THE EFFECTS OF VARIOUS WATERSHED MANAGEMENT PRACTICES UPON POPULATIONS OF SMALL MAMMALS

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Master of Science

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by

Terry Douglas Hudgins

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THE EFFECTS OF VARIOUS WATERSHED MANAGEMENT PRACTICES

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure | Page

INTRODUCTION

Rodents comprise one of the most abundant and diverse groups of vertebrates in many regions. They occupy a variety of habitats as a group, but individual species show varying degrees of habitat selectivity with some being euryoecious and others rather stenotopic. For example, Hoffmeister and Durham (1971) indicated that the canyon mouse (*Peromyscus crinitus*) was closely restricted to rocky situations regardless of plant associations while its congener, the cactus mouse (*P. eremicus*) was found in nearly every habitat available in a large and diverse study area.

In some cases specific environmental parameters have been shown to be influential in determining the actual occurrence and density of a species, but it is often difficult to isolate the effects of influential factors since most natural systems are so complex. For example, Turkowski and Reynolds (1970) disclosed that deer mice (*P. maniculatus*) occurred in greater numbers on rangelands where pinyons and junipers were uprooted; while pinyon mice (*P. truei*) and brush mice (*P. boylii*) together were fewer. It is the cumulative effect of the changes in biotic physical factors (such as temperature and moisture) that subsequently allows for changes in vegetative types which are crucial to the existence of certain mammalian species.

Powell (1969) showed on mechanically controlled brush treatments on Texas rangelands that successional changes in a plant community were often accompanied with associated changes in the rodent species and numbers present. In this case Powell (op. cit.) found cover, rather than food supply, to be the factor determining relative numbers of rodents.

Man's involvement in manipulating the natural ecosystem for his own use has provided field biologists the opportunity to measure the effects of particular land management practices upon the biotic community with experimental techniques. Indeed the two previously cited papers (Turkowski and Reynolds, 1970; Powell, 1969) are these types of studies. The immediate impact of such changes to the environment are usually well known and adjacent unaltered areas provide useful control areas for determining the long term effects of such actions.

To study rodent populations under such conditions not only assesses the effects of habitat manipulations, but may frequently yield answers to questions concerning the biology of certain species in various communities. For example, Gashwiler (1970) investigated the influence of clearcutting on deer mouse populations in old growth Douglas Fir (Pseudotsuga menziesii) in Oregon. Ahlgren (1966) examined the impact of cutting and burning of tracts of Minnesota Jack Pine (Pinus sp.) on populations of small mammals. His results suggested that food was the primary factor inducing population fluctuations. Pearson (1959) found that the presence or absence and relative abundance of small mammals on the piedmont of New Jersey during various seral stages could be explained on the basis of changes in the types and amount of vegetative cover. Gentry, et al. (1968), found that forest thinning at lower elevations in the Southeast resulted in fewer mammals being taken in standard traplines. Beck and Vogl (1972) measured the effects of repeated spring burning on rodent populations in a brush prairie savannah and found that treated and untreated areas were equally productive, but that species composition varied between areas. Schuster (1967) has examined the effects of alterations of the density and canopy of a timber stand on understory production and concluded that forage production increased in proportion to the reduction in timber stand. Thus, experimental manipulations of plant communities have been shown to have definite influence upon the plant community itself and on rodent diversity and productivity.

The objectives of this study were to investigate the effects of watershed management practices upon populations of rodents, knowing vegetative changes, as documented by the U. S. Forest Service, on three watershed units. The study areas were part of the Beaver Creek Watershed Project located roughly 40 miles southeast of Flagstaff in Coconino County, Arizona. Included were a clearcut area, a stripcut, and an uncut or control area.

Systematic removal trapping was done to determine: the composition of the small mammal community inhabiting each watershed; the age structures and relative densities of the populations of small mammals occurring on the watersheds; the relative effects of shelter in the form of slash and fallen trees and limbs; and the seasonal activity patterns of the small mammals.

CHAPTER II

MATERIALS AND METHODS

Description of the Study Area

The Beaver Creek Watershed Project was established in the late 1950's in the Coconino Forest in northcentral Arizona. The area was covered with ponderosa pine (*Pinus ponderosa*), pinyon pine (*P. edulis*), and juniper (*Juniperus deppeana*, *J. osteosperma*). Various acreages were modified by clear cutting, strip cutting and thinning, all treatments were designed to increase water yields. The results are currently being evaluated in terms of erosional effects, timber and forage yields, and wildlife management. Much of the following description of the major features of the habitat is based upon unpublished data gathered by personnel of the U. S. Forest Service Rocky Mountain Forest and Range Experiment Station located on the campus of Northern Arizona University.

The study area consisted of three watersheds. Two had been subject to treatment, while the third served as a control area. Unit 12 was clearcut, Unit 14 was stripcut, and Unit 13 was uncut, and served as the control. These watersheds were located on soils of the Siesta-Sponseller and Stoneman types (Ffolliott, 1966). Intermixed with the pine and juniper species were Gambel oak (*Quercus gambelii*) and quaking aspen (*Populus tremuloides*).

Watershed Unit 12. This clearcut watershed consisted of 455 acres with a mid-area elevation of 7041 feet, and a slope of seven percent. Its general aspect was southwest and it received precipitation at a mean annual rate of 24 inches, mainly as summer rain and winter snow.

The area was logged in 1967. Before treatment, this area had approximately 1066 ponderosa pine trees per acre. Intermixed with these were an average of 125 Gambel oaks, and 36 individuals of various juniper species. At last study (Forest Service Data, 1972), the principal grasses and grass-like species were bottlebrush squirreltail (Sitanion hystrix), mutton bluegrass (Poa fendleriana), and blue grama (Bouteloua gracilis). The principal weed species were western ragweed (Ambrosia psilostachya), showy goldeneye (Viguiera multiflora), and broom snakeweed (Gutierrezia sarothrae) (Table 1).

A characteristic feature of Area 12 was the arrangement of slash in parallel windrows 100 feet apart. These were aligned either east to west or northwest to southeast to increase the trapping and retention of snow (Figure 1). A result of this arrangement was and increase in water yield (Brown, 1969).

The clearcutting treatment has had a definite effect on herbage production (Table 1). As an untreated area, this land was producing 13 pounds per acre of perennial grasses, and 54 pounds

Table 1. Vegetational analysis of two of the watersheds in terms of productivity expressed in pounds per acre.

Species	1967	1971	1972
Watershed Unit 12, Clearcut (U.S.F.S. Data, Unpublished)			
Grasses			
Agropyron intermedium			13.9
Bouteloua gracilis	13.2	68.8	
Sedges	2.7	22.7	13.6
Poa fendleriana	9.4	186.8	205.2
Sitanion hystrix *	18.7	164.5	237.5
Sporobolus interruptus	8.4	52.3	60.8
TOTALS (all species)	60.1	513.3	609.2
Forbs and Half Shrubs			
Allium spp.	2.7	73.4	16.9
Ambrosia psilostachya	22.8	72.5	156.7
Antennaria spp.	.6	22.7	10.6
Arabis canescens		21.5	36.9
Aster commutatus	13.1	34.1	40.0
Bahia dissecta		11.2	23.8
Erigeron divergens	1.2	2.4	41.9
E. flagellaris	.1	5.3	13.7
Gutierrezia sarothrae	1.6	49.2	61.5
Senecio neomexicanus	2.0	1.7	31.2
Viguiera multiflora	3.7	35.0	52.4
TOTALS (all species)	54.1	286.8	1142.4
Shrubs			
Quercus gambelii	22.8	59.5	89.9
Total for Watershed	141.4	859.7	1232.3

Table 1. (continued)

Species	1967	1971	1972
Watershed Unit 13, Uncut			
Grasses			
Bouteloua gracilis	4.0	9.5	13.1
Poa fendleriana	13.5	45.7	66.0
Sitanion hystrix	18.7	44.4	65.3
TOTALS (all species)	56.1	137.8	159.0
Forbs and Half Shrubs			
Achillea lanulosa	.2	.5	5.6
Ambrosia psilostachya	10.3	6.9	7.1
Antennaria spp.		.8	6.9
Arabis canescens		7.2	10.4
Artemisia spp.	10.0		
Erigeron divergens	.1	2.7	7.9
Gilia multiflora		2.0	9.0
Solidago missouriensis		.7	6.9
Viguiera multiflora	6.3	9.9	18.7
TOTALS (all species)	35.9	51.6	103.6
Shrubs			
Quercus gambelii	35.3	25.0	37.6
Total for Watershed	127.3	219.1	309.6

* Sitanion hystrix is now S. longifolium, J. G. Smith (McDougall, 1973)

per acre of forbs and half shrubs. Four years after treatment (1971) the production of grasses increased to 513 pounds per acre and the forbs to 286 pounds per acre. In 1972, browse, in the form of oak sprouts, added an additional 90 pounds per acre.

Prior to this study, cattle were allowed to forage on Unit 12 and hunters have found it to be particularly good for game such as elk (*Cervus elaphus*), deer (*Odocoileus hemionus*), and turkey (*Meleagris gallopavo*).

Watershed Unit 13. This watershed included 867 acres ranging in altitude from 7000 to 7800 feet. Its general aspect was southwest, its slope was eight percent, and the area was located just northwest of Area 12. It possessed the characteristic look of a mature forest with a canopy cover of over 50 percent (Figure 2).

This control area underwent its last commercial timber cut from 1950 to 1955. Ponderosa pine was the main component of the overstory with approximately 899 trees per acre. Gambel oak contributed 134 trees per acre, and a variety of junipers added 22 trees per acre. At last study (1972), it was found that the primary grasses were bottlebrush squirreltail, and mutton bluegrass. The major forbs were western ragweed, and showy goldeneye (Table 1).

The forest floor was thick with decaying pine needles and cones. There were a minimum of fallen logs and rocky outcroppings to serve as hiding places for small rodents. The virtual lack of

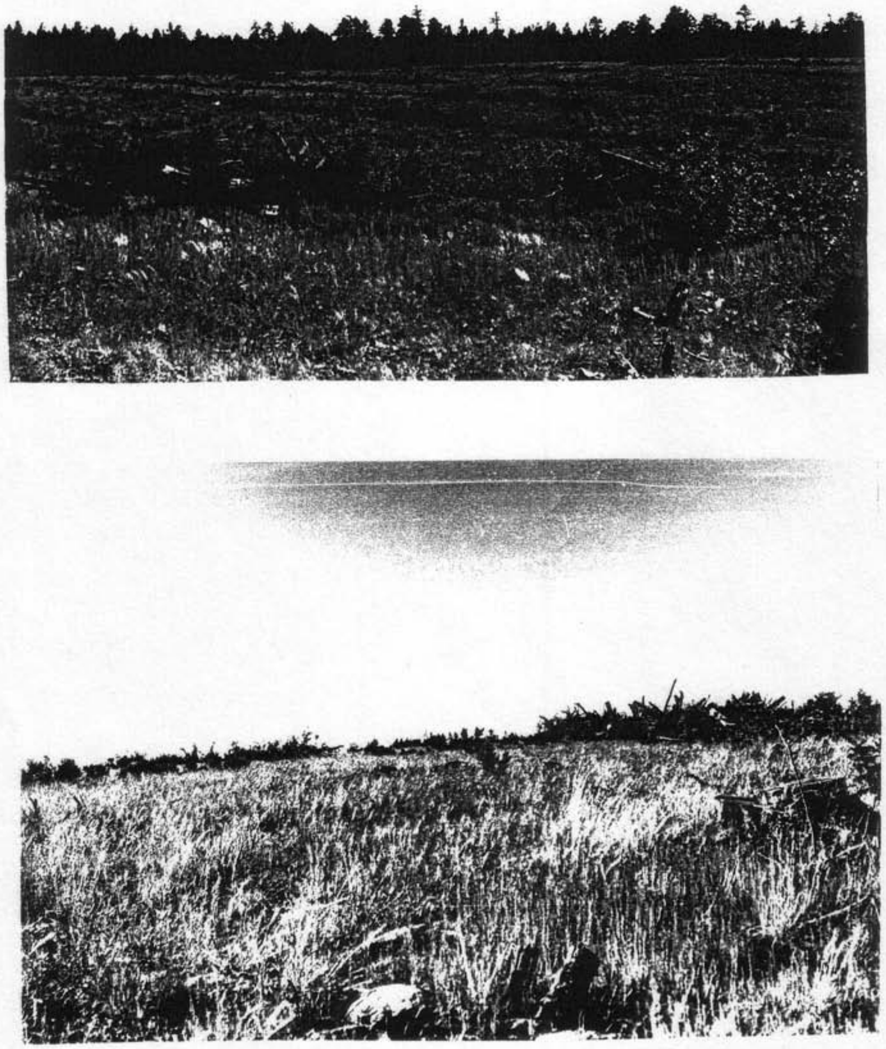

Figure 1. The arrangement of slash piles and the vegetational make-up of the areas between the slash piles on Watershed Unit 12, the clearcut.

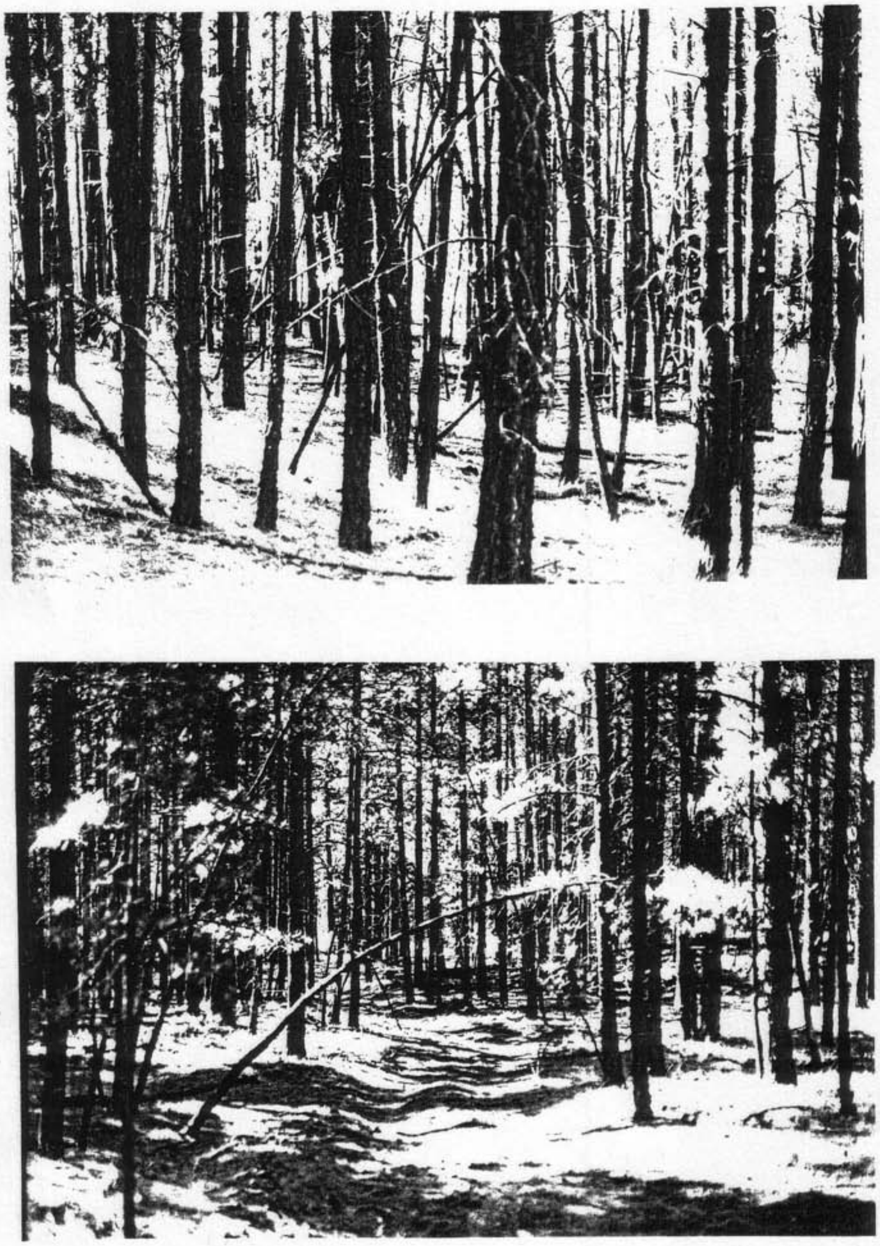

Figure 2. A demonstration of the thick canopy cover and lack of an understory on Watershed Unit 13, the uncut control area.

any kind of understory was quite evident. In areas where enough light penetrated the overstory New Mexican locust (Robinia neomexicana) did contribute to this level.

Watershed Unit 14. This was the largest watershed of those I studied, covering 1267 acres. It ranged in altitude from 7000 to 7600 feet, had a general aspect of southeast, and a slope of 13 percent.

This area was completed as a stripcut in 1970. The cut strips were 60 feet wide and aligned with the direction of the slope. They were somewhat irregularly oriented for aesthetic reasons, but were efficient in transporting water to the stream channels. In between the cut strips were "leave" strips. These were 120 feet wide and trees here were thinned to a basal area of 80 square feet per acre. This was considered to be the optimum stocking level for good timber production in ponderosa pine (Kennedy, 1959). Slash from thinning and stripcutting was gathered in the strips and burned in the winter of 1971 (Figure 3).

Before treatment, ponderosa pine comprised the major overstory with approximately 726 trees per acre. Gambel oak contributed 68 trees per acre, and a variety of junipers added five trees per acre. The last data for grasses and forbs were collected by the Forest Service in 1962, before treatment. The results showed bottlebrush squirreltail, and mutton bluegrass to be the most abundant grasses. The major forbs were western ragweed and spreading

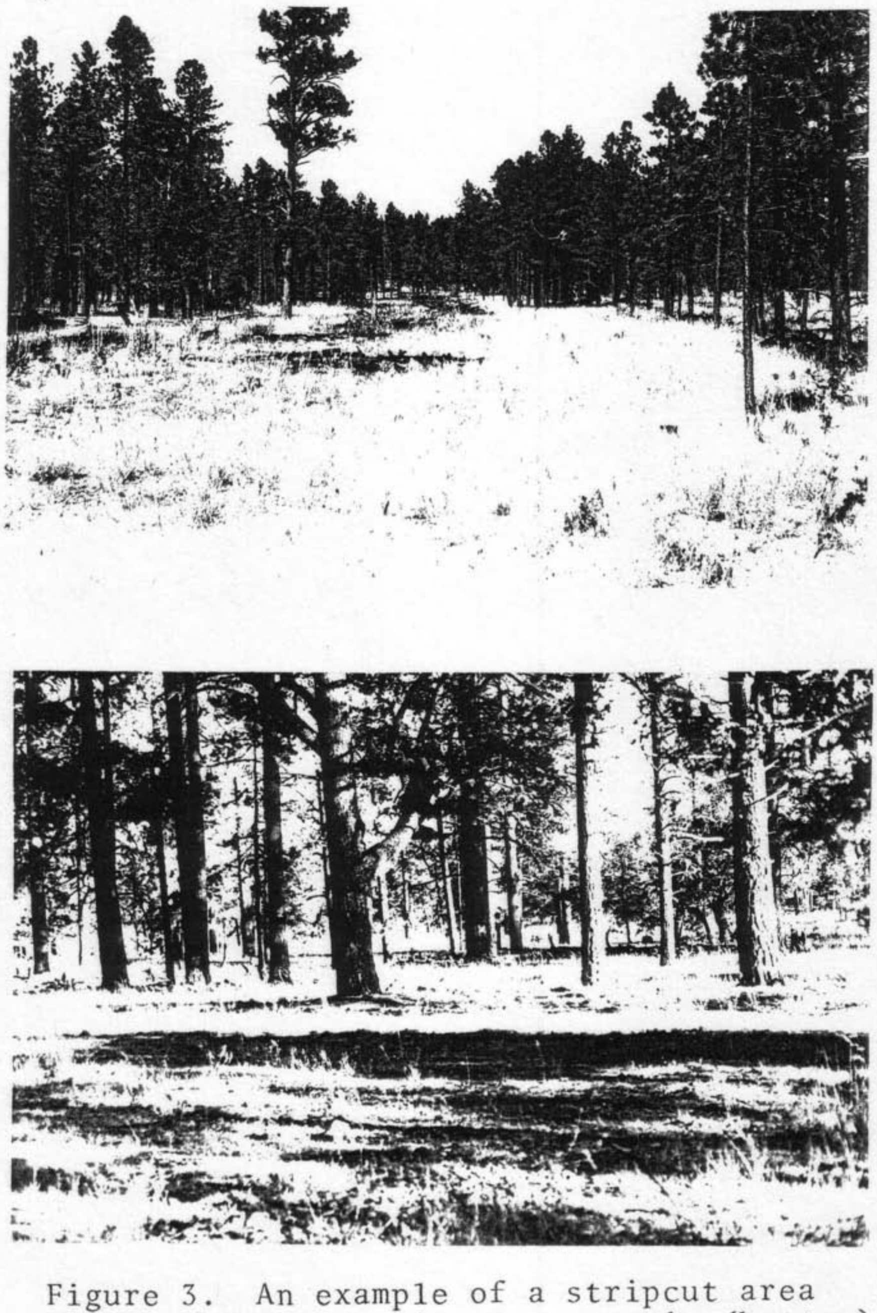

Figure 3. An example of a stripcut area (top), and intervening leave strip (bottom) on Watershed Unit 14, the stripcut area.

fleabane (Erigeron divergens).

This area appeared to be a relatively good rodent habitat. The strips provided many hollowed logs burned out by fire for hiding and nesting. The cut strips also provided an area of increased herbage production through the reduction of the canopy cover. The thinning of the intermittent "leave" strips also provided for an increase in forage production.

Research Activities

Trapping Methods. Trapping was conducted from November, 1971 through September, 1972. It was originally planned that trapping would be conducted twice per month through spring, summer, and fall, and once per month during the winter. However, closure of forests due to lack of moisture during the summer, and the impassability of roads in the winter months, because of snow, resulted in data being collected during the months of November, January, February, March, April, June, July and September.

One hundred museum special traps were placed in a line on each watershed, one trap per station, eight paces, or approximately 25 feet apart. One trapline was established within each watershed during any one 24 hour sampling period to insure uniformity of meteorological conditions. Thus, the changes of meteorological variability differentially influencing trapping success on any single watersheds were reduced. The traplines were non-permanent, and lines utilized during any given sampling period were far removed (in terms of rodent movements) from those used during the immediately preceding period. Trappings were conducted using a mixture of peanut butter and oatmeal as bait.

Within a given watershed adjustments were made as to the placement of the traps. On Watershed 12, traplines originally were placed midway between and parallel to rows of slash. After the January trapping, the method of using a single trapline was modified so that two lines, each of 50 trap sites, were used. One line remained midway between the slash rows while the other followed the southerly margin of the slash piles and was placed within five feet of the slash. This trapping scheme was used to determine if the intensity of use of these two micro-environments by nocturnal rodents differed.

On Watershed 14, traps were placed about midway in the cut strips. The traplines skirted large piles of ashes that existed after burning of slash in the winter of 1971. As the cut strips were irregularly oriented, it was sometimes necessary to place traps through "leave" strips in order to get to another stripcut area.

The evenness of the terrain on Watershed 13 allowed a relatively straight trap line. Snow lasted longest on this area, and traps were set on snow through March, long after the last traces had disappeared from the other areas.

It was found early in the study that traps could not be left in the same place two nights in succession since trapping efficiency in terms of catch per trapnight became greatly reduced (Table 3, Page 26). For example, on November 13, 1971, a catch of 16 animals was recorded. The traps were rebaited and left in the same sites. The next day's catch was only three animals. It was decided after another trapping period later in November to move the traps after each night's sampling.

In general, traps were set out in the early evening and picked up early the next morning. The specimens were gathered and placed in plastic bags and put on ice. All specimens were labeled so comparisons could be made later.

Laboratory Techniques. The small rodents were stored in a freezer until their dissection. They were identified using Hall and Kelson (1959), Cockrum (1960) and the collection of study skins and skulls in Northern Arizona University Museum of Vertebrates. A number of study skins were made of the representative mammals collected during my study, and, along with their skulls, they have been added to the museum collection.

Standard body measurements were made and sex and age were determined. Deer mice were classified as juveniles, subadults, and adults, primarily by their pelage color. Juveniles were characterized as having a gray dorsal coat, subadults had gray being replaced by brown, while adults were completely brown or in some cases ochraceous.

In some instances, the stage of sexual maturity was important in determining age. A female carrying embryos or having placental scars was considered adult. In males, scrotal testes were taken to indicate sexual maturity.

Data Analysis. Statistical analyses were conducted to determine if the catches of rodents on each area were distributed as would be expected if chance were the only factor operating. A Chi-square test was used to determine if the observed data conformed to probable expected distribution.

Data were also expressed in terms of percent trapping success. This value was the number of animals trapped divided by the number of trapnights. The percent trapping success for animals on each area was calculated along with the success of capturing females in varying reproductive states.

Data were analyzed specifically for two full-moon nights that occurred during the year's trapping. It was by chance that these nights were chosen for trapping dates and the results deserve additional observation and discussion.

CHAPTER III

ANALYSIS OF VEGETATION

Based on information supplied by the U. S. Forest Service Rocky Mountain Experiment Station in Flagstaff, Arizona, a survey of the change in vegetation and vegetational productivity resulting from watershed treatment was made possible. The Forest Service amassed vegetation data for Watersheds 12 and 13 by maintaining permanent transects on these areas. Herbage production was estimated at ten locations within each watershed. At each location, ten permanently located 9.6 square-foot plots were present. Herbage weights were estimated on five of these plots, while the remaining five were reserved for clipping (Worley, 1965). These estimates are sufficient only to point out relative vegetational relationships between areas.

The first transects reported here were taken in 1967, before any manipulation had occurred. At this time, transect evaluations were completed on Watersheds 12 and 13. Data collection on Watershed 14 was halted in 1962 and none have been collected since that time.

Productivity has greatly increased on the clearcut watershed since treatment. In 1967, the total grass production was 60 pounds per acre (Table 1). This increased to 513 pounds per acre by 1971, and by 1972, rose to 609 pounds per acre.

Forbs and half shrubs increased at an even faster rate. In 1967, 54 pounds per acre of forbs and half shrubs were recorded. The data collected in 1971 showed an increase to 286 pounds per acre, and with the passing of another year, increased to 1142 pounds per acre.

The main shrub on the clearcut area demonstrated a like response. Gambel oak (Quercus gambelii) in 1967 comprised 22 pounds per acre. By 1971, it had increased to 59 pounds per acre, and in 1972, it added 89 pounds per acre of browse to the area.

On Watershed 13, plants showed a more gradual increase in productivity through the years than those on Watershed 12. In 1967, this area's grass production was 56 pounds per acre (Table 1). By 1971, grasses had increased to 137 pounds per acre, while 1972 showed an increase to 159 pounds per acre.

Forbs and half shrubs displayed a similar increase from 35 pounds per acre in 1967 to 51, and 103 pounds per acre in 1971 and 1972. Gambel oak, again the major shrub, varied somewhat through these years. In 1967, 35 pounds per acre were recorded. Then in 1971, production dropped to 25 pounds per acre only to rise again by 1972 to 37 pounds per acre.

The total productivities on the clearcut area for 1967, 1971, and 1972 were 141, 859, and 1232 pounds per acre respectively. The control area, changing slower under a canopy, showed a somewhat lesser increase from 1967 with 127 pounds per acre, to 219 pounds per acre in 1971, and 309 pounds per acre by 1972.

The increase of forage production on each of these areas over the years has occurred in three species of grasses and three of forbs and half shrubs. The three grasses were blue grama (Bouteloua gracilis), mutton bluegrass (Poa fendleriana), and bottlebrush squirreltail (Sitanion hystrix) (Table 1). All three of these grasses were characteristic of open pine woods where drier conditions prevailed.

The forbs and half shrubs showing major gains on each area were western ragweed (Ambrosia psilostachya), showy goldeneye (Visuiera multiflora), and, on the clearcut watershed, broom snakeweed (Gutierrezia sarothrae). Western ragweed is most common along stream beds and roadsides, while showy goldeneye is characteristically found on dry slopes and in mountain meadows. Broom snakeweed is a plant of dry stony plains, mesas and slopes (Kearney and Peebles, 1969).

Vegetational Changes. Not only did a change in production occur over the years, but the diversity and species composition recorded on each area also varied. After the alteration of the habitat by clearcutting, various taxa on Watershed 12 were eliminated or so drastically reduced that they were not recorded on future transect evaluations. On the other hand, due to clearcutting, other plants were able to enter the area.

Five taxa of forbs and half shrubs that were present in 1967 on the clearcut area were not recorded in the 1972 transect evaluations. Goldaster (Chrysopsis sp.), dandelions (Taraxacum sp.), sagebrush (Artemisia sp.), phlox (Phlox sp.), and flannel mullein (Verbascum thapsus) were missing in 1972. Generally, these types are considered early arrivals to disturbed areas. Dandelions are known to propagate either totally or partially through parthenogenetic means (Kearney and Peebles, 1969). This would enable this species to colonize an area more rapidly.

The grass lost over this five-year period was sprangletop (Leptochloa sp.) and sedges were also absent. Sprangletop is often a pioneer on cultivated or open land.

New grasses present on the clearcut area in 1972 were western wheatgrass (Agropyron smithii), pine dropseed (Blepharoneuron tricholepis), side-oats grama (Bouteloua curtipendual), red sprangletop (L. filiformis) and mountain muhly (Muhlenbergi montana). These grasses are all perennials and some are good forage.

Some of the new forbs that infiltrated the clearcut watersheds were silver rockcress (Arabis canescens, not reported for Arizona, probably A. perennans, J. Rominger), ragleaf bahia (Bahia dissecta), thistle (Cirsium sp.), autumn willow-weed (Epilobium paniculatum), and 15 other genera or species. These forbs are common in grasslands and open areas in forests.

Changes in ground cover in virgin timber are relatively slow, yet they are constantly taking place (Gashwiler, 1970). Watershed 13 was a mature forest of ponderosa pine although it had been cut over in the 1950's. Two genera of grasses and seven genera of forbs and half shrubs have been reduced or eliminated since 1967. In contrast, the 1972 transect recorded three new grasses and 12 new forbs and half shrubs.

Reduced or eliminated from this area were sprangletop and brome (Bromus sp.) grasses. Sprangletop has been mentioned already as a first arrival, while brome favors open fields. With the advance of secondary succession toward a climax community, it appears that both of these grasses have become reduced in density.

The forbs and half shrubs affected were dandelions, phlox, James bundleflower (Desmanthus cooleyi), nettle (Urtica sp.), and sagebrush. Most of these are characteristic of dry slopes, mesas, plains or open areas in pine forests.

Grasses that have invaded this uncut area include side-oats grama, red sprangletop and muhly. Some of the new forbs present in 1972 were silver rockcress, tasselflower brickellia (Brickellia grandiflora), woody gilia (Gilia sp.), Missouri goldenrod (Solidago missouriensis), American vetch (Vicia americana), and seven others. Most of these types are charcteristic of rich soil and coniferous pine forests (Kearney and Peebles, 1969).

Browse, in the form of Gambel oak, was found on both areas. It provided excellent ground cover as well as browse for livestock, deer and elk. The acorns produced are important food items of birds, squirrels and other wild animals.

CHAPTER IV

RESULTS

The 408 animals captured in 6000 trapnights represented a total trapping success of 6.8 percent (Table 2). Trapping on the clearcut area yielded 224 animals in 2000 trapnights for a trapping success of 11.2 per cent. On the stripcut area 139 animals were captured representing a trapping success of 6.95 per cent while the uncut area had 45 animals captured and a 2.25 per cent trapping success.

The total number of deer mice (Peromyscus maniculatus) captured on the clearcut, stripcut, and uncut areas were, respectively 198, 99, and 9 animals (Tables 2 and 3). Deer mice, totalling 306, made up the majority of animals caught. Based on 2000 trapnights on each watershed these mice were caught with 9.90, 4.95, and 0.45 per cent success for the clearcut, stripcut, and uncut watersheds.

Brush mice (P. boylii) totaled 15, 39, and 36 animals for the clearcut, stripcut, and uncut areas. Brush mice were the second most numerous animals captured with 90 being taken. They were captured with a trapping success of 0.75, 1.95, and 1.80 per cent for 2000 trapnights on the clearcut, stripcut, and uncut watersheds respectively.

Table 2. Distribution and Numbers of Captures of Small Mammals

Species	Watersheds			Animals Captured
	Clearcut (12)	Stripcut (14)	Uncut (13)	
Peromyscus maniculatus	198	99	9	306
Peromyscus boylii	15	39	36	90
Microtus mexicanus	8			8
Reithrodontomys megalotis	3			3
Neotoma mexicana		1		1
TOTALS	224	139	45	408
Percent Trapping Success	11.2	6.95	2.25	6.8

Table 3. A list of trapping dates and the number of animals captured on each area on that date.

Trapping Dates		Deer Mice			Brush Mice			Others			Totals		
		12	14	13	12	14	13	12	14	13	12	14	13
November	13	12	4		3	1		(1)			16	5	
	14	3	1			1					3	2	
	20	16	4	2		3	1				16	7	3
	21	8									8		
January	22	7	6			1					7	7	
	23	10	3		1		2				11	3	2
February	12	7	3			1					7	4	
	13	9	2	1	1	3	1				10	5	2
	27	8	2	2							8	2	2
March	4	7					2				7		2
	5	20	5			1	3				20	6	3
	25	9	4		2	1		(1)			12	5	
April	6	11	5			2	3	(1)			12	7	3
	7	14	4			6	3	(1)			15	10	3
	8	6	6			6	5	(4)			10	12	5
June	13	16	13	4		3	2				16	16	6
July	8	3	10		4	2	6				7	12	6
	28	6	9		2	4	8		1*		8	14	8
September	4	9	9		1	4					10	13	
	30	17	9		1			3**			21	9	
TOTALS		198	99	9	15	39	36	11	1		224	139	45

( ) - Mexican vole
* - Mexican woodrat
** - Western harvest mouse

Other small rodents captured were the Mexican vole (Microtus mexicanus), the western harvest mouse (Reithrodontomys megalotis), and the Mexican woodrat (Neotoma mexicana). Together these animals accounted for only 12 of the 408 animals collected. The western harvest mice and voles were caught exclusively on the clearcut area, while the Mexican woodrat was captured on the stripcut watershed.

The overall trapping success experienced on each area was lowered somewhat by early trapping techniques. During the month of Novebmer traps were left in the same spot for two consecutive nights. This resulted in a very low trapping success for the second night of trapping. Therefore, the success for this month and, for that matter the whole year, was lowered. After November, traps were set for only one night in a particular spot.

Trapping success was almost always greatest on Watershed 12 (Figure 4). The exception occurred during mid-summer when Watershed 14, the stripcut area, produced a higher yield of P. maniculatus. As a result on July 8, the stripcut area realized a 12 per cent trapping success as compared to only seven per cent on the clearcut watershed.

Trapping success on the uncut watershed was low throughout most of the study. Success did increase somewhat in late summer and early fall.

The observed total of animals captured on the watersheds

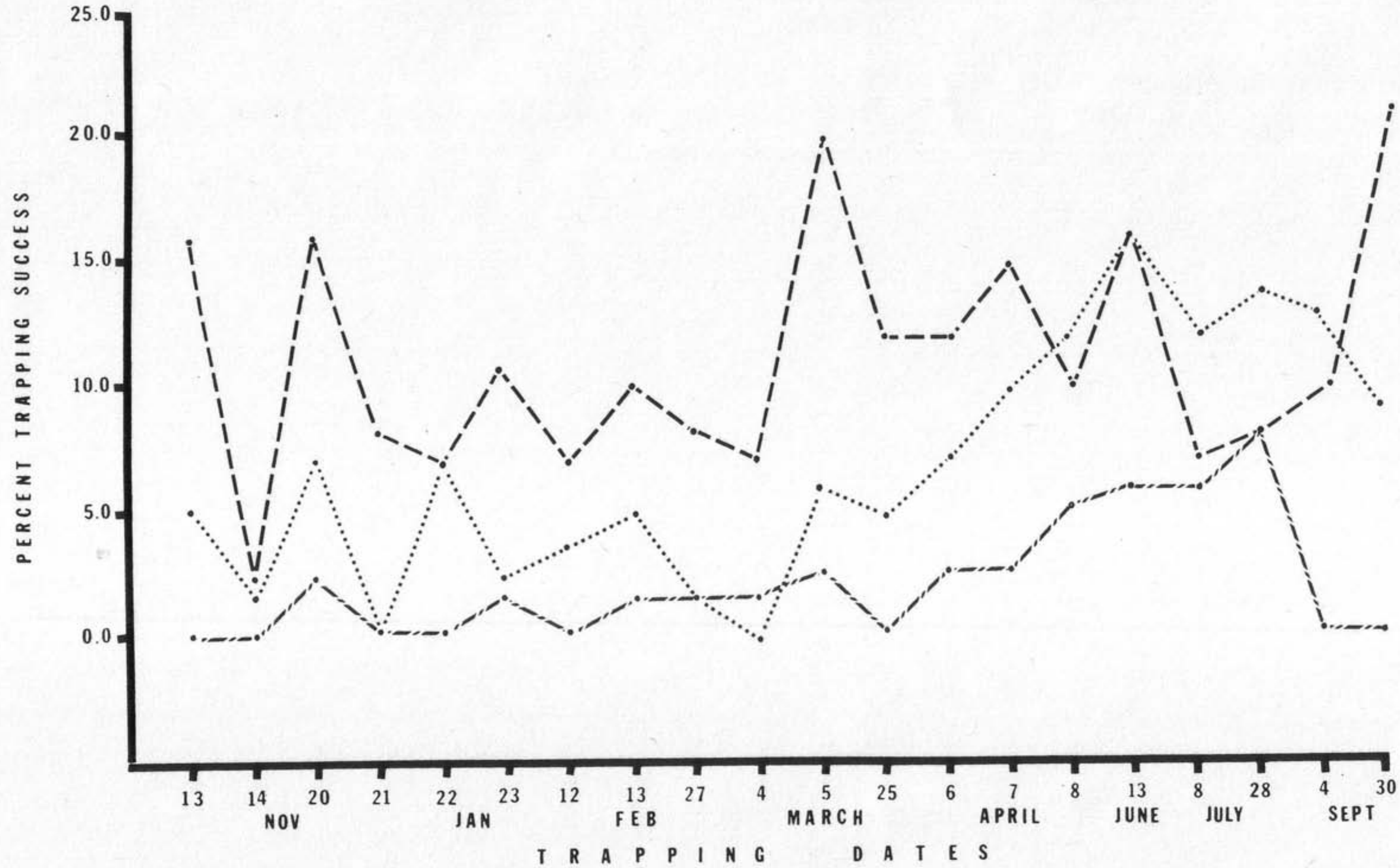

Figure 4. Percent Trapping Success on Individual Trapping Dates. Bold Dashed Line Represents Watershed 12 (Clearcut), Dotted Line is Watershed 14 (Stripcut), and the Slashed Line is Watershed 13 (Uncut). Note that Trapping Dates are Evenly Spaced on the Figure Although the Temporal Intervals Separating Actual Dates Varied.

differ significantly from the expected 1:1:1 ratio. In comparing the total number of individuals captured on the clearcut and uncut watersheds a Chi-square value of 19.4 was calculated. This leads to a rejection of the Null hypothesis since $P < 0.005$ (Table 4).

Similarly, when the total number of animals caught on the clearcut watershed was compared with the total number on the stripcut watershed a significant value of 117.8 was obtained for Chi-square ($P < 0.005$). In the final comparison, the stripcut total was significantly different from the total number of animals caught on the uncut area with a Chi-square value of 49.0 ($P < 0.005$).

Chi-square analysis was also applied to the individual totals of deer mice and brush mice caught on each watershed. The analysis of the distribution of captures of deer mice on all watersheds resulted in a Chi-square value of 175.23, which, again, results in a rejection of the Null hypothesis since $P < 0.005$. In the case of P. boylii a comparison of total animals caught on all watersheds produced a Chi-square value of 11.4, which is significant at the $P < 0.005$ level.

A trend of species abundance can also be noted from the data. Peromyscus maniculatus made up progressively less of the total numbers of animals caught in the stripcut and uncut watersheds. It remained the most abundant rodent caught on the stripcut area. On the stripcut and uncut watersheds P. boylii increased in abundance becoming the most numerous species caught on the uncut

Table 4. Chi-square values comparing total animals captured on each watershed.

Comparison	No. Animals in Watershed		Expected	Chi-square
12 to 14	12 224	14 139	181.5	19.4
12 to 13	12 224	13 45	134.5	117.8
13 to 14	13 45	14 139	92.0	49.0

watershed (Figure 5, Table 3).

Age Distribution. The proportions of adults, subadults and juveniles of a species in a population is somewhat indicative of the success of that species (LoBue and Darnell, 1959). On the clearcut watershed, 20 percent of the deer mice caught were either subadults or juveniles. The adult male deer mouse, numbering 91 individuals, was the type most often captured in the clearcut. This is probably attributable to the roving behavior and extensive movements of males (Terman, 1968). The adult female deer mouse made up 64 of the individuals captured on the clearcut area.

The brush mouse was caught in low numbers on the clearcut watershed with a total of 15 animals for the year (Table 5). Twenty seven percent of this total, or four mice, were juveniles or subadults. There were seven adult males and four adult females. The Mexican vole was represented by one subadult and five adult females and only one adult and one subadult male.

On Watershed 14, the deer mouse was caught in rather large numbers (Table 2). Twenty two of these animales, or 22 percent, were either subadults or juveniles. Adult males of this species numbered 42 while adult females numbered 35 individuals (Table 6).

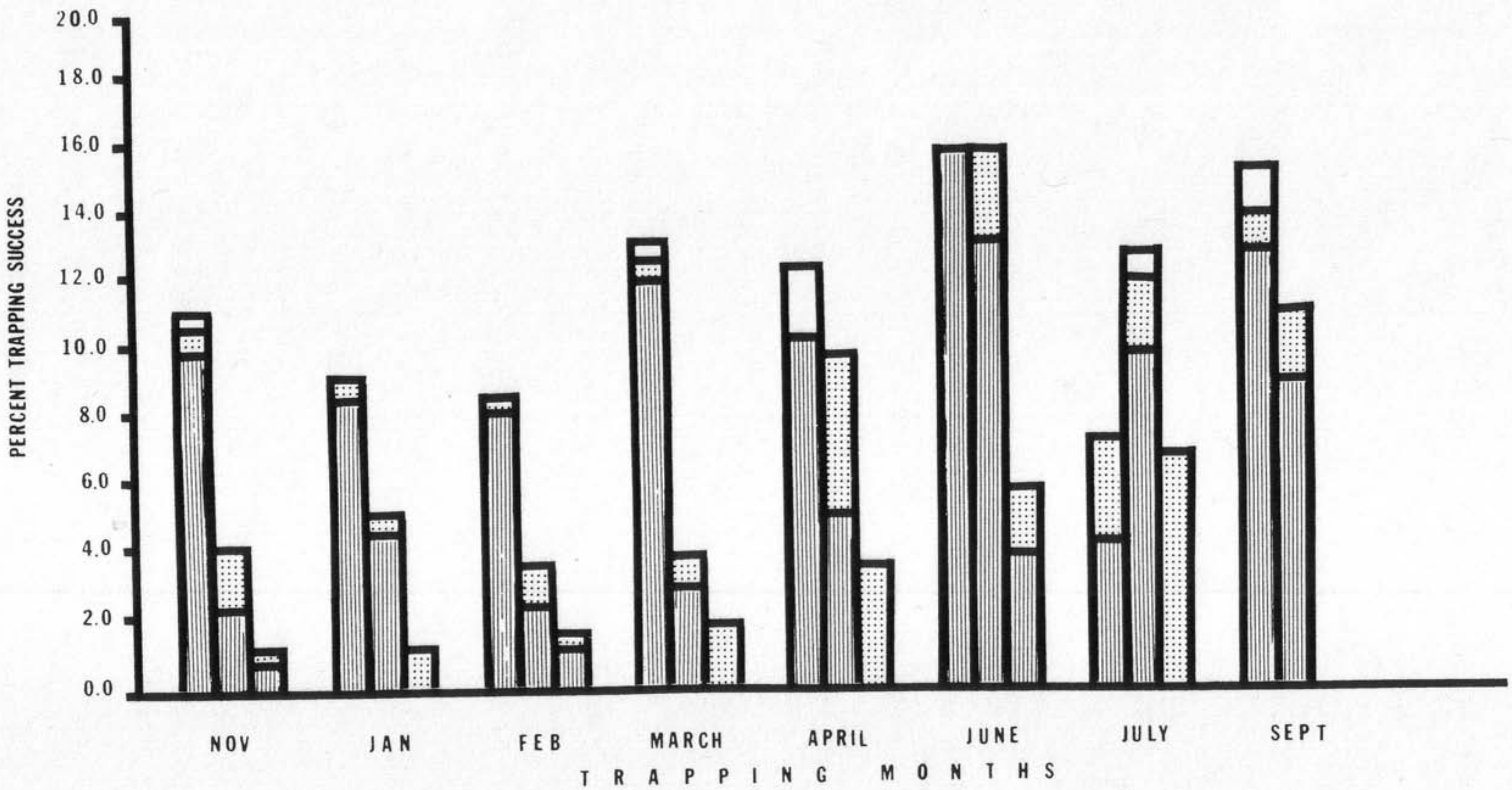

Figure 5. The Monthly Percent Trapping Success for Each Species on Each Area. The First Column in Each Month Represents Watershed 12, the Second is 14, and the Third is 13. The Striped Areas Represent *Peromyscus maniculatus*, the Dotted Areas *P. boylii*, and the Clear Areas All Other Species.

Table 5. Summary of age conditions of rodents captured on Watershed 12, a clearcut.

Peromyscus maniculatus

	Males			Females		
Month	Juv	Subadult	Adult	Juv	Subadult	Adult
Nov	5	3	15	2	2	12
Jan		2	7		3	5
Feb		1	9		4	10
March		1	20			10
April			17		1	13
June	3	1	9		1	2
July	1	2	2	1	1	2
Sept	1	2	12		1	10
Totals*	10	12	91	3	13	64

* Five animals unclassifiable as to age

Peromyscus boylii

	Males			Females		
Month	Juv	Subadult	Adult	Juv	Subadult	Adult
Nov			2			1
Jan			1			
Feb						1
March			1			1
April						
June						
July	1	2	2			1
Sept			1		1	
Totals	1	2	7		1	4

Microtus mexicanus

	Males			Females		
Month	Juv	Subadult	Adult	Juv	Subadult	Adult
Nov						1
Jan						
Feb						
March						1
April		1	1		1	3
June						
July						
Sept						
Totals		1	1		1	5

Table 6. Age distribution of rodents captured on Watershed 14, a stripcut.

Month	Males			Females		
	Juv	Subadult	Adult	Juv	Subadult	Adult
Peromyscus maniculatus						
Nov	1		4			4
Jan		1	6			2
Feb			4		1	2
March	1		4			4
April		1	10	1	1	2
June	2	1	5		1	4
July	2	4	5	3		5
Sept	1		4	1		12
TOTALS	7	7	42	5	3	35
Peromyscus boylii						
Nov			3			2
Jan		1				
Feb			4			
March			2			
April			6	1		7
June				1		2
July	1		1		2	2
Sept	1		1			2
TOTALS	2	1	17	2	2	15

Peromyscus boylii was more abundant on the stripcut area than on either of the other watersheds. The increase was distributed through all age groups with 17 adult males and 15 adult females being trapped. In addition, seven juveniles and subadults comprised 18 percent of the brush mice taken on this area (Table 6).

On the uncut watershed, the brush mouse was the most numerous species (Table 7). Adult male brush mice were caught in fewer numbers than females, 11 and 17 respectively. Subadults and juveniles comprised 18 percent of the sample with a total of six being captured. Two animals were not classed because of spoilage.

The deer mouse population was small on the control area. A total of only nine deer mice were captured; four were adult males, two adult females, one male juvenile, one male subadult, and one female juvenile (Table 7).

Reproduction. Evidence of reproduction in *P. maniculatus* was recorded for every trapping period during the year. The following criteria were used to establish the reproductive status of adult deer mice.

The reproductive conditions of all females were determined by dissection. They were grouped as having placental scars, embryos, or neither of these conditions. The numbers of adult females in each of these categories were summed and expressed as a percent of the total number of adult females captured. The catch of

Table 7. Age conditions of rodents captured on Watershed 13, uncut area.

Peromyscus maniculatus

Month	Males Juv	Males Subadult	Males Adult	Females Juv	Females Subadult	Females Adult
Nov		1		1		
Jan						
Feb			2			1
March						
April						
June	1		2			1
July						
Sept						
TOTALS	1	1	4	1		2

Peromyscus boylii

Month	Males Juv	Males Subadult	Males Adult	Females Juv	Females Subadult	Females Adult
Nov						1
Jan						2
Feb						1
March			2			3
April		1	3	1		6
June		1	1			
July		1	5	1	1	4
Sept						
TOTALS*		3	11	2	1	17

* Two mice were unidentifiable as to their age.

females in January, February and March consisted primarily of non-reproductive types. The number of females having or bearing embryos or placental scars began to increase in March. Their numbers surpassed those of non-reprodcutive types in each of the succeeding months (Figure 6).

Reproductive capabilities of males were determined by gonadal measurements. Means and ranges of testis length were calculated for adults captured in each month (Figure 7). Male P. maniculatus with testes eight millimeters or more in length were considered by Jameson (1950) to be in breeding condition. A minimum of 11.0 mm was determined to be the length of testis in P. boylii representing breeding condition (Jameson, 1950). These figures were used as criteria of fecundity in this study.

Adult male P. maniculatus showed a similar reproductive pattern to that of the females. During November and January, males with very low mean testis lengths were captured, 4.82 mm and 5.55 mm respectively. In February, the mean increased to 6.8 mm while in March, the mean decreased somewhat to 6.3 mm. Mean values increased and varied only slightly in the next four months. In April, a mean testis length of 7.6 mm was calculated while during June, July and September, monthly means of 7.7 mm, 8.4 mm and 8.3 mm were recorded. It should be noted however that the range of testis measurements fell within the fecund zone in every month but November and January,

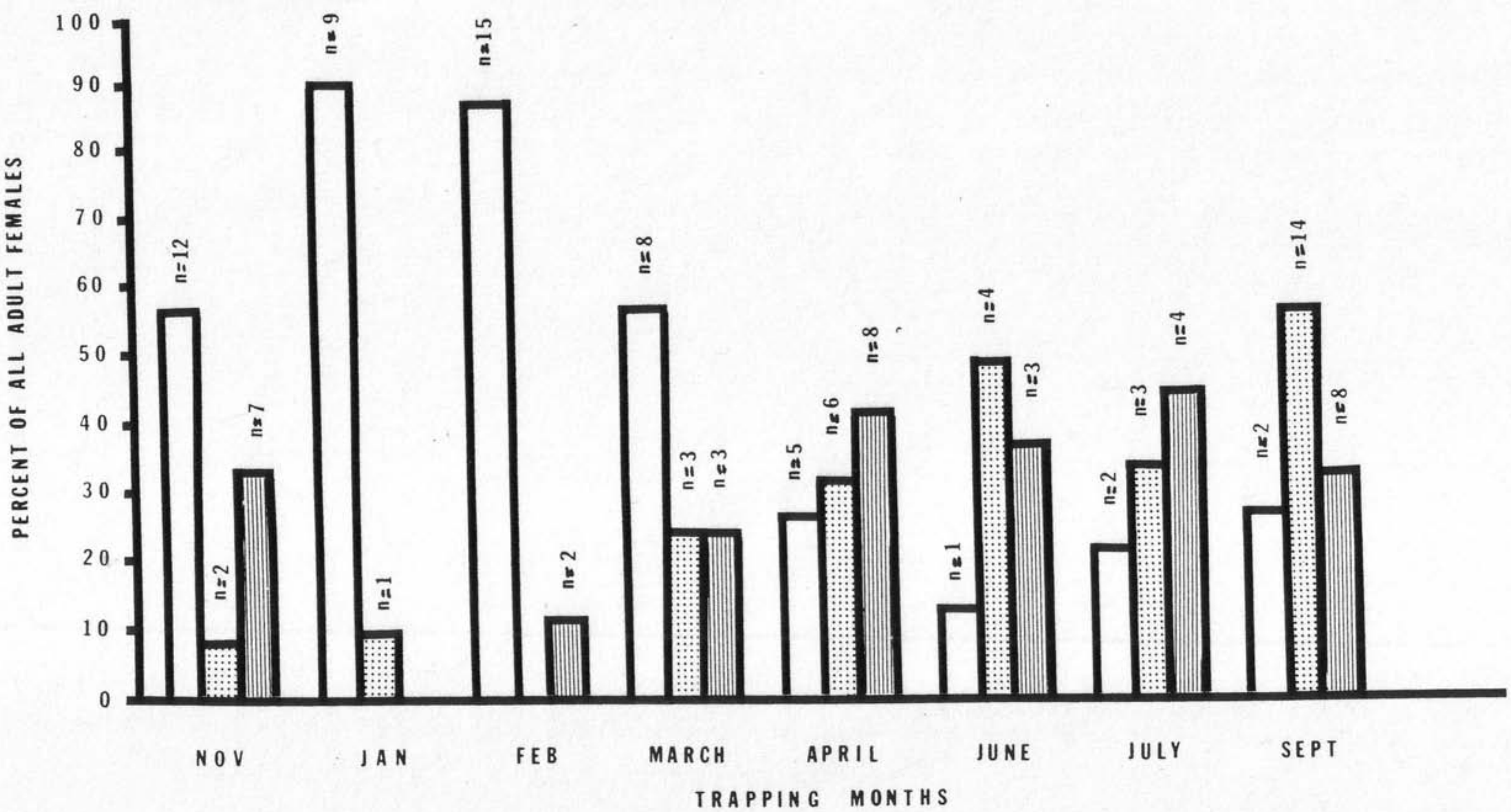

Figure 6. The Percent of Adult _P. maniculatus_ Females Having Evidence of No Reproduction, Embryos, or Embryonic Scars Present for Each Trapping Month. The First (Clear) Column in Each Month Represents the Percent Females Without Any Indication of Reproduction. Second (Dotted) Column is the Percent With Embryos, the Third (Stripped) Column Represents Those Females With Scars.

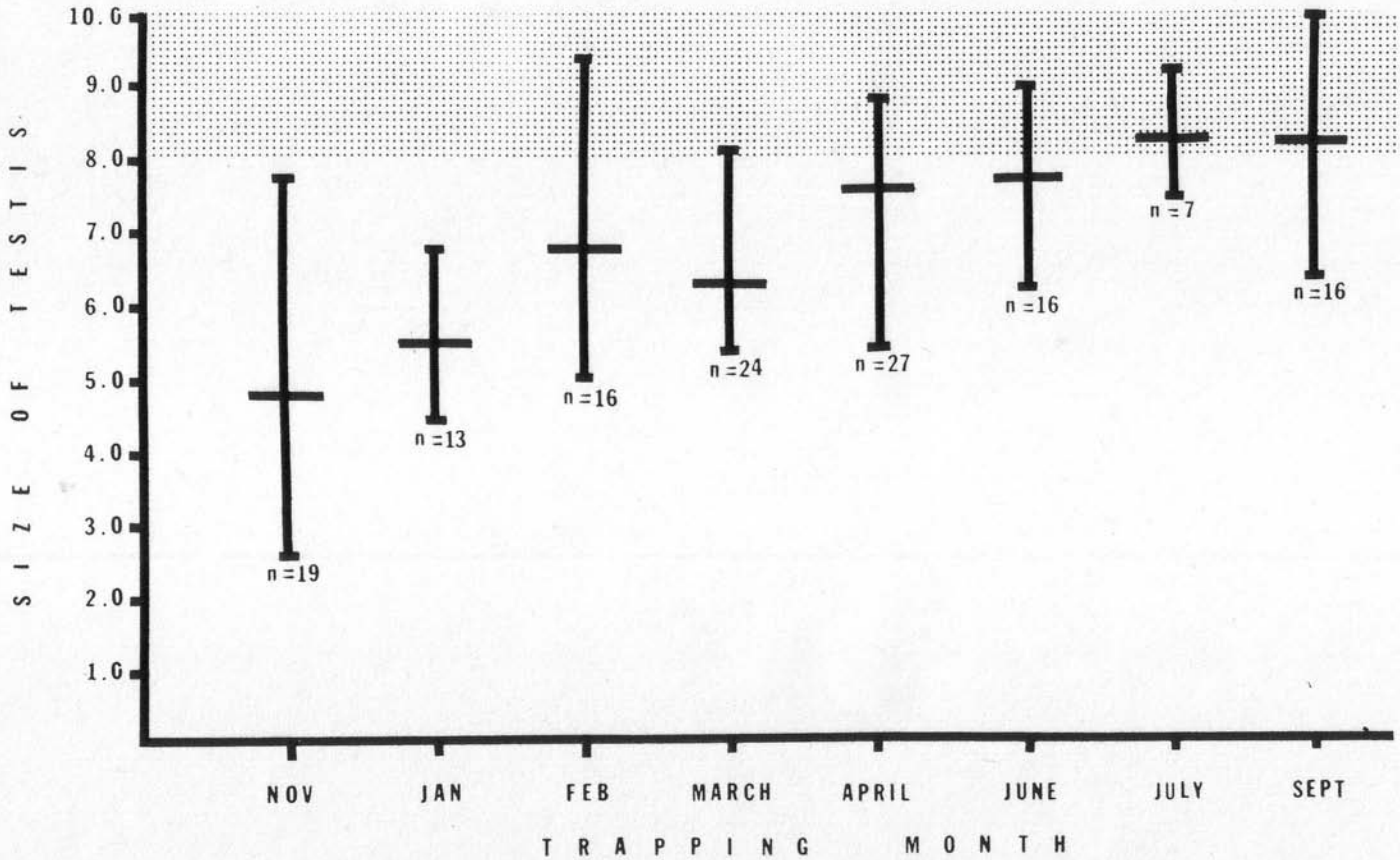

Figure 7. The Mean Testis Length, and the Range of Testis Lengths for Each Trapping Month of P. maniculatus Male Adults. A Testis Over 8.0 mm in Length is Considered Fecund

indicating that a portion of the male population was in a reproductive state most of the year.

In the case of P. boylii the winter months of November and January were periods of little reproductive activity. Adult males had a mean testis length in November of 5.5 mm and the single male in January measuring 4.1 mm. In February, the mean increased to 9.2 mm with one animal within the predicted fecundity range. March trappings resulted in one adult male in this category while the mean for all adult males was 9.7 mm. In April and July, the mean testis length calculated were above the minimum suggested by Jameson (1950) indicating fecund conditions. Only one adult male was captured in June, with a testis length of 10.8 mm. September trapping did not produce much better results as only two adult male P. boylii were captured with one having testes measuring 12.9 mm and the other 4.1 mm (Figure 8). The range of testis measurements for P. boylii demonstrates the identical condition found in P. maniculatus as discussed above; a portion of the adult males were fecund in all months but November and January.

Lunar Conditions and Trapping Success. The amount of light present during rodents' nocturnal activity is an important factor determining their susceptibility to capture. Blair (1943) found that rodent activity in open areas gradually decreased with increasing light intensity. In grouping trapping dates by the moon phases,

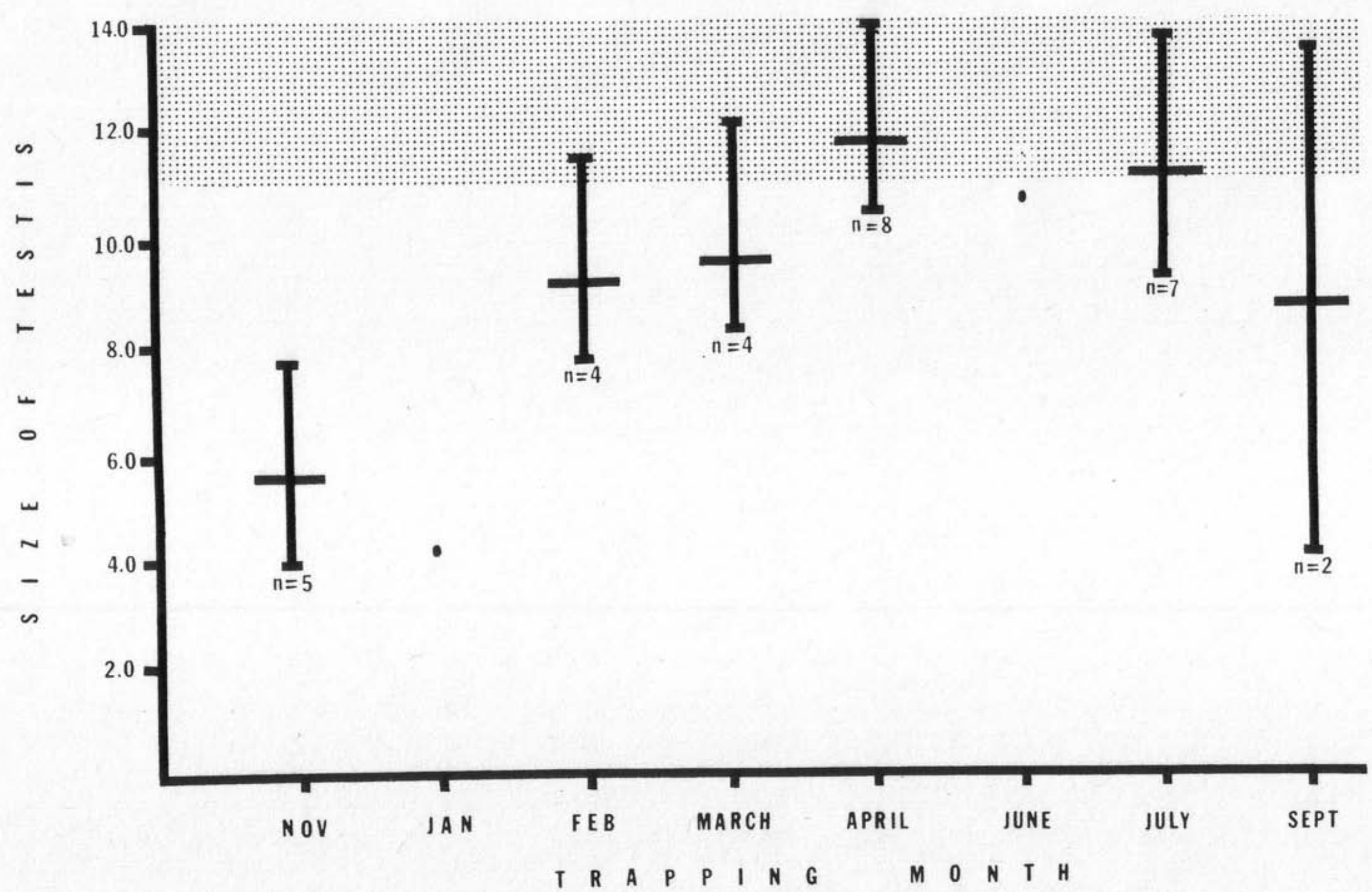

Figure 8 The Mean Testis Length, and the Range of Testis Lengths for Each Trapping Month of P. boylii Male Adults. A Testis Over 11.0 mm in Length is Considered Fecund.

two dates occurred during a full moon, eleven occurred during a half moon, while the remaining seven dates were considered in the new moon phase.

The results are all expressed in the percent trapping success on each watershed during each lunar phase. The rodents captured on the clearcut watershed were subject to the greatest variations of light intensity due to the lack of canopy. Trapping success on the clearcut watershed was 8.0, 12.18, and 10.57 percent during full moon, half moon and new moon phases (Table 8).

In the stripcut area, success was relatively stable with 8.0, 6.0 and 8.14 percent during full, half and new moon conditions. The uncut area had the lowest trapping success of all areas with 5.0, 1.6 and 2.4 percent in full, half, and new moon phases, respectively. One must also recall that these values reflect, somewhat, the number of mice present on each area, therefore their susceptibility to being captured. Lunar conditions are not the only factors affecting the catch, but the relative abundance of animals is also a contributing factor. A better example of the possible influence of lunar phases on trapping success was observed one night before a complete full moon (World Almanac, 1971). On February 27 traps were set out as usual, fifty between the slash piles and fifty adjacent to the slash on the clearcut area. The result was a total of eight animals captured. The

Table 8. Percent trapping success on each watershed during each lunar phase.

	WATERSHEDS		
	Clearcut (12)	Uncut (13)	Stripcut (14)
FULL MOON	8.0	5.0	8.0
HALF MOON	12.18	1.6	6.0
NEW MOON	10.57	2.4	8.14

uniqueness is found in the fact that all eight mice were caught adjacent to the slash piles. No mice were caught midway between the slash rows during this full moon.

Another trapping date (July 28) took place two days after a full moon with somewhat different results. Eight animals were captured but they were distributed five between the slash rows, and three adjacent to the slash. The difference between these dates, in terms of distribution of captures, may be the result of many other biological and climatological factors. The latter sampling period occurred in mid summer with heavier herbaceous vegetation being present. The traps were not in the same location during each trapping period. The trapping results on these dates were probably not differentially influenced by weather conditions as extensive cloud cover was non-existent during these dates.

Influence of Slash Piles. Another consideration of the data concerns the use of the area midway between the slash, and that adjacent to and within the slash piles by animals. The total number of animals caught between the slash was 127, while 97 animals were captured adjacent to the slash rows. This appears to be a significant difference until it is noted that trapping adjacent to the slash rows did not take place until January. When the data for the four trapping dates previous to January are subtracted from the total 127, a value of 87 is obtained for the number of animals captured between the slash rows (Table 9).

Most of the animals captured on the clearcut watershed were deer mice. Seventy-seven of these mice were caught between the slash rows, while 82 were captured adjacent to them. This represents a Chi-square value of 0.16 thereby indicating deer mice as a group probably have no preference for slash piles or open area. Of the number of meadow voles captured, seven occurred adjacent to the slash rows while only one was recorded between the slash. Runways constructed by the voles were observed most frequently in the area of the slash piles.

The brush mice captured did not significantly demonstrate a preference for either slash piles or the open areas. Eight animals were captured between the slash while six were caught adjacent to it, but because of the few animals captured, the significance of this pattern is difficult to assess. The western harvest mouse made up the remainder of the animals captured on the clearcut with one caught between the slash and two adjacent to the slash rows.

The most significant effect of slash piles on small rodents appeared when examining trapping success in concurrence with the lunar cycle as mentioned previously. In particular, on February 27, it was evident that the presence of slash most likely influenced the trapping results. As previously discussed, eight animals were captured adjacent to the slash rows while no animals were captured in the open area. This possible influence of slash piles was not

Table 9. Distribution of animal captures on Watershed 12 for each trapping month, with percent trapping success of each species per month.

Peromyscus maniculatus

Month	Trapnights	Total	BS*	NS*	% Success
Nov	400	40	40	ND**	10.0
Jan	200	17	12	5	8.5
Feb	300	24	8	16	8.0
March	300	36	14	22	12.0
April	300	31	16	15	10.3
June	100	16	10	6	16.0
July	200	9	1	8	4.5
Sept	200	26	16	10	13.0
TOTALS	2000	199	117	82	

Peromyscus boylii

Month	Trapnights	Total	BS*	NS*	% Success
Nov	400	3	3		0.75
Jan	200	1	1		0.50
Feb	300	1	1		0.33
March	300	1			0.66
April	300	2		2	0.00
June	100				0.00
July	200	6	1	5	3.00
Sept	200	2	2		1.00
TOTALS	2000	15	8	7	

Microtus mexicanus and *Reithrodontomys megalotis*

Month	Trapnights	Total	BS*	NS*	% Success
Nov	400	1	1		0.25
Jan	200				0.00
Feb	300				0.00
March	300	1		1	0.33
April	300	6		6	2.00
June	100				0.00
July	200				0.00
Sept	200	(3)	(1)	(2)	1.50
TOTALS	2000	11	2	9	

* NS - next to slash rows BS - between slash rows
** ND - no data

demonstrated during other trapping dates approximating full moon conditions that occurred at other times of the year.

CHAPTER V

DISCUSSION

It has been established that at one time the forest types on Watersheds 12, 13 and 14 were all quite similar. In 1967, clearcutting was completed on Watershed 12, and by 1971, Watershed 14 was completed as a stripcut. What resulted was a setback of community development to earlier seral stages.

In the case of Watershed 12, treatment caused a reversion of the land to what were essentially early, or pioneer, seral stages characterized by having many "weed species," both plant and animal. The opening of the land to the elements allowed for a highly productive community of grasses and weeds to develop. On Area 14, the treatment returned the community to a subclimax seral stage. The "leave" strips on the stripcut area had a considerable number of mature trees present. This canopy cover modified, to some degree, the microenvironment of the forest floor limiting some physical parameters while producing others. This resulted in a decrease in amount of grasses and forbs present. The cut strips were areas of increased productivity because of the reduction of the canopy and changes of the microhabitat.

The control area, Watershed 13, was at still another developmental stage approximating a climax. In general, there was some understory but it was sparse and did not provide much cover or food. There were scattered oaks and junipers on this area which modified the microhabitats where these trees were found. Throughout the area, the canopy was so dense that the amount of sunlight reaching the forest floor was minimal. This environment did not provide much in the way of herbaceous growth.

Associated with the observable differences in the physical appearances of these areas were measurable variations in the microhabitats they provided. Moisture, temperature, food and shelter became modified on the treatment areas because of changes in the amounts and types of vegetative cover, and it was upon these changes that the presence or absence and relative abundance of small mammals depended (Pearson, 1959).

The changes in vegetative production and plant species composition of Units 12 and 13 were outlined earlier. Beck and Vogl (1972), Pearson and Jameson (1967) and Schuster (1967) noted that the amount of timber stand reduction was correlated with an increase in forage and herbage production. This trend was also evident in this study where the total herbage production was lowest in the uncut and highest in the clearcut area. Although data were not collected on the stripcut area, there is good reason to assume that with a thinned timber stand, the production in this area would fall somewhere between the values of the uncut and clearcut watersheds.

Utilization of Watersheds by Small Rodents. Succession in a plant community is often accompanied by changes in the number and types of rodent species. Because of their preference for habitats at particular stages of succession, certain rodents reach greater population densities at different times in the community's life history. In essence, each treated or manipulated watershed studied was equivalent to a seral stage in the development of a ponderosa pine forest. The uncut area was a climax stage, while the clearcut area was a pioneer stage. The stripcut area exemplified some intermediate stage between the other two extremes.

Watershed Unit 12, Clearcut. *Peromyscus maniculatus*, *P. boylii*, and *Microtus mexicanus* have responded to the altered habitat caused by logging. Ahlgren (1966), Baker (1968), Gashwiler (1970) and Williams (1955) have found *P. maniculatus* to be one of the first animals to reinvade disturbed situations or communities that represent fairly early successional stages. This species is often referred to as a "weed species" and is characterized by having high biotic potential and good dispersal powers.

Deer mice were significantly more abundant on the clearcut area, and decreased in numbers from the stripcut to the uncut area. This evidence may be interpreted as a decrease in the number of deer mice present with the advance of succession. With the increase in timber stand development, hence canopy cover, P. maniculatus, is believed to be at some disadvantage (Black, 1968; Gashwiler, 1970; Koestner, 1944; Turkowski and Reynolds, 1970). It would seem that deer mice initially prefer areas with very limited or disturbed vegetational growth and good shelter.

With limited amounts of vegetation in the earliest stages of community development, animal populations must depend on something other than plants to supplement their diet. Tevis (1956) found that on a burned area, insects represented the main staple in mice's stomachs. A wide variety of plant material as well as numerous kinds of arthropods were utilized as food by deer mice in a study by Black (1968) on grazing land. Jameson (1952) found that P. maniculatus shifted its food preferences with seasonal availability. In winter, ponderosa pine seeds were the primary staple but in spring, insects became more abundant and were sometimes taken by deer mice to the exclusion of other items.

A good basis exists for deer mice to remain the most populous rodent on the clearcut area. They did not have any extremely long periods of time without reproduction taking place and subadults and juveniles were well represented in the trapping data.

Slash that was left on the clearcut area in windrows served to trap and retain the snow. It seems that the slash would have provided excellent hiding and nesting places for small rodents, and indeed Turkowski and Reynolds (1970) found that cabling, a process of leveling pinyon and juniper trees, did provide additional habitat for small rodents as evidenced by their increased numbers. However, results from trapping midway between the slash rows and adjacent to the slash piles in this study produced no evidence that the small rodents were restricting their activities to the vicinity of slash piles.

Peromyscus boylii was the second most abundant animal caught on the clearcut watershed. The brush mouse is a rock dweller and often has a strong dependency upon acorns (Baker, 1968). Perhaps the small population of brush mice gained an important share of its sustenance from the Gambel oak on this area. Also of some importance to their diet are seeds, fruits and arthropods.

Brush mice differ physically from deer mice in that they possess longer hind feet and tails. These differences allow brush mice to exploit a semi-arboreal habitat in addition to the prairie and riparian habitat that deer mice, with shorter tails and hind feet, primarily inhabit.

Reproduction in the population of brush mice tended to occur in late summer and early fall. This reproduction was indicated by the capture of four subadults and juveniles during this time.

The slash provided the same benefits for the brush mouse as it did for the deer mouse. Additional hiding and nesting areas were made available. Yet, as in the case of P. maniculatus, there was no difference in animals captured midway or adjacent to the slash.

The Mexican vole, Microtus mexicanus, is typical of open fields and meadows, creating runways through matted grasses. It is an herbivore, eating the seeds, leaves and stems of forbs and grasses (Burt and Grossenheider, 1964; Vaughn, 1974).

Microtines tend to be much more cyclic in their population fluctuations than cricetines, a group which includes the brush mouse and deer mouse. The number of Mexican voles caught during this study was saml1 and did not exhibit any apparent cyclic fluctuations. The largest catch occurred in April. There was some indication of reproduction at that time as a pair of subadults was caught.

Temporal differences partially separate the Mexican vole from possible competition with the brush mouse and deer mouse. The Mexican vole is active by day as well as at night while most species of the genus Peromyscus are nocturnal. This fact may permit two groups that might otherwise be in direct spatial competition to co-exist (Koestner, 1944).

The presence of Microtus is directly related, while Peromyscus is inversely related, within limits, to the amount of cover on an area. Eadie (1953), Koestner (1944), and LoBue and Darnell (1959) all found that Microtus favors fields with considerable vegetative cover, and that this might be due to its diurnal activity pattern. The fact that *Peromyscus* is more strictly nocturnal indicates it may be able to move freely in open areas without benefit of cover. The same observations by LoBue and Darnell (1959) led them to conclude that not only is cover unnecessary for *Peromyscus* but that its absence may be preferable. The presence of the western harvest mouse, *Reithrodontomys megalotis*, on Unit 12 can be attributed to its habitat preference for grasslands and weed patches where vegetation has become rather dense. These mice are nocturnal and are active throughout the year (Burt and Grossenheider, 1964). They were reproductively active on this area as one female was caught with seven embryos and another had three. They feed mostly on seeds but are known to eat other plant parts and some insects.

Watershed Unit 14, Stripcut. Although stripcut and thinned, this area still had an overstory of ponderosa pine. Intermixed with the pine were Gambel oaks and on some southerly exposed slopes, junipers were present.

The response of *P. maniculatus* to the vegetative changes brought on by modifying this watershed falls within the pattern discussed in the previous section. The numbers of this species have dropped significantly from those recorded on Unit 12; however, the species maintains its relative dominance over the number of other species captured.

The abundance of P. maniculatus here at the time of trapping probably exceeded that prior to treatment. With the opening of the canopy, new environmental conditions were produced on the forest floor allowing for an increased production of herbaceous growth.

Peromyscus boylii was found in higher numbers on this area than on the clearcut area. This indicates these mice prefer conditions associated with more heavily wooded areas.

There are two very distinct areas within this watershed. The cleared areas have many of the characteristics prevalent on the clearcut watershed, while the intervening "leave" strips have some overstory development and approach the conditions of the uncut watershed. With these areas in such close proximity, rodents could move to take advantage of each type of area. It may be said that this area represents an ecotonal situation.

With the reduction of slash by fire in the winter of 1971, one would expect some reduction in rodent numbers. However, it has been found that deer mice respond positively to freshly burned areas by rapidly moving back into them (Ahlgren, 1966; Gashwiler, 1959).

Deer mice seemed to be doing well in maintaining high densities on this area. The captures of subadults and juveniles were scattered throughout the year with the greatest number occurring in July.

The lone Mexican woodrat was caught on this area. The capture took place near a rocky slope with some slash that was missed by the burn. The area provided good habitat for this species as it feeds on acorns, nuts, seeds, fruits and mushrooms. It deposits sticks and rubbish among crevices in rocks, and under fallen logs or tree roots to serve as a nest (Burt and Grossenheider, 1964). Seemingly, this animal could also be present on the clear-cut area but the microhabitat necessary for its existence may not be present there. The scope of this study made it virtually impossible to measure densities of rodents of this size. The animal that was captured was a juvenile and just small enough to be caught by the type of trap used.

Both *P. maniculatus* and *P. boylii* should be able to maintain themselves on the area. The reduction of the timber stand caused a freshly disturbed area in the cut strips providing ideal conditions for the deer mouse, while adjacent to these were thinned areas which retained an overstory sufficient for the brush mouse to become more numerous when compared to Unit 12.

Watershed Unit 13, Uncut. The conditions of the terrain underlying a ponderosa pine forest are best characterized as sterile. The lack of growth on the forest floor was startling. Wherever light was able to penetrate the dense foliage of the trees and strike the forest floor, a small group of grasses or forbs usually occurred. In areas where the canopy opened small meadows existed.

There were few dead trees, fallen logs, or rock outcroppings that small animals could use as homesites. It was a moist area with snow drifts lingering until March.

These factors and many others came into play in reducing the number of small rodents captured here. Fewer animals were caught on this area than on either of the other two.

Peromyscus maniculatus, the dominant rodent caught on the clearcut and stripcut watersheds, was surpassed by P. boylii on this area. The increased canopy cover may have caused the limitation of optimum conditions necessary for the existence of P. maniculatus while providing conditions that allowed P. boylii to out compete P. maniculatus. Only nine deer mice were caught here over the year.

The most abundant small mammal captured on Unit 13 was P. boylii. It was caught throughout the year and had peaks in April and July. There was evidence of reproduction occurring with the capture of six juveniles and subadults.

The total number of animals captured on this watershed indicated that this area was not favorable to the establishment of large populations of small rodents. Gashwiler (1970) found that in two growing seasons after a burn in a Douglas fir forest, the rodent populations on the clearcut were more than eight times that of a virgin forest. He postulated that this finding strongly supported the idea that a virgin forest was poor deer mouse habitat.

CHAPTER VI

SUMMARY

This study investigated the effects of watershed management practices on small rodent abundance and distribution from November 1971 to September 1972 in a ponderosa pine (Pinus ponderosa) forest in Northern Arizona. The study areas consisted of a clearcut watershed with slash piles arranged to intercept snowfall; a stri-cut watershed and an uncut, or control watershed. Conclusions were based on a total of 6000 trapnights, 2000 trapnights being recorded on each area.

The clearcut watershed had returned to early pioneer stages dominated by weeds and grasses. Seemingly its high productivity and disturbed condition were favorable to certain "weed species" both in flora and fauna.

By comparison, the stripcut watershed represented a more extensive forest habitat. Although thinned, the "leave strips" resembled a true forest while the "cut strips" represented areas more comparable to the clearcut watershed. In essence, this watershed represented an ecotone.

The true ponderosa pine forest of the control watershed represented sterile ecosystem development especially in relation to wildlife habitat.

A total of 408 animals were snaptrapped during the study. The species trapped on the study areas were the deer mouse, Peromyscus maniculatus, brush mouse, P. boylii, Mexican vole, Microtus mexicanus, western harvest mouse, Reithrodontomys megalotis, and Mexican woodrat, Neotoma mexicana. Deer mice were the most numerous small rodents captured numbering 306, while the brush mice totaled 90 animals. Small rodents were caught most frequently on the clearcut watershed with 224 being taken; 139 were captured on the stripcut area, and only 45 were taken on the uncut watershed. Deer mice were the most numerous animal caught on the clearcut and stripcut areas while brush mice were more abundant than deer mice on the uncut watershed.

This research indicates that deer mice are attracted to early successional stages and they gradually give way to other small mammal species with an increase in canopy cover. As a "weed species" deer mice exhibit reproductive activity during each month of the year that trapping was conducted.

Brush mice show an affinity for areas covered to some degree and were captured with more frequency on the uncut watershed than any other small mammal. Their breeding season seems to be concentrated within the months between April and July.

On the clearcut area, slash was piled into windrows to aid the retention of snow. Animals were categorized as to the location of capture, either midway between the slahs rows or adjacent to them. No significant difference in trapping success was found between the two areas.

In conclusion, it appears that the reduction in canopy cover and the disruption of the forest floor by clearcutting and stripcutting provided for increased productivity thus allowing for an increased carrying capacity of small animals. This occurred to a much greater extent on the clearcut watershed than stripcut watershed and the animals responded accordingly. Meanwhile, the control watershed maintained its relative sterility as compared to the treated areas.

In reference to the Forest Service's multiple-use program, the stripcut management practice appears to offer a compromise between extreme conditions produced by clearcutting and those found on uncut areas. If it is necessary to artificially manage areas such as those occurring on the Beaver Creek watershed in order to increase water yields, it is this writer's opinion that the stripcut technique would be preferable, while increasing water runoff the area retains its aesthetic recreational value and provides somewhat enriched small mammal habitat.

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