



Small mammal populations in clearcuts of various ages in south central Montana
by Martin Lyle Heath

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Zoology
Montana State University
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Abstract:

Four clearcuts of various ages, located in a subalpine fir (*Abies lasiocarpa*) forest in south central Montana, were live-trapped to determine the species composition and density of small mammals in the area. An adjoining forest site was concurrently trapped in the same manner, to serve as a control. Each site was trapped for eight days (1600 trap nights) during the months of June to September, 1972. The animals, captured were in a ratio of 48% *Peromyscus maniculatus*, 21% *Clethrionomys gapperi*, 16% *Sorex cinereus*, and *Sorex Vagrans*, and 15% a mixture of six other species. The spatial and temporal distribution of the first three groups was examined using a linear correlation model, with the significance level set at $P=0.10$. Results showed a number of significant correlations between age of clearcut and the number, of various animals captured in the clearcut or the adjoining forest. *P. maniculatus* was shown to decrease in number, as the clearcuts aged, while *C. gapperi* increased and *Sorex* sp. remained at a relatively constant level. Species diversity decreased in the forest adjoining a clearcut as the clearcut aged.. Significant correlations were also found between the distance from the clearcut-forest interface that a trap was placed and the number and species of animals captured. .

P. maniculatus was found to increase, in number as sampling progressed into the clearcut, and to decrease as sampling entered the forest. *C. gapperi* showed the opposite, trend, increasing in the forest and decreasing in the, clearcut; *Sorex* sp. showed slight increases in number as trap sites were moved deeper into the forest. Other population trends tested were found to be statistically nonsignificant.

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MARTIN LYLE HEATH.

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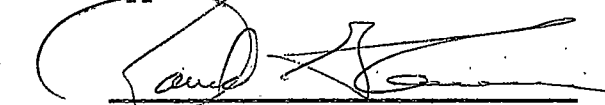
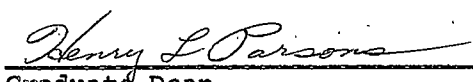
of

MASTER OF SCIENCE

in

Zoology.

Approved:


Head, Major Department
Chairman, Examining Committee
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MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1973

ACKNOWLEDGMENT

The author expresses his appreciation and thanks to Dr. David Cameron, whose supervision and advice made the completion of this project possible. Sincere thanks are also extended to Dr. Stephen Chapman for his aid in the statistical analyses, to Dr. Robert Moore, Dr. John Rumely and Dr. Richard Mackie for critically reviewing the manuscript. The author's wife, Jackie, provided invaluable assistance and patience throughout the study.

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ABSTRACT

Four clearcuts of various ages, located in a subalpine fir (*Abies lasiocarpa*) forest in south central Montana, were live-trapped to determine the species composition and density of small mammals in the area. An adjoining forest site was concurrently trapped in the same manner, to serve as a control. Each site was trapped for eight days (1600 trap nights) during the months of June to September, 1972. The animals captured were in a ratio of 48% *Peromyscus maniculatus*, 21% *Clethrionomys gapperi*, 16% *Sorex cinereus* and *Sorex vagrans*, and 15% a mixture of six other species. The spatial and temporal distribution of the first three groups was examined using a linear correlation model, with the significance level set at $P=0.10$. Results showed a number of significant correlations between age of clearcut and the number of various animals captured in the clearcut or the adjoining forest. *P. maniculatus* was shown to decrease in number as the clearcuts aged, while *C. gapperi* increased and *Sorex* sp. remained at a relatively constant level. Species diversity decreased in the forest adjoining a clearcut as the clearcut aged. Significant correlations were also found between the distance from the clearcut-forest interface that a trap was placed and the number and species of animals captured. *P. maniculatus* was found to increase in number as sampling progressed into the clearcut, and to decrease as sampling entered the forest. *C. gapperi* showed the opposite trend, increasing in the forest and decreasing in the clearcut. *Sorex* sp. showed slight increases in number as trap sites were moved deeper into the forest. Other population trends tested were found to be statistically non-significant.

INTRODUCTION

Communities of small mammals in Rocky Mountain forest clearcuts have been studied from two viewpoints. Silviculturists have examined the influence of rodent and insectivore population changes upon reforestation rates. Moore (1942) reported that shrews (*Sorex* sp.) selectively ate large conifer seeds, thus giving small-seeded conifer species such as lodgepole pine (*Pinus contorta*) an advantage. Radvanyi (1970) found 3 to 35% of white spruce (*Picea glauca*) seeds destroyed by *Peromyscus* sp. and 2 to 10% destroyed by *Sorex cinereus*. Studying a western Oregon clearcut, Gashwiler (1967) reported that birds and mammals consumed 63% of the tree seed.

Mammalian ecologists have studied the ways changes in the vegetation on clearcuts are reflected in changes of the small mammal community (Trowsdell, 1954; Tevis, 1956; Gashwiler, 1970).

A typical field design for studying small mammal population changes on clearcuts involves trapping a forest site before and after clearcutting. The site is then periodically sampled as the vegetation undergoes temporal changes.

There are two disadvantages to this experimental design. First, the vegetational changes on a coniferous clearcut cover a long time span. Basile and Jensen (1971) found that on lodgepole pine clearcuts, seral herbaceous plants prosper for twenty years before they are stifled by the growth of pine. Few researchers have the ten to twenty years

necessary to sample a single clearcut as it passes through the early stages of vegetative succession. Second, in sampling a single clearcut annually, most investigators fail to compensate for the normal annual fluctuations in rodent populations (see Terman, 1966 for a complete analysis of these trends). Because of their magnitude and aperiodicity, these fluctuations can distort or obscure any succession-dependent trends in population data for a number of years.

An alternative to sampling a single clearcut as it passes through successive vegetational stages is to sample clearcuts of various ages during a single year, thus possibly minimizing the confounding effects of annual population fluctuations. This is the approach used in the present study. The confounding factors of such a method include all of the ecological factors that can affect multiple sites differentially: slope, altitude, aspect, soil conditions and history of treatment.

The influences of these variables upon the data were minimized for this study in two ways. First, sites of various ages were selected such that slope, altitude, aspect and treatment were as comparable as possible for all sites. Second, for each clearcut sampled, a plot was also sampled in a mature timber stand that immediately adjoined the clearcut and had similar features. Therefore, if it is assumed that each clearcut and the adjacent forest were co-inhabited by a single pre-clearcut small mammal community, and if progressive changes

can be shown in those communities in the sampled clearcuts but are not found in the control sites, temporal changes in the clearcuts would logically be considered a major cause of the change.

Although the main objective of this project was the assessment of small mammal population changes in relation to the aging of a series of coniferous clearcuts, several subordinate hypotheses were also tested:

- 1) There are no significant changes in species diversity of small mammals as clearcuts undergo successional changes.
- 2) There are no significant differences between the numbers of animals captured or species diversity of the small mammal community within a clearcut and that of the adjoining forest.
- 3) There is no significant edge effect with respect to the clearcut-forest interface.

DESCRIPTION OF AREA

Four clearcut areas, 4, 6, 8, and 10 years old were selected for study. These were located in the Gallatin Mountain Range, approximately 15 miles southwest of Bozeman, Montana (see Figure 1). All were located in mid-slope of northeast-facing slopes in the Little Bear Creek and Big Bear Creek drainages, northwestward flowing tributaries of the West Gallatin River. The physical characteristics of the sites are given in the following table.

Table 1. Physical Characteristics of Experimental Clearcut Sites.

Date of cut	1962	1964	1966	1968
Age of cut when trapped	10 years	8 years	6 years	4 years
Size of cut (ha.)	10.5	3.3	14.9	15.7
Slope (%)	2-5%	8-12%	6-9%	3-7%
Aspect	60° ENE	60° ENE	55° ENE	50° NE
Altitude (meters)	2120	2100	2080	2040
Location	NE $\frac{1}{4}$ S16 R5E T4S	NE $\frac{1}{4}$ S16 R5E T4S	NE $\frac{1}{4}$ S8 R5E T4S	SW $\frac{1}{4}$ S10 R5E T4S

In this area mature forest of northeast-facing slopes at approximately 2000 meters elevation is similar to the *Abies lasiocarpa-Vaccinium scoparium* habitat type of Daubenmire and Daubenmire (1968). The Daubenmire study was developed for forests of eastern Washington

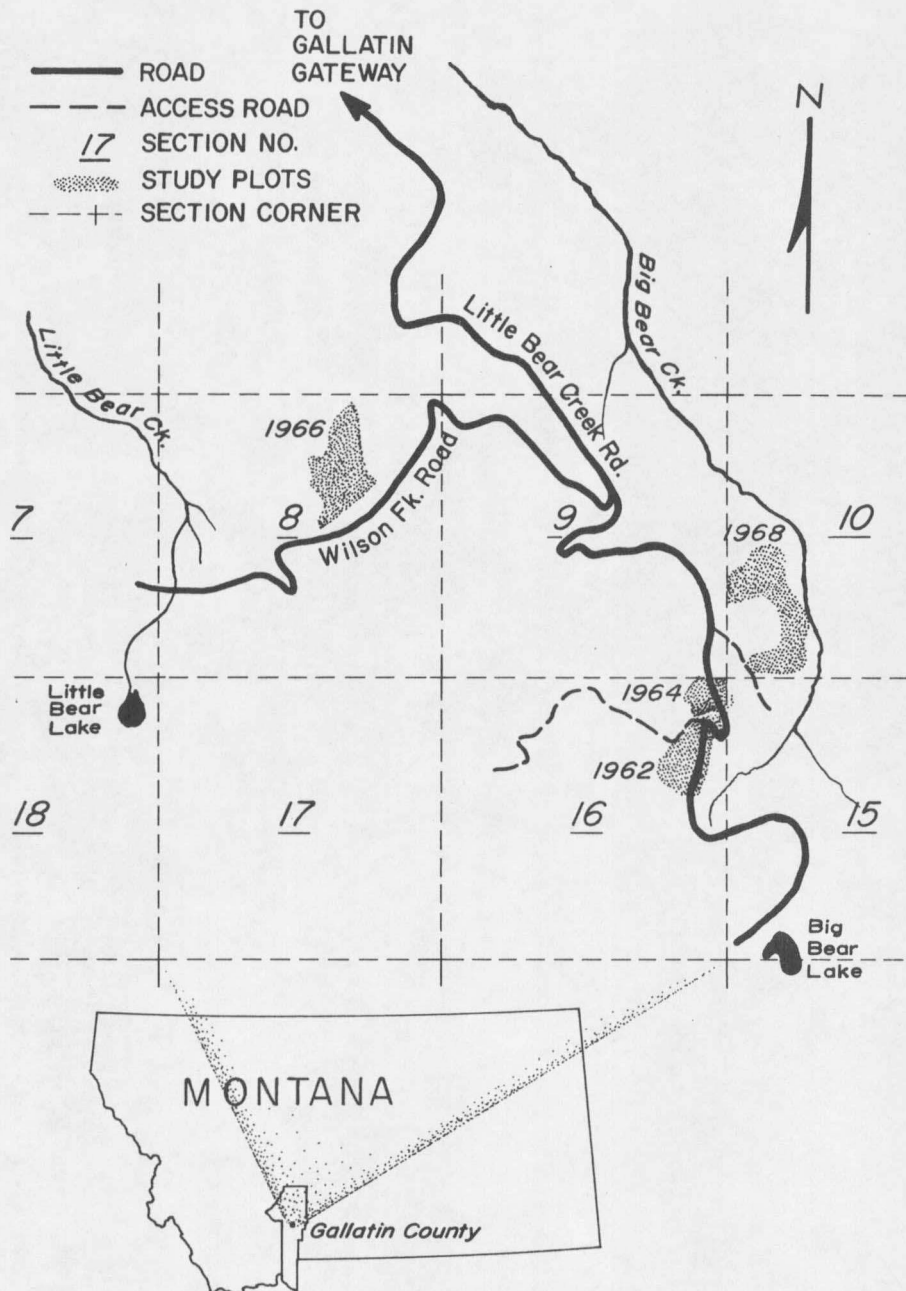


Figure 1. Map of Study Area. Garnet Mountain Quadrangle, Montana.

and northern Idaho. The Bear Creek study area is closely similar to the *A. lasiocarpa*-*V. scoparium* habitat type of Pfister *et al.* (1972). The latter work contains detailed lists of the composition of understory vegetation found in the seral stages of each habitat type. Although Pfister's work describes coniferous forests of the western slope of the Rocky Mountains, a different climatic region than the present study, the proximity of the two study regions should allow considerable predictive value to be placed on Pfister's data. A complete analysis of central and eastern Montana forest habitat types is presently being developed (Pfister, personal communication).

In the areas sampled, varying quantities of Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine were found. Following disturbance, especially fire, a seral stand of commercially valuable lodgepole pine usually replaces the fir. Therefore, clearcuts are usually burned following logging to favor the pine. The study areas were all clearcut during the summer, with slash piled and burned the following fall. Each clearcut was bordered for at least 200 meters by a stand of "undisturbed" mature timber.

METHODS

At each clearcut site, 200 permanent trapping points, spaced five meters apart, were set up in a ten by twenty rectangular array. The long axis of the rectangle paralleled the aspect of the clearcut, while the short axis lay along the clearcut-forest interface, such that adjoining ten by ten trap grids covering 0.25 hectare were located in the clearcut and adjacent timber.

Trapping was conducted at each site for two or three successive days during each of three periods (early, middle and late summer). Sites were sampled at random within each period. Clearcut sites and their adjoining control sites were always trapped simultaneously. Dates of trapping are given in Table 6 of the Appendix.

A large Sherman live trap, baited with rolled oats and peanut butter, and supplied with cotton waste as bedding, was placed at each trapping point. Traps were sometimes placed on logs or stumps. Traps were checked within two hours of sunrise each morning and captured animals were marked by toe-clipping and released. Sex, age class and reproductive condition of the animals, and vegetational surroundings of the trap were noted for each capture. Pelage color and size were used to classify animals as adult or juvenile. Sub-adults were treated as juveniles. Evident scrotal testes were the criterion used to classify adult males as sexually active. Adult females were classified as pregnant (externally palpable embryos), lactating

(visible mammae), or nongravid. Nomenclature of mammals follows Hall and Kelson (1959). Eight days of trap data (1600 trap nights) from each site were used in analyses. Trapping took place from June 22 to September 16, 1972.

DATA

Two hundred and thirty animals, comprising ten species, were captured 329 times. The animals caught were deer mice (*Peromyscus maniculatus*); masked and vagrant shrews (*Sorex cinereus* and *Sorex vagrans*); montane voles (*Microtus montanus*); western jumping mice (*Zapus princeps*); boreal red-backed mice (*Clethrionomys gapperi*); short-tailed weasels (*Mustela erminea*); northern pocket gophers (*Thomomys talpoides*); yellow pine chipmunks (*Eutamias amoenus*) and a single house mouse (*Mus musculus*). Red squirrels (*Tamiasciurus hudsonicus*) and pikas (*Ochotona princeps*) were seen near all experimental sites but were not captured. The numbers of each species captured on each clearcut and its adjoining control during 1600 trap days are shown in Table 2. Animals captured repeatedly were counted only once in analyses except in the spatial distribution calculations.

Several *Sorex* were identified in the laboratory as both *Sorex cinereus* and *Sorex vagrans* based on skull characteristics but, because the two species could not be readily distinguished in the field, all *Sorex* captured were listed as *Sorex* sp. *Microtus* were classified as *Microtus montanus* on the basis of dental characteristics as given by Hall and Kelson (1959).

Table 2. Numbers of Animals Caught, by Species. The Data for each Clearcut are Pooled for all Trap Days.

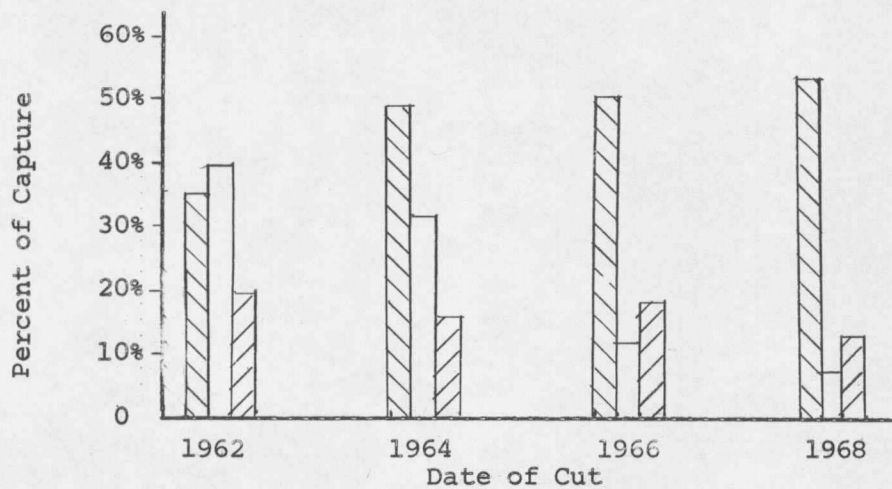
Species	Age of Cut (Years)									
	4		6		8		10		Total	
	F [†]	C [†]	F	C	F	C	F	C	F	C
deer mice <i>Peromyscus maniculatus</i>	8	27	9	24	7	18	7	10	31	79
red-backed mice <i>Clethrionomys gapperi</i>	3	2	3	4	6	10	15	5	27	21
shrew <i>Sorex sp.</i>	3	5	4	8	1	7	2	7	10	27
voles <i>Microtus montanus</i>	4	2	0	6	0	0	0	0	4	8
chipmunk <i>Eutamias amoenus</i>	4	1	1	2	0	2	0	2	5	7
jumping mice <i>Zapus princeps</i>	0	3	0	1	0	1	0	0	0	5
weasel <i>Mustela erminea</i>	1	0	0	2	0	0	0	0	1	2
pine chipmunk <i>Thomomys talpoides</i>	1	0	0	1	0	0	0	0	1	1
house mouse <i>Mus musculus</i>	0	0	0	1	0	0	0	0	0	1

[†]F = Trap Data for Forest.

[†]C = Trap Data for Clearcut.

Total capture data for *P. maniculatus*, *C. gapperi*, and *Sorex sp.* are shown in Table 7 of the Appendix. Only those species comprising fifteen percent or more of the total summer catch are included in statistical calculations unless otherwise stated. Statistical analyses were tested at a level of significance of $P=0.10$.

Statistically significant trends in species composition proportions were observed for *P. maniculatus* and *C. gapperi*. Changes in species proportions for the four sites are graphed in Figure 2.



P. maniculatus 
C. gapperi 
Sorex 

Figure 2. Proportions of Total Individuals Captured in each Site. The data for each clearcut are pooled for all trap days and for clearcut and forest. Values are derived from Table 7 in Appendix.

Data were tested for significant trends using a linear correlation model, with the correlation coefficient "r" tested at a $P=0.10$ level of significance by the "Student t". The coefficient of determination " r^2 " was used to determine the maximum percentage of variation in the dependent variable which can be attributed to variation in the independent variable (Steel and Torrie, 1960).

Table 3 shows the correlation coefficients (r), coefficients of determination (r^2) and "t" values for correlations between age of clearcuts and numbers of each species captured. A positive correlation

Table 3. Calculated Statistical Values for Population Trends Among all Sites Sampled. Data are Pooled for all Trap Dates.

	Adult			Juvenile			Combined		
	r	r ²	t	r	r ²	t	r	r ²	t
<i>Peromyscus maniculatus</i> :									
Forest	-.258	.066	.37	-.894	.799	2.82	-.674	.454	1.29
Cut	-.835	.697	2.15	-.982	.964	7.35*	-.981	.962	7.15*
Combined	-.798	.636	1.87	-.991	.982	10.47*	-.973	.946	5.96*

Clethrionomys gapperi:

Forest	+.916	.839	3.22*	+.718	.515	1.45	+.886	.785	2.70
Cut	+.597	.356	1.05	+.513	.263	0.85	+.294	.086	0.44
Combined	+.984	.968	7.81*	+.894	.799	2.82	+.973	.946	5.96*

	Sorex			Number of Species			Total # Animals		
	r	r ²	t	r	r ²	t	r	r ²	t
Forest	-.600	.360	1.06	-.944	.891	4.04*	+.755	.570	1.62
Cut	+.517	.263	0.84	-.447	.199	0.71	-.719	.517	1.46
Combined	-.068	.004	0.09	-.939	.882	3.86*	+.166	.028	0.24

For P=0.10 critical t=2.92 based on 2 degrees of freedom.

*Significant t values.

indicates that as clearcuts age, the species in question grows more numerous. Of the above list, nine of 27 correlations are statistically significant. Because of the low number of clearcuts sampled, and the resultant low number of degrees of freedom in calculations, only correlations greater than 0.90 are significant. Thus the null hypothesis is rejected that all species of small mammals on clearcuts are distributed randomly with respect to clearcut age.

In particular, *P. maniculatus* decreases significantly as a clearcut ages, while *C. gapperi* increases. *Sorex* are not influenced significantly by clearcut succession.

The null hypothesis that there are no significant changes in species diversity as a clearcut undergoes succession is also rejected (see Table 3).

Because a simple correlation model was employed, no points of inflection were determined for any of the trends; i.e., from these data one cannot extrapolate the age of the clearcut in which *P. maniculatus* will reach the pre-clearcut population level and stop decreasing.

Trapping data were also analyzed to determine the distribution of various animals with respect to the clearcut-forest interface. Data were pooled for all dates of trapping at each site. Table 4 shows "r", "r²" and "t" values for correlations between distance from interface and animal numbers. Table 5 shows the calculated statistical values for pooled data from all four clearcuts. Tables 4 and 5 are derived from data shown in Tables 8 and 9 of the Appendix.

In Tables 4 and 5 a positive correlation indicates that as the distance from the forest-clearcut interface increases, the species in question is captured more often. Therefore, if the data for a species on a particular site showed negative correlations with both distance into the forest and distance into the clearcut, an edge effect would

Table 4. r , r^2 and t for Association of Trap Success with Distance from the Forest-Clearcut Interfaces. This table is based on data which include multiple captures of animals.

Date of Cut and Species	Adult			Sample Size	Juvenile			Sample Size
	r	r ²	t		r	r ²	t	
1962								
<i>Peromyscus maniculatus:</i>								
Forest	-.752	.565	4.84*	5	-.348	.121	1.57	2
Cut	.092	.008	.39	11	.262	.068	1.15	4
1964								
Forest	-.761	.579	4.98*	14	-.265	.070	1.16	3
Cut	-.319	.101	1.43	32	.441	.194	2.08*	5
1966								
Forest	.311	.096	1.39	10	-.389	.151	1.79	5
Cut	.647	.418	3.60*	31	.591	.349	3.11*	10
1968								
Forest	-.265	.070	1.16	6	-.389	.151	1.79	5
Cut	.294	.008	1.31	18	-.134	.018	.573	20
1962								
<i>Clethrionomys gapperi:</i>								
Forest	.853	.728	6.93*	14	-.262	.068	1.15	6
Cut	-.736	.541	4.61*	5	.087	.007	.370	2
1964								
Forest	.536	.287	2.69*	7	.261	.068	1.14	2
Cut	.177	.031	.762	8	.025	.001	.106	4
1966								
Forest	.696	.484	4.11*	2	.406	.164	1.88*	1
Cut	-.087	.007	.370	2	.174	.030	.749	2
1968								
Forest	.522	.272	2.59*	1	.058	.003	.246	2
Cut	-.406	.164	1.88*	1	.058	.003	.246	1

Table 4. Continued.

Date of Cut and Species	r	r ²	t	Sample Size
1962				
<i>Sorex:</i>				
Forest	.435	.189	2.05*	2
Cut	-.462	.213	2.21*	7
1964				
Forest	.058	.003	.246	1
Cut	-.367	.134	1.67	7
1966				
Forest	-.265	.070	1.16	3
Cut ¹	-.419	.175	1.96*	6
1968				
Forest	.135	.018	.578	3
Cut	-.129	.016	.551	5

For P=0.10 critical $t > 1.860$, based on 8 degrees of freedom.

*Significant t values.

be implied. Two positive correlations would indicate an "inverse edge effect". Since none of the twenty-five pairs of correlations is made up of two significant correlations of the same sign, no significant edge effect is demonstrated. Therefore, the null hypothesis, that there is no edge effect with respect to the forest-clearcut interface, is accepted. This interpretation may be faulty due to type "A" error; i.e., correlations that are actually significant may have been rejected due to small sample size.

Table 5. r , r^2 and t Values for Association of Trap Success with Distance from the Forest-Clearcut Interface. Data Pooled for all Sites and all Dates of Trapping. This table is based on data which include multiple captures of animals.

Species	Adult			Total No. Animals in Each Group	Juvenile			Total No. Animals in Each Group
	r	r ²	t		r	r ²	t	
<i>Peromyscus maniculatus</i> :								
Forest	-.823	.678	6.17*	35	-.609	.370	3.25*	15
Cut	.285	.081	1.26	92	.662	.439	7.75*	39
<i>Clethrionomys gapperi</i> :								
Forest	.854	.729	6.96*	24	.124	.015	.530	11
Cut	-.526	.276	2.62*	16	.284	.080	1.26	9
Species	r	r ²	t	Total No. Animals in Each Group				
<i>Sorex</i>								
Forest	.166	.027	.714	9				
Cut	-.609	.370	3.26*	25				

For $P=0.10$ critical $t > 1.860$, based on 8 degrees of freedom.

*Significant t values.

DISCUSSION

These results show that in the sites studied there are basic differences between the small mammal communities of young and old clearcuts, of clearcuts and the adjoining forest, and of areas adjacent to and removed from the clearcut-forest interface. The causes of these differences are subject to various interpretations.

The strength of the significant correlations in Table 3 show that for the clearcuts studied, certain animal populations change in number as the clearcut ages. Of the nine significant correlations, six are direct reflections of three determining correlations. These key correlations (*P. maniculatus* juvenile-clearcut, *C. gapperi* adult-forest and species number-forest) will be discussed below.

The strong negative correlation between clearcut age and numbers of *P. maniculatus* juveniles captured in the clearcuts appears to show that *P. maniculatus* react favorably to clearcutting in this area. It should be noted that all *P. maniculatus*-clearcut age correlations in Table 3 are negative, i.e., in every case *P. maniculatus* increases as the clearcut ages.

This interpretation would agree with the findings of Tevis (1956) who showed that *P. maniculatus* numbers increase due to clearcutting, and decrease due to regrowth on Douglas fir clearcuts in northwest California with maximum numbers occurring six years after cutting. Black and Frischknecht (1971) found more *P. maniculatus*.

on the most heavily-grazed (i.e., disturbed) grass range and cited a series of papers showing evidence that *P. maniculatus* may be at a disadvantage in areas of abundant cover. Gashwiler (1970) found more *P. maniculatus* in Douglas fir clearcuts than in the adjoining timber, with the difference maximized four years after cutting. In contrast, Krull (1970) caught more *Peromyscus* sp. in uncut hardwood forests than in the adjoining clearcuts.

The positive correlations between clearcut age and *C. gapperi* density, particularly in the forest, indicates that as clearcuts age, the red-backed mice increase in number. The observed increase may reflect a return to a pre-cut population level. It appears that environmental disturbance results in a sharp decline in *Clethrionomys* numbers. According to the literature reviews below, *Clethrionomys* is at a disadvantage in disturbed areas and does well in areas of dense cover.

Morris (1969) reports that in areas of Saskatchewan *C. gapperi* are found exclusively in aspen (*Populus* sp.) stands, and not in the adjoining grassland. Krull (1970) captured more *C. gapperi* in uncut hardwood forest than in clearcuts for nine out of ten years. Brown (1967), studying the Medicine Bow Mountains of Wyoming, captured *C. gapperi* most often in spruce-fir forests (*Picea* sp.-*Abies* sp.) and least often in grass meadows. Hoffman (1960) stated that the distribution of *C. gapperi* is related to the distribution of

coniferous forests, and within the forest to the distribution of suitable cover.

The negative correlation between these clearcut ages and the number of species captured in the forest apparently indicates that there is a spill-over influence of the clearcut upon the adjoining forest. As these clearcuts age, the number of pioneer plant species seems to decrease as does the number of opportunistic rodent niches. Thus the clearcut, and probably the adjoining forest as well, is unable to support as many species. The weak negative correlation between clearcut age and clearcut species diversity supports this interpretation.

Since changes in clearcut age influence the number of rodents captured in the forest, it is apparent that the forest immediately adjoining a clearcut does not accurately represent conditions on the clearcut prior to cutting. However, if a control site is selected that is far enough away from the clearcut to be undisturbed by the cutting, differences in soil conditions, slope, weather, and altitude would come into play. The reliability of such distant controls is questionable. Therefore, a completely unbiased control for a clearcut is difficult to imagine.

For Tables 4 and 5, only those cases made up of two significant correlations will be discussed. It should be noted that several of the significant correlations in Table 4 are based on the capture of

a single animal. While these trends are meaningful, the biological value is obviously limited.

There are five pairs of significant correlations in Tables 4 and 5. Three of these involve *C. gapperi* adults. In each of these cases, a positive forest-animal number correlation is coupled with a negative clearcut-animal number correlation. This means that along a transect running from the "center" of the forest to the center of the clearcut, *C. gapperi* numbers decrease as the forest-clearcut edge is approached, and also decrease as the clearcut is penetrated. This trend would be consistent with the habitat requirements of *C. gapperi*, as described above. Red-backed mice are forest-inhabiting animals that are largely unsuccessful in clearcuts unless the cut contains large amounts of slash. The build-up of *C. gapperi* along the interface may be due to dense slash piles. In the 1962 clearcut *Sorex* sp. are found most commonly along the clearcut edge, becoming less common toward the center of the clearcut. The significant *Sorex*-forest correlation for this cut is based on two animals and thus has little meaning.

The total juvenile *P. maniculatus* trends are negative in the forest and positive in the clearcut. In other words, *Peromyscus* decrease in number as the distance from the clearcut center increases. *P. maniculatus* seems to be an opportunistic species that thrives in disturbed habitat and decreases in areas of dense cover.

These findings could have some value in determining an optimal clearcut design. While it is obvious that other physical and economic factors are the main considerations in determining the size of clearcuts, rodent populations that destroy conifer seeds must also be taken into account. Of the small mammal species commonly captured in the study areas, *P. maniculatus* and *Sorex* sp. have been shown to damage conifer seed crops. *C. gapperi* also eats lodgepole pine seeds but is not as destructive as *P. maniculatus* and *Sorex* sp. (Radvanyi, 1971). Assuming all other factors to be equal, one way to increase seed survival would be to suppress the numbers of *P. maniculatus* and *Sorex* sp. on the clearcuts. This could possibly be done by poisoning as suggested by Neils *et al.* (1955), who also recommend fencing the forest to keep the deer out. Another alternative would be snap trapping of animals. However, Gashwiler (1970) and Tevis (1956) showed that animals moved back into poisoned or snap-trapped clearcuts almost as fast as they could be removed.

A third way to keep seed-eating rodent numbers low on clearcuts is to design the cuts to depress the post-cutting population increases. This study indicates that *Sorex* sp. are weakly influenced by clearcuts, and do not constitute a large proportion of the small mammal community in the study area. *Sorex* sp. are therefore probably not a major factor in seed survival in the study area. *P. maniculatus*, on the other hand, are known to increase in numbers in response to

clearcutting, and make up the largest proportion of the captured small mammals in this study. Since *P. maniculatus* seem to be at a disadvantage in dense cover, piling of slash on clearcuts might reduce their numbers, although this method has aesthetic drawbacks. Since there is some evidence that *P. maniculatus* are found more commonly deep in the clearcuts, thereby possibly avoiding the edge, a clearcutting pattern that maximized the clearcut edge-clearcut area ratio (i.e., many small clearcuts instead of a few large ones) might repress the *P. maniculatus* population increase.

CONCLUSIONS

The following conclusions may be limited only to the study area.

- 1) As clearcuts age from four to ten years after cutting, the number of *Peromyscus maniculatus* decrease significantly in the clearcut, while *Clethrionomys gapperi* increase significantly in the adjoining timber.
- 2) *Sorex* sp. numbers are not significantly influenced by clearcut aging.
- 3) Clearcut aging is accompanied by a significant decrease in small mammal species diversity in the adjoining forest.
- 4) Small mammals are not distributed randomly with respect to the forest-clearcut interface:
 - a) *P. maniculatus* numbers increase significantly as the center of the clearcut is approached and decrease significantly as the adjoining forest is penetrated.
 - b) *C. gapperi* numbers decrease significantly as the clearcut is entered and increase significantly as the forest is entered.

LITERATURE CITED

- Basile, J. V. and C. E. Jensen. 1971. Grazing potential on lodgepole pine clearcuts in Montana. USDA Forest Serv. Res. Pap.
- Black, H. L. and N. C. Frischknecht. 1971. Relative abundance of mice on seeded sagebrush-grass range in relation to grazing. USDA Forest Serv. Res. note. INT-147.
- Brown, Larry N. 1967. Ecological distribution of mice in the Medicine Bow Mountains of Wyoming. Ecology 48(4): 677-680.
- Daubenmire, R. and Jean B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Wash. Agri. Exp. Sta. Tech. Bull., Dec. 1968.
- Gashwiler, J. S. 1967. Conifer seed survival in a western Oregon clearcut. Ecology 48(3): 431-438.
- Gashwiler, J. S. 1970. Plant and mammal changes on a clearcut in western Oregon. Ecology 51(6): 1018-1026.
- Hall, E. R. and K. R. Kelson. 1959. The Mammals of North America. 2 Vol. Ronald Press. New York. 1083 p.
- Hoffman, G. R. 1960. The small mammal components of six climax plant associations in eastern Washington and northern Idaho. Ecology 41(3): 572-573.
- Krull, J. N. 1970. Small mammal populations in cut and uncut hardwood forests. New York Fish & Game J. 17(2): 128-130.
- Moore, A. W. 1942. Shrews as a check on Douglas fir reproduction. J. Mamm. 23: 37-41.
- Morris, Ralph D. 1969. Competitive exclusion between *Microtus* and *Clethrionomys* in the Aspen Parkland of Saskatchewan. J. Mamm. 50(2): 291-301.
- Pfister, R. D., S. F. Arno, R. C. Presby and B. Koualchik. 1972. Preliminary forest habitat types of western Montana. USDA Forest Serv., Intermountain Forest & Range Exp. Sta. Publication in progress.

- Neils, George, Lowell Adams and Robert M. Blair. 1955. Management of white-tailed deer and ponderosa pine. Trans. 20th N. A. Wildlife Conf. p. 539-551.
- Radvanyi, A. 1970. Small mammals and regeneration of white spruce forests of western Alberta. Ecology 51(6): 1102-1106.
- Radvanyi, A. 1971. Lodgepole pine degradation by small mammals in W. Alberta. Forest Sci. 17(2): 213-217.
- Steel, Robert G. D. and J. H. Torrie. 1960. Principles and procedures of statistics, with special reference to biological sciences. McGraw-Hill Co., New York. 481 p.
- Terman, Richard C. 1966. Population fluctuations of *P. maniculatus* and other small mammals as revealed by the North American census of small mammals. Amer. Midland Natur. 76(2): 419-426.
- Tevis, L., Jr. 1956. Responses of small mammal populations to logging of Douglas fir. J. Mammal. 37: 189-196.
- Trousdell, K. B. 1954. Peak populations of seed eating rodents and shrews occurs one year after loblolly stands are cut. U.S.F.S. S.E. Expt. Sta. Res. Note #68.

APPENDIX

Table 6. Number of Animals Captured in Forest or Cut for each day.

		<u>P. maniculatus</u>		<u>C. gapperi</u>		<u>Sorex</u>	Total	No. Species Caught*
		Adult	Juv.	Adult	Juv.			
10 Year Old Cuts								
6/29	F**	2	0	1	0	0	3	2
	C**	0	0	1	0	1	2	2
6/30	F	0	1	3	1	0	2	2
	C	0	1	1	0	1	4	4
7/1	F	0	1	1	0	0	2	2
	C	2	0	0	0	2	4	3
8/14	F	0	0	2	1	1	4	2
	C	1	0	1	1	1	4	3
8/15	F	0	0	1	1	0	2	1
	C	2	0	0	1	0	3	2
8/16	F	1	0	1	1	0	3	2
	C	1	1	1	0	1	4	3
9/15	F	0	0	1	0	1	2	2
	C	1	0	0	0	1	2	2
9/16	F	0	0	1	0	0	1	1
	C	1	0	0	0	0	1	2
Total	F	3	2	11	4	2	23	3
	C	8	2	3	2	7	24	4
8 Year Old Cuts								
7/4	F	3	0	0	0	0	3	1
	C	1	0	0	0	0	1	1
7/5	F	1	1	0	0	1	3	2
	C	1	2	2	0	1	6	3
7/6	F	0	0	2	0	0	2	2
	C	1	0	1	0	4	6	2
7/23	F	0	0	1	0	0	1	1
	C	2	0	1	0	0	3	3
7/24	F	0	0	0	1	0	1	1
	C	5	2	2	1	0	10	2
7/25	F	0	0	0	1	0	1	1
	C	0	0	0	2	0	2	2
8/22	F	1	0	0	0	0	1	1
	C	1	0	1	0	1	3	4
8/23	F	0	1	1	0	0	2	2
	C	2	0	0	1	1	4	4
Total	F	5	2	4	2	1	14	3
	C	13	4	7	4	7	35	4

Table 6. Continued.

		<i>P. maniculatus</i>		<i>C. gapperi</i>		<i>Sorex</i>	Total	No. Species Caught*
		Adult	Juv.	Adult	Juv.			
6 Year Old Cuts								
6/22	F	0	2	1	0	0	3	2
	C	3	2	0	0	0	5	2
6/23	F	1	0	1	0	0	2	2
	C	3	2	0	0	1	6	2
6/24	F	1	1	0	0	0	2	1
	C	0	0	1	0	0	1	1
8/10	F	0	0	0	0	0	0	0
	C	3	0	1	0	2	6	6
8/11	F	1	0	0	1	0	2	2
	C	2	1	0	1	0	4	3
8/12	F	1	0	0	0	1	2	2
	C	1	0	0	0	1	2	2
9/8	F	1	0	0	0	2	3	3
	C	3	2	0	0	1	7	4
9/9	F	1	0	0	0	0	1	1
	C	2	0	0	0	1	3	4
Total	F	6	3	2	1	4	16	4
	C	17	7	2	2	8	36	8
4 Year Old Cuts								
7/16	F	1	0	0	1	0	2	3
	C	4	2	0	0	0	6	2
7/17	F	0	0	1	1	1	3	2
	C	0	0	0	0	0	0	2
7/18	F	0	0	0	0	1	1	2
	C	1	2	0	0	0	3	1
7/27	F	2	2	0	0	0	4	2
	C	3	1	0	0	2	6	2
7/28	F	0	0	0	0	0	0	1
	C	3	3	0	0	1	7	3
7/29	F	1	0	0	0	1	2	4
	C	1	2	0	0	0	3	1
9/1	F	1	0	0	0	0	1	2
	C	2	0	0	1	1	4	3
9/2	F	2	2	1	0	1	6	3
	C	2	2	1	0	1	6	3
	F	5	3	1	2	3	14	6
	C	15	12	1	1	5	35	7

*Species column includes all species caught; so number may not coincide with data in rest of table.

**F=Forest, C=Clearcut

Table 7. Species Proportions of Total Capture for each Clearcut Plus Forest Site. Values expressed in percent.

					Mean
Age of Cut (in years)	10	8	6	4	
<i>Peromyscus maniculatus</i>	35.4*	48.1	50.0	54.7	47.8
<i>Clethrionomys gapperi</i>	40.2	30.8	10.6	7.8	20.9
<i>Sorex</i> sp.	18.8	15.4	18.2	12.5	16.0
<i>Microtus montanus</i>	0	0	9.4	9.1	5.2
<i>Eutamias amoenus</i>	4.1	3.8	4.5	7.8	5.2
<i>Zapus princeps</i>	0	1.9	1.5	4.6	2.1
<i>Mustella frenata</i>	0	0	3.0	1.6	1.3
<i>Thomomys talpoides</i>	0	0	1.5	1.6	0.8
<i>Mus musculus</i>	0	0	1.5	0	0.4

*Columns may not add to 100% due to rounding.

Table 8. Number of Animals Captured-Distance from Forest-Clearcut Interface. Data include multiple captures of animals. Data are pooled for all days at each site.

	Distance (in meters)	<i>P. maniculatus</i>		<i>C. gapperi</i>		<i>Sorex</i>
		Adult	Juv.	Adult	Juv.	
Forest		1962 Site				
	50	0	0	4	0	0
	45	0	0	2	0	1
	40	0	0	2	1	0
	35	0	0	3	1	1
	30	0	0	2	0	0
	25	1	1	0	0	0
	20	0	0	1	2	0
	15	1	0	1	1	0
	10	2	1	0	1	0
	5	1	0	0	0	0
Cut	0					
	5	0	1	3	0	1
	10	1	0	1	0	2
	15	1	0	1	0	1
	20	2	0	0	1	0
	25	0	0	0	0	1
	30	2	0	0	0	0
	35	3	0	0	0	0
	40	1	2	0	1	1
	45	1	0	0	0	1
	50	0	1	0	0	0
Forest		1964 Site				
	50	0	0	0	0	0
	45	0	1	3	1	0
	40	1	0	1	0	0
	35	0	0	1	0	0
	30	1	0	2	0	1
	25	1	0	0	1	0
	20	4	0	0	0	0
	15	2	1	0	0	0
	10	3	0	0	0	0
	5	2	1	0	0	0

Table 8. Continued.

	Distance (in meters)	<u>P. maniculatus</u>		<u>C. gapperi</u>		Sorex
		Adult	Juv.	Adult	Juv.	
Cut.	1964 Site Continued.					
	0					
	5	9	0	0	1	0
	10	4	1	0	0	3
	15	2	0	0	1	1
	20	0	0	1	0	1
	25	1	1	3	0	0
	30	4	0	2	1	1
	35	3	0	0	0	0
	40	2	0	1	0	0
	45	5	1	0	2	0
	50	2	2	1	0	1
	1966 Site					
Forest.						
	50	2	0	1	0	0
	45	1	1	1	1	0
	40	1	0	0	0	1
	35	2	0	0	0	0
	30	0	0	0	0	0
	25	2	0	0	0	0
	20	0	2	0	0	0
	15	0	0	0	0	1
	10	0	1	0	0	1
	5	2	1	0	0	0
Cut.						
	0					
	5	1	0	0	0	1
	10	1	0	0	0	0
	15	4	1	1	0	2
	20	1	1	0	0	1
	25	4	0	0	0	0
	30	2	2	0	0	1
	35	5	0	1	2	0
	40	5	2	0	0	1
	45	5	3	0	0	0
	50	3	1	0	0	0

Table 8. Continued.

	Distance	<i>P. maniculatus</i>		<i>C. gapperi</i>		<i>Sorex</i>
	(in meters)	Adult	Juv.	Adult	Juv.	
Forest		1968 Site				
	50	0	1	1	0	0
	45	1	0	0	0	0
	35	0	0	0	0	1
	30	1	0	0	2	2
	25	1	1	0	0	0
	20	1	0	0	0	0
	15	0	0	0	0	0
	10	0	2	0	0	0
	5	1	1	0	0	0
Cut	0					
	5	0	3	0	0	1
	10	0	1	1	0	0
	15	4	2	0	0	1
	20	0	2	0	0	0
	25	3	1	0	0	0
	30	4	3	0	1	2
	35	2	3	0	0	0
	40	1	2	0	0	0
	45	1	2	0	0	1
	50	3	1	0	0	0

Table 9. Number of Animals Captured-Distance from Forest-Clearcut Interface, data for all sites pooled. Data include multiple captures of animals. Data are pooled for all trap days at all sites.

Distance (in meters)	<u><i>P. maniculatus</i></u>		<u><i>C. gapperi</i></u>		<i>Sorex</i>
	Adult	Juv.	Adult	Juv.	
Forest					
50	2	1	6	0	0
45	2	2	6	2	1
40	3	0	3	1	1
35	2	0	4	1	2
30	2	0	0	2	3
25	5	2	0	1	0
20	5	2	1	2	0
15	3	1	1	1	1
10	5	4	0	1	1
5	6	3	0	0	0
Cut					
0					
5	10	4	3	1	3
10	6	2	2	0	5
15	11	3	1	1	5
20	3	3	3	1	2
25	8	2	2	0	4
30	12	5	0	3	0
35	13	3	1	2	2
40	9	6	0	2	2
45	12	6	2	2	2
50	8	5	1	0	1

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