Niche partitioning by lesser prairie-chicken *Tympanuchus pallidicinctus* and ring-necked pheasant *Phasianus colchicus* in southwestern Kansas

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We conducted this 2-year study to determine if lesser prairie-chickens *Tympanuchus pallidicinctus* and ring-necked pheasants *Phasianus colchicus* used the same habitats where their ranges overlapped in southwestern Kansas. Telemetry locations of 50 transmitter-equipped lesser prairie-chickens and 28 pheasants were used to monitor habitat use by the two species. Additionally, vegetation characteristics at 39 nest sites of lesser prairie-chickens were compared to those at 14 pheasant nest sites. Morisita's Index of niche overlap detected moderate similarities of habitat mixes used by lesser prairie-chickens and pheasants, but location data showed that spatial use of those habitats differed. Vegetation structure around nest sites of the two species differed significantly indicating selection of different habitat for nesting birds, and lesser prairie-chickens nested far from the outer edges of native prairie whereas pheasants nested nearer the outer edges. Despite the modest amount of similarity in mixes of habitats used by lesser prairie-chickens and ring-necked pheasants, we conclude that the two species occupy separate niches given the current extent of habitat in southwestern Kansas. However, if additional habitat loss or fragmentation occurs pheasants may gain competitive advantage over lesser prairie-chickens. Thus, we recommend maintaining and conserving large blocks of native habitat as well as the connectivity between them as a management strategy for maintaining populations of lesser prairie-chickens.

Key words: lesser prairie-chickens, niche partitioning, Phasianus colchicus, ring-necked pheasant, southwestern Kansas, Tympanuchus pallidicinctus

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The lesser prairie-chicken *Tympanuchus pallidicinctus* occurs in south-central North America, primarily in rangelands of eastern New Mexico, southeastern Colorado, western Oklahoma, the Texas panhandle and southwestern Kansas. Their numbers have decreased range-wide since the 1800s (Hagen 2005). Historically the sand sagebrush *Artemisia filifolia* prairies of southwestern Kansas were a stronghold for lesser prairie-chickens, but the loss and fragmentation of extensive areas of sandsage prairie, primarily due to expansion of intensive agriculture, have reduced the numbers of lesser prairie-chickens in that habitat (Jensen et al. 2000, Robel et al. 2004). Because of long-term population declines and habitat loss, the lesser prairie-chicken was petitioned in 1995 for listing as threatened under the Federal Endangered Species Act (ESA). The bird was determined to be warranted for listing, but was precluded because of lack of funds and the existence of other species with higher priorities for protection under the ESA (U.S. Fish and Wildlife Service 2002). The status of lesser prairie-chicken populations is being closely monitored by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2002). Lesser prairie-chicken populations have continued to decline in southwestern Kansas even though losses and modifications of sandsage habitat have almost stopped. Research disclosed that this decline was due primarily to low nest success and poor chick survival (Hagen 2003, Pitman 2003). These two factors are critical to the maintenance of prairie grouse populations (Wisdom & Mills 1997).

Ring-necked pheasants *Phasianus colchicus* (hereafter pheasants) can compete for resources and reduce breeding success of greater prairie-chickens *Tympanuchus cupido* (Sharp 1957, Vance & Westemeier 1979, Westemeier et al. 1998b). Distributions of pheasants and lesser prairie-chickens overlap in southwestern Kansas (Thompson & Ely 1989). Interactions between pheasants and lesser prairie-chickens have not been studied, but high rates of nest parasitism and reduced egg hatchability have negatively impacted greater prairie-chickens where the two species overlap (Westemeier et al. 1998b). Thus, there is potential for pheasants to negatively affect lesser prairie-chicken populations. The current amount and fragmentation of lesser prairie-chicken habitat in southwestern Kansas might amplify the interactions between pheasants and lesser prairie-chickens. If these interspecific interactions negatively impact lesser prairie-chicken populations, hunting regulations in Kansas can be modified to reduce pheasant populations or habitat manipulations can be conducted to decrease interactions where distributions of the two species overlap.

We initiated this study to evaluate the extent of overlap in habitat use between pheasants and lesser prairie-chickens and to determine if the two species used the same types of habitat for nesting. Specifically, we 1) quantified monthly niche overlap indices, 2) determined spatial relationships of these niches, 3) compared vegetation structure at nest sites of pheasants and lesser prairie-chickens in sandsage prairie, and 4) evaluated spatial relationships between nests and habitat edges.

Methods

We conducted this study during 1997 and 1998 in typical sand sagebrush rangeland and agricultural fields in Finney County, southwestern Kansas (37°52'50"N, 100°59'402"W). Soils, climate, vegetation and management of the study site have been described in Robel et al. (2003).

We trapped lesser prairie-chickens on leks during spring and fall using walk-in funnel traps (Haukos et al. 1990, Salter & Robel 2000). Pheasants were captured by nightlighting (Labisky 1968) during late winter and early spring. Captured birds were fitted with necklace-style radio-transmitters with a mass of 12 and 19 g each for lesser prairie-chickens and pheasants, respectively. Radio-marked birds were located daily with a truck-mounted null-peak twin-Yagi telemetry system to determine movements and habitat use. We used triangulation from at least two known locations to determine point locations of radio-marked birds using Locate II software (Nams 2000).

We imported bird location data into a geographic information system (GIS; ArcView 3.1, Environmental Systems Research Institute 1998). We used a 1999 GAP Analysis Program (GAP) habitat cover type map of southwestern Kansas (Kansas Geospatial
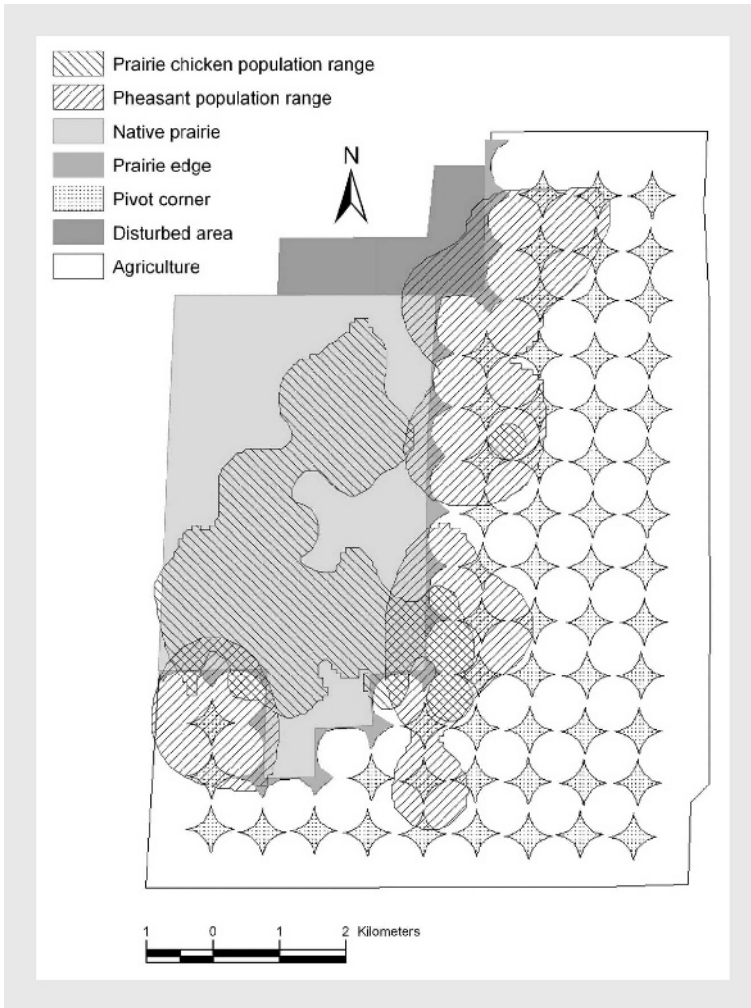
Figure 1. The study area with 95% fixed-kernel population ranges for lesser prairie-chickens and ring-necked pheasants in Finney County, Kansas, during 1997-1998. Habitat types used in niche overlap analysis are depicted as well. Cross-hatched areas indicate spatial overlap of prairie chicken and pheasant population ranges. Circles indicate agricultural fields irrigated by centre pivot systems.

Community Commons 2000) to delineate habitat boundaries and calculated the proportion of locations of radio-marked birds in each of the five habitat types: native prairie, prairie edge, disturbed area, unirrigated pivot corners and agriculture (Fig. 1). Native prairie consisted of a 2,400-ha contiguous tract of sand sagebrush. Prairie edge was a 200 m border of the native prairie adjacent to agricultural fields. Disturbed area was a sand pit surrounded by 364 ha of reclaimed area used for recreation. Pivot corners were 1.5-ha weedy patches at the outer four corners of 59-ha centre-pivot circular irrigation systems in square 65-ha fields. Agriculture consisted of approximately 4,700 ha of crop fields adjacent to native prairie, mostly devoted to production of alfalfa *Medicago sativa*, corn *Zea mays*, and wheat *Triticum aestivum*.

We used Morisita's Index (C) of niche overlap (Morisita 1959) to measure the extent to which pheas-

ants and lesser prairie-chickens were located in similar mixes of habitat types (0 = no similarity, 1 = total similarity) at a landscape scale because of its lack of bias (Smith & Zaret 1982). We calculated C monthly, and used bootstrapping (N = 5,000) to estimate 95% bias-corrected confidence limits (Manly 1991). We used all locations for all birds to estimate C (95% CLs) for each species and month.

We used bird location data to determine spatial relationships of prairie and agricultural habitats used by pheasants and lesser prairie-chickens. We calculated mean distances by month from bird locations within native prairie to agricultural edges, within agricultural fields to prairie edge, and within agricultural fields to pivot corners. We used a grand mean of monthly distances for each bird per time period. Thus each bird was represented by one mean distance for each season. We used ANOVA to test for differences

in average distances from edges and unirrigated pivot corners between pheasants and lesser prairie-chickens throughout the year and between breeding (April-September) and winter (October-March) seasons. After interpreting interaction terms, we used the LS-MEANS option in PROC GLM (SAS Institute 1998) to compare average distances if ANOVA rejected the null hypothesis that distances to each edge-type was similar between species. To reduce potential bias in breeding season average distance determinations, we used only one nest or lek location of each nesting female or lekking male, respectively.

We used telemetry to find nesting lesser prairie-chickens. We characterized vegetation structure at nest sites within three days after nest fate (successful with at least one egg hatched, depredated or abandoned) was determined, except in 1997 when measurements were taken at the conclusion of the nesting season (late July-early August). We centered two 11-m sampling transects across the nest bowl perpendicular to each other and estimated vegetation structure variables at 2-m intervals along each transect. Variables estimated were: cover (% grass, sagebrush and forbs) and bare ground in a 20×50 cm sampling frame (Daubenmire 1959) and visual obstruction readings (VOR) determined from a distance of 2 m and a height of 0.5 m (Robel et al. 1970). Means of these separate variables characterized vegetation structure of nest sites. We used MANOVA (Wilk's Λ test statistic) to examine differences between vegetation communities at nest sites of pheasants and lesser prairie-chickens (Johnson 1998). Distances from nest sites to nearest edge were determined and the differences between those for pheasants and lesser prairie-chickens were evaluated using ANOVA. We used a significance level of $\alpha = 0.05$ for all analyses.

Results

Location data from 50 lesser prairie-chickens (6,183 point locations) and 28 pheasants (3,130 point locations) were used for determining population ranges and spatial relationships of habitat use by lesser prairie-chickens and pheasants and for niche overlap analyses for the two species. Vegetation structure data from 39 lesser prairie-chicken nest sites were compared to those from 14 pheasant nest sites as were distances from the nests of each species to the nearest edge. Little spatial overlap occurred in the year-round population ranges of lesser prairie-chickens and pheasants in our study area. Lesser prairie-chicken

ranges were restricted primarily to native prairie habitat whereas pheasants were located primarily in adjacent agricultural areas (see Fig. 1).

Numbers of lesser prairie-chickens and pheasants providing data for habitat use and niche overlap estimates were less during the winter months of December-February than during the rest of the year (Table 1). The greatest numbers of individual point locations for lesser prairie-chickens were obtained during April-August and the lowest during December-March. Numbers of point locations for pheasants were greatest during March-June and least during December-February. Morisita's Index C calculated from these data detected less overlap between mixes of habitats used by pheasants and lesser prairie-chickens during the nesting and brood-rearing period (May-September: average $C = 0.175$) than other times of year (October-April: average $C = 0.482$; Fig. 2).

No point locations of lesser prairie-chickens were recorded in agricultural fields during July, August or September. When in agricultural fields, lesser prairie-chickens were closer ($\bar{x} = 206$, SE = 59 m) to prairie edges than pheasants ($\bar{x} = 460$, SE = 53 m) during April-June (Species $\times$ Season: $F_{1, 120} = 4.0$, $P = 0.049$; Table 2), but further away during other months (lesser prairie-chicken: $\bar{x} = 456$, SE = 51 m; pheasant: $\bar{x} = 309$, SE = 56 m, $P = 0.05$; Fig. 3A). Lesser prairie-chickens were further ($\bar{x} = 147$, SE = 11 m) from corner edges than pheasants ($\bar{x} = 58$, SE = 7 m) during the October-March period (Species $\times$ Season: $F_{1,120} = 5.6$, $P = 0.020$), but not during April-June (see

Table 1. Numbers of birds (individuals from which point locations were determined) and radio point locations (determined for transmitter-equipped birds during the month in question) used for determining population ranges and spatial relationships of habitat use by lesser prairie-chickens and ring-necked pheasants, and niche overlap analyses for the two species in Finney County, Kansas, during 1997-1998.

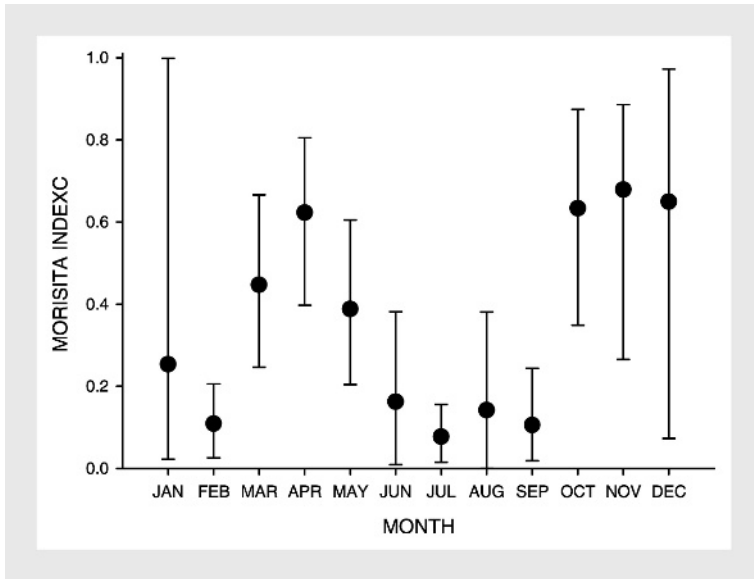| | Samples | | | |
	Lesser prairie-chicken		Ring-necked pheasant	
Month	N	Locations	N	Locations
January	10	221	3	61
February	10	180	6	47
March	26	127	22	434
April	31	695	25	647
May	39	879	20	497
June	32	736	15	369
July	27	722	10	277
August	27	720	8	230
September	26	501	7	181
October	35	593	7	196
November	28	555	7	137
December	19	254	3	54

Figure 2. Morisita's Index C with 95% bias-corrected confidence intervals of niche overlap for habitat mixes of lesser prairie-chickens and ring-necked pheasants in Finney County, Kansas, during 1997-1998. See Table 1 for sample sizes.

Fig. 3B). Analyses of bird location data disclosed that lesser prairie-chickens used native prairie area further from the agricultural-edges (breeding season: $\bar{x} = 965$, SE = 64 m; winter: $\bar{x} = 761$, SE = 64 m) than did pheasants (breeding season: $\bar{x} = 197$, SE = 19 m; winter: $\bar{x} = 199$, SE = 64 m; Species × Season: $F_{1,101} = 14.3$, P < 0.001; see Fig. 3C).

Overall vegetation communities at nest sites of pheasants and lesser prairie-chickens differed (Wilk's $\Lambda = 0.639$, P = 0.006). Percent sagebrush and forb cover were greater at pheasant nest sites than at lesser

prairie-chicken nest sites, whereas grass cover was greater at lesser prairie-chicken nest sites than at pheasant nest sites (Table 3). Visual obstruction readings in decimeter (dm) were lower at lesser prairie-chicken nests than at pheasant nest sites. The amount of bare ground near pheasant nest sites did not differ from that near lesser prairie-chicken nests (see Table 3). Nests of lesser prairie-chickens were on average 1,216 m (SE = 71 m) from the nearest agricultural edge whereas those of pheasants were 259 m (SE = 89 m) from the nearest agricultural edge.

Discussion

Our study indicated that despite modest levels of overlap in resource use by lesser prairie-chickens and pheasants, there was little spatial overlap in occupied

Table 2. Relationships between lesser prairie-chicken and ring-necked pheasant locations and distances to three types of edges: within agricultural fields to prairie edges, within agricultural fields to corner edges and within native prairie to agricultural edges, in Finney County, Kansas, during 1997-1998.

Source	Numerator df	Denominator df	F-statistic	P-value
Prairie-edge				
Season	1	120	3.86	0.052
Species	1	120	167.71	< 0.001
Species × Season	1	120	3.97	0.049
Corner-edge				
Season	1	101	26.34	< 0.001
Species	1	101	3.57	0.062
Species × Season	1	101	5.59	0.020
Agricultural-edge				
Season	1	101	1.04	0.310
Species	1	101	0.88	0.351
Species × Season	1	101	14.26	< 0.001

Table 3. Vegetation characteristics, bare ground and visual obstruction at 39 lesser prairie-chicken and 14 ring-necked pheasant nest sites in Finney County, Kansas, during 1997-1998. MANOVA indicated a difference between vegetation communities around nest sites (P = 0.006).

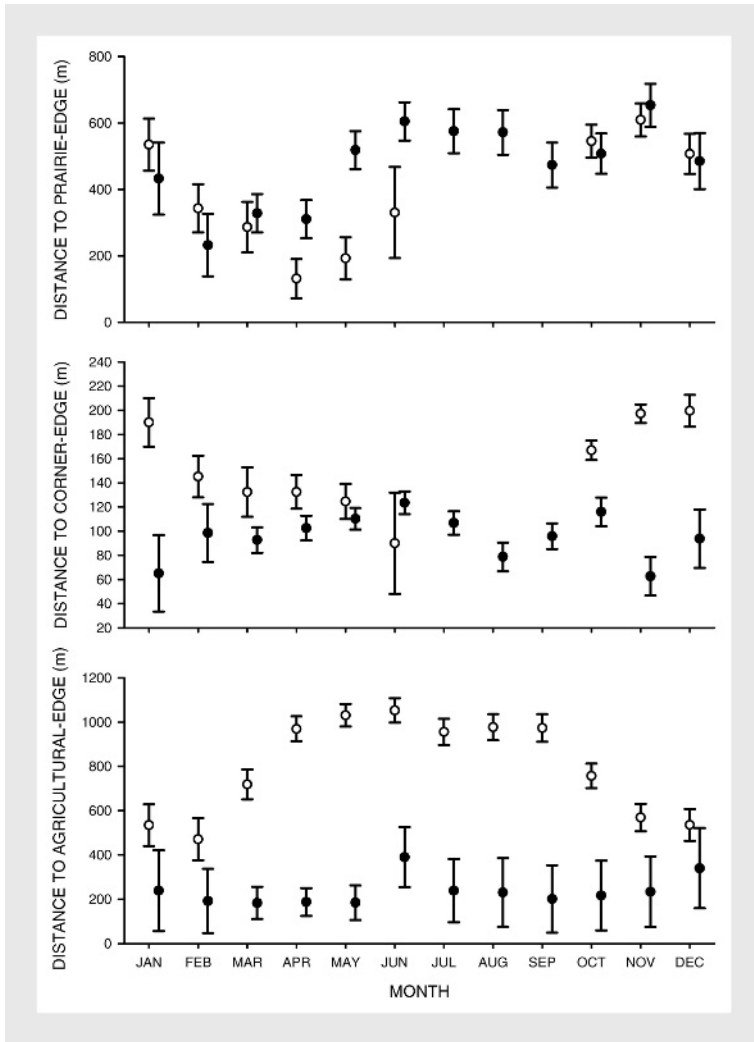| Habitat measurement	Lesser prairie-chicken		Ring-necked pheasant	
	$\bar{x}$	SE	$\bar{x}$	SE
Sagebrush cover (%)	11.9	2.0	24.0	3.3
Forb cover (%)	22.3	2.0	30.5	3.3
Grass cover (%)	45.0	2.7	27.6	4.5
Bare ground (%)	15.9	1.0	13.0	1.7
Visual obstruction (dm)	3.6	0.3	5.0	0.5

Figure 3. Distances ($\bar{x} \pm SE$) to prairie edge for lesser prairie-chickens (○) and ring-necked pheasants (●) within agricultural fields (A), to corner edge within agricultural fields (B), and to agricultural edge within native prairie (C) in Finney County, Kansas, during 1997-1998. Standard errors were derived from PROC GLM LSMEANS.

habitats (see Fig. 1). Clearly, the winter months when both species were foraging in grain fields provided the greatest opportunity for overlap in resource use. Some caution is needed interpreting our estimates of niche overlap. Because small sample sizes during winter (both individuals and locations per individual) may have skewed the estimates by some individuals having significantly more locations than other individuals. In turn, this may have introduced considerable uncertainty. However, the 95% confidence limits (see Fig. 2) enabled us to evaluate the limitations of the data for the months when such biases may have been present. It was evident that pheasants had an affinity for edge habitats, whereas the prairie-chickens were more closely tied to large blocks of native prairie. Although niche overlap does not directly

measure inter- or intraspecific competition (Abrams 1980), the extent of overlap in our study suggests that these species can coexist given the current habitat matrix. Alternatively, competition could have caused the patterns of spatial segregation we documented, and if suitable habitat becomes too limited this segregation may disintegrate as the more dominant exotic species displace the native lesser prairie-chicken. Remnant prairie habitats ($<$ 500 ha) in Illinois were small enough and so fragmented that pheasant interactions did negatively impact the greater prairie-chicken population (Westemeier et al. 1998a,b). Our data suggest that pheasants use edge disproportionately more so than lesser prairie-chickens, and as native habitat becomes limiting and edge increases, pheasants may have the competitive advantage. Because our study

area included > 2,400 ha of native prairie we hypothesize that such an area is large enough for the two species to coexist. Further work is needed to identify the threshold when native habitats become too small for prairie-chickens and pheasants to coexist.

Nest site selection by lesser prairie-chickens and pheasants indicated that these species used areas of different vegetation composition and structure when nesting. However, these characteristics were not exclusive because shrub cover and visual obstruction readings increased at prairie-chicken nests as available grass cover decreased (Pitman et al. 2005). Moreover, low rates (< 4%) of interspecific nest parasitism by pheasants in our study area on lesser prairie-chickens indicated some degree of spatial overlap and similar vegetative characteristics in nest site selection (Hagen et al. 2002, Pitman et al. 2006). The low rates of parasitism previously reported did not adversely affect hatchability or recruitment of prairie-chicken chicks (Hagen et al. 2002, Pitman et al. 2006).

Our study and other work (Hagen et al. 2002, Pitman et al. 2006) indicated that pheasants currently have no measurable effect on nesting and brood rearing habitat use or productivity of lesser prairie-chickens in southwestern Kansas. However, if additional habitat loss or fragmentation occurs, pheasants may gain a competitive advantage over lesser prairie-chickens (Hagen et al. 2002), with pheasants causing negative effects such as, nest site competition, nest parasitism and disease transmission (Kimmel 1988, Westemeier et al. 1998b). Although intensive harvests can control pheasant populations (Westemeier 1988) such methods may be too costly over the long term. There are multiple factors limiting small populations in fragmented landscapes and eliminating interspecific competition alone may not rescue a population from extirpation (Westemeier et al. 1998a). Thus, we recommend maintaining and conserving large blocks of native habitat as well as the connectivity between them as a management strategy (Hagen et al. 2004) for maintaining populations of both lesser prairie-chickens and pheasants.

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