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# PLANT AND MAMMAL CHANGES ON A CLEARCUT IN WEST-CENTRAL OREGON[1]

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*Abstract.* Plant composition and coverage and small mammal populations were compared in virgin forest (control) and clearcut (experimental) areas from April 1954 to October 1965. Changes in ground cover vegetation were modest on the control area but marked on the experimental area. A late fall burn on the experimental area may have retarded herbaceous plant establishment. Nearly half of the herbaceous species were invaders not found in the virgin Douglas-fir (*Pseudotsuga menziesii*) forest. Ground plant coverage was less than 23% in the virgin forest; 1 year after the clearcut area was burned, the cover was 2%; and by 10 years it was above 53%. Woody plant coverage (mostly sprouts) was slightly more abundant the first 2 years after burning. Herbaceous species then became dominant for a 3-year period, after which woody plants gradually gained dominance.

Deer mice (*Peromyscus maniculatus*) increased on the experimental area soon after the burn. The populations varied from an estimated 0.9 to 12.8 animals per acre and fluctuated widely and irregularly. Townsend's chipmunk (*Eutamias townsendii*), Oregon vole (*Microtus oregoni*), and snowshoe hare (*Lepus americanus*) populations also increased on the area at different periods after the burn. Trowbridge's shrews (*Sorex trowbridgii*), vagrant shrews (*Sorex vagrans*), and ermine (*Mustela erminea*) were present on both areas in relatively low numbers. Redback voles (*Clethrionomys occidentalis*), Douglas' squirrels (*Tamiasciurus douglasii*), and northern flying squirrels (*Glaucomys sabrinus*) were not found on the clearcut. California ground squirrels (*Spermophilus beecheyi*) migrated to the clearcut and established a modest population. Richardson's voles (*Microtus richardsoni*), jumping mice (*Zapus trinotatus*), bushy-tailed woodrats (*Neotoma cinerea*), and a pika (*Ochotona princeps*) were visitors.

## INTRODUCTION

Clearcutting in the old-growth Douglas-fir (*Pseudotsuga menziesii*) timber type causes drastic changes in the biota. The gross changes in the vegetation are striking, but some important, though smaller, changes are not so obvious. Mammal population changes are even less apparent, especially in some nocturnal species, whose presence is evident only by fleeting nighttime glimpses, by minute sign, or by trap captures.

Plant and mammal changes in virgin forest and in a clearcut were measured for 10 years after logging and slash burning; this study continues the work reported earlier (Gashwiler 1959). Essential minimal data previously presented are included here, and further citations will be omitted. Since the methods of compilation were not identical, the data in the two papers vary slightly. The research was started on the H. J. Andrews Experimental Forest in central Oregon in April 1954; field work ended in October 1965.

## THE STUDY AREA

The experimental forest is located in Linn and Lane Counties in central Oregon on the west slope of the Cascade Mountains. It covers the Lookout Creek watershed, a tributary of Blue River, and its elevation ranges from about 1,400 to 5,250 ft. Annual precipitation varies from 89 inches at the lower elevations to 140 inches on the highest ridges (Berntsen and Rothacher 1959). Much of the forest is old-growth Douglas-fir, western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*). It is in the humid division of the Transition Life Zone with the higher elevations and upper parts of northerly slopes in the Canadian Life Zone (Bailey 1936). The soil is porous and is mostly a clay-loam type of volcanic origin (Berntsen and Rothacher 1959).

Vegetationally and environmentally similar areas were paired for comparison, one to remain as virgin forest (control) and the other to be clearcut (experimental). A 48-acre area on a typical southerly slope of approximately 18% was scheduled for cutting and was selected for the clearcut grid. The small mammal population grid was established at 3,050 ft elevation. Logging started in June 1955 and ended the following October when the slash was burned. The old-growth forest on the area yielded 56,826 bd ft/acre of sound timber; 86.6% was Douglas-fir, 12.1% western hemlock and others, and 1.3% western redcedar.

The original virgin forest grid (timber grid) was established in an area with a gentle southerly slope at an elevation of about 2,700 ft; the old-growth timber had a little more hemlock and redcedar than the experimental area. The small mammal population was similar to that of the

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clearcut grid. In late fall, however, the deer mouse population increased rapidly on this control, perhaps the result of a logging operation about 1,000 ft away. Consequently, a second, more isolated virgin forest grid (S-23) was established in old-growth timber similar to the clearcut stand to monitor an undisturbed animal population. It was about 1,900 ft from the nearest logging operation at an elevation of about 3,450 ft. The southerly slope was less abrupt than on the clearcut area.

## Methods

### *Ground cover*

Ground-cover plant data were obtained from an area 600 by 650 ft superimposed on the small mammal grids. Each area was divided into four equal strips, and a randomly located line was selected in each strip. Permanent plot centers were located at 50-ft intervals along each line. Circular milacre plots were used, and plants to a height of 6 ft were tallied around each center. All vegetation, except moss and fungi, within this cylinder was recorded. Fifty-six plots were established in virgin forest and 55 in the clearcut. Vegetation was measured at or near peak development in July and August, except for one year when some work extended into early September. Data were taken annually from 1954 to 1961 except for the 1955 logging and burning period; thereafter the survey was made biannually.

Estimated ground cover was defined as the percentage of each plot's surface covered by vegetation. Non-growing area (logs, stumps, tree boles, rocks, and so forth) was deleted from the sample except in a few instances where it was covered by foliage. The percentage of each species in the total plot sample also was estimated. By multiplying each plot's coverage by each species' percentage, the percentage contribution of each species to the plot coverage was obtained. A similar sampling method was used by Krueger (1960) and Steen (1966).

Plant data used in this paper were obtained from the grids in the original virgin forest and clearcut areas. Only plants accounting for 1% or more of the cover during one or more years of the survey were included in the compilations. Most scientific names of plants follow Gilkey and Powell (1961); those of grasses, ferns, and sedges follow Peck (1961).

### *Mammal populations*

Two permanent small mammal grids were established to measure mouse, vole, and shrew populations, one in virgin forest and the other in the area to be clearcut. Each grid had 56 traps set on an 8-by-7 pattern with a 50-ft spacing. By operating the two grids simultaneously, the influence of weather on the comparative catches was avoided. Trapping was done annually for a 6-night period in spring and fall.

For Townsend's chipmunks (*Eutamias townsendii*) larger permanent grids with 48 traps set on an 8-by-6 pattern with 100-ft spacing were superimposed on the small mammal grids. These were trapped one 6-night period each year in September when maximum populations were expected. Large, Sherman-type live traps were used with dry wool for nest material. During the latter part of the study, in an attempt to measure the populations of California ground squirrels (*Spermophilus beecheyi*) and snowshoe hares (*Lepus americanus*), another row of trap sites was added to the top of the clearcut chipmunk grid, making a total of 56 sites. Wire live traps, 6 by 6 by 19 inches, were placed at each site and run simultaneously with the chipmunk grid traps. Bait of cracked corn, wheat, oats, and sometimes barley was used in all traps; sometimes oats were used alone. Captured animals were ear-tagged with fingerling tags and released at the site. Populations were estimated on an animal-per-acre basis by means of the mark-recapture and the Lincoln Index method. The final population estimate was based on the average for all but the first 3 days. The effective trapping area was considered to be the grid plus a strip whose width was equal to one-half the average range length added to all sides. Range length was determined by the "adjusted range length" method described by Stickel (1954). To show population changes estimates were carried to 0.1 animal per acre; this does not imply that degree of accuracy. This computation method was not used for the voles and shrews because of the small numbers captured, erratic captures, and mortality. The total number of individuals trapped per period was used as an indication of abundance for these animals. Scientific names of mammals used in this study follow Hall and Kelson (1959).

## Results and Discussion

### *Vegetation*

*Virgin forest ground cover.*—Ground cover in the virgin forest ranged from 13.8% to 19.0% (Table 1). This low but reasonably constant amount was much less than the 60% reported for the Wind River Experimental Forest, Washington, by Krueger (1960). A wide range in the degree of coverage should be expected since it is influenced by a variety of habitat conditions. In

FIG. 1. Ground cover in a virgin Douglas-fir stand. Note the accummulation of needles and twigs. Plants of Oregon grape, cool-wort, gold-thread, and wild ginger (*Asarum caudatum*) are visible.

addition, variations in field methods could also influence results. The falling of decadent trees in overmature stands creates openings in the overstory canopy, to which ground cover species respond (Fig. 1). Understory trees may also respond to the light, and gradually their crowns grow into the vacant space and tend to reestablish a closed canopy, thereby controlling ground cover abundance. Although changes in ground cover in virgin timber are relatively slow, they also are constantly taking place.

Percentage of woody plants in the ground cover increased at a nearly constant rate, e.g., hemlock, redcedar, and vine maple (*Acer circinatum*). All of the other woody species except blackberry (*Rubus macropetalus*) and yew (*Taxus brevifolia*) showed a modest increase. Of the herbaceous species, twin-flower (*Linnaea borealis*) and gold-thread (*Coptis laciniata*) decreased most. Woody species seem to respond more quickly to overstory changes due to windfall or breakup of decadent trees. Low-growing herbs, including many semi-woody plants, appear better adapted to heavily shaded areas.

*Clearcut area ground cover.*—The virgin ground cover on the clearcut area was slightly greater than on the control (22.1% vs. 17.0%). Woody plants formed 45.7% of the cover compared to 33.1% on the control (Table 2). Although species composition was similar, species abundance varied somewhat on the two areas.

Slash on the clearcut area was burned October 14 and 15, 1955. Fire burned much of the light inflammable material although many of the larger pieces of wood remained (Fig. 2). Ashes lay

TABLE 1. Percentage of cover contributed by woody and herbaceous ground cover plants on virgin forest area (control)—1954–65

| Item | 1954 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1963 | 1965 |
|---|---|---|---|---|---|---|---|---|---|
| Total area covered | 17.0 | 18.6 | 18.3 | 15.4 | 14.7 | 13.8 | 18.1 | 18.0 | 19.0 |
| Woody plants | 5.6 | 6.6 | 6.8 | 6.5 | 6.3 | 5.7 | 8.5 | 8.6 | 9.7 |
| *Berberis nervosa* | 1.5 | 1.4 | 1.3 | 1.2 | 1.3 | 1.1 | 1.6 | 1.4 | 1.7 |
| *Gaultheria shallon* | 1.2 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.3 | 1.5 |
| *Acer circinatum* | 1.0 | 1.0 | 1.1 | 0.9 | 0.9 | 0.8 | 1.5 | 1.1 | 1.5 |
| *Rubus macropetalus* | 0.7 | 0.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 |
| *Vaccinium parvifolium* | 0.6 | 0.7 | 0.7 | 0.6 | 0.5 | 0.5 | 0.7 | 0.9 | 0.9 |
| *Rhododendron macrophyllum* | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 |
| *Rubus nivalis* | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.4 |
| *Thuja plicata* | — | 0.4 | 0.4 | 0.6 | 0.5 | 0.5 | 0.7 | 0.7 | 0.9 |
| *Tsuga heterophylla* | — | 0.3 | 0.4 | 0.6 | 0.7 | 0.6 | 0.9 | 1.4 | 1.2 |
| *Taxus brevifolia* | — | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.6 | 0.6 | 0.5 |
| Miscellaneous [b] | 0.1 | 0.2 | T[a] | 0.1 | 0.1 | T | 0.1 | 0.1 | 0.1 |
| Herbaceous plants | 11.4 | 12.0 | 11.5 | 8.9 | 8.4 | 8.1 | 9.6 | 9.4 | 9.3 |
| *Linnaea borealis* | 3.4 | 3.2 | 2.8 | 1.8 | 1.7 | 1.7 | 2.0 | 1.8 | 2.1 |
| *Coptis laciniata* | 3.2 | 3.4 | 3.3 | 2.6 | 2.7 | 2.3 | 2.8 | 2.7 | 1.9 |
| *Polystichum munitum* | 1.6 | 1.7 | 1.9 | 1.6 | 1.5 | 1.5 | 1.9 | 1.8 | 1.8 |
| *Goodyera oblongifolia* | 1.5 | 1.6 | 1.3 | 1.2 | 1.0 | 0.9 | 1.0 | 1.0 | 1.0 |
| *Viola sempervirens* | 0.6 | 0.7 | 0.7 | 0.5 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 |
| *Trientalis europaea* | 0.2 | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| *Tiarella unifoliata* | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.2 | 0.3 | 0.5 |
| *Chimaphila umbellata* | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 |
| *Whipplea modesta* | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Miscellaneous[b] | 0.4 | 0.6 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.6 |
| Percentage of total cover | | | | | | | | | |
| Woody plants | 33.1 | 35.6 | 37.3 | 42.1 | 43.0 | 41.6 | 47.0 | 47.5 | 50.9 |
| Herbaceous plants | 66.9 | 64.4 | 62.7 | 57.9 | 57.0 | 58.4 | 53.0 | 52.5 | 49.1 |

[a] T = trace
[b] Includes species comprising less than 1% of 1 year's cover

TABLE 2. Percentage of cover contributed by woody and herbaceous ground cover plants on clearcut area (experimental)—1954–65

| Item | 1954[a] | 1956[b] | 1957 | 1958 | 1959 | 1960 | 1961 | 1963 | 1965 |
|---|---|---|---|---|---|---|---|---|---|
| Total area covered | 22.1 | 2.0 | 19.3 | 30.2 | 37.7 | 34.8 | 47.0 | 48.2 | 53.6 |
| Woody plants | 10.1 | 1.4 | 10.3 | 13.9 | 17.1 | 17.0 | 25.6 | 28.9 | 35.3 |
| *Berberis nervosa* | 3.3 | 0.1 | 0.2 | 0.2 | 0.6 | 0.6 | 0.7 | 0.9 | 1.1 |
| *Acer circinatum* | 2.9 | 0.3 | 1.1 | 1.8 | 2.5 | 2.3 | 4.1 | 4.4 | 5.3 |
| *Rubus macropetalus* | 1.6 | 0.9 | 7.2 | 8.9 | 10.8 | 10.1 | 14.2 | 12.6 | 10.4 |
| *Rubus nivalis* | 1.2 | T[c] | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| *Rhododendron macrophyllum* | 0.6 | T | T | T | T | 0.1 | 0.2 | 0.2 | 0.3 |
| *Rosa gymnocarpa* | 0.1 | T | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 |
| *Pachistima myrsinites* | T | 0 | T | 0.1 | 0.2 | 0.3 | 0.6 | 1.0 | 1.2 |
| *Corylus cornuta* | 0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.2 | 0.4 | 0.5 | 0.6 |
| *Prunus emarginata* | 0 | T | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.6 | 0.8 |
| *Ceanothus velutinus* | 0 | T | 0.2 | 0.5 | 1.2 | 1.6 | 3.0 | 6.1 | 11.3 |
| *Pseudotsuga menziesii* | — | T | 0.4 | 0.5 | 0.1 | 0.1 | 0.2 | 0.7 | 1.0 |
| *Sambucus caerulea* | 0 | T | 0.3 | 0.5 | 0.3 | 0.5 | 0.6 | 0.4 | 0.4 |
| Miscellaneous[d] | 0.4 | T | 0.3 | 0.3 | 0.4 | 0.5 | 0.9 | 1.1 | 2.4 |
| Herbaceous plants | 12.0 | 0.6 | 9.0 | 16.3 | 20.6 | 17.8 | 21.4 | 19.3 | 18.3 |
| *Coptis laciniata* | 4.6 | 0.1 | T | T | 0.1 | T | T | T | T |
| *Linnaea borealis* | 2.7 | T | T | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| *Viola sempervirens* | 1.4 | T | 0.3 | 0.4 | 0.8 | 0.7 | 0.6 | 0.6 | 0.3 |
| *Polystichum munitum* | 1.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 |
| *Tiarella unifoliata* | 0.8 | 0 | 0 | T | 0.1 | T | 0 | 0 | 0 |
| *Chimaphila umbellata* | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | T | 0 |
| *Goodyera oblongifolia* | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Whipplea modesta* | 0.2 | 0.1 | 1.0 | 2.6 | 4.1 | 4.7 | 6.8 | 5.5 | 3.9 |
| *Trientalis europaea* | 0 | 0.2 | 0.1 | T | 0.2 | 0.2 | 0.2 | 0.4 | 0.1 |
| *Avena* sp. | 0 | 0.1 | 0.4 | 0.1 | T | 0.1 | T | T | T |
| *Senecio* spp. | 0 | T | 4.7 | 2.6 | 0.2 | T | T | 0.1 | T |
| *Bromus* sp. | 0 | T | T | T | 0 | 0.1 | 0.1 | 0 | 0 |
| *Carex* spp. | 0 | T | 0.1 | 0.3 | 0.5 | 0.4 | 0.2 | 0.3 | 0.1 |
| *Rumex acetosella* | 0 | T | T | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 |
| *Lolium multiflorum* | 0 | T | 0.3 | 0.4 | 0.4 | 0.1 | 0.1 | T | T |
| *Anthemis cotula* | 0 | T | 0.4 | 0.8 | 0.2 | T | T | 0 | 0 |
| *Epilobium angustifolium* | 0 | 0 | 1.3 | 6.5 | 9.0 | 8.3 | 10.5 | 9.0 | 11.3 |
| *Epilobium adenocaulon* | 0 | 0 | T | 1.1 | 1.5 | 0.6 | 0.5 | 0.2 | 0.2 |
| *Epilobium minutum* | 0 | 0 | T | 0.5 | 1.4 | 0.6 | 0.1 | 0.7 | T |
| Miscellaneous[d] | 0.5 | T | 0.3 | 0.6 | 1.4 | 1.3 | 1.5 | 1.7 | 1.8 |
| Percentage of total cover | | | | | | | | | |
| Woody plants | 45.7 | 70.4 | 53.6 | 46.0 | 45.3 | 48.9 | 54.4 | 60.0 | 65.8 |
| Herbaceous plants | 54.3 | 29.6 | 46.4 | 54.0 | 54.7 | 51.1 | 45.6 | 40.0 | 34.2 |

[a]Virgin timber
[b]After logging and burning
[c]T = trace
[d]Includes species comprising less than 1% of 1 year's cover

thick and fluffy on the area until heavy rain compacted them or they washed away. The burned soil surface remained black for a year or more. Plants covered only 2% of the area one growing season after burning (Table 2). Cover percentage increased rapidly the next 2 years and then slowed. In 1960 the estimated plant coverage was less than in 1959 with most of the loss in herbaceous species; a cool May and relatively dry June and July were probably responsible. Ground cover was estimated to be over 53% by 1965, when the last survey was made. This was a lower percentage than has been reported by Isaac (1943) or Steen (1966). However, steep southerly exposures, common in the study area, often have less plant cover than adjacent, more protected, sites.

Woody plants formed more than 70% of the very light ground cover (2.0%) the first year after the fire. Much of this cover was sprout growth from stump collars and from roots, although seedlings of plants like wild cherry (*Prunus emarginata*) and cinnamon bush (*Ceanothus velutinus*) were present. The relative coverage of woody plants decreased rapidly, and by the third growing season they had less coverage than the herbs. Herbaceous plants were most important for the following 3 years, but their coverage was then again exceeded by woody species until the end of the study (Fig. 3).

The low herbaceous cover the year after logging and burning is notable. The mid-October burn may have destroyed most of the year's supply of wind-disseminated seeds, such as fireweed (*Epi-*

FIG. 2. The clearcut area after burning. The small, highly inflammable material was mostly destroyed, but the larger tree trunks remain. This material makes shade for seedling protection and supplies much good cover for small mammals.

*lobium* spp.) and groundsel (*Senecio* spp.). It is assumed the area was seeded, although it is possible that the location of the seed source, air currents, or other factors may have limited seed distribution. Fireweed seed reportedly matures from mid-July to September 10 in the Douglas-fir region (Ingram 1931). However, seed shedding is dependent on weather conditions and is probably highly variable. Time of the burn can play an important role in a clearcut's successional pattern. For example, Douglas-fir seed crops can be destroyed by slash fires (Isaac 1943, Silen 1952). Large amounts of fireweed and groundsel may appear in a clearcut one growing season after fire (Isaac 1943); although this burn was not dated, it probably occurred prior to seed dissemination. Dyrness (1965) also found a marked recovery of herbs after slash burning. The present study suggests that the influence of the burn on the relative abundance of plants, especially herbaceous species like fireweed, may extend over the first two growing seasons. About half of the post-burning herbaceous species were invaders that were not found under virgin conditions. These plants, mostly fireweed, still formed about 65% of the herbaceous cover 10 years after the fire.

Some of the forest-dwelling plants like snow bramble (*Rubus nivalis*), gold-thread, twinflower, sword fern (*Polystichum munitum*), coolwort (*Tiarella unifoliata*), prince's pine (*Chimaphila umbellata*), and rattlesnake plantain (*Goodyera oblongifolia*) apparently found survival

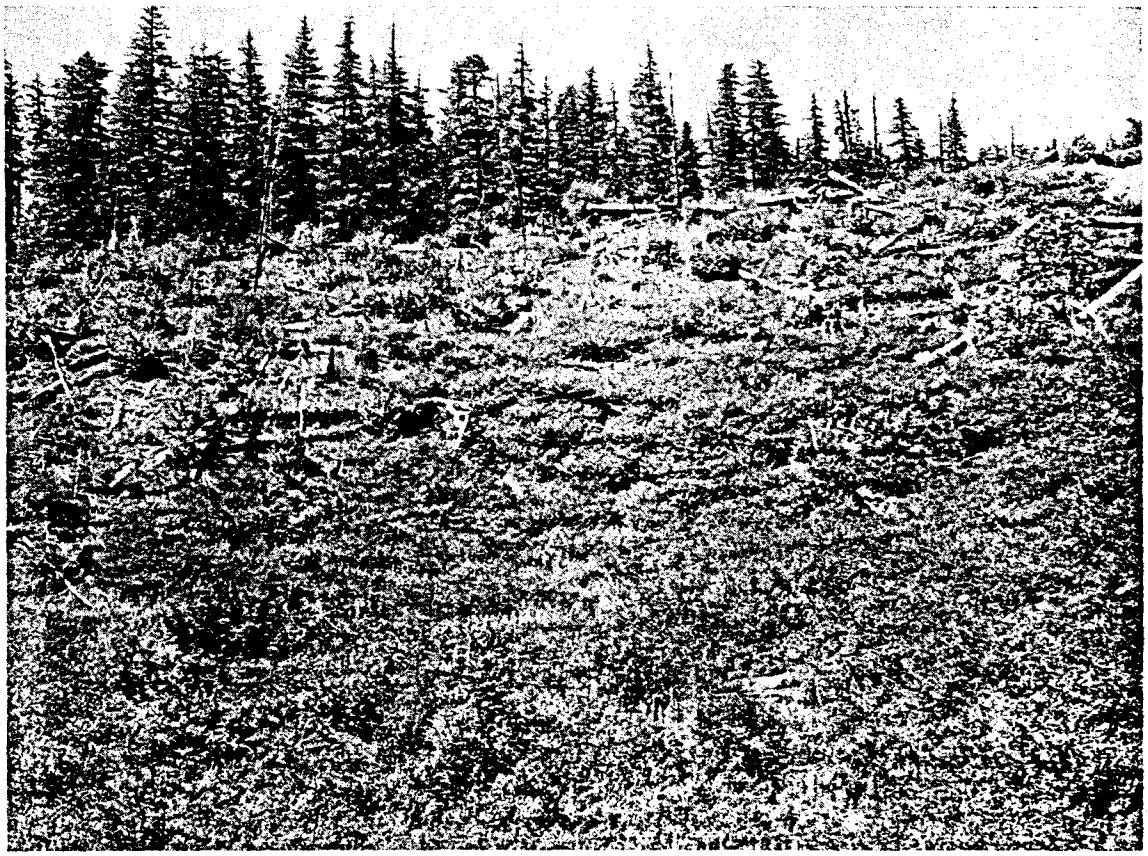

FIG. 3. Clearcut area 10 growing seasons after the burn. The foreground is mostly fireweed, cinnamon bush, and vine maple; the background, blackberry, vine maple, western hazel, and several other species.

difficult or impossible under clearcut conditions. Oregon grape (*Berberis nervosa*), rhododendron (*Rhododendron macrophyllum*), wood rose (*Rosa gymnocarpa*), and evergreen violet (*Viola sempervirens*) managed to survive and increased rapidly when conditions in their habitat improved. Vine maple, blackberry, boxwood (*Pachistima myrsinites*), and whipplea (*Whipplea modesta*) did well under clearcut conditions. Western hazel (*Corylus cornuta*), wild cherry, cinnamon bush, blue elderberry (*Sambucus caerulea*), starflower (*Trientalis europaea*), groundsel, sedge (*Carex* spp.), and fireweed were not found under the virgin forest but appeared in the plots after the burn. Starflower and sedge are sometimes found in the forest but were not in the virgin plots. Dyrness (1965) found starflower increasing each year after logging in a similar type of habitat. The hazel, cherry, cinnamon bush, and elderberry may have come from dormant seeds in the forest litter or possibly from seeds distributed by birds or mammals (Martin, Zim, and Nelson 1951). The oats (*Avena* sp.), brome grass (*Bromus* sp.), red sorrel (*Rumex acetosella*), ryegrass (*Lolium multiflorum*), and dog-fennel (*Anthemis cotula*) may have been brought in with trap bait or possibly from roadside plantings for soil stabilization.

### *Mammals*

*Deer mice.*—Fluctuations in the deer mouse (*Peromyscus maniculatus*) population on the virgin timber grid were moderate but irregular during the study period (Fig. 4). As many as 4.0 animals per acre were found in spring and fall. Spring populations averaged 1.7 mice per acre and fall populations 1.5 per acre. This difference is so small that the populations are considered the same. Before logging, the clearcut area had about twice as many deer mice per acre as the control.

The vegetation cover on the virgin forest area was reasonably uniform, with gradual changes taking place during the study period (Table 1). Many ground cover species produced light annual seed crops under the dense overstory. Small mammals apparently harvested many of the flowers and edible seeds as fast as they became available. The highly variable tree seed crop caused no marked fluctuations in the deer mouse populations.

Deer mouse populations of the clearcut area were larger than those of the virgin forest (Fig. 4), as was the case on clearcuts in northwestern California (Tevis 1956). In the present study, they varied from 0.9 to 12.8 animals per acre and fluctuated widely and irregularly. This pattern was similar to that observed in another part of the same forest (Gashwiler 1967). Densities averaged 3.1 animals per acre in the spring and 6.7 per acre in the fall. In general, spring populations were less variable than those in fall.

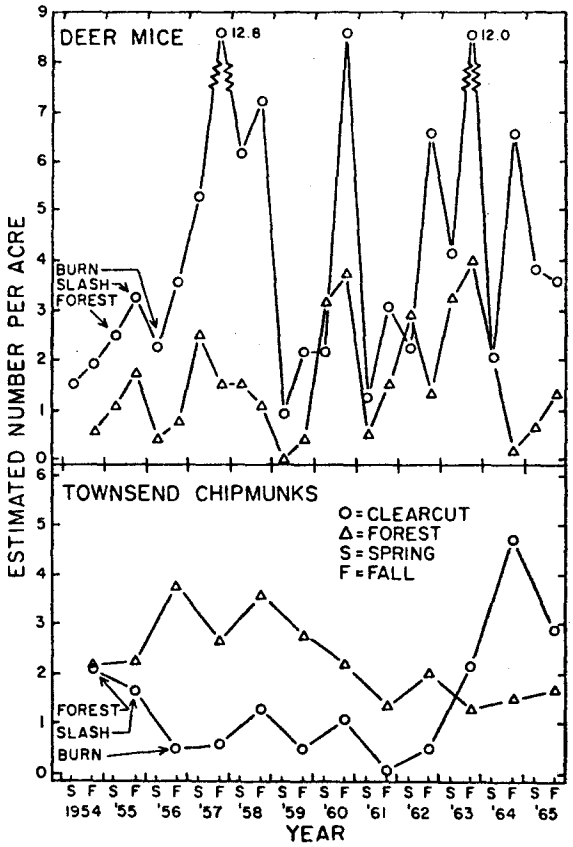


FIG. 4. Estimated number of deer mice and Townsend's chipmunks per acre on the clearcut and virgin forest areas in spring and fall, 1954–65.

Before logging, the deer mouse populations on the experimental and control areas showed similar patterns (Fig. 4). However, by 1956 (1 year after the burn) the clearcut population started to increase even though only 2% of the available area was covered with vegetation (Table 2). The ability of deer mice to adapt and to thrive in various habitats is well known. Insects can be an important part of deer mouse diets on fresh burns (Tevis 1956). Two growing seasons after the burn the clearcut grid population was more than eight times that of the virgin forest. At that time ground cover was approximately equal on the two study areas. This finding strongly supports the idea that the virgin forest on the study area was poor deer mouse habitat. During the study, deer mouse populations on the clearcut grid were equal to or higher than those of the virgin timber, with only two exceptions.

*Townsend's chipmunks.*—The estimated fall chipmunk populations on the control grid ranged from 1.3 to 3.8 and averaged 2.3 animals per acre

(Fig. 4). Populations on the control grid were generally higher the first part of the study than during the latter part. At the start, populations of the virgin forest and clearcut grid were almost the same (2.2 vs. 2.1 per acre). Populations on the clearcut grid dropped to about one animal or less per acre after the burn and remained stable for 7 years until 1963. Thereafter, they were higher than those in the virgin forest. In 1963 the ground cover was more than 48% and was composed of 60% woody species. Many clearcut plants were heavy fruit and seed producers, and the cover afforded good protection. Some of the captured animals were visitors from the adjacent timber. In northwestern California Tevis (1956) found a somewhat similar chipmunk population pattern on Douglas-fir clearcuts.

The low chipmunk population for the fall of 1961 is of particular interest (Fig. 4). The September trapping period happened to be very hot and dry, and chipmunk activity was noticeably low. In October good numbers were caught on a smaller grid at the same place.

*Oregon voles.*—Most of the Oregon voles (*Microtus oregoni*) taken on the virgin forest site were caught during the last part of the study (Table 3). In the virgin timber, where populations were very low, 0–4 animals were trapped per period. In the clearcut area as many as 18 of these voles were trapped per period. Fall numbers on the clearcut were nearly twice as large as those in spring. Throughout the study the clearcut grid produced about four times as many voles per trapping period as the virgin forest. Voles were not caught on the clearcut area until the fall of 1956, 1 year after the burn. An upward trend in numbers started when the ground plant coverage was 30.2% and was composed mostly of herbs. Grassy clearcuts are considered optimum Oregon vole habitat (Goertz 1964).

*Redback voles.*—As many as 16 redback voles (*Clethrionomys occidentalis*) were trapped per

TABLE 3. Number of Oregon and redback voles and Trowbridge's and vagrant shrews caught annually during a 6-night period in spring and fall on the clearcut and virgin forest grids—1954–65

| Year | Season | Oregon voles | | Redback voles | | Trowbridge's shrews | | Vagrant shrews | |
|---|---|---|---|---|---|---|---|---|---|
| | | Clearcut | Virgin forest | Clearcut | Virgin forest | Clearcut | Virgin forest | Clearcut | Virgin forest |
| 1954 | Spring | 0[a] | — | 3[a] | — | 0[a] | — | 0[a] | — |
| | Fall | 0[a] | 0 | 17[a] | 7 | 0[a] | 0 | 0[a] | 0 |
| 1955 | Spring | 0[a] | 0 | 13[a] | 9 | 0[a] | 0 | 0[a] | 0 |
| | Fall | 0[b] | 2 | 30[b] | 16 | 1[b] | 1 | 0[b] | 1 |
| 1956 | Spring | 0[c] | 0 | 0[c] | 7 | 0[c] | 0 | 0[c] | 0 |
| | Fall | 4 | 0 | 0 | 15 | 1 | 0 | 0 | 0 |
| 1957 | Spring | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 |
| | Fall | 2 | 0 | 0 | 4 | 0 | 6 | 1 | 5 |
| 1958 | Spring | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| | Fall | 4 | 1 | 0 | 2 | 0 | 4 | 0 | 2 |
| 1959 | Spring | 4 | 0 | 0 | 3 | 1 | 1 | 0 | 1 |
| | Fall | 18 | 0 | 0 | 3 | 0 | 0 | 0 | 1 |
| 1960 | Spring | 12 | 0 | 0 | 4 | 1 | 0 | 0 | 1 |
| | Fall | 7 | 2 | 0 | 0 | 2 | 0 | 0 | 3 |
| 1961 | Spring | 2 | 1 | 0 | 1 | 0 | 4 | 1 | 0 |
| | Fall | 8 | 3 | 0 | 0 | 3 | 10 | 2 | 1 |
| 1962 | Spring | 7 | 0 | 0 | 1 | 2 | 3 | 1 | 3 |
| | Fall | 2 | 1 | 0 | 8 | 0 | 4 | 0 | 3 |
| 1963 | Spring | 1 | 4 | 0 | 7 | 2 | 2 | 1 | 1 |
| | Fall | 3 | 4 | 0 | 16 | 1 | 3 | 0 | 0 |
| 1964 | Spring | 0 | 0 | 0 | 14 | 1 | 1 | 0 | 0 |
| | Fall | 5 | 2 | 0 | 14 | 0 | 5 | 1 | 4 |
| 1965 | Spring | 0 | 0 | 0 | 8 | 0 | 3 | 0 | 4 |
| | Fall | 6 | 1 | 0 | 6 | 3 | 0 | 0 | 1 |

[a]Virgin forest
[b]Slash
[c]Post-burn

period on the virgin forest grid (Table 3). Populations were about one-third larger in the fall than in the spring and were higher during the first and last part of the study period. Before logging, numbers on the clearcut area were larger than those on the virgin forest. However, no redbacks were captured on the clearcut grid the spring following the fall burn nor during the remainder of the study. Cover and ground temperatures may have contributed to the disappearance of the redbacks. Soil surface temperatures on the lightly vegetated south-facing slope must have been rather high; 150°F temperature pellets melted quickly in a similar habitat. The contrast between the cover and relatively cool soil conditions of the virgin forest and those of the clearcut is extreme. In northwestern California Tevis (1956) considered log cover to be the limiting factor for redbacks in clearcuts. However, food resources also could have been a factor. In Minnesota Ahlgren (1966) found low redback populations on a burned tract until the third year when a varied vegetation with a good food supply became available.

*Trowbridge's shrews.*—Numbers of Trowbridge's shrews (*Sorex trowbridgii*) on the virgin forest grid ranged from 0 to 10 animals per trapping period. Abundance in spring was only about half as great as in the fall (Table 3). Populations on both areas were at a low level when the study started. On the clearcut only single animals were caught per trapping period until 1960 when two were taken. The largest number taken per trapping period was three, and numbers in fall were generally greater than those in spring. Only an occasional Trowbridge's shrew was captured on the clearcut area soon after it was burned. The virgin timber control area apparently provided better habitat for this species until 1961, 6 years after the burn. After that, abundance was greater on the clearcut. Vegetation coverage was 47% in 1961, and woody plants had become the major group. Trowbridge's shrew populations were low but roughly comparable for the two areas during the remainder of the study.

*Vagrant shrews.*—Vagrant shrews (*Sorex vagrans*) were scarce on the clearcut grid all during the study. Captures were irregular and most were of single animals in each trapping period (Table 3). More vagrant shrews were caught on the virgin forest grid, but the numbers were still low. As many as four were captured per trapping period, and considerably more animals were trapped in the fall than in the spring. Apparently the virgin timber was better than clearcut as habitat for vagrant shrews.

*Snowshoe hares.*—A few snowshoe hares were noted in the virgin forest, and their presence was also indicated by a trailing beagle. The population appeared to be light and rather widely scattered. A snowshoe hare was observed on the clearcut area in May 1958, about 2½ years after the area was burned and when the ground cover was between 19.3% and 30.2%. Hares probably lived on the area in suitable habitat during the remainder of the study. By 1964 the population had apparently increased markedly. A young animal was captured in a squirrel trap in September and other signs were apparent. In May 1965 hare tracks were abundant in freshly fallen snow, droppings were noticeable later, and animals were captured in the ground squirrel traps in the fall. Observations suggest that hares near the forest edge work out into the clearcut as soon as cover conditions permit and take up residence in patches of suitable cover when it becomes available.

*California ground squirrels.*—About one growing season after the burn, calls were heard in the clearcut area that were considered to be made by the California ground squirrel (*Spermophilus beecheyi*). Ground cover, mostly woody species, was rather sparse at the time with a coverage of 19.3%. The first animal was observed on the area in August 1958. By October 1959 these squirrels were abundant enough to cause much trouble around the Sherman live traps. They were very persistent in their efforts to secure the bait and were a problem the remainder of the study. An effort was made to measure their populations from 1963 to 1965. They were so mobile and the populations so small that only very rough estimates were secured: 1963, 1 squirrel per 3.0 acres; 1964, 1 squirrel per 2.5 acres; and 1965, 1 squirrel per 2.0 acres. This was a much smaller population than was found in the Sierra Nevada of California by Storer, Evans, and Palmer (1944). It is amazing how rapidly ground squirrels find new clearcuts which are often connected only by roads running through the forest. Moore[2] (*personal communication*) believes that ground squirrels colonize new areas by following the road systems. He never captured squirrels in virgin Douglas-fir forest in spite of many years of extensive live trapping; however, a few have been caught in salvage-logged forest edge.

*Ermine.*—The ermine (*Mustela erminea*) was captured irregularly in small numbers on both areas.

*Other species.*—Several other species were also observed or captured once or a few times on the areas. The northern flying squirrel (*Glaucomys sabrinus*) and Douglas' squirrel (*Tamiasciurus douglasii*) were captured only in the virgin forest.

[2] A. W. Moore, retired wildlife research biologist, U.S. Bureau of Sport Fisheries and Wildlife.

Bushy-tailed woodrats (*Neotoma cinerea*), Richardson's voles (*Microtus richardsoni*), jumping mice (*Zapus trinotatus*), and a pika (*Ochotona princeps*) were caught only in the clearcut area.

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LITERATURE CITED

**Ahlgren, C. E.** 1966. Small mammals and reforestation following prescribed burning. J. Forest. 64: 614–618.

**Bailey, V.** 1936. The mammals and life zones of Oregon. U.S. Dep. Agr., Bur. Biol. Surv. N. Amer. Fauna 55. 416 p.

**Berntsen, C. M., and J. Rothacher.** 1959. A guide to the H. J. Andrews Experimental Forest. Pacific Northwest Forest and Range Exp. Sta. 21 p.

**Dyrness, C. T.** 1965. The effect of logging and slash burning on understory vegetation in the H. J. Andrews Experimental Forest. Pacific Northwest Forest and Range Exp. Sta., PNW-31. 13 p.

**Gashwiler, J. S.** 1959. Small mammal study in west-central Oregon. J. Mammal. 40: 128–139.

———. 1967. Conifer seed survival in a western Oregon clearcut. Ecology 48: 431–438.

**Gilkey, H. M., and G. M. Powell.** 1961. Handbook of northwest flowering plants. Binfords and Mort, Portland, Ore. 414 p.

**Goertz, J. W.** 1964. Habitats of three Oregon voles. Ecology 45: 846–848.

**Hall, E. R., and K. R. Kelson.** 1959. The mammals of North America. 2 vol. The Ronald Press Co., New York. 1,083 p.

**Ingram, D. C.** 1931. Vegetative changes and grazing use on Douglas-fir cutover land. J. Agr. Res. 43: 387–417.

**Isaac, L. A.** 1943. Reproductive habits of Douglas-fir. Charles Lathrop Pack Forestry Foundation, Washington, D.C. 107 p.

**Krueger, K. W.** 1960. Behavior of ground vegetation under a partially cut stand of Douglas-fir. Pacific Northwest Forest and Range Exp. Sta., Res. Note 198. 3 p.

**Martin, A. C., H. S. Zim, and A. L. Nelson.** 1951. American wildlife and plants, a guide to wildlife food habits. McGraw-Hill Book Co., Inc., New York. 500 p.

**Peck, M. E.** 1961. A manual of the higher plants of Oregon. Binfords and Mort, Portland, Ore. 936 p.

**Silen, R. R.** 1952. Timing of slash burning with the seed crop—a case history. Pacific Northwest Forest and Range Exp. Sta., Res. Note 81. 2 p.

**Steen, H. K.** 1966. Vegetation following slash fires in one western Oregon locality. Northwest Sci. 40: 113–120.

**Stickel, L. F.** 1954. A comparison of certain methods of measuring ranges of small mammals. J. Mammal. 35: 1–15.

**Storer, T. I., F. C. Evans, and F. C. Palmer.** 1944. Some rodent populations in the Sierra Nevada of California. Ecol. Monogr. 14: 165–192.

**Tevis, L., Jr.** 1956. Responses of small mammal populations to logging of Douglas-fir. J. Mammal. 37: 189–196.