Nesting and brood rearing ecology of the greater prairie chicken in the Sheyenne National Grasslands, North Dakota

by Jay Arnold Newell

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
This study was undertaken to gain insight into the nesting and brood rearing ecology of the greater prairie chicken. Forty-six prairie chicken, two sharp-tailed grouse and one hybrid hen(s) were radio-tagged and relocated every other day from nest initiation until late August in 1983 and 1984. During these periods, 1675 relocations were taken. Incubation of initial nests began in the first week of May in 1983 and 1984. Incubation periods were 26.6 and 26.4 days for initial nests and renests, respectively. Average clutch size for initial nests and renests was 13.7 (n=41) and 11.4 (n=l8), respectively, with 85% of the eggs hatching in initial nests and 92.8% hatching in renests. Over 72% of the renests and 46.5% of the initial nests had eggs that hatched. Thirty-six percent of the chicks produced came from renests. Twenty-eight-percent of the juveniles and 88.2% of the adults renested. Of the observed nests, 5 4.1% had eggs that hatched and 57.9% of the radio-tagged hens were successful in bringing off a brood. Of 76 observed grouse nests, 77.6% were initiated on public grasslands, 13.2% in alfalfa and 9.2% in privately owned grasslands. Lowland communities which had the densest cover and tallest vegetation in the spring harbored the most nests and produced the most chicks. Brood and nonbrood hens had summer ranges averaging 488.6 and 1143.2 ha, respectively. Small areas within the total summer range were used more intensively. These"areas of intensive use averaged 40.4 ha for broods and 85.8 ha for non-brood hens. Brood hens appeared to use denser vegetation than non-brood hens especially in July and August. Over 74% of all relocations were in areas without cattle and 11 of 13 hens selected pastures without cattle when renesting. None of the non-brood hens and only 1 of 22 brood hens localized in cash crops during the summer months. Mortality of hens was 47.7% and only 28.4% of 261 chicks survived until 31 August. Management of the grasslands to improve initial nest success and increase brood survival should halt recent declines in the prairie chicken population on the Sheyenne National Grasslands.

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APPROVAL

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Jay Arnold Newell

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

This study was undertaken to gain insight into the nesting and brood rearing ecology of the greater prairie chicken. Forty-six prairie chicken, two sharp-tailed grouse and one hybrid hen(s) were radio-tagged and relocated every other day from nest initiation until late August in 1983 and 1984. During these periods, 1675 relocations were taken. Incubation of initial nests began in the first week of May in 1983 and 1984. Incubation periods were 26.6 and 26.4 days for initial nests and renests, respectively. Average clutch size for initial nests and renests was 13.7 (n=41) and 11.4 (n=18), respectively, with 85% of the eggs hatching in initial nests and 92.8% hatching in renests. Over 72% of the renests and 46.5% of the initial nests had eggs that hatched. Thirty-six percent of the chicks produced came from renests. Twenty-eight percent of the juveniles and 88.2% of the adults renested. Of the observed nests, 54.1% had eggs that hatched and 57.9% of the radio-tagged hens were successful in bringing off a brood. Of 76 observed grouse nests, 77.6% were initiated on public grasslands, 13.2% in alfalfa and 9.2% in privately owned grasslands. Lowland communities which had the densest cover and tallest vegetation in the spring harbored the most nests and produced the most chicks. Brood and non-brood hens had summer ranges averaging 488.6 and 1143.2 ha, respectively. Small areas within the total summer range were used more intensively. These areas of intensive use averaged 40.4 ha for broods and 85.8 ha for non-brood hens. Brood hens appeared to use denser vegetation than non-brood hens especially in July and August. Over 74% of all relocations were in areas without cattle and 11 of 13 hens selected pastures without cattle when renesting. None of the non-brood hens and only 1 of 22 brood hens localized in cash crops during the summer months. Mortality of hens was 47.7% and only 28.4% of 261 chicks survived until 31 August. Management of the grasslands to improve initial nest success and increase brood survival should halt recent declines in the prairie chicken population on the Sheyenne National Grasslands.

INTRODUCTION

The greater prairie chicken (Tympanuchus cupido) has declined in numbers in recent years. Westemeier (1980) reported that populations have declined in 11 of 12 states and completely disappeared in 6. Conversion of prairie to cropland, overgrazing, annual burning, annual haying, and other agricultural activities continue to be the main cause of population declines. Although these activities are credited with causing the recent declines in prairie chicken populations, historically less intensive agriculture is believed to have caused increases in local populations and allowed them to extend their range northward (Hamerstrom et al. 1957).

Schwartz (1945), Baker (1953), and Hamerstrom et al. (1957) estimated that 30, 60, and 30% of occupied habitat in Missouri, Kansas, and Wisconsin, respectively, had to be maintained in permanent grassland if a viable prairie chicken population was to exist. Hamerstrom et al. (1957) further stated that birds were abundant only in areas with at least 35% grassland. Quality of the permanent grassland is also very important. Christisen and Krohn (1980), comparing three areas in Missouri, found that the region with the greatest amount of permanent grassland had a lower density of prairie chickens than expected, which they attributed to the poor quality of grassland available. Lack of quality grassland most often affects the availability of nesting and brood rearing habitat, considered to be the most important factor influencing prairie chicken population levels (Hamerstrom et al. 1957, Kirsch 1974, Westemeier 1980). Ecological requirements of hens during the nesting and brood rearing periods is not well understood (Hamerstrom and Hamerstrom 1973) even though radio telemetry studies have yielded more information on habitat use and movements during these periods (Silvy 1968, Bowman and Robel 1977, Svedarsky 1979).

One study including both sharp-tailed grouse (Tympanuchus phasianellus) and prairie chickens was conducted on the north unit of the Sheyenne National Grasslands (SNG) (Manske and Barker 1981). My study was initiated in the spring of 1983 with the following objectives:

(1) to determine the nesting and brood rearing habitat requirements of the greater prairie chicken

(2) to evaluate the effects of grazing management practices on prairie chicken habitat

(3) to develop management recommendations that may be compatable to both prairie chickens and livestock on the north unit of the Sheyenne National Grasslands.

Field work was conducted from March through August in

1983 and 1984. In 1985 John Toepfer collected data on nesting hens following a winter field season. Parts of those data are incorporated in this report.

STUDY AREA

The north unit of the Sheyenne National Grasslands (SNG) is located approximately 36 kilometers (km) southwest of Fargo North Dakota (ND) and encompasses approximately 27,150 hectares (ha) of federal land interspersed with 25,338 ha of private land (Fig. 1). Federal land is administered by the United States Forest Service (USFS) in cooperation with the Sheyenne Valley Grazing Association (SVGA). The primary economic use of the SNG is cattle grazing. There were 56 grazing allotments with 59 grazing systems utilized on public land. Allotments contain from one to five pastures, each with slightly different management schemes. Within an allotment cattle are usually grazed on a one-pasture continuous, a two-pasture rotational, a seasonal deferred rotation, or short duration basis. Because of the wide variety in number of pastures, dates of use and differences in stocking rates, the grazing systems are difficult to categorize. Table 1 presents the grazing systems utilized based on the number of pastures within an allotment. Grazing usually began 15-20 May and lasted for 5.5 to 6 months, ending 15-20 November.

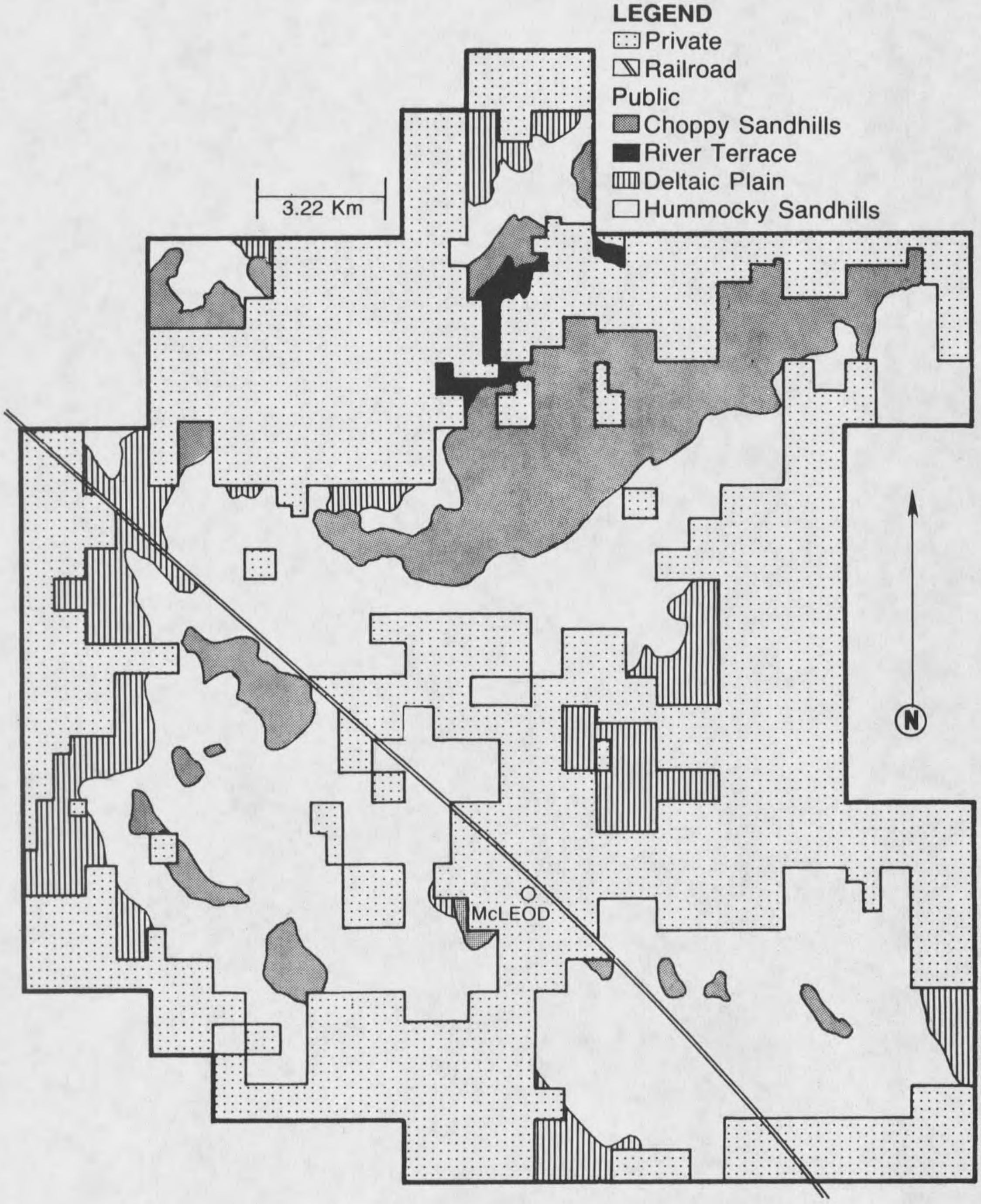

Fig. 1. The north unit of Sheyenne National Grasslands (habitat associations adapted from Manske 1980, habitat associations shown only on USFS land).

Table 1. Grazing systems used on the Sheyenne National Grasslands based on the number of pastures within an allotment, 1983-1984.

Grazing system *	Number of pastures	Hectares public	Hectares private	Hectares total
1-pasture	13	2083	65	2148
2-pasture	13	4104	0	4104
3-pasture	26	15136	470	15606
4-pasture	5	4893	0	4893
Short duration	2	917	0	917
No grazing	1	17	0	17
Total	60	27150	535	27685

*Some grazing allotments have 5 pastures but were treated as a 3-pasture and 2-pasture system within those 5 pastures.

In general 3-pasture deferred systems in areas where trapping was conducted were managed as follows: Pasture A was deferred in 1985, B in 1984 and C in 1983. Cattle were moved into pasture A in mid-May 1983, rotated to pasture B in mid-June, to A in mid-July, to B in mid-August and finally to the seasonal deferred pasture C in mid-September. Lessees were encouraged to mow the lowlands in the deferred pasture, C, prior to 1 August. The type of rotation system varied on a yearly basis and among allotments, depending upon pasture sizes within each allotment. In this system all pastures are grazed every year with grazing "deferred" in one pasture during the peak growing period (May - September 15). This is in contrast to rest rotation where one pasture is ungrazed for a whole year. Often the lessee was able to obtain permits to mow lowland vegetation in other pastures within the allotment. In two pasture systems, cattle were placed in one of the pastures for approximately 1 month and then moved to the second pasture for approximately 2 months. The lessee was then allowed to mow lowlands in the first pasture before cattle were moved back in. Continuous grazing pastures had cattle in them from the start of the season until the end, with mowing occurring in some of the lowlands during July. In addition to mowing small areas were burned in the spring to stimulate new growth for cattle forage.

The privately owned land was used for grazing, raising alfalfa (Medicago spp.), prairie hay, or corn (Zea spp.) silage for livestock or raising cash crops such as corn, sunflowers (Helianthius spp.), soybeans (Glycine spp.), and small grains. In addition, some private land was incorporated into grazing allotments (Table 1).

The entire area is located on a geologic formation known as the Sheyenne Delta, formed during the end of the Wisconsin Glaciation (Seiler 1973). Deposition of sands, clays, and gravels occurred when the glacial meltwater of the Sheyenne River emptied into glacial Lake Agassiz. Below the delta is a nearly impervious layer of lake sediments creating a high water table.

The SNG is subject to a continental climate with cold winters and hot summers. In McLeod (Fig. 1) the average annual temperature is 5.5 Celsius (C). The coldest month of the year is January and the warmest months are July and August with mean temperatures of -13.5 C, 21.6 C, and 21.1 C, respectively. Mean annual precipitation is 49.8 centimeters (cm) with 79% of this falling from April through September. The frost free period averages 130 days beginning in mid-May.

The vegetation on the SNG consists of native woodland and grassland interspersed with croplands and associated introduced species. Manske (1980) described four habitat associations on the SNG (Fig. 1), of which prairie grouse primarily utilized two, the hummocky sandhill and deltaic plain. The hummocky sandhills association, consisting of gently rolling hummocks with relief of 1.5 to 3 meters (m) comprises the largest portion of the SNG. Soils of this association are primarily well drained loamy fine sands. Three fairly distinct plant communities have developed on each hummock. The upland community exists on the shoulder slopes of the hummocks. Dominant species of the upland are blue grama (Bouteloua gracilis), Kentucky bluegrass (Poa pratensis), sunsedge (Carex heliophila), needle and thread (Stipa comata), and prairie sandreed (Calamovilfa longifolia). The midland habitat exists on the back slopes and extends into the foot of the hummock. Dominant species are big bluestem (Andropogon gerardi), little bluestem (Andropogon scoparius), Kentucky bluegrass, and switchgrass (*Panicum virgatum*). At the foot of each hummock and extending to the foot of the next hummock is the lowland community. Dominant species are *Carex lanuginosa*, Kentucky bluegrass, northern reedgrass (*Calamagrostis inexpansa*), Baltic rush (*Juncus balticus*), and switchgrass. In addition to the three native communities described above by Manske (1980) an upland shrub community was recognized in the current study. The upland shrub community usually occurs on the shoulders of hummocks and can extend to the foot. This community is most often dominated by snowberry (*Symphoricarpos occidentalis*) with an understory of associated upland or midland grasses and forbs.

Manske (1980) described the deltaic plain habitat association as the second largest association on the SNG. This association has little or no relief. Soils are loamy and have a higher moisture availibility than soils in the hummocky sandhill association. Two plant communities were described, the midland with dominant species Kentucky bluegrass, big bluestem, little bluestem, and Indiangrass (*Sorghastrum nutans*) and the lowland with dominant species slender spikerush (*Eleocharis compressa*), *Carex lanuginosa*, northern reedgrass, and Kentucky bluegrass. The uplands in this association, which have dominant species similar to those in the hummocky sandhill association, are limited in number. One additional less common lowland native community was identified during this study, the lowland II community dominated by prairie cordgrass (Spartina pectinata), northern reedgrass, Kentucky bluegrass, and Carex spp.

Both the deltaic and hummocky sandhill associations have small areas of planted shelterbelts, tree claims, groves of aspens (Populus tremuloides) and cottonwoods (Populus deltoides) and small wetlands dominated by a wide variety of species. Major farming activities in the hummocky sandhills includes corn for silage, alfalfa, prairie hay and grazing. The deltaic plain is more intensively farmed and cash crops such as corn, soybeans, small grains, and sunflowers are grown. In addition, alfalfa, prairie hay and silage are produced for winter livestock feed on the deltaic plain habitat association. Prairie hay fields in hummocky sandhills usually remain in native vegetation while many fields in the deltaic plain have been planted to species such as reed canary grass (Phalaris arundinacea), redtop (Agrostis alba), smooth brome (Bromus inermis) and Kentucky bluegrass.

METHODS

Censusing

Booming and dancing grounds were censused in April by USFS and study personnel. Numbers of grouse on display grounds (arenas) were counted by USFS personnel one to three times during a 1-week period. Research personnel censused arenas in the vicinity of trapping activities a minimum of three times during the month of April. All males on grounds were identified as prairie chickens, sharptails, or prairie chicken x sharptail hybrids.

Trapping, Banding and Radio Tagging

Four booming grounds were selected for trapping based on accessibility, distance from field station, and number of displaying cocks. Trapping was conducted throughout the month of April, rotating efforts among booming grounds to minimize disturbances.

Most grouse were captured on arenas during the morning display period with: 1) paired rocket nets placed over the dominant cock, (used only in 1983); 2) bownets (Anderson and Hamerstrom 1967); and 3) walk-in traps, an experimental modification of a clover leaf trap. To replace a faulty transmitter, one hen on a nest was recaptured with a long handled net.

Grouse were weighed using a single counter balance scale or a Pesola spring scale. Age was determined by outer primary wear (Petrides 1942, Wright and Hiatt 1943, Ammann 1944) and scapular molt (Toepfer unpubl. data). Individuals were banded with a unique combination of three colored plastic and one aluminum butt-end bands. In addition, 46 prairie chicken hens, 2 sharptail hens, and 1 hybrid hen were fitted with radio transmitters mounted on a bib (Amstrup 1980). Grouse were released on or near the display ground of capture. During the 1985 nesting season, additional information was gathered by John Toepfer on 14 radio-tagged prairie chicken hens and 2 sharptail hens.

Telemetry Equipment

Three types of transmitters emitting a pulsed signal from 150 to 151 megahertz (mhz) were employed. Thirty-five SM1 and four SB2 transmitters were purchased from AVM Instrument Company, California. The SM1 power sources were one 60 mah NiCad battery capable of supplying transmitter power for 36 days without recharging and one row of five solar panels. The SB2 power sources were two 20 mah NiCad batteries capable of supplying transmitter power for 4 days without recharging and two rows of five solar panels. Mean weights of the packages were 16.8

(SM1) and 22.0 (SB2) grams (g). The SB2 transmitter was modified by removing approximately 15 cm from the 30 cm whip antenna. One sharptail hen was fitted with a battery powered SM1 transmitter with a life expectancy of 270 days. The entire transmitter package, except for the solar panels, was covered by feathers.

A Telonics model TS-1 Scanner/Programmer plugged into a Model TR-2 series receiver (Telonics, Mesa, Arizona) was used to receive signals. Most relocations were made using a single eight-element 3.8 m antenna mounted on a vehicle. A bearing dial and pointer attached to the antenna mast permitted directional readings. Bird locations were determined by triangulating from two or three recognizable points on 8 inch/mile air photos obtained through the Soil Conservation Service (SCS). Ground to ground range was between 0.8 and 1.6 kilometers (km). Toepfer (1976) estimated mean accuracy using similar equipment to be 41 m at distances from 305 to 537 m. A fixed-wing airplane with a two-element yagi mounted on each strut was used to relocate birds that could not be found from the ground. Hand held yagis were utilized to pinpoint hens on nests and to locate hens for flushing.

Nests

Radio signals emanating from one location several days in a row indicated either death or the beginning of incubation. Incubating hens were approached, flushed from the nest and a general nest site description and clutch size recorded. At most nests in 1983 and all nests in 1984 and 1985, photo-plots were taken at the nest within 5 days of the start of incubation. Four 10-m transects were established in the cardinal directions. Two photo-plots were taken at the nest and one each at 5 and 10 m distances from the nest. A 1 m^2 piece of pegboard was held vertically behind the vegetation as a reference scale (Toepfer unpubl. data). Photos were taken from a distance of 3 m at a height of 1 m. The nest was marked by placing a 30 cm orange topped stake 10 m from the nest so that approximately 15 cm was showing above the vegetation. Hens were periodically monitored through the incubation period to determine date of hatch or nest destruction.

Further vegetation analysis was completed at the nest site when nesting activities ceased. Four 10 m transects were established as before. Along these transects, canopy coverage by species was collected at 1 m intervals in 0.1 m^2 quadrats (Daubenmire 1959). Dominant residual vegetation in each quadrat was identified when possible and considered separately from new growth. Robel pole (Robel et al.1970) readings were taken from four directions at the nest and two directions at 1 m intervals away from the nest for 10 m. The readings represented the structure of the vegetation at the end of incubation which was quite different than when the nest site was selected. At each nest 76 readings were recorded, summed, a mean computed, and the means averaged. In addition, the four readings taken from the center of the nest bowl were averaged and a mean of those means was calculated. Only nests from 1983 and 1984 are included and no Robel pole readings were taken from nests in alfalfa. All nest site locations were plotted on SCS air photos.

Photo-plot Transects

Photo-plots were taken every 2 weeks along 21 permanent transects during the study. Two additional transects were established and photo-plots of upland transects were taken every 4 weeks in 1984. Twenty-two of the 30 m long photo-plot transects were established in 11 different pastures near booming grounds where trapping had been conducted, although one, established in 1984 on a burned site, was not located near any of the grounds trapped. Colored slides were taken at 5 m intervals for a total of six photographs per transect. Most transects were established in 3-pasture deferred systems, the most common grazing system on the SNG (Table 2). Vegetation monitoring began before new growth provided cover and ended the last 2 weeks of August. Photo-plots for 1983 and 1984 were not taken on the same dates and they were combined as follows; early May (May 1) before greenup, mid-May (May 15) greenup begins, early June (June 1), mid-June (June 15), early July (July 1), mid-July (July 15), late July (July 30), mid-August (Aug 15), and late August (Aug 30).

Table 2. Photo-plot transect location in relation to pasture system and community type.

Pasture system	Community type		
	Upland	Midland	Lowland
1-pasture	0	0	1[a]
3-pasture	6	9	5
Burn	0	1	0
Prairie hay	0	1	0

[a] Lowland II.

Analysis of photo-plots at nests and transects involved selecting ten equally spaced columns of dots on the pegboard. Three readings were taken on each column: 1) height, the highest point at which vegetation intersected the column; 2) effective height, the point below which all other dots in that column were obscured by vegetation; 3) obstruction category, the dominant type of vegetation providing visual obstruction. Nine obstruction categories were recognized: graminoids, forbs, brush, grass/forb, grass/brush, grass/forb/brush, forb/brush, water, and miscellaneous. Those obstruction categories with more than one classification (e.g. grass/forb) had approximately equal proportions of grasses and forbs providing visual obstruction. There were 60 height, effective height, and visual obstruction readings taken at each photo-plot transect and 100 readings at each nest site.

Movements and Home Range

Following destruction of nests or hatching, hens were monitored through August. An attempt was made to locate hens at least once every other day although hens that moved great distances from site of capture, hens with faulty transmitters and non-brood hens not in the vicinity of brood hens were located less often. Telemetry data gathered were grouped into three periods: 1) renesting period: time between initial nest loss and initiation of incubation of a renest; 2) non-brooding period: time following nest destruction or brood loss with no further nesting attempts; 3) brood rearing period: time following hatch of nest until brood was lost or field season ended. Distances from nest to nearest booming ground and initial nest to renest were determined.

Radio locations were digitized into an X and Y coordinate system using the Universal Transverse Mercator Grid (UTM) (Avery and Berlin 1977). In this format the locations were entered into a computer program TELDAY (Lonner and Burkhalter 1983) to determine home range area.

Home range is that defined by Burt (1943) and it is the area calculated by enclosing the outer perimeter (Hayne 1949). Only ranges of hens which lived through an entire period or were alive 10 August were used to calculate means during the above time periods.

Habitat

Areas around each booming ground on which birds were trapped were cover-typed in early May and late August of each year. Vegetation was classified into the following height classes: Class I, 0-8 cm; Class II 9-25 cm; Class III, 26-50 cm Class IV, over 51 cm. These classes were applied to the predominant screening level of the vegetation relative to a standing prairie chicken with Class I to the belly of the bird, Class II to the eye, Class III and IV above the birds head. In instances where two classes formed a mosaic pattern, the stand was assigned to the dominant form. Each location plotted was assigned to one of the above height categories and a specific community type.

Community type was determined from SCS air photos, flushes, photo-plot transects, marking of night roosts and nest site analyses. Community types recognized in this study were upland, midland, lowland, upland shrub, lowland II, alfalfa, cash crops and prairie hay (planted). Difficulty sometimes occurred in assigning a relocation to a specific community because of inaccuracy of telemetry equipment and proximity of community types in the hummocky sandhills association. Where relocations were within 41 m of another community type, they were assigned an edge code. In addition each relocation was assigned a land disturbance code based on past and present land use, pasture system, cattle presence and ownership. As with community types, locations within 41 m of a second disturbance type were assigned a code for edge. Renesting hens were not included in analysis of disturbance type use since their tie to a nest site decreased their probability of changing locations when cattle were moved into the pasture.

RESULTS

Census

From 1982-1985 the USFS began conducting censuses on a regular basis and personnel from this study assisted from 1983-1985. After 1982, most grounds were counted once or twice and even though the highest of two counts was recorded, population estimates probably represent a minimum since new grounds were not searched for. This becomes especially apparent in 1985 when more time was spent searching for dancing grounds and the sharptail population estimate increased dramatically. Many of the display grounds had a mixture of sharptails and prairie chickens; in such cases the arena was classified as a booming or a dancing ground depending on the species with the greatest number of cocks. Numbers of cocks recorded on individual display grounds on the SNG from 1983-1985 are presented in Table 41, Appendix.

Limited information is available about prairie grouse populations on the SNG prior to 1975. Manske and Barker (1981) summarized information from 1961-1974. From 1975-1980 Manske censused the grouse on the SNG. Data from 1975 through 1985 are presented in Fig. 2 and indicate a decline from a high of 412 cocks in 1980 to 262 in 1985.

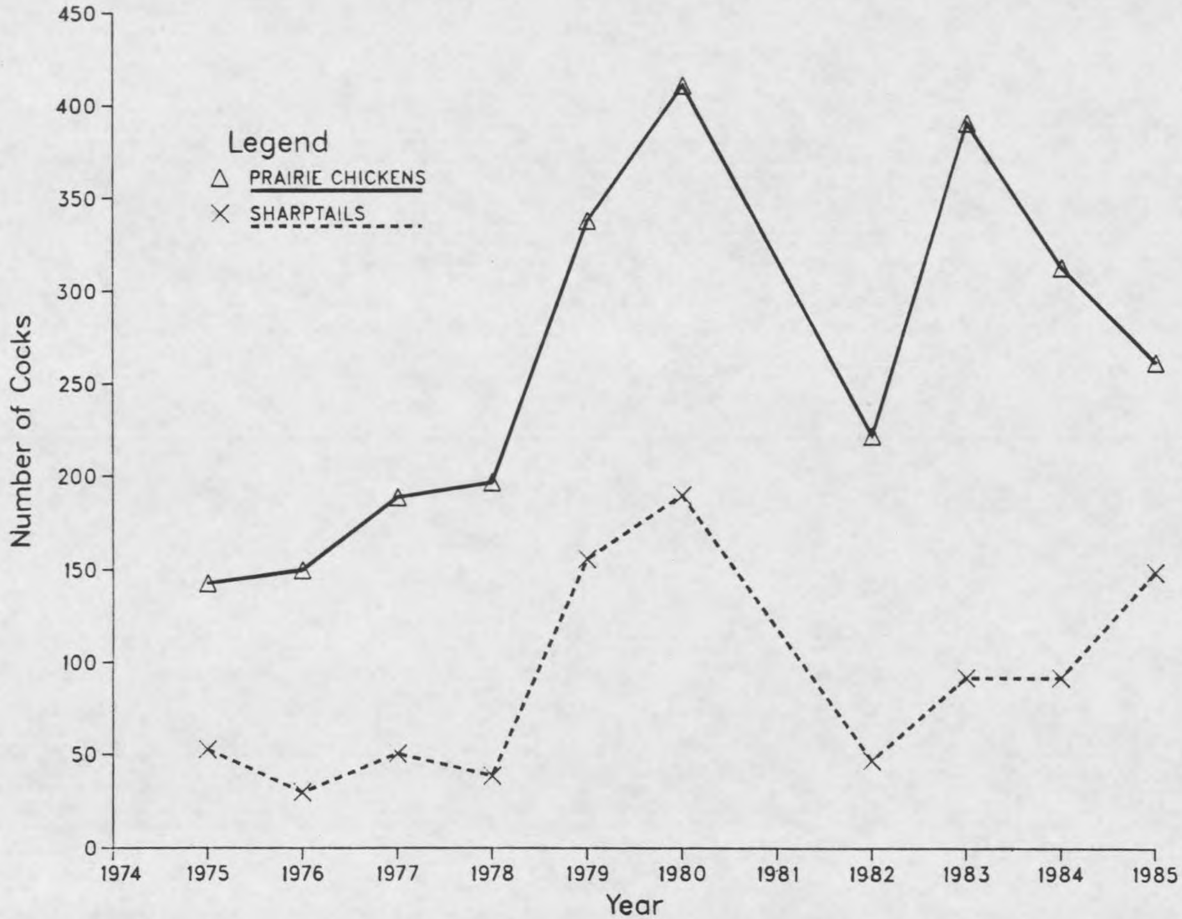

Fig. 2. Prairie grouse display ground counts on the Sheyenne National Grasslands, 1975-1985 from Manske 1981.

A partial census completed in 1981 was excluded from data presented in Fig. 2.

Trapping

The four booming grounds selected for trapping were 02, 16, 24 and 25 (Fig. 3). Walk-in traps proved to be the most effective and caused the least disturbance. Of 111 grouse handled 89 were captured in walk-in traps, 12 in bownets and 10 in rocket nets. Trap mortality was minimal. One prairie chicken hen had a wing broken by a rocket net. A male hybrid and male prairie chicken died when a red-tailed hawk (Buteo jamaicensis) attacked them in a walk-in trap. One prairie chicken male died of shock shortly after removal from a walk-in trap.

The earliest a hen was captured was 2 April, the latest 3 May. In 1983, 75% of the hens were captured between 20 and 25 April. In 1984, 61% of the hens were captured between 17 and 24 April.

Radio Tagging

Of 46 prairie chicken hens fitted with radio transmitters in 1983 and 1984, 47.8% and 52.2% were classified as adults and juveniles (hens entering their first breeding season) respectively (Table 3). Two hens

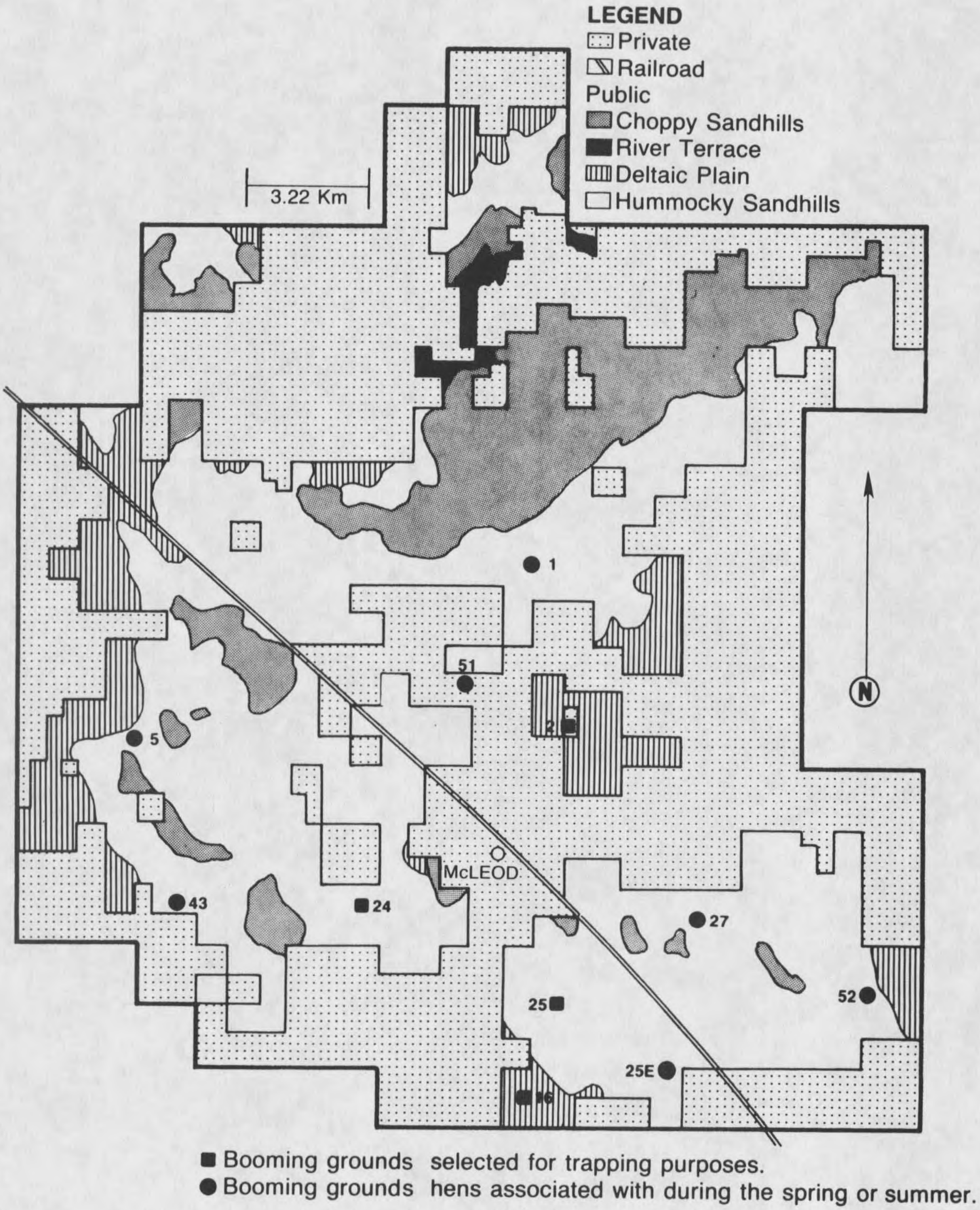

Fig. 3. Booming grounds trapped and those some hens dispersed to in 1983 and 1984.

were listed as of unknown age but egg laying behavior, weights and movements indicated that one was an adult and one a juvenile.

Table 3. Sex and age of prairie grouse captured on the Sheyenne National Grasslands, 1983-1984.

	Prairie chicken		Sharptail		Hybrid	
	Cock	Hen	Cock	Hen	Cock	Hen
Adult	30	21	1	1	1	0
Juvenile	15	23	1	1	0	1
Unknown	6	2	7	0	0	0
Total	51	46	9	2	1	1

In 1985, 11 adult and 3 juvenile prairie chicken hens were followed through the nesting period. Four radio-tagged hens survived from 1983 to 1984 although information was collected on only three of them. Five hens, two of which were tagged in 1983, survived from 1984 to 1985. In addition, two sharptail hens were radio-tagged in 1984 and 1985 and one hybrid hen was radio-tagged in 1984.

Prairie chickens of known-age, captured in the spring, were used to calculate mean weights. Mean weights of sharptails and hybrids were not calculated due to the small sample sizes (Table 4).

An attempt was made to radio-tag at least six hens at each of the four booming grounds. Due to variability in hen attendance this was not always accomplished (Table 5).

Table 4. Mean weights of prairie chickens captured 1983-1984.

	Cocks			Hens		
	No.	Mean (g)	(SD)	No.	Mean (g)	(SD)
Adult	25	1117.0	75.6	20	967.3	60.6
Juvenile	14	1084.2	70.9	22	937.4	50.0

Table 5. Number of hens radio-tagged on each booming ground each year of the study 1983-1984.

Booming ground	Number 1983	Number 1984	Carry overs from 1983	Total
02	5	13	1	19[ab]
16	5	3	2	10
24	7	4	0	11
25	6	6	1	13[a]

[a]Includes one sharptail captured in 1984.
[b]Includes one hybrid captured in 1984.

Initial Nests

Over the course of 3 years, 43 initial nests, 17 second nests and two third nests of radio-tagged prairie chickens were located. Four initial nests and one renest of radio-tagged sharptails were observed. In addition, five nests of unmarked prairie chickens were located after eggs had hatched. Nest data from unmarked birds and data collected in 1985 were not used in analysis unless specified.

In eight instances, the suspected initial nest of a hen was not located, but the renest was found. A hen was recorded as having had an initial nest if an initial nest was found, a hen had been relocated several times in the same place indicating incubation, a hen exhibited a pronounced shift in daily patterns and/or a hen had a late nest initiation and a smaller clutch size.

Chronology

Data from 38 initial nests were used to estimate the first day of egg laying. The date of nest initiation was calculated assuming an egg laying rate of one per day and back-dating from an observed first day of incubation. Mean dates of first egg laid were 3 May 1983, 2 May 1984 and 22 April 1985. The earliest date an egg was laid in an initial nest was 17 April 1985 and the latest was 9 May 1983. The latest dates may include birds that lost an initial nest prior to incubation. Assuming 3.8 days between copulation and first egg laid (Svedarsky 1979) the calculated copulation peak was 27-28 April in 1983 and 1984 and 18-19 April 1985. There appeared to be little difference in date of nest initiation between adults and juveniles with both initiating egg laying 2 May in 1983 and 1984 and 21 April and 25 April for juveniles and adults, respectively, in 1985.

Incubation Length and Nest Attentiveness

A hen was considered incubating if she was relocated and inactive in the same place two consecutive days or was relocated in the same place during the day and night. Estimated period of incubation ranged from 24-30 days with a mean of 26.6 days. (SD 1.5, n=14). Hens were very faithful to their nest sites as evidenced by the following events. Of 755 random incubation relocations, hens were found off their nests only 15 times, eight of which were between the hours of 0600-0900, 5 between 1623 and 2016 and one at 1209 Central Standard Time (CST). One exception, a juvenile, was off her nest for 3 hours and 6 minutes, 7 days before her eggs hatched. There was evidence at two nest sites of hens returning after having been disturbed by a predator. In both instances large numbers of breast feathers were located around the nest but none of the eggs had been removed. All hens except one sharptail returned to their nests after being flushed by researchers. One juvenile hen incubated a clutch of what appeared to be infertile eggs for 39 days before it was finally destroyed by a predator.

Clutch Size and Hatchability

Clutch sizes were determined only from radio-tagged prairie chickens flushed shortly after incubation began. Average clutch size of 41 initial nests was 13.9 (SD

1.41). Mean clutch size of adults, 14.3 (SD 1.28, N = 22), was slightly larger than juveniles, 13.6, (SD 1.50, N=19). The smallest complete clutch (11) recorded for an initial nest was laid by a juvenile while the largest (17) was observed in each of two adults nests.

Hatchability was determined from nests where no full or partial predation had occurred. Of 212 eggs in 15 initial nests 15% did not hatch, including a full clutch of 13 eggs laid by a juvenile. Ten of 15 nests contained at least one egg that did not hatch. In addition four dead chicks were found at three different nest sites. Two chicks had not successfully exited the shell and two apparently died of exposure during a two-day rain storm.

Initial Nest Success

Only nests of radio-tagged prairie chickens in which one or more eggs hatched were used in calculations of nest success. Eight hens were considered renesters. Their initial nests were not located but radio-tracking suggested that each nest had been destroyed during egg laying or early in incubation. Four radios, including that of the hybrid hen, failed before their nest was located and those hens were not included in the success calculations (Table 6). Fate of individual hens and nest success is included in Table 40, Appendix.

Table 6. Number of initial nests found, probable initial nests, successful nests and prairie chicken hens killed during egg laying, 1983-1985.

	Initial nests found	Probable nests	Number successful	Dead hens
Adult	23	8	9	3
Juvenile	20	0	11	6
Total	43	8	20	9

Nesting success is frequently calculated by dividing the number of successful nests located by the total number of nests found. Since most nests are located by flushing an incubating hen, this method fails to include those nests that are destroyed during egg laying and those of hens killed during the egg laying period. Nest success calculated in the usual way and with these elements included are given in Table (7). In all calculations juveniles were more successful than adults. Nest success was much higher in 1985 than in the previous 2 years and again juveniles were more successful than adults (Table 8).

Prenesting Movements

There appeared to be a behaviorial difference between the two age classes of hens during the pre-egg laying period. Adults and most juveniles nested nearest the booming ground on which they were captured. However, in 1983 and 1984, six juvenile prairie chickens and one hybrid moved an average of 9.7 km before nesting or being killed (Table 9). Only one adult in 2 years made a lengthy move, 6.4 km, after capture. That adult was captured on 30 April and may have been returning to the arena after losing an initial nest.

Table 7. Initial nest success calculated by: a) number of successful nests (SN) divided by total number of nests found (TNF), b) SN/TNF+ probable nests (PN) and c) SN/TNF+PN+ number of birds killed during egg laying (DB).

Age	Success SN/TNF (%)	Success SN/TNF+PN (%)	Success SN/TNF+PN+DB (%)
Adult	39.1	29.0	26.5
Juvenile	55.0	55.0	42.3
Total	46.5	39.2	33.3

Table 8. Success of initial nests of adult and juvenile prairie chicken hens (SN/TNF).

	1983			1984			1985		
	%	S[a]	U[b]	%	S	U	%	S	U
Adult	37.5	3	5	28.6	2	5	50.0	4	4
Juvenile	55.6	5	4	50.0	4	4	66.7	2	1
Total	47.1	8	9	40.0	6	9	54.5	6	5

[a] S=successful.
[b] U=unsuccessful.

Distribution of Initial Nests

Hens nested 0.1 to 3.8 km from booming grounds. Seventy-five percent of the adult and 65% of the juvenile hens nested < 1.5 km from the nearest display ground (Fig. 4, 5, and 6). Juvenile hens nested an average of 1.4 km (SD = 0.82, N = 20) from the nearest ground while adults averaged 1.2 km (SD = 0.54, N = 24).

Table 9. Straight line distances from booming ground of capture to initial nest site or last location of dispersing juvenile prairie chickens, 1983-1984.

Hen I.D.	Distance (km) to nest site	Distance (km) to last location
1092	-	10.50
1363	4.81	-
1488	-	10.50
1610	15.30	-
1732	11.50	-
1126	-	11.50
1788*	-	4.02

*Hybrid

Initial Nests of Sharptails

Initial nests of four radio-tagged sharptails were located over the course of 3 years. Two adults and two juveniles had a mean clutch size of 14 (SD=.82). Only one adult was successful. A juvenile abandoned her nest shortly after being flushed and was the only known study induced abandonment.

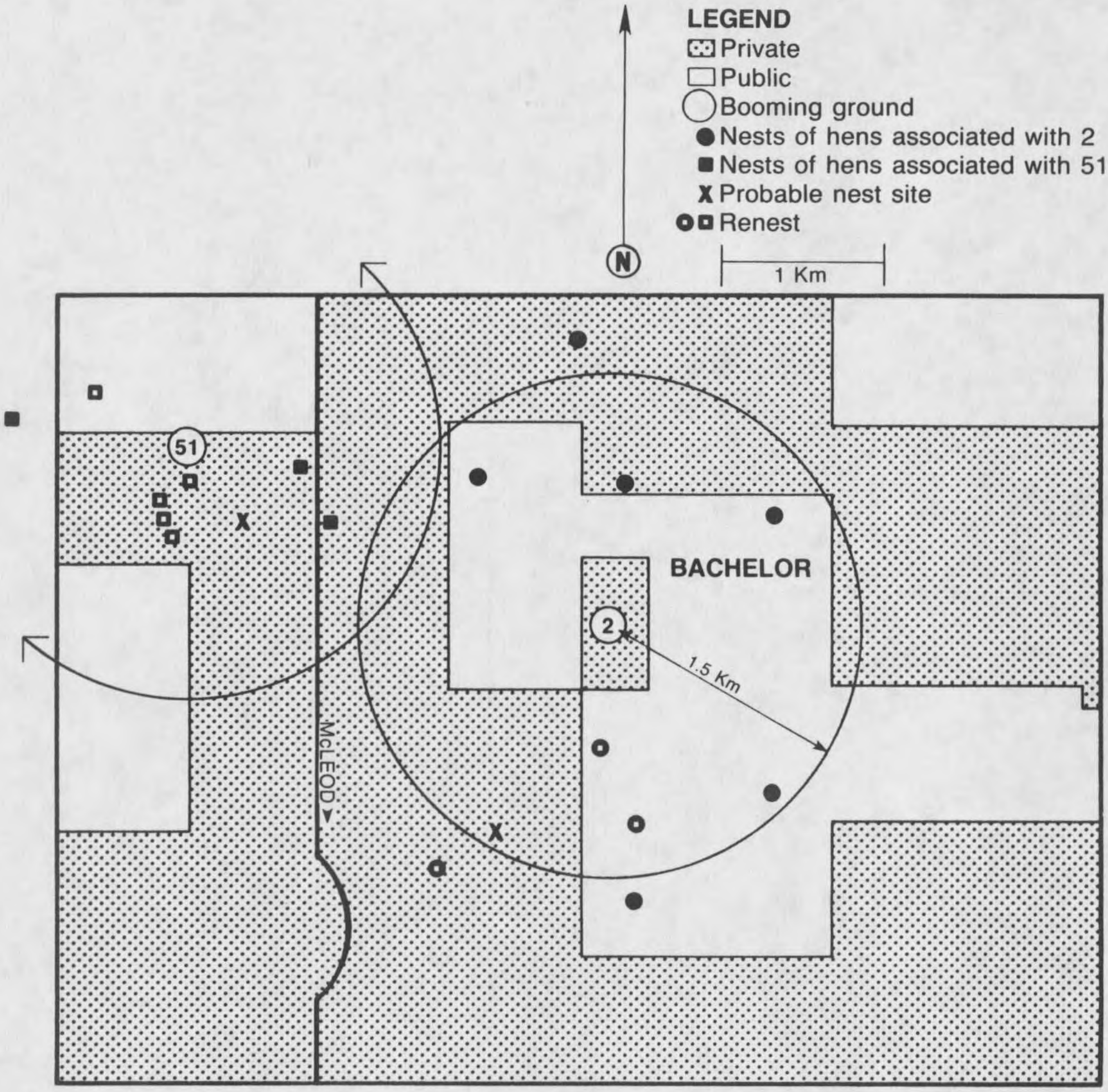

Fig. 4. Nest site locations near booming grounds 2 and 51, 1983-1985.

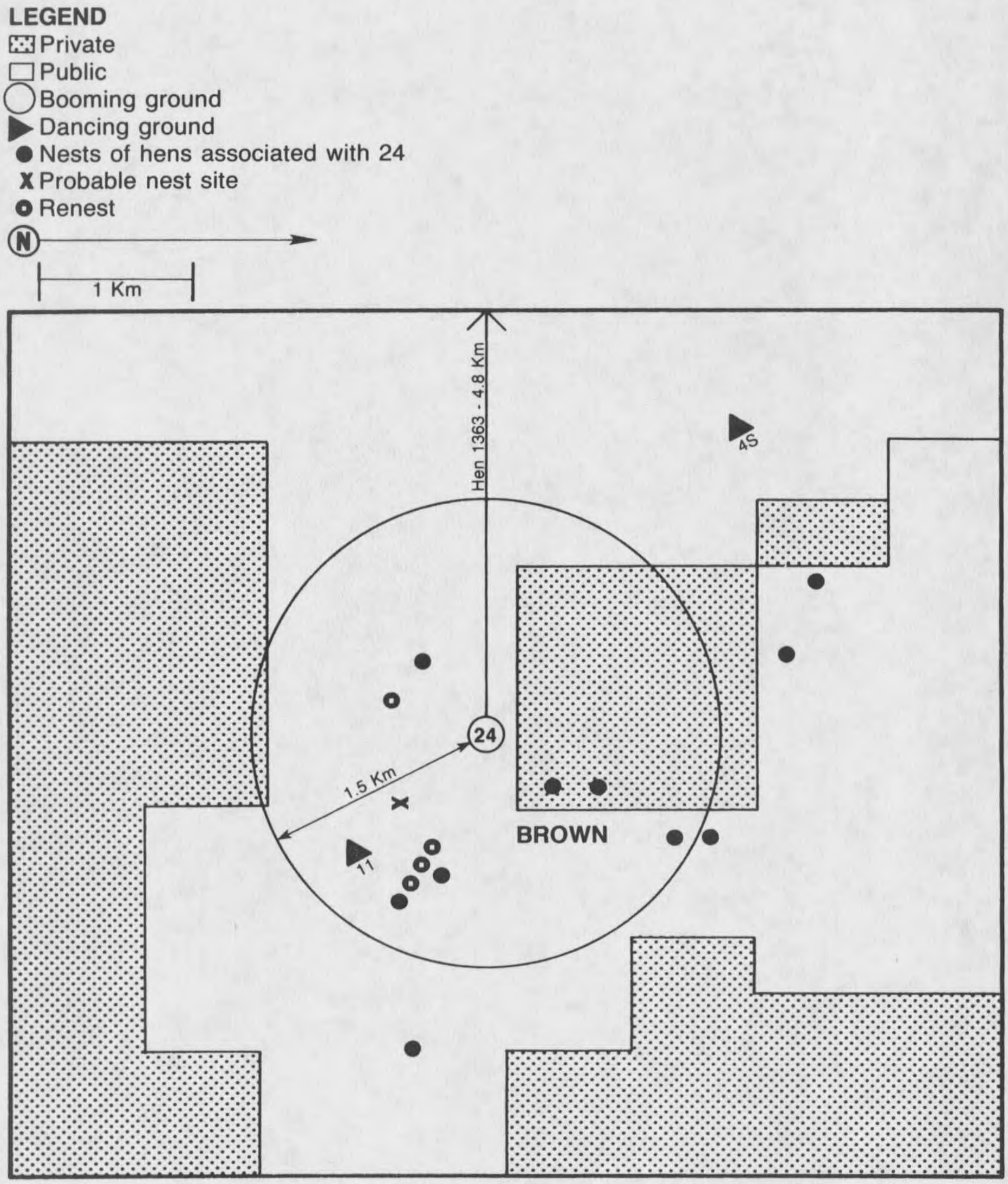

Fig. 5. Nest site locations near booming ground 24, 1983-1985.

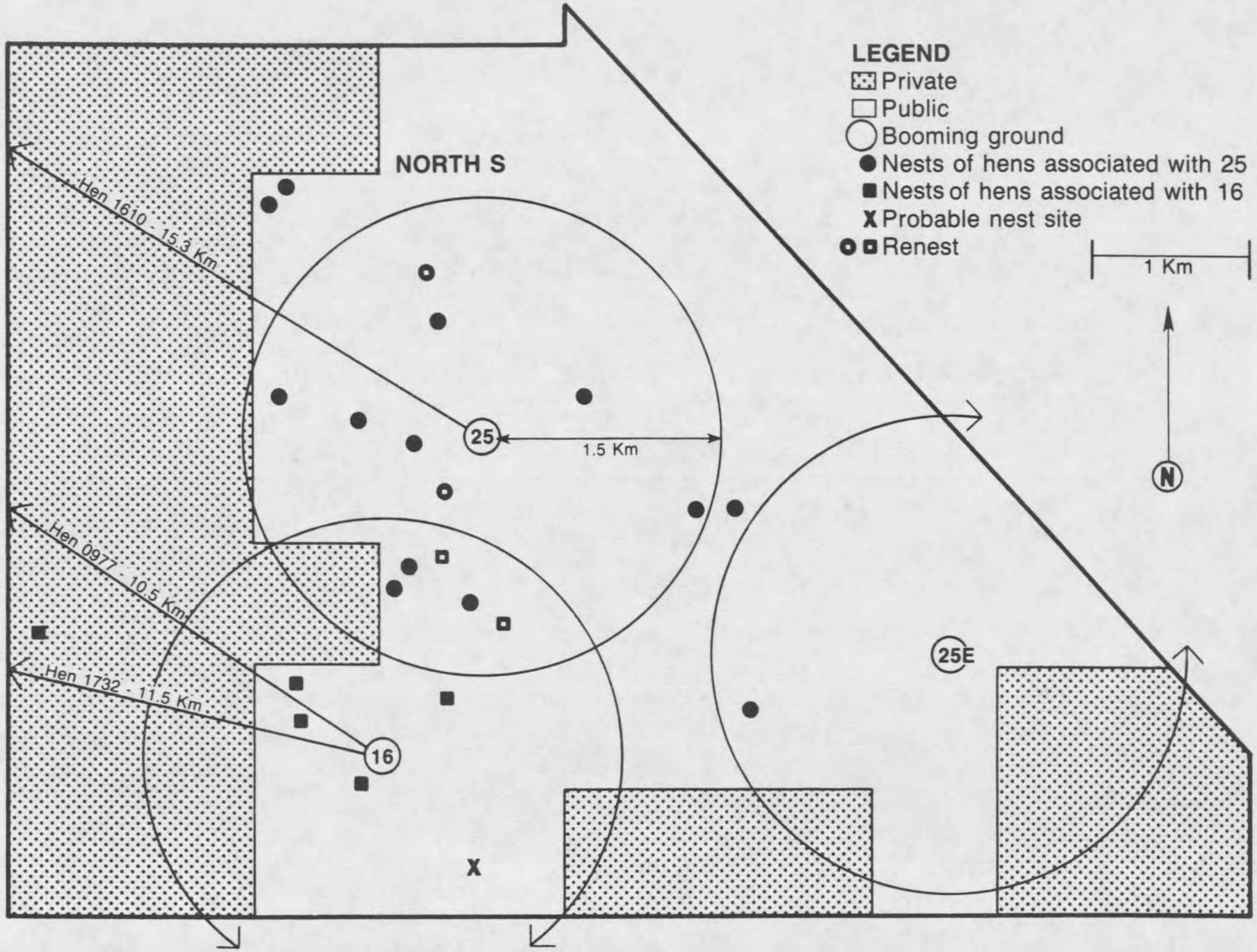

Fig. 6. Nest site locations near booming grounds 16 and 25, 1983-1985.

Renests

Timing of Renests

The interval between destruction of initial nests and initiation of a renest was determined for 11 hens. Renest initiation was calculated as with initial nests and the interval ranged from 1 to 16 days (mean, 6.5, SD = 4.5). One copulation was observed on 20 May, 3 days after the hen's initial nest was destroyed, she began laying 25 May.

Incubation Length of Renests

Incubation periods determined for renests ranged from 24-29 days (mean, 26.4, SD=1.6, N=8). The latest hatching date for a radio-tagged female was 19 July. One unmarked hen was killed by a mower while incubating on 25 July and represents the latest known date of incubation during the study.

Renesting Capability

Renesting effort was measured on 24 hens (Table 10). Two adult hens were killed shortly after the loss of an initial nest and represented the only known mortality during the renesting period. The data suggested that juveniles were less likely to renest than adults. Renesting effort could not be confirmed for 5 of 7 (71.4 %) juveniles and 2 of 17 (11.8%) adults.

Of the seven hens that did not renest, two juveniles incubated their initial nest for 30 and 39 days. One juvenile and two adults localized shortly after the loss of their initial nests and may have initiated a renest that was not found. The other two juvenile hens were very difficult to relocate and provided limited information.

Table 10. Fate of prairie chicken hens after initial nests, 1983-1985.

	No.of hens	Dead hens	Successful initial	Radio failures	No renest found	Second nests
Adult	36	7[b]	9	3	2	15
Juvenile	27	7	11	2	5	2
Total	63[a]	14	20	5	7	17[c]

[a] Counts three carryover hens once for each year.
[b] Includes two hens that were killed after initial nest was destroyed.
[c] Two hens had second renests, not included.

Hens were capable of renesting after long periods of incubation. Two hens renested after incubating an initial nest for 21 days. Two hens renested twice.

Clutch Size and Fertility

Seventeen second nests and two third nests were located over the 3-year period. Clutch sizes of adult renests ranged from 8 to 12 eggs and the mean of 11.4 (SD=1.85, N=17) was substantially smaller than in initial nests. Two juveniles which renested had clutch sizes of 11 and 12.

Fertility of eggs in renests was higher than in initial nests. Only two of seven nests contained unhatched eggs and 92.8% of all eggs hatched.

Renest Success

Only nests of radio-tagged hens from 1983-1985 were used in calculations of renest success. One radio failed between initial nest and renest and that hen was excluded from calculations. Hens were much more successful with renests (Table 11) than with initial nests. Over the course of 3 years 33 of 63 (57.9%) prairie chickens had a successful nest (Table 12).

Table 11. Success of renests calculated three ways: a) SN/TNF b) SN/ (TNF+PN) c) SN/ (TNF+PN+DB). For meaning of abbreviations see Table 7.

	a) Successful		b) Successful		c) Successful	
	%	No.	%	No.	%	No.
Adult*	68.8	11	68.8	11	61.1	11
Juvenile	100.0	2	100.0	2	100.0	2
Total	72.2	13	72.2	13	65.0	13

*Fate of one renest unknown and excluded from calculation.

Renests were quite important in overall chick production on the SNG especially in 1984 when 48.1% of all chicks that hatched came from renests (Table 13).

Distance From Initial Nest

Absolute distances from initial nest to renest site was calculated for 11 hens (mean, 0.94 km, SD = 0.74). The closest a renest was located to an initial nest was

0.08 km by an adult while the farthest was 2.5 km by a juvenile. This does not include one adult hen that may have initiated incubation on an initial nest (2 days) and then moved approximately 12 km and renested.

Table 12. Number of prairie chicken hens successful in bringing off a brood 1983-1985.

Age	Number hens	Radio failures No.	%	Unknown No.	%	Successful No.	%[b]	Unsuccessful No.	%[b]
Adult	36	3	8.3	1	2.7	20	62.5	12	37.5
Juvenile	27	2	7.4	0	0.0	13	52.0	12	48.0
Total[a]	63[a]	5	7.9	1	1.5	33	57.9	24	42.1

[a] Includes carryover hens counted once each year.
[b] Does not include radio failures or one hen whose nest fate was unknown.

Table 13. Number of chicks produced in initial nests and renests on the Sheyenne National Grasslands, 1983-1985.

Nest type	1983 No.	%	1984 No.	%	1985 No.	%	Total No.	%
Initial	112	84.8	69	51.8	84	56.0	265	63.9
Renest	20	15.2	64	48.1	66	44.0	150	36.1
Total	132	100.0	133	99.9	150	100.0	415	100.0

Distance to Booming Ground

Mean distances of 17 renests to the nearest booming ground was 0.9 km, (SD = 0.36). The renest nearest a display ground was 0.2 km, the most distant, 1.7 km.

Causes of Nest Failure

Of 20 nests that were observed after destruction, 14 were attributed to mammals, and 6 to avian predators (Table 14). Red fox (*Vulpes vulpes*) appeared to be the most common cause of nest destruction. Avian predation was surprisingly high, but in all cases except one some eggs were missing from the nest indicating the possibility of initial mammalian predation and secondary predation by birds. Skunks (*Mephitis mephitis*) were present on the SNG, but were not known to have destroyed any nests. Two adults and one juvenile were killed while incubating. One sharptail abandoned a nest shortly after being flushed by a dog. The initial nest of an adult sharptail was destroyed by an avian predator and the renest by a fox.

Table 14. Suspected causes of nest destruction 1983-1984.

Cause	Number
Red fox (*Vulpes vulpes*)	8*
Avian	6*
Racoon (*Procyon lotor*)	3
Unknown mammal	2
Badger(*Taxidea taxus*)	1*
Total	20

* Includes hen that was killed while incubating.

Characteristics of Nest Sites

Calculations of nesting success were based on observed nests of radio-tagged grouse. Success calculations in this section differ somewhat from those made before, because hen 1610 incubated an apparently infertile clutch for 39 days and though biologically unsuccessful, was considered succcessful in habitat selection and sharptails are included in this section.

Of 76 prairie grouse nests, 77.6% were initiated on public land (Table 15). Most nests (59.2%) on USFS land were in 3-pasture deferred systems, but three of four booming grounds on which birds were trapped were in 3-pasture deferred systems. Success of nests was slightly higher on private land (60.0%) versus public land (51.0%). If two renests located in alfalfa had not been marked they may have been destroyed by swathers which would have caused nest success on private land to drop to 46.7% (Table 16).

Only seven (9.2%) of all nests were found in privately held grasslands, one of which was successful. Three of the seven nests were in portions of prairie hay fields that could not be mowed due to the roughness of terrain or moisture conditions and thus were virtually undisturbed. It appeared that land management practices on public grasslands provided nesting cover that was superior to that found in privately owned grasslands.

Table 15. Land disturbance and ownership of land at prairie grouse nest sites, 1983-1985.

	Nest type				Total		Ownership	
Land use	IN	RE	UN	PR	No.	%	Private	Public
4-pasture	2	0	0	0	2	2.6	0	2
3-pasture	26	14	4	1	45	59.2	0	45
2-pasture	5	0	0	0	5	6.6	0	5
1-pasture	5	1	1	1	8	10.5	1	7
Alfalfa	4	5	0	1	10	13.2	10	0
Prairie hay	2	0	0	1	3	3.9	3	0
Grazed	3	0	0	0	3	3.9	3	0
Total	47	20	5	4	76	99.9	17	59

[a] IN = initial nests of 43 marked prairie chickens and 4 sharptails, RE = renests of 19 marked prairie chickens and 1 sharptail, UN = nests observed unmarked prairie chickens, PR = probable nests of marked prairie chickens indicated by telemetry data.

Table 16. Success of radio-tagged grouse nests related to disturbance type and ownership of land, 1983-1985.

Disturbance	Initial		Renest		Total		Private	Public
	No.	%[a]	No.	%[a]	No.	%[a]	%[a]	%[a]
4-pasture	2	100.0	0	-	2	100.0	-	100.0
3-pasture	26	46.2	14[b]	61.5	40[b]	51.3	-	51.3
2-pasture	5[b]	75.0	0	-	5[b]	75.0	-	75.0
1-pasture	5	20.0	1	0.0	6	16.7	0.0	20.0
Alfalfa	4	75.0	5	100.0	9	88.9	88.9	-
Prairie hay	2	50.0	0	-	2	50.0	50.0	-
Grazed	3	0.0	0	-	3	0.0	0.0	-
Total	47[b]	47.8	20	68.4	67[b]	53.0	60.0	51.0

[a] Percent of nests successful SN/TNF.
[b] Includes one or more nests that could not be considered successful or unsuccessful and are not included in success calculations.

Hens that incubated nests in pastures with cattle present were slightly less successful (42.9%) than hens that incubated in areas without cattle (54.1%). Only one of seven nests in a continuous system (1-pasture) was successful. Hens avoided renesting in pastures in which cattle were present. Of 13 hens that could have selected pastures with or without cattle, when renesting, 11 selected pastures without cattle. Both hens that renested in pastures with cattle localized in those pastures prior to cattle introduction and laid their first egg 4 days after cattle were introduced. One hen renested in a 1-pasture system but initiated the nest before cattle were present. Only one renest was intiated in a pasture which had been grazed earlier in the year; this hen initiated her renest in West Carlson on 11 June, after cattle had grazed this pasture from 15 to 29 May.

There was a wide overlap in species composition of uplands and midlands and lowlands and midlands. Topography, land use and species composition were all used to determine the community in which a hen nested. Most nests on public land were in the lowland community while on private land alfalfa was utilized most often (Table 17).

Table 17. Number and percent of prairie grouse nests in habitat communities, 1983-1985.

	Public land		Private land		Total	
Habitat community	No.	%	No.	%	No.	%
Upland	3	5.3	2	13.3	5	6.9
Midland	14	24.6	1	6.7	15	20.8
Lowland	32	56.1	3	20.0	35	48.6
Shrub	8	14.0	0	–	8	11.1
Alfalfa	0	–	9	60.0	9	12.5
Total	57	100.0	15	100.0	72[a]	100.0

a Does not include four nests indicated by telemetry but not observed.

Highest nest success was experienced by hens in alfalfa although as mentioned before two of those nests may have been destroyed if not marked (Table 18). Species composition was not determined at nest sites in alfalfa or at two nests in pastures where cattle introduction greatly altered the vegetation structure. In addition, one nest site was mowed before the nest analysis could be completed. Since species composition data in 1985 were gathered differently than in 1983 and 1984 they are not included in Table 19. No clear patterns were evident in species composition between successful and unsuccessful nests although one possible exception was the comparatively high nesting success when located in stands containing big and little bluestem, major components of the midland community.

Table 18. Success of radio-tagged prairie chickens and sharptails by community type.

Community	Successful initial %	Successful initial No.	Sucessful renest %	Sucessful renest No.	Successful total %	Successful total No.
Upland	40.0	2	-	-	40.0	2
Midland	60.0	6	50.0	1	58.3	7
Lowland	39.1	9	55.5	5	43.8	14
Shrub	60.0	3	33.3	1	50.0	4
Alfalfa	75.0	3	100.0	5	88.9	8
Total	48.9	23	60.0	12	53.0	35

Table 19. Dominant species at 17 successful (S) and 19 19 unsuccessful (U) nests 1983-1984.

Species	Percent cover[a] S	Percent cover[a] U	Number[b] S	Number[b] U
Poa pratensis	20.90	25.54	16	17
Panicum virgatum	14.79	13.51	5	7
Andropogon gerardi	10.13	12.56	7	1
Andropogon scoparius	24.74	31.00	7	1
Calamagrostis inexpansa	18.70	8.35	3	4
Spartina pectinata	12.29	14.32	2	4
Agropyron repens	6.63	10.35	4	1
Phalaris arundinacea	0.00	8.35	0	4
Muhlenbergia asperifolia	0.00	10.40	0	5
Carex spp.	7.50	14.50	16	9
Symphoricarpos occidentalis	9.69	14.69	3	2
Spiraea alba	8.82	9.88	3	3
Solidago spp.	8.95	12.01	8	11
Anemone canadensis	8.41	13.00	2	4
Ambrosia psilostachya	8.67	9.06	3	1

[a] Percent cover is a mean of those nests with greater than 5% cover.

[b] Number of nests used to calculate the mean.

Successful initial nests and renests had a higher total grass cover, total cover, and more litter than unsuccessful nests. Unsuccessful nests had more bare ground, residual grass, and forbs (Table 20).

Grass was the most important cover provided at most of the nests (Table 20). Photo-plot analysis supported the canopy coverage data, since 73% of the obstruction categories of all nests were in grass (Table 21).

Table 20. General vegetation characteristics at nest sites.

	Initial N=29[a]				Renests N=7[b]			
	% Cover		Frequency		% Cover		Frequency	
	S	U	S	U	S	U	S	U
Bare ground	3.8	6.2	31.5	42.5	3.2	8.5	29.0	47.5
Litter	89.3	84.9	100.0	99.9	90.9	81.1	100.0	98.3
Residual	13.4	14.3	75.6	81.0	7.7	6.4	60.0	60.8
Total cover	66.7	57.0	100.0	100.0	75.8	70.2	100.0	100.0
Total forb	12.0	14.1	87.5	90.1	19.9	20.5	92.5	100.0
Total grass	59.9	49.1	100.0	100.0	67.9	53.5	100.0	100.0

[a] n=12 successful and 17 unsuccessful.
[b] n=5 successful and 2 unsuccessful.

Robel pole readings had lower means at successful initial nests than unsuccessful nests (Table 22). However, when all nests are combined, successful nests had a mean overall reading of 1.01 (SD=0.40) and a mean nest site reading of 1.49 (SD=0.65) which was higher than unsuccessful nests (overall mean, 0.96, SD=0.46; nest site mean, 1.34, SD=0.58). In addition, if nests in alfalfa had been included the readings for successful nests would have been much higher.

Table 21. Vegetation causing visual obstruction in photo-plots at nest sites, 1983-1985.

Obstruction category	Number	Percent of total
Grass	5567	73.0
Forb	633	8.3
Brush	270	3.5
Grass/forb	669	8.8
Grass/brush	357	4.7
Grass/forb/brush	121	1.6
Forb/brush	2	0.0
Miscellaneous	7	0.1

Table 22. Mean Robel pole readings at successful (S) and unsuccessful (U) nests, 1983-1984.

	Initial nest		Renest	
	Overall	At nest	Overall	At nest
S	0.86 SD 0.30	1.14 SD 0.29	1.39 SD 0.38	2.33 SD 0.47
U	0.94 SD 0.48	1.38 SD 0.61	1.09 SD 0.36	1.79 SD 1.07

Photo-plots taken at nest sites shortly after incubation began, most accurately reflect the density and height of vegetation at the time of nest site selection. Successful initial nests and renests had a higher effective height (EHT) and height (HT) of vegetation than unsuccessful nests at 0, 5, and 10 m from the nest, except

Table 23. Mean effective height (EHT) and height (HT) of vegetation at the nest, and 5 and 10 m from the nest, 1983-1985.

Nest		NO.	0 meters EHT	0 meters HT	5 meters EHT	5 meters HT	10 meters EHT	10 meters HT
Initial	S[a]	16	13.1 SD 3.4	35.0 SD 12.1	9.7 SD 5.1	25.5 SD 12.9	8.9 SD 5.1	25.1 SD 14.2
Initial	U[b]	18	12.5 SD 4.7	34.4 SD 11.7	9.5 SD 7.9	26.7 SD 13.8	7.9 SD 3.5	24.7 SD 12.1
Renest	S	11	25.3 SD 9.1	41.8 SD 9.8	21.1 SD 13.8	36.2 SD 15.6	19.3 SD 13.8	34.7 SD 15.9
Renest	U	6	20.8 SD 7.7	41.2 SD 7.4	15.5 SD 10.0	32.2 SD 14.8	15.1 SD 11.3	33.2 SD 14.2
Combined	S	27	18.2 SD 8.8	37.8 SD 11.6	14.4 SD 11.2	29.9 SD 15.0	13.2 SD 10.9	29.2 SD 15.6
Combined	U	24	14.5 SD 6.5	36.0 SD 11.8	11.1 SD 7.8	28.2 SD 14.2	9.8 SD 7.3	26.9 SD 13.2

[a] Successful nests
[b] Unsuccessful nests

for mean height which was higher 5 m from the nest in initial unsuccessful nests (Table 23). Mean EHTs of vegetation at renests were 11.1, 9.6, and 9.5 cm higher at 0, 5, and 10 m from the nest than at initial nests. In addition, renests had mean HTs of vegetation that were 7.4, 8.9 and 9.5 cm taller at 0, 5, and 10 m from the nest, than HTs at initial nests. This increase in HT and EHT of vegetation probably contributed to the greater success of renests compared to initial nests. When data from all nests were combined, EHT at successful nests exceeded those at unsuccessful nests by an average of 3.7, 3.3 and 3.4 cm at 0, 5 and 10 m from the nest site, respectively. The average HT difference between successful and unsuccessful nests was 1.84, 1.74 and 2.15 cm at 0, 5 and 10 m respectively. Also apparent from photo-plots was a decline in effective height and height at 5 and again at 10 m from the nest.

Successful nests had greater densities of vegetation at 0, 5 and 10 m from the nest than unsuccessful nests (Table 24). Thirty-four photo-plots of successful nests had an effective height greater than or equal to 15 cm compared to only 17 photo-plots of unsuccessful nests.

The first set of photo-plot transects was taken prior to green-up and represents the conditions available to hens initiating a nest. The second set was taken in mid-May and represents vegetation structure at the beginning of incubation just prior to cattle introduction. To permit comparison with data from the transects, a mean EHT and HT was determined from all 10 photo-plots at each nest (Table 25). Comparison of these two data sets indicates that uplands and prairie hay do not provide vegetative structure attractive to nesting hens. All upland transects had effective heights of <5 cm; no initial nests were found in that category. Primarily midland and lowland communities were the areas potentially providing an adequate vegetative structure within which hens could nest; however, many provided inadequate cover due to grazing and mowing.

Table 24. Cumulative mean effective height of vegetation at 0, 5 and 10 m from 50 nests, 1983-1985.

	Successful (N=26)			Unsuccessful (N=24)		
EHT (cm)	0 m	5 m	10 m	0 m	5 m	10 m
>=20	8	5	5	4	2	2
>=15	16	10	8	10	4	3
>=10	24	15	13	18	12	7
>=5	26	26	25	24	22	22

As spring and summer progressed the photo-plot transects showed an increase in EHT and HT. Structure of vegetation became more dense and taller in all three communities especially in pastures without cattle (Table 26). Table 26 excludes a Lowland II in a continuous

Table 25. Distribution of effective heights and heights in communities and at initial nest sites, 1983-1985.

	Early May EHT[a], HT[b]					Initial nests		Mid-May EHT, HT				
(cm)	Up[c]	Md[d]	Ll[e]	Ph[f]	Bu[g]	S[h]	U[i]	Up	Md	Ll	Ph	Bu
0-5	11,4	7,1	3,0	1,0	0,0	0,0	0,0	12,1	5,0	3,0	1,0	1,1
5-10	0,2	7,0	3,3	0,1	0,0	10,0	12,0	0,4	9,1	6,1	0,1	0,0
10-15	0,4	2,5	1,3	0,0	1,0	3,0	5,0	0,6	3,4	2,3	0,0	0,0
15-20	0,1	0,2	0,0	0,0	0,0	3,5	1,6	0,1	0,3	1,3	0,0	0,0
20-25	0,0	0,2	0,0	0,0	0,0	0,4	0,1	0,0	0,2	0,0	0,0	0,0
>25	0,0	0,6	0,3	0,0	0,1	0,7	0,11	0,0	0,7	0,3	0,0	0,0

[a] Effective height
[b] Height
[c] Upland
[d] Midland
[e] Lowland
[f] Prairie hay
[g] Burn
[h] Successful
[i] Unsuccessful

pasture that had low numbers of cattle and a large expanse of lowlands. This pasture showed a substantial increase in vegetation during this time period even though grazed.

Renests were initiated between 16 May and 23 June, although most were in early to mid-June. As indicated before, hens which renested avoided pastures with cattle and pastures which had been previously grazed. Eleven of 17 renests were in vegetation which had effective heights greater than 15 cm (Table 27). In early June only the lowlands had EHTS equal to or greater than 15 cm and only the midlands and lowlands had EHTS greater than 15 cm in mid-June (Table 27).

Table 26. Increase in effective height of vegetation relative to grazing from early May to mid-June.

Community	Grazed (cm)	Ungrazed (cm)
Upland	1.65 SD 0.53 n=4	5.90 SD 1.52 n=4
Midland	3.38 SD 3.06 n=4	7.25 SD 3.34 n=4
Lowland	2.40 SD 1.47 n=3	10.95 SD 6.40 n=4

Movements and Home Range of Non-brood Hens

Juveniles were much more mobile than adults and were less likely to renest following loss of initial nests. Of seven juveniles only hen 1270 remained in the area of her initial nest following its destruction. Hen 1270 was one of two juveniles known to have renested, her renest being only 80 m from her initial nest. Juvenile hen 0827 was

Table 27. Distribution of effective heights and heights in communities and at renests, 1983-1985.

	Early June EHT[a], HT[b]					Renests EHT, HT		Mid-June EHT, HT				
(cm)	Up[c]	Md[d]	Ll[e]	Ph[f]	Bu[g]	S[h]	U[i]	Up	Md	Ll	Ph	Bu
0-5	4,0	3,0	0,0	-	1,0	0,0	0,0	6,1	2,0	0,0	0,0	-
5-10	2,1	9,1	6,0	-	0,1	1,0	1,0	5,1	4,1	3,0	0,0	-
10-15	0,3	4,3	1,0	-	0,0	3,0	1,0	0,3	4,1	2,1	1,0	-
15-20	0,2	0,2	2,4	-	0,0	2,0	2,0	0,3	5,2	2,1	0,0	-
20-25	0,0	0,3	0,2	-	0,0	2,1	2,1	0,2	0,3	2,1	0,1	-
>25	0,0	0,7	0,3	-	0,0	3,10	0,5	0,1	0,8	2,8	0,0	-

[a] Effective height
[b] Height
[c] Upland
[d] Midland
[e] Lowland
[f] Prairie hay
[g] Burn
[h] Successful
[i] Unsuccessful

relocated 6.1 km from her initial nest 5 days after its destruction. She then moved back towards her initial nest and localized in an area completely independent of the range used prior to losing the initial nest (preincubation range). Her renest was 2460 m from her initial nest. No renest was found for the other five juveniles and none were relocated in their preincubation ranges following destruction of the initial nest. Of those five hens, hen 1180 and 1610 moved 2.6 and 15.3 km, respectively, from booming ground 25 prior to initiating an initial nest. Both hens established ranges that did not include ground 25. They lost their initial nests, moved back to within 1.5 km of ground 25 and established new ranges independent of their preincubation range. Juvenile hens 1110, 1363 and 1766 were located (greatest distance) 9.6, 4.0 and 3.1 km, respectively, from their initial nest following its destruction and were never again relocated in their preincubation range. Hen 1766's radio failed in mid-June and hen 1363 was difficult to relocate following loss of her initial nest.

Adults were much more likely to renest in the area with which they were familiar. Only 3 of 12 hens established a renesting range completely independent of the preincubation range or were relocated over 3 km from their initial nest following its destruction. Of those three hens 0977 had a probable initial nest, moved 12 km and renested. Hen 1241 established a renest egg laying range independent of her preincubation range and renested 2060 from her first nest. Adult hen 1458's transmitter failed on the nest. Her nest was destroyed prior to 27 May and her transmitter was recovered on 3 July, 13.7 km from the nest. Adult hen 1457 was killed within 0.5 km of her initial nest 12 days following its destruction. The remaining eight adults, two for which no renest was found, remained in the area of their initial nest following its destruction and had ranges that overlapped their preincubation range.

Of the two sharptail hens, the juvenile abandoned her nest, dispersed 4 km and established a new range while the adult renested within 210 m of her initial nest.

Two other categories of non-brood hens existed,those that lost their renest or broods. Three adult prairie chickens and one adult sharptail lost their renest. All except 0977 remained in the area of the renest following its destruction. Hen 0977 moved back 11.1 km to within 0.9 km of her probable initial nest following the loss of the renest. Hens that lost broods shortly after hatching dispersed away from the nest. Again, although sample sizes are small, juveniles appeared to move greater distances. Juvenile hens 1576 and 1540 moved 9.7 and 11.1 km respectively after losing their broods during the first week of brood rearing. Adult hen 1414 lost her brood 1 day after hatching, shifted 3.2 km north of her renest and remained in that area the rest of the summer.

In summary juvenile non-brood hens were more mobile than adult non-brood hens and often responded to nest or brood loss by moving great distances. Eight juveniles that lost initial nests or broods moved an average of 7.7 km (SD=4.5) following the loss. Adults were less likely to disperse following brood or nest loss with only 4 of 12 moving over 3 km.

Home range during the non-brood period was varible and ranged from 308 to 2096 ha (Table 43, Appendix). Juveniles had much larger ranges than adults (Table 28). Out of five juveniles whose total non-brood range could be measured, four had ranges over 1300 ha while of five adults, four had ranges of less than 850 ha.

Table 28. Mean home range sizes (ha) of non-brood prairie chickens following loss of initial nest.

	Juveniles			Adults			Combined		
Range	Mean	SD	N	Mean	SD	N	Mean	SD	N
Renesting[a]	337.0	452.5	2	398.8	670.3	9	387.6	616.9	11
Egg-laying[b]	31.5	37.5	2	72.5	28.6	8	65.5	31.6	11
Non-brood[c]	1316.2	607.7	5	470.2	400.9	5	893.2	659.1	10
Total NB[d]	1316.2	607.7	5	970.2	1066.1	5	1143.2	838.2	10

[a] Renesting range measured from the time of loss of the initial nest until incubation of renest began.
[b] Egg-laying range, renest, measured during the egg laying period.
[c] Non-brood range range following loss of last known nest.
[d] Total NB, range following loss of initial nest.

Range size during the renesting period varied from 17 to 2177 ha with a mean of 387.6 ha (Table 28). Although total renesting ranges varied greatly among individuals, the size of the range used while laying eggs in the renest (egg laying range) was less variable and much smaller. Egg laying ranges were an excellent example of intensive use areas (IUAs) within a larger total range. IUAs were areas in which relocations for at least 5 days fell within a small area relative to the total range. Other relocations were considered to be movement relocations between areas of intensive use. Seven non-brood hens utilized at least 10 IUAs after losing their last known nest. The average size of these areas (85.8 ha) was comparable to the egg laying range (65.5 ha) (Table 29).

Hens spent most of their time in small areas relative to the total range. An average of 80.7% of the days and 88.3% of the locations were in 38.8% of the total non-brood range. Four adults spent an average of 88.3% of their time in 61.3% of their total range while three juveniles spent 70.7% of their time in 9% of their total range.

Movements and Home Range of Brood Hens

Data on movements, habitat use and mortality of 22 broods were collected in 1983 and 1984. Known hatching dates for initial nests ranged from 7 June to 21 June and for renests, 28 June to 19 July.

Table 29. Size of intensive use areas (IUAs) and their percent of the total non-brood range.

I.D.	Age	Days		Locations		Size	
		No.	%[a]	No.	%[a]	(ha)	%[a]
1332	Adult	45	94	12	92	45	100
1360	Adult	18	18	26	25	113	32
"	Adult	70	71	68	67	94	27
1414	Adult	42	88	20	91	137	44
1486	Adult	31	36	52	68	169	32
"	Adult	39	46	18	24	54	10
1180	Juvenile	83	86	34	87	72	18
1610	Juvenile	16	21	15	23	59	3
"	Juvenile	47	60	46	70	85	4
1110	Juvenile	35	45	12	71	30	2

[a] Percentage of the total number of days during the non-brood period, locations taken, and size of non-brood range.

Brood hens were found in IUAs for periods ranging from 7 to 57 days (mean, 24.8 days SD=14.88) Twenty hens had 40 IUAs identified during the course of this study. Four hens who lost their broods or were killed early in brood rearing were not included in calculations of mean IUAs (Table 30). Average size of an IUA was 40.4 ha, smaller than the average egg laying ranges of renesting hens (65.5 ha) and less than one-half the average size of non-brood hen IUAs, (85.8 ha). Adults and juveniles had similar sized IUAs but hens from successful renests had much smaller IUAs than hens from successful initial nests.

On the average, hens with broods from initial nests were relocated in 30.2% (SD=34.9) of their total range 83.0% (SD=10.5) of the time while brood hens from renests utilized 57.8% (SD=16.2) of their total range 89.7% (SD=2.7) of the time.

Table 30. Average size of intensive use areas of broods on the SNG, 1983-1984.

Age	Mean (ha)	SD	N
Adult	40.5	47.7	19
Juvenile	40.2	50.3	17
Total	40.4	48.2	36
After renest	21.6	11.7	11
After initial	48.6	55.7	25

Distances were measured between the nest and first IUA and between subsequent IUAs as an indicator of mobility. Measurments were taken from the last location in the prior IUA to the first location in the next IUA. Mean distance from the nest to the first IUA was 0.47 km, (SD=.56) with little difference seen between adults and juveniles, 0.57 and 0.39 km, respectively (Table 31). Mean distances to the second and third IUAs were over two times greater for juveniles than adults. The furthest distance moved by an adult with a brood between IUAs was 2.3 km. while 3 of 10 juveniles, hens 1001, 0810 and 1732, moved great distances with their broods. Hen 1001 moved 10.5 km after spending 23 days in her first IUA. Hen 0810's first and second IUAs overlapped greatly but she travelled 10.3 km in an 8 day period with her 12 day old brood before remaining in her second IUA. Hen 0810 moved her chicks again, 4.2 km when they were 36 days old. Hen 1732 moved 3.6 km and 2.4 km between first and second and second and third IUAs. Her chicks were 8 and 32 days old when the two moves were made.

Table 31. Mean distance (km) moved by brood hens from nest site to first intensive use area and subsequent intensive use areas.

	km from nest			km to second			km to third			km to fourth		
Age	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Adult	.57	.66	9	1.01	.36	6	1.03	.28	4	1.12	-	1
Juvenile	.39	.47	11	2.83	3.94	6	2.86	1.19	3	-	-	0
Total	.47	.56	20	1.92	2.83	12	1.82	1.21	7	1.12	-	1

Brood ranges were largest for juvenile hens that hatched initial nests (Table 32). The smallest brood range that any juvenile, which had hatched eggs in an initial nest and had chicks at the end of the summer, was 229 ha which was larger than all adult brood ranges except one, (405 ha). Individual brood rearing ranges varied greatly from 22 ha to 2248 ha (Table 44, Appendix).

Habitat Utilization

There were 1675 relocations of 33 non-incubating hens taken from May to August. Community types were recorded for 921, 371, and 351 hen relocations during the brood rearing, non-brooding and renesting periods, respectively. All hen relocations in May were combined and treated as locations of renesting hens because such a high percentage of hens renested.

Table 32. Mean brood range size of adult and juvenile prairie chicken hens.

Age	Nest type[a]	Mean (ha)	SD	N
Adult	I	255.8	99.8	4
Juvenile	I	1178.8	915.5	5
Combined	I	768.6	812.1	9
Adult	R	77.5	42.3	4
Juvenile	R	51.0	35.4	2
Combined	R	68.7	38.9	6
Adult	R&I	166.6	118.8	8
Juvenile	R&I	856.6	928.4	7
All combined	R&I	488.6	709.5	15

[a] I= Initial nest, R= Renest.

Use of Agricultural Communities

Most of the use associated with agricultural communities was in alfalfa and planted prairie hay (Table 33). Renesting hens in May spent a greater portion of time in non-native communities than any other group (Fig. 7), probably for the following reasons: cash crops such as corn had not been replanted and continued to provide a food source; alfalfa and prairie hay was growing rapidly and provided an excellent food source and cover; and 25.5% of all renests were in alfalfa.

Table 33. Number and percent of relocations in planted communities for renesting, brood and non-brood hens from May-August, 1983-1984.

Community[a] Type	Renesting Hens			Brood Hens			Non-brood Hens			Total		
	No.	%[b]	%[c]	No.	%	%	No.	%	%	No.	%	%
AL	63	43.2	17.9	93	41.0	10.1	13	22.8	3.5	169	39.3	10.3
AL edge	10	6.8	2.8	17	7.5	1.8	1	1.8	.3	28	6.5	1.7
PH	38	26.0	10.8	86	37.9	9.3	12	21.1	3.2	136	31.6	8.3
PH edge	1	.7	.3	2	.9	.2	1	1.8	.3	4	.9	.2
CR	27	18.5	7.7	28	12.3	3.0	30	52.6	8.1	85	19.8	5.2
CR edge	7	4.8	.2	1	.4	.1	0	0.0	0.0	8	1.9	.5
Total	146	100.0	41.6	227	100.0	24.6	57	100.0	15.4	430	100.0	26.2

a AL=Alfalfa, PH= Planted prairie hay, CR= Crops.
b Percent of locations in planted communities.
c Percent of all relocations for that group of hens.

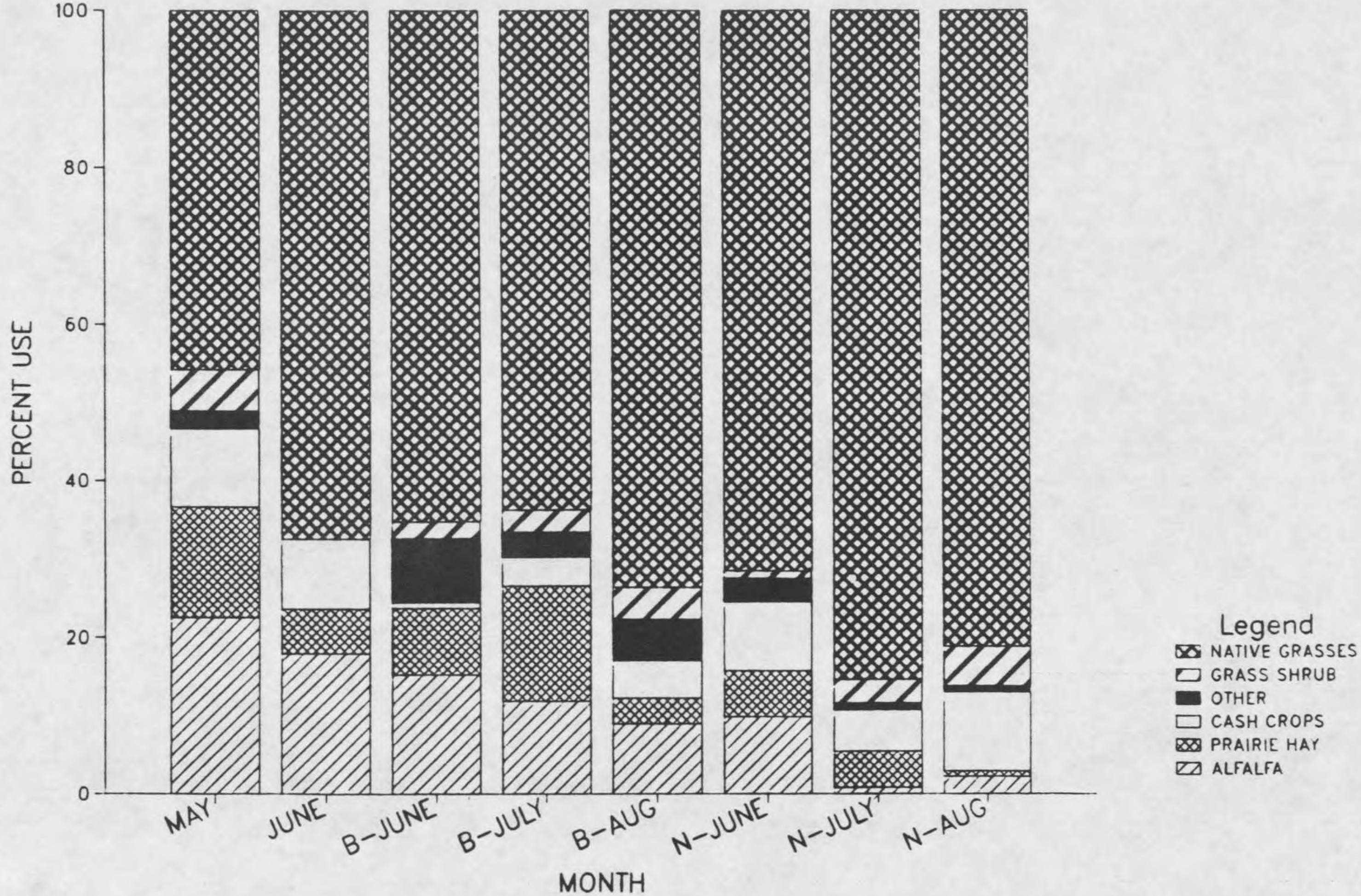

Fig. 7. Habitat use by prairie chicken hens, May through August, Sheyenne National Grasslands, 1983-1984 (Renesting hens May and June; hens with broods (B) and without broods (N), June through August).

Brood hens frequented non-native communities more during the months of June, July and August than did renesting or non-brood hens. Of all the locations recorded for broods in agricultural communities, 87.3% were in planted prairie hay, alfalfa or their associated edge communities. There was a decrease in utilization of agricultural types by broods and non-broods in August due mainly to mowing of prairie hay. Three broods used alfalfa almost exclusively during the 2 years of the study. When the alfalfa was mowed brood hens remained in the fields but used the edge of windbreaks and ditches for cover. Only 93 (5.7%) of all locations taken from May through August were recorded in cash crops or their associated edge (Fig. 7).

Use of Native Communities

All three classes of hens used native stands of vegetation more than agricultural community types (Fig. 7). Renesting, brood and non-brood hens were relocated in native vegetation (public and private land) 57.0, 70.1 and 83.3% of the time respectively. Structurally, midland and lowland vegetation were more similar to each other than either to upland. Upland vegetation was preferred by cattle and grazed heavily throughout the summer. Very few relocations in the upland community were recorded for renesting hens in May and June (Fig. 8). Both brood and non-brood hens had more locations in lowlands during the

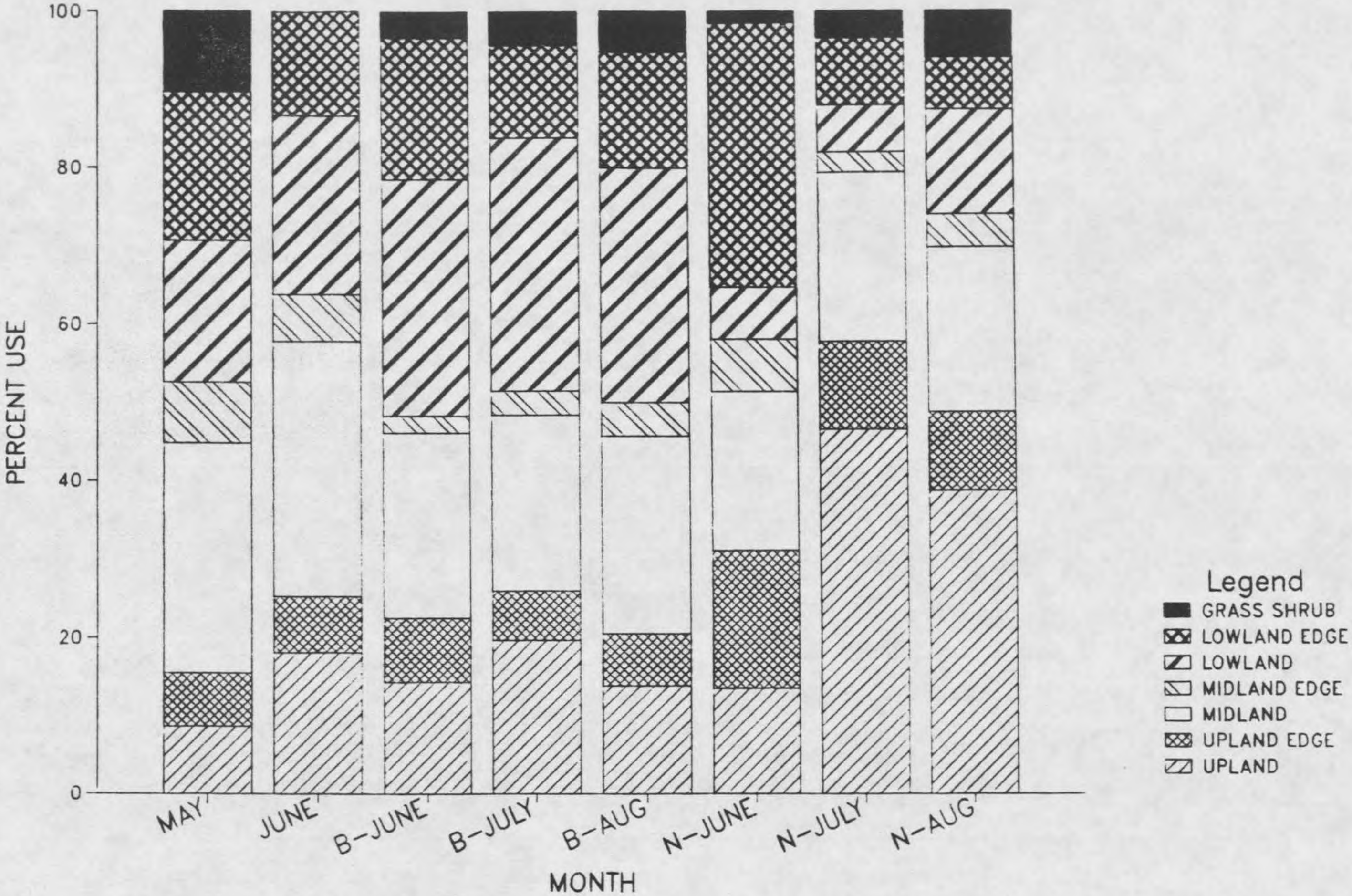

Fig. 8. Use of native habitats by prairie chicken hens, May through August, Sheyenne National Grasslands, 1983-1984. (Renesting hens May and June; hens with broods (B) and without broods (N), June through August).

month of June than any other month (Table 34). As the summer progressed there appeared to be differences in habitat utilization by brood and non-brood hens. In July and August non-brood hens made extensive use of upland communities and their associated edge, while broods remained relatively constant in their use of lowlands. The reason for this apparent difference in habitat use may be due to broods requiring the greater HTs and EHTs of vegetation provided in the lowlands.

Table 34. Percent use of native communities, combined with their respective edges, by broods and non-broods.

	June		July		August	
	Brood	Non-brood	Brood	Non-brood	Brood	Non-brood
Upland	22.5	31.1	26.0	57.8	20.5	48.8
Midland	25.8	27.1	25.5	24.2	29.5	25.2
Lowland	48.3	40.6	44.1	14.6	44.8	20.1
Grass/shrub	3.3	1.4	4.3	3.4	5.2	5.9

Night Roost Sites

A mean Robel pole reading of 1.03 (SD .93) was calculated from measurements taken at 61 roosts of grouse. Ninty-two percent of marked roosts were in Class III (26-50 cm) or taller vegetation. It appeared that lowlands were used more frequently for roosting by broods (51.2%, N=43) than non-brood hens (33.3%, N=18). There were 165 night relocations taken, during May through August and hens used native communities in about the same proportion at night (75.2%) as day (70.3%).

Disturbance Type Use

Practically all of the land associated with the SNG is disturbed every year by mowing, grazing or cultivation. Selection of areas by hens seemed to be based first on land use (disturbance type) and second on community types. There are slight differences between raw data totals presented here and data presented in the community use section for the following reasons. First, if a native community type was recognized within prairie hay it was assigned that community type while the disturbance code would assign it to prairie hay. Secondly, nine sorghum locations were assigned to crops in the community type section but were treated as prairie hay in this section. Thirdly, often a relocation was assigned to a disturbance type even if it could not be assigned to a community type.

Fewer brood hen (55.6%) than non-brood hen (82.7%) relocations were on public land. Only in the month of July did either hen class spend more time on private land than public land (Table 35). Areas that had been mowed the previous year, but were currently undisturbed were used more often by brood hens than by non-brood hens. During the month of July, 45.9% of all relocations of brood hens were in either prairie hay or alfalfa while

Table 35. Number and percent of relocations in disturbance types for brood and non-brood hens June-August, 1983-1984.

Disturbance type	June				July				August				Total			
	Brood		Non-brood		Brood		Non-brood		Brood		Non-brood		Brood		Non-brood	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public																
4-pasture	11	4.1	0	0.0	5	1.3	7	5.1	3	1.1	16	10.6	19	2.1	23	5.9
3-pasture	95	35.2	56	54.9	130	33.9	101	74.3	119	44.1	94	62.3	344	37.3	251	64.5
2-pasture	11	4.1	16	15.7	30	7.8	12	8.8	7	2.6	9	6.0	48	5.2	37	9.5
1-pasture	58	21.5	2	2.0	25	6.5	0	0.0	35	13.0	4	2.6	118	12.8	6	1.5
Private																
Prairie hay	41	15.2	6	5.9	131	34.2	10	7.4	43	15.9	12	7.9	215	23.3	28	7.2
Alfalfa	41	15.2	10	9.8	45	11.7	1	.7	24	8.9	3	2.0	110	11.9	14	3.6
Crops	3	1.1	9	8.8	10	2.6	5	3.7	13	4.8	11	7.3	26	2.8	25	6.4
Misc.[a]	10	3.7	3	2.9	7	1.8	0	0.0	26	9.6	2	1.3	43	4.7	5	1.3
Total	270	100.1	102	100.0	383	99.8	136	100.0	270	100.0	151	100.0	923	100.1	389	100.0

[a] Includes road ditches and undisturbed areas.

only 8.1% of non-brood hen relocations were in those types. Alfalfa and prairie hay use by broods declined by 21.1% in August due to mowing. Hens which used prairie hay fields always left those fields after they were mowed whereas broods in alfalfa sometimes remained even after mowing.

Use of Pastures

In June, July and August, 64.9, 49.5 and 60.8% of all brood locations and 72.5, 88.2 and 81.5% of all non-brood relocations, respectively, were in pasture systems. Of all pasture systems utilized, 3-pasture deferred systems were used the most by both brood and non-brood hens (Table 35). Hens tended to avoid pastures with cattle and pastures that had been disturbed (grazed) earlier that year. Of all brood and non-brood locations, 74.2% and 74.4% respectively were in areas without cattle. The deferred pasture of 3-pasture systems was used by brood and non-brood hens a high percentage of the time relative to other pastures (Table 36).

Current or previous cattle use in the same year seemed to be one of the most important factors determining the amount of use by brood and non-brood hens, with both classes seeking areas that had not been disturbed during the current year.

Table 36. Number and percent of locations in pasture systems relative to year deferred, June-August, 1983-1984.

	Deferred		Deferred 1 year prior		Deferred 2 years prior		Other[a]	
	No	%	No.	%	No.	%	No.	%
Broods	179	33.8	102	19.3	51	9.6	197	37.2
Non-broods	166	52.4	20	6.3	46	14.5	85	26.8
Total	345	40.8	122	14.4	97	11.5	282	33.3

[a] Includes locations in 2-pasture, 1-pasture, other 3-pasture systems without a deferred pasture and 4-pasture systems.

Brood hens often moved their broods from the disturbance type in which they nested, to a different disturbance type after hatching. A determination based on cattle use or mowing was made as to whether the newly selected IUA was more disturbed, less disturbed, or as disturbed as the disturbance type the hen left.

Out of 22 hens that nested successfully, 13 moved to a new disturbance type, 2 lost their broods, and 7 stayed in the same disturbance type after hatching. Of the seven that stayed in the same disturbance type after hatching, four remained in unmowed alfalfa, one stayed in a 4-pasture system with cattle, one stayed in a deferred pasture of a 3-pasture system and one stayed in a grazed pasture of a 3-pasture system. Of the 13 hens that moved, 1 lost her brood before selecting a new type, 6 moved into areas that were less disturbed, 4 into areas that had similar disturbance types and only 2 moved into pastures that were more disturbed than the pastures in which their nest was located. Of 19 hens that made a selection of disturbance type following hatching of their nests, 15 moved into or stayed in disturbance types that were currently undisturbed. Of the four that were in disturbed pastures one lost her brood within 6 days, one stayed in the more disturbed area for 7 days, one remained in the more disturbed area for 11 days and the last hen remained in a relatively undisturbed portion of a grazed pasture throughout brood rearing.

Of the total relocations of brood and non-brood hens 42.7% and 49.9%, respectively, were in deferred pastures and prairie hay. Analysis of IUAs indicated that hens chose those areas in part because of the lack of disturbance. Each IUA was assigned one disturbance code even though it might have consisted of more than one type. The disturbance type to which the IUA was assigned was the type with the most number of relocations. Twenty-three of 50 (46%) IUAs consisted mainly of prairie hay or deferred pastures while 47.7% of all brood days and 65% of non-brood days were spent in those types (Table 37). Besides prairie hay and deferred pastures few other disturbance types go undisturbed for the entire summer and only two other disturbance types had significant numbers of IUAs:

the second pasture grazed of 3-pasture systems and alfalfa. In all but one case brood and non-brood hens utilized the second pasture grazed when cattle were not present and the undisturbed edges of alfalfa fields when they were mowed. Prairie hay and deferred pastures represent a relatively small area compared to all disturbance types available to a hen. The superior height and density of vegetation associated with those disturbance types was the most probable reason hens selected them.

Table 37. Disturbance types that were major components of intensive use areas (IUAs) and the number of brood and non-brood (NB) days in those IUAs.

Disturbance type	No. IUAs		No. days		N[a]	
	Brood	NB	Brood	NB	Brood	NB
4-pasture	2	0	25	0	2	0
3-pasture[b]	1	0	10	0	1	0
3-pasture[c]	6	5	154	16	4	1
3-pasture[d]	10	0	243	277	7	5
2-pasture[b]	3	0	59	0	7	0
2-pasture[c]	1	0	10	0	1	0
1-pasture	2	0	38	0	2	0
Prairie hay	8	0	197	0	7	0
Alfalfa	5	0	143	0	4	0
Barley	1	0	23	0	1	0
Private pasture	1	0	20	0	1	0
Mixture	0	4	0	133	0	4
Total	40	10	922	426	32	10

[a] Number of different brood or non-brood hens.
[b] First pasture grazed.
[c] Second pasture grazed.
[d] Deferred pasture.

Vegetative Structure

Analysis of photo-plot transects showed that EHTs and HTs were greatest in those areas that were the least disturbed during the summer months. By 15 June EHT and HT in deferred pastures was superior to EHT and HT in grazed pastures. From 15 June to 30 July EHT and HT was greater in all communities, uplands, lowlands and midlands, except the upland on 1 July (Figs 9-14). One prairie hay transect in 1984 showed a trend similar to the vegetation development in the deferred pasture. By 15 June EHT and HT were 12.4 cm (SD 2.87) and 22.7 cm (SD 4.49), respectively. Mowing in August caused the decrease in EHT and Ht observed in prairie hay and lowlands of the deferred pastures.

EHT and HT were the greatest in the lowland communities in all disturbance types throughout the summer months except after mowing (Table 38). The greatest EHTs and HTs in the uplands and midlands were in the deferred pastures. It appeared that brood and non-brood hens might avoid vegetation that was too dense. One photo-plot transect was located in a lowland II community. Few relocations were recorded in this community even though several hens nested in, and several broods utilized the edges of the lowland II. EHTs and HTs in this lowland II community were greater than other communities (Table 38).

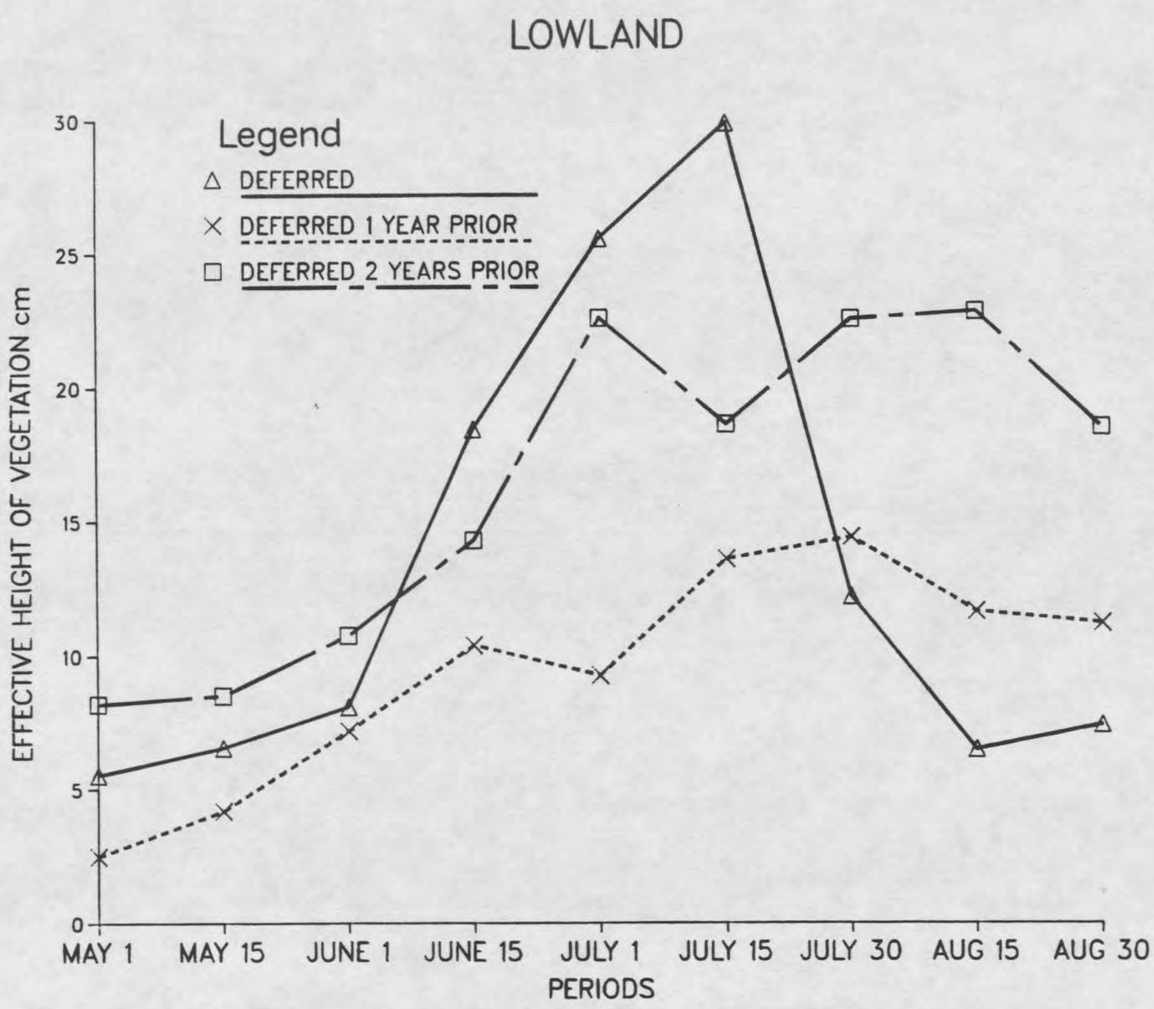

Fig. 9. Seasonal trends of effective height of vegetation on lowland transects, 1983-1984.

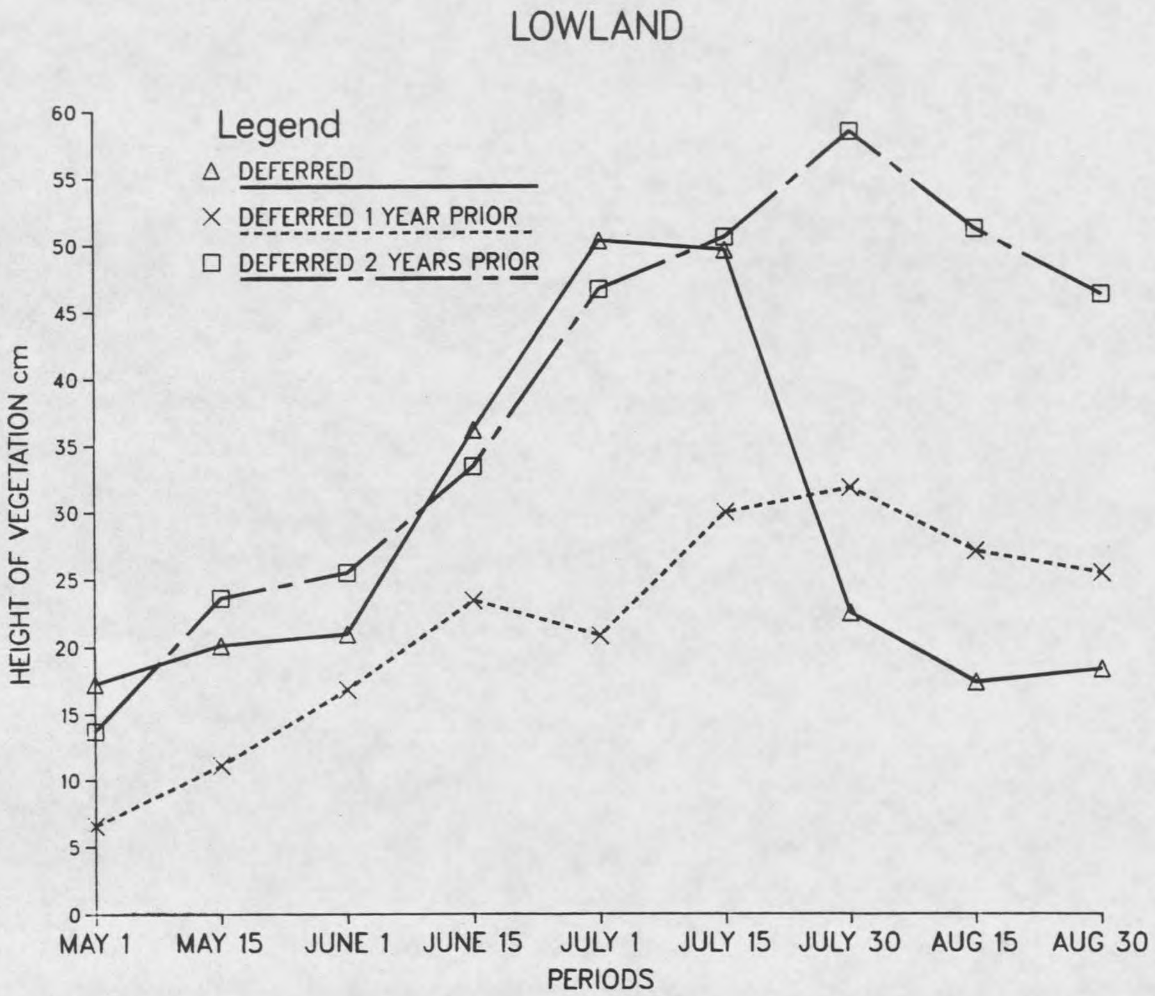

Fig. 10. Seasonal trends of height of vegetation on lowland transects, 1983-84.

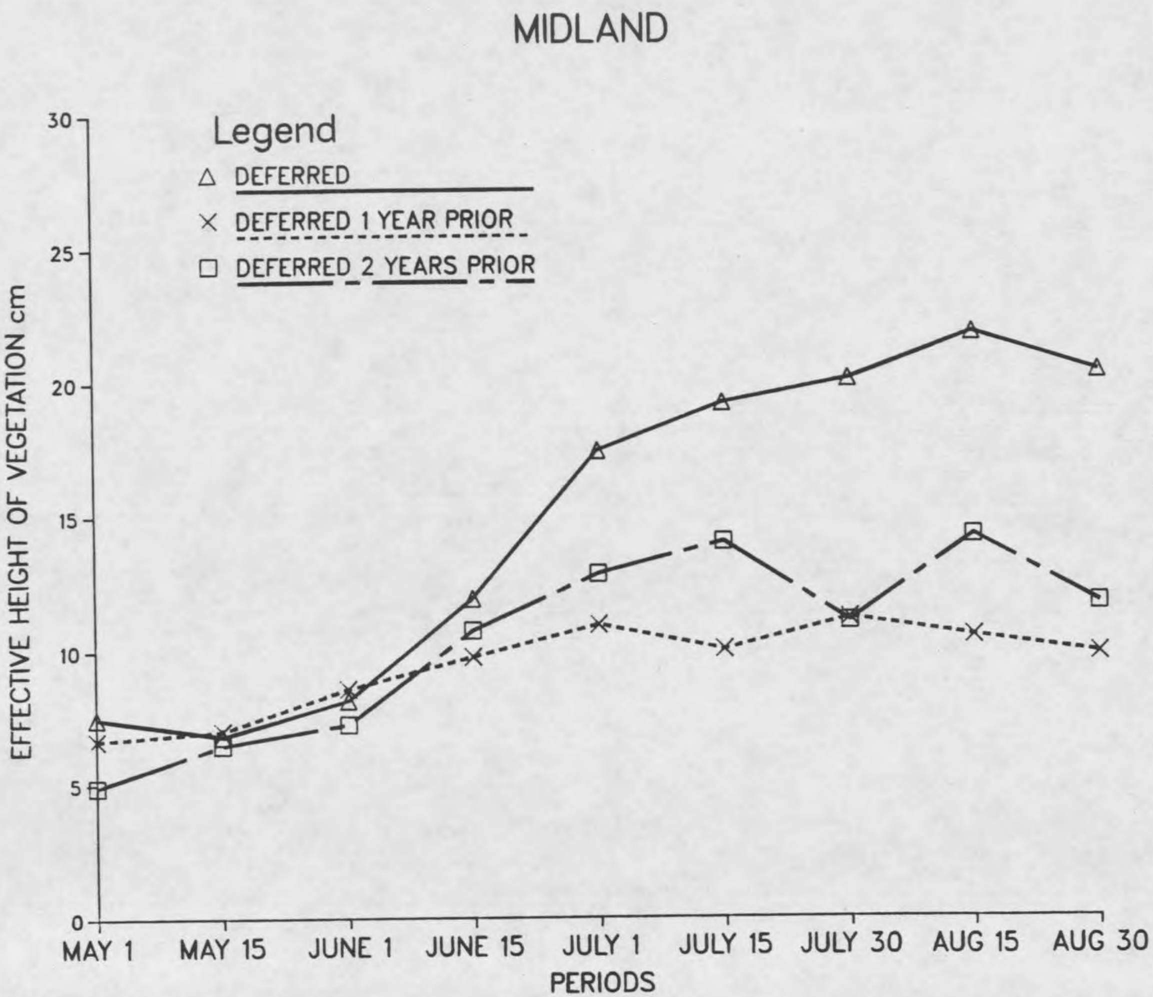

Fig. 11. Seasonal trends of effective heights of vegetation on midland transects, 1983-84.

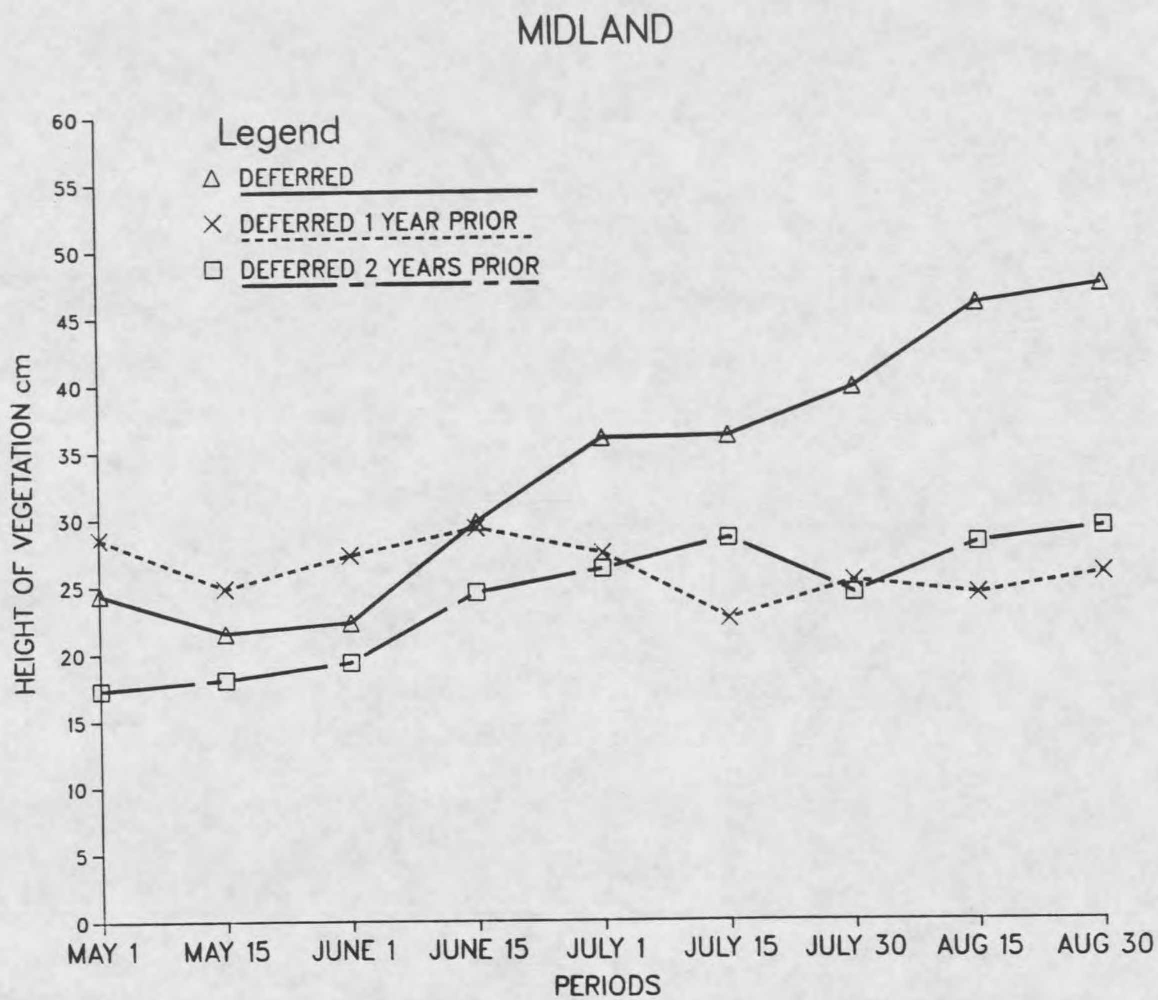

Fig. 12. Seasonal trends of height of vegetation on midland transects, 1983-84.

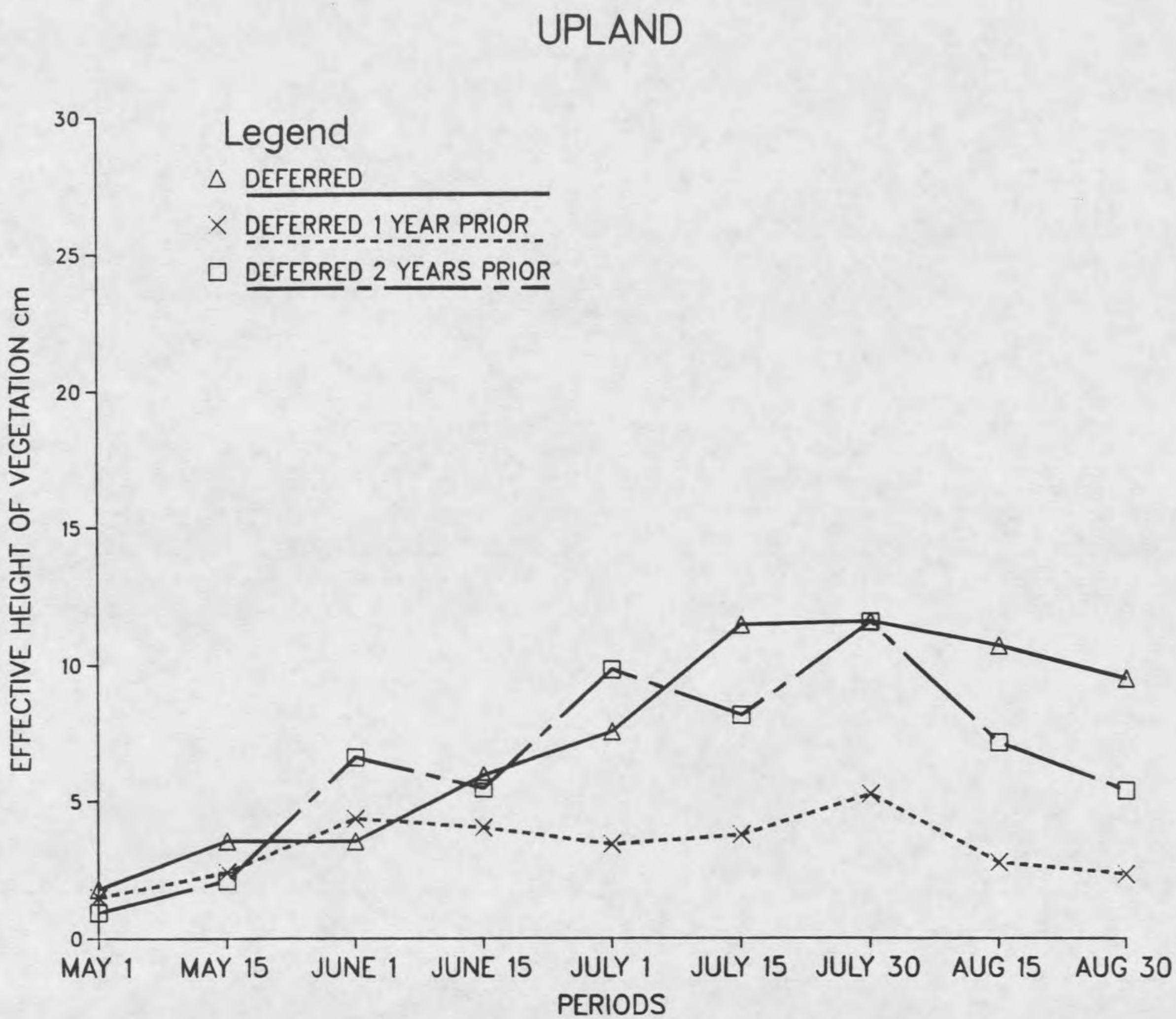

Fig. 13. Seasonal trends of effective height of vegetation on upland transects, 1983-84.

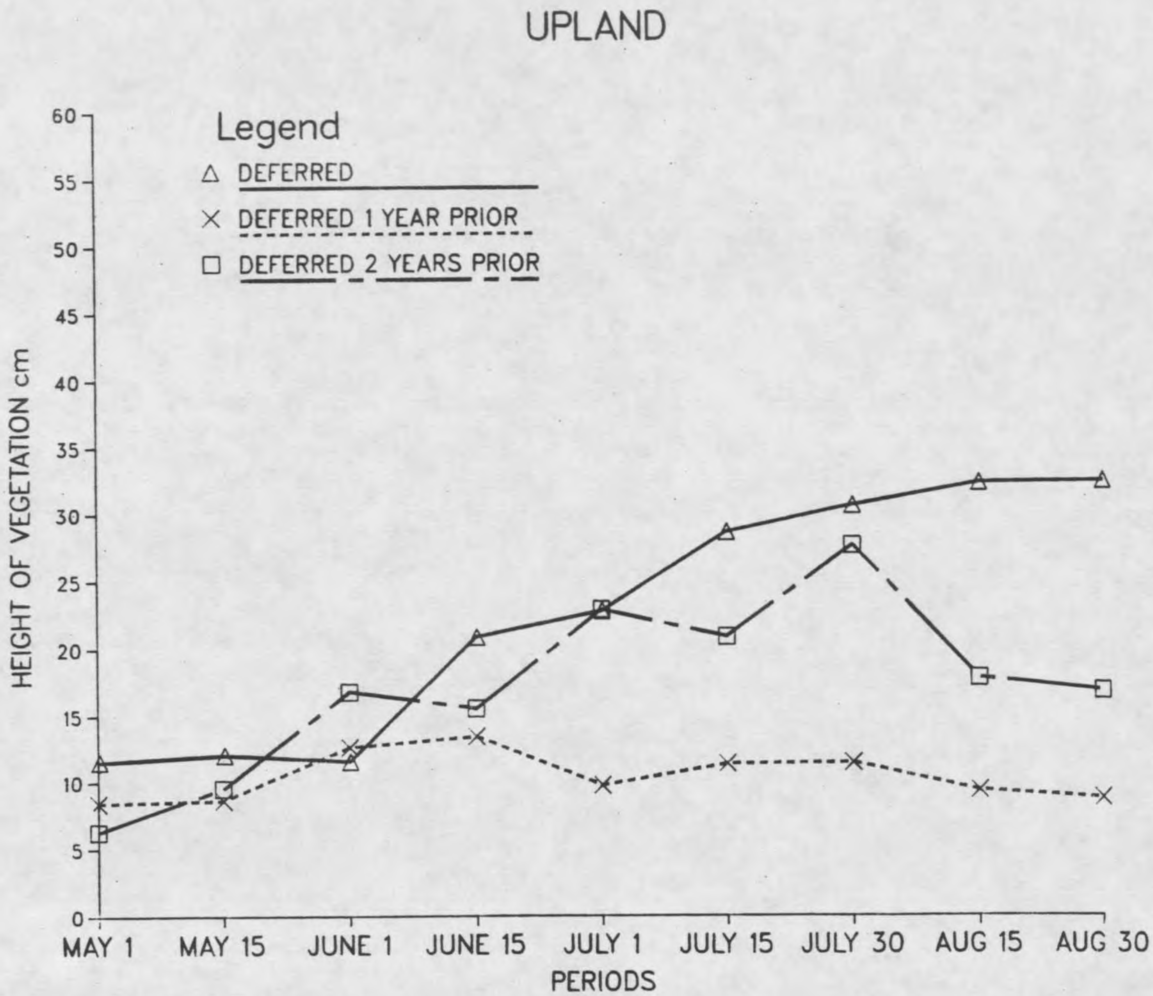

Fig. 14. Seasonal trends of height of vegetation on upland transects in, 1983-84.

Table 38. Range of effective heights (EHT) and heights (HT) (cm) along photo-plot transects.

	Upland			Midland			Lowland		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
EHT[a]	3- 6	7-12	8-12	8-12	17-20	20-21	8-18	25-30	6-12
HT[a]	11-21	22-31	31-33	22-30	35-40	40-48	20-36	22-50	17-22
EHT[b]	3- 4	3- 6	3- 5	8-10	10-11	9-11	7-10	9-14	11-14
HT[b]	12-13	9-11	7-11	27-28	22-27	24-25	16-23	20-31	25-31
EHT[c]	5- 6	9-11	5-11	7-10	12-14	12-14	10-14	18-22	18-22
HT[c]	15-17	20-28	16-28	19-25	24-28	24-29	25-33	46-59	46-59
EHT[d]				3-13	17-21	2			
HT[d]				9-23	34-42	6			
EHT[e]							16-29	35-39	35-39
HT[e]							31-51	61-72	69-72

[a] 3-pasture, deferred pasture.
[b] 3-pasture, deferred 1 year prior.
[c] 3-pasture, deferred 2 years prior.
[d] Prairie hay.
[e] Continuous system. Lowland II community.

Additional data gathered on vegetative structure showed that hens selected vegetation that had good height characteristics. Brood hens were relocated in vegetation shorter than 25 cm only 9.2% of the time while non-brood hens were relocated in the same height vegetation 26.2 % of the time. Both classes of hens sought vegetation greater than 25 cm in height most of the time in summer months (Table 39).

Mortality and Radio Recovery

Twenty-two radio-tagged prairie chickens produced 265 chicks, all but 4 of which left the nests. Mortality of broods was high, especially during the first 2.5 weeks of brood rearing. Hens 1414, 1540, and 1576 made 3.2, 11.1 and 9.7 km moves 1, 5 and 10 days, respectively, after successfully hatching eggs inn a nest. Periodic marking of their roosts, and flushing, indicated that each had lost their entire broods prior to these moves. Five hens were killed during the brood rearing period, three within 17 days after hatching and two after 45 and 53 days.

Table 39. Use of height classes of vegetation by brood and non-brood (NB) hens on the SNG, 1983-1984.

Height class (cm)	June				July				August			
	Brood		NB		Brood		NB		Brood		NB	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-8	15	5.7	37	16.6	6	1.6	5	3.8	5	1.9	13	9.4
9-25	23	8.7	61	27.4	12	3.2	7	5.3	24	9.0	6	4.3
26-50	150	56.8	63	28.3	202	53.2	88	66.7	116	43.4	76	55.1
>50	38	14.4	7	3.1	135	35.5	13	9.8	94	35.2	21	15.2
Edge	38	14.4	55	24.7	25	6.6	19	14.4	28	10.5	22	15.9

Determining early partial brood mortality was difficult since chicks less than 3 weeks of age often did not flush with hens. In one instance a 34-day old chick was stepped on after two hunting dogs had searched the area and flushed only the hen. Shortly thereafter, three more chicks flushed.

To compare early and late brood mortality, the summer was divided into two time periods, from hatching until the first time the brood was flushed and from first flush until the end of the summer. It was assumed that if a hen was killed during the brood period, her chicks also died. Brood hens were flushed an average of 24 (SD 13.13) days after leaving the nest. Mean rate of chick loss during this early period was 0.31 chicks per day per hen resulting in a loss of 62.8% of the chicks. The average number of days in the second time period was 32.9 (SD 12.48) days, with an average chick loss of 0.04 chicks per day per hen, indicating that 8.9% of all chicks were lost in this time period. Even though a wide variation in the number of days between hatching and first flush existed among hens, the rate of chick loss in the first 24 days appeared to be much higher than during the second time period.

Of 261 chicks that left the nest, 28.4% (74) survived to the end of the summer. Of the 22 radio-tagged prairie chicken hens that produced chicks only 13 had chicks (average brood size 5.7, SD=3.75) at the end of the summer. In 2 years 45 prairie chicken hens had 74 chicks survive until 31 August. Two radio-tagged sharptails failed to produce young in the second year of the study.

Mortality of hens was high with 21 of 44 (47.7%) dying (6 radio faliures not included) from mid-April through August. Mortality rates were highest prior to incubation of initial nests and during the brood rearing period, (20.0% and 22.7%, respectively) and lowest during the incubation, renesting and non-brood periods, (8.5, 5.7 and 16.7%, respectively). Twelve of 47 (25.5%) hens (3 radio failures not included) were preyed upon in May.

Fourteen of 23 and 18 of 31 transmitters were recovered from dead birds during the 12 month periods April-April in 1983-84 and 1984-85, respectively. Thus a minimum annual mortality rate was calculated to be 60.9% in 1983 and 58.1% in 1984.

DISCUSSION

Nesting

Hens began incubating first nests on 3 May, 2 May and 22 April in 1983, 1984, and 1985 respectively. The earlier dates of incubation initiation in 1985 may have been in response to the warmer spring. In Minnesota Svedarsky (1979) reported that hens were in their first week of incubation by 13 May so it appears that hens on the SNG initiate incubation at least 1 week earlier.

The incubation period of 26.6 days on the SNG is longer than the 25.5 day period in Minnesota (Svedarsky 1979) and the 23-25 day period reported in Missouri (Schwartz 1945) and (Arthaud 1968) in Wisconsin (Gross 1930) and in Kansas (Silvy 1968). The reason for the apparent differences is not clear.

Mean clutch size for 59 nests was 13.2 eggs which is larger than that reported by Svedarsky (1979) for 29 nests (mean, 12.7) in Minnesota, by Robel (1970) for 19 nests (mean, 11.6) in Kansas and by Hamerstrom (1939) for 66 nests (mean, 12.0) in Wisconsin. Baker (1953), Robel (1970), and Svedarsky (1979) found that clutch size decreased as the nesting season progressed. Data from this study also indicate that later nests (renests) had smaller clutches (11.4) than initial nests, (13.9). One possible reason for the wide variation in clutch size reported is the proportion of initial nests to renests which was 41 and 18 in this study.

The 85 and 93% hatchability of eggs in initial nests and renests was lower than the 98% reported in Wisconsin, (Hamerstrom 1939), and the 100% reported in Missouri and Kansas, (Schwartz 1945) and (Silvy 1968). However, it was similar to hatchability reported in Illinois, 93% (Yeatter 1943) and Minnesota, 91.9% (Svedarsky 1979). This study apparently contains the first report of a hen which incubated a full clutch of what appeared to be infertile eggs for 39 days.

Of the observed nests 54.1 % were successful which is lower than the 62.4% reported by Svedarsky (1979) but higher than the average of 50.0% reportly needed to maintain populations of prairie chickens in Illinois (Westmeier and Vance 1975). Fifty-eight percent of the hens successfully hatched eggs. Robel (1970) found that later nests were not as successful and did not produce as many chicks as earlier nests. In this study renests were much more successful (72.2%) than initial nests (46.5%) and produced 36.1% of the chicks over a 3 year period. If probable nests and birds killed during this period are included as not having a successful nest then initial nest success dropped to 33.3%. Juvenile hens had higher initial nest success than adults which is surprising in that Wallestad and Pyrah (1974) reported that adult sage grouse were more successful. Because initial nests had larger clutches than renests and because an increased energy demand on renesting hens might decrease their chance of survival management on the SNG directed towards improving initial nest success might enhance prairie chicken populations.

Adult hens were capable renesters with 15 of 17 having a second nest and 2 having third nests. Juvenile hens were not as persistent with only 2 of 7 initiating a second nest. Svedarsky (1979) and Robel (1970) also found that hens were capable of establishing three nests.

Females usually shifted daily patterns following loss of the initial nest. Adults usually established new ranges that overlapped their initial nest egg laying range. Shifts away from an unsuccessful nest would probably be a beneficial strategy for increasing the chance of a successful renest. Juveniles usually made long moves following the loss of a nest, which may be a beneficial strategy for range expansion into suitable habitat.

Of 76 observed prairie grouse nests 77.6% were initiated on public land, 13.2% in alfalfa and only 9.2% in privately owned grasslands. None of the nests were in cash crops. Lowland communities had the most number of nests and produced the most chicks. It appeared that the form of the vegetation, height and effective height was an important factor determining nest success. Hamerstrom et al. (1957), Tester and Marshall (1962), and Jones (1963) all suggested that form is more important than species composition in the selection of habitat by prairie chickens. Schwartz (1945) and Baker (1953) noted that the height and density of residual cover from the previous growing season probably influenced nest site selection and success. Jones (1963) found that nests were in taller and heavier cover than was usual for the tall grass prairie with a mean height of 45 cm. Svedarsky (1979) found that hens preferred habitats which were undisturbed for two or more years and that had "dense cover close to the ground" with mean visual obstruction of 2.2 decimeters (dm) and heights around 40 cm. Westmeier (1972) felt that vegetation at nests should be 25-30 cm tall and have dense cover to that height. Jones (1963) and Drobney and Sparrowe (1977) found that vegetation averaged 45 cm in height around the nest while Kirsch (1974) felt that native grassland should be managed at about the 51 cm height for nesting prairie chickens. Buhnerkempe et al. (1984) studying prairie chickens in Illinois found that hens nested in fields with vegetation over 21 cm and recommended that the lower 90% of the residual should be in the range of 25-40 cm. The great variability in the recommended height requirements in these studies probably is due in part to the multitude of sampling techniques. Successful renests in this study had EHT of 25.3 cm and HT of 40.8 cm while successful initial nests had EHT of 13.1 cm and HT to 35.0 cm. The greater success for renests and similarity of vegetative structure around renests to that reported in other studies leads one to believe that a shortage of secure residual cover reduces success of initial nests on the SNG. Grass was the most important component providing visual obstruction at the nests. Management of pastures to provide more residual grass in early spring with complete visual obstruction to 25 cm and taller vegetation to 41 cm might help to increase initial nest success.

Hen Movements and Home Range

Researchers previously thought that hens with broods remained in the area of the nest following hatching (Schwartz 1945, Hamerstrom and Hamerstrom 1949). Using radio telemetry, investigators found that broods were capable of making large moves within the first week of hatching (Viers 1967, Silvy 1968, Svedarsky 1979). Our data agree and show that radio-tagged hens with broods are very mobile since several hens made moves of 2.3 to 10.5 km within 34 days of hatching.

Svedarsky (1979) followed two females from the prelaying period through the postbrood period and found their mean range to be 133.8 ha while one hen with a brood had a range of 82.6 ha. He also reported that the largest range a hen had during this period was 503 ha. Copelin (1963) reported that lesser prairie chickens (Tympanuchus pallidicinctus) had a brood range from 66 to 136 ha. Arthaud (1968) found that five hens and one male prairie chicken had a mean late spring and summer range of 234.8 ha. The female in his study had the smallest summer range, 26 June to 24 August, of 56.7 ha. Bowman (1971) and Viers (1967) found spring and summer ranges of broods were 225.9 and 70.4 ha, respectively. In my study, ranges of brood and non-brood hens showed great varability, from 22 to 2248 and 308 to 2096 ha respectively, but generally appear to be larger than previously reported. The smallest range of a hen hatching an initial nest was 197 ha while the smallest non-brood range was 308 ha. Non-brood hen ranges tended to be larger than brood ranges and IUAs were over twice the size of brood IUAs. This is probably because non-brood hens have greater mobility than hens with chicks.

It appeared that several factors influenced the size of the brood range, the first of which was the time of nesting. Broods hatching from renests had much smaller ranges (mean, 68.7, SD=38.9, N=6) than broods from initial nests (mean, 768.6, SD=812.1, N=9). None of the hens on hatching renests made large moves following incubation. In fact all brood ranges originating from renests were smaller than brood ranges from initial nests. Other researchers also have found that prairie chickens tend to become less mobile as the summer progresses (Svedarsky 1979, Robel et al. 1970b).

Another factor which influenced the size of the range was the age of the hen. Females in their first breeding season had much larger ranges (mean, 856.6 ha, SD=928.4, N=7) than adults (mean, 166.6 ha, SD=118.8, N=8). The largest move made between intensive use areas by any adult was 2.3 km while four of six juveniles hatching initial nests made at least one move over 2 km.

Svedarsky (1979) felt that early long moves and subsequently larger home ranges of brood hens may have been the result of hens searching for suitable brood rearing habitat. Copelin (1963) found that broods made longer moves in dry years apparently searching for water. The large ranges in this study may also have been a result of hens searching for suitable brood rearing habitat. Other researchers have found that broods sought areas disturbed the previous year by mowing, grazing or burning but undisturbed and rapidly growing in the year of brood use (Svedarsky 1979, Skinner 1973, Toepfer 1973, and Jones 1963). Hens on the SNG appeared to search out areas that were undisturbed or had minimal disturbance in the present year. The large brood ranges in this study might have been partially in response to disturbances such as mowing and grazing of given IUAs and/or brood predation which may have caused broods to shift out of an IUA as illustrated by the following examples.

Five shifts out of IUAs were attributed to mowing. Hen 1180 moved into a moderately grazed lowland complex in a 2-pasture system shortly after hatching. She remained in a 9 ha area for 11 days until the lowlands were mowed. She immediately shifted 0.86 km to a new pasture. Hen 1038 spent 57 days in a 46 ha area of prairie hay. She left the area 2 days after it was mowed. Hen 1657 remained in a 83 ha IUA for 34 days. The IUA consisted mainly of the deferred pasture of a 3-pasture system. The lowlands in this pasture were mowed and the hen shifted 1.36 km to a prairie hay field. Hen 1371 spent 41 days in a 36 ha area of a prairie hay field. After the field was mowed she shifted 1.37 km to a 3-pasture system and was predated. Hen 1241 spent 12 days following hatching in the alfalfa field in which her nest was located. The field was mowed and she shifted 1.1 km with only one chick of the initial 11 surviving. Three hens did remain in or near alfalfa fields after those fields were mowed. These hens used adjacent windbreaks, prairie hay, road ditches and pastures for essential cover. One of those hens was preyed upon shortly after the second cutting of the alfalfa field.

A second disturbance that appeared to cause one hen to shift was cattle introduction. Hen 1270 had spent 32 days in a 35 ha IUA in the deferred pasture of a 3-pasture deferred system. Three days after cattle were introduced she moved from the pasture. Although only one hen shifted immediately following cattle introduction data indicated that brood and non-brood hens avoided establishing IUAs in pastures with cattle. Over 74% of all relocations were in areas without cattle and 11 of 13 hens selected pastures without cattle to renest in.

A third factor that may have caused shifts was the loss, or the potential loss of a nest or brood due to predation. Sharptail grouse broods made long moves after the female was captured and those moves may have been percipitated by the capture (Artmann 1970). Svedarsky (1979) hypothesized that it may be advantageous for a hen to move out of an area following a predator encounter and that researcher approaches may be viewed as predator encounters. Some support for this hypothesis was noted in this study. Hen 0810 was approached by two people and two hunting dogs when her brood was 34 days old. The dogs flushed the hen but none of the chicks. When leaving the area one of the chicks was stepped on and immediately three other chicks flushed. Two days later the hen and brood moved 4.2 km. This was the only instance where a brood hen moved immediately after being flushed and also the only case of known researcher-caused mortality.

Five other brood shifts may have been caused by predator avoidence. Hen 1001 was not flushed by the researcher and remained in a 28 ha area for 23 days. A Swainsons hawk (Buteo swainsoni) which was often observed in nearby trees, was seen on the ground 8 July. Signals indicated that the brood was very close by. The hawk was flushed but no dead chick was observed. The following day the hen began moving with her brood of eight. She was relocated 10.5 km from the site. Hen 1154 may also have shifted out of her first IUA because of a predator encounter. She moved from her nest into a pasture with a fox den known to harbor six pups. She spent several days and nights within 150 m of the den. After spending 7 days in this pasture she abruptly moved 1.5 km west of the area. Although she had hatched 13 chicks, 2 remained in her brood following the move. In addition, eight juvenile hens shifted an average of 7.7 km (SD=4.5) following predation of initial nests or broods while 4 of 12 adults moved over 3 km following loss of nest or brood.

Habitat Use

It appeared that disturbance types at least 40 ha in size with suitable cover but without large areas of short vegetation were selected for brood and non-brood IUAs.

Vegetation in lowlands, midlands and uplands in deferred pastures and prairie hay had heights and densities superior to that found in grazed pastures. Night roosts were in vegetation that provided complete visual obstruction over 1 dm and had heights over 2.5 dm. Broods used lowlands and midlands more than uplands both day and night seemingly because of the superior cover provided. Horak (1985) also reported that broods avoided areas of sparse vegetation and concentrated use in vegetation that was over 1.5 dm and Rice and Carter (1982) felt that brooding hens selected the best available habitat with ample vegetation present. Data from this study indicated that brood and non-brood hens used vegetation with screening capabilities to 2.5 dm in June-August.

Hens avoided large expanses of sparse vegetation as found on heavily grazed uplands and mowed lowlands and mowed prairie hay. Brood and non-brood hens had 54.3% of all relocations and 56.0% of all IUAs in alfalfa, prairie hay or deferred pastures. Brood and non-brood hens apparently avoided cattle with over 74% of all relocations in disturbance types without cattle.

Hens avoided cash crops, especially row crops during the summer with only 51 of 1312 (3.9%) relocations in cash crops. In addition, zero non-brood hens and only 1 of 22 broods spent a portion of the summer in cash crops. Arthaud (1968) and Svedarsky (1979) also reported that prairie chickens spent little time in cultivated crops during the summer.

Brood and non-brood hens used IUAs that averaged 40.4 and 85.8 ha respectively. Brood hens tended to select vegetation with tallest EHTs within a disturbance type, using lowlands to the greatest extent in all summer months. Non-brood hens apparently did not need as dense vegetation as brood hens and used uplands much more intensively, especially in July and August. Because both brood and non-brood hens selected areas that were undisturbed in the current year, management that provides 40 ha areas that are undisturbed for most of the summer should benefit the population.

Mortality

Mortality of radio-tagged hens was 47.7% during the period April through August. Radio-tagged hens in Minnesota experienced a 57.5% summer mortality rate (Svedarsky 1979) while banded hens in Wisconsin had an anuual mortality rate of 56.0% (Hamerstrom and Hamerstrom 1973). Most mortality occurred in May which may have been in part due to hens adjusting to the radio package. Casual observations also indicated large numbers of migrating raptors during this time period. Radio-tagged hens may have been more susceptible to predation but we felt that hens did not exhibit atypical behavior in nest site and habitat selection which is in agreement with Erikstad (1979) on willow grouse and Dumke and Pils (1973) and Johnson and Berner (1979) on pheasants. Although the radio usually did not inhibit flight, as several hens made moves over 5 km, two radio-tagged hens did not fly when approached by the researcher.

Mortality of chicks was very high especially in the first 24 days following hatching. Populations have declined from 391 males in 1983 to 202 males in 1986. These declines may be due in part to the poor brood survival.

In summary, prairie chicken brood ranges on the SNG appear to be larger than those found in several other studies. Habitat use on the area is influenced by the effective height and height of the vegetation which in turn is influenced by the land use. The SNG has a checkerboard pattern both in larger blocks by land-ownership and smaller units by land use. Secure brood habitat thus tends to lie in distinct, disjunct units, often seperated from one another by large areas of low security or less preferred habitat. Late nesting efforts were more successful and brood ranges smaller than with early nesting efforts because current season growth provided taller vegetation and increased security in a wider array of units. Adult hens, which had smaller brood ranges than juveniles may have been extended this luxury because their familiarity with the area permitted greater capabilities in secure habitat selection. When disturbances, mowing and grazing, reduced security and induced movements to another intensive use area, increased predation often resulted. In short, large brood ranges or extensive moves between intensive use areas during the brood rearing season, are not conducive to high survival. Management practices that provide residual grass with effective heights to 25 cm in early spring and a more continuous pattern of relatively undisturbed newly growing grassland with screening capabilities to 25 cm during the brood rearing months would undoubtedly enhance production and survival of prairie chicken broods and in turn provide a better recruitment base for the population.

MANAGEMENT RECOMMENDATIONS

The Sheyenne National Grasslands is the only area remaining in North Dakota with a substantial population of prairie chickens. The presence of these birds is dependent upon the maintenance of a distribution of prairie at least comparable to that which now exists.

The following guidelines are provided for maintaining or increasing numbers of prairie chickens within the framework of established land-use practices. The first decision that will have to be made is how many prairie chickens are desired and at what cost. The following recommendations can then help achieve this goal.

1. More intensive annual censuses should be conducted. Birds on booming and dancing grounds should be counted a minimum of three times each spring. In addition, time should be allotted for conducting listening runs each spring for locating new grounds. Questionnaires could be sent to lesees for information relative to prairie grouse activity in the allotments they rent.

2. Lowlands and midlands received the most amount of use in the spring by all hens and in summer by brood hens. Most of the nesting occurs on public lands (76.6%) in the lowland (48.6%) or midland community (20.8%). Renests which were more successful than initial had much taller

and denser vegetation surrounding them. Lowlands and midlands were also of great importance to brood hens. Because of the demonstrated importance of lowlands and midlands to this population, modifications in the management of these two communities could have the greatest positive impact on prairie chickens.

Of primary importance is an adjustment in the mowing pattern to provide a wider distribution of unmowed lowlands. Secondly, an effort should be made to increase the total amount of residual vegetation left for nesting. Currently mowing is done on a block basis with all the lowlands in a given pasture being mowed. Disturbance of rank vegetation is necessary to protect upland vegetation but a pattern of mowing and burning that leaves some residual vegetation in each of the pastures would be beneficial to prairie chickens.

One possibility to insure a more even distribution of residual lowland and midland grasses would be to mow only 50% of a given pasture on a 3 year rotation. In a 3-pasture deferred allotment, two pastures (the deferred and one other) would have 50% of their lowlands mowed. In a 2-pasture system 33% of each pastures lowlands would be mowed once every 3 years, thus insuring some 3-year deferred lowlands in 2-pasture systems. In continuous systems no more than one-third of the lowlands should be mowed. A second alternative would be to evaluate individual allotments relative to the number of grouse present. Thus mowing practices would remain the same in areas within 1.5 km of booming grounds with high numbers of birds, while mowing less acreage around booming grounds with low or unstable numbers. No area should be mowed more than once every 3 years except in some large lowlands with very high growth potential as is found in the South S.-W. allotment. The midland strip around lowlands should be excluded from mowing in most cases.

3. Delay mowing of the lowlands until 10 August. This will insure that all nesting activities will be complete and broods will be mature enough to avoid mowers. During this study one nesting hen was observed killed when lowlands were mowed although a second would have lost her nest had it not been destroyed before that time. In addition, six radio-tagged hens were still incubating nests after 10 July. Field observations suggest that chicks less than 24 days old tend to sit rather than fly when threatened but become more mobile with age. By delaying mowing until 10 August most chicks would be less vulnerable to mowing mortality.

4. Data from this study indicate that vegetation grew slowly until 15 June. Delaying the introduction of cattle into pastures until 15 June would be desirable to permit early vegetational growth for early hatching broods and renesting hens. However two alternatives are: delay

cattle introduction until 1 June or distribute the cattle evenly between pastures during the first 2 weeks of grazing. Undisturbed vegetative growth in all pastures would be advantageous to broods hatching in early June.

5. Maintain areas at least 40 ha in size that were heavily disturbed the previous year but undisturbed in the current year. Prairie chickens showed a decided aversion to pastures with cattle present. However, it was undetermined if the aversion was due to the cattle or the resulting reduction in heights of the vegetation.

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APPENDIX

Table 40. Counts and species composition of individual display grounds on the Sheyenne National Grasslands, 1983-1985.

	1983			1984			1985		
Display ground	PC[a]	ST[b]	HY[c]	PC	ST	HY	PC	ST	HY
01	37	1	0	36	0	0	40	0	0
02	35	2	4	18	1	2	10	0	0
02S	0	0	0	1	0	0	0	0	0
02E	0	0	0	1	0	0	0	0	0
03	1	0	0	0	0	0	0	0	0
03S	0	0	0	0	0	0	2	0	0
04	0	0	0	0	0	0	2	0	0
04S	0	9	0	0	11	0	0	10	0
04N	0	0	0	6	0	0	0	0	0
04W	0	0	0	4	0	0	0	0	0
05	14	5	0	11	7	0	8	0	0
06	13	0	1	28	1	0	19	0	0
07	0	0	0	0	8	0	0	7	0
08	22	0	0	7	0	0	14	0	0
09	5	2	1	5	5	0	6	0	0
10	0	4	0	0	0	0	0	2	0
10S	0	0	0	0	0	0	0	3	0
10N	0	0	0	0	0	0	0	14	0
11	1	7	0	0	8	0	0	0	0
12	5	0	0	0	8	0	0	0	0
13E	0	0	0	4	0	0	5	0	0
13W	7	12	0	0	14	0	0	13	0
14	0	0	0	0	0	0	0	3	0
15	0	1	0	0	0	0	0	0	0
16	17	1	0	13	0	0	8	0	0
17	0	0	0	0	0	0	0	8	0
18	0	0	0	0	0	0	0	6	0
19	18	0	0	19	0	0	16	0	0
20	0	0	0	0	0	0	0	9	0
21	6	1	0	12	0	0	13	0	0
23	4	0	0	6	0	0	12	0	0
24	15	0	1	13	0	1	8	2	0
24S	0	0	0	3	0	0	0	0	0
24E	0	0	0	0	0	0	1	0	0

Table 40. (Continued).

Display ground	1983			1984			1985		
	PC[a]	ST[b]	HY[c]	PC	ST	HY	PC	ST	HY
25	25	0	0	15	1	1	16	0	1
25E	0	0	0	6	0	0	5	0	0
27	18	0	0	9	4	0	9	6	1
28	2	1	0	2	7	0	0	10	0
28W	0	0	0	0	0	0	10	0	0
29	1	7	0	0	0	0	0	6	0
30	5	9	0	0	0	0	0	8	0
31	0	0	0	0	0	0	0	5	0
32	0	0	0	0	0	0	0	4	0
33	0	11	0	0	0	0	0	7	0
34	3	1	0	9	5	0	0	0	0
34E	13	0	0	0	0	0	5	0	0
35	8	0	0	5	0	0	0	0	0
36	2	0	0	0	0	0	0	0	0
37	20	0	0	12	0	0	2	0	0
37W	0	0	0	0	0	0	1	4	0
37N	0	0	0	0	0	0	1	0	0
39	16	0	0	14	0	0	8	0	0
40	16	0	0	24	0	0	9	0	0
41	0	6	0	0	0	0	0	5	0
42	13	0	0	8	0	0	0	6	0
43	15	1	0	8	0	0	9	0	0
43S	0	0	0	0	0	0	4	0	0
44	0	0	0	0	0	0	0	2	0
45	2	12	1	0	0	0	0	0	0
46	0	0	0	0	0	0	0	9	0
48	7	0	0	8	0	0	5	0	0
49	1	0	0	0	0	0	2	0	0
51	11	0	0	4	1	0	8	0	0
52	10	0	0	2	0	0	4	0	0
53	3	0	0	0	0	0	0	0	0
UNK	0	0	0	0	11	0	0	0	0
TOTAL	391	93	8	313	92	4	262	149	2

[a]PC=Prairie chicken.
[b]ST=Sharp-tailed grouse.
[c]HY=Hybrid.

Table 41. Fate of individual grouse hens on the Sheyenne National Grasslands, ND, 1983-85.

Hen I.D.	Year	Age[a]	Spp.[b]	Initial[c] Nest	Renest	RF[d]	Unknown[e] Fate	Known[f] Dead
1241	83*	A	PC	U	S	-	-	-
1269	83	A	PC	-	-	-	-	-
1332	83	A	PC	P	U	-	U	-
1389	83	J	PC	U	-	-	-	6-10-83
1540	83	J	PC	S	-	SU-83	-	-
1001	83	J	PC	S	-	-	-	W-83,84
1062	83	A	PC	-	-	SP-83	-	-
1153	83	J	PC	S	-	-	-	W-83,84
1207	83	A	PC	S	-	-	-	W-83,84
1363	83	J	PC	U	-	-	-	W-83,84
1414	83	A	PC	U	S	-	-	W-83,84
1575	83	J	PC	S	-	-	-	6-20-83
0977	83*	A	PC	P	U	-	-	-
1091	83	A	PC	U	-	-	-	5-23-83
1488	83	J	PC	-	-	-	-	5-08-83
1732	83*	J	PC	S	-	-	-	-
1766	83	J	PC	U	-	SU-83	-	-
1657	83	A	PC	S	-	-	U	-
1125	83	A	PC	U	-	-	-	5-25-83
1038	83	A	PC	S	-	-	-	W-83,84
1457	83	A	PC	U	-	-	-	5-22-83
1180	83*	J	PC	U	-	-	-	-
1609	83	A	PC	-	-	-	-	5-10-83
1070	84	J	PC	-	-	-	-	5-31-84
0990	84	J	PC	-	-	-	-	5-01-84
1154	84	J	PC	S	-	-	-	W-84,85
1317	84	J	PC	-	-	SP-84	-	-
1220	84	A	PC	-	-	SP-84	-	-
1454	84	A	PC	U	-	-	-	7-04-84
1437	84	A	PC	U	-	SU-84	-	-
1746	84	J	PC	S	-	-	-	7-24-84
1241	84	A	PC	P	U,S	-	-	W-84,85
1371	84	A	PC	P	S	-	-	8-19-84
1206	84	A	PC	P	S	-	-	7-19-84
1270	84*	J	PC	U	S	-	-	-
1486	84	A	PC	U	-	-	-	8-14-84
1126	84	J	PC	-	-	-	-	5-03-84
1576	84	J	PC	S	-	SP-85	-	-
1092	84	J	PC	-	-	-	-	5-05-84
0827	84*	J	PC	U	S	-	-	-
1110	84	J	PC	U	-	-	-	W-84,85
0935	84	A	PC	S	-	-	U	-

Table 41. (Continued)

Hen I.D.	Year	Age[a]	Spp.[b]	Initial[c] Nest	Renest	RF[d]	Unknown[e] Fate	Known[f] Dead
1610	84	J	PC	U	–	–	U	–
1390	84	J	PC	–	–	–	–	5-09-84
1180	84*	A	PC	U	S	–	–	–
1360	84	A	PC	U	–	–	–	8-24-84
0810	84*	J	PC	S	–	–	–	–
1469	84	A	PC	–	–	–	–	5-05-84
1732	84	A	PC	S	–	–	–	6-17-84
0977	84*	A	PC	–	–	–	–	–
1788	84	J	HY	–	–	SP-84	–	–
1027	84	A	ST	U	U	–	–	7-22-84
1590	84	J	ST	U	–	–	–	5-27-84
0632	85	A	PC	U	S	–	U	–
0100	85	A	PC	S	–	–	U	–
0977	85	A	PC	P	U,S	–	U	–
0827	85	A	PC	U	S	–	–	SP-86
0344	85	J	PC	S	–	–	–	SU-85
1180	85	A	PC	S	–	–	U	–
0443	85	J	PC	S	–	–	U	–
1270	85	A	PC	U	UNK	–	U	–
0071	85	A	PC	U	S	–	U	–
0032	85	A	PC	S	–	–	U	–
0064	85	A	PC	S	–	–	U	–
0433	85	A	PC	P	U	–	U	–
0081	85	J	PC	U	–	–	U	–
0810	85	A	PC	P	S	–	U	–
0402	85	A	ST	S	–	–	U	–
0645	85	J	ST	U	–	–	U	–

[a]A=Adult, J=Juvenile.
[b]PC=Prairie chicken, ST=Sharp-tailed grouse, Hy=Hybrid.
[c]S=successful, U=unsuccessful, UNK=Unknown fate.
[d]Known radio failure during time of tracking. SP=Spring, Su=Summer, W=Winter.
[e]Unknown fate, radio not recovered.
[f]Known dead, radio recovered.
*Hens known to have lived to the following year.

Table 42. Size of ranges (ha) of individual non-brood hens following loss of initial nest.

Hen	Age	RR[a]	N[b]	RE-LR[c]	N[b]	NBR[d]	N[b]	TR[e]	N[b]
0827	J	657	27	58	22	-	-	-	-
1270	J	17	10	5	9	-	-	-	-
1241	A	235	16	66	11	-	-	-	-
1241	A	85	20	54	19	-	-	-	-
1241	A	163	23	121	20	-	-	-	-
1180	A	255	33	68	29	-	-	-	-
1332	A	286	31	89	9	45	13	286	57
1206	A	117	75	78	46	-	-	-	-
1371	A	131	32	48	22	-	-	-	-
1414	A	140	16	35	10	308	22	846	46
0977	A	2177	9	99	7	1116	25	2837	43
1486	A	-	-	-	-	533	76	533	76
1360	A	-	-	-	-	349	102	349	102
1766*	J	-	-	-	-	178	10	178	10
1110	J	-	-	-	-	1305	17	1305	17
1180	J	-	-	-	-	392	39	392	39
1363*	J	-	-	-	-	386	8	386	8
1610	J	-	-	-	-	2096	66	2096	66
1540	J	-	-	-	-	1432	17	1432	17
1576	J	-	-	-	-	1356	25	1356	25

[a]RR=Renesting range from time of loss of initial nest until incubation of renest.
[b]N=Number of relocations.
[c]RE-LR=Home range during the egg laying period of renest.
[d]NBR=Range of non-brood hens following loss of the last known nest.
[e]TR=Total non-brood range from loss of initial nest to 31 August, death or loss of signal.
*Not used in calculation of means.

Table 43. Brood range sizes of indivdual hens on the Sheyenne National Grasslands, 1983-1984.

Hen I.D.	Age[a]	Nest[b]	Dates Monitored	N[c]	Size (ha)
0810	J	I	6-11 to 8-10	76	2248
1154	J	I	6-07 to 8-29	93	891
1001	J	I	6-14 to 8-30	42	2041
1153	J	I	6-14 to 8-27	45	229
1732 (83)	J	I	6-20 to 8-30	41	485
0827	J	R	7-17 to 8-31	48	26
1270	J	R	7-11 to 8-29	29	76
1746*	J	I	6-08 to 7-23	67	40
1576*	J	I	6-09 to 6-15	11	7
1575*	J	I	6-11 to 6-20	12	76
1540*	J	I	6-14 to 6-18	7	6
0935	A	I	6-08 to 8-31	91	197
1038	A	I	6-15 to 8-30	53	216
1207	A	I	6-08 to 8-30	67	405
1657	A	I	6-14 to 8-31	54	205
1180	A	R	6-27 to 8-30	67	67
1241 (83)	A	R	7-10 to 8-29	34	22
1241 (84)	A	R	7-12 to 8-29	45	111
1371	A	R	6-29 to 8-19	56	110
1206*	A	R	7-02 to 7-18	21	13
1414*	A	R	None		
1732* (84)	A	I	None		

[a] J=Juvenile, A=Adult.
[b] I= Initial Nest, R=Renest.
[c] N=Number of Relocations.
* Not used in calculation of means.