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REPLACEMENT

PINE REGENERATION IN OREGON

Habits and Control of Seed-Eating Mammals

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Forest Management Research
FOREST RESEARCH LABORATORY
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FOREST RESEARCH LABORATORY

The Forest Research Laboratory, Oregon State University, is part of the Forest Research Division of the Agricultural Experiment Station. The industry-supported program of the Laboratory is aimed at improving and expanding values from timberlands of the State.

A team of forest scientists is investigating problems of growing and protecting the timberland crop, while wood scientists endeavor to make the most of the material produced.

The current report stems from studies of forest management.

PURPOSE . . .

Develop the full potential of Oregon's timber resource by:

increasing productiveness of forest lands with improved practices.

improving timber quality through intensified management and selection of superior trees.

reducing losses from fire, insects, and diseases--thus saving timber for products and jobs.

Keep development of the forest resource in harmony with development of other Oregon resources.

PROGRAM . . .

REGENERATION through studies of producing, collecting, extracting, cleaning, storing, and germinating seed, and growing, establishing, and protecting seedlings for new forests.

YOUNG-GROWTH MANAGEMENT through studies of growth and development of trees, quality of growth, relationship of soils to growth, methods of thinning, and ways of harvesting to grow improved trees.

FOREST PROTECTION through studies of weather and forest fire behavior to prevent fires, of diseases and insects to save trees, and of animals to control damage to regrowth.

TREE IMPROVEMENT through studies of variation, selection, inheritance, and breeding.

Contents

SUMMARY

A 4-year investigation of the habits and population densities of small seed-eating mammals was made in central Oregon as a basis for possible control measures to encourage regeneration of economically desirable tree species. The study concentrated on the chipmunk, ground squirrel, and mouse in an area chosen as average in ability to regenerate naturally.

Live-trapping and tagging determined estimates of population. Baiting the area with wheat soaked in 1080 or thallous sulfate and further trapping produced data which indicated that these poisons may be only initially effective in reducing populations of seed-eating animals, because the area was soon invaded by outside populations. More frequent baiting on a larger area might produce better results. Success in population reduction depends upon place and time of baiting in relation to habits of different animals.

Chemical treatment of pine seed with tetramine or endrin as a repellent appeared to offer some protection for the individual seed.

The most effective assistance to regeneration in central Oregon is probably a combination of baiting for population reduction, treating seed to repel seed eaters, and removing debris which provides protection for them.

Pine Regeneration in Oregon:

Habits and Control of Seed-Eating Mammals

By

Edward F. Hooven

INTRODUCTION

Regeneration of economically desirable tree species such as ponderosa pine (Pinus ponderosa) by natural seeding or planting of nursery-grown seedlings is uncertain and often inadequate in central Oregon. Main factors influencing success of regeneration are climatic conditions and animals.

Information concerning habits of the abundant small seed-eating mammals and birds of central Oregon is necessary to understand their relationship to the economics of the forest industry of that region. The increasing report of failures in attempts at restocking, or of damage to the stocking, reflects a growing awareness of animal influence on regeneration by local timber producers.

The chief attempt at regeneration in the pine-growing regions has been the planting of nursery-grown seedlings. Planting is expensive and not so adaptable to field conditions as might be desired. Transplanting subjects nursery stock to physiological disturbance and possible injury and weakens the ability of seedlings to adapt successfully to an adverse environment.

Recently, interest has developed in direct seeding. Attempts have not been successful in the past; generally, blame for the failure has been placed upon rodents or birds. With the availability of chemical compounds such as 1080 (sodium fluoroacetate) and thallous sulfate as rodenticides, and tetramine and endrin as repellents, removing or discouraging small seed eaters appears possible.

In 1957, an area was established for preliminary study of the small mammals of central Oregon. The primary purpose of the study was to determine population densities and movements of the main species present as a basis for control measures.

STUDY AREA

The timber-growing area of central Oregon is on the eastern side of the high Cascade range and extends eastward on lava plains at elevations generally above 4,000 feet (Figure 1).

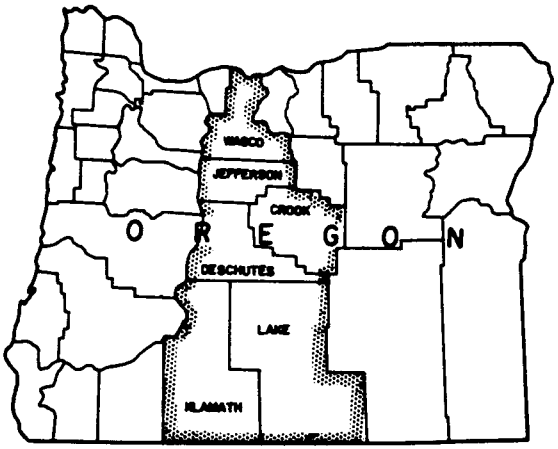

Figure 1. Pine timber-growing area of central Oregon.

Geological description

The areas where the study plots were established are part of a broad expanse of Pleistocene lavas and tuffaceous deposits (14)*. Nearly 2,000 square miles northeast of ancient Mt. Mazama are covered by pumice blown out prior to the formation of Crater Lake about 6,600 years ago. Upon the northern part of this region, pumice from the Newberry craters was deposited before the formation of Paulina and East lakes. The general area is known for its recent volcanic action such as that near the base of Lava Butte (3). The area of the upper Deschutes River basin thus can be described as a plateau of pumice whose uniformity is interrupted by lava flows and numerous cinder cones (Figure 2). Depth of the pumice diminishes to the northeast with increasing distance from the two main craters.

Climate

Central Oregon is characterized by low rainfall, usually less than 15 inches a year. Winters are moderately cold, and snow is common. Summers, although generally dry and warm, often have cool

*Numbers in parentheses refer to numbered references in Literature Cited.

Table 1. Average Monthly Temperatures (Fahrenheit) for Four Years in Bend, Oregon

Month	Average temperature			
	1957	1958	1959	1960
January	18	34.1	34.2	27.2
February	34.2	40.2	31.4	31.5
March	38.8	35.2	38.9	38.9
April	43.5	41.7	44.7	43.6
May	52.1	56.6	46.3	47.0
June	58.5	58.5	57.3	57.8
July	60.6	65.7	64.0	66.1
August	57.9	67.1	59.7	59.9
September	57.5	54.3	52.6	55.8
October	43.5	48.5	47.7	47.9
November	36.0	38.6	39.7	36.2
December	36.5	39.2	32.0	33.2

Figure 2. Cinder cones (foreground and background) and recent lava flow (middle ground) of central Oregon east of the Cascades.

Figure 3. View of study area showing bitterbrush understory, with some rabbit brush.

nights. Freezing is likely to occur at night during any month. In August, at Bend, Oregon, there were 2 days in 1955, 1 in 1956, and 5 in 1957 during which the minimum temperatures were below 32 F (Table 1).

The months from June through October normally have the least precipitation, although April, which is usually preceded and followed by wet months, is frequently among the driest (Table 2).

Description of study plot

Tumalo plot is located in Sec. 17, T17S, R11E, on land owned by Brooks-Scanlon Lumber Company of Bend. The original stand was largely ponderosa pine with a mixture of western juniper (Juniperus occidentalis Hook.). The understory vegetation was bitterbrush (Purshia tridentata) and Idaho fescue (Festuca idahoensis Elm.) (Figure 3). The area has been heavily logged, leaving a scattered stand of mature seed trees and groups of reproduction in various stages of development. Cattle grazing has modified the vegetational structure so that rabbit brush (Chrysothamnus nauseosus (Pall.) Britt.) has invaded the area (Figure 4). This change in vegetation has proceeded to the extent that rabbit brush now equals bitterbrush in density.

Table 2. Monthly Precipitation in Inches for Four Years in Bend, Oregon

Month	Total precipitation			
	1957	1958	1959	1960
January	0.77	2.31	1.26	1.27
February	1.68	1.30	1.44	1.43
March	1.68	0.22	0.73	2.28
April	0.24	0.63	0.07	0.90
May	1.30	1.96	0.63	0.58
June	0.01	2.47	0.30	0.01
July	0.14	0.24	0.12	0.15
August	0.24	0.01	0.01	0.23
September	1.02	0.13	0.21	0.05
October	0.59	0.32	0.44	0.10
November	0.22	0.70	0.26	4.19
December	3.28	0.65	0.28	1.04
Total	11.17	10.94	5.75	12.23
Departure from long-term mean	-1.08	-1.31	-6.50	-0.02

Figure 4. Heavy growth of rabbit brush resulted from modification of the vegetational structure by cattle grazing.

The soil is a well-drained mixture of pumice and alluvial sand. It varies in depth but is generally shallow. The underlying rock causes the pine to have a shortened taproot and large, spreading lateral roots that penetrate the soil to a depth of about 30 inches.

Because of soil conditions and general lack of moisture, about half the area has no vegetation and consists of small, open expanses of bare sand. A small amount of slash is on the ground, and stumps left from logging are in the last stages of decomposition.

Animals

At present, most protection work in eastern Oregon is being concentrated against the chipmunk, ground squirrel, white-footed mouse, and porcupine. Less attention is being given to control measures for rabbits and squirrels.

The western chipmunk of the genus Eutamias occupies all of western North America from the central Yukon of Canada in the north into Mexico in the south (9).

The Klamath chipmunk (Eutamias amoenus Allen) ranges throughout central and eastern Oregon north to the Columbia river and south into Nevada and the mountains of northeastern California. It is a small, richly colored animal with 9 stripes on the back, 3 blackish, 2 brown, 2 gray, and 2 white; sides of head have 3 dark and 2 white stripes; sides, shoulders, and lower surface of tail are a rich orange-brown; the belly is whitish. Total length is about 197 mm. The young appear in May, June, and July; when they appear they are about half-grown and independent of the mother. Embryos indicate that there are 4-6 young to a litter, but no data have been collected on either the gestation period or the number of young dropped successfully in a litter. This chipmunk does not hibernate but does become torpid during cold weather (4).

The subspecies of Townsend's chipmunk (Eutamias townsendii senex (Allen)) is the smallest subspecies of this group in Oregon and is paler in color than the Klamath chipmunk. It ranges throughout central and southern Oregon on the forested slopes immediately east of the Cascades, from Mt. Jefferson south into California. It has 5 brown and 4 light-gray stripes; sides of head have 2 light-gray and 3 brown stripes; sides of body are a rusty brown with lower parts white or creamy. Total length is about 245 mm. The young appear aboveground about July; there are 4-6 in a litter.

The golden-mantled ground squirrel (Citellus lateralis chrysodeirus (Merriam)) is one of the North American ground squirrels (Figure 5). It inhabits the mountain slopes and foothills in somewhat open forested areas among rocks and fallen timber where it can con-

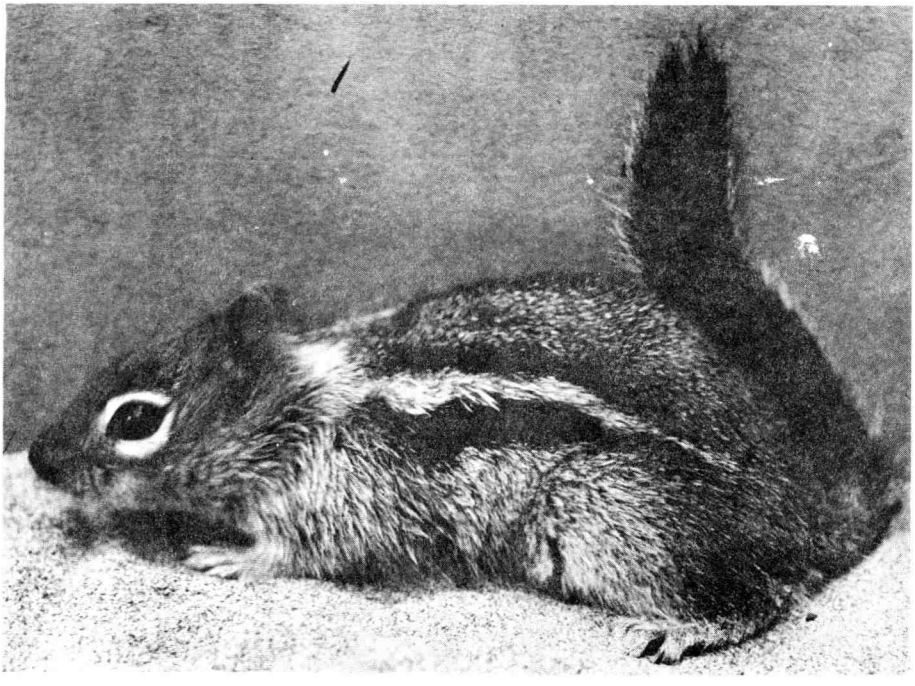

Figure 5. The golden-mantled ground squirrel, a primary consumer of seed on the study area, ranges east from the Cascades through central Oregon and south into northeastern California; it hibernates from mid-September to May.

struct a burrow. Its range is east from the Cascades of central Oregon throughout the pine-juniper forests and south from the Columbia River into northeastern California (6).

The golden-mantled ground squirrel is larger and heavier than the true chipmunks. In summer pelage, it has 4 black and 2 white stripes; the middle of the back, rump, and hams are a rusty gray, and the shoulders, neck, cheeks, arms, and lower tail surface are a bright yellowish-orange (15).

This squirrel hibernates, becomes fat by early fall, by mid-September usually retires underground and emerges when the weather warms in the spring. Factors initiating and ending hibernation are obscure (11). Possibly the amount of body fat deposited, determined by the available food, tends to influence its retirement underground. The reduction of fat and rising environmental temperatures may promote emergence. By May, these squirrels can be observed in large numbers.

Breeding begins soon after the general emergence aboveground. Parturition occurs in the latter part of May, in June, and early July. There are 4-6 young in a litter.

The deer mouse (Peromyscus maniculatus) is the most widely distributed species of the genus, its habitat extending from the Arctic Circle into Mexico and from the Atlantic to the Pacific oceans.

The white-footed mouse (Peromyscus maniculatus gambelii (Baird)) is found in most of Oregon east of the Cascades (Figure 6). It is a medium-sized mouse with a total length of about 160 mm. The tail is less than half the total length; the ears are smaller and the color paler than those of Peromyscus maniculatus rubidus. The lower parts of the body, feet, and tail are white. Young are produced mostly during the spring and summer months, the females having 2-4 litters each year, with 4-6 young in a litter.

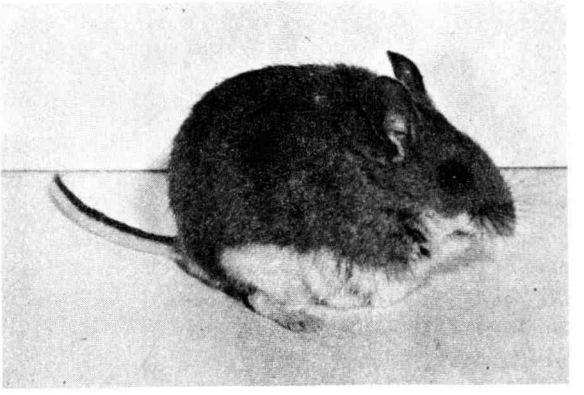

Figure 6. The white-footed mouse was an important seed-eater on the study area. It is a medium-sized mouse found in most of Oregon east of the Cascades.

The yellow-haired porcupine (Erethizon dorsatum epixanthum Brandt) occurs from the Pacific eastward into the Great Plains and from the southern plains region of Canada south into Mexico. It is a non-hibernating, essentially solitary animal with no definite home territory (10). Although better adapted to forested areas, it also occurs in treeless sagebrush country and extremely dry areas. At present in Oregon, it occurs west of the Cascades near the head of Butte creek in Clackamas County and south from Eden ridge in Coos County. High rainfall may limit occurrence of the porcupine in northwest Oregon west of the Cascades.

For this porcupine, the gestation period is about 7 months; the female generally has but one young, in the spring. The young are well developed, with quills that provide good protection shortly after birth.

Among the other small mammals seen occasionally but not commonly, were the chickaree and gray squirrel. Wherever they occur in numbers, they decidedly influence natural regeneration because they feed on ripening cones (7).

The orange-bellied chickaree (Tamiasciurus douglasii) ranges throughout the Cascades and into the pine regions of the east slope. It is a small squirrel about 320 mm in total length, with short ears and a wide, flattened bushy tail. In summer pelage, the upper parts are a dark brownish-gray, the ear tufts and stripe on each side of the body are black, and the entire lower part of the body and top of the feet are a dark, rich yellowish-orange. According to Bailey (2), the young are dropped in the early summer, with 4-7 in a litter.

The silver-gray squirrel (Sciurus g. griseus Ord.) is a large squirrel, about 570 mm long, that ranges throughout western Oregon in the transition-zone forests and into the forest areas east of the Cascades. In summer pelage, the upper parts are a bright gray and the lower parts are white. The tail is long and bushy and the ears are not tufted. Breeding apparently occurs during January and February; the young, about two to a litter, are dropped in March and April.

The pocket mouse (Perognathus sp.) and the kangaroo rat (Dipodomys sp.) were uncommon on the study area and were not considered detrimental to either coniferous seed or seedlings. The little Oregon cottontail (Sylvilagus nuttallii nuttallii Bachman) was sighted occasionally, and a few young were caught in the spring. Other animals seen on the study area or known by tracks to have been present were these: Klamath flying squirrel (Glaucomys sabrinus), marmot (Marmota flaviventris), coyote (Canis latrans), badger (Taxidea taxus), weasel (Mustela erminea spp.) and mule deer (Odocoileus h. hemionus (Rafinesque)).

METHODS

The area was chosen as representative of pine areas that appeared average in their ability to regenerate naturally. Part of the area had previously been fenced with barbed wire to prevent cattle from damaging direct-seeding and soil-moisture studies.

Trapping for population count

A quadrat 10 chains square was staked. A stake marked each trap site, spaced 1 chain apart. Thus the plot was serviced by 100 traps, each trap servicing 0.1 acre. The traps were offset 5-10 feet, wherever necessary, to take advantage of the shade of a bitterbrush plant, a stump, or a log (Figures 7 and 8).

The original 10-acre area was later surrounded with 79 additional traps. These were spaced 2 chains apart in a circular grid so that the size of the plot was increased to 41.5 acres.

The traps were modified from the Sherman live-trap, enlarged to 3.5 by 3.5 by 10 inches. A hardware-cloth window was added in the back of the trap to provide additional ventilation. The traps were usually covered with a slab of bark or a cow chip for more protection from the heat of day and from low temperatures at night (Figure 8).

Traps were examined daily for 3 consecutive days once a month, the time depending upon activity of the chipmunks when they were not hibernating. Traps were baited with whole oats. Trapped animals were ear-tagged, recorded, and released at the point of capture. Ear tags were monel fingerling tags, easily applied to an ear of any of the animals. Occasional difficulty in reading the numbers was caused by the tag rolling on the ear and becoming scabbed over.

Baiting for control

On April 18, 1958, the area was baited and observed for possible long-range effects of early-spring baiting on populations of the principal seed eaters. Bait chosen was clean wheat soaked in 1080 or thallous sulfate and colored green to discourage birds from eating it. The bait was applied in swaths about 16 feet wide at the rate of 0.75 pound of each rodenticide to an acre (a total of 1.5 pounds an acre). Application was made by a cyclone seeder. On September 9, 1960, another baiting was done with the same rodenticides, again using wheat for the carrier.

In addition, during 1958, a small amount of ponderosa pine seed coated with tetramine was broadcast and lightly covered by soil with swaths of brush.

Figure 7. Trap set at base of young pine.

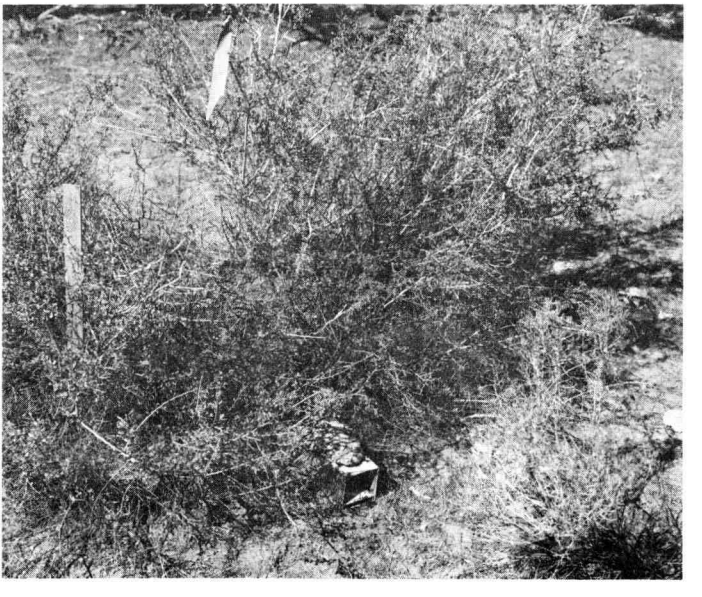

Figure 8. Trap set in bitterbrush plant and partly covered.

TRAPS SET TO TAKE ADVANTAGE OF SHADE

RESULTS

Results of trapping during the 4-year period helped to estimate fluctuations in population and determine home range of the most common species in the area. Observation of food habits of seed eaters and experiments with rodenticides and repellents yielded valuable information about control of seed eating.

Fluctuations in populations

Total numbers of animals fluctuated in the trapping periods throughout the 4 years. During 1957, Peromyscus maniculatus was the most abundant mammal on the 41 acres. Its numbers (208) were roughly double those of Eutamias and about seven times those of Citellus lateralis (Table 3).

During 1958, all of the species declined sharply in numbers from the preceding year; Peromyscus decreased 67 percent, Eutamias 37 percent, and Citellus 86 percent.

The summer's catch for 1959 showed a marked increase, especially for the Eutamias and Citellus, which increased to a high of 334 for Eutamias and 191 for Citellus. The catch of Peromyscus increased to 121 animals, but they were still less numerous than in 1957.

During 1960, the total numbers declined again; compared to 1957, Eutamias and Citellus were almost twice as numerous, but numbers of the largest group, Peromyscus, declined about 80 percent to reach a 4-year low. Thus there was a conspicuous increase in the total number of animals caught during the 2 years 1959 and 1960 compared with the total of 1957 and 1958.

The first emergence of chipmunks and ground squirrels, as indicated by trapping results, occurred during late March and early April, with the chipmunks appearing several weeks before the ground squirrels. The young of these two species generally appeared aboveground during June and July; at that time, the catch from each trapping period resulted in 25-100 percent new animals for the chipmunks and ground squirrels. The mouse population was more stable.

Home ranges

Because of the rapid turnover of populations, it was difficult to determine the home range for chipmunks and ground squirrels. On the assumption that the traps serviced a square area whose dimensions were determined by half the distance to the next trap, lines were connected to the outside corners of the trap sites and the enclosed area was determined. The possibility of a change in size of home-range area

because of fluctuations in populations during different years was considered. No change was found, however, for variations in population pressure, although there was a decided difference because of sex. For Eutamias, the size of home range for males was 3.1 acres and for females, 1.8 acres. The golden-mantled ground squirrel showed an even sharper contrast between the sexes, the males ranging over 3.05 acres and the females, 1.47 acres.

Determination of home-range area for the deer mouse was based on a measure of the average radius fixed upon a point considered as the center of activity. The circle of activity was determined from enclosed points of actual capture by standard deviation of a circular bivariant normal distribution in which the animal was assumed to range 95 percent of the time (8).

The ranges were based on 10 or more captures in a single year; the male mice had a home-range area of 4.19 acres and the females, 3.40 acres. The records also indicated the range of the juveniles, which was 13.41 acres. The large area over which the juvenile mice roamed appeared to be a good indicator of what was happening among all the different species: large numbers of young were searching for food and shelter on a site that was not thickly covered with ground vegetation.

Because of the sparsity of protective cover on the area, most individual animals constantly moved about seeking niches of their own.

Food habits

Animals on the plot had few plant species for food. Trees present were ponderosa pine and western juniper. Pine is an important source of food to wildlife because many mammals and birds eat the nutritious, oily seeds (1, 12, 5). Whenever available, seeds of pine were gathered by all the small seed eaters, and the seeds were especially available in the fall of 1958. Figure 9 suggests that in many years few pine seeds would escape being eaten because of the small crop, but in 1959, following the exceptionally large seed crop of the year before, there were many spots where seed had been cached and overlooked and then had germinated. Regeneration eventually failed in most of these places because crowded seedlings competed for the little moisture available. Successful regeneration in some spots, however, would indicate that sometimes small mammals may help in pine regeneration (Figure 10).

Ponderosa pine seed ripens and first becomes available to the seed eaters late in the summer when squirrels cut the ripening cones. Later, the cones open on the trees and the seeds fall, usually in early September.

Table 3. Population Figures for Seed-Eating Mammals Trapped Most Frequently on Area

Month	Species									
	Eutamias			Peromyscus			Citellus			All three
	New[1]	Old[2]	Both	New	Old	Both	New	Old	Both	
Catches in 1957										
April	2	0	2	19	0	19	0	0	0	21
May	7	1	8	25	16	41	9	0	9	58
June	4	11	15	15	25	40	3	3	6	61
July	15	11	26	11	26	37	1	2	3	66
Aug.	15	9	24	5	23	28	3	0	3	55
Sept.	7	12	19	3	16	19	3	2	5	43
Oct.	9	11	20	6	18	24	0	3	3	47
All	59	55	114	84	124	208	19	10	29	351
New catches[3]				162						
	36%			52%			12%			
Catches in 1958										
Jan.	0	0	0	2	12	14	0	0	0	14
March	0	2	2	4	11	15	0	0	0	17
April[4]	5	7	12	6	11	17	0	1	1	30
May	2	0	2	11	0	11	0	0	0	13
June	4	2	6	3	0	3	1	0	1	10
Sept.	50	0	50	8	1	9	2	0	2	61
All	61	11	72	34	35	69	3	1	4	145
New catches				98						
	62%			35%			3%			
Catches in 1959										
June	60	35	95	27	0	27	51	23	74	196
July	47	59	106	18	7	25	27	37	64	195
Aug.	23	59	82	28	10	38	13	22	35	155
Sept.	17	34	51	13	18	31	6	12	18	100
All	147	187	334	86	35	121	97	94	191	646
New catches				330						
	45%			26%			29%			

Table 3 (Continued)

Month	Species									
	Eutamias			Peromyscus			Citellus			All three
	New[1]	Old[2]	Both	New	Old	Both	New	Old	Both	
Catches in 1960										
June	8	5	13	11	0	11	3	5	8	32
July	20	12	32	4	4	8	7	2	9	49
Aug.	82	29	111	8	4	12	15	13	28	151
Sept.[5]	40	15	55	10	1	11	10	5	15	81
All	150	61	211	33	9	42	35	25	60	313
New catches				218						
	69%			15%			16%			

[1]Refers to mammals trapped for the first time.

[2]Refers to mammals previously trapped and tagged.

[3]All new catches are noted in the center column for the three species combined. The percentage of the total for each species is noted separately.

[4]Area was baited with 1080 on April 18, 1958.

[5]Area was baited again on September 9, 1960.

The correlation between amount of seed falling and densities of animal populations was difficult to determine in the present study because baiting interfered with the natural course of the animals' life cycles. During 1958, the summer populations were low after baiting in April until September. Then an abrupt increase in numbers was noticeable, especially among the chipmunks. It is conceivable that the large amount of pine seed available to the seed eaters was responsible for animal survival and successful reproduction as shown by the catches for 1959.

Seed of western juniper is an important food source for birds and small mammals. The bluish-black berrylike fruit ripens in the second year. Juniper appeared to be a more prolific seed producer on the study area than did the pine, and juniper seed was generally available. Chipmunks, ground squirrels, and deer mice ate it.

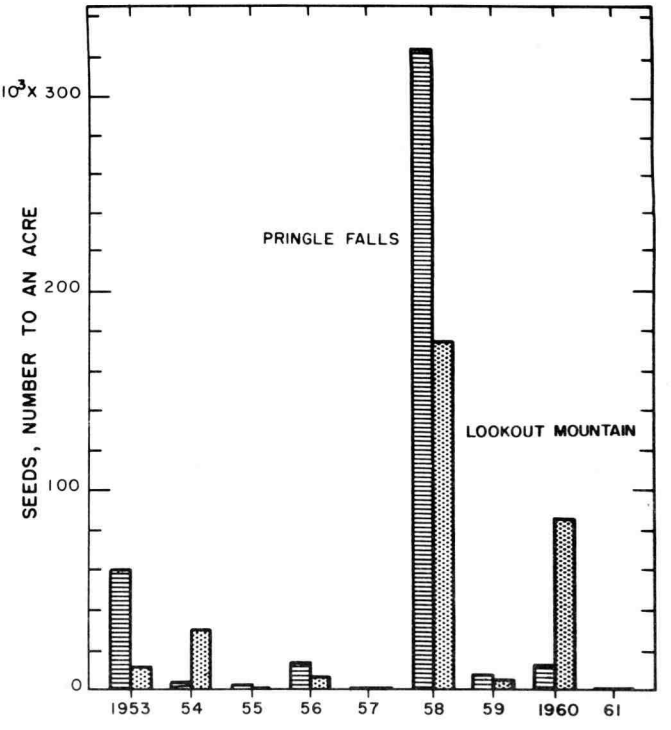

Figure 9. Yearly seed crop on two areas in central Oregon. Compare with Figure 12 for possible correlation between abundant seed in 1958 and large catch of seed eaters in 1959.

Bitterbrush, also a major food source, supplied about 12 percent of the understory cover and was well dispersed over the area. The seeds of this shrub are large and easily gathered and stored by the small seed eaters. As with the pine, seed is buried and sometimes forgotten, to germinate in clumps the following spring. Animals may be important in reproduction of bitterbrush, because the only germinants found were results of animal caches. Like the pine, the germinants were in groups, numbering as many as 15-20 seedlings in a group.

Rabbit brush, a dense, shrubby, narrow-leaved plant, is covered in the summer and fall with masses of small yellow flowers. This plant is abundant in many of the cut-over pine areas and is eaten by the smaller mammals. During late summer and fall, chipmunks and golden-mantled ground squirrels were observed eating the yellow flowers. Especially during the fall, stomachs of animals examined were yellow because the animals had been feeding on rabbit brush.

Among the grasses, Idaho fescue, Gray's fescue (Festuca Grayi), and needlegrass (Stipa occidentalis) were well represented on the plot,

especially the first two. The fescues were plentiful and well distributed over the area, although by mid-September they were dry and brown and had dropped all their seed.

Mention is made in the literature of feeding by chipmunks and golden-mantled squirrels on hypogenous mushrooms. This supposition could not be confirmed because none of these mushrooms were found on the plot or on the adjacent areas.

Baiting results

During 1957, primary seed eaters trapped for the first time totaled 162. Of this total, Eutamias made up 36 percent, Peromyscus 52 percent, and Citellus 12 percent. (Figures 11, 12, 13, and 14 graphically portray the data in Table 1.) The following year, before baiting, the number caught was slightly more. The area was baited April 18, 1958, and trapped 3 weeks later. Animals caught totaled less than half the catch before baiting, and the animals were untagged, indicating that initial baiting had been successful. One month later, in

Figure 10. Pine seedlings that developed from seeds cached by animals and then not needed for food or forgotten.

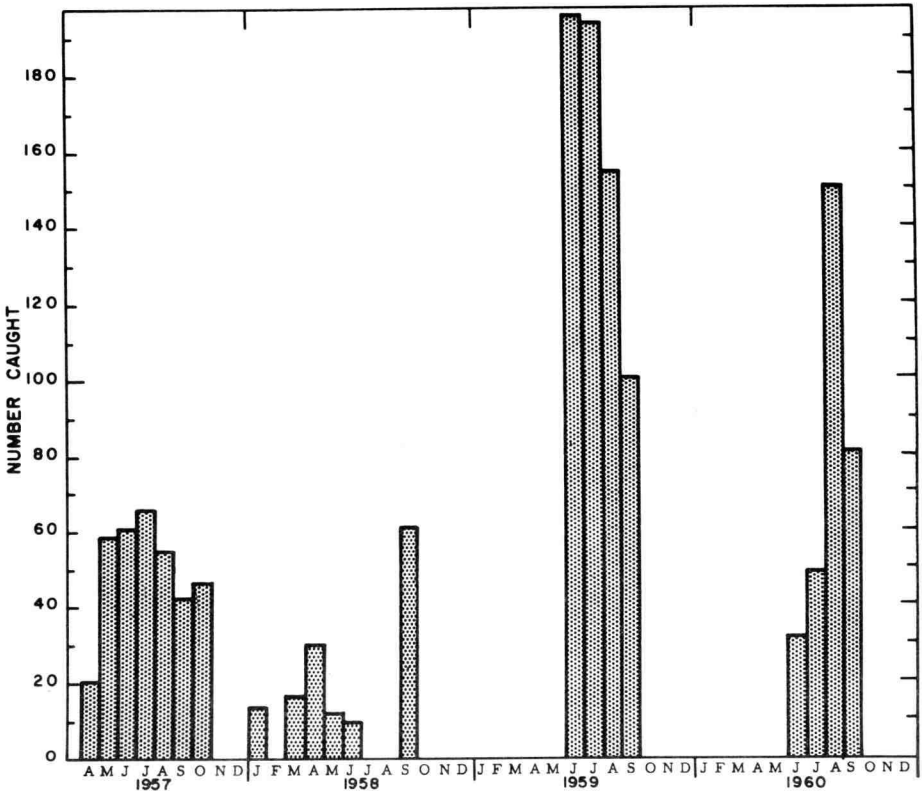

Figure 11. Total number of Eutamias, Peromyscus, and Citellus caught in a 3-day trapping period. Spring baiting on the area was on April 18 in 1958 and fall baiting in 1960 was on September 9.

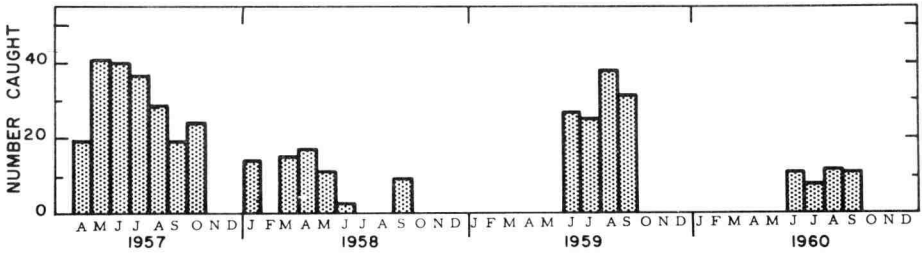

Figure 12. Total number of golden-mantled ground squirrels (Citellus lateralis) trapped during a 3-day period. Area was baited on April 18, 1959, and September 9, 1960.

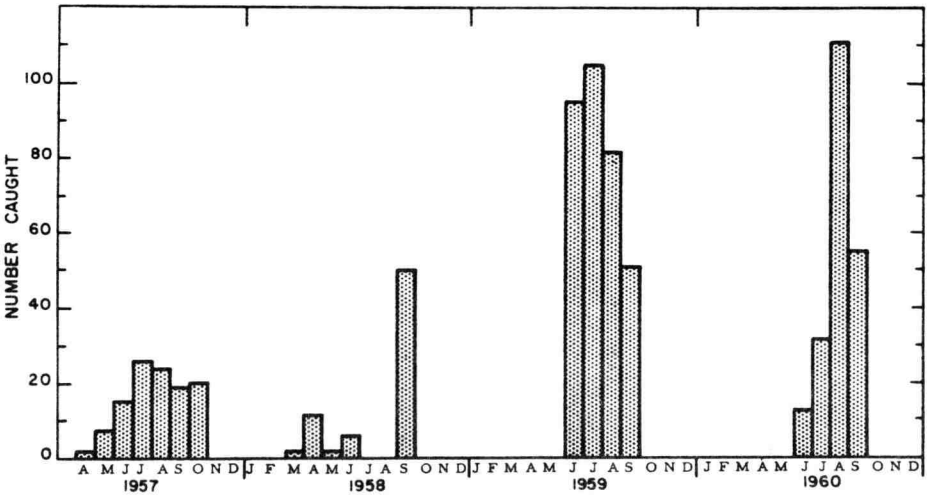

Figure 13. Total number of mice (Peromyscus maniculatus) trapped during a 3-day period. Area was baited on April 18, 1958, and September 9, 1960.

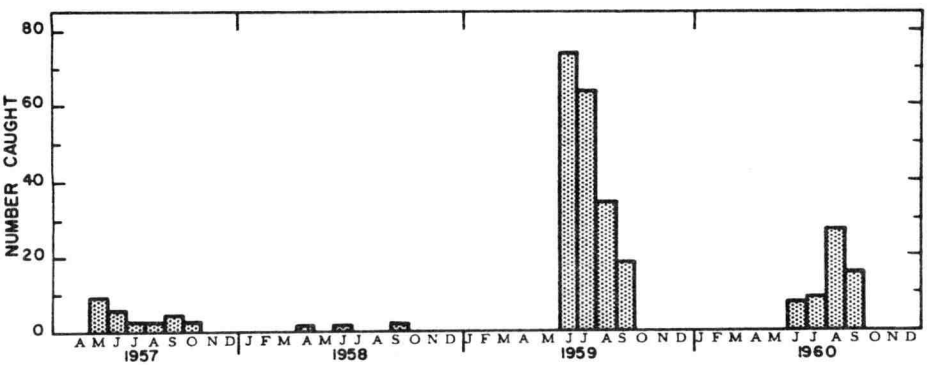

Figure 14. Total number of chipmunks (Eutamias amoenus) trapped during a 3-day period. Study area was baited on April 18, 1958, and September 9, 1960.

June, the total catch was one-third of that before baiting, and tagged animals were being recaptured. Though the treated wheat was still on the area, there was an abrupt increase in number of animals, especially chipmunks; during the trapping period in September, 50 untagged animals were caught. This general increase of animals continued into 1959, the overall catch being nearly double that of 1957. Throughout

the summer of 1960, the populations remained large, although the carry-over of tagged animals from preceding years was small, indicating an extremely fluid movement of animals.

The area was rebaited during September, 1960. Two weeks later, trapping indicated a reduction by half for chipmunks and ground squirrels, but no reduction for mice. The reduction was from 151 animals to 81, about 2 animals to an acre.

Effects of repellents

Coating pine seed with tetramine as a repellent appeared successful for the small amount of seed broadcast in 1958. Pine seeds treated with endrin and fed to caged chipmunks produced the following results: 20 seeds of 1 percent effective endrin and 10 seeds of 2 percent effective endrin were lethal. Some animals became hesitant about the treated seeds before a lethal amount was consumed. Consumption did not stop completely, however, because treated seed was still taken infrequently by both chipmunks and mice until they were released.

DISCUSSION

Because of the vast numbers of seed-eating mammals and birds, regeneration is extremely difficult on the excessively dry areas of the pine region of central Oregon.

The white-footed mouse is one of the primary consumers of seed and is closely followed in importance by the golden-mantled ground squirrel and the common western chipmunk. In cage tests, individuals of all three species ate 50 or more ponderosa pine seeds a night.

The protection of seed by reducing mammal populations was unsatisfactory on the area. Thallous sulphate and 1080 gave good original control, but success was shortly nullified by invasion from outside populations. From the number of small animals present and the speed with which they repopulated an area, a rodenticide apparently should be applied more often, and possibly on a larger area, for continuous reduction of the rodent population.

In baiting for control of the seed eaters, note that the deer mouse does not hibernate but is active throughout the year. The chipmunk is inhibited by low temperatures but is active from April into fall. The golden-mantled ground squirrel hibernates and is inactive during the late fall, throughout the winter, and into midspring. Bait thus would be acceptable to the mouse throughout the year, but the best time to offer bait to the other two species would be before hibernation in the fall and after emergence in the spring, during April and May (13).

Chemical treatment of pine seed possibly offers better protection for the individual seed than does broadcast baiting to control the seed-eaters. Tetramine-treated pine seed appeared to have good repellent properties. Even when not taken in quantities large enough to be lethal, pine seeds treated with endrin were less likely to be consumed than uncoated seeds.

The success of any work involving direct seeding in central Oregon would be enhanced by combining the use of repellent-treated seed, reductional control by baiting with 1080, thallous sulfate, or both, and cultural practices that would remove the brush and debris which provide protection to the small mammals.

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