DISCUSSION

Comparison of the results in Table I indicates that definite differences in time of breeding do exist between some of the herds studied.

Also, these data show results contrary to previous reports that white-tailed deer in southern latitudes breed later than those in northern latitudes. Some of the herds in this state breed earlier than herds in such northern states as New York (Cheatum and Morton 1946).

On a local basis, little difference can be found to substantiate such radical differences in breeding dates. Photoperiod does not seem to be a major factor, for only 12-15 minutes difference in day length occurs between northern and southern extremes. Furthermore, some of the southerly herds in the state breed earlier than the northern herds in the state. Ecological factors offer no substantial reason either.

The only correlation which can be found in the breeding pattern of any of these herds is between the later breeding herds of Delta Refuge, and Tensas Parish. The common factor among these herds is the annual flooding of the Mississippi River which normally occurs in the spring. While flooding does not still occur in Tensas Parish, it did when the herd was started. At Delta Refuge flooding occurs annually. Flooding does not occur at Jackson-Bienville, but because of the deer restocking program this herd is directly descended from the Tensas Parish herd, and could carry this late breeding factor as an inherent characteristic. Possibly all these deer have evolved a race which breed later in the year which in turn would bring about a later fawn drop and thus affect fawn survival.

LITERATURE CITED

Armstrong, R. A. 1950. Fetal development of the northern white-tailed deer (*Odocoileus virginianus borealis*). The American Midland Naturalist. Volume 43(3):650-666.

Cheatum, E. L., and Glenn H. Morton. 1942. Techniques used in determining the period of the rut among white-tailed deer of New York. Trans. North Amer. Wildl. Conf. Vol. 7:334-342.

————, and Glen H. Morton. 1946. Breeding season of white-tailed deer in New York. Journ. Wildl. Manag. 10(3):249-263.

DELINEATION OF THE PERIOD OF RUT AND BREEDING SEASON OF A WHITE-TAILED DEER POPULATION [1]

By R. L. PAYNE,[2] E. E. PROVOST,[3] AND D. F. URBSTON[4]

Presented at the 20th Annual Conference of the Southeastern Association of Game and Fish Commissioners

Asheville, N. C.
October 24-26, 1966

INTRODUCTION

The white-tailed deer (*Odocoileus virginianus*) is undoubtedly one of the most important game species throughout its range. It is of particular importance in the Southeast where deer are the only large game mammals which provide numerous, huntable populations. The astounding reproductive potential of these large herbivores is well-known among wildlife biologists. One of the best documented examples of this aspect of deer biology is that of the George Preserve deer herd in which six

[1] Cooperative project sponsored by the Georgia Forest Research Council, the School of Forestry and the College Experiment Station of the University of Georgia, and the U. S. Forest Service, Savannah River Project, S. C.

[2] Graduate Research Assistant, School of Forestry, University of Georgia, Athens.

[3] Associate Professor of Wildlife Management and Zoology, University of Georgia, Athens.

[4] Wildlife Biologist, U. S. Forest Service, Savannah River Project, S. C.

animals increased to 160 between 1928 and 1933 (O'Roke and Hamerstom, 1948). In the period 1942-61, approximately 39% of the fall population had to be removed annually to hold the herd at the desired level (Chase and Jenkins, 1962).

In recent years deer populations have become re-established throughout much of their former range. This has occurred primarily because of the creation of more and better deer habitat resulting from logging, fire, and grazing (Leopold, 1950). Re-establishment of deer herds, coupled with the tremendous biotic potential of the species, has led to problems in deer management. Deer lack effective intrinsic mechanisms which act to limit population size. The only such "feedback" known to be characteristic of deer is inversity, a phenomenon in which lowered fertility is associated with high population density. However, range devastation generally begins before this characteristic is detected. Thus, more research is needed before sound management principles can be effected.

The primary characteristics which condition any population are *mortality* and *natality* rates. Therefore, reproduction studies are a necessary prerequisite to intelligent and effective herd management. In June of 1965, a comprehensive deer reproduction study was initiated on the Savannah River Project (S.R.P.). This area is located in the upper coastal plain of west-central South Carolina and encompasses some 315 square miles in portions of Aiken, Barnwell, and Allendale counties. The S.R.P. was chosen primarily because of the rigid security measures practiced on the area, and the lack of interference with the deer herd since the removal of the resident human population in 1951-52.

A study area of approximately 30 square miles was delineated within the S.R.P. boundaries. This area, located in Barnwell County, encompasses the major deer concentration on the project, and is bordered by the Savannah River on the South, road A on the North, Four Mile Creek on the West and Steel Creek on the East (Figure 1). The area under study includes part of the river swamp and is bordered on three sides by natural barriers, the Savannah River and two hot water streams, which limit immigation and emigration. The habitat can logically be broken into six basic types as follows: (1) river swamp, (2) young pine plantations, (3) old pine plantations, (4) old fields, (5) railroad cuts, and (6) abandoned home sites.

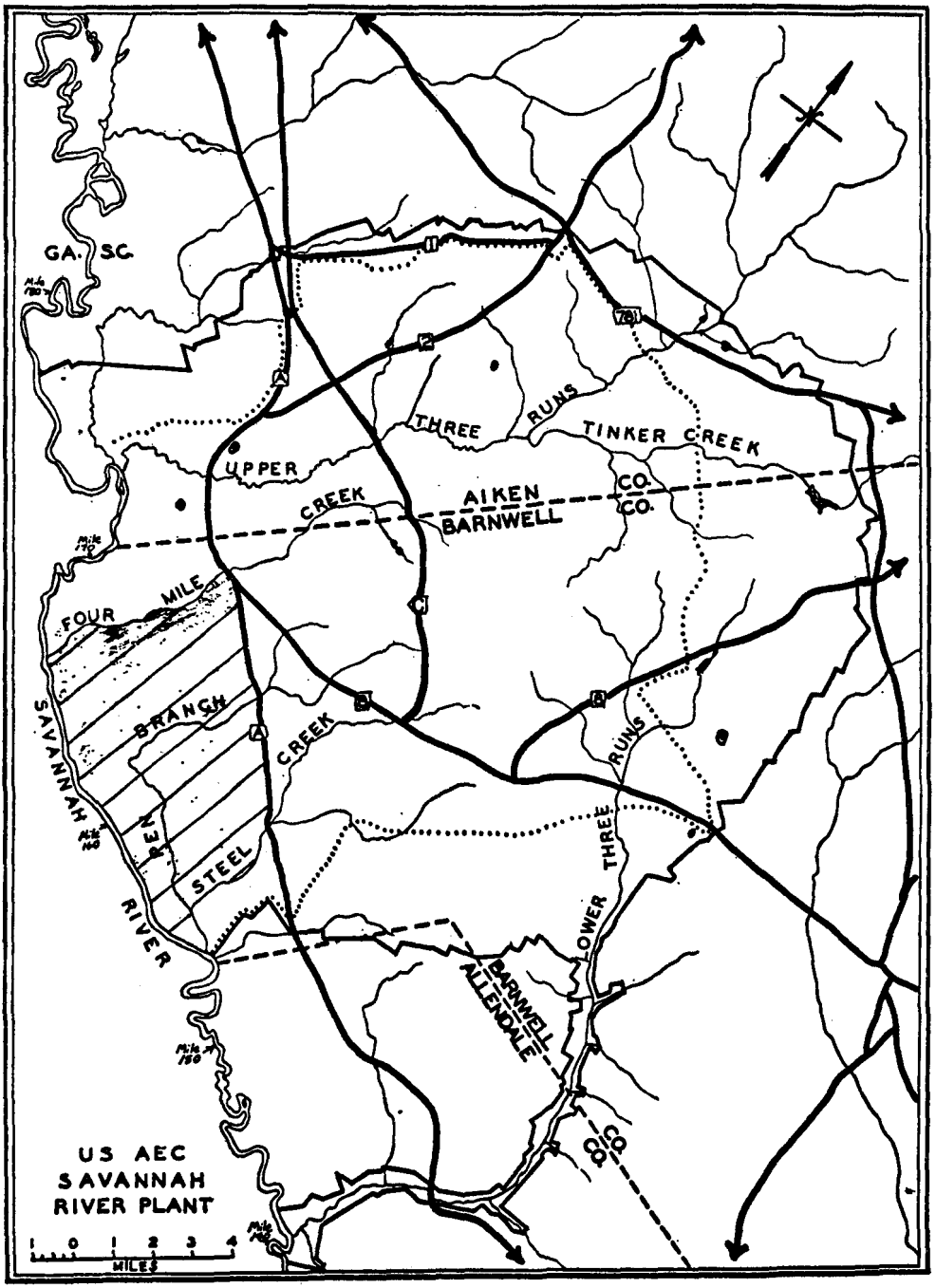
The deer population under study was estimated at less than 10 animals in the early 1950's. In 1963 the density of deer south of road A was considered to be about eight per square mile (Jenkins and Provost, 1964). At the onset of the formal deer reproduction study in 1965, the population in the limited study area is thought to have been in excess of 20 deer per square mile. In any case, the deer herd on the S.R.P. has shown a remarkable growth rate as indicated by the increase in the frequency of annual deer-vehicle collisions on the plant site. However, the lack of efficient census methods for deer precludes any accurate measurement of density at this time.

Data from all phases of the S.R.P. deer reproduction study have not been fully analyzed as yet. However, results are complete on two major objectives of the research. These are determination of the period of rut and peak and duration of the breeding season. The period of rut is here defined as the annual period when adult bucks (1½ years and older) are capable of fertilizing ova.

METHODS

Deer were collected throughout the study (June 1965 - May 1966) under special permits granted to the authors by the South Carolina Wildlife Resources Department and the U. S. Atomic Energy Commission. Collections were usually made during nocturnal hours along the improved dirt roads, railroad cuts, and power lines within the study area. These access routes were driven at a speed of five to ten miles per hour in a spotlight-equipped vehicle, and deer were collected with high-velocity rifles, primarily .222 and .30/06. Adults were selected whenever possible. Shots were placed in the head or neck to minimize the possibility of losses due to crippling. A considerable number of deer

FIGURE 1


GA.
SC.
THREE RUNS
TINKER CREEK
UPPER
CREEK
AIKEN CO.
BARNWELL CO.
FOUR MILE
BRANCH
SAVANNAH RIVER
STEEL CREEK
THREE RUNS
LOWER
BARNWELL CO.
ALLENDALE CO.
US AEC
SAVANNAH
RIVER PLANT
0 1 2 3 4
MILES

were also collected while still-hunting during the late afternoons. Collections were supplemented by animals obtained from four concentrated public deer hunts held in the study area during September and October of 1965. Also, several specimens were gained as the result of deer-vehicle collisions.

The standard measurements were taken on all animals and critical portions of the anatomy were salvaged for use in determination of each objective of the research. Mandibles were removed from all specimens as described by Marshall *et al.* (1964). The age of each animal was estimated from dental characteristics (Severinghaus, 1949).

The period of rut was determined from mature bucks 1½ years of age and older. Smears were made from the tails of the epididymides. Normal saline solution was added immediately to activate any viable spermatozoa present, and smears were viewed fresh (whenever possible) for the presence of motile sperm cells. Epididymides were removed from the testes, and the volume of each testis was determined by direct displacement of water. The total volume (cc) of the testes was divided by the total length (mm) of the buck. The ratio obtained, rather than volume alone, was used in detection of the peak of rut in an effort to reduce bias due to the difference in the size of mature bucks (Illige, 1951). Testes and epididymides were fixed in A.F.A. for future study.

Breeding dates were determined from pregnant does. The prenatal age class of fetuses was estimated through the use of a modified key (Table 1) based on developmental criteria as described by Armstrong (1950). The approximate mid-point of each age class was used in backdating fetuses from the date of collection for estimating the breeding date of the doe. A gestation period of 200 days was used for the upper limit of pre-natal age. Fetuses were preserved in 10% formalin for later reference.

RESULTS

Period of rut: During the study, testes and epididymides were examined from 66 mature bucks collected within the study area. The data gained were supplemented by nine road-killed bucks obtained from surrounding areas, bringing the total to 75 adult males examined from June, 1965 through May, 1966. The frequency of examinations varied each month because of variation in collection success and the large number of animals obtained from three public deer hunts held during October of 1965.

Motile spermatozoa were present in all smears from the tails of the epididymides examined fresh between August 12, 1965 and February 22, 1966. Epididymides collected during this period which could not be subjected to immediate analysis revealed an abundance of spermatozoa upon subsequent examination. Spermatozoa were absent in 12 of 15 adult males collected from June 10 to July 30, 1965, and March 1 to May 26, 1966. Two of the three animals in which spermatozoa were present showed only non-motile sperm, and the one remaining animal's epididymis could not be examined fresh. Therefore, the data indicated that the period of rut as defined was from early August through late February.

Data obtained from volumetric analysis of the testes indicated the peak of rut to be mid September through November (Figure 2). The ratio of testes volume to total length of adult males increased rapidly from mid July to mid September and began a gradual decrease from December through the middle of March, when the minimum ratio was reached. A gradual increase was evident from mid March through the middle of July.

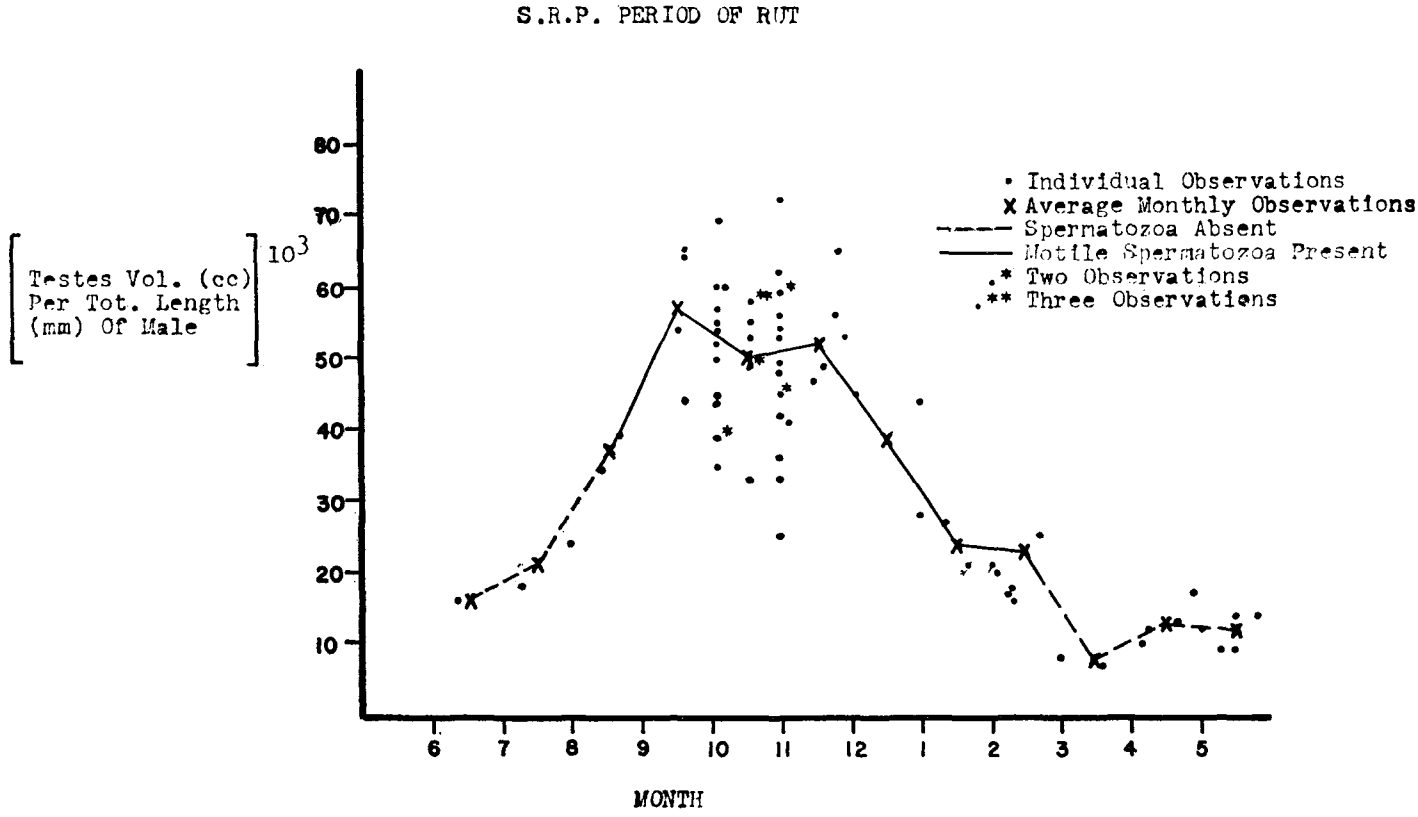
Breeding season: Thirty-eight pregnant does were obtained from the study area between November 27, 1965 and May 10, 1966. Data concerning the breeding season are summarized in Table 2. Breeding evidently occurred from late September through late December in adult females (1½ and older). No doe fawns which bred during the 1965-66 breeding season were found in a sample of 13 juvenile females collected between February 2 and May 26, 1966.

TABLE 1. FETAL DEVELOPMENT—WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS*) CONDENSED FROM ARMSTRONG (1950)

Developmental Characteristics

Age in Days		
	I	Fetus "C" Shaped—wrapped around own liver.
37- 40		A—Vibrissae follicles absent, limb buds only formed.
41- 44		B—Vibrissae follicles present on muzzle, between rami, over and under eye—digits differentiated.
	II	Fetus shaped like a fish hook—Angle between long axis of body and a straight line through muzzle less than 90°.
45- 52		A—Liver prominent, eyelids absent, mouth opened, mesencephalon protudes as a hump, nerve cord exposed.
53- 60		B—Liver prominent, eyelids formed, mouth closed, mesencephalon "normal," nerve cord exposed only at posterior.
	III	Fetus shaped like and adult—Angle between long axis of body and a straight line through muzzle equal to or greater than 90°.
		A—Vibrissae follicles only present.
61- 65		(1) Sagittal suture prominent, forehead prominent, liver prominent, preorbital fold absent.
66- 75		(2) Neural arch completely closed, preorbital fold at anterior median side of eye, liver prominent.
76- 85		(3) Liver near "normal," grey pigmentation on top of nose.
		B—Vibrissae broken through skin, no light pigment spots on trunk.
86- 90		(1) Black pigment on dorsal area at nose, brown pigment on anterior surface of nose, unpigmented spots on anterior nose.
91- 95		(2) Brown pigment on surface of lower lip, black pigment on closing surface of eyelids, metatarsal gland appears as a white spot.
96-105		(3) Black pigment appears on hoofs, nares closed.
106-110		(4) External nares open, forehead near "normal."
		C—Light pigment spots visible along trunk, hair covering incomplete.
111-120		(1) Eyelashes present, dark pigment in both sexes where antler buds appear in bucks, tarsal gland absent.
121-132		(2) Hair present on proximal ends of femur and humerus, line of hair down underside of neck to umbilicus, fetus with light colored rump as in adult, tarsal glands present.
133-150		(3) Stiff bristles around top of hoofs, stiff hair around edge of tarsal glands, hair appears in metatarsal glands, spots along back of neck fused in a line at least two inches long.
		D—White spots along trunk, hair covering complete.
151-180		(1) Incisors and canine teeth partially covered with membrane.
181-200(205)		(2) Incisors and canine teeth entirely bared of membrane.

FIGURE 2


S.R.P. PERIOD OF RUT
Testes Vol. (cc) Per Tot. Length (mm) Of Male
10^3
80
70
60
50
40
30
20
10
6
7
8
9
10
11
12
1
2
3
4
5
MONTH
• Individual Observations
X Average Monthly Observations
Spermatozoa Absent
Motile Spermatozoa Present
.* Two Observations
.** Three Observations

Data indicated the peak of the breeding season to be a 27-day period from November 17 through December 13, in which 17 (44.7%) does bred (Figure 3). A secondary peak the last half of October through the first week of November was also indicated.

DISCUSSION

Adult bucks only were used in determination of the period of rut because buck fawns are characteristically incapable of breeding in their first year (Cheatum and Morton, 1946). Although an instance of breed-

TABLE 2

Female Breeding Dates - S.R.P.

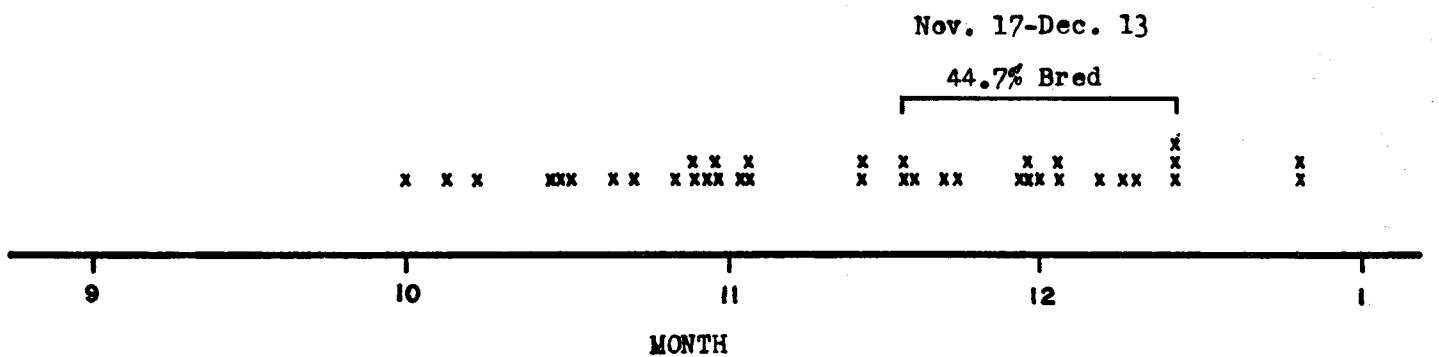
Animal Number	Age During 1965 Breeding Season	Date Collected	Estimated Age of Fetus(es)	Estimated Breeding Date
281	4 1/2	11/27/65	37 - 40 (38)	10/20/65
287	4 1/2	12/21/65	37 - 40 (38)	11/13/65
294	4 1/2	1/ 3/66	76 - 85 (80)	10/15/65
296	1 1/2	1/ 5/66	37 - 40 (30)*	12/ 6/65
297	1 1/2	1/ 5/66	37 - 40 (38)	11/28/65
298	1 1/2	1/ 7/66	37 - 40 (25)*	12/13/65
300	6 1/2	1/ 8/66	53 - 60 (56)	11/13/65
301	3 1/2	1/ 8/66	37 - 40 (30)*	12/ 9/65
310	3 1/2	1/17/66	53 - 60 (56)	11/22/65
314	1 1/2	1/21/66	76 - 85 (80)	11/ 2/65
315	3 1/2	1/21/66	76 - 85 (80)	11/ 2/65
322	4 1/2	2/ 3/66	96 -105 (100)	10/26/65
327	2 1/2	2/ 6/66	111 -120 (115)	10/14/65
328	3 1/2	2/ 6/66	96 -105 (100)	10/29/65
334	2 1/2	2/ 7/66	106 -110 (108)	10/22/65
339	2 1/2	2/ 8/66	111 -120 (115)	10/16/65
341	2 1/2	2/18/66	91 - 95 (93)	11/17/65
342	3 1/2	2/19/66	53 - 60 (56)	12/25/65
343	2 1/2	2/20/66	111 -120 (115)	10/28/65
345	4 1/2	2/22/66	111 -120 (115)	10/30/65
351	1 1/2	3/ 6/66	86 - 90 (88)	12/ 8/65
352	3 1/2	3/ 9/66	96 -105 (100)	11/29/65
355	4 1/2	3/12/66	96 -105 (100)	12/ 2/65
357	3 1/2	3/14/66	151 -180 (165)	9/30/65
359	3 1/2	3/15/66	76 - 85 (80)	12/25/65
361	3 1/2	3/17/66	106 -110 (108)	11/29/65
365	3 1/2	3/21/66	151 -180 (165)	10/ 7/65
370	3 1/2	4/ 5/66	121 -132 (126)	11/30/65
374	2 1/2	4/ 7/66	133 -150 (141)	11/17/65
376	4 1/2	4/ 7/66	111 -120 (115)	12/13/65
377	3 1/2	4/11/66	151 -180 (165)	10/28/65
379	3 1/2	4/11/66	133 -150 (141)	11/21/65
381	4 1/2	4/12/66	181 -200 (190)	10/ 4/65
383	4 1/2	4/13/66	151 -180 (165)	10/30/65
387	1 1/2	4/18/66	121 -132 (126)	12/13/65
391	4 1/2	4/22/66	133 -150 (141)	12/ 2/65
396	1 1/2	5/ 2/66	151 -180 (165)	11/18/65
402	3 1/2	5/10/66	181 -200 (190)	11/ 1/65

*Prenatal age estimated to be less than youngest category described by Armstrong (1950).

FIGURE 3

S.R.P. BREEDING DATES

1965



ing in a juvenile male white-tailed deer was reported by Silver (1965), this is believed to be an exceptional case.

Antler development in mature bucks closely followed the period of rut. Spermatozoa were present in all mature bucks examined from "hardening off" of the antlers until approximately one month after the onset of antler shedding.

Determination of the breeding season was based on fetuses "aged" through the use of developmental criteria because this method was thought to be the most accurate. This was demonstrated by animal No. 355, a 4½-year-old doe bearing twin female fetuses. The fetuses were placed in the same age class (96-105 days) using developmental characteristics. However, linear measurements placed them in separate age classes. Weight also indicated that the fetuses were in separate age classes, but these classes were different from those obtained by use of linear measurements. Both fetuses appeared to be "normal," and it was assumed that the twins were the same age. The authors are unaware of any evidence of ovulation during gestation in deer.

The use of the approximate mid-point of each pre-natal age class in estimating conception dates may have led to some error in calculating the peak and duration of the breeding season. Also, the criteria used were originally based on northeastern white-tailed deer. However, the technique as used was thought to be as good as any available.

The late extremity of the breeding season was estimated to be the latter part of December. However, doe fawns breeding in their first year may extend this somewhat. Some breeding probably occurs in this age class, but pregnant fawns were not evident in the sample taken after the 1965-66 breeding season.

When a comparison is made between the period of rut and breeding season, the data indicate that spermatogenesis precedes ovulation by approximately one and a half months, and spermatogenesis and/or spermiogenesis evidently continues for some two months after the late extremity of breeding occurs in adults The peak of rut preceded the peak of breeding by a slight margin.

SUMMARY

A white-tailed deer reproduction study was conducted on the Savannah River Project, South Carolina from June, 1965 through May, 1966. During this period, 75 adult bucks and 38 pregnant adult does were examined for determination of the period of rut and the peak and duration of the breeding season.

The period of rut was indicated to occur from early August through late February. The peak of rut occurred from mid September through November, and slightly preceded a peak of breeding activity the last half of November through the first half of December. Onset of the period of rut apparently occurred well before the early extremity of breeding, and continued for approximately two months after adult breeding ceased.

LITERATURE CITED

Armstrong, R. A. 1950. Fetal development of the northern white-tailed deer (*Odocoileus virginianus*). Am. Midland Nat. 43(3):650-666.

Chase, W. W. and D. H. Jenkins. 1962. Productivity of the George reserve deer herd. Proc. 1st. Nat. White-tailed Deer Disease Symp. 1: 78-88.

Cheatum, E. L. and G. H. Morton. 1946. Breeding season of white-tailed deer in New York J. Wildl. Mgmt. 10(3): 249-263.

Illige, Denis. 1951. An analysis of the reproductive pattern of white-tail deer in south Texas. J. Mammal. 32(4): 411-421.

Jenkins, J. H. and E. E. Provost. 1964. The population status of the larger vertebrates on the Atomic Energy Commission Savannah River Plant site. U.S.A.E.C.; Div. Biol. and Med., TID — 19562. iii — 45 pp.

Leopold, A. S. 1950. Deer in relation to plant succession. Trans. 15th N. A. Wildl. Conf. 15: 571-580.

Marshall, C. M., J. F. Smith and A. J. Weber. 1964. A simple technique for removing mandibles of deer without trophy defacement. Presented at 18th Ann. Conf. S. E. Assoc. Game and Fish Comm., Clearwater, Fla. 6 pp.

O'Roke, E. C. and F. N. Hamerstrom, Jr. 1948. Productivity and yield of the George Preserve deer herd. J. Wildl. Mgmt. 12(1): 78-86.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Mgmt. 13(2): 195-216.

Silver, Helenette. 1965. An instance of fertility in a white-tailed buck fawn. J. Wildl. Mgmt. 29(3): 634-636.

EUROPEAN WILD HOG HUNTING SEASON RECOMMENDATIONS BASED ON REPRODUCTIVE DATA [1]

VERNON G. HENRY

Tennessee Game and Fish Commission

Tellico Plains

ABSTRACT

Wild sows are physiologically capable of farrowing during any season of the year. However, there are two main farrowing periods; mid-winter (January and February) and early summer (May and June). To determine the importance of the different farrowing periods and the most appropriate time to subject the species to hunting pressure, the year was divided into three periods: December-March, April-July, and August-November. Based on the percentage of sows killed on managed hunts which were pregnant, the December-March period has the highest natality and litters are larger during this same period. The April-July period is when hunting would be most damaging to herd productivity because most of the adult sows are either pregnant or suckling, and death of the sows means death to the fetuses or dependent pigs. Most of the hogs killed during the managed hunts were born in the April-July period, indicating higher mortality among winter born hogs. The August-November period has the highest number of juveniles per female and is thus the period of the highest population. August would probably be the month best suited for hog hunting to minimize harmful effects to the reproductive capacity of the herd. Because an August hunting season is impractical, due to the climate and terrain, it is concluded that the fall hunts in November, as now conducted, are the most desirable of the possible hunting periods.

The European wild hog *(Sus scrofa L.)* has been the subject of a full time research project by the Tennessee Game and Fish Commission since 1959. This project has been conducted on the Tellico Wildlife Management Area in the Appalachian Mountains of southeastern Tennessee. During this study the hog has apparently not achieved its reproductive potential and has never been as numerous as other big game animals, such as deer *(Odocoileus virginianus)*. The hog has several advantages over similar big game species in maintaining populations, particularly their omnivorous diet and greater productivity (4-5 young per litter). Because of these apparent advantages the failure to increase in numbers is a matter of some concern.

Possible limiting factors include hunting and non-hunting mortality, range capacity, reproductive failures, and interspecific and intraspecific competition. This paper summarizes available information on reproduction in wild hogs to determine if the present fall hunting season for

[1] A contribution from Tennessee Federal Aid Project W-34-R-7, Game Division, Research Section. Presented at the 20th Annual Conf., S. E. Assoc. Game and Fish Commissioners.