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Tree Seed Abundance vs. Deer Mouse Populations in Douglas-Fir Clearcuts

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The Douglas-fir (*Pseudotsuga menziesii*) region of the Pacific Northwest runs from northern California through Oregon and Washington to central British Columbia. It includes most of the west slope of the Cascade Mountains and extends westward nearly to the Pacific Ocean. That part occurring in this country is of great importance since it contains an estimated 40 percent of our standing sawtimber. In Oregon, about 52 percent of the yearly income is derived from the lumbering and wood products industry; a high percentage of this comes from the Douglas-fir belt.

As the old-growth timber in the Douglas-fir type is harvested, regeneration must be started on the clearcuts at an early date if a maximum sustained yield is to be maintained. The early re-establishment of desirable species, at a reasonable cost, is hampered by many things. One of the more acute problems is the adverse effect of wildlife on the establishment and production of new crops. These forest-wildlife problems in the Douglas-fir belt have been well documented by Moore (*15*); Isaac (*7*); Kangur (*10*); Lawrence (*13*); Hooven (*6*); Kverno (*12*); Hagar (*4*); Lawrence, Kverno, and Hartwell (*14*); Radwan (*17*) and others. A brief outline of the types of wildlife damage in the Douglas-fir belt and the more common vertebrate animal depredators follows:

Seed destruction by—
- Deer mice (*Peromyscus maniculatus*)
- Shrews (*Sorex* spp.)
- Tree squirrels (*Tamiasciurus* spp.)
- Juncos (*Junco oreganus*)

Foliage and twig clipping, debudding, and browsing by—
- Deer mice
- Voles (*Microtus* spp.)
- Snowshoe hares (*Lepus americanus*)
- Brush rabbits (*Sylvilagus bachmani*)
- Mountain beaver (*Aplodontia rufa*)
- Deer (*Odocoileus* spp.)
- Elk (*Cervus canadensis*)
- Sooty grouse (*Dendragapus obscurus*)
- Pocket gophers (*Thomomys* spp.)
  (Gophers will probably cause damage at higher population levels)

Root, stem, and branch barking by—
- Voles
- Mountain beaver
- Snowshoe hares
- Woodrats (*Neotoma* spp.)
- Tree squirrels
- Black bears (*Ursus americanus*)
- Pocket gophers
- Porcupine (*Erethizon dorsatum*)
  (This animal is extending its range into western Oregon and may eventually be a serious forest problem)

During the last several years I have been engaged in an investigation of the ecology and biology of birds and small mammals as related to forest-wildlife problems on the H. J. Andrews Experimental Forest. These studies are only concerned with a small segment of a large complex problem. The Andrews Forest is located in Linn and Lane counties in central Oregon on the west slope of the Cascade Mountains. It includes nearly the entire watershed of Lookout Creek with elevations ranging from about 1,400 to 5,250 feet. Timber on the area is largely old-growth Douglas-fir, some of which is nearly 400 years old. The Andrews Forest is under the jurisdiction of the Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service, and within the boundaries of the Willamette National Forest.

In northern California, Jameson (*8*) found deer mice eating seeds (including conifer and broad-leaved tree, shrub, forb, and grass seed), fruits, arthropods, leaves, fungi, and miscellaneous items. These animals are very adaptable and when a preferred food becomes unavailable they turn to one which can be secured even though not so well liked. This ability to adjust to a variety of situations helps to make these mice one of our most successful species. Forest managers responsible for regeneration work in the Douglas-fir belt frequently ask if high deer mouse populations can be predicted. Since deer mice increase rapidly in clearcut areas, are one of the most abundant small mammals, and feed heavily on tree seed, they are a species causing much concern. If the high populations can be predicted, it would permit advance planning for a potentially greater reinvasion problem and thus aid in getting maximum returns from artificial and natural seeding.

A comparison of the annual seed crop with deer mouse populations on the Andrews Forest over an 11-year period strongly suggests a relationship between seed abundance and the following fall's deer mouse populations. This paper will present the data and interpretations.

Methods

The seed traps used in this study are the common U. S. Forest Service type. They are 2×3 feet in size and have an effective area of 5.7 square feet. The western redcedar (*Thuja plicata*) framework is covered with ordinary wire screen with 14×16 meshes per square inch for the floor and with tops of ⅜-inch hardware cloth. The top mesh is small enough to exclude birds and small mammals yet large enough to permit Douglas-fir, western hemlock (*Tsuga heterophylla*), and redcedar seeds to enter easily. The seed traps were located to sample the entire seed fall in the 4 cuttings: 2A (24 acres), 3B (21 acres), 3G (41 acres), and 9A (25 acres). Fifteen traps were used on 2 cuttings in 1954, 16 on 1 cutting in 1955, and 24 on single cuttings the rest of the time. Forest Service personnel (*11, 16*) checked the traps in 1954 and in October 1955; the writer has tended them the remaining time. The cutting test was used to determine soundness; only fill[illegible] seeds were included in the com[illegible] tions. Since redcedar seeds [illegible] readily taken by deer mice (*15*), the abundance of these seeds probably does not affect the populations. Consequently, only Douglas-fir and hemlock seeds which are preferred by deer mice (*15*) were used in the computations. The estimated seed crop per acre was converted to pounds using 40,000 Douglas-fir and 300,000 hemlock seeds per pound (*7*).

Deer mouse population estimates were secured on grids with 10×10 trap sites spaced 50 feet apart. Large Sherman type live traps were used and were baited with whole oats supplemented in cold weather with wheat and cracked yellow corn. Dry wool was kept in the traps at all time for nesting material. Trapping was for a 6-night period in April or May and again in September each year. Captured animals were ear tagged with monel fingerling tags and released at the trap site. The "Lincoln Index"

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Table 1.—Year, Estimated Pounds of Filled Douglas-Fir and Hemlock Seed, and Estimated Deer Mouse Population in Spring and Fall on Clearcuts

Year	Cutting	Pounds of seed per acre	Mice per acre	
			Spring	Fall
1954	2A & 3B	0.81	....	....
1955	3G	0.04	....	10
1956	3G	2.38	3	4
1957	3G	0.02	2	12
1958	3G	0.10	3	7
1959	3G	4.82	1	2
1960	3G	......[1]	2	11
1960	9A	0.03	....	4
1961	9A	0.23	1	6
1962	9A	0.93	2	5
1963	9A	0.05	4	9
1964	9A	0.28	0	2

[1]Seed traps were moved from 3G to 9A in 1960; however, live-trapping was continued on 3G.

method was used to compute daily populations; the last 3 daily figures were averaged for the final estimate. The grids were expanded on all sides by ½ the "Adjusted Range Length" (*18*). This delineated the effective area covered by the grid traps. All population estimates are rounded to the nearest whole figure.

Many factors influence the number of deer mice in a population. Since it is very difficult to separate each factor and measure its direct influence on wild populations, indirect methods must often be used. If a certain condition (in this case, a large seed crop) is associated with a specific response (a high deer mouse population) and this is repeated several times, a cause-effect relationship is assumed. This is the type of interpretation used to analyze the data in this paper.

Results

From Table 1 it can be noted that data were secured annually from 1954 until 1964 inclusive. In 1954, the seed production estimate was obtained by Koenig (*11*) from the 2A and 3B clearcuts which are about 700 feet lower than 3G. Cone crop estimates (*1*) for a cutting adjacent to 3G were abundant for both Douglas-fir and hemlock. It seems very likely the 3G cutting also had a good seed crop although the pounds estimated on 2A and 3B may not be representative. From 1955 until 1959 seeds were trapped on the 3G cutting; in 1960 the traps were moved to the 9A cutting and are presently there.

Pounds of seed per acre varied from a low of 0.02 to a high of 4.82. The crop was considered to be abundant in 1956 and 1959. In 1954 and 1962 it was classed as being moderate and was rated light in 1955, 1957, 1958, 1960, 1961, 1963, and 1964. Thus, in an 11-year period there were only 4 moderate to abundant seed crops. The year after each moderate or abundant crop the production of seeds dropped to a low level. Isaac (*7*) reported that Douglas-fir trees often failed to flower the year following a heavy seed crop. This would account for the greatly reduced production.

Spring deer mouse populations varied from 0 to 4 animals per acre with a mode of 2. All of the spring trapping was done in April except in 1956 when heavy snow cover delayed trapping until May. Although the yearly data are variable, other studies indicate May is probably near the low point in the yearly population cycle of the animals. May was also reported as the low point in the yearly deer mouse population in northwest Oregon by Hooven (*5*).

The spring deer mouse populations generally remained at low levels. There is one modest exception in 1963 when the estimate was 4 mice per acre. Sampling variability could have been responsible for this exception. However, there was a heavy snowfall in 1962-1963 and it may have favored overwinter survival and thus a greater population.

Fall populations ranged from 2 to 12 deer mice per acre. There were 4 falls with relatively high populations, 4 with moderate, and 2 with low during the 10-year period. These September populations are probably not the maximum. Unpublished data indicate the peak population is reached in November or even later. Hooven (*5*) also reported that deer mouse population estimates in northwest Oregon generally reached peak abundance in November. Fall populations were consistently greater than the corresponding spring estimates; they also fluctuated greatly and were more variable.

Discussion

Ordinarily, seed dissemination on the Andrews Forest starts in September, builds quickly to a peak in October or November, and gradually declines until the following summer. The exact pattern, however, is determined largely by variable weather conditions (*7*).

Since the fall trapping was also done in September there was little chance for the current seed crop to have a measurable impact on the deer mouse population at that time. Bendell (*2*) demonstrated that a food supply could have a determining influence on the ability of wood mice (*Peromyscus leucopus*) to survive and thrive on a timbered island. Thus, it could be expected this preferred food would have some influence on the population the following spring. My data, however, reveal no such response during the good seed years of 1956 and 1959. Stickel and Warbach (*19*) give instances of wood mice in a wooded area apparently responding quickly to good crops of mast. They also report a rapidly declining population during a good pine seed crop. The spring population of 1963 which followed a moderate seed fall was the highest recorded. Even so, it was only twice as great as the mode and was only ⅓ of the largest fall population.

It could also be reasoned that a small seed fall would have an adverse effect on the size of the following spring's deer mouse population. This response, however, is not evident from data in the table. Generally speaking, the tree seed crop, regardless of its size, had very little if any effect on the size of the following spring deer mouse population in this study. Bendell (*2*) reported, "The most important effect of food supply is on the survival of young from birth to approximately 1 month of age," but deer mouse breeding in western Oregon is much restricted if not suspended altogether during late fall and winter. Consequently, tree seed would not have much opportunity to affect breeding activities or survival of young at that time.

Bendell also found a lower lifelong mortality rate with ample food compared to inadequate food. Improved food resources should increase the carrying capacity and thus maintain a larger overwinter population. It is not known why this pattern did not prevail. Some additional field data, not yet compiled, may help explain this condition.

There appears to be a direct relationship between moderate to good seed crops and high deer mouse populations the following fall. However, tree seeds apparently are not a critical mouse food since the table shows the populations reached moderate abundance even during periods of near seed failure. The moderate to heavy seed crops of 1954, 1956, 1959, and 1962 were all followed by high deer mouse populations the succeeding fall. The mouse population on another clearcut about 1.5 airline miles distant and at a slightly higher elevation, for which no seed crop data are available, followed essentially the same pattern. Since it is generally accepted that good seed crops in the Douglas-fir region are often uniform over relatively large areas, these additional data corroborate the experimental results.

It is of interest to note the mice were able, under field conditions, to increase nearly 6 times from April to September. Most of this increment probably resulted from increased breeding success and higher spring and summer survival rates. However, it is possible some movement may have contributed to the increase. The exact way seed abundance influences the populations has not been determined. One can only conjecture, but it seems probable the seeds supplied just enough additional nutrients in winter or spring to trigger a spring and summer breeding and/or survival response in the animals. The table shows that 2 of the 3 available spring estimates which preceded the large fall populations were 2 animals per acre each. In northern California, Jameson (*9*) also found brushfield *Peromyscus maniculatus* reaching peak abundance about 1 year after a heavy mast crop. He considered the changes in numbers of deer mice to be due to varying rates of reproduction.

The 7 poor seed years which ranged from 0.02 to 0.28 pounds of seed per acre caused no apparent response in the fall deer mouse populations. The moderate to abundant years which ranged from 0.81 to 4.82 pounds of seed per acre all caused approximately the same degree of increase the following fall. No data are available on population response to seed abundance between 0.28 and 0.81 pounds per acre. It would seem that the lowest poundage which might cause a measurable response would fall somewhere between these values.

The number of deer mice in the spring had little influence on the size of fall populations. Blair (*3*) reported similar findings for deer mice in blue-grass habitat in southern Michigan. In 1957 and 1960 the high fall population was preceded by only a normal spring population of 2 animals per acre. The high 1963 spring population of 4 animals per acre did not cause a corresponding increase the following fall. Although the fall population was high, it was less than in 1957 and 1960 when the spring figure was 2 animals per acre. Although breeding stock is necessary to produce a population, the two are not always directly proportional. Many interacting factors operate to determine the population levels.

It can also be noted the high fall populations of 1955, 1957, and 1963 were followed by spring populations of 3, 3, and 0 deer mice per acre respectively. The high 3G population of 1960 was followed by a spring one (not shown in the table) of only 1 mouse per acre. These spring populations are comparable to those preceded by smaller fall populations. The only possible exception would be the fall population of 5 deer mice per acre in 1962 which was followed by a spring population of 4. It seems evident that size of the fall populations has little influence on that of the following spring. These data do not agree with the 5-year study of Blair (*3*) who found the carryover of deer mice to the following spring was greater in years of comparative abundance than from those of scarcity. It is not known why the two sets of data disagree.

Summary and Conclusions

Tree seed abundance had only a small influence on spring deer mouse populations in this study. The spring population was roughly the same regardless of the amount of seed. The reasons for the lack of response to seed abundance have not been determined.

Fall deer mouse populations displayed no response to current tree seed abundance. However, there was a marked response by the following fall to moderate or good seed crops. Since this was replicated 4 times, and duplicated on another cutover, it is assumed to be a valid relationship.

Deer mouse response to moderate and good seed abundance was considered to be nearly the same. This study indicated that approximately 0.8 pounds of seed per acre will cause a high mouse population the following fall. Since there was no available information between 0.28 and 0.81 pounds of seed per acre the lowest activating quantity may be between these figures.

These data suggest that size of the spring deer mouse population has little or only a modest influence on the fall population and vice versa. High breeding potential of deer mice is capable of increasing a small population to high levels in a short time under favorable conditions.

In addition to adding to our understanding of forest ecology some findings from this study may be of practical use. The most obvious would appear to be in direct seeding programs. When the filled Douglas-fir and hemlock seed crop amounts to about 0.8 pounds of seed per acre it would seem reasonable to expect a high deer mouse population the following fall. If seeding is attempted then, additional precautions should be taken to periodically census the mouse populations because of the possibility of heavy reinvasion and thus seed destruction. It might even be prudent to hold the seed another year in anticipation of a decline in the mouse population. It is assumed that reinvasion would be less during periods of low population.

It is generally believed that control operations during low periods in an animal's life cycle are most effective and economical. The data indicate that early spring is a low point in the deer mouse yearly cycle. Where feasible from an operational viewpoint, early spring would seem to be a good time to reduce mouse populations.

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