

- Reservation in northwestern Florida. Proc. Southeastern Assoc. Game and Fish Comm. 18: 140-152.
- Marchinton, R. L., A. S. Johnson, J. R. Sweeney, and J. M. Sweeney. 1970. Legal hunting of white-tailed deer with dogs: biology, sociology and management. Proc. Southeastern Assoc. Game and Fish Comm. In Press.
- Perry, M. C., and R. H. Giles, Jr.. 1970. Studies of deer-related dog activity in Virginia. Proc. Southeastern Assoc. Game and Fish Comm. In Press.
- Sweeney, J. R., R. L. Marchinton, and J. M. Sweeney. Responses of radio-monitored white-tailed deer chased by hunting dogs. J. Wildl. Mgmt. In Press.

COMPARISON OF CRIPPLING LOSSES OF WHITE-TAILED DEER CAUSED BY ARCHERY, BUCKSHOT, AND SHOTGUN SLUGS

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ABSTRACT

Of the 126 deer killed by hunters within a 746-acre enclosure at Albany, Georgia, during a 10-year period, 24 (19 percent) were not found by the hunter. Archers lost 4 of 8 deer killed (50 percent), gunners using buckshot lost 16 of 61 (26 percent), and gunners using shotgun slugs lost only 4 of 57 (7 percent). Antlered bucks were lost at more than twice the rate of antlerless deer. Only 2 of the 24 lost cripples were fawns, the lowest rate recorded for any group. In both sexes, yearlings were lost at a higher rate than older deer. Archery loss data from Virginia are included for comparison.

INTRODUCTION

Deer herd managers never obtain a complete picture of the kill on their lands because there is always a portion of the herd that is mortally crippled or for other reasons not retrieved. This paper reports on a 10-year effort to find and classify every hunting season mortality of white-tailed deer (*Odocoileus virginianus*) within a 746-acre enclosure at the Marine Corps Supply Center, Albany, Georgia. The area was described in detail by Johnson and Downing (1962) but can be briefly characterized as slightly rolling, upper coastal plain containing a mixture of cutover pineland and abandoned old fields. Most upland sites had sparse overstory with a ground cover of dense forbs, grass, blackberry brier (*Rubus* spp.) and Japanese honeysuckle (*Lonicera japonica*). Clumps of hardwoods and plum (*Prunus angustifolia*) occupied old fence rows and moist sites.

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METHODS

During 1959-63, all deer were killed with buckshot. From 1964-69, all gun hunting was with shotgun slugs, but a few deer were killed by archers. Throughout the study, hunters were required to report immediately every deer thought to have been wounded but which could not be found. A trained dog was available at every hunt to trail wounded deer to determine their fate. Numerous searches were also made after the hunting season to find additional carcasses. Periodic removal of low-growing vegetation by controlled burning facilitated these searches. Since 1964, two skeletons were found in which cause of death could not be determined, but inasmuch as most hunting during those years was with shotgun slugs, these two animals were assigned to the slug category.

There was no reason for hunters to intentionally abandon antlerless deer because 14 of the 19 hunting periods were for either sex, and there was no penalty for killing a doe on any of the 5 buck hunts; the 4 adult does accidentally killed with slugs on buck hunts were merely confiscated. As a result, these data represent only crippling losses and include no known illegal or unclaimed deer.

Deer were completely removed in 1963 and 1969 to determine the fate of the original stockings. Only 4 of the 31 deer stocked in 1959 and 1960 were unaccounted for in 1963; thus buckshot crippling losses given here are very nearly correct. Fifteen of the 44 deer stocked in 1964 were never recovered, but several of these are known to have escaped and others were poached. During the second period, about the same amount of effort was spent as was required to successfully find lost deer during the first period, and for that reason these data are believed to be representative of the losses that occurred.

Unfortunately, so few deer were killed by archers that archery data cannot be compared to gun data with any confidence. Unpublished data of archery crippling loss from Radford Arsenal in Virginia are presented to strengthen the archery comparison. Radford Arsenal habitat was described by McGinnes and Downing (1970).

RESULTS AND DISCUSSION

COMPARISON OF WEAPONS

Of the 126 deer killed during the 10-year period, 24 (19 percent) were not recovered by the hunter (Table 1). Archery caused the highest rate of crippling loss; buckshot an intermediate rate; and slugs, the lowest rate.

Many deer were reported hit by archers, but of the 8 that died, 4 (50 percent) were not recovered. The high loss by archers was most easily explained by the small size of the sample, but data from 1965 and 1966 hunts at Radford Arsenal in Virginia (F. Kreitzer, pers. comm. to R. L. Downing Dec. 22, 1965; and Petcher, 1967) indicated very nearly as high a loss in that area. Of the 138 deer killed by archers in Radford Arsenal, 43 (31 percent) were not recovered. Most of these were lost during any-deer hunts and would normally be considered crippling; however, some abandonment was likely, since many hunters were only interested in trophy bucks. At both locations, archers had frequent opportunities for shots at too great a distance to be sure of making a clean kill. Crippling is likely to be high under these conditions and appeared to be the principal cause of loss.

In Georgia, buckshot resulted in almost four times as high a crippling loss as slugs (Table 1). Many deer that were "missed" or fired on from out of range were apparently hit by one or more shot, allowing them to escape the hunter but causing them to die later. Most losses apparently resulted because hunters could not confirm a buckshot hit or trail the animal easily because bleeding from the wound was slight.

Deer mortally wounded with slugs do not travel as far before dying as deer hit with buckshot, and are easier to trail because they usually bleed more freely. For these reasons slug losses were quite low (Table 1).

TABLE 1. Crippling losses attributed to type of weapon*; Albany, Georgia enclosure, 1959-1969

Weapon	Total Killed	Lost Cripples	Percent Lost	Loss as Percent of Retrieved Deer
Buckshot	61	16	26	36
Shotgun slugs	57	4	7	8
Archery	8	4	50	100
Total	126	24	19	24

* All losses 1959-1963 due to buckshot; 2 skeletons found since 1964 died of unknown cause but are assigned to slug losses. Therefore, slug losses are maximum and archery losses minimum.

However, slug losses may not have been as low as observed, since many of the deer introduced in the area were not recovered. Georgia slug losses are also lower than those reported for other areas. For instance, slug hunters in Illinois lost an estimated 350 (25 percent) of 1423 deer (Roseberry, *et al.*, 1969). In Wisconsin, when hunters use both rifles and shotgun slugs, Dahlberg and Guettinger (1956) reported finding 7 lost deer in areas where 49 had been removed by hunters. These authors quote Kabat, *et al.* (1953) as estimating that lost cripples amounted to 17 to 22 percent of the legal kill elsewhere in Wisconsin.

A few other authors have compared crippling losses for various types of weapons. Severinghaus (1963) found that on Howland Island Game Management Area in New York, gunners using shotguns with slugs lost 27 (4 percent) of 706 deer, while archers lost 14 (7 percent) of 212. In Wisconsin, DeBoer (1958) found that archers lost only 10 percent of the deer killed, while gunners on a separate area lost 31 percent. F. Haberland (pers. comm. to R. L. Downing June 10, 1971) stated that on the Sandhills Wildlife Area of Wisconsin in 1970, hunters using magnum handguns lost more than 3 times as many deer as hunters using rifles and shotguns with slugs. No trend is exhibited by these data, but it is probable that hunter density also plays an important role in determining crippling loss. A lost deer is more apt to be recovered by another hunter when hunter density is high. W. L. Robinette (pers. comm. to R. L. Downing April 9, 1971) found that crippling loss in Utah was inversely related to hunter density.

Only two instances of recovery by other hunters were observed for the Georgia enclosure, where hunting pressure was composed of equal numbers of days of 4, 8, and 12 men per day, a maximum density of only 10 hunters per square mile. A complicating factor was that many lost deer were found by the trained dog within an hour or two, and thus were not available for recovery by other hunters.

Under the conditions prevailing in Georgia, buckshot was the most effective in harvesting deer. Most shots were taken at bounding deer, and slug hunters registered many misses. The highest success rate recorded for a single day was with buckshot, when 4 hunters killed 7 of the 13 deer present in the enclosure. However, 2 of the 7 were lost cripples. No further comparison of hunter success is possible because of the uncertainty of population estimates during some years.

SEX AND AGE STRUCTURE

The sex and age classification of deer lost to crippling in the Georgia enclosure was also interesting. Antlerless deer were lost at less than half the rate of antlered bucks (Table 2). In both sexes, fawns were lost at the lowest rate, yearlings at the highest rate, and adults at an intermediate rate. These data can be compared with those from Radford Arsenal, where 15 percent of fawns, 42 percent of yearling and adult does, and 32 percent of yearling and adult bucks killed were not recovered. At Radford, antlerless deer were lost at a rate nearly as high as that for antlered bucks, 29 percent vs. 32 percent. As mentioned pre-

TABLE 2. Sex and age classification of deer lost to crippling. Albany, Georgia enclosure 1959-1969

Type deer	Total Killed	Lost Cripples	Percent Lost
Bucks			
Fawns	20	2	10
Yearlings	23	7	30
2+ years	32	8	25
Does			
Fawns	7	0	0
Yearlings	14	3	21
2+ years	30	4	13
Total antlered	55	15	27
Total antlerless	71	9	13

viously, some loss of antlerless deer at Radford Arsenal may have been due to abandonment, not crippling. Among 40 unretrieved deer found in Wisconsin (Sanders, 1939), only 4 were fawns, a lower proportion than usually found in the kill.

Fawns are usually much less vulnerable to hunting, as demonstrated by an earlier study¹, but the rate at which they are lost as cripples is even lower than the rate at which they are shot. Perhaps fawns are less resistant to injury than other deer, and fewer of those shot escape.

Crippling losses of mule deer (*Odocoileus hemionus*) in Utah also seem to be in a different proportion than the kill; however, contrary to the situation for whitetails, the trend seems to be toward more fawns being left than adults. Robinette (1947) reported that lost fawns amounted to 30 percent, lost does amounted to 20 percent, and lost bucks amounted to 7 percent of those killed in the Fish Lake National Forest. Julander and Robinette (1950) reported that unrecovered fawns amounted to 39 percent, unrecovered does amounted to 23 percent, and unrecovered bucks amounted to only 6 percent of those killed on the Oak Creek Range in Utah. Costley (1948) reported that antlerless deer amounted to 75 percent of the cripples but only 36 percent of the legal removal from the Dixie National Forest in Utah.

Robinette (pers. comm. to R. L. Downing April 9, 1971) states that losses of does and fawns were more than twice as high on the Oak Creek Range during 1948 to 1950, when only a third of the hunters had either-sex permits, as in 1951 to 1959, when all hunters had either-sex permits. Among antlerless deer, fawns are left at the highest rate, yearlings at the lowest rate (probably because they are in the best condition), and adult does at an intermediate rate.

Abandonment was undoubtedly the reason for loss of many of the 77 antlerless deer found by DeBoer (1957) in Wisconsin following buck hunts. Among these, 43 (56 percent) were fawns. Obviously, crippling and abandonment are different factors having a different effect on the sex and age composition of lost deer. However, cause of loss usually cannot be determined in the field, and it is necessary to consider both factors simultaneously.

RECOMMENDATIONS

Few hunters will have the will power to resist shooting at deer that are beyond the effective killing range of their weapon, or that are too far or moving too fast to be hit consistently in a vital spot. Poorly hit deer invariably result in some crippling losses. The wildlife manager should consider this problem when setting harvest regulations. When the cover is thick and deer are apt to be moving, buckshot may be the best choice. However, the extent of crippling loss experienced with buckshot demands that this type load be used only in conjunction with high hunting pressures or dog-hunting. Buckshot and dog-hunting were made for each other, and both produce poorly when used separately. A deer being chased by dogs has more chance of being hit with buckshot, and when buckshot is used, dogs are required to find the cripples.

A high density of hunters may serve the same purpose as dogs. If a deer is lost by one hunter, it may be found by another. And where hunter density is high, buckshot is sometimes prescribed because of its theoretical safety advantage. The velocity and trajectory of buckshot are less than those of other modern firearms, but where nine or more projectiles are fired instead of one, the chance of a hunter being hit by a stray shot is not necessarily less and may even be greater. Because buckshot hunters do not need as much time to sight their weapons, they may shoot before the target can be accurately identified. The manager should seek the advice of others who have used buckshot in high-density situations before automatically assuming that it is safer than the single projectile.

Archery hunting is a challenging sport, and its participants derive a great deal of high-quality recreation. However, the rate of archery

¹ Downing, R. L. (Unpublished.) Determination of recruitment rates from samples of female deer killed by hunting.

loss is high, and if a large portion of the hunting pressure is by archers, an effort to control this loss may be required. Organized archery groups should be encouraged, since they usually require their members to practice high standards of woodsmanship, marksmanship, and responsibility. Land managers can exercise some control over the problem by scheduling archery hunts only in relatively dense cover where the number of opportunities for long shots would be fewer.

The job of the population analyst would be greatly simplified if crippling and other unknown losses could be eliminated. The problem of illegal and abandoned deer can be minimized by making every deer legal for the entire season, but this will necessitate a short season if hunting pressure is high. Crippling losses could be held to a minimum by requiring .300 magnums and telescopic sights, but there are many factors such as cover conditions and hunter preference that would make such regulations unpopular.

Accurate population analysis is impossible without some knowledge of the extent of crippling, abandonment, illegal kill, accidents, and "natural" mortality. Well-documented differences in age class vulnerability to hunting¹ mean that under no known circumstance does the age structure of the kill represent the age structure of the living herd. And when the reported kill has a different age structure than other causes of death, it thus represents neither the living nor the dead. The only practical solution is to attempt to quantify the losses as I, Robinette et al. (1954), Robinette (1956), and others cited in this paper have done. The cost of such information in terms of time and manpower is apt to be high, but may be justified if the need for such information is great.

LITERATURE CITED

- Costley, R. J. 1948. Crippling losses among mule deer in Utah. *Trans. N. Am. Wildl. Conf.* 13:451-58.
- Dahlberg, B. L. and R. C. Guettinger. 1956. The white-tailed deer in Wisconsin. *Tech. Wildl. Bull. No. 14.* Wisconsin Cons. Dept., Madison. 282 pp.
- DeBoer, S. G. 1957. Waste in the woods. *Wisconsin Cons. Bull.* 22(10):10-15. Oct. 1957.
-, 1958. Less waste in the woods. *Wisconsin Cons. Bull.* 23(10):13-17. Oct. 1958.
- Johnson, F. M. and R. L. Downing. 1962. Preliminary investigations of deer census techniques applicable to the Southeast. *Proc. Soc. Am. Foresters, Atlanta, Ga.* pp. 162-165.
- Julander, O. and W. L. Robinette. 1950. Deer and cattle range relationships on Oak Creek Range in Utah. *J. Forest.* 48:410-415.
- Kabat, C., E. C. Collias, and R. C. Guettinger. 1953. Some winter habits of white-tailed deer and the development of census methods in the Flag Yard of Northern Wisconsin. *Tech. Wildl. Bull. No. 7,* Wisconsin Cons. Dept., Madison. 32 pp.
- McGinnes, B. S. and R. L. Downing. 1970. Fawn mortality in a confined Virginia deer herd. *Proc. Southeastern Assoc. Game and Fish Commissioners Conf.* 23:188-191. Mobile, Ala. 1969.
- Petcher, R. L. 1967. A population study of a confined deer herd. MS Thesis, Va. Polytech. Inst. 1967. 77 pp.
- Robinette, W. L. 1947. Deer mortality from gunshot wounds. *U. S. Fish and Wildl. Serv. Wildl. Leaf.* 295. 8 pp.
- 1956. Further analysis of methods for censusing winter-lost deer. *J. Wildl. Mgmt.* 20(1):75-78.
- D. A. Jones, J. S. Gashwiler, and C. M. Aldous. 1954. Methods for censusing winter-lost deer. *Trans. N. Am. Wildl. Conf.* 19:511-525.
- Roseberry, J. C., D. C. Autry, W. D. Klimstra, and L. A. Mehrhoff, Jr. 1969. A controlled deer hunt on Crab Orchard National Wildlife Refuge. *J. Wildl. Mgmt.* 33(4):791-795.
- Sanders, R. D. 1939. Results of a study of the harvesting of white-tailed deer in the Chequamegon National Forest. *Trans. N. Am. Wildl. Conf.* 4:549-553.

Severinghaus, C. W. 1963. Effectiveness of archery in controlling deer abundance on the Howland Island Game Management Area. N. Y. Fish and Game J. 10(2):186-193. July 1963.

THE SIGNIFICANCE OF A "TIME LAG" IN CONDUCTING A POSTAL SURVEY OF ARCHERY DEER HUNTERS¹

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ABSTRACT

A postal survey of 301 archery deer hunters was conducted during April-May, 1970 to determine the utilization of South Carolina game management areas by archery hunters during 1969. The hunters were asked three questions; namely (1) the number of deer killed, (2) the number of visits made to the management areas, and (3) the number of hours spent while hunting deer.

Due to an oversight, the random selection of archery hunters to be contacted in the postal survey was made from returned "hunt permits" on which each archery hunter had previously answered the same questions asked in the postal survey. The questions on the returned hunt permits had been "answered" by the archery hunters at the close of each scheduled archery hunt that was held during the September-December, 1969 hunting season.

A tabulation of the information obtained from the postal survey revealed that the 301 archery hunters had killed 30 deer. These same 301 hunters had previously reported a total kill of 10 deer when answering the question on the hunt permits at the close of the archery hunts, all of which had been completed by December 31, 1969.

A comparison of the postal survey data and the returned "hunt permit" data, as regards the number of visits and the number of hours hunted, revealed also that the information submitted in the postal survey was greater than that reported at the conclusion of the hunts.

The general conclusions made from the analyses of these two "sets" of data from the same archery hunters were (1) that postal surveys of hunters should be conducted immediately after the conclusion of the hunts involved and (2) that hunters with a special interest may possibly, at times, be inclined to report erroneous information so as to achieve a specific objective.

Prior to 1969, the South Carolina Wildlife Resources Department depended upon data obtained from returned "hunt permits" to estimate the extent to which hunters utilized the state's game management areas for hunting white-tailed deer (*Odocoileus v. virginianus*). Free hunt permits were required of all deer hunters participating in each of the several deer hunts scheduled for each management area or hunt unit. The hunt units usually included several game management areas that were administered as a single unit.

From analyses of the data tabulated from the returned hunt permits (usually about 15 to 20 percent of the permits issued), it was believed that the information obtained was extremely biased. Consequently, it was decided to conduct a postal survey of a portion of the deer hunters that utilized the game management areas during the 1969 deer season so as to obtain more valid information.

Through an oversight, the postal survey included the archery hunters although the records of their hunting success, etc., that were made at the conclusion of each hunt were already available.

¹ A joint contribution of the South Carolina Wildlife Resources Department and Clemson University.

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