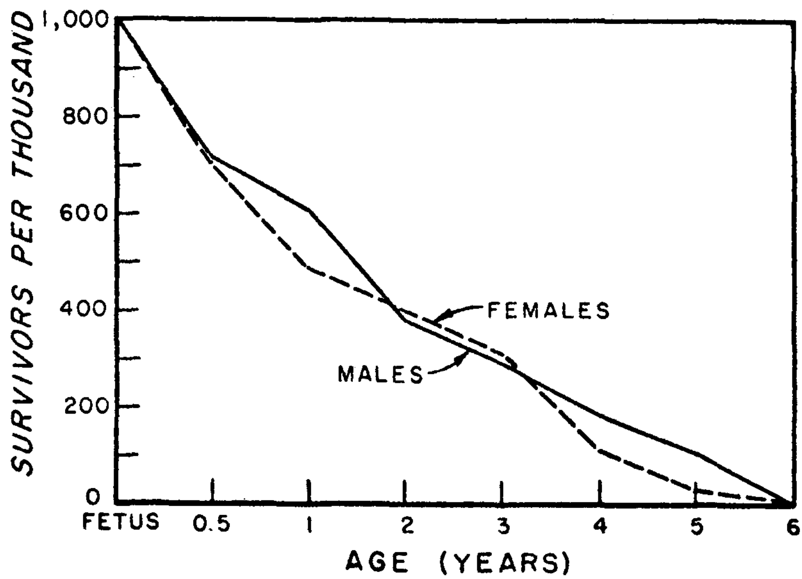

Figure 1. Sec-specific survival curves.

VARIATION IN PEAKS OF FAWNING IN VIRGINIA

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The influence of environmental factors on the timing of the rut and the length of the gestation period in the white-tailed deer *(Odocoileus virginianus)* is poorly understood. Since 1965, we have been recording population data for a confined herd of whitetails in Virginia. Although the peak of the fawn drop appears to be rather consistent from year to year, some variation has occurred during our 8 years of study. This variation led us to examine some factors which might bear on the time of fawning.

Environmental factors as influences on deer reproduction have been studied by several wildlife researchers. McDowell (1970) reported on conception dates of whitetails and concluded that light duration has a powerful influence on breeding periodicity. Cheatum and Morton (1946) found regional differences in the onset of mating between northern and southern New York deer. These differences were believed to be due to latitude, altitude, light intensity, temperature, and other external influences. Cheatum and Morton cited Bis-

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sonette (1941), who observed that the fall breeding season may be hastened by keeping goats in dim light. Severinghaus and Cheatum (1956) discussed the possible influences of light and temperature on the onset of breeding among white-tailed deer and in addition, referred to similar work done on other species. Sadlier (1969) reviewed the effect of temperature, daylight, and nutrition on the breeding cycles of various wild and domestic species.

Verme (1965), in his examination of reproduction in penned whitetails, reported that deer on a high plane of nutrition began breeding 15 days earlier than deer on a low plane of nutrition. One-third of the well-fed deer had bred before the poorly fed deer began to breed. Additionally, well-fed deer averaged 6 days' shorter gestation period. These combined factors resulted in the average fawning date being 12 days earlier in the well-fed deer.

Thanks are due personnel of the Radford Army Ammunition Plant for cooperation in this study. Special gratitude is due Lt. Col. Virgil E. Moore, Jr., Commanding Officer, and graduate students R. Petcher, J. Sandt, F. Kreitzer, R. Poux, J. Gavitt, and C. Smart.

METHODS

The experimental deer herd is within a 2040-acre enclosure of the Radford Army Ammunition Plant, Dublin, Virginia. An 8-foot-high cyclone fence surmounted by barbed wire forms the enclosure. The habitat is rolling abandoned grassland with small isolated stands of mature hardwoods and scattered cedars *(Juniperus* spp.). Approximately 200 acres have been planted to shortleaf pines *(Pinus echinata)*, but few deer use these for cover. The area is traversed by a road system which affords excellent observation over practically the entire enclosure.

Fawns were captured, marked, and released each spring from 1965 to 1972 by the techniques described by Downing and McGinnes (1969). Each of the 411 fawns was aged subjectively according to size, agility, and general condition. We frequently had the opportunity to check the assigned age by making recaptures and aging the animals each time observed, or by observing twin fawns that had been captured at different ages. We believe that the aging was accurate within 2 days in most cases.

Fawns captured over the 8-year period were taken between May 26 and June 20. Median fawn drop peaks were determined from these data for each year. The dates on which capturing was begun did not seem to be important because any fawn up to 10 days of age was captured easily, and we always began capture efforts well before any fawns became too large to capture.

Environmental factors and the median fawning dates were compared by simple linear correlation analysis.

Weather records were obtained from Pulaski, Virginia which is 6 miles from the study site.

RESULTS AND DISCUSSION

Median birth dates for the 411 fawns taken over the 8 years are shown in Table 1. The medium birth date was quite consistent for the first 7 years, but was about 5 days earlier than normal the last year (1972). In our opinion, this was a real difference, since we caught 32 fawns in 1972 which were born before the normal June 1 peak and only 6 born after June 1, even though our late-season capture efforts in 1972 were as intense as in previous years.

Table 1. Median birth dates of whitetail deer fawns, Radford Army Ammunition Plant, Dublin, Virginia, 1965-1972.

Year	No. Captured	Median Birth Date
1965	23	June 1
1966	60	June 2
1967	51	June 2
1968	43	May 31
1969	80	June 2
1970	66	June 1
1971	46	June 1
1972	42	May 27
	411	

Onset of Estrus

The Two major factors influencing birth dates of fawns are the onset of estrus and length of gestation. The onset of estrus is possibly affected by food conditions, by photoperiod, and by the onset of cold weather. There may be other factors, but these are the only ones which we had opportunity to measure.

We did not have direct measures of food supply, but felt justified in using rainfall as an indirect measure of food supply, since the rainfall, in our experience, is a determining factor in the height of vegetation in this area. Mast was not an important food in the area.

Among months, high rainfall for May and June prior to conception appears to be best correlated with early median birth dates (Table 2). Rainfall in May and June 1971 was twice as high as the same months in the other years. High rainfall late in the summer, July and August, was weakly correlated with late fawn births, an apparent contradiction. Perhaps high rainfall in late summer causes late fawn births through the pathway suggested by Verme (1965); that is, an overabundance of food may cause obesity, which in turn delays the onset of estrus.

Photoperiod does not vary from year to year; however, the intensity of light may be modified by cloud cover. Sadlier (1969) stated that, although daylight varies in intensity, the minimum intensity on even very dull and overcast days is still well above light intensities which have been found to be experimentally effective in altering the breeding of mammals. This was the only reference to the effect of cloud cover on the estrus we found in the literature. In spite of this opinion, we included August, September, and October cloud cover as a variable in our correlation analyses. The correlation between sky cover for these months, August, September, and October, and early fawn birth dates was stronger (coefficient, -.854) than any other factor we examined. Apparently deer were very sensitive to this variable; because 1971, the cloudiest year during these months. was only 24 percent cloudier than the least cloudy year, 1966.

Table 2. Simple linear correlation coefficients of weather factors possibly effecting median birth dates of fawns, Radford Army Ammunition Plant, Dublin, Va., 1965-1972.

Factor	Correlation Coefficient
Rain, prior to conception	
April	+.097
May	-.692
June	-.661

July	+.480
August	+.380
April and May	-.516
April, May, June	-.649
April, May, June, July	-.520
May, June	-.802*
May, June, July	-.668
May, June, July, August	-.316
Sky Cover, prior to conception	
August	+.170
September	-.587
October	-.510
August, September	-.480
September, October	-.755*
August, September, October	-.854**
Temperature. Average low prior to conception	
September	-.054
October	-.793*
Number of days of 32° and below prior to conception	
September and October	+.582
October	+.650
Rain, during gestation	
April	-.499
May	-.476
April and May	-.549

* Significant at the .05 level
** Significant at the .01 level

Sadlier (1969) reported evidence that a sudden fall in temperature stimulated libido in the ram and was necessary to start male mating behavior in the red deer *(Cervus elaphus)*. Our evidence agrees more closely with that of Einarson (1956), who reported that *increasing* temperature (as a Chinook) stimulated the onset of rut in the mule deer *(O. hemionus)*. In our data, the correlation coefficient between average minimum October temperatures and median fawn birth dates was -.793. The average low in October 1971 was 6 to 11 degrees warmer than any other year, which may have been responsible for the early fawn birth dates in 1972.

It is possible that does which lose their fawns and are not subjected to the burden of lactation may come into estrus earlier than those which raise fawns. Only in 1967 did we observe abnormally high fawn mortality, approaching 25 percent (Table 3 and McGinnes and Downing 1969). The median fawn birth date for 1968 was one day early. Fawn mortality in 1971 was 14 percent, which is only slightly higher than in other years. We doubt that this was sufficient to cause the early median fawn birth date observed in 1972.

Table 3. Summer fawn mortality rates observed at Radford Army Ammunition Plant, Dublin, Va., 1965-1971.

Year	No. Marked	No. Lost	Percent Mortality
1965	23	1	4.3
1966	60	4	6.7
1967	51	12	23.5
1968	43	3	7.0
1969	81	8	9.9
1970	51	4	7.8
1971	43	6	14.0

Age of the dam could also be a factor in onset of estrus where female fawns breed in their first winter, because such breeding is usually delayed approximately a month beyond the normal rut of the adults. However, only one instance of fawn breeding in the area has been documented in the last 5 years and would not appear to be a factor in this case.

Length of Gestation Period

As was previously discussed, high rainfall in May and June previous to conception appeared to cause early fawning (Table 2), but it is not known if this was due to early conception, short gestation, or both.

Verme (1965:74) said that . . . "famine in the final third of pregnancy is inimical to fetal development." Rainfall as a factor late in gestation was analyzed for the 2 months immediately preceding parturition, and gave a rather weak correlation coefficient, about .500 (Table 2). Apparently rainfall in the latter part of pregnancy had little effect upon birth dates. However, cool season grasses are always fairly abundant at this time, and famine conditions rarely, if ever, exist.

SUMMARY

Three weather factors considered were found to correlate statistically with early median fawn birth dates, these were high rainfall the previous summer, high temperature immediately preceding the rut, and cloudy days in the months immediately preceding the rut. Our data do not indicate which of these factors is the most important. We could not determine that the percentage of fawn mortality (dry does) in previous years had any important effect on fawn birth dates.

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STUDY OF WHITE-TAILED DEER FAWN MORTALITY ON COOKSON HILLS DEER REFUGE EASTERN OKLAHOMA[1]

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Thirty-three white-tailed deer (*Odocoileus virginianus*) fawns 5 to 27 days of age were captured in 1970 through 1972. Movements were monitored during June and July to determine their survival and causes of mortality. Three hundred and thirty-one radio locations were plotted for the 22 fawns monitored. Mortality rates in 1970, 1971 and 1972 were 18, 64 and 45 percent respectively. Eighty-three percent of fawn mortality occurred during the first month of age. Blood loss and gross infection resulting from the feeding of lone star ticks (*Amblyomma americanum*) were associated with the causes of 71 percent of fawn mortality where causes were determined. The decrease in fawn mortality in 1972 followed high mast production in the Fall of 1971. Corresponding to this decreased mortality was an increase in production of both total fawns and twin fawns in 1972 as compared to 1971. Significant correlations were determined between general health of fawns, magnitude of movements, tick loads and survival. Mean tick loads at capture were 57.9 adult ticks for surviving fawns compared to 119.8 for those that died. Fawns that died exhibited more sedentary movements several days prior to death. Area of activity of surviving fawns was 5.5 acres while area of those dying averaged 1.7 acres.

INTRODUCTION

Low productivity and high postnatal fawn mortality has been acknowledged by most big game managers as natural population regulating mechanisms. Studies have repeatedly demonstrated that these factors are responses of populations that are in excess of the carrying capacity of their habitat and they often preclude drastic herd reductions (Allen 1968, Cheatum and Severinghaus 1950, Dahlberg and Guettinger 1956, Dechert 1967, Goodrum 1962, Lewis and Safley 1966, Marbuger and Thomas 1965, Severinghaus 1951, Severinghaus and

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