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RH: Sharp-tailed grouse reproduction & CRP

# CONSERVATION RESERVE PROGRAM LANDS AS SHARP-TAILED GROUSE NESTING AND BROOD REARING HABITAT.

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Abstract: We investigated use of Conservation Reserve Program (CRP) lands by sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) during nesting and brood-rearing seasons in southeastern Wyoming in 1994-5. Nineteen of 29 radio collared hens incubated nests, 17 of these nests hatched. All nests were located in CRP. Hens selected nest sites in larger CRP patches. Mean distance from nests to CRP edge did not differ from the overall mean distance to CRP edge. Ten hens reared ≥1 chick to 45-days post-hatching. Hens with broods used CRP and irrigated alfalfa patches more often and wheat and rangeland patches less often than they were available. Hens with broods used CRP patches that did not differ

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in size from available patches. While in CRP, they showed no preference for or avoidance of edge. When hens with broods were outside CRP, their mean distance to CRP edge was smaller than the overall mean distance to CRP edge. Comparing different CRP vegetation types, hens with broods used CRP patches with high coverage of broad leafed weeds and annual grasses more often and patches without alfalfa less often than these patch types were available in the landscape. Within individual CRP patches, hens with broods used vegetation with lower height and higher diversity, evenness, and richness than random sites. We found that CRP was the vital reproduction habitat for sharp-tailed grouse populations in southeastern Wyoming. Further, we recommend that future CRP patches contain alfalfa. We also speculate that younger aged CRP patches may be good brood rearing habitat an suggest developing a mosaic of CRP patches of different ages throughout the southeastern Wyoming.

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Key words: sharp-tailed grouse, Tympanuchus phasianellus, Conservation Reserve Program, CRP, grassland, nests, brood-rearing, habitat use, alfalfa, Wyoming

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Plains sharp-tailed grouse (Tympanuchus phasianellus jamesii) were rare or absent from much of the intensively cultivated and grazed portion of southeastern Wyoming before the implementation of the Conservation Reserve Program (CRP) (J. Rinehart, Wyoming Game and Fish, personal communication) . CRP was initiated by the 1985 Food Securities Act and provides annual payments, under 10-year contracts, from the federal government to landowners who plant and maintain perennial vegetation on highly erodible cropland. Nationally, most wildlife professionals viewed CRP as a significant habitat improvement for both game and non-game wildlife species (A. W. Allen, National Ecology Research Center, pers. commun.). In the Great Plains, CRP has been linked to improved waterfowl nesting success (Reynolds 1992), and has provided key habitat to several avian species experiencing long-term population declines (Johnson and Schwartz 1993). Large numbers of CRP fields were planted in southeastern Wyoming during 1986-9 (R. Miller, Natural Resources Conservation Service, pers. commun.), by 1990 sharp-tailed grouse increased in number and expanded their range into new areas. This sudden population increase and range expansion prompted us to investigate sharp-tailed grouse use of CRP as nesting and brood-rearing habitat.

Sharp-tailed grouse population changes have been found to be correlated with the proportion of successfully reproducing females (Bergerud 1988). Nesting success has been postulated to be a major factor in sharp-tailed grouse population dynamics (Kobriger 1975). A major annual variable in plains sharp-tailed grouse production is the quality of nesting cover due to variation in precipitation (Bergerud 1988). Nesting cover is considered to be a limiting factor for plains sharp-tailed grouse (Hillman and Jackson 1973, Sisson 1976, Grosz 1988). Sharp-tailed grouse selected nest sites with greater vegetation height (Kohn 1976) and density (Bernhoft 1969) in native grasslands.

Although nest success has been given greater attention in the literature (e.g. Kobriger 1975, Bergerud 1988) than brood survival, it is possible that chick survival is at least as important as nest survival, just more difficult to study. The precise mechanisms of brood mortality are more difficult to identify, than nest failures, because of chick mobility and a lack of visual evidence after predation events. Sharp-tailed grouse hens with broods selected taller and more dense vegetation in native rangelands (Christenson 1970, Kohn 1976) presumably increasing survival.

The spatial characteristics of habitat patches as well as vegetation structure can influence avian habitat selection (Wiens et al. 1987). Avian habitat use is thought to result from a sequence of responses to various spatial scales (Hutto 1985). Kotliar and Wiens (1990) suggest that multiple scales of animal-habitat interactions imply a hierarchical framework of patch use by organisms. To develop a more realistic description of the importance of CRP to grouse reproduction, we examined nest and brood use at 4 spatial scales: land use type (~km2), between CRP patches (~10-200 ha), within the CRP patch (~1-4 ha), and near the nest or brood site (<0.05 ha). We specifically addressed 5 questions related to CRP as sharp-tailed grouse nest and brood-rearing habitat. (1) Is CRP used preferentially over other land use types? (2) Are any CRP vegetation types used preferentially? (3) Does CRP patch size or distance to CRP edge influence use? (4) Are vegetation structural characteristics selected for within CRP patches? (5) Do differences in vegetation structure around nests and broods exist at a scale of <0.05 ha?

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## STUDY AREA

This study was conducted in Laramie, Platte, and Goshen counties in southeastern Wyoming (41°-42° N, 104°-105° W) from 1 March-1 August, 1994-5. The study area (2836 $km^2$) was historically short grass prairie, but is now dominated by intensively grazed native range land (1330 $km^2$) and crop land (1077 $km^2$), primarily winter wheat. CRP (421 $km^2$) comprised 15% of the study area, with a mean patch size of 211 ha (SD = 387 ha). Elevation ranged from 1400-1700 m. Most CRP contracts in southeastern Wyoming were initiated in 1986-9. CRP fields were usually planted to wheatgrasses (Agropyron sp.) or smooth brome (Bromus inermis) mixed with either alfalfa or yellow sweet clover (Melilotus officinalis). CRP fields were fairly homogenous with relatively low plant species richness. The CRP patches were not typically grazed, hayed, or otherwise disturbed during the contract period. Trees and shrubs were uncommon and limited to shelterbelts around widely dispersed farmsteads.

## METHODS

Sharp-tailed grouse leks were located from road surveys during March, 1994-95. Ten leks were chosen to trap female grouse based on accessibility, permission from landowners, and geographic information system (GIS) analysis of CRP spatial characteristics. A map of CRP lands in the study area was digitized in the Geographical Resource Analysis Support System, version 4.1 (Grass4.1) and analyzed with the r.le.patch program (Baker and Cai 1992). Mean and standard deviation of CRP patch size, CRP perimeter length, and distance to the nearest CRP patch; percent cover of CRP; and number of CRP patches were calculated for each of 28 (100 $km^2$) sampling squares overlaid on the study area. A cluster analysis, based on these 8 variables, grouped sampling squares into 5 clusters. We had originally intended to select 2 leks from each cluster of sampling squares so that nest and brood use could be monitored across the widest possible CRP arrangement. We selected, instead, 3-4 leks in each of the 3 clusters with the highest CRP landscape measures, because no leks could be found in the 2 clusters with the lowest CRP measures.

Twenty-nine female grouse were captured (1-4 per lek) with walk-in traps (Schroeder and Braun 1991) and cannon nets (Table 1). They were fitted with 13 g necklace radio transmitters (Advanced Telemetry Systems, Isanti, MN) and released immediately. Hens were located at 4-5 times weekly via triangulation with hand-held Yagi antennas and a truck mounted null antenna system until incubation behavior was identified. During the last two weeks of incubation, we placed small, inconspicuous vinyl flags on the four cardinal directions, 200 m from the nest. Care was taken not to approach within <200 m of the nest at any time during incubation. Only after the hen had permanently left the nest site did we visit the nest to determine nest fate and clutch size. During the post-hatching period, hens were located via triangulation (2-3 times weekly) and by flushing (not >1 per week). Triangulation locations were used only for land use, CRP patch type, patch size, and distance to CRP edge analyses. Brood flushes were marked with vinyl flagging and revisited, within 1-2 days, for vegetation sampling after the hen and brood had left the area. When hens were flushed, the presence and number of chicks was noted. Hens with chicks typically flushed only short distances ($<$50 m), while those without chicks tended to fly long distances ($>$200 m) and not return to the same site. Counts of chicks were, at best, rough estimates because young chicks were difficult to find in heavy cover and older broods (~45 days post hatching) tend to be aggregations of several hens and broods.

Triangulation locations were calculated in the field from a minimum of 3 bearings using a Hewlett-Packard 100LX palmtop computer and a Quick Basic adaptation (M. Gillingham, pers. comm.) of the program TRIANG (White and Garrott 1990). The program outputs estimated UTM location, error polygon area, $\chi^2$ test statistic, and fit probability. UTM coordinates of observer, nest, and flushed brood locations were determined from 1:24,000 topographic maps. Bearing error was determined at the study area, for all personnel, using hidden transmitters and found to be $\pm$ 5° for the hand held antenna and $\pm$ 2° for the truck mounted null antenna. The dense road system in the study area, field calculation of fit probabilities, and flat, open terrain allowed for very accurate triangulation locations. Further, when the error polygon appeared to overlap with a CRP edge, additional bearings were taken to place the estimated location and the error polygon wholly within one habitat patch. If this was not possible, the estimated location was not used for analyses.

Each nest, brood, and random vegetation plot contained 25 sample points, 1 point at the center and 8 equally spaced points on each of 3 concentric rings of 4, 8, and 12 m radii. Percent cover by plant species was measured with 20 by 50 cm Daubenmire frames (Daubenmire 1959). Vegetation height was estimated with visual obstruction readings (VOR) using Robel poles (Robel et al. 1970). Each point in a plot consisted of 1 VOR and 1 Daubenmire frame placement. Two random (in direction and distance) plots were measured within 50-250 m of each nest or brood centered plot. The 2 random plots were averaged for analyses. Seven vegetation structure variables were calculated: species richness, species diversity, evenness, vegetation cover, litter cover, mean height, and standard deviation of height (SD height). Species diversity was calculated for each plot using the Shannon-Wiener diversity index (*H*) formula:

$$H = -\sum_{i=1}^{S} \rho_i \ln \rho_i$$

where $S$ is number of species present and $\rho_i$ is the proportion of the total sample belonging to the $i$th species. Evenness ($J$) was calculated as:

$$J = \frac{H}{H_{max}} ; H_{max} = \log S$$

where $S$ is the number of species in the sample (Krebs 1989).

Size and location of CRP, crop, and range fields were obtained from local Natural Resource Conservation Service (NRCS) offices and digitized into IDRISI Geographic Analysis System (Eastman 1995) to form the base map layer, with each pixel representing 20 by 20 m. CRP vegetation type for each patch was determined from NRCS planting records: Nest and brood locations were overlaid on the base map layer and the following spatial variables were measured for each location: patch area, distance to CRP edge, land use type, and CRP vegetation type.

We used IDRISI to calculate available values for 4 land use types, 6 CRP vegetation type, CRP patch sizes, and distance to CRP edge individually for each nest and for each hen with a brood. For nest analyses, available values for these 4 variables were calculated within a circular sample window of radius 2730 m (our greatest lek to nest distance) centered on the capture lek. For brood analyses, a sample window of radius 1840 m (our greatest nest to brood location distance) was centered on the nest.

We conducted our statistical analyses with SOLO Statistical Software (BMDP Statistical Software, Inc., Los Angeles, California). We performed a $\chi^2$ test to test for the goodness of fit of utilized brood habitat to available habitat type. We used paired t-tests to test for differences in CRP patch size (Fig. 1) and distance to CRP edge (Fig. 2) within available-nest pairs and available-brood pairs. We used multivariate analysis of variance (MANOVA) to test for group differences in the 7 vegetation structure variables between nest and random plots and between brood and random plots (Table 2). We also tested for group differences in vegetation structure variables between the 4, 8, and 12 m vegetation sampling rings, with MANOVA.

RESULTS

Sharp-tailed grouse used CRP for nesting and brood-rearing more than other land use types. All 19 nests were located in CRP. Hens with broods did not utilize land use types in proportion to their availability ($n = 111$, $\chi^2 = 136.6$, 3 df, $P < 0.00001$). They used CRP and irrigated alfalfa more often, and wheat and range less often (Fig. 3). Hens with broods did not utilize CRP vegetation types in proportion to their availability ($n = 69$, $\chi^2 = 136.5$, 5 df, $P < 0.00001$). They used CRP without alfalfa less often and weedy CRP more often, while the number of brood and expected locations were nearly equal in the wheatgrass-alfalfa type (Fig. 4).

Sharp-tailed grouse hens nested in larger CRP patches ($n = 19$, $t = 2.24$, $P = 0.038$, Fig. 1). Hens with broods in CRP, however, showed no selection based on CRP patch size ($n = 13$, $t = 1.75$, $P = 0.11$, Fig. 1). We found no difference for mean distance to CRP edge between nests and all points within CRP patches ($n = 19$, $t = 0.86$, $P = 0.85$, Fig. 2) and between individual brood locations in CRP and all points within CRP patches ($n = 69$, $t = 1.63$, $P = 0.13$, Fig. 2). When broods were outside of CRP, however, individual brood locations were significantly closer to CRP edge than the mean of all points outside CRP ($n = 42$, $t = 7.55$, $P < 0.00001$, Fig. 2).

Nest plot vegetation had lower mean height and SD height than random plots. Nest and random plots did not differ for the other vegetation variables (Table 2). Brood plot vegetation had higher mean species richness, species diversity, and evenness and lower mean height and SD height than random plots (Table 2). No differences were detected for any of the 7 vegetation variables between the 4, 8, and 12 m concentric rings for either the nest sites ( MANOVA, $P = 0.98$) or brood sites ($P = 0.12$).

Predation of hens was the largest source of mortality during our study (Table 3). The pre-incubation period (1 April to 20 May) had the highest rate of predation and overall mortality. Our telemetry data suggest that hens were moving greater distances visiting leks, feeding, and searching for nest sites during this period than later in the season. Further, vegetation cover was at its lowest level of the year, since vegetation growth had not begun at that time. The 3 hens that disappeared were presumed dead, their collars were functioning one day and no signal was found the next. Two of the 3 had been located repeatedly on either side of roads and may have been struck by vehicles. No deaths were observed among incubating females.

Only 2 of 19 nests failed (89.5% success rate, Table 1), american crow (Corvus brachyrhynchos) predation caused 1 nest failure. The other was predated by a mammal during the hatching process. This nesting success rate was much higher than the average success rate of 50% for sharp-tailed grouse calculated from several studies by Bergerud (1988).

Ten of 29 hens (34.5%) reared a brood (>1 chick) to 45 days old, producing approximately 48 chicks. This brood success rate of 34.5% was similar to the 30% success rate reported by Bergerud (1988). Brood success rate was lower in 1994 (21.4%) than 1995 (46.7%, Table 1). Virtually no rain fell on the study area during May-July, 1994, whereas April- mid June 1995 was very wet. In 1994, 4 of 8 hens lost their entire broods within 1-2 weeks of hatching, (the 4 hens survived whatever caused the loss of their broods). The 3 surviving broods showed a steady decrease through the summer. The remaining hen was predated, presumably with her brood. We observed no losses of entire broods in 1995 (apart from hen predation, n = 2), rather a steady decrease in brood size was observed as the season progressed. The causes of chick mortality were not determined. We stopped counting chicks at age 45 days, but we do not imply that they were added to the reproductive population, mortality could have occurred before the next spring.

## DISCUSSION

### Nesting Habitat

Exclusive use of CRP for nesting habitat probably relates to the residual vegetation cover in CRP in the spring. Sharp-tailed grouse have been found to select nest sites with high residual cover (Sisson 1976, Prose 1987). Range lands were typically grazed to a VOR of < 0.05 m (Wachob 1997). Wheat stubble had a litter cover of <20% (Wachob 1997) and was typically plowed or disced before 1 June (before first nest hatching date). The current year's crop of winter wheat was only 10-50 cm tall and contained no residual cover at initiation of nesting. Alfalfa had all residual cover removed by haying the previous year and had not begun to grow before the nesting season. Road ditch habitat was very limited in extent, with residual cover severely compacted by snow. CRP was the only widespread habitat type in the study with residual cover, so it is not surprising that grouse nested in no other habitats.

CRP was also a very secure nesting habitat. The low nest predation we found may be due to the large size (therefore reduced edge) and typically uniform vegetation of CRP patches. Lower nest predation rates are generally found in larger patches, away from edges and predator travel corridors (e.g. Niemuth 1995, Vander Haegen and DeGraaf 1996). The lack of preferrence or avoidance of CRP edge for nesting (Fig. 2) may simply be a function of hens selecting larger CRP patches (Fig. 1), i.e. because CRP patches were very large, no obvious avoidance of edge would likely be detected. Christenson (1970) found that sharp-tailed grouse had higher nest success in areas of uniform vegetation cover.

Our nest vegetation structure results (Table 2), appear at cursory examination to contradict the findings of other studies suggesting sharp-tailed grouse hens prefer nest-sites with tall vegetation (Kohn 1976, Prose 1992, Kirby and Grosz 1995). However, the mean height of 0.29 m at our nests was very similar to the 0.31 m of Kohn (1976) and greater than the 0.19 m of Kirby and Grosz (1995) both from nests in North Dakota. 'Tall' is a term relative to the study area that does not translate well to other areas. In our study grouse did select nest sites with higher vegetation height at a coarse scale (i.e. CRP) but at a finer scale (i.e. within CRP patches) chose nest-sites with shorter vegetation height. Vegetation height can vary with the spatial scale examined. Further, the difference in height between our nest and random plots may indicate selection for heterogenous nesting habitat at a scale of 1-4 ha. Prose (1992) found selection for hetreogenous nesting habitats at a scale of 1-16 ha.

Brood Habitat

Hens with broods would be expected to use more land use types than for nesting. By mid-June, the vegetation height was greater in all land use types providing cover for broods where none existed for nesting. Preferential use of alfalfa and CRP over wheat and range land (Fig. 1) probably reflects greater hiding cover and higher food abundance. Of the 3 hens with broods killed by predators, 2 took place in range land and 1 in alfalfa after it had been mowed. Brood use of range land was higher in 1995 (n = 14) than 1994 (n = 3). In 1994, a very dry year, very little cover existed on range land, while 1995, a wet year, had considerable cover on range land. The preference of hens with broods for CRP and alfalfa land use types based on food abundance is probably best explained in the context of their use of specific CRP vegetation types and vegetation structure variables.

Hens with broods avoided CRP without a forb component and preferred weed and alfalfa (Fig. 4), this may be due to greater food densities in areas with higher forb densities. Bernhoft (1969) reported that grasshoppers and green leaves were common foods of immature sharp-tailed grouse in North Dakota. Evans (1988) found that grasshopper numbers increased with increasing biomass of forbs in Kansas prairie. Brood use areas in Nebraska had relatively dense forb canopies (Sisson 1976). CRP with higher forb densities (i.e. alfalfa or broadleafed weeds), therefore, could have provided better foraging for chicks. We observed that forb leaves desiccated and fell off in large numbers during late June, 1994 due to drought conditions. We speculate that the loss of entire broods during this period maybe related to poor chick foraging conditions. This may be a mechanism for the positive correlation of soil moisture and sharp-tailed grouse production in North and South Dakota reported by Bergerud (1988).

Our brood vegetation results (Table 2) indicate a definite selection for heterogenous vegetation structure within CRP patches. Broods were located in areas with higher richness, diversity, and evenness, but were within 250 m of taller, less diverse areas. Even though CRP vegetation was relatively uniform, compared to most natural communities, there were small areas that were dominated by weedy forbs and annual grasses, where we typically located broods. Surrounding the weedy patches were stands of the dominant species planted in the CRP patch. The weedy areas may have been foraging areas, with the planted stands serving as nearby roosting and escape cover . These weedy areas appeared to be much more extensive in the few young (1-2 year old) CRP patches in the study area. Apparently, planted species take a few years to become well established. Young CRP patches were used more heavily by male grouse than adjacent 6-8 year old patches (Wachob, unpubl. data). Sharp-tailed grouse in Nebraska selected feeding sites in earlier stages of succession, characterized by relatively dense forb cover (Sisson 1976). We speculate that early successional stages of CRP may have been good brood rearing habitat and may have contributed to the sharp-tailed grouse range and population expansion of late 1980's-early 1990's in southeastern Wyoming.

MANAGEMENT IMPLICATIONS

CRP is obviously the critical reproduction habitat for sharp-tailed grouse in southeastern Wyoming. We recommend that CRP acreage be maintained at least at its current acreage. Further, we advocate that CRP fields with alfalfa be retained in the landscape preferentially over those without alfalfa. Alfalfa should be strongly encouraged as a component of any new CRP plantings.

In this grouse population, with its secure nesting habitat, brood survival appears to be an important component to successful reproduction. High quality brood-rearing habitat may be important to maintaining healthy sharp-tailed grouse populations. We suggest that a mosaic of younger CRP patches interspersed among older CRP patches would provide critical brood-rearing habitat for sharp-tailed grouse. One means of accomplishing this would be to encourage new CRP contracts near CRP patches that are returned to agricultural production. Limited experimentation with ways to encourage greater forb production on CRP lands or setting CRP patches back to an earlier successional stage should be encouraged, e.g. limited grazing (Kirby and Grosz 1995).

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Table 1. Sharp-tailed grouse nesting and brood success. The number of chicks at 45 days post-hatching represents an approximate count.

| | 1994 | 1995 | Total |
|---|---|---|---|
| # Hens Radio Collared | 14 | 15 | 29 |
| # Hens Incubating Nests | 9 | 10 | 19 |
| # Nests Hatched | 8 | 9 | 17 |
| # Broods @ 45 Days | 3 | 7 | 10 |
| # Chicks @ 45 Days | 12 | 36 | 48 |

Table 2. Nest and brood vegetation structure means. Vegetation variable means were tested with a one-way MANOVA for random versus nest centered vegetation structure (n = 19) and random versus brood centered vegetation structure (n = 31). '*' denotes significantly higher mean. Values in parentheses are standard deviations.

| | Random | Nest | F | P | | Random | Brood | F | P |
|---|---|---|---|---|---|---|---|---|---|
| **Nest Model** | | | **4.84** | **0.0008** | **Brood Model** | | | **23.0** | **<0.0001** |
| Species richness | 5.0 (1.44) | 5.7 (2.36) | 1.28 | 0.27 | | 6.6 (2.64) | 9.4* (2.94) | 15.9 | 0.0002 |
| Species diversity | 0.75 (0.37) | 0.76 (0.47) | <0.01 | 0.95 | | 0.95 (0.50) | 1.41 * (0.39) | 16.8 | 0.0001 |
| Evenness | 0.40 (0.19) | 0.41 (0.23) | 0.02 | 0.88 | | 0.44 (0.19) | 0.64* (0.14) | 21.7 | <0.0001 |
| Vegetation cover (%) | 54.1 (0.21) | 52.7 (22.6) | 0.04 | 0.84 | | 62.8 (20.8) | 69.2 (16.8) | 1.83 | 0.18 |
| Mean height (m) | 0.56 * (0.30) | 0.29 (0.21) | 10.95 | 0.002 | | 0.59* (0.29) | 0.27 (0.10) | 33.6 | <0.0001 |
| SD height (m) | 0.22* (0.14) | 0.09 (0.03) | 18.3 | 0.0001 | | 0.21* (0.08) | 0.14 (0.05) | 17.2 | 0.0001 |
| Litter cover (%) | 27.9 (20.9) | 25.5 (18.7) | 0.14 | 0.71 | | 15.9 (16.6) | 10.9 (13.3) | 1.69 | 0.20 |

Table 3. Sources of Sharp-tailed grouse hen mortality. The pre-incubation period was 1 April-20 May. Nests hatched from 11 June-20 June. No hen mortalities were recorded during incubation. Hens disappeared were presumed dead.

| Hen Mortality | Time Period | 1994 | 1995 | Total |
|---|---|---|---|---|
| Predation | Pre-Incubation | 3 | 2 | 5 |
| Predation | Post-Hatching | 2 | 2 | 4[1] |
| Cause Undetermined | Pre-incubation | 0 | 1 | 1 |
| Disappeared | Pre-incubation | 2 | 1 | 3 |

[1] 3 of 4 were hens with broods.

Figure 1. Available versus actual CRP patch size for sharp-tailed grouse nests (n = 19) and broods (n = 13). Means were tested with paired t-tests. * denotes significantly higher mean.

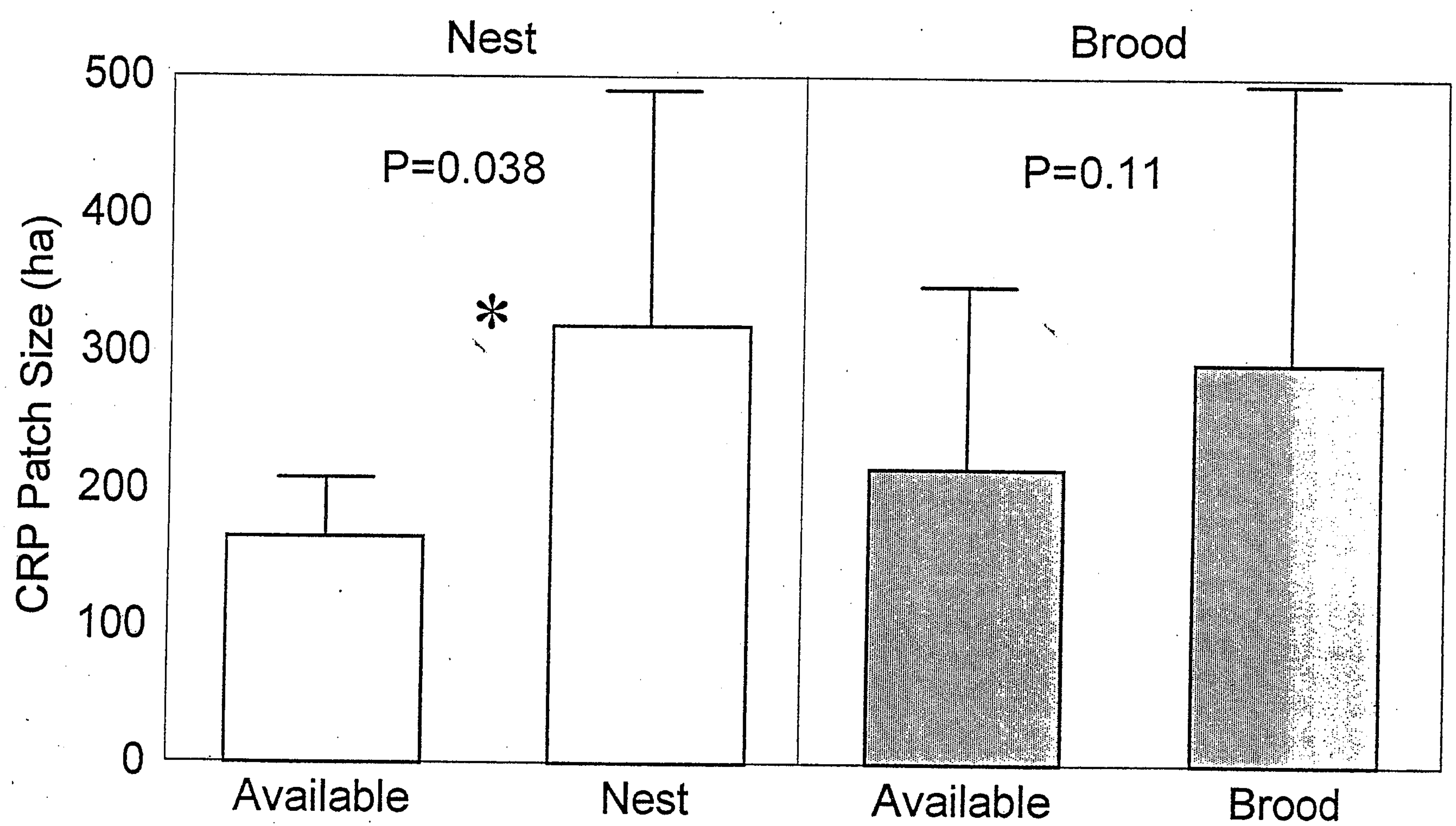
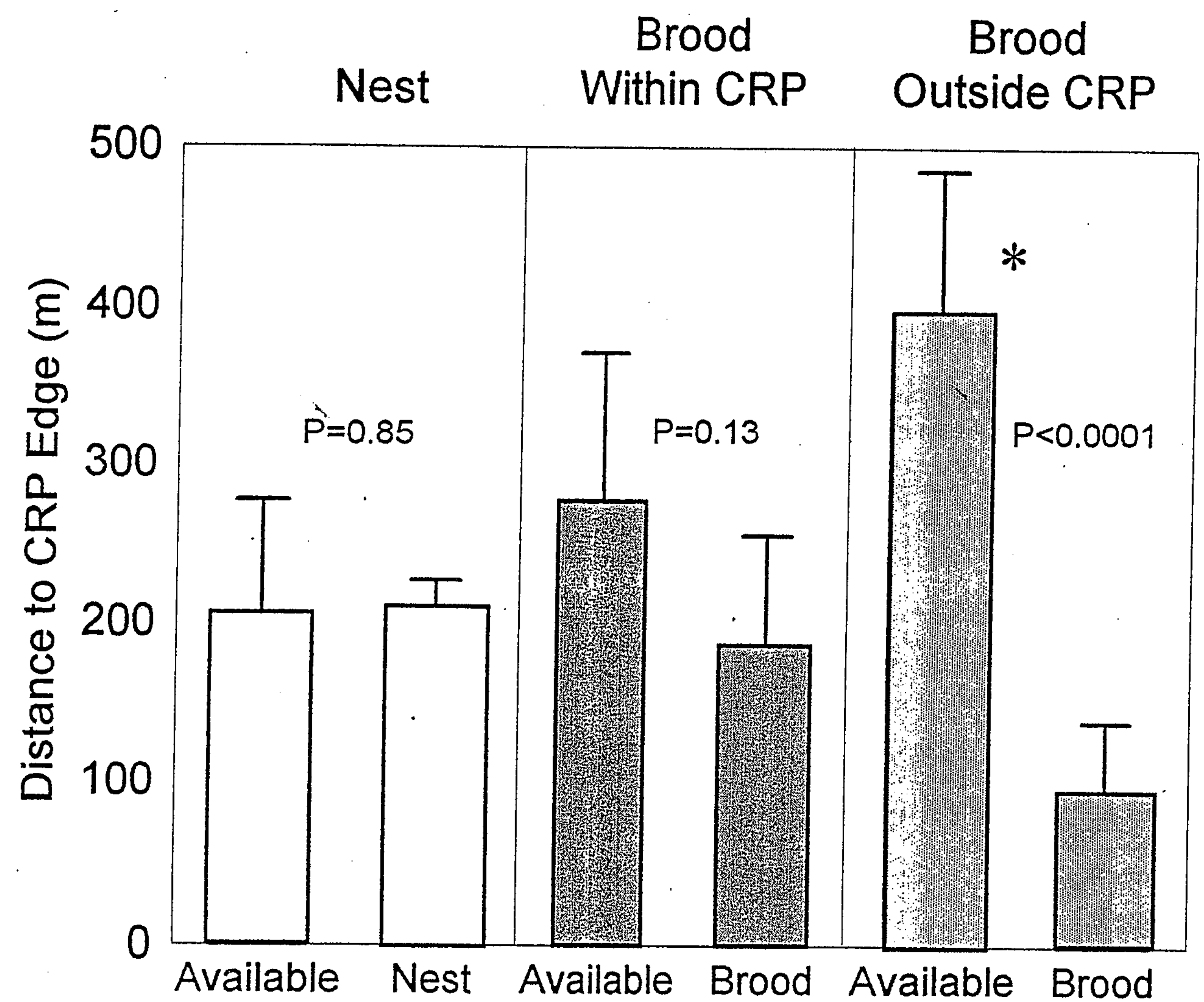
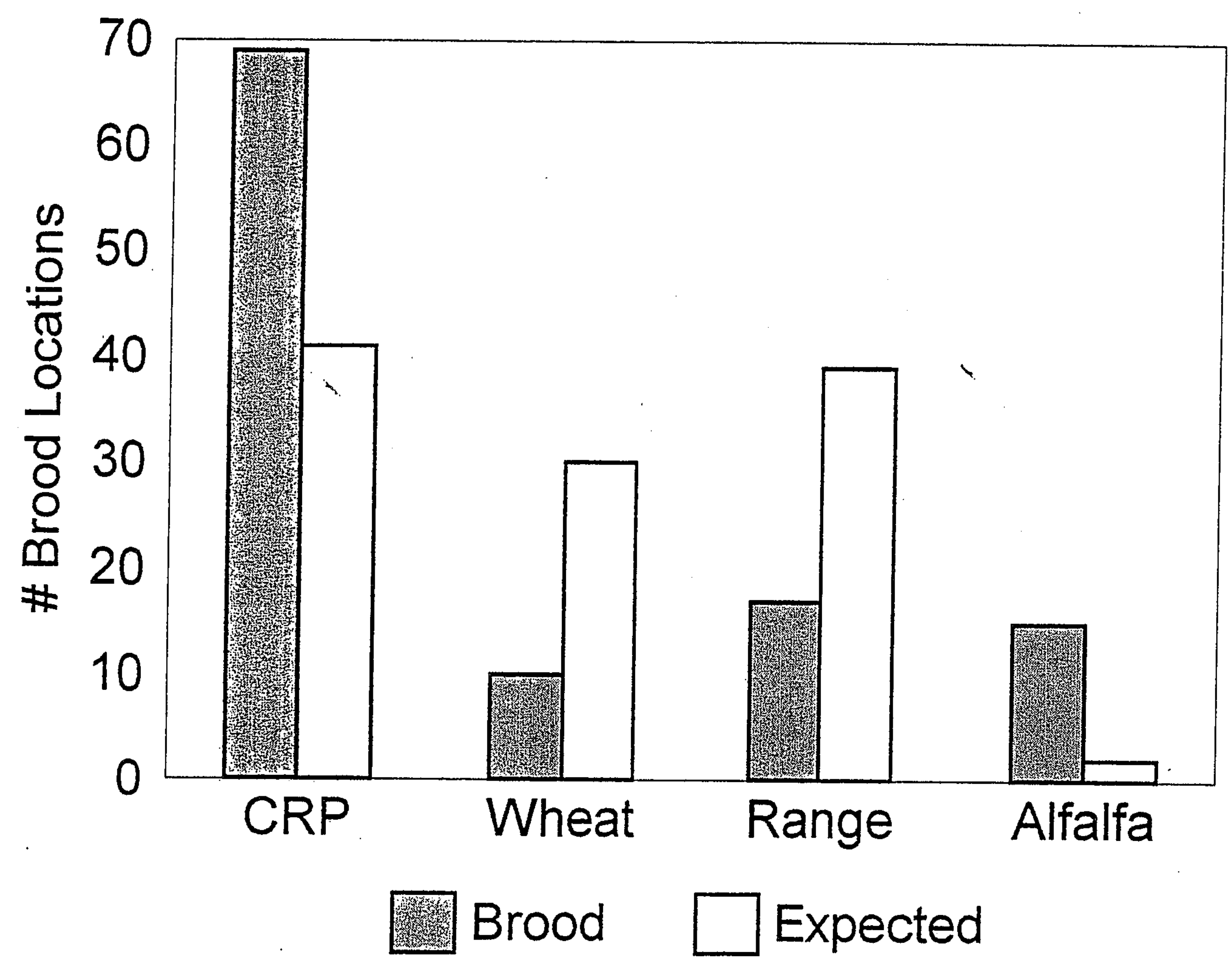

Nest
Brood
CRP Patch Size (ha)
500
400
300
200
100
0
P=0.038
*
P=0.11
Available
Nest
Available
Brood

Figure 2. Available versus actualdistance to CRP edge for sharp-tailed grouse nests (n = 19), broods within CRP (n = 13), and broods outside CRP (n = 13). Means were tested with paired t-tests. * denotes significantly higher mean.



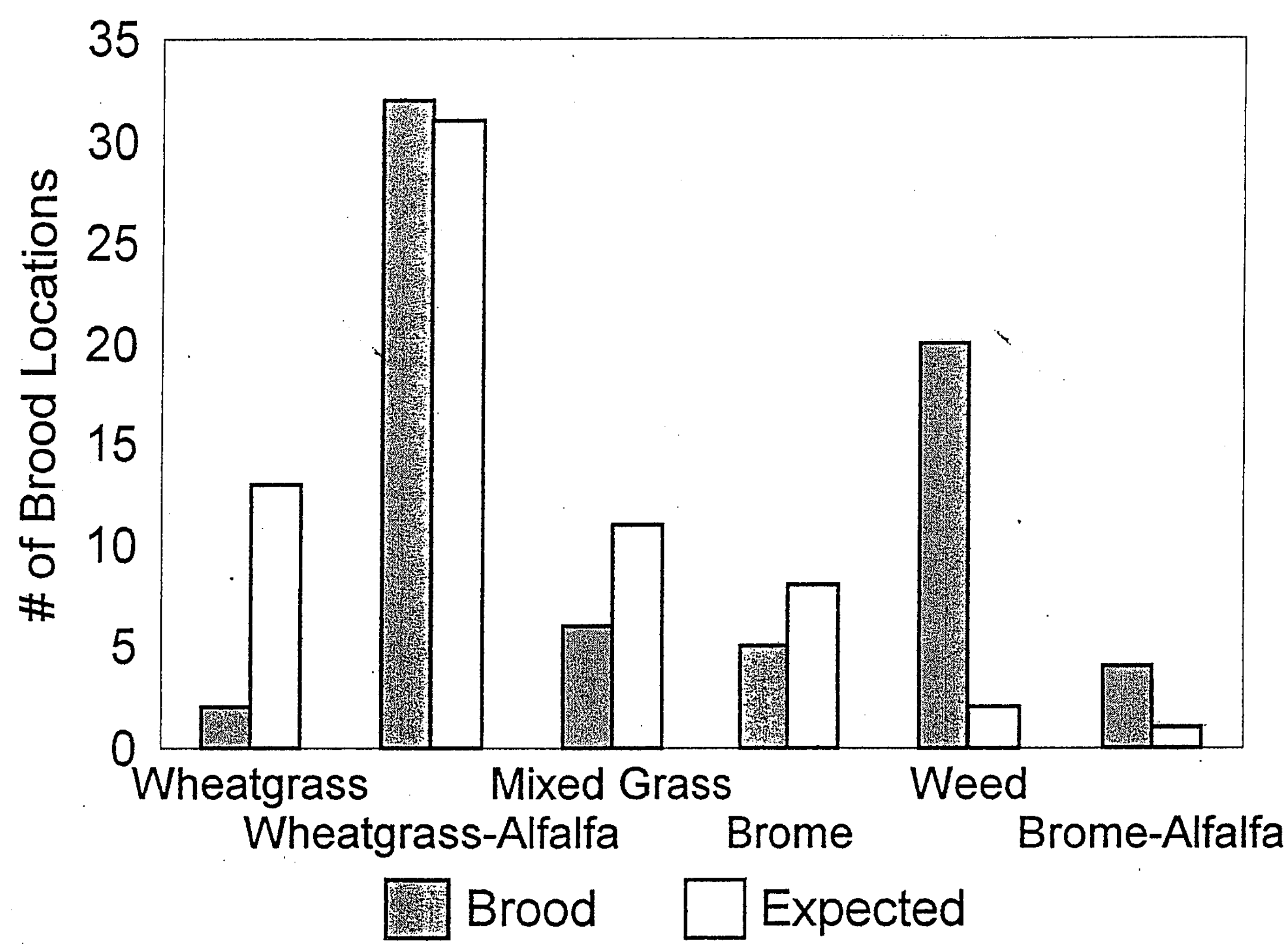
Nest
Brood
Within CRP
Brood
Outside CRP
Distance to CRP Edge (m)
500
400
300
200
100
0
P=0.85
P=0.13
P<0.0001
*
Available
Nest
Available
Brood
Available
Brood

Figure 3. Individual brood and expected locations by land use type. Expected locations were based on sharp-tailed grouse broods utilizing land use type in proportion to area (n = 111).



# Brood Locations
70
60
50
40
30
20
10
0
CRP
Wheat
Range
Alfalfa
Brood
Expected

Figure 4. Individual brood and expected locations by CRP vegetation type. Expected locations were based on sharp-tailed grouse broods utilizing CRP vegetation type in proportion to area (n = 69).



# of Brood Locations
35
30
25
20
15
10
5
0
Wheatgrass
Wheatgrass-Alfalfa
Mixed Grass
Brome
Weed
Brome-Alfalfa
Brood
Expected