The effects of human-made disturbances on small mammal populations

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Abstract

Since small mammals are important indicator of ecological health and also provide insight on tick populations and Lyme disease, it is important to understand the effects of human-made disturbances on white-footed mouse (*Peromyscus leucopus*) populations. This summer at Brookhaven National Laboratory (BNL), I conducted research on small mammals and the disturbances they encounter, specifically roads. The goal of the study was to determine if trap location and recapture rates are affected by the distance to roads. Each week, four separate 35 meter square plots were set with 64 Sherman traps at each site. Each trap was five meters apart and marked with a flag. The GPS location of each plot was recorded and mapped with Geographic Information Systems (GIS). The population density was determined and graphed according to the sites distance from the nearest road and then compared across each site. This research will help determine how small mammal populations are effected by roads. The skills I learned include setting up Sherman traps, handling small mammals, and using mark and recapture methods to determine population size. This research has helped me grow professionally by allowing me to work with scientists and see how proper science is completed.

Introduction

Small mammals are good indicators of ecological health. It is important to understand the effect of anthropogenic or human-made disturbances on local animal populations. White-footed mice (*Peromyscus leucopus*) populations are effected by varying anthropogenic disturbances.

Disturbances that are human-made cause stress, fragmentation of habitats, and create patches and isolation to other habitats; increases in fragmentation can lead to high population densities in edge habitats (Mathis et al. 2004). Roads have been found to act as barriers to small mammal movement, including movement of white-footed mice *(Peromyscus leucopus*), the focal species in this study (Rytwinski, T. and Fahrig, L. 2007). High road densities can limit white-footed mice *(Peromyscus leucopus*) population densities and abundance. Forman (2000) estimated that about one-fifth of the United States land area is directly affected ecologically by the network of public roads and that this fraction is increasing. Brookhaven National Lab has roads that have been used since World War One. Since then the lab has grown and more human-made disturbances have been introduced. This study aims to document the effects of roadways on white-footed mice *(Peromyscus leucopus*) populations. Some objectives for this study include learning how to properly handle white-footed mice *(Peromyscus leucopus*), and record data correctly, and to determine the population density. I hypothesized that plots further away from roads will have a higher white-footed mice *(Peromyscus leucopus*) population density.

Site Description

The study area was Brookhaven's 5,321-acre campus located in Long Island's Central Pine Barrens region and within the watershed of one of Long Island's four major rivers, the Peconic River. Often described as Long Island's last remaining wilderness, the Central Pine Barrens covers more than 100,000 acres of public and privately-owned land in Suffolk County. The Pine Barrens are a unique ecosystem dominated by groundcover, shrub thickets, a variety of oaks and pitch pine trees which grow in sandy, acidic, and infertile dry upland soils. The Pine Barrens also contain a diverse range of wetland communities such as marshes, coastal plain ponds, bogs, and river corridors ("Brookhaven National Laboratory").

Methods

Small mammal population surveys were conducted at Brookhaven National Laboratory (BNL) in Upton, NY throughout June, July and August 2017. All mice were captured using Sherman live traps at sixteen study plots within BNL's campus over an eight week period. At each site a 35 meter x 35 meter grid was established of 64 traps each marked with a flag and spaced 5 meters apart. The GPS location of each site was recorded. Traps were baited with a peanut butter/oat mixture. Animals were trapped at each site over four consecutive nights during two alternate weeks for a total of 8 days. The total trap nights were 8192. Traps were checked each morning; captured animals were weighed, sexed, and marked with individual ear tags. Recaptured individuals were noted. All attached ticks were removed and preserved. Each site was measured from its center to the road and recorded. Using this data the GPS location of each plot was mapped with ArcMap 10.1 a Geographic Information Systems (GIS). The population density was determined and graphed according to each sites distance from the road and then compared across each site.

Table 1. GPS coordinates (Universal Traverse Mercator units) of the sixteen sites used in the study. See figure 1.

Plot	Latitude	Longitude		Plot	Latitude	Longitude
Site 1	0678997	4524445		Site 9	0681104	4527788
Site 2	0679011	4524464		Site 10	0681231	4528161
Site 3	0679730	4524870		Site 11	0681098	4527741
Site 4	0679742	4524914		Site 12	0681239	4528025

Site 5	0680555	4527194		Site 13	0678160	4524539
Site 6	0680575	4527175		Site 14	0678191	4524599
Site 7	0681117	4526649		Site 15	0681273	4528249
Site 8	0681090	4526683		Site 16	0681033	4528793

Program MARK Version 8.1, robust design model was used for a parameter estimate of white-footed mice abundance at each site. The robust design model considers the time interval between trapping sessions as "open" and the time interval during trapping as "closed" (Cooch and White 2006). Program DENSITY Version 5.0 was also used to predict the size of white-footed mice population using the spatially explicit capture-recapture data collected (Efford 2012).

Results

Table 2. Abundance of mice calculated from MARK recapture analysis, and Program Density from each encounter at each site. Compared to the distance from the center of the plot to the road of each site.

Site	Abundance of mice from MARK analysis	Densities of mice calculated from program DENSITY	Distance from the road (m)
1	31.1	30.5	40
2	35.4	27	46
3	3.3	6	37
4	35.4	35	48
5	8.6	9	46

6	35.6	18.5	36
7	12.6	18.5	23
8	19	19	31
9	11.1	13.5	21
10	8.5	12.5	36
11	13	12.5	49
12	24.8	27	36
13	26.9	31.5	32
14	20.5	26.5	24
15	14.3	13.5	30
16	22.3	24	38

There was no significant relationship between the sizes of the populations of mice calculated from program MARK and the distance from the road at each site (Fig 1A; R^2= 0.86, p = 0.27, n=16). Additionally, the basic linear regression showed there was not a significant relationship between the density of mice calculated from program DENSITY with distance from the road at each site (Fig 2A; R^2= 0.71, p = 0.02, n=16).

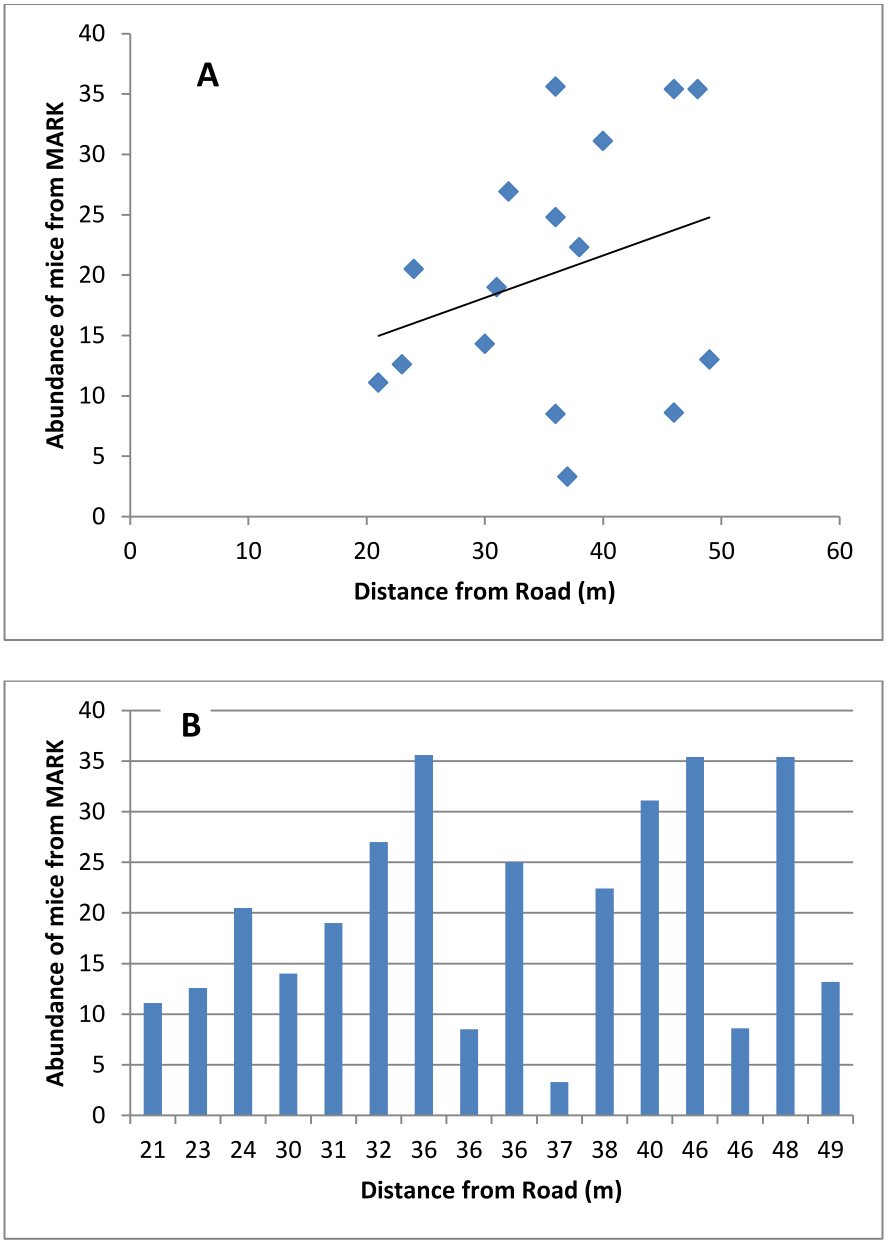

Figure 1 A- Each sites distance from the road in relation to the abundance of mice from MARK recapture analysis at each site as a linear regression. **B-** Each sites distance from the road in relation to the abundance of mice from MARK recapture analysis at each site as a bar graph sorted from smallest to largest.

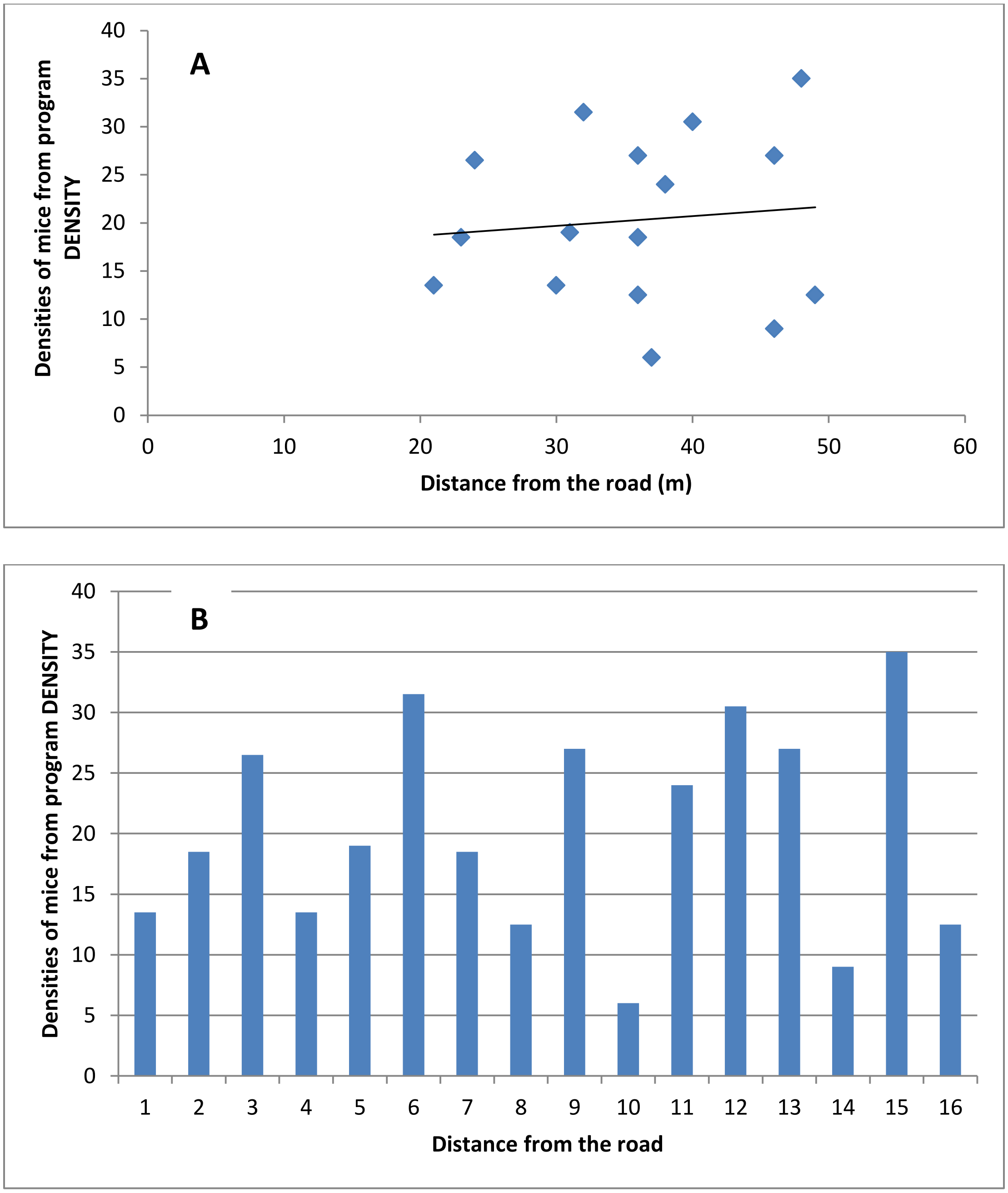

Figure 2 A- Each sites distance from the road in relation to the density of mice calculated from Program DENSITY at each site as a linear regression. **B-** Each sites distance from the road in relation to the density of mice calculated from Program DENSITY at each site as a bar graph.

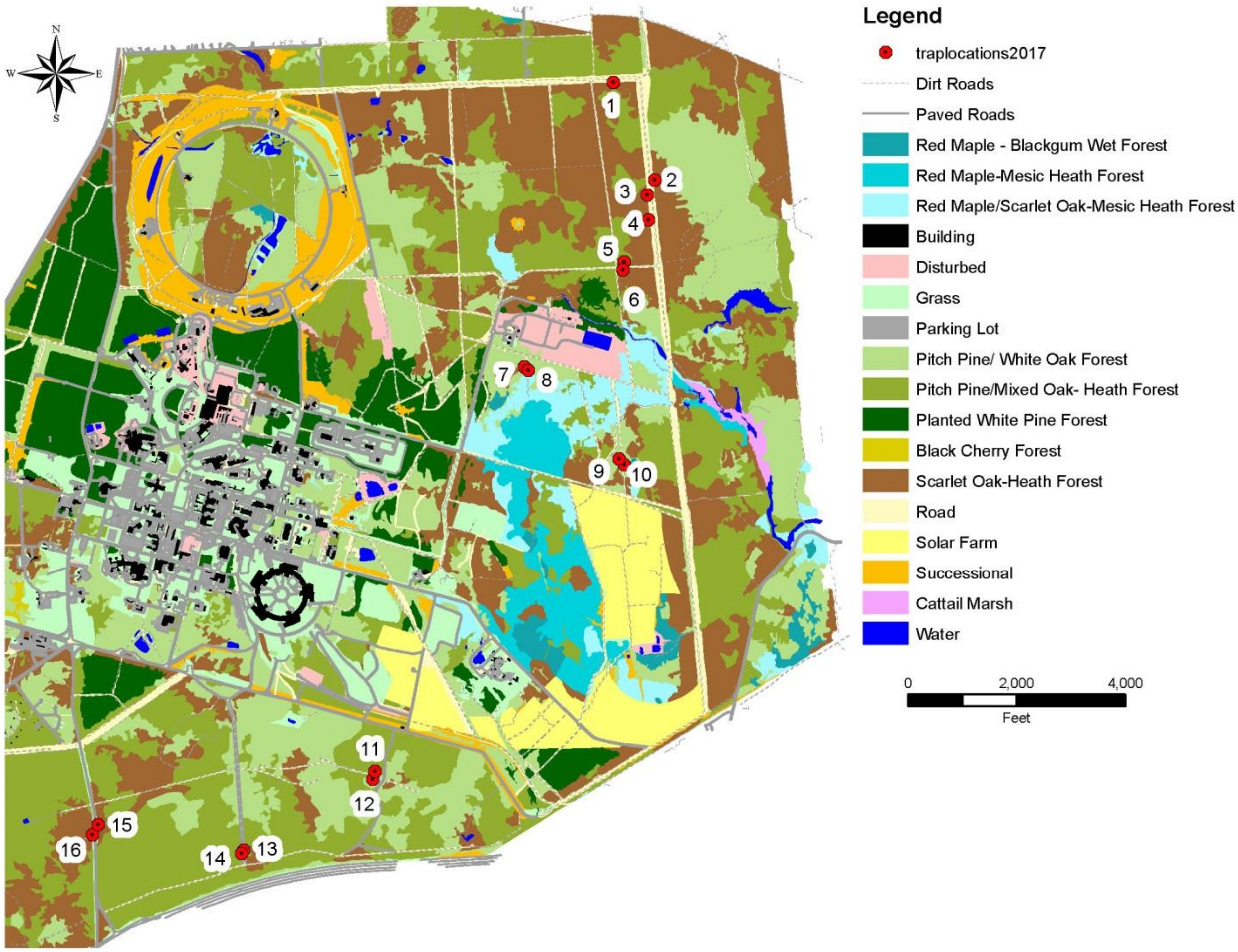

Figure 1. Map of Brookhaven National Laboratory with the sixteen sites surveyed.

Discussion

Peromyscus leucopus is a keystone species in relation to *Ixodes* scapularis and *Borrelia burgdorferi* bacteria in major Lyme disease infection regions (Tsao et al., 2004). Therefore, understanding the ecological relationships that affect their populations are crucial to assessing Lyme Disease risks. I predicted that the closer the site was to the road the lower the abundance and density of mice. The hypothesis formed in this study was not supported. This conclusion may be due to varying human-made and natural disturbances that includes vegetation type, and cover, weather and prescribed fire burns. In another similar study they found no significant relationship, between road density and the presence of *P. leucopus* during the early spring (Rytwinski, T. & Fahrig, L 2007). They also found that there study was the first to test their hypothesis making no other published reports to which they could compare their findings (Rytwinski, T. & Fahrig, L 2007).

Other experiments may replicate this study using more sites to determine how greatly roads effect *Peromyscus leucopus* populations. Some potential modifications to this experiment's replication may include sites located in other areas besides BNL and more variable distances used. Although this experiment was well-designed, there are a few possible sources of error that should be considered. Possible sources of error may include mistakes with baiting, raids by other wild animals, trap failure, misreading ear tags and escapees which could potentially skew data in plots and miscalculations made using the collected data.

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