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FIELD AND LABORATORY TESTS OF SOME FOREST RODENT CONTROL PREPARATIONS

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Introduction

For years foresters in the Pacific Northwest have been concerned with the failure of vast areas of burned and cut-over lands to support coniferous reproduction even though neighboring old growth stands produced sufficient seed to restock the denuded tracts.

It has been difficult to establish reproduction by direct seeding methods in areas lacking natural seed sources. The destruction of seed by forest rodents is believed to be the main cause of the failure of natural or artificial seeding. Application of poison baits to areas prior to the aerial seeding has so far produced the best control of these rodents. The Tillamook Burn, a tract of approximately 311,000 acres in Northwest Oregon which suffered three severe fires in 1933, 1939, and 1945, has been the scene of several experiments and projects in direct seeding and baiting from helicopters by the Oregon State Board of Forestry. Post-poisoning rodent censuses run shortly after seeding and stocking surveys run a year after seeding show that the present baits control the rodent population sufficiently to allow the seeded areas to achieve fair to good stocking of year-old seedlings. Better baits should produce better control and better stocking.

The purpose of this experiment is to test some of the candidate baits and to measure more exactly the efficiency of the present materials. Since it is preferable to merely protect the seed from the mice without eliminating the resident population and its destruction of weed seeds and injurious insects, several potential repellents were also tested.

Field Leaching Experiment

Purpose

To determine the effect of exposure to weathering agents on poison baits and repellents.

Description of Poisons Tested

Coated "1080": This bait was coated with a mixture of "1080", three grams of the poison being applied to one hundred pounds of wheat.

Soaked "1080": The wheat was impregnated by soaking in an eight percent aqueous solution by weight of "1080" for twenty-four hours at a temperature of sixty-five to seventy degrees Fahrenheit. Wheat to be colored with green food dye during impregnation with poison. In addition to the green dye, the wheat received an over-treatment with a coating of cooking oil, soya or cottonseed, in which was dispersed a monastral green light-fast pigment. The over-treatment was applied at the rate of one pound green pigment and forty ounces of cooking oil to each four hundred pounds of wheat.

Thallous sulfate (Tl_2SO_4): The wheat was impregnated by soaking in a five percent aqueous solution by weight of thallous sulfate for twenty-four hours at a temperature of sixty-five to seventy degrees Fahrenheit. The wheat was colored with green dye during impregnation with poison. In addition to the green dye, the wheat received an over-treatment with a coating of cooking oil, soya or cottonseed, in which was dispersed a monastral green light-fast pigment. The over-treatment was applied at the rate of one pound green pigment and forty ounces of cooking oil to each four hundred pounds of wheat.

Coated "1080" with a single overcoat of safflower (Carthamus tinctorius)[1] oil: This bait is the plain coated "1080" described above which has been given an additional coat of safflower oil after the coat of poison has dried.

Coated "1080" with a double overcoat of safflower oil: This bait is the coated "1080" described above which has been given two additional coats of safflower oil after the coat of poison has dried.

Tetramethylene Disulpho Tetramine: The Douglas fir seed was soaked in a one percent solution of Tetramethylene Disulpho Tetramine in acetone for one hour and then dried.

Promurit: The Douglas fir seed was soaked in a one-half of one percent solution for twenty-four hours and then dried for twenty-four hours.

Warfarin: The wheat was treated with a mixture of approximately one-tenth of one percent warfarin in Diamond K Soya.

Description of Study Area

The site of the experiment is located in Sections 13 and 14 in Township 6 South, Range 9 West. This area is adjacent to the highway between Grand Ronde and Ocean Lake in Northwest Oregon and borders the southeastern portion of the Van Duzer Forest Corridor on the north flank of Saddle Mountain. The average elevation is approximately seven hundred feet above sea level. This area was cut-over during 1941-43 and the northwest portion of Section 13, where most of the plots were located, was moderately burned

1. A product of the seeds of a spiney-leaved annual of the Compositae family, native of the East Indies, and cultivated in Egypt for centuries for the brilliant red dye extracted from the flowers. The oil is used commercially in the paint industry and as a fuel for lamps.

in the fall of 1942. Re-logging operations carried on during the 1950 logging season covered most of the experimental site but this work was completed before the experimental plots were laid out so none of these plots was disturbed by the operation. The ground cover was made up largely of the following plants: grasses (Graminae), bracken fern (Pteridium aquilinum), trailing blackberry (Rubus vitifolius), vine maple (Acer circinatum), elderberry (Sambucus spp.), Oregon grape (Berberis spp.), Salal (Gaultheria shallon), huckleberry (Vaccinium spp.), and Douglas fir (Pseudotsuga taxifolia) reproduction. The major portion of the area supported a light or medium ground cover but there were scattered patches of salal where the cover was quite heavy (see photo #1).

The Oregon State Board of Forestry and other agencies have run many trap lines in cut-over areas in western Oregon. The data taken from these lines indicate that the rodent populations vary enormously even on areas with cover of similar types and densities. Therefore a line of snap traps was run (see sketch) near the proposed study area before the plots were located. These fifty traps were checked after one night and seven white-footed deer mice (Peromyscus maniculatus rubidus)[1] were tallied. No other animals were caught. Subsequently fourteen live traps (see photo #2) were placed (see sketch) and checked every night for three nights. Fifteen white-footed deer mice were trapped and brought to the laboratory at Salem; no other animals were caught. The results of this trapping indicated a population level that was approximately average for cut-over lands in western Oregon. The snap traps were set at intervals of one-third chain and baited

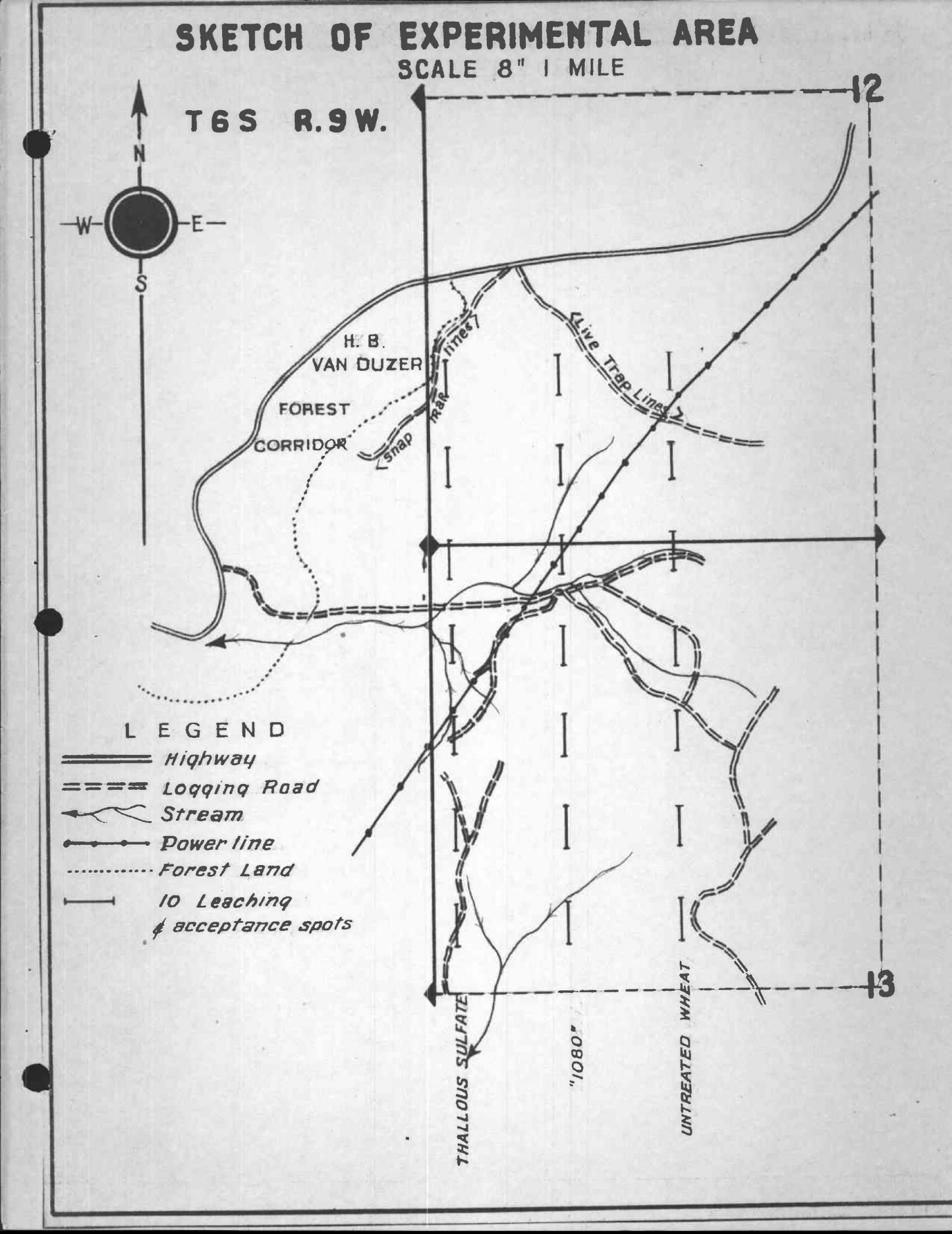
1. "Mammals of North America", Anderson, H. E.

Photo No. 1. Site of the experiment, Van Duzer Forest Corridor in background.

Photo No. 2. Tin can type live trap.

SKETCH OF EXPERIMENTAL AREA

SCALE 8" I MILE



with filbert nuts. The live traps were set at average intervals of one chain and also baited with filbert nuts. The weather during the trapping period was cloudy and light rain fell on the second night. Experience on areas of greatly varying size and cover type in western Oregon has shown that where the rodent population has been artificially removed by poisoning or trapping the mice from surrounding areas migrate into the treated lands and re-establish the population in a short time. Therefore it is believed that the slight drain on the resident population caused by the adjacent trapping did not lower the population level of the experimental tract appreciably.

Method

Field experiments by the Oregon State Board of Forestry had indicated that soaked Sodium Fluoroacetate ("1080") and Thallous sulfate baits afforded the best control of all the candidate rodenticides tested. A combination of these baits was used in the aerial seeding projects conducted by the Oregon State Board of Forestry in 1950. These two poisons were tested in this experiment to determine more accurately the effect of weathering on the lethal properties and palatableness of these rodenticides.

Early in January of 1951, three hundred leaching spots (see photo #3) were set, one hundred each of the Thallous Sulfate and soaked "1080" baits along with one hundred control spots of the untreated wheat. Ninety spots, or thirty of each type, were placed in Section 14 between the Van Duzer Corridor and the Salmon River. Each row of thirty spots contained only one bait or the untreated wheat and was laid out as follows: ten leaching spots spaced one-third of a chain apart, a five-chain interval, ten more

Photo No. 3. Typical leaching spot.

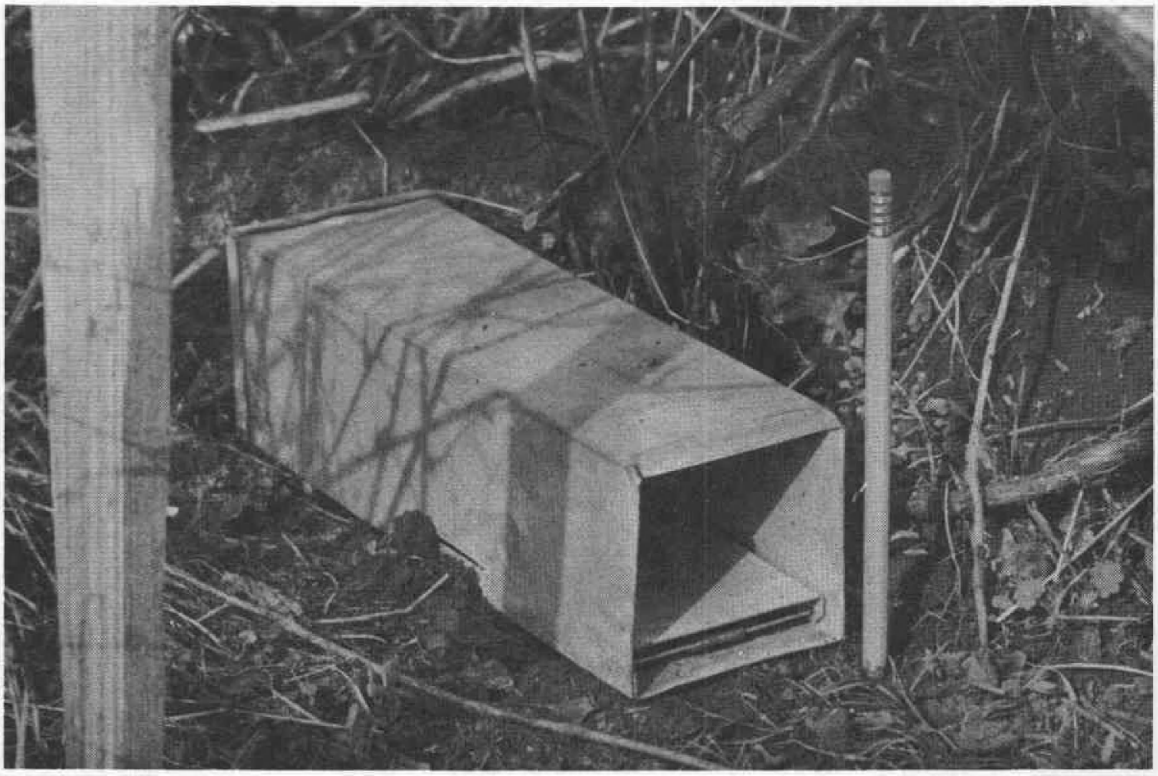


Photo No. 4. Sherman live trap.

spots, a five-chain interval, etc. There was an interval of ten chains between each of the parallel lines. The remaining 210 spots were laid out in a like manner in the west half of Section 13, directly south of the eastern end of the Van Duzer Corrider (see sketch). The topography of the area chosen is rolling and the spots sampled every type of exposure. A rain gauge was placed on the area to record weekly rainfall.

A week after the leaching spots had been laid out, the first ten spots in each line in Section 14 were visited. All the material (approximately three tablespoons) in each of the poison bait spots was picked up and placed in jars except for ten grains of each bait which were arranged as field acceptance spots (see photos #5, 6) on the sites of the leaching spots. The poison bait collected in the field was dried in the laboratory to facilitate handling and offered to mice in a series of bio-assay tests. The mice tunneled under all the protective wire covers which had been set over the leaching spots and destroyed the untreated wheat making it necessary to place fresh wheat to provide check acceptance spots.

The following week the acceptance spots were visited and the number of grains destroyed along with the probable agency responsible for this destruction noted (see Table #1). The next ten leaching spots were treated in the same manner as described for the first ten in each line and a second set of acceptance plots was laid out. This procedure was followed during the entire experiment except when snow conditions made the location of the field leaching spots impossible. Each time the site of the experiment was visited the rainfall since the previous visit was recorded.

Two more baits were added to the experiment during the third week of

Photo No. 5. Placing a typical acceptance spot.

Photo No. 6. Bark-cover over the acceptance spot protects it

field work. During the winter of 1950-51 the Oregon State Board of Forestry had established several experimental plots of five hundred acres each in the Tillamook Burn to test the field efficiency of several different poison baits. Wheat treated with "1080" and then overcoated, both in single and double with safflower oil proved more effective than the plain coated "1080" bait. Laboratory tests showed that the mice would accept materials treated with safflower oil that they would otherwise reject (see page 14) and therefore it was desired to determine if the safflower oil coating increased the field acceptance of the bait. This bait was not leached in a line of field leaching spots since time did not permit, but was placed in a large, single spot protected by screening and allowed to weather on the site of the experiment. Each week a small quantity was removed from this large spot to provide material for the acceptance spots and for laboratory tests. The bait was incorporated in the odd-numbered acceptance plots laid out in the poison bait lines and the results tabulated with those of other baits.

The repellents were incorporated in the acceptance spots in the untreated wheat series. Again, no line of leaching spots was established for these repellents, and they were allowed to weather in large, single spots protected by screening. The procedure followed in incorporating the repellents into the experiment and in recording the results was the same as outlined above.

Results and Analysis of Data

A summary of data recorded from observation of the acceptance spots (Table #1), which was too erratic to afford a basis for definite conclusions, does not indicate a decrease in palatableness due to weathering except for the thallium bait which dropped from 59 percent acceptance at 14.2 inches of rainfall to 11 percent at 28.9 inches. Furthermore, no marked preferance

was shown for one type of bait over another.[1] Of all the poison baits used in this experiment only the coated "1080" bait showed even slight signs of germination during the experiment. The untreated wheat germinated and grew vigorously throughout the experiment except when it was discovered and destroyed by animals. Apparently the germinated grain lost none of its palatableness since grains with sprouts as long as two inches were completely destroyed in the leaching spots.

It is evident that the repellents tested in this experiment were complete failures (see Table 1), in fact more of the seed coat of the Douglas fir seed was destroyed when the seed was treated with either mink castor or peppermint oil than when the untreated seed was used. Both these repellents were applied to the fir seed in an alcohol solution. The seed was placed in the solution and allowed to remain until the alcohol had completely evaporated and the repellent agent had been absorbed into the seed coat. The Good-rite z.i.p., a commercial deer repellent manufactured by B. F. Goodrich Chemical Company, Cleveland, Ohio, was carried on Idaho white wheat and proved no more effective than the other two repellents tested. This material was applied to the wheat in an aqueous solution according to the manufacturer's directions. (It is interesting to note that a live trap of the Sherman type which caught a weasel subsequently caught a mouse in less than a week even though the stench of the weasel was still very strong. Therefore it appears that there is little hope for the success of these predator odors as repellents.)

1. A limited number of acceptance spots of ten grains of untreated fresh wheat and ten grains of fresh, warfarin-treated bait were established in the area and checked after a week's exposure. The mice accepted the warfarin-treated bait as readily as they did the untreated wheat.

Although the mice seemed quite capable of tunneling under the protective screen caps to secure the untreated wheat, only two field-leaching, poison bait spots were so molested, and these were completely destroyed. Numerous signs of deer were noticed and apparently these animals destroyed several of the field-leaching spots in the untreated wheat line. However, none of the poison bait field-leaching spots were so molested. At no time during the experiment were any dead animals or birds which could possibly have been killed by the poison bait noted in the area.

Table #1

Field Acceptance Tests

Date	1080 Treated Wheat[1] (Zehrung)	Thallium Treated Wheat	Unpoisoned Fresh Wheat	Unpoisoned Leached Wheat	Repellent (Zip) treated unpoisoned Wheat	Poisoned Wheat (1080) 1 coat Safflower oil	Poisoned Wheat (1080) 2 coats Safflower oil	Repellent Treated unpoisoned DF seed (Mink castor)	Repellent Treated unpoisoned DF seed (peppermint oil)
1/25/51	14.2" rain* 7/10-25/100**	14.2" 7/10-59/100	0" 10/10-59/100	--	--	--	--	--	--
2/2/51	16.78" 8/22-16/220	16.78" 7/11-22/100	0" 10/10-100/100	16.78" 10/10-100/100	2.6" 10/10-100/100	2.6" 4/5-4/50	2.6" 5/6-10/60	--	--
2/9/51	22.4" 6/11-13/110	22.4" 4/10-5/100	0" 10/10-100/100	22.4" 10/10-100/100	8.0" 10/10-100/100	8.0" 3/5-5/50	8.0" 1/5-2/50	--	--
2/16/51	25.0" 6/10-27/100	25.0" 4/10-19/100	0" 10/10-100/100	25.0" 10/10-100/100	10.6" 10/10-100/100	10.6" 2/4-6/40	10.6" 2/5-11/50	2.6" 10/10-100/100	2.6" 10/10-96/100
3/2/51	28.9" 5/10-17/100	28.9" 2/10-11/100	0" 7/9-70/90	28.9" 7/9-70-90	-- --	14.5" 3/5-22/50	14.5" 1/5-2/50	6.5" 7/9-70/90	6.5" 7/9-70/90
	Totals 32/63-98/630	24/51-106/500	47/49-470/490	37/39-370/390	30/30-300/300	12/19-37/190	9/21-25/210	17/19-170/190	17/19-166/190
	Percent 51 16	47 21	96 96	95 95	100 100	63 19	43 12	89 89	89 87

1. Manufactured by the Zehrung Chemical Company, 2201 N. W. 20th Avenue, Portland, 9, Oregon.

*14.2" refers to inches of rain which had fallen on the bait or repellent when the acceptance spot was placed.
**7/10-25/100

7 refers to number of spots disturbed.
10 refers to total number of spots exposed.
25 refers to number of seeds taken.
100 refers to total number of seeds exposed.

Laboratory Bio-Assay Experiment

Purpose

To determine the palatableness and the lethal properties of fresh and leached poison baits.

Method

All the rodents subjected to bio-assay experiments by the Oregon State Board of Forestry were Peromyscus. These animals were obtained by live-trapping in cut-over lands within a fifteen-mile radius of Salem, Oregon. Most mice were found on areas with a mixed cover of grasses and trailing blackberry and an overstory of second-growth Douglas fir and Oregon white oak (Quercus garryana) (see photo #7). Small Sherman-type traps and home-made traps (see photos #2, 4) baited with filbert nuts and supplied with nest material to keep the animals warm were used to trap the mice. It was found that mice caught in traps lacking the nesting material died of exposure before the trap line could be examined. During the winter the traps were visited and set in the morning, but during the summer they were examined in the morning and reset in the late afternoon to prevent the catch of day-feeding animals (chipmunks).

Each animal was housed in a separate cage constructed of quarter-inch, zinc-coated, wire mesh and equipped with a water dish and nest material (see photo #8). A daily record of the poison and food offered to each animal was kept as well as the quantity consumed (Both the bedding material and the refuse pan placed under the cage were carefully examined to insure the accuracy of these figures). Each mouse was fed only one kind of bait and, in the case of the leached bait, bait subjected to only one period of rainfall. If the animal did not die from the results of the poison treatment, it was discarded and not used in experiments with other poisons.

Photo No. 7. Typical of areas near Salem which were live-trapped to provide subjects for the bio-assay experiment.

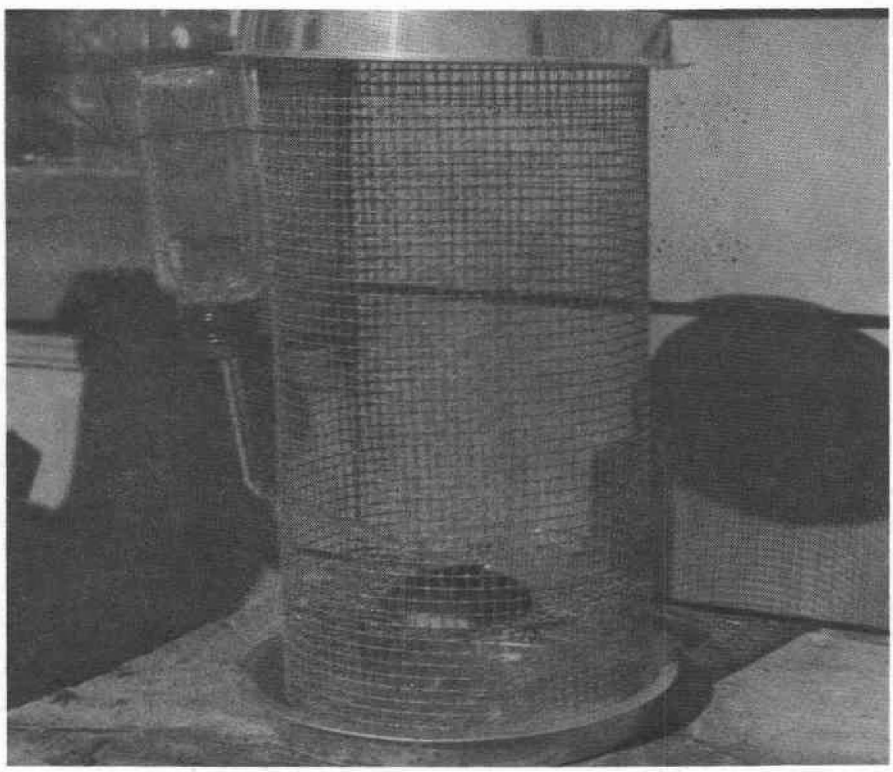


Photo No. 8. Cage used to house animals during the bio-assay experiment.

Results and Analysis of Data

Coated "1080": Little work was done with this bait since its complete ineffectiveness has been demonstrated in the field. After being subjected to only twelve inches of rainfall (it is not at all unusual to have over one foot of rain in a two week period during the winter months in the forests of the Pacific Northwest), this bait had lost much of its lethal quality and was inferior in killing power to the soaked "1080" bait. Furthermore, this type of bait presents a problem in field dissemination as much of the poison flakes off and collects in the base of the hoppers installed on the helicopters which are used in disseminating bait by the Oregon State Board of Forestry, thus creating a considerable concentration of the poisonous material. Such a concentration is a definite hazard to the personnel involved in the baiting operations.

Coated "1080" with a single overcoat of safflower oil: This bait lost much of its lethal quality after being exposed to only fourteen inches of rainfall, and is therefore only slightly superior to the plain coated bait.

Coated "1080" with a double overcoat of safflower oil: Of all the coated baits tested this preparation demonstrated the greatest resistance to weathering agents. It has the additional advantage of being relatively safe to handle as the heavy oil-coating prevents much of the poison from sloughing off in the hoppers of the helicopters.

Soaked "1080": this bait proved very effective until it was subjected to more than two feet of rainfall, when its lethal powers greatly diminished. Nevertheless it resisted the leaching action of weathering agents much better than did the plain coated bait (see graphs); and, therefore, a soaked

bait with a double overcoating of safflower oil may prove to be superior to any bait now employed.

Thallous sulfate: This bait loses much of its lethal property after only fifteen inches of rainfall. Apparently additional rainfall does not further reduce the potency of this bait since it was as effective after thirty-eight inches of rainfall as it was after being exposed to fifteen inches. Field experiments using this bait alone have produced varying degrees of control, but a combination of soaked "1080" and Thallous Sulfate has given the best control yet achieved.

Castrix overcoated with one coat of safflower oil: Little work was done with this poison because its field performance was so poor. One of the five hundred acre test plots established during the winter of 1951 in the Tillamook Burn by the Oregon State Board of Forestry was baited with this material. A comparison of pre and post-poisoning trap-line data indicated that this poison bait was ineffective. The results of the limited bio-assay work indicate that it is greatly weakened by weathering agents.

Warfarin: It is difficult to subject this bait to weathering agents since the germ is not killed and the grain germinates after a short exposure. Experiments with the fresh bait indicate a high degree of toxicity even when the animal consumes only one dose of the treated grain. This is apparently unusual for this rodenticide since most experimental data indicate that ingestion repeated at intervals is required to produce lethal results.[1]

Tetramethylene disulpho tetramine: At the present time all the aerial seeding projects administered by the Oregon State Board of Forestry are pre-poisoned

1. U.S.D.I. Fish and Wildlife Service in cooperation with State Agricultural Colleges, North Central States Experiment Station Annex.
Warfarin - Its Use in Controlling Rats and Mice. Lafayette, Indiana. August, 1950.

with rodenticides carried on wheat. The United States Fish and Wildlife Service laboratory at Denver, Colorado has developed many candidate poisons and repellents which were applied to the Douglas fir seed. The Cooperative Seed Laboratory of the Agricultural Experiment Station at Oregon State College and the Oregon State Board of Forestry cooperated with the Denver laboratory by running germination tests on the treated seed and bio-assay tests on the seeds whose germination was not seriously impaired by the poison treatment. All the candidate poisons except Tetramethylene Disulpho Tetramine ("Tetramine") destroyed the germinative capacity of the Douglas fir seed. None of the bio-assay experiments with this bait employed leached material, but the Oregon State Board of Forestry has established a field plot in the Tillamook Burn where the efficiency of this rodenticide under natural conditions is being thoroughly studied. The results of this study will be treated in a future publication. Limited experiments conducted in the spring of 1951 by the Oregon State Board of Forestry indicated that the fresh Douglas fir ("Tetramine 1%") bait possessed definite repellent value together with acceptable lethal powers. However subsequent field checks showed that the mice refused both the "Tetramine"-treated seed and untreated seed during the spring of the year. Cage tests with fifty Peromyscus in the late fall of 1951 also demonstrated the erratic behavior of this poison as a repellent. It does appear to have adequate killing power, however, since the fifty mice ingested an average of only five treated seed before dying.

Promurit: (0.5% - 24 hour soak - 24 hour dry) This was the only other test of a rodenticide carried directly on Douglas fir seed. Twenty Peromyscus were fed the treated seed together with untreated wheat. An average of nearly twenty-nine treated seeds was required to kill each of these animals and even

this low concentration of the poison was sufficient to destroy the germinative power of the seed.

In each of the above experiments it was desired to determine the minimum quantity of poison bait required to kill, thus each animal was first given a small quantity of the bait (on fresh or lightly-leached wheat baits the initial dose was one grain) and then on succeeding days, steadily increasing doses until death occurred. Since it is debatable whether the first small doses were significant in the death of the animal, especially in cases where the animal was fed highly-leached bait, two graphs have been prepared, one showing the average total number of grains of bait consumed prior to death, and the other showing the average number of grains consumed on the day prior to the animal's death.

This laboratory is continuing to conduct bio-assay experiments on poisons and repellents prepared by Donald A. Spencer of the United States Fish and Wildlife Service, and any promising preparations will be discussed in future joint publications.

Safflower oil: It was found that mice will consume ninety percent of cork treated with safflower oil even when a supply of untreated wheat is present. Under the same conditions they will not touch untreated cork. Nearly seventy-five percent of the seed coat of wheat treated with safflower oil was consumed by mice, while they ate only twenty-five percent of the untreated coat. Approximately eighty to ninety percent of the previously unacceptable Douglas fir seed coat was consumed.

The data of the bio-assay experiments discussed in this paper are based upon results using approximately five hundred animals trapped intermittently over a period of fifteen months.

Table #2

Percent Killed By 1 Grain

Rain "	Soaked 1080	Thallous Sulfate	Coated 1080 with 1 coat Safflower oil	Coated 1080 with 2 coats Safflower oil	Coated 1080
2"	90	90	--	--	--
8"	100	100	40	20	--
14"	10	0	0	40	--
22"	0	0	--	--	--

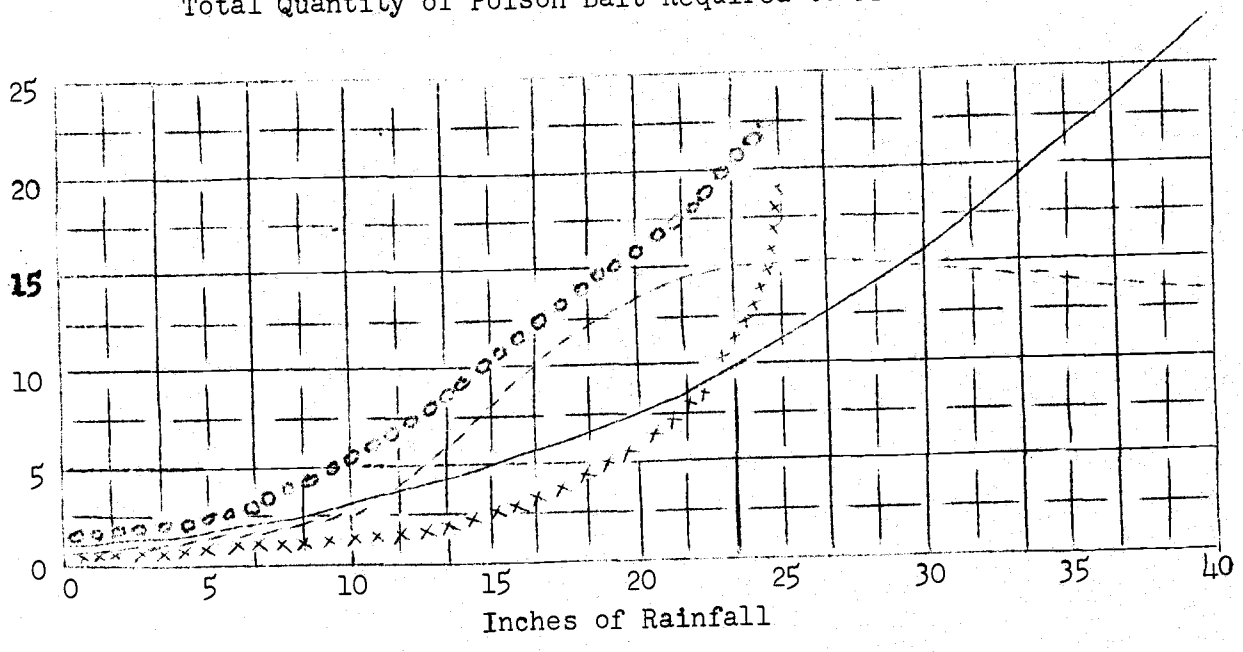
Percent Killed By 5 Grains

2"	100	100	--	--	56
8"	100	100	80	90	75
14"	40	30	10	100	--
22"	60	10	--	--	--
29"	--	--	--	--	--

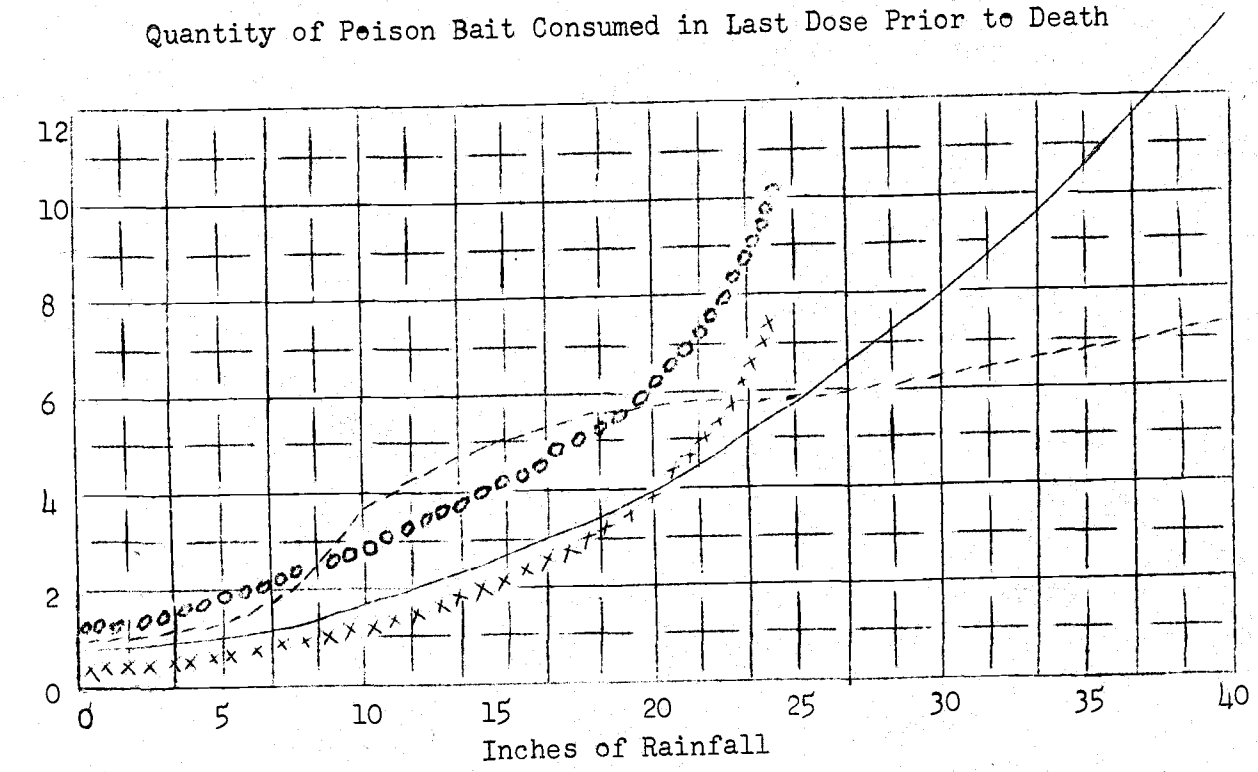
Percent Killed By 10 Grains

2"	100	100	--	--	--
8"	100	100	100	100	56
14"	70	60	50	100	75
22"	80	30	--	--	--
29"	10	--	--	--	--

Total Quantity of Poison Bait Required to Produce Death



Quantity of Poison Bait Consumed in Last Dose Prior to Death



Data expressed in the above graphs based on results obtained from bio-assay experiments with approximately 250 mice.

———— Soaked "1080"
oooooooooo "1080" with single coat of Safflower oil
xxxxxxxxxx "1080" with double coat of Safflower oil
---------- Thallous sulfate