EFFECTS OF FALL ORPHANING ON WHITE-TAILED DEER FAWNS

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Wildlife Management

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May 1974

Blacksburg, Virginia

ACKNOWLEDGEMENTS

Very special appreciation is extended to

and his wife, , whose guidance and friendship were of immeasurable value throughout this study.

To Dr. Burd S. McGinnes, for his assistance, suggestions, and friendship during the last 2 years.

To committee members Dr. H. S. Mosby and Dr. P. F. Scanlon who provided valuable advice and encouragement.

Special thanks are extended to my fellow graduate students and friends, , , , and for the many hours of assistance they contributed in tagging fawns, gathering data, and capturing does.

To my parents and parents-in-law who provided financial assistance and much needed encouragement.

Immeasurable appreciation is extended to my loving wife and daughters who endured many early hours and lonely evenings throughout this study. Their encouragement and support were the foundation for the successful completion of this degree.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

For most state game agencies, the successful management of their white-tailed deer (Odocoileus virginianus) herds is of paramount importance because the agency's reputation is often determined by the quality and quantity of deer hunting it provides. The scientific regulation of deer populations requires consideration of the needs of the hunting public, the economics of agriculture and timber production, and the biology of the deer themselves.

Removal of does is usually necessary to adjust population size. The public has come to recognize the necessity of this practice because it prevents over-population, starvation, and agricultural crop and forest damage, and because it also provides additional sport hunting. A consequence of removing does, which, based on the bulk of the literature on the subject, has apparently not been considered either by the professional biologist or by the layman, is the fate of fawns that are orphaned during antlerless hunts or from other causes. Do orphaned fawns die? Do they disperse to other areas? Do they remain in the same area and associate normally with other deer? What other behavioral changes occur? These questions have been ignored largely in the past but must be addressed.

Changes in hunting regulations might be needed if it is shown that killing does significantly decreases the chance of fawn survival. If orphaned fawns wander and disperse following the death of their mother, this information may provide a technique to stimulate dispersion of deer from areas having high populations to areas lacking deer. In addition to providing valuable information to the

deer manager, the results of this work will provide a scientific basis for settling humanitarian arguments which may be raised against doe hunting. Knowledge concerning the fate of orphaned fawns is thus an important, but inadequately understood, component of deer management decisions.

This study was designed to determine if fall orphaning causes a change in: 1) the survival rate of fawns, 2) the location of home ranges, and 3) the association of fawns with other deer. Satisfying these objectives should provide a more complete picture of the effects of doe hunting and thus provide a foundation for more intelligent management.

LITERATURE REVIEW

White-tailed Deer

The age of weaning in the white-tailed deer was reported by Severinghaus and Cheatum (1956) as being between 2 and 3 months of age. They claimed that at the age of 2 months fawns were unable to survive if deprived of milk, while by 3 months most fawns could exist independent of their mothers' milk.

There appears to be a difference between the age at which fawns can survive without milk and the time they actually stop nursing. Mohler et al. (1951) cited a letter from W. T. McKean of the South Dakota Department of Game, Fish and Parks that mentioned that 50 percent of the white-tailed does checked in January 1944 were still lactating and 82.6 percent examined in November 1945 were producing milk. Severinghaus and Cheatum (1956) also agreed that many fawns nursed up to 5 months of age.

Although the fawn-doe bond of the white-tailed deer is not as strong as in some of the larger cervids, it is a well documented fact that fawns normally remain with their mother for at least their first winter. Male fawns stay with the adult doe until the next fawning period when they are usually driven away (Michael 1965). Female fawns remain with their mother for at least 1.5 years, except possibly immediately following the birth of the next fawn when yearling deer are forced to remain at a distance (Hawkins 1967). Montgomery (1959) also supported the observation that both male and female fawns remained in the family group for the first winter.

Severinghaus and Cheatum (1956:136) reported that although fawns do stay with their mother, the maternal bond is not strong enough to keep the does from driving them away from a limited food supply. In summarizing the relationship during the first winter they claimed that, "...by early fall and certainly by the onset of winter the maternal instincts have waned. The fawns tag along for company, the older deer tolerating them as long as they do not interfere with their activities." Studies on the social organization of deer at winter cuttings substantiated the subordinate position of fawns in competing for food (Ozoga 1972). Out of 89 interactions observed, fawns were subordinate to does in 85. Among fawns the dominance of males was ranked higher than females.

References pertaining to the fate of orphaned fawns fall into one of two categories: those that describe fawns orphaned while still nursing, and those orphaned post-weaning. Severinghaus and Cheatum (1956) stated that in the wild, adoption sometimes occurred during the lactation period. Four attempts to have young fawns adopted by nursing does under penned conditions resulted in two successful adoptions (Severinghaus 1949). Palmer (1951) mentioned an orphaned female fawn that he received in the spring of 1934. The fawn was bottle-fed for a few weeks, released, and adopted by a wild doe which already had a fawn. Not all such instances result in a successful adoption. An attempt in 1949 to have an orphaned buck fawn adopted into the same local herd failed at first. The fawn was kicked while trying to associate with other deer and sustained a broken leg. He was nursed back to health, released in mid-September,

and was gradually integrated into the herd. McGinnes and Downing (1969) reported one positive instance of an abandoned fawn being adopted by a doe with a fawn of her own.

Published research seems to indicate that the survival of fawns orphaned during the fall is the same as non-orphaned fawns even though the social impact was not totally understood. Thomas et al. (1965:317) reported that following antlerless deer hunts in Texas, "...we rarely saw does or fawns traveling alone. It was apparent that these deer had attached themselves almost immediately to social groups headed by adults...however, we did observe fawns to attach themselves to groups of normal males, and, in two instances, to groups of 'velvet horns'."

Hawkins (1967:23) studied the social organization of deer on the Crab Orchard National Wildlife Refuge in Illinois and stated that, "There was little evidence during this study that orphan fawns attached themselves permanently to unrelated family groups. They were randomly associated with several family groups, especially during feeding; but, orphan twin fawns stayed together as a family. When an adult doe dies the remaining members stayed together and continued to function as a family in the absence of the adult doe."

Ozoga (1972) mentioned the behavior of a particular fawn as being unusual in that it frequently associated with four different does. He did not suggest a reason for this behavior, but since there appeared to be no strong attachment to any one doe this may have been an orphaned deer.

Mule Deer and Black-tailed Deer

The available information concerning the weaning of mule deer (Odocoileus hemionus hemionus) fawns leaves some doubt as to whether or not they are weaned prior to the hunting season. McLean (1940) claimed that fawns were weaned by the time they were 2 or 3 months old. Dixon (1934) also believed that fawns were weaned when about 60 to 75 days old or by mid-September. Yet, he reported an example of a doe that was nursing twin fawns in December. Dixon felt that since they had not yet learned to obtain food from other sources, the death of the mother would have made their survival doubtful. In providing evidence of a longer lactation period, Mohler et al. (1951) reported that of those does 2.5 years of age and older examined in Nebraska during the hunting season, 41 percent were still lactating. They also cited a letter from W. T. McKean of the South Dakota Department of Game, Fish, and Parks which reported that 50 percent of the mule deer does he examined in January 1944 were lactating, and 70 percent of those checked in November 1945 were still lactating.

Estimates vary as to the duration of fawn-mother associations and the strength of the associations. McLean (1940) stated that 15 to 16 months was the length of association. The bond between doe and fawn was considered weak by Long (1940:180) who commented that, "Fawns are inclined to stay with their mothers through the first winter, although the relationship is a loose one." Dasmann and Taber (1956:149) claimed that the young remained with the family

group for 2 years and that this long association provided, "...opportunity for them to learn much from their mother." They believed that home range and migration behavior were learned during this period.

Taber and Dasmann (1954) reported differences in the behavior and survival of male and female Columbian black-tailed deer fawns (Odocoileus hemionus columbianus). They claimed that male fawns were more independent than females, spent less time with the mother, and wandered extensively, investigating new situations. Doe fawns, on the other hand, remained close to the mother and were more dependent on the doe for learning to survive. This resulted in a higher mortality of buck fawns due to accidents and predation. Thus, if orphaning affects behavior or mortality rates, female fawns would be more likely to suffer from the loss of their mother. This is assuming that fawn mortality is not caused by premature weaning. Taber and Dasmann (1954) also mentioned that more males under 18 months of age died of starvation during the winter than females. If fawn mortality was the result of starvation caused by early weaning, the higher metabolic rate of the male fawns would place them at a disadvantage.

Direct comments concerning the fate of orphaned mule deer fawns are rare. Robinette (1966:345) expressed the opinion that, "Even fawns orphaned during the hunt apparently attach themselves to another doe or group of does and fawns."

Swenson (1972) is the only worker to study experimentally the effects of orphaning on fawns. Working in Colorado, he orphaned 9

fawns between the ages of 5 and 9 weeks. Eleven fawns were left with their mothers as a control. All fawns were observed until they were 3 to 4 months old. He observed no adoptions by other does and found that orphaned fawns younger than 6 weeks died and those older than 6 weeks survived.

Moose

The social organization of the North American moose (Alces alces) is characterized by intolerance among individuals and a subsequent lack of herd formation. Peterson (1955:57) reported that only 15.4 percent of moose cows produced twins. Thus it appears that orphaned moose calves, since they are not familiar with any adult moose, and usually have no siblings, may suffer greatly from the loss of their dam.

Altmann (1958:158) claimed maternal guidance was an important factor during the calf's first winter, especially in the selection of shelter, feeding places, and in safety and flight decisions. She stated that, "It is a known fact that if the dam is killed the moose-calf rarely survives the winter. Guidance and protection are still needed by the moose-calf. The winter group in moose does not take care of an orphan moose-calf...." This mortality of orphaned calves may be explained by the fact that since the calf shares the social ranking of the dam, the orphaned calf relinquishes that ranking and thus suffers during the winter when competition for a limited food supply is crucial.

LeResche (1968) found abandonment to be an important mortality factor in calves less than 2 to 4 weeks old, and thought that a lack of maternal care later in life may also cause some calf mortality. He later stated that he believed orphan moose calves survived and mentioned that new populations have been established by stocking orphaned calves (letter dated May 7, 1973, State of Alaska, Department of Fish and Game). Although he did not suggest what happened to orphaned calves, Goddard (1970:443) reported that, "Unless orphaned, the movement of the calf during its first year of life is governed by the movement of the cow."

Elk

The elk (Cervus canadensis), in contrast to the moose, displays a herding behavior that is a major influence in the life of the calf. Johnson (1951:405) pointed out the extent of herd cooperation by reporting an instance when 13 calves were accompanied by 4 cows; he felt that the cows were functioning as guards or "baby-sitters" while the rest of the herd fed elsewhere.

During the weaning period, the calf was gradually integrated into the herd and developed an attachment to the total group. Altmann (1963) established that even though weaned, the elk calf was still dependent on the cow for selection of feeding sites, for the timing of daily activities, for leadership in social interactions, and for guidance in dangerous situations. Within the herd the elk calf shared the social rank of its mother. "For example, in a hailstorm the calf of a high-ranking elk cow will enter the

shelter-tree group with its mother, whereas yearling and other lesser elk remain outside. The elk mother sees to it that its calf is not threatened by other elk" (Altmann 1963:240).

Murie (1951:191) in commenting on the opinion that many calves lost during the winter died as a result of fall orphaning, refuted the idea on a nutritional basis by pointing out that calves start consuming grass during July and August and are weaned by the start of winter. Even though winter calf mortality begins in February, he did not believe it was related to nutrition. Since he had no way of knowing which calves were orphans and offered no explanation for the winter mortality, the influence of fall orphaning on elk remains unknown.

Red Deer

The European red deer (Cervus elaphus) differs from the elk in that maternal care may extend into the third year, with lactation occurring for 1 whole year (Darling 1937). There seems to be little chance of survival of calves that lose their dams during the first winter. However, Darling (1937:183) noted that some controversy does exist concerning the 12-month lactation period. Since few hinds are intentionally shot during the hunting season, the total significance of lactation may be inadequately understood because of the small number of cows examined.

Caribou

Bergerud (1971) studied a hunted population of Newfoundland caribou (Rangifer caribou) and reported only 7 percent of total calf

mortality occurred during the winter. Thus it seems that fall orphaning has little influence on winter survival of Newfoundland caribou calves. Harper (1955) presented conflicting opinions concerning the fate of orphaned calves of the barren-ground caribou (Rangifer arcticus). Some observers believed that orphaned calves can not survive, while others reported that cows adopt orphaned calves. Since barren-ground caribou calves are weaned by the time they are 3 to 4 weeks old (Kelsall 1968) the nutritional impact of fall orphaning is probably minimal.

Pronghorn Antelope

Bromley and O'Gara (1967) reported that 2 male pronghorn antelope (Antilocapra americana) kids which were orphaned at 7 weeks of age retained their social rank among other kids and survived until at least February of their first winter.

Bears

Knowledge and opinions concerning the effects of orphaning are not confined to the Artiodactyla but also include other big game species, particularly those members of the family Ursidae. One of the most common bear hunting laws is the regulation that prohibits the killing of a female bear if she is accompanied by 1 or more cubs. The basic premise underlying this law is that bear cubs that are orphaned before they are independent of maternal guidance are unable to survive, especially during their first fall when they are only 6 to 7 months old. Contrary to tradition, recent evidence indicates that bear cubs are able to survive when orphaned before 1 year of age.

In a controlled experiment in Michigan, Erickson (1959) found that orphaned black bear (Ursus americana) cubs survived as well as those that remained with their mother. There was no sexual difference in the ability of orphaned cubs to survive. Cubs as young as 5½ months and as small as 18 pounds became self-sufficient when removed from their mothers. In Alaska, Johnson and LeRoux (1973) reported that a 57 pound, 7½-month-old brown/grizzly bear (Ursus arctos) cub was orphaned and released on August 25, 1970, in an uninhabited area. The animal survived for 12 months until it was illegally killed on August 24, 1971. Craighead and Craighead (1972) presented data on hibernating grizzly bears which included an orphaned cub that successfully hibernated and survived its first winter.

TECHNIQUES AND PROCEDURES

Study Area

This investigation was conducted in the 826-hectare (2,040 acre) enclosure at the Radford Army Ammunition Plant, Dublin, Virginia. The area is surrounded by a 2.28-meter-high (7.5 feet) cyclone fence topped with barbed wire. The habitat is mostly rolling, abandoned pastureland with small patches of hardwoods (*Quercus* spp. and *Carya* spp.), scattered cedars (*Juniperus virginianus*), and an 81-hectare (200-acre) plantation of shortleaf pine (*Pinus echinata*). Primary grasses include orchard grass (*Dactylis glomerata*), rye grass (*Lolium perenne*), and fescues (*Festuca* spp.). Approximately 90 percent of the area is visible from the extensive network of roads.

Investigational Techniques

From the middle of May until the middle of June 1973, 65 fawns were captured and marked using techniques described by Downing and McGinnes (1969). Since a large number of deer had been marked by ear streamers and ear tags in previous years, an attempt was made to determine whether or not the mother of a captured fawn was tagged, and when possible, her identification was recorded. This identification was made to facilitate removal of does at a later date.

Starting in July 1973, observations were made on tagged fawns. Data recorded included the location of the fawn, the number, sex, and age of deer associated with the fawn, and the identification of any tagged deer. Location data were recorded by estimating, in 23-meter (25-yard) intervals, the distance of a fawn from the nearest

bunker. A center of activity was plotted using the method described by Hayne (1949:6). To determine the effect of orphaning on the location of the home range, the change in the center of activity was measured. Since by fall some of the fawns had not been seen sufficiently often to determine accurately their home range, only those fawns with a large number of sightings were considered eligible for orphaning. Twenty-one fawns were randomly selected for orphaning and 18 fawns designated as controls. Orphaning was simulated by the removal and relocation of the fawns' mothers to a portion of the Jefferson National Forest 27 kilometers (17 miles) from the study area. Removal began on September 20, 1973, and was completed on November 11, 1973. The median orphaning date was October 16, 1973. Does were immobilized by means of Pneu-Darts (Pneu-Dart Inc., Williamsport, Pennsylvania) containing succinylcholine chloride (Liscinsky et al. 1969).

The recording of observations on all fawns, orphaned and controls, continued through March 1974. Following the observation period, home range maps were made for all tagged fawns. Separate maps were plotted for each orphaned fawn for the periods before and after orphaning to determine if the removal of the mother caused a change in the location of the home range. Comparative maps for the non-orphaned fawns were plotted using data collected prior to, and following, the median orphaning date.

Association with other deer was analyzed to determine if orphaning caused a change in the social life and behavior of the fawn. The major factors considered were the fawns' participation

in groups prior to and following orphaning, and the social role which siblings play in modifying this behavior.

RESULTS

Survival

Under the conditions of this study, fall orphaning did not have any influence on the survival of fawns. All of the fawns, both orphans and controls, were alive at the conclusion of the study in March 1974.

Of the 65 fawns tagged in June, 13 (20 percent) did not survive the period from tagging until observations began in July. Only 2 fawns were known to have died during the winter. One was an untagged buck fawn which was found in early February. He had apparently died after falling from a 3-meter-high (10-foot) bunker onto concrete. The other fawn was also a buck and was one of the tagged fawns which, due to insufficient data, had not been included in the study. This fawn was found on February 22nd, 1974. The cause of death was not determined.

Changes in Center of Activity

The center of activity was determined for 18 of 21 orphaned fawns. One fawn was not used because of insufficient data, and a set of twins was omitted because their home range was located in the large pine plantation which limited the opportunity to observe their entire range. Eighteen non-orphaned fawns were selected as controls. Since the Virginia Game Commission removed between 100 and 150 deer during the winter it was impossible to tell which of the control fawns had also been orphaned, and the comparison of orphans to controls was

terminated on December 31, 1973. Table 1 summarizes the shifts in the center of activity.

The mean shift in center of activity for orphans was 216 meters (range 23 to 617). The mean change for the non-orphaned group was 172 meters (range 46 to 366). Although there was a 44-meter difference in the average shift, this degree of shifting was not significant ($0.50 > P > 0.10$).

The mean change for those orphans accompanied by other fawns was 206 meters (range 69 to 411) while those without siblings shifted an average of 233 meters (range 23 to 617). Non-orphaned fawns that were associated with siblings made an average 172-meter shift (range 91 to 343) while those without siblings made an average shift of 170 meters (range 46 to 366). None of these shifts was significantly different ($P < 0.50$).

Female orphaned fawns displayed a significantly greater shift in the center of activity ($P < 0.05$) than male orphans. Doe fawns shifted an average of 324 meters while buck fawns averaged a 162-meter shift. Considering the influence of siblings it was found that the high average shift of females was due to a difference ($P < 0.02$) in those fawns without siblings. Doe fawns without a sibling shifted 370 meters while buck fawns without a sibling shifted 118 meters.

Changes in Association

Differences in association were based on the average number of deer seen with a tagged fawn per sighting. Due to insufficient data, 2 orphaned fawns and 1 non-orphaned fawn were omitted from the

Table 1. Mean shift in meters (± S.D.) of the center of activity of orphan and control fawns following orphaning in the Radford Arsenal, July through December 1973.

	Orphans		Controls	
	With siblings	Without siblings	With siblings	Without siblings
No. fawns	6	11	4	11
Mean shift	206 ± 126	233 ± 179	172 ± 116	170 ± 114
Range	69--411	23--617	91--343	46--366

analysis, leaving a total of 19 orphans and 18 non-orphans. Comparisons were made on the basis of the average total number of deer seen; this was then segregated into the categories of fawns, does, bucks, and unidentified deer (Table 2). These figures were further separated on the basis of whether or not a tagged fawn had a twin (Table 3). A two-tailed "t" test was used to compare group size data.

The average number of deer seen with an orphan decreased slightly, but not significantly, from 2.33 prior to orphaning to 2.20 following the removal of the mother. During the same time period, the group size associated with non-orphaned fawns increased significantly ($P < 0.01$) from 2.01 to 2.66. As illustrated in Table 2 the stability associated with the orphaned fawn group size was due to a significant ($P < 0.01$) decrease in the number of adult does (1.49 to 0.82) which was compensated for by a significant ($P < 0.01$) increase in the number of fawns (0.66 to 0.99) and bucks (0.16 to 0.38). On the other hand, the increase in group size of non-orphaned fawns was caused by significant increases in both does (1.39 to 1.72, $P < 0.02$) and fawns (0.40 to 0.70, $P < 0.01$).

Considered from the viewpoint of what percentage of the groups were composed of fawns, does, and bucks (Table 4), the groups associated with orphaned fawns changed from 28 percent fawns, 64 percent does, and 7 percent bucks, to 45 percent fawns, 37 percent does, and 17 percent bucks. Non-orphaned groups, despite the total increase, remained relatively stable as far as the composition of the various classes was concerned. They changed from 20 percent

Table 2. Mean number (± S.D.) of deer associated with orphan and control fawns prior to and following orphaning in the Radford Arsenal, July through December 1973.

	Orphans*		Controls**	
	Pre	Post	Pre	Post
No. observations	264	195	187	166
Mean no. deer per observation				
Total	2.33 ± 1.80	2.20 ± 2.40	2.01 ± 1.49	2.66 ± 2.03
Fawns	0.66 ± 0.73	0.99 ± 1.05	0.40 ± 0.58	0.70 ± 0.86
Does	1.49 ± 1.26	0.82 ± 1.35	1.39 ± 1.06	1.72 ± 1.40
Bucks	0.16	0.38	0.18	0.22
Unknown	0.03	0.01	0.04	0.02

* Based on 19 fawns.
** Based on 18 fawns.

Table 3. Mean number (± S.D.) of deer associated with orphan and control fawns segregated on the basis of the presence of a sibling, Radford Arsenal, July through December 1973.

	Orphans				Controls			
	With siblings*		Without siblings**		With siblings***		Without siblings****	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
No. observations	127	91	126	91	40	50	120	96
Mean no. deer per observation								
Total	2.62 ± 1.76	1.88 ± 1.44	2.01 ± 1.71	2.51 ± 3.04	2.13 ± 1.34	2.70 ± 1.93	1.91 ± 1.50	2.54 ± 2.56
Fawns	0.99 ± 0.64	1.27 ± 0.79	0.30 ± 0.40	0.76 ± 1.20	0.75 ± 0.63	0.88 ± 0.66	0.24 ± 0.49	0.54 ± 0.84
Does	1.44 ± 1.28	0.40 ± 0.77	1.54 ± 1.20	1.22 ± 1.65	1.20 ± 0.97	1.50 ± 1.31	1.43 ± 1.04	1.80 ± 1.37
Bucks	0.19	0.21	0.11	0.51	0.18	0.32	0.20	0.16
Unknown	0.00	0.00	0.06	0.02	0.00	0.00	0.03	0.04

* Based on 8 fawns.
** Based on 10 fawns.
*** Based on 4 fawns.
**** Based on 12 fawns.

Table 4. Percentage composition of groups associated with orphan and control fawns prior to and following orphaning in the Radford Arsenal, July through December 1973.

	Orphans*		Controls**	
	Pre	Post	Pre	Post
No. observations	264	195	187	166
Percent of total group				
Fawns	28	45	20	26
Does	64	37	69	64
Bucks	7	17	9	8
Unknown	1	1	2	1

* Based on 19 fawns.

** Based on 18 fawns.

fawns, 69 percent does, and 9 percent bucks, to 26 percent fawns, 64 percent does, and 8 percent bucks.

Considering the data in light of the presence of a contemporary sibling, the greatest change in total group size was exhibited by those orphans that had a twin (Tables 3 and 5). They experienced a significant ($P < 0.01$) decrease from 2.62 to 1.88, caused mainly by the decrease ($P < 0.01$) in does from 1.44 (55 percent) to 0.40 (21 percent). In partial compensation for the decrease in does, there was an increase ($P < 0.01$) in the number of fawns from 0.99 (38 percent) to 1.27 (68 percent).

The total group size of orphans without siblings increased slightly from 2.01 to 2.51 but was not significantly different from non-orphans without siblings, 1.91 to 2.54. Nevertheless, the composition of groups differed between orphans without siblings and non-orphans without siblings. The former displayed an increase ($P < 0.01$) in association with fawns from 0.30 (15 percent) to 0.76 (30 percent); a non-significant decrease in does from 1.54 (77 percent) to 1.22 (49 percent); and a significant increase ($P < 0.01$) in association with bucks from 0.11 (6 percent) to 0.51 (20 percent). Non-orphaned fawns without siblings experienced proportional increases in association with fawns, 0.24 (13 percent) to 0.54 (21 percent)($P < 0.01$), and does, 1.43 (75 percent) to 1.80 (71 percent) ($P < 0.05$), while the association with bucks decreased from 0.20 (10 percent) to 0.16 (6 percent).

Non-orphans with siblings displayed the greatest stability. They experienced non-significant increases in total group size, 2.13 to

Table 5. Percentage composition of groups associated with orphan and control fawns segregated on the basis of the presence of a sibling, Radford Arsenal, July through December 1973.

	Orphans				Controls			
	With siblings*		Without siblings**		With siblings***		Without siblings****	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
No. observations	127	91	126	91	40	50	120	96
Percent of total group								
Fawns	38	68	15	30	35	33	13	21
Does	55	21	77	49	56	56	75	71
Bucks	7	11	6	20	8	12	10	6
Unknown	0	0	3	1	0	0	2	2

* Based on 8 fawns.
** Based on 10 fawns.
*** Based on 4 fawns.
**** Based on 12 fawns.

2.70; fawn associations, 0.75 (35 percent) to 0.88 (33 percent); and doe associations, 1.20 (56 percent) to 1.50 (56 percent).

DISCUSSION

Survival

Fawn mortality was very low during the fall and early winter. All of the 21 orphaned fawns and the 18 control fawns were alive as of March 31, 1974. During the fall 3 tagged fawns disappeared. Two were last seen in September prior to the orphaning period and 1 was last observed on October 12, 1973. This fawn had, at last sighting, lost the tags from 1 ear so that its disappearance, as well as that of the other 2 fawns, may have been due to tag loss rather than death.

Most fawn mortality in the Radford Arsenal takes place during June and July. McGinnes and Downing (1969:190) reported that 11.2 percent of the fawns tagged from 1965 to 1969 died during the 2 months following birth. In the present study 12 of the 65 fawns tagged in the spring were never seen following release. In addition, 1 was found dead of undetermined causes on June 14, 1973. Thus the 20 percent mortality recorded during this study is high compared to past averages but is not completely out of line since McGinnes and Downing recorded 23.5 percent mortality in 1967.

Following the orphaning period there were 49 tagged fawns remaining on the study area. Of these, 21 were orphans, 18 were designated as controls, and 10 were not seen often enough to justify their use as experimental animals. The total estimated density of deer on the area in September reported by Gavitt (1973:43) was 1 deer per 2 hectares (5 acres).

The nutritional independence of the fawns was obviously established by the time they were orphaned. This is in agreement with Severinghaus and Cheatum (1956:73) who reported that weaning occurred between the 2nd and 3rd month of life. Mohler et al. (1951:144) and Severinghaus and Cheatum (1956:74) both claimed that fawns may nurse for as long as 5 or 6 months. Scanlon and Urbston (unpublished data) found that of 339 does examined during December in South Carolina, 159 (53.10 percent) still had milk in their mammary tissue, indicating that they had recently nursed fawns. In support of these observations, all of the 7 does killed during the orphaning portion of this study had milk in their mammary tissue. Fawns were obviously capable of surviving without milk, but they apparently continue to nurse into late fall or early winter. The significance of this prolonged nursing behavior is unknown.

It should be noted that the enclosed study area may be unusually conducive to high survival. During this study no hunting was allowed on the area and security measures eliminated illegal removal.

In addition, the area did not contain any predators capable of causing significant mortality. Dogs were frequently seen in the enclosure, but recent work by Gavitt (1973:44) on this deer herd demonstrated that dogs are not detrimental to this deer population. It is quite possible that the exceptionally high density of deer prevented dogs from chasing an individual deer long enough to do any harm (Gavitt 1973:43).

Security personnel reported to the author that bobcats (Lynx rufus) were frequently seen in the pine plantation. R. E. Mirarchi

(pers. comm.) also mentioned a possible sighting of a bobcat within the enclosure. Since both of these reports are unverified and no sign of bobcat kills was found, the presence of bobcats in the study area is questionable.

Most deer mortality in the Arsenal is caused by collisions with trucks and falls from bunkers. One control fawn was captured on January 18, 1974. The fawn had a broken front leg and it was suspected that it was either hit by a truck or struck by the falling door of a deer trap. The fawn survived its injury and was still alive at the end of March 1974.

In many northern states, whitetails display migratory movements to reach adequate food and shelter during the winter months (Carlsen and Farmes 1957; Rongstad and Tester 1969; Sparrowe and Springer 1970; Verme 1973). This movement usually occurs between the hunting season and early winter and is controlled mainly by temperature.

Under the highly competitive situation caused by a limited food supply, there seems to be little to suggest that orphans are at a greater disadvantage than other fawns since Ozoga (1972:865) reported that all fawns were dominated by older deer. Even though subordinate deer were permitted to feed, they suffered during periods of limited food, and along with old does made up the bulk of the winter mortality.

In addition to documenting the movement of deer from their summer to winter areas, Verme (1973:550) cited trapping data that reported the homing ability of deer which had been relocated from yarding areas. Of 192 deer that were trapped and moved, 47 were

subsequently recaptured at the same yard during the same year or the following winter. But, of 78 fawns among the relocated deer, only 2 successfully returned. This suggests that movement from summer range to the wintering area may be learned behavior. In support of this conclusion, Dasmann and Taber (1956:149) believed that the migratory behavior of Columbian black-tailed deer was learned from adults.

This raises the question of what happens to fawns that are orphaned during the hunting season. The results of this study indicate that orphans without siblings may learn the proper behavior because they associate regularly with adult deer. On the other hand, orphans with siblings associated mainly with their twin or other orphans and did not have adult guidance, and thus might not be able to find their way to the shelter and food of the winter yard. As an example, a set of orphaned twins in this study associated almost exclusively with another orphaned fawn. If migratory behavior is learned, I would question the ability of these 3 fawns effectively to survive a difficult winter under northern climatic conditions.

In addition, orphans might have to contend with other dangers. The major predator on deer in the Southeast is the free-running dog and in some areas the bobcat. Barick (1969:29) reported that an estimated 6 percent of the annual deer mortality in the Southeast was due to dogs and 2 percent due to bobcat predation. He also mentioned that an estimated 63 percent of the annual mortality resulted from legal hunting and 20 percent from illegal shooting. Since on this area there is a lack of hunting and predation, and

since the food supply is evenly distributed, the total effect of orphaning on survival can not be completely evaluated or compared to other areas.

Changes in Center of Activity

Orphaning appeared to have a minimal effect on the fawns' home ranges. As measured by shifts in the center of activity (Hayne 1946:6), no fawn displayed a marked change in home range. The largest shift was 617 meters and the smallest change was 23 meters, both of which involved orphaned fawns.

Orphans displayed a numerically larger (non-significant) average shift than non-orphans; 216 meters compared to 172 meters. In the control group the difference between those fawns with siblings and those without siblings was negligible; 172 meters compared to 170 meters. Orphans with siblings changed an average of 206 meters, while orphans without siblings shifted an average of 233 meters, also non-significant. The impact of orphaning on the location of the home range, although not greatly significant, is important to subsequent discussions.

Disturbances frequently force deer to leave the safety of familiar territory. Sparrowe and Springer (1970:424) reported that in South Dakota deer moved as much as 16 kilometers (10 miles) in response to heavy hunting pressure. In New York Schoonmaker (1938: 504) also noted that hunting frequently forced deer from their home range. During archery hunts in the Radford Arsenal, Downing et al. (1969:22) reported that two-thirds of the deer under study moved

outside of their home range on hunt days.

Free-running dogs and legal deer hunting with dogs have also been cited as factors responsible for deer leaving their normal range. Sweeney et al. (1971:715) chased radio-monitored whitetails in Alabama, Florida, and South Carolina. They found that in 65 chases 51 deer left their home range. In the mountains of North Carolina Corbett et al. (1971:73) reported that during 20 dog chases 70 percent of the deer left their home range and in most cases moved more than 1.6 kilometers (1 mile) beyond the home range boundary. Gavitt (1973:45) chased deer in the Radford Arsenal and found that deer were not adverse to leaving their home range.

It should be noted that all of the authors that reported deer being forced out of their range either by hunting or dog activity agreed that the deer usually returned within a short time and only in a very rare case did a permanent change in home range occur. The time required to return ranged from 2½ hours to 7 days (Corbett et al. 1971:73) and most workers mentioned that deer returned within a day or 2.

This leads to the question of what happens to fawns which are orphaned while outside their home range. This possibility is greatest during hunts involving dogs or in situations such as described by Sparrowe and Springer (1970:424) in South Dakota where protective cover is widely dispersed and deer are forced to travel long distances in attempting to escape.

A fawn attempting to home without the guidance of its mother may be more vulnerable to hunters. It is also possible that hunting

pressure or associating with deer from other areas may result in the fawn establishing a new home range. Since under the conditions of this study no disturbance factors operated which would have normally caused the deer to leave their home range, additional research is needed to determine the fate of fawns which lose their mothers while out of their home range.

Association

This study confirms the findings of others that most fawns seek the company of other deer. Prior to orphaning, 31 of the 264 observations (11 percent) consisted of a single fawn. Orphaning had little effect on this since 28 of 195 observations (14 percent) following orphaning were of a fawn by itself. The control group was similar in that 25 of 187 observations (13 percent) before the median orphaning date were of a single fawn, while 26 of 266 (12 percent) seen following the median orphaning date were alone. These figures are high in comparison to Dasmann and Taber (1956:148) who reported that of 1,057 observations of groups of black-tailed deer only 1 to 6 percent were composed of a single fawn. This discrepancy was probably due to the fact that they recorded all deer groups while this study was concerned only with those which contained tagged fawns.

Other authors have commented on the effect of orphaning on group behavior. Thomas et al. (1965:317) commented that they rarely saw fawns alone following antlerless hunts. They felt that young animals which were dispersed by hunting attached themselves to

other social groups. In reporting on mule deer Robinette (1966:345) mentioned that "Even fawns orphaned during the hunt apparently attach themselves to another doe or group of does and fawns."

Due to unexplained differences in the mean group size between orphans and controls prior to orphaning only the direction and magnitude of changes will be considered in discussing the influence of orphaning. The most interesting impact of orphaning on social behavior was the difference in how those fawns with siblings and those without siblings associated with other deer. The mean number of deer associated with orphan twins decreased from 2.62 ± 1.76 to 1.88 ± 1.44 following orphaning. The decrease in does from 1.44 ± 1.28 to 0.40 ± 0.77 was primarily due to the removal of the dam. Group size and standard deviations of the other 3 categories (orphans without siblings, controls without siblings, and controls with siblings) increased. In fact, orphans without siblings displayed essentially the same mean number of associated deer as the control group, but the standard deviations, and thus the variability of the group sizes, were much higher. Thus orphans without siblings had joined with other groups, variable in both size and composition.

The 2 categories of orphans apparently satisfied their need to associate with other deer in different manners. Those fawns with siblings remained with their twin and associated yearlings, or in some cases another orphan in the same area, while orphans without siblings joined other groups of deer within the home range.

The data collected in this investigation, based on the percentage of does, fawns, and bucks, support this conclusion. The percentage

of fawns, does, and bucks in groups with control fawns remained the same throughout the study period. The composition of the orphan groups changed in a similar direction and degree but differed in the manner of the change.

Both groups showed twice the percentage of association with fawns following orphaning. The change in orphans with a twin (38 to 68 percent) was caused by the removal of the doe from the family group while the orphans without siblings (15 to 30 percent) attached themselves to various family groups, many of which included a fawn. The reason for a decrease in the percentage of does (55 to 21) for orphans with a twin is obvious but the orphans without a sibling also dropped about 30 percent (77 to 49). This was caused by increased association with orphaned fawns, family groups of varying sizes, and a large increase in association with adult bucks (6 to 20 percent).

In summarizing this section, it appears that orphans displayed a need to associate with other deer. This need was fulfilled by orphans with siblings through remaining with their twin. Orphans without siblings sought out the company of other available deer.

Home Range Versus the Need to Associate

The behavior of orphaned fawns observed in this study resulted from an apparent conflict between the desire to remain in the home range and the need to associate with other deer. Orphans with siblings were left with a twin which apparently satisfied the need to be with other deer. Orphans without siblings appeared to move around

seeking companionship. The fact that orphans without siblings displayed the largest mean shift in the center of activity indicated that they were willing to move to some extent to locate or associate with other deer. This difference in the shift in center of activity between orphans without twins and those with twins was due to a significantly greater shift by female fawns. As mentioned previously, orphaned doe fawns without siblings shifted an average of 324 meters while buck fawns under the same conditions shifted 162 meters. Thus it seems that doe fawns have a greater desire to associate with other deer and are willing to move a greater distance from familiar territory to satisfy that need. Taber and Dasmann (1954:311) lend support to this conclusion. They found that buck fawns strayed further than doe fawns from their mother and exhibited a weaker attachment to the family group.

Orphans without siblings probably associated with deer whose home ranges overlapped a portion of their own range. It is suspected that when traveling with such groups, a point was reached at which, as the group or individual moved out of the fawn's range, the desire to remain in familiar territory overcame the need to follow other deer and the fawn returned to its range where it sought the company of other deer.

The sex and age composition of deer groups sought out for association did not appear to be important since orphaned fawns, adult bucks, and normal family groups all were observed with orphans. This explains the facts that orphans without siblings had the largest shift in center of activity, the largest standard deviations

of mean group sizes following orphaning, only a minor decrease in the mean doe group size, and a large increase in the number of adult bucks encountered.

Both familiarity with the home range and association with other members of the species have survival value. Altmann (1958:158) mentioned that moose calves need the guidance of their dam during the first winter. She also reported (1963:240) that association with other members of the herd is an important part of an elk calf's development. The presence of other individuals also has value in avoiding predators. As mentioned before, Gavitt (1973:43) found that the ability of dogs to significantly harrass individual deer was reduced in a high density situation. This was due to dogs repeatedly switching trails. It also would seem that the ability to avoid predators which stalk their prey would be greater when several individuals move together. This assumption is supported by Hornocker's (1970:24) research which indicated that adult mule deer bucks were more susceptable to mountain lion (Felis concolor) predation since they wintered at higher elevations and were alone more than other deer.

The association of fawns with adult deer during the fall and early winter is probably necessary to provide the learning experiences needed for migration (Dasmann and Taber 1956:149), location of the home range (Byford 1970:58), and the avoidance of hunters. The extension of lactation beyond the point of being nutritionally necessary may also have evolved as a means of maintaining the doe-fawn relationship during this period. This is in accord with

the observation that migratory movements occur late in the fall, well after weaning takes place (Verme 1973:548).

Since the study area held an unusually high density of deer, it was impossible to determine whether orphaned fawns would follow other deer beyond their home ranges. All orphans in the Radford Arsenal had ranges which overlapped with other deer, thus they did not need to move out of their home range to associate with others. In less dense populations, fawns might be faced with a clear choice of remaining alone in their home range, or leaving their range to associate with other deer. There are undoubtedly advantages and disadvantages to either action, and the relative survival value of each may vary according to weather, habitat, predators, and population densities. Obviously, additional research is needed to determine if problems exist under various combinations of these factors.

Management Implications

In northern climates, it may be imperative that orphans leave their home range and accept the leadership of adults to find suitable winter range. Results of this study indicate that fawns are reluctant to join other groups if there is a sibling with which to associate. Thus, managers of northern herds should place high priority on determining if orphaned twins survive as well as other fawns, and if not, consider means of preventing does with twins from being shot.

SUMMARY AND CONCLUSIONS

Fawns which were subjected to simulated orphaning exhibited a survival rate identical to non-orphaned fawns. Thus the results of this research indicate that orphaning has a minimal influence on the ability of fawns to survive.

Orphaning did have a minor influence on the location of the home range. Orphans without siblings displayed a greater shift in their center of activity than any other group. Among orphans without siblings, females exhibited a significantly greater shift than males.

Social interaction with other deer was also affected by the removal of the dam. Orphans with twins tended to remain in the company of their siblings while orphans without siblings sought out the company of other deer.

Orphans, especially doe fawns, displayed a conflict between the need to be with other deer and the desire to remain in familiar territory. Orphaned twins were able to satisfy the need for association by remaining with their sibling and subsequently demonstrated little change in home range. Orphans without siblings displayed a larger shift in home range and thus indicated that they were willing to move farther to seek the company of other deer.

Unfortunately the study area used for this research was unique in that no hunting was allowed, few, if any, predators were present, illegal removal was virtually impossible, the food supply was uniformly distributed, and there was no need to migrate to a different winter range. Thus more research is needed to determine the total impact of orphaning under the wide variety of conditions

which exist in other areas.

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EFFECTS OF FALL ORPHANING ON WHITE-TAILED DEER FAWNS

by

Edward T. Reed

ABSTRACT

This study was conducted in the 826-hectare enclosure at the Radford Army Ammunition Plant, Dublin, Virginia, and was designed to determine the effect of fall orphaning on white-tailed deer fawns (Odocoileus virginianus). Data were collected on: 1) the survival rate of fawns, 2) the location of home ranges, and 3) the association of fawns with other deer.

Twenty-one tagged fawns were orphaned in the fall by immobilizing and removing their mothers. Eighteen fawns were selected as controls. Data were recorded from July 1973 through March 1974, and included the location of the fawns and the number, sex, and age of associated deer.

Under the conditions of this study, fall orphaning did not have any influence on the survival of fawns. All of the fawns were alive at the conclusion of the study in March 1974.

The mean shift in center of activity was 233 meters for orphans without siblings, 206 meters for orphans with siblings, and 171 meters for controls.

Orphans with twins remained together while orphans without siblings sought the company of other deer and associated with a

variety of family groups, orphans, and adult bucks. Shifts in centers of activity and association patterns with other deer indicate that orphaning causes a conflict between the need to remain in familiar territory and a desire to associate with other deer.