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POPULATION STUDIES OF THE DESERT COTTONTAIL (*Sylvilagus auduboni*) AND BLACK-TAILED JACKRABBIT (*Lepus californicus*) IN THE SONORAN DESERT

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ABSTRACT

Monthly censuses of *Lepus alleni*, *L. californicus* and *Sylvilagus auduboni* were conducted on the Silverbell bajada. Collections were made on the Silverbell bajada and the adjacent portions of the Avra Valley with a monthly goal of ten females of each species from January through April to complete our first collection year. From June through December this rate was reduced to five females of each species each month. A total of 329 rabbits was collected and fertility rate, sex ratio and adult weights were found to be similar to the 1971 collection. Breeding was found to occur at any month of the year, extending by three and four months the known breeding season for these Sonoran Desert species as reported by earlier investigators. Two peaks of breeding occur, one in February and a second in July and August. Reproductive success was related to the frequency of occurrence of grass and forb plants, which were measured on the study area monthly (except in February and May) on both disturbed and natural sites. Plant abundance was directly related to seasonal rainfall, and the number of species preferred by cotton tails and jackrabbits was found to be greater on the disturbed sites.

Radio-location transmitters were attached to two *Sylvilagus auduboni* and to two *Lepus californicus*. Triangulation and observations showed a tentative home range of 0.96 and 0.58 ha for the two cottontails. Only limited data on the black-tailed jackrabbits were gathered but movements of 329 m were noted. Telemetry yielded but a minor amount of information considering the time, equipment, vehicles and manpower involved.

INTRODUCTION

The lagomorphs are among the larger Sonoran Desert consumers, especially *Lepus alleni* and *Lepus californicus*, and their relative mobility in comparison with desert rodents can increase their influence on habitats. The two native jackrabbits and the cottontail, *Sylvilagus auduboni*, all have variable breeding and survival rates in response to climatic and other factors. Determination of the processes involved in terms of computable functions started with reproductive, mortality and dispersal rates in 1971 and continued into 1972.

The research in 1972 continued the collection of data on breeding, sex and age structure of the populations and population trends in numbers, but a smaller sample of animals was collected each month. Additional research effort yielded data on plant food abundance in response to seasonal rainfall. Reproduction and survival was therefore relative to precipitation time and amount. The daily movement and habitat selection of individual animals was investigated by tagging and by radio-location telemetry.

OBJECTIVES

1. To determine the age and sex structure, and the increment and loss rates for certain populations which control their density in the Sonoran Desert.
2. To determine the rate of reproduction, and the effects upon it of side variables such as weather, plant phenology, quantity of vegetation, and modifications to vegetation.
3. To measure the rate of dispersal and mobility.
4. To determine the overall rate of mortality, and its seasonal variations.
5. To construct a life table from the sum of information.

The bulk of our efforts in 1972 have been directed toward fulfilling objectives number two, three, and portions of number one. The mortality rate and life table work has been postponed until definitive age classes can be established.

METHODS

A monthly census was conducted along a 7.8 km route with the observer recording species and flushing distance at each encounter. The King strip method was used to compute estimated population size as the modified method reported by Hayne (1949) proved unreliable with the low densities found in this area. DSCODE A3UHP01.

Collections of the three lagomorphs on the Silverbell bajada (*Lepus alleni*, *Lepus californicus* and *Sylvilagus auduboni*) were made twice a month. From January through April an effort was made to collect ten females of each species. In June this rate was reduced to five females of each species each month.

The rabbits were refrigerated and within 24 hrs after collection the eyes, one half of the mandible, one humerus and the reproductive organs were removed, tagged and stored. Standard weight and measurements were recorded along with incidence of parasites, testes position, nipple pigmentation, lactation and number of visible implanted fetuses. DSCODE A3UHP02.

The eyes were stored in 10% formalin for at least 30 days, after which the lenses were removed and dried in a vacuum oven at 80 C for four days. After drying, the lenses were weighed to the nearest 0.1 mg. DSCODE A3UHP02.

The reproductive organs were stored in 10% formalin and analyzed within two weeks of collection. The testes were stripped of associated structures and weighed to the nearest 0.1 g. The female reproductive organs were macroscopically analyzed for the following: number and size of visible implantation sites, number and size of corpora lutea and corpora albicantia in each ovary, striations of the uterine horns, position, length, weight and age of each embryo. Embryos over 40mm in length were sexed. DSCODE A3UHP02.

The humeri were checked for the condition of the epiphyseal cartilage. The mandibles were stored in 10% formalin for future analysis by thin sectioning. DSCODE A3UHP02.

References for the above analyses are: eye lens weights, Lord (1959); ephiphyseal cartilage, Hale (1949); reproductive organs, Bookhout (1964) and Rongstad (1969).

Live specimens of all three species were captured using a modification of the technique reported by Griffith and Evans (1970). High intensity quartz-iodine automotive driving lights were used for illumination. One light was manipulated by a man in the back of each of two pick-up trucks. The trucks also carried one or two other men in the back to act as netters. The netters rode in the bed of the truck and not on outrider structures (Griffith and Evans, 1970) because the vehicles were not permanently assigned to the project and could not be modified. The minimum crew was six men: two drivers, two light men and two netters. The maximum crew was eight, the additional men acting as netters. The two vehicles traveled the roads of the capture area side by side and upon encountering a rabbit attempted to surround the animal. The resulting noise, light and confusion unsettled the rabbits sufficiently to allow capture in about fifty % of the attempts. The success ratio was held down by the

roughness of the terrain and the denseness of the vegetation in the area. It was found that a higher percentage of capture was afforded by using two vehicles instead of one.

Radio transmitters in the 148 MHz range were affixed to the cottontail rabbits by means of a buckskin harness and to the jackrabbits with a colar of flat braided nylon. Radio locations of the rabbits were obtained by triangulating from semi-permanent sites 160-320 meters apart. A short three meter mast on a tripod base was used to support a three element yagi antenna. Holes in the tripod feet were placed over steel rods at each triangulation site to assure the proper orientation of the tripod and mast. Two fixes per location of the rabbit were used as only one receiver was available and the time lag in moving from one triangulation site to the next negated the usefulness of a third or fourth fix.

Two 1.6 km plant transects were established on the study area, one on a disturbed and one on an undisturbed site. These transects were run at least monthly, except February and May when no records were made. A flexible, circular drop frame covering one m^2 was used to take a sample every twenty meters along each transect. The resulting data were used to calculate frequency of occurrence values.

RESULTS

Aging

The lack of known age animals has prevented the construction of a lens weight curve for the rabbits of this study. The closure of the epiphyseal cartilage is an accurate indicator of age as can be seen by comparison with other indicators such as the reproductive status and the eye lens weight of the individual. Figure 1 shows the correlation between epiphyseal closure and eye lens weight.

Lagomorph teeth do not show annual layering as in higher animals. However, the mandibles often have an interruption in the layers of the periosteum around the tooth root (Klevezal and Kleinenberg, 1967). Thin sectioning of the mandible to show these layers was tested on four jaws from the collection. While adhesion layers were identified, we found no correlation with the lens weights or closure of the epiphysis of those individuals. Sectioning of a larger sample of mandibles will be carried out to determine conclusively the worth of the technique to this study.

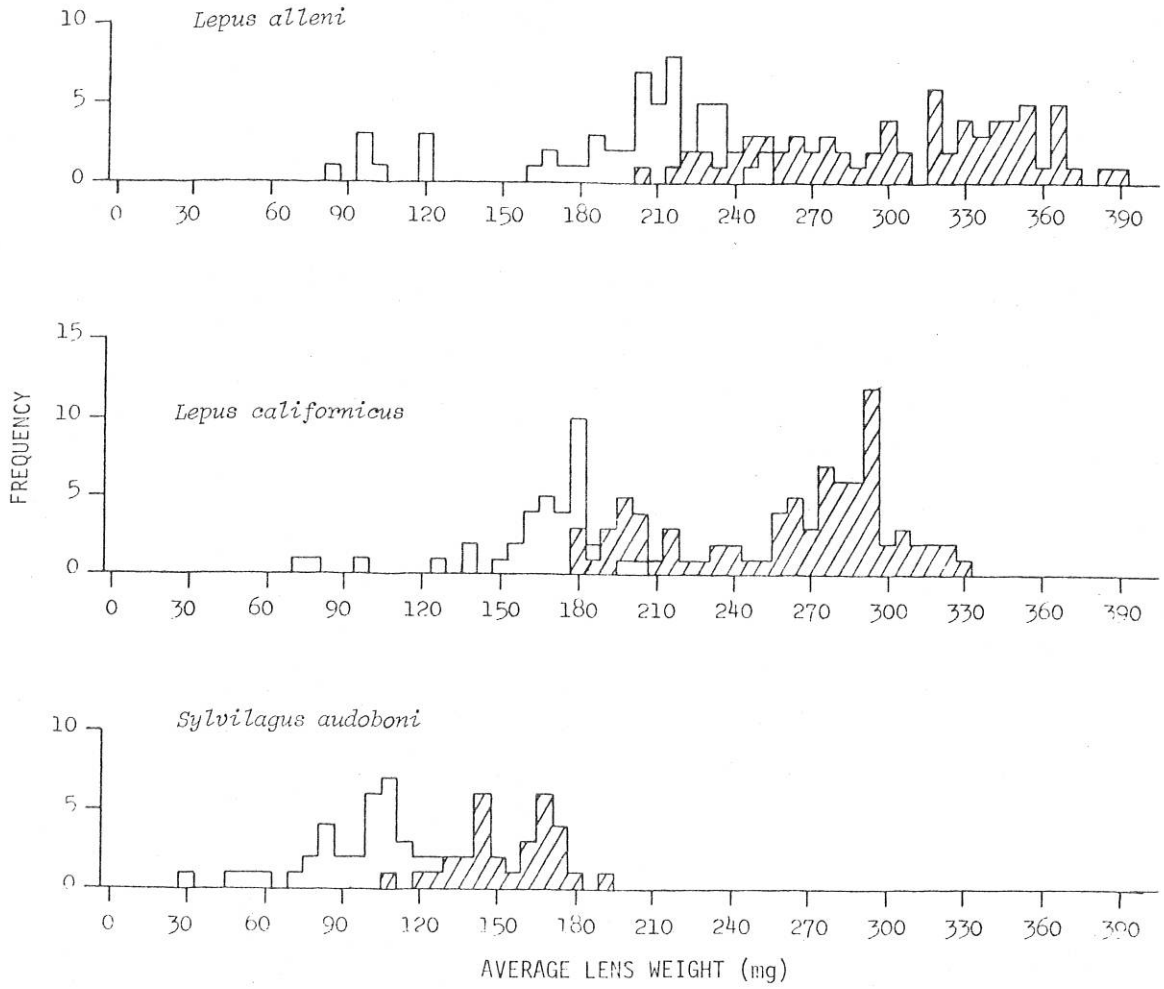

Figure 1. Distribution of average eye lens weights in the 1972 Silverbell collection. Crosshatching indicates lens weights from adult rabbits as determined by closure of the epiphyseal cartilage (Hale, 1949). DSCODE A3UHP02

Site variables

Rainfall data were gathered from six locations in and around the census area. Although a fair amount of variation existed in the quantity of rain gathered in each guage, the average yearly precipitation for the study site was close to that for the two nearest recording stations in the valley (Table 1).

Table 1. 1972 monthly precipitation (inches, ave six gauges) at the census plot for this study compared to the records from the towns of Silverbell, 5.0 mi. west; Cortaro, 20.0 mi. east; and the IBP Avra Valley study plot, 4.5 mi. northwest (DSCODE A3UHP02)

Month	Silverbell	Cortaro	IBP	Census
J	0.00	0.00	0.00	0.00
F	0.00	0.00	0.00	0.00
M	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00
M	0.36	0.17	0.13	0.08
J	2.14	0.83	1.49	3.00
J	1.09	1.00	2.22	1.75
A	1.75	2.17	2.44	2.50
S	1.35	0.50	1.53	1.28
O	5.60	4.50	4.48	4.58
N	2.96	2.39	1.97	2.22

The spring of 1972, January to May, was the driest on record for the past fifteen years. However, the heavier than normal winter rains have put the total for this year about three inches above the long-term average for the valley, with the month of December yet to be included.

The two plant transects were run thirteen times each during 1972. Below are the number of species encountered on each and their general classification.

	Natural	Disturbed
Cactus	6	4
Grass	10	12
Forbs	15	26
Shrubs	9	11
Trees	3	4

As can be seen, the disturbed area supports a larger and more diverse plant community than the natural area. Some of the plants found on the perturbed area are strictly disturbed-site species and not found elsewhere on the study plot. Other plants found on the disturbed site are also encountered in the natural areas but at such low frequencies as to not show up in the transect results.

Table 2 shows the monthly frequencies of occurrence for the grasses, forbs and shrubs. The values for the cacti and trees remain virtually constant. The values for bare ground are included to give an indication of the amount of ground cover.

Table 2. Monthly frequencies of occurrence of the major plant groups found on the natural and disturbed areas of the Avra Valley study plot

	J*	M	A*	J	J	A	S	O	N
NATURAL									
GRASSES	13.7	2.2	2.0	8.5	11.2	13.6	11.8	14.5	9.4
FORBS	20.4	1.3	1.2	1.6	2.8	1.6	1.6	15.2	27.0
SHRUBS	15.9	23.7	13.4	20.2	16.3	16.4	18.0	20.8	23.8
BARE GROUND	--	20.5	33.0	26.0	22.5	20.6	21.9	3.8	0.0
DISTURBED									
GRASSES	65.6	7.0	9.8	5.4	7.9	14.4	15.6	19.8	15.6
FORBS	16.9	4.0	2.0	3.4	3.8	4.6	5.2	18.9	25.9
SHRUBS	15.1	13.1	12.4	9.2	6.6	11.8	11.8	8.9	11.8
BARE GROUND	--	--	37.6	33.0	31.3	25.2	18.2	10.0	3.8

* No data were gathered in February or May

Census

Figure 2 shows the results of the monthly censuses for 1971 and 1972. The large variation month to month arises in part from the technique used to census the populations. The results can be significatnly affected by the alertness and experience of the observer at spotting the rabbits. However, even when the observer is attentive and accustomed to the procedure, a great deal of variation can result.

We have some reservations as to the accuracy of this method for estimating the monthly population sizes. However, the estimated population for October, 1971, was within one rabbit of the total actually seen during a drive census through the same area. Unfortunately, a similar drive could not be arranged for 1972 but one is planned in the spring of 1973.

Despite large monthly variations, the annual mean population estimates for the two years are very close. The average estimated population size for 1972 was 2.2 rabbits/40 ha and for 1971 was 2.6/40 ha. The student's t test shows no significant difference between these estimates ($t = 0.46$, $P > .60$).

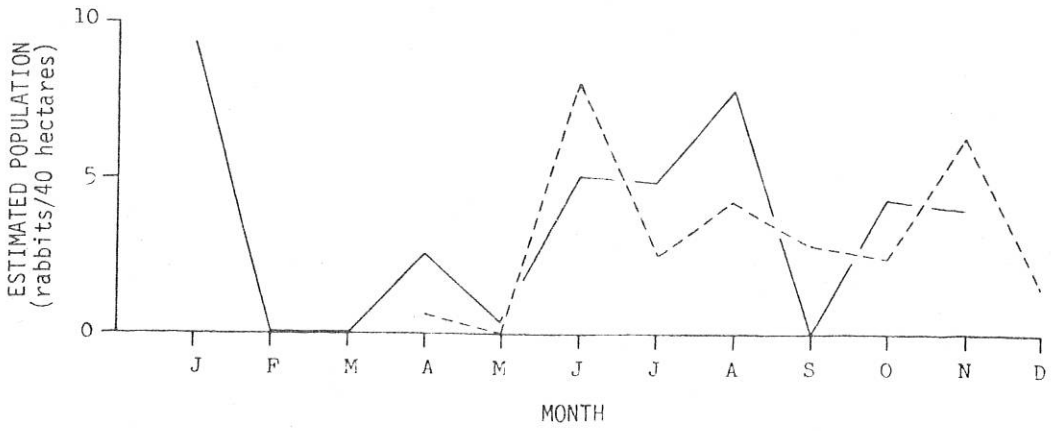

Figure 2. Estimated rabbit population (*L. californicus* and *S. auduboni*) on the Silverbell bajada for 1971 (broken lines) and 1972 (solid lines). DSCODE A3UHP01

Reproduction

Table 3 shows the monthly breakdown by species of the 329 rabbits collected in the Avra Valley in 1972. The sex ratios of the samples taken did not differ significantly from the expected of 50:50 ($P < .005$).

Table 3. Monthly collections of rabbits from the Avra Valley (DSCODE A3UHP01)

	S. auduboni			*L. californicus*			*L. alleni*		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Jan	5	5	0	21	12	9	15	5	10
Feb	3	1	2	24	14	10	22	12	10
Mar	10	8	2	23	11	12	17	7	10
Apr	11	5	6	14	4	10	21	12	9
May									
Jun	9	4	5	6	1	5	11	6	5
Jul	11	6	5	6	1	5	6	1	5
Aug	9	4	5	9	4	5	7	2	5
Sep	6	1	5	5	0	5	13	8	5
Oct	9	3	5	7	2	5	6	1	5
Nov	6	1	5	9	4	5	9	4	5
	78	38	40	124	53	71	127	58	69

The general fertility rates (Lord, 1961) for 1971 and 1972 are shown in Figure 3. The general fertility rate is the product of the mean litter size (number of viable fetuses) and the percentage of pregnancy.

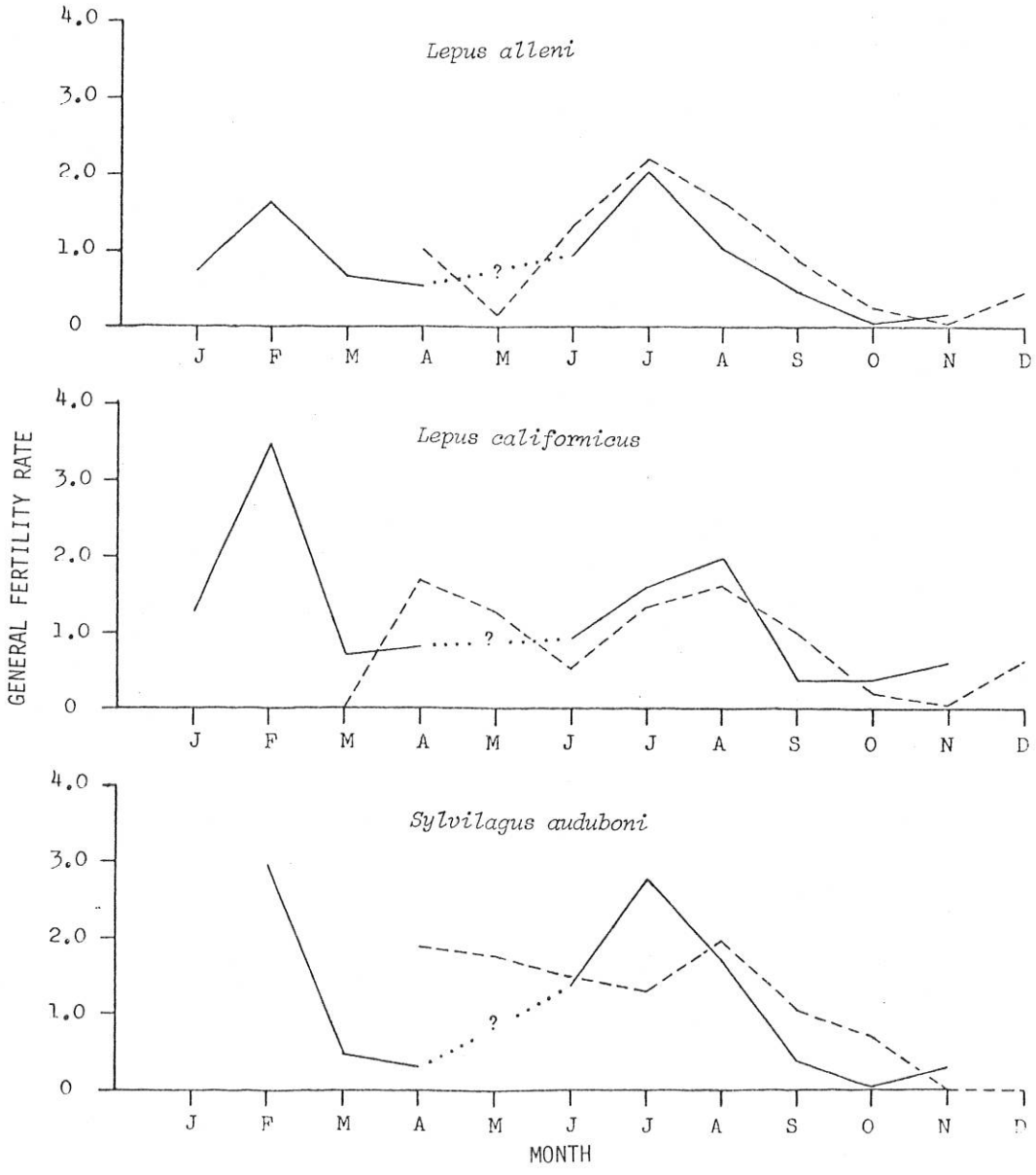

Figure 3. General fertility rates (Lord, 1961) for the Silverbell bajada collections of 1971 (broken lines) and 1972 (solid lines). No collections made in May 1972.

The female cottontail was captured and instrumented at the same wash crossing but on the east side of the gas-line road. This rabbit was instrumented on September 9, 1972. However, no triangulation was attempted as the transmitter pulse rate began to increase almost immediately, indicating a battery failure. The week of September 9 to 16 was spent in an effort to recover the transmitter package. Unfortunately, the radio ceased to function before we could recapture the rabbit and, without the aid of the radio-tracking, we were unable to locate her.

The two female black-tailed jackrabbits were instrumented on October 9 and 13. By October 13, the transmitter fitted to the rabbit on October 9 had ceased to operate. The radio put on the second rabbit on October 13 was no longer working by October 20. Since the radio stopped functioning, this second rabbit has been observed twice within 320 m of the original capture site. Neither time were we able to get close enough to attempt to shoot her without risking damage to the radio package.

Forty-five man hours were spent in trying to recover the faulty radio on the *L. californicus*. Nine of these man hours were donated by volunteer helpers.

Figure 4 gives the percentage of juveniles in the monthly collections for both 1971 and 1972. No rabbits were collected in May of 1972.

Dispersal and mobility

In 1972, fifteen *L. californicus*, one *L. alleni* and five *S. audubonii* were captured, ear-tagged and released. Of these twenty-one rabbits, four were equipped with transmitter-battery packages, a male and female cottontail and two female black-tailed jackrabbits. The male cottontail was tracked from August 15 to 29, 1972. On August 29 it chewed out of the harness used to fasten the radio. During this period the rabbit's activities were centered mainly on the south edge of the dry wash shown in Figure 5. This area was in an ecotone between the predominant creosote bush community and the mesquite, palo verde and catclaw along the wash. The site was covered with grasses and forbs and offered a great deal of protection in the form of catclaw thickets and brushpiles washed up during heavy run-offs. The rabbit spent a large amount of time in and around the rock-pile indicated by the dotted line in Figure 5. There were numerous burrows among and under these rocks.

One advantage to the observer of the use of the rock-pile by the rabbit was that the radio transmission was cut out whenever the animal was in a burrow under the rocks. We were thus able to ascertain accurately the beginning and ending of activity periods. While there was no discernable pattern to the rabbit's activities, it was generally out of its burrow between 7 and 8 p.m., active intermittently during the night, and back into the burrows by 9 a.m.

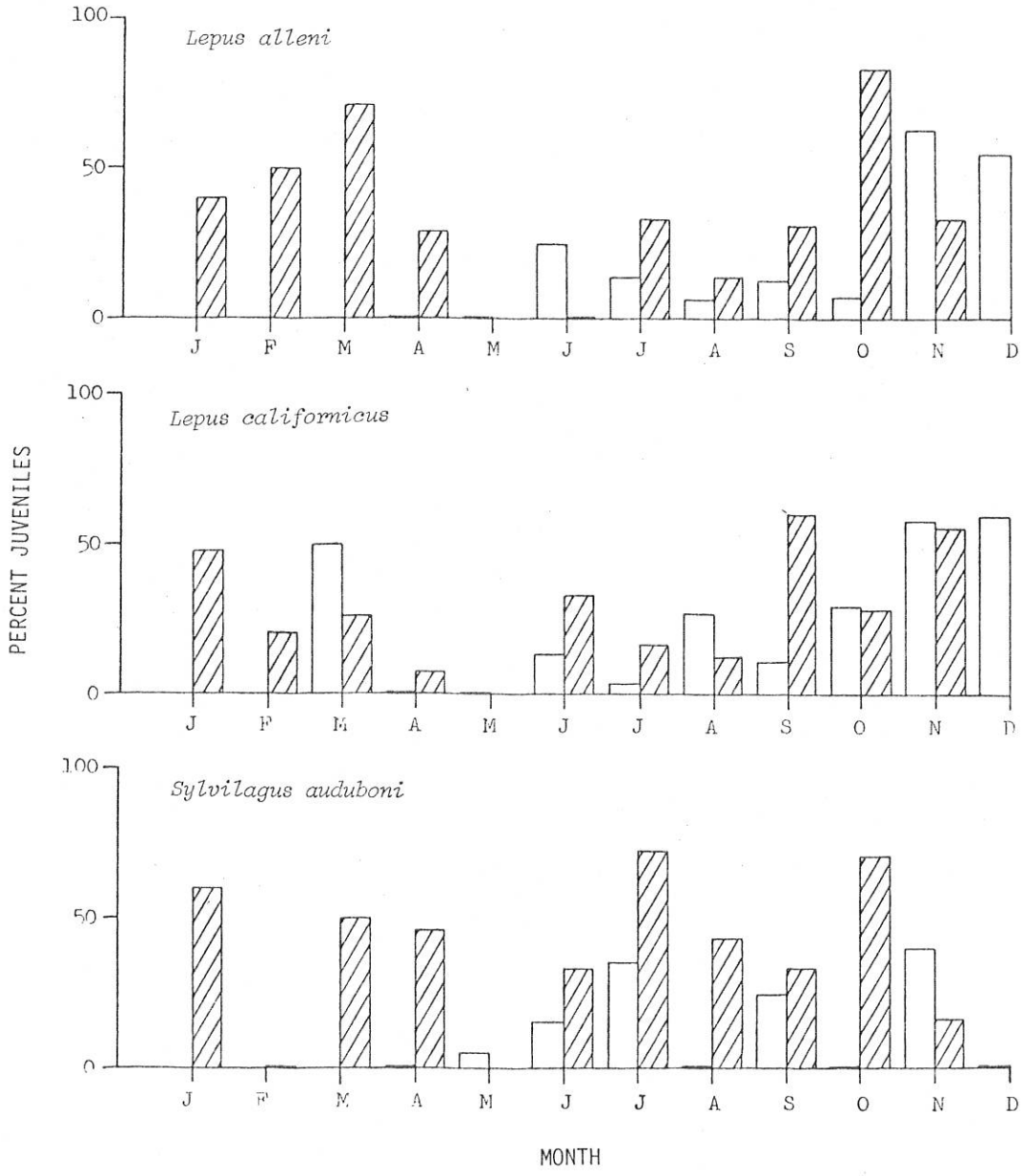

Figure 4. Percentage of juveniles in the monthly Silverbell bajada collections of 1971 and 1972 (crosshatched). No collections made in May 1972.

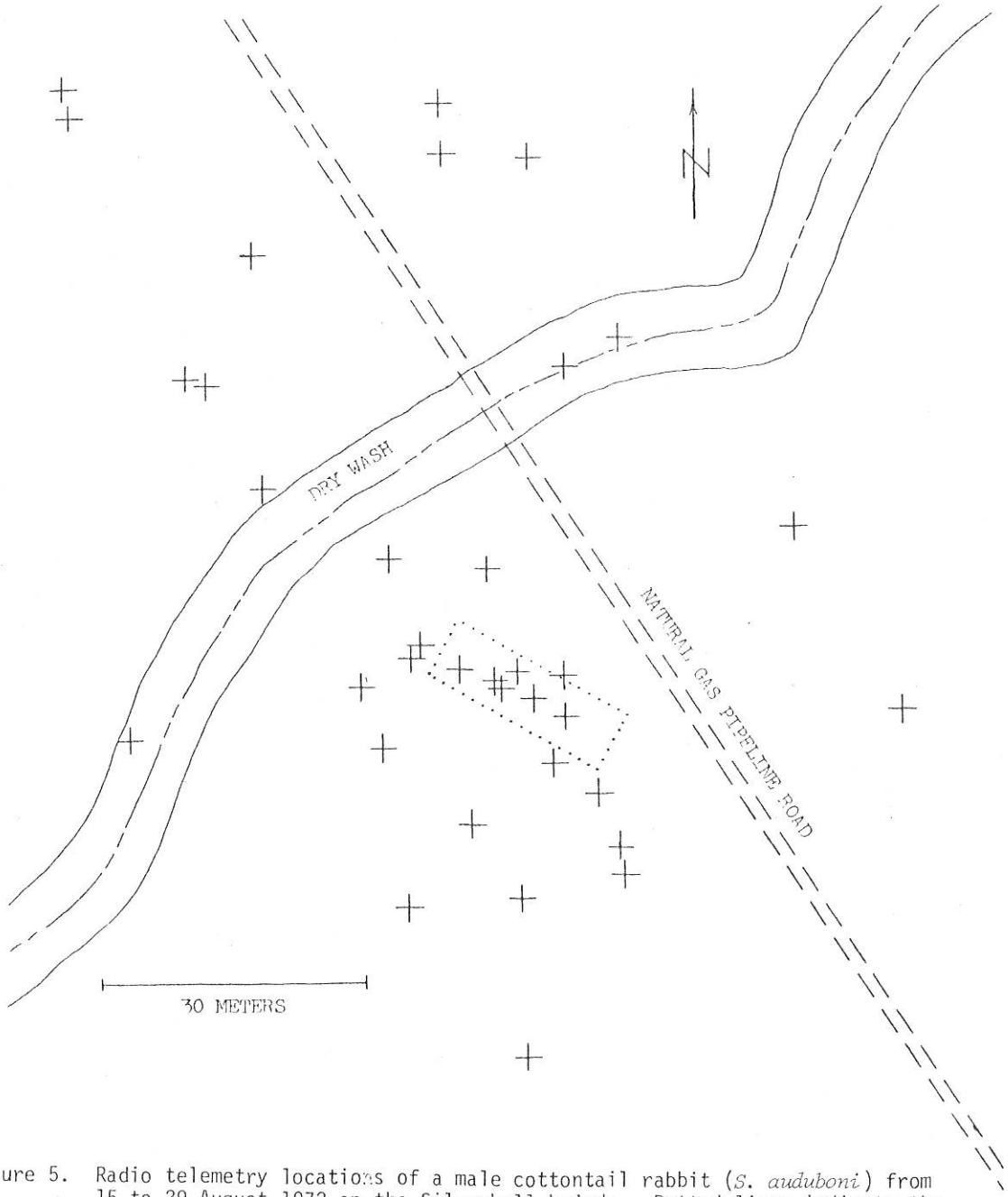

Figure 5. Radio telemetry locations of a male cottontail rabbit (*S. auduboni*) from 15 to 29 August 1972 on the Silverbell bajada. Dotted lines indicate the rock-pile (see Results, dispersal and mobility).

DISCUSSION

Breeding season and influencing factors

The specimens collected during the two years of this study indicate that breeding occurs in all three species of rabbits in the Sonoran Desert on a year-round basis. We have collected pregnant females of each species every month in 1972. These data extend the breeding season for cottontails reported by Sowls (1957) as January to August and for jackrabbits reported by Vorhies and Taylor (1933) as December to September.

Although the breeding season for the rabbits in this area is year-round, there are two major peaks, the first in February and the second in July-August. The highest values for the frequency of occurrence of grass and forbs, reported by Vorhies and Taylor (1933) and DeCalesta (1971) as comprising the bulk of the rabbit diet, occurred in September and October. These values began to increase in June and July following the start of the summer rains. Thus, the late summer breeding activity seems to be closely correlated with the onset of the summer rains and the resultant plant growth. The early breeding activity during this study has been in the middle of the driest part of the year. Our plant data show the highest amount of forage is available in the winter months and it is possible that the winter green-up lasts long enough to stimulate breeding in the spring.

Dispersal and mobility

The radio-telemetry data have not given us the information we need to define and quantify the dispersal of the rabbits in this study. Part of the problem has been the difficulty in capturing young of the year to instrument, and part has been the short duration of the tracking operations due to untimely radio failures.

The known locations of the male cottontail shown in Figure 5 indicate a home range during this study of 0.96 ha. An approximate home range value for the female cottontail, based on nine visual sightings while trying to recapture her, is 0.58 ha. This figure is, of course, highly suspicious in that it is based on only a few locations which were obtained while the rabbit was under the stress of being chased by a group of desperate researchers.

As was mentioned in the Results section of this report, the second female jackrabbit instrumented has been observed on two different occasions within 320 m of the location of original capture. However, these sightings were seven days apart, on October 21 and 28. As the rabbit was not seen again on five other days, between October 28 and November 5, we have no indication of the size of the range covered. The jackrabbit could have been in the same area on each subsequent search but was not spotted, or she could have been in an entirely different part of a much larger range.

This project has had more than its share of the usual telemetry problems. So much so in fact that the returns on our time and effort have been very meager. It was extremely discouraging to spend forty-three man hours (twenty-one of which were volunteered) in capturing and instrumenting the two female jackrabbits and in putting in the triangulation sites in exchange for the sketchy data received. Nevertheless, we have on hand the parts for ten more radios and the suggestions of the local men experienced in the field of telemetry as to improvements we can make on the battery package and antenna design that should increase the input for the dispersal and mobility phase of the project.

EXPECTATIONS

A bi-monthly sample of the three lagomorph species will be continued to gather data on their reproductive condition as well as the sex and age structure of the populations on the Silverbell bajada. The collection of these animals is important as it is related to the seasonal rainfall and plant growth.

Capture and monitoring of the movement and dispersal of individuals with radio-location transmitters will continue as long as present equipment is available. An attempt will be made to capture and equip with a radio package as many young animals as possible. Visible color markers on other individuals will be used as a secondary procedure to establish movement and dispersal rate and distance.

Rainfall will be measured in six rain gauges on the study area and rainfall measurements made by other investigators and in surrounding communities will be compared with our records. Seasonal plant growth, especially of fast-growing annuals, will be measured by frequency plots. Our objective will be to quantify the relative abundance and duration of availability of such plants to the rabbits. The timing of the reading of the plant frequency plots will vary with rainfall during the year.

Population demography, including increment and loss in the populations of these species, will be calculated from collection, observation and census data gathered this year and previous years. A life table will be constructed to show the dynamic state within the populations of these three species.

Age categories will either be estimated by eye lens weight change or by annulations in the periosteum of the mandible for those individuals not ageable by other procedures.

Further unknowns relating to our original objectives may be quantified through computer analysis of data from this and associated studies.

LITERATURE CITED

Bookhout, T. A. 1964. Prenatal development of snowshoe hares. J. Wildl. Mgmt. 28(2):338-345.

DeCalesta, D. S. 1971. A literature review on cottontail feeding habits. Colo. Div. of Game, Fish and Parks Special Report 25. 15 p.

Griffith, R. E., and J. Evans. 1970. Capturing jackrabbits by night-lighting. J. Wildl. Mgmt. 34(3):637-639.

Hale, J. B. 1949. Aging cottontail rabbits by bone growth. J. Wildl. Mgmt. 13(2): 216-225.

Hayne, D. W. 1949. An examination of the strip census method for estimating animal populations. J. Wildl. Mgmt. 13(2):145-156.

Klevezal, G. A., and S. E. Kleinenberg. 1967. Age determination of mammals from annual layers in teeth and bones. 48-50. Israel Program for Scientific Translations, Jerusalem (1969).

Lord, R. D. 1959. The lens as an indicator of age in cottontail rabbits. J. Wildl. Mgmt. 23(3):358-360.

Lord, R. D. 1961. Magnitudes of reproduction in cottontail rabbits. J. Wildl. Mgmt. 23(1):28-33.

Rongstad, O. J. 1969. Gross prenatal development of cottontail rabbits. J. Wildl. Mgmt. 33(1):164-168.

Sowls, L. K. 1957. Reproduction in the Audubon cottontail in Arizona. J. Mamm. 38(2):234-243.

Vorhies, C. T. and W. P. Taylor. 1933. The life histories and ecology of jackrabbits, *Lepus alleni* and *Lepus californicus* spp., in relation to grazing in Arizona. Univ. of Ariz. Agr. Exp. Sta. Tech. Bull. 49:471-587.