Appendix 1: Study sites, bird assemblages, and trait selections

Complementary information about study areas

For the placement of the 23 focal landscapes with different forest covers, we also evaluated if forest cover varied within radii of 1, 2, or 3 km based on each landscape centroid. Landscape-level forest cover did not vary more than 5% within those radii. It shows that we are avoiding the influence of any outside larger patch on colonization processes (Pasher et al. 2013).

Sampling sites inside forest patches were spaced a minimum of 800 m apart (1591 ± 621 m) and they were placed within the forest patch at the end of a 100 m transect, always oriented to the center of the forest patch.

Bird assemblages

We restricted our analysis to forest specialist and forest generalist species, excluding open area species eventually detected inside smaller forest patches. We recorded 180 bird species in both regions: 93 specialists and 87 generalists. **Specialist species richness** was higher in the low-quality than in the high-quality matrix region (82 and 68 species respectively), with 57 species common to both regions. However, the median of specialist species richness per landscape and site in the high-quality matrix was higher than in the low-quality matrix (Table S1.1). There were 11 specialist species (16% of total richness) in the high-quality matrix detected only once (singletons), and 15 singletons (18% of total richness) in the low-quality matrix.

Generalist species richness was quite similar between regions, with 77 and 74 species in the high and low-quality matrix, respectively (64 common species). Accordingly, generalist species richness per landscape and site did not vary much between high-quality and low-quality matrices (Table S1,1). There were 9 singleton generalist species in the high-quality matrix (12% of total richness) and 12 in the low-quality matrix (16% of total richness). For more details in biodiversity metrics of both regions see Boesing et al. (2018).

Table S1.1: Species richness for the assemblages in the high and low-quality matrix landscapes for landscape and local spatial scales.

Assemblage	Total richness	Landscape Median (min – max)	Local Median (min – max)
Specialists	93		
Low-quality matrix	82	32 (17 – 61)	16 (4 – 42)
High-quality matrix	68	40 (29 – 48)	24 (12 – 40)
Generalists	87		
Low-quality matrix	74	38 (34 – 44)	19 (10 – 31)
High-quality matrix	77	44.5 (38 – 49)	22.5 (15 – 31)
Total	180		

Species traits selection

Bird traits selection and the associated hypothesis of how species may respond to habitat loss according to its traits are summarized in Table S1.2 and described in detail in the following paragraphs.

Table S1.2: Bird traits with the information of the operational variables, the hypothesis of species habitat loss filtering according to trait values, and the sources of data acquisition.

Trait	Operational variable	Hypothesis	Data source
Body size	Continuous. Log of mean body mass in grams.	Abundance decreases more intensely with habitat loss for larger species.	Ramirez et al. 2008; Rodrigues et al. 2019
Nest type	Categorical. Nest in cavities; open or semi-open nest; closed nest.	The abundance of species with open/semi-open nests decreases more intensely with habitat loss than for species with other nest types.	Del Hoyo et al. 2014
Diet	Categorical main diet: omnivorous, frugivorous, nectarivorous, insectivorous, granivorous. Continuous. Percentage of fruits in the diet. Continuous. Percentage of invertebrates in the diet.	The abundance of frugivorous and insectivorous species decreases more intensely with habitat loss than for species with other diets.	Sick 1997, Del Hoyo et al. 2014; Willman et al. 2014

Foraging stratum	Categorical. Main foraging stratum: ground and/or understory, midstory and/or canopy, and all strata. Continuous. Percentage of lower strata (ground and understory) use.	The abundance of species in the ground and understory strata decreases more intensely than species using midstory, canopy, or all strata.	Sick 1997, Del Hoyo et al. 2014; Willman et al. 2014

Body size is one of the key attributes of vertebrates in respect of extinction risk, reproduction, and dispersal (Owens and Bennett 2000, Ripple et al. 2017). In birds, species with large mean body sizes are often considered more vulnerable to extinction given their low population densities, large home ranges, slow growth rates, high energetic requirements, and high sensitivity to anthropogenic overexploitation (Cardillo et al. 2005). The risk of local extinction in altered and smaller habitats correlates with mean body size (e.g. Barbaro and Halder 2009, Flynn et al. 2009, Newbold et al. 2013, Bregman et al. 2016, Bovo et al. 2018). However, sometimes this trait is not a good predictor of community changes (e.g. Tscharntke et al. 2008, Angert et al. 2011), probably because large species may also benefit from having higher mobility (Tscharntke et al. 2012). We compiled information on avian body mass in Boesing et al. (2018a), which followed Ramirez et al. (2008) and Rodrigues et al. (2019). Body mass was log-transformed before modeling.

Nest type is often associated with reproduction effort and is most likely to affect recruitment (Bennett and Owens 2002). For example, species that make nests in cavities have higher growth rates (Bellier et al. 2018) probably because it is a safer nest against parasitism and predation (Sibly et al. 2012). Nest predation and parasitism are among the most impacting factors of bird populations' decline in fragmented landscapes (Cavitt and Martin 2002). In addition, the lack of suitable nesting habitats in disturbed environments can have a strong effect on the reproductive success of certain bird species, such as those from Picidae and Psittacidae families, which require old or dead trees to build their nests (Sick 1997). We assigned the species to 3 nesting categories: closed, cavity, and open/semi-open. We collapsed open and semi-open nest types due to the low proportion of specialist species with open nests in our data. Nest type information was collected in Del Hoyo et al. (2014).

Habitat loss, fragmentation, and land-use change affect the structure of the habitat by altering differently the provision of food for birds. For example, nectarivorous, frugivorous, and insectivorous species seem to be more sensitive to habitat loss and fragmentation than omnivorous and granivorous (Şekercioğlu et al. 2004, Newbold et al. 2013, Bovo et al. 2018, Chatterjee and Basu 2018). We assigned species to five **main diet** categories according to information available in the literature (Sick 1997, Del Hoyo 2014): omnivorous, insectivorous, frugivorous, nectarivorous, granivorous. Because of the special relationship found for frugivorous and insectivorous species in land-use change (Newbold et al. 2014), we also assigned the percentage of each of these components in species' diet as trait variables. The percentages of fruits and insects in the species' diet were extracted from the EltonTrait database (Wilman et al. 2014). For the analysis, we excluded the single granivorous forest specialist species in the high-quality matrix region and two omnivorous forest specialist species in the low-quality matrix region because of issues during model fit.

Foraging stratum is of most importance for birds in fragmented landscapes. Ground and understory species are more prone to extinction (Laurance and Gomez 2005), mostly because of higher dispersal limitation and avoidance of open areas (gaps, matrix, and forest edges). We assigned each species to 3 foraging strata categories: ground-understory, midstory-canopy, and all strata. We also used the percentage of use of lower foraging strata (ground and understory) as an alternative operational variable extracted from EltonTrait database (Wilman et al. 2014).

Comparing traits between forest specialists and generalists

All traits were compared between forest specialists and forest generalists using graphical and multivariate analysis to ensure that the selected traits are comparable between groups, i.e., there was not a single trait that could separate specialist from generalist species. The only noticeable difference between generalists and specialists was in the main diet variable, where there were nectarivorous birds only for generalists and insectivorous were more common among specialists.

Below, we present the comparisons of trait values between specialists and generalists. Continuous variables were Z-score scaled and are presented in Figure S1.1, Categorical variables are summarized in Table S1.3.

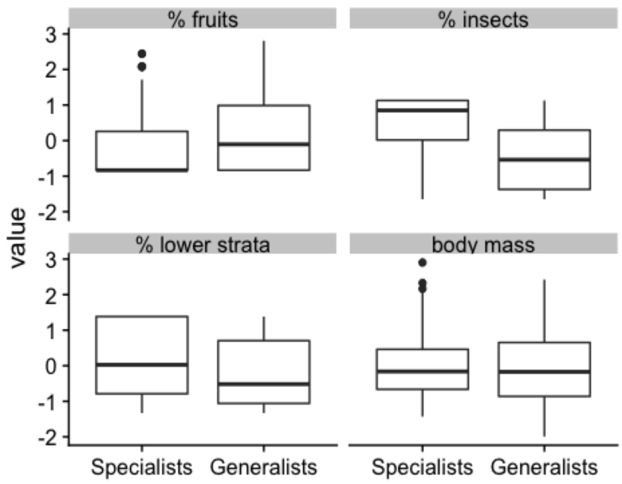

Figure S1.1: Boxplots of values for the traits measured as continuous variables for the specialists and generalists.

Table S1.3: Percentage of the species in each trait category for specialists and generalists. Numbers inside brackets are the number of species.

Traits	Specialists	Generalists
Nest type		
Cavities	25% (23)	22% (19)
Closed	27% (25)	21% (18)
Open/semi-open	48% (45)	57% (50)
Main diet		
Frugivorous	17% (16)	23% (20)
Granivorous	2% (2)	6% (5)
Insectivorous	77% (72)	40% (35)
Nectarivorous	0% (0)	15% (13)
Onivorous	3% (3)	16% (14)
Foraging stratum		
All	5% (5)	20% (17)
Ground/Understory	58% (54)	32% (28)
Midstory/Canopy	37% (34)	48% (42)

References on bird traits and environmental change

Below, we list the consulted references of bird traits.

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