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THE STRATEGY FOR CONTROLLING RODENT DAMAGE TO PINES IN THE CANADIAN MID-WEST

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ABSTRACT: The transitional zone between prairie and boreal forest in Manitoba and Saskatchewan is more suited to the needs of forestry than to agriculture. Tree production is difficult in this zone for a number of reasons, one of which is the depredations of small mammals, especially the meadow vole, Microtus pennsylvanicus (Ord.). Vole populations peak every 3 to 5 years and on the average irruptions of serious importance occur about every 10 years. Populations in the transitional zone are generally higher than those in the treed areas of adjacent zones: areas of extreme populations coincide with areas of greatest forestry concern. Key factor analysis indicates that a high degree of damage predictability may be achieved by measuring juvenile vole survival. Spruce, jack pine, white pine, red pine and Scotch pine are increasingly vulnerable to rodent damage. Seed and stand density also influence degree of impact.

Strategy of vole damage control must involve prediction surveys coupled with cultural, operational and baiting tactics.

The Canadian Prairie Provinces of Manitoba and Saskatchewan lie to the east of British Columbia and Alberta, to the west of Ontario and to the north of the U.S. States of Minnesota, North Dakota and Montana. At the U.S. Boundary they are some 600 miles in breadth, and extend northward about 800 miles to the tree line. They are transected by a band of variable width, running from the south east corner, through the center of the larger lakes and thence westerly to the Saskatchewan-Alberta boarder. North of this band the land is covered by extensive boreal forest, and south of it is prime grassland currently producing cereal grains (Fig. l). The band itself is transitional land with interspersed poplar bluffs, more suitable for conifer production than for agriculture (Rowe 1959, Gill 1956).

Coniferous production in the transitional zone has been plagued by problems. Because the area is adjacent to steppe conditions it receives limited precipitation which prohibits growth of certain conifers and limits growth rates of others. Fires, grazing and insect attack also reduce production. The depredations of small mammals, especially Microtus pennsylvanicus (Ord.), on seeds, seedlings and younger trees also rank among the more important production problems (Cayford and Haig 1961). The formulation of a strategem to reduce the damage by M. pennsylvanicus to regeneration conifers in the area has been the subject of a long term research project, with emphasis on rodent population surveys, damage appraisals, and food utilization studies.

POPULATION STUDIES

The numbers of M. pennsylvanicus were the subject of extensive and intensive studies over a 15-year period from 1955 to 1969. Populations were monitored in various habitats in a network of areas over the two provinces by means of standard snap-back traplines (Buckner 1957). These were operated by Forestry rangers who preserved the specimens for determination and examination. This general survey was supplemented by intensive live trapping studies (Buckner 1966) in 4 locations in Manitoba: two of these were in the transitional zone, and two in the boreal forest zone. In both extensive and intensive studies, emphasis was placed on populations in coniferous plantation and regeneration areas.

The general survey indicated that there were four irruptions in the populations of M. pennsylvanicus between the years 1955 and 1969; in the years 1956, 1960, 1964 and 1967. In these years the species was in abundance over the whole area monitored but concentrations were particularly evident in the transition zone. Five general areas during both the 1956 and 1964 irruptions had particularly high populations (in excess of 50 specimens per 100 trap-nights) (Fig. 2), and these in general were in the areas of greatest forestry concern. Areas of highest vole densities were in the southeastern irruption zone.

Fig. 1. Regional types in Manitoba and Saskatchewan. Dots indicate intensive sampling areas (from east to west: McMann, Telford, Riverton, Andy Lake).

Fig. 2. Areas of extreme vole populations during the 1956 and 1964 outbreaks.

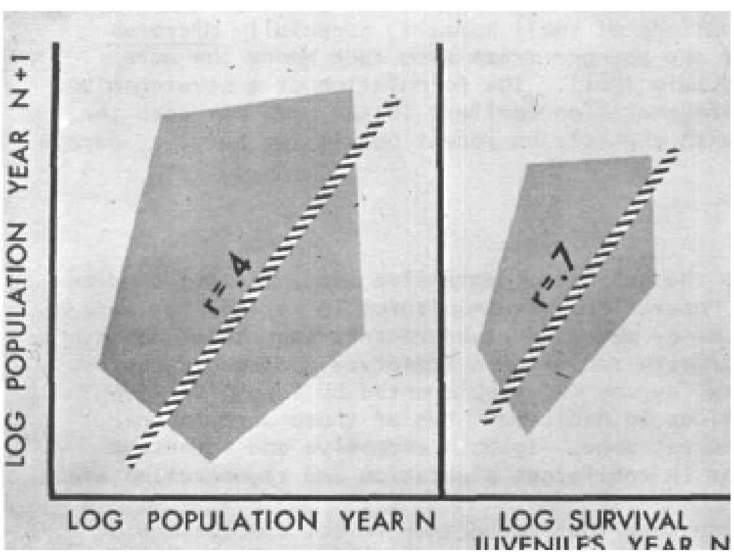

Fig. 3. Single key factor analysis of vole populations using survival of juveniles.

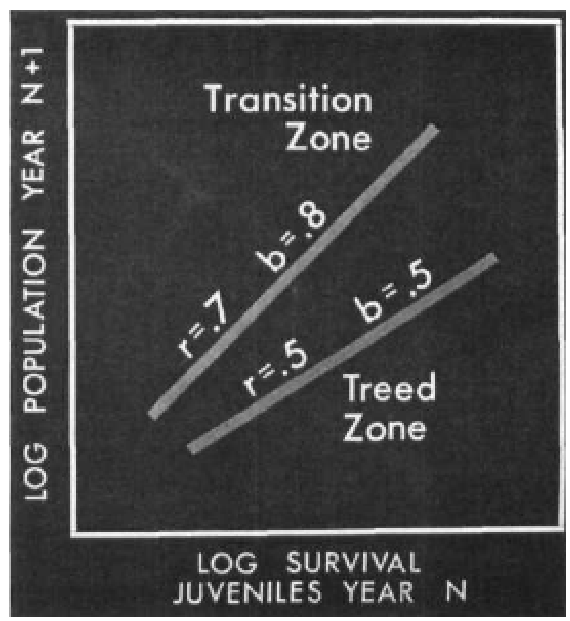

Fig. 4. Differences in strength of key factor (survival of juveniles) in transition and treed zones.

Of the four areas of intensive investigation, two fell within the southeastern irruption zone, one in the center and the other on the periphery. The third lay well within the boreal forest zone, and the fourth within the irruption zone straddling the central provincial boundaries. Vole populations within the irruptive zones were characterized by extremely high peaks and low troughs: populations in the boreal zone had lower peaks and higher troughs. The intensive studies confirmed the peak years and provided positive population benchmarks (Table 1).

Table 1: Populations per acre of Microtus pennsvlvanicus (Ord.) on four plots in eastern, central and western Manitoba over a 15-year period.

Year	McMann	Telford	Riverton	Audy Lake
1955	2.3	3.6	3.8	.6
1956	8.1	9.1	21.3	18.9
1957	.2	.4	<.1	<.1
1958	1.5	2.1	2.5	1.1
1959	2.1	3.8	4.3	2.6
1960	7.3	7.9	8.4	11.4
1961	.8	1.3	.9	.3
1962	1.4	.9	1.2	.9
1963	2.9	4.6	3.5	2.3
1964	9.7	10.2	30.6	46.5
1965	>.1	1.0	.9	>.1
1966	.9	1.2	1.9	.4
1967	5.3	6.5	8.8	17.8
1968	.1	.3	.5	>.1
1969	.9	1.4	1.9	.3

Analytical techniques are available for evolving predictive population models and one of these is the key-factor approach (Morris 1959). The logarithm of the population of the generation in year n is plotted against the logarithm of the population in year n + 1, resulting in an eliptical figure. The sequence of the points is ignored and a correlation calculated. The process is then repeated using survival in year n. Improvement in correlation then measures the predictability of the factor. In the current vole study, survivals of juveniles were apparent population indicators (Fig. 3). When analysed in this manner it becomes evident that the strength of the irruption is proportional to the survival of juveniles. Furthermore, this response is stronger in the transitional zone than it is in the treed zone (Fig. 4).

IMPACT STUDIES

Rodent damage to young conifers was estimated in all areas adjacent to the vole census areas each year. Injury was categorized as (1) damage to growing tips (2) damage to the main branches (3) damage to the trunk (4) and completes girdling of the main stem. Percentages of damage in the various categories were estimated each year for a variety of tree species (Table 2). Even in years of peak rodent populations, white spruce was in general only moderately attacked, with the preponderance of damage being to the young growing tips. Damage to jack pine was generally more severe, with heavy barking of primary branches. Still more severely damaged was red pine, with many specimens exhibiting gnawing on the main stem. And in years of high rodent population it was not infrequent to find young stands of Scotch pine completely girdled.

Table 2. Percentage of damage incidence by voles to trees under 15 years of age in plantations of Manitoba and Saskatchewan.

	White spruce				Jack Pine				Red pine				Scotch pine			
Year	Branch tips	Main branches	Trunk	Complete girdling	Branch tips	Main branches	Trunk	Complete girdling	Branch tips	Main branches	Trunk	Complete girdling	Branch tips	Main branches	Trunk	Complete girdling
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	9	5	3	1	12	5	5	4	23	17	17	11	19	38	24	17
1957	0	0	0	0	0	0	0	0	5	2	0	0	4	6	0	0
1958	0	0	0	0	0	0	0	0	1	0	0	0	2	1	0	0
1959	0	0	0	0	2	0	0	0	3	1	0	0	4	2	1	0
1960	0	0	0	0	5	3	1	0	9	6	4	1	12	9	6	4
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
1963	0	0	0	0	0	0	0	0	5	0	0	0	8	4	0	0
1964	16	6	5	3	14	14	8	5	27	24	20	9	28	23	19	23
1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1967	0	0	0	0	5	2	0	0	6	4	1	0	5	5	4	2
1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	1	1	2	0	1	3	3	1

Experiments were conducted to estimate the effect of stand density on damage. The small mammal complex of islands was removed, the islands stocked with varying densities of small jack pine and then single specimens of M. pennsylvanicus introduced: similar experiments were conducted using varying densities of jack pine seeds (Table 3). As the density of young trees increased, damage to them increased in sigmoid fashion, with a leveling off at high densities. In the case of seeds, consumption increased to a maximum and then declined to a lower level. Limited trials with mixtures of tree species indicated that the response to each was relatively independent.

Table 3. Functional response of M. pennsylvanicus to jack pine seeds and seedlings.

Density of seeds per acre	Seeds destroyed per acre	Density of seedling/acre	No. seedlings attacked/acre
200	16	100	5
400	38	200	27
600	356	300	69
800	689	400	256
1,000	907	500	327
1,500	806	600	389
2,000	790	700	427
2,500	765	800	456
3,000	785	900	449
3,500	779	1,000	468

DISCUSSION

The strategem of protecting conifers then depends upon the predictability of vole numbers and feeding responses. In the study zone it is apparent that voles irrupt in numbers every three to five years. Greater precision can be achieved by examining juvenile survival which operates as a key factor and is related to the strength of the irruption. As only two irruptions in 15 years exerted sufficient tree damage to warrant protection measures, the initial step in the strategy of controlling damage is to monitor juvenile survival of the vole in the areas of latent outbreaks.

Restocking programmes must consider stand composition. Spruce the least vulnerable species, is also the most susceptable to drought. In order to ensure acceptable yields the pines must form the highest proportion of the stands and monospecific stands should be small in extent. Scotch pine, the most vulnerable species studied, should not be used extensively in restocking plantations. Vulnerable stands should be protected by any of the available rodenticides in years of potential vole irruptions. No stand should require more than three control treatments during its history, because by the time the fourth irruption is likely to occur the trees should be sufficiently mature to withstand damage.

Planting of young trees rather than seeding programmes is recommended because of the decrease in the number of vulnerable years. However, seeding can be successful if attempted the year following a vole population peak and if the density of seeds broadcast falls below the threshold of functional response of the pest.

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