Habitat Use and Distribution of the Mice *Peromyscus leucopus* and *P. maniculatus* on Mount Desert Island, Maine

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Garman, Steven L., Allan F. O'Connell Jr., Judith Hazen Connery. 1994. Habitat use and distribution of the mice *Peromyscus leucopus* and *P. maniculatus* on Mount Desert Island, Maine. Canadian Field-Naturalist 108(1): 67–71.

We studied habitat use and distribution of *Peromyscus leucopus* (White-footed Mouse) and *P. maniculatus* (Deer Mouse) on Mount Desert Island, Maine. *Peromyscus leucopus* used areas dominated by deciduous vegetation whereas *P. maniculatus* was more of a habitat generalist occurring equally in deciduous and coniferous habitats. Extent of overlap of these two species does not support an hypothesis of interspecific interactions; *P. leucopus* appears limited solely by habitat. *Peromyscus leucopus* and *P. maniculatus* have been identified as important components in the transmission cycle of Lyme disease which has been documented from a small section of Mount Desert Island. Land management practices that increase suitable habitat and influence population densities of *P. leucopus*, the primary host for the Lyme disease spirochete, may locally increase the incidence of this disease.

Key Words: Deer Mouse, *Peromyscus maniculatus*, White-footed Mouse, *Peromyscus leucopus*, Lyme disease, habitat use, Maine, Mount Desert Island.

Choate (1973), based on data available to him, noted a geographic separation of *Peromyscus* species in Maine based on habitat preferences, with *Peromyscus maniculatus* (Deer Mouse) occupying the mesic coniferous region north and east of the Penobscot River, and *P. leucopus* (White-footed Mouse) inhabiting the more arid habitats dominated by transitional hardwoods, White Pine (*Pinus strobus*), and Hemlock (*Tsuga canadensis*) in the region south and west of the Penobscot river. Since then, the known range of *P. leucopus* has been extended along coastal Maine as far as Mount Desert Island (MDI) (44° 12′- 44° 27′ N., 68° 10′- 68° 27′W.) located approximately 50 km east of the Penobscot River (Aquadro et al. 1980). Prior to 1957 small-mammal trapping studies failed to indicate the presence of *P. leucopus* on MDI which lies only 0.6 km from the mainland (Branin 1939; Manville 1942, 1960). This species was first suspected by Calhoun and Arata (1957) and later verified by chromosomal analysis of two specimens by Aquadro et al. (1980). These authors suggested that *P. leucopus* became established on MDI due to the large expanse of suitable hardwood habitat resulting from a catastrophic wildfire in 1947 and implied that the species was recently established. However, given the short distance between the mainland and MDI, access across a roadway established in 1836 or via tidal flats or ice may have permitted earlier colonization by *P. leucopus*.

The extent to which *P. leucopus* has colonized MDI has not been thoroughly investigated, however. Confirmed records have been limited to less than 10 specimens from only four locations. Factors other than habitat availability may limit its distribution. Negative interactions between *Peromyscus* species have been reported in the northeastern United States (Klein 1960; Parren and Capen 1985). Use of post-fire hardwood habitat on MDI by the indigenous *P. maniculatus* and the degree of habitat overlap with *P. leucopus* is unknown.

With the recent discovery of Lyme disease on MDI (Ginsberg and Ewing 1988) and the role of *P. leucopus* and *P. maniculatus* as competent reservoirs for the Lyme disease spirochete (Donahue et al. 1987; Rand et al. 1993), there is an increased need to determine the distribution of both species of *Peromyscus*. Herein, we report on their habitat use and distribution on MDI.

Study Area and Methods

Mount Desert Island falls within the spruce-fir northern hardwoods zone of Westveld et al. (1956). The western side of MDI is covered by a mosaic of coniferous forests of mature Red Spruce (*Picea rubens*), Northern White Cedar (*Thuja occidentalis*), Black Spruce (*P. mariana*), and hardwood patches of primarily aspen (*Populus grandidentata*, *P. tremuloides*), birch (*Betula papyrifera*, *B. populifolia*), and Red Maple (*Acer rubrum*) (Figure 1). Conifer and mixed hardwood-softwood stands covered the eastern side of the island prior to a large wildfire in 1947 (Smith 1960). Much of the burned area is currently dominated by 40+ year-old forests of Aspen and Birch.

Live-trapping was conducted on grids and along transects. All grids and transects were located on exposed upland sites. Grids were trapped during June-September 1987-1988; transects during June-August 1989. Grids were located in three mature stands of Red Spruce and three secondary hardwood stands located within the area burned by the 1947 fire. Each grid contained 42 (6x7) trap stations with a 15-m interval between traps. Nineteen transects were established in stands of mature conifers (n = 10) and in 40-80 year-old hardwood stands (n = 9) dominated by Aspen and Birch. Each transect was 250 m long with a trap station every 10 m and two Sherman live-traps at each station. Traps were baited with mixtures of peanut butter, sunflower seeds, raisins, rolled oats, and suet. Identification of *Peromyscus* specimens recorded on grids was made in the field, based on external characteristics (Choate 1973). Saliva was collected from questionable specimens only during grid trapping and species confirmation was made from these using the electrophoretic technique of Aquadro and Patton (1980) with modifications (Garman 1991). A discriminant-function classification equation derived from grid captures, using tail-to-body length ratio as the independent variable, was used to classify species of *Peromyscus* captured on transects.

Capture rates for *Peromyscus* spp. were calculated as the number of individuals per 1000 undisturbed trap nights. Capture rates were pooled across trapping periods and compared between deciduous and coniferous habitat types for each species and between species within each habitat type using one-way ANOVAs. Pairwise comparison of means were performed using the Bonferroni multiple comparison procedure (Neter and Wasserman 1974) with a significance level of $P \leq 0.01$ (n = 4).

Results and Discussion

Habitat Use

Totals of 382 and 114 individuals of *P. maniculatus* and *P. leucopus*, respectively, were captured. *Peromyscus maniculatus* occurred more frequently in coniferous habitats, but there was no significant difference ($P > 0.01$) in mean rate of capture between habitat types (Table 1). Captures of *P. maniculatus* were recorded on all sites and in each trapping period. *Peromyscus leucopus*, however, clearly exhibited a preference for deciduous habitats ($P < 0.01$). All grids and all but two transects in deciduous habitats recorded captures of this species, whereas captures occurred on all grids, but on only four transects in coniferous habitat.

Although the number of captures of *P. maniculatus* was about twice that of its congener, there was no significant difference ($P > 0.01$) in the capture rate between species in deciduous habitat. There was, however, a substantial difference ($P < 0.01$) between capture rates of the species in coniferous habitat, where the mean capture rate of *P. maniculatus* was a magnitude greater than that of *P. leucopus*.

TABLE 1. Capture rates of *Peromyscus* spp. in deciduous and coniferous habitats on Mount Desert Island, Maine.

Species	Deciduous Habitat n	Deciduous Habitat Capture Rate[1]	Coniferous Habitat n	Coniferous Habitat Capture Rate[2]
P. maniculatus	168	20.75A[3]	214	27.50A
P. leucopus	94	13.11A	20	2.47B

[1]Based on 33 trapping periods.
[2]Based on 34 trapping periods.
[3]Column or row sharing a letter in common are not significantly different.

Other authors have reported *P. maniculatus* to be more common in moist coniferous forests and northern hardwoods (Morris 1955; Klein 1960; Smith and Speller 1970; Wrigley 1969). Some studies have found habitat use by *P. maniculatus* may be influenced by competition with the Red-backed Vole (*Clethrionomys gapperi*) (Kirkland and Griffin 1974; Vickery 1981). In an experimental introduction of selected small mammal species on a coastal Maine island, Crowell and Pimm (1976) found *C. gapperi* to displace *P. maniculatus* from woodland habitats especially under increasing densities. Our findings indicate that *P. maniculatus* on MDI is a habitat generalist occurring equally in deciduous and coniferous habitats. Based on vegetation and environmental features at trap stations in both habitat types microhabitat analyses failed to show a significant ($P > 0.05$) negative interaction between *C. gapperi* and either *Peromyscus* species (Garman 1991). In addition, a higher degree of overlap in microhabitat use with increasing density was also evident, further indicating that habitat use by either species of *Peromyscus* was not limited by *C. gapperi*. Lack of interspecific competition between *P. maniculatus* and *C. gapperi* has also been reported in Maryland (Barry et al. 1990), Virginia (Wolff and Dueser 1986), and New York (Stewart 1991).

The strong selection of deciduous habitats by *P. leucopus* detected in this study is in agreement with results of other studies (Klein 1960; Smith and Speller 1970; Wrigley 1969). Although captures of *P. leucopus* in coniferous habitats on MDI suggest some use of this vegetation type, some individuals may have been transients. Recapture rates of *P. leucopus* in coniferous habitat (30%) was less than half of that in deciduous habitat (67%) and about half of that for *P. maniculatus* (55%) in either habitat type. Despite attempts to place grid traps in coniferous sites away from noticeable edges, most were within 300 m of deciduous stands of varying sizes. This distance is well within the dispersal range of *P. leucopus* (Stickel 1968). Field observa-

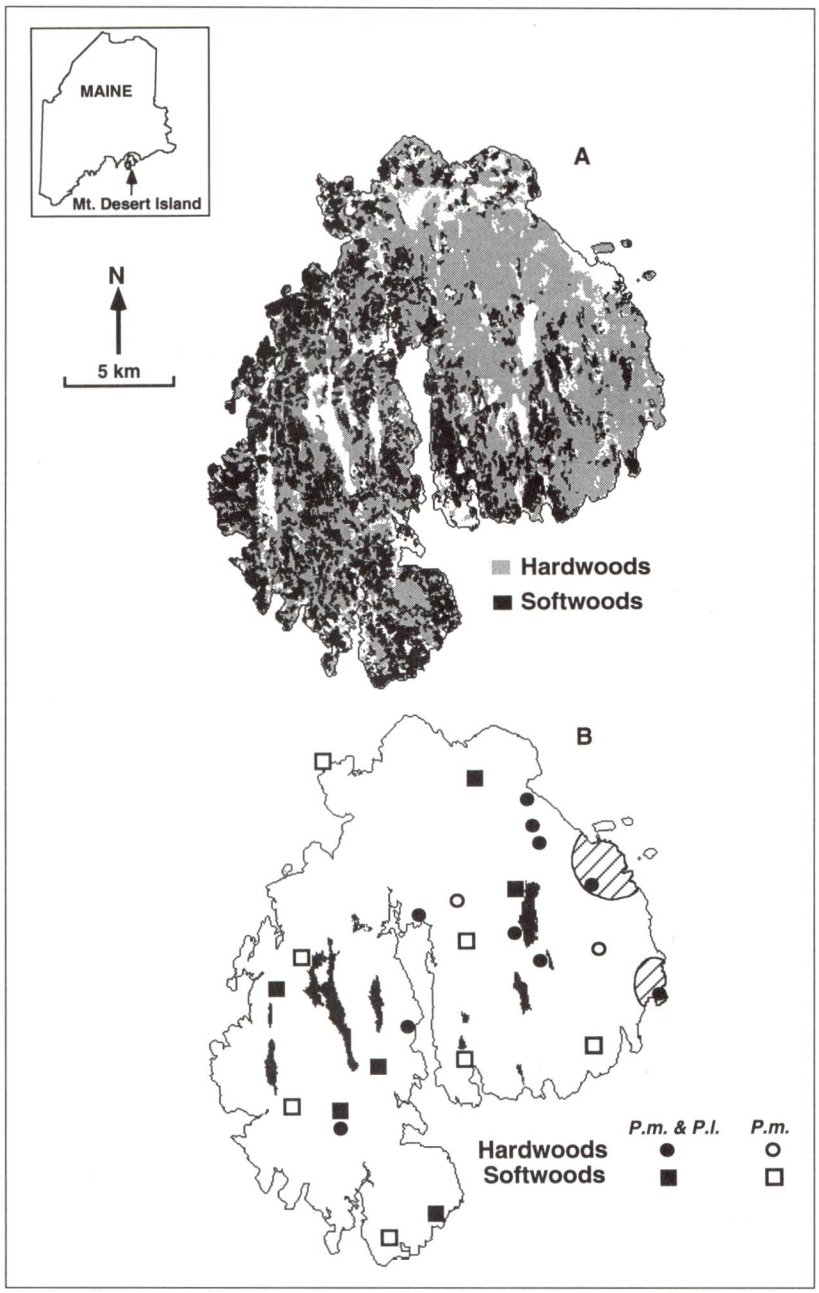

FIGURE 1. A: Map of hardwood and softwood cover types on Mount Desert Island, Maine. Water, rock, and developed areas are coded in white. B: Location of trap sites and captures of *Peromyscus maniculatus* (P.m.) and *P. leucopus* (P.l.). Hatched areas are where Lyme disease has been documented based on Ginsberg and Ewing (1988) and Hazen et al. (1992).

tions of movements by *P. leucopus* from mature Red Spruce to hardwood stands indicated overnight travel exceeding 250 m.

Similar capture rates and co-occurrence in 26 of the 31 trapping periods in deciduous habitat of *P. leucopus* and *P. maniculatus* indicate a high degree

of overlap. Analyses of microhabitat use for grid captures failed to show significant negative interactions between *Peromyscus* species but indicated that *P. leucopus* was positively associated with shrub and herbaceous cover less than 0.5 m high in deciduous habitat (Garman 1991). Microhabitat use by *P. leucopus* in deciduous habitat became less selective with increasing density of either *Peromyscus* species indicating that intraspecific interactions (i.e., density) may be important in determining trap site selection for either species of *Peromyscus* (Garman 1991). Similar findings were reported by Wolff (1985) in Virginia where space use by species of *Peromyscus* was found to be regulated equally by intraspecific and interspecific aggression.

Distribution

Although trap sites were not located randomly or systematically, trapping results provided an indication of species distribution across MDI. *Peromyscus maniculatus* appears to be the most widespread small mammal currently on MDI. Any negative effect the 1947 fire may have had on its distribution has been obviated over the 40 years of vegetative change. It is apparent, from visually interpolating among trap sites for captures of *P. leucopus,* that this species has become widely established throughout the area burned by the 1947 fire on the eastern side of MDI. The relatively large contiguous tracts of secondary hardwoods established after 1947 likely provided ample habitat for rapid dispersal, whereas the degree of interspersion of hardwoods among softwoods on the western side of MDI evidently has permitted colonization of suitable habitat.

Distribution of the indigenous *P. maniculatus* on MDI does not appear limited by habitat or by interspecific interactions with the recently established *P. leucopus*. Conversely, habitat alone seems to limit the distribution of *P. leucopus*, and given the current amount of available habitat, this species appears to have an extensive yet localized distribution across MDI.

Currently, the occurrence of Lyme disease on MDI appears limited to a small area (Ginsberg and Ewing 1988; Connery et al. 1992; see Figure 1). However, *P. maniculatus* is reservoir competent for the Lyme disease spirochete in nature (Rand et al. 1993) and the widespread distribution of this species on MDI may facilitate local spread of Lyme disease. Further, the presence of *P. leucopus* may increase the incidence of Lyme disease, especially if land-use practices increase the amount and connectivity of suitable habitat across the MDI landscape.

Acknowledgments

We thank K. Anderson, B. Bernatowitz, B. Connery, S. Crowley, L. Hall, and E. Schultiz for their assistance in trapping. Critical reviews of this manuscript were provided by D. Wallin and K. Crowell. Financial support was provided by the U.S. National Park Service, North Atlantic Region, Office of Scientific Studies.

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Received 25 March 1993
Accepted 14 February 1994