LIFE HISTORY OF THE SWAMP RABBIT (SYLVILAGUS AQUATICUS) IN MISSOURI

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Master of Arts

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by

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The undersigned, appointed by the Dean of the Graduate Faculty, have examined a thesis entitled

LIFE HISTORY OF THE SWAMP RABBIT (SYLVILAGUS AQUATICUS) IN MISSOURI

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a candidate for the degree of Master of Arts

and hereby certify that in their opinion it is worthy of acceptance.

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CHAPTER I

INTRODUCTION

In Missouri, the swamp rabbit (Sylvilagus aquaticus (Bachman)) occurs principally in the southeastern portion of the state, but it is also found in small areas in southwestern and south-central Missouri. Bennitt and Nagel (1937:99) wrote that the swamp rabbit occupies a limited range in Missouri and appears to be decreasing in numbers. They thought that the species had only local importance as a game animal or source of food.

The swamp rabbit is probably still declining in numbers, because drainage and clearing continue to reduce its habitat, but it can no longer be said that the species is of importance only locally. Because of its large size, its ability to give rabbit hounds a good chase, and its quality as food, the swamp rabbit is sought by many hunters who may journey more than a hundred miles to hunt it. This species continues to be prized by local hunters.

Some idea of the popularity of the swamp rabbit as a game species can be gained from the hunting statistics for the Missouri Conservation Commission's Duck Creek Wildlife Area near Puxico, Missouri, during 1956 and 1957, as shown in Table I.

Table I. Statistics on rabbit hunting, Duck Creek Wildlife Area, 1956-57[1]

	1956	1957
Number of guns	921	495
Swamp rabbits killed	654	181
Kill per gun	0.71	0.38
Cottontails killed	261	137
Kill per gun	0.28	0.28
Acres of swamp rabbit habitat hunted	945	945
Hunters coming farther than 100 miles	---	21%

In view of the declining habitat and the increasing number of hunters with greater mobility, it is important that we gain more basic information about the habitat requirements, reproductive potential, and various aspects of the life history of the swamp rabbit in order to manage the species intelligently. Moreover, there is considerable biological interest in this species, and only fragmentary information has been published.

This study was designed to provide information about various phases of the life history of the swamp rabbit, with special emphasis on home ranges and the reproductive cycle. Field work was begun in June, 1956, and ended in July, 1957.

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[1] Data obtained from unpublished reports by G. K. Brakhage, Superintendent of the Duck Creek Area.

CHAPTER II

REVIEW OF THE LITERATURE

There is relatively little published information on the swamp rabbit. The literature available is chiefly concerned with distribution, description, and very general observations of the animal. However, three studies are more substantial. Svihla (1929) made a general study of food habits, behavior in captivity, and habitat. Lowe (1958) studied several phases of the life history of the swamp rabbit, and treated in detail the differences in skull characteristics between the swamp rabbit and the cottontail. Hunt's (1956) study dealt mainly with the reproductive history of the swamp rabbit.

Since so little is known about many phases of the life history of the swamp rabbit, the review below also deals in part with literature on the cottontail, and comparisons are made between the two species when possible.

Weights and Measurements

The swamp rabbit is a large rabbit; it may attain a total length of 22 inches (Seton, 1928), and a weight as great as six pounds (Audubon and Bachman, 1846; Hamilton, 1943). A summary of published weights and measurements is

presented in Table II. When necessary, conversion has been made to the metric system.

Lowe (op. cit.) found no significant differences in body measurements of males and females and in weights of males and (non-pregnant) females.

Several workers have recorded the weights of cottontails (S. floridanus). Those who separated their data according to sex have generally found the females to be heavier (Schwartz, 1942; Elder and Sowls, 1942; Bruna, 1952). Similarly, in the Audubon cottontail (S. audubonii), females are significantly heavier than males (Sowls, 1957).

Sex and Age Ratios

Hunt (1956) has presented the only extensive data on sex and age ratios in the swamp rabbit. He shot 152 rabbits during all months, and classified them according to sex and age. Adult males constituted 30 per cent of the total, adult females 38 per cent, juvenile males 13 per cent, and juvenile females 19 per cent. Thus, males comprised 43 per cent and females 57 per cent of the total sample; adults comprised 68 per cent and juveniles 32 per cent of these collections made throughout the year. Age was determined on the basis of body weight and/or the condition of the reproductive tract.

In the cottontail, weight criteria are of questionable value in distinguishing juveniles from adults. In Missouri, Schwartz (1941) found them to be useless after September.

Table II. Published measurements and weights of swamp rabbits

Workers	Number	LENGTHS (mm.) Total Ave.	Total Range	Tail Ave.	Tail Range	Hind foot Ave.	Hind foot Range	Ear Ave.	Ear Range	WEIGHTS (gms.) Ave.	WEIGHTS (gms.) Range
Harrison & Hickie, 1931 (Ind.)	4	462	402-523	50	40-55	106	98-113	69	66-72	1991	1409-2474
Sherman, 1939 (S. C.)	5										2040 (max.)
Hamilton, 1943 (La., Ala. & Ga.)	10	522		67.5		105					2720 (max.) 1590 (min.)
Lowe, 1958 (Ga.)		(Body length) Max.	Min.	Ave.				(Ear notch) Max.	Min. Ave.		
	43	498	268	444	72	57-93	104	93-111	77	68 73	
	24									1895	1432-2345
	12									1951	1332-2385

Elder and Sowls (1942) found juvenile cottontails in Wisconsin weighing 1,000 grams by August, and pointed out that many adults weigh no more than this in spring. Petrides' (1951) findings in Ohio were similar.

Condition of the testes and the presence of placental scars have also been used to determine age of cottontails (Elder and Sowls, 1942). However, as was pointed out by Hale (1949), placental scars may not be accurate indicators of adulthood, because juvenile female cottontails may breed in their first summer.

A very useful method of determining age in cottontails was that developed by Thomsen and Mortensen (1946), based on the presence or absence of cartilege in the proximal epiphysis of the humerus. Hale (1949) determined that this method was reliable until the rabbit was at least nine months old. Using this method, he found 79 per cent young among 339 rabbits collected in Wisconsin during a three-year period. Collections were made from November 1 to January 15 each year.

Closure of the distal epiphyses of the radius and ulna also provides a very useful criterion for age determination in the cottontail, and x-ray films of the fore-paws of live rabbits of known age have shown this criterion to be valid at least until the young are seven or eight months old (Petrides, 1951). Using this method, Petrides determined the following numbers of young per adult female: (1) for rabbits trapped in Ohio during a 21-month period, 25.4; (2) for

rabbits trapped in Ohio during November, 1947, 9.7; and (3) for rabbits shot in Pennsylvania, November, 1947, 12.3.

Many workers have published data on sex ratios of the cottontail, S. floridanus. Petrides (1951) drew together many of these data from earlier publications and presented new data. In many series, males outnumbered females. One explanation is that females enter holes more readily than males, at least in the northern part of the cottontail's range. As pointed out by Petrides (op. cit.) this tendency would particularly affect shot samples from northern states in winter. Samples taken by live-trapping or ferreting show more nearly equal sex ratios, or in some cases, a preponderance of females.

Home Range

The only attempt to determine the home range of the swamp rabbit was made by Lowe (1958). He estimated the average fall and winter home range of seven rabbits to be 18.9 acres. Estimates were based upon routes taken by dogs trailing the rabbits. The rabbits were not marked, but Lowe thought that the amount of overlapping was small.

Two workers have published information on size of home ranges in the marsh rabbit, S. palustris. Blair (1936) estimated the home range diameter for two individuals of this species to be 200 yards; the estimate was based on four trapping records for each rabbit. Carr (1939) used a leashed dog

to trail marsh rabbits and found that they rarely traveled over an area larger than 200 yards in diameter. He also watched dogs which were not leashed run rabbits at various times and thought that he could distinguish routes of four individuals in his study area, because the points of origin of the chases and the routes taken seemed to differ from one another consistently. These four rabbits were chased from four to seven times each, and had range diameters of from 150 to 300 yards.

Data about home ranges in the cottontail are much more extensive; in this species all data are based on trapping information. The placement of traps in the study areas (whether in grids, in selected sites, or randomly distributed) and the interpretation of data differed greatly in the various studies.

Several workers calculated home range in cottontails by connecting the outside points of capture and computing the size of the enclosed area. Traps were not arranged in grids. Using this approach, Dalke (1942) determined the average home range of the cottontail in Connecticut to be 2.9 acres for the adult female and 8.3 acres for the adult male. Allen (1939) concluded that most of the cottontails he trapped in Michigan had home ranges of 5 to 10 acres. The more favorably located the rabbits were with respect to food and water the smaller the home range tended to be. Schwartz (1941) found the average home range of the cottontail in Missouri

to be 1.4 acres for males and 1.2 acres for females.

Haugen (1942) calculated size of home range of the cottontail in Michigan from trapping data covering a two-year period. His traps were placed in a grid; each trap was considered to represent a square area extending from the trap halfway to each neighboring trap. A home range was computed simply by adding the areas (or "trap squares") in which a rabbit was trapped, plus any intervening squares. For adult females he found the winter home range to be 14.0 acres and the home range during the breeding season to be 22.5 acres. Male and female juveniles had home ranges of 13 to 14 acres during the fall. Home ranges of the adult males were not calculated because of incomplete data. He estimated that the males roam over 100 acres or more.

In Kentucky, Bruna (1952) determined home ranges of cottontails by live-trapping and tagging; placement of traps was not explained. The average size of annual home ranges for eight females was 4.3 acres; for five males, 13.3 acres. Ranges were much larger in spring and summer than in winter.

Reproductive History

Hunt (1956) made a detailed study of the reproductive pattern of the swamp rabbit. He found that the breeding season probably extended throughout the year in Brazos County, Texas. The peak of the breeding season seemed to be in January or February. He attributed the extended breeding season

to the temperate climate. Hunt also established the gestation period for the swamp rabbit to be 39 to 40 days and the embryonic litter size to be from 1 to 5, averaging 2.8. Two and three embryos were the most common, occuring nine times in 29 litters.

Other information on reproduction in the swamp rabbit is fragmentary. Audubon and Bachman (1846) "had been told" the litter size ranged from four to six. Strecker and Williams (1929) found a nest containing two young. Svihla (1929) found the number of young ranged from one to six found in the nest and the embryo count ranged from 3 to 5, with an average of 3.7. She was the first to observe that the young were born with hair instead of naked as in the cottontail. Goodpastor and Hoffmeister (1952) found a nest in Tennessee containing four young. Lowe (1958) found two nests containing three and four young. He collected three pregnant females with embryo counts from one to three.

Several studies have been made of the reproductive history of the cottontail. A summary of information concerning breeding season and litter size is given in Table III.

Cooley (1946) and Hendrickson (1947) both reported cottontails reproducing as young of the year.

Even though reproductive information about the swamp rabbit is limited, it appears that the reproductive capacity is lower than that of the cottontail.

Table III. Breeding season and litter size in the cottontail

Worker	Breeding season	Litter range	Size average	Basis
Allen (1938)	Feb.-July		5.1	11 nests
Haugen (1942)	Mar.-Sept.		5.4	nests, embryo counts, captive litter
Dalke (1942)	Jan.-Sept.		5.5 wild 5.2 penned	nests
Hamilton (1940)		2-7	4.3	nests
Beule (1940)		3-8	5.4	26 nests
Schwartz (1942)	Mar.-Sept.		4.4	embryo counts in 40 pregnant

Food Habits

No thorough studies of the food habits of the swamp rabbit have been made. Hamilton (1943) mentioned that this species is fond of cane (Arundinaria). Svihla (1929) observed that the coastal subspecies (S. a. littoralis) in Louisiana fed on marsh grasses and sedges throughout the year. She also noted that captive rabbits would eat almost any plant given them.

In Oklahoma, Smith (1940) provided a more detailed list of plants eaten by swamp rabbits (S. a. aquaticus) and compared them with foods taken by cottontails. Part of the

winter diet of both species was provided by forbs such as the aster (A. praealtus), goldenrod (Solidago missouriensis), and sweet clover.

In addition, Smith noted:

> ....twigs of willow, cottonwood, Baccharis, Tamarix, and Amorpha fruticosa are extensively browsed, especially by the swamp rabbits. Although Johnson grass, Bermuda grass, and Panicum virgatum are abundant in places, they are not much utilized as food during the winter months. The cottontails eat more of the grasses than do the swamp rabbits.

Calhoun (1941) observed that swamp rabbits near Reelfoot Lake, Tennessee, ate corn stalks, maple bark, bark from cypress trees, and that barking of water locust (Gleditsia aquatica) was severe.

While food habit studies of the swamp rabbit are far from adequate, several studies of the winter food habits of the cottontail have been made. In Michigan, Allen (1939) found the most important woody plants used in the winter were dwarf and staghorn sumac (Rhus copallina and R. typhina). In Connecticut, Dalke and Sime (1949) used direct observation of feeding rabbits, inspection of feeding areas and an analysis of stomach contents. With respect to cottontail feeding habits, they divided the year into three seasons: winter (January, February, March); summer (April to October); and fall (November and December). Feeding habits followed closely the availability of plants as they developed from early spring to late fall. The winter diet was mostly of bark, buds, twigs, and dried herbs. During November and Decem-

ber, there was a change from herbaceous plants to woody perennials.

In a summary of observations covering the years 1942-1948, Sweetman (1949) listed 111 woody species found on a three-acre plot in Massachusetts. Of the 111 species, 64 were injured extensively by cottontails, 13 were damaged slightly, and 30 were relatively free of attack by the cottontails.

Coprophagy

That coprophagy occurs in domestic and wild European rabbits (Oryctolagus cuneatus) has been known for some time. A summary of findings was provided by Eden (1940):

> Observations of other workers showed that two kinds of feces were voided by the rabbit, the familiar dry pellet type during the day and a soft mucous type during the night, rarely observed because the animal collects them directly from the anus and swallows them again.

Coprophagy in a North American rabbit was first reported by Hamilton (1955). He found pellets in the fundic portion of the stomach of a marsh rabbit (S. palustris). He speculated that coprophagy might be common in other North American rabbits even though he had examined many cottontails, with negative results. Kirkpatrick (1956) watched a cottontail eating pellets that were taken directly from the anus.

Lechleitner (1957) has completed the only detailed study of coprophagy on any North American rabbit. He collected the black-tailed jack rabbit (Lepus c. californicus)

during every month of the year and at various times of the day. He concluded that the soft feces are taken during the daylight hours when the rabbit is the least active. No seasonal trend could be detected in the practice of coprophagy.

Several papers have been written about the nutritional value of coprophagy in the domestic rabbit. By placing copper sulfate in the feed of some rabbits, Eden (1940) found it took five times as long to recover the sulfate when the rabbits were allowed to practice coprophagy than when they were prevented from doing so by placing a collar around their necks. He also found that the refected pellets were high in protein, having 28.5 per cent as compared with 9.2 per cent for pellets of the dry type that were not refected.

Kulwich, et al. (1953) collared rabbits to prevent coprophagy and were able to recover 29 per cent more feces by weight than when coprophagy was not prevented. They found the intake was greater by 83 per cent for niacin, 100 per cent for riboflavin, 165 per cent for pantothenic acid, and 42 per cent for vitamin B_{12} in rabbits as a result of coprophagy. Thacher and Brandt (1955) were able to prove an increase in the digestive efficiency as a result of this habit.

CHAPTER III

THE STUDY AREA

This study was made on the Duck Creek Wildlife Area, the Mingo National Wildlife Refuge, and neighboring land. The Duck Creek Area, 6,000 acres in extent, adjoins the 22,000-acre Mingo Refuge; these areas are located in Stoddard, Wayne, and Bollinger counties in southeastern Missouri. Both areas are within the Mingo Swamp and hereinafter the area of study referred to is the entire swamp.

The Mingo Swamp lies in an abandoned valley cut by the Mississippi River some 20,000 years ago. After the Mississippi River changed its channel and abandoned the Mingo Swamp, the Castor River on the northeast and the St. Francis River on the southwest continued to empty into it. The overflow from these two rivers, plus other small streams and local hill drainage, filled the swamp with water several times a year. Sediment washed into it settled in the still water, building up a layer of alluvial soil over the old river sand. The New Madrid earthquake of 1811-1812 caused irregular and local settling of the land the the formation of lakes. Cracks and holes were created and old river bottom sand and other materials were forced up through these to form mounds and ridges (Marbut, 1902). These are known locally as "donnocks." Most of the "donnocks" are small, less than 100 yards across,

but some are up to 50 acres in size. Many of them are high enough to afford refuge for animals during flood periods. Fifty of these are located on the trapping area.

Before 1900 the Mingo Swamp supported extensive stands of large cypress (Taxodium distichum) and tupelo gum (Nyssa aquatica) in the lower areas. The areas not so low but still relatively wet supported overcup oak (Quercus lyrata) and some pin oak (Q. palustris) stands. Pin oak and willow oak (Q. phellos) were dominant on the drier portions of the swamp. About 1900, lumbermen started cutting the giant cypress and tupelo gum stands and the farmers started clearing small areas on the higher parts of the swamp. Soon after this, lumbermen started cutting the better oak and some of the gum.

After the swamp was drained in the 1920's, farmers began to clear large areas. At one time nearly one-third of the swamp was cleared and attempts were being made to farm it. It soon became obvious that the drainage ditches would not be effective, so most of the land was abandoned and soon reverted to timber and brush (Keefe, 1955).

The Mingo Swamp has always been a recognized wildlife area and is especially noted for its large concentration of ducks. The area also abounds with many types of mammals, including deer, raccoon, muskrat, mink, bobcat, and swamp rabbits. The Mingo Refuge was purchased in 1942 by the U. S. Fish and Wildlife Service for a national refuge. A few years

later the Missouri Conservation Commission bought the adjacent Duck Creek Management Area to be used as a hunting and fishing area.

The Mingo swamp lies in a zone near which many of the cold fronts moving across the northern states reach their southern limits. Freezing weather is always of short duration and rarely does the ground stay frozen for more than a week at a time. Summers are hot and humid, temperatures above 100° F. being common. The precipitation averages 47.3 inches of rainfall and 8.2 inches of snow (Decker, 1955). The January average daily maximum temperature is 45° F. The July average daily maximum temperature is 91° F. The average frost-free period is 220 days and the average last killing frost in the spring is March 26 (Collier, 1955).

Much information on the history and ecology of the Mingo Swamp, together with a detailed description of the forest, can be found in the unpublished thesis by Puchbauer (1956).

CHAPTER IV

RESULTS

A total of 245 swamp rabbits and 100 cottontails were examined during this study. Of this number 45 of the swamp rabbits and 16 of the cottontails were trapped, and the remainder shot. Almost 200 of the 354 total of both species were furnished by hunters on the Duck Creek Management Area during the rabbit season in January, 1957. That accounts for the large collections made during that month. Weights and standard measurements of all rabbits collected were taken when possible. However, many of the hunters field-dressed their game, rendering it impossible to secure weights and some measurements for these animals. When possible, one foreleg was taken from each rabbit to be used for ageing.

Weights

All weights and standard measurements of swamp rabbits collected during this study are shown in the Appendix (Tables XI-XVI).

Weights of 93 male swamp rabbits taken from October through June averaged 4 lb. 8.5 oz (range 2 lb. 9 oz. to 5 lb. 10 oz.). Sixty-five females averaged 4 lb. 8.3 oz. (range

3 lb. 5 oz. to 5 lb. 9 oz.), excluding weights of pregnant females. Thus, there was no significant difference in weights of male and female swamp rabbits. In this respect, this species differs from other members of its genus, for Schwartz (1942), Elder and Sowls (1942), and Bruna (1952) have all found female cottontails (S. floridanus) to be heavier than males. Similarly, Sowls (1957) found female Audubon cottontails (S. audubonii) to be significantly heavier than males.

The large collection made in January permitted analyses of weight data not only according to sex but also according to presumed age as determined by epiphyseal closure in the humerus, radius, and ulna. Maximum, minimum, and average weights for rabbits of the various sex and age groups are shown in Table IV. There was virtually no difference in the weights of males and females, whether young or presumed adults.

Table IV. Weights of swamp rabbits and cottontails in January

	Number	Maximum Lb.	Maximum Oz.	Minimum Lb.	Minimum Oz.	Average Lb.	Average Oz.
SWAMP RABBITS							
Presumed adult males	12	5	10	4	0	5	0
Juvenile males	15	5	2	3	14	4	9
Presumed adult females	6	5	3	4	4	4	14
Juvenile females	12	5	1	3	12	4	9
COTTONTAILS							
Males*	30	3	1	1	15	2	9
Females*	23	3	4	2	2	2	12

* Age groups lumped in cottontails.

Fifty-three cottontails collected on the same area were weighed in January. Thirty males averaged 2 lb. 9 oz. (range 1 lb. 15 oz. to 3 lb. 1 oz.). Twenty-two females averaged 2 lb. 12 oz. (range 2 lb. 2 oz. to 3 lb. 4 oz.). Individual weights and standard measurements of cottontails are shown in Tables XVII and XVIII (Appendix).

Measurements

Standard measurements were taken for 19 adult male and 9 adult female swamp rabbits collected in January, 1957 (Table V). Again, presumed age was determined by examination of the humerus.

Table V. Measurements of 19 male and 9 female swamp rabbits

	Total length	Tail	Ear	Hind foot	Fore foot
MALES					
Max.	540	80	85	112	52
Min.	470	60	69	100	43
Avg.	501.5	71.3	74.9	104.4	47.4
FEMALES					
Max.	525	90	80	105	50
Min.	468	68	69	100	44
Avg.	503	73.8	73.8	103.5	46.3

Sex Ratios

In this study 43 per cent of 35 trapped swamp rabbits were males. Fifty-one per cent of 229 rabbits shot were males.

Combining data from shot and trapped rabbits gives 128 males to 126 females or about 50 per cent males.

The sex ratio reported by Hunt (1956) for 152 swamp rabbits that he shot was 43:57 in favor of females. Females predominated in each age group.

As indicated earlier in this thesis, sex ratios of cottontails have been found by most workers to be unbalanced in favor of the males. Most workers agree that this is the result of the method of collection and/or the differences in habits of the two sexes, and that the sex ratios of cottontails are nearly equal. Among 16 cottontails trapped in the present study the sex ratio was 56 per cent males. Among 84 shot cottontails, 53 per cent were males. Combined data for trapped and shot cottontails gave a figure of 54 per cent males.

Of 116 swamp rabbits shot in January, 1957, 58 per cent were males. This figure differs markedly from the overall figure of 50 per cent males for all seasons. It was felt that this might be the result of a greater tendency of females to hide in cold weather, as described by several investigators who have worked with cottontail. However, local cottontail data do not seem to support this, because 50 per cent of 77 cottontails taken in January were males, which is less than the figure obtained for all seasons.

Age Ratios

Two methods were used to separate juvenile swamp rabbits from adults. The first was by the degree of ossification of the epiphysis at the proximal end of the humerus, as described by Thomsen and Mortensen (1946) for cottontails. The other method was to x-ray the paws of the rabbit and note the progression of ossification of the distal epiphyses of the radius and ulna. As was pointed out in the review of literature, Hale (1949) thought the humerus criterion to be valid in cottontails for about nine months. If the criterion is not valid beyond that length of time for swamp rabbits, then the January collections do not give a correct adult-juvenile ratio. The indicated ratio would favor adults, for animals would be correctly classified as juveniles, but presumed adults could also be early young-of-the-year.

The adult-young ratio for January, the largest single sample, showed 32 adults to 55 young or 63 per cent. Table VI lists the adult-young ratios by months. Numbers were inadequate in some months, but there is a marked progressive decrease in the percentage of juveniles after January. Thus, if the ageing criterion has not become invalid by January, it probably does so soon thereafter.

The limited data now at hand indicate that winter age ratios among swamp rabbits are not so unbalanced in favor of young as they are in the cottontail. The figure of 63 per

Table VI. Percentages of juvenile swamp rabbits in monthly collections

Month	Number of adults	Number of juveniles	Percentage of juveniles
January	32	55	63
February	3	4	57
March	14	8	36
April	21	8	28
May	12	1	8
June	5	0	0

cent young swamp rabbits in January obtained in this study can be compared with 79 per cent young among Wisconsin cottontails collected from November 1 to January 15 during each of three years (Hale, 1949) and with 87 per cent young obtained during a November hunting period in Pennsylvania (Petrides, 1951).

Home Ranges

The Trapping Area

Home range sizes were determined both by trapping and by beagle chases. These operations were carried out on a portion of the Duck Creek Wildlife Area. This trapping area comprises 72 acres and extends from the edge of a lake on the south to higher dry land on the north, as shown in the map (Figure 1). This is a logged-over lowland hardwood site. Pin and overcup oaks dominate; overstory trees seven to ten inches d. b. h. are most common. Stand density varies from about 95 overstory trees per acre to openings with only 15 per acre;

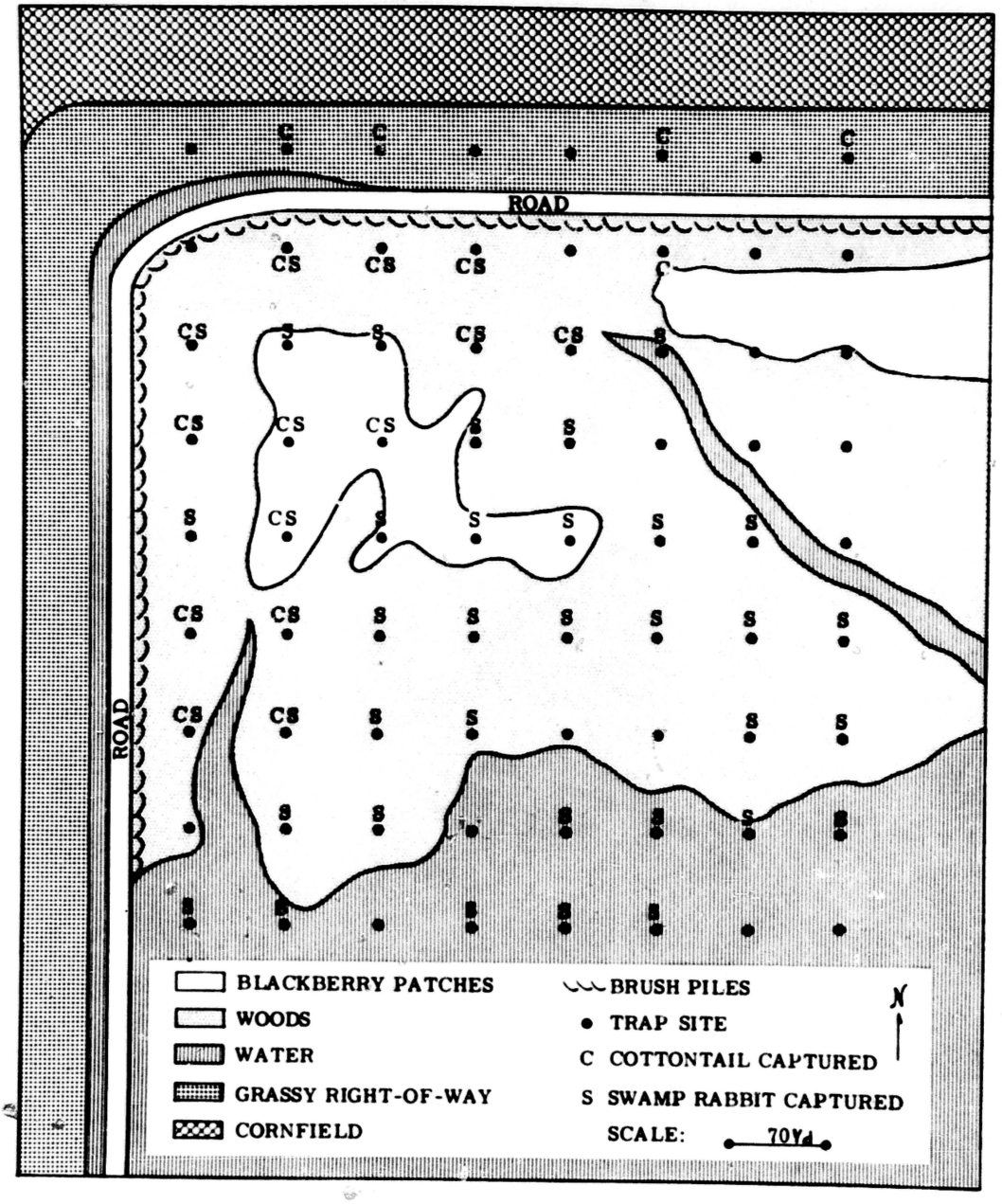


Figure 1. Diagram of trapping area, showing locations of traps, and sites at which cottontails and swamp rabbits were captured. Water boundaries shown as of December 19, 1956.

in these openings there is undergrowth of blackberries and other small shrubs. The north and west sides of the area are bordered by a road with a grassy right-of-way 70 yards across.

Trapping and Tagging Procedure

The trapping area was separated into 72 one-acre plots. A trap was placed in the center of each plot, making a grid nine traps deep and eight traps wide; traps were 70 yards apart. Box traps operated with a treadle were used.

Various types of bait, such as apples, carrots, corn, commercial rabbit pellets, anise oil, and rabbit urine were used. Unbaited traps were as successful as baited ones.

Trapped rabbits were weighed, sexed, measured, tagged, and released. Recaptured rabbits were recorded and released.

Two types of tags were used. One was a small aluminum poultry tag that could be attached to the ear with crimping pliers. The cottontails were marked with this tag only. The aluminum tag was placed in one ear of swamp rabbits, and a numbered plastic tag was attached to the other ear. The plastic tags were round or square and were assembled in various color combinations so that each rabbit could be identified individually. The plastic tags were one inch across and were attached to the ear by rabbit ear tags sold by the National Band and Tag Company. None of the poultry tags were known to be lost and the one plastic tag known to be lost came off when the rabbit was confined in a trap.

With binoculars a rabbit could be identified by the plastic tag about 75 yards away when the rabbit was still, and at about 30 yards when it was running. There are few openings over 50 yards in length in the trapping area, so the tags were generally quite satisfactory for the area.

Trapping Results

Traps were set for short periods starting in June, 1956. Trapping success was too low to warrant full-time trapping until November 15, 1956. (See Table VII.) Traps were closed in the latter part of February, 1957 and no further trapping efforts were made.

Table VII. Monthly trapping success

Trap nights	Month	Captures of swamp rabbits	Percentage of success for swamp rabbits	Captures of cottontails
60	June	0	0	0
224	July	3	1.3	0
336	August	0	0	0
432	September	2	0.5	0
0	October			
720	November	40	5.6	11
1360	December	43	3.2	13
1800	January	52	2.9	10
1050	February	16	1.5	1

During the month of November most of the trap sites were on dry land. Water levels rose in December reaching a peak about the 18th. At that time the water boundaries were as shown on the map (Figure 1), and although the traps were placed

on logs or other dry situations, most traps in the southernmost two rows were surrounded by water. As the water encroached, trapping success diminished, and when water depth reached about six inches no more captures were made. During the period of trapping, 35 swamp rabbits were trapped a total of 143 times. Twenty-one of these rabbits were trapped at least three times each. The greatest number of captures for a single female was 16 and for a male, 8. Eighty per cent were captured more than once.

Eighteen cottontails were caught a total of 35 times. Recapture rates were much lower than those for the swamp rabbit. Only 39 per cent of the cottontails were recaptured, and only one cottontail was caught more than three times. No attempt was made to estimate sizes of the home ranges of cottontails because of the low recapture rate, which may have indicated movement in and out of the trapping area.

Both Calhoun (1941) and Lowe (1958) indicated sharp delimitation of swamp rabbit and cottontail ranges where both species occurred. In the present study, however, much overlapping of ranges of the two species was proved by trapping results. There was an area in which no swamp rabbits were caught and another area where no cottontails were trapped, but between these was a belt 70-140 yards wide where both were captured. This belt can be seen on the map (Figure 1). Whereas cottontails were usually trapped farther from open water than were swamp rabbits, there were exceptions. In

general, the cottontails stayed closer to the fields, road strips, and brush piles.

Calculation of Home Ranges from Trapping Data

Two systems for calculating home ranges from trapping data were used. The first method used was the "trap square" method of Haugen (1942). This system, as explained earlier in the thesis, involves adding all the "trap squares" in which a rabbit was caught, plus any intervening ones. The other system used was to determine "minimum home ranges," as described by Mohr (1947): areas enclosed by lines connecting points of capture were determined by planimeter. Sizes of home ranges for all trapped swamp rabbits are shown in Table VIII.

Average home range sizes were computed only for swamp rabbits trapped four times or more; the choice of this figure was arbitrary. Results for these selected individuals are shown in Table IX. Home ranges for seven females averaged 5.9 acres when computed by the "trap squares" method, and 2.1 acres when computed by Mohr's "minimum home range" procedure. Home ranges of seven males averaged 4.6 acres ("trap squares") and those of five males averaged 1.8 acres ("minimum home range").

Beagle Chase Procedure

Most of the recorded chases of tagged rabbits by beagles were made in January and February. All recorded chases were

Table VIII. Home ranges of all trapped swamp rabbits

Tag no.	No. of captures	No. of beagle chases	Size of home range in acres according to: "trap squares"	"minimum home range"	beagle chases
FEMALES					
409	16	3	8.1	4.0	4.6
414	13	3	9.1	3.5	3.5
450	11	2	7.1	2.5	5.5
418	9	2	6.1	2.0	3.4
460	6	2	4.0	1.0	2.5
406	6		4.0	1.0	
430	5	3	3.0	1.0	5.0
447	3	1	2.0		4.8
405	3		2.0		
411	3		2.0		
424	3		2.0		
448	2	1	1.0		3.0
402	2				
412	2				
RU24	1	1	1.0		1.5
453	1				
452	1				
403	1				
427	1				
446	2				
MALES					
444	8		7.1	2.4	
425	6		5.1	1.5	
441	5	1	4.0		1.9
417	4	3	4.0	2.0	2.6
413	4	1	6.1	2.0	1.7
442	4	1	4.0	1.0	1.6
415	4		2.0		
449	3				
454	3		1.0		
456	3		3.0		
457	2	2	3.0		7.9
437	2	2	3.0		2.5
428	2				
416	1				
401	1				

Table IX. Home ranges of swamp rabbits trapped at least four times

Tag. no.	No. of captures	No. of beagle chases	Size of home range in acres according to: "trap squares"	Size of home range in acres according to: "minimum home range"	Size of home range in acres according to: beagle chases	Maximum diameter of home range in yards derived from: trapping	Maximum diameter of home range in yards derived from: beagle chases	Maximum diameter of home range in yards derived from: both	Greatest departure of beagle chase from "minimum home range" (yards)
FEMALES									
409	16	3	8.1	4.0	4.6	210	234	242	84
414	13	3	9.1	3.5	3.5	284	280	350	79
450	11	2	7.1	2.5	5.5	219	263	263	84
418	9	2	6.1	2.0	3.4	219	238	252	46
460	6	2	4.0	1.0	2.5	219	284	284	89
406	6	-	4.0	1.0	-	140	-	-	-
430	5	3	3.0	1.0	5.0	156	298	298	130
Averages for			5.9	2.1	4.1	208	266	282	85
MALES									
444	8	-	7.1	2.4	-	280	-	-	-
425	6	-	5.1	1.5	-	159	-	-	-
441	5	1	4.0	-	1.9	210	140	215	93
417	4	3	4.0	2.0	2.6	158	200	205	93
413	4	1	6.1	2.0	1.7	280	130	280	24
442	4	2	4.0	1.0	1.6	196	163	233	82
415	4	-	2.0	-	-	98	-	-	-
Averages for			4.6	1.8	2.0	197	158	233	73

made on the trapping area described previously. During most successful chases the observer was aided by one or two other persons.

When a chase was started one person stayed at the point of origin and tried to identify the rabbit from its ear tag when the rabbit returned. Many times the rabbit was identified when "jumped" and its identity could be checked upon its return.

One person followed closely behind the dogs, and marked the trail with tissue paper. It was a simple matter to retrace and record the route taken when the chase was over. The paper was picked up to avoid confusion on subsequent runs. It was found to be impossible to follow the dogs and record the route at the same time. Beagle chases were not recorded if the identity of the rabbit was uncertain, or if the dogs lost the trail for an extended period and the rabbit's identity could not then be rechecked.

Results of Beagle Chases

A total of 29 chases of 15 individuals were made. Of these 15 rabbits, nine were females and six were males. The greatest number of acceptable chases of any individual was three. The route taken by the rabbit was plotted to scale and the area calculated with a planimeter. The maximum home range sizes determined by this method were 5.5 acres for a female and 7.9 acres for a male. These ranges are much smaller

than those reported by Lowe (1958) in Georgia; the latter averaged about 19 acres.

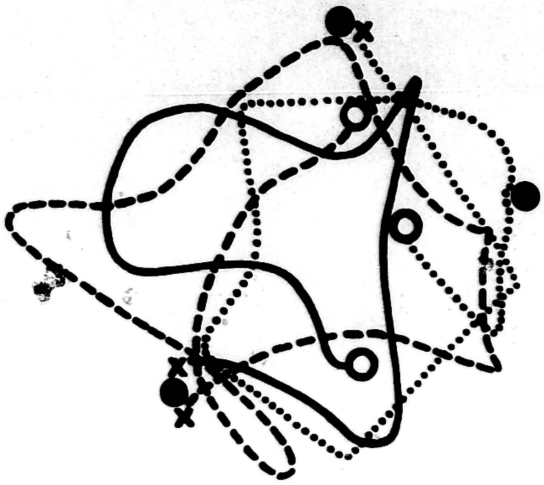
Of interest is the similarity in the routes taken by the same animal on separate runs, which can be seen in Figures 2, 3 and 4. These figures also show the close correspondence between successful trap sites and the routes taken during beagle chases. Another expression of this correspondence is the fact that the greatest departure of a beagle chase from the "minimum home range" for a rabbit trapped four or more times was 130 yards. This information, as well as a summary of home range sizes as determined by several methods for rabbits trapped four or more times is shown in Table IX. Included in the table are measures of "maximum diameters" or the greatest distance between any points in an indicated home range.

Overlapping Ranges

The great extent of overlapping of home ranges is illustrated in Figure 5 where home ranges of 11 males, determined by trapping and beagle chases, are plotted in spatial relationship. Home ranges of the females overlapped similarly, and those of males and females overlapped one another. Lowe (1958) thought that home ranges of the swamp rabbits he studied in Georgia overlapped but little.

Discussion

There are probably as many methods for collecting home



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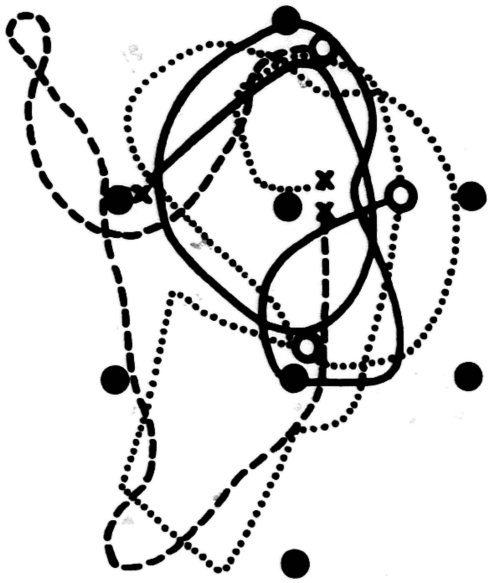

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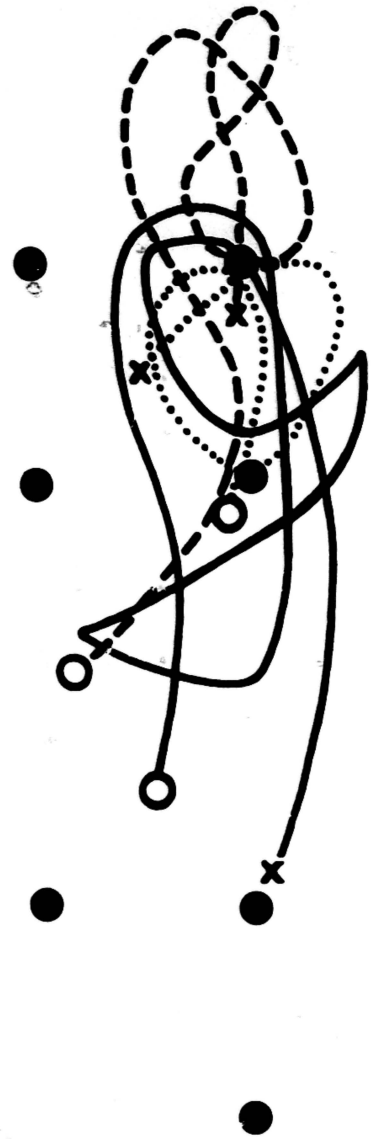
PATHS OF BEAGLE CHASES

POINT OF ORIGIN OF BEAGLE CHASES
POINT OF TERMINATION OF BEAGLE CHASES
SITES AT WHICH RABBIT WAS TRAPPED

Figure 2. Correspondence between trapping sites and paths of beagle chases for a male and a female swamp rabbit.



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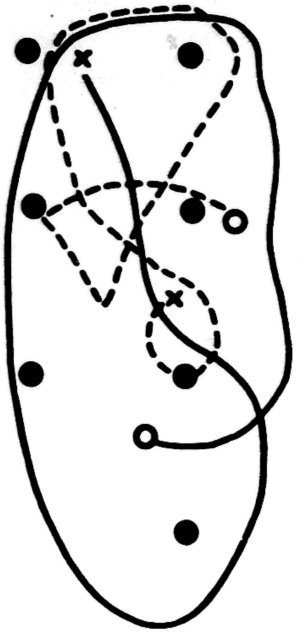
PATHS OF BEAGLE CHASES

POINT OF ORIGIN OF BEAGLE CHASES
POINT OF TERMINATION OF BEAGLE CHASES
SITES AT WHICH RABBIT WAS TRAPPED

Figure 3. Correspondence between trapping sites and paths of beagle chases for a female swamp rabbit.



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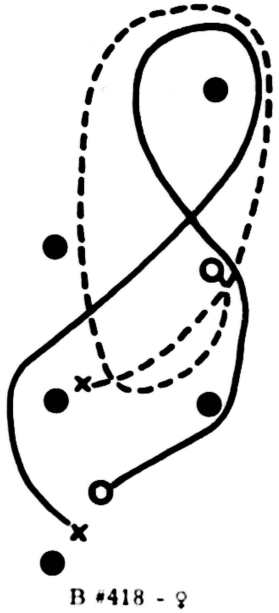

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PATHS OF BEAGLE CHASES

POINT OF ORIGIN OF BEAGLE CHASES
POINT OF TERMINATION OF BEAGLE CHASES
SITES AT WHICH RABBIT WAS TRAPPED

Figure 4. Correspondence between trapping sites and paths of beagle chases for two female swamp rabbits.

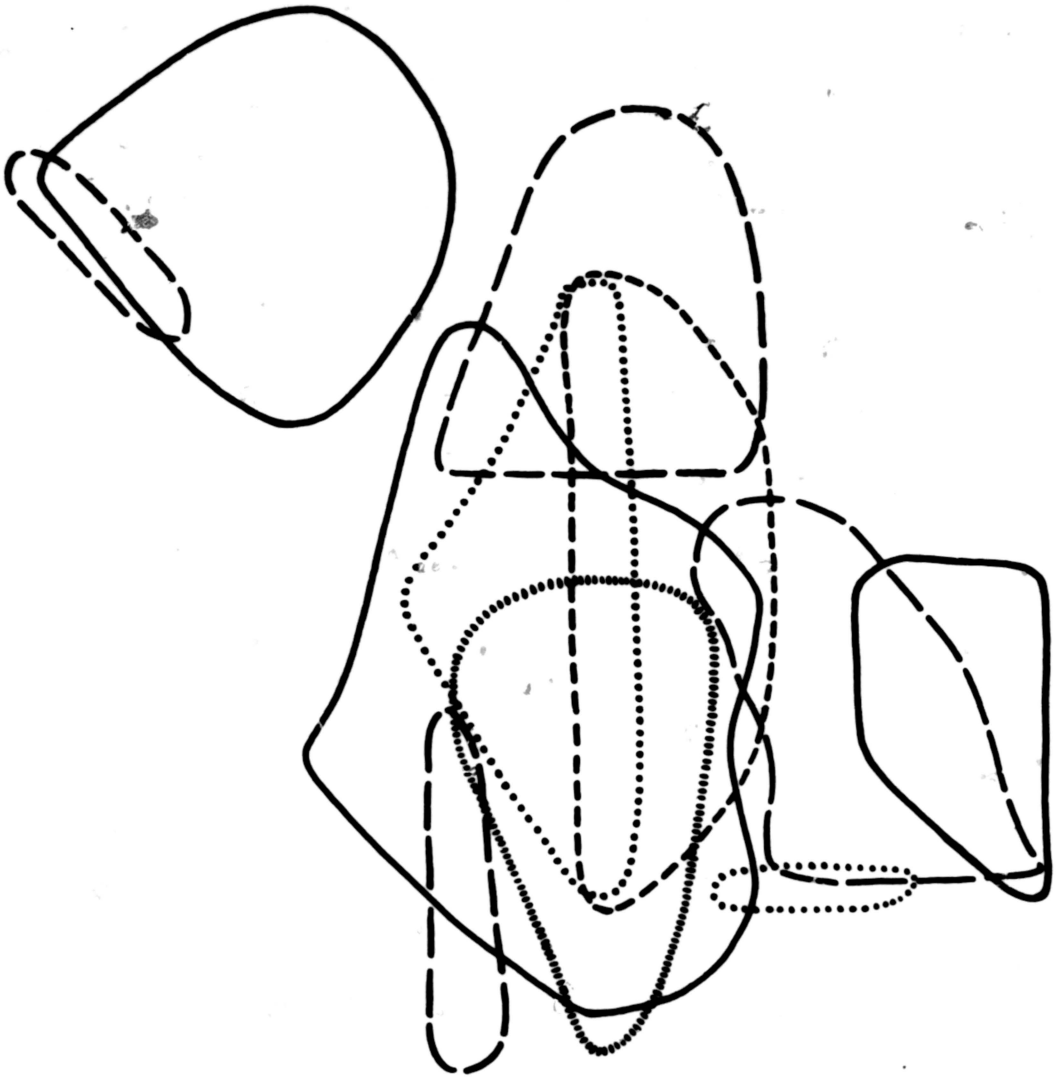

Figure 5. Overlapping ranges of male swamp rabbits.

range data as there are procedures for interpreting the data once they are gathered. As was pointed out earlier, chasing by dogs has been used to give some information about the sizes of home ranges of the marsh rabbit by Carr (1939), and the swamp rabbit by Lowe (1939); however, neither of these workers gathered detailed information about individually marked rabbits by chasing with dogs, and the data they secured were not related to trapping records for the rabbits.

The adequacy of beagle chases in determining size of home ranges is worthy of discussion. One might wonder how often in the course of a supposed chase the beagle shifted to a different rabbit. In my opinion this could have happened rarely, if at all, because: (1) during several chases rabbits were individually identified more than once, and (2) whenever there was real doubt about this point, the record of the chase was discarded.

A second question is: do beagle chases really represent home ranges, even when accurately mapped? This question cannot be answered categorically, but the fact that the rabbits usually return to the point of origin of the chase implies that they tend to remain within a familiar area. Wight (Pers. Comm.) has observed cottontails that were released several miles from their home ranges running in a straight line when chased by a dog. Thus, a rabbit pushed out of its home range might run in a straight line and the pattern of the chase would be quite different from those shown in Figures 2-4.

Further, beagles are often far behind the rabbit. During a chase, rabbits were sometimes seen to stop and lick themselves in leisurely fashion. It is hard to imagine that under such circumstances the animal is being pushed out of its home range.

Two other points already mentioned lend evidence that the estimate of home range as found by beagle chases is accurate. First is the correspondence between the successful trapping sites and the area enclosed by beagle chases. Second is the similarity in areas enclosed by different chases of the same rabbit.

In evaluating the "trap squares" method and the "minimum home range," Hayne (1949) noted that the critics of the "trap squares" approach believe that it gives an estimate that is too large, and that the critics of the "minimum home range" think that it gives an estimate that is too small. Interestingly, in eight of nine cases, the estimated size of home range obtained by beagle chases fell between the sizes obtained using the other two methods.

One advantage of determining home ranges by beagle chases is the rapidity of the method. From the results obtained in this study it would seem that as much information about home ranges could be obtained in a few days by beagle chases as during several weeks of trapping. Another advantage of this method is the simplicity of determining and expressing results.

Reproductive History

Onset of Breeding Season

The start of the reproductive season in cottontails is controlled by the breeding condition of the female, for as Hamilton (1940) pointed out, the male is capable of breeding before the female and remains fertile after the female is no longer in breeding condition. In Texas, Hunt (1956) found that both sexes of swamp rabbits were in breeding condition throughout the year, but he suggested that this condition probably resulted from the temperate climate and might not be true in the north.

The first reproductively active female swamp rabbit collected in this study was taken on February 25, 1957. The reproductive tract of this female was enlarged, well supplied with blood, and appeared to be estrus. Two similar-appearing tracts were collected on March 9, 1957.

On March 16, 1957, a female in full lactation was taken; the reproductive tract was much enlarged and bloody detritus was seen in the uterine lumen. From a field examination she appeared to have just had young. A later laboratory examination showed a corpora lutea count of five and four distinct placental scars. Back-dating 40 days (an average of Hunt's estimated gestation period for the swamp rabbit), February 4 was estimated to be the conception date. Using Hunt's information about embryo development and back-dating rabbits

that had just had young, five more females were estimated to have been bred during February. Only one female taken after February 25, 1957, was reproductively inactive. This was a young animal (possibly from a late litter of the previous year), collected on April 5, 1957. However, one juvenile taken before this was in breeding condition, and another was pregnant, having four embryos. Apparently a few females are in estrus the last part of January or the first part of February, and the breeding season is at its peak by the latter part of the month. Collections were not sufficient to determine the end of breeding activity for the females but no females taken from October through January were reproductively active.

Breeding Condition in Males

Testes were preserved from some males during each month, October, 1956 through June, 1957. Histological sections were prepared from one testis and cauda epididymis of each male. If sperm was found in the testis and in the tail of the epididymis, the rabbit was considered to be in breeding condition. Material from 42 animals was analyzed.

Since no collections were made during August and September, the reproductive status through this period is unknown. In October four males were collected and only one of these was in breeding condition. During November three adult males were collected. One of these had no sperm in either the testis or epididymis while the other two showed active spermatogenesis.

Three of the five males taken during December were producing sperm while two (one adult and one young) had no stages later than secondary spermatocytes in the testes. All animals taken through the spring and early summer were reproductively active.

Some male swamp rabbits in Missouri populations may be in breeding condition every month of the year. Because no collections were made in the late summer this statement cannot be supported with direct evidence. Probably the number of breeding males begins to decline during the late summer and remains low through November. By the end of December both juvenile and adult males are in breeding condition.

The testes of swamp rabbits are conspicuously smaller than those of cottontails. The average weight of the testis for the swamp rabbit was 1.38 grams. Dalke (1942) found the average weight of testes of the cottontail covering the same period of the year to be about 6 grams. The heaviest swamp rabbit testis taken weighed 2.5 grams.

Litter Size

Litter size was estimated by three methods. The first was to count the corpora lutea of all swamp rabbits collected between March 16 and June 23, 1957. Forty-six females were checked and found to have an average corpora lutea count of 3.7 with a maximum of 6 and a minimum of 2. Of the 46 total, 41.3 per cent had three corpora lutea, 37 per cent had four,

15 per cent had five, 4.4 per cent had two, and 2 per cent had six. These figures indicate maximum litter size and would not account for post- or pre-implantation losses.

The second approach was to count the embryos found in the pregnant females. Only embryos that had a crown-rump measurement of 35 mm. or more were included, since excluding embryos of small size would tend to reduce the error introduced by resorption. Embryos in 14 females were counted; half of them had 3 embryos and the average was 2.8 (range 1 to 4). When 24 females with embryos of all sizes were included, the average litter size was 3. Hunt's (1956) embryo counts averaged 2.8 (range 1 to 5) for 29 female swamp rabbits.

The last approach was counting placental scars. Those counted were probably not more than two weeks post-partum. The average placental scar count in 7 rabbits was 3.4 (range 3 to 4). Conaway (1955) showed that in rats the placental scars formed at the sites of resorbed embryos were indistinguishable from those formed at the sites of term embryos. If this is also true in the swamp rabbit the placental scar method would result in an over-estimation of litter size.

Food Habits

A few observations upon food habits of the swamp rabbit were made, and since there is little information about this, they are reported here.

The plant most commonly eaten by the swamp rabbit seemed to be Carex lupulina, locally called swamp grass. This plant is abundant throughout the study area and is used by swamp rabbits from the time it becomes green in the spring until it turns brown in mid-winter. Large areas of Carex were found eaten close to the ground during the period after frost and before it died in mid-winter. During the same period large amounts of hazelnut (Corylus sp.) shoots were eaten.

After the Carex "died back" in late December or early January, swamp rabbits started eating twigs and bark of woody plants. These plants that were found on the trapping area were marked with colored cloth streamers and were identified in the spring. Care was taken to mark plants only in the area used by the swamp rabbits and not areas used by both the swamp rabbits and cottontails. Table X lists plants used, time of usage, and a coarse measure of abundance of the plants.

During a two-month period of flooding in the spring of 1957, swamp rabbits were forced to roadways running through the Mingo Refuge. They ate Alta fescue, winter wheat, and sericea lespedeza (L. cuneata).

Coprophagy

Soft pellets occurred frequently in the stomachs of the swamp rabbits and cottontails that were collected. During the later part of the study all rabbits collected were examined for soft feces in the stomach and rectum. Information ob-

Table X. Plants used as food by swamp rabbits, 1956-57

Species	Amount of usage	Season used	Abundance of plant
Blackberry (*Rubus spp.*)	heavy	fall & winter	very common
Hazelnut (*Corylus sp.*)	heavy	fall & winter	very common
Deciduous holly (*Ilex decidua*)	heavy	winter	common
Spice bush (*Lindera benzoin*)	heavy	winter	common
Hackberry (*Celtis laevigata*)	medium	winter	common
Sumac (*Rhus aromatica*)	medium	winter	common
Sassafras (*Sassafras albidum*)	medium	winter	rare
Trumpet vine (*Campsis radicans*)	light	winter	very common
Hercules club (*Aralia spinosa*)	light	winter	common
Overcup oak (*Quercus lyrata*)	light	winter	common
Pin oak (*Quercus palustris*)	light	winter	very common
Elm (*Ulmus rubra*)	light	winter	common
Elm (*Ulmus americana*)	light	winter	common
Cherry bark oak (*Quercus falcata* var. *pagodaefolia*)	light	winter	common
Hickory (*Carya spp.*)	light	winter	common
Green brier (*Smilax spp.*)	light	winter	common
Paw paw (*Asimina triloba*)	light	winter	rare

tained was recorded in hourly intervals (Figure 6). Apparently coprophagy occurs during the daylight hours when the rabbits are resting, and not at night, when they are feeding. This is the pattern observed in the jack rabbit by Lechleitner (1957).

General Notes and Observations

A few miscellaneous observations made during this study seemed worth recording and are presented below.

Voice

Lowe (1958) and others have described the loud screams of the swamp rabbit when handled by men or caught by dogs. I heard this sound, and another previously undescribed--a wheezing-whistling sound which was uttered by the swamp rabbit when startled. The rabbit always struck the ground with its hind foot when the whistling sound was made. It was noted most frequently at night when rabbits were being spotlighted.

Defecation Sites

Defecating on logs, stumps, and other elevated objects is a common habit of the swamp rabbit, but no explanation has been published for this behavior. During this study it was noted that the swamp rabbit practiced this habit only during the seasons when the leaves were off the trees, suggesting that the elevated areas are observation posts.

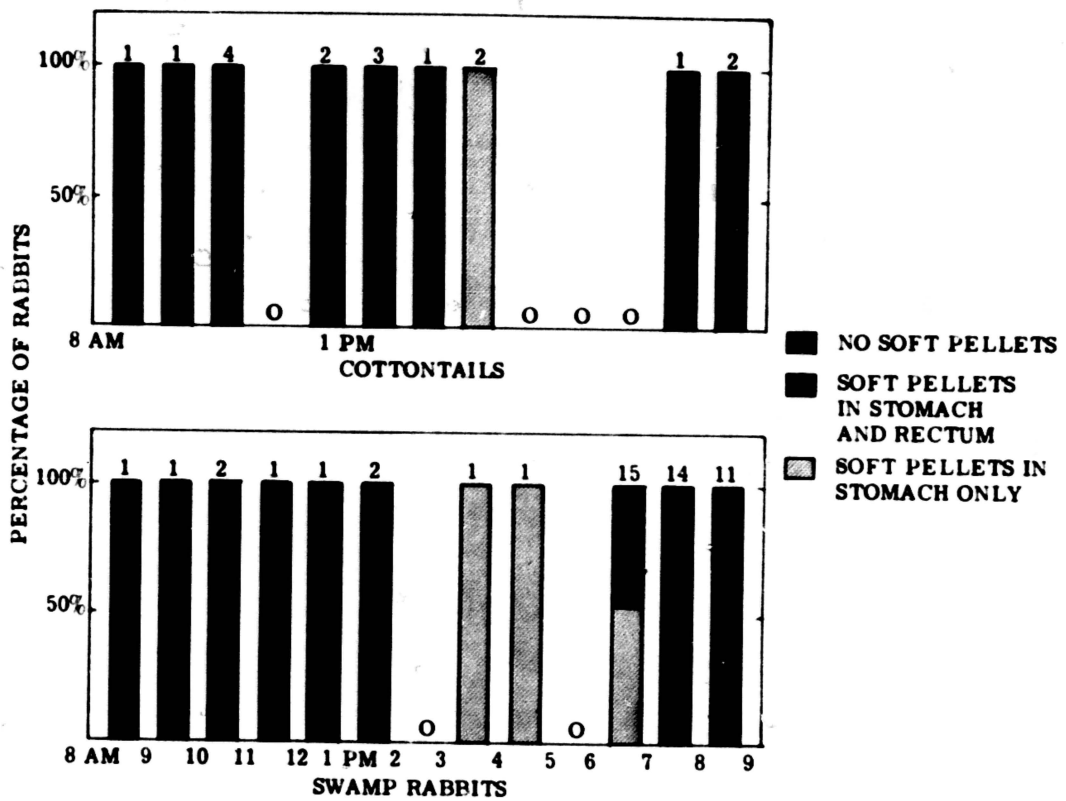

Figure 6. Percentages of cottontails and swamp rabbits containing soft pellets. Numbers above bars indicate sample sizes.

CHAPTER V

SUMMARY

1. This study of the life history of the swamp rabbit was made during 1956 and 1957 in the Mingo Swamp of southeastern Missouri.

2. Weights of 93 male swamp rabbits taken from October through June averaged 4 lb. 8.5 oz. (range 2 lb. 9 oz. to 5 lb. 10 oz.). Sixty-five females averaged 4 lb. 8.3 oz. (range 3 lb. 5 oz. to 5 lb. 9 oz.), excluding weights of pregnant females.

3. The sex ratio for 254 swamp rabbits shot or trapped was 50:50. The sex ratio for 116 cottontails shot or trapped in the same area was 54:46 in favor of the males.

4. The adult-young ratio was determined for 163 swamp rabbits collected from January through June, 1957. Determination of age was based on the degree of epiphyseal ossification of the humerus. Percentages of adults increased from 37 in January to 100 by June, indicating inaccuracy of this method after January. The validity of the method before January awaits confirmation.

5. Thirty-five swamp rabbits were trapped 143 times on a 72-acre area. Traps were located in a grid pattern, 70 yards apart. All rabbits were tagged with colored plastic

tags which made field identification of individuals possible.

6. Home ranges for females trapped four times or more averaged 5.9 acres when computed by addition of "trap squares," and 2.1 acres when determined by the "minimum home range" method. Corresponding figures for males were 4.6 acres and 1.8 acres.

7. Sizes of home ranges were also estimated by chasing individually tagged rabbits with beagles, and recording the paths of the chases. Home ranges determined in this fashion averaged 4.1 acres for females and 2.0 acres for males. Routes taken by rabbits during beagle chases corresponded very closely with trap records for the same individuals, and with routes taken by the same rabbits in different chases. Beagle chases appear to have much promise for determining home ranges of rabbits. Data can be gathered rapidly and interpretation is simple. Evidence for the validity of this method is that in eight out of nine cases the estimated size of home range obtained by beagle chases fell between the home range sizes estimated by "trap squares" and "minimum home ranges."

8. Female swamp rabbits in southeast Missouri were probably estrous by early February, and only one female was found reproductively inactive after February 25. No females collected from October through January were in breeding condition. Males attain breeding condition before the females and remain in it longer. Some male swamp rabbits probably

are capable of breeding throughout the year.

9. Litter sizes were estimated from corpora lutea counts, embryo counts, and placental scar counts. From corpora lutea counts, the average was 3.7 (range 2 to 6). From embryo counts the average was 2.8 (range 1 to 4). From placental scar counts the average was 3.4 (range 3 to 4).

10. The plant most commonly eaten by the swamp rabbit was Carex lupulina. This plant was eaten until late winter, when it was no longer green. The four most-used plants during the late winter months were blackberry, hazelnut, deciduous holly, and spice bush.

11. Coprophagy was found to be practiced regularly by both swamp rabbits and cottontails. Coprophagy seemed to occur in the daytime during the resting period, and was discontinued at night during the feeding period.

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Table XI. Weights and measurements of 42 juvenile male swamp rabbits

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
19	Dec. 13	4 - 8	498	70	80	105	49	no
22	Dec. 20	5 - 8	517	63	85	105	50	no
	1957							
11	Jan. 4	4 - 2	480	65	75	105	45	no
34	Jan. 4		460	70	75	105	45	no
36	Jan. 4	4 - 8	500	68	75	105	47	no
35	Jan. 4	3 - 14	470	70	69	105	46	no
59	Jan. 4	4 - 3	440	70	70	100	44	no
73	Jan. 4		480	80	78	102	47	no
76	Jan. 4		500	70	75	105	46	no
78	Jan. 4	5 - 1	500	80	78	110	40	no
81	Jan. 4	4 - 7	490	74	70	105	45	no
87	Jan. 5	5 - 2	510	75	70	105	45	no
92	Jan. 5		480	70	80	105	49	no
104	Jan. 5		490	80	75	103	46	no
112	Jan. 5	4 - 12	510	73	78	105	48	no
114	Jan. 5	4 - 4	480	70	75	100	46	no
117	Jan. 5	5 - 9	550	80	80	106	45	no
120	Jan. 5	5 - 0	530	75	74	105	45	no
121	Jan. 5	4 - 6	500	72	78	100	48	no
122	Jan. 5		485	75	72	102	44	no
125	Jan. 5	4 - 12	505	70	70	105	43	no
126	Jan. 5	4 - 2	480	70	69	100	43	no
129	Jan. 5		485	79	75	105	50	no
134	Jan. 5		500	65	83	105	45	no
137	Jan. 5		470	60	70	102	46	no
138	Jan. 5		505	70	75	104	45	no
139	Jan. 5		450	70	70	105	48	no
155	Jan. 5	4 - 4	500	70	75	107	46	no
157	Jan. 5	4 - 4	500	65	70	105	47	no
166	Jan. 5		470	70	70	105	47	no
174	Jan. 6		490	80	80	102	41	no
179	Jan. 6		490	73	73	100	41	no
191	Jan. 7		430	65	67	102	45	no
199	Feb. 7	5 - 8	510	74	74	107	50	yes
206	Feb. 25	4 - 0	470	71	65	110	50	yes
none	Mar. 1	4 - 4						yes
208	Mar. 2	4 - 2						yes
214	Mar. 19	4 - 4	502	72	70	105	45	yes
219	Mar. 21	3 - 4	450	70	67	96	45	yes
221	Mar. 21	4 - 8	505	65	74	110	47	yes
223	Mar. 23	4 - 2	468	70	68	106	50	yes
228	Mar. 26	4 - 0	510	75	70	106	48	yes

Table XII. Weights and measurements of 44 presumed adult male swamp rabbits

Tag no.	Date	Weight (lb.-oz)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
12	Nov. 7	4 - 14	491	60	77	105	50	no
13	Nov. 9	5 - 4	483	70	80	105	55	no
15	Nov. 22	5 - 8	505	77	80	110	55	no
25	Dec. 20	5 - 0	512	60	75	100	50	no
18	Dec. 13	4 - 4	490	70	80	103	50	no
	1957							
5	Jan. 4	4 - 14	500	60	79	100	50	no
6	Jan. 4							
8	Jan. 4	5 - 5	470	70	77	105	50	yes
18	Jan. 4		500	73	76	100	45	no
19	Jan. 4		500	60	73	105	47	no
40	Jan. 4	5 - 10	510	70	79	112	51	no
72	Jan. 4		490	70	75	110	50	no
90	Jan. 5	5 - 0	480	70	80	100	48	no
91	Jan. 5	5 - 5	520	75	78	102	43	no
95	Jan. 5	4 - 11	510	72	70	105	52	no
113	Jan. 5	5 - 5	500	70	85	105	48	no
115	Jan. 5	4 - 13	480	70	73	102	45	no
124	Jan. 5	5 - 7	510	70	70	105	47	no
136	Jan. 5		510	75	70	105	47	no
143	Jan. 5		495	80	76	101	47	no
145	Jan. 5		510	75	70	102	46	no
156	Jan. 5	4 - 0	540	70	73	110	51	no
172	Jan. 6	5 - 0	500	73	80	105	48	no
175	Jan. 6		510	80	69	106	47	no
176	Jan. 6		505	72	75	102	43	no
197	Jan. 11	4 - 8	490	70	70	100	43	yes
202	Feb. 7	4 - 13	470	70	65	110	46	yes
204	Feb. 13	5 - 4						
205	Feb. 14	5 - 4	530	75	70	110	50	yes
216	Mar. 19							yes
220	Mar. 21	5 - 2	502	80	74	106	49	yes
222	Mar. 21	4 - 6	515	80	73	105	47	yes
224	Mar. 23	5 - 8	500	60	75	112	46	yes
230	Apr. 1	5 - 0						yes
287	Apr. 20	3 - 8	490	63	68	101	47	yes
289	Apr. 20	4 - 2	480	75	70	102	45	no
301	May 25	4 - 9	510	70	80	101	46	yes
302	May 25	5 - 0	503	80	84	103	46	yes
303	May 25	4 - 12						yes
304	May 25	5 - 4	504	81	77	102	46	yes
314	June 23	5 - 0						yes
315	June 28	3 - 12						yes
316	June 28	5 - 0						yes
317	June 28	5 - 7						yes

Table XIII. Weights and measurements of 39 male swamp rabbits of unknown age

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
28	Dec. 28	5 - 0	485	55	83	100	48	no
	1957							
25	Jan. 4	4 - 11	490	80	80	105	48	no
27	Jan. 4	4 - 4	450	80	79	103	50	no
29	Jan. 4	4 - 9	470	70	70	100	45	no
31	Jan. 4	4 - 15	520	80	75	105	47	no
51	Jan. 4	4 - 6	460	70	80	105	45	no
62	Jan. 4		520	70	75	110	46	no
75	Jan. 4		520	70	75	105	45	no
148	Jan. 5	5 - 5	500	80	68	102	45	no
150	Jan. 5	4 - 8	505	70	80	105	47	no
151	Jan. 5	4 - 2	475	75	68	103	45	no
153	Jan. 5	5 - 0	490	70	80	107	50	no
177	Jan. 6		490	70	79	110	50	no
178	Jan. 6		485	70	76	102	45	no
187	Jan. 6		500	70	76	102	48	no
192	Jan. 7		520	75	74	106	43	no
233	Apr. 4	4 - 12	510	80	71	105	45	no
235	Apr. 4	4 - 12	500	75	74	108	45	no
236	Apr. 4	4 - 4	490	70	66	105	46	no
237	Apr. 4	4 - 2	520	71	70	111	45	no
239	Apr. 4	4 - 8	490	65	72	110	45	no
244	Apr. 5	4 - 4	485	70	70	106	47	no
245	Apr. 5	4 - 2	510	70	68	105	45	no
247	Apr. 5	5 - 0	503	70	71	105	44	no
248	Apr. 5	4 - 3	485	72	71	106	48	no
261	Apr. 5	5 - 0	500	73	70	102	46	no
267	Apr. 6	5 - 10	505	80	74	106	51	no
268	Apr. 18	4 - 4	485	72	73	105	46	no
271	Apr. 18	2 - 9	470	66	64	102	42	no
272	Apr. 18	4 - 4	520	78	73	110	45	no
273	Apr. 18	4 - 2	470	70	70	108	46	no
274	Apr. 18	4 - 0	510	72	74	108	46	no
275	Apr. 18	4 - 2	478	70	70	105	48	no
281	Apr. 18	4 - 12	520	78	70	110	46	yes
282	Apr. 18	4 - 12	480	70	70	108	46	no
285	Apr. 18	5 - 0	545	70	70	104	46	no
286	Apr. 18	4 - 14	520	72	73	105	46	no
292	May 18	5 - 0	490	80	75	105	50	yes
313	June 23	4 - 13						yes

Table XIV. Weights and measurements of 42 juvenile female swamp rabbits

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
14	Nov. 9	3 - 8	450	65	83	100	52	no
16	Nov. 23	4 - 6	470	67	85	106	53	no
21	Dec. 20	4 - 9	495	65	84	110	51	no
23	Dec. 20	4 - 0	470	65	86	100	50	no
24	Dec. 20	5 - 0	490	70	89	102	50	no
29	Dec. 28	5 - 0	475	65x40	85	107	49	no
	1957							
22	Jan. 4		510	90x35	80	107	45	yes
26	Jan. 4	4 - 10	450	78x45	73	105	45	yes
28	Jan. 4	4 - 6	460	80x43	75	100	45	yes
37	Jan. 4		485	80x45	73	110	47	yes
49	Jan. 4	4 - 0	490	75x35	70	107	45	yes
74	Jan. 4		500	80x43	79	105	46	yes
77	Jan. 4		490	83x41	77	110	46	no
80	Jan. 4	4 - 9	490	75x40	70	103	50	yes
88	Jan. 5	4 - 7	500	73x37	77	104	44	yes
89	Jan. 5	5 - 1	510	80x43	85	104	45	yes
94	Jan. 5	4 - 13	510	80x50	73	103	52	yes
116	Jan. 5	5 - 0	510	78x35	78	102	45	yes
131	Jan. 5		500	73x40	80	102	48	yes
132	Jan. 5		510	80x37	80	105	46	yes
133	Jan. 5		470	70x40	70	100	41	yes
135	Jan. 5		500	70x40	80	103	43	yes
140	Jan. 5		460	60x39	62	95	42	yes
144	Jan. 5		505	79x40	73	105	45	yes
154	Jan. 5	4 - 2	510	75x36	78	107	50	no
167	Jan. 5		540	80x45	77	107	50	yes
180	Jan. 6	5 - 0	500	72x35	79	106	47	yes
183	Jan. 6	3 - 12	467	70x40	74	102	47	yes
196	Jan. 8	4 - 12	500	70x34	70	100	45	yes
203	Feb. 11	3 - 13						no
207	Feb. 25	4 - 5	505	71x40	75	111	51	no
215	Mar. 19	4 - 14	515	70x30	73	110	45	yes*
246	Apr. 5	3 - 12	495	82x30	69	104	46	yes
249	Apr. 5	3 - 5	485	75x30	70	98	43	yes
250	Apr. 5	4 - 5	480	80x30	70	106	44	yes*
260	Apr. 5	4 - 6	493	80x35	68	108	46	yes
264	Apr. 5	4 - 0	480	74x38	70	102	43	yes
265	Apr. 5	3 - 10	490	78x40	70	103	46	yes*
279	Apr. 18	3 - 12	485	70x38	71	102	44	yes
280	Apr. 18	3 - 8	483	69x35	69	98	44	yes*
311	May 28	5 - 2						

* pregnant

Table XV. Weights and measurements of 51 presumed adult female swamp rabbits.

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
20	Dec. 20	4 - 8	510	65	85	100	46	no
30	Dec. 28	4 - 12	505	70	85	110	50	no
	1957							
30	Jan. 4	5 - 1	525	75	70	105	50	yes
43	Jan. 4	5 - 3	480	70	70	105	50	no
79	Jan. 4	4 - 4	500	68	77	102	44	yes
93	Jan. 5	5 - 0	510	78	75	105	45	yes
127	Jan. 5		520	75	80	100	48	yes
128	Jan. 5		515	90	72	103	46	no
130	Jan. 5		510	70	69	103	45	yes
169	Jan. 5	5 - 1	500	70	75	105	45	no
181	Jan. 6							yes
182	Jan. 6							yes
188	Jan. 7	4 - 12	468	70	74	104	44	yes
209	Mar. 9	4 - 4						yes
210	Mar. 9	4 - 4						yes
211	Mar. 16	4 - 12	530	70	71	102	55	yes
212	Mar. 16	5 - 0	510	70	70	110	48	yes*
213	Mar. 19	5 - 0	520	70	76	110	48	yes*
217	Mar. 21	5 - 0	480	70	73	105	48	yes*
218	Mar. 21	4 - 12	474	70	70	103	48	yes*
225	Mar. 26	5 - 0	505	75	70	110	48	yes*
227	Mar. 26	4 - 12	500	78	70	105	50	yes*
229	Mar. 26	4 - 12	510	70	70	110	50	yes
231	Apr. 1	4 - 8						yes*
232	Apr. 1	5 - 4						yes*
234	Apr. 4	4 - 4	450	63	72	104	47	yes*
238	Apr. 4	5 - 4	510	75	76	110	50	yes*
240	Apr. 4	5 - 0	490	70	74	102	46	yes
241	Apr. 4	5 - 0	490	83	74	111	47	yes
243	Apr. 5	4 - 4	500	70	70	105	46	yes
262	Apr. 5	4 - 8	505	78	67	105	45	yes*
263	Apr. 5	4 - 12	515	85	73	102	47	yes
266	Apr. 6	4 - 8	475	83	71	106	45	yes*
269	Apr. 18	4 - 6	500	75	72	105	46	yes
270	Apr. 18	4 - 12	515	72	72	107	46	yes
276	Apr. 18	4 - 12	490	70	72	106	45	yes*
277	Apr. 18	4 - 5						yes
283	Apr. 18	4 - 8	490	70	72	105	45	yes
284	Apr. 18	5 - 4	530	75	72	107	47	yes*

* pregnant

Table XV (cont.). Weights and measurements of 51 presumed adult female swamp rabbits

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
288	Apr. 20	4 - 4	492	71	73	101	46	yes
290	Apr. 20	4 - 0	480	75	74	103	48	no
300	May 25	5 - 0	504	80	76	103	47	yes*
305	May 25	5 - 12	500	75	80	103	45	yes
306	May 25	5 - 0						yes*
307	May 27	4 - 8						yes
308	May 27	5 - 2						yes*
309	May 27	4 - 4						yes
310	May 28	5 - 0						yes*
312	May 28	5 - 0						yes
318	June 29	4 - 0						yes
319	Sept. 23	5 - 2						yes

*pregnant

Table XVI. Weights and measurements of 20 female swamp rabbits of unknown age

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot	Reproductive tract taken
	1956							
17	Dec. 13	4 - 12	517	70	83	105	50	no
	1957							
17	Jan. 4	5 - 0	500	85	80	110	50	yes
20	Jan. 4	5 - 8	520	87	76	105	46	yes
32	Jan. 4		520	80	75	110	48	yes
33	Jan. 4		505	80	75	100	45	yes
38	Jan. 4		480	80	70	110	47	no
86	Jan. 5	4 - 3	480	75	78	106	46	yes
118	Jan. 5	5 - 9	520	83	77	107	50	yes
149	Jan. 5	4 - 7	495	70	77	103	45	yes
152	Jan. 5	4 - 0	480	70	75	102	47	no
184	Jan. 6	5 - 9	510	84	80	110	47	yes
185	Jan. 6	4 - 7	500	70	77	102	43	no
194	Jan. 8		510	70	72	107	47	yes
195	Jan. 8		520	70	72	107	47	yes
198	Jan. 11	4 - 13	490	73	74	107	46	no
201	Feb. 7							yes
226	Mar. 23	4 - 14	470	70	70	105	47	yes*
242	Apr. 4	4 - 4	490	72	74	102	45	yes
278	Apr. 18	5 - 2	535	90	75	105	45	yes
291	May 16							yes

*pregnant

Table XVII. Weights and measurements of 40 male cottontails

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of: Tail	Ear	Hind foot	Fore foot
	1957						
4	Jan. 4	1 - 15	384	50x45	58	92	45
10	Jan. 4	2 - 8	385		60	100	41
14	Jan. 4	2 - 10	400	60x47	58	92	45
15	Jan. 4	2 - 13	415	60x51	65	100	40
41	Jan. 4	3 - 0	405	57x42	60	91	41
42	Jan. 4	2 - 10	410	60x50	60	87	40
47	Jan. 4	3 - 1	405	60x50	50	95	45
50	Jan. 4	2 - 12	415	60x45	65	95	40
61	Jan. 4		400	60x45	55	90	42
63	Jan. 4		410	60x40	61	93	40
64	Jan. 4		410	60x45	60	90	43
66	Jan. 4	2 - 10	380	65x48	60	95	43
67	Jan. 4		400	60x48	60	91	40
70	Jan. 4		410	55x40	56	93	40
71	Jan. 4		400	53x40	57	90	40
82	Jan. 4	2 - 8	370	52x45	55	95	40
83	Jan. 4	2 - 8	400	55x40	58	93	40
84	Jan. 4	3 - 1	380	60x40	61	95	42
85	Jan. 4	2 - 12	410	60x40	58	95	40
96	Jan. 5	2 - 12	405	50x40	60	90	40
97	Jan. 5	2 - 7	380	50x40	58	85	42
100	Jan. 5	2 - 12	415	53x50	65	95	40
102	Jan. 5	3 - 1					
103	Jan. 5	2 - 7	400	60x45	55	95	40
107	Jan. 5		405	68x45	56	90	41
108	Jan. 5		410	60x50	60	90	42
111	Jan. 5		420	60x50	60	92	40
119	Jan. 5	2 - 12	390	50x46	60	90	40
142	Jan. 5		385	52x45	60	90	38
146	Jan. 5	2 - 8	385	60x50	60	90	41
158	Jan. 5	2 - 2	400	60x45	58	90	41
159	Jan. 5	2 - 2	370	60x50	60	90	40
160	Jan. 5	2 - 2	410	55x45	58	82	43
161	Jan. 5	2 - 0	375	50x45	65	97	42
162	Jan. 5	2 - 8	420	50x45	58	94	45
163	Jan. 5	2 - 8	430	58x42	60	100	46
164	Jan. 5	2 - 4	425	60x43	61	95	44
165	Jan. 5	2 - 5	410	60x45	58	93	42
170	Jan. 5	2 - 15	410	50x40	60	90	41
190	Jan. 7	2 - 8	381	60x47	55	90	38

Table XVIII. Weights and measurements of 37 female cottontails

Tag no.	Date	Weight (lb.-oz.)	Total length (mm.)	Lengths (mm.) of:			
				Tail	Ear	Hind foot	Fore foot
	1957						
3	Jan. 4	2 - 10					
7	Jan. 4	2 - 13	380	63x50	61	95	46
12	Jan. 4	2 - 5	380	50x45	55	90	38
13	Jan. 4	2 - 2	380	60x50	52	85	37
16	Jan. 4	3 - 4	445	60x47	62	90	40
23	Jan. 4		390	63x50	50	90	35
24	Jan. 4		420	60x45	65	91	40
35	Jan. 4	2 - 6	400	60x50	60	90	40
39	Jan. 4		400	70x50	60	97	42
44	Jan. 4	3 - 0	400	60x45	65	93	40
45	Jan. 4	3 - 0	420	60x50	65	90	42
48	Jan. 4	3 - 0	400	60x50	55	95	45
52	Jan. 4	2 - 9	415	70x45	55	95	40
53	Jan. 4		400	65x45	65	100	40
54	Jan. 4	3 - 1	435	60x50	65	100	45
56	Jan. 4	2 - 8	410	60x50	63	90	42
57	Jan. 4		430	60x38	60	90	40
58	Jan. 4		420	70x51	58	100	44
60	Jan. 4	2 - 4	400	60x45	55	91	40
65	Jan. 4	3 - 0	420	60x45	63	95	40
68	Jan. 4		410	70x50	60	95	41
69	Jan. 4		420	70x50	61	95	40
98	Jan. 5	3 - 1	420	60x50	60	95	44
99	Jan. 5	2 - 10	400	60x52	63	90	40
101	Jan. 5	3 - 0	405	50x43	60	90	44
105	Jan. 5		420	70x50	65	100	45
106	Jan. 5		420	70x49	65	95	45
109	Jan. 5		420	68x43	58	95	40
110	Jan. 5		410	60x47	65	92	42
123	Jan. 5	2 - 9	410	60x45	64	95	41
141	Jan. 5		400	65x52	58	93	41
147	Jan. 5	3 - 1	430	60x50	61	95	42
168	Jan. 5	2 - 9	380	55x45	55	90	44
171	Jan. 5	2 - 13	390	60x40	51	96	41
173	Jan. 6	2 - 12	420	60x50	56	95	40
189	Jan. 6		420	60x47	60	94	42
193	Jan. 6		432	60x50	62	100	45

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