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ECONOMICS AND CONTROL OF DAMAGE CAUSED BY LOW-DENSITY POPULATIONS OF MEADOW VOLES IN ONTARIO APPLE ORCHARDS

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Abstract. Live trapping and questionnaires were used to evaluate amount, distribution, and costs of control of damage to Ontario apple trees by meadow voles (*Microtus pennsylvanicus*) in 1981-82. In a sample of 180 orchards, 5802 (0.77%) trees were damaged or killed by voles. Orchards with high levels of damage (> 2.5%) were smaller than the average orchard in our sample. Application of rodenticides showed no relationship to levels of damage, but was effective in short-term population reduction. Growers spent an average of $17/ha on rodenticides and $38/ha on herbicides, and they estimated that voles destroyed 2% of their crop each year. About 55% of our sample of growers stated that damage by voles was more significant than that caused by insects or other pests. In the 1981-82 season, vole numbers were lower than in 1980-81, and reported levels of damage were also lower. These differences are discussed.

Introduction

Rodents and other herbivorous mammals inflict widespread and sometimes costly damage in apple orchards throughout Ontario. In September 1981, at the request of Ontario growers, we initiated a four-year research program to identify the species causing damage to trees, to assess the amount and cost of this damage, to evaluate current control practices and to develop recommendations for effective and cost-efficient control of these pests. In Ontario, it appears that the meadow vole (*Microtus pennsylvanicus*) is the only small microtine causing damage to apple trees and that pine voles (*M. pinetorum*) are not a significant pest even in those parts of the province that are within this species' range (Brooks and Struger, 1982). Therefore, although Ontario orchards are dispersed over a wide range of environmental conditions, control methods can be directed toward a single species, the meadow vole. Further background on the vole problem in Ontario orchards may be found in reports in earlier proceedings of the Eastern Pine and Meadow Vole Symposia (Brooks and Schwarzkopf, 1981; Brooks and Struger, 1982; Siddiqi and Blaine, 1982).

In this report, we describe results from the second year of our study. Our objectives in the second year were:

(a) to assess levels of damage over a second winter and to relate damage to population levels of meadow voles;

(b) to monitor population changes in voles in orchards, particularly in relation to control procedures;

(c) to assess type and costs of current control methods in relation to several variables.

Materials and Methods

1. Questionnaire

In May 1982, questionnaires were distributed by mail to 900 apple growers in Ontario. These questionnaires provided information on (a) tree composition (i.e. - number, age, variety, etc.) and size of the orchard; (b) methods (i.e. - timing, and frequency of use of herbicides, rodenticides, mowing, cultivation, etc.) of habitat management and rodent pest control used by growers; (c) cost ($/ha) of herbicide and rodenticide applications; (d) amount of damage inflicted by meadow voles on apple trees; (e) growers' attitudes towards various control measures, and; (f) growers' attitudes regarding the importance of voles, as compared to diseases, and insects and other pests, as sources of economic losses.

Returned questionnaires (180) were allocated to four regions (Brooks and Struger 1982; Fig. 1).

A. Lake Erie = all counties bordering Lake Erie

B. Central Ontario = all counties from Lambton to York

C. Georgian Bay = counties of Grey, Simcoe and Wellington

D. Eastern Ontario = all counties east of York

2. Trapping Program

Standard live-trapping techniques (Davis 1956, Krebs et al. 1969, Renzulli et al. 1980, Stockrahm et al. 1981, Webster and Brooks 1981) were used to monitor meadow vole population levels. Trap grids were located in orchards in Haldimand-Norfolk municipality, Grey county and Prince Edward county (Brooks and Struger 1982). Four 0.21-ha, live-trap grids were established in each of the three sample areas in 1981. The grids were trapped in Sept., Oct. and Nov. of 1981 and April, Sept. and Nov. of 1982. During each trapping session, grids were trapped throughout four consecutive 24-h periods. Baited Sherman live traps were set at each grid marker with 7.6 m between markers (49 traps). Traps were locked open for 24 h before each four-day trap cycle began. Captured animals were marked with numbered ear tags, weighed, sexed and released. Reproductive activity was also noted.

Results and Discussion

The data from 180 questionnaires are summarized in Table 1 to show the per cent of apple trees damaged by meadow voles across Ontario in the winter of 1981-82. The per cent change from values obtained in the winter of 1980-81 is also shown. Overall, meadow voles damaged 0.7% of all reported apple trees through the winter of 1981-82, a decline of 18% from the previous winter's figure. Declines of damage

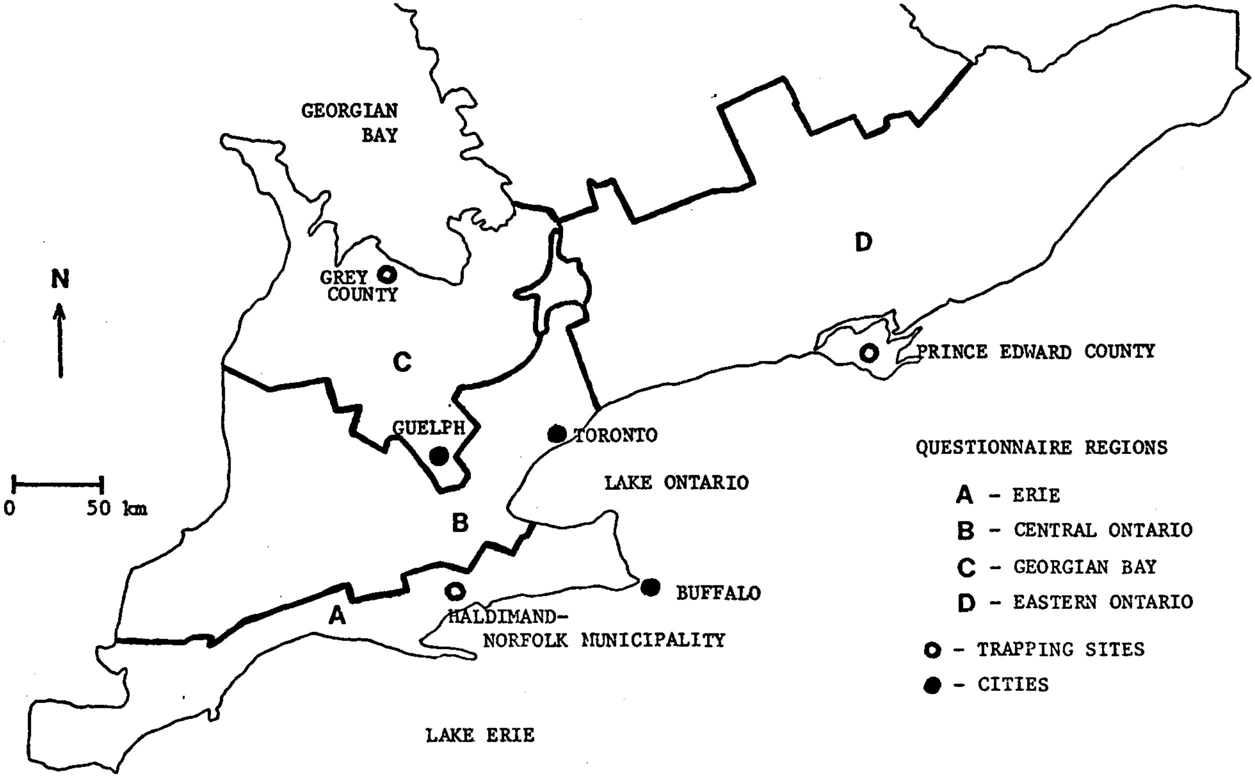

Figure 1. Questionnaire regions and trapping locations in southern Ontario.

estimates ranged from 13 to 65% in Lake Erie-Niagara, Georgian Bay and Eastern Ontario. In central Ontario 1.07% of trees were damaged, an increase of 37% from 1980-81.

Table 1. The percentage of apple trees damaged by meadow voles (*Microtus pennsylvanicus*) in Ontario in 1981-82. Sample sizes given in parentheses.

	Region				
	Lake Erie Niagara	Central Ontario	Georgian Bay	Eastern Ontario	Ontario total
Total % apple trees damaged	0.39(48)	1.07(54)	0.39(31)	0.85(47)	0.70(180)
% change from 1980-81+	-43	+37	-65	-13	-18
Mean number of trees/orchard	5633	5159	4777	2919	4629

+ Some orchards used in this comparison were only sampled in one of the two sample years.

To examine the relationship between orchard size (number of apple trees) and levels of damage, we compared orchards (N = 18) in which more than 2.5% of the trees were damaged by voles to orchards in which less than 2.5% of the trees were damaged (Table 2). An average of 5.4% of all trees were damaged in the high-damage (greater than 2.5%) orchards. The mean number of trees in these orchards was 3067 (Table 2), approximately two-thirds the size of the average Ontario orchard of 4629 trees (Table 1). The size of high-damage orchards in Lake Erie, Georgian Bay and Eastern Ontario ranged from 12% to 36% of the average Ontario orchard. Orchard size in low-damage (less than 2.5%) orchards was higher than the Ontario average of 4629 trees in all regions except Eastern Ontario. However, in Eastern Ontario low-damage orchards were still twice as large as high-damage orchards.

It is interesting to compare these values from 1981-82 with those obtained in 1980-81. In both years, damage levels were higher in smaller orchards. However, in 1981-82, overall mean number of trees per orchard (4629) was greater than in 1980-81 (3542), and mean number of trees in high-damage orchards was also higher in 1981-82 (3067) than in 1980-81 (1428). In 1980-81, high-damage orchards were about 40% the size of the average orchard, whereas in 1981-82 they were 65% as large. Further analyses of the data are required to explain these differences. Many orchards were dropped from the Ontario Apple Marketing Commission mailing list and fewer growers responded to the questionnaire in 1981-82. Presumably, many orchards that were dropped

Table 2. Size of orchards in relation to low and high levels of damage by meadow voles in Ontario. Sample sizes in parentheses.

	Region				
	Lake Erie Niagara	Central Ontario	Georgian Bay	Eastern Ontario	Ontario total
Damage level greater than 2.5%					
Total % apple trees damaged	4.54	4.90	6.38	9.16	5.40
Mean number of apple trees/ orchard	1650(2)	5470(8)	545(4)	1492(4)	3067(18)
Damage level less than 2.5%					
Total % apple trees damaged	0.34	0.36	0.30	0.47	0.36
Mean number of apple trees/ orchard	5810(46)	5104(46)	5404(27)	3052(43)	4804(162)

and/or did not respond were smaller operations. Whether the loss of these small orchards from our sample contributed to the decline in estimates of damage from 1980-81 to 1981-82 can not be ascertained at present.

It is possible that larger orchards have more experienced or efficient owners than do smaller operations, but in 1981-82, we found no relationship between reported damage levels and number of years of experience of the grower. It seems likely that reinvasion by voles from surrounding habitats may be more important in smaller orchard operations (Pagano and Madison 1982). Improving perimeter control of voles may help to reduce the amount of reinvasion and thus slow down the recovery of vole populations during the spring.

Zinc-phosphide-treated corn was applied to orchards by 77.3% of the growers in our sample. In these orchards, voles damaged 0.51% of the trees (Table 3). In orchards treated with both zinc-phosphide treated corn and Ramik Brown, voles damaged 1.40% of the trees, whereas in orchards treated only with Ramik Brown, voles damaged 3.07% of the trees (Table 3). An intermediate level of damage was experienced in orchards where no rodenticide was applied. As in 1981 (Brooks and

Struger 1982), the number of trees in orchards not treated with rodenticide was less than one-third (1457 trees) of the average Ontario orchard (4629 trees).

Table 3. The percentage of apple trees damaged by meadow voles (Microtus pennsylvanicus) in orchards treated or not treated with rodenticide. Sample sizes are in parentheses.

	Rodenticide program			
	Zinc phosphide treated corn	Zinc phosphide & Ramik Brown	Ramik Brown	No rodenticide
Total % apple trees damaged	0.51	1.40	3.07	1.58
Mean number of apple trees/ orchard	5306(133)	6346(8)	3552(8)	1457(23)

No relationship was detected between the level of damage sustained in an orchard and the cost of rodenticides and herbicides applied by individual growers. Exclusive of labor, growers spent on average $17 per ha for rodenticide supplies and $38 per ha for herbicide supplies.

Growers, who responded to the questionnaire, estimated that they may have lost approximately 2% of their crop due to meadow vole damage. More than one-half (55%) of growers who responded, felt voles were as serious or more serious than insects and diseases as a cause of a decrease in fruit production and profits.

In 1982, as in 1981, no pine voles were taken. Few deer mice (Peromyscus maniculatus) and short-tailed shrews (Blarina brevicauda) were captured. By April 1982 (Fig. 2), vole densities (number of voles/ha) had dropped to lower levels than were recorded in November of 1981. Densities in April 1982 ranged from 1.2 to 3.6 voles/ha with a mean of 2.8 voles/ha in all regions. By September, some degree of population recovery had occurred in all three regions, and overall density was 14.7 voles/ha. By November, 1982, populations in Prince Edward and Haldimand-Norfolk had declined drastically, while the Georgian Bay population continued to increase. In November, the mean density over all three regions was 8.8 voles/ha.

Vole densities declined rapidly (Fig. 2) during the last trap session in Prince Edward (20.2 to 3.6 voles/ha) and Haldimand-Norfolk (15.5 to 2.4 voles/ha) after the orchards had been treated with rodenticide (zinc-phosphide treated corn). In contrast to these areas, in Georgian Bay, no rodenticide was applied before the last trap session, and vole populations rose from 8.3 to 20.2 voles/ha (Fig. 2). In 1981, when rodenticide was applied in all the regions before the last trap

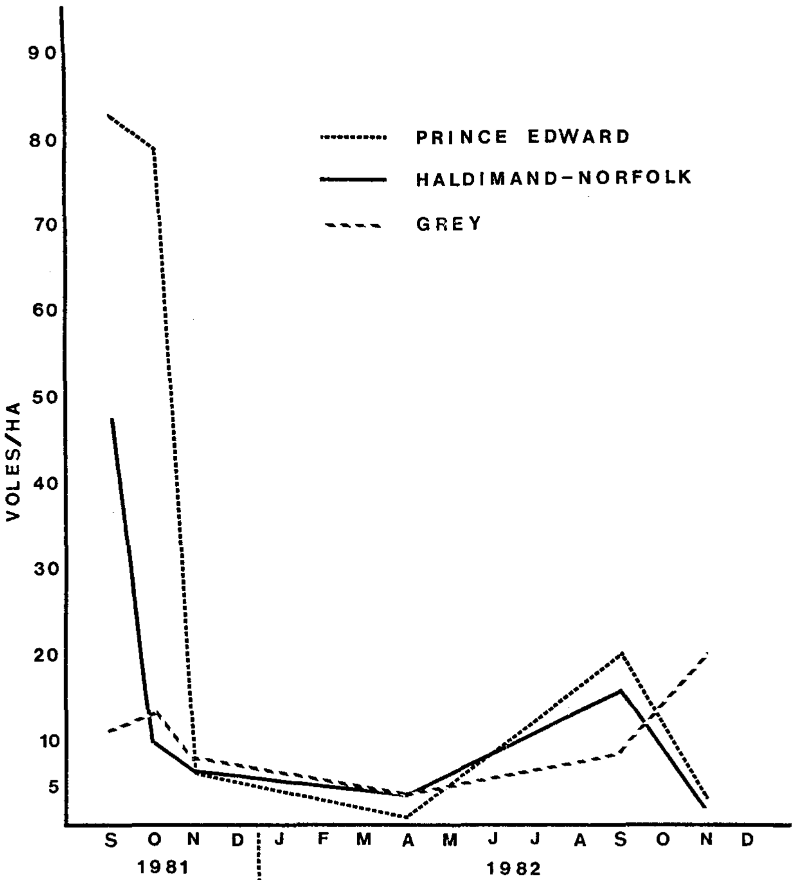

Fig. 2. The number of meadow voles (*Microtus pennsylvanicus*) per ha live trapped in apple orchards in three regions of Ontario.

session of the year, vole populations declined in all three regions. It is apparent that growers in Ontario can achieve excellent short-term control of voles in their orchards. However, consistency of control from year to year is not so easy to achieve as evidenced by damage levels reported in 1981 (Brooks and Struger 1982). Growers who use rodenticides still report damaged trees. No single control method is perfect and differences in habitat quality within a single orchard also may influence the degree of control and the extent of vole population recovery.

Growers who use an integrated vole management plan and are aware of vole population dynamics within their orchards throughout the year, should be able to maintain meadow vole populations at acceptable levels. Perhaps, the greatest unknown at present is the extent of vole movements within an orchard during winter and spring. A thorough understanding of vole movements, when combined with our present knowledge, would allow growers to optimize their rodenticide and habitat alteration programs and increase the reliability of maintaining vole populations at acceptable low levels.

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