




## Article

# Bird Occupancy of a Neotropical Forest Fragment Is Mostly Stable over 17 Years but Influenced by Forest Age

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**Abstract:** The effects of forest degradation, fragmentation, and climate change occur over long time periods, yet relatively few data are available to evaluate the long-term effects of these disturbances on tropical species occurrence. Here, we quantified changes in occupancy of 50 bird species over 17 years on Barro Colorado Island (BCI), Panama, a model system for the long-term effects of habitat fragmentation. The historical data set (2002–2005) was based on point counts, whereas the contemporary data set (2018) was based on acoustic monitoring. For most species, there was no significant change in occupancy; however, the occupancy of four species (*Tinamus major*, *Poliophtila plumbea*, *Myiarchus tuberculifer*, and *Certhopipra mentalis*) increased significantly, and the occupancy of three species (*Saltator grossus*, *Melanerpes pucherani*, and *Cyanoloxia cyanoides*) decreased significantly. Forest age explained the majority of occupancy variation and affected the occupancy of more bird species than survey period or elevation. Approximately 50% of the species seem to favor old-growth forest, and 15 species (30%) had a significantly higher occupancy in old-growth forest sites. Elevation had no significant impact on the occupancy of the majority of bird species. Although BCI has been a protected reserve for approximately 100 years, land-use legacies (i.e., forest age) continue to influence bird distribution.

**Keywords:** passive acoustic monitoring; occupancy; detectability; Barro Colorado Island; Panama; Arimon neotropical birds



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## 1. Introduction

Changes in community composition continue long after initial isolation of habitat remnants [1]. Evidence and theoretical predictions indicate species losses occur for decades, even centuries, depending on the size of the remnant, characteristics of the surrounding habitat matrix, and species traits [2–5]. Predictors of which species are most at risk of decline and disappearance in fragmented landscapes are many, including initial local abundance at the time of habitat isolation, degree to which movements affect colonization dynamics, diet, and preferences for particular habitat characteristics [6,7]. Land-use change surrounding habitat remnants and successional dynamics within remnants (forest age) affect population dynamics and community structure as well. A naïve expectation is that remnants with mature forest surrounded by stable habitat matrix characteristics may be less likely to show evidence of community change or species' abundances through time. However, long-term studies have recently documented avian population declines and community shifts even in large tracts of undisturbed forests in Ecuador [8] and the Amazon [9]. Some bird species groups, such as terrestrial insectivores, appear to be more sensitive to habitat isolation and reduction in habitat area [10]. In undisturbed forests in the central Amazon, terrestrial and near-ground insectivorous bird species appear to be the most vulnerable, whereas some frugivorous species may increase in abundance [9]. Relatively few long-term studies of