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RH: Sharp-tailed grouse leks & CRP. Wachob and Anderson

SHARP-TAILED GROUSE LEK LOCATIONS AND THE CONSERVATION RESERVE PROGRAM IN SOUTHEASTERN WYOMING.

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Abstract: We investigated the location of plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) dancing grounds (leks) relative to Conservation Reserve Program (CRP) lands in Platte, Goshen, and Laramie Counties, Wyoming during 1994-5. Sharp-tailed grouse were rare or absent in much of the study area before implementation of CRP in 1986-9. Grouse numbers increased dramatically during the late 1980's-early 1990's. We located sharp-tailed grouse leks with road surveys in March-May, 1994-5, and analyzed lek locations relative to CRP patch distribution with IDRISI, a geographic information system (GIS). We found that leks were located closer to CRP and had greater coverage of CRP

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within 1 km, compared with the entire study area. We also found that CRP patch size, percent cover of CRP, and CRP patch number predicted the number of leks and the number of males at leks, at a scale of 100 km^2. We recommend the continuation of CRP as an important habitat for sharp-tailed grouse in southeastern Wyoming. We suggest that CRP be maintained in a clumped distribution, rather than evenly distributed, at large scales (>100 km^2). At smaller scales (~100 km^2) as much CRP as possible should be retained and where possible keep patch sizes large (200-400 ha) and numerous to maintain grouse habitat.

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Key words: sharp-tailed grouse, Tympanuchus phasianellus, Conservation Reserve Program, CRP, grassland, Wyoming, GIS, lek, dancing ground.

Plains sharp-tailed grouse were rare or absent in 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, pers. commun.). 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 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 dramatically increased in number and expanded their local distribution into new areas.

Sharp-tailed grouse males display at communal arenas. They are polygynous with no long-term pair bond. Numerous hypotheses have been put forth to explain the lek mating system, e.g. stimulation-conspicuousness hypothesis (Hjorth 1970), male vigilance hypothesis (Wittenberger 1981), male comparison hypothesis (Bradbury 1981). Bergerud (1988a) contends that female behavior drives the lek mating system by breeding with males that display communally at arenas disjunct to good nesting cover. CRP has been shown to be important habitat to sharp-tailed grouse in Wyoming (Wachob 1997). Therefore, we hypothesized that leks should be located near CRP fields. We viewed sharp-tailed grouse leks as an indicator of habitat association and the number of males attending leks as a measure of abundance.

The sudden population increase and local expansion of sharp-tailed grouse, coinciding with the inception of CRP, prompted us to investigate the relationship between CRP and sharp-tailed grouse lek locations. We examined the location and distribution of leks at 4 spatial levels: the study area (2200 km^2), 100 km^2 blocks, 3-km^2 circles centered on the leks, and at the lek sites (0.04 ha). Our objectives were to determine : (1) Lek locations relative to CRP. (2) The relationship between CRP spatial characteristics and the distribution of leks and the number of males in a given area. (3) Short-term grouse population trend.

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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-20 May, 1994-5. The study area (2,235 km^2) was historically short grass prairie, but is now dominated by intensively grazed native range land (1042 km^2) and crop land (809 km^2), primarily winter wheat. CRP (384 km^2) comprised 17% of the study area, with a mean patch size of 209 ha (SD = 373 ha). Elevation ranged from 1400-1700 m. Most CRP contracts were initiated in 1986-9. Most CRP fields were planted to wheatgrasses (Agropyron sp.) or smooth brome (Bromus inermis) mixed with either alfalfa or yellow sweet clover. 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

Leks surveys were conducted on 21 transects (32 km each) using vehicles on public roads. A map of CRP lands in the study area was digitized in the Geographical Resource Analysis Support System, version 4.1 (Grass 4.1) 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) sample squares (blocks) overlaid on the study area in GIS. A cluster analysis, based on these 8 variables, grouped sampling squares into 5 clusters. Transects were laid out so that each cluster type was sampled as equally as the road system would allow. Over 90% of the road system in the study area was used for the surveys.

The location, land use type, and number of males present (gender determined by dancing activity) were recorded for each lek. We confirmed observers' data with follow up visits to leks. Each transect traversed areas with distinctly different spatial characteristics of CRP patches, determined by GIS analyses. Surveys began 30-45 min before sunrise and ended 1.5-2 h after sunrise. Stops were made approximately every 0.8 km (on hill tops where possible) for visual and auditory searches. Surveys were conducted, when possible, on relatively calm, clear mornings. Each transect was surveyed 4 times in 1994 (twice in each direction) and once in 1995. At least 1 additional observation of each lek was made in 1995. Visual and auditory searches were also conducted in areas that were difficult to survey from public roads in 1995. Wyoming Game and Fish personnel conducted lek surveys using similar protocol in a limited portion of the study area during April, 1992-3. The flat topography and short vegetation in the study area permitted detection of leks at distances as great as 1.5 km during favorable weather.

Size and location of CRP, crop, and range fields were obtained from local Natural Resource Conservation Service offices and digitized into IDRISI Geographic Analysis System (Eastman 1995) to form the base map layer (20 by 20 m pixels). Maps were ground truthed during May, 1993-August, 1995. UTM coordinates of lek locations were determined from 1:24,000 topographic maps and overlaid on the base map layer. We determined, using IDRISI, the percent cover of 3 land use types (CRP, crop, and range) and the distance to CRP (distance within CRP patches = 0 m) at 4 spatial scales: the entire study area, within 22 100-km^2 blocks (placed in a grid covering the entire study area), within 3-km^2 (1-km radius) circles centered on each lek ($\underline{n} = 69$), and at the 0.04-ha lek site ($\underline{n} = 69$).

We conducted our statistical analyses with SOLO Statistical Software (BMDP Statistical Software, Inc., Los Angeles, California). Male attendance data were means of all observations. χ^2 tests were used to test for goodness of fit between the distribution of land use types at lek sites and the distribution of land use types within the 3-km^2 circles. Similarly, we used χ^2 tests for goodness of fit between the area of each land use type within 3-km^2 circles and the distribution of land use types in the study area. We tested for differences in distance to CRP between lek sites, 3-km^2 circles, and the study area with Analysis of Variance (ANOVA) and Newman-Keuls multiple comparison tests (Zar 1984). Within the 100-km^2 blocks, we used simple linear regression to test the dependence of the number of leks or males on the percent cover of CRP (%CRP), and multiple linear regression to test the dependence of the number of leks or males on mean CRP patch size and number of CRP patches. We used simple linear regression to test for dependence of the number of males at the lek on %CRP within 3-km^2 circles. We were able to get reliable male attendance data on 5 leks from 1992-5 and on 7 more from 1993-5. We used repeated measures ANOVA to test for a difference in lek attendance between years (1993-5) at these 12 leks.

RESULTS

We located 69 leks with 642 males in attendance (male/lek $\bar{x} = 9.9$, SD = 5.9). The area of CRP, crop, and range within the 3-km^2 circles differed significantly from the proportions of the 3 land use types in the entire study area ($\chi^2 = 160.37$, 2 df, $P < 0.00001$, Fig. 1). CRP was the main χ^2 contributor ($\chi^2_{CRP} = 132.76$) due to higher proportion of CRP in the 3-km^2 circles (51%) than in the study area (17%), indicating the area surrounding leks contained a greater area of CRP than expected based its availability in the study area. Similarly, the distribution of the 3 land use types at lek sites differed significantly from expected based on proportions of the 3 land use types in the 3-km^2 circles ($\chi^2 = 7.96$, 2 df, $P = 0.019$, Fig. 1). The main χ^2 contributor ($\chi^2_{Range} = 5.77$) was the higher proportion of lek sites on range land compared to its availability in 3-km^2 circles (42% versus 27%), indicating that leks were located on range more often than expected based on its availability in the 3-km^2 circles.

The study area, 3-km^2 circles, and lek sites all differed significantly from each other in mean distance to CRP ($F = 3031.7$, 2 df, $P < 0.0001$, Fig. 2). The distance to CRP from lek sites was smaller than mean distance in 3-km^2 circles, and both had smaller distances than the study area as a whole ($P < 0.05$).

%CRP in 100-km^2 blocks was a significant predictor of the number of leks (r^2 = 0.52, $P < 0.0001$, Fig. 3A) and the number of males ($r^2 = 0.54$, $P < 0.0001$, Fig. 3B). Blocks with higher %CRP had higher numbers of leks (#Leks = 20.7 * %CRP) and males (#Males = 199.4 * %CRP). The number of males at a lek versus %CRP within 3-km^2 circles model was significant ($P = 0.008$) but its predictive ability was extremely low ($r^2 = 0.12$, Fig. 3C).

CRP patch size and number of CRP patches in 100-km^2 blocks were also significant predictors of the number of leks ($r^2 = 0.58$, $P < 0.0001$, Fig. 4) and the number of males (r^2 = 0.61, $P < 0.0001$, Fig. 4). As CRP patch size and number of patches increased, the number of leks (# Leks = -3.71 +0.013 * Patch size + 0.43 * # Patches) and total male attendance increased (# Males = -36.8 + 0.137 * Patch size + 4.02 * # Patches). The CRP patch size and number, as well as %CRP, may also influence lek distribution. %CRP was not included in the multiple regression model because it was highly correlated (r = 0.93) to CRP patch size and number of CRP patches (Neter et al. 1989). Variance inflation factors were >7.95 with %CRP in the model and 1.10 without it.

Male attendance at the 12 leks (Fig. 5), for which >2 years of male attendance data was available, differed between the 3 years ($F = 3.93$, 2 df, $P = 0.0295$). Male attendance was higher in 1993 ($\bar{x} = 11.1$, SD = 5.9) than 1995 ($\bar{x} = 4.9$, SD = 5.7), while 1994 ($\bar{x}$ = 7.6, SD = 4.9) did not differ from either 1993 or 1995 ($\alpha = 0.05$). The downward attendance trend on these 12 leks reinforces our observations indicating a general decline in lek attendance and establishment of few new leks during 1992-5.

DISCUSSION

Sharp-tailed grouse leks are typically at an elevated site with wide-viewing horizons and low or sparse vegetation (Baydack 1988). Leks at our study site typically had these characteristics, regardless of the land use type. Even leks sites defined as within CRP were often on small patches of short, unplowed native grasses. Range land often had very short vegetation and tended to hillier than crop or CRP, which may explain the higher number of lek sites on range. We observed sharp-tailed grouse flying >0.5 km to and from leks. In the immediate area of many leks there were often >1 site with similar characteristics that were presumably available to the grouse. Provided the lek site has the basic requirements, the placement of leks at a small spatial scale was probably not as important to successful reproduction as the habitat quality at slightly larger spatial scales (Bergerud 1988a). The 100-km^2 scale better predicted numbers of males than did the 3-km^2, further evidence that larger, rather than smaller, scale habitat pattern influenced lek site selection.

Sharp-tailed grouse leks were clearly associated with CRP. Leks were located nearer to CRP and in areas with greater coverage of CRP. Bergerud (1988a) contends that female behavior drives the lek mating system by breeding with males that display communally at leks disjunct to good nesting cover. Leks in our study area were similarly disjunct to nesting habitat. CRP was found to be good sharp-tailed grouse nesting habitat (Wachob 1997). Leks were in areas of high %CRP and near CRP but 61% of leks were not in CRP (Fig. 1). Whether this is due to female preference for leks near (but not too close) to good nesting cover, or merely to greater availability of suitable lek sites slightly disjunct to CRP, can not be determined from our data.

Further evidences of larger spatial scale influence on lek location, are the positive regressions of lek and male numbers on %CRP, CRP patch size, and number of CRP patches in the 100-km^2 blocks. Since CRP appears to be important reproduction habitat to grouse (Wachob 1997), it is not surprising that higher %CRP should result in more leks and males in an area. As individual regressors, both CRP patch size and number of CRP patches were significant ($\underline{P} < 0.009$), but their simple r^2 values were low (<0.24). Tested together in the multiple regression models, these variables were reasonably predictive lek and male numbers ($r^2_{lek} = 0.58$, $r^2_{male} = 0.61$). Areas with low numbers of patches and small patch size did not have as many leks and males as areas with more and larger CRP patches. The simple %CRP regressions and the multiple regressions both indicate the same general result: more CRP yields more leks and males. However, the multiple regressions indicate the spatial arrangement may also be important. The highest concentrations of leks and males were in blocks with 200-400 ha patch size and 10-15 CRP patches, not in blocks with >500 ha patch size and <10 patches (Fig. 4). Therefore, it may benefit sharp-tailed grouse more to increase %CRP by adding 200-400 ha patches to the landscape rather than increasing %CRP by adding to the size of existing patches.

The response of sharp-tailed grouse to new habitat areas may be of real importance to sharp-tailed grouse habitat management and is worthy of further research. The rapid increase in grouse numbers shortly after the inception of CRP, followed by a decline in lek attendance (Fig. 5), coupled with the apparent affinity of male grouse (Wachob, unpubl. data) and hens with broods (Wachob 1997) for younger (<2 years) CRP patches raises further questions about the reproductive ecology of sharp-tailed grouse and CRP. It may be possible that the earlier succession stages of CRP were excellent reproduction habitat due to high weedy forb cover. Sharp-tailed grouse in Nebraska were associated with earlier stages of succession characterized by high forb cover (Sisson 1976). Classic numerical and functional response of predators to a new prey species would suggest that a lag time may exist early in the exploitation of a new habitat by the prey. At higher densities of grouse, predators may more easily form a search image and more actively search for grouse adults, nests and young than at low densities where predation may be a more or less random event. Bergerud (1988b) states that density dependent nest predation may operate in grouse populations in this manner. A combination of large areas of early succession habitat and a lack of predation pressure may have contributed to the large increase in grouse numbers in the late 1980's. The subsequent decline in numbers may reflect the succession of CRP away from weedy forb cover to mature stands of planted grasses and the functional and numeric response of avian and mammalian predators. Predator densities were highest near CRP in 1994-5 (Wachob 1997). Unfortunately, we did not have sufficient numbers of younger CRP patches in our study area nor grouse and predator data from 1987-1993 to test these assertions.

MANAGEMENT IMPLICATIONS

We recommend the continuation of CRP in southeastern Wyoming as a valuable habitat for sharp-tailed grouse. We recommend that CRP acreage be maintained at least at its current level. Economic and political factors may require limitations or reductions of CRP acreage. Landowners may need to regularly evaluate the status of their CRP contracts and make decisions whether to return CRP to agricultural production. We suggest that land managers evaluate CRP distributions at larger scales (>100 km^2), strive to maintain CRP in a clumped, rather than even, distribution at larger scales, and then target areas where they can encourage landowners to maintain, renew, or establish new CRP contracts. At smaller scales ($\leq$100 km^2) as much CRP as possible should be retained and where possible keep patch sizes large (200-400 ha) and numerous to maintain grouse habitat. If CRP acreage becomes severely limited, we believe that these strategies could help to maintain grouse populations by concentrating CRP habitat in certain areas rather than having valuable and potentially limited habitat scattered in disjunct and isolated small patches.

LITERATURE CITED

Baker, W.L. and Cai, Y. 1992. The r.le programs for multiscale analysis of landscape structure using the GRASS geographical information system. Landscape Ecology 7:291-303.

Baydack, R. K. 1988. Characteristics of sharp-tailed grouse leks in the parklands of Manitoba. Can. Field Nat. 102:39-44.

Bergerud, A. T. 1988a. Mating systems in grouse. Pages 439-472 in Bergerud, A. T. and Gratson, M. W. eds. Adaptive strategies and population ecology of northern grouse. Univ. of Minnesota Press, Minneapolis.

___. 1988b. Population ecology of North American grouse. Pages 574-685 in Bergerud, A. T. and Gratson, M. W. eds. Adaptive strategies and population ecology of northern grouse. Univ. of Minnesota Press, Minneapolis.

Bradbury, J. W. 1981. The evolution of leks. Pages 138-169 in Alexander and Tinkle, eds. Natural selection and social behavior. Chiron Press, New York, N.Y.

Eastman. J. R. 1995. IDRISI: Geographic Analysis System. Clark University, Worcester, Mass.

Hjorth, I. 1970. Reproductive behavior in Tetronidae with special reference to males. Viltrevy 7:183-596.

Johnson, D. H., and M.D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Cons. Biol. 7:934-937.

Neter, J., W. Wasserman, and M. H. Kutner. 1989. Applied linear regression models. Second Ed. Richard D. Irwin, Inc. Burr Ridge, Ill.

Sisson, L. 1976. The sharp-tailed grouse in Nebraska. Neb. Game and Parks Comm. Lincoln, Neb. 88pp.

Wittenberger, J. F. 1981. Animal social behavior. Duxbury Press, Boston, Mass. 722pp.

Wachob, D. G. 1997. The effects of the Conservation Reserve Program on wildlife in southeastern Wyoming. Ph.D. dissertation. Univ. Wyoming, Laramie, Wyoming.

Zar, J. H., 1984. Biostatistical Analysis. Second ed. Prentice-Hall, Inc., Englewood Cliffs, N.J.

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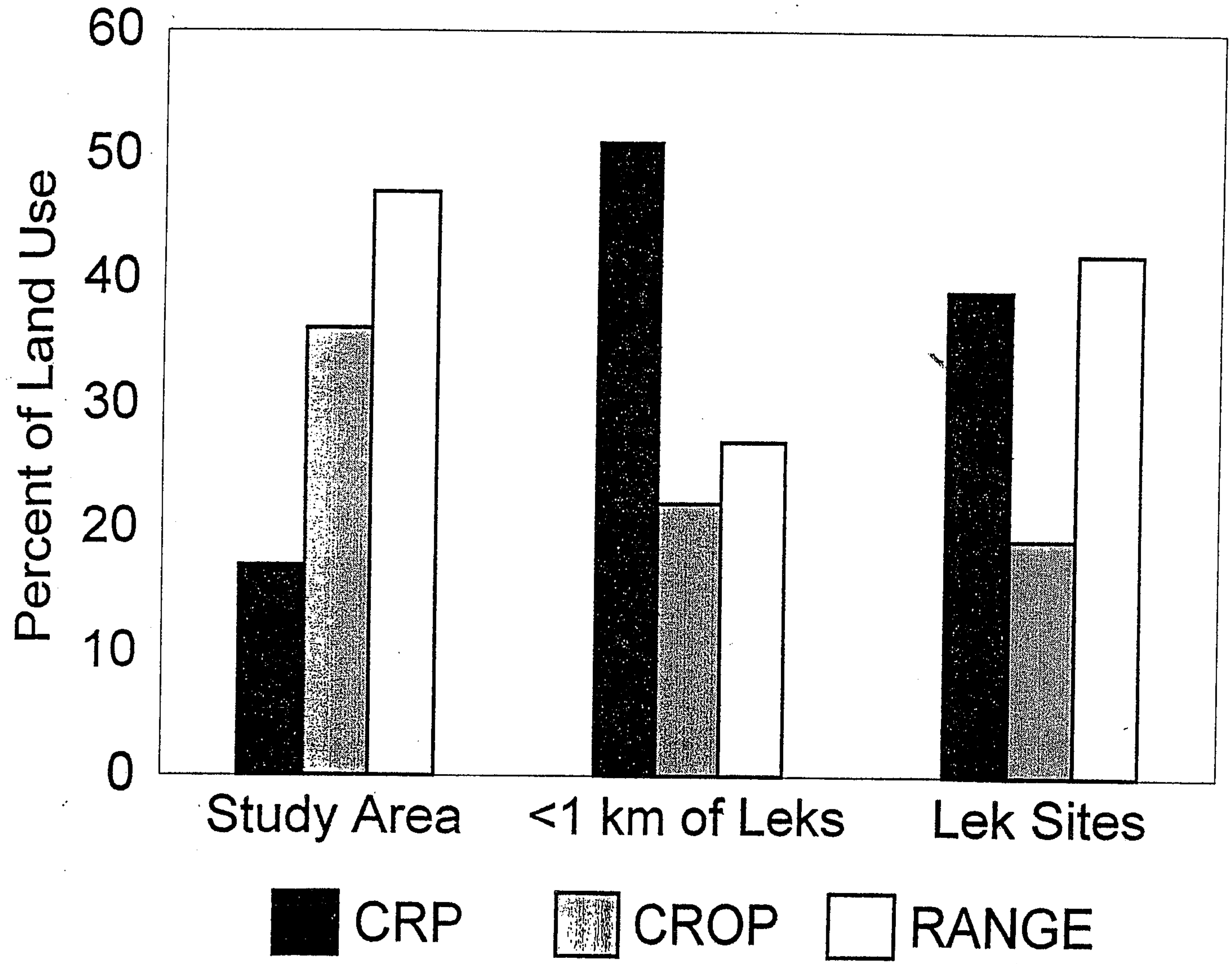
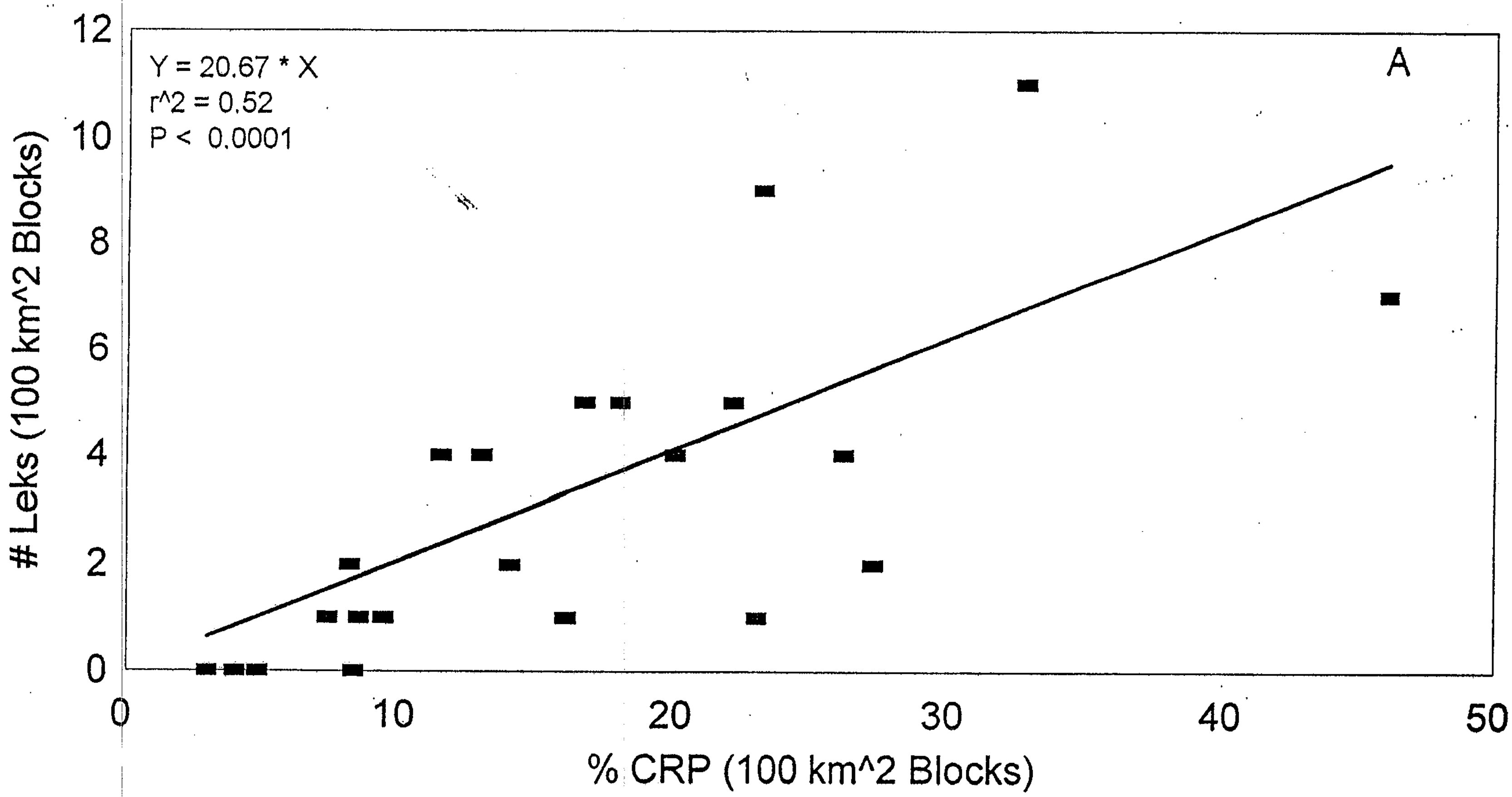
Figure 1. Percent coverage of CRP, crop, and range land within the study area, 3-km^2 circles (1-km radius) centered on sharp-tailed grouse leks ($\underline{n} = 69$), and at sharp-tailed grouse lek sites ($\underline{n} = 69$) in Wyoming during 1994-5.



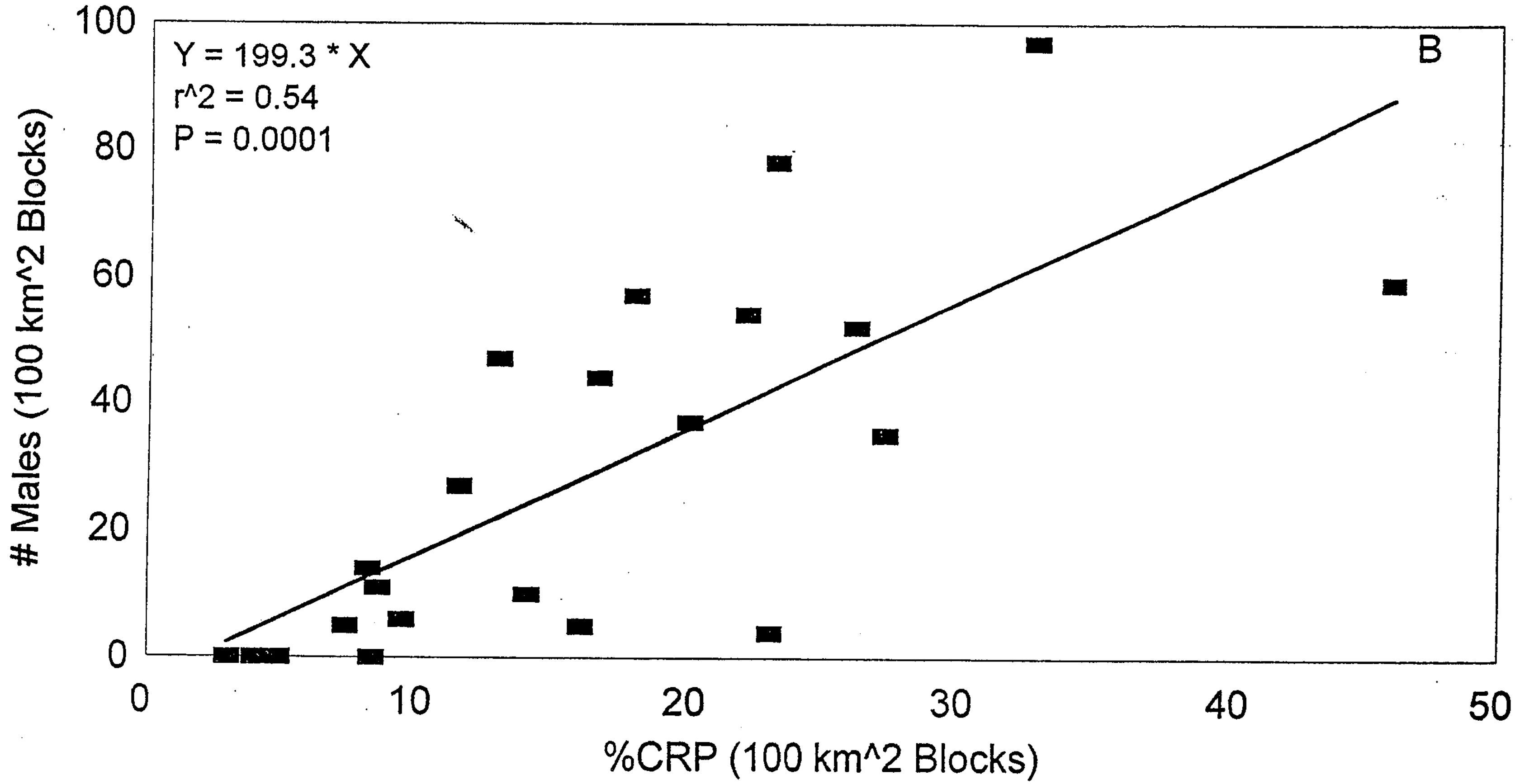
Percent of Land Use
60
50
40
30
20
10
0
Study Area
<1 km of Leks
Lek Sites
CRP
CROP
RANGE

Figure 2. Mean distance to CRP within the study area, 3-km^2 circles (1-km radius) centered on sharp-tailed grouse leks ($\underline{n} = 69$), and at sharp-tailed grouse lek sites ($\underline{n} = 69$) in Wyoming during 1994-5. Error bars are 95% confidence intervals. Letters denote significantly different means ($\underline{P} < 0.05$).

Figure 3. Regression of the number of sharp-tailed grouse leks (A) and male lek attendance (B) on percent coverage of CRP within 100-km^2 blocks ($\underline{n} = 22$) and male lek attendance on percent coverage of CRP within 3-km^2 circles (1-km radius) centered on sharp-tailed grouse leks (C, $\underline{n} = 69$) in Wyoming during 1994-5.



Y = 20.67 * X
r^2 = 0.52
P < 0.0001
A
Leks (100 km^2 Blocks)
% CRP (100 km^2 Blocks)
0
2
4
6
8
10
12
0
10
20
30
40
50


Y = 199.3 * X
r^2 = 0.54
P = 0.0001
B
Males (100 km^2 Blocks)
%CRP (100 km^2 Blocks)
0
20
40
60
80
100
0
10
20
30
40
50

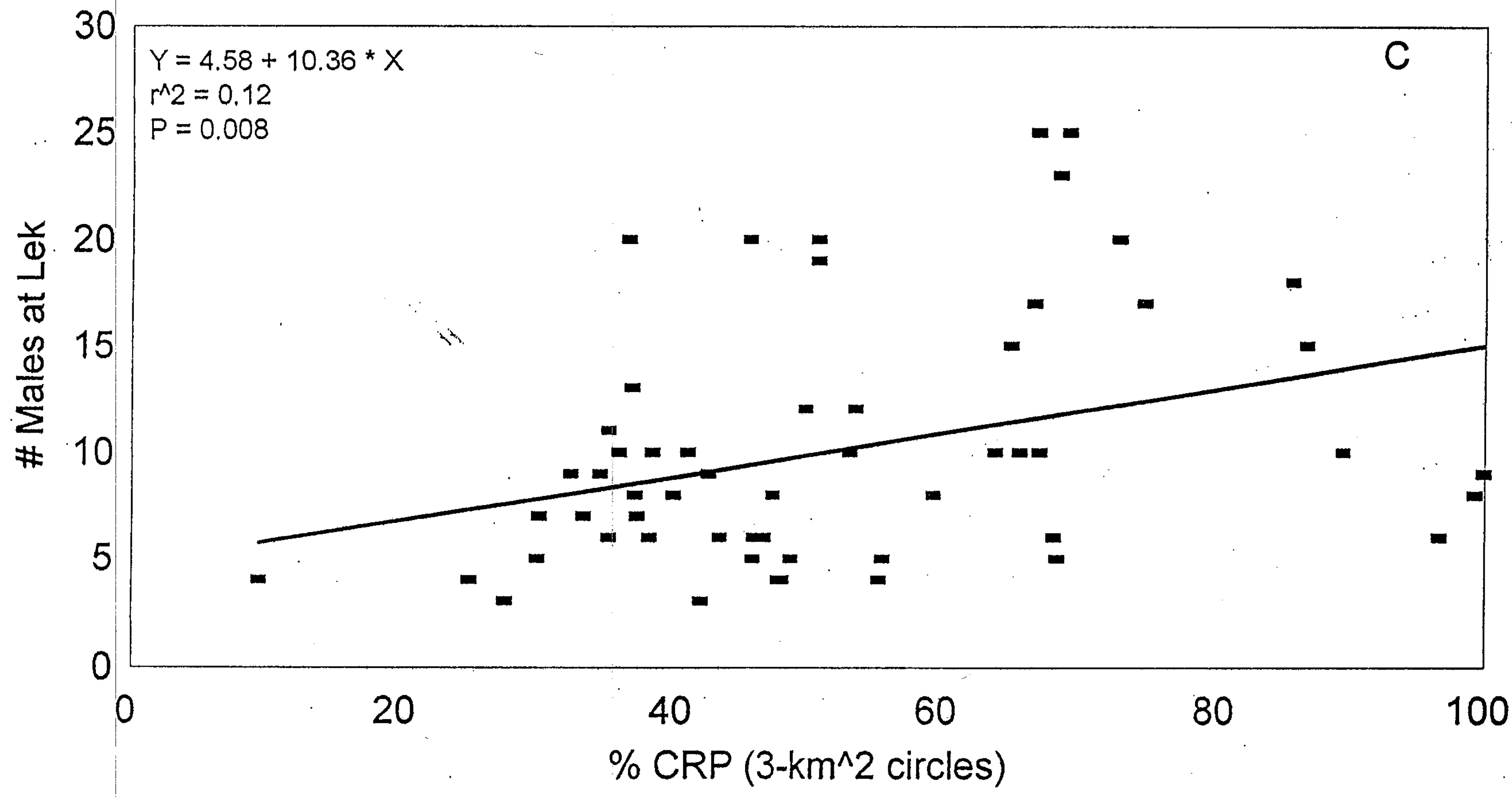
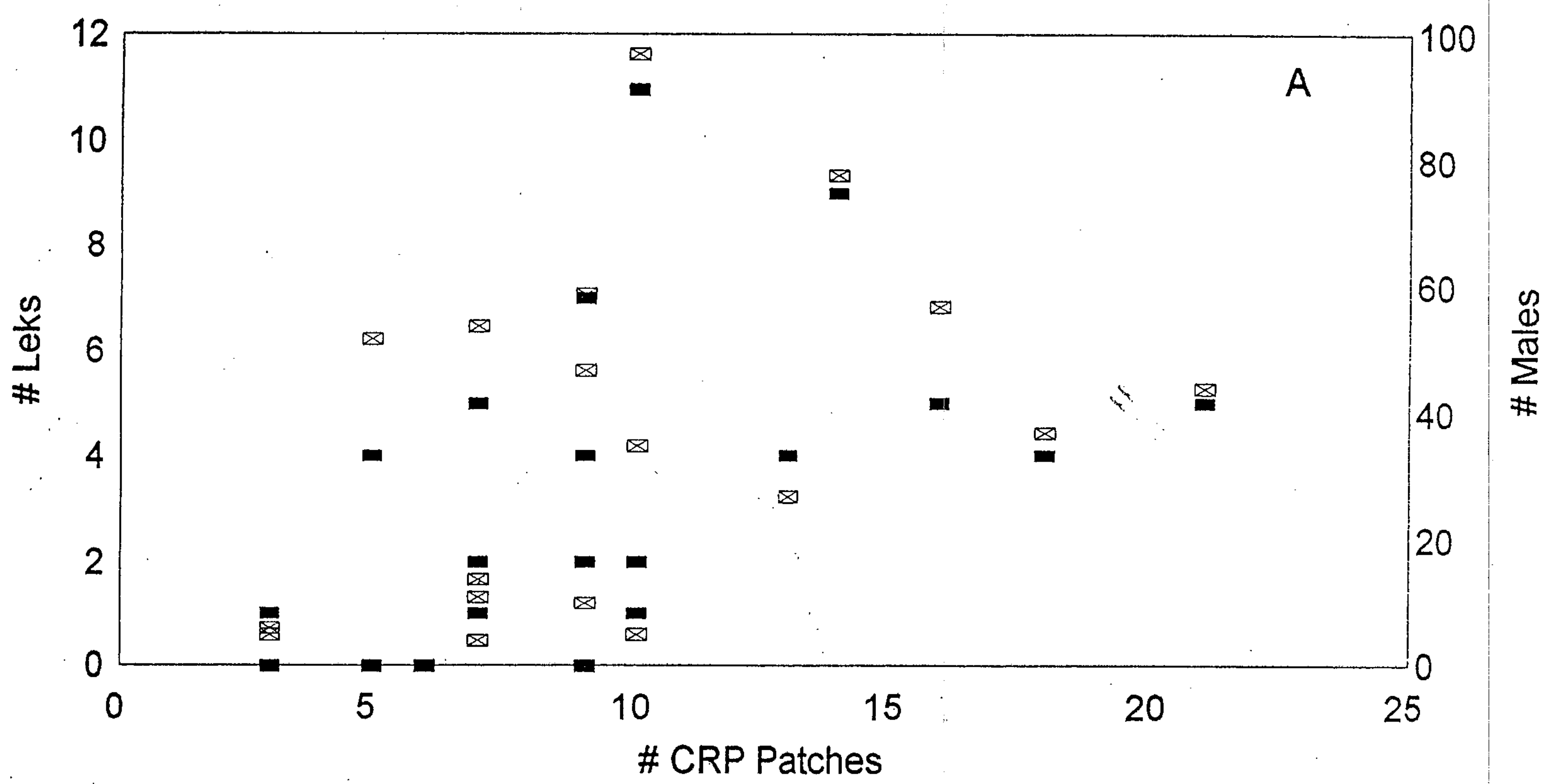
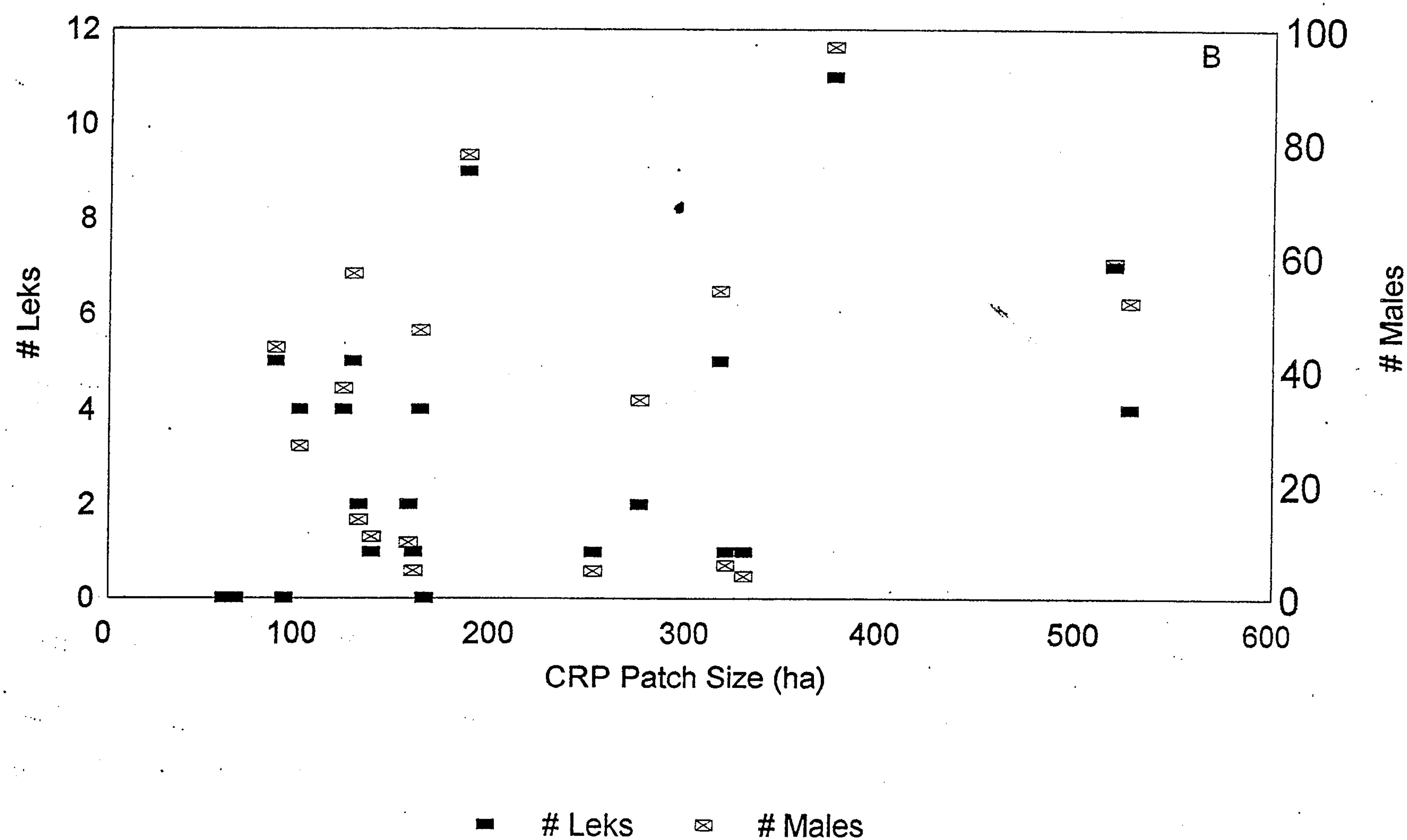

Y = 4.58 + 10.36 * X
r^2 = 0.12
P = 0.008
C
Males at Lek
0
5
10
15
20
25
30
0
20
40
60
80
100
% CRP (3-km^2 circles)

Figure 4. The number of sharp-tailed grouse leks and male lek attendance versus the number of CRP patches (A) and CRP patch size (B) within 100-km^2 blocks ($\underline{n}$ = 22) in Wyoming during 1994-5. Multiple regression equations: # Leks = -3.71 +0.013 * Patch size + 0.43 * # Patches and # Males = -36.8 + 0.137 * Patch size + 4.02 * # Patches.

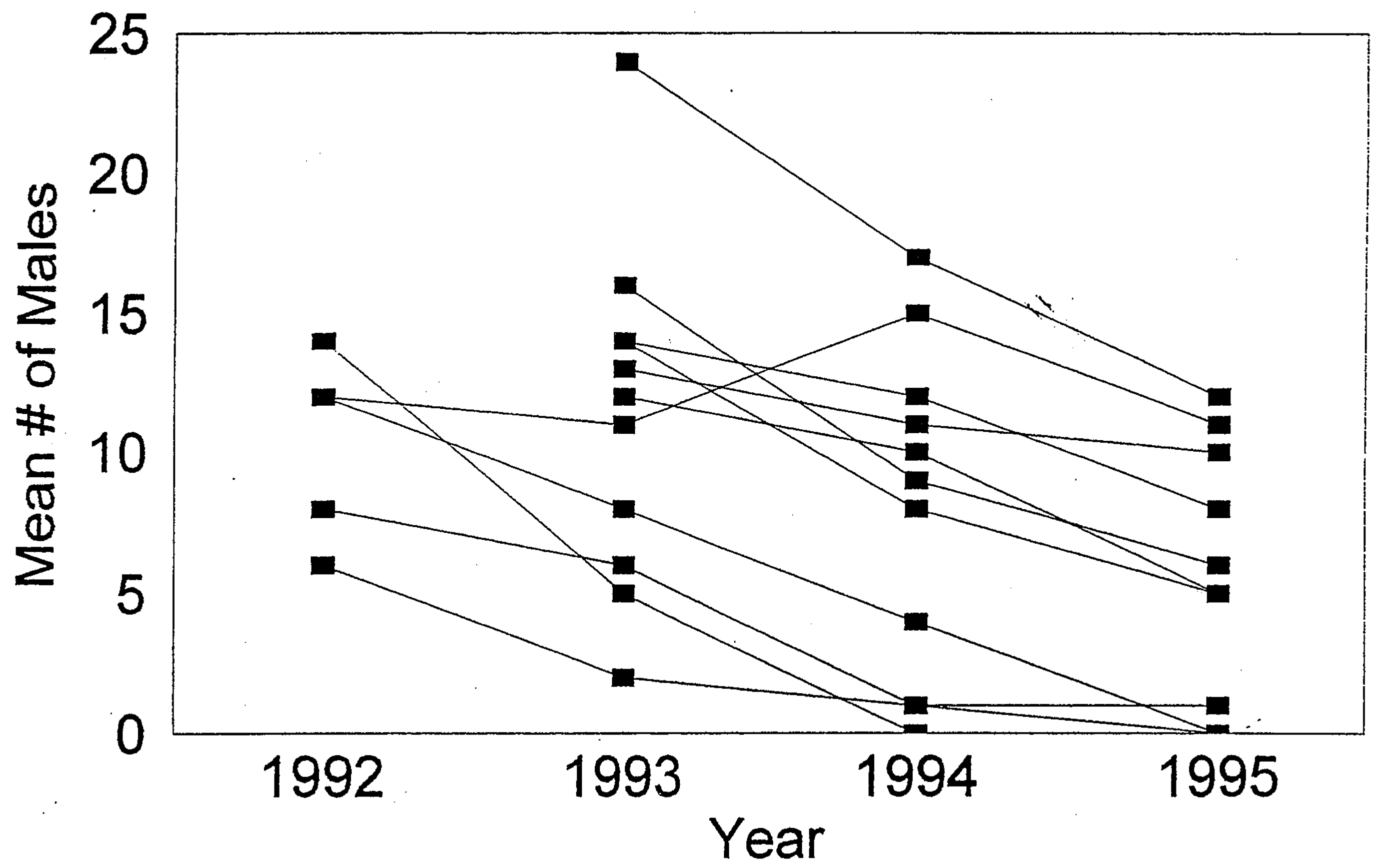


A
Leks
CRP Patches
Males



B
Leks
Males
CRP Patch Size (ha)
0
100
200
300
400
500
600
2
4
6
8
10
12
20
40
60
80
100
Leks
Males

Figure 5. Mean number of sharp-tailed grouse males at 12 leks for 1992-5 in Wyoming. Lines connect the same lek between years.


Mean # of Males
25
20
15
10
5
0
1992
1993
1994
1995
Year