The Effects of Adult Sex Ratio on Reproduction in White-tailed Deer

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The variation in breeding dates of white-tailed deer is thought to be influenced by nutrition, age, photoperiod, fawn survival during the previous year, climatic factors and adult sex ratio. Deer on the Mt. Holly Plantation, S.C. were harvested from 1981 to 1985 to transform a high density herd with an imbalanced buck to doe ratio to a moderate density herd with a balanced buck to doe ratio. Mean conception dates shifted from 11 Nov. in 1981 to 22 Oct. in 1985. The range of conceptions decreased from 96 days in 1981 to 53 in 1985. Factors other than adult sex ratio did not appear to account for the observed shift in conception dates. The fetal sex ratio shifted from favoring males from 1981 to 1983 to females in 1984 and 1985. Rutting activity, determined by sightings of antlered bucks, was intense during 1983, '84 and '85, peaking at 60 antlered bucks sighted per 100 antlerless deer about 2 weeks prior to the peak of conception.

Factors Affecting the Breeding Season

Regional variations in the breeding season of the white-tailed deer have been demonstrated in numerous studies and several factors have been suggested to influence breeding dates. Age and nutrition are known to affect the onset of estrus in deer. Yearling does (1 1/2 years old) tend to breed a few days later than the average for older animals, and doe fawns breed substantially later (Haugen 1975, Butts et al. 1978, McCullough 1979). Verme (1965) reported that does on a high level of nutrition began breeding 15 days earlier than poorly fed animals. Teer et al. (1965), McGinnes and Downing (1977) and McCullough (1979) also indicated that time of estrus must be controlled to some extent by nutrition. Breeding seasons tend to increase in length from northern to southern latitudes (McDowell 1970, Richter 1981). McGinnes and Downing (1977) suggested that does losing their fawns tend to enter the next breeding season in better shape, thus breeding earlier than those successfully raising fawns.

Imbalanced adult sex ratios also may affect the breeding season of whitetails. Jacobson et al. (1979) suggested that buck:doe ratios were so imbalanced in Mississippi herds that some estrus does were unable to find a buck during the 24-hour period when they were receptive to breeding. Such does would cycle into estrus again one or more times before conceiving, resulting in a later average conception date and a longer breeding season. Gruver et al. (1984) reported that the timing of bucks-only and antlerless deer harvests affected reproductive parameters of Mississippi deer. Delaying the start of buck hunting from mid-November to mid-December increased the proportion of does served on their initial estrus of the season from 0.77 to 0.91 and resulted in a mean fawning date that was 4 days earlier. Decreasing the harvest rate for bucks similarly increased the proportion of does bred on their first estrus.

Problems that could result from imbalanced sex ratios have been reported for Rocky Mountain elk (Follis 1972, Kimball and Wolfe 1974, Prothero et al. 1979). These problems included: (1) later calving with resulting higher overwinter calf mortality; (2) perpetuation of later breeding by cows; and (3) lower pregnancy rates. Clutton-Brock et al. (1982) found that reproductive success was related to birth date in red deer.

The sex ratio of breeding adults also may affect fetal sex ratio. Verme (1981) suggested that white-tailed deer herds with an imbalanced adult sex ratio (more does than bucks) generally produce a preponderance of male fawns. Boissonnas (1935) observed that where red deer stags were greatly harassed by hunters during the rut, the hinds carried a preponderance of male fetuses. In herds with a balanced sex ratio, more females were produced. Nutrition has been shown to affect fetal sex ratio in white-tailed deer (Verme 1969). Does on a low-nutrition diet produced a higher proportion of male fetuses than does on a high-nutrition diet.

This paper concerns the results of a harvesting experiment that altered the adult sex ratio of a deer herd in South Carolina and describes subsequent changes in conception dates and fetal sex ratios.

Study Area

The study area was the 6,250-acre Mt. Holly Plantation located near Charleston, South Carolina. The plantation is owned by ALUMAX of South Carolina and is the site for the Mt. Holly Plant which refines bauxite ore into aluminum ingots. The plantation is currently managed for wildlife, timber and aesthetics. Major habitat types on the area are natural stands of longleaf pine, plantations of loblolly pine, expanses of bottom-land hardwoods and hardwood-cypress bays, stands of mixed hardwoods and pines and agricultural fields.

Prior to the purchase of the Mt. Holly Plantation by ALUMAX in 1979, the deer were hunted by a hunting club. The plantation manager was allowed to hunt on the property from 1979 to 1981 and it is suspected that poaching and the manager's hunting with dogs greatly depleted antlered bucks on the property during this time. From 1982 to the present, deer were harvested as part of a research project to study the population dynamics of the herd.

Harvest Strategy

Prior to 1981, few antlerless deer were harvested on the Mt. Holly Plantation (Table 1). Beginning in 1982, deer were harvested selectively to reduce deer density and balance the sex ratio. The mortality of antlered bucks during 1980 and 1981 is probably underestimated because of the activities of the manager and poaching.

Table 1. Known mortality on the Mt. Holly Plantation, 1980-85.

Year	Antlered bucks	Does	Fawns		Total[a]
			Bucks	Does	
1980	6	6	3	4	19
1981	19	31	11	10	72
1982	15	40	12	16	84
1983	23	27	17	9	77
1984	18	28	6	5	60
1985	11	23	7	3	46

[a]Totals may exceed the sum of bucks, does and fawns as some deer (poaching, highway kills) could not be classified by age and sex.

Selective harvests from 1981 to 1985 transformed a high density population with an imbalanced sex ratio to a moderate density herd with a balanced sex ratio (Table 2). Density estimates were based on pre-hunting season spotlight counts and hunter observations from August 15 to October 1. Buck:doe ratios during and prior to 1983 were based primarily on spotlight counts while those of 1984 and 1985 depended mostly on hunter observations. We suspect that hunters often identified fawns as does and thus the antlered bucks:100 antlerless deer ratio may be a better indicator of sex ratio than the buck:doe ratio. The ratios in 1982 should be viewed with care. Few bucks were removed from the herd between the time of the survey and the rut. This may not have been the case during 1980 and 1981.

Table 2. Density and sex structure estimates for the Mt. Holly deer herd, 1980-85.

Year	Density (acres/ deer)	Sex structure	
		Male:Female	Male:antaler-less deer
1980	6	25:100	13:100
1981	14	- -	- -
1982	22	25:100	14:100
1983	19	75 :100	32:100
1984	28	62:100	31:100
1985	18	45:100	36:100

Conception Dates

Fetuses were aged using the forehead-rump length relationship of Hamilton et al. (1984). Mean conception date was significantly later in 1981 than in 1982, 1983, 1984 or 1985 (Table 3). The range of conception dates decreased from 96 days in 1981 to 53 days in 1985.

The shift in conception dates does not appear to be strictly controlled by nutrition. Increases in body weights, due to the reduction in herd size, did not appear until 1983 (Table 4). Note that although weights of yearling bucks leveled off in 1983, the weights of buck fawns continued to increase through 1985. Antler development of yearling bucks has continued to improve over this period and yearling bucks with six to eight points were common in 1985. This could be a reflection of the decreased range of conception dates.

The shift in conception dates does not appear to have been caused by the age of breeding does. The average age of pregnant does collected on the plantation has declined slightly during the study (Table 5). If age at breeding was an important factor, conception dates should have shifted to later rather than earlier in the year. The incidence of pregnancy increased during the study, as did the mean number of fetuses carried by mature does (>= 2 1/2 years old). The first indication of breeding by doe fawns was observed during 1985.

Table 3. Conception dates and fetal sex ratios for white-tailed deer on the Mt Holly Plantation, S.C. (1981-85).

Year	Number of pregnant does	Mean conception date	Range of conceptions	Fetal sex ratio male:female
1981	16	11 November[a]	6 October - 9 January	64:36[b]
1982	17	21 October	11 September - 21 November	59:41
1983	15	24 October	9 September - 28 November	69:31
1984	24	23 October	24 September - 22 November	48:52
1985	23	22 October	30 September - 21 November	46:54

[a]The mean conception date during 1981 was significantly later than during 1982, 83, 84, or 85 ($P \leq 0.05$).
[b]The combined fatal sex ratio for 1981 to 1983 was significantly different from that for 1984-85 ($P \leq 0.10$).

Table 4. Live weights (lbs.) of deer harvested on the Mt. Holly Plantation, S.C. (1981-1985). Numbers in parenthesis are sample sizes.

Year	Antlered Bucks		Does		Fawns	
	1 1/2	≥ 2 1/2	1 1/2	≥ 2 1/2	Male	Female
1981	91(6)	154(4)	75(4)	100(22)	46(3)	48(9)
1982	90(11)	130(4)	84(8)	101(25)	47(12)	44(15)
1983	112(8)	144(14)	81(3)	106(20)	51(16)	53(9)
1984	111(9)	141(9)	87(5)	104(20)	61(6)	56(5)
1985	111(7)	131(3)	90(3)	111(20)	65(7)	61(3)

Table 5. Fecundity rates of female white-tailed deer on the Mt. Holly Plantation, S. C. (1981-1985).

Year	Mean no. of fetuses/doe			Pregnancy rate	Mean age of pregnant does
	1/2	1 1/2	≥ 2 1/2		
1981	0	1.0	1.64	0.90	4.3
1982	0	1.3	1.77	1.00	3.6
1983	0	1.3	1.73	0.96	4.1
1984	0	1.0	1.79	0.96	3.7
1985	0.3	1.0	1.90	1.00	3.9

Fetal Sex Ratio

The fetal sex ratio of the Mt. Holly herd appears to have changed significantly from 1981 to 1985 (Table 3). These changes may be due to improved nutritional conditions or a more balanced adult sex ratio. Although the effects of the two factors are difficult to separate, it appears that nutrition may be the primary factor as the sex ratio favored females beginning in 1984, one year after a notable increase in weights was observed (Table 4). The combined fetal sex ratio for 1981, 82 and 83 was significantly different ($P<=0.10$) than the combined fetal sex ratio for 1984 and 1985.

Rutting Behavior

Rutting behavior of bucks appeared to increase greatly during the study. As buck age structure improved, the number of rubs and scrapes found on the area increased. The intensity of rutting behavior during the latter half of the study is reflected in hunter observations of antlered bucks. Deer observations peaked during October at about 60 bucks sighted per 100 antlerless deer. Buck observations peaked about 2 weeks prior to the peak of conceptions. These results are consistent with those of Kile and Marchinton (1977).

Conclusions

In addition to being a primary factor affecting the quality of hunting experiences, the adult sex ratio may have important biological implications for the white-tailed deer. It appears that adult sex ratio affects breeding season length and the mean conception date in adult deer. With a balanced sex ratio, estrus does have less difficulty finding a buck during their 24-hour period of breeding receptivity, and fewer does recycle and conceive during subsequent estrus periods. This situation favors a relatively short breeding season and an early mean conception date. Fawns conceived in herds with a balanced buck:doe ratio will be born at the optimal time for their survival and growth. Early-born fawns should exhibit increased body size, antler development, resistance to disease and parasites and reproductive potential.

Fetal sex ratio is affected by nutritional conditions and perhaps by the adult sex ratio. Mean and range of conception dates and fetal sex ratios should be explored as indicators of herd condition and balance of age and sex structure.

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