Comparison of Inventory Methods for Wild Turkeys in South Texas

Charles A. DeYoung, *Caesar Kleberg Wildlife Research Institute, Texas A&I University, Kingsville, TX 78363*

James C. Priebe, *Caesar Kleberg Wildlife Research Institute, Texas A&I University, Kingsville, TX 78363*

Abstract: Line transect, mark-recapture, and 200-m strips counted from a truck were compared as methods of estimating numbers of Rio Grande wild turkeys (*Meleagris gallopavo*) on a 5,700-ha south Texas study area. Line transect produced the highest population estimate (N = 561, SE = 78), followed by 200-m truck strip (N = 312, SE = 53), and mark-recapture (N = 278, SE = 28). Compliance with underlying assumptions was assessed for each method. The line transect method was judged most promising for further evaluation.

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Rio Grande wild turkey numbers have been estimated using a variety of methods. Thomas et al. (1966) and Cook (1973) obtained counts of birds at winter roosts by interviewing landowners in west-central Texas. They concluded that interviews adequately indexed populations after comparing results with direct counts by biologists. Glazener (1967) used a composite of counts at roosts, counts at watering places, and a "cruise census" to compile county by county turkey numbers in Texas. Beasom (1970) counted turkeys along strip transects by helicopter and from a ground vehicle in south Texas. The ground vehicle transects resulted in higher density estimates. These inventory techniques were somewhat specific to location, some were only suitable to intensive research projects, and no widely applicable method has emerged.

Our objective was to find a practical, unbiased method for inventorying wild turkeys in south Texas. We compared 3 population estimators: (1) line transect (Burnham et al. 1980) using turkeys sighted along a truck route, (2) strip transect using a 200-m belt along the truck route (Beasom 1970), and (3) mark-recapture using marked turkeys resighted on the truck route.

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Methods

The study was conducted on a 5,700-ha portion of the Kenedy Ranch located 25 km southeast of Sarita in Kenedy County, Texas. The study area is an "island" of common live oak (*Quercus virginiana*) surrounded by extensive grassland and shifting sand dunes. The oak forest is broken by numerous openings and stands of honey mesquite (*Prosopis glandulosa*). The area is grazed by cattle, white-tailed deer (*Odocoileus virginianus*), and nilgai antelope (*Boselaphus tragocamelus*).

For the mark-recapture estimates, 83 turkeys were trapped with a rocket net (Austin 1966) from 9 through 26 March 1987 at 5 sites scattered over the study area. There were 7 rocket net firings resulting in 3 to 40 turkeys captured. Five firings resulted in a mixed catch of hens and gobblers, while the remaining 2 yielded gobblers only. Captured turkeys were individually marked with a patagial tag in each wing (Knowlton et al. 1964) and released. One or 2 of the birds (8 total; 5 males, 3 females) from each capture also were instrumented with a radio transmitter on the back between the wings.

A 16-km route was driven 8 times in a pickup truck by a single observer (3 different people made counts) from 9 through 17 April 1987. Four counts began at 0730, and 4 at 1800. The route was driven in the same direction each time at an average speed of 16 km/hour. The observer used a pair of binoculars or a spotting scope when necessary. Data tallied along the route were turkey group size, perpendicular distance to the nearest meter (continuous data) visually estimated from the road to the group, and individual color-pattern codes of patagial tags of marked turkeys. Before each repetition of the route, the observer practiced estimating distance to 150 m by observing a line of flagged stakes spaced at 25-m intervals.

Locations of turkeys with radio transmitters were used as an index to determine whether or not the population was closed (restricted to the study area). On 3 April 1987 (before vehicle counts), locations of radioed turkeys were checked from an airplane with a yagi antenna mounted on each wing strut, flown at 750 m altitude around the boundary of the study area. Turkeys were determined to be inside or outside of the study area by listening to signal strength while observers alternated use between antennas.

The 8 repetitions of the truck route were pooled (considered as 1 129-km route) for the line transect estimate in order to have enough group sightings ($\geqslant 40$) to define a detection function (Burnham et al. 1980). Program TRANSECT (Laake et al. 1979) was used to select an appropriate detection curve (distance measurements were not grouped) through Chi-square goodness-of-fit tests with a critical value of $P = 0.05$. The curve with the lowest coefficient of variation was selected from those meeting the Chi-square criterion. The density estimate, for groups calculated with program TRANSECT, was multiplied by mean group size to estimate turkey density. The density estimate was then multiplied by the number of ha in the study area to estimate population size. A 95% confidence interval was calculated according to Burnham et al. (1980:52).

The population was estimated for the 200-m belt along the truck route by first averaging density estimates from the 8 route repetitions. The density estimates were area of the strip (320 ha) divided by number of turkeys sighted within 100 m of the road. A population estimate was computed as the product of the average density estimate and area. A 95% confidence interval for the population estimate was calculated as that for the mean of a normal population with unknown variance (Huntsberger 1967:166).

Using the number of marked and unmarked turkeys, a separate, modified Peterson estimate was determined after each repetition of the truck route, and an average population estimate was calculated for all 8 repetitions (Rice and Harder 1977). A standard error (SE) for the average population estimate was computed by the formula of Rice and Harder (1977). Two SE's were considered an approximate 95% confidence interval (Rice and Harder 1977).

Results and Discussion

Fifty-four turkey groups were sighted during the truck counts. Program TRANSECT identified the exponential power series and negative exponential as appropriate models for the detection function. The exponential power series was selected because it had a lower percent coefficient of variation (13.9 versus 19.3). The line transect estimator resulted in the highest population estimate, followed by the truck strip transect, and the modified Peterson (Table 1).

There were potential problems with satisfying underlying assumptions of all

Table 1. Comparison of 3 methods of estimating a wild turkey population, Kenedy Ranch, south Texas, April 1987. Data for all estimators were derived from sightings along a 16-km route driven 8 times in a truck.

Estimator	Estimated population	SE	95% confidence interval
Line transect[a]	561	78	371–751
Mark-recapture[b]	278	28	222–335
200-m strip (truck)	312	53	188–436

[a]Estimator = Exponential Power Series; $\hat{f}(o)$ [estimated probability density function at distance = 0] = 0.01547; SE $\hat{f}(0)$ = 0.00043; $\bar{x}$ group size (N = 54) = 2.98.

[b]Modified Peterson Estimator using resightings of 83 turkeys with patagial markers.

the estimators. An assumption of line transect estimators is that objects to be counted are distributed independently of (are in no way influenced by) the transect followed (Burnham et al. 1980). This did not appear to be the case with the turkey counts, as 23% of the groups tallied were on the road (0 perpendicular distance). Turkeys were mating at the time of the counts and appeared to be using roads as display sites. Concentration of turkeys along the transect line would impose positive bias on the population estimate. Among other assumptions of line transect estimators are: (1) all animals visible on the line will be observed, (2) birds are not frightened away from the line and are not counted twice, (3) distance measurements are accurate, and (4) sightings are independent (Burnham et al. 1980). We do not believe that the truck surveys seriously violated any of these assumptions.

An essential assumption of the strip transects was that all turkeys within 100 m of the road were seen. It is questionable if this expectation was satisfied. The study area was mostly dense oak or grassy openings. It was difficult to see turkeys very far into the oak, although they were readily visible in openings. It is likely we missed turkeys screened by oak. Strip transects, such as we conducted, are likely to be variable because detection functions may change between habitat types and between years within habitat types (Anderson et al. 1985).

Some of the assumptions on which the mark-recapture estimates depend are: (1) that the population was of constant size over the sampling period, (2) that the probabilities of capturing (resighting) marked and unmarked turkeys were equal, (3) that markers on turkeys were not overlooked, and (4) markers were not lost from turkeys (Rice and Harder 1977). The radio-transmitter data indicated that the population was restricted to the study area at the beginning of the truck counts. The signal from 1 bird was not heard on the 3 April airplane flight, and transmitter failure was assumed after we searched approximately 20 km around the study area. A transmitter that was placed on top of a post as a beacon also failed. The remaining 7 birds were in the study area on 3 April. We assumed that mortality was minimal since only 39 days separated the beginning of marking and the last truck count. No young entered the population during the study.

The validity of assumption (2) was difficult to evaluate. The truck route passed within a few meters of all sites where birds were marked, which should have helped ensure that marked birds had an equal chance of being sighted. Nevertheless, the truck route was only a small portion of the 5,700-ha area and some birds could have avoided it. Two marked birds were sighted 4 times, 3 were seen 3 times, 3 were seen twice, 17 were seen once, and 58 were not seen. Group size seemed to diminish from the beginning of trapping to the completion of counts. However, there was no evidence that this behavior was related to a change in movements. If marked birds were not available for observation along the truck route, this would cause the population estimate to be positively biased.

Patagial tags were easily seen and not likely to be overlooked. We do not believe that turkeys lost tags. No birds were observed with only 1 tag.

Distortions can occur when a density estimate is projected to a population estimate by multiplying it by study area size. The manner in which the study area is defined can influence comparisons with estimators, such as mark-recapture, which produce a population estimate directly. We defined the study area by drawing a line on a topographic map around the edge of the oak habitat. Otherwise, if the surrounding open country (where turkeys were never sighted) was included, the line transect estimator would be expected to produce a lower population estimate than the mark-recapture estimator.

None of the estimators was entirely satisfactory under study conditions. Truck strip transects are subject to considerable variability through time, and it is difficult to prove the assumption that all turkeys within the belt are sighted. The mark-recapture estimator has potential for research studies if violations of the equal-sightability assumption are minimized. However, the mark-recapture estimator probably involves too much time and expense to be practical for large-area management uses. Line transect estimators have the potential for broad applicability because they compensate for differences in observability along a survey route. Therefore, we recommend additional evaluation of line transect estimators based on turkeys sighted along a truck route. However, evaluations should be conducted outside of the breeding season when turkeys are less likely to be attracted to roads.

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