Control of White-footed Mice of the Pacific Northwest

by

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PREFACE

This thesis on Control of White-footed Mice of the Pacific Northwest is written in partial fulfillment of the requirements for the degree of Bachelor of Science.

The writer attempted to gather the most recent data in presenting the problems connected with reforestation in the Douglas-fir region.

The writer wishes to thank Mr. A. W. Moore, Biologist for the U. S. Fish and Wildlife Service, and Mr. John Woods, Jr., Assistant State Forester of Oregon, for their splendid cooperation in furnishing information in personal interviews. For several years these two men have cooperated in experimental work to control the white-footed mouse population in direct seeding of Douglas fir.

Material gathered from Mr. Moore and Mr. Woods has been given a number referring to the Bibliography, as has data obtained from other sources.

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INTRODUCTION

Maintaining a constant supply of timber from which to draw for industrial needs has been of concern to foresters for a number of years. World War II placed such a drain on the Douglas-fir timber resource of the Pacific Northwest that government agencies, as well as private foresters, are making efforts to increase reforestation by artificial means. In the course of their efforts they have found that many factors interfere with maximum natural or artificial regeneration.

It is believed that the greatest single problem in reforesting these cut-over Douglas-fir lands by both natural and artificial reseeding, is the depredation of seed-eating rodents. Other factors which hamper reforestation are: availability of seed source, soil type and condition, moisture supply, prevalence of destructive insects, birds and diseases, and temperature. However, as a result of this study, it is concluded that small rodents are the great problem in reforesting Northwestern Douglas-fir lands. Chief among these rodents are the white-footed mice (Peromyscus).

This thesis will deal mainly with the destructive work of mice in Douglas-fir reforestation, and the various methods for control of these rodents.

Data has been obtained from rather wide reading of library sources and from personal interviews with members of

the Oregon State Department of Forestry and the U. S. Fish and Wildlife Service. These two agencies have cooperated in some detailed studies of rodent control in Douglas-fir reforestation in Oregon.

Early Attempts at Rodent Control

Attempts at rodent control in the United States have been made since as early as 1808.[14] At that time, of course, they were confined primarily to farm and orchard protection. These early experiments were usually of the repellent type and consisted of protective coatings to seeds, such as red lead, copper sulphate and coal tar. They are ineffective, however, since rodents readily remove the coating to obtain the seed kernel.

For many years attempts at poisoning were confined to the use of strychnine in baits. This is not effective in controlling white-footed mice, however, as the bitter taste of strychnine prevents their taking enough to kill.[13] Also, small doses of strychnine at intervals will develop a tolerance for it in the rodent. As a matter of fact, Moore cites cases of white-footed mice making nests and giving birth to young in sacks of poisoned grain. The young do not live, however, whether due to the poisoned grain or the milk of the mother, in which a tolerance for strychnine has been developed.[20]

With the initiation of reforestation experiments in 1908 by the U. S. Forest Service near Hebo, Oregon, the problem of

rodent control in connection with forestry achieved increasing importance. In 1912 Dearborn reported that, of the animals likely to destroy seed in this area, white-footed mice were at least 4 to 1 in preponderance.[8] Further attempts in 1912 and 1913 to reseed this area resulted in failure, apparently due to the rodent population and ineffective controls.

DESTRUCTIVE MICE IN THE DOUGLAS FIR REGION

Area Involved

The Douglas-fir region in Oregon and Washington west of the Cascade Mountains includes an area of 54,885 square miles, of which about 82.5 percent, or 29,001,910 acres, is classed as forest land.[8] This area, before World War II, included 38 percent of the Nation's standing saw timber.

White-footed Mice (Peromyscus)

In a well-forested area the loss of tree seeds to seed-eating rodents is of small significance. In reseeding cut-over lands, either naturally or artificially, however, seed loss to rodents becomes of major concern. It would be impossible to calculate the number of white-footed, or deer, mice in the Douglas-fir region in Oregon and Washington. They are found in great numbers in all parts of this region, as well as being widely distributed throughout the United States from sea level to mountain peaks. These mice, therefore, are extremely influential rodents. Because their food preference is Douglas-fir seed, and because of their great

numbers, white-footed mice consume more conifer seed over this Douglas-fir region than do animals of any other group.[8]

The white-footed mouse has prominent black eyes and large, rounded ears, lightly haired, and is gray in color. It has a long tail which is more than one-third of the mouse's length, and conspicuous white underparts and feet. The young are slate gray, changing to brown as they approach maturity. The average weight of the medium-sized adult is one ounce. Its over-all length is about eight inches.[4]

Fig. 1. White-footed Mouse. (Courtesy U. S. Fish and Wildlife Service)

Like all mice, the white-foot is very fecund. In the Douglas-fir region each female gives birth to litters of from 4 to 6 from April to September, gestation period being approximately one month. Midwinter males are not sexually active apparently.[8]

White-footed mice are very adaptable in their food habits. They prefer seeds, nuts and grains. If pressed for food, they devour bodies of mice killed in traps and will also kill and eat pocket mice.[4]

Seed preference in the Douglas-fir region rates Douglas-fir and hemlock the same, spruce and true firs quite low, and cedar not at all acceptable.[20]

These mice are nocturnal in their foraging habits, and while they do not make runways themselves as do the meadow mice, they use the trails of other mice and tend to develop a pattern.[2] Like various other rodents, the white-foot stores food, frequently in an abandoned bird's nest.

It is interesting to note that Moore has found in field studies that shrews play a definite, deleterious part in natural reforestation.[8] However, so little is known of these animals and their numbers that it is difficult to make a definite estimate of the damage they cause to Douglas fir reforestation.

In Moore's Technical Bulletin 706[8] he describes tests made with Douglas-fir seed spots. ". . . on these the type of hulling proved the work to be that of these little ani-

mals. (Shrews) In contrast to the clean cleavage of the hull by Peromyscus . . . 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."

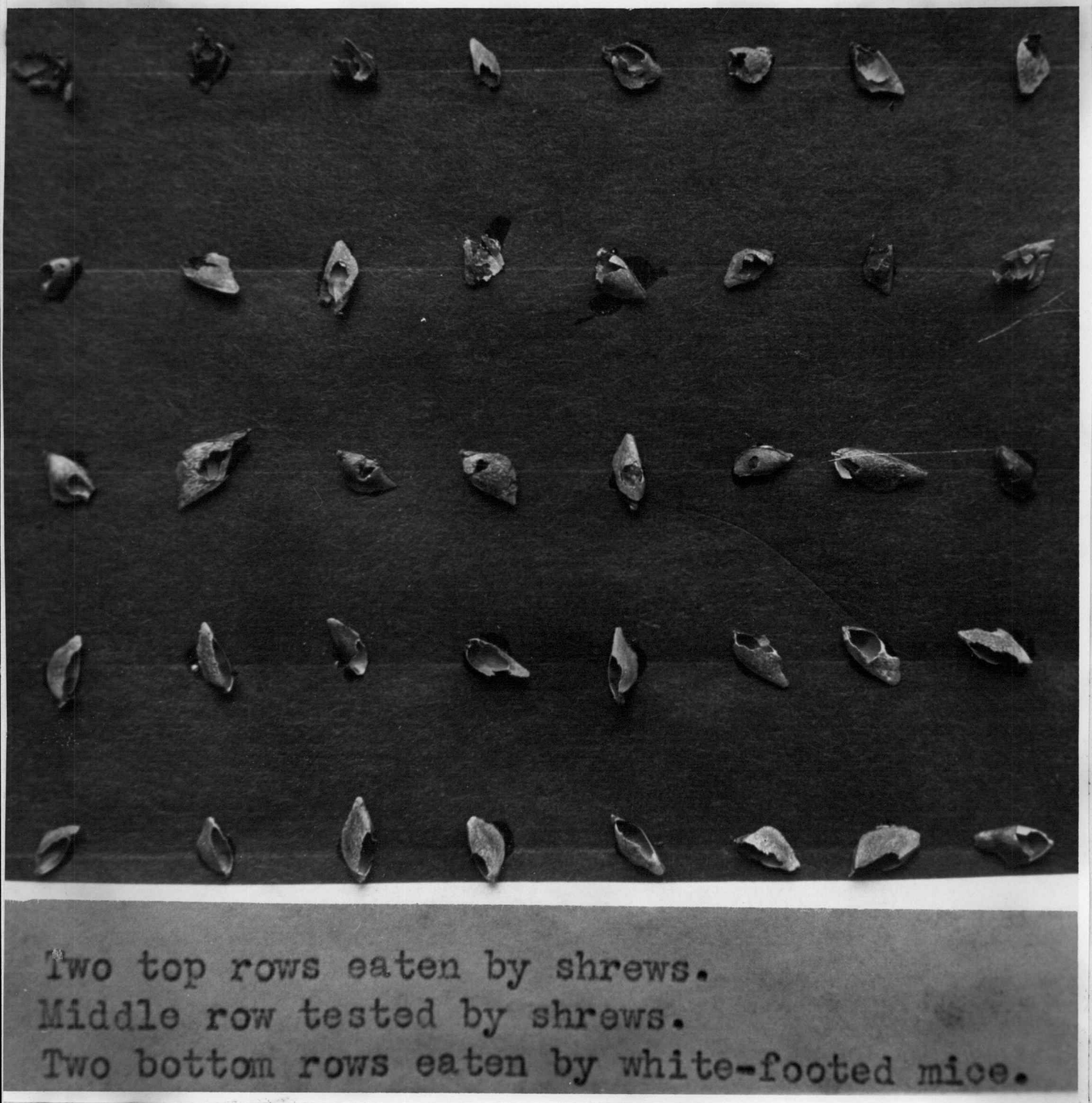

Fig. 2. Douglas fir seed hulled by shrews and mice.
(Courtesy U. S. Fish and Wildlife Service)

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Fig. 3. Shrew caught in trap baited with Douglas-fir seed.
(Courtesy U. S. Fish and Wildlife Service)

Since numerous attempts to keep shrews in captivity have failed, it has been difficult to make a detailed study of their habits. It will be observed in the following trapping test, however, that shrews seem to be not so plentiful as white-footed mice, and therefore unable to commit the same extent of damage. It is possible, of course, that trapping shrews may be more difficult than trapping white-footed mice.

The following table covers a four-year trapping record on the same trap line, homestead area 5 miles southwest of Ryderwood, Washington. This homestead had been cleared and reverted to Douglas-fir, cedar, and hemlock, and on which

about 5 acres of 40-foot second growth timber was left standing when the surrounding old growth was logged.[8]

Date	Traps used	Animals taken: White-footed mouse		Oregon meadow mouse		Townsend chipmunk		Wandering shrew	
		Males	Females	Males	Females	Males	Females	Males	Females
	No.	No.	No.	No.	No.	No.	No.	No.	No.
1935									
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	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

Table 1.[8]
Four-year trapping record on homestead area near Ryderwood, Wn.

Meadow or Field Mice

The meadow mouse (Microtus) is another rodent which eats forest-tree seeds. However, since these mice occur mainly in grasslands where conifer seeds find difficulty in becoming established, field or meadow mice are considered relatively

harmless in the reforestation of the Douglas-fir region. According to A. W. Moore[20] meadow mice are primarily green-feed eaters, in comparison with the white-footed mice which are primarily seed eaters.

These mice frequently do considerable damage to seedlings, particularly during the winter months under cover of the snow.[9]

The meadow mouse is chunky shaped, has a short tail and coarse, gray-black fur, all of which distinguish it from other mice.[9] Meadow mice may breed throughout the year, the litters averaging five young. However, severe increases are usually cyclical, at about 4-year intervals.

From the evidence, meadow or field mice are more addicted to attacking young seedlings and shrubs, and would, therefore, be a more serious problem on plantations than in forest cut-over areas.

TYPES OF CONTROL

For the last few years methods for controlling rodents have received considerable study from the Fish and Wildlife Service and from agencies concerned with reforestation.

Methods of protecting seeds may be divided into two general classes; namely, reductional control, which would involve the removal of all or most seed-eating rodents, and the use of repellents or mechanical barriers. Under reductional control, the following are discussed: Diseases, nature control, trapping, and poisons. Progress in the repellent type of control is discussed under Repellents.

Diseases

Attempts at rodent control through the use of biological diseases have not proved very successful, although they have been tried to some extent. Epidemics do occur in nature among certain animals, but in general, they are somewhat limited and are cyclic in nature.

It is possible that the use of diseases may become of value in rodent control, but to date it has not been favored because of the danger of spreading to other animals and to human populations.[12]

Nature Control

It is true that small rodents are taken by predators such as carnivorous mammals, snakes, hawks, and owls. However, this method of control is not likely to be of much value. In nature there is generally a balance maintained among animals, so that a rodent population sufficient to furnish food for predators would exert pressure on natural or artificial reseeding.[12]

Trapping

Trapping has been effective in removing rodents from an area for experimental purposes but is not practical over large areas or where continued reduction in population is necessary. It is too expensive to be practical, and the rodents may reinfest the area as fast as they are removed by traps.[12]

Poison

The use of poisons to control rodents where reforestation is done by direct seeding has so far proved to be the most satisfactory and the cheapest means of reducing rodent populations enough to permit adequate restocking of forest land. A good many poisons have been tried, but, for one reason or another, they have not proved entirely satisfactory.

E. E. Horn, in a publication of the North American Wildlife Conference, states that a poison to be effective should be quite toxic, tasteless, gritless, odorless, and slow to exert toxic action.[15]

The most common poisons used are:[19]

1. Barium carborate
2. Red Squill
3. Arsenic Trioxide
4. Alkaloid Strychnine
5. A.N.T.U. (Alphanapthylthiourea)
6. Zinc Phosphide
7. Thallium Sulphate
8. 1080 (sodium fluoroacetate)

Of these poisons Thallium Sulphate has proved to be probably the best all-purpose poison and "1080" the most potent of all because it will cause secondary poisoning to rodents or other animals that may eat those killed by the poison. There is no known antidote for "1080". For these reasons this poison would have to be handled by trained persons.[7]

1080. "1080", or Sodium fluoroacetate, was developed in the Fish and Wildlife research laboratory in Denver, under special grant of the research group of the Signal Corps. It received its name by being the one thousand and eighty-th ?

material tried. During the war this laboratory sought rodent repellents and poisons to be used on packaged goods, K-rations, etc.[20]

If it were not for the fact that 1080 leaches badly under climatic conditions of the forest, this poison might have been the answer to rodent control in reforestation. Seed soaked in 1080 solution does not lose its germinating power as does that soaked in Thallium Sulphate, and there is an ample and not-too-expensive supply of the 1080.[20]

Thallium Sulphate. Thallium Sulphate is a smelter by-product discovered and developed for use in Germany. This product was first discovered during investigations of the frequent deaths of laborers who cleaned the flues in lead, silver, and zinc mining operations. Thallium Sulphate was obtained from flue dust and was found to be the cause of numerous deaths.

Before the war the United States could purchase Thallium Sulphate from Germany at $6.50 per pound, but at present it is $75.00 a pound, when obtainable at all. As yet, the United States is salvaging very little of this by-product. Thallium Sulphate is a corrosive type poison. Poisoned seed mixed with clean seed for more than 24 hours is apt to injure the clean seed. A filled planting tool usually lasts one-half day, and it is recommended that seed be mixed as it is used.[20]

The State of Oregon Forestry Department has been using

Thallium Sulphate with favorable results in treating Douglas fir seeds for artificial seeding. It is quite toxic and must be handled with care.[4]

In earlier experiments oat groat or sunflower seeds were impregnated with the poison and distributed over the area. Where the poison was used in this manner and the tree seeds mixed with the oats or sunflower seeds, it was found that the mice would generally eat the tree seeds first. Later, better results were obtained by impregnating Douglas fir seed with the poison, and at the time of sowing, non-poisoned seeds were mixed with the poisoned ones in a mixture of one-third non-poisoned to two-thirds poisoned. With this ratio the mice would soon get enough poisoned seed to effectively reduce their number, although a considerable number of the non-poisoned seeds would also be destroyed.

It has been found that coloring the seeds with a green dye is effective in preventing the seeds from being picked up by birds.

An interesting observation here concerns the manner in which the Douglas-fir seedcoat absorbs dye. One side of the seedcoat has a waxy layer and the other, a corky layer. The corky layer will absorb the dye, but the waxy side remains the natural color. If this side is up when the seed comes to rest, it is not camouflaged and will be seen by birds. It is believed, however, that Thallium Sulphate is not toxic to birds.[20]

Repellents

For a number of years investigations have been carried on to find a repellent that is generally effective for rodents.

Red lead was perhaps the first repellent applied to seeds but was found only slightly deterrent to rodents.[12]

A. W. Moore states that the Fish and Wildlife research laboratory of Denver has tried some 1800 materials for their repellent possibilities hoping to find one that will repel rodents. Moore, himself, has tested at least 20 of these materials on white-footed mice. Every possible combination from the most potent-smelling concoction to simple ingredients has been tried. Some have proved successful against many rodents, but none has been found that will render Douglas fir seed repellent to white-footed mice.

Mice are guided by their sense of smell in feeding habits, and when a seed is found they deftly chip the seedcoat off the kernel before eating it. These two characteristics in foraging habits add to the difficulty of finding a satisfactory repellent. The scent of the seed must be masked so it is not easily found, or the seed must have a repulsive taste when eaten. Along with these requirements, the repellent cannot be injurious to the kernel or impair its germinating ability under normal weather conditions in the forest.

Moore has found that when Douglas-fir seeds are put

in the ground late in the season and do not germinate until the next season, they seem to lose their odor and are passed up by the mice. It may be possible that some treatment which will produce results similar to this natural condition can be given the seeds to kill their odor and yet not destroy their germinating ability.[20]

Moore has attempted to remove the odor from seeds with alcohol, since odor is volatile oil. However, this results in a weak seedling if germination is achieved at all.[20]

Actually the only repellent found to be completely effective against white-footed mice is creosote, and this destroys the seeds' germinating ability.[20] Consequently, its value in Douglas-fir reforestation would be negligible.

TYPES OF DESTRUCTION

Destruction of Seeds

Because of their wide habitat and geographic distribution, mice as a group are perhaps the greatest animal factor in retarding forest regeneration by seeds. Of the group, the white-footed mice have been found to be the most widely distributed and the most influential species.[12]

A. W. Moore agrees entirely with this opinion, and states that these mice consume more conifer seed over the Douglas-fir region than do animals of any other group.[8]

On the Columbia National Forest, 98 percent failure of seed spots of Douglas fir was attributed to the work of mice.[12]

Other mice known to feed on coniferous seeds are red-backed mice (Clethrionmys), meadow mice (Microtus), pocket mice (perognathus), and sage mice.[12]

In cage tests it has been found that the white-footed mouse will eat as many as 300 Douglas fir seeds daily.[12]

Experiments in the Black Hills by the U. S. Forest Service established that 30 to 70 percent of seed had been destroyed within 6 days after planting. Trapping on one-half acre containing 2,000 seeds secured 11 white-footed mice.[1]

Destruction of Seedlings

In observations made on study plots in the Wind River Valley, Washington, Leo Isaac noted the destruction of Douglas fir seedlings by Peromyscus.[8]

In a plantation near Chemault, Oregon, the mice did considerable damage to seedlings. A probable explanation of why nursery-grown seedlings are more readily eaten than natural seedlings is the fact that the stems of nursery stock are more pulpy because of rapid growth under nursery conditions.[20]

It is probable that mice will not do very extensive damage to seedlings unless other food is limited. The food habits of the white-footed mice are so varied that they would need to choose seedlings only as a last resort. Included in their diet are practically all seeds, insects, insect eggs and larvae, and succulent plant tissues.[8]

Other animals that are particularly destructive to seedlings in the Douglas-fir region are the brush rabbits (Sylvilagus backmani ubericolor). A. W. Moore feels that these rabbits are much more destructive than the Mountain Beaver, which does not cause as much damage to seedlings as is generally supposed.[20]

EXPERIMENTS IN RODENT CONTROL IN OREGON

T. T. Munger, formerly of the Pacific Northwest Forest Experiment Station, has advanced the theory that "control of rodents in large field operations has never been demonstrated to be practicable."[13]

On the basis of his own wide experience in rodent control in the Pacific Northwest, and as the result of recent experiments in cooperation with the State of Oregon Department of Forestry, A. W. Moore feels quite definitely that control on a large scale can be accomplished.[20]

Following are some experiments in reforestation and rodent control conducted by Moore, employed by U. S. Fish and Wildlife Service, and by Mr. John Woods, Assistant Forester, State of Oregon Department of Forestry. This information was obtained during an interview with Mr. Woods in Salem on October 28, 1947.

Experiment I

About five years ago the State of Oregon Department of Forestry made its first attempt at direct seeding in reforestation, using small plots. One half was seeded to Port Orford

cedar and one-half to Douglas-fir. The mice ate all of the Douglas fir seeds, leaving a good part of Port Orford cedar seeds.

Experiment II

The next year A. W. Moore of the U. S. Fish and Wildlife Service was called in to assist in the experiments, since he had recently conducted experiments at Ryderwood, Washington.

His system was to treat the area before planting with a bait of oat groat and Thallium Sulphate. The area of 40 acres was poisoned, plus a buffer strip of 1/4 mile entirely around the area.

About two months later results were checked and it was found that the groats had been dissolved by the rain. No rodent kill was obtained, as the groats dissolved almost immediately on application.

Experiment III

In this experiment Douglas-fir seed, itself, was used as bait, since this was also the most desired food of the rodents. New seeds were used and treated with Thallium Sulphate. The seeds were soaked in a 4½ percent solution of Thallium Sulphate at room temperature for 24 hours, thus impregnating both the seedcoat and the kernel. The seeds were then dried and colored green.

The area of 105 acres, plus a buffer strip of 1/4 mile on all sides, was first prepoisoned. When the seeding was done, additional poisoned seeds were placed in the seeding

spots, using 2/3 poisoned seed to 1/3 good seed.

Prior to the prepoisoning, a rodent count was made by setting 50 traps for three nights. The total catch was 36 white-footed mice and 21 meadow mice. Following prepoisoning, another count was made, and with 50 traps during three nights, 3 white-footed mice and one meadow mouse were caught.

Approximately one month after the seeding, another 50 trap-three-night count secured 3 white-footed mice and 3 meadow mice.

In this plot, rows of Douglas-fir seed were sown alternately with rows of Port Orford cedar. A germination count in May of 1946, about 4 months after the seeding, showed 33 percent of the Douglas-fir spots stocked and 40 percent of the Port Orford cedar spots stocked. In August of 1946 another count showed 40 percent of Douglas fir spots stocked and 35 percent of Port Orford cedar spots stocked. The last survey made in January 1947 showed 32 percent of Douglas fir spots stocked and 21 percent of Port Orford cedar. These checks were made by counting stocking at staked plots. Stocking at all stakes would show an over-all stocking of 1200 trees per acre.

Experiment IV

The next experiment in seeding Douglas-fir was conducted on a plot of 160 acres. Douglas fir seed was again used as bait, but not new seed. In a very old seed the inside

separates, becomes hard and less attractive as food. The soaking process again moistens up and fills out the inside, although it is better to use new seed. These seeds were processed with Thallium Sulphate in solutions of from 2 to 5 percent.

Prepoisoning of the area was completed on January 10, and required two days for a 5-man crew. The buffer strip was a talley, or 5 chains, wide, instead of the usual 1/4 mile. When the seeding was done the 2/3 to 1/3 ratio was used.

Between February 27 and March 1, 50 traps were set. The catch was one white-footed mouse and one meadow mouse, whereas before the prepoisoning there was an average of 12 mice to the acre.

This seems to indicate fairly effective poisoning.

Experiment V

A fifth experiment was conducted in Eastern Oregon in planting Ponderosa pine seeds, on an area of about 170 acres.

This time Moore recommended using whole oats impregnated with 1080 for prepoisoning, applied in strength of 3 ounces of 1080 per 100 pounds of oats. Approximately as much oats was dropped as poisoned seed on other experiments, and a buffer strip of ten chains wide completely around the area was also poisoned. A total of 16 pounds treated oats was used, or about 1/10 of a pound to an acre, requiring 15-man-hours to poison. This was completed March 25.

On April 15-16-17, the area was seeded to Ponderosa

pine seed. 15 pounds were used in seeding, 5 pounds of it left untreated. Five pounds was soaked for 4 days and frozen for 48 hours, and the remaining 5 pounds was stratified in moist peat moss for 50 days to make it germinate quickly.

Two-thirds of the spots were seeded with poisoned Douglas-fir seed and pine seed mixed. The rodents in Eastern Oregon again seemed to prefer the fir seed. The Douglas fir seed was treated with Thallium Sulphate in 5 percent solution.

As an experiment, Ponderosa pine seed soaked in 1080 was used in some spots. These were soaked for 52 hours in a solution at the ratio of 5 ounces of 1080 to 100 pounds of seed.

Very little damage was noted on the above area, according to Moore, until the seedlings started to come up. This seems to indicate that the heaviest damage in Eastern Oregon is caused by chipmunks or golden mantle ground squirrel. Mice smell the seed and dig them out before sprouting, while the chipmunk and ground squirrel forage mainly by sight.

Experiment VI

Following the Tillamook Fire of 1945, the largest experiment yet was undertaken. An area of 600 acres to be seeded by airplane was located on a peak, to enable seeding of all exposures. About two-thirds of the plot had been burned in varying degrees.

Before prepoisoning an effort was made to determine the

rodent population after the burn. On November 15-17, 1945, 50 traps were set out for the three nights, obtaining a catch of 42 mice.

In preparing for prepoisoning a buffer strip 1/4 mile wide was poisoned by hand, on the south, east, and north sides. The west was left unpoisoned because it bordered on an extremely hard burn and was also on a steep canyon. The strips were one chain apart, with poisoned seed every 20 to 30 feet. The seeds used were Douglas-fir treated with Thallium Sulphate.

On January 22, 1946, the job of prepoisoning the 600-acre planting area was started, but was not completed until January 27, because of adverse weather. One quarter pound of Douglas fir seed per acre treated with Thallium Sulphate was used.

The seeding was begun on February 16 and completed on February 18. At the time of the seeding, it had snowed and that was found to be advantageous for at least two reasons; namely, (1) It produces stratification effect on seed, and (2) it is easy to check distribution of seed, as the seeds are readily seen on the white background.

500 acres were seeded to Douglas-fir and Port Orford cedar, using one quarter pound each to an acre, or a total of one half pound per acre. One hundred acres were seeded to a mixture of Port Orford cedar, Western hemlock, and Sitka spruce in the following amounts per acre: 1/4 pound cedar, 1/8 pound hemlock, and 1/8 pound spruce.

From February 27 through March 1, 50 traps were set out over the 3 nights, obtaining a total catch of 6 mice. Wood suggests that a factor to be considered here is that the weather was pretty cold, and in cold weather mice are somewhat less active.

After the prepoisoning but before the seeding, 7 mice were caught in the heaviest burned portion of the plot. Burning seems to remove the mice only temporarily.

The total costs of this airplane seeding experiment were $5.13 per acre, divided as follows:

Prepoisoning buffer strip by hand	$ 0.65	per acre
Falling snags	0.58	" "
Airplane prepoisoning, use of plane	1.00	" "
Seeding by airplane, use of plane	1.00	" "
Cost of seed	1.90	" "
Total	$ 5.13	" "

On August 8, 1946, a check of the stocking results was made by the stock quadrant method. It was found that best results had been obtained on the north, northeast, northwest, and west exposures. For the area as a whole, the stocking by 250th acres was 42.5 percent. Stocking by slopes was as follows:

North slope	64.6%
NE slope	64.6%
NW slope	62.8%
West slope	60.0%
East slope	35.3%
SE slope	25.0%
South slope	21.0%
SW slope	0.0%

This would seem to indicate a higher stocking rate than would have been obtained under natural regeneration and without the use of poisoned seed.

OBSERVATIONS MADE DURING EXPERIMENTS

It has been generally believed that a bad burn is a fairly successful eradicator of rodent populations. This is a temporary condition, since it was observed during the foregoing and other experiments that white-footed mice range up to 800 feet (in a straight line) in a night. With such a wide range, they may shortly reinfest a burned area. Since Douglas-fir seeds can withstand a prolonged temperature of 200 degrees F., as during a forest fire, seeds are still available for food and would readily attract white-footed mice.[18]

Meadow mice also drift, but not to the extent of the Peromyscus.[20]

Prepoisoning an area before planting, including a wide buffer strip, seems to control the rodent population sufficiently well to allow the establishment of seedlings, which are less attractive to mice than are seeds. Since, in the planting, seeds are mixed 2/3 poisoned to 1/3 clean seeds, this acts as a second poisoning operation. It was felt that the prepoisoning would suffice, but the use of poisoned seeds in the seeding was additional precaution.

Experimentation proved that 6 freshly poisoned seeds will kill a mouse. It requires 12 seeds to get a killing when using poisoned seeds that have been placed under a screen throughout the winter and then used as poisoned bait. Leaching of Thallium-Sulphate-treated seeds is therefore not

a great problem.[21]

On page 6 of this text one can observe the appearance of Douglas-fir seeds hulled by mice. They make an opening just large enough to remove the kernel. In addition, the experimenters noted that seeds taken by mice were hulled at the seed spot, instead of carried away, as they would be if taken by other rodents, for example, chipmunks.[21]

CONCLUSION

The ubiquitous white-footed mice are an important factor in Douglas-fir reforestation because of their wide range and their preference for Douglas-fir seed in their diet. Many failures at reforestation by seeding have been caused by this small animal. Early attempts at control were generally unsatisfactory or economically impossible. In recent years poisoning with Thallium Sulphate has been used with more success than any other system of control.

The goal of those working on control methods is to find a suitable repellent with which to treat seed to prevent its being eaten by mice, and yet not to endanger the germinating qualities of the seed. Recently extensive work has been carried on by the U. S. Fish and Wildlife Service to find a suitable repellent, but, so far, no repellent has been discovered which will prevent the mice from locating the seed by smell or their chipping off the seedcoat and eating the kernel.

Quite recently a method has been devised to roll up

the seed in a pellet of soil and fertilizer, which furnishes an excellent environment for early germination of the seed. When a suitable repellent is found to include with the ingredients of the pellets, it is quite possible this method would insure a much higher percent of germination than has so far been attainable. The use of pellets would be particularly adapted to seeding by airplane, which, according to Mr. Woods, is the most economical means of seeding.

If, on the 29,001,910 acres of Douglas fir land in Oregon and Washington, there were an average of 12 mice per acre consuming 200 Douglas fir seeds per day, it would require approximately 1,800,000 seed trees per day, or 54,000,000 trees for a month of seed fall, to supply the mice with food. This is calculated on the basis of a seed tree producing 40,000 seeds per year.

These are rather astonishing figures, also significant ones when one considers it means almost two seed trees per acre supplying the mouse population with food. These figures are still more significant when viewed along with all of the other factors that may prevent seeds from germinating and becoming established as seedlings.

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