Virginia Journal of Science
Volume 41, Number 4A
Winter 1990

Small Mammal Population Densities and Habitat Associations on Chincoteaguc National Wildlife Refuge, Assateague Island, Virginia

Jack A. Cranford[1] and Mark S. Maly,
Department of Biology
Section of Ecology and Evolutionary Biology
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

ABSTRACT

Evaluation of small mammal distributions in Chincoteague National Wildlife Refuge show that each species exhibited specific habitat associations. *Microtus pennsylvanicus* was the most numerous followed by *Oryzomys palustris*, *Mus musculus*, *Cryptotis parva*, and *Peromyscus leucopus*. *Microtus* showed the lowest variation in population density while the remaining four species showed clear seasonal shifts in density. *Peromyscus* were not associated with any of the other species and occurred primarily in the pine wood habitats. The other four species occurred in both the dune and marsh habitats. *Microtus* tended to occupy microhabitats in which monocot vegetation and abundant ground cover occurred, *Oryzomys* were most common in moist microhabitats and were locally abundant in tidal creek areas. *Mus* were abundant in the open habitat of the dune grassland, but also occurred in shrub dominated habitats. *Cryptotis* were common at relatively open sites in the shrub-marsh edge habitat as well as in open microhabitats of the dune grassland area. *Microtus* were reproductively active in every month except January, while the other species exhibited seasonal reproductive patterns.

Key words: Population density, habitat associations, *Microtus*, *Mus*, *Cryptotis*, *Peromyscus*, *Oryzomys*.

INTRODUCTION

Habitat associations and population density estimates of small mammals on the Virginia barrier islands are frequently limited to data gathered from line transects or from rather short-term studies (Paradiso and Handley, 1965; Dueser and Brown, 1980; Porter and Dueser, 1982). For the most part, these studies have reported on species occurrence, habitat associations, and have speculated on the importance of competition in determining/influencing community structure. Adkins (1980) concluded, from a year-round study on Assateague, that habitat separation among five of six common small mammal species was minimal and that

1 To whom all correspondence should be addressed

interspecific competition was pervasive among species sharing habitats. Direct evidence for competition was lacking in a reciprocal removal experiment as no habitat shift or density change occurred (Scott, 1983). Evidence for strong interspecific competition also was not reported by Dueser and Porter (1986) and habitat selection seemed to be the more important variable in sorting the species assemblage on Assateague island.

This research examines population densities over seasons, years, and habitat associations among the common small mammal species on Assateague Island. Evaluation of a number of habitat variables permitted examination of niche overlap over the course of the study period. These data were then compared to results previously reported which permitted an evaluation of the importance of habitat selection by species within this community.

METHODS

The study sites were located within the Chincoteague National Wildlife Refuge, Assateague Island, Virginia. Three non-adjacent trapping grids were established in June 1983 and were trapped bi-monthly until March 1985 when two of the grids were destroyed by fire. The grids were located in dune grassland, marsh, and pine woodland habitats which incorporated the major habitat types available on the island (Higgins *et al.*,1971; Hill, 1986), Grids (0.64 ha) were permanently staked to ensure that the same sites were used in subsequent trapping sessions. Each trap grid was well within a habitat type with the nearest habitat edge more than 20 m beyond a grid boundary. Traps were set at 10 m intervals on 9 by 9 square arrays with two traps per station. Capture data from both trap stations were used in all subsequent analysis except as otherwise noted. One small (165x64x51 mm) and one large (279x89x76 mm) Sherman trap was placed at each station and was baited with crimped oats. During winter, traps were provisioned with supplemental food and cotton nest material to improve survival. Traps were checked twice daily for five days during each trapping period. All small mammals were toe-clipped upon first capture for individual identification. On each capture, body mass, total length and reproductive condition (position and size of testis, perforate or non-perforate vagina, teat condition, and presence of palpable embryos) were recorded.

Each grid was characterized, based on frequency of occurrence, by particular vegetation types. On the woods grid, *Pinus taeda* formed the overstory canopy while the understory was composed of *Panicum virgatum*, *Spartina alterniflora*, *Hydrocotyle verticillata*, *Parthenocissus quinquefolia*, *Iva fructescens*, *Myrica cerifera* and *Rhus radicans*. The marsh and dune grids lacked any significant overstory canopy. The marsh was dominated by *Distichlis spicata* and *Spartina patens* with *Myrica cerifera*, *Baccharis halimifolia* and *Iva fructescens* also present. *Juncus dichotomus*, *Panicum scoparium*, *Scirpus americana* and *Spartina patens* formed the greatest proportion of the monocots on the dune grid. In addition, *Solidago sempervirens*, *Lepidum virginicum* and *Eupatorium pubescens* were common forbs, while *Myrica cerifera* and *M. pennsylvanica* formed the dune grid shrub layer. The great variety of plant species on the dune grid produced a wider variety of microhabitats. This was the only location where all seven species of small mammals were captured.

TABLE 1. Habitat variables used to calculate multivariate microhabitat ovcrlap and their method of measurement.

Variable	Description
Gras cov	Percent cover of grasses and sedges within a 1.0 m^2 quadrat centered on the trap station
Forb cov	Same as grass except forhs only
Shrb cov	Same as grass except shrubs only
Wood cov	Same as grass except woody species only
Shrb sps	Number of shrub species within a 5.0 m radius circle centered on the trap station
Litter	Mean depth (cm) of litter layer deterrnined from 4 measurements taken within a 1 .0 m^2 quadrat centered on the trap station
Htveg	Height of tallest vegetation (excluding canopy trees) within a 5.0 m radius circle centered on the trap station
Flood	Depth (cm) of spring tidc flooding

Each trap site was characterized with a series of quantitative microhabitat variables (Dueser and Shugart, 1978; Geier and Best, 1980; Kitchings and Levy, 1981). Sixteen habitat variables were measured during the summer trapping period, 8 of which were used in the habitat analysis: percent cover of grass (Gras cov), forbs (Forb cov), shrubs (Shrb cov) and woody species (Wood cov), height of understory vegetation (Htveg), shrub species (Shrb spp), litter depth (Litter), and height of the spring flood (Flood) (Table 1). Discriminant function analysis was then used to determine if small mammal species differed with respect to habitat variables (SAS Candisc procedure; SAS Institute, 1982). The number of sample groups (*i.e.*, species) in these analyses was six in summer samples (June - September) and five in all others. Only data from the first capture of an individual during a trap session were used in the analyses. Habitat variables associated with the capture of mammal species were analyzed using canonical variate analysis (SAS Candisc procedure; SAS Institute, 1982). The multivariate niche overlap measure of MacArthur and Levins (1967) was used to evaluate niche overlap among the five abundant species. The overlap was estimated from habitat utilization data from trapping records using discriminant function analyses (Harner and Whitmore, 1977). Population densities were calculated by minimum number alive method (Krebs, 1966).

RESULTS

There were 2430 trap nights per trap session and a total of 24,300 trap nights which resulted in 3856 captures over the study period. The relative efficiency of large and small traps in capturing small mammals did not differ significantly among difrerent trapping periods ($X^2 = 4.15, P > 0.20$), but species which have large body size were more frequently captured in large traps (Maly and Cranford, 1985). A total of 567 individuals were captured of the five common species: *Mus musculus* (128), *Microtus pennsylvanicus* (167), *Oryzomys palustris* (131), *Peromyscus*

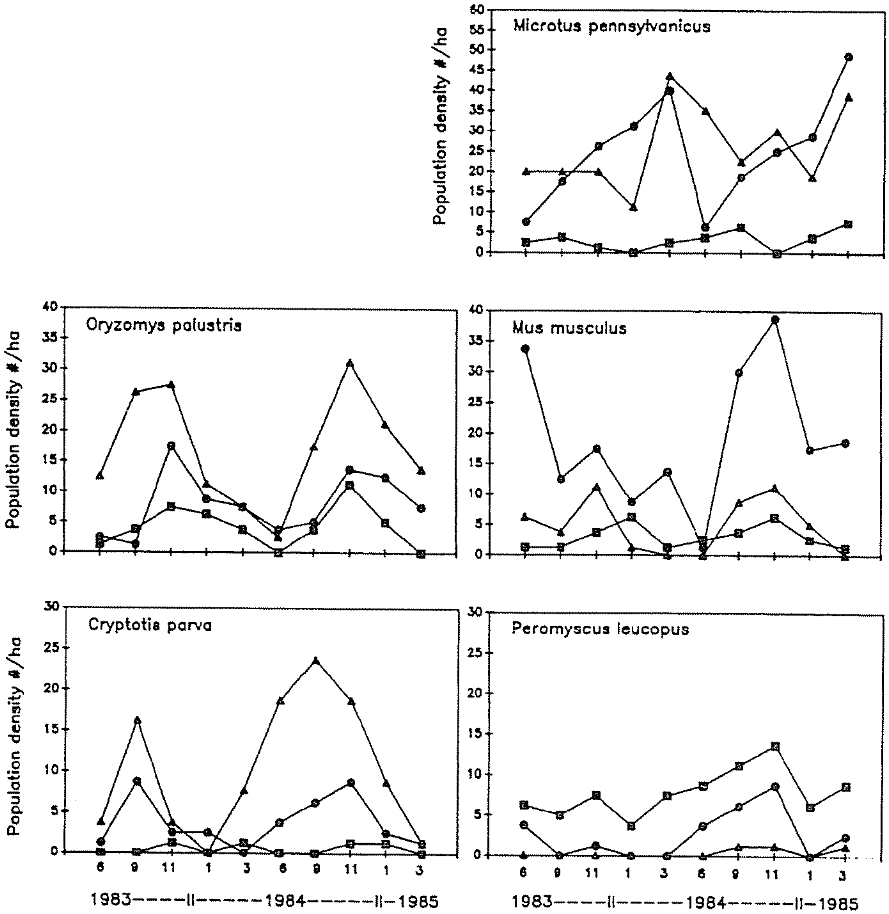

FIGURE 1. The minimum number known to be alive of the five common species on the three grids (Marsh, Dune and Pine Woods) from June 1983 to March 1985. The months are represented on the X-axis by their numerical value. Dune data plotted as circles, marsh by triangles and pine woods by squares.

leucopus (56), and *Cryptotis parva* (85). In addition, *Rattus norvegicus* (3) and *Zapus hudsonius* (26) were captured but not in sufficient numbers for further analysis. Population densities of five of the seven species (*Peromyscus leucopus, Mus musculus, Microtus pennsylvanicus, Oryzomys palustris*, and *Cryptotis parva*) varied both by habitat, season, and by year (Fig, 1), *Mus, Microtus* and *Cryptotis* rarely occurred on the woods grid, but with the exception of *Peromyscus* all these small mammal species occurred on the marsh and dune grids. *Mus* was most common on the dune grid, while *Oryzomys* and *Cryptotis* were most common on the marsh grid. *Microtus* occurred with nearly equal numbers on both the dune and marsh grids, *Mus, Cryptotis*, and *Oryzomys* reached highest densities in late fall and showed clear seasonal changes in densities, while *Microtus* peaked in late spring and showed smaller seasonal shifts in densities. *Peromyscus leucopus* was very rare on the marsh

TABLE 2. Discriminant function analysis of small mammal microhabitats both monthly and overall using the 8 habitat variables. The upper half of the figure reports the number of each species caught in that sample. The lower portion reports the correlation coefficient (r) of that variable with the first discriminant function.

Variable	Jun.	Aug.	Nov.	Jan.	Mar.	Overall
Cryptotis	20	40	27	14	9	-
Mus	31	42	64	30	25	-
Microtus	52	59	69	60	96	-
Oryzomys	16	41	75	47	30	-
Peromyscus	16	18	23	7	15	-
Gras cov	0.78	0.84	0.47	0.06	0.69	0.70
Forb cov	-0.24	-0.10	-0.04	-0.29	-0.29	-0.08
Shrb cov	-0.70	-0.38	-0.29	0.57	0.09	-0.36
Wood cov	-0.46	-0.50	0.03	-0.06	-0.19	-0.24
Shrb sps	-0.35	-0.45	-0.04	0.10	0.19	-0.18
Litter	0.71	0.59	0.18	0.02	0.31	0.30
Htveg	-0.92	-0.59	-0.86	-0.90	-0.59	-0.75
Flood	0.42	0.64	0.15	0.23	0.11	0.25
Wilk'sLamdba	0.20	0.10	0.46	0.47	0.32	0.39
p value	all less than 0.001					

grid, common on the woods grid, and only present on the dune grids in 1984 from July to November. Reproduction in *Mus* and *Oryzomys* began in May and continued through November while in Cryptotis it occurred from March through October. *Microtus* were reproductively active in all samples except January 1984, but the proportion of reproductively active females varied from 18% in winter to 75% in summer. *Peromyscus* was reproductively active from March through September. For all species studied, young born early in the reproductive season became reproductively active during that season. Young of *Mus* and *Oryzomys* born late in the year did not reproduce until the following spring.

The correlation coefficients between the first discriminant function for small mammal captures and the habitat variables indicate that grass cover and the height of the vegetation were most important (Table 2.). These two variables distinguished between the species based on microhabitat use. In general, grass cover was the most important variable in separating habitat occurrence except in November and January when it was not highly correlated with the first discriminant function. In that time period vegetation height, previously the second most important variable, was highly correlated along with shrub cover in January. Seasonal differences in each variable are clear and thus reflect the differential use by small mammals of the microhabitat space over time. The Wilk's lambda statistic (SAS Candisc Procedure, 1982) was significant for all sample dates as well as for the overall analysis. This clearly indicates that the small mammal species present did differ with respect to habitat use. For most sample intervals the first discriminant function

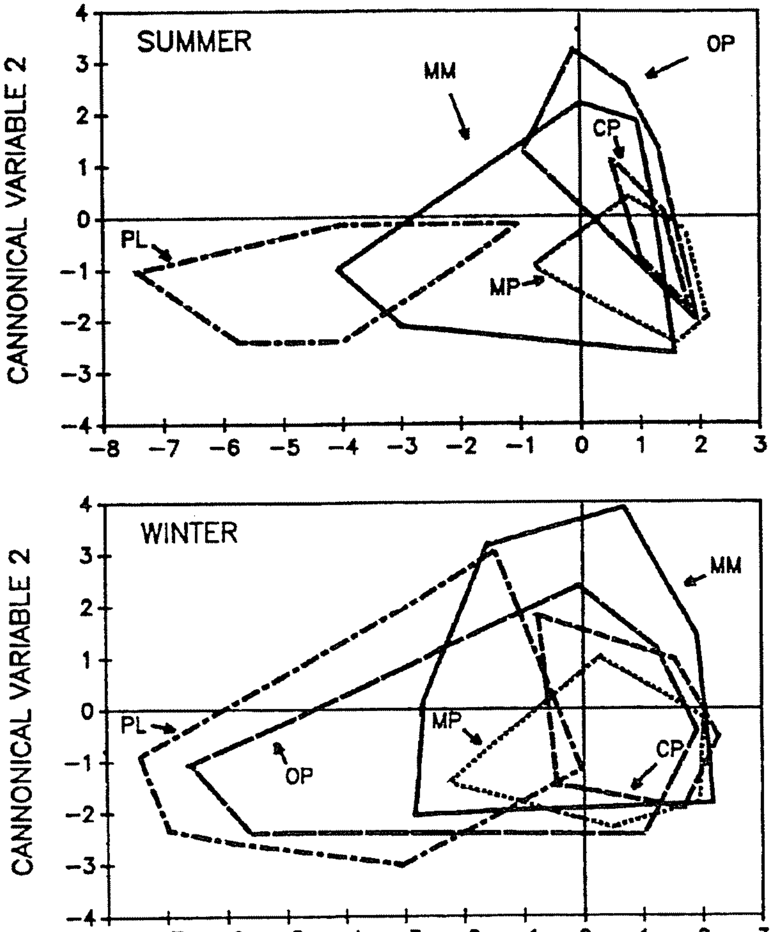

FIGURE 2. The enclosed spaces surround all the capture stations which caught a particular species. Each species is indicated by a two letter abbreviation which is the first letterof the genus name followed hy the first letter of the species name. The upper panel utilized the June capture data and represents "Summer" while the lower panel is the November capture data representing "Winter".

accounted for 52-65% of the variance, while the second accounted for an additional 22-33%.

Microhabitat overlap between species pairs varied considerably with season (Table 3). For *Peromyscus* the association with woods greatly reduces the possible overlap with the other species which rarely occur in that habitat. The other three species show considerable overlap over time, especially during the winter months. Mean community overlap did not differ significantly over time. However, if *Peromyscus* was excluded, microhabitat overlap was considerably higher in winter for the other species. This shift in habitat use and hence microhabitat overlap can also be seen in the two plots of capture locations for all species with respect to the

TABLE 3. Microhabitat overlap between 5 pairs of small mammals resident on the grids,

Species Pair	Microhabitat Overlap Jun.	Aug.	Nov.	Jan.	Mar.	Mean
Mus -Cryptomys	0.05	0.10	0.13	0.19	0.10	0.11
Mus -Microtus	0.47	0.31	0.87	0.76	0.60	0.60
Mus-Oryzomys	0.44	0.58	0.86	0.87	0.40	0.63
Mus-Peromyscus	0.33	0.38	0.33	0.10	0.09	0.25
Microtus-Cryptomys	0.32	0.35	0.50	0.65	0.28	0.42
Microtus-Oryzomys	0.45	0.19	0.80	0.80	0.75	0.60
Microtus-Peromyscus	0.07	0.01	0.00	0.02	0.04	0.08
Oryzomys-Cryptomys	0.35	0.40	0.68	0.84	0.35	0.52
Oryzomys-Peromyscus	0.09	0.05	0.25	0.29	0.27	0.19
Peromyscus-Cryptomys	0.06	0.05	0.08	0.10	0.13	0.08
Overall	0.23	0.24	0.45	0.44	0.30	0.33

first two cannonical variables (Fig. 2). Although the distribution of captures shows considerable overlap along these axes, the "winter" (November data) plot shows the increased microhabitat overlap and, in general, reflects a wider range in usage of habitat by these species (Table 3).

DISCUSSION

Population densities varied with season and exhibited similar patterns during each year of the study. *Peromyscus* was the most restricted species in distribution and the lowest in

population density, Although each species was absent at least once on a study grid, *Peromyscus* was missing from the marsh grid for the first year of the study, Our data and those reported by Kirkland and Fleming (this volume, 1988) both demonstrate that *Mus* and *Peromyscus* had little spatial overlap with the former showing a preference for dune habitat and the latter the woods habitat. *Microtus* was the most abundant and most widely distributed. Additionally, *Microtus* exhibited nearly continuous reproduction on the study areas while the other species had clear seasons in which no reproductively-active individuals were noted.

Habitat affinities of mammals in the present study were similar to those previously reported on other Virginia barrier islands (Dueser and Brown,198O; Porter and Dueser,1982; Dueser and Porter,1986), Microhabitat analysis demonstrated that significant habitat selection was exhibited by all species during all seasons of the year. *Peromyscus* exhibited the least overlap with other species and they also failed to show a general increase in habitat overlap in winter as did other species. *Microtus* tended to occupy microhabitats in which monocot vegetation and abundant ground cover occurred. *Oryzomys* were most abundant in moist microhabitats and were locally abundant in tidal creek areas. *Mus* were abundant in the open habitat of the dune grassland and also occurred in shrub dominated habitats. *Cryptotis* were relatively common at open sites in the shrub-marsh edge habitat as well as in open microhabitats of the dune grassland area. The dune grid had a greater variety of microhabitats and was the only grid on which all seven species of small mammals were captured. Although the specific descriptors for species occurrence differ between this study and prior studies, both characterize the same general habitats and the small mammal species were found in the same associations.

Schoener (1982, 1983) reviewed and evaluated the published evidence for strong competition in the formation of communities and found little evidence to support this conceptual hypothesis. He noted that most studies show that during the most restrictive seasons of a year the amount of interspecific overlap is reduced as the resident species specialize on particular resources. Although many prior studies on Virginia barrier islands suggest that interspecific competition is present, habitat selection always was a very significant variable. This study revealed that habitat selection by the small mammal species was always very strong and was present throughout the year. The degree of habitat overlap increased in the winter, and during that season the potential for competitive interactions was probably the greatest. The centroids for distribution of all species along the resource axes are distinct even though the total range of sites at which a species was captured may exhibit a fair degree of overlap. This study, as did that of Dueser and Porter (1986), produced evidence for habitat selection as a very strong force in determining the small mammal species diversity present in the different communities on this coastal barrier island.

ACKNOWLEDGEMENTS

This paper is dedicated to Mark Maly whose sudden accidental death cut short a promising career in mammalian ecology. His initial data stimulated me to continue the study beyond the first year in an attempt to address some of the questions he raised about the species assemblage on Assateague Island. I wish to thank Irvin Ailes (Chincoteague Wildlife Refuge biologist) for his help during the study period and Dr. R. D. Dueser for organizing the symposium from which this paper is derived.

LITERATURE CITED

Adkins, L,C, 1980. Contributions of habitat selection, interspecific competition and tidal flooding to small mammal species diversity in an Assateague salt marsh. Unpubl. M.S. Thesis, Univ. of Virginia, Charlottesville, Va. 78pp.

Dueser, R.D, and W.C. Brown, 1980. Ecological correlates of insular rodent diversity. Ecology 61:50-56.

Dueser, R.D. and J.H. Porter. 1986, Habitat use by insular small mammals: relative effects of competition and habitat structure. Ecology 67:196-201.

Dueser. R.D. and H. H. Shugart. 1978. Microhabitats in a forest-floor small mammal fauna. Ecology 59:89-98.

Geier, A.R. and L.B. Best. 1980. Habitat selection by small mammals of riparian communitics:evaluating effects of habitat alterations. J. Wildl. Manag. 44:16-24.

Harner, E. J. and R. C, Whitmore. 1979. Multivariate measures at niche overlap using discriminant analysis. Theor. Pop. Biol. 12:21-36.

Higgins, E. A. T., R. D. Rappleye and R. G. Brown. 1971 The flora and ecology of Assateague Island. Univ. of Maryland, Agric. Exp. Sta., Bull. A-172. 78pp.

Hill, S. R. 1986. Anannotated checklist of the vascular flora of Assateague Island (Maryland and Virginia). Castanea. 51:265-305.
Kirkland, G. L. and T. V. Fleming. 1990. Ecology of feral housemice (*Mus musculus*) on Wallops Island, Virginia. Va. J. Sci. 41: this volume.
Kitchings, J. T. and D. J. Levy. 1981. Habitat patterns in a small mammal community. J. Mammal. 62:8 14-820.
Krebs, C. J. 1966. Demographic changes in fluctuating populations of *Microtus californicus*. Ecol. Monogr. 36:239-273.
MacArthur, R. H. and R. Levins. 1967. The limiting similarity, convergence, and divergence of coexisting species. Am. Nat. 101:377-385.
Maly, M. S, and J. A. Cranford. 1985. Relative capture efficiency oflarge and small Sherman live traps. Acta Theriol. 30:161-165.
Paradiso, J. L. and C. O. Flandley. Jr. 1965. Checklist of mammals of Assateague Island. Chesapeake Sci. 6:167-171.
Porter, J. L. and R.D. Dueser. 1982. Niche overlap and competition in an insular small mammal fauna: a test of the niche overlap hypothesis. Oikos 39:228-236.
SAS Institute Inc, 1982. User's guide: statistics. SAS Institute Inc. Cary, NC. 584 pp.
Schoener, T. W. 1982. The controversy over interspecific competition. Am. Sci. 70:586-595.
Schoener, T. W. 1983. Field experiments on interspecific competition. Am. Nat. 122:240-285.
Scott, D. E. 1983. Habitat utilization by two small mammal species: what is the role of competition? Unpubl. M.S. thesis, Univ. of Virginia, Charlottesville, Va. 56 pps.