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Bait type and timing for deer counts using cameras triggered by infrared monitors

Ben H. Koerth and James C. Kroll

Abstract The use of remote photography in wildlife research is increasing and studies are needed to clarify the best use of techniques. We used cameras triggered by infrared monitors to determine the best of 4 commonly used baits to attract white-tailed deer (*Odocoileus virginianus*) and the time of year yielding the most precise estimates of sex and age ratios. We conducted our study on the Qué Pasa Ranch in an 890-ha portion enclosed by a 2.4-m-high fence. Five replicates of covered trough feeders provided shelled corn, protein pellets, mineral, and salt *ad libitum*. Use of corn feeders was greater ($F_{3,6} = 36.33$, $P \leq 0.001$) than use of other bait types for all sex and age classes of deer. Fawn:doe ratios were least variable during February, March, and September. Buck:doe ratios were least variable during May, June, and October. No single month provided best estimates of sex or age ratios. A multi-stage survey may be necessary to reliably estimate sex and age ratios.

Key words age ratio, bait, cameras, infrared monitors, *Odocoileus virginianus*, sex ratio, Texas, timing, white-tailed deer

Managers must estimate sex and age ratios to effectively manage white-tailed deer (*Odocoileus virginianus*). Unfortunately, the secretive nature of deer often introduces bias in data derived from field observations (Downing et al. 1977). Jacobson et al. (1997) introduced a technique to census deer populations using cameras triggered by infrared monitors. This technique relies on photographic documentation of deer attracted to bait sites and does not require continuous presence of human observers, which may affect deer behavior.

Jacobson et al. (1997) demonstrated that the camera technique could provide reliable estimates of deer population size. Likewise, Koerth et al. (1997) found that the camera technique could provide precise estimates of sex and age ratios in one week or less. However, both studies indicated possible sex and seasonal biases in attracting deer to bait in proportion to their occurrence in the population. The most attractive bait and optimum time of year to operate cameras for deer surveys are unknown. Thus, our objectives were to assess the attractiveness of 4 baits and the monthly use of bait stations to determine which time periods yielded the most precise estimates of sex and age ratios for white-tailed deer.

Study area and methods

We conducted our study on the Qué Pasa Ranch, about 5 km northeast of Navasota, Texas, in Grimes County. Qué Pasa, a privately owned ranch, was located in the Post Oak Savannah vegetation region (Gould 1975) of central Texas. We conducted the study on the 890-ha portion of the ranch enclosed by a 2.4-m netwire fence. Prior to our study, 33 bucks and 22 does were released from scientific breeding facilities into the fenced portion of the ranch to enhance the native deer population. No releases into the population were made during the

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study. Therefore, deer numbers within sex and age classes could change only through birth or mortality of resident animals.

We began the study by installing 5 replicates of feeders in December 1994. Each replicate consisted of 3 wooden trough feeders erected around existing metal trough feeders used by the ranch to supplementally feed deer. Wooden feeders were covered by a corrugated metal roof to protect contents from weather. Metal feeders used the storage bin above the trough to protect the feed. All feeders were constructed so that the feeding platform was about 68 cm above ground. Each replicate of feeders consisted of one corn, one protein pellet, one salt, and one mineral feeder. Metal feeders supplied corn. Remaining bait types were assigned randomly to wooden feeders within each replicate. Each feeder within a replicate was 100–130 m from the next nearest feeder. Each replicate of feeders was >500 m apart.

Corn feeders provided whole, shelled corn. Pellets were a commercially prepared 16% protein ration (Deer Pellet, Producer's Coop, Bryan, Tex.). Salt was a granular livestock salt (Farm and Ranch Stock Salt, Morton Salt Co., Chicago, Ill.) and mineral stations provided a granular mineral supplement (Kal-Phos 12-12 mineral supplement, Texas Farm Products Co., Nacogdoches, Tex.). All feeders provided contents *ad libitum*. Bait types chosen for this study were not intended to be all-inclusive. However, they were typical of the types encountered normally in Texas where baiting is commonly used to attract deer.

We assumed that no bias existed in selection of feeder types by deer. Prior to the study, adult deer were accustomed to feeding from trough feeders. Before installing camera systems, we allowed deer ≥9 months to become accustomed to the presence and use of wooden feeders. Visual observations indicated that deer readily used both types.

Camera systems installed at each feeder consisted of a TrailMaster® TM 1500 active infrared monitor and a TM 35-1 camera kit (Goodson & Associates, Inc., Lenexa, Kans.). We positioned the transmitter and receiver so that the infrared beam was directed parallel to the ground and across the area in use by an animal feeding from the trough. We positioned cameras to photograph the animal(s) at the feeder when the infrared beam was interrupted. Sensitivity of the TM 1500 was set at the manufacturer's recommendation of 5 for deer, with a photographic delay interval of 4 minutes. This delay helped avoid consecutive photographs of the same individuals while minimizing the risk of missing animals. Previous research has shown that deer feed at trough feeders from a mean of 2.6 (Zaiglin and DeYoung 1989) to 10 minutes (Kozicky 1997).

We installed camera systems in September 1995. Although cameras were operating at installation, data acquisition began 1 October 1995 to allow animals to become accustomed to presence of the camera and monitor units. All units were checked and feeders filled as necessary on a twice-weekly basis until the end of September 1996.

We used only data from photographs because of the great use of feeders by nontarget animals. Although the TM 1500 records number, date, and time of events, interruption of the beam by nontarget animals could cause erroneous conclusions from monitor data alone. Also, no sex and age information was gained from monitor data. Data recorded from photographs included feeder number, date, time, and number of does, fawns, bucks, and unknown deer in each photograph. We classified fawns as animals born during 1995. We classified those surviving to 1 April 1996 as adults. Fawn classification then became animals born during 1996.

To determine the bait type most effective to attract deer, we analyzed number of deer by sex and age counted from photographs at each bait type using analysis of variance (ANOVA) with bait type and deer type (buck, doe, or fawn) as main effects. Because the interaction term was significant ($P < 0.05$), we conducted Tukey's studentized range test on the concatenation of the main effects to separate significant ($P < 0.05$) differences among means. Correctly identifying all classes of deer throughout the year was critical to this analysis. Jacobson et al. (1997) determined that experienced observers varied little in estimates of number of individual deer and for sex and age ratios. In our study, a single experienced observer analyzed all photographs. Though marked deer to test accuracy of sex and age determinations were unavailable, we feel confident of correct assessments.

To determine when different bait types were most attractive, we analyzed total number of deer each month at each bait type by repeated measures ANOVA with bait type and month as main effects. The interaction term was not significant ($P > 0.05$). We used Tukey's studentized range test on the concatenation of the main effects to separate significant ($P < 0.05$) differences among means.

To determine when camera data provided the most precise estimates of sex and age ratios, we divided months into 4 weekly time periods. We evaluated precision using coefficient of variation (CV) to measure variability of sex and age ratios determined from the photographs using weeks within months as replications. We considered precise estimates to be those having the least variation, thus least CV, among weekly estimates within a month.

Table 1. Mean number and standard error (SE) of white-tailed deer by sex and age photographed at different bait types (n=5 replications/bait type) with cameras triggered by infrared monitors on Qué Pasa Ranch in central Texas from October 1995 through September 1996.

	Corn		Pellet		Mineral		Salt	
Class	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Buck[a]	88.8a	11.91	8.8c	1.59	0.1d	0.09	0.7d	0.22
Doe[a]	38.4b	5.74	11.8c	3.13	1.3d	0.35	0.6d	0.19
Fawn[a]	14.2c	2.87	1.9d	0.73	0.2d	0.12	0.1d	0.07

[a] Means followed by the same letter are not different at $P < 0.05$.

Results

Bait attractiveness

We recorded 6,860 photographs of deer (2,903 does, 956 fawns, and 5,771 bucks). We found differences ($F_{3,6}$=36.33, $P \leq 0.001$) in use of bait types by deer type (buck, doe, fawn), with corn feeders receiving the greatest use (Table 1). Protein pellet feeders received the next greatest visitation rate, with salt and mineral feeders receiving light use. However, all feeders received some deer activity.

For bucks, use of corn feeders differed ($P<0.05$) from other bait types (Table 1). Protein pellets received the next greatest use. Use of pellet feeders by bucks differed ($P<0.05$) from corn feeders and from salt or mineral feeders. Use of salt and mineral feeders by bucks did not differ ($P>0.05$). In the same pattern, use of corn feeders by does was greater ($P<0.05$) than for the other bait types. Protein pellets received the next greatest use, whereas mineral feeder use by does did not differ ($P>0.05$) from salt feeder use. Likewise, corn feeders received more ($P<0.05$) use by fawns. However, we found no differences ($P>0.05$) in use of pellet, mineral, or salt feeders by fawns.

Deer use of the different bait types was not consistent ($F_{3,28}=33.18_{(\text{bait type})}$, $P \leq 0.001$; $F_{11,28}=3.53_{(\text{month})}$, $P \leq 0.001$) throughout the year (Table 2). Use of corn feeders was greatest during late winter and summer through early fall. We noted a marked decline in use of corn and pellet feeders during April coinciding with normal greenup of native vegetation and planted forage crops. Deer also reduced their use of corn feeders during November and December, coinciding with availability of oak (*Quercus* spp.) mast. Use of pellet feeders did not differ ($P>0.05$) among months. Mean use of pellet feeders peaked in June. However, great variability in use of individual feeders likely caused a lack of statistical differences ($P>0.05$) among months. Deer use of mineral and salt feeders appeared to vary by month. However, use remained low in all months and we found no differences ($P>0.05$) among months.

Table 2. Mean number and standard error (SE) of white-tailed deer photographed at 4 bait types (n = 5 replications/bait type) by month with cameras triggered by infrared monitors on Qué Pasa Ranch in central Texas from October 1995 through September 1996.

	Corn[a]		Pellet[a]		Mineral[a]		Salt[a]	
Month	Mean	SE	Mean	SE	Mean	SE	Mean	SE
October	156.2bc	40.19	16.6c	8.98	0.7c	0.38	1.1c	0.61
November	35.4c	14.86	11.2c	5.74	0.3c	0.18	0.7c	0.38
December	82.2bc	49.68	22.2c	20.21	0.3c	0.18	0.8c	0.18
January	138.8bc	62.66	15.4c	6.34	0.3c	0.18	0.5c	0.22
February	202.0ab	69.98	10.0c	6.71	0.1c	0.01	0.8c	0.35
March	120.0bc	25.66	3.2c	2.26	0.1c	0.01	0.1c	0.01
April	75.0c	30.27	0.6c	0.59	0.1c	0.01	0.1c	0.01
May	362.2a	55.37	16.8c	14.86	0.3c	0.18	0.7c	0.38
June	198.4ab	49.17	58.0c	24.41	0.3c	0.18	0.3c	0.18
July	149.0bc	22.83	37.0c	14.67	1.3c	0.077	0.9c	0.56
August	234.8ab	57.56	18.2c	8.57	0.3c	0.18	1.8c	0.95
September	180.8ab	34.98	18.6c	12.26	0.9c	0.078	1.2c	0.75

[a] Means followed by the same letter do not differ at $P < 0.05$.

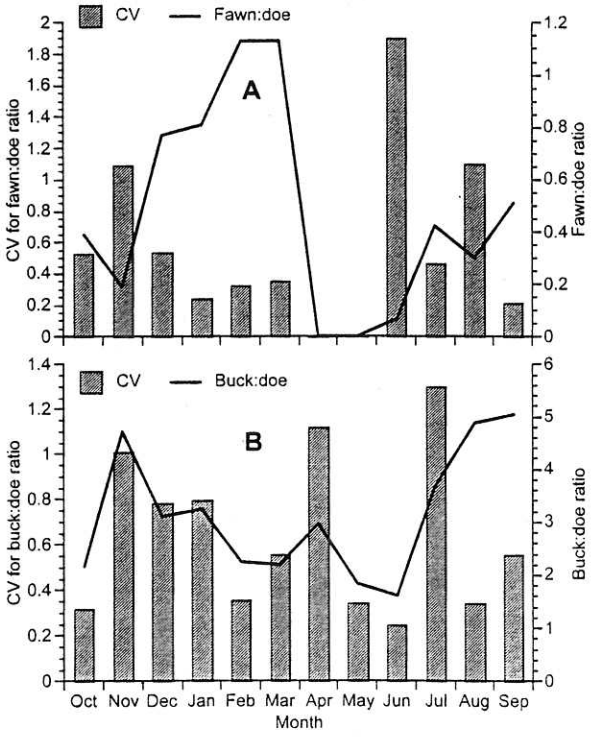


Figure 1. White-tailed deer sex and age ratios (right axis) and coefficients of variation (CV) of ratios (left axis) determined from photographs ($n = 4$ weeks/month) from cameras triggered by infrared monitors at corn feeders on Qué Pasa Ranch in central Texas from October 1995 through September 1996.

Timing of camera counts

Assuming that the bait type receiving the greatest use by all sex and age classes would give the best estimate of numbers and ratios, corn was the best bait tested. The small number of photographs obtained from the other baits makes it unlikely an accurate survey could be conducted. Therefore, we limited analyses on timing and precision of camera counts to corn feeder data.

Concern about bias in estimating sex and age ratios from camera counts was warranted because a wide variation in sex and age ratios existed among months (Figure 1). Coefficients of variation for fawn:doe ratios were least in January, February, and March (Figure 1). Small CV values indicate that weekly camera counts within those months were relatively consistent. A large fawn:doe ratio and small CV (Figure 1) and great use of corn feeders (Table 2) in February suggests this may be a good month to estimate age ratios. We obtained smallest buck:doe ratios during May, June, and October (Figure 1). These 3 months also had relatively small CV values, indicating precise estimates for those months.

Discussion

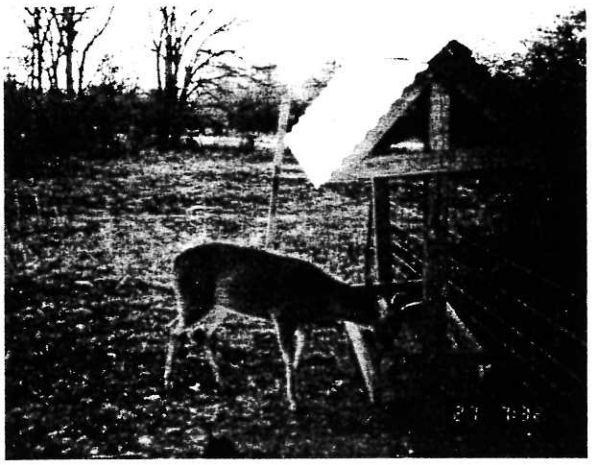
Bait attractiveness

Corn is very attractive to deer (Kozicky 1997). Thus, corn often is used to attract and acclimate deer to feeders prior to use of other feeds of greater nutritional quality (Varner 1996, Kozicky 1997). This study demonstrated that corn was the best attractant of the baits used. Although protein pellets were used readily by deer, corn was used more consistently and provided a larger sample size of photographs on which to base judgments about characteristics of the deer herd. Our results agree with Henke (1997) that corn feeders often result in multiple feeding events by deer on a daily basis.

Low use of salt and mineral feeders suggests their use is unwarranted to attract deer to bait stations in central Texas. Other researchers have found salt or natural mineral licks to be attractive to deer at certain times (Wiles and Weeks 1986, Morgan and Dusek 1992). However, deer use of natural licks (Wiles and Weeks 1986) was considerably less than deer use of corn feeders experienced in this study. Although does apparently used mineral feeders slightly more than bucks, the reason is not clear. A subjective explanation could be a perceived dietary choice by the animals. Possibly demands of pregnancy and lactation caused at least some does to supplement their diet with a greater mineral intake than that found in the commercial pellet ration.

Timing of camera counts

We estimated 2 different fawn crops, which may explain inconsistencies in the beginning and ending estimates of fawn:doe ratios. A notable dip in the fawn:doe ratio occurred during November, the beginning of the breeding season and general hunting season. Fawns learn to visit feeders by following their dams. Loss of a maternal figure after legal harvest or through aggressive behavior by bucks courting does (Marchinton and Hirth 1984) may have caused fawns to adjust their movement patterns until they learned to negotiate paths to feeding areas. Fawn:doe ratios appeared to follow a logical trend of increasing number of fawns from time of birth until the end of March, when they were classified as adults. Fawns were not observed in the photographs until June, although visual observations indicated that peak fawning occurred in late May. A lag time exists between parturition and the time when fawn and dam movements coincide (Marchinton and Hirth 1984). High fawn:doe ratios



Wooden trough feeder used as a photographic station for camera surveys of deer.

estimated for February and March reflected the great doe harvest. The ranch's primary goal during 1995 was to substantially reduce the population by removing breeding-age females through legal harvest. Doe harvest began with limited hunting during the archery season in October, with more intensive doe harvest during the general season in November through early January.

The greater buck:doe ratio observed in all months may be an artifact of the resident population. Number of bucks photographed peaked at 5 bucks/doe. A plausible explanation was behavioral (Main and Coblentz 1996) or physiological (Johns et al. 1984) differences resulting in bucks responding to bait stations differently from does during some months. We assumed the least sex ratios obtained from the photographs to be closest to the true value as this agreed more with results from spotlight counts and hunter observations. Replicated spotlight counts during September 1996 and incidental observations indicated 1.15 bucks/doe (R. Fash, Qué Pasa ranch, unpublished data). However, bucks often are underrepresented in spotlight counts (McCullough 1982); thus, number of bucks in the population may have been greater than indicated from spotlight counts.

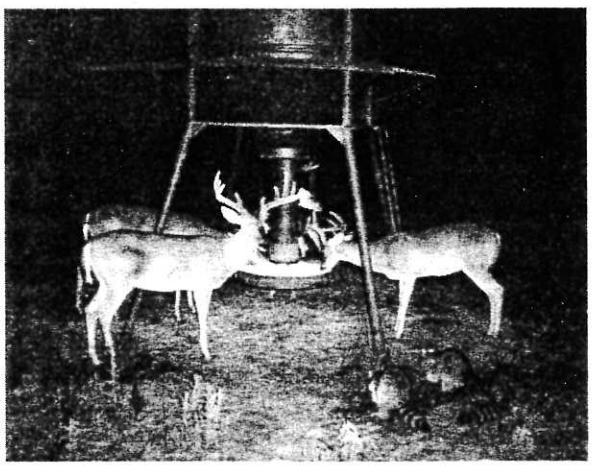
Timing of camera counts may depend on management goals. Great use of corn feeders and lesser CV for sex and age ratios suggest that late winter after the breeding season, but before antler drop, may be a good time. Unfortunately, this period falls after the hunting season and predictive ability about the population for the next hunting season would be limited because the estimate would be based on assumptions of natality and mortality through spring and summer (Hayne 1984). However, an estimate of adult survival and recruitment from the previous fawn crop can be made from a late winter survey.

If a fall count is necessary to determine net productivity and establish harvest rates before the hunting season, our data indicated a relatively small CV for age ratios in September and for sex ratios during October. Relative age and antler quality of bucks available for the hunting season can be evaluated in October. Koerth et al. (1997) found that an October camera survey in south Texas provided sex and age ratios comparable to aerial surveys.

Alternatively, if number of antlered males or sex ratios need to be determined during other periods of the year, small CV for buck:doe ratios were found in May and June. Antlers were large enough in May and June to accurately distinguish bucks from does, although full growth potential was not yet realized. However, using cameras with bait may provide an inaccurate estimate of number of fawns during spring and summer.

Management implications

Other baits or lures may be effective and warrant further research. Mason et al. (1993), Bean and Mason (1995), and Hakim et al. (1996) have investigated liquid baits, artificial sweeteners, and several chemosensory attractants with limited success. We used baits used commonly as feed supplements that would likely be readily available on many ranches. In that case, deer would be accustomed to visiting the stations and allow immediate data acquisition with cameras.



Metal bulk feeder used as a photographic station for camera surveys of deer.

Estimating sex and age ratios of white-tailed deer is difficult (Downing et al. 1977, Beasom 1979, McCullough 1982). We believe camera systems can be used to obtain precise sex and age ratios. However, a multi-stage survey may be necessary to get the best estimates. No single month provided the most precise estimates for sex and age ratios in our study.

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