Deer Mouse Reproduction and Its Relationship to the Tree Seed Crop

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ABSTRACT: Deer mice (*Peromyscus maniculatus rubidus*) averaged 57% males in a sample of 3833 collected in the Douglas fir (*Pseudotsuga menziesii*) belt in western Oregon from 1952-1966. The percentage of mice captured in autumn and recaptured in spring was significantly greater in good (2.66 kg/ha or more) than in poor (0.45 kg/ha or less) Douglas fir and western hemlock (*Tsuga heterophylla*) seed years. However, the autumn-spring population estimates for good and poor seed years were not significantly different, but by the following autumn the good seed years had significantly greater populations. There was a significantly larger number of young female (and, by inference, male) deer mice in the population during the good seed years. Individuals of both sexes were fecund each month of the year; however, yearly fecundity periods varied and the longest were 11 months. Males were most active sexually from February through November and females from March through October. Males reached peak fecundity in May, 1-2 months earlier than the females. The average male and female fecundity percentage from September-March, when tree seed was most abundant, was significantly greater for good seed years. Average yearlong fecundity for both sexes was not significantly larger in the good seed years, but for the females there was a significant difference. The percentage of pregnancies from September-March was significantly greater (eight times) in good years, but during April-August was only one-half of those for the poor, a significant difference. However, on a seed year basis, the average percentage of pregnancies was 2.9% greater for good years but was not significantly different. Average litter size was not significantly affected by the size of the seed fall, being 4.6 for corpora lutea and 4.4 for both the embryos and placental scars. Smallest average embryo litters were found in winter and spring and larger ones were tallied in summer and autumn. Calculated average number of litters per year was 2.9 for good seed years and 2.5 for poor, a significant difference. The positive factors contributed variously to higher populations during and/or following a good seed crop, at least by the following autumn.

INTRODUCTION

Reproduction of the deer mouse (*Peromyscus maniculatus rubidus*) was investigated from 1952-1966 during a forest-wildlife ecological investigation in western Oregon. Although *rubidus* has been studied for many years, there is limited published material on its reproduction (Bailey, 1936; Beer, 1956; Hooven, 1958). This is especially true of the relationship of the size of tree seed crops to breeding. The main objectives of this paper are: (1) to present additional information on the reproductive pattern of this deer mouse, and (2) to document the relationship of the size of the tree seed fall with this pattern.

STUDY AREAS

Small mammals were collected on the Half Pint Area in the Lakes Ranger District, Mount Hood National Forest, Clackamas Co., Oregon; and on the H. J. Andrews Experimental Forest and vicinity, Blue River Ranger District, Willamette National Forest, Lane and Linn counties, Oregon. Most of the trapping was at elevations ranging from 396-1219 m.

The study areas are on the W slope of the Cascade Mountains in the Humid Division of the Transition Life Zone (Bailey, 1936) or the *Tsuga heterophylla* Zone of Franklin and Dyrness (1973). The topography includes moderately sloping benches alternating with steep slopes, and the soil of volcanic origin is generally porous sandy or clay loam, although some silt occurs in small basins. Precipitation ranges from about 203-305 cm per year and occurs mostly in winter.

The old-growth crown cover trees on the study areas were primarily Douglas fir (*Pseudotsuga menziesii*) with smaller amounts of western hemlock (*Tsuga het-*

erophylla) and red cedar (*Thuja plicata*). Understory trees included reproduction of the crown species and scattered western yew (*Taxus brevifolia*), big-leaf maple (*Acer macrophyllum*), vine maple (*Acer circinatum*) and dogwood (*Cornus nuttallii*). Shrub cover was variable but included salal (*Gaultheria shallon*), blackberry (*Rubus ursinus*), Oregon grape (*Berberis nervosa*) and rhododendron (*Rhododendron macrophyllum*). Herbaceous plants and part-shrubs often found were twinflower (*Linnaea borealis*), gold thread (*Coptis laciniata*), sword fern (*Polystichum munitum*) and evergreen violet (*Viola sempervirens*).

After mature forests are logged by clear-cutting small patches, and the areas burned to reduce the fire hazard and improve seedbed conditions, a variety of plants appear. Hardwood sprouts, seedlings of snowbrush (*Ceanothus velutinus*) and cherry (*Prunus emarginata*) form some of the first growth and are soon joined by plants such as willow herb (*Epilobium* spp.), horseweed (*Conyza canadensis*) and hawkweed (*Hieracium albiflorum*) which have wind-disseminated seeds. Some of these may be inconspicuous residents of the former old-growth stand, while others are invaders (Dyrness, 1973). Blackberry, whipplea (*Whipplea modesta*), hazelnut (*Corylus cornuta*) and starflower (*Trientalis latifolia*) are also present in early successional stages. Douglas fir, western hemlock and red cedar become established, and the clear-cut vegetation gradually changes to a woody type.

METHODS

Seed traps were 61x91 cm wooden frames floored with painted 5.5x7.1-meshes/cm² screen and topped with 1 cm mesh hardware cloth (Gashwiler, 1969). Twenty-four traps were located randomly to sample one clear-cut each year for the seed years of 1956-1961, in which small mammal sampling was continuous. The sample of seeds was cut open to determine the percentage filled with normal endosperm and probably viable (U.S. Forest Service, 1948).

It is generally accepted by foresters that during years of low seed abundance the crop tends to be unevenly distributed; however, during good years distribution is more uniform. To minimize the possibility of not having representative data, seed fall compilations were recorded in two broad categories called poor (0.45 kg/ha or less) and good (2.66 kg/ha or more). In fact, there was a separation of these two categories in the data (Table 1). Although seed fall is much heavier in the timber (Gashwiler, 1969), it was assumed the relative abundance in the clear-cut and timber would follow the same pattern. Since red cedar seed is not a preferred deer mouse food (Gashwiler, 1967), only the filled Douglas fir and western hemlock seed crop estimates were used.

To facilitate comparisons of mouse reproduction with seed fall, most of the data are expressed on a seed year basis, *i.e.*, from September until the end of the following

TABLE 1.—Kilograms/ha of filled Douglas fir and western hemlock seeds by seed year[a]

Seed year	Kilograms/ha of filled seeds		
(Sept.-Aug.)	Douglas fir	Western hemlock	Total
1956	2.39	0.27	2.66
1957	0.01	0.01	0.02
1958	0.06	0.05	0.11
1959	4.73	0.67	5.40
1960	0.01	0.03	0.04
1961	0.21	0.24	0.45
Total	7.41	1.27	8.68
Avg.	1.24	0.21	1.45

[a] Kilograms/ha of seed were calculated from Gashwiler (1969). The number of viable seeds per pound used in the conversion was Douglas fir 40,000 and western hemlock 300,000 (U.S. Forest Service, 1948)

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August. Tree seeds are considered most available for deer mouse food from September through the following March (Gashwiler, 1969). Some seed is available from April-August, but the amount is small. In addition, the effects of these seeds and also the sprouting seeds would be so diluted by the availability of other foods that their effects on the mice would probably be minimal.

Deer mice were kill-trapped with household mouse traps and Museum Special traps mostly in clear-cuts averaging ca. 12-16 ha. Traps were spaced 20 m apart on meandering lines. They were run generally for 3 consecutive nights and tended daily. Trapping was on a monthly schedule and was done yearlong from 1952-1966. The kill-trap data were supplemented by animals which died in live traps. Data from young mice in gray pelage are not included in this paper.

Large (8.0 mm or longer), pink, turgid testes; large, turgid seminal vesicles; and macroscopic tubular cauda epididymides were all considered evidence of male fecundity. A representative group of slides was made from samples of testes and cauda epididymides; these were colored with Fast-Green stain and examined microscopically for sperm content. These slides were used for reference in the determination of male fecundity.

Female deer mice were checked for vulva condition and lactation. The mammary glands were also examined internally for condition and for milk. Uteri were observed for nodular swellings of early pregnancy, embryos or scars, and the blood supply of the mesentery was noted. The ovaries were examined for fresh or distinct corpora lutea and these were tallied. In this paper, corpora lutea is used in the broad sense to include all types of corpora. After each animal was examined, all of the evidence of reproduction was considered together in evaluating the individual for fecundity (Jameson, 1953).

Data were analyzed by the chi-square test, the t-test and standard error of the mean determinations. The 0.05 level of probability was used as a basis for significance. Scientific names follow Hall and Kelson (1959) for mammals and Hitchcock *et al.* (1955-1969) for plants.

RESULTS, DISCUSSION AND CONCLUSIONS

Tree seed crop.—The estimated amounts of filled Douglas fir and western hemlock seed fall/ha in clear-cuts from 1956-1961 are given in Table 1. Although western hemlock averaged 141,375 filled seeds/ha over the 6-year period compared with 110,208 for Douglas fir (Gashwiler, 1969), hemlock only averaged 0.21 kg/ha, as opposed to 1.24 kg/ha, for the larger-seeded Douglas fir. Good (2.66 kg/ha or more) seed years were immediately preceded and followed by poor (0.45 kg/ha or less) during the years of this investigation.

Sex ratios.—The monthly percentage of males trapped ranged from 47-66 during 1952-1966, and averaged 57 in a sample of 3833 mice. There was a significant difference (χ^2, $P < 0.005$) in the number per month of males and females captured. Hooven (1958) found 54% males for a 14-month trapping period, and 53% was reported by Beer (1956) for a small (198) August sample in western Oregon. Terman (1968) gives sex data for trapped mice as follows: *Peromyscus maniculatus*, 583 animals, 54% males; *Peromyscus maniculatus bairdii*, 1,468 animals, 51% males; and *Peromyscus maniculatus gracilis*, 935 animals, 58% males. The *P. m. rubidus* of this study are within these extremes. In the present investigation, males comprised the largest proportion of trapped animals for every month except September and October, when females composed 53 and 51%, respectively. The largest proportion of males were trapped from February-June when they formed 62% or more of the captures.

Recaptures and populations by seed years.—Live-trap data on 615 tagged deer mice show the spring recapture rate of autumn-marked animals is significantly related to the size of the tree seed crop (χ^2, $P < 0.005$). Average autumn-spring mouse recapture rate of good years is 13.3% (20÷151), which is higher than the 3.9% (18÷464) found in poor years. Nevertheless, the spring mouse-population estimates by the Lincoln Index method were numerically close, averaging 6.3 deer mice/ha for good seed years vs. 4.3/ha for poor (Gashwiler, 1965), and are not significantly different (t-test, $P > 0.2$). Since the seed fall started in the autumn when other food was abundant and when fecundity was declining, the full effect of the tree seeds on the population was delayed beyond the following spring. Gashwiler (1965) also indicated that deer mouse populations increased significantly (t-test, $P < 0.001$) by the following autumn, apparently in response to a seed fall of 0.91 kg/ha or more. In another Oregon study Hooven (1976) also noted a definite increase in deer mice during the year immediately after a moderate-to-good cone crop. Additional analysis of the present data shows the average percentage of adults in the 1148 female sample was significantly (χ^2, $P < 0.005$) lower (74.7%) during the good seed years than the poor (89.8%). (Similar male data were lost in an office fire.) Since the populations were increasing, this suggests the probability of a greater survival of young females (by inference, young males, too) in 0.91 kg or more seed years and agrees with the findings of Bendell (1959) who studied *Peromyscus leucopus noveboracensis* in eastern Ontario, Canada. He concluded that food in excess results in an increase in the number of young animals per adult female taken in traps. Jameson (1953) gives data for *Peromyscus maniculatus* from coniferous forest in the northern Sierra, California, which roughly agree with data from the present study. Jameson found a generally small population peak in the spring with a large one in the autumn following a heavy mast crop in 1948, a large spring or summer population peak following a lighter mast crop in 1949, and a small, although decreasing, spring population peak following a mast crop failure in 1950. Differences between Jameson's data and that of the present study can probably be attributed primarily to different methods of gathering data, variations in the respective habitats and climatic differences. The populations of the present study exhibit the northern cycle (Stickel and Warbach, 1960), whereas Jameson's populations seem intermediate between the northern and southern cycles. Other factors also affect the size of deer mouse populations and they probably exerted an influence on both sets of data.

Fecundity of combined sample.—Although fecund individuals (nongray pelaged) of both sexes were found year-round among the 3833 individuals trapped, the longest fecundity periods in a given year were from January-November and February-December, inclusive. Adult males were least fecund in December and January averaging 6 and 7%, whereas females were least fecund from November-February with a range of 3-9%. Average male fecundity increased in February to 28%, rose smoothly to a peak in May (96%), declined gradually in June, July and August to 71%, dropping abruptly in September to 34% and to 6% in December. Females were a month later than males in the average upward surge in average fecundity (March, 30%). Their fecundity increased smoothly to peaks in both June and July (73%), 1 or 2 months later than the male peak. Female fecundity declined to 66% in August and then at an accelerated although regular rate to 3% in December. The average yearlong breeding pattern of each sex was not significantly different (χ^2, $P < 0.250$).

Tevis (1956) presented fecundity data for 625 adult *Peromyscus maniculatus* from the Douglas fir region near Salyer, Calif.; most of his trapping was done from May-November 1952. His data show spring and autumn fecundity peaks for both sexes with an intermediate summer lull (southern cycle, Stickel and Warbach, 1960). In the northern Sierra Nevada in California, Jameson (1953) found instances of the

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	Males-
Months	Good[a]
Tree seeds available	
Sept.	76.5
Oct.	67.5
Nov.	20.5
Dec.	25.0
Jan.	12.0
Feb.	49.0
Mar.	94.0
Subtotal	344.5
Avg.	49.2
Tree seeds mostly not available	
April	98.5
May	94.0
June	86.0
July	38.0
Aug.	21.5
Subtotal	338.0
Avg.	67.6
Grand total	682.5
Avg.	56.9

[a] 1956 and 1959 seed years—
[b] 1957, 1958, 1960, and 196

deer mouse reproductive period in spring diminishing gradually and ceasing altogether. He also found spring and autumn fecundity peaks with a midsummer lull. In coastal British Columbia, male *Peromyscus maniculatus* also started their spring breeding cycle earlier than the females (Sadleir, 1972).

Average fecundity by seed years.—It should be noted that deer mouse breeding intensity varies seasonally throughout the year. Therefore, comparisons of fecundity percentages should be made for the same periods between years or groups of years. In good seed years for the September-March period the average male fecundity was 49.2% and in poor years 13.3% (Table 2). The arc-sine transformed percentages were significantly different (χ^2, $P < 0.005$) and it appears that male fecundity responded positively to the size of the seed crop. From April-August, males averaged 67.6% fecundity with a good seed crop, and 92.2% with a poor crop; there was a significant difference between the transformed percentages (χ^2, $P < 0.010$). Male fecundity over the entire seed year was 56.9% in good seed years and 46.2% in poor. The arc-sine transformed percentages were not significantly different (x^2, $P > 0.100$) for the good and poor seed years.

The average percentages of fecund female deer mice from September-March in good seed years were 41.6% but only 4.7% in the poor, a significant difference (χ^2, $P < 0.005$). Fecund females were most numerous in September, with none fecund from November-January. Average female fecundity for the April-August period was greater (68.3%) in poor than in good (44.4%) seed years, a significant difference (χ^2, $P < 0.005$). The good seed years averaged 11.6% greater female fecundity, which was a significant difference (χ^2, $P < 0.005$).

The data already presented show that both sexes of deer mice have significantly greater fecundity from September-March in good seed years. However, from April-August both sexes have significantly greater fecundity during the poor seed years (x^2, $P < 0.025$, based on arc-sine transformed percentages). Average yearlong fecundity for both sexes was greater (11.2%) in good seed years, but not significantly

TABLE 2.—Average percentage of fecund deer mice by sex, month and amount of Douglas fir and western hemlock seed production in western Oregon

Months	Males—% fecund		Females—% fecund	
	Good[a]	Poor[b]	Good	Poor
Tree seeds available				
Sept.	76.5	27.7	88.5	24.0
Oct.	67.5	27.3	68.4	3.9
Nov.	20.5	0.0	36.7	0.0
Dec.	25.0	0.0	15.6	0.0
Jan.	12.0	0.0	14.8	0.0
Feb.	49.0	4.3	18.2	1.4
Mar.	94.0	34.0	57.6	4.3
Subtotal	344.5	93.3	299.8	33.6
Avg.	49.2	13.3	42.8	4.8
Tree seeds mostly not available				
April	98.5	91.0	76.9	30.3
May	94.0	99.3	54.6	78.7
June	86.0	98.8	40.6	85.7
July	38.0	87.5	35.1	78.2
Aug.	21.5	84.5	18.2	79.1
Subtotal	338.0	461.1	225.4	352.0
Avg.	67.6	92.2	45.1	70.4
Grand total	682.5	554.4	525.2	385.6
Avg.	56.9	46.2	43.8	32.1

[a] 1956 and 1959 seed years—2.66 kg or more/ha
[b] 1957, 1958, 1960, and 1961 seed years—0.45 or less/ha

so (χ^2, P > 0.100, based on arc sine transformed percentages). Although I can only conjecture, it seems probable that in many cases in northern climates and under field conditions the deer mice can sustain only a limited breeding period. In good seed years they tend to start and end their heaviest breeding early, and in poor years they start and end late. The early breeding of good seed years could contribute to larger autumn populations by permitting reproduction by early litters-of-the-year. From April-August, most females do not breed until they are in adult pelage or 10 weeks of age and older (Bendell, 1959). *Peromyscus maniculatus austerus* in British Columbia also have an early start-early ending and late start-late ending pattern (Petticrew and Sadleir, 1974). Jameson (1953) found a clear correlation between amounts of mast and the reproductive activity of *Peromyscus maniculatus* in northern California. He also found continuous fecundity of variable intensity, except for January, in heavy and lighter mast years and a later start when mast was not available. Food is not always associated with an immediate population response, however; in Maryland a population of *Peromyscus* declined during a heavy pine seed fall (Stickel and Warbach, 1960), and in eastern Ontario, Canada, food in excess did not affect the fecundity of *Peromyscus leucopus noveboracensis* (Bendell, 1959).

In good seed years the percentage of fecund adult females was 50.7 compared to 16.7 for the young, a significant difference (χ^2, P < 0.005). In poor seed years the percentages were 29.4 and 26.9, respectively, a nonsignificant difference (χ^2, P > 0.500). The decrease of adult breeding in poor seed years seems reasonable; however, reasons for the increased breeding of young are not known.

Percentage of pregnancies by seed years.—The average percentage of pregnancies from September-March for 219 females was 17.8 in good seed years and 2.3 for 484 females in poor years (Table 3), a significant difference (χ^2, P < 0.005). This difference was reversed during April-August when the average percentage of pregnancies was 19.3 for good seed crops and 38.0 for poor, a significant difference (χ^2, P < 0.005). When the entire seed year (September-August) was considered, the good years averaged 18.4% compared to 15.5% for the poor, a nonsignificant difference (χ^2, P > 0.100).

The data on percentage of pregnancies were further analyzed to see if poor seed years preceded by good years were related to a different reproductive response than poor years which were preceded by other poor years. The sample from poor seed

TABLE 3.—Deer mouse pregnancies by months in good and poor seed years

Months	Good		Poor	
	Total no. of females	% pregnant	Total no. of females	% pregnant
Sept.	26	61.5	95	9.4
Oct.	38	23.7	77	2.6
Nov.	30	6.7	71	0.0
Dec.	32	3.1	62	0.0
Jan.	27	7.4	61	0.0
Feb.	33	3.0	70	0.0
Mar.	33	24.2	47	0.0
Subtotal	219	17.8	484	2.3
April	26	42.3	66	18.2
May	22	13.6	47	40.4
June	32	12.5	49	42.9
July	37	21.6	55	52.7
Aug.	44	11.4	67	40.3
Subtotal	161	19.3	284	38.0
Grand total and avg.	380	18.4	768	15.5

years preceded by good years consisted of 451 females, of which 55 or 12.2% were pregnant. The sample of poor seed years preceded by poor crops consisted of 436 females, of which 64 or 14.7% were pregnant. There was no significant difference (χ^2, $P > 0.250$). Thus, the size of the seed crop did not appear to affect the percentage of mice pregnant the following seed year.

Litter size.—The number of corpora lutea found in the ovaries of 747 females ranged from 1-11, compared with 1-9 for both the embryos (427 uteri) and placental scars (252 sets) (Table 4). The modal size of the litters was four in each of the categories. The average litter size was 4.6 ± 0.05 for corpora lutea, 4.4 ± 0.02 for embryos and 4.4 ± 0.06 for placental scars. Some discharged ova would probably not be implanted, and some of the fertilized ova implanted may be resorbed at an early date; therefore, some placental scars may not be readily apparent nor properly aged by gross examination. Consequently, the corpora lutea count would tend to be slightly higher than the placental scars and embryo counts.

Embryo litter size ranged from 3.5-6.5 in monthly data from 1319 (206 pregnancies) deer mice (Table 5). However, the November figure (6.5) is based on only two litters and the September average (5.8 ± 0.26), based on 26 litters, is considered a more reliable average extreme. The average litter for the yearlong data was 4.5 ± 0.20, which is also the same average shown by a smaller sample in Table 6. The average litter size was reasonably similar from January-June but from July through December litters were larger.

Beer (1956) examined 10 pregnant *Peromyscus maniculatus rubidus* captured in August at Otter Rock, Oregon. The number of embryos ranged from 4-8, had a mode of 6 and averaged 6.0. His average is considerably higher than the August data of the present study (Table 5). In northwestern California, Tevis (1956) examined 65 gravid *P. maniculatus,* collected from May-December, whose embryos ranged from 1-5, had a mode of 3 and averaged 3.4. These figures are considerably smaller than those of the present study. Jameson (1953), who worked in the northern

TABLE 4.—Corpora lutea, placental scar and embryo data for female deer mice kill-trapped in western Oregon (1952-1966)

Reproductive stage	No. of sets	Total no. of units	Avg. sets and SE of the mean	Mode of sets	Range of sets
Corpora lutea	747	3430	4.6 ± 0.05	4	1-11
Embryos	427	1890	4.4 ± 0.02	4	1- 9
Placental scars	252	1166	4.4 ± 0.06	4	1- 9

TABLE 5.—Occurrence and average number of embryos by months from 1319 deer mice kill-trapped in western Oregon

Month	No. of females	Percent pregnant	Avg. no. of embryos	SE of the mean
Jan.	88	2.3	3.5	--
Feb.	103	1.0	4.0	--
March	80	10.0	3.6	±0.30
April	100	25.0	3.7	±0.20
May	89	24.7	3.6	±0.16
June	93	32.3	3.9	±0.11
July	99	41.4	4.4	±0.24
Aug.	120	30.8	5.2	±0.30
Sept.	148	17.6	5.8	±0.26
Oct.	145	7.6	5.2	±0.15
Nov.	137	1.5	6.5	--
Dec.	117	0.9	5.0	--
Total and avg.	1319	15.6	4.5	±0.20

Sierra Nevada, California, found the yearlong average embryo litter size was 4.6 for 97 gravid *P. maniculatus;* this was nearly identical to my findings. In British Columbia, Sadleir (1972) examined 57 *P. maniculatus austerus* which had an average embryo litter of 4.52, nearly the same as in this study. They ranged in monthly average from 2.00-5.36.

It is interesting to note that the greatest percentages of pregnancies were found from June-August, 1-3 months prior to greatest average litter size (Table 5). This finding does not agree with Jameson (1953) who stated, "Larger litters occur at the height of the breeding season in *maniculatus* . . .". In the present study, smaller average litters were found in winter and spring and larger were tallied in summer and autumn (Table 5). Smaller spring litters may be the result of a higher percentage of first litter-bearing females in the population in the spring than at other seasons, and spring breeding by older animals nearing the end of their life span. Drickamer and Vestal (1973) showed that laboratory colonies of *Peromyscus maniculatus bairdii* and *P. maniculatus gracilis* have smaller average first and last litters. Jameson (1953) found that the earliest spring litters were smallest in California. Fuller (1969) and Sadleir (1972) also noted that earliest *Peromyscus maniculatus* litters were smaller than later litters in their respective studies near the Great Slave Lake and coastal British Columbia, Canada.

Litter size by seed year.—Embryo litter-size of deer mice was compared with size of seed crop to see if any relationship could be detected (Table 6). For the September-March period, poor seed years had larger average litters than good (6.0 vs. 5.0); however, the difference was not significant (t-test, $P > 0.200$). The 11 litters comprising the poor seed crop sample were all found in September and October, when food and weather conditions appear to be most favorable, whereas the 39 litters of the good crop sample were scattered unevenly over the entire September-March period. During April-August, when tree seeds are largely unavailable, aver-

TABLE 6.—Average deer mouse embryo litter size by quantity of seed and month of good and poor seed years. Standard error of the mean in parentheses

	Good		Poor	
Month	No. of preg.	Avg. no. of embryos	No. of preg.	Avg. no. of embryos
Tree seeds available				
Sept.	16	5.6	9	6.1
Oct.	9	5.1	2	5.5
Nov.	2	6.5	0	0.0
Dec.	1	5.0	0	0.0
Jan.	2	3.5	0	0.0
Feb.	1	4.0	0	0.0
Mar.	8	3.6	0	0.0
Subtotal and avg.	39	5.0	11	6.0
Tree seeds mostly not available		(±0.42)		(±0.31)
April	11	3.8	12	3.8
May	3	3.7	19	3.6
June	4	3.5	21	4.0
July	8	4.4	29	4.2
Aug.	5	4.4	27	5.3
Subtotal and avg.	31	4.0 (±0.19)	108	4.3 (±0.31)
Grand total and avg.	70	4.5 (±0.28)	119	4.5 (±0.37)

age litter sizes were 4.0 for go
ence (t-test, $P > 0.500$).

When the litter size for th
crop, both the good and poor
ably have smoothed or equal
ever, there was no direct rela
crop and deer mouse litter size

Calculated number of lit
was calculated as described
pregnant females per month
plied by the number of day
result was divided by the aver
divided by the number of mo
litters/year.

The average number of l
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General statement.—The
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overwinter recaptures and a gr
This suggests greater survival
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Besides adding to our und
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operations to take greater adv
iations of deer mice.

TABLE 7.—Average ca

Seed year
Good
1956
1959
Avg.
Poor
1957
1958
1960
1961
Avg.

age litter sizes were 4.0 for good and 4.3 for poor seed years, a nonsignificant difference (t-test, $P > 0.500$).

When the litter size for the entire seed year was compared for each size of seed crop, both the good and poor seed years averaged 4.5. Larger samples would probably have smoothed or equalized the period differences by size of seed crop. However, there was no direct relationship between the size and availability of the seed crop and deer mouse litter size. This finding agrees with that of Bendell (1959).

Calculated number of litters by seed years.—The number of litters/female/year was calculated as described by Gashwiler (1972) (Table 7); the percentages of pregnant females per month were summed for each seed year, this figure was multiplied by the number of days in months when pregnancies were found, and the result was divided by the average gestation period (24.5). The resulting figure was divided by the number of months with pregnancies, to give the estimated number of litters/year.

The average number of litters/female/year varied from 1.7-3.2, a lower range than is sometimes given for *Peromyscus maniculatus rubidus*. Hooven (1958) reported that females usually had two litters in the spring and two in the autumn. Both the lowest and highest estimated number of litters/year occurred in poor seed years. This tends to support the idea that over a seed year, the size of the seed fall has either small or no effect on the annual number of litters; however, the difference of this small sample was significant (t-test, $P < 0.02$). The average calculated number of litters/year was 13% greater in good seed years than in poor (2.9 vs. 2.5).

General statement.—The present data show that high populations of deer mice in the autumn following a good seed crop are associated with greater percentage of overwinter recaptures and a greater percentage of young deer mice in the population. This suggests greater survival of the mice although food-related behavioral patterns, or other factors, may be responsible for part of the difference. Good seed crops are also associated with increased overwinter and early spring fecundity of deer mice and more litters per female per year, which would contribute toward higher populations the autumn following a good seed crop.

Besides adding to our understanding of deer mouse biology and how it influences the populations in relation to the tree seed crop, the data should be useful to forest managers faced with tree seed depredation problems. The information could be used in protecting the natural seed fall and small seedlings and in seeding and control operations to take greater advantage of the natural changes in the biology and populations of deer mice.

TABLE 7.—Average calculated number of litters per female per year in good and poor seed years

Seed year	No. of females	Est. no. litters/ female/year
Good		
1956	176	3.1
1959	204	2.7
Avg.	190	2.9
Poor		
1957	188	1.7
1958	160	2.1
1960	208	3.0
1961	212	3.2
Avg.	192	2.5

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Small Mami

Department of Biol.

ABSTRACT: Ten woodl
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islands. The number of spe
Islands contained sign
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populated by few subadul
size and weight of *P. leuco*
and Wilson model.

MacArthur and Wilson
generated increased interest
have been with oceanic is
islands of habitat on ma
surrounded by fields, past
burns, and so on, are all
the distribution of species
1971; Culver, 1970; Smith
In eastern Iowa, exte
These habitat islands provi
tions of the MacArthur and
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propagules reaching these
investigate this system.

Strict criteria were use
islands selected were com
also isolated from other islan
(MacArthur and Wilson, 19
constant for at least a 5-
disturbed (*e.g.*, fire, cutting
were wooded, with oak (Q
A total of 10 islands met th
ties (forests over 30 ha) were
Trapping was initiated
Snap traps (McGill Compa
placed in a grid on each isla
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were caught. Minimum du
each mainland was intensive
the mainlands in a nonsystem
small mammals caught in
where they were identified

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