A STUDY OF DUMMY NESTS AND GREATER PRAIRIE CHICKEN (TYMPANUCHUS CUPIDO PINNATUS) NESTS IN NORTHEASTERN KANSAS WITH NOTES ON FEMALE NESTING BEHAVIOR

by 6791

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INTRODUCTION

To effectively manage a species or evaluate environmental manipulations which may affect it, a basic ecological and behavioral understanding of the species must be acquired. To obtain this basic understanding an extensive study of the greater prairie chicken (Tympanuchus cupido pinnatus) was initiated in 1964 in the Flint Hills of northeastern Kansas.

The objectives of the overall study were to determine home range sizes, mobility patterns, habitat preferences and behavioral patterns of the greater prairie chicken. This thesis includes data pertinent to dummy nests, prairie chicken nests, and female nesting behavior collected during the 1969-1970 phase of study and supplements similar data acquired in the studies of Cebula (1966), Viers (1967), Silvy (1968), and Watt (1969).

Dummy nest studies facilitated achieving the objectives of this study; to determine the effects of nest location, nest inception, and nest predation on greater prairie chicken production. Additional data were gathered to supplement the information acquired earlier in the study on greater prairie chicken nesting behavior.

REVIEW OF LITERATURE

Production and Nesting Behavior

Literature indicates that the nesting and rearing period is the most critical time for greater prairie chicken survival because of weather and other environmental conditions (Baker 1953:30, Yeatter 1943:401). Throughout much of the greater prairie chicken range in both remnant populations (Schwartz 1945, Hamerstrom 1941) and stable populations (Baker 1953, Robel 1970) many nests fail to produce young.

Lehmann (1941:15) stated that a successful season for Attwater's prairie chickens (Tympanuchus cupido attwateri) in Texas depends largely on the fate of the early nests. Baker (1953:28) likewise concluded for the greater prairie chickens in Kansas that the early clutches produce the most young. Conversely, in Illinois late prairie chicken nests are found in better cover, experience less predation, and are more likely to produce young than early nests (Yeatter 1943:392).

The productivity of greater prairie chickens in Kansas was similar to that found by Lee (1950) in New Mexico for lesser prairie chickens (Tympanuchus pallidicinctus) but far lower than found by Bennitt (1951) for bobwhites (Colinus virginianus), which Baker (1952:365) believed was the result of greater prairie chicken inability to renest after failure of one or a few early attempts. Although Hamerstrom (1939) and Evans (1968) believed that prairie chickens possess little propensity for renesting, several authors have presented evidence to substantiate a significant amount of renesting (Baker 1953, Erickson and Petraborg 1952, Robel 1967, 1970). Yeatter (1943:392) believed that renesting attempts allowed a high percentage of female greater prairie chickens to bring off broods. Attwater's prairie

chickens compensate for the loss of early nests to predators by renesting (Lehmann 1941:15).

Greater prairie chickens normally lay one egg per day (Baker 1953, Edminster 1954), but Gross (1932) and Schwartz (1945) have reported intervals of several days between layings. Schwartz (1945:66) believed that the rate of laying probably depended on such factors as weather, the health of the hen, and available food.

The average greater prairie chicken clutch size varies from 11 to 13 eggs (Hamerstrom 1941, Gross 1932, Yeatter 1943, Ammann 1957, Baker 1953 and Schwartz 1945). The largest clutch, 25 eggs, was reported by Schwartz (1945) but Gross (1932) believed that clutches of this size are laid by two or more hens. Hamerstrom (1939) and Baker (1953) reported that the largest clutches are laid early in the nesting season and clutch size diminishes as the season progresses.

The incubation period of greater prairie chickens varies from 22-24 days (Baker 1953, Gross 1932, Schwartz 1945). Most eggs are fertile and hatch barring nest destruction or desertion (Hamerstrom 1941:52). Fertility of the eggs depends on the health and activity of the hen and upon other environmental and physical factors (Romanoff et al. 1938).

During incubation greater prairie chicken hens are on the nest constantly except for short absences in the morning and evening (Schwartz 1945:61, Gross 1932:249). During these absences from the nest during incubation, females normally do not cover the nest (Hamerstrom 1939:117). However, a few females cover rather exposed nests with nesting material before departing during the laying period (Gross 1932:248).

Nest Site and Burning

Greater prairie chicken nests observed by Hamerstrom (1939), Schwartz (1945), and Gross (1932) were shallow bowl depressions in the ground, lined with litter. In most cases nests were in mixed cover of grass and weeds rather than pure stands (Hamerstrom 1939, Gross 1932, Schwartz 1945, Yeatter 1943, Ammann 1957). Jones (1963:772) reported that greater prairie chicken nests in Oklahoma are in taller and heavier cover than usual for tall grass communities.

In Illinois the distance between nesting cover and booming grounds influenced the choice of nest sites (Yeatter 1943:389). Hamerstrom (1939:115) thought that this relationship resulted from the tendency of females to nest near the booming ground on which they mated. In Wisconsin prairie chicken nests are less than 1.25 miles from booming grounds (Hamerstrom 1939:115) which is similar to findings in Oklahoma (Jones 1963) and in Kansas (Horak 1967).

Burning of rangeland in the Flint Hills is as old as the grassland, for it is unlikely that prairies could long exist without repeated removal of tops (Anderson et al. 1970). Owensby (1970) explained that burning maintains a prairie habitat suitable for wildlife.

Causes of Nesting Failures

The causes of nesting failures are numerous and vary with the location of the study. Yeatter (1943) in Illinois noted that female prairie chickens are likely to abandon their nests during early laying if slightly disturbed. For this reason Baker (1953) questioned the value of studying greater prairie chicken nests. Nest desertion following disturbances was also observed by Davison (1940) for lesser prairie chickens and by Lehmann (1941)

for Attwater's prairie chickens.

Nesting females are sometimes killed by predators. Hamerstrom (1939) reported six nesting hen mortalities: three were killed by coyotes (Canis latrans) and one each by a mink (Mustela vison), a horned owl (Bubo virginianus) and an unknown predator. Losses of nesting female prairie chickens were also reported by Lehmann (1941) and Ammann (1945).

The most common cause of nesting failure is destruction of the nest either by predators or the physical environment. Heavy rains destroy many nests in Illinois and have its most pernicious effect during hatching (Schwartz 1945:67). Hamerstrom (1939:113) found flooding to be a common cause of nest losses in Wisconsin and also reported the loss of one nest to the heat of the sun. Mammalian predators cause many losses of prairie chicken nests (Hamerstrom 1939, Yeatter 1943, Schwartz 1945, Baker 1953). Crows (Corvus brachynchos) and horned owls are the only avian predators reported to have caused losses of greater prairie chicken nests (Hamerstrom 1939, Yeatter 1943). Grange (1948:115) listed snakes as an important nest predator in a study of three grouse species in Wisconsin. Yeatter (1943) also believed that snakes are potential predators on eggs of greater prairie chickens.

MATERIALS AND METHODS

The Study Area

The area on which this study was conducted was located 9 miles east of Junction City T12S, R7E of Geary County, Kansas and predominantly encompassed the 6,000-acre Simpson Ranch.

The topography of the study area consisted of branched, rounded ridges, belted with limestone exposures and crossed with intermittent streams. The elevation ranged from 1180 feet in the bottoms to over 1400 feet on the main ridge tops. (U.S. Department of Interior Geological Survey Contour Map, 1955).

The vegetation of the area was typical of the Flint Hills and has been described by Briggs (1968). Bidwell (1960) described the soil associations and major range sites of the study area.

From 1964 until 1968 grazing included moderate year-round cow-calf units, with some season-long grazing by steers and rotation of pastures. In the spring of 1968 the ranch was leased and season-long grazing by steers was the primary management practice.

Burning was initiated as a range management practice in April 1968 when the northern half of the ranch was burned. Subsequently, the southern half was burned in April 1969 and the northern half in April 1970.

Three greater prairie chicken booming grounds (north, central, and south) were active from 1964 to 1967. An additional "territorial male" booming ground (Hamerstrom and Hamerstrom 1949:327) was observed in the spring of 1967 (Silvy 1968:23). Only the north and central grounds were active in the spring of 1968 and 1969. All three grounds were active in spring 1970.

During the 1969-1970 phase of the study, an additional study area was used. This new area, the Lutheran pasture, was located 12 miles south and 2 miles east of Manhattan in T8, R13, S13 of Wabaunsee County, Kansas. This area was not used extensively for this study but trapping, banding and telemetry records from the area are included in this thesis.

Trapping, Banding and Telemetry

Cannon nets (Smith 1962:3) and mist nets (Silvy and Robel 1968) were used to live-trap female prairie chickens during the study. All trapped birds were banded and all females were equipped with miniature transmitters and released at the capture site. Trapping techniques were described in detail by Silvy (1968) and Watt (1969).

Telemetry equipment used in this study was developed by Marshall (1960) and was constructed by Sidney L. Markusen. A plastic capsule connection to conserve battery life, developed by Silvy (1968:29), was used in conjunction with a plastic tubing harness (Brander 1968) connected to the transmitter.

Telemetry techniques used in this study were described by Silvy (1968). The reliability and methodology of permanent antennas were discussed by Slade et al. (1965) and hand-held antennas by Watt (1969). An aerial search similar to that described by Hawkins and Montgomery (1969:198) and Artmann (Personal communication) was conducted when a signal was lost during regular ground procedures. A hand-held antenna was attached to the strut of a plane and a 50-square mile area was searched from a low altitude. When the signal was relocated, ground procedures were resumed for the lost female.

Dummy Nest Studies

Sixty-four dummy nests containing five uncleaned domestic hen (Gallus domesticus) eggs were placed on the study area for 21-day periods in May, June, and July of 1968 (Watt 1969:40), in June and July of 1969, and in May of 1970. During each of the six periods, equal numbers (16) of dummy nests were placed in each of four sites: claypan range site, shallow range site, limestone breaks range site, and a burned site. Nests in the burned site were placed in small grassy areas where the burn was incomplete.

A block of four nests in each site received different treatment (method of approach): four were inspected on foot, designated "walk;" four were inspected daily from a vehicle, designated "drive;" and four were marked with flags and approached daily to within 25 yards by vehicle and then inspected on foot, designated "flag." The final treatment consisted of four "control" nests which were not approached until the final day of the 21-day period. Standard references were used to identify predators responsible for nest destruction (Sooter 1946, Rearden 1951, Einarsen 1956).

Prairie Chicken Nest Studies

Prairie chicken nests were located by: 1) flushing transmitter-equipped females from suspected nesting sites, 2) observing areas frequented by females, 3) observing suspected feeding areas during morning and evening feeding periods, 4) searching suspected nesting habitat with the aid of a dog, and 5) dragging ropes across suspected nesting habitat.

Thermistor probes were inserted in the nests of transmitter-equipped females which permitted continuous nest attentiveness data to be gathered (Silvy 1968).

Weights and measurements were determined for greater prairie chicken eggs. Intact eggs were weighed to 0.01g, while the length and width of all eggs were determined to the nearest 0.01 cm.

Analysis Procedures

In past phases of study the mean area of monthly ranges or mean distance of daily movements have been used as indices to activity of female prairie chickens (Silvy 1968:48). These indices included the period when females were attending a nest but also included movements to the booming ground and movements when the females were not nesting. In this study, previous data and data which I collected were analyzed to determine the area used by a female during laying and incubation. The "nesting area" was determined by joining the outermost points of location (Mohr 1947) and measuring the area within the joined points. When eight or more telemetry readings were plotted to delineate the nesting area no significant ($P<0.05$) correlations were detected between the ranked size of the area and the ranked number of telemetry readings (Fryer 1966). Therefore eight locations was the minimum number used to determine individual nesting area.

The dummy nest data from Watt (1969) and the data collected in 1969-70 were tabulated and analyzed by an analysis of variance and the results subsequently tested using Fisher's Least Significant Difference (Fryer 1966). The numbers of destroyed dummy nests were compared in the four sites: claypan, shallow, limestone breaks range sites, and the burned site. The effects of the four treatments (walk, drive, flag, and control) and the variations in time (May, June, and July) were tested. Yearly differences in destruction for 1968 and 1969 were analyzed with the periods in May 1968 and May 1970 excluded. An additional source of variation, predator categories:

skunks, crows, and other agents, was analyzed with sites, treatments, and the time periods in 1969-70. Three variables were used in the four-way analysis of variance: the numbers of nests destroyed, the total days to destroy a block of four nests, and a ratio of the first two variables. The control nests were excluded from this analysis because the day of destruction was unknown. Nests which were not destroyed were assigned the value 21, the number of exposure days to potential destruction.

RESULTS

Trapping, Banding, and Telemetry

During the 1964-1970 study period 242 greater prairie chickens were trapped. Sixty-six birds were trapped during the 1969-1970 phase of the study; of these, 45 were banded (Table 1). Twelve birds were killed during the 1964-1970 trapping efforts, five in 1969-1970. During the 1969-1970 phase of the study three males and one female were killed during cannon net trapping and one adult male was killed by a coyote in a walk-in trap.

One hundred and twenty-two transmitters were placed on 93 birds during the entire study. Sixty-three transmitters were lost and 59 were recovered. Twenty-two transmitters were placed on 23 birds during the 1969-1970 phase, 12 of which were lost and 10 recovered. Six transmitters were broadcasting intermittently before their signals were lost. Three inoperative transmitters were observed on prairie chickens during the course of field work but these transmitter-equipped birds evaded recapture and the transmitters were not recovered. Of the 10 transmitters recovered, 4 were located after the prairie chickens carrying them had been killed by large carnivores, 5 were removed from recaptured birds, and 1 transmitter was taken from a bird killed by a cannon net.

Table 1. Summary of prairie chickens trapped by all methods for the entire study and for the 1969-1970 phase of the study.

	Trapping Method					
	Mist Net	Cannon Net	Walk-in	Hand or Dip-net	Bow Net	Totals
Entire Study						
Males	17	78	14	20	2	131
Females	12	21	6	23	0	61
Juveniles	7	7	14	20	1	49
Totals:	36	106	34	63	3	242
1969-1970						
Males	0	28*	9*	2*	0	39
Females	0	7	1*	2	0	10
Juveniles	0	3*	8*	6*	0	17
Totals:	0	38	18	10	0	66

* Data includes trapping by Bowman and Ballard (Personal communication) on the Simpson Ranch and Lutheran pasture in 1969- 1970.

Aerial searches were utilized four times and resulted in locating two birds which probably would not have been located by normal methods.

Booming Grounds

Censuses of the three traditional booming grounds during the height of the spring booming season resulted in totals of 31 male prairie chickens in 1964, 35 males in 1965, 35 in 1966, and 30 in 1967. Twenty-two males were on the north and central booming grounds in 1968. No observations were made on the three grounds in 1969. In 1970, 30 males were using the three grounds at the height of the season with 9 males on the central booming ground, 10 on the north and 11 on the south ground (Ballard Personal communication).

In 1970, observations were made during 54 mornings on the central booming ground. Trapping attempts were made on 47 of these mornings.

Decline in attendance of males on the central booming ground was observed as the season progressed (Fig. 1). The greatest number of males observed using the central booming ground in 1970 was 15 on March 18. No males were on the ground after the end of May.

The area around the north booming ground was intentionally burned on April 18, 1968 and on April 8-10, 1970. Visits of female prairie chickens to the north and central booming grounds were greatest during the first two weeks in April and during the second and third weeks in May 1968 (Fig. 2). In 1970 there were many female visits in mid-April but no peak occurred later in the season, although a few females continued to visit the booming grounds. In 1970, two copulations were observed on the central booming ground.

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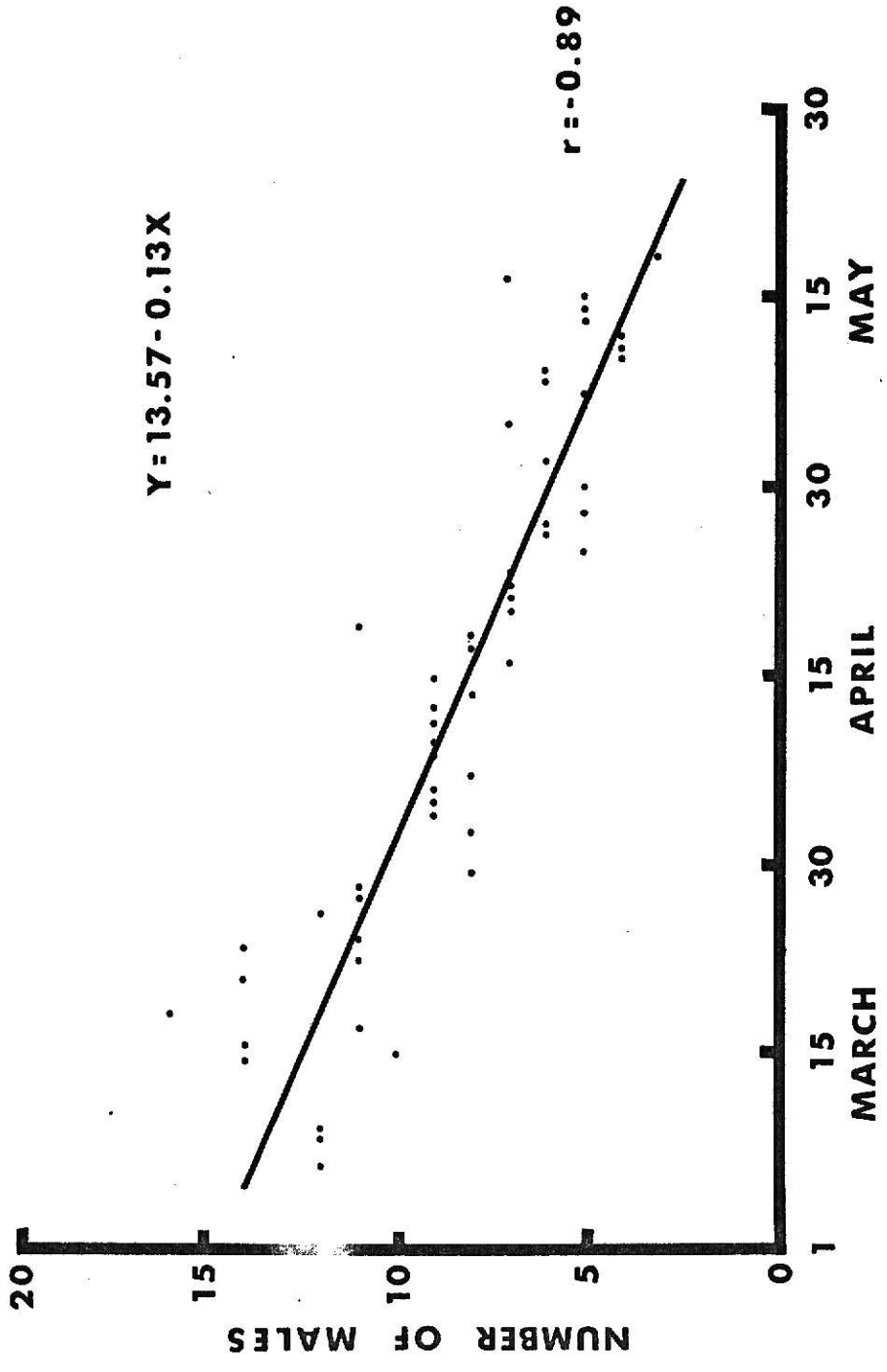

Fig. 1. Numbers of male prairie chickens on the central booming ground in the spring booming season of 1970.

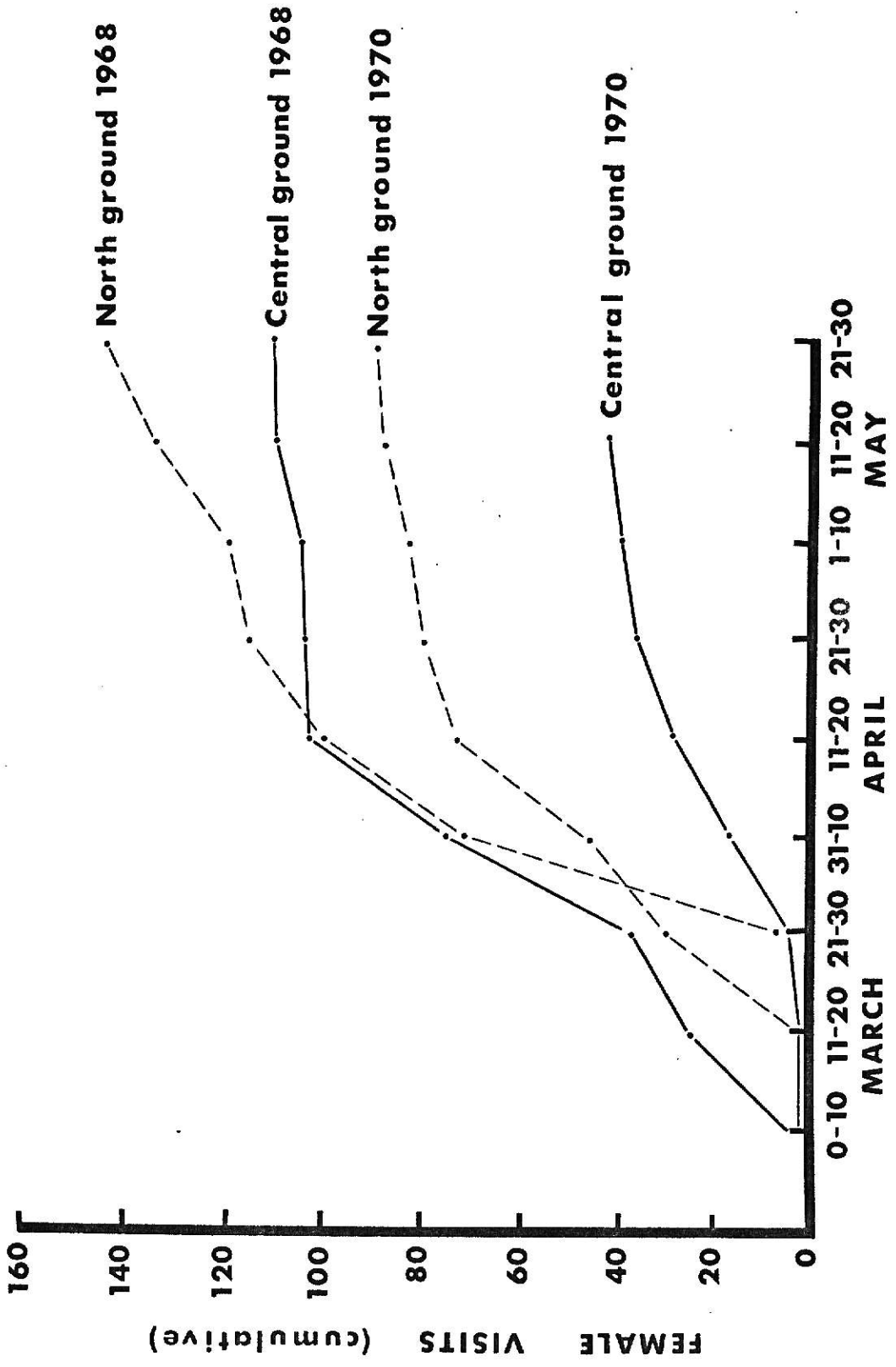

Fig. 2. Cumulative frequency of visits of female prairie chickens to booming grounds in burned areas, the north ground in 1968 and 1970; and unburned areas, the central ground in 1968 and 1970.

Dummy Nests

Throughout the entire dummy nest study, 285 of 384 nests were destroyed (Table 2). During the three periods in 1968 cattle destroyed 75 nests, striped skunks 14, undetermined agents 9, coyotes 9, crows 7, badgers (Taxidea taxus) 2, and one was accidentally destroyed by the research vehicle (Tables 3-5, appendix). In the 1969 and 1970 periods, skunks destroyed 78 nests, crows 53, unidentified agents 20, cattle 10, coyotes 6, an ornate box turtle (Terrapene ornata ornata) 1, and 1 was crushed by the research vehicle (Tables 6-8, appendix). In 1969 and 1970, 27 nests were destroyed by two or more agents and 7 were destroyed by predators over a period of two or more days.

Throughout the dummy nest study the nests marked with flags sustained more ($P<0.10$) destruction than walk, drive or control nests. There were no differences ($P>0.10$) between the numbers of nests destroyed in drive or walk nests or between walk and control nests.

No differences ($P>0.10$) were detected between the numbers of nests destroyed in the burned site, the claypan range site, or the shallow range site. The dummy nests in the limestone breaks range site sustained less ($P<0.10$) destruction than those in the claypan range site and the burned site, but were destroyed about as frequently as nests in the shallow range site.

A significantly greater ($P<0.01$) number of dummy nests were destroyed in June and July of 1968 than in June and July of 1969. No differences in numbers of nests destroyed ($P>0.10$) were detected between June 1968 and July 1968 or between June 1969 and July 1969.

Table 2. Summary of dummy nests destroyed during 1968, 1969, and 1970 in the four sites and by the four treatments.

	NUMBERS OF NESTS DESTROYED												
Range sites:	Claypan			Shallow			Limestone Breaks			Burned			Totals
Treatments:													
Years	May	June	July	May	June	July	May	June	July	May	June	July	
1968	0	3	4	1	2	3	0	0	1	2	4	4	24
Walk 69	-*	4	4	-	3	3	-	3	4	-	3	3	27
70	4	-*	-*	4	-	-	4	-	-	4	-	-	16
Totals:	4	7	8	5	5	6	4	3	5	6	7	7	
			19			16			12			20	67
1968	1	3	1	1	4	2	0	2	4	4	4	3	29
Drive 69	-	4	4	-	4	4	-	4	3	-	2	3	28
70	4	-	-	4	-	-	4	-	-	4	-	-	16
Totals:	5	7	5	5	8	6	4	6	7	8	6	6	
			17			19			17			20	73
1968	2	4	4	1	4	4	4	3	2	4	4	4	40
Flag 69	-	4	4	-	4	3	-	4	2	-	2	4	27
70	4	-	-	4	-	-	4	-	-	4	-	-	16
Totals:	6	8	8	5	8	7	8	7	4	8	6	8	
			22			20			19			22	83
1968	3	2	2	2	1	0	1	2	1	3	3	4	24
Control 69	-	4	3	-	3	4	-	3	4	-	2	1	24
70	3	-	-	3	-	-	4	-	-	4	-	-	14
Totals:	6	6	5	5	4	4	5	5	5	7	5	5	
			17			13			15			17	62
Grand Totals:			75			68			63			79	285

* Study not conducted during this time period.

Dummy Nests in 1969-1970

Skunks destroyed 44 percent of all the dummy nests which was significantly greater ($P<0.05$) than the 31 percent destroyed by crows or the 15 percent destroyed by other agents. The numbers of nests destroyed did not vary from the above pattern when either site-treatment or site-month comparisons were made (Table 9).

Skunk and crow predation was equivalent in all range sites with the exception of the burned site where crows destroyed no nests. Destruction by other agents was consistantly less than that of skunks and crows with the above exception (Fig. 3).

In June 1969 and May 1970 crows destroyed more dummy nests than skunks and skunks destroyed more nests than other agents (Fig. 4). In July 1969 this pattern was significantly altered ($P<0.01$) when skunks destroyed 75 percent of all dummy nests, other agents 12 percent, and crows destroyed no nests.

Blocks of burned site nests were destroyed on the 40.44 day which was significantly later ($P<0.05$) than destruction on the 34.33 day for blocks of nests in the shallow range site. Both of these means were significantly later ($P<0.05$) than the mean day of destruction (27.44 day) of a block of nests in the claypan range site or in the limestone breaks range site (28.11 day). Drive nests were destroyed significantly later ($P<0.05$) in the burned site than in the other three range sites. Walk nests in the shallow range site were destroyed later ($P<0.10$) than nests in the other sites.

Ratios were calculated for skunks, crows, and other agents by tabulating the number of nests in a block of four nests destroyed by each predator and dividing the total days it took all three predator groups to destroy that block of four nests. These ratios were used as variables in a four-way

Table 9. Analysis of variance of dummy nest data for June and July 1969, and May 1970 for three variables: nests destroyed, days to destroy a block of four nests, and the ratio of the first two variables.

Source of Variation	Degrees of Freedom	F-Ratios		
		Nests	Days	Ratio
Range Sites	3	0.217	9.184*	1.307
Treatments[1/]	2	0.061	1.946	1.426
Months	2	0.217	48.661*	4.658*
Predators[2/]	2	11.504*	0.000	5.811*
Site-Treatment	6	0.095	2.656*	0.286
Site-Month	6	0.286	6.843*	2.097*
Site-Predator	6	3.528*	0.000	3.216*
Treatment-Month	4	0.022	6.733*	1.820
Treatment-Predator	4	0.464	0.000	0.973
Month-Predator	4	13.220*	0.000	6.846*
Residual	68			

* $P<0.10$

1/ Flag, walk and drive treatments

2/ Skunks, crows and other agents

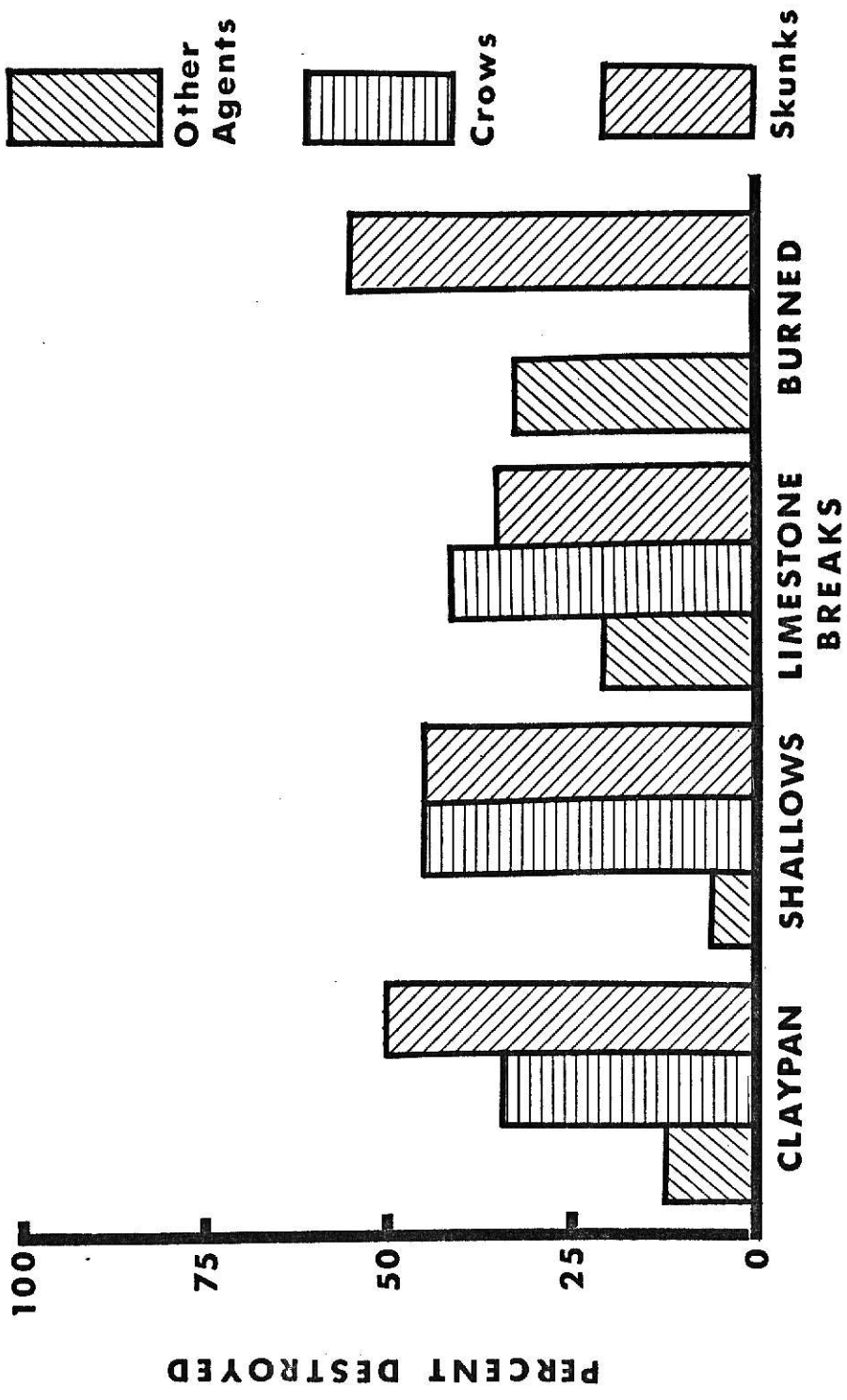

Fig. 3. Percent of dummy nests destroyed by skunks, crows and other agents in four range sites in June and July 1969 and May1970.

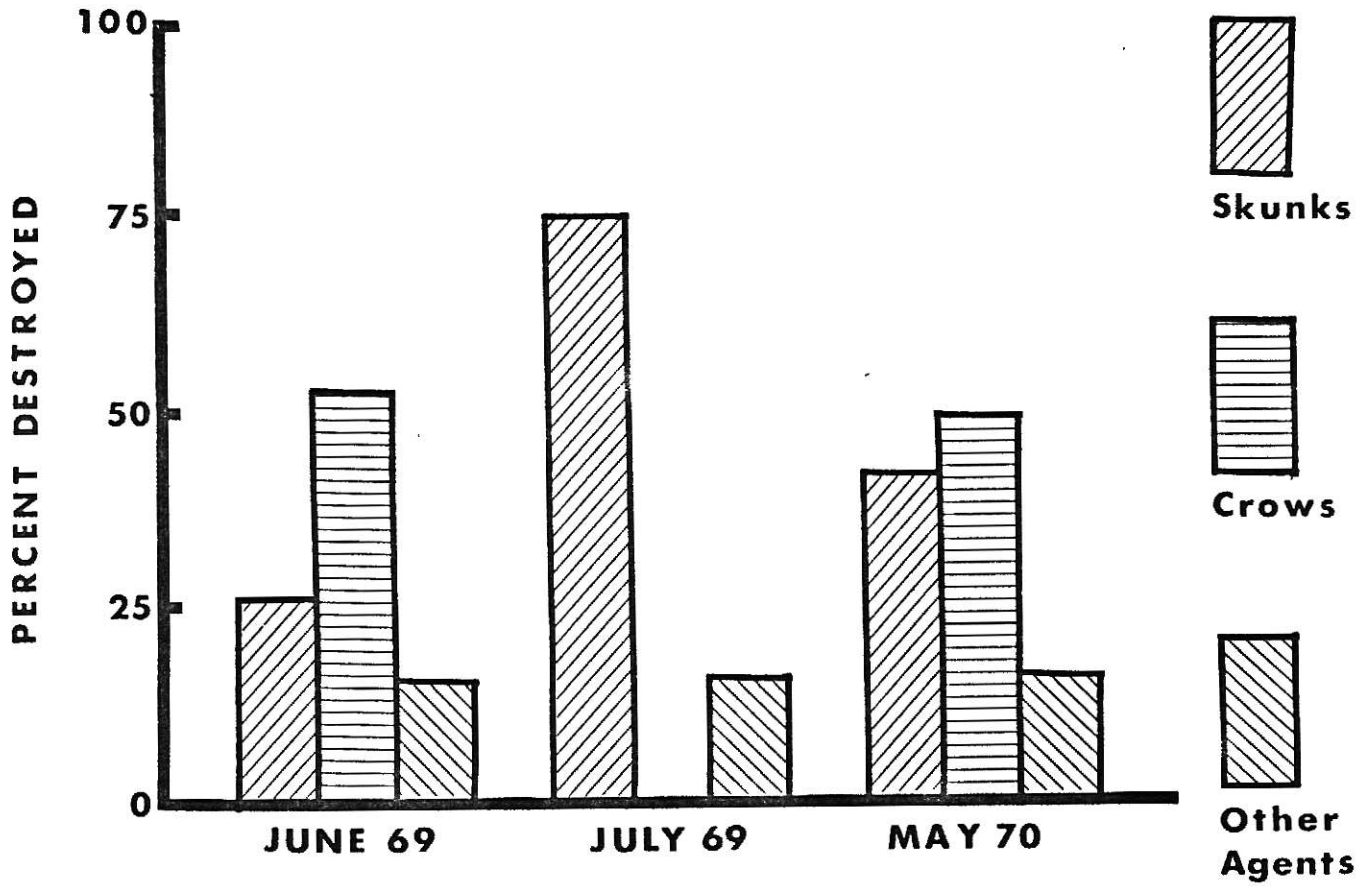

Fig. 4. Percent of dummy nests destroyed by skunks, crows and other agents in June 1969, July 1969 and May 1970.

analysis of variance to compare the destructive potential of the three predator groups. Skunks and crows had approximately equal ratios of 0.0614 and 0.0718, respectively. Other agents had a ratio of 0.0271 which was significantly lower ($P<0.05$) than those for skunks or crows.

The mean ratios for skunk predation were essentially the same for all range sites as were the ratios for other agents (Fig. 5). The crow ratio was higher ($P<0.10$) for the limestone breaks and shallow range sites than for the burned or claypan range sites. The ratio for crows was significantly higher ($P<0.05$) for the limestine breaks site than that of skunks or other agents.

The ratio for crow predation in June exceeded ($P<0.10$) the ratios for crows in other months and for skunks and other agents. The ratios for skunks were about the same for all months as were the ratios for other agents. Crows had a ratio of 0.0000 in July because no nests were destroyed by crows in July.

Greater Prairie Chicken Nests

Twenty-five prairie chicken nests were located during the entire study; of these, 13 were located by flushing nesting transmitter-equipped females. Five nests were accidentally discovered and two were found while observing females flying to their nests from feeding areas. Two were brought to the attention of the investigators by ranch personnel and two were discovered while investigators were dragging suspected nesting habitat with ropes. One nest was found while searching the controlled burn areas for nests (Table 10).

A total of 82 man-hours were spent observing suspected feeding habitat on 20 mornings during May and June of 1970. Three females were seen but nests were not subsequently located for these birds. During the first 15 days in June 1970, 47 man-hours were spent dragging ropes across suspected prairie chicken habitat. Two prairie chicken nests were located by this

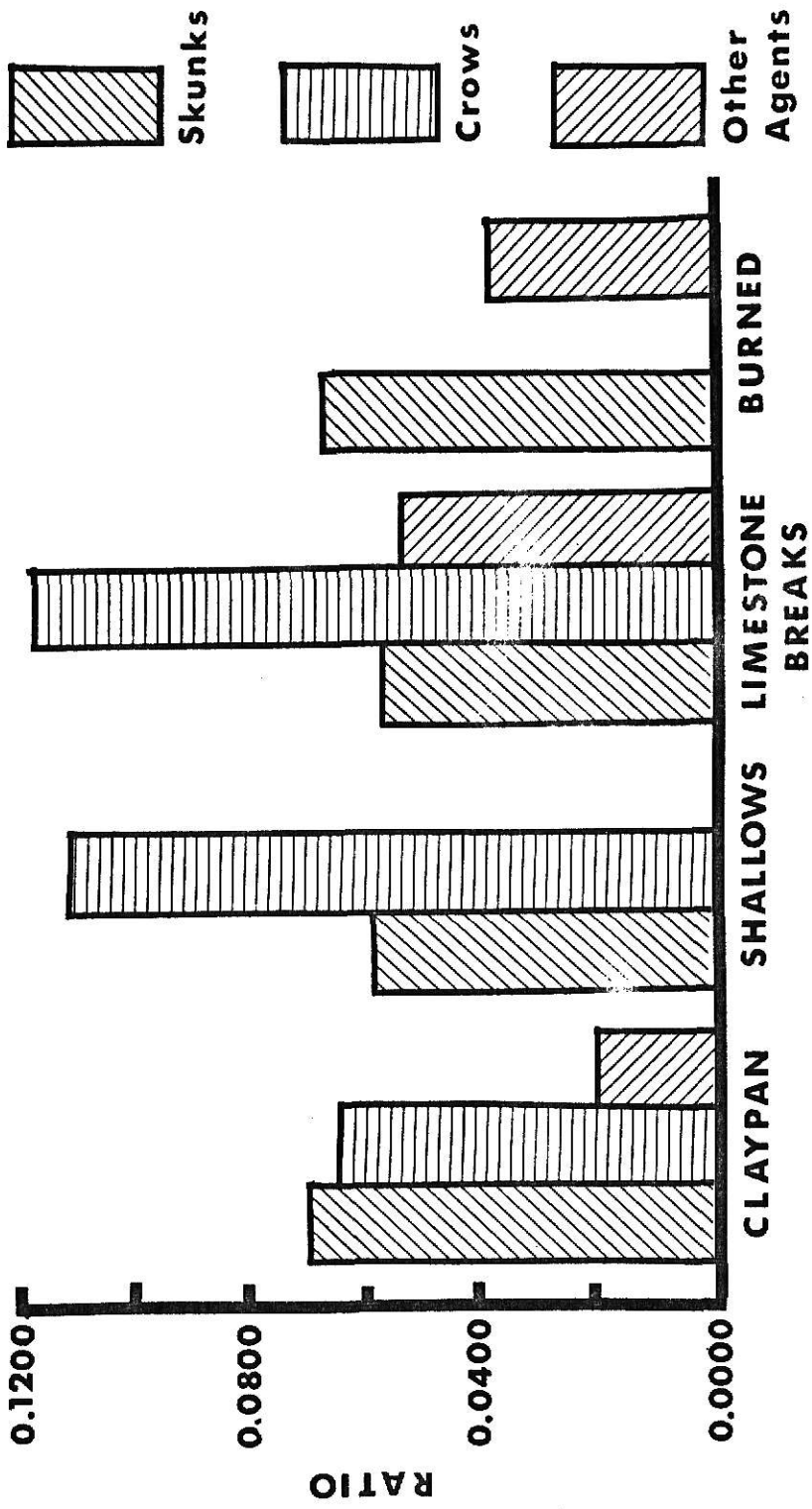

Fig. 5. The ratios (nests/day) for skunks, crows and other agents in the four sites in 1969-1970.

Table 10. Summary of data gathered from 25 prairie chicken nests during the entire study.

Bird or Nest Number	Distance to Nearest Booming Ground (yards)	Range Site	Direction of Slope	Nesting Area (acres)	Date of First Egg	Date of Last Use	Number of Eggs	Termination Reason
AF14	1298	lsb[1]	N	144	4-26-65	6- 3	13*	hatched
AF22	1430	s[2]	SE	-	4-19-65	5-27	15*	hatched
AF41	1430	s	SE	104	5- 4-66	5-13	9	predation
AF41	1690	s	N	31	5-28-66	6-25	7*	predation
AF42	1298	lsb	N	26	4-20-66	5-29	13*	hatched
AF51	1298	lsb	S	-	4-18-65	5-26	15*	hatched
AF52	1804	s	top	72	5-19-66	6-19	9*	cattle
AF53	704	s	N	60	5-25-66	6-10	8*	predation
AF54	638	s	N	-	5-19-66	6-24	13*	partial hatch
AF70	1848	s	NW	170	4-23-67	5-12	14*	predation
AF70	1650	s	N	103	5-20-67	6- 1	11*	predation
AF70	946	s	N	60	6- 7-67	6-28	9*	predation
AF71	1100	lsb	bottom	-	4-27-67	5-13	13*	predation
AF71	924	s	N	-	5-21-67	6- 9	11*	predation
AF83	528	s	N	-	5-26-67	6- 9	12*	deserted
AF207	1952	lsb	N	23	5-12-70	5-24	13*	predation
AF208	2668	s	N	64	5-11-70	5-26	11*	predation
NAF1	1364	s	N	-	-66	6-18	12	deserted
NAF2	1980	s	top	-	-66	-	-	unknown
NAF3	1320	lsb	E	-	-66	5-21	14	predation
NAF4	330	s	top	-	5-21-67	6-10	11*	predation
NAF5	462	s	S	-	-67	5-20	10	unknown
NAF6	948	lsb	S	-	-70	6- 2	11	predation
NAF7	1359	s	SW	-	-70	-	16	predation
NAF8	450	s	N	-	4-11-68	4-18	6	burned

[1] limestone breaks range site

[2] shallow range site

* indicates a complete clutch

method, plus the nests of 12 other ground nesting birds (Table 11, appendix).

The mean distance of the 25 prairie chicken nests to the nearest booming ground was 1,257±569[1/] yards (0.71±0.3 miles). Eighteen nests were located in shallow range sites and the remaining 7 were found in limestone breaks range sites. Fourteen nests were located on north facing slopes, 6 on south facing slopes, 3 on ridge tops, 1 in a draw, and 1 on an east facing slope. Two nests were within 8.5 feet of each other.

Four of the 25 prairie chicken clutches hatched and 1 clutch partially hatched. The latter clutch was partially destroyed by a skunk during pipping; at least 7 of the 13 eggs were destroyed.

Fourteen nesting attempts were terminated by predators. In 11 cases the females escaped, but their nests were destroyed. On two occasions both the female and the nest were destroyed by coyotes. One female was killed at the nest site but only two eggs in the clutch were destroyed.

Predators never destroyed a nest during the laying period; destruction was always during incubation. The average time from initial laying until predator termination was 19 days, which places nest destruction during the eigth day of incubation. The initial clutch of adult female AF41 may not have been completed prior to destruction but she was continually on her nest on the day of destruction which indicated that incubation had begun or was imminent.

Two nests were deserted and one was destroyed by cattle. One was terminated by an unknown agent and one nest which could not be relocated was presumed lost to a predator. One nest was destroyed during a controlled burn.

1/ Mean ±one standard error (Snedecor 1956)

The estimated dates of laying of the first egg of a clutch were from April 11 to June 7. Nine nests were begun before May 5, 10 were started after this date, and the initial dates for 8 nests were unknown. Three female prairie chickens were known to have renested. The second nesting attempt was begun by adult female AF70 on June 7. Four successful nests were started in April and one in May.

A negative correlation ($r=-0.82$) existed between the date nests were started and the number of eggs produced. There was significantly less ($P<0.02$) variation about the linear trend line in clutch size for those nests begun before May 5 than those begun after May 5 (Fig. 6). The average full clutch for the entire study contained 11.8 eggs and ranged from 7 to 16 eggs. The seven complete clutches begun before May 5 averaged 12.1 eggs and the later clutches averaged 10.2 eggs. The number of eggs comprising complete clutches of renesting females became smaller with each renesting effort. Adult female AF70 laid complete clutches of 14, 11 and 9 eggs. Adult female AF41 laid clutches of 9 and 7 eggs and adult female AF71 laid complete clutches of 13 and 11 eggs (Fig. 7).

Measurements of 60 greater prairie chicken eggs during the 1966-1967 phase of study averaged 4.17 ± 0.02cm (mean $\pm$ standard error) in length and 3.20 ± 0.01cm in width. The average weight was 23.73 ± 0.10g for 23 eggs measured during early stages of incubation (Silvy 1968:58). Eggs from the second and third nests of female AF70 and the second nest of female AF71 did not vary significantly in size from eggs in their first nests. In 1970 measurements were made on the eggs remaining in the nest after the death of AF207. One small prairie chicken egg in this clutch weighed only 11.75 grams and measured 3.44x2.68cm. The other nine eggs in the clutch appeared normal and their average weight was 21.90 ± 1.40 grams. The nine

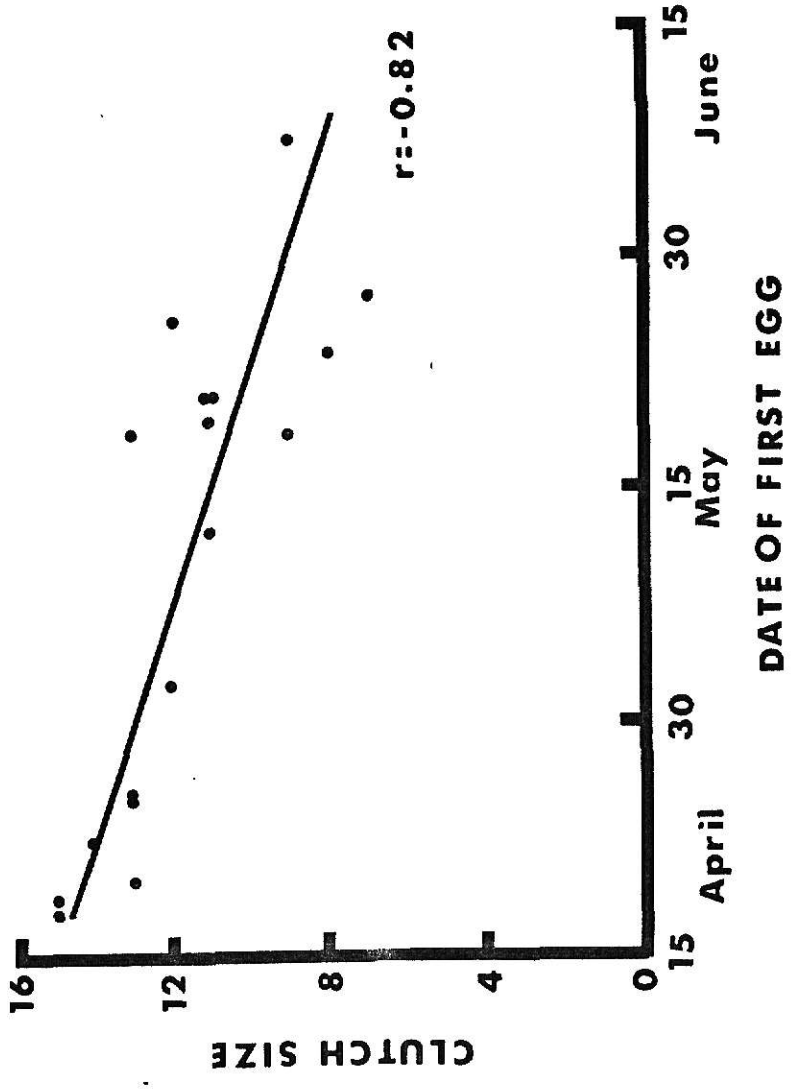

Fig. 6. Relationship between numbers of eggs in a clutch and the date the first egg was laid.

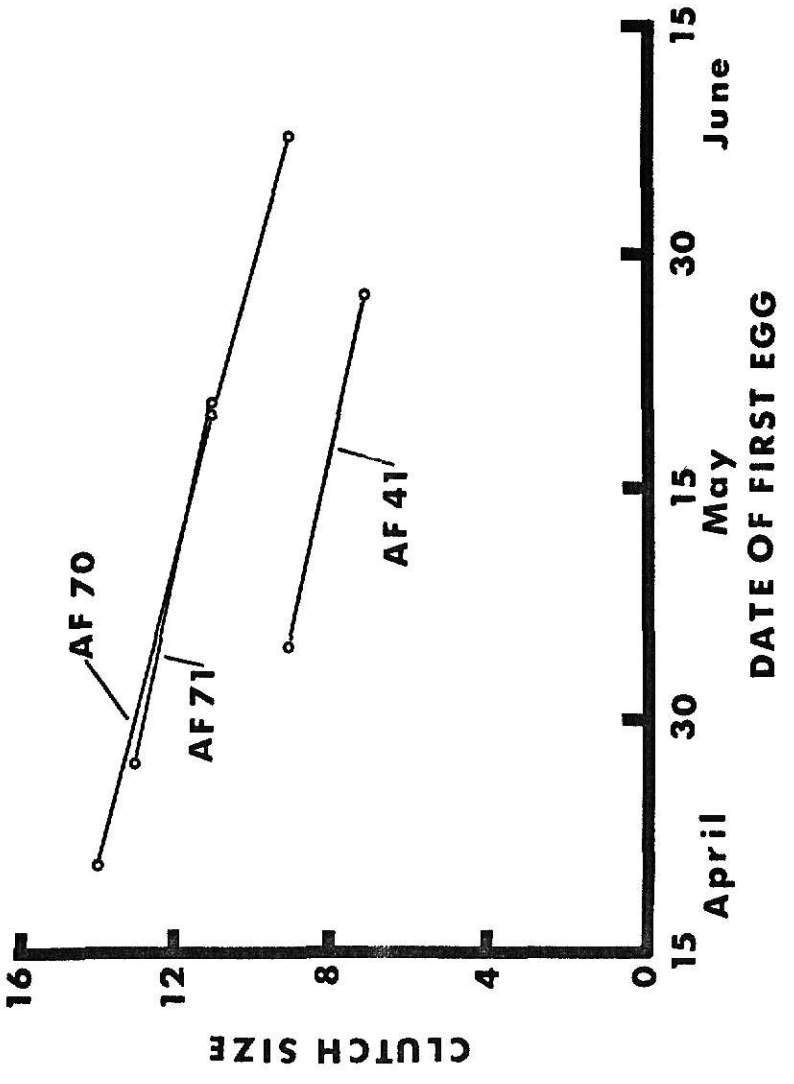

Fig. 7. Diagram showing the reduction in clutch size as the nesting season progressed for three adult females: AF70, AF71 and AF41.

normal eggs had an average length of 4.33±0.16cm and an average width of 3.23±0.03cm (Table 12). Six eggs in the nest of adult female AF208 were sufficiently intact after predation to get partial measurements. The average length was 4.23±0.30cm and the average width was 3.10±0.10cm (Table 13).

Nesting Behavior

During the entire study 1,185 hours of egg-laying and nest attentiveness data were obtained for five female prairie chickens. During the 1969-1970 phase of study a total of 145 hours of data were recorded for adult female AF207 (Table 14) and adult female AF208 (Table 15) before termination of their nesting efforts. Adult female AF207 was killed and eaten by a coyote near her nest early in the morning of May 24, 1970. Female AF208 left her nest prior to its destruction by a skunk early in the morning of May 26, 1970.

The average time spent off the nests by females AF207 and AF208 was 38 minutes in the morning and 50 minutes in the evening period during incubation.

After an unsuccessful attempt was made to capture adult female AF207 on May 22, 1970 she remained on the nest during the morning of May 23 and the evening feeding period on May 23 was the shortest recorded for her. Adult female AF208 was flushed from her nest on May 21 but had a normal feeding pattern on May 22, 1970. Female AF208 left her nest at 2255 hours on May 22 and did not return until 0950 hours on May 23, which is atypical for nesting prairie chickens.

Both females laid their eggs at the rate of one per day during the periods of laying when the nests were checked for egg numbers. One discrepancy was noted. Female AF208 was presumed to have begun laying on May 11, 1970 based on the beginning of incubation and backcounting a day per egg in the clutch. She visited the central booming ground on May 13-14 and

Table 12. Lengths, widths, and weights of nine greater prairie chicken eggs from the nest of AF207. Two eggs in the nest had been destroyed by a skunk prior to making the measurements.

Eggs	Length(cm)	Width(cm)	Weight(g)
1	4.49	3.30	23.83
2	4.56	3.20	23.04
3	4.15	3.25	22.49
4	4.40	3.24	22.47
5	4.38	3.25	21.90
6	4.32	3.23	21.88
7	4.38	3.26	21.67
8	4.25	3.21	20.86
9	4.04	3.17	18.93
Means	4.33 ± 0.16 [1]	3.23 ± 0.03	21.90 ± 1.40

[1] Standard error

Table 13. Measurements made on intact egg shells in the nest of adult female AF208 after skunk predation.

Eggs	Length(cm)	Width(cm)
1	4.37	3.17
2	4.21	3.05
3	4.36	3.12
4	4.18	3.05
Means	4.23 ± 0.30 [1]	3.10 ± 0.10

[1] Standard error

Table 14. Nesting activity determined from changes in nest temperature during the incubation period of female AF207 during 1970.

Date	Morning		Evening	
	Departure	Return	Departure	Return
May 19			1900	1924
20	0656	0735	1819	1901
21	0639	0705	1802	1935
22	0741	0802	1822	1858
			2207	2300
23			1823	1848
24	0104 Female killed by coyote.			

Table 15. Nesting activities of AF208 determined from nest temperature change during her incubation period prior to nest destruction.

Date	Morning		Evening	
	Departure	Return	Departure	Return
May 21			1735	1955
22	0507	0613	2005	2100
			2255	
23		0950		
24	No record			
25			1628	1922
			2010	2035
26	0345 Nest destroyed by a skunk			

copulated on May 15, the morning of her final visit to the booming ground. This would have placed the initial laying four days prior to copulation.

At the beginning of incubation nests were shallow depressions one to three inches deep. They were lined with dead vegetation found at the nest site and were in clumps of dead grass of the previous year's growth. Females did not cover their nests when they left to feed.

Nesting areas used by eight females ranged from 26 acres to 170 acres (Fig. 8). Adult female AF41 reduced the size of her nesting area from 104 acres to 31 acres when she renested. Adult female AF70 reduced the size of her nesting areas with each successive nesting effort. The first area was 170 acres, the second 103 acres, and the third 60 acres.

DISCUSSION

The Booming Ground

In 1970 the greatest number of male prairie chickens were present on the central booming ground early in the spring booming season and there was a consistent decrease as the season progressed. This booming ground attendance pattern by male prairie chickens was similar to those reported by Hamerstrom (1941), Robel (1967), and Watt (1969).

In 1970 the trends for female prairie chicken visits to both the north and the central booming grounds were similar although the area around the north booming ground was burned and the number of visits was greater on the north ground. Watt (1969:67) reported a dicotomy in frequencies of female visits to the central and north booming grounds in the spring of 1968. After burning the area around the north booming ground there was a marked increase in female visits to that ground, but no increase was observed on the central booming ground which was in a pasture not burned that year.

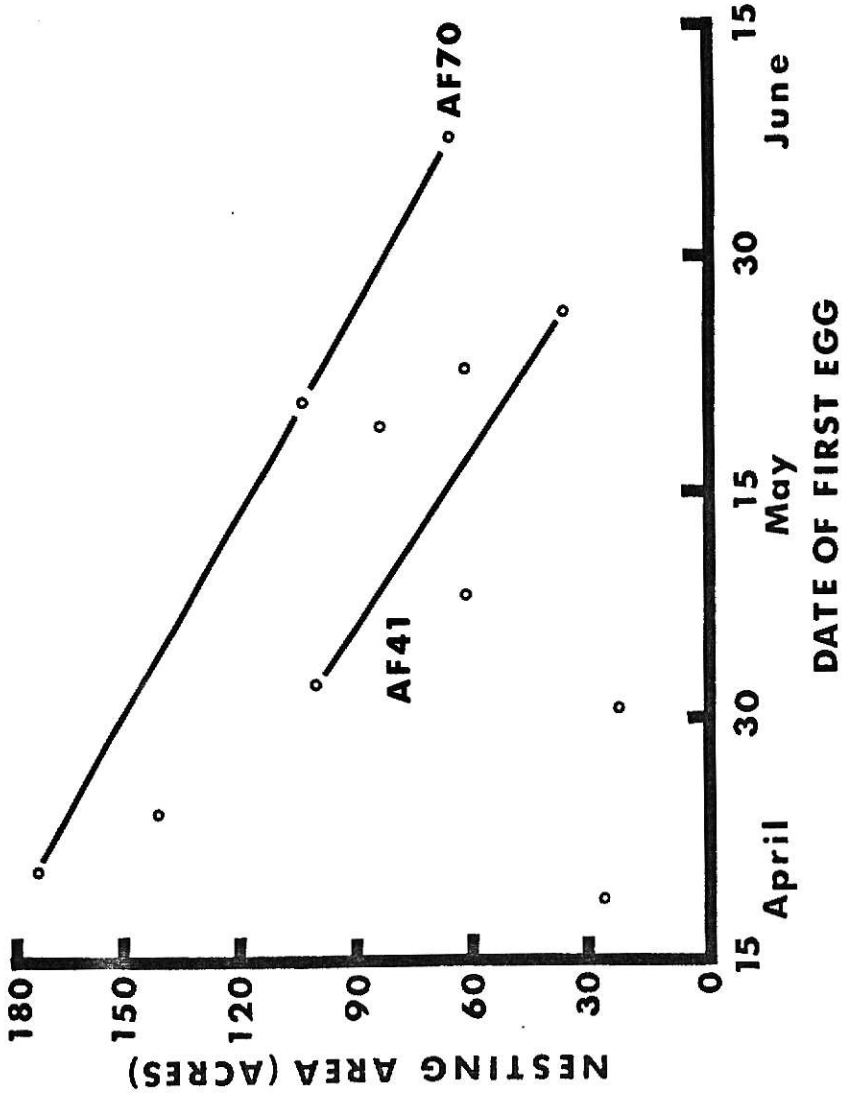

Fig. 8. Diagram showing the season-long reductions in the sizes of the nesting areas of renesting adult females, AF70 and AF41. The unconnected points represent the sizes of the nesting areas of females not known to renest during the study.

The increased numbers of visits to the north booming ground indicated that the controlled burn destroyed a number of first nests of prairie chickens in the area around the north booming ground and the increase was due to renesting. A possible reason for the lack of a noticeable second peak of female visits on the north ground during 1970 following the controlled burn may have been due to the early burn, April 8, prior to nesting of hens on the study area. All copulations on the north booming ground occurred after the burn which meant that nests were not present when the burn occurred. Thus no nests were destroyed.

Only two copulations were observed on the central booming ground during 1970. This low number was probably the result of the early losses of the alpha and beta males from the booming flock and the harassment of the males by trapping attempts. The two females which copulated had been transmitter-equipped earlier and no attempts were made to capture them while they were on the booming ground. Silvy (1968:99) observed small numbers of matings in 1966 and 1967 and stated that continued disturbances may have resulted in females visiting other booming grounds or visiting the central booming ground after early morning trapping operations had been completed.

Dummy Nests

Dummy nests marked with flags sustained more ($P<0.10$) destruction than walk, drive, or control nests. Cattle frequently trampled the flag nests, completely destroyed 36 nests and partially destroyed 4 others making these nests more susceptible to predation. Frequently, flags were chewed off the supporting stakes by the cattle in 1969-1970 but eggs in the dummy nests were not destroyed. The affinity of cattle for flag marked nests was due to their tendency to congregate around foreign objects (blinds, fence posts, piles of stones, etc.) erected in a pasture (Watt 1969:101). When cattle were present at a dummy nest, they matted the grass and concealing vegetation

around it, thus exposing the nest to visual predators. Many times cattle mashed several eggs in the nest which increased the odor of the nest and enhanced the possibility that an olfactory predator would find it.

Crows also contributed to high losses of flag nests. They destroyed 16 nests and opened eggs in 13 other nests which were later found and destroyed by skunks. The additional visual clue of the flag may have been a reason for high losses of these nests to crows. Van Tyne and Berger (1959), Walls (1942), and Welty (1962) were among many authors who have pointed out the excellent vision of birds and its use in finding food. Exendine (1970:12) noted that crows and ravens destroyed eggs for no apparent reason in a dummy lesser prairie chicken nest study in Oklahoma.

The destruction by cattle of 32 dummy nests in the burned site was also due to the tendency of cattle to congregate around foreign objects in a pasture. The white domestic chicken eggs probably attracted the attention of the cattle which concentrated in the small unburned areas to bed down (Watt 1969:101).

Significantly more ($P<0.05$) burned site nests were destroyed in 1968 than nests in the other three range sites (Watt 1969). When the data for 1968 were combined with 1969-1970 data, more ($P<0.10$) burned site nests were destroyed than limestone breaks nests but there were no differences ($P>0.10$) between burned, claypan, and shallow range site nests. Crows did not destroy burned site nests in 1969-1970. However skunks destroyed over 50 percent of all dummy nests in the burned site in 1969-1970. This indicated that the success of renesting female prairie chickens would be very poor in pastures that had been burned earlier in the year because skunks were effective prairie chicken nest predators in burned pastures.

Destructive Agents, 1969-1970

In 1968-1970 skunks destroyed 44 percent of all dummy nests which was significantly greater ($P<0.05$) than the 31 percent destruction by crows or 15 percent destruction by other agents. For all treatments skunks destroyed more nests than crows and crows more than other agents. Although crows had an advantage in finding flag marked nests because they are daylight feeders and responded to visual clues, they were not more efficient at destroying flag nests than skunks, which are nocturnal feeders (Hall 1955). This advantage that crows had in finding nests was not manifest in the analysis because crows frequently did not take all the eggs from a nest on the day the nest was initially raided. On seven occasions crows took eggs from nests which were later destroyed by skunks.

In 1969-1970 skunk and crow predation was similar in all range sites with the exception of the burned site nests which crows did not destroy. Alternating halves of the Simpson Ranch were burned during 1968-1970. Therefore dummy nests in the burned site were placed on the half of the study area opposite the dummy nests in the range sites. In 1969-1970 crows were not seen in the half of the ranch that was burned but were frequently seen in the unburned areas which may explain the lack of burned site dummy nest destruction by crows. Contrary to this, in 1968 Watt (1969:102) believed that crow predation was associated with burned sites.

Although in 1969-1970 skunks destroyed 44 percent of the dummy nests and crows destroyed only 31 percent, skunks had a slightly lower nest/day ratio than crows (0.0614 and 0.0718, respectively). This means that crows destroyed nests early in the 21-day experimental period, while skunk predation was not time related or occurred later in the period. Other agents had a low ratio of 0.0271 because regardless of time relation, these agents

never destroyed many nests. After crows had destroyed the poorly concealed dummy nests, they ceased searching the area for dummy nests or continued to locate other exposed food items. Skunks searched an area more intensively than crows and were able to locate well concealed nests. Prairie chicken nests, which were well concealed, were never destroyed by crows during the entire study but skunks found and destroyed 9 of 25 nests observed during the study.

Disturbances of Prairie Chicken Nests

There were no significant differences in destruction between walk nests and control nests throughout the entire dummy nest study. Walk nests were inspected daily and the control nests were never visited. This meant that daily visits to a dummy nest had a minimal effect on the "success" of the dummy nest. Human visits to prairie chicken nests probably had a minimal effect in regards to predators finding the nest. However human disturbances caused two females to abandon their nests during this study. Minimally, visits to a nest disrupted normal feeding patterns. Adult female AF207 skipped a morning feeding period and fed briefly in the evening after she had been flushed from her nest late the previous day. Alterations in normal prairie chicken behavior caused by human visits to a nest may persist after the human has left the nest site. A decrease in the wariness of the hen and an increase in the possibility of nest predation could have resulted. For example, AF70 was killed by a coyote on her nest during the third nesting attempt in a season, after the previous two nesting attempts had been continuously monitored and she had been exposed to considerable human disturbances.

Nest Locations

All prairie chicken nests during the entire study were found in either the limestone breaks or the shallow range sites. Three of seven (43 percent) nests in the limestone breaks range site hatched. Two of 18 (11 percent)

prairie chicken nests in the shallow range site hatched; 1 hatched completely and 1 hatched a minimum of three chicks. Therefore, although prairie chickens nested less frequently in the limestone breaks range site, their nests were more successful than those in the shallow range site.

Dummy nest data substantiated the fact that fewer nests were destroyed in the limestone breaks range site. Nests in the limestone breaks range site sustained less ($P<0.10$) destruction than nests in the claypan range site or the burned site but losses were equivalent to those in the shallow range site

The distance from 25 prairie chicken nests to the nearest booming ground averaged 0.71 ± 0.3 miles during the entire study. This was very similar to the report of Horak (1967:7) for 10 nests in Kansas which averaged 0.78 miles from the nearest booming ground. Jones (1963:772) found nests within 1 mile of the nearest booming ground in Oklahoma. Hamerstrom (1939:115) stated that such groupings of nests were not by chance and believed that females in Wisconsin tended to nest near the booming ground on which they mated.

It is interesting to note that adult females AF207 and AF208 nested 1.52 and 1.11 miles from the central booming ground where they both mated. In both instances the closest booming ground was the central ground where they mated. Although booming grounds were about 1.50 miles apart on the study area their linear arrangement permitted these birds to nest long distances from the nearest booming ground.

The preponderence of nests during the study have been located on north facing slopes which was similar to the findings of Horak (1967:7) in Kansas who found nests primarily on north and west facing slopes. The paucity of data for this aspect of nest site selection did not permit an explanation. However, several possible explanations were suggested: reduction in temperature extremes and prevailing wind exposure or increased cover density.

Nesting Losses

During the entire study, 20 of 25 nesting attempts were terminated before hatching; 14 of these nests were destroyed by predators. Hamerstrom (1939), Grange (1948), Lehmann (1941), and Baker (1953) all reported losses of prairie chicken nests to predators. Three nesting hens were killed during the study. Two of their nests were completely destroyed but in one nest only 2 of 13 eggs were destroyed. Hamerstrom (1939), Ammann (1957), and Lehmann (1941) all reported losses of nesting hens.

There was evidence that predators clued on the female rather than the nest prior to its destruction. In no case did a predator destroy a nest during the laying period. Silvy (1968) reported that females spent an average of only 3.25 hours per day on the nest during laying. Destruction was always during incubation when females typically spent over 22 hours per day on the nest. It seemed likely that the presence of the female at the nest amplified the possibility that a predator would find the nest even if the predator did not capture the hen. In 11 out of 14 nesting attempts terminated by predators, only the eggs were destroyed. Adult female AF208 spent an entire night away from her nest during incubation and the presumed cause of her absence was a predator. Her nest was not destroyed that night but had the predator been searching for the nest rather than adult female AF208 the nest should have been destroyed.

Clutch Size

The average completed clutch size for the entire study was 11.8 eggs and ranged from 7 to 16 eggs. This average was similar to the average clutch sizes reported by Hamerstrom (1941), Gross (1932), Yeatter (1943), Ammann (1957), Baker (1953), and Schwartz (1945).

When clutch sizes and the initial laying dates of 17 nests were compared,

a negative correlation ($r=-0.82$) was found. Significantly greater ($P<0.02$) variation in clutch size about the linear trend line was found for the 10 nests started after May 5 (presumed renesting attempts) than for the 7 nests begun before May 5. A possible explanation for this variability in clutch size for renesting attempts was based on the time of loss of the first nests to predators. Seventy-five percent (3 of 4) of the known renesting females reduced the size of their clutches by two eggs. Predators never destroyed nests during laying but destroyed many nests during the 23-day incubation period. Hypothetically, a female laying 15 eggs in her first clutch begun on April 15 might have her nest destroyed from April 30 (first day of incubation) until May 23 (the last day of incubation). The renesting clutch (15 eggs minus 2 eggs = 13 eggs) would then be initiated between May 5 and May 28, after allowing 3-5 days to initiate renesting. This or any other similar pattern, would have introduced considerable variation about the linear trend line for the decline in the size of renesting clutches.

The season long decline in clutch size may have resulted from divergent reproductive capacities of the females visiting the booming ground manifested by age, aggression, or a combination of these two mechanisms.

Of the 33 females captured on the booming grounds none were 1-year old females. The capture methods (cannon nets and mist nets) presumably were not selective for older females and the absence of captured 1-year old females intimated their absence from the booming ground or presence in low numbers. Schwartz (1945:58) calculated sex ratios from birds seen on booming grounds and found 32 percent were females. This low proportion of females may have reflected the lack of attendance by 1-year old females rather than a skewed sex ratio.

Lack (1966:44) stated that yearling great tits (Parus major) had on the

average, smaller clutches than the older parents. Kluyjver (1951) and Lack (1958 and 1966) both showed that the average clutch of the great tit and blue tit (Parus caeruleus) varied with the date of laying and the age of the parent.

Aggressiveness of females was noted by Silvy (1968:52) on several occasions. On March 23 and March 28, 1967 females were observed to mount juvenile males after juvenile males had completed nuptial bows. Aggression between females was observed on the central booming ground during 1966 and 1967. Adult female AF42 was observed to exclude five other females from the territory of the breeding male for two days. On the third day the aggressive female copulated after which aggression between females was no longer observed. Aggressive interactions were observed between females on the central booming ground on three other occasions in 1966 and 1967. Hamerstrom and Hamerstrom (1960) reported aggressive behavior among female prairie chickens prior to copulation. Robel (1970:311) stated that differential aggressiveness in females may result in delays of copulation (and nesting) for subordinate birds. Scott (1942) reported aggressive behavior on the lek for female sage grouse (Centrocercus urophasianus) and Lumsden (1968) also described aggressiveness in female sage grouse but did not believe it was a persistent social hierarchal characteristic.

Guhl (1950) indicated that female chickens high on the peck order were less likely to mate than their social inferiors. Johnstone (1969) reported that submissive female black grouse (Lyrurus tetrix) were involved in a greater number of copulations. In this study the female prairie chickens which copulated first were involved in fewer copulations because the earliest nests were the successful nests. It was only the unsuccessful females who returned to the booming grounds to initiate renesting efforts. Robel

(1967:112) stated that copulations in late May probably reflected renesting attempts by females.

Nesting Behavior

Females fed during the morning and evening for periods less than one hour with few exceptions. Females remained away from the nest up to three hours when flushed from the nest and frequently omitted feeding periods following disturbances. Regular morning and evening absences from the nest were reported by Silvy (1968), Watt (1969), Schwartz (1945), Gross (1932), and Lehmann (1941).

The sizes of nesting areas declined for successive nesting attempts by two nesting females. This trend probably resulted from the increased abundance of food sources near the nests as succulent parts of plants became more available. Thus the females fed closer to the nest and nesting area was reduced.

Nests were never covered with vegetation during the incubation periods of the two females observed during this phase of study. Silvy (1968:55) did observe that the nest of adult female AF83 was covered with plant material on two occasions when she was gone from the nest during the laying period. Gross (1932:248) reported that female prairie chickens generally did not cover their nests during incubation, but that some females covered exposed nests with nesting material before departing during the laying period.

The measurements of the eggs found in 1970 were similar to the findings for 60 eggs from Kansas (Silvy 1968) and for 100 eggs from Wisconsin (Gross 1932).

CONCLUSIONS

The following conclusions are justified by the data collected during the study:

1. Daily visits to dummy nests did not increase the probability of their destruction by predators. However, human disturbances could have contributed to losses of greater prairie chicken nests through disruptions of the normal behavioral patterns of the hens.

2. Burning of pastures in late April or early May had the potential of destroying most prairie chicken nests and increasing predation on those remaining nests in small unburned areas. Dummy nest data indicated that renesting attempts in burned pastures were not likely to be successful.

3. Predators probably clued on the nesting females rather than their nests since all prairie chicken nest destruction occurred during incubation when females spent over 22 hours per day on the nest.

4. Typically, female greater prairie chickens laid one egg per day until the clutch was completed both early and late in the nesting season.

5. Female prairie chickens had regular morning and evening feeding periods during incubation.

6. Greater prairie chicken hens frequently renested after the loss of the initial nest.

7. Dummy nest data indicated that nests located in the limestone breaks and shallow range sites were destroyed less frequently than nests in the claypan range site or the burned site. Greater prairie chicken nests located in the limestone breaks range site were destroyed less frequently than nests in the shallow range site.

8. Nesting areas became smaller with successive renesting as females utilized food sources nearer their nests.

SUMMARY

The objectives of this study were to determine the effects of nest location, nest inception, and nest predation on greater prairie chicken production. Dummy nest studies facilitated these objectives and additional data were gathered to supplement the information acquired earlier in the study on greater prairie chicken nesting behavior.

Cannon nets and mist nets were used to live-trap female greater prairie chickens. Trapped birds were banded, transmitter-equipped, and released at the capture site. Aerial searches were made for lost birds. Nests of greater prairie chickens were equipped with thermistor probes to gather continuous nest attentiveness data.

Sixty-four dummy nests containing five uncleaned domestic hen eggs were placed on the study area for 21-day periods in May, June, and July of 1968, in June and July of 1969, and in May of 1970. During each period equal numbers of nests were placed in each of four sites: claypan, shallow, and limestone breaks range sites, and a burned site. A block of nests in each site received different treatment. Walk nests were inspected daily on foot. Drive nests were inspected daily from a truck. Flag nests were marked with flags and approached daily to within 25 yards by truck and then inspected on foot. Control nests remained uninspected until the end of the 21-day period.

During 1964-1970, 242 greater prairie chickens were trapped. Ninety-three birds were transmitter-equipped. Four aerial searches were conducted and two birds were relocated using this technique.

Attendance of male prairie chickens on the central booming ground declined as the season progressed. Female visits to the central and north grounds were recorded in 1968 and 1970. A marked rise in female visits to

the north ground in 1968 may have reflected renesting of prairie chickens following spring burning.

A total of 285 of 384 dummy nests were destroyed. Skunks destroyed 92 dummy nests, cattle 85, crows 60, unidentified agents 29, coyotes 15, badgers 2, the research vehicle 2, and an ornate box turtle 1. Dummy nests marked with flags sustained more destruction than did other nests. This may have resulted from the additional visual clue to predators and the affinity of cattle for foreign objects in a pasture. In 1969-1970 skunks destroyed over 50 percent of the dummy nests in burned sites which indicated that renesting attempts in pastures after they were burned were likely to be unsuccessful.

In 1969-1970 skunks destroyed 44 percent of all dummy nests, crows 31 percent, and other agents 15 percent. Crows did not destroy dummy nests in the burned site but the number of nests they destroyed was similar to skunks in the three range sites. Crows destroyed nests early in the 21-day experimental periods while skunks destroyed nests later in the periods.

Daily visits to dummy nests had little effect on their "success." Human visits to prairie chicken nests may have disrupted the normal behavioral patterns of hens and made the nests more susceptible to predation.

Prairie chicken nests were found in shallow and limestone range sites. Although fewer nests were found in the limestone breaks range site than in the shallow range site, nests in the limestone breaks range site were more successful. Fewer dummy nests were destroyed in the limestone breaks than in the claypan range site.

The distance of prairie chicken nests to the nearest booming ground was 0.71 miles although several nests were over 1 mile away.

Of the 25 greater prairie chicken nests found during the entire study, 4 hatched and 1 partially hatched. Fourteen of the 25 nests were destroyed

by predators. Predators destroyed prairie chicken nests during incubation when hens spent over 22 hours per day on their nests. This indicated that predators clued on the female rather than the nests prior to nest destruction.

The estimated dates of first laying fell between April 11 and June 7. Nine nests were begun before May 5, 10 were started after this date. The initial dates for eight nests were not known. Four successful nests were started in April and one in May.

A negative correlation ($r=-0.82$) existed between the date the nests were started and the number of eggs produced. The season long decline in clutch size may have resulted from divergent reproductive capacities of the females visiting the booming ground manifested by age, aggression, or a combination of these two mechanisms.

There was significantly less ($P<0.02$) variation about the linear trend line in clutch size for those nests begun before May 5 than those begun after May 5. The time during incubation of initial nest destruction and the reduction of clutch size of usually two eggs was cited as possible causes for variability in the size of renesting clutches.

Females laid one egg per day until their clutches were completed. During incubation females never covered their nests when absent for regular morning and evening feeding periods but occasionally covered them during the laying period.

Measurements of 13 prairie chicken eggs from this study were similar to 60 eggs from Kansas (Silvy 1968) and to 100 eggs from Wisconsin (Gross 1932).

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APPENDIX

Table 3. Dummy nest results from May 1968 summarizing the agents of destruction and the day on which the nest was destroyed.

Treatment	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk		21	Sk	1		21		21
		21		21		21		21
		21		21		21	Cr	19
		21		21		21	Ca	19
Drive	Cy	14		21		21	Cr	19
		21	Sk	14		21	Ca	21
		21		21		21	Cr	16
		21		21		21	Cy	15
Flag	Ca	12	Cr	1	Sk	8	Ca	1
	Ca	7		21	Cy	10	Ca	18
		21		21	Ca	6	Ca	21
		21		21	?	1	Ca	16

[1] Destructive agents: Cr crow
Cy coyote
Sk skunk
Ca cattle
? unknown agent
A blank indicates an undestroyed nest

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 4. Dummy nest results from June 1968 summarizing the agents of destruction and the day on which the nest was destroyed.

Treatments	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk	Sk	8	Ca	6		21	Cy	10
	Sk	18	Ca	10		21	?	5
	Ca	3		21		21	Cr	5
		21		21		21	Ca	9
Drive	Ca	1	Ca	2	Ca	1	Cr	6
	Ca	18	Ca	3	Ca	8	Ca	6
	Ca	12	Sk	21		21	?	1
		21	Sk	21		21	Sk	9
	Ca	13	Ca	5	Ca	1	Sk	5
	Ca	2	Cy	9	Ca	6	Ca	5
	Ca	9	Ca	5	Ca	4	Ca	1
	Ca	10	Cy	5		21	Ca	5

[1] Destructive agents: Cr crow
Cy coyote
Sk skunk
? unknown agent
A blank indicates an undestroyed nest.

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 5. Dummy nest results from July 1968 summarizing the agents of destruction and the day on which the nest was destroyed.

Treatments	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk	Ca	9	Ca	3	Ca	5	Sk	18
	Ca	4	Sk	3		21	Ca	4
	Ca	1	Ca	19		21	Ca	12
	Sk	1		21		21	Ca	9
Drive	?	20	Ca	15	Ca	10	Ca	2
		21	Sk	15	Cy	14	Ca	8
		21		21	Ca	3	Ca	13
		21		21	Ca	20		21
Flag	Ca	4	Ca	8	Ca	1	Ca	4
	Ca	14	Ca	2	Ca	4	Ca	4
	Ca	3	Ca	15		21	Ca	1
	Ca	17	Ca	2		21	Ca	4

[1] Destructive agents: Cy coyote
Sk skunk
Ca cattle
? unknown agent
A blank indicates an undestroyed nest.

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 6. Dummy nest results from June 1969 summarizing the agents of destruction and the day on which the final egg in the nest was destroyed.

Treatments	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk	Cr/Ca	17	Cr	3	Ca	3	Sk	4
	Cr	5	Cr	10	Cr	3	Ca/Sk	4
	Cr	10	Cr	18	Ca/Sk	17	Ca/Sk	4
	Ca/Cr	6		21		21		21
Drive	Ca/Cr	10	Cr	3	Sk	2	Ca/Ca/Sk	14
	Cr	3	Sk	1	Cr	1	Sk	1
	Cr	6	Sk	3	Cr	3		21
	Tr	1	Cr	3	Ca	3		21
Flag	Ca/Cr	11	Ca/Cr	3	Ca	3		21
	Sk	10	Cr	3	Cr	1	Sk	1
	Cr	2	Cr	1	Cr	1	Sk	6
	Cr	3	Cr	3	Cr	1		21

[1] Destructive agents: Cr crow
Ca cattle
Sk skunk
Tr research vehicle
/ a lapse between days

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 7. Dummy nest results from July 1969 summarizing the agents of destruction and the day on which the final egg in the nest was destroyed.

Treatments	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk	Ca/Sk	18	Sk	18	Sk	15	Ca/Sk	16
	Sk	10	Sk	1	Sk	6	Sk	18
	Sk	2	Sk	6	Sk	3	Sk	3
	Sk	2		21	Sk	6		21
Drive	Ca/Sk	2	Sk	11	Ca/Sk	6	Ca/Tt	12
	Sk	9	Sk	11	Sk	6	Sk	19
	Sk	6	Sk	20	Sk	1	Sk/Cy	16
	Sk	3	Sk	20		21		21
Flag	Sk	6	Sk	11	Sk	6	Ca/Ca	6
	Sk	1	Ca/Ca/Sk	18	Sk	17	Ca/Ca/Ca	5
	Ca/Ca	13	Ca/Sk	10		21	Sk	20
	Sk	9		21		21	Sk	6

[1] Destructive agents: Cy coyote
Ca cattle
Tt turtle
Sk skunk
/ lapse between days
A blank indicates an undestroyed nest.

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 8. Dummy nest results from May 1970 summarizing the agents of destruction and the day on which the final egg in the nest was destroyed.

Treatments	Range Sites							
	Claypan		Shallow		Limestone Breaks		Burned	
	Agents[1]	Day[2]	Agents	Day	Agents	Day	Agents	Day
Walk	Cr	5	Sk	5	Cr	5	Sk	2
	Cy	5	Cr/Sk	6	Cr	5	Sk	2
	Cr	3	Cr	5	Cr	5	Sk	9
	Ca/Sk	8	Cr	5	?	5	Cy	8
Drive	Cr	5	?	5	Cr	5	Sk	2
	Cr	5	Cr/Cr	3	Cr	5	Sk/ ?	2
	Cr/Cr	8	Cr	5	Cr	5	Sk	9
	?	5	Cr/Cr	6	?	5	Ca	2
Flag	Sk/Sk	7	Cr/Sk	8	Cr/Sk	8	Sk	2
	Cr/Sk	6	Cr/Sk	6	Cr	5	Cy	9
	Cr/Sk	7	Cr/Cr/Cr	8	Cr	5	?	8
	Cr/Sk	8	Cr	5	?	5	Cr	7

[1] Destructive agents: Cr crow
Cy coyote
Ca cattle
Sk skunk
? unknown agent
/ lapse between days
Blank indicates that the nest was not destroyed.

[2] Days: 1-21 indicates the day on which the nest was destroyed. A 21 indicates that the nest was not destroyed.

Table 11. Summary of the data gathered for ground nests of species other than prairie chickens during 1970 while dragging ropes across suspected prairie chicken nesting habitat.

Date Discovered	Species	Range Site	Clutch Size	Young in the nest	Nest Status
May 6	Dove[1]	Shallows	2	-	Incubation
June 1	Dove	Limestone Breaks	-	1	Brooding
	Dove	Limestone Breaks	2	-	Incubation
2	Dove	Shallows	-	1	Brooding
	Dove	Shallows	2	-	Incubation
	Dove	Old Field	1	-	Incubation
4	Dove	Shallows	-	2	Brooding
	Meadowlark	Shallows	6	-	Incubation
5	Meadowlark	Shallows	4 + 1 Cowbird egg	-	Incubation
	Meadowlark[2]	Shallows	2	-	Unknown
	Upland plover	Limestone Breaks	4	-	Incubation
	Dove	Limestone Breaks	-	2	Brooding
12	Meadowlark[2]	Shallows	1	-	Egg destroyed by a cowbird
13	Dove	Shallows	2	-	Incubation
	Meadowlark[2]	Hay field	1	-	Egg destroyed by a mammal
	Night hawk	Limestone Breaks	2	-	Incubation

[1] Located during routine field work, not while dragging.

[2] Eggs found on ground but not in a nest

A STUDY OF DUMMY NESTS AND GREATER PRAIRIE CHICKEN (TYMPANUCHUS CUPIDO PINNATUS) NESTS IN NORTHEASTERN KANSAS WITH NOTES ON FEMALE NESTING BEHAVIOR

by

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The objectives of this study were to determine the effects of nest location, nest inception, and nest predation on greater prairie chicken (Tympanuchus cupido pinnatus) production. Dummy nest studies facilitated achieving these objectives and additional data were gathered to supplement the information acquired earlier in a study of greater prairie chicken nesting behavior.

Female greater prairie chickens were live-trapped, banded, transmitter-equipped, and released at the capture site. Aerial searches were made for lost birds. Nests of greater prairie chickens were equipped with thermistor probes to gather continuous nest attentiveness data.

Sixty-four dummy nests containing five uncleaned domestic hen eggs were placed on the study area for 21-day periods in May, June, and July of 1968, in June and July of 1969, and in May of 1970. During each period 16 dummy nests were placed in each of four sites: claypan, shallow, and limestone breaks range sites, and a burned site. A block of nests in each site received different treatment. Walk nests were inspected on foot. Drive nests were inspected from a truck. Flag nests were marked with flags and approached daily to within 25 yards by truck then inspected on foot. Control nests remained uninspected until the end of the experimental period.

Female visits to the central and north grounds were recorded in 1968 and 1970. A marked rise in female visits to the north ground in 1968 may have reflected renesting of prairie chickens following spring burning.

A total of 285 of 384 dummy nests were destroyed. Skunks destroyed 92 dummy nests, cattle 85, crows 60, and other agents 48. Dummy nests marked with flags sustained more destruction than did other nests. This may have resulted from the additional visual clue to predators and the affinity of cattle for foreign objects in a pasture. In 1969-1970 skunks destroyed

over 50 percent of the dummy nests in burned sites which indicated that renesting attempts in pastures after they were burned were likely to be unsuccessful. Crows destroyed dummy nests earlier in the 21-day experimental periods than did skunks.

Daily visits to dummy nests had little effect on their "success". Human visits to prairie chicken nests may have disrupted the normal behavioral patterns of hens and made the nests more susceptible to predation.

Fewer nests were found in the limestone breaks range site than in the shallow range site, but nests in the limestone breaks range site were more successful.

The distance of prairie chicken nests to the nearest booming ground was 0.71 miles although several nests were over 1 mile away.

Fourteen of 25 greater prairie chicken nests were destroyed by predators. Predators destroyed nests during incubation when hens spent over 22 hours per day on their nests. This indicated that predators clued on the female rather than on the nests prior to nest destruction.

Nine nests were begun between April 11 and May 5. Ten nests were begun between May 5 and June 7. Four successful nests were started in April and one in May. A negative correlation existed between the date the nests were started and the number of eggs produced. This may have resulted from divergent reproductive capacities of the females. There was significantly less variation about the linear trend line in clutch size for those nests begun before May 5 than those begun later. The time during incubation of the initial nest destruction was cited as a possible cause for variability in the size of renesting clutches.

Females laid one egg per day until their clutches were completed. Females were absent from the nest for regular morning and evening feeding periods during incubation.