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Bird community responses to reduced-impact logging in a certified forestry concession in lowland Bolivia

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ABSTRACT

We studied bird community composition and abundance within the logged and unlogged forest areas of a certified forestry concession in lowland Bolivia. The logged forest was harvested using reduced-impact logging techniques between one and four years previously. We used canonical correspondence analysis to describe the relationship between selected environmental variables and bird species abundance data, and the Indicator Value procedure to test for associations between bird species and the logged and unlogged habitats. Approximately one-third of birds were restricted to either the logged or unlogged areas, with 20% of all species only encountered in, or significantly more abundant in, the unlogged areas of the concession. The majority of birds found in significantly higher abundance in the unlogged areas of the concession were associated with forest habitats dominated by large trees, or a high diversity of trees, providing dense canopy cover and deep leaf litter, with an understorey dominated by ferns. Over 40% of bird species that were significantly associated with the unlogged areas of the concession are of conservation concern. In contrast, the majority of birds associated with the logged areas of the concession are known to be relatively resilient to human disturbance. The majority of species which exhibited significant lower abundances in the logged areas of the concession belonged to insectivorous or frugivorous feeding guilds. We discuss whether current management practices within this certified concession are sustainable and how our results can be used to guide future research and inform better practice.

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1. Introduction

Reduced-impact logging (RIL) is a modified form of selective logging that is increasingly employed in tropical forests. It

incorporates a variety of techniques aimed at lowering levels of damage to the residual stand (Putz et al., 2001). These include directional felling, pre-harvest vine cutting, and preliminary inventories to reduce the number and density of

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logging roads (Heinrich, 1995). Recent studies suggest that reduced-impact logging of tropical forests causes less damage to forest structure than conventional selective logging techniques (Asner et al., 2004a; Huth et al., 2004). However, reduced-impact logging is still a form of commercial forestry that increases the frequency and extent of canopy discontinuities (Jackson et al., 2002). These changes to vegetation structure can alter microclimatic conditions, including temperature, wind and humidity levels (Pinard and Cropper, 2000; Asner et al., 2004b). The capacity of these forests to retain their original complement of biodiversity is not well known (Bojanic and Bulte, 2002; Dauber et al., 2005).

Birds are an ideal taxon for assessing the impacts of logging on biodiversity in tropical forests, as bird community composition can be strongly influenced by disturbance to forest vegetation structure (Wiens, 1992; Mason and Thiollay, 2001; Barlow and Peres, 2004). Birds also perform vital ecological functions in tropical forests and have roles as pollinators, seed dispersers, and predators (Stiles, 1983). Furthermore, quantitative assessment of the IUCN red list shows that the threat status of the world's birds has steadily worsened since 1988 (Butchart et al., 2004), with 93% of threatened forest avifauna found in tropical forests (Birdlife-International, 2004).

Studies of conventional selective logging suggest that disturbance to vegetation structure and microclimate affects bird species in a variety of ways, and is highly dependent on the guild being considered (Mason, 1996; Woltmann, 2003; Wunderle et al., 2006). For instance, because reproductive activity in understory plants is positively correlated with increased irradiance (Costa and Magnusson, 2003), members of some avian guilds (e.g. frugivores, nectarivores) can increase in abundance following selective logging due to the increased availability of nectar and fruit in areas of canopy discontinuity (Mason, 1996; Wunderle et al., 2006). In contrast, understory insectivores are particularly susceptible to disturbance associated with selective logging (Mason and Thiollay, 2001; Sekercioglu et al., 2002; Sodhi et al., 2004; Barlow et al., 2006; Barlow et al., 2007; Gray et al., 2007). Members of this guild may be physiologically intolerant to increased variation in temperature and humidity levels associated with decreased canopy continuity (Karr and Brawn, 1990; Mason, 1996; Sekercioglu et al., 2002; Barlow and Peres, 2004). Each species may react differently to a given forest disturbance depending (in part) on its foraging behavior, habitat specialization, and physiological sensitivity to microclimatic changes (Thiollay, 1992; Sekercioglu et al., 2002). For these reasons, studies of bird species' responses to tropical forest disturbance have reported negative or positive impacts depending on the extent of disturbance, and the species pool being considered (Hill and Hamer, 2004).

There are over 1400 species of bird known from Bolivia, with the majority of species found in the sub-tropical and tropical forests of the lowlands (Pacheco, 1998). Almost half of these areas are now granted to forestry concessions (Mostacedo and Fredericksen, 1999). In 1996, a new forestry law was enacted to promote the sustainable harvesting of timber (Mostacedo and Fredericksen, 1999). To achieve best-

management practices, reduced-impact logging techniques have gained widespread application in Bolivia and, as of 2005, concessions covering over 2.2 million hectares had obtained certification by the Forest Stewardship Council (FSC, 2005).

We suggest that there is a need to evaluate the compatibility of reduced-impact logging with biodiversity maintenance. In this paper, we use a reduced-impact logged sub-tropical forest in Santa Cruz province, lowland Bolivia, as a case study to examine: (i) differences in avian diversity and community composition in logged and unlogged forests; and (ii) the potential conservation related repercussions of any observed differences.

2. Methods

2.1. Site description

Our study area was located in the subtropical humid forest of the Guarayos Forest Reserve, Departamento Santa Cruz, Bolivia. Research was conducted in the 100,000 ha forestry concession "La Chonta". This is owned and managed by Agroindustria Forestal La Chonta (509,000–545,000 easting, 8,275,500–824,900 northing; Fig. 1). The forest has an average elevation of 320 m (range 230–390 m). The soils consist of oxisols, ultisols, and inceptisols (Park et al., 2005). The mean annual temperature is 25 °C with a mean annual precipitation of approximately 1560 mm. The region experiences a distinct dry season from May to October. The entire concession was subjected to legal and illegal selective logging of mahogany (*Swietenia macrophylla*), and spanish cedar (*Cedrela odorata*) 10–25 years prior to this study. The concession was certified by SmartWood in 1998.



Fig. 1 – Map of Bolivia with approximate location of the La Chonta forestry concession indicated within the department of Santa Cruz.

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