Summer Brood-Rearing Ecology of the Greater Prairie Chicken on the Sheyenne National Grasslands[1,2]

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Abstract--Twenty-two radio-tagged hens hatched 265 chicks, of which all but 4 left the nest. Mortality of chicks was high, especially in the first 24 days, with only 28.4% surviving to the end of summer. Brood ranges varied from 22 to 2248 ha with an average of 488.6 ha for 15 broods that had at least one chick alive on 10 August. Several factors influenced the size of the range, including timing of the nest, age of the hen, and loss or potential loss of young due to predation, mowing or grazing. Small areas within the total range were used more intensively. These areas averaged 40.4 ha. Broods were relocated in native vegetation 70.1% of the time. When in native vegetation they were found in lowlands, midlands and uplands 45.5, 26.9 and 23.2% of the time, respectively. Broods seldom night roosted in upland vegetation, the community most heavily grazed by cattle. Broods were seldom relocated in pastures with cattle (26.8%) and usually left areas once they were mowed. Deferred pastures contained the greatest number of intensive use areas, 10, while prairie hay and alfalfa had 8 and 5 respectively. Population declines in recent years might be due in part to the poor brood survival.

INTRODUCTION

Quantity of grassland vegetation appears to be directly related to pairie chicken (Tympanachus cupido) population levels (Schwartz 1945, Baker 1953, Hamerstrom et al. 1957). However, quality of the grassland vegetation is also important (Christisen and Krohn (1980).

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, Westemeir 1980). Although spring and summer ecology of hens and broods is important, it is probably the, least understood period in the life cycle of the prairie chicken (Hamerstrom and Hamerstrom 1973). Radio telemetry studies have povided some information on habitat use and movements during the brood rearing period (Silvy 1968, Bowman and Robe1 1977, Svedarsky 1979) but more information is needed.

This study was initiated in the spring of 1983 to:

(1) determine the brood-rearing habitat requirements of the greater prairie chicken,

(2) evaluate grazing management practices and their effects on prairie chicken habitat, 'and

(3) develop compatible management recommendations for prairie chickens and livestock.

Field work was 'conducted from March through August in 1983 and 1984 on the north unit of the Sheyenne National Grasslands, North Dakota.

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STUDY AREA

The north unit of the Sheyenne National Grasslands District of the Custer National Forest (SNG) is located approximately 36 km southwest of Fargo, North Dakota. It encompasses approximately 27,150 ha of USFS land interspersed with 25,338 ha of private land. The primary economic use of the SNG was cattle grazing. The private land was used for pasture, alfalfa hay (Medicago spp.), prairie hay, or cash crops.

Grazing on public lands usually began 15-20 May and ended 15-20 November. Management of pastures varied on a yearly basis and between allotments depending upon pasture size, stocking rates, and weather conditions. The most common grazing systems were the 3-pasture deferred, 2-pasture rotation and continuous system. Lessees were encouraged to mow "rank" vegetation in lowlands of the deferred pastures and first pasture grazed of the 2-pasture systems between 15 July and 15 August. Lessees were occasionally allowed to mow lowland vegetation in the continuous systems and in other pastures besides those previously mentioned.

METHODS

Forty-six prairie chicken hens were captured using paired rocket nets, bownets (Anderson and Hamerstrom 1967), and walk-in traps. Captured birds were aged by outer primary wear (Petrides 1942, Wright and Hiatt 1943, Ammann 1944). Hens entering their first breeding season were considered juveniles throughout the summer while all others were adults. Radio transmitters mounted on a bib (Amstrup 1980) were placed on captured birds then they were released on or near the display ground of capture. Two types of solar-powered radio transmitters were used with mean weights of 16.8 and 22.0 grams.

Most relocations were made using a single eight-element 3.8 m antenna mounted on a vehicle. Bird locations were determined by triangulating from two or three recognizable points on 1:660 air photos. Ground to ground range was between 0.8 and 1.6 km. Estimated accuracy using similar equipment was 41 m at distances from 305 to 537 m (Toepfer 1976). A fixed-wing airplane with a two-element yagi mounted on each strut was used occasionally to relocate birds. Hand held yagis were used to pinpoint hens on nests and to periodically flush hens. An attempt was made to locate broods at least once every other day through August.

Night roosts of hens were periodically marked by approaching hens in the dark and flagging nearby vegetation. The roost was found the next day by searching the area with a dog. Height-density of vegetation at the center of the roost was estimated using a Robe1 pole (Robe1 et. al. 1970).

Radio locations were digitized into an X-Y coordinate system using the Universal Transverse Mercator Grid (UTM) (Avery and Berlin 1977) and were entered into a computer program TELDAY (Lonner and Burkhalter 1983) to determine home range area. Home range was defined as the area enclosed by connecting the outer perimeter of points (Hayne 1949). Only ranges of hens with at least one chick alive on 10 August were used to calculate mean brood ranges. Within the total brood range, hens spent a greater portion of time in small areas called intensive use areas (IUAs). IUAs were areas where all relocations for at least five consecutive days fell within a small area relative to the total brood range. The assumption was made that hens remained within the IUA between successive locations. Distances were measured between IUAs as an indicator of brood mobility.

The vegetation surrounding booming grounds on which birds were captured was cover-typed in early May and late August of each year. Vegetation was classified into the following height classes: Class I (O-8 cm); Class II (9-25 cm); Class III (26-50 cm); Class IV (over 51 cm). Each location of a prairie chicken was assigned to one of the above height classes and a community type. Community types included upland, midland, lowland (Manske 1980), grass/shrub, lowland II (dominated by prairie cordgrass (Spartina pectinata)), alfalfa, or planted prairie hay. Community types were: determined from SCS air photos superimposed over radio relocations; or at night roosts, nest sites, or sites where birds were flushed.

Each relocation was assigned a land disturbance type based on past and present land use, pasture type, cattle presence, private land use, and ownership. Analyses of use of disturbance types by prairie chickens were based on whether the areas selected were grazed or mowed and whether the disturbance type selected after hatching was more disturbed, less disturbed, or as disturbed as the type the nest was in. Even though an IUA may have consisted of more than one disturbance type, it was assigned assigned the disturbance type from which the most relocations were recorded. The total number of days broods spent in each disturbance types was then calculated.

In cases where a relocation was within 41 m of another community or disturbance type, those relocations were originally assigned a code for edge. However, there were relatively few edge relocations for disturbance type so edge codes were not incorporated in disturbance type analysis.

Vegetation in four communities -- upland, midland, lowland, and planted prairie hay -- was monitored for changes in height and density along 21 photo-plot transects throughout the summer (Newell 1987).

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 the first flush until the end of the summer. If a hen was killed during the brood period it was assummed that the chicks also died.

RESULTS

Movements and Home Range

Brood hens utilized IUAs for periods ranging from 7 to 57 days (mean-24.8 days SD==14.9). 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 1).

Table 1. Average size of intensive use areas of broods on the SNG, 1

Age	Mean (ha)	SD	No. area
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

Mean distance from the nest to the first IUA was 0.47 km (SD-0.56) with little difference exhibited between adults and juveniles (Table 2). 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 moved from 2.4 to 10.5 km with broods 12 to 34 days old.

Mean brood range sizes were largest for juvenile hens that hatched initial nests (Table 3). The smallest brood range for any juvenile that hatched 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. Individual brood rearing ranges varied greatly from 22 · 2248 ha, and averaged 488.6 ha (SD-709.5, n-15).

Table 3. Mean brood range size of adult and juvenile prairie chicken hens.

Age	Nest Type1	x-(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

I = initial nest, R= Renest.

Habitat Utilization

Community type locations were recorded for 921 hen relocations during the brood rearing period. Most of the use associated with agricultural communities was in alfalfa and planted prairie hay. Of all brood locations in agricultural communities, 87.3% were in planted prairie hay (37.9%) alfalfa (41.0%), or in associated edge communities (8.4%). Hens decreased use of agricultural community types by 23% in August. Three broods used alfalfa almost exclusively. Following the mowing of alfalfa, brood hens remained near the fields but used the edge of windbreaks, ditches, and adjacent prairie hay for cover. Twenty-nine (12.7%) of all brood locations in non-native communities were recorded in cash crops or their associated edge, most of which were those of one brood.

Brood hens were relocated in native vegetation (public and private land) 70.1% of the time. Structurally, the vegetation in midlands and lowlands was similar, and differentfrom uplands. Upland vegetation was heavily grazed by cattle throughout the summer. Most brood relocations were in the lowlands with the highest use occurring in June when lowland vegetation was much taller and denser than upland or midland vegetation (Table 4).

Table 2. Mean distance (km) moved by brood hens from nest site to first intensive use area, and mean distances between subsequent intensive use areas.

Age	km from nest			km to second			km to third			km to fourth		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Adult	0.57	0.66	9	1.01	0.36	6	1.03	0.28	4	1.12	·	1
Juvenile	0.39	0.47	11	2.83	3.94	6	2.86	1.19	3	·		0
Total	0.47	0.56	20	1.92	2.83	12	1.82	1.21	7	1.12	·	1

Table 4. Percent use of native communities, combined with their respective edges, by broods.

Community type	June %	June N	July %	July N	August %	August N
Upland	22.5	41	26.0	66	20.5	43
Midland	25.8	47	25.5	65	29.5	62
Lowland	48.3	88	44.1	112	44.8	94
Grass/shrub	3.3	6	4.3	11	5.2	11

Mean Robe1 pole reading from 43 night roosts of brood hens averaged 1.04 (SD = .68). Thirty-seven (86.0%) were located in Class III or taller vegetation while none were recorded in Class I vegetation; only 18.6% of all brood night roosts were found in the upland community.

Fifty-six percent of all brood locations were on public land (Table 5). Although in July broods spent more time on private land . Brood hens often used areas that had been mowed the previous year, with 30.4% and 45.9% of the relocations in prairie hay or alfalfa, respectively, in June and July. Alfalfa and prairie hay use by broods declined to 24.8 % in August due to the mowing of those community types. Hens with out broods left mowed prairie hay fields, whereas those with broods sometimes remained in or near mowed alfalfa fields.

In June, July, and August 64.9, 49.5 and 60.8% of all brood locations, respectively, were in pastures. Three-pasture deferred systems were used most by broods in all months (Table 5). Within 3-pasture systems, 53.9% of the locations were in the deferred pasture. Pastures deferred one and two years prior had 30.7 and 15.4% of the locations, respectively. Hens tended to avoid pastures with cattle and pastures that had been grazed earlier that year. Seventy-three percent of all brood locations were in disturbance types without cattle.

After hatching, hens often moved their broods from the disturbance type in which they nested, to a different disturbance type. Of 19 hens that made a selection of disturbance type following hatching, 6 moved their broods from areas with cattle to areas without cattle and 9 stayed in disturbance types that were undisturbed (unmowed or ungrazed) in the current year. Of the 4 that remained in grazed pastures, one lost her brood within 6 days, two stayed in the more disturbed area for 7 and 11 days, and one remained in a relatively undisturbed portion of a grazed pasture throughout brood rearing.

Forty-three percent of all locations of hens with broods were in deferred pastures and prairie hay. Analysis of IUSa suggested that hens selected those areas because of the lack of disturbance. Eighteen of 40 IUAs consisted mainly of prairie hay or deferred pastures, while 47.7% of all brood days were spent in those types (Table 6). Two other disturbance types

Table 6. Disturbance types that were the major components of intensive use areas (IUAs) and the number of brood days spent in each.

Disturbance type	No. IUAs	No. Days	Nl
4-pasture	2	25	2
3-pasture[2]	1	10	1
3-pasture[3]	6	154	4
3-pasture[4]	10	243	7
2-pasture[2]	3	59	7
2-pasture[3]	1	10	1
l-pasture	2	38	2
Prairie hay	8	197	7
Alfalfa	5	143	4
Barley	1	23	1
Private pasture	1	20	1
Total	40	922	32

1 Number of different broods.
2 First pasture grazed.
3 Second pasture grazed
4 Deferred pasture.

Table 5. Number and percent of relocations in disturbance types for brood hens June-August, 1983-1984.

Disturbance type	June No.	June %	July No.	July %	August No.	August %	Total No.	Total %
Public1								
4-pasture	11	4.1	5	1.3	3	1.1	19	2.1
3-pasture	95	35.2	130	33.9	119	44.1	344	37.3
2-pasture	11	4.1	30	7.8	7	2.6	48	5.2
l-pasture	58	21.5	25	6.5	35	13.0	118	12.8
Private								
Prairie hay	11	15.2	131	34.2	43	15.9	215	23.3
Alfalfa	41	15.2	45	11.7	24	8.9	110	11.9
Crops	3	1.1	10	2.6	13	4.8	26	2.8
Misc.2	10	3.7	7	1.8	26	9.6	43	4.7
Total	270	100.0	383	99.8	270	100.0	923	100.0

1 Includes nine locations in grazed pastures, private land
2 Includes road ditches and undisturbed areas.

Table 7. Range of heights (HT) and densities (EHT) (cm) of vegetation along photo-plot transects.

Vegetation	Upland			Midland			Lowland		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
EHT[1]	3-6	7-12	8-12	8-12	17-20	20-21	8-18	25-30	6-1
HT[1]	11-21	22-31	31-33	22-30	35-40	40-48	20-36	22-50	17-22
EHT[2]	3-4	3-6	3-5	8-10	10-11	9-11	7-10	9-14	11-14
HT[2]	12-13	9-11	7-11	27-28	22-27	24-25	16-23	20-31	25-31
EHT[3]	5-6	9-11	5-11	7-10	12-14	12-14	10-14	18-22	18-22
HT[3]	15-17	20-28	16-28	19-25	24-28	24-29	25-33	46-59	46-59
EHT[4]				3-13	17-21	2			
HT[4]				9-23	34-42	6			
EHT[5]							16-29	35-39	35-39
HT[5]							31-51	61-72	69-72

1 3-pasture, deferred pasture.
2 3-pasture, deferred 1 year prior.
3 3-pasture, deferred 2 years prior.
4 prairie hay.
5 continuous system. Lowland II community

contained significant numbers of IUAs, the second pasture grazed of 3-pasture systems and alfalfa. In all but one case, 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 represented a small portion of the area available to a hen. Height and density of vegetation was superior in all communities in the deferred pasture (ungrazed) in June and July (Table 7). Height and density of vegetation was similar to the deferred pasture in the undisturbed prairie hay in July. Lowland and prairie hay vegetation was mowed in August which accounts for the tremendous reduction in height and density in that month. Lowland vegetation that received the most use was the tallest and densest in most disturbance types during the summer. Even though hens nested in and broods were relocated close to the lowland II community, they were seldom observed in it. The lowland II community may have contained vegetation too tall and dense for easy brood movement.

Brood hens selected Class III (26-50 cm) or taller vegetation 81.8% of the time throughout the summer. Hens appeared to avoid Class II or shorter vegetation, especially as the growing season progressed and taller vegetation became more available (Table 8).

Table 8. Height class of vegetation used by brood hens on the Sheyenne National Grasslands, 1983-84.

Height Class (cm)	June. N.	%	July No.	%	August No.	%
I (0-8)	15	5.7	6	1.6	5	1.9
II (9-25)	23	8.7	12	3.2	24	9.0
III (26-50)	150	56.8	202	53.2	116	43.4
IV (> 51)	38	14.4	135	35.5	94	35.2
edge 1	38	14.4	55	24.7	28	10.5

1 Locations within 41m of two height classes.

Brood Mortality

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. Three hens made 3, 11, and 9 km moves 1, 5, and 10 days, respectively, after hatching. Periodic marking of roosts, and flushing, indicated they had each lost their entire brood prior to these moves. In addition, five hens were killed during the brood rearing period, three within 17 days after hatching and two after 45 and 53 days.

Brood hens were first flushed an average of 24 (SD 13.1) days after leaving the nest. Mortality during this early period averaged 0.31 chick per day per hen, 'resulting in a loss of 62.8% of the chicks. The average number of days to the end of the summer was 32.9 (SD 12.48) days. Mortality during this later period was 0.04 chick per day per hen, resulting in a loss of 8.9% of the chicks.

Of 261 chicks that left the nest, only 28.4% (74) survived to the end of the summer. Average brood size for 13 hens that had chicks at the end of the summer was 5.7 (SD = 3.75). In two years, 45 prairie chicken hens had only 74 chicks survive until August. Of the 22 radio-tagged prairie chicken hens that produced chicks, only 13 had one or more chicks at the end of the summer.

DISCUSSION

Brood Movements and Home Range

Earlier studies indicated that hens with broods remained in the area of the nest following hatching (Schwartz 1945, Hamerstrom and Hamerstrom 1949). With the advent of radio telemetry, investigators found that broods were capable of making extensive moves within the first week of hatching (Viers 1967, Silvy 1968, Svedarsky 1979). Our data agree, and show that hens with broods were very mobile with five hens moving 2.0 to 10.5 km within 34 days of hatching.

Brood ranges in this study showed great varability, from 22 · 2248 ha, but are greater than previously reported in other areas. The smallest range for a hen which hatched an initial nest and had chicks at the end of the summer was 197 ha.

Several factors appeared to influence the size of the brood home range. All broods hatching from renests had smaller ranges than broods from initial nests. Successful renesting hens generally had much more restricted movements compared to hens having successful initial nests. Vegetation development, food availibility, and greater energy outlay for renesting hens might have influenced hen movements following hatching. Others have found that prairie chickens tend to become less mobile as summer progresses (Svedarsky 1979, Robe1 et. al. 1970).

Age of the hen seemed to influence brood range size. Females in their first breeding season had much larger ranges than adults. 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.

Early long moves and subsequent larger home ranges of brood hens may have resulted from hens searching for suitable brood-rearing habitat (Svedarsky 1979). Suitable brood habitats have been described as areas that had been mowed, burned, or grazed the previous summer, and without tall, rank vegetation (Svedarsky 1979, Skinner 1977, Toepfer 1973,). Most of the SNG and associated land is disturbed annually by mowing, grazing, or cultivation with relatively small tracts of land going undisturbed for a period of time in any given year. Hens in this study appeared to avoid areas disturbed in the current year and utilize areas that were undisturbed or had minimal disturbance in the current year. The large brood ranges in this study might have been partially in response to disturbances such as mowing and grazing and/or brood predation.

Five hens remained in undisturbed IUAs that ranged in size from 9 to 83 ha. Two of the IUAs were in prairie hay and one each in alfalfa, the deferred pasture of a 3-pasture system and the first pasture grazed of a 2-pasture system. The average number of days spent in those IUAs was 31 (SD=19.7) and ranged from 11 to 57 days. Within three days of mowing, hens moved an average of 1.2 km, which may have resulted in increased mortality to chicks. One hen with 12-day-old chicks moved 1.5 km after the alfalfa she was in was mowed. Another hen which remained near a mowed alfalfa field was killed by a predator shortly after the second cutting.

Cattle appeared have to caused at least one hen to move from the area. Hen 1270 had spent 32 days in a 35-ha IUA in the deferred pasture of a 3-pasture system. Three days after cattle were introduced she moved from the pasture. Although only one hen was observed to shift immediately upon cattle entry into the pasture, only 27% of all brood relocations were in pastures with cattle, and hens appeared to avoid establishing IUAs in areas with cattle.

Attempted brood predation appeared to prompt moves. Sharp-tailed grouse (T. phasianellus) broods made long moves after the female was captured, and those moves may have been precipitated 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. A hen and brood moved 4.2 km following a flushing during which one of her chicks was accidently killed. This was the only instance where a brood hen moved immediately after being flushed. Five other shifts may have been caused by predator avoidance. A hen with a brood of 8 was oftened observed in close proximity to a perching Swainsons hawk (Buteo swainsoni). The hawk was observed on the ground near the hen and brood on 8 July. Subsequently, the hawk was flushed but no dead chicks were observed. However, the following day the hen moved her brood 10.5 km from the site. Another hen moved from her nest into a pasture with a fox den with six pups. After spending seven days in this pasture, the hen abruptly moved 1.5 km west of the area. Although 13 eggs had hatched only 2 chicks remained following the move. Moves of 3.2, 11.1 and 9.7 km were noted for hens that lost entire broods.

In summary, it appeared that the size of individual brood ranges was influenced by the timing of nest, age of the hen and loss or potential loss of chicks due to predation or habitat alteration.

Habitat Use

It appeared that disturbance types with suitable cover were selected for brood IUAs. Brood IUAs averaged 40.4 ha and might be considered a suitable management unit. Vegetation in lowlands and midlands of deferred pastures and prairie hay had superior height and density compared to grazed pastures. After mowing in late July or early August this was no longer true. Night roosts were in vegetation

that provided complete visual obstruction over 1 dm with heights over 2.5 dm. Broods used lowlands and midlands more than uplands both day and night because of the superior cover provided, avoiding areas of sparse vegetation (Horak 1985). Rice and Carter (1984) reported that brooding hens selected the best available habitat with ample vegetation. Hens with broods in this study utilized vegetation which provided visual screening in excess of 2.5 dm in all summer months. Hens also avoided areas with sparse vegetation resulting from heavy grazing of uplands and mowing of prairie hay fields and lowlands. Hens appeared to avoid pastures with cattle present or areas with very tall and dense vegetation.

Although data were not collected on species composition at brood rearing sites, hens may have selected IUAs with concentrations of high-energy forbs such as alfalfa or sweet clover (Melilotus spp.). Five IUAs were located in alfalfa and 8 in prairie hay that was adjacent to or contained alfalfa. Diet analysis from fecal samples (Rumble et al., this proceedings) showed a high composition of alfalfa/sweet clover in the diets of brood hens. Svedarsky (1979) found that broods showed a preference for alfalfa fields.

Brood hens avoided cash crops, especially row crops during the summer and selected lowlands over midlands and midlands over uplands. Three percent of all brood relocations were in cash crops. Arthaud (1968) and Svedarsky (1979) also reported that prairie chickens spent little time in cultivated crops. Thus, with the exception of use made of mowed alfalfa, brood hens chose the areas on the SNG with relatively undisturbed vegetation.

Mortality

Mortality of chicks in this study was very high, with only 28.4% of the chicks surviving to the end of the summer. Chick mortality during the first 24 days appeared to be much higher than later periods. Mortality of hens was also high; 21 of 44 hens died during the spring and summer months (April · August). Most of the adult mortality was the result of predation, but the causes of chick mortality could not be determined. Populations of prairie chickens on the SNG have declined from 391 males in 1983 to 202 males in 1986, and these declines may be in part due to poor brood survival. There is a need to provide more areas 40 ha or greater with undisturbed vegetation that provides visual screening to 2.5 dm in height during the brood-rearing months on the SNG.

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