Roads and Desert Small Mammal Communities: Positive Interaction?

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Introduction

Several indirect effects of roads on wildlife communities have been reported such as habitat quality alteration, loss in landscape connectivity, and barrier effects (Forman et al., 2003; Jaeger et al., 2005). An effect zone of up to 100m on either side of the road has been described as causing measurable impacts on ecological communities (Underhill and Anglod, 2000).

Roads can impact small mammal communities by: 1) creating an edge with different habitat characteristics (Garland and Bradley, 1984; Tyser and Worley, 1992); 2) promoting the introduction of exotic species (Getz et al., 1978; Vermeulen and Opdam, 1995; Underhill and Anglod, 2000); 3) increasing stress and reducing survival (Benedict and Billeter, 2004) through disturbance and contamination (Jefferies and French, 1972; Williamson and Evans, 1972; Quarles et al., 1974); 4) blocking movement thus causing genetic barriers and home range rearrangements (Oxley et al., 1974; Garland and Bradley, 1984; Mader, 1984; Swihart and Slade, 1984; Merriam et al., 1989; Gerlach and Musolf, 2000); and finally 5) causing direct road mortality (Wilkins and Schmidly, 1980; Ashley and Robinson, 1996; Mallick et al., 1998).

While the main focus of studies on the impact of roads on small mammals has been on road barrier effects, less attention has been given to the effect of roads on density and diversity of local communities.

Further analysis on the effect of roads on natural habitats is needed. Our objective was to assess and compare density estimators and diversity of small mammal communities in areas influenced by roads with areas having no road influence.

Study Area

This study was conducted in the high elevation desert region of southwestern Utah, USA. It is included in the Great Basin geographic region (Durrant, 1952; Barosh, 1960; Cronquist, 1978). The study area was located near Beaver, Utah (38°16'N latitude and 112°37'W longitude) adjacent to Interstate 15 (I-15) (figure 1).

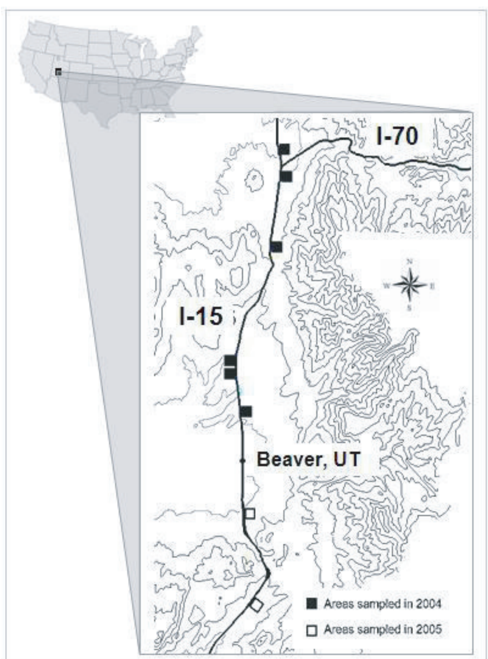

Figure 1. Study area map with trapping location in 2004 and 2005 and geographic areas (A, B, and C) used for comparison of densities in 2004 in southern Utah, USA.

Methods

Field Methodology

Small mammal sampling was conducted exclusively in sagebrush habitat on both sides of the road during the summer periods of 2004 and 2005. Trapping was conducted close to and distant from the road to sample communities with and without putative road influence.

For the first year (2004), 2 trapping webs were placed on a perpendicular transect from the road at each site. In total, each web had a total of 98 traps. We used both lethal (snap traps) and non-lethal (Sherman) traps to maximize the number of species detected and to allow sampling during the diurnal period. The first webs were centered at 50 m from the road (Close) and the second webs centered on average 400 m from the road (Distant).

A different trapping design was used in 2005 to correct problems detected in the first trapping season. Trapping lines were used. Three trapping lines were placed in a perpendicular transect from the road. Trapping lines were set at increasing distances from the road verge (0m - Close, 200m - Mid, 600m - Distant).

Data Analysis

Diversity

We used the Shannon-Wiener diversity index (H) to compare community diversity at different distances from the road (Begon et al., 2006). The index was calculated for each web or trap-line in all transects.

Abundance and Density Estimation

Analysis for 2004 web-based data employed a distance method described by Anderson et al. (1983) and accounted for first capture locations for each individual and their distances to the center. Program DISTANCE 4.1 (Buckland et al., 1993, 2001) was used to calculate densities and variance estimates. For analysis purposes, capture data in different transects were pooled in close webs and distant webs because of the low number of animals sampled in each web.

Analysis for 2005 trapping-line-based data was performed using a closed population mark-recapture method in Program MARK 4.3 (White and Burnham, 1999). Closure was assumed given that trapping occurred in a sufficiently brief interval and the removals were known and accounted for in the analysis (Williams et al., 2001). The Huggins Closed Capture estimator was used to obtain abundance estimates.

Results

Trapping

We completed a total of 8,406 trap nights (webs 7,056; trap-lines 1,350) and captured 484 small mammals (webs 420; trap-lines 58) comprising 13 species and 11 genera.

In 2004 we captured a total of 11 species (table 1). Two of the species, rock squirrel (*Spermophilus variegatus*) and sagebrush vole (*Lemmiscus curtatus*), were captured exclusively in areas closer to the road, and 2 other species, pinyon mouse (*Peromyscus truei*) and white-tailed antelope squirrel (*Ammospermophilus leucurus*), were captured exclusively distant from the road. The remaining 7 species were captured at both distances.

During 2005 we captured a total of 7 species (table 1). Three of the species - desert cottontail (*Sylvilagus audubonii*), jackrabbit (*Lepus californicus*) and desert woodrat (*Neotoma lepida*) - were only detected closer to the road. No unique species were detected at mid or at distant classes. The number of species decreased as distance to road increased.

During the two years of sampling we noted that some species were only detected in areas with unique micro-habitat characteristics.

Table 1: Species detected at different distances from I-15 in 2004 and 2005 in southern Utah, USA. Species (number of individual captures). * = species uniquelly detected at certain distance

Distance to road	2004	2005
CLOSE	*Peromyscus maniculatus* (124) *Perognathus parvus* (39) *Tamias minimus* (27) *Dipodomys microps* (5) *Rethrodontomys megalotis* (4) *Peromyscus boylii* (3) *Neotoma lepida* (2) *Lemmiscus curtatus* (1) * *Spermophilus variegatus* (1) *	*Perognathus parvus* (12) *Peromyscus maniculatus* (10) *Dipodomys microps* (8) *Tamias minimus* (2) *Sylvilagus audubonii* (2) * *Lepus californicus* (1) * *Neotoma lepida* (1) *
MID	-	*Dipodomys microps* (11) *Perognathus parvus* (4) *Peromyscus maniculatus* (1) *Tamias minimus* (1)
DISTANT	*Peromyscus maniculatus* (120) *Perognathus parvus* (54) *Tamias minimus* (18) *Peromyscus boylii* (11) *Ammospermophilus leucurus* (4) * *Rethrodontomys megalotis* (3) *Peromyscus truei* (2) * *Neotoma lepida* (1) *Dipodomys microps* (1)	*Dipodomys microps* (2) *Perognathus parvus* (2) *Peromyscus maniculatus* (1)

Diversity Analysis

Results of Shannon-Wiener diversity index (H) analysis showed different trends in diversity according to different sampling years. For 2004, diversity was 43.2% higher in areas distant from the road while in 2005 diversity was 57-87% lower further from the road.

Abundance and Density Analysis

Analysis to compare total small mammals distribution relative to road distance seems to indicate opposite trends for different years. In 2004 (figure 2), despite the fact that density was 28.9% higher at distant webs, the difference was not significant (Z = -0.49, P = 0.63). In 2005, abundance was found to be 87.3% lower at distant transects (figure 3) as compared with close distances (Z = 3.99, P < 0.001).

Figure 2. Density estimates of small mammals (and 95% Confidence Intervals) in 2004 at different distances from the road in southern Utah, USA.

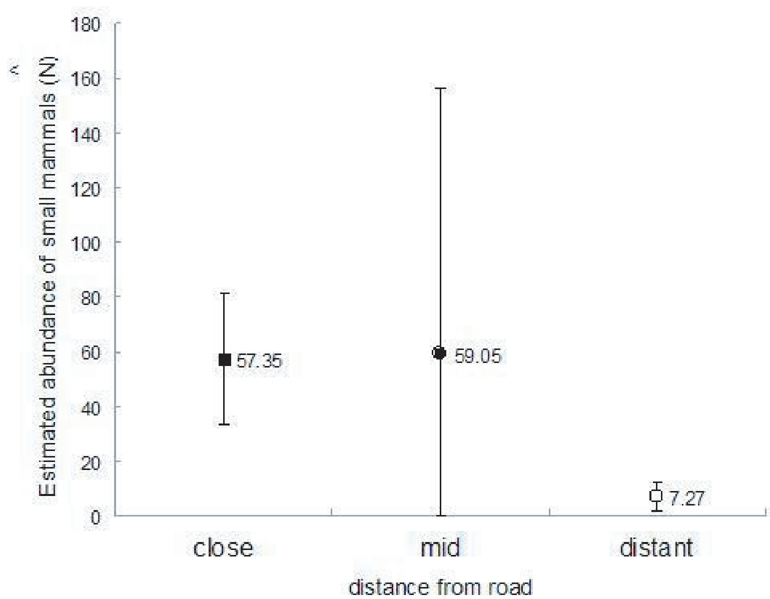

Figure 3. Abundance estimates of small mammals (and 95% Confidence Intervals) in 2005 at different distances from the road in southern Utah, USA.

When we compared densities between 3 different geographic areas, we were able to test if differences in habitat influenced density. One of the areas (area B) had significantly higher densities of all organisms (figure 4).

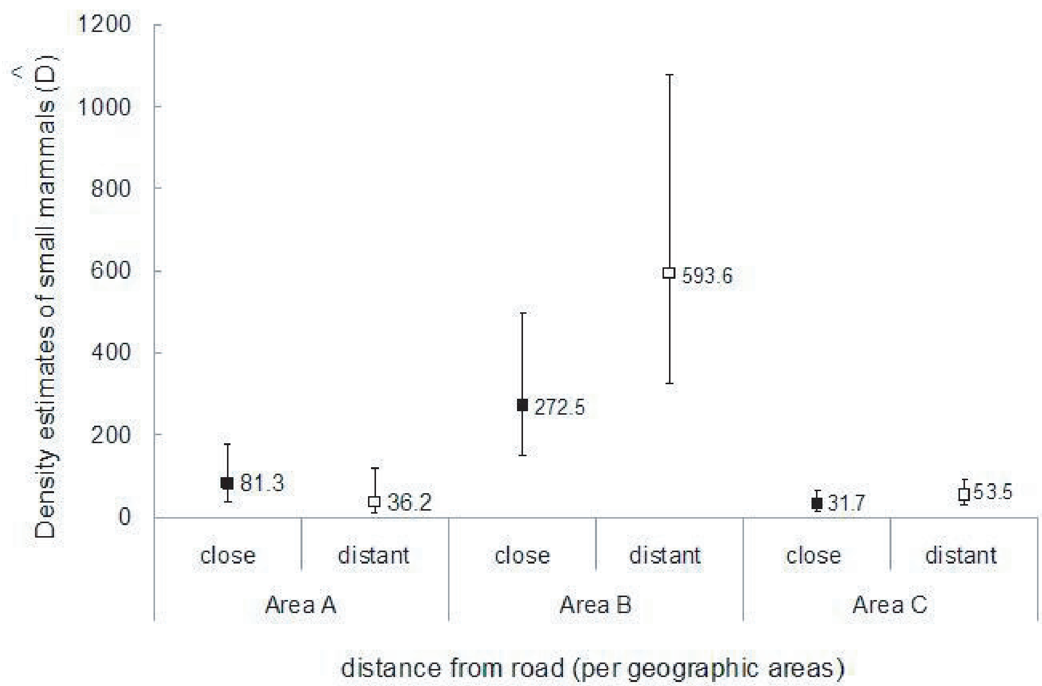

Figure 4. Density estimates of small mammals (and 95% Confidence Intervals) in 2004 at different distances from the road in three distinct geographic areas (A, B, C) in southern Utah, USA.

Discussion

The main objective of this study was to assess if roads had any zone effects on small mammal community abundance and density. The null hypothesis was that abundance and density would not vary significantly at increasing distances from the road if the road had a no effect. We expected effects, if any, to be constant throughout the length of the study. However, the results are contradictory in different sampling years and suggest that there is no clear effect on small mammal populations relative to distance to the road.

Abundances of small mammals were similar close and distant in 2004, and higher closer to the road in 2005. Diversity was higher away from the road in 2004 and closer to the road in 2005. The road by itself did not seem to influence abundance or diversity patterns. We did not consistently detect any negative impacts. Small mammal populations did not appear to be negatively affected by the presence of the road. Roads may intervene in the landscape as distinctive structures causing barrier effects but do not appear to cause disturbance or habitat impoverishment for small mammals.

Differences in areas sampled, sampling methods, or different trapping years, could have influenced the results. Differences between areas were clearly more important than differences between close and distant trapping sites. Results show that micro-habitat highly influenced organism abundances.

Our results also suggest that the abundance and diversity of small mammals responds more markedly to habitat quality and complexity than to the presence of roads. The comparison of geographic areas in 2004 showed that higher densities of mammals existed with favorable habitat conditions (higher food and shelter availability in Area B than on other areas). Therefore, we suggest that management of roaded landscapes to increase small mammal populations would more profitably focus on roadside habitat improvement rather than on road disturbance mitigation.

This study suggests that the scientific predisposition to consider roads as negative landscape elements for all wildlife is not valid for small mammal communities.

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