Final Report

U.S. Forest Service Grant #RR551-125

"The effects of habitat fragmentation on the behavior of the cotton rat (*Sigmodon hispidus*): Phase II"

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"Habitat use and movement patterns of small mammals (*Peromyscus gossypinus, P. polionotus*, and *Sigmodon hispidus*) in an experimentally fragmented and enriched landscape: Phase III"

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I) Overview

This document is intended to serve as the final report for the projects entitled "The effects of habitat fragmentation on the behavior of the cotton rat (*Sigmodon hispidus*): Phase II," and "Habitat use and movement patterns of small mammals (*Peromyscus gossypinus, P. polionotus,* and *Sigmodon hispidus*) in an experimentally fragmented and enriched landscape: Phase III." The term of the Phase II agreement (# RR551-125) between the U.S. Forest Service and the University of Georgia was 15 May 1999 to 14 May 2001, and the term of the Phase III agreement (#RR551-144) was 1 August 2000 to 31 July 2001.

II) Project Objectives

This project was designed to test the effects of corridors, patch size, and habitat quality on population dynamics and movements of three small mammal species; the cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), and the old-field mouse (*P. polionotus*). There were four primary hypotheses for the Phase II investigation:

1) Small mammal population densities will be higher in connected than in isolated large (1.6 ha) patches.
2) Small (0.4 ha) patches will have lower small mammal population densities than large (1.6 ha) patches.
3) Population densities will be greater in high-quality patches (increased vegetative cover and food availability) than in low-quality patches.

4) Edge habitat will have a negative effect on forest interior species.

Three additional hypotheses were tested during Phase III of the project:

5) Movements of the cotton mouse, a habitat generalist, will not be affected by the various landscape elements (patch, corridor, and matrix).
6) Individual cotton mice initially captured in both patch and matrix habitat types will utilize both habitat types.
7) A higher proportion of cotton mice will move between isolated habitat patches (i.e., cross the forest matrix) than either cotton rats or old-field mice, both grassland species.

III) Study Site and Methods

Study Site

This investigation was conducted in an experimentally fragmented landscape consisting of 15 clearcut patches (128 x 128 m (n = 9) and 64 x 64 m (n = 6)) located within a managed loblolly pine (*Pinus taeda*) forest on the Savannah River Site (SRS), Aiken County, South Carolina (Fig. 1). Three pairs of large patches were connected by corridors (length 128, 256, and 384 m), and three large patches were not connected. Three small patches were experimentally enriched by seeding with *Lespedeza cuneata*, fertilization, and the addition of coarse woody debris (CWD); habitat quality in the remaining three

small patches was unmanipulated. During March 2000, three 1.6 ha trapping grids were established within the pine forest matrix.

Live-trapping

Patches within the experimental landscape were trapped twice weekly during June-October 1999 and May-December 2000. Matrix grids were trapped weekly March-November 2000. Trap stations were placed at 32-m intervals in patches, corridors, and matrix trapping grids, with two Sherman live traps at each station. Thirty-two traps were set in each large patch, 8 traps were set within each small patch, and 8-24 traps were set in each corridor, depending on corridor length.

Analyses

Population densities

Population densities were estimated weekly or each species in each patch using the minimum number alive (MNA) method (Krebs 1966). Densities were then averaged for each treatment during each week and generalized estimating equations (GEE), a type of repeated measures ANOVA (Stokes et al. 2000), were used to test for significant differences in population densities between treatments (connected vs. isolated and high vs. low-quality). Differences in population densities between large and small patches could not be analyzed statistically because habitat quality was not similar between large and small patches due to experimental enrichment. Sign tests (Sokal and Rohlf 1981) were used to test for significant trends in densities. Chi-square tests were used to

determine if animals utilized patch interior, patch edge, or corridor habitats more often than would be expected if captures were randomly distributed across the study area.

Movements

Animals that were captured >2 times as adults were included in analysis of interpatch movement. The proportion of animals of each species that was captured outside the patch of initial adult capture was determined, and comparisons were made between species. Animals were categorized by the treatment of the patch of original adult capture (connected or isolated). The null hypothesis that cotton mice initially captured in connected patches were no more likely to emigrate from a patch than cotton mice initially captured in isolated patches was tested using a chi-square test.

IV) Results

1) Small mammal population densities were never significantly different between connected and isolated patches for any species (Table 1). However, cotton rat population densities tended to be higher in connected than isolated patches significantly more often (Sign test; 1999, $P < 0.005$; 2000, $P < 0.05$), and old-field mouse population densities tended to be higher in isolated patches during both years (1999, $P < 0.25$; 2000, $P < 0.005$). No significant differences in trends were observed for cotton mice.
2) Differences in population densities between large and small patches were not tested statistically. However, small patches typically supported somewhat higher densities of cotton rats and cotton mice than large patches. There were very few captures of old-field mice in small patches.

3) There were no significant differences in population densities between high and low-quality patches for cotton rats or cotton mice (Table 1). Trends were not significant ($P > 0.05$).

4) Habitat utilization by each species was non-random during each year of the study ($P < 0.05$). Cotton rats were captured more often than expected in corridors, while cotton mice and old-field mice were captured more often than expected in patch interiors.

5) Movement by cotton mice was affected by corridors; cotton mice were more likely to emigrate from a patch with a corridor (Chi-square test, $P > 0.05$).

6) Only two cotton mice were captured within matrix habitat, thus this hypothesis could not be tested due to low sample size.

7) Cotton mice moved between isolated patches more frequently than cotton rats or old-field mice did during 1998 and 1999 (Fig. 2).

V) Conclusions

Neither corridors nor habitat quality had a significant effect on population densities of any of the species considered in this study. The effect of patch size was not statistically tested, however, small patches tended to have slightly higher densities of cotton rats and cotton mice than large patches. At this site, landscape elements appear to have little effect on population densities of small mammals.

Habitat use by cotton mice captured in both patch and matrix habitat could not be assessed due to low numbers of captures in the forest matrix. Cotton mice initially captured in connected patches were more likely to move from the patch than cotton mice initially captured in isolated patches. Cotton mouse movements were less affected by

forest matrix than those of cotton rats or old-field mice; movements between isolated patches were more common for cotton mice during 1998 and 1999.

VI) References cited

Krebs, C.J. 1966. Demographic changes in fluctuating populations of *Microtus californicus*. Ecological Monographs 36:239-273.

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Stokes, M.E., C.S. Davis, and G.G. Koch. 2000. Categorical data analysis using the SAS system. 2nd ed. Cary:SAS Institute.

Table 1. Results of generalized estimating equations (GEE) to determine significant effects of patch connectivity and patch quality on population densities of three small mammal species at the Savannah River Site (SRS).

	Connectivity			Quality	
Species	Year	χ^2	P	χ^2	P
S. hispidus	1999	2.19	0.14	-	-
	2000	1.42	0.23	2.00	0.16
P. gossypinus	1999	0.01	0.93	0.70	0.40
	2000	0.79	0.37	0.01	0.91
p. polionotus	1999	0.77	0.38	-	-
	2000	2.29	0.13	-	-

Figure 1. Aerial photograph (1999) of the experimentally fragmented landscape on the Savannah River Site (SRS), Aiken County, South Carolina. Each large patch is 128 x 128 m and each small patch is 64 x 64 m. Locations of forest matrix trapping grids are outlined in white.

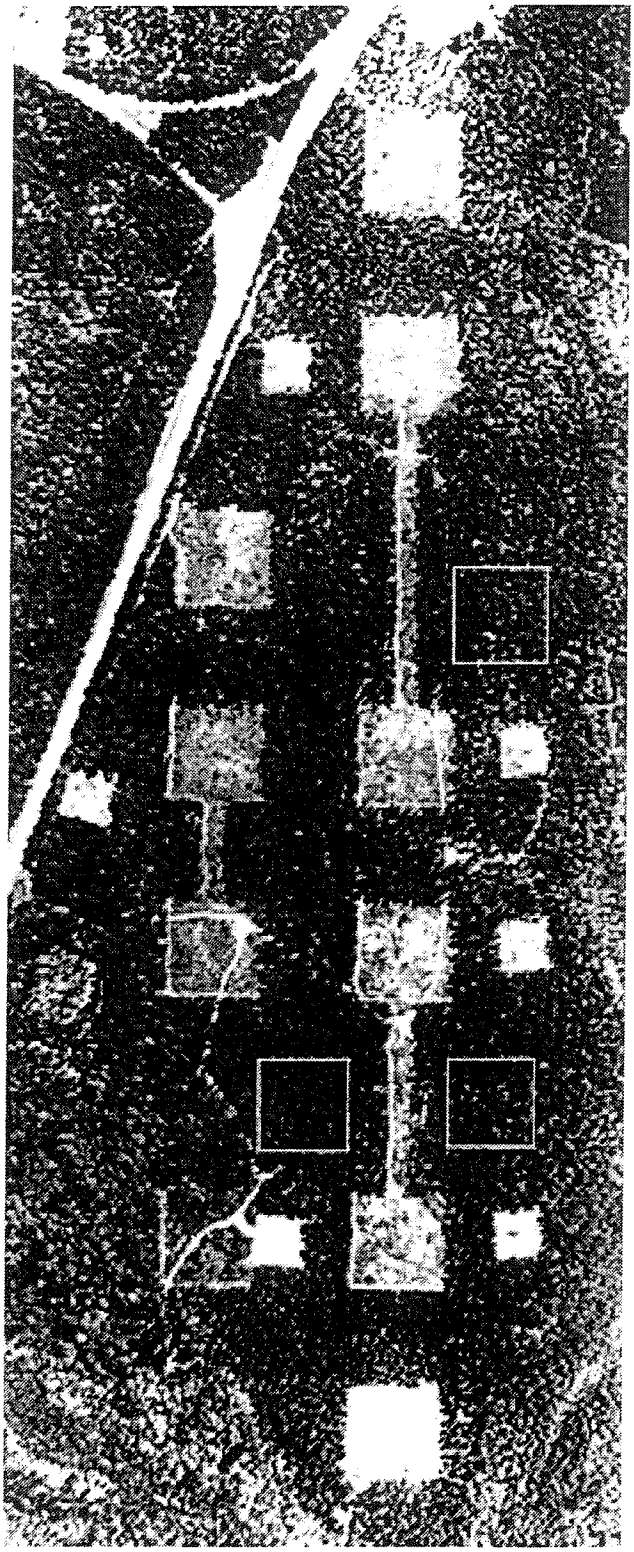
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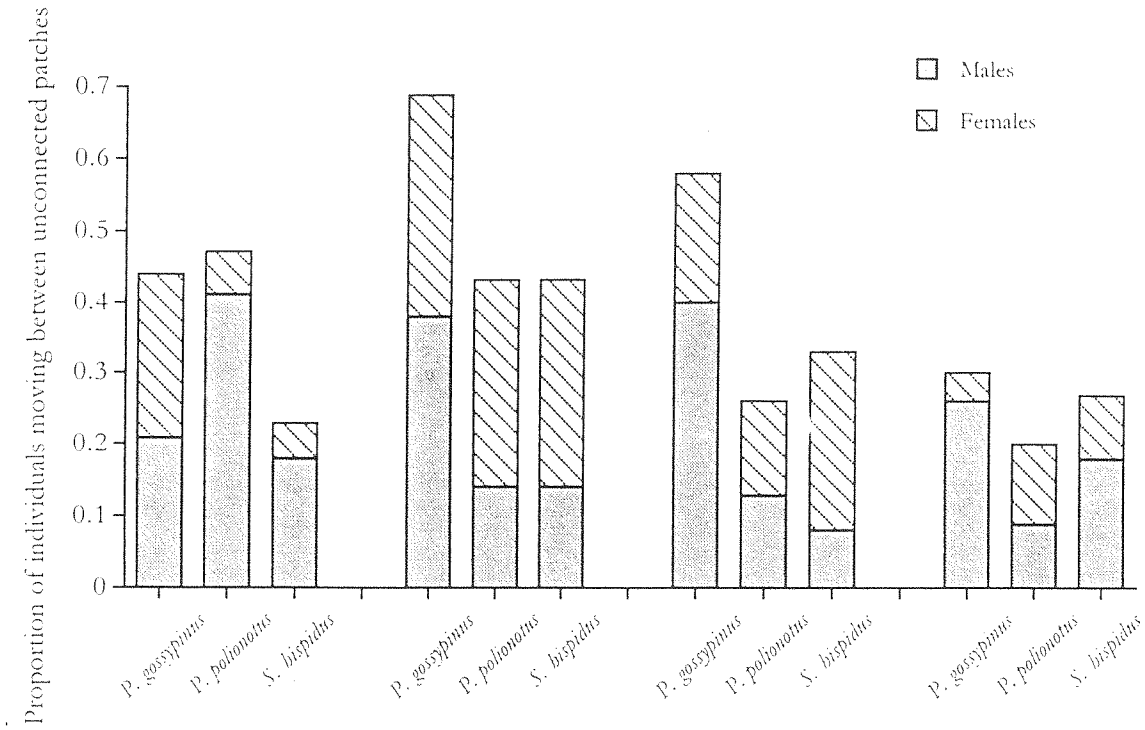
Figure 2. Proportion of individuals of each species captured >2 times that moved between habitat patches unconnected to each other.


Proportion of individuals moving between unconnected patches
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Males
Females
P. gossypinus
P. polionotus
S. bispidus
P. gossypinus
P. polionotus
S. bispidus
P. gossypinus
P. polionotus
S. bispidus
P. gossypinus
P. polionotus
S. bispidus

Publications, abstracts, and presentations resulting from the grants "Effects of habitat fragmentation on the behavior of the hispid cotton rat (*Sigmodon hispidus*):Phase II" awarded to G.W. Barrett and E.A. Dreelin and "Habitat use and movement patterns of small mammals (*Peromyscus gossypinus, P. polionotus*, and *Sigmodon hispidus*) in an experimentally fragmented and enriched landscape: Phase III" awarded to G.W. Barrett and K.E. Mabry

Journal articles

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Thesis

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