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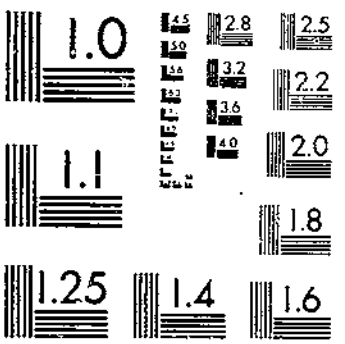

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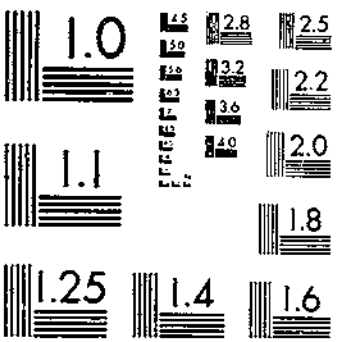

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UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Wild Animal Damage to Seed and Seedlings on Cut-over Douglas Fir Lands of Oregon and Washington[1]

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INTRODUCTION

Upon arrival at their goal in the Oregon Territory in October, the early settlers, most of whom had left "St. Joe," Mo., in April, had one especially urgent need, that of providing food for their trail-worn stock. Fortunately, the native grasses on the glades, or "prairies," solved their immediate problem. The following spring they broke the land for crops. Grassy hummocks gave mute evidence that these alluvial prairies had once been populated by giant trees uprooted in ages past.

As a few years passed the settler learned that the brush-interspersed pastures were turning into young forests. The dense stand of mighty trees included along the eastern portion of his homestead was regimenting its offspring and marching westward. He was being forced to move in the headlands of his first tilled field. Were he in a reflec-

[1] Received for publication June 20, 1939.

[2] Much of the field investigation prior to September 1937 was made while the writer was a member of the Control Methods Research Laboratory of the Bureau. It is hoped that his presentation in this bulletin of the activities of wildlife in relation to Douglas fir reforestation may stimulate other workers to delve further into these relationships and supply data to supplement the continuing research made by the Biological Survey. Experiments now under way are designed to show the quantitative role that animals perform in forest regeneration and what steps should be taken to encourage or discourage their activities.

tive mood he may have tried to picture this so-called prairie if left unmolested for the next 500 years. He would have been more perplexed had he known that 200 feet underground was a buried forest that would later be discovered by a well driller. But the settler, being of the advance guard, usually accepted things as he found them. Even the smoke-palled sky during the dry summer months concerned him not, so long as the cause was distant. His was a fight against the encroaching forests in the effort to provide food for his family and stock. Today, his small burial plot is guarded by two 60-foot fir trees, a silent reminder that nature carries on.

THE DOUGLAS FIR REGION

The Douglas fir region in the parts of Oregon and Washington west of the Cascade Mountains covers an area of 54,885 square miles, of which about 82.5 percent, or 29,001,910 acres, is classed as forest land. Here, in an area containing a little more than 1.5 percent of the acreage of the United States, is 38 percent of the Nation's standing saw timber. About 4,360,000 acres of this forest land are charted as idle, in that reproduction is poor or lacking, and about half of it is on areas logged within the last 20 years, where its poor condition may be attributed to logging methods, with their accompanying recurring fires.[3] This large idle forest area nearly equals in extent the agricultural land in these parts of the two States. For the greater part, it is in the better-quality Douglas fir (*Pseudotsuga taxifolia*) area where soil productivity is favorable to a large timber yield.

Logging Methods

Forest-management practices have an effect not only on the timber stand but also, either favorable or unfavorable, on the resident wildlife. The logging and lumbering of the early settler was of minor effect. Only the best trees were felled, and the resulting gaps filled in quickly, a sort of sustained-yield program thus being unwittingly carried out. Skid roads were carefully laid out, over which oxen, usually three yokes, "clunked" the logs to the mill. The skids were small logs placed crosswise of the trail at intervals of about 6 feet. They were greased to lessen friction. At the water-power mill the logs were sawed into lumber. Large timbers usually were hewn by hand.

Today many logging companies use standard-gage railroads, with union train crews, section gangs, and dispatchers, to transport men and equipment into the woods and to haul the logs to the mill. In the timber, dead snags and everything merchantable is felled. Huge units, powered by steam, electricity, gasoline, or Diesel oil, wind in or pay out thousands of feet of cables from their drums as they obey the signals of the "whistle punk." Dangling grotesquely in the choker loop, a log weighing several tons will batter down tall saplings on its way to the landing. Here the unit sinks its tongs and loads the log on the car. Smaller operators employ tractors and transport the logs to market with large trailer trucks, a method not generally practiced

[3] ANDREWS, H. J., and COWLIN, ROBERT W. FOREST RESOURCES OF THE DOUGLAS FIR REGION: A SUMMARY OF THE FOREST INVENTORY OF WESTERN OREGON AND WESTERN WASHINGTON. Pacific Northwest Forest Expt. Sta., Forest Res. Notes 13: 5. 1934. [Mimeographed.

by large operators. Under either system protection of the young forest is usually not given sufficient thought. Economically, the problem is complex: taxation, interest, and competition, both local and international, force the operator to deliver the logs at the lowest possible cost.

Slash Disposal

Most of the Douglas fir region is in the humid Transition Zone. In the virgin forests, which are usually damp, the ground is covered with humus, at times several feet deep. Very little light filters through the canopy of treetops, which reduces the light values, often to a tenth of what they are in the open. There are many partly decayed fallen trees and much understory and herbaceous growth. The more common woody plants are salal (*Gaultheria shallon*), salmonberry (*Rubus spectabilis*), thimbleberry (*R. parviflorus*), Oregon grape (*Berberis*

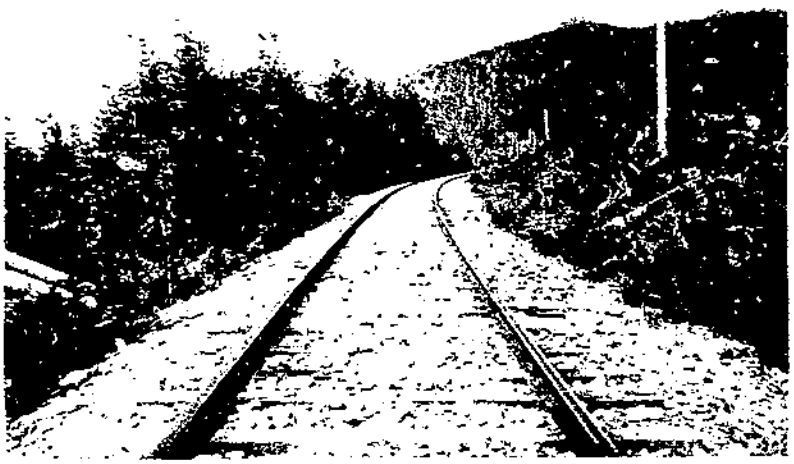

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Figure 1.—Effect of slash burning on reproduction, Olympic National Forest: Left, slash not burned, so that the nucleus of a stand is provided in an area subject to heavy rabbit cropping; right, slash burned.

nervosa and *B. aquifolium*), huckleberry (*Vaccinium* spp.), devilsclub (*Fatsia horrida*), vine maple (*Acer circinatum*), hazelnut (*Corylus rostrata*), and dogwood (*Cornus* spp.). Beneath these grow mosses, ferns, woodsorrels, mints, and other herbs.

In modern logging, for each thermal unit of combustible material removed from the forest a greater number of units are often left on the ground. This debris includes stumps, tops, and limbs, broken and unsalable logs, fallen snags, broken trees often a foot in diameter, and mashed understory trees and shrubs. Moreover, duff that is exposed to the sun for the first time in hundreds of years and succulents dry out and become tinderlike. Should fire occur in these devastated areas during a rainless summer period, adjoining standing timber would be severely menaced. Accordingly, State laws in Oregon and Wash-

ington require in effect that such fire hazards be removed by burning the annual slashing, which is usually done in fall or early winter, after a rainfall.

Before the slash burning, these areas normally contain young coniferous growth and seed sufficient for the nucleus of a stand, but when slash is burned the reproduction is greatly curtailed (fig. 1). This is shown in table 1, which records the conifer reproduction per acre in June 1938 of two areas on the Ray-Adams area, near Otis, Lincoln County, Oreg. (p. 13) that had been logged in one operation in the summer of 1937, one of which had been burned in the fall of 1937 and the other left unburned.

TABLE 1.—*Comparison of coniferous reproduction, June 1938, on burned and unburned areas on the Ray-Adams area, near Otis, Lincoln County, Oreg., logged in one operation, summer 1937*

Area	Seedlings reproduced per acre [1]				
	Hemlock	Douglas fir	Red cedar	Sitka spruce	Total
	Number	*Number*	*Number*	*Number*	*Number*
Burned [2]	218	31	0	0	249
Unburned [3]	833	333	3,831	83	5,080

[1] On the burned area all seedlings were of the current year; on the unburned area it was impossible to determine which were current year seedlings, but it was estimated that 96 percent were 3 years of age or less. Counts were made under the field guidance of L. A. Isaac, of the Pacific Northwest Forest Experiment Station, to whom much credit is due for assistance and suggestions pertaining to studies upon the Ray-Adams area.

[2] See fig. 4, *A*, p. 12.

[3] See fig. 4, *B*, p. 12.

Seed crops for the previous 2 years had been very light, and the reproduction on the burned area came from seed that had fallen from cones high up in the uncut fire-killed trees.[4] On the unburned area, in addition to the good degree of restocking, eight western hemlocks (*Tsuga heterophylla*) and three Douglas firs remained to provide additional seed. On the burned area, seed trees that would have been capable of producing seed in future years were killed by fire. Survival of the seedlings on the cinder-blackened burned area may be low because of the heat-absorbing capacity of the darkened surface.[5]

By practicing some method of strip burning around these slash areas, seed trees and reproduction would be saved and adjoining uncut timber protected; thus a nucleus for a new stand of desirable timber would be present regardless of rodent and rabbit population and the burned areas would gradually restock.

EARLY EFFORTS IN ARTIFICIAL REFORESTATION

Reforestation experiments were initiated the year after the establishment of District 6 of the United States Forest Service in December 1908, and many of the early trials were conducted near Hebo, Oreg.,

[4] ISAAC, L. A., and MEAGHER, G. S. NATURAL REPRODUCTION ON THE TILLAMOOK BURN TWO YEARS AFTER THE FIRE. Pacific Northwest Forest Expt. Sta. March 1936. [Mimeographed.]

[5] ISAAC, L. A. SEEDLING SURVIVAL ON BURNED AND UNBURNED SURFACES. Pacific Northwest Forest Expt. Sta., Forest Res. Notes 3: 3-4. 1929. [Mimeographed.]

on the Siuslaw National Forest, the area being characterized as a "region of superlative timber growing capacity." [6] Here was a large burned-over area, a relic of the big fire that covered a large part of the Oregon coastal mountains, presumably in 1846.

In the fall of 1909 and in the following spring and fall, 4,000 acres were sown to Douglas fir, Sitka spruce (*Picea sitchensis*), and a number of species from other regions. Seed was broadcasted and spot planted. Reports showed the "operation almost a complete failure." [7]

At about this time were started some of the Biological Survey's first economic investigations in this area. Dearborn,[8] in making a study of animal influences relative to reforestation on the area, found that the animals likely to destroy seed are chipmunks (*Eutamias townsendii*) and redwood white-footed mice (*Peromyscus maniculatus rubidus*). As many as 6 chipmunks and 25 white-footed mice were found per acre, with the heavier concentrations in brushlands. Birds, among them juncos (*Junco oreganus* subspp.) and Puget Sound sparrows (*Zonotrichia leucophrys pugetensis*), contributed slightly to seed destruction but over a large plantation caused no significant damage. In another report Dearborn[9] stated:

> The rodent population of the Warren Gap seeding area amounts to 1 or 2 chipmunks and at least 24 white-footed mice per acre—enough to destroy not less than 80 percent of any seed sown before it could germinate.

After these biological investigations, attempts were made to control the seed-eating rodents, and approximately 2,600 acres of the original 4,000 were reseeded to Douglas fir in 1912. This was followed by seed spot sowing of 340 acres of Douglas fir in 1913. Again failure resulted, and no further large-scale seeding was attempted by the Forest Service in the Douglas fir region.[10]

THE SEED EATERS

Tree seeds form an important part of the diet of many small mammals in the natural forest, but their loss is there unimportant. With the removal of the trees through logging, fire, and wind, seeds again become important, and insatiable mammalian appetites become inimical as they interfere with nature's attempt to renew the forest.

White-Footed Mice

Owing to their numbers, white-footed, or deer, mice (*Peromyscus* spp.) consume more conifer seed over this Douglas fir region than do animals of any other group. From the sandy beaches to the summit of the Cascade Mountains, these mice are omnipresent. They may be found in the smouldering burn, or their dainty paired tracks may be traced through the hoar frost on the snow in subzero weather. They are present whether the annual precipitation is measured in

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[6] Johnson, H. M. Annual silvical report. U. S. Forest Serv. Dist. 6. Feb. 16, 1915. [Unpublished.]
[7] Johnson, H. M. Annual silvical report. U. S. Forest Serv. Dist. 6, Jan. 15, 1914. [Unpublished.]
[8] Dearborn, Ned. Unpublished report, U. S. Biological Survey files, an investigation concerning seed-eating animals on the Siuslaw National Forest, Oreg. Submitted June 1, 1912.
[9] Dearborn, Ned. Unpublished report, Biological Survey files. Rodents on and around Wind River Nursery and Warren Gap seeding area (Columbia National Forest, Wash.). Submitted June 18, 1912.
[10] More recent information shows that the control methods advocated by Dearborn in 1912 are ineffective for this region. For methods of control write Bureau of Biological Survey, Washington, D. C.

inches or in feet. During the rainy season, however, they take advantage of the dryer and more protected travel routes in their nightly wanderings, and low trap catches during the first few nights of this season probably indicate that these mice object to rainfall.

The only species of *Peromyscus* found in the Douglas fir region is *P. maniculatus* (*11*),[11] but four subspecies occur. The Oregon area is occupied by *P. m. rubidus*, the redwood white-footed mouse (*2*, *11*) (fig. 2, *A*); and the Washington area, by three subspecies as follows (*11*, *13*): *P. m. oreas*, the Washington white-footed mouse, practically everywhere; *P. m. hollisteri*, the Hollister white-footed mouse, on some of the islands of the San Juan group; and *P. m. austerus*, in the lowlands.

The white-footed mouse can be mistaken for no other mouse in the Douglas fir region. The young are slate gray, changing to brown as they approach the adult stage. The under parts and feet are white, and the tail, which is more than one-third of the mouse's length, is sparsely haired. The normal weight of adults is about 15 to 20 gm. The heaviest individual taken, an adult female *P. m. oreas* that was suckling but not carrying young, weighed 26 gm. The rounded membranous ears, about half an inch long, are gray and lightly haired. The nose is rather pointed, and the protruding black eyes are comparatively large.

Observations made in the vicinities of Ryderwood, Wash., and Otis, Oreg., disclosed that the white-footed mouse normally gives birth to young, usually 4 or 5, from May to September. Examinations of 69 females of breeding age were made. The following field notes on breeding records were made:

A total of 285 trap-nights on an 8-year-old slashing burn, about 2 miles west of the Ryderwood, Wash., area, for the period April 8 to 12, 1937, yielded 4 females not breeding, very fat; 2 females not breeding; 1 female not breeding, average condition; 1 female not breeding, thin; 4 males—1 fat, 1 thin, and 2 normal—breeding condition not noted.

On a trap line on a 2-year-old slashing burn near Ryderwood, Wash., May 24 and 25, 1938, 30 traps yielded 22 breeding adults, 14 males and 8 females. The breeding condition of the females was as follows: (1) 5 uterine scars about 10 days old; (2) 5 scars not more than a week old; (3) 1 full term; (4) 4 embryos at full term; (5) 4 embryos at nearly full term; (6) 5 amniotic sacs ¼ inch in diameter; (7) 5 sacs 3/16 inch in diameter; (8) 5 sacs ⅛ inch in diameter.

Midwinter males were not sexually active, possibly owing to the rainy season. Coventry (*4*) shows an apparent nonbreeding period in one of the northern forms (*Peromyscus leucopus novaboracensis*). Dice (*5*) tells of mice of this genus (*P. maniculatus gracilis*) that lived in captivity for more than 5 years—one male for more than 8 years—but that apparently did not breed during their later years.

The white-footed mouse shows great adaptability in food habits. In normal seed years, the forest provides food from September to April. Years occur, however, in which little or no seed is available, yet the numbers of mice appear to remain rather constant (table 2). After the forest is logged, this source of food is removed entirely and the animal must depend upon produce of the succeeding flora for a living.

[11] Italic numbers in parentheses refer to Literature Cited, p. 28.

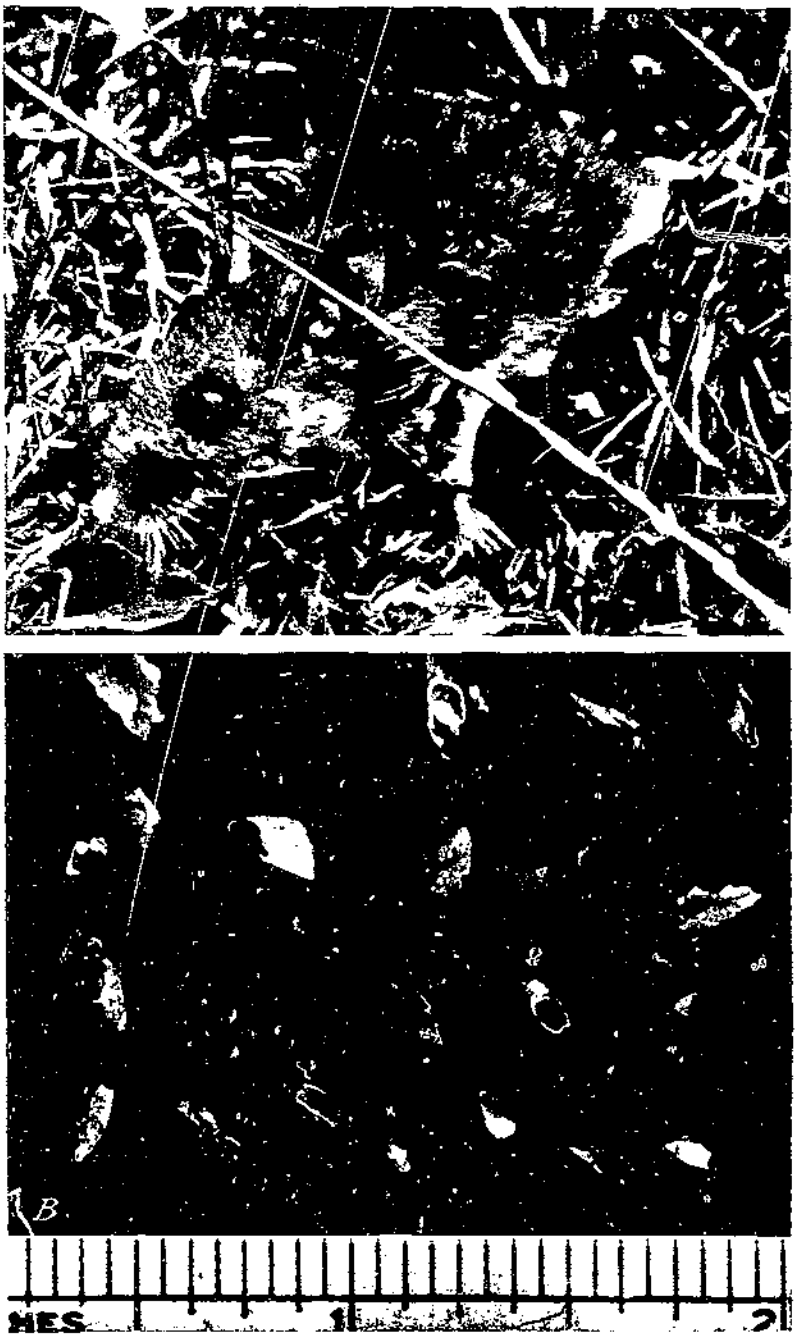

FIGURE 2.—A, The redwood white-footed mouse; *B*, Douglas fir seed hulled by white-footed mice (bottom row, chips from seed coat).

TABLE 2.—*Four-year trapping record on the same trap line, homestead area, Ryderwood, Wash.*[1]

Date	Traps used	Animals taken							
		White-footed mouse		Oregon meadow mouse		Townsend chipmunk		Wandering shrew	
		Males	Females	Males	Females	Males	Females	Males	Females
1935	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Sept. 25	24	5	7	1	0	0	0	0	0
Sept. 26	24	5	2	1	0	1	2	0	0
1936									
Sept. 23	30	4	8	0	1	0	0	0	0
Sept. 24	28	8	4	0	0	0	0	0	0
1937									
Sept. 24	24	5	9	0	0	0	0	0	0
Sept. 25	[2] 24	4	3	0	0	0	0	0	0
1938									
Sept. 23	24	5	6	0	0	0	0	1	0
Sept. 24	24	7	6	0	0	0	0	0	1

[1] An old timber homestead about 5 miles southwest of Ryderwood, Wash., cleared and reverted to Douglas fir, cedar, and hemlock, on which about 5 acres of 40-foot second growth timber was left standing when the surrounding old growth was logged.

[2] 1 trap had been carefully covered with duff by a bobcat (*Lynx* sp.).

Food-preference studies have been confined to seeds of the more valuable conifers. Cage tests showed hemlock and Douglas fir seeds to be equally acceptable. Spruce seed was well taken, and although seeds from the true firs formed an important item of diet, they were passed by if others were available. Alder (*Alnus rubra*) seed was likewise passed by, though it is readily gleaned from the surface of the snow when other food is difficult to obtain. Seed of the western red cedar (*Thuja plicata*) was but slightly taken, and apparently that of Port Orford cedar (*Chamaecyparis lawsoniana*) was disliked. Table 3 records some field depredations on seeds.

TABLE 3.—*White-footed mouse depredations on spot-planted seeds of hemlock, western red cedar, and Douglas fir, Ryderwood, Wash.*

[Seeds planted Feb. 17, 1937; checked June 2, 1937]

Item	Hemlock			Western red cedar			Douglas fir		
Row no. in which planted	1	4	7	2	5	8	3	6	9
Spots planted...number	60	54	51	54	53	51	49	49	51
Spots from which seeds were taken...do	29	41	43	6	8	9	43	47	49
Do...percent	48	76	84	11	15	18	88	96	96

In observations made on study plots in the upper Wind River Valley, Wash., Isaac (*7, p. 35*) recognized the destruction of Douglas fir seedlings by *Peromyscus*.

Casual field observations show that the diet of the white-footed mouse is varied. Insects and insect eggs and larvae, succulent plant tissues—including tender conifer seedlings—and practically all seeds are taken. Cats-ear (*Hypochoeris radicata*), locally known as yellow weed or false dandelion, an introduced European composite that is

common on the logged-over areas, provides much food. During winter, larvae within the galls on the dead flower stalks of this plant provide an important diet item, and the chipping of these galls is an indication of mouse population.

Cogshall (*3*), in a study of the food habits of 4 forms of *Peromyscus*, includes in the diet list seeds, fruits, and nuts of 52 plant species; buds and bark of 16 species of trees and shrubs; and 20 groups of animals, including insects, spiders, crayfishes, slugs, and salamander and frog eggs. Her conclusions as to food habits were that—

> food is probably not an important factor in limiting the habitat distribution of the different species of deer mice. Regardless of the wide variation of range inhabited by the forest, prairie, and desert forms of *Peromyscus* observed, all readily ate the same sorts of food with only slight differences in food preference.

Shrews and Related Forms

Field studies indicate that shrews play a definite, deleterious part in natural reforestation. Too little is known concerning these animals, and numerous attempts to keep them in captivity have failed. Jackson (*8, pp. 1–2*) states:

> No other group of American mammals having a wide distribution, and in many localities an abundance of individuals, is so little known to the nonprofessional mammalogist as the long-tailed shrews belonging to the genera Sorex and Microsorex.
>
> * * * So little are shrews known to the layman that when actually seen they are generally confused with mice, though in reality as closely related to wolves or foxes as to mice.

So far as known, there are nine subspecies of shrews, exclusive of water forms, in the Douglas fir region, and it is known that five of them eat Douglas fir seed. The wandering shrew (*Sorex vagrans vagrans*) is common to nearly all of this area and adapts itself to a wide variation in climate. The others are more local in distribution and live in moister settings. All members of this group have pointed noses (fig. 3, *A*), full complements of teeth, and plushlike fur. Colors vary from brown in the Baird shrew to dusky gray in the Trowbridge.

Early catches of shrews in block traps baited with Douglas fir seed caused a check to be made with live traps containing a liberal amount of the same seed as bait. Later, seed spots were used, and in depredations on these the type of hulling proved the work to be that of these little animals. In contrast to the clean cleavage of the hull by *Peromyscus* (fig. 2, *B*), the shrew leaves serrated hull fragments. In the live traps it was not uncommon to have 100 Douglas fir seeds so hulled in a single night.

The shrew mole, or Gibbs mole (*Neurotrichus gibbsii*), has the same food-habits relation to reforestation as does the true shrew. It is gray black and weighs about half an ounce, or about twice as much as the shrew, from which it may be distinguished by two characteristics, namely, that the front feet have large palms similar to those of a mole, and the bristled tail is constricted near its base.

None of the shrews survived the burning of the logging slash referred to in table 4 (p. 14); but 2 months after the fire, individuals began to drift into the area. It is possible, also, that the changed environment may in time prove inviting to other species, the wandering shrew, for

instance. Moles, apparently the Townsend (*Scapanus townsendii townsendii*), judging from the size of the mound, continued to work in the burn immediately after the fire.

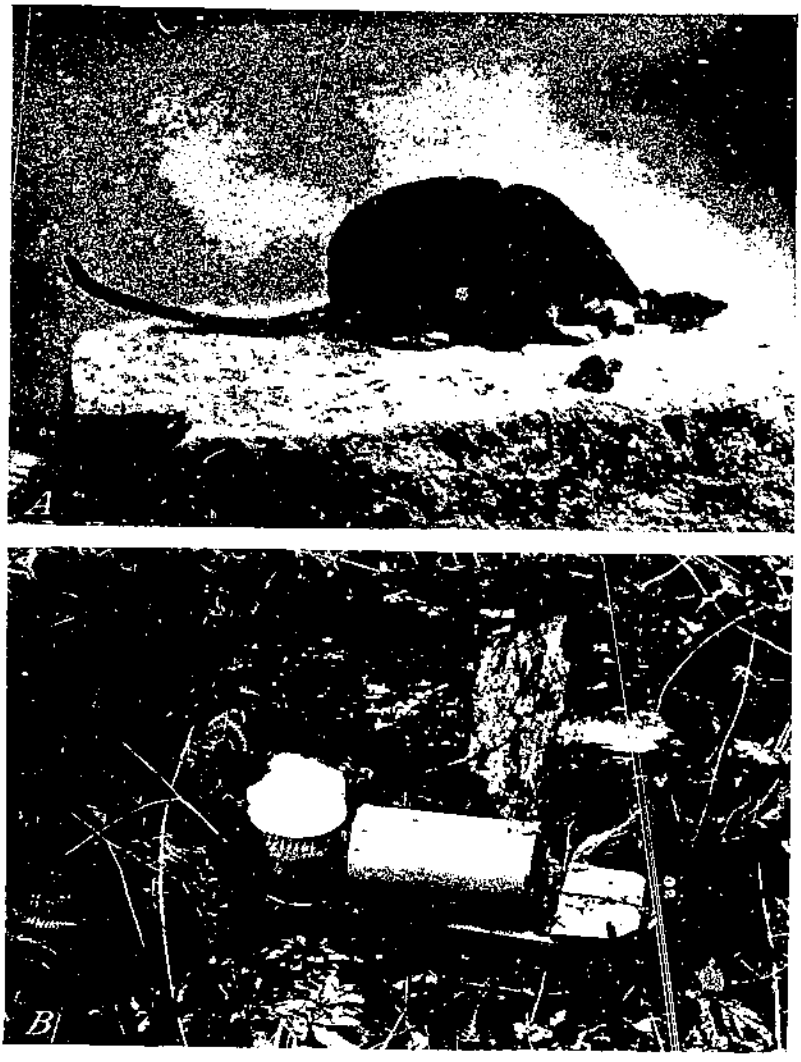

FIGURE 3.—*A*, The Trowbridge shrew. *B*, Small mammal live trap: Left, crimped nesting can filled with shoddy wool; background, bark used for shelter to protect trap from rain.

THE SQUIRREL GROUP

Economically, squirrels are of little importance to forestry in the region, as they prefer forests where reproduction is a small factor and as they harvest from trees having an abundance of heavily seeded cones. Their numbers also are relatively low. The silver gray squirrel

(*Sciurus griseus griseus*) (*2, 13*), which prefers the more open types of mixed forests, occurs in Oregon and Washington, although it seldom reaches the coastal strip. Two subspecies of pine squirrel are found in the region, namely, *S. douglasii douglasii* and *S. d. cascadensis* (*2, 13*), the former ranging westward to the sea and the latter common to the Cascade Mountain section. Although they are smaller than gray squirrels, their chatter is more conspicuous, as the hunter who attempts to creep through the Douglas fir thickets unnoticed will testify.

Squirrels play a spectacular, though relatively insignificant, role in conifer reforestation through their habit of dropping cones from which they later extract the seeds. Disdaining to wait for individual seeds to fall to the ground, squirrels harvest the cones as they near ripeness by nipping and twisting them loose from the tips of branches. At times cones may nearly cover the ground under a tree in which a family of squirrels is working. The squirrels may eat the seeds from some of the cones while still in the tree, or they may pick up cones from the ground and carry them to vantage spots on nearby logs to extract and consume the seeds, but they cache by far the greater number of cones in some cavity. Although this habit of storing cones that are later found by the forester and planted is reputedly an aid to reforestation, seed collectors in the Douglas fir region find it more profitable to climb the trees and do their own picking than to rely on the caches. Those found, however, almost invariably contain cones with a high seed content.

During summer, squirrels at times feed upon the more tender bark of trees, often girdling and killing the tops. This type of injury has been noted on Douglas fir and on oak.

Chipmunks also are members of the squirrel family. The Townsend chipmunk (*Eutamias townsendii townsendii*) (*6*) or one of its near relatives is to be found over the entire Douglas fir region in numbers that vary greatly from year to year. Normally, these rodents prefer the more open parts of the forest. Their diet closely resembles that of the white-footed mouse. Like true squirrels, they climb some of the smaller seed-producing trees, from which they cut and drop the cones, but as they hibernate in this region, usually from November to March, their demands upon seed on the ground are reduced. Townsend chipmunks have been kept in outdoor captivity by the writer for 11 years and have remained active at all times.

Other Seed-Eating Mammals

Probably all the other mouselike and ratlike rodents (superfamily Muroidae) also eat forest-tree seeds. Meadow mice are the most numerous of this group, but as they occur mainly in grassy areas where conifer seeds find difficulty in becoming established, they have a minor effect on conifer reforestation.

Birds

Many birds eat seeds of various kinds, but their beneficial insect-eating habits probably outweigh the damage they do in taking a few surface seeds or seedlings. Winter bird residents are scarce during the period that seeds are available. Catches of winter wrens (*Nannus hiemalis*) at different times indicate that they eat Douglas fir seed.

The large catch of song sparrows with Douglas fir seed bait shown in table 8 (p. 17) was probably due to a northward migration. The California purple finch (*Carpodacus purpureus californicus*) is in disfavor with forest-tree nurserymen, as during its spring migration it takes seeds and emerging seedlings from nursery beds and a flock of birds may cause great damage.

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FIGURE 4.—Ray-Adams area, near Otis, Oreg.: *A*, Slash burned after logging; *B*, slash not burned.

Environmental Field Studies

To determine the effect of slash burning on the abundance of small seed-eating mammals, a privately owned area near Otis, Lincoln County, Oreg., logged during the summer of 1937 was studied cooperatively with the Pacific Northwest Forest Experiment Station. For convenience it is called the Ray-Adams area. The original stand consisted of a forest of thrifty middle-aged Douglas fir, hemlock, and western red cedar, with an occasional Sitka spruce and lowland white fir (*Abies grandis*). The area had been selectively logged, in that undesirable and undersized trees had been left standing. Part of the logged area had been burned late in October (fig. 4, *A*); but because of the proximity of standing uncut timber the remainder had been left unburned (fig. 4, *B*). The burning had been moderate. In some spots nothing but bare mineral soil remained; in others, the duff was merely charred. Nearly all the standing trees on the burned area had been fire-killed.

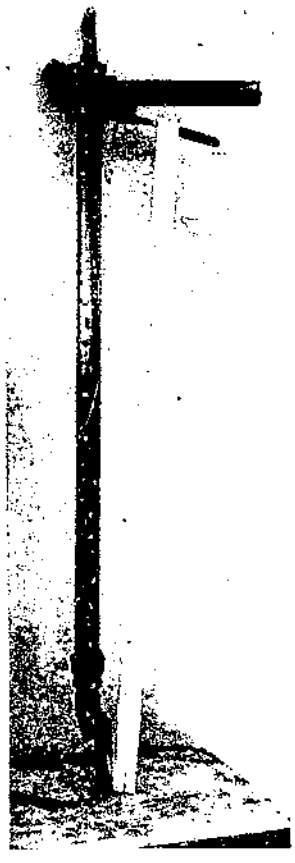

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Figure 5.—Corn-planter type of forest-tree seeder.

On November 5, 1937, a plot 200 feet square was marked off on the burned area and one of similar size on the unburned slash. The distance between the two was 735 feet. On each plot 36 numbered traps, spaced 40 feet apart, were placed in 6 rows along contours, with trap No. 1 at the corner of approach to the plot and No. 36 diagonally opposite. Each trap was allowed variation in position within 6 feet from its stake so as to provide a placement favoring a catch in view of the habits of the animals concerned. On the burned area live traps of the Scheffer type, with an attached nesting can in which shoddy wool waste served as nesting material (fig. 3, *B*), were used (*9*). Some of these live traps were later replaced with a spring-floor type. On the unburned plot killing traps were used, and later, when it was desired to obtain more information relative to food habits of the shrews, some live traps were substituted. All traps were provided with bark shelters as protection from the almost constant rain, and all were baited with Douglas fir seed. Live traps were locked open on alternate nights, as trapping on successive nights caused too high mortality and was thought to inhibit normal travel. Table 4 compares the catches made on the burned and unburned areas.

The 34 white-footed mice taken in traps on the burned area were numbered by ear marks, recorded, and released. The numbering system used was as follows: Right ear—1 underbit represented No. 1; 2 underbits, No. 2; 1 overbit, No. 3; 2 overbits, No. 4; a swallow-fork, No. 5. Swallow-fork plus the bits in order gave numbers to 9, and a

TABLE 4.—*Animals trapped November 6, 1937, to April 9, 1938, on burned and unburned logged-over land, Ray-Adams area, near Otis, Lincoln County, Oreg.*

Animal	Individuals trapped on—	
	Burned area [1]	Unburned area [2]
	Number	*Number*
Redwood white-footed mouse (*Peromyscus maniculatus rubidus*)	34	12
California red-backed mouse (*Clethrionomys californicus*)	0	1
Oregon meadow mouse (*Microtus oregoni oregoni*)	0	1
Townsend chipmunk (*Eutamias townsendii*)	0	5
Trowbridge shrew (*Sorex trowbridgii*)	5	50
Baird shrew (*S. bairdi*)	1	16
Yaquina shrew (*S. yaquinae*)	0	6
Shrew mole (*Neurotrichus gibbsii*)	1	5

[1] See table 5 and fig. 4, *A*.
[2] See fig. 4, *B*.

TABLE 5.—*White-footed mice and other animals trapped, 1937–38, on the Ray-Adams burned slash area, near Otis, Oreg.; logged summer 1937, burned October 1937*

[Area: T. 6 S., R. 9 W., SW1/4 sec. 17]

NUMBER OF MICE TRAPPED EACH DATE

Trap No.	November			December				January					February			March			April		
	6	8	9	5	7	16	18	11	13	25	27	29	19	21	25	16	18	20	5	7	9
1–36	[1] 1	7	10	5	7	3	3	8	6	2	7	7	5	7	5	7	3	4	3	4	6

EAR-MARK NUMBERS OF MICE

1		2	9	10	10			17			11										
2			10						(2)							29	28				
3																					30
4		1			15				3												
5			[3] 1		3			3													
6	1			3		3		(4)	(4)			[3] 17		13						(4)	
7				9				18					(5)	24							
8		4							17				11						30		29
9		3	3																		
10																				30	
11							3														
12													(5)								
13		5	4	11																	33
14																					
15			11													30					
16																					27
17																13		13			
18											17		22		30						
19			12					20												29	
20												11									
21																					
22												20	18					30			
23																		29			
24												[3]									32
25		7	6		13			13								30					
26								11			21										
27														25						31	
28											13		13		28					27	34
29												23					27				
30								19			22	22			13	27					
31		8			11		11		11	21	20			23	29	28	29		29		
32			[4] 8		16	11			13		18			26							
33								12	21				23								
34																					
35					12				16			16		18							
36			13	14		13	13			13		13		22	16	16		27	27		

[1] Low catch first night may have been due to new and freshly painted traps.
[2] Shrew mole (*Neurotrichus gibbsii*) caught.
[3] Mouse dead.
[4] Trowbridge shrew (*Sorex trowbridgii*) caught.
[5] Baird shrew (*Sorex bairdi*) caught.

crop gave zero. Tens were obtained by using the left ear in similar manner. Should hundreds be desired, holes could be punched through the ear. Mouse No. 11 was taken in trap 8 on the burned area on the night of February 19. The following night it was taken in trap No. 2 on the unburned area, a distance of 815 feet over territory littered with much charred debris. One other mouse made a similar trip within a month. As killing traps were used upon the unburned area, no travel could be recorded in the opposite direction.

To learn whether hibernation occurred and to compare populations and their travels, a similar live-trap study was conducted on the Long-Bell area near Ryderwood, Wash., an area of slash burned 5 years before the study. Here the forests are an inland type in contrast to the fog-belt type on the Ray-Adams plots and, as stated earlier, the subspecies of the white-footed mouse found is *Peromyscus m. oreas*. Tables 5 and 6 compare white-footed mouse captures on the 2 burned slash sites. The similarity in catches is of interest, 34 *Peromyscus* visiting and inhabiting one area during the winter and 35 the other.

TABLE 6.—*White-footed mice and other animals trapped, 1937–38, on the Long-Bell burned slash area near Ryderwood, Wash.; logged fall 1931, burned fall 1932*

[Area: T. 11 N., R. 3 W., NW1/4SE1/4 sec. 33]

NUMBER OF MICE TRAPPED EACH DATE

Trap No.	October					November			December		January			March		
	23	24	25	26	27	13	15	17	21	23	18	20	22	8	10	12
1–36	19	6	9	7	7	12	13	5	5	5	3	7	3	3	4	4

EAR-MARK NUMBERS OF MICE

Trap No.																
1						29	20					29				
2		5	5	5			5	5				32				6
3		3				5				26		6				
4	1		13	16	16										24	24
5				17	18				26				31		23	35
6	2	11				16	26								35	
7			14	12											6	
8	3			3												
9			3		13	7								6		
10											6					
11						17			30						(2)	25
12																
13	4	12														
14	5															
15																
16							17							22		
17						21										
18						22	27									
19			11													
20												(4)				
21			1		7											
22									24							
23																
24						23	28									
25					1					(2)	31		6			
26	6		15	1								33	33			
27	7						6					(3)				
28	8	7	6			24	24	23		23						
29							7				24	23			(2)	(2)
30							23									
31					19			6				13				
32									5	6				25		
33						6	29	27	27	27						
34						25		25		25		25				
35	10	10	10	7		10	25						(2)		(2)	
36	9				9		10									

[1] Mouse dead.
[2] Wandering shrew (*Sorex vagrans vagrans*) caught.
[3] Oregon meadow mouse (*Microtus oregoni oregoni*) caught.

Table 7 shows the resulting stands from spot seeding with Douglas fir and Port Orford cedar and from broadcasting Douglas fir seed at the rate of 1½ pounds an acre on two areas—(1) a "controlled" area, from which seed-eating animals had been removed, and (2) a control area, from which no attempt had been made to exclude them. The controlled area embraced about 5 acres. The animals removed from it are listed in table 8. The method of seeding normally tried in the region has been to rake seed into relatively large spots. In areas where sooty, or blue, grouse (*Dendragapus*) are common, as in the Long-Bell area, these spots serve the birds as welcome dusting places. Spot seeding was done with a corn-planter type of tool (fig. 5), as it was believed this would simulate the natural seed-spot sowing of mice (fig. 6) and chipmunks in caching seeds. The cost an acre, with the use of Douglas fir seed and with labor at 50 cents an hour, was $1.50.

Figure 6.—Thirteen 3-year-old Douglas fir seedlings, the result of seed cached by white-footed mice.

Practically all seeds that fell in suitable places and escaped mortal hazards germinated the first year, although a few may have carried over a year before germinating (table 7).[12] Some of the seedlings, however, were eaten by birds and small mammals. Some of the advance germination in a small seed cache reminded a mouse or chipmunk of its oversight and was uprooted as the spoonful of seed was retrieved (fig. 6). Others failed because they were in locations unsuited as to moisture and temperature requirements as the season progressed. All were faced by the danger of fire.

[12] J. F. Kummel, U. S. Forest Service, reported as follows: "In spring sowing as late as the middle of April, the seed has a marked tendency to hold over until the next year. Even so first year germination is on a par with that obtained in fall sowing. With the second year germination added, spring sowing produces a far greater number of trees than did fall sowing." W. F. Will, U. S. Forest Service, M. A. McLarty, Long-Bell nurseryman, and V. L. McDaniel, State of Oregon Forest Nursery, also report second-year germination of Douglas fir at times in nursery seedbeds.

TABLE 7.—*Germination and stand on controlled and control areas near Ryderwood, Wash., following direct seeding early in March 1936 with Douglas fir and Port Orford cedar*

[Slash burned 1929; shade density about 60 percent; southern exposure. Germination readings made April, May, and June 1936. Survival readings made December 7–11, 1936, and May 24, 1938]

Type planting and results	Douglas fir				Port Orford cedar	
	Controlled area [1]		Control area		Controlled area [2]	Control area
	1936	1938	1936	1938	1936	1936
Open:						
Spots—						
Planted ..... number	251	248	278	250	265	260
Germinated ..... do	195	.....	44	.....	120	137
Survived ..... do	163	[3] 175	37	.....	59	41
Stand ..... percent	65	70.6	13	12.4	22	16
Seedlings—						
Germinated ..... number	500	.....	235	.....	198	327
Survived ..... do	377	518	151	144	93	68
Hand-broadcasted seeds: [3]						
Seedlings counted ..... do	28	.....	3	.....	.....	.....
Estimated stand per acre ..... do	2,439	(4)	271	(4)	.....	.....
Under cones:						
Spots—						
Planted ..... do	256	[5] 189	250	[5] 193	246	251
Germinated ..... do	222	.....	192	.....	136	190
Survived ..... do	220	163	189	135	117	97
Stand ..... percent	87	87	76	70	48	39
Seedlings—						
Germinated ..... number	1,134	.....	851	.....	289	449
Survived ..... do	1,111	1,222	820	867	209	218

[1] Areas from which animals were removed. For numbers removed, see table 8.
[2] See footnote 12 (p. 16) pertaining to second-year germination.
[3] Rate 1½ pounds of seed per acre. Two 500-foot transects, each 6 inches wide, made across each area.
[4] From 50 random milacre samples examined December 1938 estimated survival was 2,140. Variation caused by method of examination.
[5] From 50 random milacre samples examined December 1938 estimated survival was 660. Variation caused by method of examination.
[6] Cones removed during summer of 1937 from all but 1 row, which was not read in 1938.

TABLE 8.—*Animals trapped in 1936, with Douglas fir seed used as bait, from controlled area shown in table 7*

Animal	Individuals trapped										Total
	January				March				April		
	19	21	24	28	3	12	19	24	6	14	
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
White-footed mouse (*Peromyscus*)	7	2	0	0	3	1	3	4	4	1	27
Meadow mouse (*Microtus*) [1]	1	0	1	6	0	0	1	6	1	0	16
Shrew (*Sorex*)	0	0	0	0	0	2	1	5	9	3	23
Song sparrow (*Melospiza melodia*)	1	0	2	2	0	4	0	6	3	6	34
Winter wren (*Nannus hiemalis*)	0	0	0	1	0	0	0	0	0	0	1
Junco (*Junco oreganus*)	0	0	0	1	0	0	0	0	0	0	1
Towhee (*Pipilo maculatus*)	0	0	0	0	0	1	1	1	0	0	3

[1] Taken in grassy area in protective strip below plot.

ANIMALS THAT AFFECT GROWING TREES

Rabbits

In the Douglas fir region, rabbits retard to a greater extent than any other animal the growth of young trees by cropping. Investigation made after the Crown Willamette Paper Co. reported in 1925 that their reforestation efforts near Astoria, Oreg., were experiencing a severe setback proved that the redwood brush rabbit (*Sylvilagus*

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FIGURE 7.—Singed and whiskerless, a young redwood brush rabbit driven out of a slashing by fire.

bachmani ubericolor) (*10*) (fig. 7) was damaging planted Sitka spruce. Within 3 weeks after planting, as high as 40 percent of the seedlings, which were 6 to 20 inches high, were cropped. The cutting varied from removal of the terminal bud to severance of the seedling at the ground. Some of the tops lay where they had fallen; others had been eaten. Examination showed also that the natural reproduction of Sitka spruce had suffered too but not so much. Other natural food was abundant, as the area had not been burned after logging.

The next report of this type of injury came in January 1932, when the Long-Bell Lumber Co. stated that serious damage was being experienced on their attempted plantings. Upon examination it was estimated that up to 95 percent of the planted Douglas fir seedlings were being cut off and eaten by the Washington varying hare, or snowshoe rabbit (*Lepus washingtonii washingtonii*). Some of the planted trees were larger than a lead pencil in diameter and up to 18 inches high (fig. 8, *A*). On test areas 38 percent of the trees were cropped by this rabbit within a month and 94.4 percent within a year,

and of the injured trees, 35 percent were heavily, and usually fatally, cropped. Attack appeared to be heaviest immediately following planting and continued into early summer. When the tree survived, its bushy growth seemed to be more attractive to the rabbits and the pruning was continued from year to year (fig. 8, *B*).

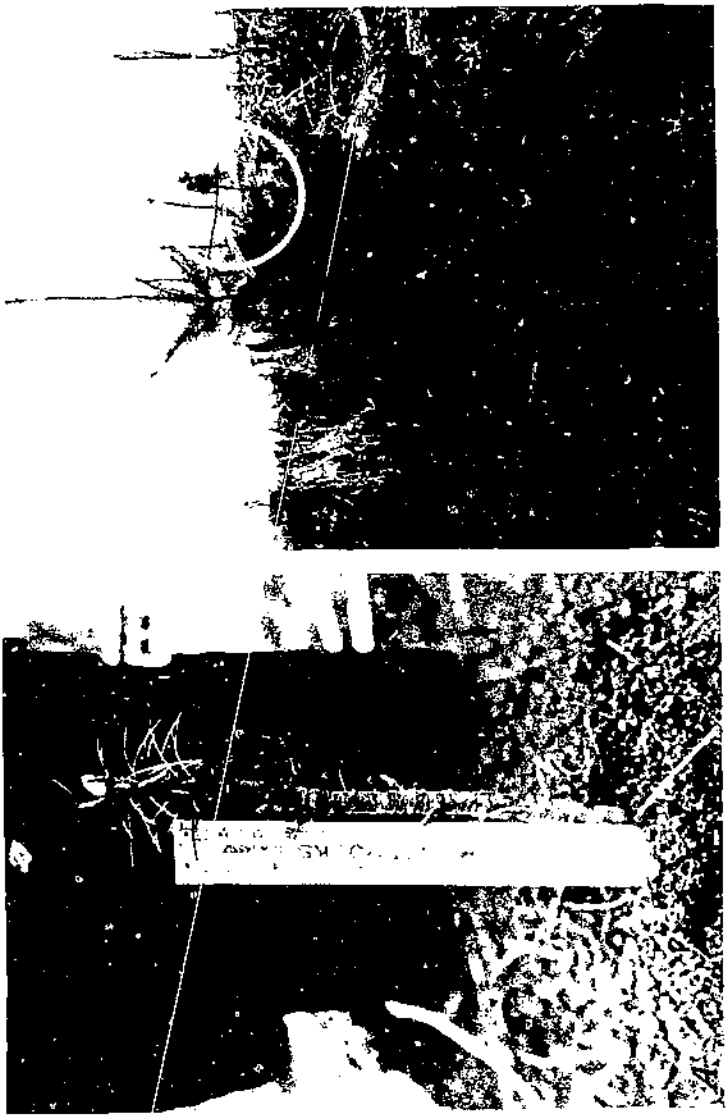

FIGURE 8.—Douglas fir croppings: *A*, Planted tree cropped by Washington varying hare; *B*, two trees planted under same conditions 6 years before picture was taken, one of which has been constantly cut back by rabbits.

The Washington varying hare is of about the same weight as the eastern cottontail but is more rangy in build. In the coastal section its pelage remains rusty brown throughout the year. A crew that spent about 350 hours over a period of 3 years in experimental planting in the Long-Bell Summit yard planting area saw but three live

varying hares, but browsing signs and fecal deposits showed the population to be extremely heavy.

Anthony (*1, p. 483*) states:

> Varying Hares have usually 3 or 4 young in a litter, but may have as many as 8 or 10 during the cycle of increase. There is evidence to show that these Hares have more than 1 litter a year.

In the encouragement it gives to poachers, the varying hare probably does much harm in the reforestation areas, not as to actual reforestation operations, but in its effect on wildlife. Though seldom used for food, it provides an excuse for carrying guns. Out-of-season grouse shooting results, and under the guise of rabbit hunting, dogs that also may chase deer are afforded entry.

Nelson (*10, p. 18*) states:

> The scarcity of rabbits, both individuals and species, in such humid, heavily forested sections as exist on the northwest coast and even in the wooded eastern third of the United States is in strong contrast to their abundance on the arid plains of the Desert Plateau.
>
> The vertical range of rabbits appears to be governed only by the presence or absence of sufficient vegetation for food and shelter, and extends from the tropical coast to above timberline, sometimes on the lofty volcanoes of Mexico reaching an altitude of over 14,000 feet.

Primarily, the brush rabbit and varying hare are browsers. Succulents, such as clovers, apparently are not eaten, although a red huckleberry bush or a young Douglas fir growing near them may be trimmed severely. Many data are available concerning trees and shrubs cropped by these rabbits, but as they cover nearly the entire list of those common to the region, no detailed record is presented. Two similarly vegetated areas, about 6 miles apart, on the Long-Bell logged-over holdings were checked as to croppings. Although rabbit population, elevation, and climatic conditions were apparently similar, on one plot salal had been heavily cropped but on the other, merely touched.

Little is known about the relation of the cottontail rabbit (*Sylvilagus nuttallii*) to reforestation, but the species is believed to be of minor economic importance. It is distinguished from the brush rabbit by the white part of the tail that is plainly visible when the rabbit is running.

Port Orford cedar is one commercially important tree that, aside from light sampling, is not attacked by rabbits. This fact was demonstrated by plantation checks over a relatively wide area and by cage tests. It is claimed that hutches constructed of Port Orford cedar are left untouched by rabbits, whereas those built of other types of lumber are badly gnawed. In suitable situations, the growth of this tree exceeds 2 feet a year, making excellent pole and post stock in a relatively short time.

Although natural conifer reproduction may be cropped only lightly or to a moderate degree by rabbits, planted stock is attacked immediately after planting, even in areas that have a light sprinkling of naturally seeded trees. As the individual rabbit ranges over only a few acres, it would appear that the attacks are caused by the introduction of something new in the region. With one exception, these croppings were found at elevations under 2,000 feet.

The theory that odors from the planters' hands possibly have an attractive effect must be dropped. Planting is often done in rainy, cold weather, which causes the hands to become blanched and odorless, but trees planted under these conditions were readily attacked by rabbits. Cultural methods in the nurseries vary as do their soils; fertilizers of different types, from plowed-under green manures and barnyard manures to concentrated commercial forms singly or in combination, produced Douglas fir trees that showed no apparent difference in susceptibility to attack (table 9).

TABLE 9.—*Rabbit cropping of Douglas fir planting stock at Summit Yard site, Ryderwood, Wash.*

[200 of each stock planted March 1933; checked April 1933 and April 1934]

Condition of trees	Oregon Clark-McNary 1-1 stock [1]		Long-Bell stock			
			2-0 stock [2]		Repellent-treated [3]	
	1933	1934	1933	1934	1933	1934
Cropped:	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Slightly	29	15	57	13	57	49
Moderately	33	41	64	94	32	33
Heavily	111	130	50	78	36	67
Total	173	186	171	185	125	149
Not cropped	25	10	29	14	75	49
Missing	2	4	0	1	0	2
Dead	0	81	0	128	0	120
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cropped	87	93	86	93	63	75
Dead	0	41	0	64	0	60

[1] 1-1 stock: 1 year in seedbed, 1 year in transplant bed.
[2] 2-0 stock: 2 years in seedbed, not transplanted.
[3] 1 of the best of a number tried. Repellents are seldom effective for more than a few weeks if dependent upon volatile oils.

Trees from weed-choked, neglected nursery beds were just as attractive to rabbits as healthy stock, but pulled trees of natural reproduction proved less acceptable, according to a check made at Summit Yard site March 22, 1932, of rabbit cropping of Douglas fir of 2–0 healthy and 2–1 [13] sickly and weed-choked Long-Bell nursery stock and 2- to 3-year-old natural seedlings, 250 of each stock having been planted on March 8, 1932. Of the healthy stock, 85 percent had been cropped; of the sickly stock, 93 percent; and of the natural seedlings, 51 percent. It would seem that rabbit attack depends on something other than succulence, as the weed-choked trees were far from being tender morsels and their remaining needles were comparatively yellow. Nursery-grown trees are usually at least twice the size of naturally produced trees of like age. Accordingly, when a 2-year-old artificially grown Douglas fir is planted, the top consists of 3 to 6 inches of 1 year's growth compared with 1 or 2 inches on the natural reproduction. Histologists may be able to furnish added information as to why rapid nursery growth provides a seedling that is attractive.

[13] For explanation, see footnotes 1 and 2, table 9.

Mountain Beaver

The mountain beaver (*Aplodontia*) (fig. 9, *A*), a nocturnal animal with a misleading common name, as it prefers lowlands to mountains and is not a beaver, occurs in scattered areas over the Douglas fir region.

Figure 9.—*A*, This mountain beaver objects to being held by the back of its neck. *B*, Surrounded by dense timber 80 to 100 feet tall, glades kept open by mountain beavers make favored deer nooks.

Distribution is mainly along the coastal strip but is very spotty and is not known exactly because of the density of cover. Scheffer (*12*) has presented a detailed discussion of the habits, economic status, and

control of this animal, and further reference here will pertain to supplemental information.[14]

The animal has the same broad range in food habits as have the browsing rabbits of the region. It, too, passes up Port Orford cedar, but, unlike the rabbit, it eats succulents of nearly all kinds. Stakes up to more than half an inch in diameter that mark plantings and small trees of all kinds are cut off when they interfere with the animal's progress.

Some of the mountain beaver's activities are seasonal. Spring house cleaning is practiced by the removal of winter refuse from the burrows when this sodden accumulation loses some of its water content with the cessation of rainfall. Individual range is more extensive in summer than in winter. Large bracken fern areas provide cover under which the animal extends its surface trails. In fall the fern fronds, often head-high, rising from a dense root system, die and settle to the ground. With this cover gone, the animal restricts its wanderings to the margins of timber and brush shelter, occasionally working out into the fern area a short distance under the cover of a fallen tree.

The animal's actual status in relation to the forest is questionable. Its pruning of forest plantations brings disfavor of the planter. In dense forests, however, its browsing maintains openings in which deer food flourishes (fig. 9, *B*). These small glades abound with evidence of black-tailed deer (*Odocoileus hemionus columbianus*) occupation, and fawn tracks are numerous.

Mountain beaver and rabbit croppings are almost identical in appearance, but the beaver climbs, delimbs, and tops small saplings (fig. 10). Both animals have been trapped from mountain beaver runways. Studies are under way to learn more about the relations of the two and the true position of the mountain beaver in nature.

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FIGURE 10.—Red alder topped and pruned by mountain beavers.

OTHER ANIMALS

Porcupines (*Erethizon*) are of little importance in the Douglas fir region, as their numbers are few. Pocket gophers (*Thomomys*) occasionally crop and bark trees when deep snows cover the ground, and the damage is often attributed to porcupines (fig. 11). Pocket gopher identification signs are tooth marks smaller than those of the porcupine and the presence of winter earthen casts, called ropes.

[14] For later information on control methods consult the Bureau of Biological Survey, Washington, D. C.

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FIGURE 11.—Lodgepole pines barked and trimmed by pocket gophers under cover of deep snow; commonly thought to be work of porcupines.

Winter concentrations of deer and elk (*Cervus canadensis roosevelti*) at times cause concern because of the denudation of areas by their browsing. Changes in management alone can remedy such conditions. O. J. Murie views the Olympic elk concentration with no alarm so far as commercial conifers (fig. 12) are concerned.

A spectacular type of damage to trees in a 20-year-old plantation on Mount Hebo, Oreg., the work of the black bear (*Euarctos americanus altifrontalis*), was noted in 1935. Bark, often three-fourths of an inch thick, had been clawed from the trees and the cambium, or under bark, grooved, apparently with the lower incisors (fig. 13). This occurred during

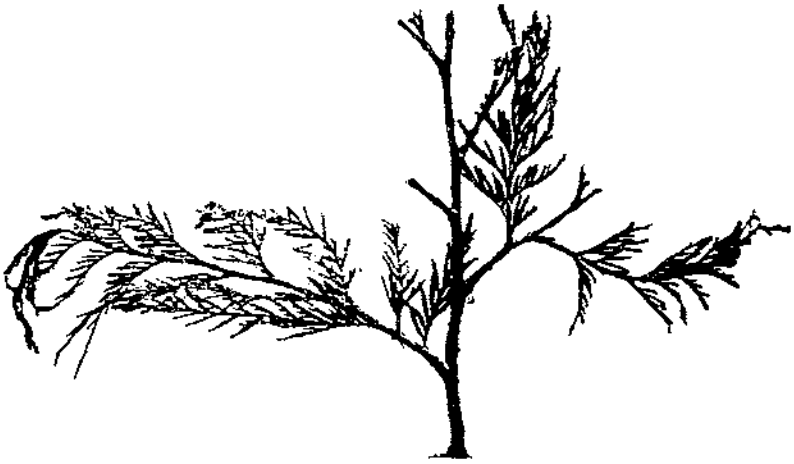

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FIGURE 12.—Elk cropping of tip of young western red cedar. Elk and deer seldom make a clean cut.

late winter and early spring, at the time the bark was slipping. Apparently about 2 percent of the trees in this plantation had thus been

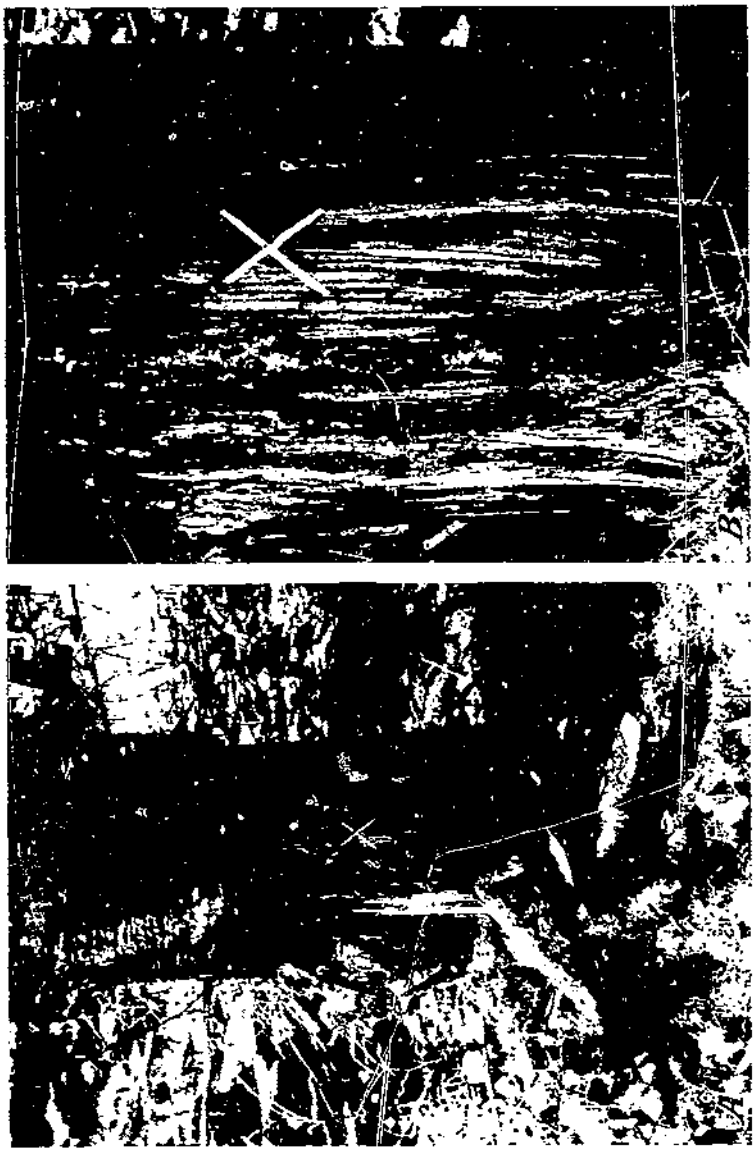

FIGURE 13.—A 25-year-old Douglas fir barked by black bear: *A*, Clawed-off pieces of bark at base of tree (matches crossed on tree); *B*, close-up of grooving made by bear on cambium of tree.

damaged over a period of several years. Some of the western Indians used cambium as a part of their normal diet.

The sooty grouse (*Dendragapus fuliginosus fuliginosus*), which has the startling habit of noisily flushing underfoot, in places takes a light

toll of small seedlings. Browsing by this feathered animal also occurs on conifers of all ages. On one of the Long-Bell study plots 300 1–1 [15] Douglas fir seedlings were planted on March 9, 1939. A check made 11 weeks later showed 15 seedlings with needles and buds and 4 with needles only cropped by the sooty grouse (fig. 14); 5 cropped by rabbits; and 1, by an undetermined agent. All the needles nibbled by the grouse were old ones. The same type of browsing has been observed on other areas.

FIGURE 14.—A 3-year-old Douglas fir browsed by sooty grouse.

INDICES OF DAMAGE

All attempts to develop some index for use in predicting faunal influence upon flora of certain areas have failed. Animal populations may be carefully determined upon two given areas and the findings of injury traceable to the animals may show that the lesser populated area has received the greater damage. Further study may qualify the meaning of the term, damage.

In January and February 1938 approximately 1,500 natural-reproduction forest-tree seedlings on the Cascade Head experimental forest were marked by stakes to indicate the species and whether cropped. From a 1-acre plot on the study area, mountain beavers were excluded by trapping. In 14 months, 112 were taken from traps placed around the margin of the acre. In addition, 7 brush rabbits were unintentionally caught. In live trapping on the area only 1 rabbit was taken during the winter of 1938–39.

Despite the severe reduction in the population of cropping rodents, the number of Douglas fir seedlings cropped increased 21 percent, Sitka spruce 24 percent, and hemlock 11 percent. The average height of the Douglas fir seedlings decreased 0.2 inch, while Sitka spruce and hemlock gained 2 and 1.3 inches respectively. On an uncontrolled acre, the number of Douglas fir seedlings cropped increased 38 percent, Sitka spruce 8 percent, and hemlock 29 percent. Gains in average height were one-half, three-fourths, and one-third of an inch, respectively. Mortality was found to be three times greater among the uncropped trees. Accordingly, even were a "yardstick" available it would be difficult to determine whether its measurements should be used to commend or to condemn a species.

Population counts of seed-eating mammals give the same unstable readings. Extremely light populations often leave indications of having taken a heavier toll of seed than far greater populations take. Seed broadcasted on snow or seed covered by snow soon after being

[15] For explanation, see footnote 1, table 9, p. 21.

sown appears more readily to escape detection by mice than that sown without benefit of snow. Trials in 2 years on the Long-Bell area have given indications of this variable factor.

SUMMARY

In the Douglas fir region in Oregon and Washington, an enormous quantity of debris remains on the logged-over areas after the removal of salable logs. State laws in general effect require the controlled burning of this trash. With this burning most of the desirable young tree growth is destroyed. Recurring fires in subsequent years make the denudation more complete. When logging operations are confined to small blocks, nature reseeds the cut-over areas from nearby standing timber. Large-scale operations leave deforested areas too extensive to be so regenerated. The condition may be remedied in part by burning only that part of the slash that presents a fire hazard to standing timber.

Seed-eating mammals, active at all times of the year, find in forest-tree seeds a favorite food. White-footed mice are the most important consumers, as they occur over the entire region. The shrew and related forms, although classed as insect eaters, also take heavy toll of seeds, owing to their great abundance in the coastal strip. Squirrels, chipmunks, and other mammals are of minor importance in total seed consumption.

Reproduction from such seeds as escape and germinate furnishes food for browsing animals. The brush and snowshoe rabbits, common in the region, do the greatest amount of cropping. The mountain beaver plays a minor role, as apparently do big-game animals also. Artificial reforestation appears to suffer more from animal attack than does natural regeneration.

Population counts of animals give unstable readings as to measurements of damage, because of the ever-present factor of variables.

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