

Coleoptera were twice as frequent in the diet from fresh water sites. Orthoptera were about three times more common (by volume and frequency) in the diet at fresh water sites. These differences probably reflect varying availability of prey species in salt and fresh water.

The feeding habits of the white ibis may have some economic importance. Baynard (1912) states that the taking of crayfish by white ibis favorably affects the fishery associated with the feeding marsh by reducing predation on fry. On the other hand in areas where crayfish are used for human food, white ibis may be pests. Though crayfish and aquatic insects make up the bulk of the normal diet, white ibis are at times able to take advantage of unusually high or low water conditions to find food.

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EFFECT OF DOGS ON DEER REPRODUCTION IN VIRGINIA¹

by

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ABSTRACT

Dogs were used to chase female white-tailed deer (*Odocoileus virginianus*) in a 2,040-acre enclosure at Radford Army Ammunition Plant, Dublin, Virginia, during late pregnancy from April to June 1972 (Phase I) and throughout pregnancy from October 1972 through May 1973 (Phase II) to determine the effect on reproduction. During Phase I, trained deer hounds were used to chase approximately 40 percent of the deer in the study area; the other 60 percent were used as a control. During Phase II, hounds and other dogs were used for chasing deer on the entire study area. All healthy deer easily escaped the chase dogs, but a badly deformed piebald fawn was caught. Neighborhood dogs apparently killed one additional young fawn during the study, but the problem is not serious because of the protective behavior of the does and the secretive nature of young fawns. No significant difference in fawns per doe surviving to late summer censuses was found between deer chased by dogs and those that were not. No permanent home range changes were noted as a result of dog chasing, but temporary changes of 1 or 2 days duration occurred. Dogs were not measurably detrimental to this enclosed, densely populated herd, either by limiting its reproduction, inducing permanent home range changes, or killing individual deer.

INTRODUCTION

Free-running dogs are often thought to be a serious threat to deer, but scientific evidence is lacking to support this viewpoint. The question is filled with emotion, and many writers of popular wildlife articles appear to be caught up in the anti-dog

¹Major financial support for this Master's study came from the Virginia Commission of Game and Inland Fisheries.

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³Cooperatively supported by the U. S. Fish and Wildlife Service, Virginia Polytechnic Institute and State University, Virginia Commission of Game and Inland Fisheries, and Wildlife Management Institute.

crusade, accusing dogs of running down and killing healthy adult white-tailed deer and their fawns, affecting reproductive success, and causing large home range changes that eventually "run the deer out of the country." Dog chases are rarely seen to the end, yet such writers apparently assume that the deer was eventually caught or harmed in some way. If dogs do capture deer, or are seen feeding on one, conclusions are reached without the benefit of an autopsy to determine if there were contributing factors, such as a previous injury, extreme old age, deformity, or disease.

The few scientific studies conducted to date (Progulski and Baskett 1958, Corbett et al. 1971, Sweeney et al. 1971) indicate that dogs are likely to catch only extremely old, diseased, or otherwise unhealthy deer, and that most deer readily return to their home range after being chased. No study has been made of the effect of dog chasing on deer reproduction, but game wardens and biologists in Virginia surveyed by Perry and Giles (1970) believed that chasing deer during pregnancy was detrimental, seriously affecting productivity of the herd. Because no supportive evidence was available, the present study was initiated to gain insight into some effects of dog chasing on deer reproduction.

The authors are indebted to personnel of the Radford Army Ammunition Plant for their cooperation during this study and to R. J. Coe and E. T. Reed for field assistance.

TECHNIQUES AND PROCEDURES

This project was conducted at the Radford Army Ammunition Plant near Dublin, Virginia. The 826-hectare (2,040-acre) area is completely surrounded by a 2.4 m (8 ft) chain-link fence. The habitat is abandoned pastureland with occasional clumps of mature hardwoods, scattered cedars (*Juniperus virginianus*) and several young shortleaf pine (*Pinus echinata*) plantations. Rolling, open terrain and an extensive road system permitted excellent observation of deer movements and chase behavior and the easy capture of fawns for tagging.

Dog chases were observed during two periods: the first (Phase I) was during late pregnancy in April, May, and June 1972, and the second (Phase II) was throughout pregnancy from October 1972 through May 1973. The area contained an estimated 425 deer.

Phase I Dog Chases

The area was divided into "chase" and "control" areas. The chase area was a single watershed occupying about one-third of the enclosure and containing approximately 40 percent of the 106 tagged adult does. These does were captured and tagged previous to the study, either as fawns, using the techniques described in Downing and McGinnes (1969), or as adults, using drug darts.

Chases were conducted each Saturday and Sunday morning from 22 April to 3 June 1972. Trained deer hounds were released within 100 m of groups of deer containing adult does and the chase initiated by the observer leading the dogs in a rush toward the deer until a "sight chase" was established. Chases were followed as closely as possible by the observer in a truck. As the hounds approached the boundary of the chase area, they were picked up, rested, and set on another group of deer within the chase area. Only two hounds were used in each chase to facilitate their recapture at the boundary of the chase area. Usually, only three or four chases were necessary to drive all the deer from the chase area each day.

Techniques of Evaluation and Analysis. Several techniques were used to compare fawn production by does in chase and control areas. The number of fawns reared by each tagged doe was determined by repeated (when possible) direct observation. Proportions of does in the chase and control areas rearing 2, 1, or no fawns were then compared.

From late May until the middle of June, fawns were captured and ear tagged by the method described by Downing and McGinnes (1969). Because of the relative infrequency with which fawns are observed during the summer (Downing et al., in press),

counts of fawns and does to determine rearing success were not undertaken until 15 September. Eleven counts were then made along a route that covered the entire study area. The "direct" ratio of fawns per doe was obtained for both chase and control areas by summing numbers of does and fawns seen daily in each area. "Indirect" estimates of the total numbers of fawns and does in each area were obtained by the Lincoln Index formula using the ratios of tagged to untagged individuals seen each day.

We used two-tailed "t" tests to detect any significant difference between the two areas in terms of fawn production per doe, and the chi-square test to determine whether the proportion of tagged does which had two, one, or no fawns was different between the chase and control areas.

Locations of all tagged does and fawns were recorded whenever possible to detect home range changes caused by dog chasing. Home ranges of nearly all tagged does had been previously recorded (Downing and McGinnes, in press) and current locations were compared to these ranges.

Activities of all neighboring dogs observed in the area were noted to determine their effect on the herd.

Phase II Dog Chases

In order to sustain longer chases than were possible in Phase I, the entire study area and all the dogs at our disposal were used during this phase. Deer were chased with hounds twice each weekend from 21 October 1972 until late May 1973, except in late November and December when the hounds were returned to their owners for the 6-week deer season. Chasing resumed on 7 January 1973, this time with hounds and nonhounds that appeared capable of an effective chase. The four nonhounds used most often were a collie, a German shepherd, a mixed doberman, and a mixed setter obtained from a local pound. Thus, all deer in the study area were chased throughout pregnancy except during parts of the second and third months.

Dogs were allowed to run until an active chase was no longer being sustained. When deer escaped or were so far ahead of the dogs that they were no longer being forced to run, the dogs were picked up, rested, and set upon another group of deer.

Techniques of Evaluation and Analysis. Techniques and analysis were similar to those in Phase I, except that reproductive success in 1973 was evaluated by comparing it with estimates of fawn production for previous years.

RESULTS

Phase I

Thirty chases were conducted the spring of 1972. Chase time varied from 1 to 30 minutes, and averaged 11 minutes per chase. The short duration of most chases resulted from stopping the hounds at the boundary of the control area. Chase distances ranged from 0.3 to 3.4 kilometers (0.2 to 2.1 miles), averaging 1.3 kilometers (0.8 mile) per chase.

Many deer in the chase area, hearing the barking of dogs, would flee immediately. Chased deer would join other deer while running, thus increasing group size. Almost every deer would be run out of the chase area each day after three or four releases of dogs.

Other Dogs in the Study Area. Neighboring dogs, observed in all parts of the study area, were never seen chasing deer. However, on 4 June, at 0615, two dogs were observed feeding on a 3-day old fawn that had been tagged just 12 hours before. A veterinarian's necropsy revealed that the fawn had died of a head wound, probably inflicted by the dogs. Neighborhood dogs were seen in the study area eight other times during the spring of 1972 but never chasing deer. Arsenal guards reported that chases sometimes occurred at night, which agrees with Scott and Causey's (1973) observation that feral dogs are more active at night. Nevertheless, Downing has observed only three chases by neighborhood dogs on the study area during 8 years of work, involving at least 2,000 hours of early morning and late afternoon observations. At least 700 hours of this work were during the fawning season, but the fawn described above was the only

one whose death could be definitely attributed to dogs. An additional fawn was reported by McGinnes and Downing (1969) as killed by dogs because dogs were feeding on it when discovered by Arsenal personnel. The fawn, however, was not examined by biologists.

In May 1972, a pregnant doe was observed chasing a mongrel dog to the top of a soil pile, keeping the dog there for several minutes. Apparently, protective maternal instincts caused such behavior. Robinette et al. (in press) reported similar behavior of mule deer (*Odocoileus hemionus*) toward coyotes (*Canis latrans*) and other predators.

Home Range Changes. No permanent home range changes were noted as a result of dog chasing. Almost every deer was driven from its home range during each chase, but no deer was seen outside its home range more than 2 days later.

Fawn Production per Doe. In spite of the large numerical difference in Lincoln Index fawn/doe ratios between areas (Table 1), there was no significant difference at the 0.05 level. Production estimates in the control area were abnormally high, whereas those in the chase area were similar to previous years' data. The large numerical difference and the large confidence interval were both partially due to small samples. This measure must necessarily be regarded as inconclusive.

Table 1. Comparison of fawn/doe ratios and 95-percent confidence intervals in "chase" and "control" areas, based on "indirect" ratios using the Lincoln Index and "direct" ratios determined by summing field observations. Phase I, 1972.

Area	"Indirect" Fawns/Doe (Lincoln Index)	"Direct" Fawns/Doe
"Chase"	0.59 + 0.19	0.68 + 0.13
"Control"	0.75 + 0.37	0.61 + 0.08
Entire Enclosure	0.65 + 0.15	0.63 + 0.10

Direct counts of does and fawns (Table 1), were also not significantly different between areas. In fact, the direct ratio of fawns per doe was numerically higher in the chase than in the control area. A X^2 test indicated that there was no significant difference between the two areas in the proportion of tagged does which reared fawns (Table 2).

Table 2. Fawn production by tagged adult does during the 1972 season at Radford Army Ammunition Plant, Dublin, Virginia.

Dogs	Adult Does Producing						Total Does	Fawn/Doe Ratio
	Two Fawns		One Fawn		No Fawns			
	No.	Percent	No.	Percent	No.	Percent		
"Chase" Area	5	23	11	50	6	27	22	0.95
"Control" Area	7	17	24	59	10	24	41	0.93

Phase II

Chase characteristics were similar to those in Phase I, with dogs switching trails and splitting up, often following several groups of deer during an extended chase. But because there was no need to pick up the dogs until they became tired or hopelessly out-distanced, chase times were longer than in Phase I, and many chases extended over 30 minutes and some for an hour or more.

Because of the openness of the terrain and the excellent road system, many of the chases during Phase II were visually observed in their entirety. The dogs appeared to tire much more quickly than the deer and did not pursue them fast enough to cause much exertion after the first 5 to 10 minutes of the chase. Because most chases of individual deer were of at least this duration, the stress on individual deer was apparently as great as would be experienced with less dense herds. And because deer often formed into large groups, many more deer were chased than would be possible in less densely populated areas. An average day's chase moved more than 100 deer.

On 28 January 1973, a tagged piebald fawn, which moved in a sidewise manner due to his short legs and enlarged, crooked joints and feet, was caught by the dogs when it ran only 80 yards and stopped. There were two other instances of deer being closely approached by the dogs when the deer ran against the fence, but each time the deer escaped without apparent injury. Unfortunately, there was no snow during chases, and the effect of this factor could not be evaluated.

Other Dogs in the Study Area. Other dogs were frequently seen in the study area during this phase, but as in Phase I, the dogs were at no time seen chasing deer. In three instances, deer ran from the dogs, but the dogs did not give chase.

Home Range Changes. As in Phase I, no permanent home range changes were observed for any tagged doe as a result of dog chasing. Temporary changes were noticed for six tagged does, but they all returned to their original home ranges within a few days. However, it was noted that an unusually low percentage of the total fawns were tagged in the chase area during both years of the study (Table 3). Reasons for this apparent conflict with other findings are unknown, since capturing efforts in the chase area were equal to those of other years. Even though the entire area was used for chasing during Phase II, many of the chases were originated in the chase area, making the disturbance there greater than in the remainder of the area. Does possibly moved to the more inaccessible parts of their home range to give birth or made more effort to conceal fawns following the disturbance.

Table 3. Numbers and percent of fawns tagged in the "chase" area in relation to total numbers tagged, 1965-1974, Radford Army Ammunition Plant.

Year	Total Number Tagged	Number Tagged in Chase Area	Percent of Total
1965	23	9	39
1966	60	19	32
1967	51	20	39
1968	43	17	40
1969	81	35	43
1970	51	17	33
1971	43	16	37
1972	42	10	24
1973	65	14	22
1974	30	13	43

Fawn Production per Doe. No significant difference was found between estimates of fawns per doe made during 1973 and those of any previous year (Table 4).

Calculations of the number of tagged fawns surviving until September (Table 5) reveal that survival rate was slightly lower than usual in 1973. However, this was offset by what appears to have been the largest group of fawns ever born in the enclosure, so that the surviving crop was equal in number to the largest crop previously recorded.

Table 4. Comparison of fawn/doe ratios and 95-percent confidence intervals during 1973 with previous estimates. Data based on Lincoln Index and direct field observations.

Year	Fawns/Doe (Lincoln Index Populations)	Fawns/Doe (Direct Observations) ^a
1967	0.42 + 0.26	0.61 + 0.11
1968	—	0.59 + 0.09
1969	—	0.64 + 0.10
1970	0.58 + 0.11	0.62 + 0.12
1971	0.59 + 0.11	0.55 + 0.07
1972	0.65 + 0.15	0.73 + 0.12
1973	0.56 + 0.10	0.61 + 0.06

^aTo make both ratios comparable, direct field observation ratios were adjusted to correct for the unequal observability of fawns and does measured in other years (Downing et al., in press).

Table 5. Estimates of total fawn production based on the known survival of tagged fawns and Lincoln Index estimates of the number of fawns surviving to September.

Year	Lincoln Index Estimate of September Fawn Crop	Tagged Fawns Surviving (Percent)	Estimated Total Fawn Production (June)
1967	88	78.4	112
1968	132	93.0	142
1969	130	90.1	144
1970	118	92.2	128
1971	116	86.0	135
1972	120	85.4	140
1973	133	80.0	166

DISCUSSION

Home Range Changes

No permanent home range changes caused by dog chasing were observed during this study. Chased deer left their home ranges, but returned in a short time. In fact, the temporary movements were similar to those reported for other types of disturbance (Downing and McGinnes, in press) and for other recorded dog chases (Corbett et al. 1971, and Sweeney et al. 1971). Permanent home range changes were not expected in this study because the enclosure fence prevented long-distance chases and probably contributed to easier homing. The slightly smaller number of young fawns captured for tagging in the more intensively chased area suggests that the does which lived there somehow concealed their fawns more effectively.

Effects of Dogs on Deer Reproduction

Chases during this study were as frequent and as intense as we could make them. During Phase I, almost every deer was run out of the chase area twice each week. During Phase II, every doe probably was run at least once a month, and many more were run more than twice a month. An average chase day would move over 100 deer, most of them adult does and yearlings. Nevertheless, dog chasing had no measurable effect on the productivity of this herd. Most chases were not sustained because of the density of the herd, but the dogs tired and slowed so quickly that the stress probably would not have been appreciably greater if longer chases had been possible.

This conclusion may not apply to hunting situations where several different packs of fresh dogs may be used on the same deer in rapid succession.

A review of the literature on the causes of reproductive failure in farm animals (Ulberg and Burfening 1967) indicates that elevated temperatures, especially immediately following conception, can cause embryo mortality and fetal dwarfing. Temperature elevation caused by dog chasing in the present study is unknown. However, deer always accepted these chases in a relaxed manner, stopping frequently to observe the dogs, and never appeared to be under much stress.

In October 1966, Downing measured rectal temperatures of 12 deer killed while being chased by hunting dogs at Aiken, South Carolina, and found 4 that had temperatures of 42°C (107°F) and above. Yet, Urbston (pers. comm.) has been unable to show a significant reduction in reproduction or a shift in breeding periods as a result of those hunts. It may never be possible to measure the effect on wild herds because individual deer are chased infrequently and because the critical period in the reproductive cycle (of farm animals, at least) appears to be short. Laboratory studies may be necessary to determine if the reproduction of individual deer can be affected by elevated body temperature.

An often expressed concern is that young fawns are easy prey for free-hunting dogs. Dogs used during fawn tagging at Radford Arsenal usually could not scent fawns which were less than 3 days old and usually could not capture fawns more than 2 weeks old. Between these ages, fawns could be scented and were easily caught. However, during this period the fawn is likely to stay hidden rather than run with the mother. The mother seems to encourage the dog to chase her, leaving the fawns in hiding. The fact that we observed no chases of adult deer by neighborhood dogs may indicate that the dogs had learned the futility of such activity. If individual dogs learn not to chase adults, they may have a better chance of finding concealed fawns. Coyotes have apparently learned to find young fawns in Texas (Cook et al. 1971), so perhaps some dogs also learn to find fawns effectively. The fact that survival of tagged fawns at Radford Arsenal often exceeds 90 percent (Table 5) is ample evidence that dogs destroy few fawns in this study area.

We are unable to explain the relatively poor survival of fawns (80 percent) in 1973 (Table 5). However, this poor survival was apparently offset by an exceptionally large fawn crop. Perhaps there were more fawns born than the does were able to feed, thus the larger fawn crop itself contributed to the poorer survival.

CONCLUSIONS

This study dealt only with the effects of dogs on an enclosed, densely populated deer herd where sustained chases could not be maintained. However, because the dogs seemed no match for the deer in either speed or endurance, it is doubtful that these results would have been different at lower densities. Dogs probably cannot catch deer unless the deer are in poor physical condition as a result of disease, old age, injury, or deformity, such as the piebald fawn which the dogs captured. In this instance, dogs probably benefited the herd by removing a genetically inferior individual.

Although dogs can catch young fawns, the problem is not serious because of the protective behavior of the doe and the low probability of dogs finding unattended fawns.

Home range of the white-tailed deer is not often permanently changed by disturbance. This and several previous studies indicate that the disturbance caused by dog chasing is not an exception. Dog chases cause temporary changes in the deers' locations, but once conditions return to normal, deer soon return to their home range.

Fawn production was not significantly affected by dog chases during this study. Deer were chased throughout gestation without measurable adverse effect. Further research under laboratory conditions seems justified because chasing has been demonstrated to elevate body temperature in deer and because elevated body

temperature has been demonstrated to cause embryo mortality during a brief period immediately following conception in domestic ungulates. But even if deer reproduction can be affected by chasing, the critical period may be so brief that a large portion of the herd would have to be chased each day to have any measurable effect.

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