needed on spatial distribution of roosts and number or roosts used by individual ducks. Are wood ducks attached to traditional roost sites and why? Do all age and sex classes make equal use of roosts?

One other management implication of consequence is the problem of shooting roosting wood ducks. It is evident that in almost all cases if a hunter hunts until wood ducks stop flying in the evening he is in violation. Attention should be given to this problem as well as the high crippling loss and unretrived kill resulting from roost shooting.

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PRODUCTIVITY OF GEORGIA COTTONTAILS [1]

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ABSTRACT

Between October, 1965 and April, 1968, 446 adult female cottontail rabbits (*Sylvilagus floridanus*) were collected from the Mountain, Piedmont, and Coastal Plain physiographic regions of Georgia. Prevalence of pregnancy and litter sizes were determined from data on dissected specimens. Although average litter size exhibited a peak of 3.53 in April, no significant differences were noted among months. Also, no significant differences in litter sizes were observed among physiographic regions. Data on prevalence of pregnancy revealed a high percentage of pregnant females in March, April, and May only. Reduced litter sizes, numbers of litters per season, and prevalence of pregnancies

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indicate lower potential productivity by Georgia cottontails as compared to cottontails from Missouri. A higher potential productivity would appear to be a selective advantage to populations of cottontails in areas where severe climatic conditions might cause significant population declines. Conversely, lower potential productivity is apparently adequate for survival in areas of less severe winter weather.

INTRODUCTION

Wagner (1969) emphasized that the field of wildlife management must pay increasing attention to an ecosystem perspective toward management in the years ahead. In order to fully understand all the ramifications of such a perspective, detailed and accurate productivity data become vital. Small game species are especially important because of their trophic level status and the amount of available energy contributed annually to secondary consumers (especially man).

Few reproduction studies have been based on collections from the entire breeding season. Thus, notable gaps exist concerning detailed information on productivity. The following data were gathered as a part of a study on reproduction of the cottontail rabbit in Georgia.

METHODS

Between October, 1965 and April, 1968, 446 female cottontail rabbits were collected from the Mountain, Piedmont, and Coastal Plain physiographic regions of Georgia. Reproductive status was evaluated by determining the condition of teats, mammary tissue, ovaries, uteri, and presence of implanted young or placental scars. Preimplantation pregnancies were determined by the presence of fresh corpora lutea sites and the absence of young in the uteri. Litter size data were subjected to analysis of variance ($P<0.05$) for the effects of month and region.

RESULTS

Table I presents the reproductive status of female cottontails collected from the Georgia Piedmont in 1966 and 1967. No females were pregnant during the months of October, November, December, or January. March, April, and May of both years was the peak period of reproduction with 90, 100, and 100 percent of the females pregnant in 1966 and 88.8, 100, and 81.8 percent pregnant in 1967 for the respective three months. Preimplantation pregnancies accounted for 15.5 percent of the total pregnancies in 1966 and 10.9 percent in 1967. Total figures for both years indicate a peak in prevalence of pregnancy in April. A decline in prevalence of pregnancy was also noted in August.

Prevalence of pregnancy data for Coastal Plain females in 1966 and 1967 are presented in Table 2. No individuals were found to be pregnant in November and December. Eleven pregnant females collected in February were also actively lactating, thus indicating some breeding in January. As in the Piedmont region, the peak period of reproduction for Coastal Plain rabbits was March, April, and May with 100 percent pregnant each month in 1966 and 90.5, 100, and 88.8 percent pregnant in 1967 for the respective months. Preimplantation pregnancies accounted for 20.2 percent of the total pregnancies in 1966 and 13.3 percent in 1967. Total figures for 1966 and 1967 for the Coastal Plain also denote a definite peak in prevalence of pregnancy in April.

A greater percentage of Coastal Plain females was pregnant than Piedmont females in February of 1966 and 1967 (24.0 versus 14.3 percent and 47.0 versus 17.6 percent, respectively). Also a greater percentage was pregnant at the end of breeding for both years (50.0 versus 0 percent and 42.8 versus 33.3 percent, respectively) (Tables 1, 2, and 3).

Too few rabbits were collected from the Mountains to determine adequately the beginning and end of breeding. However, the high percentage of pregnant females from March through June coincides with the data obtained for the Piedmont and Coastal Plain regions during that period (Table 4).

TABLE 1. Reproduction of adult female cottontails collected in the Piedmont region of Georgia during 1966 and 1967

Month	Number Collected	Number Implanted Pregnancies	Number Non-pregnant	Number (and %) Preimplantation Pregnancies	% Pregnant
			1966		
January	4	0	4	0 (0)	0
February	14	0	12	2 (14.2)	14.2
March	10	6	1	3 (30.0)	90.0
April	10	7	0	3 (30.0)	100.0
May	6	4	0	2 (33.3)	100.0
June	7	4	1	2 (28.5)	85.7
July	6	4	1	1 (16.6)	83.3
August	11	5	5	1 (9.0)	54.5
September	5	0	5	0 (0)	0
October	6	0	6	0 (0)	0
November	5	0	5	0 (0)	0
December	6	0	6	0 (0)	0
Subtotal	90	30	46	14 (15.5)	48.9
			1967		
January	8	0	8	0 (0)	0
February	17	3	14	0 (0)	17.6
March	9	8	1	0 (0)	88.8
April	9	8	0	1 (11.1)	100.0
May	33	19	6	8 (24.2)	81.8
June	8	5	1	2 (25.0)	87.5
July	12	11	1	0 (0)	91.7
August	10	5	4	1 (10.0)	60.0
September	3	1	2	0 (0)	33.3
October	1	0	1	0 (0)	0
November	..	..	..	..	..
December	..	..	..	..	..
Subtotal	110	60	38	12 (10.9)	65.4
Total	200	90	84	26 (13.0)	58.0

A summary of the data from the two regions during 1966 and 1967 is presented in Table 5.

Table 6 presents a comparison of litter sizes among regions. Mean litter sizes for Coastal Plain, Piedmont, and Mountain rabbits were 3.18, 3.11, and 3.06, respectively. A peak of 3.53 in litter sizes in April is noted in Table 7. A mean litter size in February of 2.90 and a July mean litter size of 2.87 were the lowest litter sizes recorded. Analysis of variance revealed no signficant difference in litter sizes between regions and months.

DISCUSSION

First litters are conceived in February in Georgia. Breeding synchrony is also exhibited by cottontail populations in this state (Pelton, 1968). The above phenomenon, combined with nearly 100 percent pregnancy among females from March through July, results in the potential production of five litters per female per year. An additional sixth litter in August is also indicated among approximately 50 percent of the females. Conaway, Wight and Sadler (1963) present evidence for seven or eight litters in Missouri based on essentially 100 percent prevalence of pregnancy throughout the season. A theoretical maximum production of five or six litters in Georgia or seven or eight in Missouri is seldom met for one or more of the following reasons: (1) It is probable that the

TABLE 2. Reproduction of adult female cottontails collected in the Coastal Plain Region of Georgia during 1966 and 1967

Month	Number Collected	Number Implanted Pregnancies	Number Non-pregnant	Number (and %) Preimplantation Pregnancies	% Pregnant
			1966		
January	1	0	1	0 (0)	0
February	25	1	19	5 (20.0)	24.0
March	13	10	0	3 (23.0)	100.0
April	19	17	0	2 (10.5)	100.0
May	13	7	0	6 (46.1)	100.0
June	8	3	2	3 (37.5)	75.0
July	1	1	0	0 (0)	100.0
August	7	3	4	0 (0)	42.8
September	4	2	3	0 (0)	50.0
October	3	0	3	0 (0)	0
November	0	0	0	0 (0)	0
December	0	0	0	0 (0)	0
Subtotal	94	44	31	19 (20.2)	67.0
			1967		
January	8	0	8	0 (0)	0
February	17	6	9	2 (11.7)	47.0
March	21	10	2	9 (42.8)	90.5
April	11	9	0	2 (18.1)	100.0
May	18	15	2	1 (5.5)	88.8
June	5	3	2	0 (0)	60.0
July	0	0	0	0 (0)	0
August	16	9	7	0 (0)	56.2
September	21	7	12	2 (9.5)	42.8
October	3	1	2	(0)	33.0
November	..	..	..	..	..
December	..	..	..	..	..
Subtotal	120	60	44	16 (13.3)	63.3
Total	214	104	75	35 (16.3)	64.9

number of females still surviving to produce litters in July, August, or September is small compared to the number that produced litters in March and April. (2) Generally, onset of breeding of cottontails has been reported to occur in February in most areas of the species range (Hill 1965, Pelton 1968, Schwartz 1942). However, recent evidence indicates that cold weather in late winter may delay onset of breeding. Weather could determine whether first litters are born in February, March, or April (Conaway and Wight 1962, Hill 1965, Pelton 1968). Numbers of litters per season would vary accordingly. (3) Other extrinsic (weather) or intrinsic (population density) factors may have an influence on breeding efficiency later in the season. The potential effects of hot and/or dry weather on cottontail reproduction were described by Hill (1965) and Pelton (1969b). (4) Also, is the possible inherent ability of some populations to exhibit greater breeding efficiency.

Since the average litter size for Georgia cottontails is approximately three, the theoretical maximum number of young that could be produced by an adult female is 15 to 21. Female cottontails in Missouri have average litter sizes of greater than five per litter and could therefore potentially produce 35 to 40 young per season (Conaway, Wight and Sadler 1963). Smaller litter sizes and decreased prevalence of preg-

TABLE 3. Pooled reproduction data on adult female cottontails collected in the Georgia Piedmont and Coastal Plain regions during 1966 and 1967

Month	Number Collected	Number Implanted Pregnancies	Number Non-pregnant	Number (and %) Preimplantation Pregnancies	% Pregnant
			Piedmont		
January	12	0	12	0 (0)	0
February	31	3	26	2 (6.4)	16.1
March	19	14	2	3 (15.7)	89.4
April	19	15	0	4 (21.0)	100.0
May	39	23	6	10 (25.6)	84.6
June	15	9	2	4 (26.6)	86.6
July	18	15	2	1 (5.5)	88.8
August	21	10	9	2 (9.5)	57.1
September	8	1	7	0 (0)	12.5
October	7	0	7	0 (0)	0
November	5	0	5	0 (0)	0
December	6	0	6	0 (0)	0
Subtotal	200	90	84	26 (13.0)	0
			Coastal Plain		
January	9	0	9	0 (0)	0
February	42	7	28	7 (16.6)	33.3
March	34	20	2	12 (35.2)	94.1
April	30	26	0	4 (13.3)	100.0
May	31	22	2	7 (22.5)	93.5
June	13	6	4	3 (23.0)	69.2
July	1	1	0	0 (0)	100.0
August	23	12	11	0 (0)	52.1
September	25	9	14	2 (8.0)	44.0
October	6	1	5	0 (0)	16.6
November	0	0	0	0 (0)	0
December	0	0	0	0 (0)	0
Subtotal	214	104	75	35 (16.3)	64.9
Total	414	194	159	61 (14.7)	61.5

TABLE 4. Reproduction of adult female cottontails collected in the Mountain region of Georgia during 1966 and 1967

Month	Number Collected	Number Implanted Pregnancies	Number Non-pregnant	Number (and %) Preimplantation Pregnancies	% Pregnant
January	..	..	..	..	..
February	1	0	1	0 (0)	0
March	11	7	1	3 (27.2)	90.9
April	3	2	0	1 (33.3)	100.0
May	1	1	0	0 (0)	100.0
June	10	6	0	4 (40.0)	100.0
July	1	0	1	0 (0)	0
August	1	0	1	0 (0)	0
September	1	0	1	0 (0)	0
October	3	0	3	0 (0)	0
November	..	..	..	..	..
December	..	..	..	..	..
Total	32	16	8	8 (25.0)	75.0

TABLE 5. Summary of reproduction of adult female cottontails collected in the Coastal Plain and Piedmont regions of Georgia during 1966 and 1967

Month	Number Collected	Number Implanted Pregnancies	Number Non-pregnant	Number (and %) Preimplantation Pregnancies	% Pregnant
January	21	0	21	0 (0)	0
February	73	10	54	9 (12.3)	26.0
March	53	34	4	15 (28.3)	92.4
April	49	41	0	8 (16.3)	100.0
May	70	45	8	17 (24.2)	88.5
June	28	15	6	7 (25.0)	78.5
July	19	16	2	1 (5.2)	89.4
August	44	22	20	2 (4.5)	54.5
September	33	10	21	2 (6.0)	36.3
October	13	1	12	0 (0)	7.6
November	5	0	5	0 (0)	0
December	6	0	6	0 (0)	0
Total	414	194	159	61 (14.7)	61.5

TABLE 6. A comparison between physiographic region and litter sizes of cottontail rabbits collected in Georgia during 1966 and 1967

Region	Sample size	Mean litter size	Standard deviation
Coastal Plain	108	3.18	1.14
Piedmont	85	3.11	0.90
Mountain	16	3.06	1.00

TABLE 7. A comparison between litter sizes of the cottontail rabbit and month of collection during 1966 and 1967

	February	March	April	May	June	July	August	September
Sample size	10	34	41	45	14	16	22	11
Mean	2.90	3.00	3.53	3.26	2.92	2.87	3.04	2.90
Standard Deviation	±0.56	±1.07	±1.02	±1.30	±0.73	±0.80	±0.78	±1.04

nancy in August and September among Georgia cottontails (as well as less breeding by young-of-the-year, Pelton (1969b) result in significantly less potential production of young than in Missouri. Fgures from these two areas are not available regarding fall and winter age ratios or population densities. Small litters have also been reported in Mississippi —3.5 (Heard, 1963) and Alabama—3.1 (Majors, 1955). In contrast northern areas have reported litter sizes comparable to Missouri—5.1 in Michigan (Allen, 1938) and 6.2 in Connecticut (Dalke, 1942). Thus, a general contrast in productivity potential is exhibited by the cottontail between the northern and southern parts of its range. Colder temperatures and greater numbers of days of snow cover with concomitant less availability of food and cover result in a more severe environment for cottontails in Missouri and other northern areas than in Georgia and other southern areas. The higher potential productivity of more northern areas would therefore appear to be a selective advantage to populations of cottontails where severe climatic conditions might cause significant population declines. Conversely, a lower potential productivity is ap-

parently adequate for survival of cottontail populations in areas of more moderate winter weather.

Intrastate differences in litter sizes were reported by Evans, *et al.* (1965) and Kline (1962). These authors present conflicting results regarding a decline in litter size as related to latitude. Lord (1960 and 1961) postulated that litter size of cottontails changes approximately one young for each 250 miles of latitude. Evans, *et al.* (1965) supported these findings by showing a decline in litter size from northern to southern Missouri. However, Kline (1962) found no significant difference between litter sizes of cottontails from northern to southern Iowa. Results from the Iowa study are similar to those in the present study. No significant differences were noted in litter size among the Mountain, Piedmont or Coastal Plain physiographic regions. Although changes in litter sizes have been documented by both Barkalow (1962) and Lord (1960), intrastate changes as reported by Lord (1961) and Evans, *et al.* (1965) may be a reflection of factors other than latitude.

One factor that has received some attention in the literature is the relationship between soil fertility and cottontail reproduction. This relationship has been investigated by Negus (1956), Russell (1966), Stevens (1962), and Williams and Caskey (1965). Negus (1956) felt that soil quality was the primary factor influencing reproduction and therefore population densities of the cottontail in Ohio. He reported highly significant differences in litter sizes between rabbits from good and poor soils; better soils produced more young per litter. Stevens (1962) found that thyroid gland activity and pituitary gonadotrophin content varied significantly in rabbits among physiographic regions in Ohio. He postulated that the differences in pituitary gonadotrophin production were the reasons for the differences in regional reproduction rates. The low rates were associated with poor soils. Williams and Caskey (1965) collected cottontails from soils of contrasting fertility and found that the most fertile soils produced significantly larger litters than the least fertile soils.

Evidence reveals that cottontails from the Coastal Plain region of Georgia come from a better soil regime than Mountain or Piedmont region rabbits (Pelton 1968, and Pelton and Jenkins 1970). The lack of a concomitant change in litter size (e.g. larger litters in the Coastal Plain) might be attributed to the following: (1) Any observable increase in litter sizes of Coastal Plain cottontails may have been masked by the north-to-south latitudinal decrease in litter sizes as reported by Lord (1960) and Barkalow (1962). (2) General soil conditions in all three physiographic regions of Georgia may be such that no reproductive response could be observed even though differences in body measurements and fat levels were noted (Pelton 1968, and Pelton and Jenkins 1970).

Seasonal variations in litter sizes were noted by Conaway and Wight (1962), Conaway, Wight and Sadler (1963), Kline (1962), Lord (1961), and Schwartz (1942). Conaway and Wight (1962) found that age and/or previous reproductive experience have a marked influence on the litter size of the first pregnancy of the breeding season. These authors point out that since conception dates of first pregnancy can vary as much as six weeks, any attempt to compare litter size which does not consider age and/or previous numbers of litters produced is invalid. No statistically significant differences were found between months (and sequences of litters) among female cottontails in Georgia. The above finding of Conaway and Wight (1962) apparently does not apply to this area. First litters of the season among Georgia cottontails were smaller than the second and third but the differences were not significant.

Conaway and Wight (1962) utilized only females with fetuses greater than 20 days old to determine litter size. This procedure was used to avoid stages when resorptions are apparently more common (Brambell and Mills, 1948). However, Pelton (1969a) disclosed no significant differences in litter sizes between various stages of pregnancy. Counts of

implanted young were useful as estimates of litter sizes regardless of the stage of pregnancy of the female when counts are made.

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