Do small mammals and birds affect REPRODUCTION of SPRUCE and FIR?

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WHY FIR NOT SPRUCE?

AFTER BEING CUT, many spruce-fir stands in the Northeast reproduce to fir rather than spruce. Why? One reason for this may be that wildlife prefer to feed on the seeds and seedlings of spruce rather than fir, so that a smaller proportion of spruce becomes established.

A recent study of the seed-eating habits of mice and voles showed that white spruce seed were taken in preference to balsam fir seed in a ratio of 70 to 1 on the basis of seed weight.[1] The animals were given free access to an unlimited supply of seeds exposed in a small area. This mouse and vole population, which ranged from 15 to 30 animals per acre, consumed more seed than normally is produced in a natural seed crop. However, the concentration of large amounts of seed in a small area may have resulted in unnatural feeding.

To determine the influence of small mammals and ground-feeding birds on spruce-fir regeneration under more natural conditions, we began a new study on the Penobscot Experimental Forest in 1961.

[1] Abbott, Herschel G., and Arthur C. Hart. MICE AND VOLES PREFER SPRUCE SEEDS. U. S. Forest Serv. NE. Forest Exp. Sta., Sta. Paper 153. 12 pp., illus. Upper Darby, Pa. 1960.

STUDY METHODS

A 3-acre area in a mature spruce-fir stand on a well-drained glacial till soil was used for the study. About half of the volume had been cut for pulpwood, leaving 850 cubic feet per acre in seed-bearing dominant and codominant trees. They were well distributed over the area. About half of these trees were spruce, a third fir, and the rest white pine and northern white-cedar. A 2-acre block laid out within the cut area was divided by a grid with 80 stations that were 36.9 feet apart.

To observe the number of spruce and fir germinants that appeared under different degrees of protection against mice and birds, we installed forty 1/2-milacre sample plots in late August 1961. The plots were 7.26 feet long by 3 feet wide. Ten were unprotected controls, marked only by corner stakes (treatment I); the other 30 plots were protected by exclosures constructed of 1/2-inch mesh hardware cloth on wooden frames. We used three types of exclosures for treatments II-IV:

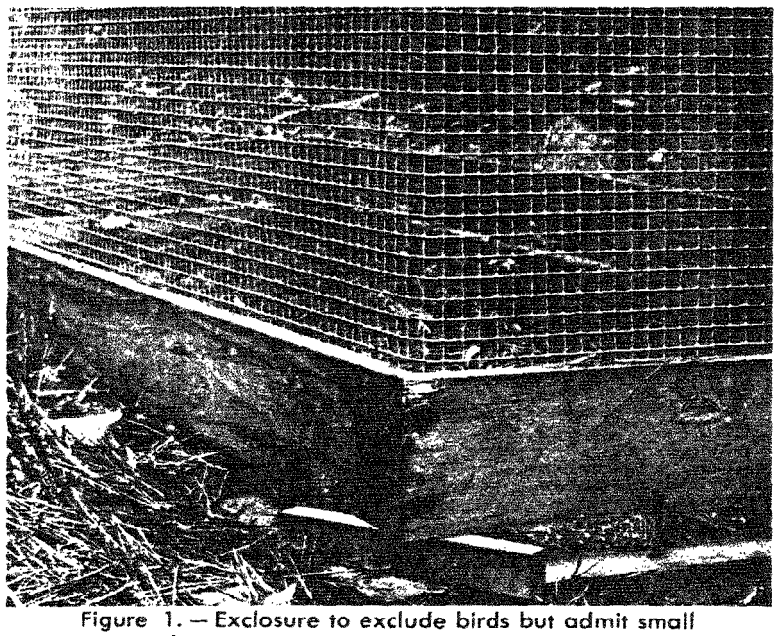

Figure 1. — Exclosure to exclude birds but admit small mammals.

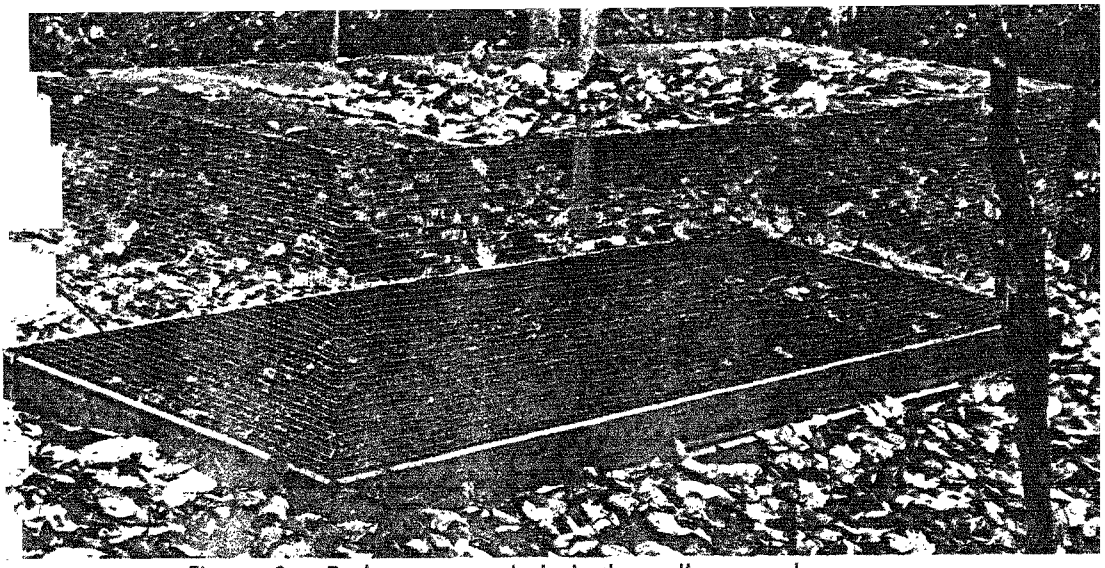

Figure 2. — Exclosure to exclude both small mammals and birds.

- Treatment II—Birds excluded; accessible to small mammals (fig. 1).
- Treatment III—Both birds and small mammals excluded (fig. 2).
- Treatment IV—Small mammals excluded; accessible to birds (fig. 3).

Each treatment comprised 10 plots. Locations for the 40 plots were systematically distributed over the area at or near every other grid station. Treatments were assigned at random to these locations. All exclosures were placed on 2-by-2-inch wooden bases on mineral soil to cut off any small mammal burrows in the duff (figs. 2 and 3). The bird exclosures were elevated on 1-inch blocks to allow small mammals to enter at the bottom (fig. 1).

All spruce and fir seedlings less than 3 inches high were clipped and removed from each of the 40 sample plots at the time of establishment. The number of newly germinated seedlings in each plot was recorded at the end of each growing season before hardwood leaf-fall. Small colored wooden dowels were placed beside each seedling, a different color marked each year's crop.

A census of small mammals was made each year for 4 years:

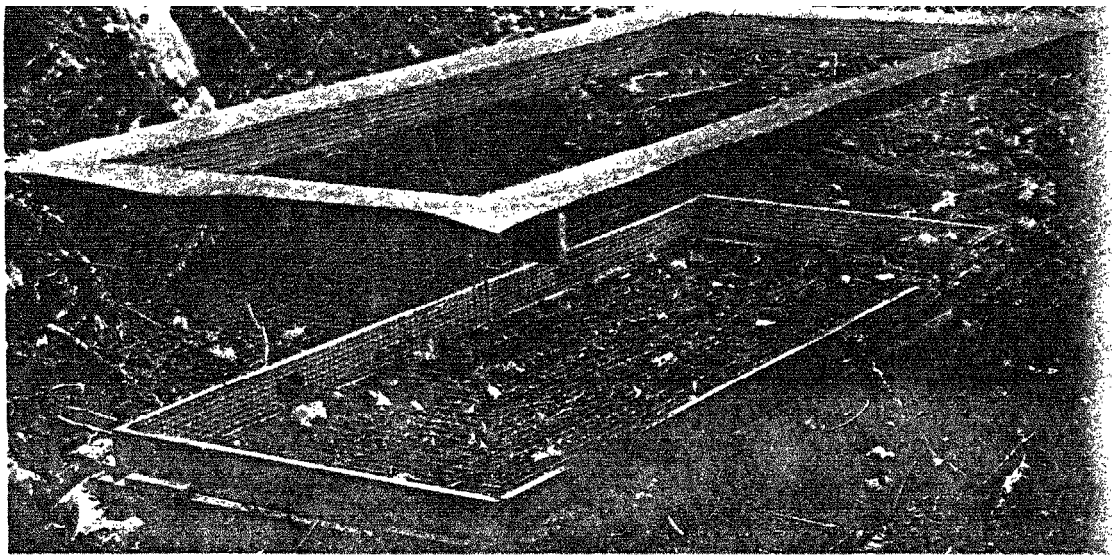

Figure 3. — Exclosure to exclude small mammals but admit birds.

In August before seedfall, again in October after most seedfall had occurred, and again in May before the young animals of the year had entered the mobile population. Eighty Sherman live traps,[2] baited with a mixture of peanut butter and rolled oats, and containing cotton for nesting material, were distributed in the grid pattern. Each trap was placed at the most suitable location within a 5-foot radius of the stake marking a grid coordinate. Such spots included the immediate vicinity of rocks, stumps, slash, and other debris offering cover.

The traps were checked daily in the early morning. Caught animals were identified by species, marked by toe clipping according to a code, and released. Trapping continued until no unmarked animals were taken; this required 4 to 9 consecutive days.

An estimate of the bird population was made at the same time. Nine standard 4-shelf, ¾-inch mesh mist nets, each about 7 feet wide and 36 feet long, were erected in openings with the net bottom placed as close as possible to the forest floor. Nets were erected in the morning, tended on a 1-to-2-hour schedule, and taken down in the evening. Trapped birds were identified, leg-

[2] The Sherman small mammal live traps are made of galvanized sheet metal and have a spring-loaded entrance door that is triggered when an animal enters the trap (Mention of a particular product does not imply endorsement by the U. S. Department of Agriculture.)

banded, and released. Netting periods for birds coincided with the days when the small-mammal censuses were conducted.

Twenty 3-by-3-foot seed traps were distributed at random among the forty ½-milacre sample plots. Collections were made in November before snowfall, and again in May after snowmelt. Spruce and fir seeds were separated from each seed trap collection and counted.

RESULTS AND DISCUSSION

The population of deer mice and boreal red-backed voles—the principal seed eaters among the small mammals captured—ranged from 9 to 20 per acre in August and 10 to 16 in October (table 1) for each of the 4 years 1961 to 1964. The major species of seed-eating birds trapped on the study area also are shown in table 1.

Total estimated spruce seedfall per acre per year ranged from about 55,000 to 1,164,000 for the years 1961 to 1964. Fir seedfall ranged from about 127,000 to 1,385,000 (table 2). Total estimated viable seed per acre ranged from 9,000 to 509,000 for spruce and from 3,000 to 568,000 for fir.

The total number of spruce germinants found in plots accessible to small mammals (treatments I and II) was slightly greater than in the plots where these animals were excluded (treatments III and IV) (table 3). Thus, under the conditions of this study, no evidence was produced to indicate that small mammals affect the regeneration of spruce by feeding upon its seeds.

Because small mammals showed a marked preference for spruce seeds in previous investigations, our results raise some doubts about our experimental techniques. The design or the presence of the exclosures or some unnatural condition on the plots—like lack of cover—may have discouraged the mice and voles from entering the plots because food was ample elsewhere. Uncontrolled study variables, like uneven natural seedfall, also may have confounded the results. More studies like this are needed to fully answer the question "Do small mammals affect spruce-fir reproduction?" Such studies probably should employ

Table 1. Known number of small mammals and seed-eating birds on 2 acres at various census dates

Species	1961		1962			1963			1964		
	Aug.	Oct.	May	Aug.	Oct.	May	Aug.	Oct.	May	Aug.	Oct.
SMALL MAMMALS											
Woodland jumping mouse (*Napaeozapus insignis*)	4	0	0	0	0	0	3	0	0	1	0
Deer mouse (*Peromyscus maniculatus*)	1	4	2	1	3	0	13	4	2	8	2
Red-backed vole (*Clethrionomys gapperi*)	12	17	4	18	18	7	16	18	1	31	30
Short tailed shrew (*Blarina brevicauda*)	2	0	0	1	0	0	0	1	0	0	0
Masked shrew (*Sorex cinereus*)	0	0	0	2	0	0	0	0	0	0	0
Total	19	21	6	22	21	7	32	23	3	40	32
SEED-EATING BIRDS											
Slate-colored junco (*Junco hyemalis*)	4	0	2	2	5	4	0	0	0	2	2
Black-capped chickadee (*Parus atricapillus*)	6	7	0	3	5	0	4	0	4	3	0
Red-breasted nuthatch (*Sitta canadensis*)	6	3	0	4	0	6	4	0	0	1	0
White-breasted nuthatch (*Sitta carolinensis*)	0	0	0	0	1	0	0	0	0	0	0
Purple finch (*Carpodacus purpureus*)	0	0	0	0	2	2	0	0	0	0	0
White-throated sparrow (*Zonotrichia albicollis*)	0	0	8	1	1	2	0	0	1	0	4
Total	16	10	10	10	14	14	8	0	5	6	6

Table 2. Estimated seedfall per acre by year

Year	Spruce			Fir		
	Total number	Germination[1]	Total viable	Total number	Germination[1]	Total viable
	Thousands	*Percent*	*Thousands*	*Thousands*	*Percent*	*Thousands*
1961	829	12	99	128	2	3
1962	55	16	9	1,385	41	568
1963	1,164	29	338	214	2	4
1964	835	61	509	421	7	29

[1] From germination tests made by the Seed Testing Laboratory, Massachusetts Agricultural Experiment Station, Amherst, Mass.

larger plots, and unbaited pitfall traps probably should be used for trapping within the plots. Natural seedfall also might be excluded, and the plots could be sown with known quantities of seed in amounts comparable to natural seedfall.

The plots protected against birds had more spruce germinants for 3 of the 4 years than unprotected ones (table 3). This might imply that birds appreciably reduced the numbers of seeds on the uncovered plots, but we don't believe this happened.

Although at least six species of seed-eating birds were present on the area after seedfall, we found no evidence that they fed on the seeds. Neither the birds nor their droppings were ever seen within the ½-milacre plots.

The wire exclosures protecting treatments II and III from birds also prevented hardwood leaves from falling within the plots (fig. 2). Numerous investigators have reported that such protection greatly enhances conifer germination and seedling survival. We are convinced that hardwood leaves were a major factor in accounting for the differences in numbers of germinants between plots with and without screen covers. Where leaves were excluded, there were nearly 4 times as many spruce germinants. However, such protection did not increase fir germination significantly.

Hardwood leaves did not appear to affect seedling survival.

Table 3. Number of germinants each year by treatment

Year	I		II		III		IV	
	Spruce	Fir	Spruce	Fir	Spruce	Fir	Spruce	Fir
1962	21	0	29	2	21	3	5	2
1963	1	89	7	107	5	253	2	164
1964	5	3	11	4	34	8	2	3
1965	9	13	30	10	34	4	1	5
Total[1]	36	105	77	123	94	268	10	174

[1] Analysis of variance of numbers of germinants transformed to $\sqrt{x+1}$ and a comparison of means by Tukey's test showed significant differences at the 10-percent level between treatments III and IV, II and IV, and III and I for spruce. Fir differences were not significant at the 10-percent level.

We realize that the infrequency of observations could have caused some short-lived germinants to go undetected, thus affecting our survival data. However, we took special care in examining two open plots where the leaf litter was heaviest. Of the nine germinants found on these plots, only one failed to survive 4 years. This seedling succumbed, presumably from drought, in midsummer of the first year.

Our findings are in sharp contrast to those published by Davis and Hart.[3] They found mortality of first year germinants to be especially high on plots more than 25-percent covered by hardwood leaves.

Although we cannot definitely answer the question posed by the title at this time, our study has cast some doubt on the importance previously attached to mammal preferences for spruce rather than fir seeds. Further carefully designed studies will be needed to establish the true importance of this preferential feeding under natural conditions.

[3] Davis, Grant, and Arthur C. Hart. EFFECT OF SEEDBED PREPARATION ON NATURAL REPRODUCTION OF SPRUCE AND HEMLOCK UNDER DENSE SHADE. NE. Forest Exp. Sta., Sta. Paper 160, 12 pp., illus. Upper Darby, Pa. 1961.