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By Jay S. Gashwiler

The lumbering and wood products industry is the most important in the Pacific Northwest. As more old-growth timber is harvested, farsighted people are becoming increasingly concerned about managing the resource on a sustained yield basis. A major problem confronting foresters is to get prompt and full restocking of clearcut areas. Small seed-eating mammals, primarily deer mice, are one of the factors responsible for poor stands of seedlings (Moore, 1940). Considerable research has been done on small mammals, but additional basic information is needed on their relationship to the staggered-setting system of clearcutting widely practiced in western Oregon and Washington. In an attempt to secure some of this information, a project was started on the H. J. Andrews Experimental Forest in April, 1954. This progress report includes data on small mammals secured until the end of November, 1956.

The major objectives of the study were (1) to measure the small mammal populations in virgin, recently logged, and recently burned forest habitats; (2) to gather as much information as possible on the mechanics of small mammal population fluctuations after logging and burning.

This study was made in cooperation with the Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service. I am especially grateful to R. H.

Ruth, R. R. Silen and H. J. Gratkowski, all of the Station; and to Leo A. Isaac and R. C. Koenig, formerly of the Station. Their kind suggestions, consideration and assistance were very helpful during the study. I would also like to acknowledge the fine cooperation of Dr. Albert N. Steward, Oregon State College Herbarium, and Mike M. Savelich, Eugene, who logged the 5B unit.

LOCATION AND TOPOGRAPHY

The H. J. Andrews Experimental Forest is typical of timber-harvesting areas of the region. It is located in central Oregon on the west slope of the Cascade Mountains in Linn and Lane counties. The forest includes the entire watershed of Lookout Creek, a tributary of Blue River. Lookout Creek flows in a westerly direction, and the forest is composed primarily of northerly and southerly exposures. Elevation varies from about 1400 feet at the lowest point to 5250 feet on top of Lookout Mountain.

STUDY UNITS

A 48-acre area (5B) scheduled for clearcutting was selected for study. It had a southerly exposure with an average slope of approximately 18 per cent and an elevation ranging from about 2900 to 3500 feet. It was typical of the general forest terrain, being bench-like with relatively steep intervals. The unit was in virgin forest at the start of the study, and surrounding timber offered an opportunity for movement lines and an isolated virgin timber control grid. Logging started in June, 1955, and ended the following October when the slash was burned. The experimental grid was established in the 5B cutting at the 3050-foot level.

Movement lines were located laterally from each side of the experimental grid. They were in essentially the same timber type with approximately the same slope and elevation.

The control grid was located in old-growth timber about 1900 feet from the nearest logging operation and was essentially free from man-caused disturbance. Its elevation was near the 3450-foot level. The slope was toward the south but was less abrupt than the experimental grid.

VEGETATION

Virgin timber.—The timber on the study area was primarily old-growth Douglas-fir (*Pseudotsuga menziesii*). Some of the trees were over 400 years old and were starting to break up—a few had their tops broken, others were blown over, and still others were dead and starting to decay. Wherever there was an opening in the stand, shade-tolerant western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) reproduction was present. The volume of sound timber logged on the 5B unit was:

Species	*Board feet*	*Per cent*
Douglas-fir	2,362,580	86.6
Western hemlock and others	330,330	12.1
Western red cedar	34,730	1.3
Total	2,727,640	100.0

The composition of species in the Douglas-fir belt varies considerably, but the percentages for the 5B unit appear to be about average for the type.

Ground cover.—Ground-cover data were obtained from an area of 600 × 650 feet superimposed on the small-mammal grids. Four randomized lines were run across each unit with permanent milacre plots taken at 50-foot intervals. The sample for each unit consisted of 56 plots. Logging and burning destroyed the markers but they were relocated as close as possible to the original sites. Ocular estimates of the percentage of shade cast by each species on the

TABLE 1.—*Ground cover (per cent of total) on the virgin timber control area (Area A) and the experimental area (Area B) prior to cutting (1954) and at end of first growing season after logging and burning (1956)*

SPECIES COMPOSITION	AREA A		AREA B	
	1954	1956	1954	1956
Herbaceous plants:				
Gold-thread, *Coptis laciniata*	19	19	21	3
Twin-flower, *Linnaea borealis*	20	18	12	1
Sword fern, *Polystichum munitum*	9	9	6	3
Rattlesnake plantain, *Goodyera decipiens*	9	9	1	
Violet, *Viola* sp.	2	3	6	2
Starflower, *Trientalis europaea*	1	1	–	8
Cool-wort, *Tiarella unifoliata*	1	1	4	
Lady fern, *Athyrium felix-femina*	–	–	1	
Oats, *Avena sativa*	–	–	–	4
Whipplea, *Whipplea modesta*	1	1	–	4
Inside-out flower, *Vancouveria hexandra*	–	1		
Meadow-rue, *Thalictrum occidentale*	–	1		
Groundsel, *Senecio vulgaris*	–	–	–	2
Brome-grass, *Bromus* sp.	–	–	–	1
Miscellaneous	3	3	3	1
Total	65	66	54	29
Brush plants:				
Mountain Oregon grape, *Berberis nervosa*	9	8	15	3
Salal, *Gaultheria shallon*	7	7		
Vine maple, *Acer circinatum*	6	6	13	13
Wild blackberry, *Rubus macropetalus*	4	4	7	45
Huckleberry, *Vaccinium* sp.	4	4		
Rhododendron, *Rhododendron macrophyllum*	2	2	3	
Snow bramble, *Rubus nivalis*	1	1	5	1
Prince's pine, *Chimaphila umbellata*	1	1	1	1
Common dogwood, *Cornus nuttallii*	–	–	1	
Western hazel, *Corylus rostrata*	–	–	–	3
Wood rose, *Rosa gymnocarpa*	–	–	–	1
Wild cherry, *Prunus emarginata*	–	–	–	1
Cinnamon bush, *Ceanothus velutinus*	–	–	–	1
Miscellaneous	1	1	1	1
Total	35	34	46	69
Miscellaneous and conifers	0	0	1	2
Average density of total cover	17	19	22	2

available seed bed were made. An estimate was also made of the density of all ground cover on each plot. Only plant species comprising one per cent or more of the ground cover were included in the compilations.

Ground cover was measured on the control grid and on the experimental area during August and early September, 1954, when both were still in their virgin state. Another survey was

made during August, 1956, after the logged and burned experimental area had gone through one growing season following the fire.

There was only a slight increase in the density of the ground cover on the control area during the two-year period (Table 1). The species comprising the sample and their percentage are essentially the same. That variation which does occur is probably the result of sampling error rather than a change in cover.

The results of the ground-cover survey on the experimental area are also given in Table 1. Ground-cover density dropped from 22 to 2 per cent, and the composition changed from a predominately herbaceous to a woody or brushy type the first growing season after burning. It is of interest to note that very few wind-borne seeded species were present on the area. This was probably the result of late burning which came after the main period of seed dispersal and destroyed most of the seeds which previously had drifted onto the area. The great increase in the percentage of wild blackberies is worth note; under virgin forest conditions they are suppressed. Oats which were recorded came from the live-trap bait. Very few seeds were produced by plants on the experimental area the first growing season after burning. Their value to the small mammals for food must have been so slight as to be almost nil. However, the plants did produce some vegetative material which could have been used for food.

The post-burning ground-cover data for the experimental unit do not correspond with that given by Isaac (1943). He found a plant density of 35.4 per cent the first growing season after the burn, and a preponderance of herbaceous species. The bulk of his herbaceous vegetation was composed of wind-borne seeded species which were nearly absent in the present study. When these plants are deleted from Isaac's table, the two sets of data are more nearly comparable.

EFFECT OF BURNING ON THE SOIL

Many cull logs and much wood debris are left on cutting units after logging and, when dry, this constitutes a fire hazard. To reduce this hazard, foresters commonly burn these areas under controlled conditions. Burning also leaves more mineral soil exposed and many foresters consider this to be a superior type of seedbed for Douglas-fir.

Slash burning is generally done in late fall or early spring. Foresters try to select periods when the soil is moist but when the debris is dry enough to burn readily. Moist soil helps to reduce the loss of humus and lowers the fire hazard in green timber.

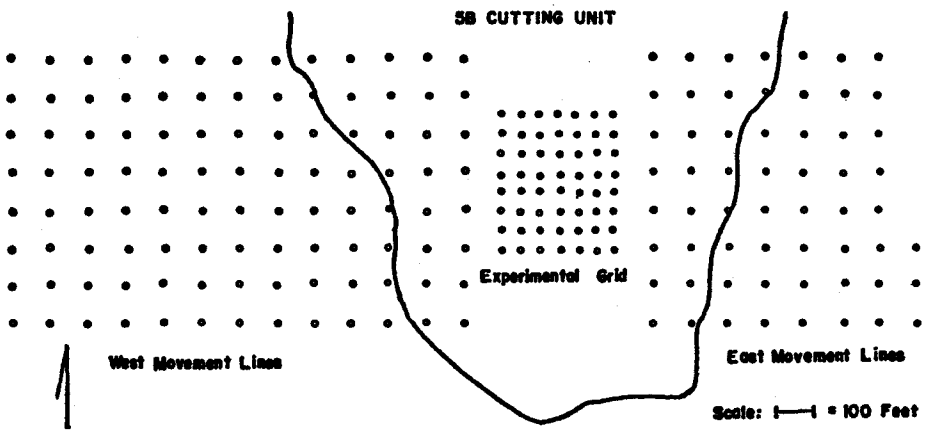

FIG. 1.—Map of lower 5B cutting showing trap sites on experimental grid and movement lines.

Fires were started at the top of the clearcut unit and were set progressively downward. The broadcast burning was started October 14, 1955, and progressed to within approximately 200 feet of the small mammal grid when operations stopped for the day; the remainder of the area was burned October 15.

The intensity of slash burning is dependent on many factors and is apt to vary within the same or different cuttings. The type of burn may affect the small mammal population. Therefore, it seemed desirable to measure the intensity of burn so different areas could be compared more accurately and the effect on the small mammal population could be better understood.

The intensity of the burn was measured on a 400 × 450 foot area superimposed on the experimental grid. Eight hundred randomized line point observations were made. Three classes of soil condition were recognized: (1) Unburned; most of the soil surface escaped burning; (2) Light burn; soil surface was mostly charred litter but some organic matter was not burned; (3) Severe burn; all organic matter burned and soil baked to highly colored state.

Results of this survey are:

Type of burn	*Per cent*
Unburned	46.1
Light burn	47.5
Severe burn	6.4
Total	100.0

The compilation compares favorably with the average for 10 Oregon clearcuts presented by Tarrant (1956). However, the percentage of severe burn was a little higher in the present study. Part of the landing fell within the sample and the large accumulation of cull logs caused severe burn; thus, the data may be biased on that account.

RESULTS AND DISCUSSION

Two small-mammal grids were established to investigate mouse populations in virgin, logged, and burned forest habitat. The control grid was placed in an isolated spot and the experimental grid was located within the 5B cutting unit. Each grid covered a 300 × 350 foot area and contained 56 trap sites spaced 50 feet apart (Fig. 1). The grids were made small so they could be run simultaneously, to avoid the influence of weather on the comparative catches. They were too small with traps too closely spaced for chipmunk population estimates; therefore, grids covering a 500 × 700 foot area containing 48 traps spaced 100 feet apart were also used. These were superimposed on the small-mammal grids and trapped one period during late fall each year when maximum populations were expected. The normal trapping period was six consecutive nights; there were a few times when the length of the trapping period was reduced because of excessive snowfall, cold weather and burning of the 5B area. Large-sized Sherman live traps baited with chicken scratch feed containing cracked corn, wheat and oats were used. Dry wool was kept in the traps for nesting material. Captured animals were ear-tagged with monel fingerling tags and released at the site. Population densities were estimated on an animal per acre basis by means of the ratio or "Lincoln Index" method. The final population estimate was based on the average for all but the first three days. The effective trapping area was considered to be the grid plus one-half the range length added to all sides. Range length was determined by the "Adjusted Range Length" method described by Stickel (1954).

Lines of traps were also set parallel and laterally to the experimental grid, across the cutting and into the timber on the east and west sides. These movement lines were set in an attempt to follow the movements of the small mammals between the cutting and the standing timber. Eight traps were spaced 100 feet apart in lines 100 feet apart. There

were eight lines east of the small-mammal grid and 13 to the west (Fig. 1). The traps were run for a period of three consecutive nights, with few exceptions, generally after the grids had been trapped.

DEER MOUSE (*Peromyscus maniculatus rubidus*)

Populations.—The *Peromyscus* population in an overmature Douglas-fir forest varied from 0.0 to 2.5 animals per acre depending on the time of year. During 1955, the population on the control grid had an early spring build-up, a summer recession and a late fall increase; this seems to be the normal population pattern for western Oregon. Because of the difference in elevation and slope, the control grid population for June, 1955, was more comparable with the population on the experimental grid in May.

The *Peromyscus* population was 1.5 to 1.9 animals per acre on the experimental grid during 1954. In May, 1955, the estimate increased to 2.5 animals per acre. Timber felling started on the experimental unit in June, 1955. By August, the grid was logged, and it was possible to resume trapping. It seemed unlikely that mice would persist on the area in the face of such great logging activity; however, the August trapping revealed a population of 2.0 deer mice per acre—just a little less than the last pre-logging population estimate in May. The *Peromyscus* population was 3.5 animals per acre in September and 3.4 per acre for the first part of October. Spencer (1955) found that slash constituted a favorable habitat for rodents.

The 48-acre area, including the experimental study plot, was burned October 14 and 15. Ten days after the fires were started, the grid was remarked and trapping was resumed. At that time, fires were still blazing on the area and smoke was sometimes quite dense. Ashes were loose and in places flowed over shoes six inches high. The *Peromyscus* did not seem to be unduly frightened by the fire—some were captured within two feet of a blaze. The October trapping indicated an estimated population of 4.0 deer mice per acre; this was slightly greater than the pre-burning estimate. By November, the population had increased to 6.2 per acre, or about double the pre-burning numbers and nearly three times the number on the same area the previous fall. At this post-burning population peak, the number of *Peromyscus* was about three times as great as the number on the control grid. The build-up on the experimental grid was partially due to the normal yearly population cycle; however, the freshly logged and burned area had some attraction for *Peromyscus*. It seemed strange that deer mice would be attracted to an area which was so devoid of vegetation but Stickel (1946) found that *Peromyscus* tend to move into depopulated range. Later it will be shown that the local deer mice were not seriously reduced in numbers by the fire, although many were driven from their homes, temporarily depopulating the area. Other investigators feel that burning does not entirely destroy the food resources of an area and enough remains to feed a limited number of animals (Spencer, 1955). Tevis (1956*a*) indicated that *Peromyscus* feed heavily on insects on a fresh burn.

In 1956, the experimental area did not appear to be good *Peromyscus* habitat; however, the deer mouse population was roughly twice as great as under virgin conditions. The control grid *Peromyscus* population tended to have its usual numbers and to follow its normal pattern.

Movements.—From October 11 to 14, just prior to the start of the burn on the 5B area, 16 *Peromyscus* were captured on the experimental grid. These animals will be referred to in the following discussion as the original population.

During October 16 to 23, while the fire was burning on the 5B area, ten (62.5 per cent) of the original animals were captured on the movement lines in the green timber. Some would have been in the timber under normal conditions but not in as great numbers. The fire apparently caused an increased movement to the timber. Under somewhat similar circumstances, Tevis (1956*b*) recovered 32 per cent of his marked *Peromyscus*.

The fire died down and trapping was resumed October 24 to 29 with eight (80 per cent)

of the movement line animals from the original population recaptured on the experimental grid. Four original animals not captured on the movement lines were also taken. Thus, within 15 days after the start of the burn, 12 (75 per cent) of the 16 original animals were recaptured on the experimental grid.

On November 11 to 14 the experimental grid was again trapped. At that time all ten of the original animals which were captured on the movement lines during the fire were taken. In addition, three of the original animals not caught on the movement lines were recaptured, making a total of 13 (81 per cent) of the original animals taken. These data reveal that deer mice have a very strong attachment to their homes. Murie and Murie (1932), reporting on a different subspecies of *Peromyscus*, found a similar attachment.

During the post-burning October and November checks of the experimental grid, 14 (87 per cent) of the original *Peromyscus* population were recaptured. It is normal for a mouse population to change its composition rapidly, and the loss of a few animals during a two-month period is to be expected. Therefore, the burn on the experimental area had little influence in reducing the number of *Peromyscus* in the original population.

Eleven of the 21 animals captured on the experimental grid after the fire were caught on the movement lines during the burn. Since 12 of the 21 animals on the grid after the fire were captured there prior to the burn, the data suggest that about 57 per cent of the post-burning population on the area was composed of former occupants. The data also revealed a regular movement of *Peromyscus* between the cutting and the timber.

A compilation was made of the maximum distance between capture sites of *Peromyscus* on the experimental grid and movement lines. The minimum possible capture distance was 300 feet and the maximum about 1,700 feet. The data indicated that 14, or 19.4 per cent, of the *Peromyscus* traveled from 601 to 700 feet between the experimental grid and the timbered movement lines. This mode for 72 travel distances is about twice the minimum. The movement range was 301 to 1,500 feet. The travels of adult male No. 2539 are of special interest. He was caught each month from July to November, 1956, in the same general vicinity on both the experimental grid and the movement lines. His maximum travel distances were 1,266, 1,254, 1,204, 1,154 and 1,410 feet, respectively.

The experimental grid was located in the cutting midway between the timber on the east and west sides. The *Peromyscus* seemed to travel to the nearest standing timber and to check on this the following compilation was made:

	Number	*Per cent*
Nearest timber	60	83.3
Equidistant timber	8	11.1
Farthest timber	4	5.6
Total	72	100.0

The data show a definite tendency for the *Peromyscus* to visit the nearest timber. If one includes half of the equidistant animals, the figure approaches 90 per cent.

Sex ratios and reproduction.—During the entire study period, 132 *Peromyscus* were captured on the experimental grid. Of this group, 74 were males and 58 females: a sex ratio of 56 per cent males, which is a greater spread than is found in many populations. The monthly captures were not large enough to justify sex ratio computations.

An effort was made to follow the breeding cycle of the live-trapped *Peromyscus* on the experimental grid. The criterion used for determining the breeding cycle for the males was the location of the testes. If they were descended and prominent, the animal was considered to be in breeding condition; if small and retracted, they were considered non-breeding. The breeding status of the females was based on the vulva condition, and whether or not the animal was lactating. Jameson (1953) found that a perforate vulva occurred during estrus and parturition, and was variable during gestation. Thus, a pregnant female might not have a perforate vulva but would be in its breeding cycle.

In 1954 the *Peromyscus* were breeding at a high rate on the experimental grid. In May, 1955, there was evidence of breeding; however, breeding was low in August after the area was logged. Low breeding activity continued after burning and through the last check in November. The data for 1956 revealed a high rate of breeding from May to November inclusive, similar to the 1954 breeding season.

A few *Peromyscus* litters are born in the live traps each year. In 1954 three litters were born in the experimental grid traps, none were found in 1955, but three were found in 1956.

The disturbance caused by felling, logging and burning seemed to disrupt the breeding activity on the experimental unit. Similar data from undisturbed populations of deer mice in the same general vicinity, however, also revealed a decided slump in the 1955 breeding after early spring. During the summer of 1955 the ground temperature was frequently above 150°F. and it was very dry. This may have been responsible for the lack of breeding activity. In any event, reproduction by resident animals was not a factor in the repopulation of the 5B cutting until the spring of 1956.

RED-BACKED VOLE (*Clethrionomys californicus obscurus*)

Populations.—Red-backed voles are not as hardy as *Peromyscus*, and several died in the traps in spite of an abundance of food and of wool from which they could have made a nest. Deer mice readily make nests of the wool, but only an occasional red-backed vole utilized it for that purpose. Most of them pulled the wool from the bar and trampled it into the urine and feces until it was a sodden mass. Efforts were made to tend the traps during late afternoon and early morning—this helped to reduce but did not eliminate losses. Because of this trap mortality, the population estimates should be considered minimum figures and accepted with reservations.

Generally speaking, the red-backed vole population was a little greater on the experimental than on the control grid during the time when both areas were in virgin condition. There was a low spring and early summer population with a gradual increase during fall and early winter. The population estimate in the old-growth Douglas-fir forest varied from 0.5 to 4.0 animals per acre depending on the season. Tevis (1956*a*) considered virgin coniferous forest to be the best habitat for these voles.

During 1954, the population ranged from 0.5 to 3.2 animals per acre. In May, 1955, it was estimated to be 2.0 animals per acre. Felling started in June, and it was not possible to trap again until August after logging had been completed on the grid. August trapping indicated a population of 2.2 animals per acre which was a little greater than the pre-felling May estimate. The population increased during September and reached its highest level of 5.0 animals per acre in early October just prior to the burn. The first post-burning population check during late October revealed 1.9 animals per acre—a loss of approximately three-fifths of the population from the pre-burning level. By November red-backed voles had increased to 3.0 animals per acre.

During 1956 the experimental grid was trapped for seven periods and no *Clethrionomys* were captured. From November, 1955, to May, 1956, the voles had either succumbed or moved from the area. The data suggest that felling and logging did not change the habitat enough to discourage them. Although the closed canopy was removed, enough cull logs and wood debris remained to give a closed canopy effect at ground level in a patch-wise pattern. However, burning changed the habitat drastically; many of the cull logs and debris were destroyed, thereby reducing or eliminating the closed canopy effect at ground level, and practically all the green vegetation was burned or killed. Since these voles are thought to subsist largely on vegetation, the fire probably eliminated both their food supply and their living quarters. In contrast, during 1956 the control grid displayed a relatively normal population level. Tevis (1956*a*) reported a somewhat similar experience on cutovers in northern California.

Movements.—Unlike *Peromyscus*, the red-backed voles did not reveal much movement.

Only three experimental grid animals were captured on the movement lines. These movements were all made during May, 1955, and were of 206, 226 and 470 feet. There was not much difference in the range length of *Clethrionomys* on the control and experimental grids, or between virgin and logged conditions. The combined range length of 65 animals for both grids and both types of habitat ranged from 50 to 300 feet and averaged 154 feet.

Eleven voles were captured and released on the experimental grid during May, 1955. Felling started on the area in June and it was not trapped again until August after the area was logged. At that time, five of the May animals were recaptured; thus, 45.4 per cent of the population persisted during the three-month felling and logging period. Since 5 of the 12 voles captured in August had also been taken in May, they formed 41.7 per cent of the August population. This is lower than the average turnover for an undisturbed population, and it appears that felling and logging caused very little if any mortality.

From October 11 to 14, 27 voles were captured on the experimental grid and released. None of these animals was caught on the movement lines while the area was burning. When the experimental grid was trapped after the fire, from October 24 to 29, ten voles were captured of which four had been taken just prior to the burn. Therefore, immediately after the fire 14.8 per cent of the pre-burning population were captured on the grid, and they comprised 40.0 per cent of the population.

The experimental grid was again trapped November 8 to 11 at which time ten voles were captured. Of this group, two had been taken prior to the fire and were caught for the first time since the burn. Consequently, it was known definitely that 6 or 22.2 per cent of the pre-burning voles survived the fire.

Previous data indicate that these voles do not travel as extensively as *Peromyscus*. Even when threatened by fire, they apparently stay within their normal ranges. It is thought that the animals surviving the burn stayed on the area during the fire and were fortunate enough to reside in an unburned spot or to have dens which protected them from the heat and smoke.

Sex ratios and reproduction.—Ninety-seven *Clethrionomys* were captured on the experimental grid during the study. Of this number, 54 were classed as males and 43 as females, a sex ratio of 100 males to 80 females.

The monthly breeding data for the experimental grid were based on small samples. However, the undisturbed 1954 breeding trends were comparable to those during 1955 when the timber was felled, logged, and the area was burned. The animals were breeding in April when the first spring population checks were made and continued until the first part of October. During late October and November there was a marked decline in breeding activity. The monthly breeding pattern on the control grid was similar to that on the experimental area. The data indicate that reproduction probably was an important factor in maintaining and building up the red-backed vole population on the experimental grid during the felling, logging, and immediate post-burning period.

Although breeding started in early spring, its effect on the population was not pronounced until August or September. This delayed build-up is thought to be due to natural deaths of over-wintering animals. Thus, the early young of the year would not increase the population but would only be replacements. Since it would take some time for them to reach maturity and produce young, the population increase would be delayed. One other possibility which might explain the delayed build-up is trap mortality. Both factors probably operated together on the population in the present study.

CHIPMUNK (*Eutamias townsendi cooperi*)

Populations.—The chipmunk populations on the control and experimental grids were 2.2 and 2.1 animals per acre, respectively, during late fall, 1954. By fall of 1955, the control grid was still in virgin condition and had an estimated 2.3 chipmunks per acre. The experimental grid had been cut and logged, and the estimated density had dropped to 1.7 animals per acre. In the fall of 1956 the control grid had an estimated 3.8 chipmunks per

acre compared to 0.5 per acre on the logged and burned experimental grid. The west movement line grid was also trapped; it had a population of 1.4 chipmunks per acre, which was considerably lower than the population on the control grid.

The data show that chipmunk populations varied from 1.4 to 3.8 animals per acre under virgin forest conditions. The first year after logging and burning there were only 0.5 chipmunks per acre on the experimental grid. They must increase rapidly, however, since Tevis (1956*a*) indicated that cutovers 3 to 10 years old will have from two to four times as many Townsend chipmunks as virgin forest.

Movements.—Twenty-three range lengths were secured for chipmunks frequenting the control, experimental, and west movement line grids. All were obtained under virgin forest conditions and averaged 302 feet.

A compilation was made of the distance between the capture site of each chipmunk on the small experimental grid and the movement lines. The minimum possible travel distance was 300 feet and the maximum about 1,700 feet. The chipmunks ranged from 401 to 1,300 feet; the mode was from 501 to 600 feet.

In October, 1955, just prior to the burn, 50 per cent of the experimental chipmunks were trapped on the movement lines. Eighty per cent of the post-burning chipmunks were captured on the movement lines while the fire was burning on the experimental area. The percentage of experimental grid chipmunks captured on the movement lines varied from 33.3 to 66.7 per cent during 1956.

The data indicate that chipmunks can travel relatively long distances in a short time. While trapping, the impression was gained that burning caused the chipmunks to leave the cutting unit for the timber, and the trapping data support this impression. The chipmunks apparently ranged from the timber onto the cutting but did not reside there the first year after the burn.

Sex ratios and reproduction.—Logging reduced the number of chipmunks on the experimental grid but not so drastically as did the fire. Because of these influences the total capture was much lower than it would have been under undisturbed conditions. Altogether 85 chipmunks were caught on the experimental grid. This sample of 52 males and 33 females gave a sex ratio of 100 males : 63 females, which is a greater spread than one would normally expect.

The breeding data do not reveal any fluctuation which could be attributed to felling, logging and burning the experimental area. Chipmunks breed in early spring, about the time they emerge from hibernation, and their breeding was probably over before the logging activities started. Nestling chipmunks could have been killed by the logging operations but the study was not thorough enough to detect such mortality.

OTHER SPECIES

Oregon vole, Microtus oregoni.—There was a light population of these voles in the virgin forest of the study area. None was captured on the experimental grid during 1954 and 1955; however, one was caught in July and another in August, 1956. Two individuals were tagged in September and three in October of the same year. Although vegetation was very sparse on the cutting during 1956, Oregon voles were seemingly attracted, at least temporarily, to this recently logged and burned area.

Trowbridge shrew, Sorex trowbridgei.—Trowbridge shrews were occasionally captured in the virgin forest, although none was taken on the experimental grid prior to logging. After felling and logging, six of these shrews were caught on the area. Two were captured after the unit was burned in October, 1955, and two were taken in October, 1956. All except one of these animals died in the traps, and it was not recaptured. The trap mortality makes it difficult to evaluate the effect of logging on the Trowbridge shrews; however, the meager data suggest they may have been attracted, at least temporarily, to the area.

Vagrant shrew, Sorex vagrans.—Vagrant shrews were caught less often in the virgin forest

than Trowbridge shrews. Only one was taken on the experimental grid, and that was during September, 1955, after the area had been logged.

Chickaree, Tamiasciurus douglasi.—Chickarees were relatively common in the virgin forest, but no captures were made during the study. After the 5B unit was logged, they were not seen on the cuting but were observed in the timber near its edge. Logging apparently ruined the area as a habitat for them.

Flying squirrel, Glaucomys sabrinus.—An occasional flying squirrel was captured in the virgin timber; none was caught on the experimental grid, and it seems logical to assume that logging destroyed their habitat.

Short-tailed weasel, Mustela erminea.—These small weasels were occasionally captured in the virgin forest. None was caught on the experimental grid prior to logging; however, two were taken after logging, but prior to burning. The increased deer mouse population may have attracted them to the area.

Bushy-tailed wood rat, Neotoma cinerea.—Bushy-tailed wood rats were not trapped in the virgin forest. None was captured on the experimental grid until after the area had been logged when one was taken. It does not seem that cutting attracted the animal since there are no rock or ledge habitats nearby. It is thought the animal was wandering around and just happened onto the area. Bailey (1936) indicates that wood rats often appear at places which are long distances from their preferred habitat.

Pika, Ochotona princeps.—Only one pika was captured during the study; it was taken on the experimental grid after logging. The animal probably wandered to the area and was not attracted by the cutting.

Snowshoe hare, Lepus americanus.—A few snowshoe hares were noted in the virgin forest. Neither the hares nor their sign were observed in the clearcut the first year after logging. Freshly burned clearcuts are poor hare habitat but older, brushy cuttings are desirable.

SUMMARY AND CONCLUSIONS

The estimated deer mouse population ranged from 0.0 to 2.5 animals per acre in old-growth Douglas-fir. There was an increase in the population after felling and logging. Burning caused many *Peromyscus* to go to the nearest green timber; after the fire they returned to their homes. Shortly after the fire the density was two to three times that of the virgin timber population. The following year the deer mouse population was about twice its virgin timber level. *Peromyscus* regularly traveled between the clearcut and the timber—some individuals ranged about one-fourth mile. Breeding of resident deer mice was not an important factor in the repopulation of the cutting unit immediately after the fire.

Because of trap mortality the red-backed vole population estimates are considered to be minimum figures. The virgin timber population ranged from 0.5 to 4.0 animals per acre. They increased on the experimental grid after logging but decreased sharply after the burn, only to increase again before winter. None was captured on the experimental grid the first season after it was burned. These voles apparently remained on the area during the fire. Breeding was thought to be an important factor in maintaining and building up the population during felling, logging and the immediate post-burning period.

It was estimated there were from 1.4 to 3.8 chipmunks per acre in the virgin timber. Logging caused a modest reduction in abundance on the experimental area. The first year after burning, it was estimated there were 0.5 animals per acre. Many chipmunks moved to the forest when the cutover was burned. They apparently ranged from the timber onto the burn the first season after the fire but did not reside there.

Oregon voles, short-tailed weasels, Trowbridge shrews, vagrant shrew, bushy-tailed wood rat and pika were captured on the clearcut after logging. Chickarees, flying squirrels and snowshoe hares were neither captured nor observed on the area after logging.

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