Relative Importance of Patch Size and Landscape Forest Cover on Forest Birds*

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Abstract

The management and protection of natural areas has primarily occurred in isolation from surrounding land management. The structure of surrounding land cover however, may be very important to the abundance and reproductive success of certain species within a forest patch. The purpose of this study was to investigate the relative importance of forest patch area, core area, and surrounding forest cover on Wood Thrush, Red-eyed Vireo and Ovenbird densities, and on Ovenbird pairing success. We selected 31 isolated forest patches and three 80-ha plots in continuous forest, centred within non-overlapping 2km² landscapes, such that patch area and landscape forest cover were uncorrelated among landscapes. Each study plot was surveyed comprehensively to determine density and pairing success of the target species. Ovenbird density was best predicted by the amount of surrounding forest cover ($p = 0.02$) but not by forest patch area or core area. Wood Thrush density was positively correlated with core area ($p = 0.04$) but not surrounding forest cover. Red-eyed Vireo density decreased with forest patch area ($p = 0.0005$). Ovenbird pairing success was significantly higher in extensive forests than in forest fragments ($p = 0.002$) but was not affected by surrounding forest cover. The conservation implications of these findings are two-fold: (1) bird species with similar habitat needs respond very differently to the structure and configuration of habitat within a landscape; and (2) for some bird species, the amount of forest cover in the landscape surrounding a forest patch is as or more important than the size of the forest patch itself.

Introduction

Although forest patch size has been pronounced the most important predictor of the decline in abundance of Neotropical migrant bird species, landscape structure may moderate patch size effects (Saunders et al., 1991; Roth and Johnson, 1993; Fahrig and Merriam, 1994; Freemark, 1995). Recent studies confound the effects of isolation and landscape forest cover with patch size because they are often correlated in real landscapes (Freemark and Collins, 1992). Other studies suffer from spatial autocorrelation caused by overlapping landscapes or clustered study forest patches. As a result, the relative importance of landscape and patch effects on avian populations is poorly understood.

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Purpose

The purpose of this study was to examine the independent effects on forest bird density and pairing success of:

1) within-patch characteristics (microhabitat attributes);
2) patch level characteristics (forest fragment size and core area); and,
3) landscape level characteristics (proportion of forest cover in the landscape).

Methods

Site selection

Thirty-four 2 km^2 (200 ha) landscapes were selected for study. Landscapes were initially selected and characterized using 1:50 000 aerial photographs taken in 1996 (National Air Photo Library of Canada).

A landscape size of 2km^2 was deemed sufficiently large for study because: (1) Ovenbirds and Wood Thrush interact with the surrounding landscape by foraging occasionally outside of their 2 ha territories (eg. Zach and Falls, 1979; Anders et al., 1998); and, (2) a summary of mark-recapture studies for European and North American long distance migrants indicated that most marked individuals were re-captured within 200m of their marked location, even after multiple breeding seasons (Villard, 1991).

Study landscapes were selected to represent a range in focal forest patch size and in percent forest cover surrounding the focal patch. Landscapes were selected to minimize the correlation across landscapes between focal patch size and amount of forest in the landscape, so that their relative importance could be estimated in the statistical analysis. A non-random selection of landscapes was necessary because patch size in random samples of real landscapes are correlated with the amount of surrounding forest cover. Because selection was subjective, landscapes do not necessarily reflect the true structure and configuration of the region. Others (e.g. McGarigal and McComb, 1995; Trzcinski et al., in press) have used this pseudo-experimental approach to site selection.

Each study landscape was centered around a focal forest patch in which bird and vegetation surveys were conducted. Focal forest patches were deciduous or mixed deciduous/coniferous forest types and set within a matrix of varying amounts of both agricultural land (primarily hay and untended pasture) and forest cover (deciduous or mixed deciduous/coniferous forests). Of the 34 landscapes, 31 contained isolated focal patches. A patch was defined as "isolated" if paved roads or clearings of greater than ten metres separated it from surrounding forest cover. Most focal patches, however, were significantly more isolated from surrounding forest cover than the minimum distance of ten metres.

Due to a shortage of naturally occurring landscapes characterized by both a large focal forest patch (>70 ha) and a large amount of surrounding forest cover (>33 percent) in the study region, three continuous forest landscapes were surveyed to simulate the effect of a large forest patch embedded in a high percent forest cover. A landscape was defined as continuous if the area of its focal forest patch exceeded 2km^2, and if most of the boundaries of the focal patch extended beyond those of the study landscape. Eighty hectares at the centre of each of the three continuous forests were surveyed.

Habitat (within-patch) surveys

Habitat characteristics including tree species, tree diameter at breast height (DBH), percent living ground cover, herb height, shrub height, point to tree distance, percent canopy cover, percent crown loss, tree damage, and course woody debris, were collected from each focal forest patch using a point-quarter method.

Male density and pairing success

Focal forest patches were surveyed three times each for Ovenbirds (*Seiurus aurocapillus*), Wood Thrush (*Hylocichla mustelina*) and Red-eyed Vireos (*Vireo olivaceus*) to determine male density. Paired status of male Ovenbirds was evaluated for 20 minutes at each singing perch based on singing rate and behavioural cues.

Data Analysis

A stepwise regression analysis was used to determine which landscape, patch and within-patch variables best predicted density of each target species and Ovenbird pairing success. Predictor variables included in the regression were:

1) focal forest patch area;
2) landscape forest cover surrounding the focal patch;
3) core area of the focal patch;
4) total forest cover(i.e.,1 and 2); and,
5) within-patch variables that were significantly correlated with the above variables.

A t-test was used to compare pairing success in extensive forests versus fragments.

Results

Within-patch (Habitat) Characteristics

- No within-patch (habitat) variables were significant predictors of male density or Ovenbird pairing success in the stepwise regression ($p > 0.05$).

Patch characteristics

- Red-eyed Vireo density was best predicted by patch area, although the relationship was negative (p 0.0005) (Figure 1).
- Wood Thrush density was correlated only with core area and patch area ($p = 0.04$) (Figure 2).
- Ovenbird Pairing success was significantly higher in the three extensive forests than in the forest fragments ($p = 0.002$) (Figure 3).

Landscape characteristics

- Ovenbird density was best predicted by surrounding forest cover ($p = 0.02$) (Figure 4).

Discussion

Different responses to scale between species

Differential responses between species may be due to differences in their life history traits. As ground nesters, Ovenbirds may be more susceptible to predation-related mortality and brood failure (Gibbs and Faaborg, 1990; Villard, 1993) which tend to be lower in highly forested landscapes (Donovan, 1997).

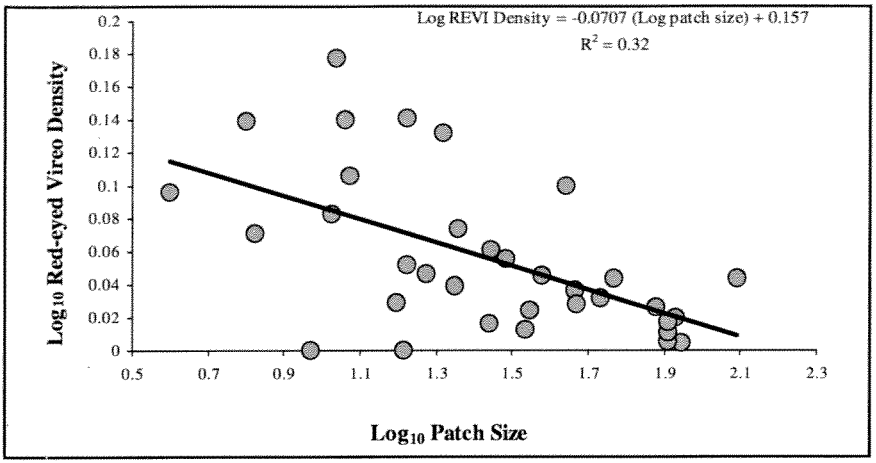

Figure 1. Relationship between male Red-eyed Vireo density and focal forest patch area (n = 34).

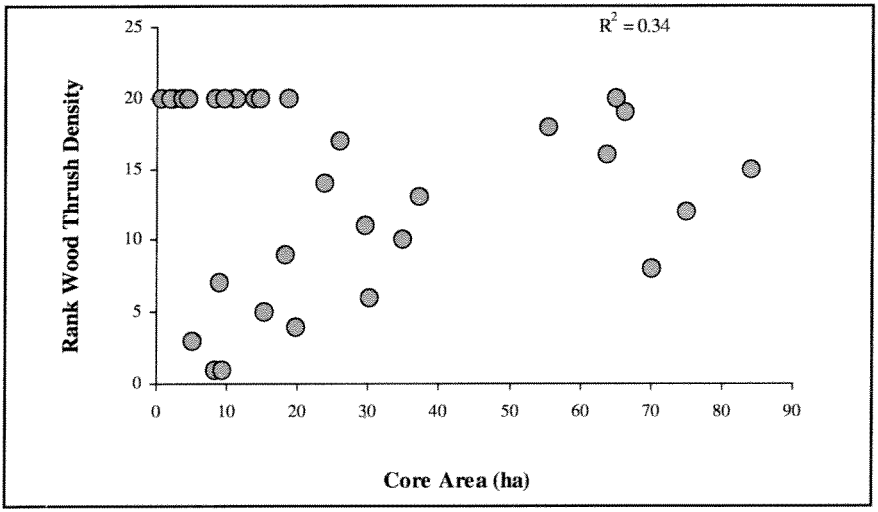

Figure 2. Relationship between Wood Thrush density and core area (n = 34).

Different responses to scale within the same species?

Landscape and Ovenbird density

Landscape forest cover may affect density by facilitating immigration of Ovenbirds to low density patches. Highly forested landscapes may also increase foraging opportunities for Ovenbirds, who have been shown to forage beyond their 1-2 ha territories (Zach and Falls, 1979). Also, Ovenbird density may be affected by predator related mortality which increases in landscapes with low forest cover (Donovan, 1997).

Patch size and Ovenbird pairing success

Since food availability increases with patch size (Burke and Nol, 1998), female Ovenbirds may choose mates with territories in larger patches (Villard, 1993). Fe-

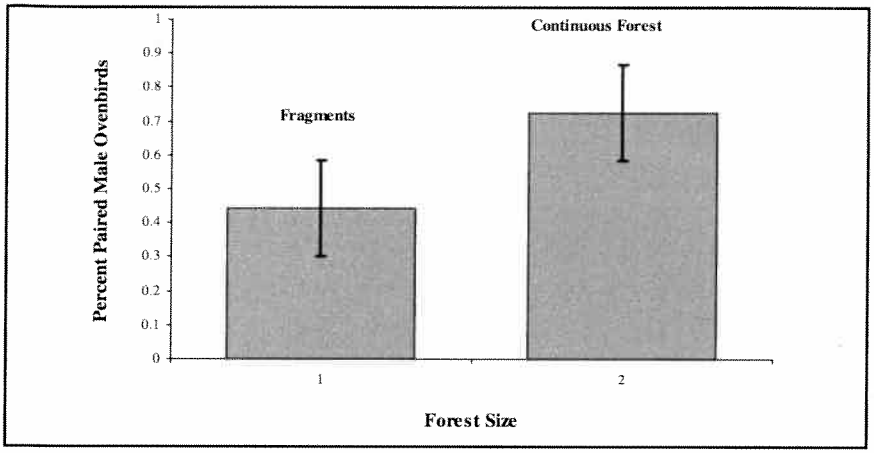

Figure 3. Difference in pairing success between 22 forest fragments and three continuous forests

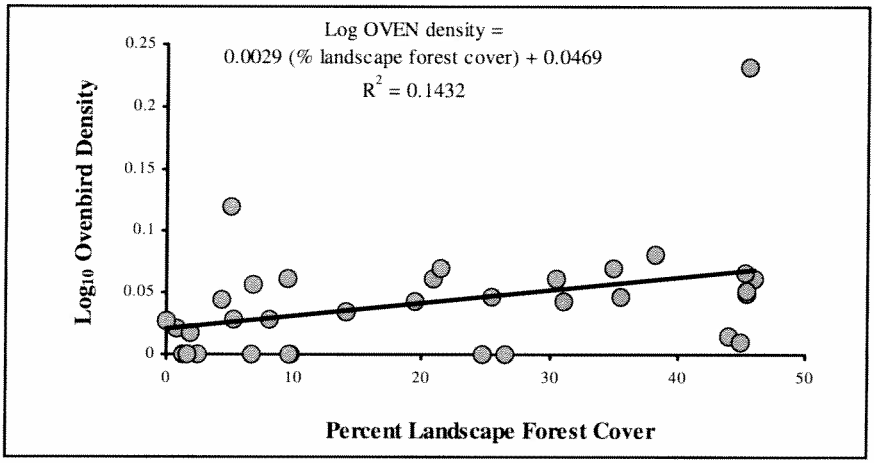

Figure 4. Relationship between logged Ovenbird density and proportion of forest cover in the surrounding 2km² landscape (n = 34).

males may also choose mates with territories that are further away from forest edges. Since the amount of available habitat that is distant from the forest edge increases with patch size, females may choose territories in large patches.

Conservation Implications

Growing empirical support for the importance of surrounding landscape on forest bird communities (e.g., Hinsley, 1995; Sisk, 1997; Saab 1999) suggests that forest reserves do not operate in isolation from the surrounding landscape; the structure and composition of the landscape surrounding a forest reserve affects the biological processes within. Thus, reserve design can not be conducted effectively without considering the surrounding landscape, and urban and landscape planning should not be conducted without due consideration of the integrity of proximal nature reserves.

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