Occurrence and relative abundance of white-tailed deer (*Odocoileus virginianus*) at Tallgrass Prairie National Preserve

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Summary

We conducted 32 deer spotlight surveys between November 2002 and August 2003 to address the lack of baseline data for the deer population. A total of 392 deer and 109 groups were recorded over the course of the study. Averages of 12.5 deer were observed for each census route conducted. Management implications and recommendations identify possible steps to manage the deer population at Tallgrass Prairie National Preserve. The outcomes of these censuses are an increased understanding of the number of deer at the preserve and a great opportunity to provide data for future population management.

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Introduction

In 1998 Congress passed the National Parks Omnibus Management Act in response to concerns about the condition of natural resources within the national parks. The act requires each park to gather baseline inventory data on pertinent natural resources, data that will provide a pivotal step toward establishing an effective monitoring program furthering the ability to effectively manage and protect park resources. The National Park Service (NPS) responded with the Natural Resource Challenge program, including the establishment of biome-based inventory and monitoring networks. The Heartland Network, as part of the NPS Inventory and Monitoring (I&M) program, has undertaken inventories of vascular plants and vertebrates within fifteen parks in eight Midwestern states.

At Tallgrass Prairie National Preserve, the population status of the white-tailed deer (*Odocoileus virginianus*) was unknown prior to this survey. Numerous research elsewhere has shown that high deer populations contribute to over-browsing of vegetation, which can lead to plant mortality, decreased plant reproduction, and may tend to favor less preferred species (McShea et al. 2003). This shift in species assemblages can reduce plant diversity on a local level and cause changes in the functioning of the prairie community. Adequate information regarding population status will enable land managers to conduct appropriate methods of control to ensure that vegetation in the park will not be negatively impacted and continuity of the prairie community is ensured.

Effective means of monitoring wildlife populations are critical to their management. Techniques that allow long-term analysis of population parameters such as density, distribution, and sex/age structure enable managers to identify population changes correlated with changing environmental conditions or human activities and to evaluate results of management actions (Lancia et al. 2000; Rabe et al. 2002).

Stemming from the Natural Resource Challenge and a concern regarding the status of deer populations at the park, a survey was deemed necessary to 1) establish a sampling method that could be used to monitor the white-tailed deer population at the park and 2) to establish baseline data on deer density, distribution, and population structure.

Study Area

Tallgrass Prairie National Preserve is located in the Flint Hills region of Kansas just north of Strong City (Figure 1). The preserve covers approximately 4,410.5 ha (10,894 ac) and is primarily tallgrass prairie with some riparian forest. The topographic features include numerous rolling hills with exposed ground surface rocks. Waterways include Fox and Palmer Creeks that dissect the preserve, other tributaries, and several small impoundments (stock ponds) scattered throughout. Rare, sensitive habitats include ponds, seeps and springs, and rock outcrops. Disturbed areas are many and include salt licks, ponds, pasture roads, and oil/gas sites.

One of the two purposes of Tallgrass Prairie National Preserve is to preserve, protect, and interpret for the public an example of a tallgrass prairie ecosystem on the Spring Hill Ranch, located in the Flint Hills of Kansas.

The Spring Hill Ranch, which forms the basis for Tallgrass Prairie National Preserve has been managed as a cattle operation since the 1880's. As the General Management Plan is implemented, the grazing regime will be altered, changing how the prairie is allowed to express itself.

Materials and Methods

Spotlight counts of deer (Progulske and Duerre 1964; McCullough 1982; Cypher 1991) were conducted on two consecutive nights, twice per season (November 2002-August 2003) along a set driving route of about 30.8 km (49.3 mi). The requirement to remain on established roads meant that parts of the route required backtracking, however, deer observations were only recorded on the initial pass on a section of road (Figure 2).

Use of roads for surveys is frequently criticized, as they are usually not distributed randomly with respect to available habitat types in the area of interest, and because roads themselves may impact distribution of animal populations (Buckland et al. 1993; Caughley and Sinclair 1994; Williams et al. 2002). Nevertheless, surveys were conducted along established roads on the preserve to facilitate repeatability of methods by other individuals in the future and to avoid damage to the prairie. The census route was established to cover as much of the preserve as possible and to represent habitats in approximate proportion to that found on the preserve.

On each of the two consecutive sampling nights, one 3-h spotlight survey was conducted beginning 30 min after sunset and one was conducted beginning 3.5 h before sunrise. A total of eight spotlight surveys were conducted for each of four seasons (Tables 1 & 2). Weather conditions were noted at the beginning of each survey. When an individual or group of deer was spotted, a common police whistle was used to deliver an attention-inducing sound in order to better view the tympanum of all deer present (Cypher 1991).

Group size, group composition (adult male, adult female, yearling, fawn), location, general habitat type, and activity (foraging, bedded, standing alert, fleeing, and sparring) were recorded. Location data of the observer was also recorded. Because we intended to use distance sampling methods to estimate deer density (Koenen et al. 2002), a rangefinder was used to estimate distance from the observer to the deer. However, the rangefinder was inconsistent in various light and weather conditions, therefore its use was discontinued. Locations of deer groups were then marked on topographic maps in a differentially corrected Garmin, Legend (E-trex series) global positioning system receiver and later converted to UTM coordinates (NAD83 14T). Perpendicular distance (meters) between deer locations and the survey route were measured in ArcView 3.3.

Distance sampling allows estimation of the density, and often abundance, of animals based on incomplete counts by estimating a declining function of detectability as distance from the observer increases (Buckland et al. 1993). Statistical models based on distance sampling require four assumptions: 1) that transect lines are distributed randomly, 2) that animals on the transect line are always detected, 3) that observers detect the animals in their initial location, before they have moved in response to the observer, and 4) perpendicular distances between the animals and the transect are measured accurately. Assumption 1 was addressed by attempting to use a census route that represented habitat types in approximate proportion to their occurrence on the preserve. Assumption 3 will be evaluated on the basis of activity of deer recorded when first observed, and assumptions 2 and 4 should be met with our methods.

The density of groups of deer and density of individual deer were then estimated for each season using DISTANCE (Thomas et al. 2003). Several models (half-normal, uniform, and hazard rate) were tested for each season. The best model for each season was then determined as that with the lowest corrected Akaike's Information Criterion (AICc) value. Differences in deer group size among seasons were tested using a Kruskal-Wallis test, adjusted for ties, because group size data were not normally distributed. However, because information on mean group sizes is, in most cases, more useful, means are also reported.

Results

In total, 32 censuses were conducted: eight per season, four per sampling trip (Tables 1 & 2, Figure 4). On four (12%) of the census runs, all pre-dawn, no deer were seen. Over all seasons, 392 deer in 109 groups were recorded. Of these, 15% were adult males, 40% were adult females, 25% were juveniles (< 1 year), and 20% were unknown age and sex. The low percentage of juveniles observed was a result of combining observations from all seasons. In spring, the previous years young were yearlings and were counted among adults. New fawns were probably not detected until late summer due to hiding/resting behavior. Between December and January, fawn to doe ratios ranged from 62.5:100 to 100:100.

Median group size of deer differed significantly among seasons ($H=8.79$, $df=3$, $P=0.032$). Group sizes were highest in winter and similar in all other seasons (Table 3).

Several different detectability models (half-normal, uniform, hazard rate) with cosine and hermite polynomial adjustments were conducted. Too few groups were observed in our study to permit analysis of density by season (distance analysis is most accurate with about 60-80 groups of animals observed), so data from all seasons were combined to estimate densities at the park. The hazard rate with cosine adjustment was the best model (lowest AICc value), but several other models also showed good fit and identical density estimates (Table 4). Effective strip width for the best model was 161 $\pm$ 138.3 m. Estimated density of deer groups along the census route over all seasons was 0.005 groups/ha. Estimated density of individual deer was 0.015 deer/ha. All deer observed during censuses were in or near riparian habitats (Figure 2), probably a result of the timing of censuses.

Discussion

When surveys were conducted, very little, if any, human activity occurred along most of the roads at night except the part of the survey route along State Highway 177.

Deer were most likely observed leaving or returning to the cover used during the day. Riparian habitat is limited on the preserve and made up a small proportion of the census route, which explains the low density estimates. While estimates of deer densities were low for the preserve overall, impacts of deer use of riparian zones should be monitored for potential negative effects with changes in deer density.

The method used in this report would be suitable for long-term monitoring of the year-round, average deer density on the preserve. The DISTANCE program can be downloaded off the Internet at no cost (Thomas et al. 2003). For accurate results, 60-80 observations are recommended for distance analysis. Based on the results of this study, the number of sampling periods (4 censuses each) would have to be more than doubled to obtain a suitable number of observations for separate density estimates by season. Depending on management needs, efforts could be focused on sampling in one season.

Conclusion

Management implications suggest that impacts of high deer density be watched in riparian vegetation, as these were the sites of highest deer use. Recommendations for management of deer on the basis of one year of census data and no direct vegetation measurements/impact studies would be unacceptable. However, evaluation of this census and analysis method for long-term monitoring is included and baseline data for future censuses has been established.

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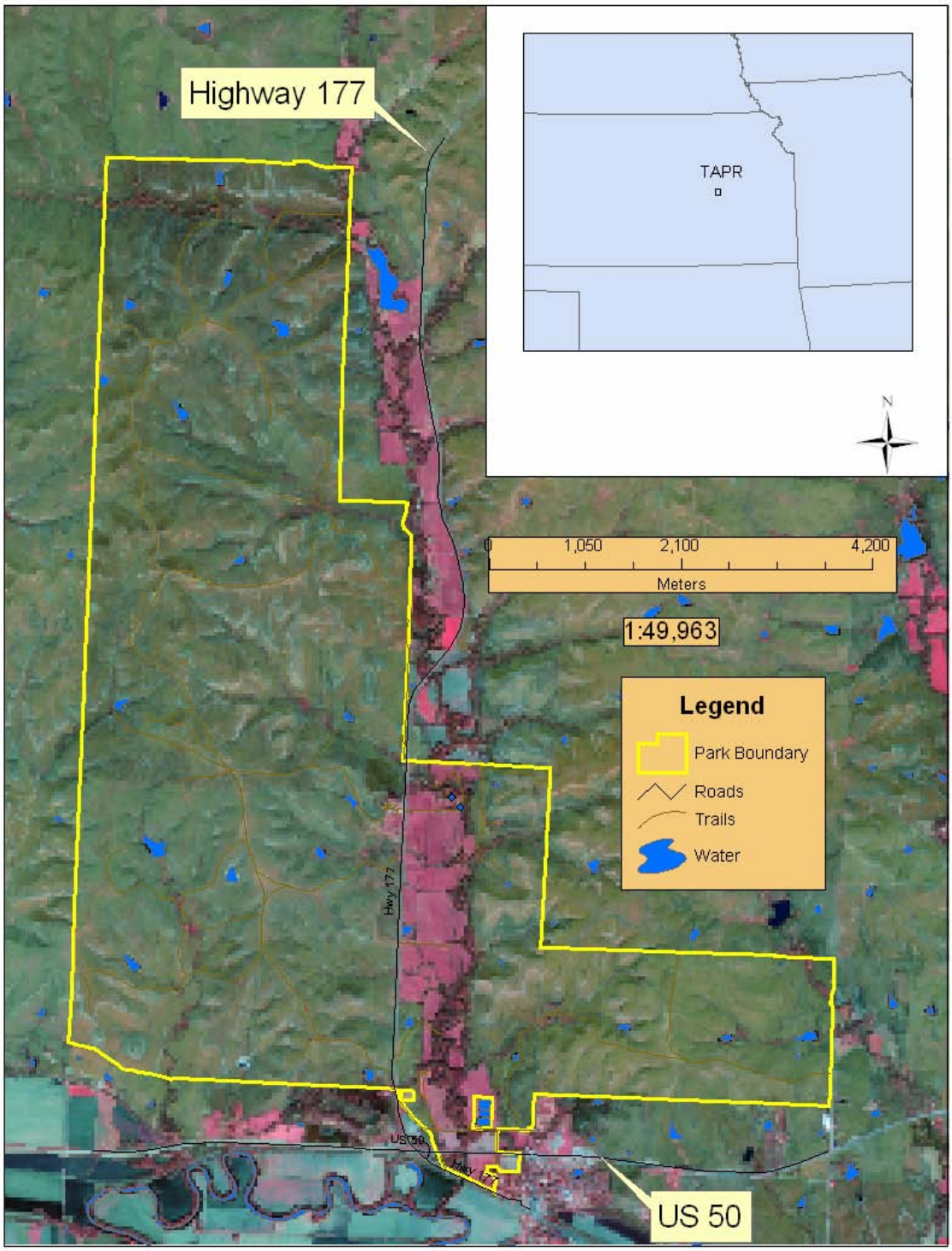

Figure 1. Location of Tallgrass Prairie National Preserve.

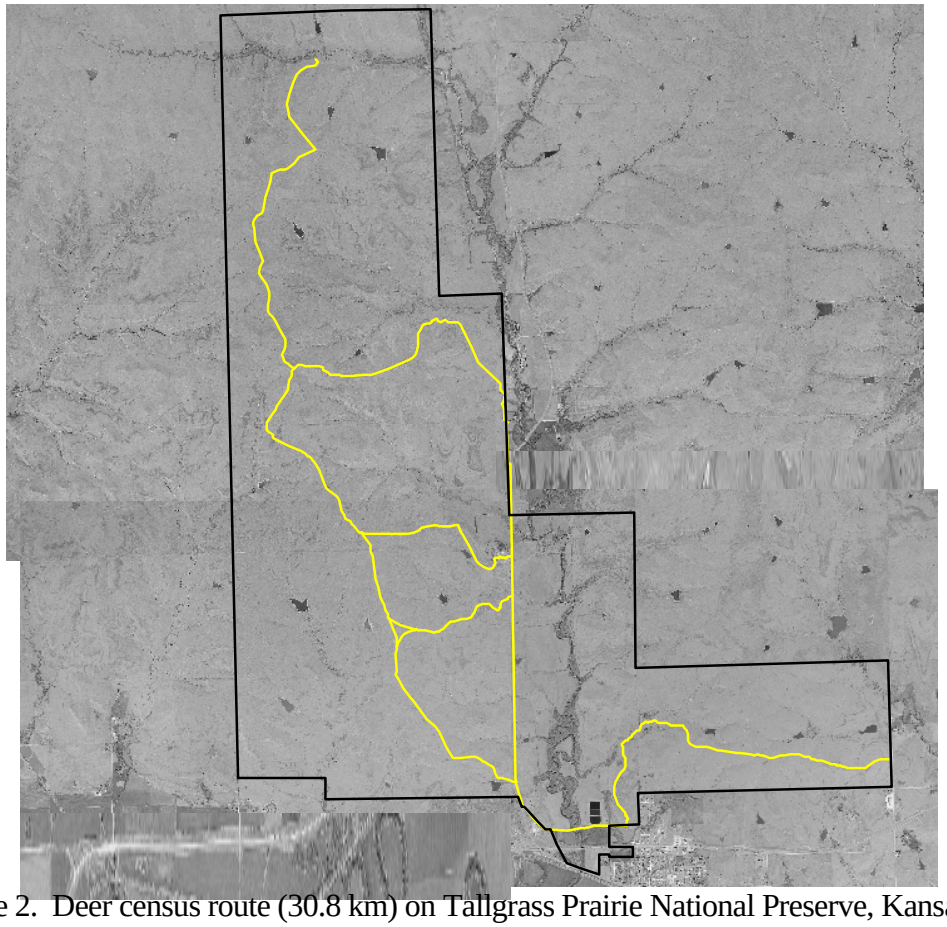

Figure 2. Deer census route (30.8 km) on Tallgrass Prairie National Preserve, Kansas.

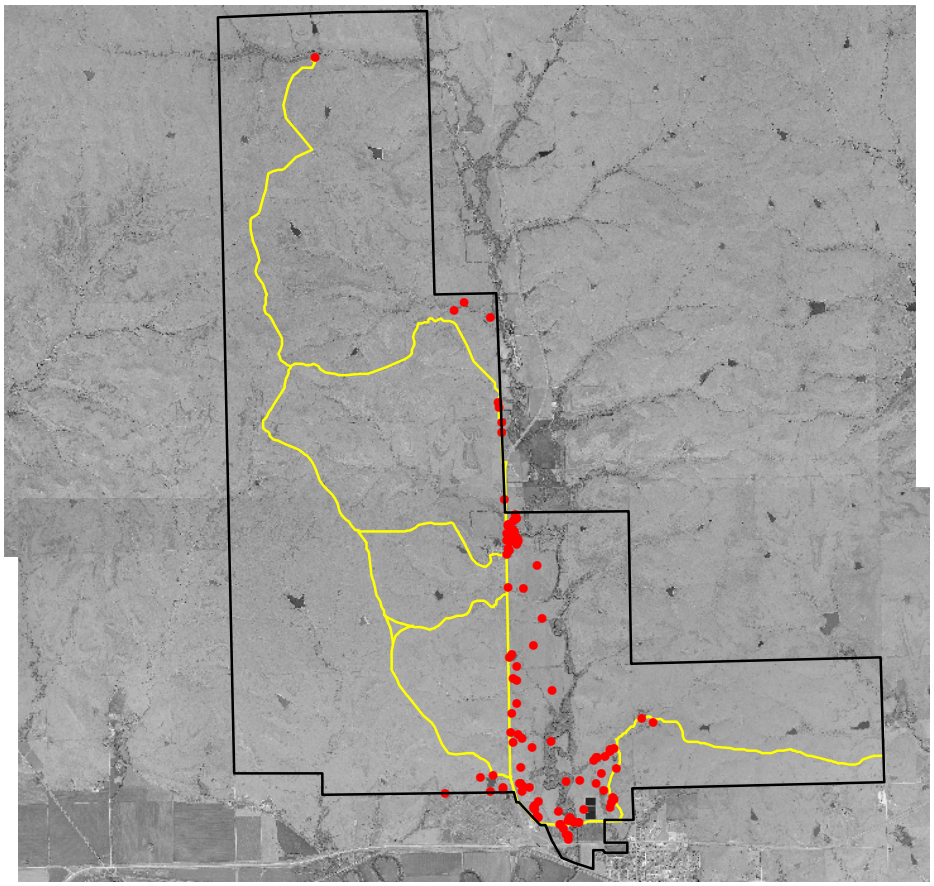

Figure 3. Location of deer groups, 2002-2003, on Tallgrass Prairie National Preserve, Kansas.

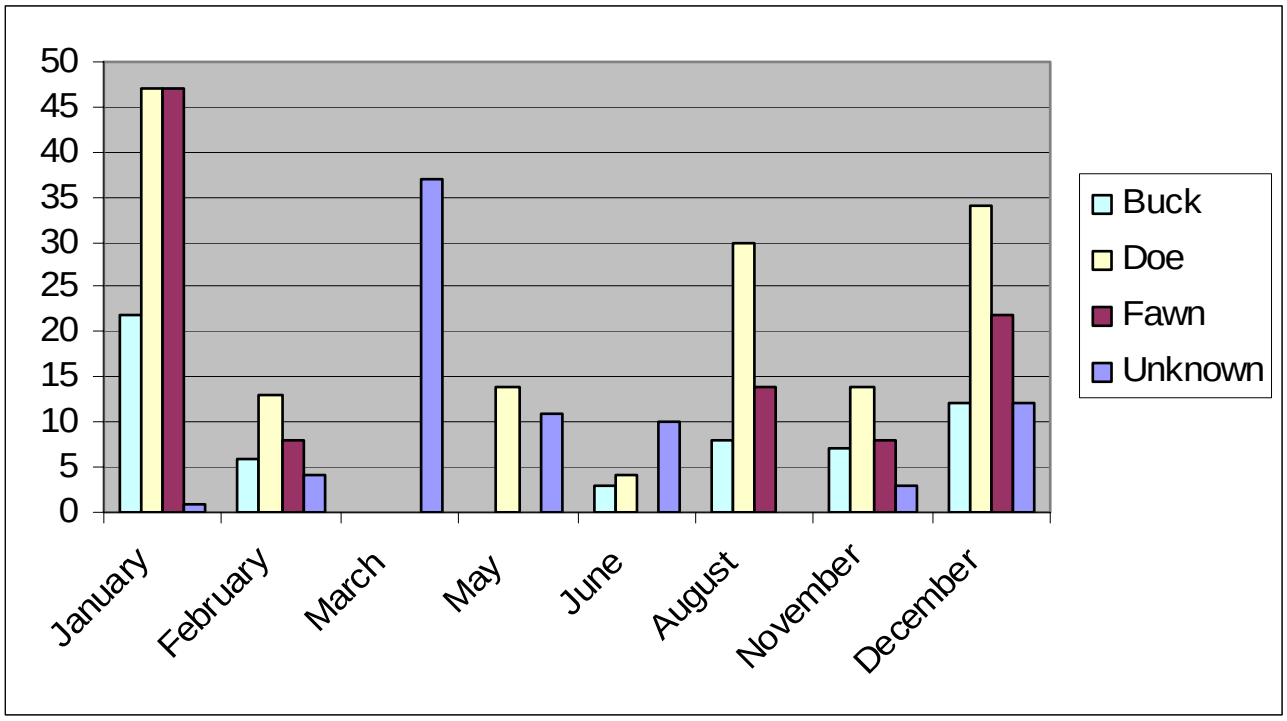

Figure 4. Number of deer observed by type and month at Tallgrass Prairie National Preserve.
Table 1. Number of deer observed by season at Tallgrass Prairie National Preserve.

Season	Month	Buck	Doe	Fawn	Unknown	Group Size
Winter	January	22	47	47	1	117
Winter	February	6	13	8	4	31
Spring	March	0	0	0	37	37
Spring	May	0	14	0	11	25
Summer	June	3	4	0	10	17
Summer	August	8	30	14	0	52
Fall	November	7	14	8	3	32
Fall	December	12	34	22	12	81

Table 2. Mean total number of deer and mean number of adult males, adult females, and juveniles (< 1 year) by sampling period at Tallgrass Prairie National Preserve, Kansas. Four censuses were run each sampling period, 2 after sunset and 2 before dawn. Number in parentheses is standard deviation.

Season	Date	Deer/Census	Male	Female	Juvenile	Unknown	M:F:J
Fall	8-10 Nov 02	8 (5.4)	1.8 (2.9)	3.5 (1.9)	2.0 (0.0)	0.8 (1.0)	51.4:100:57.1
	6-8 Dec 02	20.2 (13.6)	3.0 (2.2)	8.5 (5.1)	5.5 (4.2)	3.0 (4.1)	35.3:100:64.7
Winter	23-25 Jan 03	29.2 (19.7)	5.5 (6.6)	11.8 (8.8)	11.8 (6.8)	0.2 (0.5)	46.6:100:100
	14-16 Feb 03	7.8 (5.8)	1.5 (1.7)	3.2 (2.2)	2.0 (2.8)	1.0 (2.0)	46.9:100:62.5
Spring	22-24 March 03	9.2 (9.8)	0.0	0.0	0.0	9.2 (9.8)	*
	16-18 May 03	6.2 (5.8)	0.0	3.5 (5.2)	0.0	2.8 (2.5)	*
Summer	20-22 June 03	4.2 (4.6)	0.8 (1.5)	1.0 (0.8)	0.0	2.5 (3.8)	80:100:*
	12-14 Aug 03	13.0 (0.8)	2.0 (1.4)	7.5 (1.7)	3.5 (1.0)	0.0	26.7:100:46.7

Table 3. Mean group size of deer by season on Tallgrass Prairie National Preserve, Kansas, 2002-2003.

Season	**N Groups**	**Median Group Size**	**Mean Group Size**	**SE***
Fall	41	2.0	2.8	0.17
Winter	22	4.0	6.7	0.67
Spring	22	2.0	2.8	0.25
Summer	25	2.0	2.8	0.22

*Standard Error

Table 4. Models of individual deer density/ha (D) and deer group density/ha (DS) on Tallgrass Prairie National Preserve (all seasons combined).

					Individual				**Group**	
Model	**Adjust**	**AICc**	**GOF**	**D**	**SE**	**95% CI**		**DS**	**SE**	**95% CI**
Hazard rate	Cosine	1268.99	0.34	0.015	0.028	0.010, 0.022		0.005	0.0083	0.003, 0.007
Uniform	Cosine	1269.33	0.285	0.015	0.028	0.010, 0.023		0.005	0.0083	0.004, 0.007
Half-normal	Cosine	1269.91	0.52	0.015	0.027	0.010, 0.021		0.005	0.0078	0.003, 0.007
Hazard rate	hermite	1270.04	0.332	0.015	0.03	0.010, 0.023		0.005	0.0092	0.004, 0.008

Adjust = adjustments to the model, AICc = corrected Akaike's Information Criterion, GOF = χ^2 goodness of fit P-values, SE = standard error, CI = confidence interval. N = 110 groups of deer observed.