December 1994  Integrated Resource Management  No. 222

Relationships between the Abundance of Small Mammals and Patch Size within Fragmented Forests on Vancouver Island.

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INTRODUCTION

When an area is logged, some of the original habitat is altered, new habitats are created, and what remains of the original habitat may become fragmented (Saunders et al. 1991). Consequently, the size of native vertebrate populations may be reduced. Native species in the unlogged fragments may also be reduced if colonizing species from the logged habitats invade the residual fragments to prey upon (Saunders 1990, Yahner and DeLong 1992), parasitize (Usher 1988, Gates and Gysel 1978), or compete with them (Pahl et al. 1988, da Fonseca and Robinson 1990).

Typically, small patches have a larger ratio of edge to area than larger patches. Consequently, individuals living within small patches may be affected by the external species more than those living within large patches (Laurance 1990). Mammals were surveyed within patches of old-growth forest that remained after logging to evaluate (1) whether there were more mammalian species at the centres of large patches than small patches, and (2) whether the densities of individuals were greater for each species at the centres of large patches than small patches. The study was conducted in the montane rainforest of Vancouver Island.

METHODS

Mammals within 22 patches of old-growth 634.909 that had become isolated by logging the previous 40 years were surveyed.

Ten patches in the Nimpkish River valley (50°10' N, 126°30' W) with overstories dominated by Douglas-fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) were surveyed during 1991. Five of the initial ten patches were resurveyed during 1992, and five additional patches with overstories dominated by western hemlock, amabilis fir (Abies amabilis), and western redcedar (Thuja plicata) were surveyed during 1992. Seven patches located on the plateau above Shawnigan Lake (48°40'N, 124°0'W) were also surveyed during 1992. Patches near Shawnigan Lake had overstories dominated by western hemlock and amabilis fir.

A range of patch sizes was selected within each of the forest types/geographic locations; otherwise, patches were as similar as possible. Two sampling stations, separated by a distance of 200 m, were established near the centres of the patches. Four different survey techniques were used to survey mammals at, and between, the sampling stations. Indices of abundance for vagrant shrews (Sorex vagrans), deer mice (Peromyscus maniculatus), and Columbian mice (Peromyscus oreas) were determined by extending two traplines, separated by a distance of 20 m, between the two sampling stations. One pit-fall trap and one snap trap were placed at 20-m intervals along each trap line. Pit-fall traps and snap traps were set for four and three nights in April, respectively. An index of abundance for red squirrel (Tamiasciurus hudsonicus) was determined by counting the number of individuals heard while conducting 10-minute point counts for birds (Hutto et al. 1986). Counts were conducted at

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all stations and in all patches during six periods occurring between late March and mid-June. Remote bat detectors and recorders (S-25 Bat Ultra Sound Advice, London, U.K.) were placed at each of the stations for two nights during late May or early June to determine an index of abundance for bats. The number of bats flying past the recorders during the first 25 minutes after sunset, and the last 25 minutes before sunrise, were determined. Bats were only surveyed during 1992.

Relationships between patch sizes and species richness and abundances at the centres of patches were evaluated using analyses of covariance, with forest type/geographic area included as a grouping variable (SAS 1988). In those analyses, patch size was logarithmically transformed because other transformations and higher-order polynomial terms did not add significantly to the relationships. To avoid pseudo-replication (Hurlbert 1984), the data collected from the low-elevation Douglas-fir patches during 1992 have been omitted, since these patches were also surveyed during 1991.

RESULTS

Few small mammalian species were observed in the patches, probably because the study was conducted on an island (Schmieglov and Nuds 1987). Five mammalian species were observed in ten of the patches, four in 11 patches, and three in the remaining patch. The numbers of mammalian species found at the centres of patches were not related to patch sizes ($F=3.7, P=0.93, df=1, 18$).

Red squirrel was the only species whose abundance varied significantly among forest types/geographic areas (Table 1). The abundances of three species (deer mice, Columbian mice, and bats) were negatively related to patch sizes, with a statistically significant relationship existing only for bats (Figure 1, Table 1). The abundances of red squirrels and vagrant shrews were positively related to patch sizes, but those relationships were not statistically significant (Figure 1, Table 1).

DISCUSSION

Three of the five mammalian species (Columbian mice, red squirrels, and bats) surveyed were expected to require patches of old-growth forest for feeding, roosting, or nesting (USDA Forest Service 1991). Those species have potential to be affected more negatively by parasites, predators, and competitors at the centres of small residual patches of old-growth forest than at the centres of large residual patches. The relationship between abundance of red squirrels and patch size was positive, but not significant. The relationships for the other two species were negative—not positive as had been predicted. Consequently, there was little evidence of detrimental effects to small mammals living in small nonlogged patches of old-growth forest. However, due to the power of the tests, relationships accounting for 20% or less of the variation may have been missed 54% of the time (calculations follow Cohen 1988). Thus, if external predators, parasites, and competitors had only small negative influences on mammals within the patches, this survey may not have been sufficiently intense to detect relationships. Additional surveys would be necessary to evaluate small effects.

It was surprising to find no relationships between abundances of small mammals and patch sizes, because native mammals appear to have been detrimentally affected by habitat fragmentation in other areas (e.g., Laurance 1990). Differences among studies may have been due to differences among the original communities and/or differences among the initial landscapes. Most of the previous studies were conducted within an agricultural landscape, whereas this study was conducted within a logged landscape. Unlike agricultural landscapes, in logged landscapes the areas between the patches of old growth have trees regrowing, and consequently are in a seminatural state. Thus, within the logged landscapes in the study areas, forest mammals may be able to cope with the reductions in patch size that result from logging (Rudnicky and Hunter 1993).

There are at least two additional explanations for these results. First, the landscapes
were heterogeneous under natural conditions (Meidinger and Pajar 1991), thus the native mammals may have evolved in a system where they interacted with many types of predators, competitors, and parasites. Under such circumstances, native mammals may have been able to interact effectively with the species living outside the residual patches (Hansson and Angelstram 1991). Alternatively, competition and predation may have been low in this study because it was conducted on an island. Vancouver Island has fewer mammals and amphibians than the adjacent continental areas (Nagorsen 1990, Orchard 1984), probably because many taxa have difficulty crossing the Strait of Georgia. Some of these “missing” species might have increased competition and predation at the forest edge, had they been present in the regenerating forest, adjacent to the patches. It would be informative to determine the relationships between patch sizes and the richness and abundances of mammals for montane forests in a continental area, and to compare those relationships with the results of this survey.

This study should be treated as preliminary because the productivity and viability of the populations within each of the patches were not evaluated (Van Horne 1983). Small patches may not be isolated from larger areas of old-growth forest, and populations within these small patches may have been maintained by immigration (Saunders et al. 1991). The importance of interpatch immigration to maintaining populations in small patches can only be evaluated if reproduction and recruitment rates are known (Kellner 1992). This study did not make that evaluation.

ACKNOWLEDGEMENTS

I wish to thank A. Schieck, T. Either, and M. Weibe for assisting with the data collection. Funding for the research was provided by the British Columbia Ministry of Forests, the Canadian Forest Service (FRDA II), and the National Sciences and Engineering Research Council of Canada. The British Columbia Ministry of Environment Lands and Parks, Canadian Forest Products Ltd., and MacMillan Bloedel provided field support. Earlier drafts of this report were reviewed by B. Nyberg and R. Page.

TABLE 1. Analyses of the relationships between abundances of individuals at the patch centres and patch sizes for 22 patches of old-growth forests on Vancouver Island. Forest type was treated as a grouping variable, and patch sizes were logarithmically transformed and treated as a continuous variable in the analyses.

<table>
<thead>
<tr>
<th>Species</th>
<th>Forest Type</th>
<th>Patch Size</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Bats</td>
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<td>Vagrant Shrews</td>
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<td>0.53</td>
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<td>Deer Mice</td>
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<td>Columbian Mice</td>
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<td>0.39</td>
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<tr>
<td>Red Squirrels</td>
<td>4.9</td>
<td>0.02</td>
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</table>
FIGURE 1. Relationship between abundances of individuals and patch sizes for small mammals living within old-growth forests on Vancouver Island. Forest types have been categorized based on the dominant tree species.
LITERATURE CITED


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