Geometric constraints on bird community assembly

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Introduction

Specific groups of birds have experienced major population declines in the past 40 years, especially aerial insectivores (American Bird Conservation Initiative Canada, 2012).

Determinants of the composition and diversity of bird communities are relatively well understood, but relationships focusing on local resources have often failed to generalize at larger scales.

Objectives

Through the use of standard forest geometry measures (tree size, stem density and lateral cover), we aim to describe local bird community assembly rules that can be generalized at larger scales. To enable these rules to operate on bird communities assembled from different species pools, we studied how forest geometry filters the presence-absence of species with particular functional traits (spatial location of feeding substrate and body size).

Methods

57 sites were studied in La Mauricie National Park (Quebec, Canada), an even-aged mixed forest conservation area (536 km^2).

For each site, bird communities were studied for three consecutive years (2011-2013) through a five-minute point count per breeding season.

Vegetation at each site was characterized in summer 2013, using the point-quarter technique and a density board in four sub-plots.

Data analysis was completed in R using package MCMCglmm to fit logistic regressions with Bernoulli errors and random effects for sites and species. Model selection was based on the DIC (deviance information criteria) from a model that contained all interactions, down to the most parsimonious one.

Results

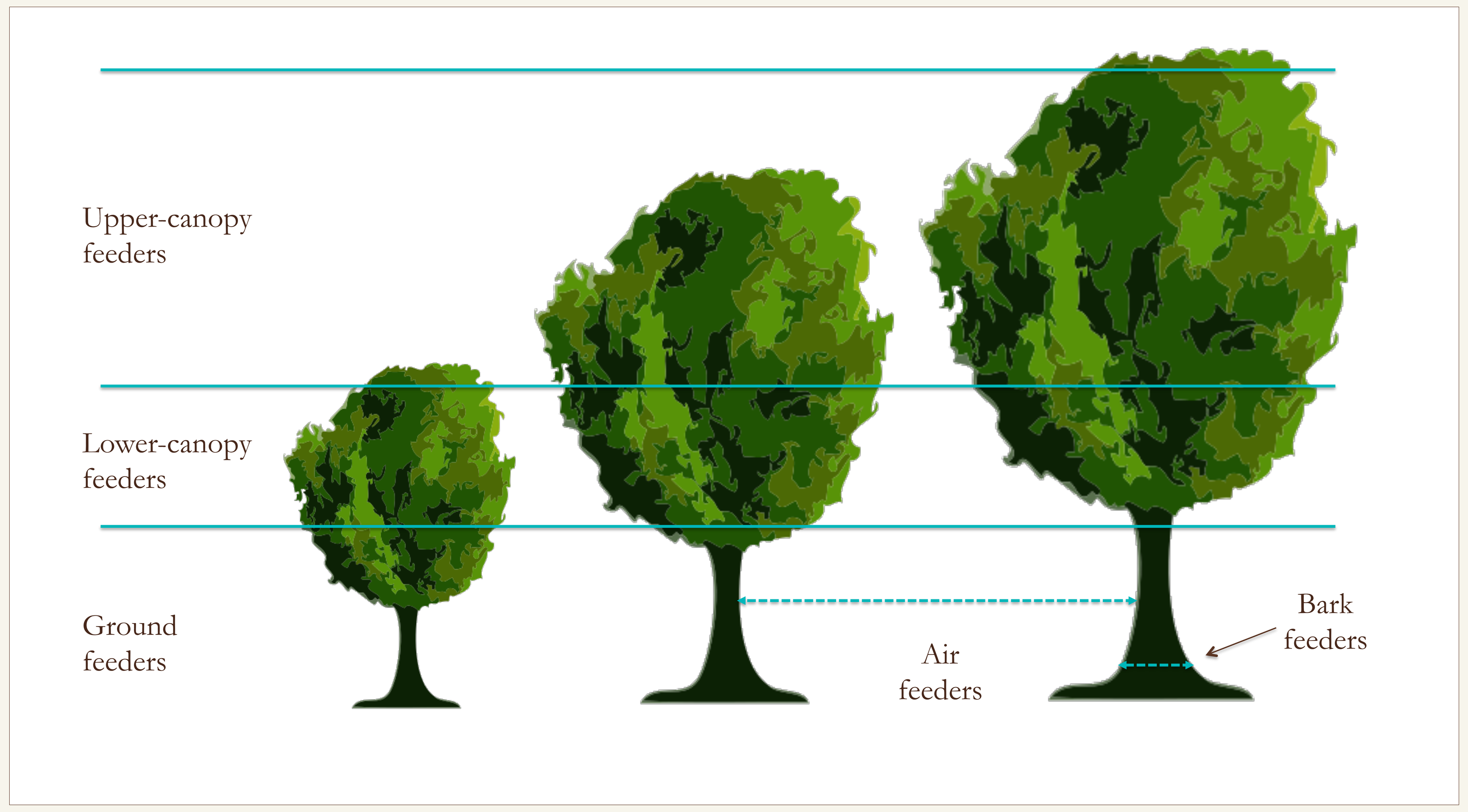

Figure 1. Schematic representation of how forest geometry might constrain the presence-absence of bird species feeding on different substrates.

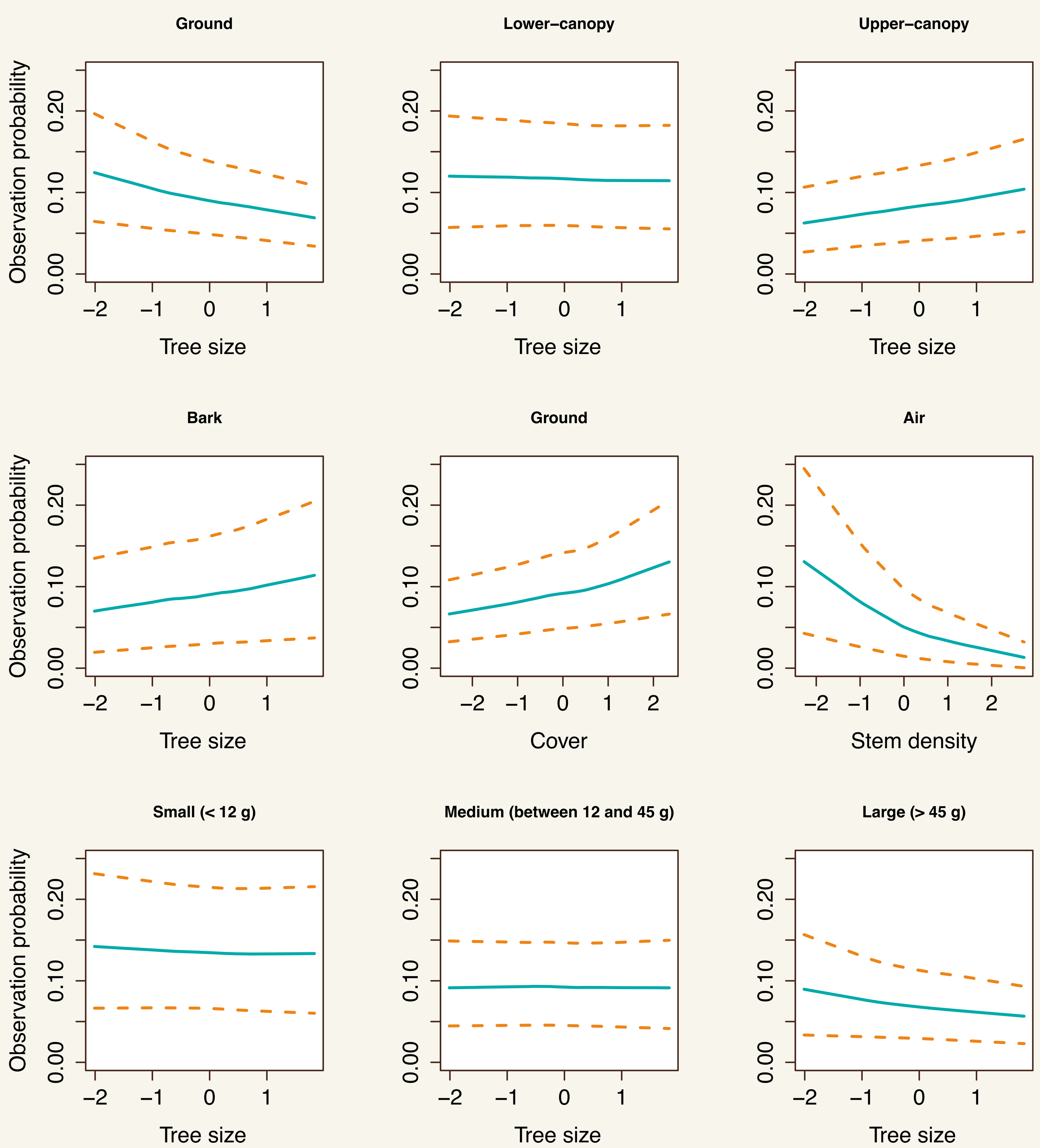

Figure 2. Predicted relationships between observation probability and forest geometry (average tree size, stem density and lateral cover) for different bird functional traits (spatial location of feeding substrate and body size). The model comprises 57 sites, 72 species and 3 years of presence/absence data in La Mauricie National Park. Forest measures are standardized. Mean with 95 % CI of predicted values are shown.

Table 1. Highlights of the MCMCglmm model selection process. Best model shown in bold.

Modeling step	DIC value
Empty model	6036.802
Model with all six interactions	5997.985
Model without stem density × body size interaction	5995.093
Model without stem density × body size and lateral cover × body size interactions	**5993.408**

Table 2. Evaluation of the classifying performance on the basis of observed presence-absence data after three years at each site for each species (n = 4104).

Prediction type	Precision	Sensitivity	Specificity
Marginalized over sites and species	0.65	0.23	0.80
Marginalized over sites only	0.75	0.39	0.85

Table 3. Simulated gain/loss in species richness across the studied environmental gradient.

Interaction	N. species	Expected richness gradient
Ground × tree size	24	-1.36
Upper-canopy × tree size	17	0.77
Bark × tree size	8	0.42
Ground × cover	24	1.46
Air × stem density	8	-0.94
Larger birds × tree size	18	-0.60

Conservation matters

Our results show that forest geometry affects the presence-absence of bird species exploiting different feeding substrates.

The relationship between stem density and the observation probability of air feeders suggests that older forests (with lower stem density) might promote aerial insectivore bird species.

Relationships for the remaining feeding groups show that forest aging might negatively affect diversity in groups favored in sites typical of younger forests (e.g. ground feeders in patches with smaller trees and high cover). Thus, bird species diversity in this conservation area is maintained by a natural mosaic of mature and successional forest stands.

Discussion

Considering the high stochasticity of community assembly rules at such small scales and the relatively narrow forest geometry gradient studied, we feel that our results are robust and generalisable at larger scales.

Forest geometry constraints on bird communities might be confounded with resource effects. Phylogenetic relatedness among bird species is another factor we did not explicitly consider. Further analyses will evaluate this effect and include other forest geometric measures derived from close-range digital photographs.

References

American Bird Conservation Initiative Canada. 2012. The State of Canada's Birds, 2012. Environment Canada, Ottawa, Canada. 36 pages.

Acknowledgments

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