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Original research article

Oil palm expansion drives avifaunal decline in the Pucallpa region of Peruvian Amazonia

Alicia Srinivas [a,*], Lian Pin Koh [b]

[a] Columbia University, Department of Ecology, Evolution, and Environmental Biology, 1200 Amsterdam Avenue, New York, NY 10027, USA

[b] Environment Institute, and School of Biological Sciences, University of Adelaide, Adelaide, South Australia 5005, Australia

HIGHLIGHTS

- First study examining effect of oil palm on avian diversity in Western Amazonia.
- Less than 5% of captured species were common to forest and oil palm habitats.
- Bird species richness, evenness and abundance higher in forest than in oil palm.
- Insectivorous and frugivorous birds most affected by oil palm conversion.
- Oil palm plantations represent particularly poor habitat for Amazonian birds.

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ABSTRACT

Oil palm is one of the world's most rapidly expanding crops, replacing humid forests across tropical regions. Studies examining the effect of this land conversion on biodiversity have tended to focus predominantly on Southeast Asia, where the majority of the world's oil palm is produced. Because the Amazon possesses the greatest area of suitable land for oil palm expansion, oil palm is considered an emerging threat to Amazonian biodiversity. This is the first study to examine how oil palm agriculture affects avian diversity within the context of Western Amazonia. We used mist nets to conduct avifaunal surveys of forest and oil palm habitat in the Pucallpa region of Peruvian Amazonia. Bird species richness, species evenness, and overall abundance were all significantly higher in the forest than in oil palm habitat. Strikingly, less than 5% of all captured species were common to both forest and oil palm habitat. The species absent from the oil palm plantations were disproportionately habitat specialists, forest interior birds, birds with high sensitivity to disturbance, and insectivores and frugivores. The results suggest that oil palm is particularly poor habitat for Amazonian birds, and that the species that are persist on them are of lower conservation value. Given the apparent lack of diversity on oil palm plantations, preventing further conversion of forests to oil palm should be prioritized.

1. Introduction

Despite covering only a small fraction of the Earth's surface, tropical humid forests are thought to be home to over 50% of the world's species (Myers, 1988). Agricultural expansion is the primary driver of deforestation in tropical regions, and one

* Correspondence to: 1839 15th St. Apt. 258, San Francisco, CA 94103, USA.
E-mail addresses: alicia.srinivas@gmail.com (A. Srinivas), lianpin.koh@adelaide.edu.au (L.P. Koh).

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of the greatest threats to global biodiversity (Geist and Lambin, 2002). Each year, millions of hectares of primary forest are destroyed to meet rising demands for food, timber, and other natural resources (Donald, 2004; DeFries et al., 2010; Gibbs et al., 2010; Foley et al., 2011; Wilcove et al., 2013). African oil palm *(Elaeis guineensis)*, a palm native to West and Central Africa, is one of the most rapidly expanding crops, and a leading cause of deforestation in tropical lowland areas around the world (Koh and Wilcove, 2008; Turner et al., 2008; Miettinen et al., 2012; Carlson et al., 2013). Over the past 40 years, global production of oil palm has increased exponentially and continues to expand by 250,000 hectares each year (Danielsen et al., 2009; Koh and Wilcove, 2008). Worldwide, oil palm accounts for one tenth of permanent cropland (Koh and Wilcove, 2008).

In tropical countries with weak environmental regulations, large areas of primary and secondary forests have been cleared to make way for oil palm plantations (Danielsen et al., 2009; Fitzherbert et al., 2008; Turner et al., 2008; Wilcove and Koh, 2010). Koh and Wilcove (2008) found that from 1990 to 2005 more than 50% of oil palm expansion in both Malaysia and Indonesia came at the expense of old growth and secondary forests. Gutiérrez-Vélez et al. (2011) found that high-yield oil palm expansion in the Ucayali region of Peru involved forest conversion 75% of the time.

Much of agricultural expansion in the next 40 years is expected to occur primarily in Latin America and Sub-Saharan Africa where land is readily available (Tilman et al., 2001). Yet the vast majority of published studies that have looked at the impacts of oil palm on biodiversity have focused on Southeast Asia (Fitzherbert et al., 2008; Danielsen et al., 2009; Wilcove et al., 2013; Abram et al., 2014). The recent increase in plans for oil palm expansion by domestic and foreign corporations in the Brazilian Amazon has caused concern among conservationists that oil palm may soon emerge as a serious threat to Amazonian forests and its biodiversity (Butler and Laurance, 2009; Lees et al., 2015).

As the country with the fourth largest area (45.8 million hectares) of forested land suitable for oil palm agriculture, Peru may be particularly under threat (Stickler et al., 2007). The Amazon Basin contains the second-highest avian species richness in the world (Orme et al., 2005), and Peru has one of the highest avian diversities of any country, with 1822 species, 173 of which are threatened (INEI, 2005). Rainforests in Peru are thought to contain 44% of all known tropical bird species, and one study recorded over 300 different bird species in just one 100-hectare area of Peruvian Amazonia (White et al., 2005; Terborgh et al., 1990).

Existing studies that have compared bird communities in forest and oil palm plantations have found significant reductions in species richness and dramatic changes in bird assemblages. A meta-analysis of existing studies that compare diversity between forest and oil palm found that vertebrate species richness in oil palm plantations is only 38% of what it is in forests (Danielsen et al., 2009). In Thailand, at least 60% of forest birds disappeared following conversion of forest to oil palm, including virtually all of the threatened species (Aratrakorn et al., 2006). In Malaysia, forest birds declined by 77% when oil palm plantations replaced primary forests, and 73% when oil palm replaced logged forests (Koh and Wilcove, 2008). In Sumatra, ten years after conversion of a primary forest to an oil palm plantation, only 5%–10% of birds previously recorded in forest were still present (Danielsen and Heegaard, 1995). Senior et al. (2013) re-analyzed data of several published studies on oil palm and biodiversity and found that overall avian species richness was reduced by 43% following conversion of forest to oil palm. A recent study that examined the potential effects of oil palm on avian diversity in the Brazilian Amazon found that oil palm plantations hosted impoverished avian communities with similar species composition to that of cattle pastures (Lees et al., 2015).

The objective of the present study is to investigate how conversion of forests to oil palm agriculture affects bird species richness, abundance, and composition in the Pucallpa region of Peruvian Amazonia. We asked four questions: (1) Does bird species richness differ in forest and oil palm habitat? (2) Does overall abundance and relative (i.e. species-specific) abundance of birds differ in forest habitat and oil palm habitat? (3) How does the functional diversity of bird assemblages (i.e. feeding guilds) in the forest differ from that in oil palm? and (4) How are "vulnerable" bird species affected by conversion to oil palm? We used sensitivity to disturbance, habitat specialization, adaptation to forest interior, and endemism as proxies for "vulnerability" because they are factors correlated with increased extinction risk (Sekercioglu et al., 2004). This is the first study to investigate the effects of oil palm agriculture on avian diversity in Western Amazonia.

2. Material and methods

2.1. Study area

This study was conducted under Permit No. 33089 from the Dirección de Gestión Forestal *y* de Fauna Silvestre (DGFFS) of Peru's Ministry of Agriculture (MINAG). The study took place in the department of Ucayali within the province of Coronel Portillo. The study area was located west of Pucallpa at 74° West and 8° South (Fig. 1), within the watershed of the Rio Aguaytía. Pucallpa is the largest city in the department of Ucayali and the second most populous Amazonian city in Peru, with an estimated 350,000 residents. It is located within the Amazon Basin on the Ucayali River, the main transportation thoroughfare in Peruvian Amazonia, and its natural vegetation cover is humid tropical evergreen forest (White et al., 2005; Uriarte et al., 2012; Porro et al., 2015). Pucallpa has an average elevation of 150 m above sea level, an average annual temperature of 25.7 °C, and an average humidity of 80% (White et al., 2005; Lojka et al., 2008). It receives between 1800 and 3000 mm of rainfall per year, occurring bimodally from February to May and September to November. Dry months are June–August and December–January (Fujisaka and White, 1998).

Logging and small-scale shifting cultivation that relies on slash-and-burn practices are the primary causes of deforestation in Peruvian Amazonia (Labarta et al., 2008; Lojka et al., 2008). In contrast with Brazilian Amazonia,