Infrared-triggered camera versus helicopter counts of white-tailed deer

Ben H. Koerth, C. David McKown, and James C. Kroll

Abstract We compared data from infrared-triggered cameras and replicated helicopter counts to estimate prehunt population size and sex and age ratios of white-tailed deer (*Odocoileus virginianus*) on La Copita Research Area, Texas. La Copita is an 1,103-ha area in south Texas with an open deer population of unknown size and composition. Number of fork-antlered bucks and total number of bucks estimated by the 2 techniques was similar. The camera technique estimated fewer does and fawns and thus a lower total population estimate than the helicopter survey. Fawn:doe ratios were similar and remained relatively stable after Day 3 of the camera census. Stocking rate of cattle at 10.1 and 12.6 ha/animal unit year precluded deer use of bait sites when cattle were present. Likewise, collared peccary (*Dicotyles tajacu*) precluded use by deer at some sites. At other sites, use by the 2 species was segregated in time. Although no tests for accuracy could be conducted, both techniques resulted in a reasonable population estimate for the area indicating the camera technique may be a viable option for counting deer in south Texas.

Key words aerial, census, helicopter, infrared-triggered camera, *Odocoileus virginianus*, white-tailed deer

Effective management of white-tailed deer (*Odocoileus virginianus*) populations often requires use of census methods to estimate population density. Density estimates, sex and age ratios, and number of antlered bucks, classified by age categories, can be used to set annual harvest quotas to meet management objectives. Numerous methods have been used to determine population characteristics with each having limitations and disadvantages (Jacobson et al. 1997).

Helicopter surveys are used commonly in Texas (DeYoung 1985) and have been considered the best technique to count deer in brushland habitats. Extensive research has focused on a technical solution to improve accuracy and precision of helicopter counts (Beasom et al. 1981, 1986; DeYoung 1985; Shupe and Beasom 1987). DeYoung et al. (1989) developed a correction factor that improved abundance estimates from aerial strip counts in south Texas brushland habitats.

Aerial surveys often are impractical for small landholdings or leases because of expense and scheduling limitations. Jacobson et al. (1997) described a new technique to census deer using infrared monitors that trigger automatic cameras. Their camera technique can be used on management units of any size. However, Jacobson et al.'s (1997) study was conducted in an area free of other large mammals that may be attracted to bait stations used with the cameras. In many areas, domestic cattle and goats, feral swine (*Sus scrofa*), collared peccary (*Dicotyles tajacu*) and free-ranging exotic animals also may be attracted to bait stations. Our purpose was to (1) compare density estimates and other population characteristics between the camera technique and replicated helicopter counts, and (2) determine feasibility of the Jacobson et al. (1997) camera technique considering interspecific interactions at bait stations.

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Study area and methods

The study was conducted on the Texas Agricultural Experiment Station's La Copita Research Area about 15 km southwest of Alice, Texas, in Jim Wells County. La Copita encompasses about 1,103 ha and lies in the transition zone between the South Texas Plains and the Gulf Prairies and Marshes vegetation regions (Gould 1975) of south Texas. The climate is subtropical with hot, humid summers and mild winters. Mean annual precipitation is 716 mm with maxima in May–June and September. Vegetation is a diverse mosaic ranging from open grassland to dense stands of brush (Scifres and Koerth 1987). Excluding residence, shop, livestock handling facilities and improved pastures, 1,055 ha were classified as deer habitat. At the time of the study, La Copita was grazed in a cow–calf operation with a 1-herd, 22-pasture, rotational grazing system. Two of the pastures, numbers 8 and 12, were grazed during the time period the cameras were in operation. Data from these 2 pastures were used to evaluate effects of cattle grazing on deer visitation of bait sites.

These 2 pastures were part of what was originally a 12-pasture cell grazing system with a common water source at the cell hub. Pastures in the cell system were separated by a 3-strand electric fence that restricted livestock but allowed free movement of deer.

During this study, stocking rate in Pasture 8 was 10.1 ha/animal unit year (auy) and 12.6 ha/auy in Pasture 12. Actual stock density during the study was 0.49 ha/cow in Pasture 8 and 0.85 ha/cow in Pasture 12.

The camera count was conducted from 8–19 October 1993 (12 days) following the method of Jacobson et al. (1997). Camera-station density (31 stations) was 1/32.5 ha. Stations were baited daily with a 1:1 (by volume) mixture of whole corn and soybeans.

The camera technique uses the number of fork-antlered bucks as the known factor from which other segments of the population are estimated. Individual fork-antlered bucks are identified based on antler configuration and body traits. Number of spike-antlered bucks is estimated from the spike:fork ratio. Estimated total buck population is the sum of fork- and spike-antlered bucks. Number of does is estimated from the doe:buck ratio, and number of fawns is estimated from the fawn:doe ratio. Estimated total population is the sum of each segment of the population (Jacobson et al. 1997).

Helicopter counts were conducted on the morning of 20 October and the morning and afternoon of 11 and 12 November 1993 for a total of 5 replications. East–west transects were flown to represent 50% coverage of the study area using strips 200 m wide. Strips were flown at about 56 km/hour at an altitude of about 15 m. All deer sighted were classified by sex and age, group size and occurrence in belts 0–20, >20–50 and >50–100 m from the flight line. Deer sighted beyond 100 m from the flight line were not included. To aid observers in estimating distances, the helicopter was flown over markers indicating the above intervals before initiation of each count and again at the midpoint of the survey. Because flush distances had to be estimated while the flight was in progress, the markers were useful for improving observer's distance estimation while airborne (DeYoung et al. 1989). This was considered a practical, although inexact, approach in the absence of measuring criteria (White et al. 1989).

Population estimates from aerial counts were corrected following DeYoung et al. (1989). Final estimates from the aerial surveys were calculated as a mean of the 5 replicates. Because this study was conducted on an open population of unknown size and composition, there was no reliable means of determining which technique was more accurate. Also, the population estimate derived from the camera technique was based on the cumulative result of the entire survey and had no variance. Therefore, descriptive statistics were used throughout to compare results.

Results and discussion

Population estimates, demographics

Total number of fork-antlered bucks was similar between the 2 techniques (Table 1). The number of bucks determined from the helicopter survey was an estimate mathematically corrected from actual observations. By contrast, the number determined from the camera technique was an absolute number of different fork-antlered bucks, counted from the photographic portfolio and based on observably different antler configurations. Therefore, the count of antlered bucks from the cameras should be considered a minimum estimate. Conceivably, unclear photographs or bucks with similar antler configuration could have caused different deer to be identified as the same individual. Therefore, for our analysis, only distinctly different deer were counted.

For the camera technique to be accurate, it is important all individuals of the known segment be represented in the sample. Cumulative catch rate indicated total number of fork-antlered bucks on the study area may not have been photographed because new individuals were identified through the last sampling day (Fig. 1). However, the curve may have been approaching asymptote as the addition of

Table 1. Number of deer by sex and age class, with ratios and density of white-tailed deer determined from replicated helicopter counts and infrared-triggered cameras on La Copita Research Area (Jim Wells Co., Tex.), 1993.

Variable	Helicopter		Camera
	Mean (n = 5)	Range	
Fork-antlered bucks	29	17–41	27
Spike-antlered bucks	13	0–32	19
Subtotal	42	17–56	46
Does	76	26–113	53
Fawns	54	17–101	38
Estimated total	172	60–258	137
Spike:fork	0.30	0–0.63	0.68
Doe:buck	1.81	1.0–2.52	1.14
Fawn:doe	0.71	0.46–0.96	0.71
Hectares/deer	6.1	4.1–17.6	7.7

new bucks over the last 4 days was 3, 3, 2, and 1, respectively. Also, we believed *a priori* that for the camera technique to be accepted as a management tool, time devoted to the camera count needed to have limits. The camera census by Jacobson et al. (1997) lasted 14 days. In their study, 100% and 82.3% of previously marked bucks were photographed in ≤10 days with a camera density of 1/65 ha in 1992 and 1993, respectively. Also, population estimates from their camera census were within the 95% confidence interval of the Lincoln-Peterson Index with the above recapture rates (Jacobson et al. 1997). With that information and a higher camera density in this study, we set the time limit at 12 days.

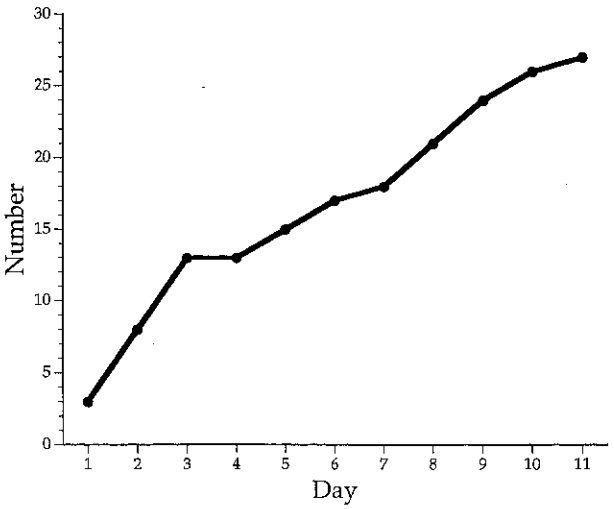


Fig. 1. Cumulative catch rate for fork-antlered bucks using infrared-triggered cameras on La Copita Research Area (Jim Wells Co., Tex.), October 1993.

Using the mean of the 5 aerial surveys, the final estimated buck population differed by only 4 individuals between the 2 techniques (Table 1). However, the range of estimates for both fork- and spike-antlered bucks varied widely in individual aerial counts.

The camera technique showed a higher spike:fork and lower doe:buck ratio than the helicopter survey (Table 1). The difference in the number of spikes and does from the helicopter survey could have been caused by a number of factors. Spikes could have been misclassified as does during the aerial count, thus raising the number of does and lowering the number of spikes. Downing et al. (1977) indicated <5% of marked yearling bucks were misclassified in their counts. However, in their flights, they scrutinized each deer with binoculars until they were reasonably sure of the correct classification. To minimize flight time and expense in most operational flights, unaided visual counts are the normal procedure. Careful observation by experienced observers is the only safeguard to misidentification.

Also, Jacobson et al. (1997) indicated there may be a sex and season bias in attracting animals to bait. Although this hypothesis could not be tested in our study, it warrants further investigation. If the bias is real, then its effect needs to be quantified to determine the optimum time to attract animals in proportion to their occurrence in the population. However, our use of the camera technique in October yielded results comparable to a locally accepted survey technique.

Similar to the other variables measured, fawn:doe ratios from individual aerial counts varied (Table 1). However, mean fawn:doe ratio from replicated aerial counts and the estimate from the camera technique were identical (Table 1). Fawn:doe and spike:fork ratios from the camera technique remained relatively stable after Day 3 (Fig. 2), indicating the possibility of attaining ratio estimates in a relatively short period. Jacobson et al. (1997) attained stable sex and age ratio estimates in 3–5 days. However, for an accurate population estimate at this time of year, it may be necessary to apply the camera technique for at least the amount of time used in this study. Jacobson et al. (1997) used a 14-day camera census resulting in a comparable estimate to mark-recapture estimates of population size.

Although different fork-antlered bucks were identified throughout the study, an increasing doe:buck ratio seemed to reflect an increase in proportion of does using the bait stations compared to bucks (Fig. 2). If the doe:buck ratio continued to increase, then a longer census period may have resulted in a higher estimate of the number of does and consequently the number of fawns. This would have brought the final

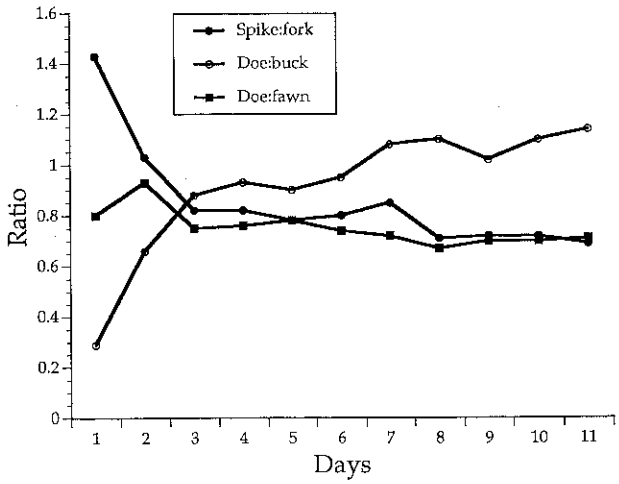


Fig. 2. Sex and age ratios of white-tailed deer by day from infrared-triggered cameras on La Copita Research Area (Jim Wells Co., Tex.), October 1993.

population estimate between the 2 techniques closer. Overall, the camera technique resulted in a lower estimate of does and fawns and a lower total population than the corrected estimate from the helicopter survey (Table 1). However, both techniques resulted in a population estimate within reasonable levels for the area based on density estimates from previous years (McKown 1993). Also, all camera estimates fell within the range of estimates from individual aerial counts, with the exception of spike:fork ratio.

Deer–cattle interactions

Cattle dramatically influenced use of bait sites by deer (Fig. 3). In Pasture 12, where cattle were present at the initiation of the study, a mean of 17.3 cows per day and no deer were photographed (Fig. 3A). On Day 6, cattle were moved to another pasture not containing camera stations. By Day 8 deer began using the bait stations in the vacated pasture.

In Pasture 8, a mean of 6.5 deer per day were photographed prior to cattle occupancy (Fig. 3B). When the cattle were moved in on Day 10, deer use of bait sites in that pasture went to zero. This result was consistent with Cohen et al. (1989) who reported deer avoided cattle concentrations in a rotational grazing system, stocked at 2.8 ha/auy, by alternating use between preferred habitats. Likewise, Loft et al. (1991) found female mule deer (*O. hemionus*) shifted use away from habitats preferred by cattle by increasing use of areas avoided by cattle.

Deer–collared peccary interactions

Collared peccary influenced deer use of bait sites, but not to the extent of cattle. Five of 31 bait sites were used exclusively by peccaries although deer had access to these sites. Use by peccaries on these sites apparently was above the threshold necessary to exclude deer use. Peccaries would sometimes bed at the bait site. Zaiglin and DeYoung (1989) reported a single peccary at a feed station would repel use by deer in most cases.

Another 5 stations were used by both deer and peccaries, but use of those sites was segregated in time (Fig. 4). In our study, deer and peccaries were not photographed together on the same bait sites. On the 5 common use sites, peak use by peccaries varied throughout the diurnal period, while deer use peaked during crepuscular periods with minor feeding periods at times when peccaries were not present (Fig. 4).

Management considerations

Large mammals attracted to bait sites used with the cameras can influence use by deer, although it is unclear if this negatively affects viability of the camera technique. Comparable results were obtained from the camera census and replicated helicopter counts in this study although deer use of some sites was influenced by cattle and peccaries. In areas where

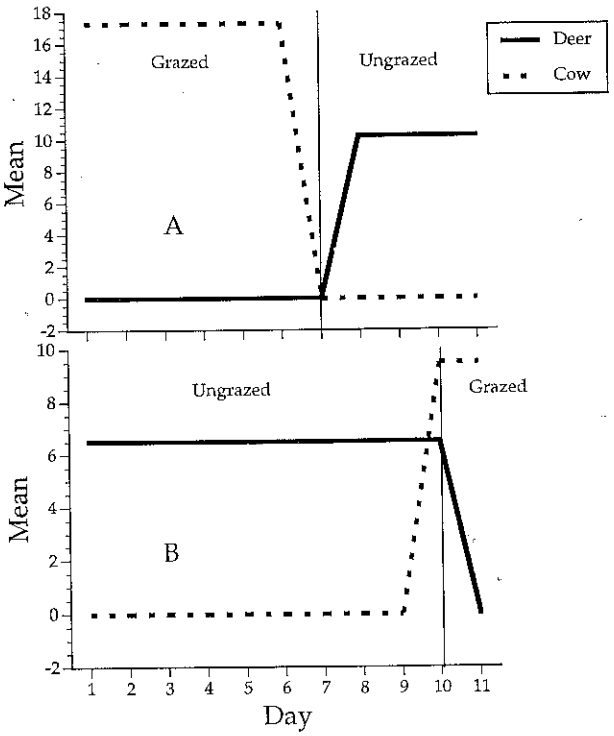


Fig. 3. Mean number of cow and deer photographs per day from infrared-triggered cameras before and after grazing in 2 pastures on La Copita Research Area (Jim Wells Co., Tex.), October 1993.

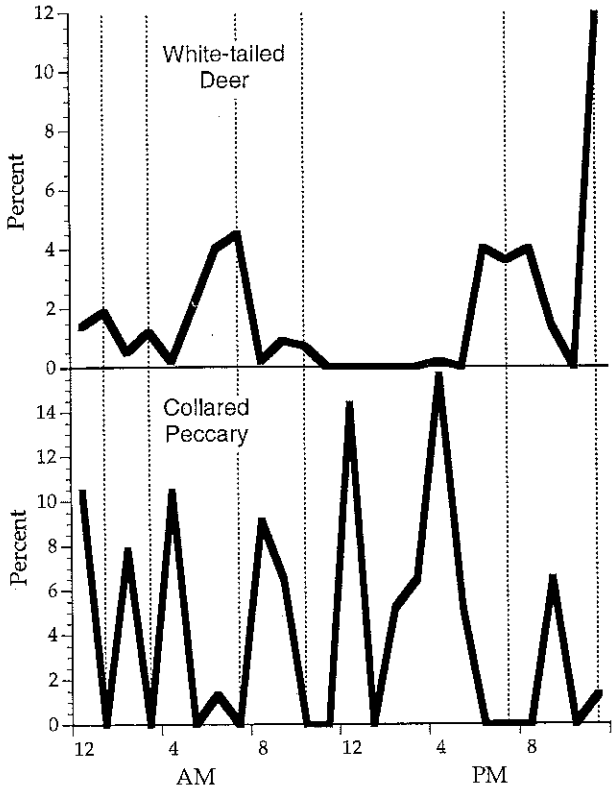


Fig. 4. Percent of total 24-hour time of photographs taken by infrared-triggered cameras of collared peccary and white-tailed deer at 5 bait sites used by both species on La Copita Research Area (Jim Wells Co., Tex.), October 1993.

stocking density of cattle is lower than experienced in this study, cattle may have little influence. Deer avoid social interaction with cattle in systems that concentrate grazing (McMahan 1966, Kramer 1973, Cohen et al. 1989, Loft et al. 1991). However, the threshold level of cattle density that significantly affects deer use is unknown.

If cattle are creating intolerable social interactions, a practical solution would be to exclude use by cattle in the immediate vicinity of the camera stations. A short-fence exclosure around bait sites or feeder stations would exclude use by cattle yet allow access by deer. This also would remedy interference by collared peccaries and feral swine. However, this would not exclude goats or exotic deer that may similarly influence white-tailed deer use.

Cost of a camera census depends on purchase price of equipment, its life span, and cost of film and processing. Jacobson et al. (1997), assuming equipment cost at $400 per unit and a life expectancy of 5 years, estimated cost of a 14-day census with a camera density of 1/65 ha at $1.29/ha/year. In this study, a 12-day census at a camera density of 1/32.5 ha cost $2.45/ha. In contrast, replicated helicopter surveys as we conducted cost $1.42/ha not including travel costs. To be cost effective, a lower camera density and longer census length similar to Jacobson et al. (1997) may be necessary. Costs could be further reduced by using lower camera densities and short census lengths (3–5 days) to determine ratios and average quality of animals without estimating total population size.

Another intangible but important value of the camera technique is the marketing and advertising potential of the photograph portfolio. Being able to confirm the quality of animals available is important in operations that charge for hunting, photography, or observation (Koerth 1996).

An aerial survey in this study took about 45 minutes each. In contrast, the camera technique consumed from 4 to 5 hours per day. Road accessibility and camera placement near points of vehicular access largely determines amount of time necessary. Camera stations must be serviced regularly to avoid running out of film or loss of operation through depletion of batteries (Kucera and Barrett 1993). However, camera stations can be serviced at any time of the day, whereas aerial surveys must be conducted by daylight.

Jacobson et al. (1997) found that the post-rut period before antler casting (February) was the most successful time to estimate deer populations with the camera technique, when compared to counts in September. Similarly, Beasom (1979) found that spring helicopter counts in south Texas were more precise than fall counts. However, ranch operational counts normally are conducted to estimate net current year productivity and population size, and to establish harvest quotas for the coming season. In this respect, population estimates before hunting season may be required. Results from this study indicated that use of the camera technique in October provided population and ratio estimates similar to replicated aerial counts.

The wide variation in all variables from individual aerial counts makes it unlikely that a single helicopter survey would provide an accurate population or sex and age estimate. Scheduling helicopter service for repeated counts may be problematic and still not provide the desired accuracy. Our study indicates the camera technique may be a viable option for estimating deer populations and herd demographics in southern Texas, particularly for small landholders whose investment in the necessary camera and monitor equipment would be minimal.

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Literature cited

Beasom, S. L. 1979. Precision in helicopter censusing of white-tailed deer. J. Wildl. Manage. 43:777–780.

Beasom, S. L., J. C. Hood, and J. R. Cain. 1981. The effect of strip width on helicopter censusing of deer. J. Range Manage. 34:36–37.

Beasom, S. L., F. G. Leon III, and D. R. Synatzske. 1986. Accuracy and precision of counting white-tailed deer with helicopters at different sampling intensities. Wildl. Soc. Bull. 14:364–368.

Cohen, W. E., D. L. Drawe, F. C. Bryant, and L. C. Bradley. 1989. Observations on white-tailed deer and habitat response to livestock grazing in south Texas. J. Range Manage. 42:361–365.

DeYoung, C. A. 1985. Accuracy of helicopter surveys of deer in south Texas. Wildl. Soc. Bull. 13:146–149.

DeYoung, C. A., F. S. Guthery, S. L. Beasom, S. P. Coughlin, and J. R. Heffelfinger. 1989. Improving estimates of white-tailed deer abundance from helicopter surveys. Wildl. Soc. Bull. 17: 275–279.

Downing, R. L., E. D. Michael, and R. J. Poux, Jr. 1977. Accuracy of sex and age ratio counts of white-tailed deer. J. Wildl. Manage. 41:709–714.

Gould, F. W. 1975. Texas plants: a checklist and ecological summary. Tex. Agric. Exp. Stn. MP-585/Revised.

Jacobson, H. J., J. C. Kroll, R. W. Browning, B. H. Koerth, and M. H. Conway. 1997. Infrared-triggered cameras for censusing white-tailed deer. Wildl. Soc. Bull. 25:547–556.

Koerth, B. H. 1996. Picture your deer. Hunting Leases Mag., Fall-Winter:3–6.

Kramer, A. 1973. Interspecific behavior and dispersion of two sympatric deer species. J. Wildl. Manage. 37:288–300.

Kucera, T. E., and R. H. Barrett. 1993. The Trailmaster® camera system for detecting wildlife. Wildl. Soc. Bull. 21:505–508.

Loft, E. R., J. W. Menke, and J. G. Kie. 1991. Habitat shifts by mule deer: the influence of cattle grazing. J. Wildl. Manage. 55: 16–26.

McKown, C. D. 1993. White-tailed deer harvest summary (10 years). Pages 14–16 *in* J. W. Stuth, ed. La Copita Research Area: 1992 consolidated progress report. Tex. Agric. Exp. Stn. CPR-5047.

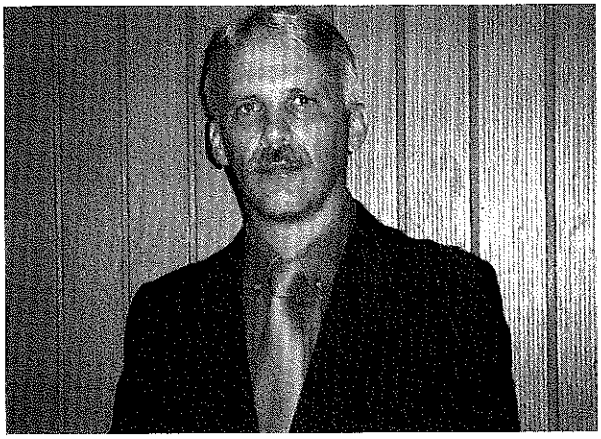
McMahan, C. A. 1966. Suitability of grazing enclosures for deer and wildlife research on the Kerr Wildlife Management Area, Texas. J. Wildl. Manage. 30:151–163.

Scifres, C. J., and B. H. Koerth. 1987. Climate, soils, and vegetation of the La Copita Research Area. Tex. Agric. Exp. Stn. MP-1626.

Shupe, T. E., and S. L. Beasom. 1987. Speed and altitude influences on helicopter surveys of mammals in brushland. Wildl. Soc. Bull. 15:552–555.

White, G. C., R. M. Bartmann, L. H. Carpenter, and R. A. Garrott. 1989. Evaluation of aerial line transects for estimating mule deer densities. J. Wildl. Manage. 53:625–635.

Zaiglin, R. E., and C. A. DeYoung. 1989. Supplemental feeding of free-ranging deer in south Texas. Tex. J. Agric. and Nat. Resour. 3:39–41.



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