

## Results of Spotlight and Helicopter Deer Surveys

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*Abstract:* Spotlight and helicopter techniques were used during late summer to survey white-tailed deer (*Odocoileus virginianus*) in young pine plantations in the Ouachita Mountains of Oklahoma and Arkansas. Spotlight sampling rates were 72–183 ha/hour and 1.6–6.8 deer/hour, and helicopter sampling rates were 655–976 ha/hour and 26.4–43.2 deer/hour. Ninety-five percent of deer observed from the helicopter were classified to age-sex classes. During spotlight surveys, 60% of deer were classified when using binoculars and 82% were classified when using a spotting scope. The helicopter method yielded deer indices (ha/deer observed, fawn/doe, buck/doe) that were generally more precise than by spotlight. Estimated survey costs per hectare surveyed, per deer observed, and per deer classified, respectively, averaged \$0.56, \$13.09, and \$19.07 by spotlight and \$0.51, \$10.91, and \$11.51 by helicopter.

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Spotlight and helicopter surveys are practical methods of deer herd assessment in open habitats (Progulske and Duerre 1964, Dealy 1966, Young 1975, Beasom 1979). Young pine plantations, with abundant forage and cover (Hurst and Warren 1980), provide good opportunities for surveying deer with these techniques in managed pine forests of the South.

Surveys of white-tailed deer have been conducted since 1981 on selected areas of Weyerhaeuser Company forestland in Oklahoma and Arkansas to evaluate differences in deer populations relative to forest and range management programs. During 1982 and 1983, spotlight and helicopter techniques were used concurrently to survey deer populations in the Ouachita Mountains. Neither survey technique resulted in the determination of actual deer densities; however, both methods yielded similar deer observation rates, fawn/doe ratios, and buck/doe ratios for the 2 popu-

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lations. This paper compares the effectiveness of spotlight and helicopter techniques to survey deer in young pine plantations in mountainous habitat of Oklahoma and Arkansas.

The study was a cooperative investigation of Weyerhaeuser Company, Oklahoma Department of Wildlife Conservation, and Arkansas Game and Fish Commission. The authors gratefully acknowledge the numerous personnel of all 3 cooperating organizations who assisted during deer surveys. The pilots and maintenance staff at the Weyerhaeuser DeQueen hangar provided support during helicopter surveys.

## Methods

Deer surveys were conducted on 2 study areas, 45 km apart, within the Ouachita Mountains: the Howard County Wildlife Management Area (Howard County) in Arkansas and the Mountain Fork Forest Wildlife Area and surrounding lands (Mountain Fork) in McCurtain County, Oklahoma. The Ouachita Mountains are characterized by rugged topography, soils developed from shale and sandstone, and a natural second-growth mixed forest of shortleaf pine (*Pinus echinata*) and upland hardwoods (*Quercus* spp., *Carya* spp., *Nyssa sylvatica*, *Liquidambar styraciflua*). Weyerhaeuser Company, the principal landowner in both areas, had established loblolly pine (*P. taeda*) plantations that varied in age up to 14 years, and comprised approximately 40%–45% of the study areas.

Nine pine plantations (3 stands of each age class 1–3 years old) were sampled by spotlight techniques (Progulske and Duerre 1964, Dealy 1966, McCullough 1982) in each study area during August–September 1982 and 1983. Spotlight surveys were conducted on 6 nights in both years in Mountain Fork, and on 10 nights in 1982 and 6 nights in 1983 in Howard County. Survey transects consisted of established roads in and adjacent to sample pine plantations; the same areas were sampled each night. Spotlight illuminated areas were delineated on aerial photos (1:12,000) and digitized for sample area determination.

Spotlight counts were initiated approximately 1 hour after sunset and transects were driven at speeds of 8–24 km/hour. Two observers operated handheld spotlights from the bed of a pick-up truck and a driver recorded visibility, weather conditions, and deer observations (antlered buck, doe, fawn, unknown). Binoculars (7×) were used to assist in identification of deer on both areas, and a zoom spotting scope (20–45×) was used in addition to binoculars in Howard County during 1982.

Helicopter surveys (Beasom 1979, Beasom et al. 1981) were conducted during the same months as the spotlight surveys. Plantations sampled by spotlight and plantations of other ages were included in helicopter surveys. In 1982, helicopter surveys were flown on 3 mornings over 12–16 pine plantations (0–6 years old) in Mountain Fork, and on 2 mornings over 12 plantations (3 stands of each age class 1–4 years old) in Howard County. In 1983, 12 plantations (1–4 years old) were sampled on 5 mornings in each study area. Results of the first 2 flights in Mountain Fork led to the standardization of sample stand age classes for subsequent flights.

Helicopter surveys were initiated at sunrise and continued for 1.5–2 hours. A Bell Jet Ranger 206 with a pilot and 3 observers flew over sample stands at altitudes of 15–30 m above ground and speeds of 50–75 km/hour. The normal sampling pattern consisted of flying the edge of a plantation (~50 m inside the perimeter) and then flying the interior area, generally parallel to topography, with flight lines approximately 150–250 m apart. Stand size averaged 105 ha and flight time over individual plantations was generally 5–7 minutes. As in the spotlight surveys, deer were classified to age-sex classes or recorded as unknowns.

Mean annual deer observation rates and coefficients of variation, a measure of precision, were calculated for each study area and technique with survey dates considered replicate samples. Differences between mean observation rates by helicopter and spotlight were tested at  $P = 0.05$  using a 2-tailed t-test for small samples of unpaired data. Herd composition ratios and 90% confidence intervals were calculated according to Czaplewski et al. (1983). Precision associated with herd composition ratios is the confidence interval expressed as a percentage of the mean (e.g.,  $80 \pm 8$  bucks-to-100 does has a precision level of 10%). Accuracy of deer observation rates and herd composition ratios could not be evaluated because we were not working with “known” populations.

Approximate costs of helicopter and spotlight surveys were calculated on the bases of the 3 sampling rates (per hectare sampled, per deer observed, and per deer classified) for areas and years combined. Helicopter costs (including pilot) were \$350/hour, vehicle costs were \$0.137/km (\$0.22/mile), and personnel costs (including salary, benefits, taxes, indirect costs, etc.) were estimated at \$18/person-hour. Driving distance during spotlight surveys totaled 2,642 km.

## Results and Discussion

Spotlight surveys conducted on 28 nights in the 2 study areas sampled 17,912 ha, and helicopter surveys flown on 15 mornings sampled 18,436 ha (Table 1). Total time expended during spotlight and helicopter surveys was 178.0 and 23.2 hours, respectively. Helicopter use resulted in more complete sampling of pine plantations, including some with too much cover to be effectively surveyed by spotlighting. Limited access, topography, and vegetative cover reduced the sample area of plantations by an average of 25% during spotlight surveys.

Conditions during spotlight surveys frequently made deer identification difficult or impossible (e.g., position or movement of deer, vegetative or topographic cover, distance to deer, ground fog, smoke from silvicultural fires). During spotlight surveys in Mountain Fork, 60% of deer observed were classified to age-sex classes with the use of binoculars. In Howard County, deer classification was 60% with binoculars and 82% with binoculars and a spotting scope. Conditions for viewing deer and assigning them to age-sex classes were usually good during helicopter surveys. Approximately 95% of deer observed from the helicopter were classified to age-sex classes. The greater proportion of identified deer by the helicopter method resulted in increased sample sizes for computation of fawn/doe and buck/doe ratios relative

**Table 1.** Results and sampling rates for spotlight and helicopter deer surveys in young pine plantations in the Ouachita Mountains, 1982–1983.

Area and Method	(N <sup>a</sup> )	Survey Area (ha)	Survey Time (hr)	Deer Observed	Sampling Rates		
					Area Sampled (ha/hr)	Deer Observed (deer/ha)	Deer Classified <sup>b</sup> (deer/hr)
<i>Mountain Fork</i>							
Spotlight	1982 (6)	4,572	63.3	103	72.2	1.6	0.9 <sup>c</sup>
	1983 (6)	4,056	52.8	261	76.8	4.9	3.0 <sup>c</sup>
	Total (12)	8,628	116.1	364	74.3	3.1	1.9
Helicopter	1982 (3)	4,880	5.0	132	976.0	26.4	26.0
	1983 (5)	6,220	7.5	324	829.3	43.2	40.4
	Total (8)	11,100	12.5	456	880.0	36.5	34.6
<i>Howard County</i>							
Spotlight	1982 (10)	5,810	42.9	292	135.4	6.8	5.6 <sup>d</sup>
	1983 (6)	3,474	19.0	106	182.8	5.6	3.4 <sup>c</sup>
	Total (16)	9,284	61.9	398	150.0	6.4	4.9
Helicopter	1982 (2)	2,226	3.4	96	654.7	28.2	25.0
	1983 (5)	5,110	7.3	307	700.0	42.1	40.5
	Total (7)	7,336	10.7	403	685.6	37.7	35.6

<sup>a</sup>N = Number of sample dates.

<sup>b</sup>Deer assigned to age-sex classes (antlered buck, doe, fawn).

<sup>c</sup>Binoculars only.

<sup>d</sup>Binoculars and spotting scope.

to the spotlight method. Spotting scopes are rarely used during standard spotlight surveys (Progulske and Duerre 1964, Dealy 1966, Harwell et al. 1979, McCullough 1982). However, in this study the proportion of deer assigned to age-sex classes increased 22% with the use of a scope.

Hourly sampling rates facilitate comparison of the 2 survey techniques because these rates compensate for differences in survey time expended between years, methods, and study areas. Average sampling rates by the helicopter method were approximately 5–7 times higher than by spotlight in Howard County and approximately 12–18 times higher than by spotlight in Mountain Fork. Combining areas and years, helicopter sampling rates averaged 794.7 ha/hour, 37.0 deer/hour, and 35.1 classified deer/hour; and spotlight sampling rates averaged 100.6 ha/hour, 4.3 deer/hour, and 2.9 classified deer/hour.

Helicopter sampling rates were similar for both study sites except for area sampled, which averaged 22% lower in Howard County than in Mountain Fork. The prevalence of ridge-and-valley topography in Howard County required narrower flight paths and more helicopter time than in Mountain Fork. In contrast, spotlight sampling rates in Howard County averaged 102–158% higher than in Mountain Fork because of road access and the distribution of sample plantations. Sample stands in Howard County averaged 3.9 km apart and access on forest roads was better than in Mountain Fork, where sample stands were separated by distances that averaged 7.7 km.

Deer observation rates ranged from 19.2 to 37.2 ha/deer by helicopter and from 15.9 to 65.7 ha/deer by spotlight (Table 2). For each area and year, mean ob-

**Table 2.** Mean deer observation rates (ha/deer) and coefficients of variation (CV) for spotlight and helicopter surveys in young pine plantations in the Ouachita Mountains, 1982–1983.

Area	Spotlight Surveys			Helicopter Surveys		
	$\bar{x}$	CV(%)	N	$\bar{x}$	CV(%)	N
<i>Mountain Fork</i>						
1982	67.5A <sup>a</sup>	73.8	6	37.2A	16.5	3
1983	15.9A	15.5	6	19.6A	17.4	5
<i>Howard County</i>						
1982	21.7A	32.4	10	24.5A	32.3	2
1983	41.3A	67.2	6	19.2A	47.3	5

<sup>a</sup>Means with the same letter within each area and year do not differ ( $P > 0.05$ ).

ervation rates for the 2 techniques were not significantly different ( $P > 0.05$ ). However, coefficients of variation averaged 47.2% for spotlight surveys and 28.4% for helicopter surveys, indicating greater precision by helicopter than by spotlight. Coefficients of variation for helicopter surveys of this study are comparable to values reported by Beasom (1979), 2.1–33.4%, and Leon et al. (1985), 19.6–69.9%, for helicopter deer surveys over South Texas Plains during fall.

Ninety percent confidence intervals for fawn-to-doe and buck-to-doe ratios by both techniques overlap considerably (Table 3), suggesting that differences between techniques are not significant. Although total survey area was roughly equivalent for all spotlight and all helicopter surveys (17,912 and 18,436 ha, respectively), precision was usually better by helicopter than by spotlight. Precision associated with fawn/doe ratios at 90% confidence averaged 38.3% by spotlight and 29.0% by helicopter; corresponding values for buck/doe ratios averaged 43.3% by spotlight and 33.2% by helicopter. The greater precision by helicopter was principally a function of larger samples of classified deer relative to the spotlight method. That is, for a given number of deer observations, herd composition ratios will be more precise by helicopter than by spotlight because a higher proportion of deer will be assigned to age-sex classes by the helicopter method.

**Table 3.** Deer herd composition ratios  $\pm 90\%$  confidence intervals<sup>a</sup> for spotlight and helicopter surveys in young pine plantations in the Ouachita Mountains, 1982–1983.

Area	Fawns : 100 Does ( $N^b$ )		Bucks : 100 Does ( $N^b$ )	
	Spotlight	Helicopter	Spotlight	Helicopter
<i>Mountain Fork</i>				
1982	86 $\pm$ 44 (41)	97 $\pm$ 38 (71)	82 $\pm$ 43 (40)	64 $\pm$ 28 (59)
1983	87 $\pm$ 25 (127)	89 $\pm$ 23 (155)	49 $\pm$ 17 (101)	49 $\pm$ 15 (122)
<i>Howard County</i>				
1982	91 $\pm$ 22 (185)	82 $\pm$ 43 (40)	57 $\pm$ 16 (152)	41 $\pm$ 27 (31)
1983	51 $\pm$ 25 (53)	87 $\pm$ 22 (166)	31 $\pm$ 18 (46)	39 $\pm$ 13 (124)

<sup>a</sup>Confidence intervals calculated according to Czaplowski et al. (1983).

<sup>b</sup> $N$  = Number of classified deer in the ratio.

For both years and areas combined, spotlight sampling costs were estimated at \$0.56/ha surveyed, \$13.09/deer observed, and \$19.07/deer classified; and helicopter costs were estimated at \$0.51/ha surveyed \$10.91/deer observed, and \$11.51/deer classified. These estimates reasonably approximate actual costs and reflect the relative differences in using spotlight and helicopter techniques to survey deer in young pine plantations in mountainous habitat. If a spotting scope had been used during all spotlight surveys (82% deer classified), estimated costs per deer classified would have been \$15.96; compared with an estimate of \$21.82 if binoculars only had been used (60% deer classified).

Helicopter techniques were cost-competitive relative to standard spotlight techniques to survey deer in young pine plantations in the Ouachita Mountains of Oklahoma and Arkansas. In addition, deer indices from helicopter surveys were generally more precise than those from spotlight surveys. Young (1979) found that the helicopter method was less expensive than a spotlight census on a cost-per-acre basis in the Edwards Plateau of Texas. In this study, the helicopter method was less expensive than the spotlight method for 3 sampling bases.

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