Accuracy of Track Counts to Estimate White-tailed Deer Abundance

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Abstract: We assessed the accuracy of population estimates of white-tailed deer (*Odocoileus virginianus*) determined from track counts by comparing them with aerial mark-recapture estimates on 2 southern Texas areas. Track counts produced very conservative estimates in relation to mark-recapture methods and failed to detect a population increase on 1 area. However, they reflected a large difference in density between the 2 areas.

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Developing accurate and precise census methods for large mammals has long been a goal of wildlife managers. In recent years, progress has been made in understanding the accuracy and precision of aerial strip counts (Caughley 1974; Beasom et al. 1981, 1986; DeYoung 1985; Bartmann et al. 1986) and spotlight counts (McCullough 1982, Fafarman and DeYoung 1986). Most of this work has been in arid habitats with a shrub cover where deer can be observed. Census methods for humid, heavily forested regions, such as the southeastern United States, have not received as much attention.

Track counts of white-tailed deer have been used in the southeastern United States for more than 30 years to estimate relative abundance and density (Tyson 1959, Brunett and Lambou 1965, Downing et al. 1965, Harlow and Downing 1967, Mitchell 1986). In comparison to large, controlled drive counts, Tyson (1959) concluded track counts could be used to estimate density. By studying known numbers of deer in enclosures, Brunett and Lambou (1965) concluded tracks could be used to estimate relative abundance but not population size. Downing et al. (1965) also studied tracks of an enclosed population of known size. They concluded that the method was workable for estimating populations but doubted its practicality because of sample-size requirements.

We evaluated the accuracy of population estimates from track counts on 2 southern Texas areas by comparing them with aerial mark-recapture estimates. The Neva and Wesley West Foundation, P. H. Welder, the Roband Bessic Welder Wildlife Foundation (Contribution 332) and the Caesar Kleberg Foundation for Wildlife Conservation funded the study. We thank the numerous individuals who aided in capturing, marking, and counting. In particular, we recognize contributions of S. W. Stedman, R. Welder, D. Harrell, J. Smith, M. Box, L. Tibiletti, and T. Honaker.

Methods

Study Area

The southern Texas study areas were a 6,500-ha portion of the Camaron Ranch 45 km northwest of Freer and an 8,500-ha portion of the Faith Ranch 40 km southwest of Carrizo Springs. Both areas had brush cover generally <3 m high with about 50% canopy coverage.

Track Count Estimates

Each study area was divided into 4 segments about equal in size. Tracks were counted on 100-m strips located randomly along unimproved roads around the perimeter of each segment. There were 55 strips on the Camaron area and 76 on the Faith area. Strips were prepared initially by discing. Subsequently, a harrow was pulled over the strips behind a 4-wheel drive truck before each count began. Typically, an individual worker took 1 day to prepare strips on a study area and 1 day to read the tracks. Time elapsed between preparation and reading varied from 22 to 26 hours. Ten track counts were made on the Camaron area between May 1987 and April 1988 (Table 1). On the Faith area, 14 counts were conducted between March 1987 and 1988 (Table 2).

Population estimates for individual counts were calculated according to Tyson (1959). We assumed an average daily home range of 259 ha in calculating estimates from track counts (Tyson 1959). One-to-7 month home ranges averaged 227 ha for 27 deer (14 female, 13 male) radio tracked on the San Pedro Ranch (Inglis et al. 1986), which adjoins the Faith Ranch. The same assumption was made for the Camaron area, as no local home range estimates were available.

Mark-Recapture Estimates

Mark-recapture population estimates were made from data collected on repeated helicopter flights conducted between September and December 1986 and 1987 on each study area. These estimates were used as base counts to assess accuracy of track counts. Sixty deer on each study area were caught by helicopter and

Table 1. Estimated populations of white-tailed deer, as determined by 2 estimators on the Camaron Ranch in southern Texas.

Date(s)	Estimator	
	Track counts	Bailey recapture (SE)
14–16 Oct 1986		2,332 (252)
13 May 1987	333	
2 Aug 1987	783	
16 Aug 1987	306	
5 Sep 1987	621	
3 Oct 1987	576	
1 Nov 1987	738	
11–17 Nov 1987		2,609 (519)
22 Nov 1987	387	
22 Jan 1988	630	
4 Mar 1988	828	
12 Apr 1988	1,170	
$\bar{x}$	637	2,471

drive net (Beasom et al. 1980) and marked before flights began in 1986. Deer were marked with colored cattle ear tags and a color-coded collar with a radio transmitter containing a mortality sensor. Before the 1987 flights, an additional 40 and 50 deer were caught and marked in the same way on the Camaron and Faith areas, respectively.

A Hughes Model 300 helicopter was used on the Faith area in 1986 and a Bell Model 47 in 1987. An Aerospatiale Model AS 355 helicopter was used both years on the Camaron area. In all flights 2 observers counted and the pilot aided in sighting deer. Five different observers participated.

The 4 similarly-sized segments were flown separately using adjacent transects until a study area was completed. Transect spacing averaged 276 m (range = 214–329) on the Camaron area and 208 m (range = 167–289) on the Faith area. Flight speed was about 56 km/hour at an altitude of about 23 m. The Faith area was flown 4 times in 1986 (361 km/replicate) and 5 times in 1987 (420 km/replicate), whereas the Camaron area was flown 5 times in 1986 (233 km/replicate) and 4 times in 1987 (152 km/replicate). The Camaron area was flown once in the morning and once in the afternoon on the same days except for 1 day in 1986 when only a morning flight was made. The complete Faith area was flown on different days twice in 1986 and 4 times in 1987. More than 1 day was required to complete all segments of the remaining Faith samples because of rain delays.

Marked deer were "recaptured" when sighted during helicopter flights. When a marked animal was sighted, the pilot left the transect line and flew close enough to the animal for identification. The pilot then returned to the transect line and resumed the flight.

Each day counts were conducted, the number of marked deer on the areas was estimated by telemetry from a fixed-wing plane with a Yagi receiving antenna under each wing. Across both years and study areas, 15% of the deer were assessed as

Table 2. Estimated populations of white-tailed deer, as determined by 2 estimators on the Faith Ranch in southern Texas.

Date(s)	Estimator	
	Track counts	Bailey recapture (SE)
3 Oct – 4 Dec 1986		955 (104)
16 Mar 1987	463	
23 Mar 1987	355	
7 Apr 1987	290	
27 Apr 1987	253	
16 Jun 1987	355	
27 Jun 1987	413	
9 Aug 1987	188	
26 Aug 1987	152	
13 Sep 1987	217	
4 – 11 Nov 1987		1,538 (118)
15 Nov 1987	282	
6 Dec 1987	282	
20 Jan 1988	275	
27 Feb 1988	347	
28 Mar 1988	340	
$\bar{x}$	301	1,247

being outside the study areas when counts were made. However, 27% of the "outside" deer were seen in the study area during helicopter flights the same day. Others may have been present but not seen. Therefore, the actual percentage outside was probably <15%. We assumed that all living, marked deer were available to be counted although this may have resulted in positive bias in the mark-recapture estimates. Between 1986 and 1987 flights, about half of the 1986 transmitters failed. These deer were incorporated into the number available to be counted on both study areas after subtracting a number equal to the mortality rate for deer with functional transmitters.

We used the Bailey estimator (Seber 1973) to calculate mark-recapture population estimates for each complete flight. Population estimates for each area were calculated as the mean of the individual estimates. The Bailey estimator is a modification of the Peterson method that allows for sampling with replacement. Variance calculations followed Rice and Harder (1977).

Results and Discussion

Track count estimates were conservative when compared to the Bailey estimates on both areas (Tables 1, 2). Furthermore, track count estimates failed to detect a 61% increase in the Bailey estimates on the Faith area (Table 2). This population increase was caused by unusually high net fawn production and adult survival attributable to excellent range conditions (DeYoung, C. A., S. P. Coughlin, S. L. Beasom, and J. R. Heffelfinger, unpubl. data). Possibly deer moved less under the excellent conditions, resulting in little change in track counts even though the population increased.

Track counts did reflect the differences in population density between the 2 areas. Mean density on the Camaron area was 262% and 277% of the Faith area using the Bailey and track count estimators, respectively.

Caution is needed when interpreting the data because in most cases Bailey estimates and track counts were not conducted at the same time. Deer populations in southern Texas reach an annual peak after fawns are born in July. However, since fawns are sedentary early in life, there may be a 2–3 month lag before fawns are adequately reflected in track counts. This would be just before the helicopter flights each fall. The population reflected by track counts should decline after the fall period as mortality occurs. This trend was not evident in the track count estimates (Tables 1, 2), possibly because of high variability.

The validity of the assessment of track counts depended on the accuracy of the Bailey population estimates. Compliance with 2 key assumptions (mortality during sampling period, lost collars accounted for) of the Bailey estimator was ensured by using radio-collared deer. Possible bias from marked deer not on the sample area was addressed previously. Additionally, in 1987, the number of live deer carrying failed transmitters was estimated using the mortality rate of deer with good transmitters. While our sample sizes of radio collared deer were relatively large, the 1987 Bailey estimates could have been biased by error in this mortality rate. Compliance was not evaluated for assumptions that: 1) probabilities of sighting marked and unmarked deer were equal, 2) markers on sighted deer were not overlooked, and 3) aerial samples were independent. Relative to assumption 1, deer caught with the aid of a helicopter might be less observable during subsequent helicopter flights. However, DeYoung (1985) found that frequency of sightings during repeated helicopter surveys were no different for 5 deer caught without the aid of a helicopter versus 40 caught by helicopter and drive net.

Our results support the conclusions of Brunett and Lambou (1965). They counted tracks in 3 65-ha enclosures stocked with either 2, 4, or 8 deer. Their results indicated track counts were not directly proportional to population size; however, differences between enclosures could be detected. Thus, we concluded that track counts, at the sampling intensities employed, can be used to detect broad differences in deer density between areas in southern Texas brush habitats. However, the ability of the track counts to accurately estimate population size, using the conventional formula (Tyson 1959), is suspect.

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