community is dominated by western wheatgrass (Agropyron smithii), blue grama (Bouteloua gracilis), prairie junegrass (Koeleria cristata), needle-and-thread (Stipa comata), little bluestem (Andropogon scoparius), and buffalo grass (Buchloe dactyloides) plus numerous forbs and some brushy plants such as Shepherdia spp. and Symphoricarpos spp.

Rocky outcropping range site was similar to the rolling grasslands sites but was usually rockier and occurred on steeper slopes. Vegetation on this range site was similar in botanical composition to rolling grassland but generally lacked woody species.

Upland grassland range site was drier than either the rolling grassland or rocky outcropping sites, and supported a preclimax vegetation. Upland grassland included hilly and steep uplands and tops of hills. Little woody vegetation was found on the slopes and none on hill tops. Vegetation consisted of short-to mid-grasses with a variety of forbs, especially Selaginella spp. (Appendix B4).

Claypan range sites had the least permeable soil type and were small and widely distributed. The soils had extremely restrictive water relations and supported preclimax vegetation. Vegetation was scarce on the claypan; only a few sparse grasses existed (Appendix B5).

METHODS

Trapping and Radio Equipment

Thirty-six females were trapped on dancing grounds (Appendices C and D) in April using a Dill recoilless cannon-net assembly (Dill and Thornsberry 1950). Each hen was equipped with a radio transmitter to locate nests and broods. The radio-tracking equipment used in this study was developed by Marshall (1960) and manufactured by Sidney L. Markusen, Electronics Specialties, Esko, Minnesota (Bernhoft 1969) and AVM Instrument Company, Champaign, Illinois (Trego 1973). The transmitter-equipped females were monitored from dancing grounds to nest sites (Appendix E). Non-nesting females were located daily. If the location remained stationary for more than 3 days, the hen was tracked and flushed. Transmittered hens with broods were under observation from early morning to the time they reached the night roost (Appendix F). Each brood was followed for 3 weeks or until radio contact was lost.

Vegetation Sampling Equipment

Height of vegetation was measured by the visual obstruction technique (Robel et al. 1970) at nest sites, at sites where broods were located, and in pastures and range sites. Alternating 7.5 cm sections were painted light gray and white on a round pole 4 x 183 cm (Appendix B6). The midpoint of each 7.5 cm section was marked with a narrow red stripe making it possible for the observer to distinguish half-sections. The pole was placed in the ground and observed at a height of 1.0 m and a distance of 4.0 m. A light plastic stick marked at 1.0 m, and a 4.0 m string, with opposite ends tied to the stick and pole, were used to standardize the observation heights. The lowest 7.5 cm section or half-section mark visible on the pole was recorded.

Species composition, relative frequency, and relative density of vegetation were sampled with a square-foot frame and point frame (Levy and Madden 1933, Tinney et al. 1937). The square-foot frame consisted of four 2.5 x 30.5 x 2.5 cm boards, braced at the corners with metal supports. Four holes were drilled along each side of the boards at 5 cm intervals providing a total of 20 holes. Metal bolts ground to a point at one end, were fitted into the holes. Wing nuts attached to the bolts allowed for adjustment of the length.

Sampling Nesting Cover

Height of vegetation at the nest site was measured by placing the pole vertically in the vegetation 5 cm west of the nest. The observer walked around the nest taking 10 readings. The pole was then placed every two steps (approximately 2 m) in a north, south, east, and west direction away from the nest until 15 measurements were recorded in each direction. Nesting and hatching chronology, nest dimensions, number of eggs, and amount of litter within each nest were recorded throughout the nesting period (Appendices G, H and I).

Plant species-composition was sampled after the eggs hatched or the nest was destroyed. In 1973 a square-foot frame was placed over the nest site, and the closest plant in a 180 degree forward arc of each point was identified and recorded. The frame was then lifted, turned 45 degrees and placed over the nest a second time until 40 readings were taken at the nest site. One frame reading was recorded at distances of 6.1 m north and south, and 1.5 m east and west of the nest site if a flip of the coin revealed heads; tails reversed distances within directions.

In 1974 a point-frame (Hanson 1934) was used to estimate species composition. Forty readings were taken at the nest site. The frame was then moved from the nest site in the same manner as the square-foot frame. Relative frequency (relative occurrence) of each plant species was estimated by counting number of times a species was adjacent (the closest plant) to a point. Relative density was calculated according to the formula:

$$\frac{\text{Relative occurrence (density) of a single species}}{\text{Total relative occurrence (density) of all species.}}$$

Sampling Brooding Cover

Height of vegetation at brood locations was measured similarly to that at nest sites. Ten readings were taken at the flush site using the obstruction pole. Pole readings were then taken at 1 m, 3 m, 9 m, and 13.5 m in each N-S-E-W direction. The square-foot frame sampled species composition at brood sites in 1973; the point frame was used in 1974. Species composition at brood sites was sampled only at the flush locations. Analysis of variance was used to analyze vegetation for nest and brood data.

Sampling Pasture Vegetation

Vegetation in pastures was sampled in May prior to nesting and in July after the vegetation had reached its maximum growth for the season. Measurements were made during other months if time allowed. Line transects were arbitrarily established in a north-south direction across each pasture. Visual obstruction readings (VOR) were recorded every 10-50 steps (approximately 10-50 m) depending upon the size of the pasture and the number of vegetation readings needed per pasture. The pole was placed vertically in the vegetation about 15 cm to the right of the observer's foot and the VOR recorded. During 1973, the only pastures measured were those containing nests or where an ocular estimate of the range suggested a good quality of grass. Range sites within pastures were not sampled independent of pastures, but site differences were recorded incidentally as transects were walked. The minimum number of pole readings in 1973 was 1500 per 256 ha of pasture. In 1974 all pastures within 1.3 km radius of sites where hens were captured (breeding grounds 5 and 9) were measured with the obstruction pole. Most pastures measured in 1974 contained only the rolling grassland range site. Data for months and range sites were pooled and considered the same for statistical analysis, because only one group of observation readings was recorded for each month in a range site within a pasture. Range sites within pastures were sampled by obtaining a minimum of 150 VOR for each range site in a pasture.

Average vegetation height within a large pasture may not reflect the small areas of tall vegetation available for sharptail use (Hormay 1970). The percentage of the total readings above the average was analyzed to estimate the uniformity of vegetation in a pasture. Pastures with 50 percent or more of the VOR above the average had a uniform vegetation height. Pastures having 40 percent or less of the readings above the average VOR reflected small areas of tall vegetation dispersed throughout the pasture. Factorial analysis of variance was run between the mean of the 10 VOR taken at nest sites and brood sites and the average pasture VOR, and range site within pasture VOR, where the locations occurred.

Availability of various habitats within 0.4 km of the nest was estimated by noting habitats immediately adjacent (at the 4 compass bearings) to the one the hen was using. The percentage of the various habitat types within 0.4 km radius of nest or brood sites was also calculated.

Scientific and common names of plants are from Stevens (1963).

RESULTS AND DISCUSSION

Pasture Measurements

Highest VOR for range sites within pastures occurred in lowland draw site (Table 2) and lowest readings in all months were in claypan. Vegetation height varied within pastures as the summer progressed. Vegetation height increased in some pastures from May to August and decreased in others. There was a significant difference ($P<0.01$) in vegetation height between range sites within pastures but not between pastures (Appendix J).

Most pastures sampled in May, 1973, had 50 percent or more of the obstruction readings above the average (Table 3). In only three pastures did the average of the above readings indicate sufficient vegetation height for nesting. Most of these pastures were introduced grass plantings or uniform native upland vegetation void of woody species. The percent readings above the average increased in most pastures as summer progressed. This probably resulted from differential growth patterns of particular plant species and/or preferences of cattle toward plants.

A factorial analysis of variance indicated significant differences ($P<0.01$) in vegetation height between pastures and between range sites for all months analyzed in 1973 (Appendix K). Range site within pasture interaction was significantly different ($P<0.01$) because of the extreme differences in vegetation height between range sites within pastures, especially in pastures containing the lowland draw site.

Table 2. Average VOR in range sites within pastures by months, 1973.

Pasture number	Lowland draws M[a]	J	J	A	Upland grasslands M	J	J	Rolling grasslands M	J	J	A	O	Claypans M	J	J	A	O
0	2.94		3.85					0.87		0.90			0.33		0.20		
1			1.11				2.02	2.93		2.60		1.70			0.45		0.26
2								1.18									
3							1.48	2.10	2.08					0.83	0.50		
4			3.25					1.50	1.50	1.13				0.80	0.35		
5	0.50				0.77			0.73	0.61	1.31			0.38				
6		2.14	6.22					1.59		0.86				0.24	0.27		
8	1.67							0.76		0.75			0.39				
9		2.75						1.22	1.18	1.10				0.32			
10										2.65							
13										2.43							
16										1.75							
18											1.62	1.04				0.50	
19				6.57							1.45					0.62	
20											0.95					0.17	
21										1.18					0.50		
22										2.08					0.33		

[a]Months of May, June, July, August and October

Table 3. Percent VOR above the average pasture VOR during the various months, 1973 and 1974.

Pasture number	Month	Average VOR		Percent of total readings above the average VOR		Average of readings above average VOR	
		1973	1974	1973	1974	1973	1974
0	May	0.87	1.33	51.3	48.4	1.30	1.84
0	July	0.90	1.54	52.2	32.6	1.24	2.54
1	May	2.93	1.33	22.1	51.2	3.05	1.85
1	June		2.27		48.7		3.16
1	July	2.60		57.2		3.55	
1	August		2.08		40.5		3.12
1	October	1.70		50.2		4.62	
2	May	1.18		47.4		1.68	
3	May	2.10	1.18	48.1	40.9	2.73	1.74
3	June	2.08		43.6		5.51	
3	July	2.24		53.4		2.91	
3	August		1.52		63.3		1.95
4	May	1.50	1.28	37.8	51.0	2.20	1.72
4	June	1.50	1.01	70.4	59.4	1.76	1.39
4	July	1.18		32.1		1.74	
4	August		0.89		42.9		1.39
5	May	0.73	1.05	37.7	35.2	1.21	1.70
5	June		1.04		74.2		1.23
5	July	1.31		18.4		1.82	
5	August		1.49		63.6		1.73
6	May	1.59		19.3		1.74	
6	June	0.61	0.74	20.4	37.0	1.16	1.18
6	July	0.86		41.6		1.21	
6	August		1.02		22.0		1.30
7	August		1.38		61.5		1.65
8	May	0.76	1.56	12.3	37.8	1.06	2.18
8	July	0.75		27.9		1.31	
8	August		1.46		59.8		1.88
9	May	1.22	2.17	24.0	42.5	1.66	1.15
9	June	1.18	0.58	46.0	16.1	1.53	1.15
9	July	1.10	3.23	37.2	36.6	1.38	5.04
9	August		1.32		52.8		1.71
10	July	2.75		21.4		2.93	
13	July	2.43		54.6		2.81	
16	July	1.75		27.7		2.11	

Table 3. Continued.

Pasture number	Month	Average VOR 1973	Average VOR 1974	Percent of total readings above the average VOR 1973	Percent of total readings above the average VOR 1974	Average of readings above average VOR 1973	Average of readings above average VOR 1974
18	August	1.62	2.07	36.9	34.4	2.38	2.62
18	October	1.04		71.0		1.96	
19	August	1.45	2.27	31.9	45.6	1.83	2.66
20	August	0.95	0.77	51.4	37.3	1.40	1.22
21	July	1.18		34.2		1.93	
21	August		2.16		49.7		2.67
22	July	2.08		41.8		3.20	
22	August		0.67		22.7		1.14
26	August		0.32		33.6		1.41
27	August		1.19		39.4		1.81
28	May		2.02		65.4		2.38
28	July		10.94		55.7		12.07
29	August		0.92		51.5		1.31

Vegetation height differences in lowland draws occurred because of woody vegetation. Little difference in vegetation height existed between pastures within the same range site. Range sites and pastures were the same units in 1974 because of change in sampling procedure.

Vegetation height on the rolling grassland site within pastures showed a gradual decline as the summer progressed (Table 4). Only pastures 9 and 28 displayed an increase. These pastures were non-grazed and contained introduced plantings. Cover height between pastures and range sites within pastures was significantly different ($P<0.01$) (Appendix J). Monthly factorial analysis of variance testing various pastures indicated significant differences ($P<0.01$) in vegetation height between pastures in every month sampled (Appendix K).

Over 50 percent of the pastures measured in 1974 had from 30 to 50 percent of the VOR higher than the average for the pasture (Table 3). Vegetation height in pastures in spring, 1974 was more uniform than in late summer. Most pastures planted to introduced vegetation had a more uniform height throughout the summer.

After vegetation height reached its maximum growth (late July), most pastures sampled in 1974 had taller vegetation than 1973; i.e. most pastures in 1974 had taller vegetation in the fall and winter. Similarly, most pastures had taller vegetation in the fall of the year than in the spring. However, this depended upon grazing intensity.

Table 4. Average VOR for rolling grassland site within pastures by months, 1974.

Pasture number	Average VOR May	June	July	August
0	1.33		1.54	
1	1.33	2.27		2.08
3	1.18		1.52	
4	1.28	1.01	0.89	
5	1.05	1.04	1.49	
6		0.74		1.02
7				1.38
8	1.56		1.46	
9	2.17	0.58	3.23	1.34
18				2.07
19				2.27
20				0.77
21				2.16
22				0.67
26				0.82
27				1.19
28	2.02		10.94	
29				0.92

bitat Used for Nesting

Regrowth vegetation and tame vegetation were used most frequently or nesting in 1973 and 1974. Most nests in the tame vegetation were n crested wheatgrass. Bernhoft (1969) and Christenson (1970) onsidered crested wheatgrass an important cover type for sharp-ailed grouse. Some nesting hens also selected the transition area etween regrowth and native vegetation with sparse woody growth. Four of 43 sharptail nests found in 1973 and 1974 were located in woody vegetation (Table 5). The majority of nests were greater than 50 m from woody cover and 100 m from fences (Appendix L). Artmann (1970) found extensive utilization of brushland cover by nesting sharptails in Minnesota. Most nests observed in the parklands of Saskatchewan were in native grass-shrub mixture (Pepper 1972).

Thirty-eight of the 43 nests described were in the rolling grassland range site during 1973 and 1974 (Table 5). Bernhoft (1969) and Christenson (1970) also observed most hens nesting in rolling grassland sites. Nesting sharptails most frequently utilized pastures under a deferred rotation grazing system. However, many nesting hens were in pastures grazed in early spring and summer. Summer-grazed pastures contained the largest number of nests located in 1967-70.

Average VOR was greater than 2.0 at 40 of 43 sharptail nest sites (Table 6) and 2.5 or greater at 30 nest sites. Average VOR for vegetation at nest sites in 1973 and 1974 was 3.12 and 2.64,

Table 5. Use of different habitats for nesting by sharptail hens, Gorham study area, 1967-1974.

	Number of nests			
	1967-70[a]	1973	1974	Total
Vegetation type				
Regrowth	5	15	2	22
Tame	12	8	4	24
Native	7	2	8	17
Woody	8	3	1	12
Range site				
Rolling grasslands	24	25	13	62
Upland grasslands	1	0	0	1
Lowland draws	7	3	1	11
Rocky outcroppings	0	0	1	1
Claypans	0	0	0	0
Land use				
Early spring grazed	7	10	2	19
Summer grazed	9	1	3	13
Winter grazed	1	6	0	7
Deferred rotation	7	7	6	20
Non-use	3	3	3	9
Nongrazed, mowed and baled	4	1	1	6
Soil bank (not in study area)	1	0	0	1

[a]Nests reported by Bernhoft (1969) and Christenson (1970).

spectively (Figs. 1 and 2). The VOR at nest sites in late summer
eraged 2.7 (Table 6). The average VOR at most nest sites in
gust 1973 was higher than the average pasture VOR in May 1974. If
ight of vegetation is not further reduced by additional fall-winter
azing or heavy snow compaction, pastures with nests averaging a VOR
eater than 2.7 in August may have areas of available nesting habitat
e following spring. Annual plant cover with a 2 m radius having an
erage VOR greater than 2.0 can be considered available nesting
bitat. Christenson (1970) indicated that sharptails on the Gorham
ea required uniform vegetation not less than 30 cm or patchy
getation less than 36 cm in height.

The average VOR declined as distance from the nests increased up
7 m. At distances from the nest site greater than 7 m the average
R fluctuated from 1.6 to 2.1 in 1973 and from 1.4 to 1.6 in 1974
igs. 1 and 2).

VOR at nest sites in the lowland draw range site had a higher
erage (3.53) than nests in either the upland grassland (2.77) or
lling grassland range sites in 1973 (3.05) (Table 7). The average
ading within 22 m of nests in lowland draw sites was 2.7,
nsiderably higher than the 1.48 for upland grassland and 1.59 for
lling grassland. VOR averaged 3.06 at nest sites in tame
getation, 2.93 in native vegetation, and 3.15 in woody vegetation.

Vegetation surrounding nests in lowland draws in 1974 was taller
an vegetation surrounding nests on other sites (Table 8).
etation was taller 2 m and 22 m from the nest of the upland

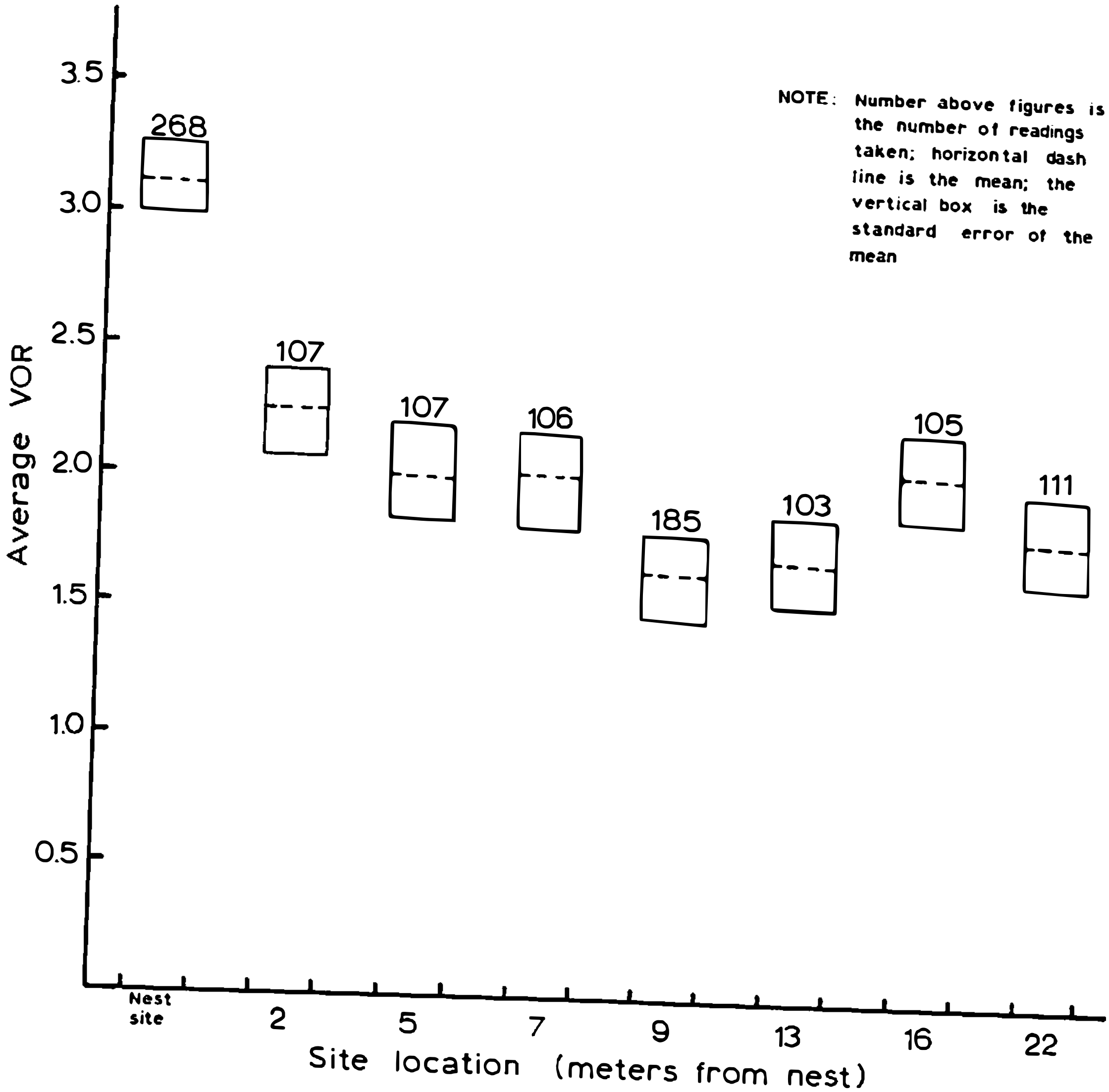


Fig. 1 Average VOR at nest site compared to VOR at various distances from the nest site, 1973.

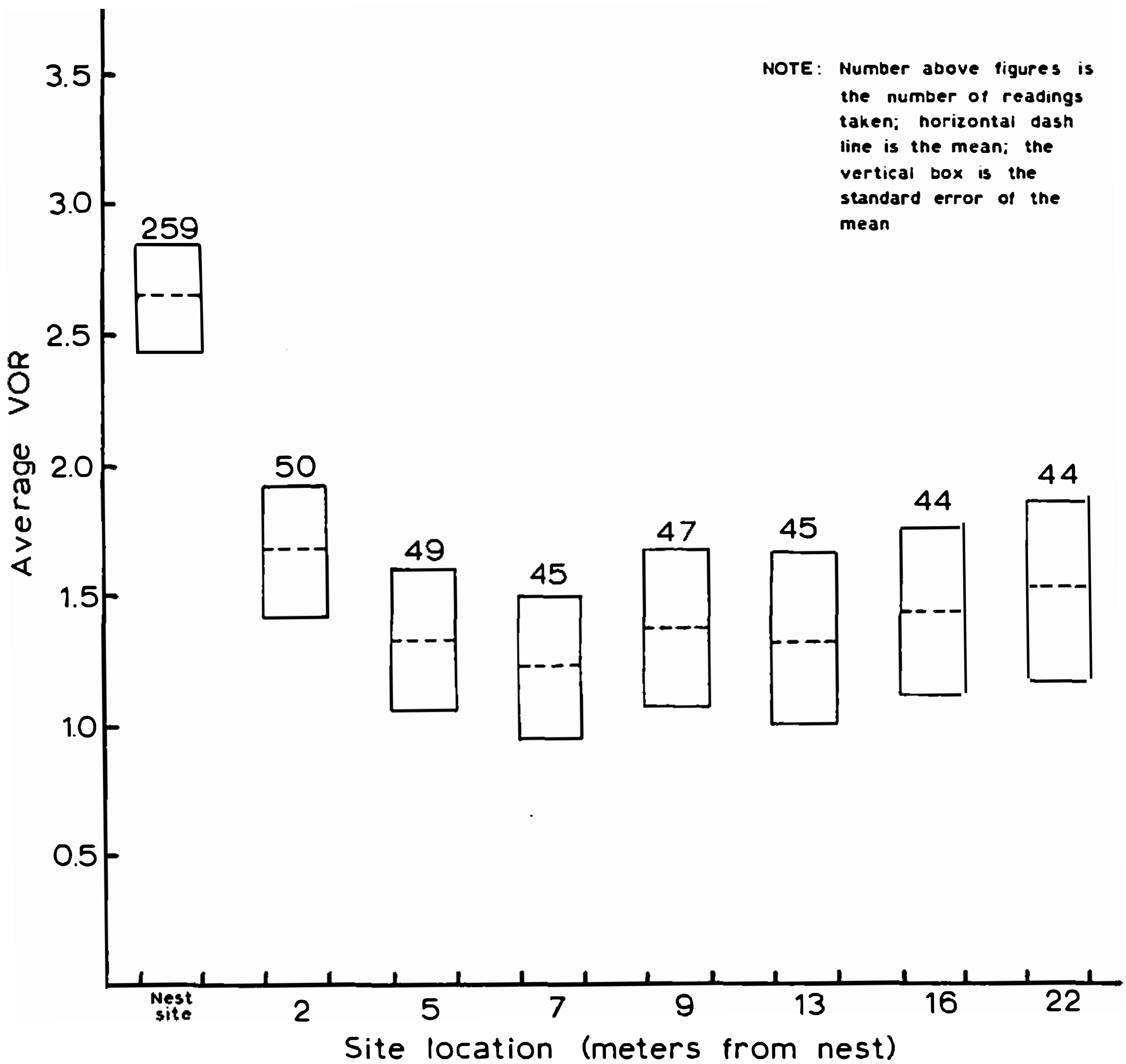


Fig. 2. Average VOR at nest site compared to VOR at various distances from the nest site, 1974.

...le 6. Average VOR at sites selected by sharptails for nesting, ...3 and 1974.

...ture ...ber	Number of nests	Average VOR May 15-June 15 Mean	Range	July 15-August 15 Mean	Range
0	1	1.7		0.9	
1	6	3.4	2.1-4.5	1.8	1.4-2.3
2	8	2.8	2.2-3.7		
3	4	2.6	1.8-3.2	3.0	2.7-3.6
4	3	2.7	2.6-2.9	2.2	1.8-2.5
5	6	2.9	1.8-4.4	2.9	1.2-5.4
6	1	2.7		6.0	
7	1	4.0		3.7	
8	3	2.5	1.6-3.3	1.8	1.4-2.4
9	2	2.8	2.5-3.0	3.0	2.2-3.7
0	2	3.3	2.0-5.7	3.9	
8	1	2.5		8.3	
0	2	2.4	2.0-2.7	2.9	2.6-3.2
1	1	2.0		2.6	

able 7. Average VOR at nest sites and surrounding areas within ange sites, 1973.

istance from est site (m)	Range site		
	Rolling grasslands	Upland grasslands	Lowland draws
0[a]	3.05	2.77	3.53
2	1.77	1.94	3.00
5	1.67	1.28	3.03
7	1.71	1.50	2.86
9	0.87	1.50	2.57
13	1.66	1.41	2.07
16	1.60	1.25	3.29
22	1.84	1.48	2.10

ero distance equals at the nest site.

Table 8. Average VOR at nest sites and surrounding areas within particular range sites, 1974.

Distance from nest site (m)	Range site: Rolling grasslands	Upland grasslands	Lowland draws	Rocky outcroppings
0[a]	2.79	1.89	3.51	2.38
2	1.54	2.37	1.87	0.87
5	1.71	1.71	0.87	1.01
7	1.35	1.54	1.12	0.91
9	1.43	1.87	0.98	1.21
13	1.05	1.87	0.67	1.71
16	1.22	1.54	1.67	1.31
22	1.13	1.97	1.67	1.31

[a]Nest site.

grassland than it was at the nest site; at other distances the readings were more uniform.

In 1973 the largest number (8) of nests was observed in pasture 2. Much of pasture 2 was plowed the following fall. Pasture 5 contained the largest number (6) of nests in 1974. Height of vegetation appeared to be a significant factor in habitat selected by sharptail hens. They nested in areas with higher than average VOR within a pasture or range site. Similar results were found for sharptails by Pepper (1972) and for sage grouse (*Centrocercus urophasianus*) by Wallestad (1974).

The average VOR at nest sites in 1973 and 1974 was consistently higher than the average VOR in rolling grassland range sites within pastures where nests were found (Figs. 3 and 4). A high correlation ($r = 0.95$) existed between average VOR at nest sites in 1973 to the average VOR in rolling grassland range site within pastures (Fig. 5). Approximately 90 percent of the variability in plant height at nest sites in 1973 can be explained by the variability within pastures in the average plant height in the rolling grassland range site.

Plant height at nest sites in 1974 was also correlated ($r = 0.97$) to the average VOR in range sites within pastures (Fig. 6). Approximately 93 percent of the variability in plant height at nest sites in 1974 can be explained by the variability in plant height in range sites within pastures. The high correlation of VOR at nest sites to VOR within pastures in 1973 and 1974 indicates that increasing the average height of vegetation in pastures in the spring increases

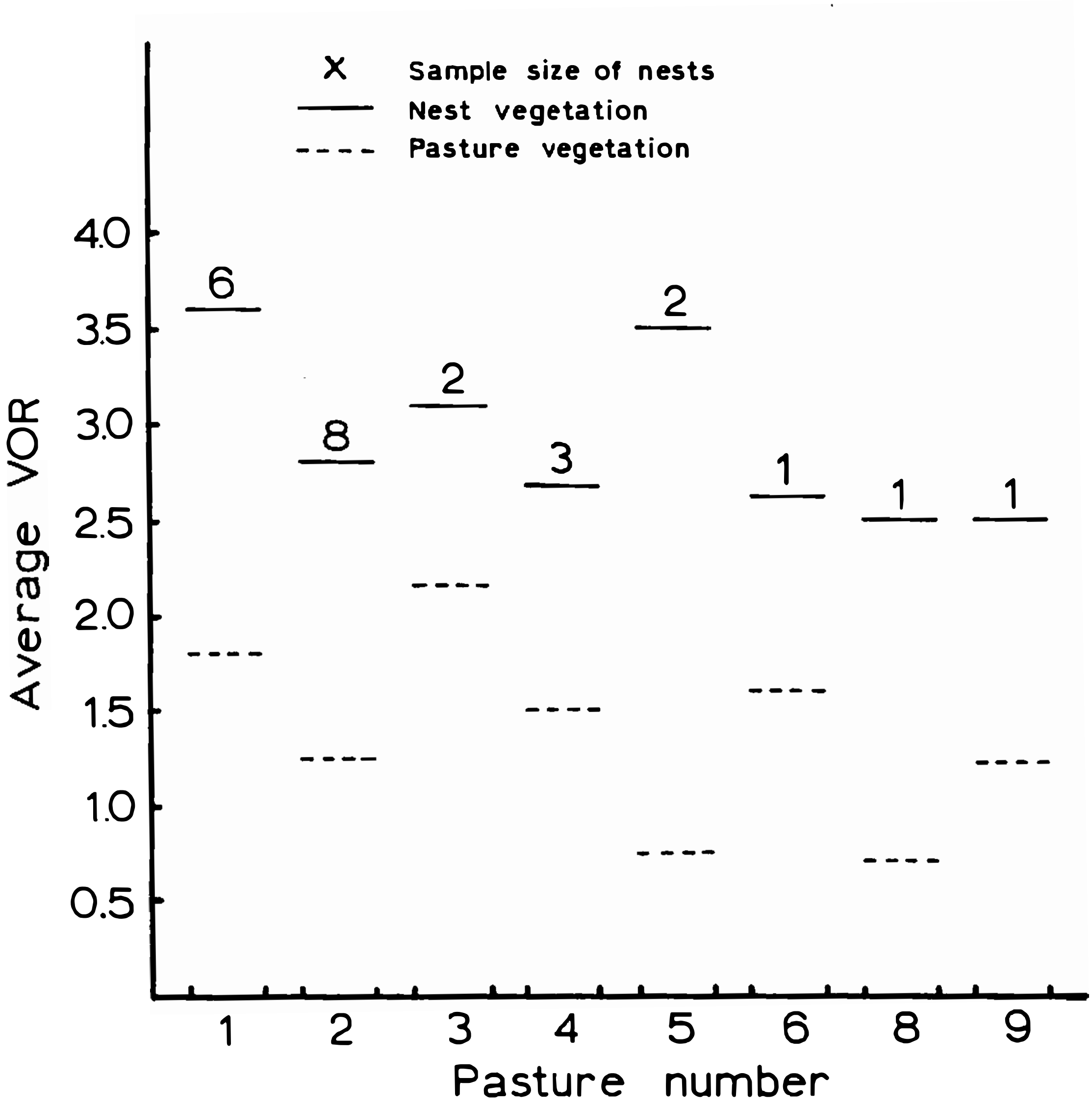
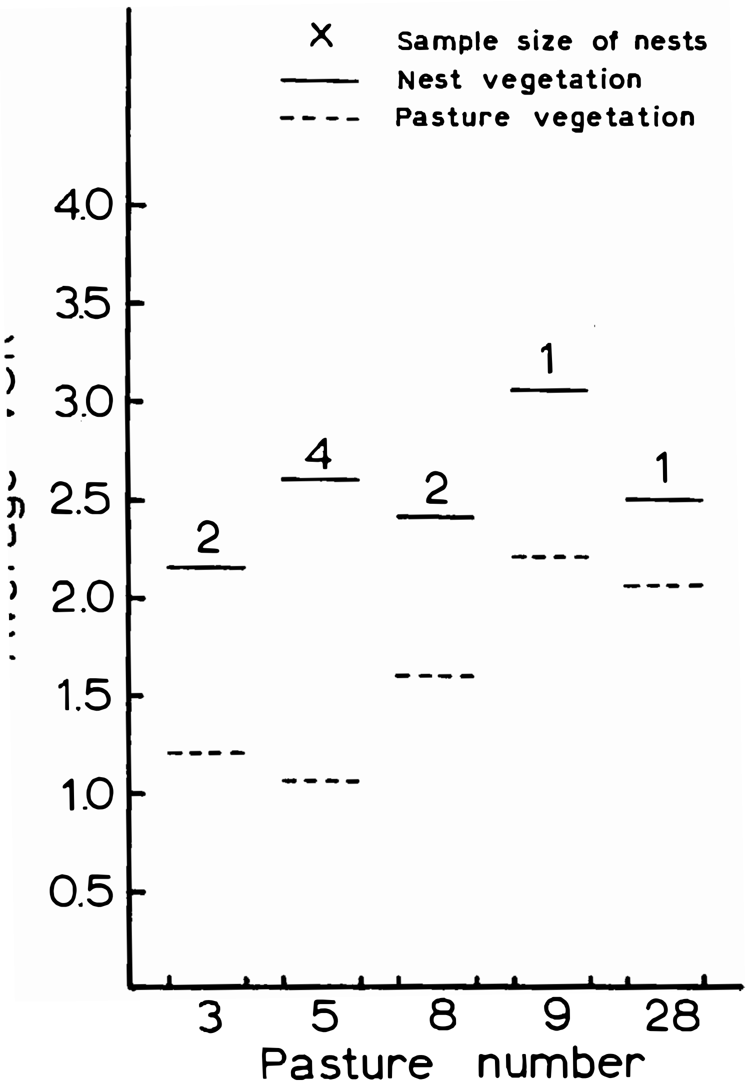


Fig. 3. Average VOR at nest sites compared to average VOR in pastures, 1973.



g. 4. Average VOR at nest sites compared to average VOR pastures, 1974.

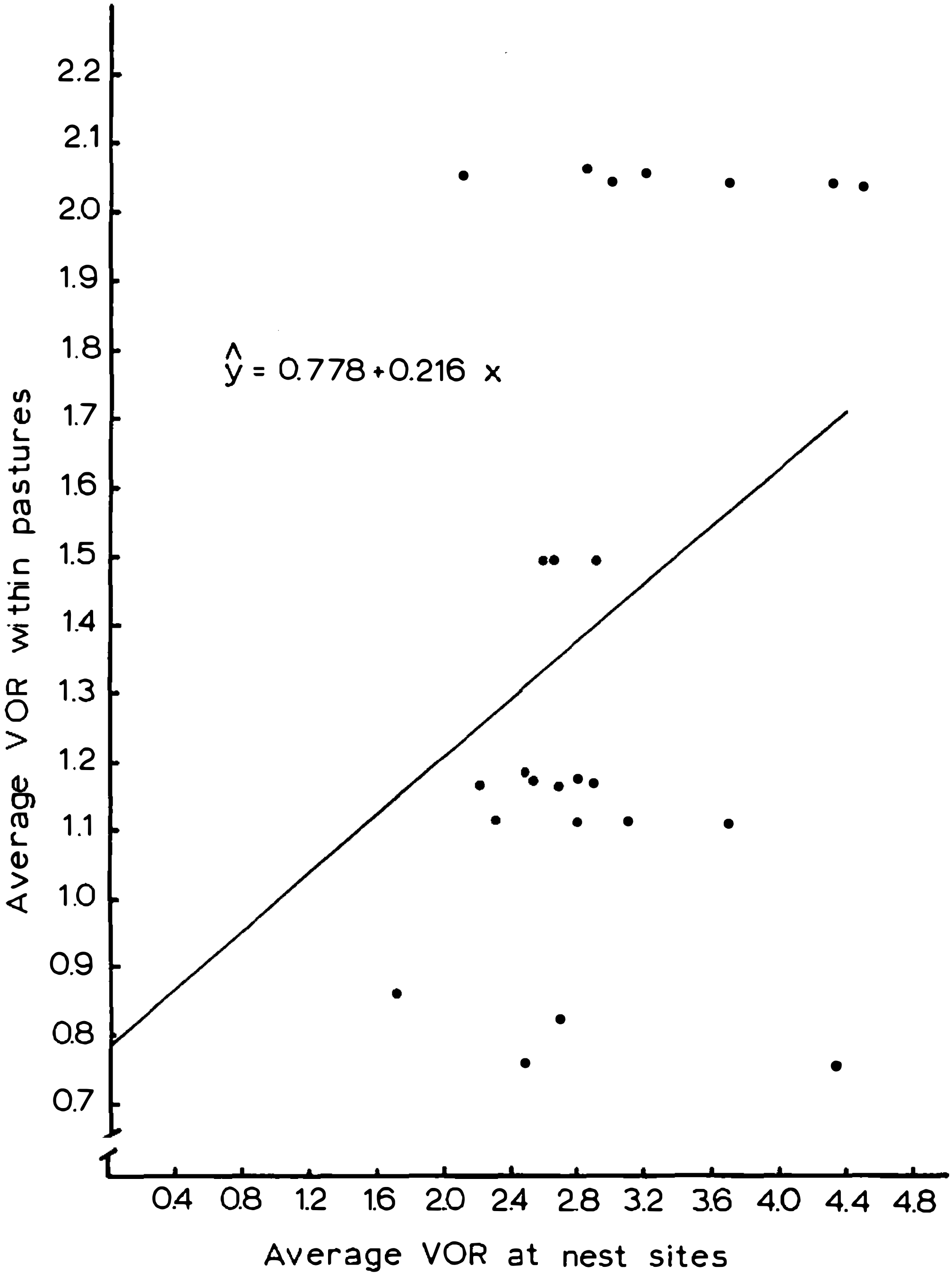


Fig. 5. Relationship of average VOR at nest sites to average VOR in pastures, 1973.

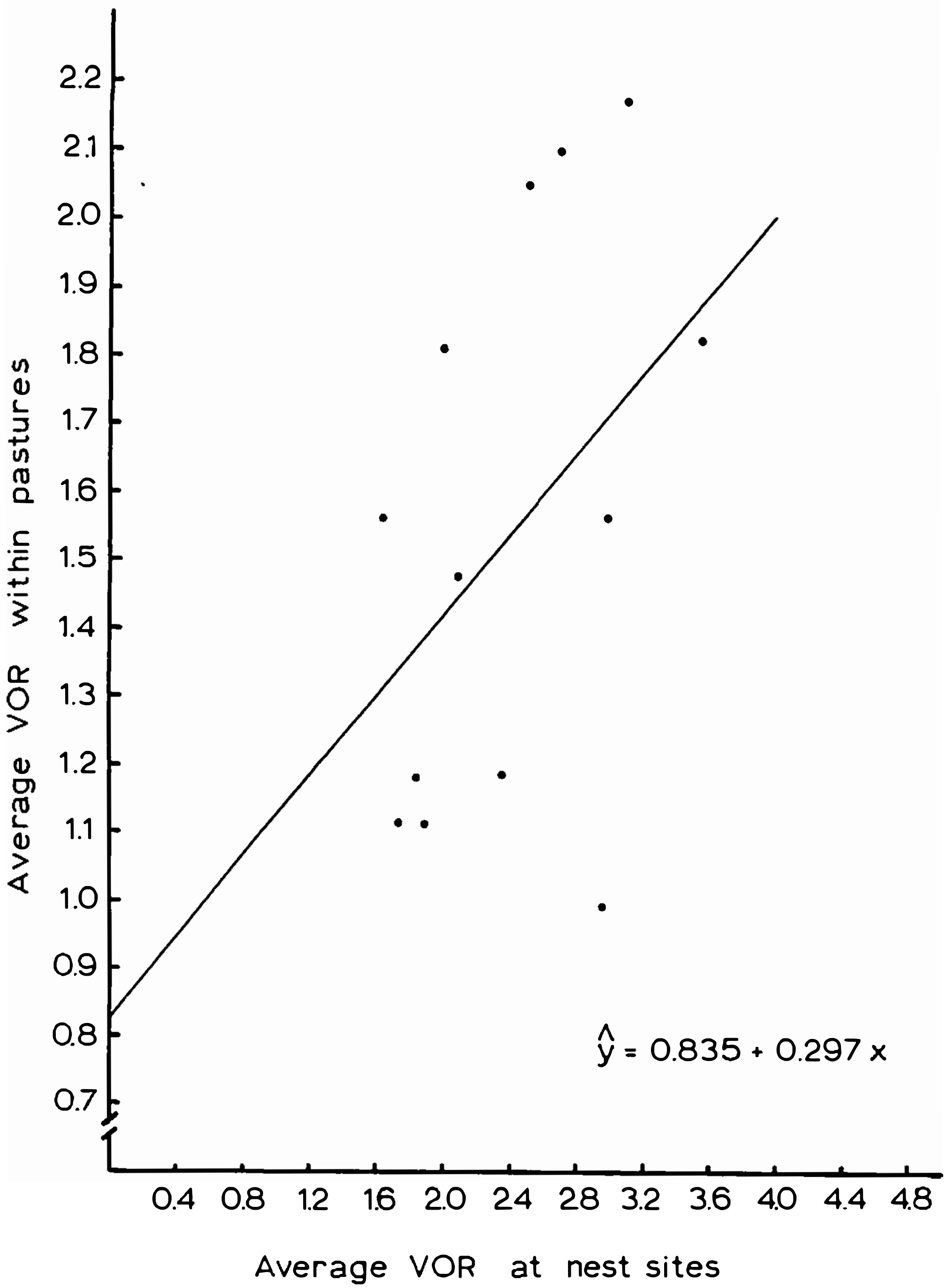


Fig. 6 Relationship of average VOR at nest sites to average VOR in pastures, 1974.

e amount of available nesting cover.

There was a significant difference ($P<0.01$) in the average VOR
tween range sites where nests were located in 1973 (Table 9). There
s no significant difference between range sites, directions, or
teractions in 1974 (Table 10). The average VOR was significantly
fferent ($P<0.01$) at varying distances and directions from the nest
te in 1973 (Table 9). However, only distances were significantly
fferent ($P<0.01$) in 1974 (Table 10). Cover height varied significantly
ween nest sites, distances from sites, and directions from sites in
4 (Table 11).

Some pastures showed more uniform vegetation height around nest
es than other pastures (Tables 12 and 13). Differences in plant
ght at various distances from nest sites were small for pastures
3, and 4 in 1973. Differences in vegetation height at varying
tances from the nest site were greatest for those nests located in
ture 5. Cover height ranged from 1.2 to 2.7 within 22 m of the nest
1973 and 1.0 to 2.5 in 1974 for pasture 5.

Sharptails used western wheatgrass and Kentucky bluegrass (Poa
tensis) most frequently in 1973 and 1974 (Table 14). They also
d crested wheatgrass and yellow sweetclover, suggesting hens did
lize tame grass pastures. Wolfberry was the only woody species
nd at nest sites during both years; prairie wild rose only occurred
und nests in 1973.

Nests located in different pastures were surrounded by different
nt species (Table 15). Western wheatgrass and Kentucky bluegrass
urred most frequently at nest sites in most pastures during both years.

Table 9. Factorial analysis of variance for pole height, testing range sites, distances, directions, and their interactions for nests, 1973.

Source	DF	Mean squares
Range site	2	33.584**
Distance	15	9.317**
Direction	3	5.999**
Range site x distance	30	2.229*
Range site x direction	6	7.032**
Error	1898	1.197

**Significant at P<0.01 level.
*Significant at P<0.05 level.

Table 10. Factorial analysis of variance, testing range sites, distances, directions, and their interactions for nests, 1974.

Source	DF	Mean squares
Range site	3	0.952
Distance	15	3.009**
Direction	3	0.306
Range site x distance	45	0.790
Range site x direction	9	1.158
Error	869	1.336

**Significant at P<0.01 level.

Table 11. Factorial analysis of variance for pole height, testing vegetation height at nest sites, distances, directions and their interactions, 1974.

Source	DF	Mean squares
Nest site	12	13.290**
Distance	15	24.585**
Direction	3	48.576**
Nest site x distance	180	1.998**
Nest site x direction	36	2.966**
Error	246	1.201

**Significant at P<0.01 level.

Table 12. Average VOR within various distances from nest sites in pastures, 1973.

Distance from nest site (m)	Average VOR (Pasture number)			
	1	2,3[a]	4	5
0	3.39	2.84	2.70	3.55
2	2.46	1.70	1.54	2.62
5	2.37	1.59	1.46	1.56
7	2.75	1.50	1.75	2.31
9	2.44	1.56	1.50	1.87
13	2.31	1.59	1.42	1.19
16	2.00	1.42	1.79	2.75
22	2.51	1.58	1.65	1.75

[a]Pastures 2 and 3 combined.

Table 13. Average VOR within various distances from nest sites in pastures, 1974.

Distance from nest site (m)	Average VOR (Pasture number)		
	3	5	8
0	2.10	2.53	2.32
2	1.12	1.94	1.47
5	1.44	1.81	1.37
7	0.87	1.36	0.87
9	1.06	1.60	1.44
13	0.69	1.44	0.94
16	0.77	1.00	1.37
22	1.15	1.01	0.75

ble 14. Plant species composition, relative frequency, and lative density of vegetation at 41 sharptail nest sites, 1973 d 1974.

ecies	Relative frequency 1973	Relative frequency 1974	Relative density 1973	Relative density 1974
asses and sedges				
Agropyron smithii	258	136	25.8	26.2
Poa pratensis	187	93	18.7	17.9
Agropyron cristatum	180	78	18.0	15.0
Carex spp.	38	45	3.8	8.7
Koeleria cristata	40		4.0	
Bromus japonicus	18	7	1.8	1.4
Stipa viridula	16	15	1.6	2.9
Stipa comata	11	14	1.1	2.7
Spartina pectinata		25		4.8
Poa compresse		23		4.4
Aristida longiseta		10		1.9
Calamovilfa longifolia		6		1.2
Andropogon scoparius	15		1.5	
rbs				
Melilotus spp.	105	33	10.5	6.4
Medicago sativa	36		3.6	
ody				
Symphoricarpos occidentalis	28	9	2.8	1.7
Rosa arkansana	17		1.7	
Other spp.	51	25	5.1	4.8

Table 15. Plant species composition, relative frequency, and relative density at sharptail nest sites within pastures, 1973 and 1974.

Species	Relative frequency				Relative density			
	P1[a]	P2-3[b]	P4	P5	P1	P2-3	P4	P5
1973								
Agropyron smithii	83	133		5	34.9	42.0		6.2
Agropyron cristatum			60				100	
Medicago sativa	36				15.1			
Koeleria cristata	19	6			7.9	1.9		
Poa pratensis	6	64		50	2.5	20.2		62.5
Symphoricarpos occidentalis				11				13.7
Carex spp.	13	7		9	5.5	2.2		11.2
Melilotus spp.	18	71			7.6	22.4		
Other	63	33		5	26.5	10.4		6.2

Species	Relative frequency			Relative density		
	P3	P5	P8	P3	P5	P8
1974						
Agropyron smithii	16	37		20.0	23.1	
Poa pratensis	35	31		43.8	19.4	
Carex spp.	13	23		16.2	14.4	
Poa compresse		23			14.4	
Agropyron cristatum			78			98.0
Stipa comata		14			8.8	
Calamovilfa longifolia	6			7.5		
Other	10	32	2	12.5	20.0	2.0

[a]Pasture 1.

[b]Different areas of the same pasture.

Relative frequency and density of plant species changed at various distances from nest sites in 1973 (Table 16). A higher relative density of the taller plants, western wheatgrass and alfalfa, was found surrounding nest sites located in pasture 1. A higher relative density of the shorter plants, Kentucky bluegrass, needle-and-thread, and blue grama occurred at locations away from nest sites. Similar results occurred for nests in pastures 2-3 and 4. Kentucky bluegrass and wolfberry occurred most frequently at nest sites in pasture 5 in 1973. No woody species occurred within 6 m of the nest sites. There was a marked increase in the relative density of western wheatgrass and blue grama at 6 m from nests located in pasture 5. This increase suggested a close association of woody species to nest selection within this pasture because the upland and rolling grass areas lacked sufficient height to support nesting sharptails.

Habitat Used By Broods

The greatest number of broods was flushed in pastures containing native and regrowth vegetation (Table 17). The rolling grassland range site was utilized most frequently by hens with broods during all daily activities. Kobriger (1965) indicated that broods roosted in sand range sites during the night in the Nebraska sandhills. In the morning the broods entered the wetland meadows where they spent the entire daylight period. Hens that nested in pastures with native or regrowth vegetation on the Gorham area rarely moved their broods from these areas. Most broods were flushed from pastures managed

Table 16. Plant species composition, relative frequency, and relative density at various distances from nest sites within pastures, 1973.

Species	Relative frequency		Relative density	
	1.5 m	6.0 m	1.5 m	6.0 m
Pasture 1				
Agropyron smithii	74	70	30.8	29.2
Medicago sativa	17	26	7.1	10.8
Poa pratensis	36	7	15.0	3.0
Stipa comata	10	23	4.2	9.6
Koeleria cristata	7	24	3.0	10.0
Bouteloua gracilis	15	10	6.2	4.2
Achillea millifolium	7	15	3.0	6.2
Melilotus spp.	26	15	10.8	6.2
Other	48	50	19.8	20.8
Pasture 2-3				
Poa pratensis	14	16	20.9	21.0
Agropyron smithii	12	18	18.0	23.7
Melilotus spp.	22	18	32.8	23.7
Koeleria cristata	9	3	13.4	4.0
Other	10	21	14.9	27.6
Pasture 4				
Agropyron cristatum	112	111	93.3	92.5
Other	8	9	6.7	7.5
Pasture 5				
Poa pratensis	24	15	30.0	15.8
Carex spp.	12	16	15.0	20.0
Bouteloua gracilis	11	9	13.8	11.2
Agropyron smithii	3	11	3.8	13.8
Other	30	29	37.6	36.2

Table 17. Use of different habitats by broods, Gorham study area, 1973-1974.

Vegetation type	Number of brood locations		
	1973	1974	Total
Native	18	13	31
Regrowth	14	13	27
Tame	8	10	[illegible]
Woody	4	13	17
Range site			
Rolling grassland	32	[illegible]	7[illegible]
Upland grassland	6	3	9
Lowland draw	6	2	8
Rocky outcropping	0	0	0
Claypan	0	0	0
Land use			
Early spring grazed	1	21	22
Summer grazed	5	8	13
Winter grazed	18	0	18
Deferred rotation	12	18	30
Non-use	1	0	1
Nongrazed and mowed and baled	6	3	9
Pasture number			
0	0	9	9
1	4	0	4
3	1	20	21
4	0	1	1
5	11	8	19
6	3	0	3
8	3	8	11
9	2	3	5
10	2	0	2
11	1	0	1
13	14	0	14
16	2	0	2
25[a]	1	0	1

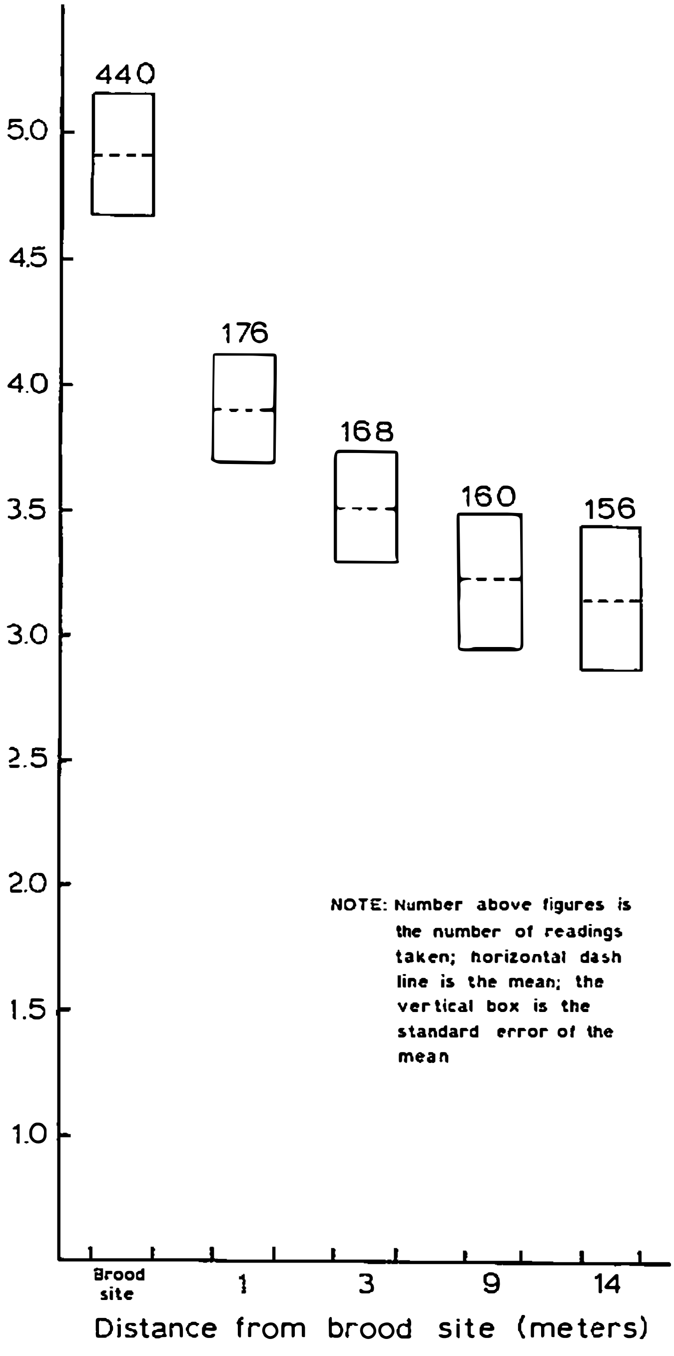
[a]Not within study area.

er an early spring or deferred-rotation grazing system.

The average VOR for all brood locations was 4.9 in 1973 and 3.5 1974 with over 75 percent of the readings at least 3.0. Plant ght progressively decreased with movement away from the site of shing (Figs. 7 and 8) except at 9 m distance in 1974. Broods ated in the lowland draw site were surrounded by taller vegetation n broods in rolling grassland or upland grassland (Table 18).

Plant height varied at brood locations within different pastures. tallest vegetation recorded at brood sites was in pasture 6 (5.5) in 1973 and pasture 9 (3.8 VOR) in 1974. Broods located in ture 5 were within 25 m of brushy cover. Plant height on the up- ds provided little cover causing hens with broods in pasture 5 to be sely associated with brushy lowland draws. VOR for broods located pastures in regrowth vegetation averaged 3.2; native vegetation, ; tame vegetation, 2.8; and woody vegetation, 5.5. Pastures or ge sites containing patches of vegetation 3 m in radius with a VOR eeding 3.0 in July provided available brooding habitat. No tures in 1973 and only two in 1974 had an average VOR of 3.0. ever, pastures or range sites containing sufficient nesting cover l also provide brood rearing areas. Therefore, any factors itively affecting nesting cover height would benefit brood cover.

Plant height was an important factor determining the location of ods. The average VOR at brood sites was consistently higher than average VOR for range sites within pastures where broods were shed (Figs. 9 and 10). The average VOR at brood sites in 1973 was



[. 7. Average VOR at flush site compared to average VOR various distances from the brood site, 1973.

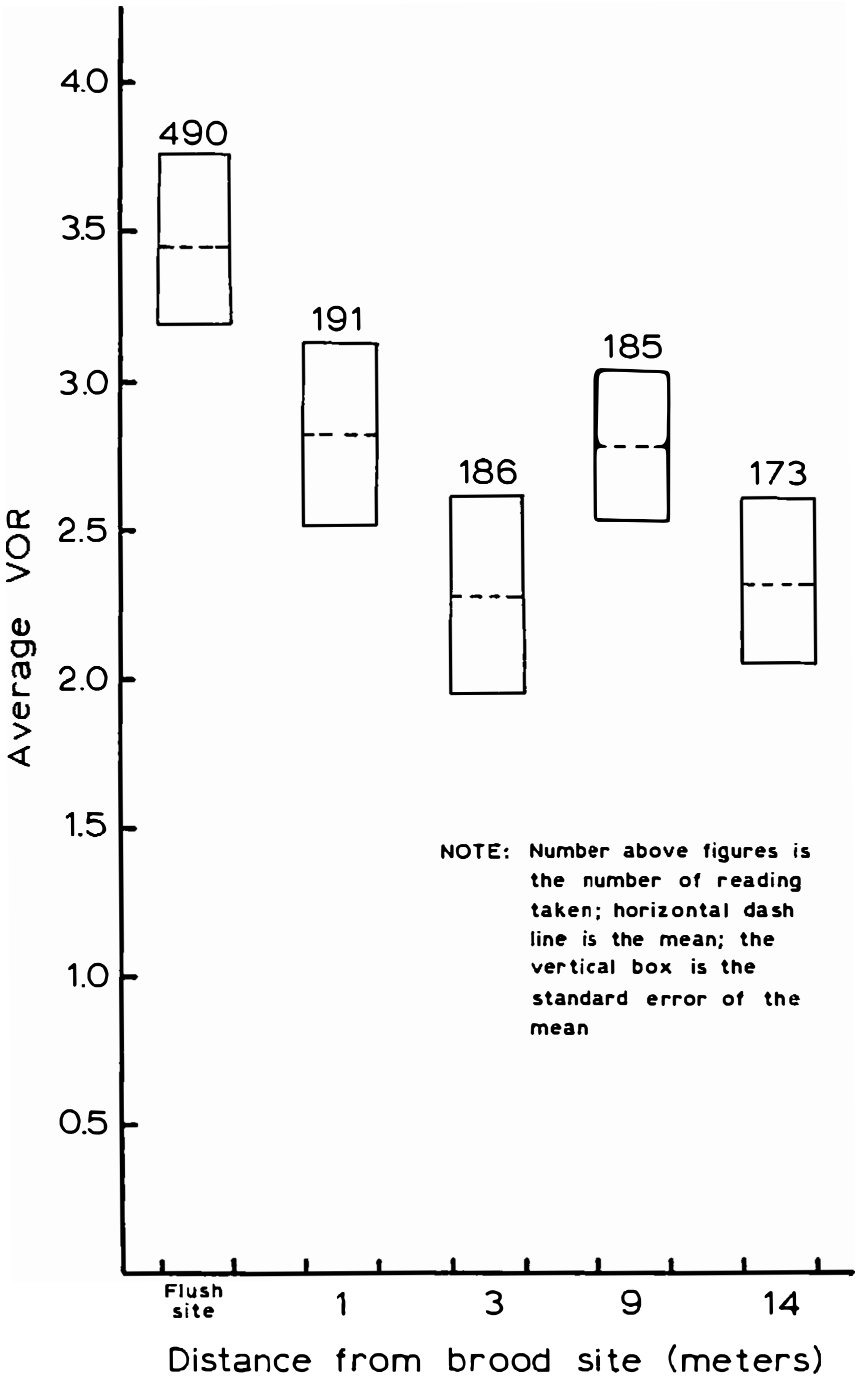


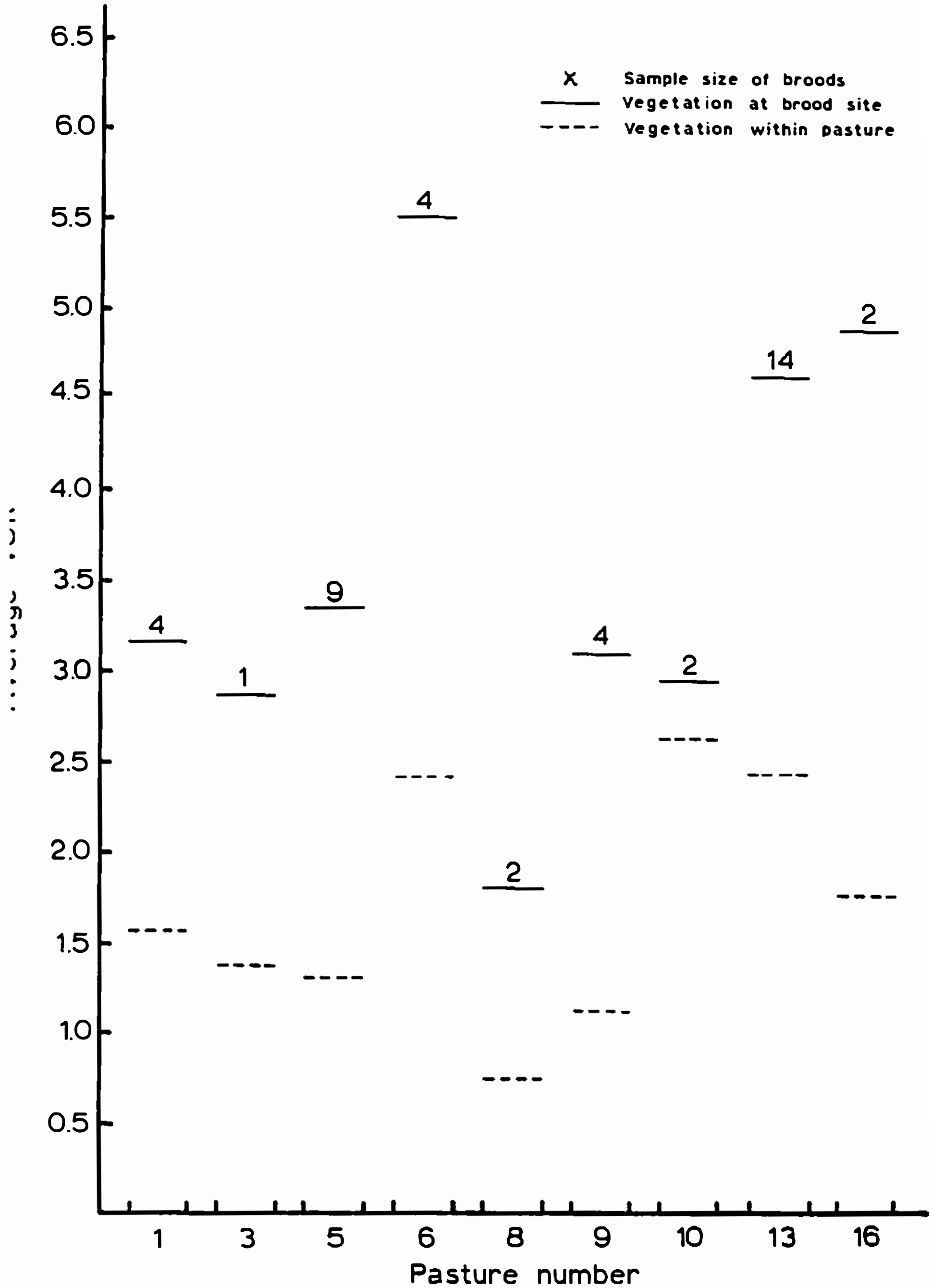
Fig. 8. Average VOR at flush site compared to average VOR at various distances from the brood site, 1974.

Table 18. Average VOR at brood sites and surrounding areas within range sites, 1973 and 1974.

Distance from brood site (m)	Range site					
	Rolling grassland		Upland grassland		Lowland	Draw
	1973	1974	1973	1974	1973	1974
0[a]	4.09	3.01	3.05	3.58	7.64	3.80
1	3.73	2.61	2.53	2.92	5.49	2.94
3	3.13	1.90	1.71	2.58	5.69	2.35
9	2.60	1.82	1.61	3.00	5.49	3.52
14	2.69	1.64	1.51	2.44	5.31	2.89
Total[b]	3.03	1.99	1.84	2.74	5.50	2.92

[a]Brood site.

[b]Averaging distances 1-14 m.



ig. 9. Average VOR at brood sites compared to average VOR
ı pastures, 1973.

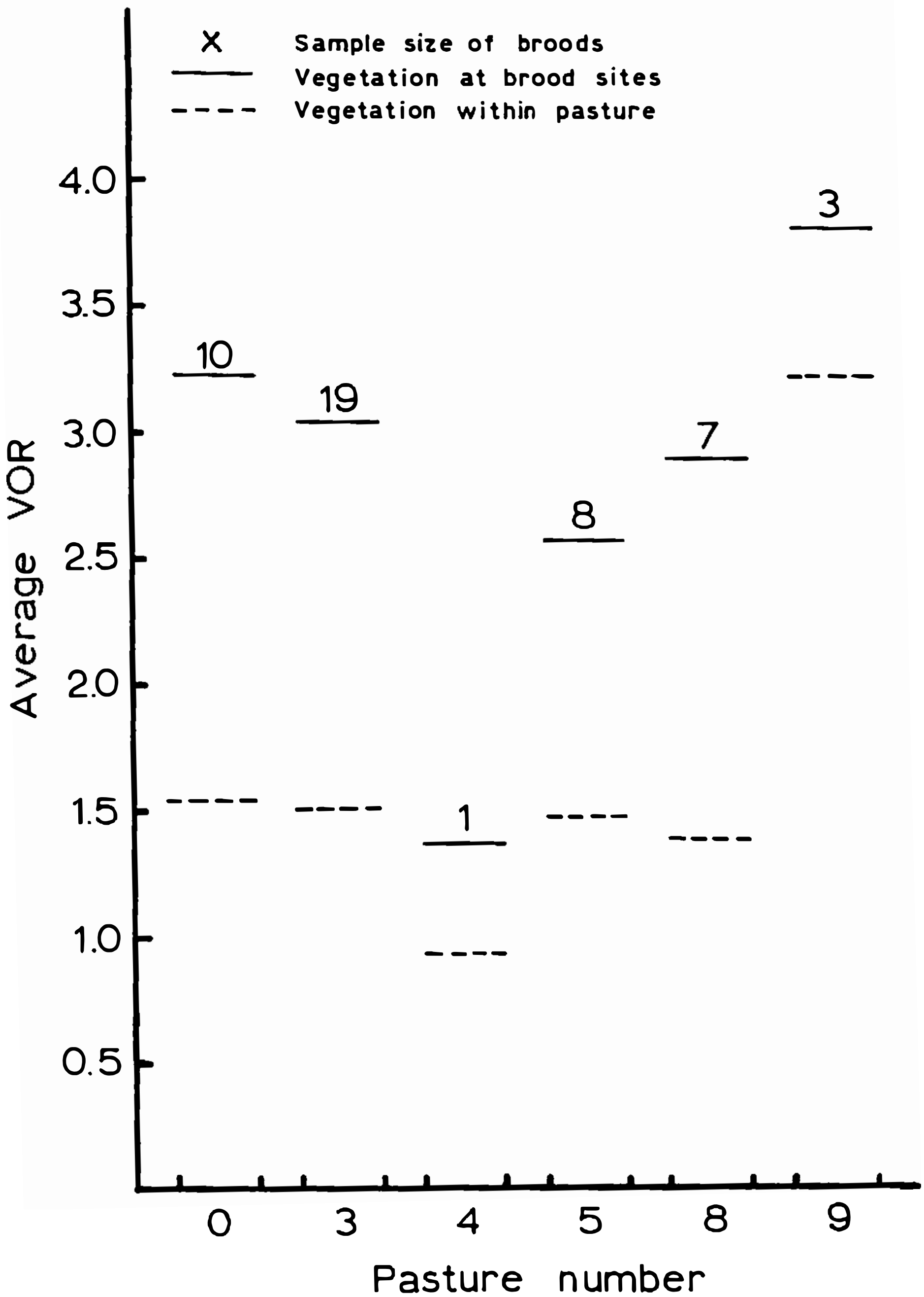
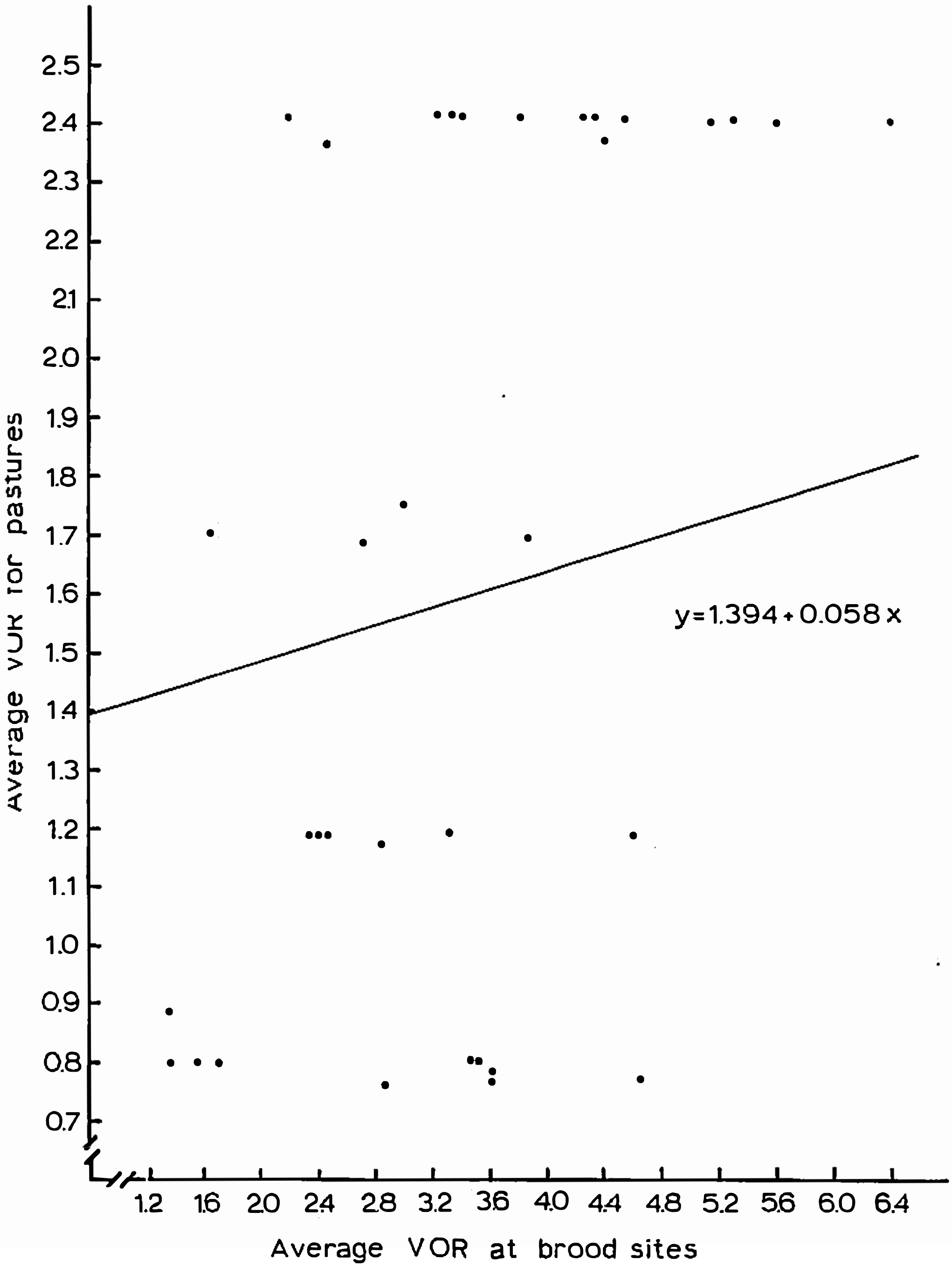


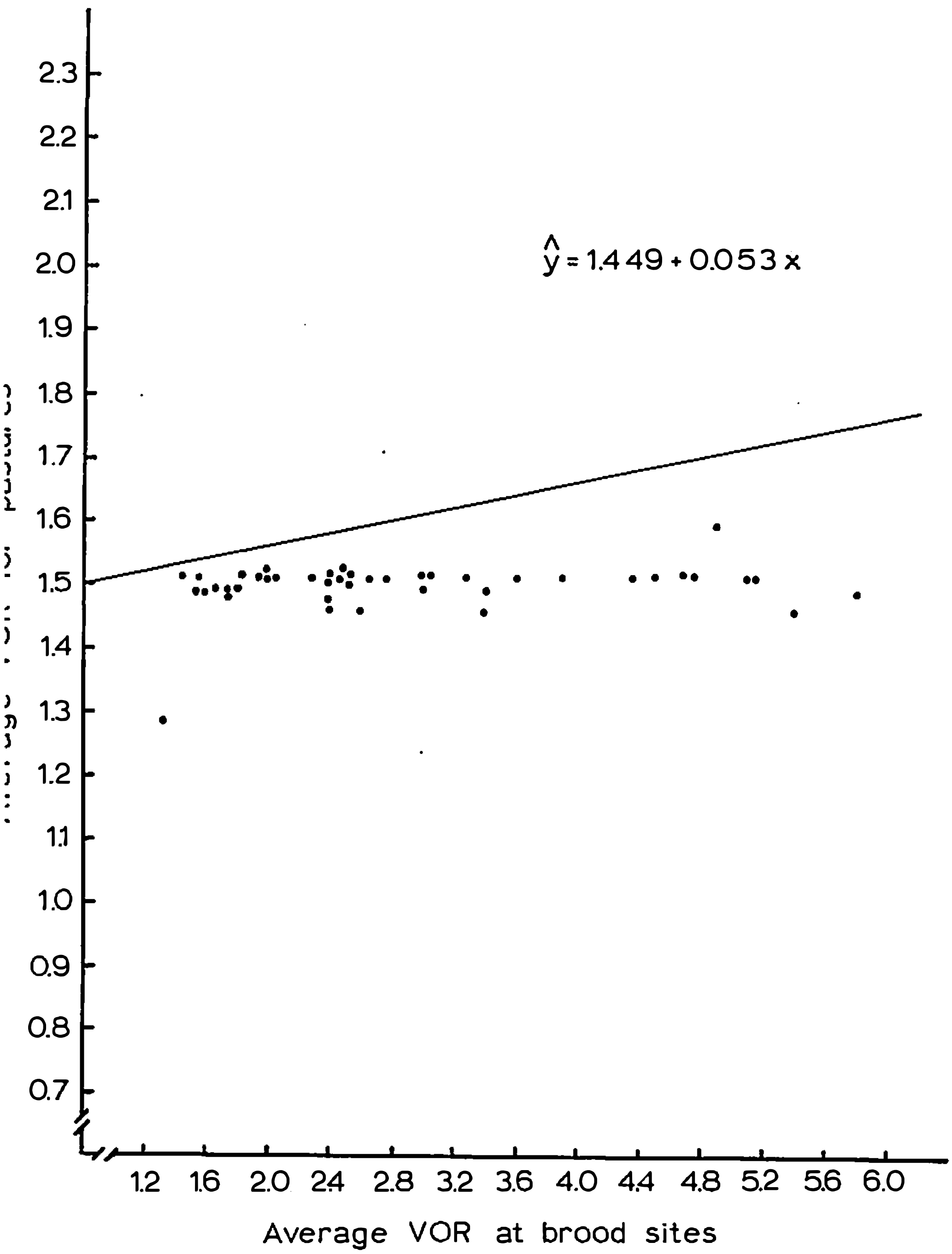
Fig. 10. Average VOR at brood sites compared to average VOR in pastures, 1974.

rrelated (r = 0.83) to the average VOR within pastures (Fig. 11). proximately 68 percent of the variability in plant height at brood tes was explained by the variability in the average plant height in nge sites within pastures. Similarly, the average VOR at brood cations in 1974 was correlated (r = 0.89) to the average VOR within stures (Fig. 12). An estimated 79 percent of the variability in ant height at brood locations can be explained by the average plant ight within pastures. The average VOR between range sites where oods were observed was significantly different (P<0.01) (Tables and 20). The average VOR in 1973 was significantly higher at rious distances (P<0.01) and directions (P<0.05) away from brood tes within particular range sites. There was no difference in the erage VOR between distances, directions, and the interactions in 74. The average VOR measuring plant height between sites of brood ushes was significantly different (P<0.01) (Table 21). Also the erage VOR at brood locations was significantly higher (P<0.01) an VOR at varying distances from the site. Plant height may have ffered between range sites or pastures because of the land use. ant height differed significantly (P<0.01) between range sites able 22).

Use of cover by sharptail broods depends upon time of day, bitat available, climatic factors, and amount of disturbance mmann 1957 and Hart et al. 1950). Hens with broods on the Gorham ea were found in shorter vegetation immediately after sunrise, and taller vegetation later in the morning (Table 23). Brushy



'ig. 11. Relationship of average VOR at brood sites to ıverage VOR in pastures, 1973.



ig. 12. Relationship of average VOR at brood sites to
erage VOR in pastures, 1974.

le 19. Least-squares analysis of variance, testing vegetation
ght between range sites, distances, directions and their
eractions for broods, 1973.

rce	DF	Mean squares
ge site	2	375.736**
tance	4	42.501**
ection	3	3.369*
ge site x distance	8	3.230
ge site x direction	6	5.602
or	1076	4.726

ignificant at P<0.01 level.
gnificant at P<0.01 level.

le 20. Least-squares analysis of variance, testing vegetation
ght between range sites, distances, directions, and their
eractions for broods, 1974.

rce	DF	Mean squares
ge site	2	19.241**
tance	4	6.210
ection	3	2.374
ge site x distance	8	1.119
ge site x direction	6	4.285
or	1201	2.156

Significant at P 0.01 level.

21. Factorial analysis of variance for cover height, testing
ration sites, distance, direction, and their interaction for
s, 1974.

e	DF	Mean squares
site[a]	5	21.124**
nce	4	21.851**
tion	3	2.855
site x direction	15	1.331
site x distance	20	2.673
	1170	2.134

pasture plan per brood site.

nificant at P<0.01 level.

22. Nested analysis of variance for cover height, testing range
, pastures, and land use for broods, 1974.

e	DF	Mean squares
site[a]	7	32.765**
re	7	23.159*
	1229	2.236

land use type per range site.

nificant at P<0.01 level.

ificant at P<0.005 level.

able 23. Average VOR at brood flush locations at various times of ay, 1973-74.

ime of day	Average obstruction pole reading
500-0700	3.23
700-1100	3.48
100-1300	4.18
300-1900	3.35
900-2100	2.72

etation was used in the morning for resting areas during hot days. s moved their broods into woody draws or brushy uplands at mid-day. nt height at the flush locations was the highest at this time, raging 4.18 VOR. Plant height utilized by sharptail broods de- ased in the afternoon hours. Broods were found in short grassy ands where VOR averaged 2.72 during the evening feeding period. s pattern is similar to the pattern reported by Christenson (1970).

Most plant species at the 92 locations where brooding hens were shed consisted of only six grasses and sedges, three forbs, and one dy species (Table 24). Fifty-three percent of the vegetation at od sites consisted of brasses. The relative density of woody species brood sites was less than 6 percent. Three plant species, Kentucky egrass, western wheatgrass, and sedges, had greater than 45 percent ative density at all brood sites combined.

Woody cover usually buffaloberry, provided shelter for broods n the mid-day heat and rain. Wolfberry was generally associated h wet, lowland areas or on north and east-facing slopes. Ground er within wolfberry patches consisted mostly of Kentucky bluegrass, ive sedges and a variety of forbs. Broods favored these buffalo- ry patches during the day or moved into densely vegetated uplands sweetclover-smooth brome mixture if brushy areas or lowlands e not available (Table 24). If a hen nested in a brushy lowland w, she was not found with her brood in a brushy draw. Most often brushy cover on the upland was the essential temporary cover. per (1972) found broods selecting low grassy openings in brush,

Table 24. Plant species composition found at locations where broods were flushed at various times of the day, 1973-74.

Species	Time of Day: 0500-0700 r.f.[a]	r.d.[b]	0700-1100 r.f.	r.d.	1100-1300 r.f.	r.d.	1300-1900 r.f.	r.d.	1900-2100 r.f.	r.d.	Total r.f.	r.d.
Grasses and sedges												
Poa pratensis	14	11.7	60	17.6	49	16.4	161	31.1	16	13.3	300	21.5
Agropyron smithii	14	11.7	76	22.4	48	16.0	88	17.0	26	21.7	252	18.0
Carex spp.	4	3.3	42	12.4	43	14.4	42	8.1	6	5.0	137	8.6
Bouteloua gracilis	7	5.8	10	2.9	36	12.0	21	4.1	8	6.7	82	5.9
Agropyron cristatum			12	3.5	24	8.0	32	6.2	9	7.5	77	5.5
Stipa viridula	4	3.3			15	5.0	15	2.9			34	2.4
Forbs												
Melilotus spp.			18	5.3	16	5.4	20	3.9	12	10.0	66	4.7
Calamovilfa longifolia	32	26.7					5	1.0			37	2.6
Chrysopsis villosa	6	5.0	6	1.8	2	1.0	12	2.3	4	3.3	30	2.1
Woody												
Symphoricarpos occidentalis	5	4.2	28	8.2	14	4.7	14	2.7	12	10.0	73	5.2
Other plant spp.											330	23.3
Total											1418	100

[a]Relative frequency.
[b]Relative density.

and Ammann (1957) suggested that broods utilized woody cover more frequently than nesting hens.

Relative density of forbs at brood locations was highest in the morning, decreasing throughout the day. The relative density of grasses increased to their largest value at mid-day, and then gradually decreased throughout the afternoon (Table 24). Wolfberry was heavily utilized at mid-day until late evening, especially during hot days.

Habitat Selected In Relation To Other Habitats

Hens generally nested in large pastures where one habitat type constituted most of the area within 0.4 km of the nest site. When hens nested in agricultural land or pastures with crested wheatgrass, or native vegetation, additional vegetation of this same habitat type was adjacent to that pasture most of the time (Table 25). In two instances, this pattern changed. When regrowth vegetation was selected as nesting cover, additional regrowth vegetation was adjacent only 8 percent of the time, while brushland was adjacent 53 percent and native vegetation 22 percent of the time. If brushy areas were selected as nesting cover, additional brushland was adjacent about 10 percent of the time, whereas native vegetation was adjacent 71 percent of the time.

Percentages of the various habitats within 0.4 km of the nest site indicate hens were nesting in areas where one habitat type constituted over 50 percent of the area within 0.4 km (Table 26). Only brushy cover changed this pattern. If the female nested in brushy habitat, 75 percent of the locations had 60-90 percent native vegetation within

Table 25. Habitat types adjacent to the habitat selected by nesting sharptails, 1973-1974.

Type of habitat selected	Adjacent habitat available (percent)					
	Brush	Native	Regrowth	Crested	Tame	Agricultural
Native	24	38	5	12	8	13
Brush	10	71	0	9	2	3
Agriculture	7	29	7	0	4	54
Regrowth	53	22	8	4	4	8
Tame	8	50	8	8	17	8
Crested	23	19	6	42	0	10

Table 26. Percentage of various habitats within 0.4 km of habitat selected by nesting sharptails, 1967-1974.

Type of habitat selected	Habitat available	Percent vegetation within 0.4 km 01-09	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Native	Brush	56	22	22	0	0	0	0	0	0	0
	Native	0	9	9	0	18	9	0	18	18	18
	Regrowth	50	0	50	0	0	0	0	0	0	0
	Crested	33	67	0	0	0	0	0	0	0	0
	Tame	0	0	0	50	50	0	0	0	0	0
	Agriculture	0	33	0	33	0	0	0	33	0	0
Brush	Brush	0	100	0	0	0	0	0	0	0	0
	Native	0	0	25	0	0	0	25	0	50	0
	Regrowth	0	0	0	0	0	0	0	0	0	0
	Crested	0	50	0	0	0	0	50	0	0	0
	Tame	100	0	0	0	0	0	0	0	0	0
	Agriculture	0	0	0	0	0	0	0	0	0	0
Agriculture	Brush	67	0	33	0	0	0	0	0	0	0
	Native	0	50	0	0	50	0	0	0	0	0
	Regrowth	33	67	0	0	0	0	0	0	0	0
	Crested	0	0	0	0	0	0	0	0	0	0
	Tame	0	0	100	0	0	0	0	0	0	0
	Agriculture	0	25	0	0	0	25	0	0	50	0

Table 26. Continued

Type of habitat selected	Habitat available	Percent vegetation within 0.4 km 01–09	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99
	Brush	27	53	20	0	0	0	0	0	0	0
	Native	40	20	13	7	20	0	0	0	0	0
	Regrowth	0	0	12	12	12	12	12	37	0	0
Regrowth	Crested	25	50	0	0	25	0	0	0	0	0
	Tame	50	17	33	0	0	0	0	0	0	0
	Agriculture	50	25	0	25	0	0	0	0	0	0
	Brush	0	0	0	0	0	0	0	0	0	0
	Native	0	0	100	0	0	0	0	0	0	0
	Regrowth	100	0	0	0	0	0	0	0	0	0
Tame	Crested	0	0	0	0	100	0	0	0	0	0
	Tame	0	0	100	0	0	0	0	0	0	0
	Agriculture	0	0	0	0	0	0	0	0	0	0
	Brush	33	64	0	0	0	0	0	0	0	0
	Native	50	50	0	0	0	0	0	0	0	0
	Regrowth	83	17	0	0	0	0	0	0	0	0
Crested	Crested	0	0	0	0	0	0	29	29	42	0
	Tame	100	0	0	0	0	0	0	0	0	0
	Agriculture	75	25	0	0	0	0	0	0	0	0

0.4 km. Fifty percent of these locations had 60-70 percent crested wheatgrass associated with them. When hens selected tame vegetation for nesting, none of the locations contained more than 50 percent of any vegetation type within 0.4 km of nest sites. However, few sharptail nests were found in tame vegetation.

Habitats selected by broods followed the same trend as for nesting hens. Hens with broods utilized areas where one habitat type contained over 40-50 percent of the area within 0.4 km (Table 27). The one exception was brushy areas. Fifty-three percent of the locations had more than 50 percent native vegetation within 0.4 km. Thirty-one percent of these locations had 30-40 percent wolfberry associated with them.

Table 27. Percentage of various habitats within 0.4 km of habitat selected by hens with broods, 1973-1974.

Type of habitat selected	Habitat available	Percent vegetation within 0.4 km									
		01-09	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
	Brush	15	38	0	31	0	15	0	0	0	0
	Native	0	8	8	8	15	23	15	0	15	0
	Regrowth	0	100	0	0	0	0	0	0	0	0
Brush	Crested	25	25	25	0	0	0	25	0	0	0
	Tame	67	33	0	0	0	0	0	0	0	0
	Agriculture	50	25	25	0	0	0	0	0	0	0
	Brush	47	20	27	6	0	0	0	0	0	0
	Native	0	5	10	5	19	14	10	10	14	14
	Regrowth	40	20	40	0	0	0	0	0	0	0
Native	Crested	20	30	30	10	10	0	0	0	0	0
	Tame	40	20	0	20	20	0	0	0	0	0
	Agriculture	20	40	20	10	0	0	0	10	0	0
	Brush	24	53	18	0	6	0	0	0	0	0
	Native	41	24	12	6	18	0	0	0	0	0
	Regrowth	0	0	17	11	17	11	11	33	0	0
Regrowth	Crested	20	40	20	0	20	0	0	0	0	0
	Tame	50	17	33	0	0	0	0	0	0	0
	Agriculture	33	50	0	17	0	0	0	0	0	0

Table 27. Continued.

Type of habitat selected	Habitat available	Percent vegetation within 0.4 km 01 09	10 19	20 29	30 39	40 49	50 59	60 69	70 79	80 89	90 99
	Brush	45	36	9	0	9	0	0	0	0	0
	Native	44	33	0	11	11	0	0	0	0	0
	Regrowth	83	17	0	0	0	0	0	0	0	0
Crested	Crested	0	0	0	15	0	8	23	23	31	0
	Tame	100	0	0	0	0	0	0	0	0	0
	Agriculture	62	12	26	0	0	0	0	0	0	0
	Brush	100	0	0	0	0	0	0	0	0	0
	Native	0	33	33	0	0	0	0	33	0	0
	Regrowth	100	0	0	0	0	0	0	0	0	0
Tame	Crested	0	0	0	0	100	0	0	0	0	0
	Tame	0	33	33	0	33	0	0	0	0	0
	Agriculture	0	50	50	0	0	0	0	0	0	0
	Brush	75	0	25	0	0	0	0	0	0	0
	Native	0	60	0	0	20	20	0	0	0	0
	Regrowth	33	67	0	0	0	0	0	0	0	0
Agriculture	Crested	0	0	0	0	0	0	0	0	0	0
	Tame	0	0	100	0	0	0	0	0	0	0
	Agriculture	0	14	0	0	14	14	14	0	43	0

CONCLUSIONS

Nesting hens utilized cover that was available but showed a preference for grassy uplands. They evidently nested in whatever grassland type was available. Hens nested in brushy lowland draws when quantity and quality of grassy areas were low. When grassy cover (native, regrowth, or tame vegetation) was selected as nesting habitat most of the land within 0.4 km was also grassland. More than 75 percent of the study area was in grassy cover and over 90 percent of the nest locations occurred in grassy vegetation. Those pastures containing sharptail nests in woody cover on the Gorham area during 1973-74 had an average VOR of less than 1.1. Most nests were found in pastures where the average VOR in the grassy areas exceeded 1.25, indicating that sharptail hens only nested in woody cover within a pasture when the grassy areas were insufficient in height. Hens selected the higher vegetation within a range site or pasture to nest; preferring vegetation with a VOR greater than 2.0 in a 2 m radius. Plant height was more important to nesting hens than plant species or grassland types.

Grasslands maintaining suitable vegetation height for nesting also provided brood rearing areas. Pastures that contained vegetation at nest sites with average VOR greater than 2.0 in May, and that were not grazed heavily during the summer, provided isolated areas of tall vegetation (averaging a pole reading greater than 3.0) through August for brooding areas. Only those hens nesting in brushy draws surrounded by low growing vegetation moved their broods into new areas of taller grassy vegetation. Hens kept their broods in the tallest available cover during the feeding and resting periods.

Woody cover is more important to sharptail broods than nesting hens. Broods frequently utilized woody cover during the warmest part of the day. When brushy cover was used for shelter, more than 50 percent of the locations had less than 20 percent brushland within 0.4 km. This indicated that woody vegetation in lowland draws was seldom used under such climatic conditions. Most often the brushy cover on the uplands provided important temporary cover. When grassy cover was selected by hens with broods, most of the land within 0.4 km also contained grassy cover indicating that broods were utilizing the available cover, not selecting particular grassland types.

Plant height varied in pastures and in range sites within pastures as the summer progressed. Reasons for the differences include but are not limited to 1) the plant response to moisture; 2) plant species composition within each pasture; and 3) grazing intensity.

In 1974 most pastures contained only one range site (rolling grassland site) within a pasture. This site was frequently utilized by nesting and brooding hens. Cattle were often observed intensively grazing on this site because it usually contained the most palatable plant species on the most accessible terrain.

Statistical differences in plant height between range sites suggests that measuring and evaluating the height of vegetation could result in management of the grasslands for domestic livestock grazing and sharptail habitat by range sites as well as in pastures. This would allow the scientist to concentrate on those primary range sites, namely the rolling grassland site which comprises over 75 percent of the study area, within a pasture that are favorite nesting and brooding areas for sharptails and preferred grazing areas for domestic livestock.

The average VOR at nesting and brooding sites was related to the average VOR in pastures. A management program that increased the average height of vegetation in pastures (or rolling grassland site) during the summer would provide taller vegetation for nesting hens the following spring. A minimum average VOR of 1.5 within a pasture in the spring could be used as the standard. This would provide adequate nesting cover and good areas for brood rearing.

Management recommendations and additional research suggestions (Appendix L) for sharp-tailed grouse in western North Dakota depend upon range management practices. Low VOR within pastures for two consecutive summers indicate the need for certain pastures to be rested. VOR on most of the crested wheatgrass pastures on the Gorham area (especially pasture 6) indicated a need for re-evaluation of the pasture management plans. The primary role of crested wheatgrass in range improvement was to provide forage early and to be tolerant of early season grazing.

Evaluation of grazing management should be initiated as an integral part of each grazing system. Timely management evaluation during the grazing season are needed to determine livestock use and plant condition. In the spring (or before the grazing period) and fall (or following the yearly grazing period) pastures should be evaluated using the visual obstruction pole. The inclined point quadrat method should be used every 2 years to obtain a trend on plant composition. These measurements would allow the range scientist to evaluate the effect of the grazing system on sharptail nesting and brooding habitat.

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APPENDICES

Appendix A. Grazing Systems

A variety of pasture management systems is practiced on the Gorham area (Table 1). Private landowners graze their pastures at their discretion. The management of public lands, administered by the U. S. Forest Service, is set down by Public Law 86-517 (Harmay 1970). A description of the grazing systems in use on and around the Gorham area follows.

Pastures 0 and 4 are public lands grazed in a deferred-rotation system. Pasture 4 consists of 58.7 ha crested wheatgrass and 6.1 ha brushy draw in the $SE\frac{1}{4}$ Sec. 24, T143N, R100W. The U. S. Forest Service (Personal Communication) estimates the dates of seeding crested wheatgrass in pasture 4 between 1937 and 1940. This pasture is the first of a two-pasture deferred-rotation system to be grazed each year. The area carries 31 animal units from 15 May to 15 September. Pasture 0, located in $N\frac{1}{2}$ $NW\frac{1}{4}$ Sec. 30, T143N, R99W, is the native unit of the rotation system. There are 28.6 ha native grass and 3.8 ha brushy draw. The 31 animal units that graze pasture 4, plus 23 additional head, are moved into pasture 0, 15 September and graze until 30 November.

Pasture 1, located in $SW\frac{1}{4}$ Sec. 7, T143N, R99W, is privately owned. It is grazed in conjunction with pasture 13 as a winter pasture. Both areas are separately fenced but one gate allows the cattle to move between pastures. Before 1960 pasture 1 was 61.5 ha native grass and 3.2 ha brushy cover. Forty hectares were planted in 1960 into a sweetclover-smooth brome mixture with some scattered areas of alfalfa.

Presently native plant species are invading the introduced plantings. This invasion of native plants produced 40 ha of regrowth vegetation. Pasture 13 consists of 61.5 ha native vegetation, 41.7 ha brushy draw and 26.3 ha regrowth vegetation. In 1960, 26.3 ha of native vegetation in pasture 13 were plowed and planted into a sweetclover-smooth brome mixture. Native plant species are now invading this area, causing a slow regrowth vegetation. These two pastures together carry 130 animal units from 1 December to 21 December. The cattle are released in pasture 1 but are neither dispersed nor relocated into pasture 13. The animals must find the open gate to pasture 13. Consequently, pasture 1 receives most of the grazing pressure.

Pastures 2 and 3, both in Sec. 19, T143N, R99W, are grazed as one pasture unit. The two areas are not fenced separately. However, a large hardwood draw passing through the area is a barrier for cattle movement. Since pasture 2 received heavier grazing pressure than 3, pastures 2 and 3 will be described and discussed separately throughout this report. Pasture 2 contains 75.6 ha regrowth vegetation, 64.7 ha native vegetation, and 48.6 ha brushy draw. The area was planted to a sweetclover-smooth brome mixture approximately 15 years ago (1960) and invasion of native plant species is now occurring. During the summer of 1973, 75 ha were plowed and planted to small grains. The area was to be reseeded to introduced grasses in the fall of 1974. Twenty-two hectares of pasture 3 were plowed and planted to a sweetclover-smooth brome mixture in 1954. Presently the area is in 8.9 ha regrowth vegetation, 6.1 ha native vegetation and 4 ha brushy draw. The two pastures together carry 180 animal units from 15 April to 15 June.

The Fairfield common pasture, containing pastures 5 and 6, is National grasslands, administered by the U. S. Forest Service. Included in the common pasture are all or parts of Sec. 28-34, T134N, R99W. These lands were purchased under Title III of the Bankhead-Jones Farm Tenant Act of 1937. They were administered by the Resettlement Administration and the Farm Security Administration until 1938. From 1938 to 1954 the control of these lands was under the Soil Conservation Service. In 1954 administration of these lands was transferred to the U. S. Forest Service. In October, 1964, the permittees erected a suspension fence in section 30. This provided a pasture of cool season grasses (primarily crested wheatgrass) to be grazed in the spring, and a native vegetation unit to be grazed during the summer in a deferred rotation grazing system. The pastures will be described individually since they are grazed separately.

Pasture 6 is the crested wheatgrass unit of the Fairfield common pasture. The area contains 104.6 ha crested wheatgrass, 20.2 ha native vegetation, and 14.1 ha brushy draw. This pasture was planted to crested wheatgrass for the third time in 1947 and a good stand was established. The native unit, pasture 5, contains areas of both native vegetation and crested wheatgrass. Native vegetation comprises 959.5 ha; crested wheatgrass plantings, 76.3 ha; brushy draw, 14.7 ha; and brushy uplands, 11.4 ha. The crested areas within the native unit were seeded around 1940 (U. S. Forest Service, Personal Communication). Two hundred and twelve animal units grazed crested wheatgrass pasture 6 from 1 May to 1 June. The animals were then moved into native pasture 5 on 1 June and grazed until 30 November.

Pasture 7 is public land situated in the S½ Sec. 13, T143N, R100W. The upland grassland area was seeded to crested wheatgrass sometime between 1937 and 1940 (U. S. Forest Service, Personal Communication). The crested wheatgrass did not subsist; native species invaded the uplands causing a regrowth vegetated stand. The pasture comprised 70.9 ha regrowth vegetation, 42.9 ha native vegetation, and 14.2 ha brushy draw. Pasture 7 was not grazed in 1973. Forty animal units grazed from 20 August to 1 November, 1974.

Public pasture 8 in the E½ Sec. 25, T143N, R100W is comprised of 62.3 ha of crested wheatgrass, 34.8 ha native vegetation, and 32.8 ha brushy draw and was grazed from 10 June to 19 August with 40 animal units. This pasture was apparently seeded to crested wheatgrass between 1937 and 1940 (U. S. Forest Service, Personal Communication).

The only nongrazed pasture utilized by sharptails on the Gorham area in 1973-74 was pasture 9 (N½ NE¼ Sec. 30, T143N, R99W). Twenty-six hectares were smooth brome or smooth brome-sweetclover mixture, while 3.2 ha were native vegetation. The brome areas were mowed and baled, usually the last of July. It is not known when this area was planted to smooth brome grass.

Pasture 10 is a tame hay field comprising 64.8 ha in SE¼ Sec. 18, T143N, R99W. The native vegetation in pasture 10 was first plowed in 1945. Sweetclover was planted on the area within the last five years. Annual mowing and baling of the tame hay occurs in mid-July.

Pasture 26 contains 25.5 ha of grassland (NW1/8 Sec. 36, T143N, R100W). Approximately 15.4 ha are in native vegetation and 10.1 ha in crested wheatgrass. The crested wheatgrass was planted in 1960 and a good stand developed. The pasture was summer-grazed by 20 animal units from 10 June to 1 September.

Native pasture 27 is public grassland located at SW¼ Sec. 25, T143N, R100W. This pasture consists of 41.7 ha native vegetation, 20.2 ha crested wheatgrass, and 2.8 ha brushy draw. U. S. Forest Service (Personal Communication) estimates the seeding dates of crested wheatgrass between 1937 and 1940. The pasture is early-spring grazed by 25 animal units from 12 July to 9 September one year and 6 October to 4 December the next year in an alternating system.

The NE¼ Sec. 13, T143N, R100W is pasture 28. The native vegetation in this pasture was plowed in 1945. In 1973, 42.5 ha were planted to barley and the following year the 42.5 ha were in summer fallow. The remaining 22.3 ha of the pasture is the sweet-clover-smooth brome mixture established in 1972 and is anually mowed and baled in mid-July.

Crested wheatgrass pasture 29 (NW¼ Sec. 25, T143N, R100W) is grazed by 90 animal units from 10 April to 5 May. This public grassland pasture has 51.8 ha crested wheatgrass, 8.1 ha native vegetation, and 4.9 ha brushy draw. The crested wheatgrass plantings were established between 1937 and 1940 (U. S. Forest Service, Personal Communication).

Several pastures were chosen outside the Gorham area because of their different grazing plans. Two pasture units were under a rest-rotation grazing system and the third was a summer-grazed crested wheatgrass pasture.

Public pastures 18 and 19, located in Sec. 33, T136N, R99W are two grazing units of a four pasture rest-rotation grazing system. Section 33 is entirely native vegetation and divided into quarter sections; pasture 18 constituting the SE$\frac{1}{4}$ and pasture 19 the NW$\frac{1}{4}$. Both pastures 18 and 19 were randomly selected for vegetation sampling. In 1973, 83 animal units grazed pasture 19 from 19 June to 19 August. Animals were then moved to the SW$\frac{1}{4}$ Sec. 33 and grazed until 18 October. The following day the cattle began grazing pasture 18 and were removed 31 November. The NE$\frac{1}{4}$ Sec. 33 was rested in 1973. Cattle began grazing in 1974 in SW$\frac{1}{4}$, then moved into NE$\frac{1}{4}$, and finished the year in pasture 19. Pasture 18 was rested in 1974. The grazing period and animal units were the same as 1973.

Crested wheatgrass pasture 20 is located south of the Gorham area (W$\frac{1}{2}$ Sec. 23, T136N, R99W). This public grassland was seeded to crested wheatgrass around 1940 (U. S. Forest Service, Personal Communication). The pasture is summer-grazed by 51 animal units from 1 May to 31 August.

Pasture 21 and 22 are grazed as a two-pasture rest-rotation unit. Public pasture 21 (SW$\frac{1}{4}$ Sec. 14, T136N, R99W) is in native vegetation interspersed with some crested wheatgrass. In 1973, 46 animal units grazed pasture 21 from 15 May until 31 August; pasture 22 was rested.

Table 1. Grazing systems and vegetation types found in pastures on the Gorham Area, 1973-1974.

Pasture number	Vegetation type	Hectares	Grazing system: Type	Animal units	Grazing dates
0	Native	28.6	Deferred rotation	54	Sept. 15 to Nov. 30
	Brushy draw	3.8			
1[a]	Regrowth	40.0	Winter grazed	130	Dec. 1 to Dec. 21
	Native	21.0			
	Brushland	3.2			
2[b]	Regrowth	75.6	Early spring grazed	180	April 15 to June 15
	Native	64.7			
	Brushy draw	48.6			
3[b]	Regrowth	8.9	Early spring grazed	180	April 15 to June 15
	Native	6.1			
	Brushy draw	4.0			
4	Crested wheatgrass	58.7	Deferred rotation	31	May 15 to Sept. 15
	Brushy draw	6.1			
5	Native	959.5	Deferred rotation	212	June 1 to Nov. 30
	Crested wheatgrass	76.3			
	Brushy draw	14.7			
	Brushland	11.4			
6	Crested wheatgrass	104.6	Deferred rotation	212	May 1 to June 1
	Native	20.2			
	Brushy draw	14.1			

Table 1. Continued.

Pasture number	Vegetation type	Hectares	Grazing system: Type	Grazing system: Animal units	Grazing system: Grazing dates
7[c]	Regrowth	70.9	Fall grazed	40	Aug. 20 to Nov. 1
	Native	42.9			
	Brushy draw	14.2			
8	Crested wheatgrass	62.3	Summer grazed	40	June 10 to Aug. 19
	Native	34.8			
	Brushy draw	32.8			
9	Tame	26.0	Nongrazed, mowed and baled		
	Native	3.2			
10	Tame hay	64.8	Nongrazed, mowed and baled		
13[a]	Native	61.5	Winter grazed	130	Dec. 1 to Dec. 21
	Brushy draw	41.7			
	Regrowth	26.3			
18[d]	Native	64.8	Rest rotation	83	Oct. 19 to Nov. 31
	Native	64.8	Rest rotation	83	Rested
19[d]	Native	64.8	Rest rotation	83	June 19 to Aug. 19
	Native	64.8	Rest rotation	83	Oct. 19 to Nov. 31
20	Crested wheatgrass	129.6	Summer grazed	51	May 1, to Aug. 31

Table 1. Continued.

Pasture number	Vegetation type	Hectares	Grazing system: Type	Grazing system: Animal units	Grazing system: Grazing dates
21[e]	Native	64.8	Rest rotation	46	May 15 to Aug. 31
	Native	64.8	Rest rotation	46	Rested
22[e]	Native	64.8	Rest rotation	46	Rested
	Native	64.8	Rest rotation	46	May 15 to Aug. 31
26	Native	15.4	Summer grazed	20	June 10 to Sept. 1
	Crested wheat-grass	10.1			
27[f]	Native	41.7	Early spring grazed	25	
	Crested wheat-grass	20.2			July 12 to Sept. 9
	Brushy draw	2.8			Oct. 6 to Dec. 4
28	Summer fallow	42.5	Nongrazed, mowed and baled		
	Tame hay	22.3			
29	Crested wheat-grass	51.8	Early spring grazed	90	April 10 to May 5
	Native	8.1			
	Brushy draw	4.9			

[a,b]Grazed as one pasture.
[c]Not grazed in 1973.
[d,e]Grazed as part of the same rotation system.
[f]Grazing dates change yearly.

Similarly 46 animal units grazed pasture 22 from 15 May to 31 August 1974; pasture 21 was rested.

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Hormay, A. L. 1970. Principles of rest-rotation grazing and multiple-use land management. U. S. Dept. of Agric., For. Serv. Training Text 4 (2200). 26 pp.

Appendix B. Topography and vegetation of the various range sites on the Gorham study area, 1973 and 1974.

1. Lowland draw range site.

2. Rolling grassland range site.

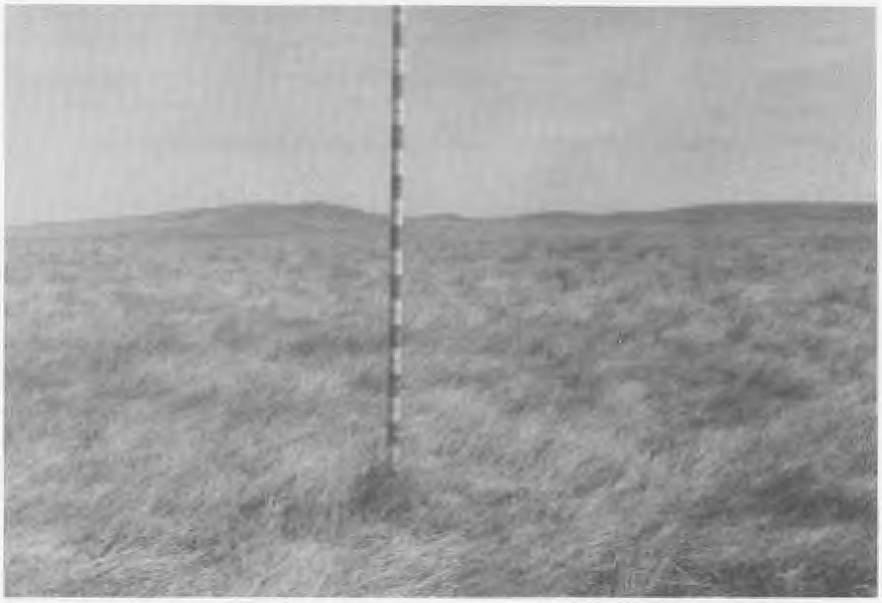
Appendix B. Continued.

3. Rocky outcropping range site.

4. Upland grassland range site.

Appendix B. Continued.

5. Claypan range site.



6. Visual obstruction pole used for measuring vegetation height at sharptail nest and brood locations during 1973 and 1974.

Appendix C. Trapping Results

Thirty-six of the 65 sharptails captured with the cannon-net were females and 29 were males. Most of the females were juveniles; most of the males were adults. Adult males weighed the most and juvenile females were the lightest (Table 1). Bremer (1966) found adult females to be 1.0 g lighter than juvenile females.

Ten band returns (3 from males and 7 from females) were received during 1973. One death was attributed to trapping mortality, seven to predation, and two to hunting. Three females were killed by predators and one male by hunting in 1974. All recovered bands were from birds found within 1.6 km of their respective capture site (Table 2).

Table 1. Weights of adult and immature sharp-tailed grouse in April, 1973-1974.

Class	Number of birds	Average weight (kg)	Range (kg)
Adult males	15	0.93	0.87-1.08
Adult females	9	0.83	0.75-0.87
Juvenile males	14	0.90	0.82-0.96
Juvenile females	27	0.82	0.73-0.90

Table 2. Bands of sharp-tailed grouse recovered from recaptured and dead birds during the two-year study period, 1973-1974.

Dancing ground	Number captured on dancing ground	Number recaptured on dancing ground	Dead birds	
			Number	Range in distance from breeding site (km)
5	45	4	11	0.21 - 3.22
7	9	0	2	2.57 - 2.82
9	14	2	0	

Table 2. Bands of sharp-tailed grouse recovered from recaptured and dead birds during the two-year study period, 1973-1974.

Dancing ground	Number captured on dancing ground	Number recaptured on dancing ground	Dead birds	
			Number	Range in distance from breeding site (km)
5	45	4	11	0.21 - 3.22
7	9	0	2	2.57 - 2.82
9	14	2	0	

LITERATURE CITED

Bremer, P. E. 1966. Sharp-tailed grouse investigations: Effects of land use practices on population densities and movement. Minnesota Game and Fish Dept. P-R Proj. Rep., W-11-R-27. 10pp.

Appendix D. Counts of sharp-tailed grouse on Gorham study area, North Dakota, 1963-1974.

Ground number	Location	Males per ground 1966[a]	1967[a]	1968[a]	1969[a]	1970[a]	1971[a]	1972[a]	1973	1974
1	NE¼SW¼ 32-143-99	8	16	16	4	2	0	0	0	0
2	SW¼NE¼ 36-143-100	17	19	14	11	9	14	10	7	7
4	SE¼SE¼ 13-143-100	23	23	24	23	17	17	22	7	8
5	NE¼NW¼ 30-143-99	29	31	11	9	15	19	16	27	23
6	SE¼SE¼ 7-143-99	0	0	24	10	3	1	0	0	17
7	SW¼NW¼ 7-143-99	0	0	0	0	10	19	13	14	18
8	NE¼NE¼ 13-143-100	0	0	0	0	0	0	18	17	0
9	SE¼NE¼ 29-143-99	0	0	0	0	0	0	0	33	27
10	SE¼NE¼ 33-143-99	0	0	0	0	0	0	0	4	3
Total males		77	89	89	57	56	70	79	109	103
Males/square mile		4.28	4.94	4.94	3.17	3.11	3.89	4.39	6.06	5.72

[a]Kobriger, G. D. 1973. Prairie grouse population data. North Dakota Game and Fish Dept. P-R Proj. Rep., W-67-R-13. 60pp/

Appendix E. Nest Locations

Dispersal distance of female sharptails to nesting site generally depended upon the closeness of good quantity and quality nesting cover. If the habitat was available, most hens moved less than 1.21 km to nest. Over 70 percent of nests located by radio-telemetry were within 1.21 km (0.75 mi.) of the breeding ground. Half of the nests discovered by Bernhoft (1969) were within 0.75 mi. of the dancing ground. Christenson (1970) calculated the mean distance of sharptail nests to breeding grounds as 0.8 mi. for the nesting hens he observed. All the sharptail nests located by Artmann (1970) were within 0.5 mile of a dancing ground. Of 23 nests found on the Asquith area in central Saskatchewan (Pepper 1972), 18 were within 0.75 mi. of a dancing ground.

Forty-four percent of the hens captured on breeding grounds eventually nested (Table 1). Predation on hens was not markedly high. Loosing contact with radioed hens was a problem. The principal causes of lost transmitter signals included: (1) electrical malfunctions within the transmitter; (2) premature battery failure or incorrect installation of battery; (3) nesting of hen outside of study area; and (4) damage to the transmitter caused by predation.

Seventeen nests were located by monitoring the movements of transmitter-equipped hens and [illegible] nests were located through use of a modified cable-chain drag as described by Higgins et al. (1969). In 1973, [illegible] ha were chained in 21 hours providing one nest per [illegible] ha

Table 1. Dispersal of sharptail females from dancing grounds, 1973-1974.

Female	Dancing ground	Date instrumented	Dispersal distance (km) Nest	Maximum	Direction from dancing ground	Days monitored[d]	Fate of hen
1 -73	5	4-23-75		1.13	NW	14	Predation
1a -73	5	4-27-73		0.80	NE	4	Signal lost
2 -73	5	4-23-73	0.80	1.61	NW	35	Nested
2a -73	5	4-23-73		0.32	NE	1	Signal lost
3 -73	7	4-15-73		0.80	S	18	Hen dead[a]
3a -73	5	4-23-73		0.64	NE	29	Signal lost
3b -73	5	4-27-73	3.36 (5.15)[b]	6.44	N	50	Nested
5 -73	5	4-23-73	0.32	0.48	NNE	64	Nested
5a -73	5	4-27-73	0.32	0.48	SE	47	Nested
6 -73	5	4-27-73	0.16	0.80	NE	60	Nested
7 -73	5	4-23-73		0.48	SW	7	Predation
7a -73	5	4-23-73	0.40	1.13	SW	55	Nested
8 -73	7	4-15-73	0.80	1.29	S	68	Nested
9 -73	7	4-13-73		2.8	NW	12	Predation
9a -73	5	4-23-73	2.9	3.38	NW	71	Nested
9b -73	5	4-27-73		0.48	NE	3	Signal lost
10 -73	5	4-23-73	1.45	2.1	SE	65	Nested
10a -73	5	4-23-73		0.32	N	15	Signal lost
11 -73	5	4-27-73	0.03	1.13	NNE	63	Nested
11a -73	5	4-23-73	1.13	1.79	SSW	59	Nested
12 -73	5	4-23-73		0.48	NW	2	Predation

Table 1. Continued.

Female	Dancing ground	Date instrumented	Dispersal distance (km) Nest	Maximum	Direction from dancing ground	Days monitored[d]	Fate of hen
12[a] -73	5	4-27-73		7.24[c]	SSW	37	Predation
1 -74	9	4-23-74		2.82	NW	33	Signal lost
2 -74	5	4-26-74		0.80	W	3	Signal lost
3 -74	9	4-23-74	1.21 (2.0)[b]	2.0	NE	82	Nested
4 -74	5	4-26-74	1.01	1.01	W	59	Nested
5 -74	9	4-23-74		0.80	N	33	Signal lost
6 -74	5	4-26-74		2.4	SE	10	Signal lost
7 -74	9	4-23-74	1.21	1.21	NW	38	Nested
8 -74	5	4-26-74		0.97	N	3	Signal lost
9 -74	9	4-23-74		0.80	NE	5	Signal lost
10 -74	5	4-26-74		0.80	W	11	Predation
11 -74	9	4-23-74	0.80	1.21	NW	96	Nested
12 -74	5	4-26-74		0.80	S	31	Predation

[a]Hen was injured in holding crate. Death probably resulted from these injuries.
[b]Renest.
[c]Hens were trapped on ground 5, but released on ground 7.
[d]Including brood movements.

per 1.3 hours chained (Fig. 1). During 1974 all chainable land within 1.3 km from each capture site (dancing grounds 5 and 9) (799 ha) was dragged in 53 hours providing one nest per 78 ha per 4.8 hours chained (Fig. 2). Some of the area was incapable of being chained because of rocky-outcroppings, wooded draws, and private landowners refusal of permission for access.

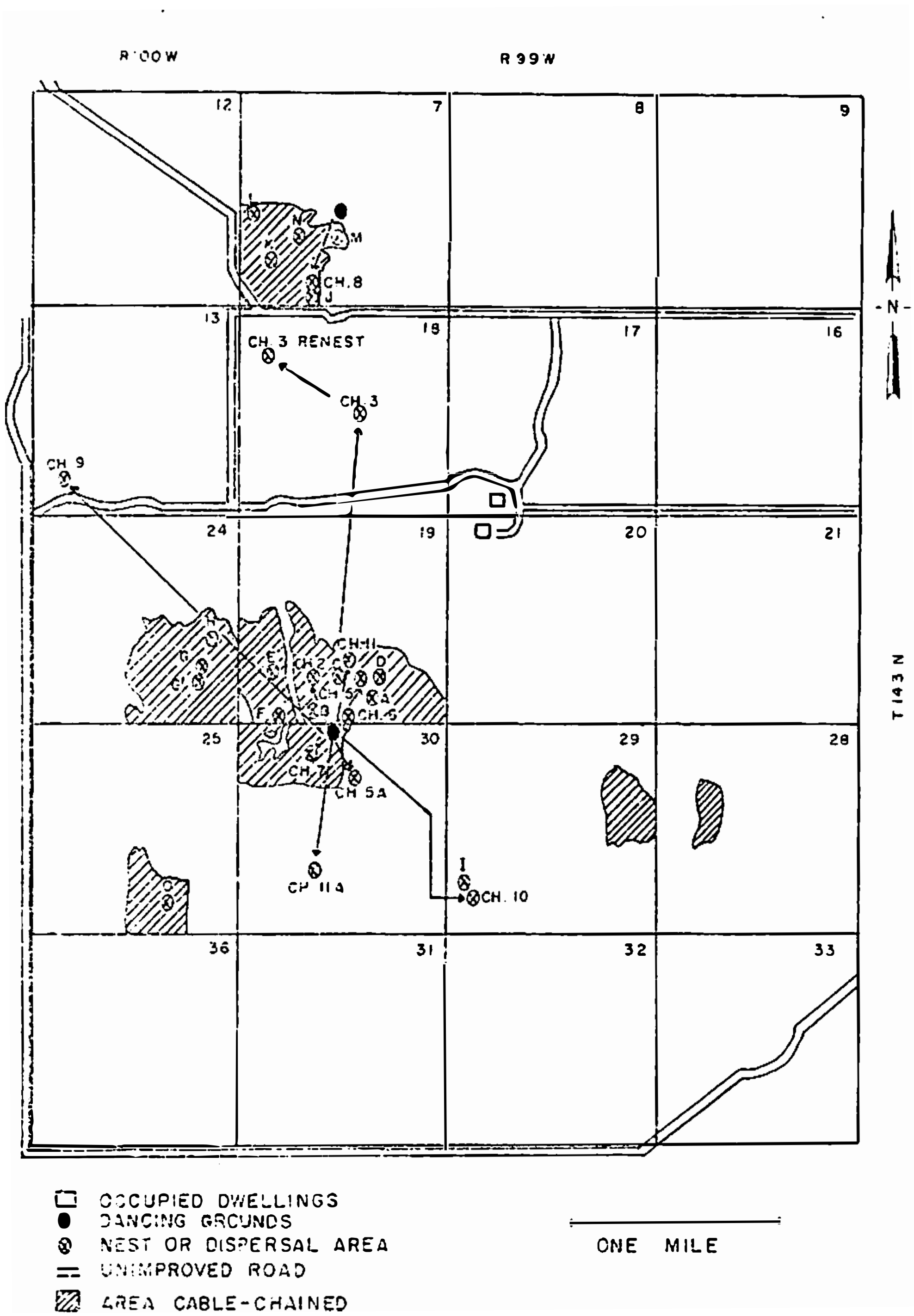


Fig. 1. Dispersal of hens from dancing grounds to nest sites, 1973.

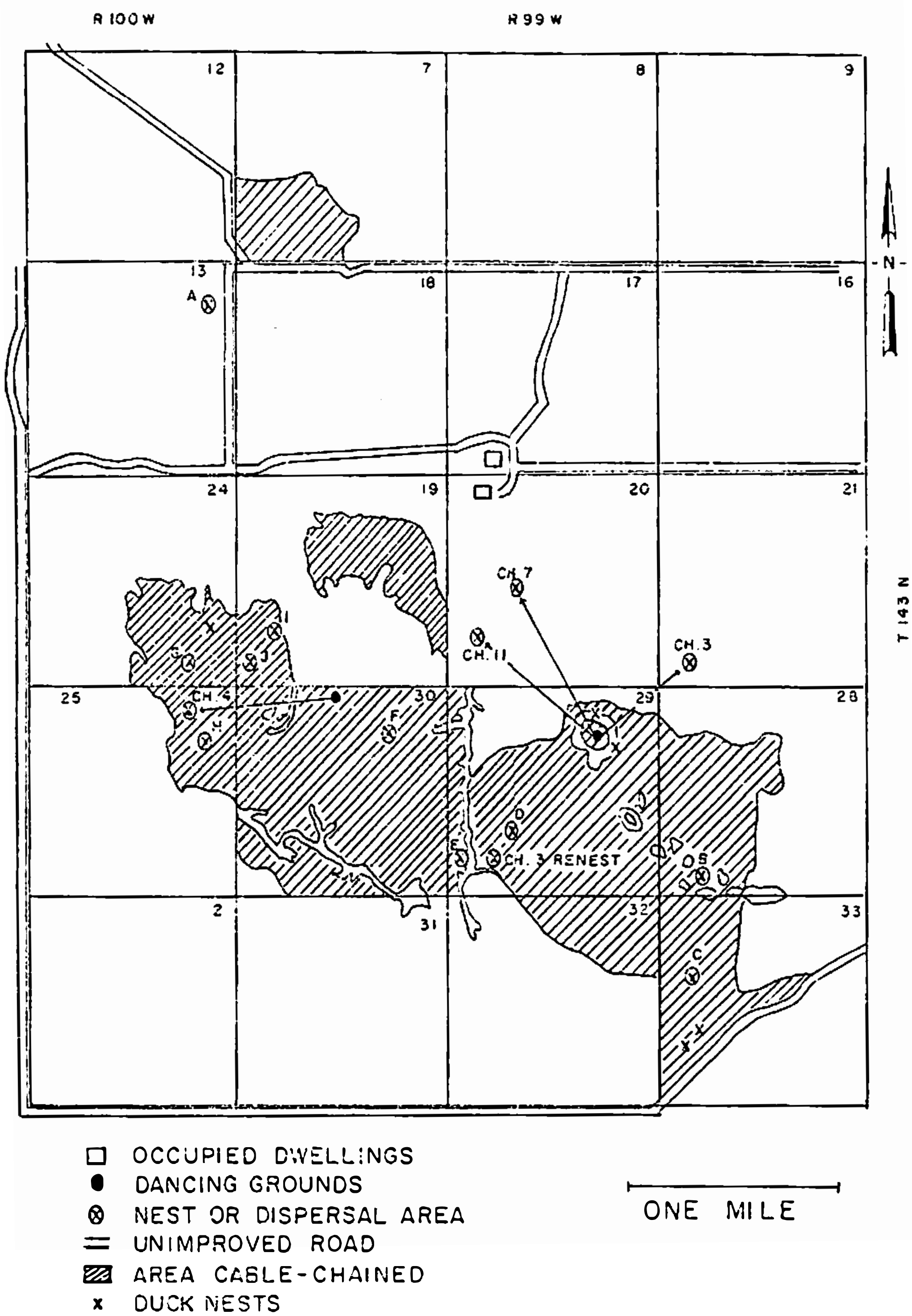


Fig. 2. Dispersal of hens from dancing grounds to nest sites, 1974.

Appendix F. Individual Brood Movement

Observations of 44 broods were made in 1973 and 49 in the summer of 1974. Fourteen of the 93 broods sighted were incidental observations during early morning brood runs, flushed while monitoring transmittered birds, and located on evening brood counts.

Eleven hens with transmitters were monitored for movement to a variety of cover situations. Brood mobility is limited immediately after hatching (Artmann 1970, Christenson 1970), and broods could often be found near their nest site. However, amount of cover adjacent to the nest site played an important role in determining distance that broods moved. Artmann (1970) found that brood mobility increased at 4-6 weeks of age.

Hen with Channel 8-73 was instrumented 15 April 1973, and successfully hatched all 10 eggs on 13 June. The initial two days of brood movement and activity were within 183 m of the nest site in a regrowth vegetated area in Pasture 7 (Fig. 1). On 15 June the brood moved 0.4 km east into pasture 16, where regrowth vegetation lay adjacent to a woody draw, and remained there four days. Hen and brood were flushed 21 June approximately 0.6 km east of nest site along a grassy drainage surrounded by clay buttes. For the next three days, the brood used this grassy drainage for roosting and feeding. Radio contact with the hen was lost on 24 June.

Nest J was found by cable-chain drag on 8 June 1973. Five days later the hen was captured and instrumented as Channel 1c-73. Nine of

10 eggs hatched 29 June. The next day she was flushed 151 m west of the nest site into regrowth vegetation (Fig. 1). The hen moved her brood 0.4 km southwest on 3 July into sweetclover-smooth brome pasture 10 that was mowed and baled one week later. Five hours later the same day, the brood was found 0.8 km west of the nest site utilizing re-growth vegetated pasture 13 consisting of sweetclover, smooth brome, alfalfa, needle and thread grass, and bluegrama. Brood movements on 4 and 5 July were within this regrowth vegetated pasture. The brood roosted along the edge of the woody draw and moved into the grassy uplands during morning hours for feeding. They dusted and loafed in tall, thick grass interspersed with wolfberry, wild rose, and buffaloberry during the afternoon. In the evenings the brood fed again in the grassy uplands. The hen and brood moved to a hardwood draw 2.1 km northwest of the nest site in the same pasture on 10-11 July when contact was lost.

Female on Channel 10-73 successfully hatched all 13 eggs. The brood spent the first three days within 0.4 km of the nest site, located in the native grass unit of the Fairfield common pasture (pasture 5) (Fig. 2). The habitat consisted of a shallow lowland draw containing Kentucky bluegrass and sedges interspersed with clumps of wolfberry. On the fourth day (17 June) the brood moved east approximately 0.4 km and utilized the slopes of a native grass-brushy draw embankment. The brood followed this brushy draw four days, roosted and fed on the grassy slopes and escaped the heat in the woody areas. On 24 June this female traveled 0.8 km south of the nest site into another woody draw and used this area intensively until contact was lost after 65 days.

Female channel 11a-73 hatched all 12 eggs on June 13, then moved approximately 0.4 km west-southwest of the nest and used the brushy woody slope of a draw in pasture 6 for the next two days (Fig. 3). On 15 June the female moved her brood 0.3 km east into a crested wheatgrass pasture adjacent to a wooded draw in pasture 4. The brood could be found roosting on grassy hillsides sloping towards the draw, but spent most of the day feeding and loafing in crested wheatgrass. Three days later, the brood was flushed 0.4 km west in the crested wheatgrass pasture. This was its center of activity until the hen was killed by an avian predator on 21 June.

On 23 June channel 12c-73 (reinstrumented from channel 5a-73) hatched 3 of 14 eggs from a nest located in unmowed, ungrazed tame grass (pasture 9). She immediately moved the brood 160 m into the crested wheatgrass unit of the Fairfield common pasture (pasture 5) (Fig. 4). On the second day after hatching, the hen moved her brood back into pasture 9. The brood remained in this area until 23 June when signal contact was lost with the hen after 64 days of monitoring.

Nest J was located by the cable-chain drag on 11 June 1974. Eighteen days later the female was captured on the nest and instrumented with channel 10a-74. Nine of 12 eggs hatched on 3 July and the hen with the brood was found adjacent to a wooded draw within pasture 3 (Fig. 5). The brood utilized a regrowth vegetated area adjacent to a woody draw the next three days. Hen and brood fed and rested in the upland grasslands in the morning and evenings. The brood sought shelter from the mid-day heat in woody cover. On 7 July the brood moved south along the west side of the woody draw utilizing the native-grass embankment. Two days later the hen and brood were flushed on the east side of the draw in heavy woody cover, consisting mostly of wolfberry and buffaloberry. The brood remained in this area almost two days utilizing the woody species interspersed with dense native grasses. On the afternoon of 10 July the hen led her brood to the northwest corner of the pasture and utilized a dense patch of brushy vegetation on the upland for about a week. The transmitter signal usually indicated the brood to be in grasslands, but the hen led her brood into the brushy cover before flushing. On 17 July the female was found dead. She was killed by an unknown predator at the bottom of the wooded draw. The transmitter was still working but the brood was not seen.

Female channel 3-74 hatched 9 of 11 eggs on her second nesting attempt. The hen was flushed approximately 83 m southwest of the nest site in pasture 5 (Fig. 6). For the next two days the hen and brood were observed utilizing the native grasses along the edge of a brushy draw, where they roosted, fed, and rested. Although the brood was never seen in the woody vegetation, the young were never more than 70 m from woody cover. On 18 July and for the 2 following days, the hen was flushed wild over 180 m from the nest site. The hen no longer displayed brooding behavior and the brood was never observed. Last radio contact with the hen was made on 22 July.

The hen from nest E was captured and transmitter-equipped with channel 5p-74 on 18 June. Two days later the hen hatched 13 of 14 eggs. Monitoring of the hen showed that the brood was in native vegetation 20 m south of the nest site in pasture 5 (Fig. 6). For the next two days the brood was on the uplands in native vegetation interspersed with light brushy cover within 25 m of the nest. On 22 June the brood was flushed 320 m southeast of the nest site. The brood remained in the brassy uplands for three days feeding in light, grazed cover and moving into heavier grassy cover to roost. Signal contact with channel 5p-74 was lost on 25 June. Thirty-six days later on 31 July the signal was heard northeast of the nest site and the hen was dead of an unknown predator.

Transmitter channel 12b-74 was fitted on the female from nest F on 18 June. The next day 13 of 15 eggs were found hatched. The brood was immediately tracked and flushed approximately 25 m south of the nest site in tame grass pasture 9 (Fig. 7). The brood remained in this tame grass pasture for several days. Intensive use was made of the grassy uplands for roosting, feeding and resting. On 20 June the hen moved the brood into native pasture 0 directly west of the nest location. A shallow drainage passed through this pasture containing mostly Kentucky bluegrass interspersed with sparse amount of wolfberry. The brood was seen throughout the day in the bluegrass area. For 9 days the brood moved only 15 m within this bluegrass-wolfberry drainage. However, on 30 June the hen moved her brood into the northeast corner of pasture 3. The next day the brood was flushed in crested wheatgrass pasture 4 and was followed back into pasture 3. The brood remained in pasture 3 for 10 days and roosted and fed on the grassy upland. They used the upland woody cover for shelter during mid-day. The telemetry segment of the study was terminated on 15 July with the hen and brood still in pasture 3.

On 10 June 1974, the female from nest C was captured using a long-handled net. Transmitter with channel 12a-74 was attached and she was placed back on the nest. The following day all 18 eggs in the clutch hatched. The brood was flushed 25 m north of the nest in native vegetation in pasture 5 (Fig. 8). The hen moved her brood 0.4 km north-northeast of nest site on 14 June to tall native cover at the base of a rocky knoll. They utilized this grassy upland cover for several days before moving 1.21 km northeast of nest site to a shallow drainage area containing mostly Kentucky bluegrass and sedges; no woody cover was present. The brood was consistently flushed from this shallow drainage for the next two days. On 19 June the hen was found dead in the bottom of this drainage from a small caliber wound. The transmitter was still operating. The chicks were not seen. Movement of the hen and brood was confined to pasture 5.

Female channel 4-74 was captured on ground 5 and instrumented on 26 April. On 27 May the hen was found nesting in crested wheatgrass pasture 4. Twenty-one days later all 14 eggs in the clutch hatched. The following day the hen and brood were observed 174 km southeast of the nest site in crested wheatgrass (Fig. 9). The next morning the brood was flushed from bluegrass-wolfberry mixture on the uplands in pasture

0. The brood was followed into pasture 4 and located in the crested wheatgrass 0.4 km southeast of the nest site. For the next three days the hen and brood were consistently observed using the crested wheatgrass. The brood roosted and fed in the crested wheatgrass. From mid-day to evening the brood used woody cover for shelter from the heat. On 18 June the hen began moving her brood east. The routine of feeding and roosting in the crested wheatgrass and escaping the mid-day heat by sheltering woody cover was maintained throughout the movement. On 25 June the hen was found dead of unknown predator south of nest site. The transmitter was working. None of the brood was seen. The brood had confined its movement to pasture 4 except for three sightings.

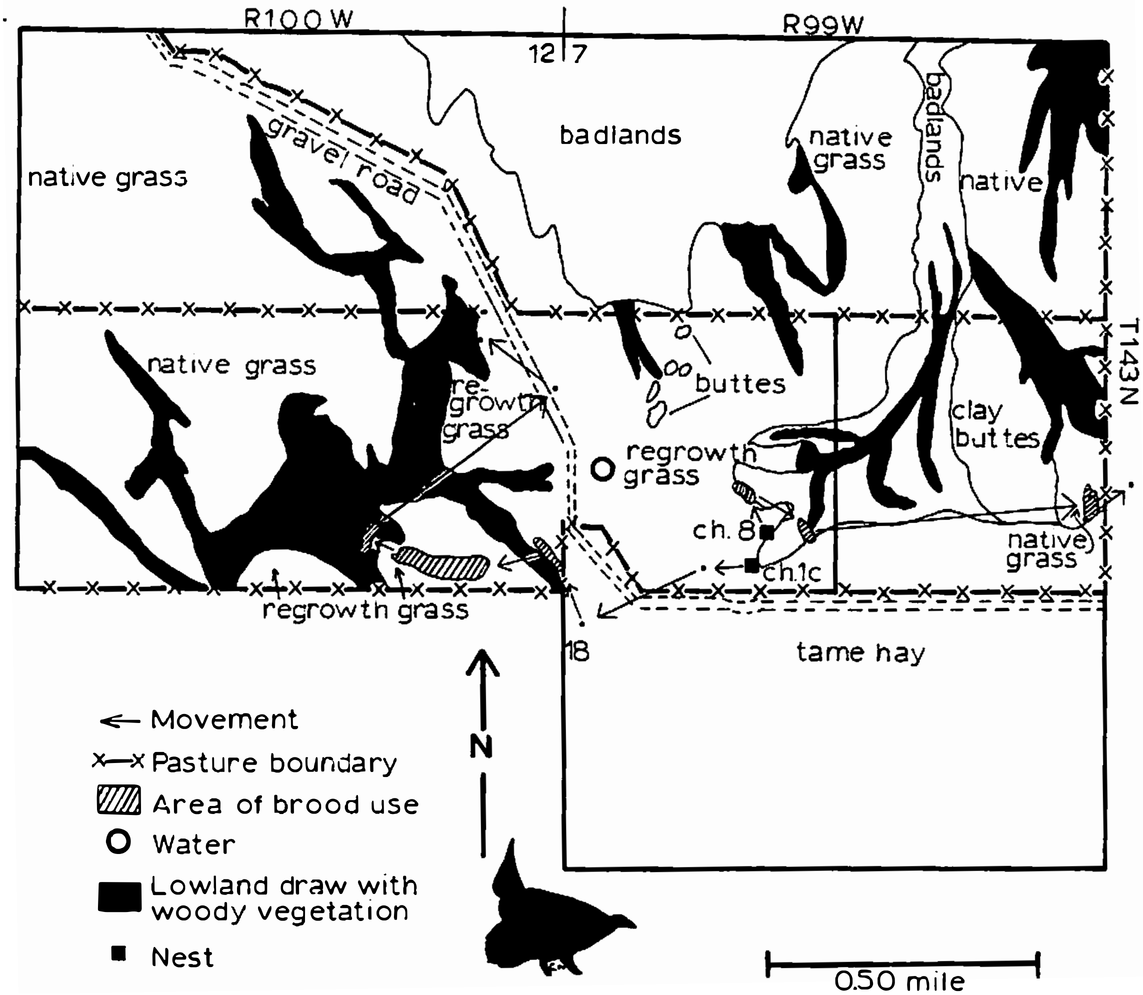


Fig. 1 Movement of two sharptail hens (channel 8 and 1) with their broods after they left the nest, 1973.

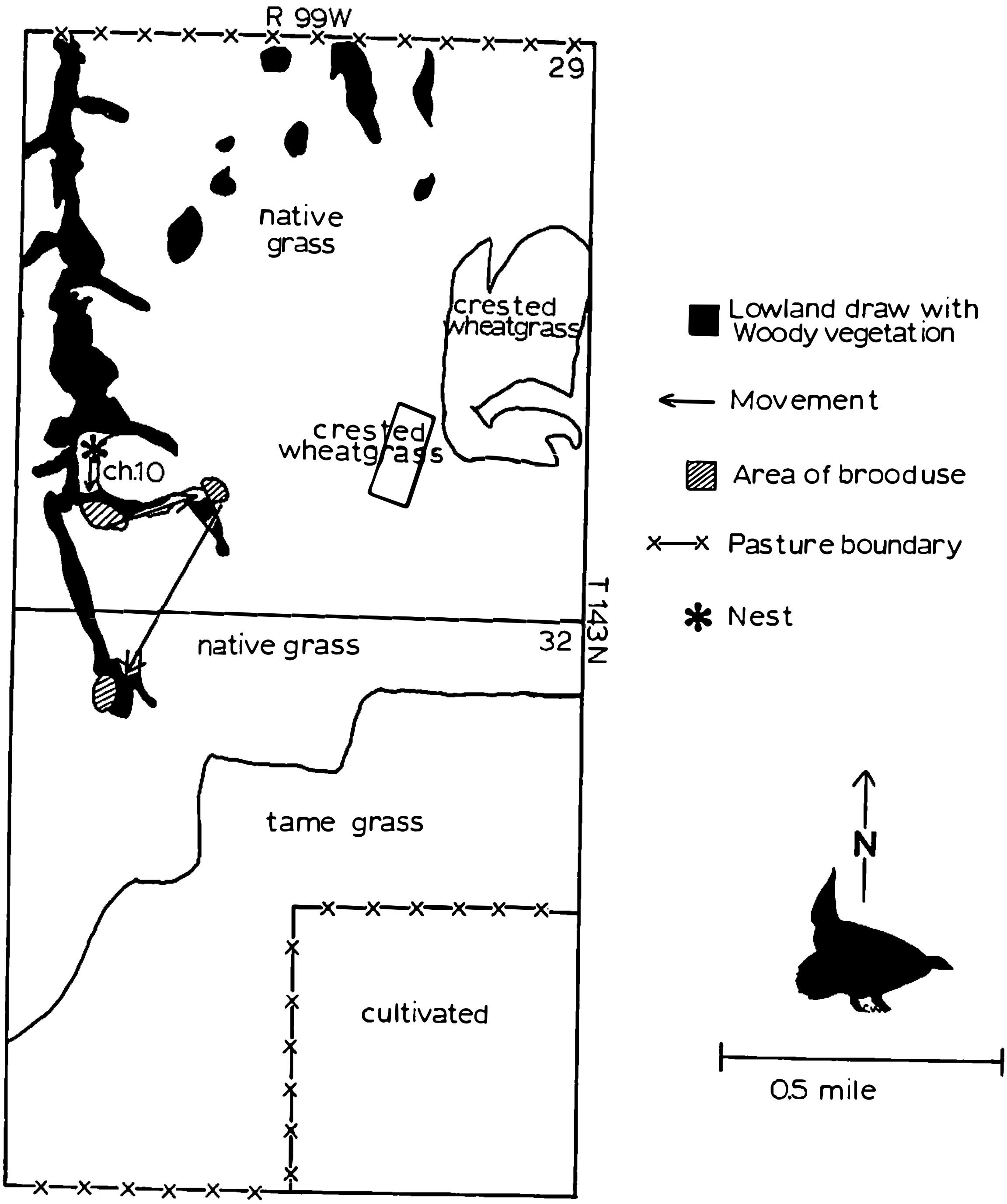


Fig. 2. Movement of sharptail hen (channel 10) with her brood after she left the nest, 1973.

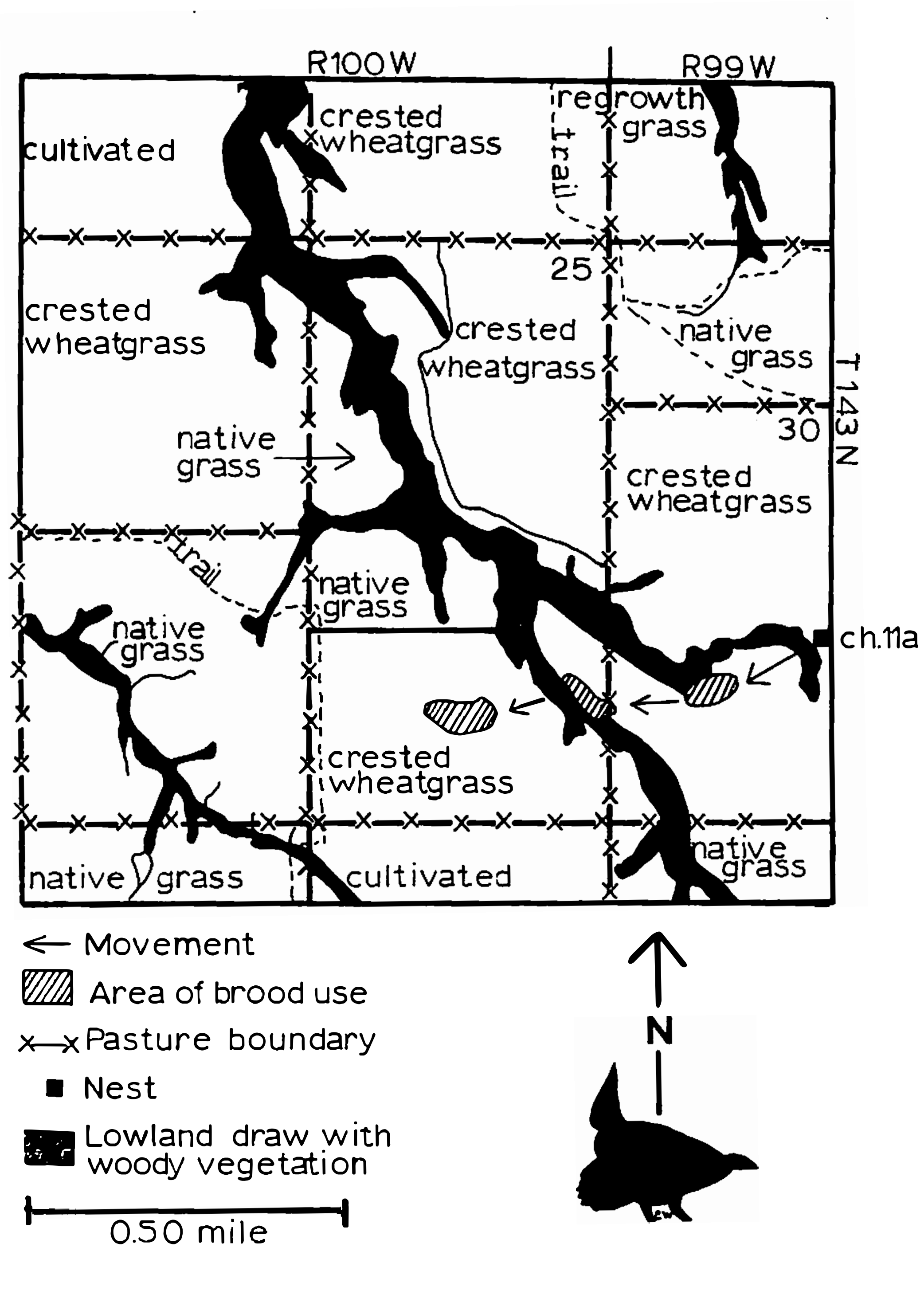


Fig. 3 Movement of sharptail hen (channel 11a) with her brood after she left the nest, 1973.

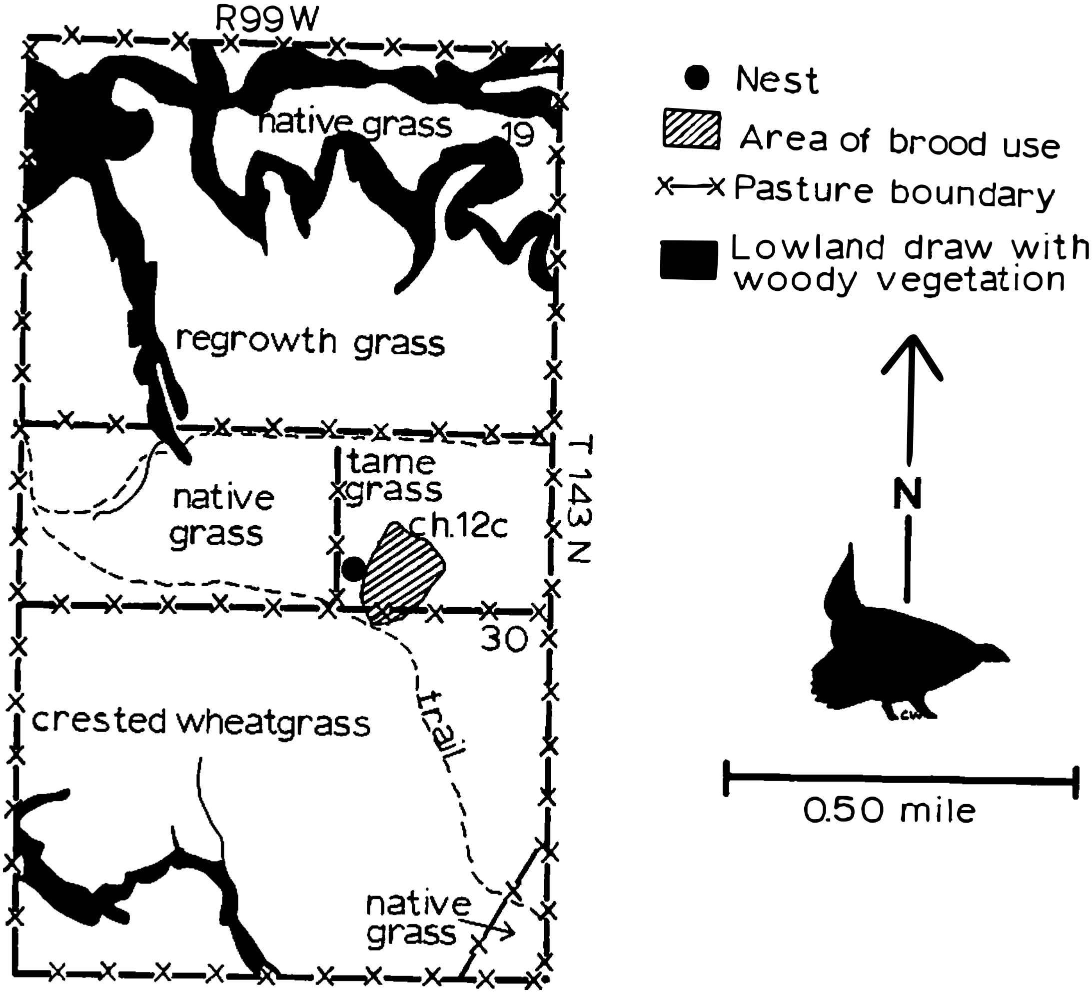


Fig. 4. Movement of sharptail hen (channel 12c) with her brood after she left the nest, 1973.

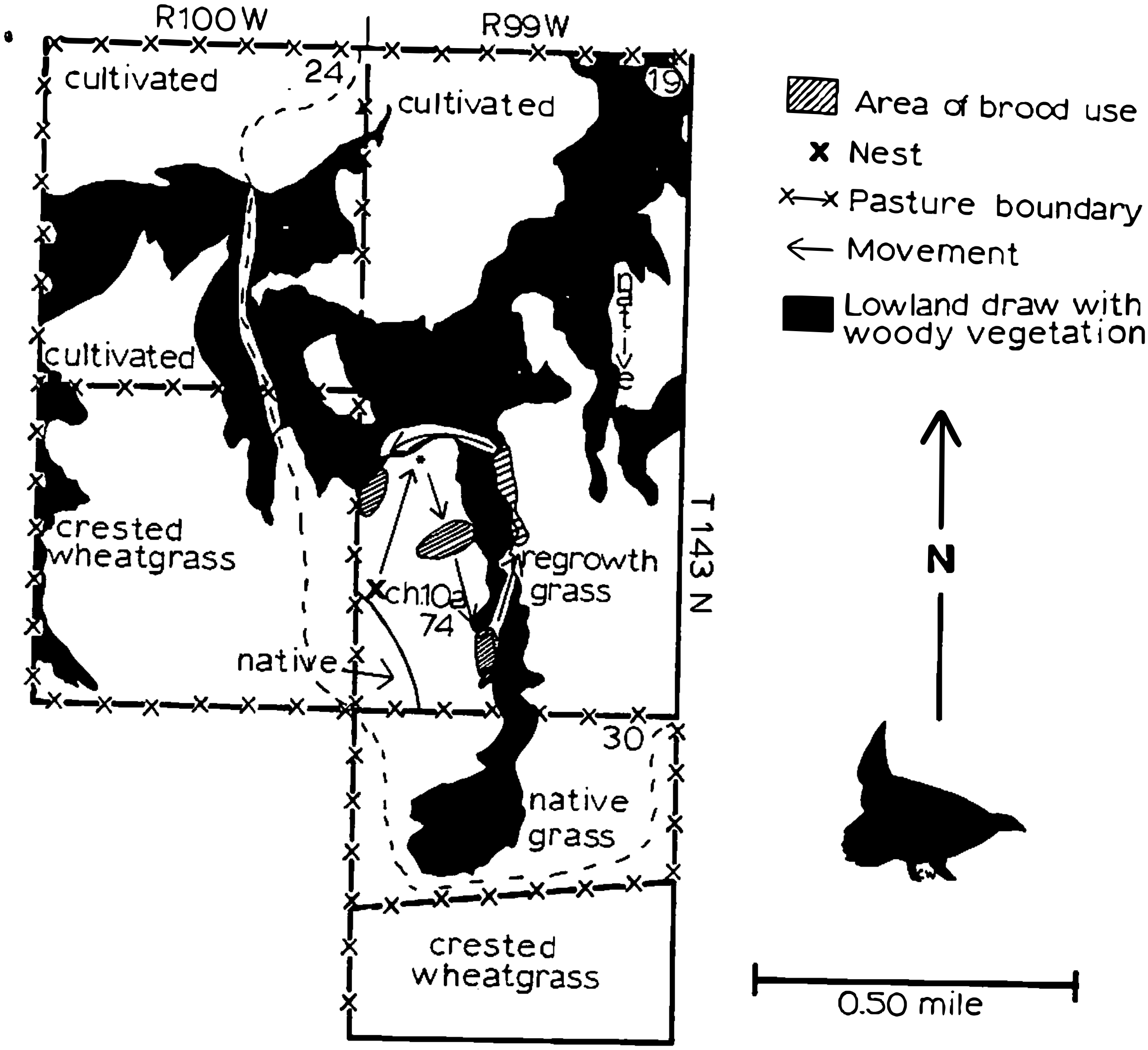


Fig. 5. Movement of sharptail hen (channel 10a) with her brood after she left the nest, 1974.

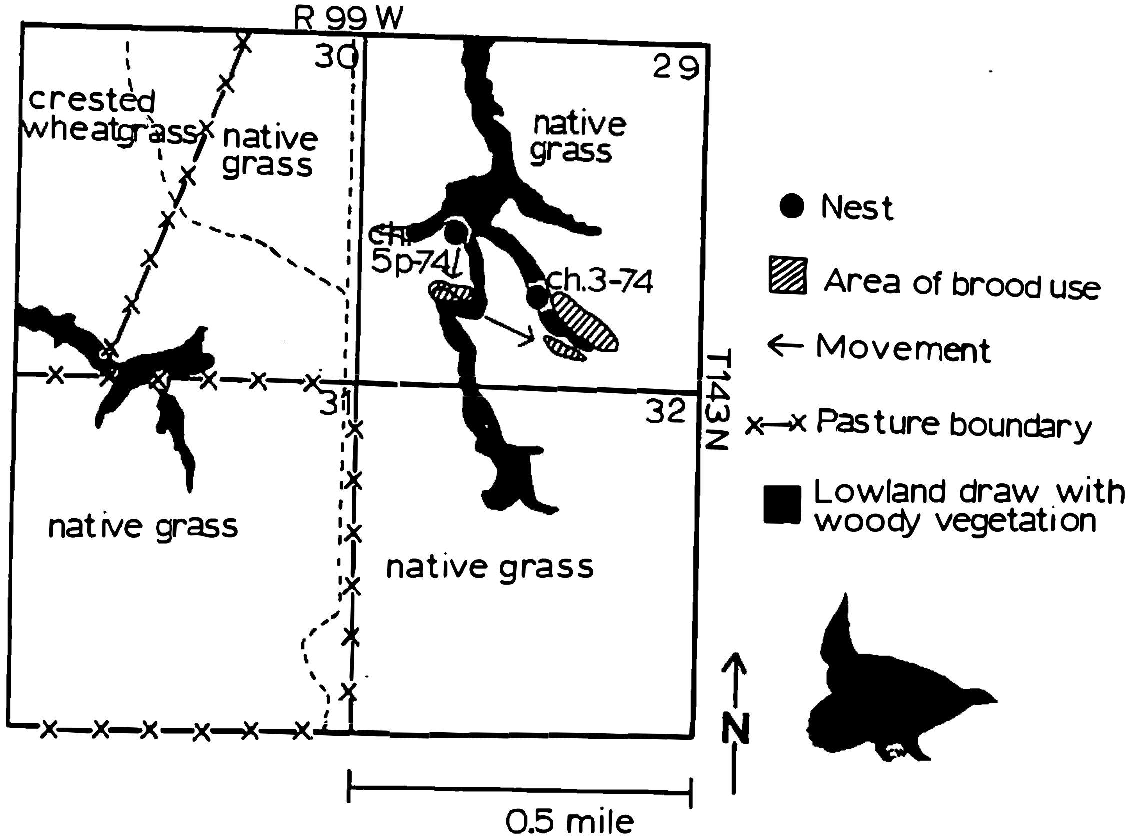


Fig. 6. Movement of two sharptail hens (channel 3 and 5p) with their broods after they left the nest, 1974.

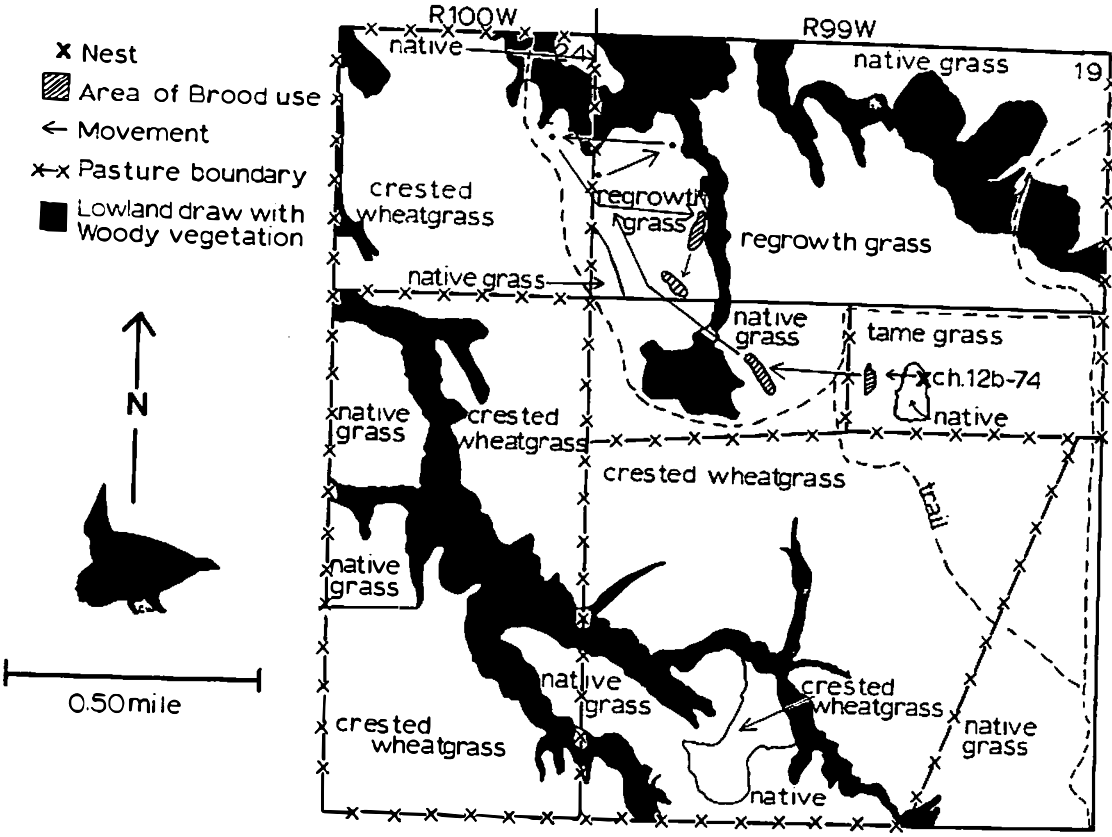


Fig. 7. Movement of sharptail hen (channel 12b) with her brood after she left the nest, 1974.

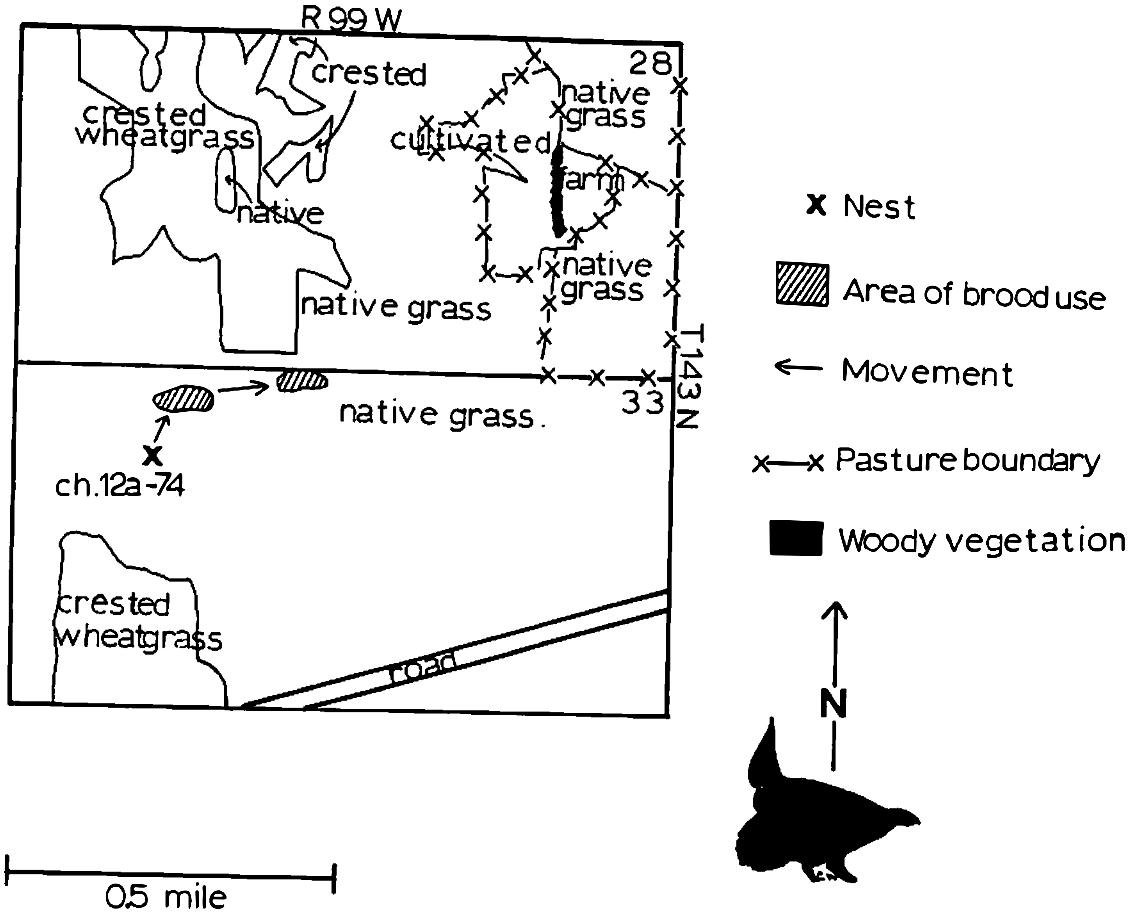


Fig. 8. Movement of sharptail hen (channel 12a) with her brood after she left the nest, 1974.

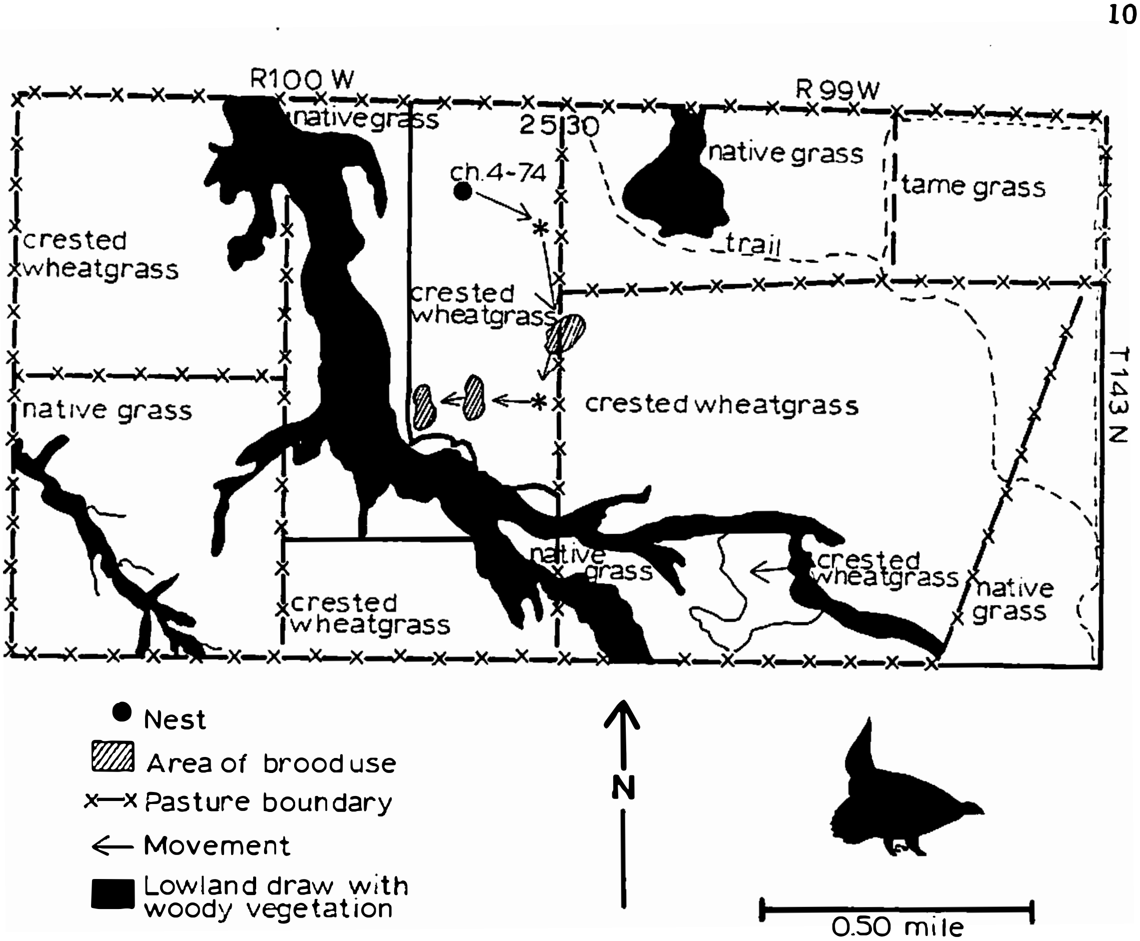


Fig. 9. Movement of sharptail hen (channel 4) with her brood after she left the nest, 1974.

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Appendix G. Nesting Chronology

The peak of the nesting season generally occurred in early May (Fig. 1). Nesting dates were determined by back-dating 1.2 days for every egg from the time the nests were discovered. With favorable weather conditions during 1973 and 1974, the peak nesting period was from 1 May to 12 May and nesting occurred as early as the fourth week in April.

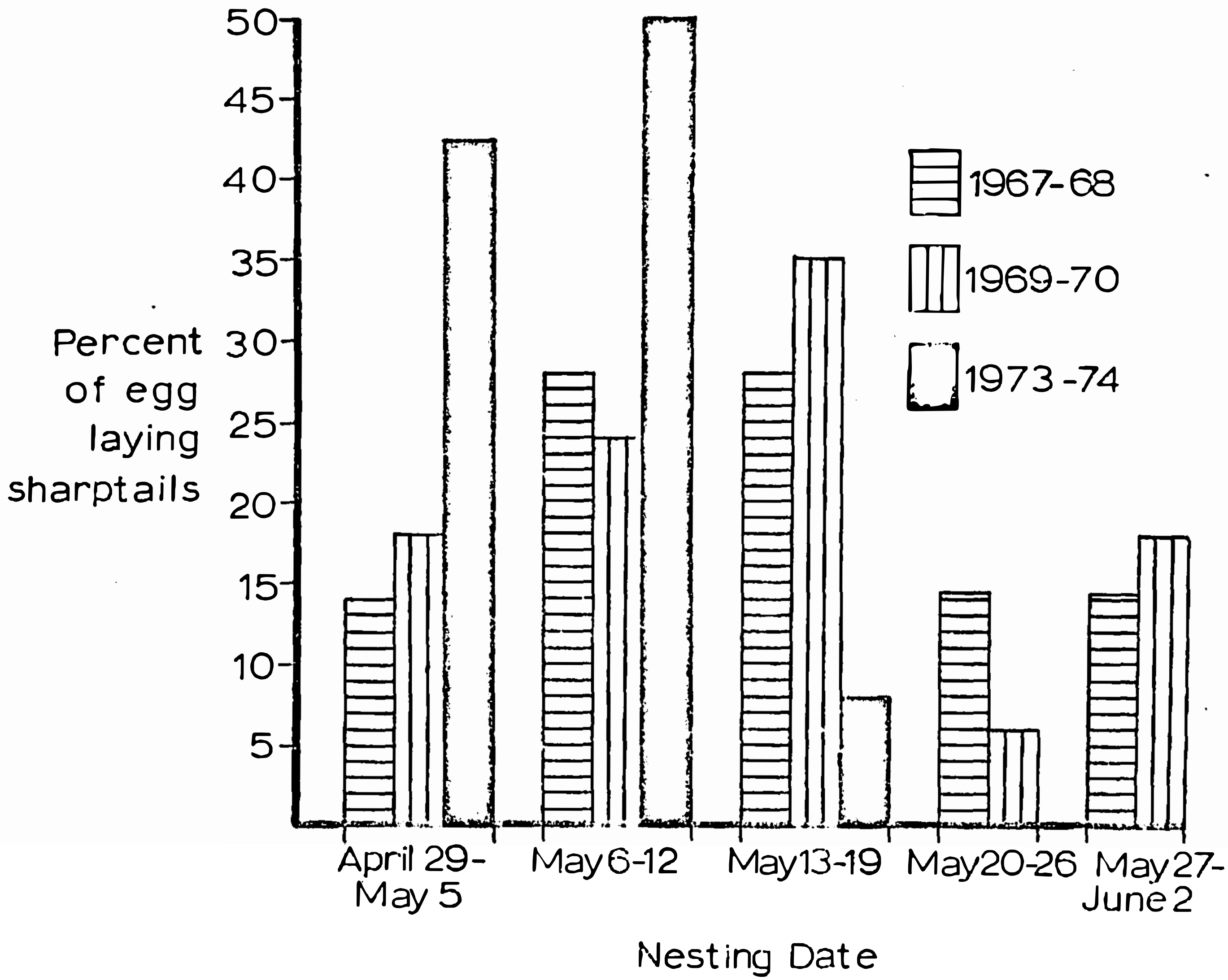

Fig. 1 Nesting chronology of sharptails on Gorham study area, 1967-1974.

Appendix H. Nests

The number of eggs found in 46 sharptail nests ranged from 9-18 for completed clutches, averaging 13 (Table 1). Two renests averaged 11.5 eggs per nest. Clutch size was similar as reported in Utah (Hart et al. 1950), Minnesota (Artmann 1970), and Saskatchewan (Pepper 1972).

Sixty percent of the nests observed in 1973-74 hatched. If at least one egg in the clutch hatched, the nest was considered successful. No real difference occurred between adult nesting success and juvenile, 60 percent compared to 58 percent. Wallestad (1974) studying sage grouse in central Montana found adults more successful than yearlings in bringing off a brood. Bernhoft (1969) had an overall nesting success of 38 percent for hens on the Gorham area. Overall nesting success during 1969-70 on the same area was 46 percent (Christenson 1970). Overall hatching success for 1973 was 94 percent; 90 percent in 1974. Only one known adult hen successfully nested in 1973. Juvenile hatching success in 1973 was 86 percent. Adult and juvenile hatching success in 1974 showed no real difference, 94 percent compared to 93 percent. Overall hatching success was 90 percent.

Twenty-three percent of the sharptail nests located were destroyed by predation, primarily by skunks (probably *Mephitis mephitis*). Only two hens renested. Christenson (1970) found predation to play an important role in limiting sharptail reproduction on the Gorham area. During his study seven hens renested. Only 1 of 5 nests located in a Minnesota study (Artmann 1970) was destroyed before hatching. Pepper (1972) found that predation accounted for 9 of 34 nests. Bent (1932) reported that sharptails are easy prey to coyotes (Canis latrans) while displaying in the spring. In contrast Symington and Harper (1957) concluded that the greatest predation on sharp-tailed grouse was on the nests by common crows (Corvus brachyrhynchos), skunks, magpies (Pica spp.), and ground squirrels (Spermophilus spp.).

The residual material in the nest bowl weighed from 16-96 g, averaging 51 g. Most of the lining was dead plant material with some feathers interspersed. The nests averaged 18 cm across, 16 cm wide and 6 cm deep. This is similar to nests observed by Bent (1932). Renests had less residual vegetation lining the nest bowl. There was no noticeable relationship between nest litter and average visual obstruction reading for the pasture.

Table 1. Sharptail nesting information, 1973-1974.

Female	Number of eggs	Fate of eggs	Nest dimension (cm)			Nest mulch	
			Length	Width	Depth	Date collected	Weight (g)
A-73[a]	17	Hatched	20	20	8		
B-73[a]	15	Hatched	20	18	5		
C-73[a]	13	Hatched	20	18	5		
D-73[a]	14	Hatched	20	18	8	6-22-73	90
E-73[a]	13	Hatched	20	15	5		
F-73[a]	15	Hatched	20	18	5	6-27-73	52
G-73[a]	15	Hatched				6-27-73	55
G-73[a]		Egg predation				6-27-73	16
H-73[a]	14	Hatched				6-27-73	45
I-73[a]	15	Hatched	18	15	8	6-27-73	46
J-73[a]	10	Hatched	18	18	5	7- 8-73	48
K-73[a]	7	Egg predation	13	13	5	6-26-73	43
L-73[a]	10	Egg predation	15	13	5	6-26-73	34
M-73[a]	11	Egg predation	18	13	5		
N-73[a]	15	Hatched	18	18	5	6-26-73	50
O-73[a]	15	Hatched	18	15	5	6-26-73	60
Ch.2-73	10	Egg predation	15	18	8		
Ch.3-73	4	Egg predation	20	18	8	6-26-73	45
Ch.3-73(renest)	12	Hatched					
Ch.5-73	2	Abandoned	18	18	8	6-22-73	23
Ch.5a-73	14	Hatched	18	18	5	6-27-73	73
Ch.6-73	9	Egg predation	18	15	5		
Ch.7-73	9	Hatched	20	15	5	6-27-73	50
Ch.8-73	10	Hatched	20	15	8	6-25-73	55
Ch.9-73	10	Egg predation	15	15	8	6-27-73	44
Ch.10-73	13	Hatched	18	18	8	6-27-73	52
Ch.11-73	6	Abandoned	15	13	8	6-22-73	44
Ch.11a-73	12	Hatched	18	15	5	6-28-73	96

Table 1. Continued.

Female	Number of eggs	Fate of eggs	Nest dimension (cm)			Nest mulch	
			Length	Width	Depth	Date collected	Weight (g)
A-74[a]	16	Hatched	15	15	5	6-19-74	35
B-74[a]	18	Hatched	23	20	5	6-18-74	65
C-74[a]	15	Hatched	20	18	5	6-17-74	47
D-74[a]	10						
E-74[a]	14	Hatched	15	15	5	6-20-74	63
F-74[a]	15	Hatched	18	18	5	6-19-74	47
G-74[a]	11						
H-74[a]	14	Hatched	18	18	8	6-19-74	52
I-74[a]	12	Hatched	18	18	5	6-18-74	52
J-74[a]	12	Hatched	18	18	5	8-15-74	52
Ch.3-74	10	Egg predation	15	15	5		
Ch.3-74 (renest)	11	Hatched	20	15	3	7-30-74	32
Ch.4-74	14	Hatched	18	15	5	6-19-74	38
Ch.7-74	11	Egg predation	18	15	5	6-19-74	40
Ch.11-74	8	Abandoned	20	15	5	6-19-74	25

[a]Nests found by cable-chain drag.

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Appendix I. Hatching Chronology

The peak hatch occurred the week of 9 to 15 June in 1967-68 and 1973-74 (Fig. 2). A distinct constant peak occurred in 1969-70 from the 9 June to 29 June period. This was the only segment in which data suggested the possibility that important renesting may have occurred. Several authors including Hamerstrom (1939), Ammann (1957), and Blus and Walker (1966) indicated that sharptails do not renest persistently. More recently Christenson (1970) found considerable renesting and noted that renesting attempts were more successful than first attempts. Brown (1967) also found sharptails to be persistent renesters, and one instrumented hen renested twice. Pepper (1972) indicated that significant renesting may have occurred in one of the three years of his sharptail study in Saskatchewan. Sharptails in Slope County, North Dakota were found to have the greatest hatch in 1 to 7 June (Bach and Stuart 1941). Most sharptail nests hatched two weeks later, 12 to 20 June, in Nelson and Bottineau Counties. However, in a later study, Bach (1943) found the week of greatest hatch in Bottineau County, North Dakota, to be the same as that for the Gorham area.

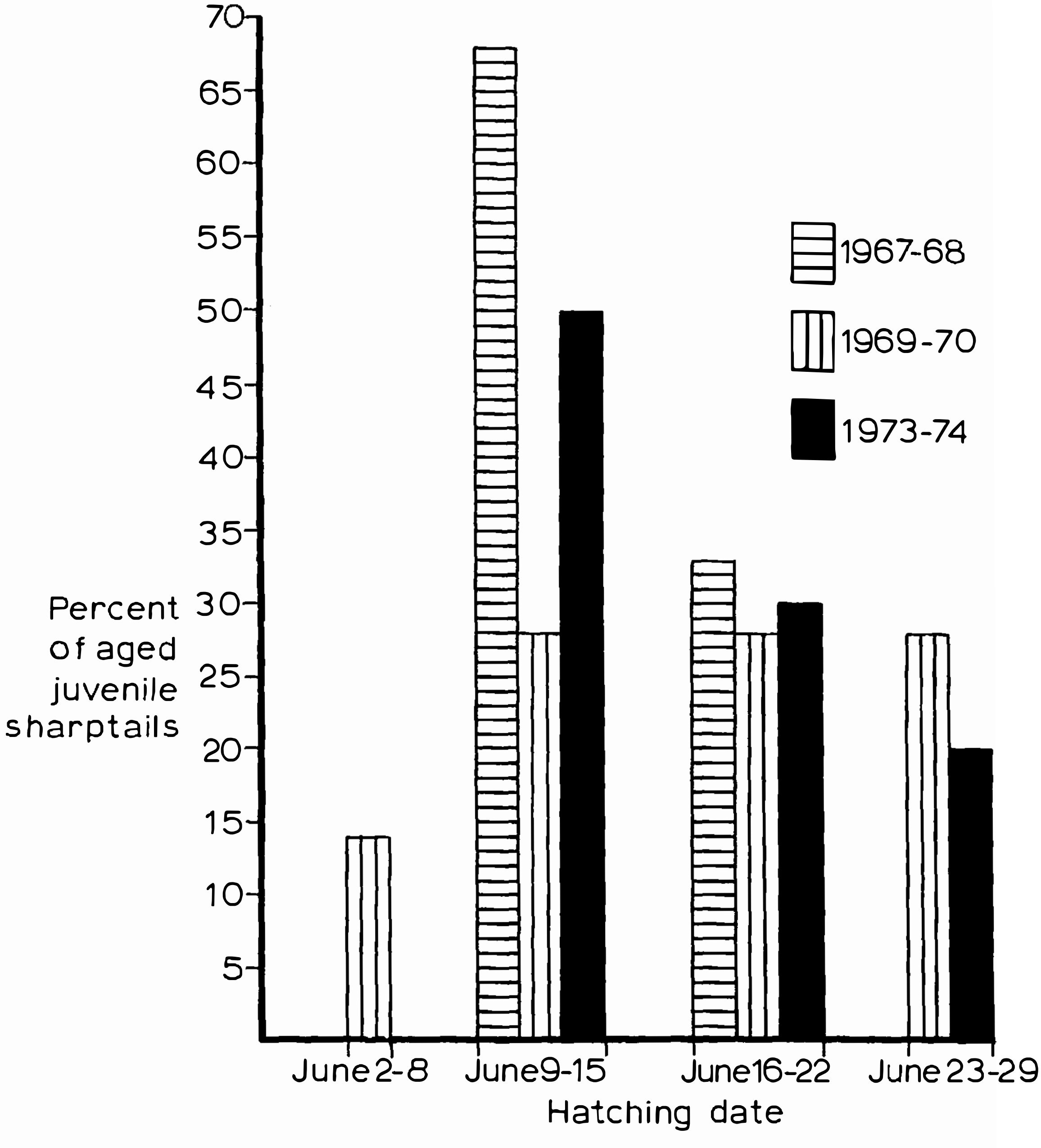

Fig. 2. Hatching chronology of sharptail chicks on Gorham study area, 1967-1974.

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Appendix J. Yearly nested analysis of variance, testing vegetation height between pastures and range sites within pastures.

1973

Source	DF	Mean squares
Pasture	13	9582.608
Range site	27	6671.647**
Error	10014	55.446

1974

Source	DF	Mean squares
Pasture	18	53908.235**
Range site	1	957.029**
Error	5948	168.227

**Significant at $P < 0.01$ level.

Appendix K. Factorial analysis of variance for vegetation height in pastures, range sites and their interaction by months, 1973.

May

Source	DF	Mean squares
Pasture	1	504.434**
Range site	2	563.320**
Range site x pasture	2	253.707**
Error	1008	35.318

June

Source	DF	Mean squares
Pastures	3	772.318**
Range sites	3	4244.036**
Range sites x pastures	4	169.704**
Error	2162	27.046

July

Source	DF	Mean squares
Pastures	6	1370.266**
Range site	3	7531.524**
Range site x pastures	10	7769.368**
Error	4155	105.357

August

Source	DF	Mean squares
Pastures	5	969.788**
Range site	2	8636.298**
Range site x pastures	7	1431.619**
Error	5770	71.921

October

Source	DF	Mean squares
Pastures	1	308.315*
Range site	1	924.288**
Error	381	49.526

*Significant at P<0.05 level.
**Significant at P<0.01 level.

Appendix L. Location of sharp-tailed grouse nests to dancing grounds, woody vegetation, and fences, 1973-74.

Pasture number	Grouse nests	Distance to nearest known dancing ground (km)[a] Mean	Range	Distance to woody vegetation (m) Mean	Range	Distance to fence (m) Mean	Range
0	1			22		100	
1	6	0.50	0.38-0.75	54	11-100	84	3-100
2	8	0.35	0.20-0.40	85	9-100	73	18-100
3	4	0.64	0.40-0.80	29	3-73	61	21-100
4	4	1.20	1.01-1.29	48	5-100	100	
5	7	1.38	0.42-2.02	21	0-100	100	
6	1			0		100	
7	1			0		100	
8	3	0.90	0.79-1.01	74	23-100	100	
9	2	0.35		54	7-100	100	
10	2			85	70-100	84	69-100
28	1	0.79		100		100	
30	2			11	6-16	54	7-100
31	1	0.78		3		21	

[a]Note appendix F for dispersal distance on transmittered hens.

Appendix M. Research Suggestions

Further research work on the sharp-tailed grouse should compare cover used by nesting and brooding hens to cover found in grasslands under different management systems. Special effort should be made to analyze and evaluate those pastures under rotational grazing, especially deferred and rested.

Perhaps the best method to evaluate grazing systems is an attempt to find a plant species or community within the various pastures that is an indicator of good grouse nesting and brooding habitat and to measure these pastures for the indicator plant species when pasture management systems change (changes in number of livestock, season of grazing and/or rotation system).

The study area should be cover mapped, outlining and identifying areas of grouse nesting and brooding habitat within different pasture management systems.

The rolling-grassland range-site within native and crested wheatgrass vegetated pastures should be fenced. Using this control system cattle could graze these areas under varying stocking rates and grazing periods. The vegetation could be continuously measured. The observer could evaluate which grazing system left the greatest vegetation quantity for use as sharptail habitat.

More data are needed to correlate VOR to weight of clipped vegetation. This would then provide a quick technique for the range scientist in estimating forage production to determine stocking rates and for the wildlife biologist in estimating cover height to determine habitat availability for sharp-tailed grouse.