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# ACTIVITY PATTERNS AND HABITAT USE OF NORTHERN BOBWHITE FEMALES IN 2 GRAZING SYSTEMS

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***Abstract:*** During spring and summer of 1985 and 1986, we investigated activity patterns and habitat use of female northern bobwhite (*Colinus virginianus*) on 2 sites in south Texas. One site had been subjected to a short duration grazing (SDG) system and the other to a continuous grazing (CG) system. Nineteen females were radio-tagged in 1985 and 28 in 1986. Rainfall was above average in 1985 and below average in 1986; as a result, herbaceous ground cover was more dense in 1985 than in 1986. Due to extensive fencing, 58% of the SDG cell was within 25 m of a mowed roadside, fencerow, or pipeline right-of-way; the same was true for 30% of the CG pasture. There were no differences ($P > 0.05$) in distances moved between successive locations or in the breeding season home range sizes of females in the 2 systems. In 1985, females preferred zones within 25 m of mowed areas and avoided those ≥50 m from such areas. In the SDG cell during 1986 only, females preferred recently grazed paddocks. The results suggest that the most important difference between the 2 grazing systems was the increased proportion of mowed areas in the SDG cell during the abnormally wet year. In the Texas Coastal Bend, landowners unable to adjust stocking rates during wet years should consider mowing to improve bobwhite habitat.

***Key words:*** *Colinus virginianus*, grazing, habitat, northern bobwhite, short duration grazing, Texas Coastal Bend.

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In Texas, quail hunting ranks third, behind that of mourning dove (*Zenaida macroura*) and white-tailed deer (*Odocoileus virginianus*), in hunter participation. In 1982, approximately 1,131,400 hunter-days were spent quail hunting (Boydson 1983). Hunting lease income makes a significant contribution to the economy of many counties, totaling $145 million in 1984 (Texas Almanac 1986).

A large portion of agricultural land in Texas is devoted to forage production, with 32.4 million ha of native rangeland providing grazing for cattle, sheep, goats, horses, and game animals. Most Texas counties derive more revenue from cattle operations than from any other agricultural commodity (Texas Almanac 1986). The economic importance of cattle and bobwhite make their combined management desirable.

Optimum cattle production is achieved through vegetation management, which includes range improvement and grazing management. Continuous grazing systems, where cattle graze yearround or throughout the grazing season, may result in undesirable plant communities (Stoddart et al. 1975). To prevent these unwanted changes, specialized grazing systems have been developed. One such system is the cell-type, SDG system in which cattle are rotated through a series of paddocks radiating from a central water source. Typically, each paddock is grazed 1-10 days, then is rested for 30-60 days, depending on the number of paddocks and the stage of plant growth (Steger 1981). The SDG system results in intensive grazing of paddocks, a beneficial feature where growth of herbaceous vegetation is abundant and rank (Goodloe 1969).

Although some researchers have investigated the use of different grazing systems by bobwhite (Bareiss 1985, Schulz and Guthery 1988), none have researched impacts of different grazing systems on reproductive activities of bobwhite females. Our objective was to compare activity patterns and habitat use of northern bobwhite females in a SDG and a CG system during spring and summer.

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# METHODS

The study was conducted March-August 1985 and 1986 on the Rob and Bessie Welder Wildlife Foundation Refuge (WWR), which is in the northern portion of San Patricio County on the Texas Coastal Bend. The 3,157 ha refuge is in the transitional zone between the Gulf Prairies and Marshes and the South Texas Plains ecological regions (Gould 1975). The climate is subtropical with hot summers and cool winters. Peaks in vegetative growth are associated with rainfall which occurs mainly in spring and fall. Annual precipitation averages 88.9 cm; rainfall on the WWR totaled 116.0 cm in 1985 and 63.5 cm in 1986.

A SDG cell was established on the WWR in 1982. The 219-ha cell consisted of 10 paddocks, 20-30 ha each. From 14 March to 25 December of 1985 and 1986, 1 herd of cattle was rotated clockwise to successive paddocks every 2-9 days. The grazing period of each paddock was based on paddock size and relative quality of vegetation. During calving (26 December-13 March), all paddocks were open to continuous grazing. The SDG cell was stocked at 4.0 and 3.2 ha/animal unit (AU) in 1985 and 1986, respectively. Within-paddock stocking rates were 0.4-0.5 ha/AU in 1985 and 0.3-0.4 ha/AU in 1986. The adjacent 267-ha CG pasture was grazed year-round at 4.0 and 3.2 ha/AU in 1985 and 1986, respectively.

Soils in both pastures were primarily Victoria clays with 0-1% slope. The SDG cell was comprised of mesquite-mixedgrass and chaparral-mixedgrass communities, and the CG pasture was comprised entirely of a mesquite-mixedgrass community (Drawe 1991, Drawe et al. 1978). Although soils and vegetative communities of the pastures were similar, treatments were not replicated, thus site effects may have confounded treatment effects.

Bobwhite females were occasionally radio-located in mesquite-mixedgrass and chaparral-mixedgrass communities on the Ford Ranch, a private ranch adjacent to the southern border of the study area. That ranch used continuous grazing in a cow-calf operation at a stocking rate of 6.1 ha/AU (J. D. Hollan, pers. commun.).

Bobwhite were live-trapped 31 March-27 June in 1985 and 4 March-19 June in 1986 using modified Stoddard quail traps. Each bird was weighed, sexed, and aged as subadult (151-270 days old) or adult (>270 days old) based on wing characteristics (Rosene 1969). A 6-g radio-transmitter was mounted on the back or neck of each female. A backpack-mounting method was used during 1985. To reduce handling time of birds during radio-tagging and to prevent loss of transmitter packages due to loose harnesses, poncho-mounted as well as backpack-mounted transmitters were used in 1986.

Coveys or pairs trapped together were released simultaneously to maintain covey or pair integrity. Upon release, radio-tagged females were observed for flight strength and abnormalities. Successful traps were relocated so that the presence of bait would not influence behavior of radio-tagged birds.

Radio-tagged females were located daily. Females repeatedly located in the same area were assumed to be nesting. Nest termination was indicated by repeated daily locations of a female away from the nest site, a location far from the nest site, or lack of an activity signal which suggested predation of the female.

A 4-element hand-held directional yagi antenna or a collapsible H-antenna was used to obtain directions from permanent stations to radio-tagged birds. Azimuths of directions were measured using a handheld compass. Accuracy checks showed that the 95% confidence interval for mean error of the telemetry system was -0.9 to +1.5° for readings taken at distances of 80-150 m, the range within which most radio locations were taken.

# DATA ANALYSES

## Activity patterns

Computer programs that incorporated signal-direction azimuths and receiving-station locations were developed at Stephen F. Austin State University and were used to determine locations and to calculate straight-line distances between successive locations. Distance values were compared between grazing systems using Student's *t*-tests. Values assigned to a grazing system included those within the grazing system and those between the grazing system and a location out of the grazing system.

Student's *t*-tests utilizing separate variance estimates indicated that 1985 and 1986 movement data could be pooled for the SDG cell ($P = 0.10$), but not for the CG pasture ($P = 0.01$). Therefore, 1985 and 1986 data were analyzed separately. Statistical tests were considered significant at $P \leq 0.05$ for this and all other comparisons.

We used harmonic home range sizes (Dixon and Chapman 1980) to determine if the type of grazing system affected home range sizes of females during the breeding season (April-August). Mean home ranges were calculated for each bird with ≥21 locations (White and Dimmick 1978) within a grazing system. The criterion for assignment to a particular grazing system was that ≥70% of the total locations of an individual be contained within that grazing system. Home range isopleths in 50-m increments were drawn for each female. The isopleth that encircled ≥95% of the bird's locations defined the home range (Dixon and Chapman 1980). This isopleth was traced with a polar planimeter to determine home range size in hectares. Student's *t*-tests and 2-sample median tests were used to compare home range sizes between the 2 grazing systems.

### Habitat use

On the WWR, vegetation along fencerows, road shoulders, and rights-of-way was mowed for brush control. Because of more fencing, a much greater proportion of the SDG cell was mowed than was the CG pasture. Computerized maps of the 2 grazing systems were built using the Map Analysis Package (Tomlin 1980). Infrared aerial photographs of the SDG cell and CG pasture were enlarged to scales of 1:3682 and 1:4023, respectively. Structural features, including fencelines, roads, underground pipeline rights-of-way, creeks, stock tanks, and the Aransas River, were digitized for storage in the computer. Each map was partitioned into 90,000 grid cells, each representing about 8.33 $m^2$. For each mowed feature, 3 zones were delineated: (1) <25 m from the center of a mowed strip, (2) 25-50 m from the center of a mowed strip, and (3) >50 m from the center of a mowed strip. Chi-square goodness-of-fit tests were used to test the null hypotheses that bobwhite females used these zones in proportion to their availability during each year in each grazing system. If significant differences between use and availability of zones were found, the null hypothesis was rejected and Bonferroni confidence intervals (Neu et al. 1974) were used to determine which zones were preferred or avoided in each grazing system.

### Response to the SDG rotation

Simple linear regression and Spearman's rank correlation were used to determine if there were correlations between grazing status of a paddock and its use by bobwhite. The grazing status of a paddock was assigned a number ranging 0-9, with 0 indicating that the paddock was currently being grazed and the numbers 1-9 designating the number of grazing periods since the paddock had been grazed (Bareiss 1985). For each year, the number of locations in each paddock by grazing status was determined; these numbers were regressed on grazing status and were used in correlation analyses.

For each female bobwhite in the SDG cell, dates on which cattle and the bird shared a paddock were identified. Using 10-14 locations before cattle were moved into a paddock and an equal number after cattle were moved out of the paddock, preentry and postentry activity areas and activity centers were plotted. The size of each activity area was determined using a polar planimeter, and preentry and postentry activity area sizes were compared using paired *t*-tests. Distance between activity centers and direction of activity center change in relation to the grazing rotation were also determined for each bird. Finally, in order to compare between grazing systems, activity area sizes and distances between activity centers were likewise determined for females in the CG pasture; these data were compared to those of the SDG birds using *t*-tests.

## RESULTS

### Activity Patterns

In 1985, 19 females yielded 502 locations, 354 in the study area. Twenty-eight radio-tagged females provided 971 locations in 1986, 821 of which were in the study area. During both years, females in the CG pasture moved farther between successive locations than did those in the SDG cell; the differences were not significant in either year, however (Sloan 1987:57).

Mortality and emigration reduced the number of birds meeting the criterion for home range size analysis to 21. As only 1 SDG and 3 CG birds met the criterion in 1985, the sample was considered too small, consequently only 1986 data were analyzed. For 1986, home range sizes of 10 birds in the SDG cell (28.1 ha ± 10.0 ha [SD]) were compared to those of 7 birds in the CG pasture (25.5 ha ± 5.2 ha [SD]). Both a *t*-test ($t = 0.62$, 15 df, $P = 0.55$) and a 2-sample median test ($P = 0.33$) indicated that home range sizes were similar during the 1986 breeding season.

### Habitat Use

Zones <25 m from the center of a mowed strip comprised the majority of the SDG cell, while the majority of the CG pasture was zones >50 m from

Table 1. Northern bobwhite female use of zones extending from the centers of mowed strips in the short duration grazing (SDG) and the continuous grazing (CG) systems of Welder Wildlife Refuge, San Patricio County, TX, in 1985 and 1986.

| System | Zone | Area (ha) | Proportional usage Actual | Proportional usage Expected | Simultaneous confidence interval |
|---|---|---|---|---|---|
| | | | **1985** | | |
| SDG | <25 m | 112 | 0.679 | 0.579 | $0.591 \le P_1 \le 0.767$[a] |
| | 25–50 m | 42 | 0.252 | 0.219 | $0.169 \le P_2 \le 0.333$[a] |
| | >50 m | 39 | 0.069 | 0.202 | $0.021 \le P_3 \le 0.117$[a] |
| CG | <25 m | 79 | 0.585 | 0.295 | $0.577 \le P_1 \le 0.593$[a] |
| | 25–50 m | 37 | 0.148 | 0.138 | $0.088 \le P_2 \le 0.210$ |
| | >50 m | 151 | 0.267 | 0.567 | $0.259 \le P_3 \le 0.275$[a] |
| | | | **1986** | | |
| SDG | <25 m | 120 | 0.667 | 0.624 | $0.611 \le P_1 \le 0.723$ |
| | 25–50 m | 44 | 0.208 | 0.225 | $0.160 \le P_2 \le 0.256$ |
| | >50 m | 29 | 0.125 | 0.151 | $0.085 \le P_3 \le 0.163$ |
| CG | <25 m | 98 | 0.347 | 0.365 | $0.291 \le P_1 \le 0.403$ |
| | 25–50 m | 48 | 0.210 | 0.180 | $0.163 \le P_2 \le 0.259$ |
| | >50 m | 121 | 0.443 | 0.455 | $0.385 \le P_3 \le 0.501$ |

[a] $P \le 0.05$.

the center of a mowed strip (Table 1). For 1985, 159 SDG and 195 CG bobwhite locations were analyzed for zone use. Expected and observed numbers of locations within zones differed in the SDG cell ($X^2$ = 17.41, 2 df, $P < 0.01$) and CG pasture ($X^2$ = 86.63, 2 df, $P < 0.01$). In both grazing systems, zones <25 m from the center of mowed strips were preferred, zones >50 m away were avoided, and intermediate zones were used in proportion to availability (Table 1). For 1986, 403 SDG and 418 CG locations were analyzed. Zones were used in proportion to their availability in the SDG cell ($X^2$ = 3.65, 2 df, $P$ = 0.16) and the CG pasture ($X^2$ = 2.68, 2 df, $P$ = 0.26) (Table 1).

## Response to the SDG Rotation

Analysis of 135 bobwhite locations in the SDG cell in 1985 regressed on the number of periods since the paddock had been grazed did not reveal a linear relationship ($r$ = 0.17, $P$ = 0.18). Likewise, Spearman's rank correlation showed no relationship between the number of locations and grazing status ($r_s$ = -0.05, $P$ = 0.34).

In 1986, 268 locations showed a linear relationship ($r$ = 0.26, $P$ = 0.01) with the number of periods since grazing, with increased paddock use by female bobwhite as the number of periods since grazing decreased. Spearman's rank correlation also indicated a negative relationship ($r_s$ = -0.29, $P < 0.01$) between the number of locations in a paddock and its grazing status.

Mean activity area sizes before cattle were moved into a paddock (1.443 ha) and thereafter (1.586 ha) were not different ($n$ = 10 females, $\bar{x}$ = 13 preentry and 13 postentry locations, $P$ = 0.53). Activity centers of 5 birds shifted in the same direction as the cattle were rotated, 3 centers shifted in the opposite direction, and 2 centers shifted in a neutral direction. Activity centers shifted an average of 98 m.

The same numbers of birds and locations were used to plot paired sets of activity areas and activity centers in the CG pasture. Activity area sizes averaged 1.943 and 1.954 ha and the distance between activity centers averaged 171 m. There were no differences between these values and those of the SDG cell ($P$ = 0.08 and 0.10 for activity area sizes and distances between centers, respectively).

# DISCUSSION

## Activity Patterns

Urban (1972) and Bell (1983) reported that bobwhite mobility and home range size were negatively related to habitat quality during spring. In this study, we could not detect differences between the 2 experimental sites in distances between successive locations or in home range sizes; we speculate that habitat quality of the sites was similar. Steger (1981) reported that 20-30% more cattle may be stocked in SDG systems than

in CG systems without loss of livestock performance or deterioration of the range. We speculate that the equal stocking rates reduced differences inherent to the grazing systems that may have otherwise affected bobwhite habitat quality.

We recorded extreme movements by females following nest depredation or abandonment. In 7 instances, birds moved a greater distance immediately following nest disturbance than would be expected by inspection of 95% confidence intervals of predisturbance movement means. Urban (1972) and Lehmann (1984) indicated that females abruptly moving long distances from nest sites are probably leaving disturbed or depredated nests.

### Habitat Use

Bobwhite have difficulty traveling and feeding in dense herbaceous cover (Lay 1965, Guthery 1986, Shulz and Guthery 1988). We believe that the preference for zones near mowed strips in 1985 resulted from the birds' avoidance of dense vegetation which was due to unusually wet conditions (>15 cm of rain were recorded in both April and May of that year). Cattle also used the mowed zones extensively, thus the heavier grazing and trails in and around these areas may have provided preferred habitat by exposing soil for dusting and roosting sites (Klimstra and Ziccardi 1963, Rosene 1969). We suggest that in 1985 neither grazing system was stocked heavily enough to allow full use of the rangeland by female bobwhite.

### Response to the SDG Rotation

It is not surprising that the number of locations was not related to the grazing status of the paddocks in 1985. In 1983, the wettest year on record at WWR, Bareiss (1985) found that cattle rotation had no effect on bobwhite densities in the SDG paddocks. In both 1983 and 1985, vegetative cover was excessive, even in recently grazed paddocks.

In 1986, when rainfall was below average and stocking rates were increased, radio locations indicated heavier use of more recently grazed paddocks by female bobwhite. These results are similar to those of Campbell (1981) who observed more bobwhite in paddocks being grazed than in those being rested. Conversely, neither Bareiss (1985) nor Schulz and Guthery (1988) showed a relationship between bobwhite densities and cattle rotation through paddocks. In fact, Schulz and Guthery (1988) found that mean density was lowest in the paddock being grazed and highest in the paddock that had been rested for the longest period; they suggested that bobwhite moved out of a paddock when cattle entered it.

We believe that effective grazing in the SDG cell in 1986 was accompanied by heavier use of recently grazed paddocks by bobwhite females. The birds were probably responding to improved habitat quality; grazing may have improved vegetative structure (Wilkins 1987, Schulz and Guthery 1988), which allowed ease of movement and suitable sites for dusting, roosting, and nesting. While the birds benefited from vegetative changes resulting from grazing in the SDG cell, they apparently were not disturbed by the presence of the cattle. Data for 10 females suggest no change in activity area size or activity centers attributable to contact with the intensively grazing cattle. Likewise, there was no discernible pattern in direction of activity center changes in relation to cattle rotation direction.

## MANAGEMENT IMPLICATIONS

Our results support Schulz and Guthery's (1988) suggestion that SDG systems have positive effects on bobwhite populations, probably because of improved vegetative structure. In this study, the major difference between the 2 grazing system sites was the increased proportion of mowed areas in the SDG cell during the abnormally wet year. Although the percentages of mowed zones on the WWR may not be representative of all SDG and CG systems, SDG systems typically contain more fencing and require more brush control than CG systems. On the WWR, brush control consisted primarily of mowing; discing and the use of chemicals are possible alternatives. In the Texas Coastal Bend, landowners unable to adjust cattle stocking rates during wet years should consider mowing or discing to improve bobwhite habitat.

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