

# Distances Moved by Small Woodland Rodents within Large Trapping Grids

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During a four-year study in New Brunswick, Canada, we documented long-distance movements (> 125 m) for three small-mammal species. Individuals from every species studied made long-distance movements, but relative to abundance, more Woodland Jumping Mice moved than any other species (9.4% of captures). Mean straight-line distances moved were: 370 m (Deer Mice, *Peromyscus maniculatus*; N = 44), 225 m (Woodland Jumping Mice, *Napaeozapus insignis*; N = 33), and 224 m (Red-backed Voles, *Clethrionomys gapperi*; N = 23). Frequency of movement decreased with distance for all species. The study demonstrated that long-distance movements were not uncommon, and as such, they may be an important component of the population dynamics of small mammals.

**Key Words:** Red-backed Vole, *Clethrionomys gapperi*, Deer Mice, *Peromyscus maniculatus*, Woodland Jumping Mouse, *Napaeozapus insignis*, movement, scale dispersal, New Brunswick.

Movement contributes to temporal and spatial structure of populations (Wiens et al. 1993). Empirical descriptions of movements for small mammals are rare, in part, because of the methods used to sample populations (Howard 1960; Clark et al. 1988). Trapping grids frequently are too small in spatial extent to detect long-distance movements (e.g., Burt 1940; Smith et al. 1975; Wegner and Merriam 1990; Merriam 1995). There are, however, scattered reports of long-distance movements for a variety of small-mammal species, for example: Deer Mice, *Peromyscus maniculatus* (Howard 1960; Bowman et al. 1999), White-footed Mice, *Peromyscus leucopus* (Krohne et al. 1984; Wegner and Merriam 1990), Woodland Jumping Mice, *Napaeozapus insignis* (Ovaska and Herman 1988), Stephens' Kangaroo Rats, *Dipodomys stephensi* (Price et al. 1994), Western Harvest Mice, *Reithrodontomys megalotis* (Clark et al. 1988), and observations of several species described in Kozakiewicz and Szacki (1995). These reports are an important source of data which can help ecologists to understand the process of dispersal (e.g., Kozakiewicz and Szacki 1995; Sutherland et al. 2000). For example, dispersal distance is frequently a component of spatially-explicit simulation models (e.g., Pulliam et al. 1992; Wilson et al. 1993; With and Crist 1995), and such models can be parameterised with empirical dispersal data.

During a four-year study of the spatial structure of small-mammal populations in a managed forest in New Brunswick, Canada, the study design involved large (4900 ha) live-trapping grids and provided an

opportunity to assess long-distance movements for three species. Here, we describe the magnitude, variability, and seasonality of long-distance movements made by: *Peromyscus maniculatus*, *Napaeozapus insignis*, and Red-backed Voles, *Clethrionomys gapperi*.

## Methods

The study took place in the private industrial forest of Fraser Papers Inc., in the Appalachian forest of northwestern New Brunswick (47°N, 67°W). Upland sites were dominated by an overstory of Sugar Maple (*Acer saccharum*), Yellow Birch (*Betula alleghaniensis*), and American Beech (*Fagus grandifolia*). Lowland sites were dominated by Black Spruce (*Picea mariana*), White Spruce (*Picea glauca*), and Balsam Fir (*Abies balsamea*).

The study design was described in detail by Bowman et al. (2000). Two 4900-ha forested landscapes with contrasting management intensities (> 50% clearcuts or plantations < 15 yrs old vs < 15% clearcuts or plantations < 15 years old) were systematically live-trapped using a set of nested grids. The two largest grids (one per landscape) had grains (or distance between sampling points) of 1000 m and areal extents of 4900 ha (8 × 8; 64 points in each grid). Nested within each of the large grids was a smaller grid with a grain of 250 m and an extent of 310 ha (8 × 8; 64 points in each grid), and on the less intensively-managed landscape, there was a third grid with a grain of 125 m and an extent of 31 ha (5 × 6; 30 points). A total of 260 sample points were spread systematically across the two

landscapes within these grids. At each point an array of five Victor Tincat multiple-capture live traps (Woodstream Corp., Lititz, Pennsylvania, USA) was used to sample small-mammal populations. Traps were placed at point centre and 35-m from the centre on each compass ordinal; each trap was placed in a "most likely runway" position. Traps were prebaited for three days with oats and sunflower hearts and then set for four consecutive nights. The trapping protocol was carried out twice per annum in spring (May–June) and fall (August–September). Captured animals were weighed, identified to species and gender, checked for reproductive condition, marked with a 1-g monel ear tag (National Band and Tag Co., Newport, Kansas, USA) and released. Our protocol was approved by the University of New Brunswick Animal Care Committee.

We considered that an animal had moved if it was recaptured (i.e., with an ear tag) at a sample point where it had not been captured previously. The finest grain in our study was 125 m (i.e., the space between sample points on the 31 ha trapping grid) so 125 m was our definition of a long-distance movement. Shorter movements were not long enough to move an animal between sample points, and were not considered in our analysis. Movement distances were calculated as straight-line distances between the centres of the capture and recapture sample points. Calculations were made using digital maps of the study area and a Geographic Information System (GIS; Arc/View).

We used nonparametric analyses to compare distances moved by different species, and where sample sizes were suitable, to compare distances moved by sex and age groups within species. We calculated the relative frequencies of long-distance movements by different species, and within-species seasonal differences in the number of captures after long-distance movements.

## Results

The three most abundant rodents captured were Red-backed Voles (9.40 captures/100 trap nights), Deer Mice (7.66 captures/100 tn), and Woodland Jumping Mice (2.78 captures/100 tn). These three were the only species for which long-distance movements were observed. Relative to abundance and

combining seasons, more Woodland Jumping Mice moved between sampling points than any other species: 9.4% of captures occurred after long-distance movements, compared to 4.2% and 1.8% for Deer Mice and Red-backed Voles, respectively (Table 1). These proportions were calculated by omitting captures on the two largest (1000-m grain) grids, because no movements were ever recorded at this largest scale.

There were no differences in distances moved by males, females, or juveniles within any species. Thus, we combined within-species sex and age classes to compare distances moved by different species and found that Deer Mice moved farther than either of the other species ( $\chi^2 = 5.9$ ,  $df = 2$ ,  $P = 0.048$ ) (Figure 1, Table 1). Sample sizes were too small to assess within-species, age- and sex-related statistical patterns in seasonal movements. However, by combining ages and sexes and controlling for trap effort, we found that Deer Mice ( $\chi^2 = 4.5$ ,  $df = 1$ ,  $P = 0.035$ ) and Red-backed Voles ( $\chi^2 = 7.4$ ,  $df = 1$ ,  $P = 0.007$ ) were more frequently captured in fall than in spring, after having moved a long distance. Conversely, Woodland Jumping Mice were more frequently captured in spring than in fall, after having moved a long distance ( $\chi^2 = 8.76$ ,  $df = 2$ ,  $P = 0.003$ ) (Table 1).

## Discussion

Individuals from all three of the abundant species in our study area moved distances in excess of 125 m. The frequency of movements generally decreased with distance, which is consistent with studies of dispersal across a range of taxa (Taylor 1980; Sutherland et al. 2000).

Deer Mice made longer movements than either Red-backed Voles or Woodland Jumping Mice — the longest of these (1768 m) was reported by Bowman et al. (1999). Other authors have recognised the ability of Deer Mice (and closely-related White-footed Mice) to move long distances. Howard (1960) recorded a movement of 1000 m for *P. maniculatus*, and Wegner and Merriam (1990) speculated about movements by *P. leucopus* of > 1000 m. While Ovaska and Herman (1988) demonstrated a movement by a Woodland Jumping Mouse of > 800 m, we are unaware of other studies reporting

TABLE 1. Distances (m) moved by small woodland rodents within large trapping grids in New Brunswick, Canada, during 1997–1999.

Species	Mean	SE	Max	N (S, F) <sup>A</sup>	Rate (%) <sup>B</sup>	J <sup>C</sup>	F <sup>D</sup>	M <sup>E</sup>
<i>Peromyscus maniculatus</i>	370	55	1768	44 (15, 29)	4.2	23	7	14
<i>Napaeozapus insignis</i>	225	22	607	33 (25, 8)	9.4	3	10	20
<i>Clethrionomys gapperi</i>	224	24	494	23 (5, 18)	1.8	13	1	9

<sup>A</sup>Total number (number in spring, number in fall)

<sup>B</sup>Percentage of captures that had moved > 125 m.

<sup>C</sup>Number of juveniles and subadults

<sup>D</sup>Number of adult females

<sup>E</sup>Number of adult males

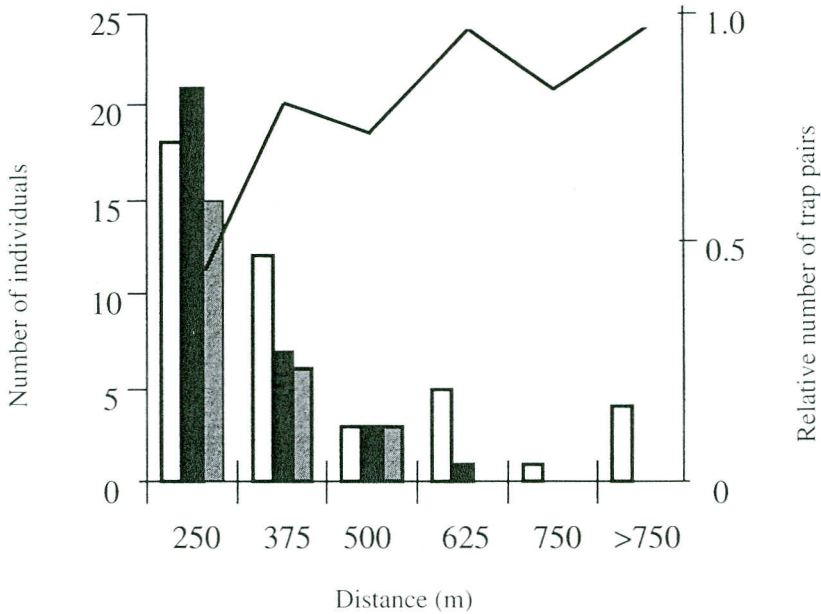


FIGURE 1. Distribution of distances moved by woodland rodents within large trapping grids in New Brunswick, Canada. White bars are *Peromyscus maniculatus*, solid bars are *Napaeozapus insignis*, and hatched bars are *Clethrionomys gapperi*. The relative number of pairs of traps within each distance class is indicated by the solid line.

long-distance movements by either *N. insignis* or *C. gapperi*, with the exception of homing studies. For example, Bovet (1980) recorded successful homing by Red-backed Voles from as far as 600 m.

Seasonal differences in captures between Woodland Jumping Mice and the other species were not surprising, as jumping mice are true hibernators whereas Red-backed Voles and Deer Mice are winter active (Whitaker and Wrigley 1972). Our data were consistent with patterns of increased movement in late summer by murids and in early summer by zaptodids. These seasonal patterns should be interpreted carefully however, as the analysis included both movements made within a trapping season, and between seasons. Thus, we actually measured the number of captures made after long-distance movements per season, rather than the season when the movement was actually made (which was often unknown).

Two additional sources of error must be considered when interpreting these data. First, we have not corrected for the uneven distribution of trap pairs within different distance classes. The number of trap pairs varied with distance (Figure 1) and in fact, appeared to bias the distribution of distances toward longer movements: there were fewer trap pairs at the shortest distances. This was further confounded by a second bias: the density of traps varied throughout the study grids as a result both of geometry and the

nested trapping design. Rather than make questionable corrections against these two biases, we present unmodified data and caution the reader against over interpretation. Even with the inherent problems, these data are of value because of the scarcity of information on small-mammal movements (e.g., Wegner and Merriam 1990; Kozakiewicz and Szacki 1995; Merriam 1995).

We expect that many of the movements which we have operationally-defined as "long-distance" were actually dispersal movements. Such movements likely have important, albeit poorly understood, effects on small-mammal populations. We are particularly interested in the relationship between dispersal and spatial population structure. For example, Deer Mouse, Red-backed Vole, and Woodland Jumping Mouse populations exhibit heterogeneity in abundance at distances of 133 - 350 m, on the same landscapes where the present movement data was collected (Bowman et al. 2000). The spatial extent of the heterogeneity is consistent with the distribution of dispersal distances. This supports speculation that dispersal distance in small mammals is related to a scale of population heterogeneity (e.g., Krohne and Burgin 1990).

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