A COMPARISON OF SPOTLIGHT AND TRACK COUNTS OF MULE DEER IN THE SIERRA NEVADA FOOTHILLS

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Abstract: Weekly spotlight and track counts of California mule deer (*Odocoileus hemionus californicus*) were conducted from July through December 1986 on two routes totaling 27 km in the Sierra Nevada foothills east of Fresno, CA. Mean nightly track counts were twice as great as same-night spotlight counts. Track and spotlight counts were significantly correlated. Both track and spotlight counts were effective in detecting an increase in the number of deer due to winter migration onto the study area, but track counts showed the increase earlier. The techniques did not detect deer in the same locations along the routes. The two methods yielded different distributions of deer occurring in available habitat types. Spotlight and track counts may provide comparable results for counts conducted on survey routes >10 km long, but for other purposes or at smaller scales, the methods yield different results.

Part of the Kings River Conservation District's (KRCD) environmental impact studies for a proposed hydroelectric project in the Sierra Nevada foothills was an assessment of California mule deer (*Odocoileus hemionus californicus*) use of the project area. The hydroelectric project was canceled before impact studies were complete. However, preliminary studies of mule deer abundance and habitat use provided information for a direct comparison of spotlight and road track counts.

Spotlighting has been extensively used and evaluated for studying deer populations (Anderson 1959, Progulske and Duerre 1964, Dealy 1966, McCullough 1982, Fafarman and DeYoung 1986, Mitchell 1986, KRCD 1987). Both general and detailed comparisons among spotlighting, helicopter and fixed wing aircraft counts have been conducted (Fafarman and DeYoung 1986, Synatzske 1986). Track counts have also been used in deer studies, but less frequently than spotlighting (Tyson 1959, Daniel and Frels 1971, Salwasser 1976, Davis et al. 1978, Mitchell 1986, KRCD 1987). They have been compared to drive counts (Tyson 1959), pellet group surveys, and the Hahn cruise (Mitchell 1986). However, no studies have compared spotlighting with track counts. Kie (1988) suggests that if an extensive road system is present and an index of abundance will suffice, then either spotlighting or track counts might be appropriate. We employed both techniques to investigate the deer population in our study area. As a result, we are able to directly compare the two techniques.

STUDY AREA

Studies were conducted along the Kings River in the Sierra and Sequoia National Forests approximately 100 km east of Fresno, Fresno County, California (Fig. 1). The topography of the Kings River canyon is rugged and steep with numerous rock outcroppings. Within 1.6 km of the river (370 m elevation) hills rise to 1,100 m, with adjacent ridges rising to 1,800 m. Springtime flows in the river reach 22,000 cubic feet/second (cfs) decreasing to below 1,000 cfs by the end of summer depending on the amount of snowmelt. Deer from both the North Kings and Hume Lake deer herds use the area as winter range, and some deer are present year-round.

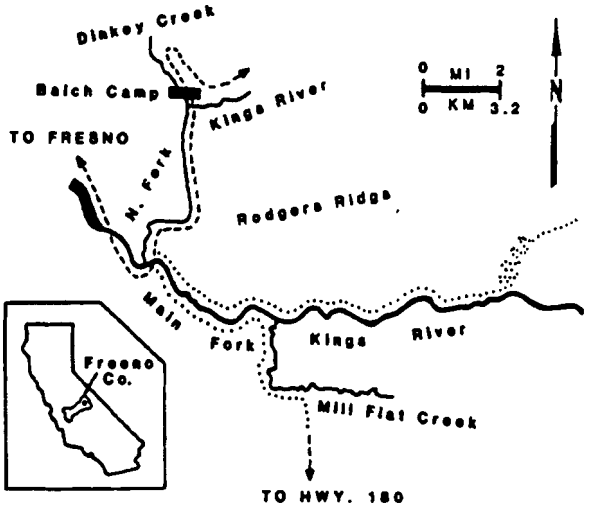

Fig. 1. Location of mule deer spotlighting and track count study. Dotted roads denote survey routes.

The study area is in the central Sierra Nevada foothills and is comprised of several types of oak woodland vegetation (Griffin 1977). We classified the area into five vegetation types: (1) riparian, (2) blue oak savanna, (3) annual grassland, (4) open-understory live oak woodland, and (5) closed-understory live oak woodland. Blue oak savanna dominates the north side of the river. The south side is covered mostly by closed understory live oak woodland. A narrow band of mixed deciduous riparian vegetation borders the

river and Mill Flat Creek, a small tributary. Additional narrow zones of deciduous riparian vegetation line smaller ephemeral drainages.

Annual rainfall averages 89 cm per year, falling mostly from November to April. Winter temperatures are usually above freezing, though occasionally drop to 6 C. Overall winter temperatures are moderately warm because the area lies between the San Joaquin Valley fog belt and lower montane snow levels. Summer temperatures are hot, usually near or above 38 C, and the mean annual temperature is 16 C.

The study area is traversed by a 17 km unpaved dead-end road along the north side of the river and a 10 km unpaved road along the south side of the river. Recreational use peaks in summer with rafting, camping, and fishing activities. Fishermen, hunters, and campers are present in low numbers during late fall and winter.

METHODS

Paired spotlight and track counts were conducted along the 2 unpaved roads weekly from 13 July to 10 December, 1986. Road surfaces were cleared with a length of carpet or chain-link fence dragged behind a vehicle late in the afternoon. Tracks were read the following morning. The driver, and a spotter sitting on an elevated seat mounted on the front bumper of a truck could easily detect tracks while driving 2-6 kph. Track counts required 2-6 hours depending on the route and the number of tracks seen.

Spotlight counts were conducted the night before tracks were read. Counts started within 1 hour after dusk and lasted 2-4 hours, depending on the route and the number of animals seen. Two observers sat on an elevated platform mounted on a truck camper shell. While being driven along the route at about 8 kph, observers used hand-held 400,000 candlepower spotlights to spot deer.

Habitat types within the study area were mapped using aerial photos with ground-truthing. The maximum effective spotlighting corridor was considered to be a constant-width band 200 m on either side of the road. Percent composition of habitat types in this 200 m band was determined with a dot grid overlay and habitat type map. The percent composition of habitat types sampled by track counts was assumed to be equal to the proportions of habitat types intersected by the road.

RESULTS

Forty paired spotlight and track count surveys (20 on each route) were conducted (Fig. 2). One or more deer were spotlighted on 50 occasions (total deer counted = 89). During track counts, tracks of one or more deer were detected on 149 occasions (total deer tracks counted = 204). The total number of deer counted nightly ranged from 0 to 33 for spotlight counts and 0 to 41 for track counts. Track counts yielded mean nightly counts approximately twice as large as those obtained from spotlighting ($\bar{x}$ = 5.10 deer, SD = 9.02; $\bar{x}$ = 2.23 deer, SD = 5.79, respectively; $t_{dep} = 3.57, df = 39, P < 0.001$). Nightly track counts showed weekly increases beginning in late September,

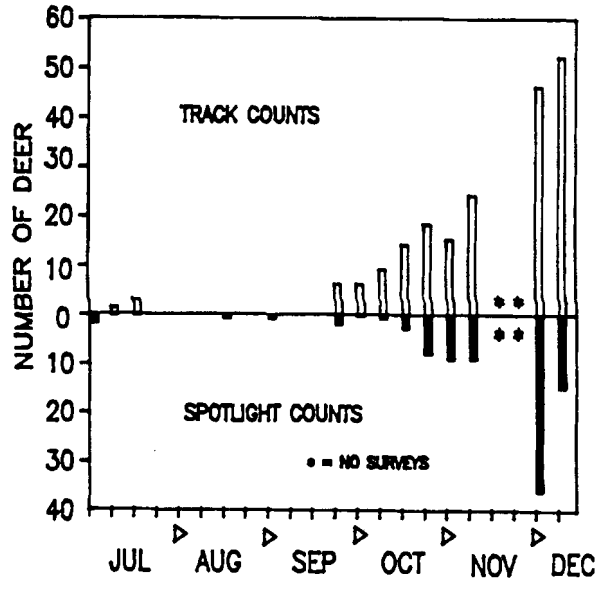

Fig. 2. Weekly total spotlight and track counts.

but spotlighting showed no increases until late October (Fig. 2). Track and spotlight counts were significantly correlated ($r = 0.87, P < 0.001$).

Track and spotlight counts did not detect deer in the same locations along the routes. The mean distance from a spotlight sighting or track registration to the nearest detection obtained by the other method was 0.27 km (SD = 0.63, n = 39). Half of these co-detections were within 0.13 km, and 90 % were within 0.65 km. Deer were detected by both methods on the same survey night on about 25% of the surveys conducted; all of these were after the autumn immigration of deer onto the study area.

The distribution of deer detections among habitat types differed between methods (Fig. 3; $X^2 = 629.87, df = 4, P < 0.001$). The methods also sampled

different proportions of habitat types. The percent composition of habitat types in the maximum effective spotlighting corridor differed from the percent composition of habitats transected by the roads (Fig. 3; $X^2 = 474.24, df = 4, P < 0.001$).

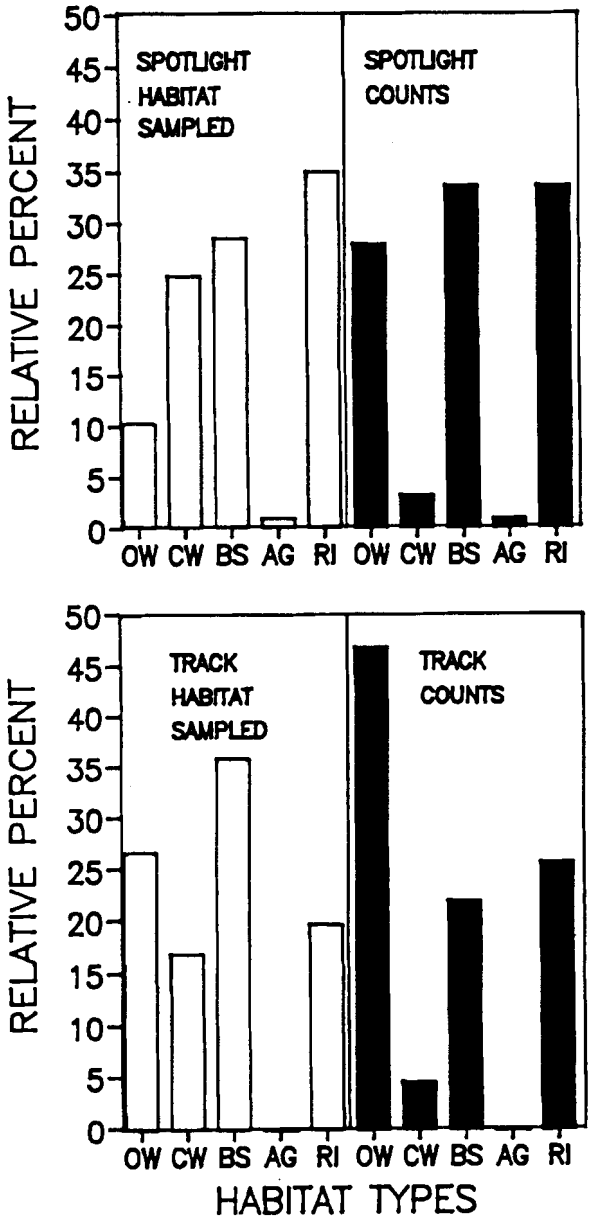

Fig. 3. Relative percent of habitat types sampled by spotlight and track count surveys, and occurrence of deer in habitat types as determined by each method. OW = open-understory live oak woodland, CW = closed-understory live oak woodland, BS = blue oak savanna, AG = annual grassland, RI = riparian.

DISCUSSION

Track counts were more effective and sensitive than spotlight counts, yielding higher mean nightly counts and detecting the winter herd immigration earlier than spotlighting. These differences may reflect the comparison of a cumulative measure (tracks accumulated over one night) to an instantaneous measure (spotlight sightings obtained at one time, or at least within a small portion of the track accumulation period). The methods also sample different proportions of different habitat types, and may effectively sample different-sized areas. Because the study area is steep, and the roads used for survey routes follow contours or gentle slopes, track counts may be affected by deer using the roads preferentially for travel.

It has been shown that road tracking can give highly unreliable results for very large or very small deer populations (Daniel and Frels 1971, Davis et al. 1978). In our study area the summer months were the time of lowest density. Even though spotlighting is apparently the less effective method, spotlighting did detect deer on the study area during the low density summer period. It seems likely that the relative effectiveness or sensitivity of the methods is not constant, but varies with deer density, which is in turn influenced by seasonal movements in this predominantly migratory herd. We would expect the methods to yield more similar results as density increases.

Nightly spotlight and track counts are well correlated at the scale of entire survey routes (10-17 km). However, the correlation of counts on entire routes cannot be generalized to individual detections. There were few instances when both methods detected deer on the same survey, although when this did occur, the methods agreed reasonably well on where along the route the deer were. The general failure of the two methods to detect deer at the same location indicates that the methods differ in how they sample the occurrence of deer. It is not clear if the same factors affecting the methods' measures of spatial occurrence also affect measures of number of deer; the relation between location and total count measures probably varies with scale and deer density.

Spotlighting and track counts yielded different patterns of deer occurrence in habitat types. We expected some differences due to differences in visibility between open and dense habitats. Spotlight counts were lower than track counts in moderately dense habitat (open-understory oak woodland) and higher than track counts in moderately open habitat (blue oak woodland). However, spotlight counts were not lower than track counts in the most dense habitat (closed-understory oak woodland) nor were they higher in the

most open habitat (annual grassland). Thus, visibility alone may not explain the differences between the methods' apparent detections of deer in different habitat types. The failure of the methods to detect deer at the same locations probably also affects measurement of the occurrence of deer in habitat types. Numerous aspects of deer behavior, such as timing of activities, needs met by different habitat types, sex, age and seasonal effects, and others, probably interact with physical attributes of the study area and characteristics of the 2 survey methods to contribute to differences in observed occurrence of deer in habitat types.

Both spotlight counts and track counts are widely used. Either method's suitability for a given task and study situation is best judged on a case by case basis; each has its own limiting assumptions and sampling characteristics. Both methods are sensitive to deer density and physical characteristics of study areas. Any relation between the methods probably is sensitive to these factors as well. It is probably unrealistic to formulate a general relation between track and spotlight counts. Our study shows that spotlight and track counts may provide comparable counts when conducted over survey routes >10 km long, but at smaller scales or when used to determine the occurrence of deer at particular locations or in particular habitat types, the methods yield different results.

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