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Movements and Habitat Use by Pine and Meadow Voles in an Orchard

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Several radiotelemetry studies have now been completed in the orchards of the mid-Hudson Valley, New York. The results of one of these projects, a 12-month study of the movements and habitat use of pine and meadow voles, will be reported on here.

The success of an integrated vole management program using cultural practices and rodenticides depends a great deal on knowing the movements and habitat use of the two orchard vole species. Species interactions that could lead to differential use of the orchard habitat are another important element in a vole management program.

This study focused on three major objectives:

1. To determine if differences in habitat use and movements existed between pine and meadow voles.
2. To determine if the habitat use and movement patterns of each species changed seasonally.
3. To integrate this information into a vole management program.

Methods

The study site was located in a commercial apple orchard near New Paltz, New York in the mid-Hudson Valley. A .75 ha grid was situated within a larger orchard block. Tree age, variety, and canopy diameter, vegetation composition and structure varied across the orchard block. The vole population was mixed as well.

Trap censuses were conducted periodically to track the populations and collect animals for telemetry. Two traps were placed at each tree on the grid which consisted of 8 rows with 16 trees in each row. An enumeration technique (Hilborn et al., 1976; Krebs, 1966) was used to calculate vole numbers present on the grid.

Five telemetry sessions were conducted over the 12-month study. Each session was completed in 10 days. Two or three 24-hour periods were covered during each telemetry session. Half-hourly positions were obtained on all voles carrying transmitters during each tracking period. Only females of each species were used. A further explanation of methods including surgical implantation of transmitters and field

techniques can be found in Pagano (MS thesis, 1982), Madison et al. (1981), and Pagano and Madison (1981).

The following is a list of the habitat variables analyzed during this study:

Vegetation
- Horizontal Vegetation Density (0-.25m)
- Percent Ground Cover Composition

Soil
- Soil Compaction
- Soil Organic Matter
- Litter Depth

Tree
- Canopy Coverage

Measurements of each habitat variable were taken at 4 locations at each tree, then averaged on a per tree basis for analysis. For a further explanation of methods see Pagano and Madison (1981) and McAninch (1979a; 1979b).

Results

Population Trends

The trapping results show that meadow voles rapidly increased in numbers during the late summer and peaked in the early autumn (Figure 1). During the same period pine vole numbers dropped off dramatically. A reversal in trend for the populations of both species occurred in the late autumn with pine vole numbers stabilizing and the meadow vole population falling off precipitously.

The marked decline in numbers of meadow voles in February was due, at least in part, to the distribution of poison bait in two orchard rows usually dominated by that species. Thereafter the meadow vole population remained drastically reduced. A much wider spacing between individuals (within and between species) prevailed the following spring and summer. Large areas, although previously occupied by one or the other, remained vacant.

Movements

As revealed by telemetry, pine vole home ranges were basically linear, having a rectangular shape, and were generally confined within the dripline of a single orchard row. Meadow vole ranges were more variable in shape during the summer months as they would cross rows more frequently than pine voles. During the December and April telemetry sessions, meadow voles occupied a more linear/rectangular range as they confined nearly all of their activity to a

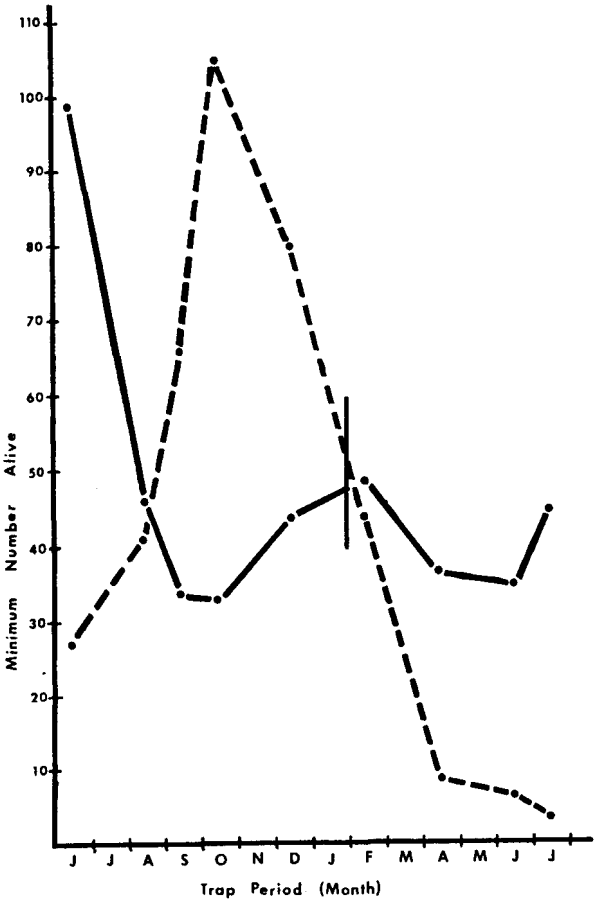

Figure 1. Minimum number of meadow voles (dashed line) and pine voles (solid line) known alive on the census grid from June, 1980 to July, 1981. Vertical line indicates date when poison bait was distributed in two orchard rows.

single row.

Individuals of both species spent most of their time within the confines of the dripline of the tree row. Any movement outside of that area was generally of short duration. Any vole crossing a row usually did so rapidly and without hesitation. The use of herbicides forced the voles to leave the tree dripline more frequently in search of food, but was not effective enough on this particular site to have any great impact.

The mean home ranges that individuals of each species covered are summarized in Table 1. The two factor analysis of

Table 1. Mean activity ranges for pine and meadow vole females as determined by radiotelemetry during the five telemetry sessions. Number of voles and total positions for each species are given in the parentheses.

Month	Activity Ranges ($M^2 \pm SD$) Meadow Vole	Pine Vole
August	115.0 ± 82.3 (5/245)	29.9 ± 27.2 (5/287)
December	17.0 ± 12.8 (5/571)	18.6 ± 9.4 (6/700)
April	21.3 ± 13.9 (4/406)	12.6 ± 6.3 (7/840)
June	437.6 ± 277.1 (3/368)	36.3 ± 45.3 (6/738)
July	236.6 ± 101.1 (3/300)	37.8 ± 42.4 (5/500)

variance performed on the data indicated significant differences between the species, among the five telemetry sessions, and also indicated a significant interaction ($p<.05$). A Neuman-Keuls multiple comparison test was used to test for all possible cell differences. No differences were found to exist among any of the 5 pine vole home range areas. The August, December, and April meadow vole ranges were not only similar to each other, but were also similar to the home ranges of the pine voles during each of the telemetry sessions. Although the August meadow vole range appeared to be larger than the other ranges in this group, a large variance among individual home range areas caused a statistical non-significant result. The areas covered by meadow voles during the June and July telemetry sessions were significantly larger than all of the other ranges of either species and were significantly different from each other as well.

Habitat Use

During the course of the study the habitat was continuously being altered, either due to seasonal changes or cultural practices. These events, in part, shaped the habitat use of the two species, therefore they must be commented on in brief.

Between July 1 and September 1, 1980, no mowing took place and the grass reached a height of 45 cm. The first telemetry session was conducted under less than ideal cultural conditions. As the December telemetry session began, cold weather had already set in and vegetation dieback was nearly complete. Snow had fallen and melted prior to the initiation of the December telemetry session, but no further accumulations occurred until after the session was completed.

Cold weather still prevailed at the time the April telemetry session began. The vegetation had just begun to grow at the start of the session but by its end had turned green and grown several centimeters. Within two weeks of the completion of the April telemetry session an herbicide was applied to the tree rows on the study site. Due to the established sod cover within the tree rows, the herbicide was not completely effective. Large amounts of dead vegetation were left standing or lying on the ground and therefore maintained their usefulness as cover. The first rotary mowing of the season was completed in conjunction with the herbicide application.

The effects of both the herbicide application and mowing were still evident during the June telemetry session, but were already wearing off. By the July telemetry session the herbicide application was even less noticeable and the grass in the aisles had grown to a height of 20 cm.

Values for each habitat variable were assigned to either the low use category (<18 positions per tree) or the moderate to high use category (>18 positions per tree) for each species. Two-factor ANOVA's were then used to analyze the differences in use between the species for each habitat variable measured during any given telemetry session. A summary of the results can be found in Table 2.

Few significant differences were found to exist between pine and meadow voles in habitat use ($p = .05$). The species showed no differences in habitat use during the August and April telemetry sessions. For only 6 of the 30 analyses did either species show a significant difference in use between the moderate to high use areas and the low use areas. It appears that, for this orchard block, all areas that individuals of each species chose to occupy were of similar composition, whether or not they were lightly or heavily used.

Table 2. Results of 2-factor ANOVA's on pine and meadow vole habitat use during 5 telemetry sessions. NS (non-significant); * (significant differences between species, $p < .05$); + (significant differences between high and low use areas, $p < .05$).

Habitat Variable	Telemetry Session August	December	April	June	July
Horizontal vegetation density	NS	**	NS	**/+	+
Ground litter depth	NS	NS	NS	+	**
Soil compaction	NS		NS	NS	+
Soil organic matter	NS	+	NS	NS	NS
Canopy	NS	NS	NS	NS	+
% Ground cover grass	NS			NS	
% Ground cover forbs	NS			**	
% Ground cover dead cover	NS			**	

Figures 2-4 represent in graphic form the differences and similarities in the habitat use of pine and meadow voles and the seasonal changes in their use of each habitat variable. Only the means for the moderate to high use areas were plotted for each species. A one-way ANOVA was used to test for seasonal differences in each species' use of each habitat variable. The Neuman-Keuls multiple comparison test was then employed to test for specific cell differences ($p=.05$).

Figure 2 deals with the soil variables analyzed in this study. No significant differences were found between the species during any of the telemetry sessions for either soil organic content or soil compaction. Pine and meadow voles showed little variation in their use patterns for either variable across the seasons.

Differences did exist between the species in their use of vegetation structure and composition (Figure 3). Comparing the species, pine and meadow voles used areas with different vegetative structure on the basis of Horizontal Vegetation Density for the December telemetry session and again in June ($p<.05$). Seasonal changes occurred in the pine voles' use of vegetative structure. The Neuman-Keuls test showed that the Horizontal Vegetation Density use patterns for pine voles were similar during the December, April, and June telemetry sessions, but their use patterns for July and August were distinctly different from each other and the other months as well. For Horizontal Vegetation Density, meadow voles showed no significant differences between the December and April telemetry sessions, but their use patterns for June, July, and August were significantly different. The shifts in seasonal use exhibited by the species

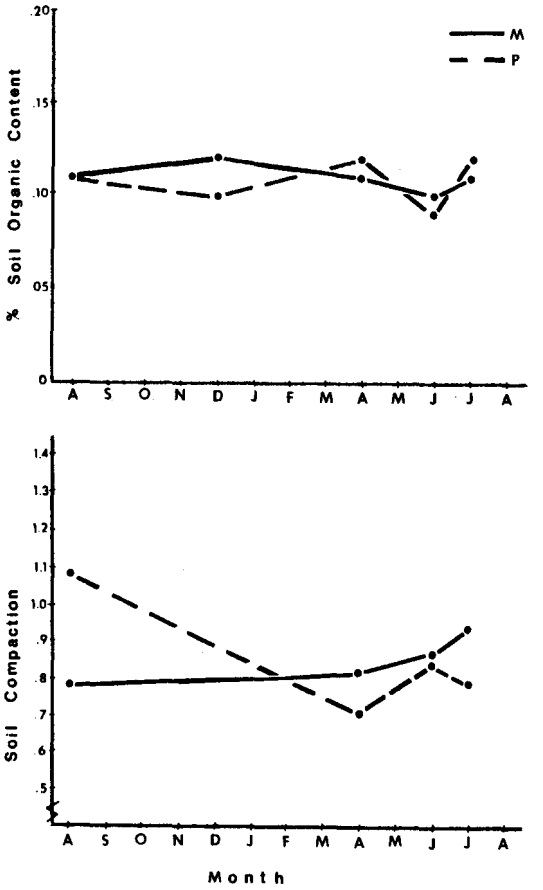

Figure 2. Graphic presentation of pine and meadow vole use of soil characteristics (soil compaction and soil organic matter) and the seasonal changes in their use patterns. Only mean values for high use areas plotted. Solid lines represent meadow vole habitat use and dashed lines represent pine vole use.

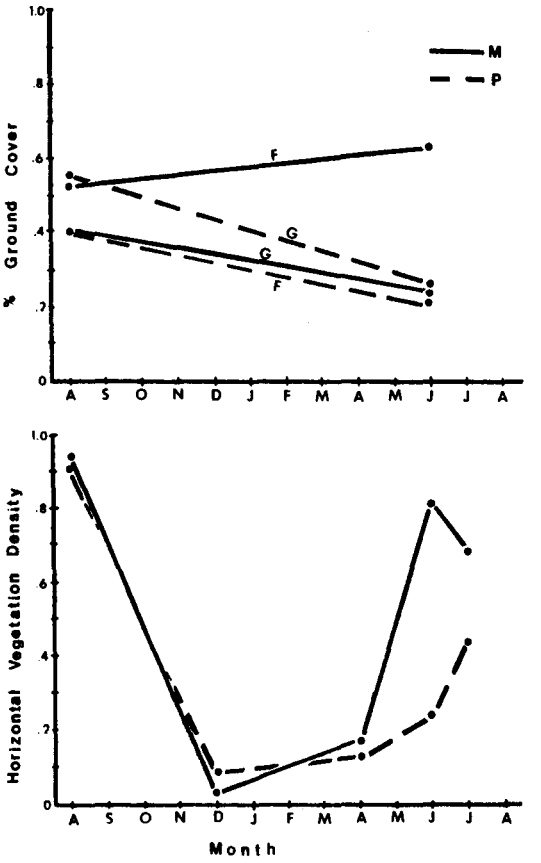

Figure 3. Graphic presentation of pine and meadow vole use of vegetation structure (horizontal vegetation density) and composition (percent ground cover) and the seasonal changes in their use. Only mean values for high use areas plotted. Solid lines represent meadow vole habitat use and dashed lines represent pine vole use. For percent ground cover, the lines marked with a 'G' represent use of grass cover and those marked 'F' represent use of forb cover. Dead cover was not plotted.

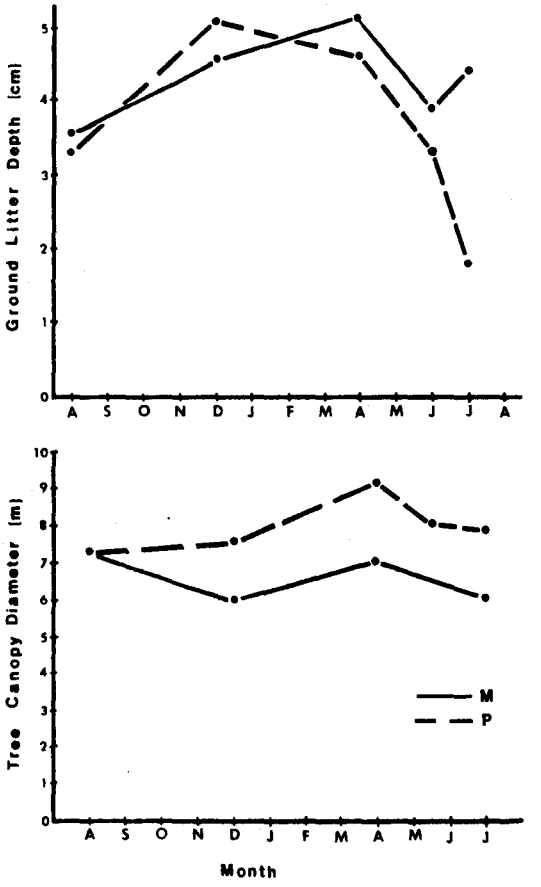

Figure 4. Graphic presentation of pine and meadow vole use of tree canopy and ground litter depth and the seasonal changes in their use of these variables. Only mean values for high use areas plotted. Solid lines represent meadow vole habitat use and dashed lines represent pine vole use.

appear to reflect the alterations in the vegetation structure caused by seasonal changes and/or cultural practices.

The only difference that exists between the species concerning their use of ground cover composition occurred during the June telemetry session (Figure 3). Meadow voles preferred areas of greater forb cover while pine voles preferred areas with greater amounts of dead cover (not shown in Figure). The tremendous amount of dead cover left by the herbicide application combined with the subsurface orientation of pine voles and the surface orientation of meadow voles could account for the species differences in vegetation composition. Both species shifted their use of grass cover between the August, 1980 and June, 1981 telemetry sessions, but only pine voles changed their use of forb cover between these same two sessions. Dead cover was measured only during the June telemetry session.

No differences were found between the species in their use of canopy coverage (Figure 4). Both pine and meadow voles preferred trees with canopies 7 m or more in diameter, which is a reflection of trees 20 or more years of age. The trees in this category are either mature semi-dwarf or full-size apple trees. The use patterns of the species could reflect the heterogeneous nature of the orchard. Past studies on more homogeneous orchard blocks have noted strong correlations between pine voles and trees with large canopies and between meadow voles and younger trees (McAninch, 1979a). Neither species changed its use pattern from one telemetry session to another.

During the July telemetry session, only a single difference in habitat use was found between pine and meadow voles and that was in their use of ground litter depth (Figure 4). Meadow voles used areas with greater thatch depth than pine voles during this month. For all other telemetry sessions the species used areas with similar ground litter depths. Meadow voles did not shift their use of ground litter depth from season to season, but pine voles did. The Neuman-Keuls test showed no significant differences between the August and June telemetry sessions for ground litter depth use by pine voles. Likewise, the pine voles' use of ground litter depth was similar between the December and April telemetry sessions, although the two separate pairs of months were distinctly different. The use of ground litter depth by pine voles during the July telemetry session was significantly different from all other months.

Discussion

Although little actual overlap in ranges occurred, the close association of pine and meadow voles combined with the considerable overlap in habitat use on this study site suggests a high potential for interspecific competition.

However, the populations of the two vole species remained at relatively low densities and the resources appeared to be abundant enough throughout the study to allow the coexistence of the two species. The constant disruptions of the vole populations by cultural practices and rodenticide applications created large vacant areas within the study site, thereby reducing the likelihood of interspecific interactions. In addition, differences did exist between the species based on habitat use. Although no significant differences existed between the species during two telemetry sessions, at least one key difference in habitat use was found between pine and meadow voles during the remaining 3 telemetry sessions.

Based on the habitat overlap that exists between the two species on this study site, a single vole management program could be developed to handle both species, although caution would be advised. The key differences between the species in habitat use coupled with the subsurface orientation of pine voles as opposed to the surface orientation of meadow voles could produce serious problems in controlling both species with one management program. Furthermore, the populations of both pine and meadow voles have the potential to reach levels at which competition could become a viable force. The control of only one species under the right conditions could cause the ecological release of the other species.

The predominant use of tree rows by both species, especially between December and April, could lead to serious tree damage and the decrease in home range size by meadow voles during this same period means that individuals are exposed to fewer rodenticide pellets if a broadcast application is made. These same movement patterns could, however, aid in targeting rodenticide applications and cultural practices to the locations the voles most frequently occupy, namely within the dripline of the tree rows.

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