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

Complementary information about study areas and bird sampling

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).

Bird assemblages

We restricted our analysis to forest specialist and habitat 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.

		Landscape	Local
Assemblage	Total richness	Median (min – max)	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		

Beta diversity (*sensu* Baselga et al. 2010) between assemblages in high- and low-quality matrix regions was very small (Fig S1.1).
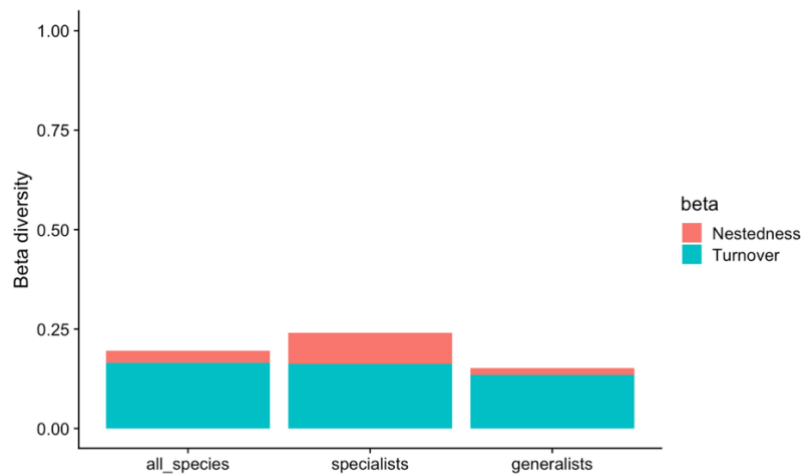

Figure S1.1 Beta diversity between high- and low-quality matrix regions partitioned in Nestedness and Turnover (*sensu* Baselga 2010), calculated with all species and separately for forest specialists and generalists. Analysis done using bepart R package (Baselga et al. 2022).

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 for both sexes in grams.	Abundance of large species decreases more intensely with habitat loss.	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; Wilman 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; Wilman et al. 2014
Hand-wing index	Continuous. Index for wing shape. Mean of Hand-wing index for both sexes.	Abundance of species with larger hand-wing index (larger dispersal ability) decreases less intensely with habitat loss.	Sheard et al. 2020

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 (mean values from males and females) in Boesing et al. (2018), 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 (Sekercioglu 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).

Hand-wing index is an estimate of wing shape widely adopted as a proxy for dispersal ability in birds (Sheard et al. 2020). Species with larger dispersal abilities are expected to suffer less

with habitat loss and fragmentation because of higher connectivity among habitat patches. We compiled hand-wing index values from (Sheard et al. 2020).

Comparing traits between forest specialists and habitat generalists

All traits were compared between forest specialists and habitat generalists using graphical and multivariate analysis to ensure that the selected traits are comparable between groups, i.e., the range of numeric trait values between generalist and specialist species are around the same range (minimum and maximum) and that there was not a single trait that could completely separate them. We found that hand-wing index presented larger maximum values and that nectarivorous birds were only 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.
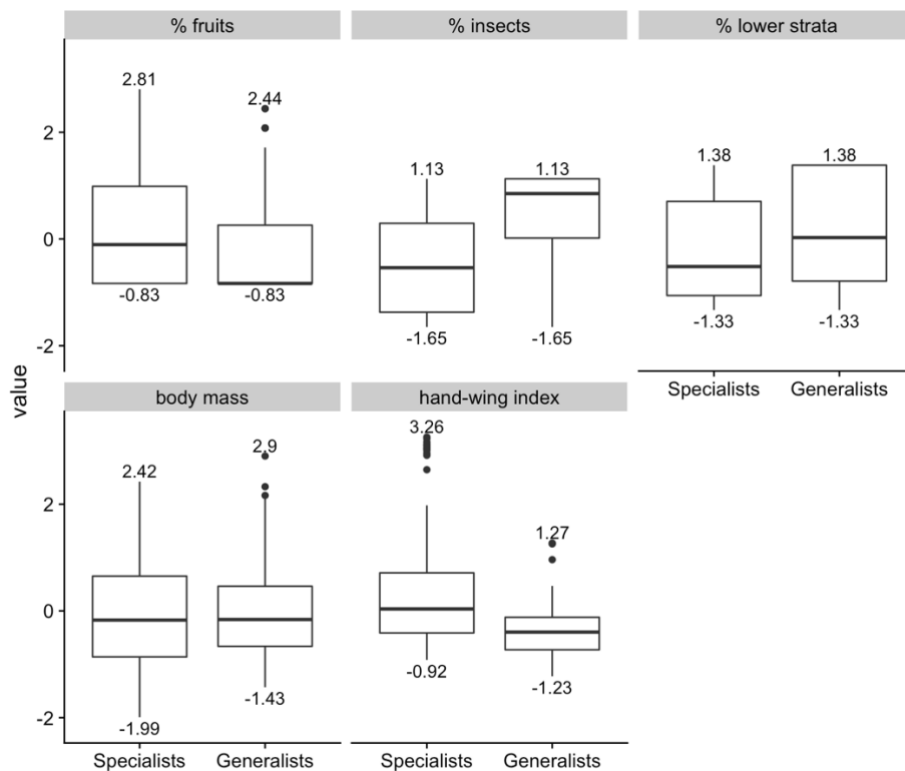

Figure S1.1: Boxplots of values for the traits measured as continuous variables for specialist and generalist birds. Values presented are maximum and minimum values in each group.

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)

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Appendix 2: Landscapes land use and forest cover at different scales

Melina Leite

2022-05-02

This appendix is a description of land uses in the focal landscapes together with the description of forest cover at both the local and the focal landscape scales. We present the baseline models for the selection of the best scale for the local forest cover variable for each dataset. For the local scale, we measured the percentage of forest cover within buffers of 400, 600 and 800 m around each sampling site. For the focaal landscape forest cover, we used the 2 km buffer around the landscape centroid.

1. Land use composition in landscapes

To clarify the differences in landscapes between regions and to show that these differences are in accordance with our categorical classification of high- and low-quality matrices for birds, we show in Figure S2.1 the composition of the main land use types per landscapes, and in Figure S2.2 and Table S2.1 the comparisons of land use types among the high- and low-quality regions.

We tested for differences in Shannon and Simpson diversity indexes using the percentage of land use types of the landscapes (Figure S2.3). We found larger diversity of land use types in high-quality matrix landscapes for both diversity indices, that is, more matrix heterogeneity in high-quality matrix landscapes.

We used Principal Coordinate Analysis (PCoA) to show the clear separation in land uses of landscapes from both regions (Figure S2.4). PCoA is more adequate than PCA given the nature of the data (sum up 100%, compositional data). We used gower distance tranformation to create a distance matrix among landscapes. Among the main land uses, landscapes in the low-quality region are more associated with larger proportions of pasture, eucalyptus plantations and urban areas to a lower extent, while landscapes in the high-quality region are more associated with larger proportions of coffee, sugar cane and lower proportions of pasture to a lower extend. The PCoA analysis also shows that forest cover variation is similar between regions and are not relevant in separating landscapes from both regions,i.e., the amount of forest cover among landscapes follows a similar gradient in both regions.

Although landscapes in the high-quality matrix region do have some proportion of pasture (mean 35.5% ± 10.2), this remains lower than the proportion of pasture in the low-quality matrix region (mean 46.9% ± 11.1). Moreover, as it can be seen in PCoA results (Figure S2.4), high-quality matrix landscapes are more negatively related to proportion of pasture when compared together with

low-quality matrix landscapes.

Eucalyptus tree plantations represent the only arboreal matrix element in all 13 low-quality matrix landscapes and compose an average of 18% ± 8.7 of matrix cover, while high-quality landscapes have on average 2% ± 3.2 of eucalyptus in matrix cover but it is still present in 7 of the 10 landscapes. Although eucalyptus trees may, in principle, provide less edge effects as pastures and coffee plantations, it doesn't necessarily mean it is a high-quality matrix for birds. (Barros *et al.* (2019)) concluded that eucalyptus plantations at the same region of our low-quality matrix landscapes were matrices of lower quality because of intensive management including biocidal suppression of native understory vegetation. Such understory vegetation suppression results not only in resource poor environments, but in very simplified stratification with a limited amount of microhabitats required specially for understory and terrestrial species, allowing only a subset of more generalist species capable of using such areas (Jacoboski, Mendonça-Lima & Hartz (2016)). Moreover, eucalyptus plantations are also less perennial elements in the landscape with cycles of clearcut around 6-8 years (Rodrigues *et al.* (2019)). It means that eucalyptus plantations may not be necessarily equally high-quality matrices as initially supposed (Barros *et al.* (2019)), especially when compared with coffee plantations, which not only present a low-contrast physical structure, but also provide a variety of resources for different species yearlong, evidenced by high-rates of spillover movements from forest to them (Boesing, Nichols & Metzger (2018)).

Also note the high negative correlation among percentage of pasture and forest cover in Figure S2.5.
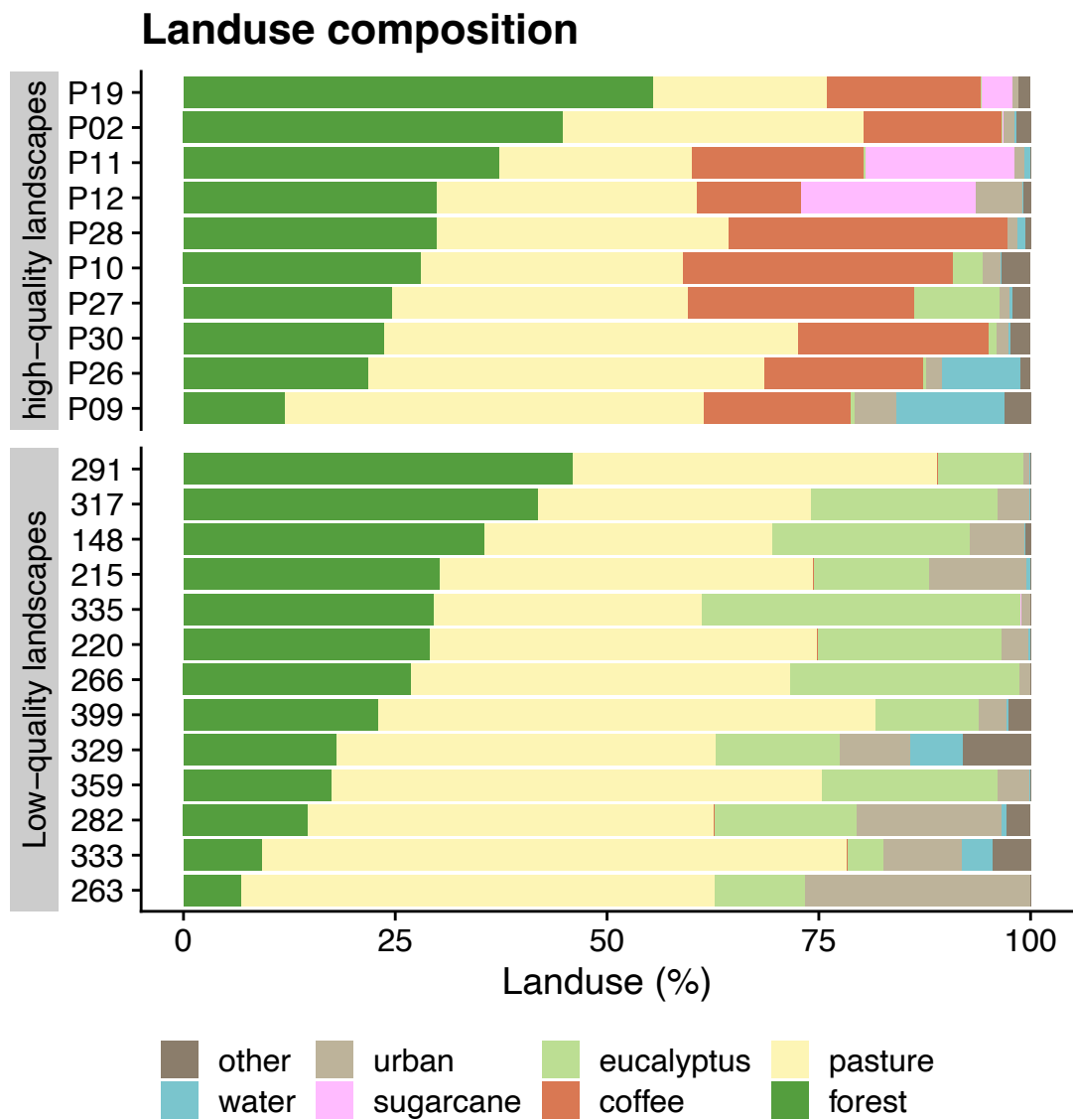
Figure S2.1: Percentage of the 8 main land use types per landscape in each region.

Table S2.1: Summary table of the land use percentages for landscapes in both regions of high- and low-quality matrix landscapes.

| matrix	landuse	min	mean	sd	median	max
high_quality	forest	12.0	30.8	12.4	29.0	55.5
high_quality	pasture	20.4	35.5	10.2	34.7	49.5
high_quality	coffee	12.4	21.7	6.8	19.5	32.9
high_quality	eucalyptus	0.0	1.6	3.2	0.4	10.1
high_quality	sugarcane	0.0	4.2	7.9	0.0	20.6
high_quality	urban	0.8	2.1	1.7	1.4	5.5
high_quality	water	0.0	2.5	4.6	0.3	12.7
high_quality	other	0.0	1.6	1.1	1.5	3.4
low_quality	forest	6.9	25.3	11.9	26.8	46.0
low_quality	pasture	31.7	46.9	11.1	44.8	69.1
low_quality	coffee	0.0	0.0	0.0	0.0	0.0
low_quality	eucalyptus	4.3	18.1	8.7	16.9	37.7
low_quality	sugarcane	0.0	0.0	0.0	0.0	0.0
low_quality	urban	0.7	7.4	7.5	3.8	26.6
low_quality	water	0.0	0.9	1.9	0.1	6.2
low_quality	other	0.0	1.4	2.5	0.0	8.0
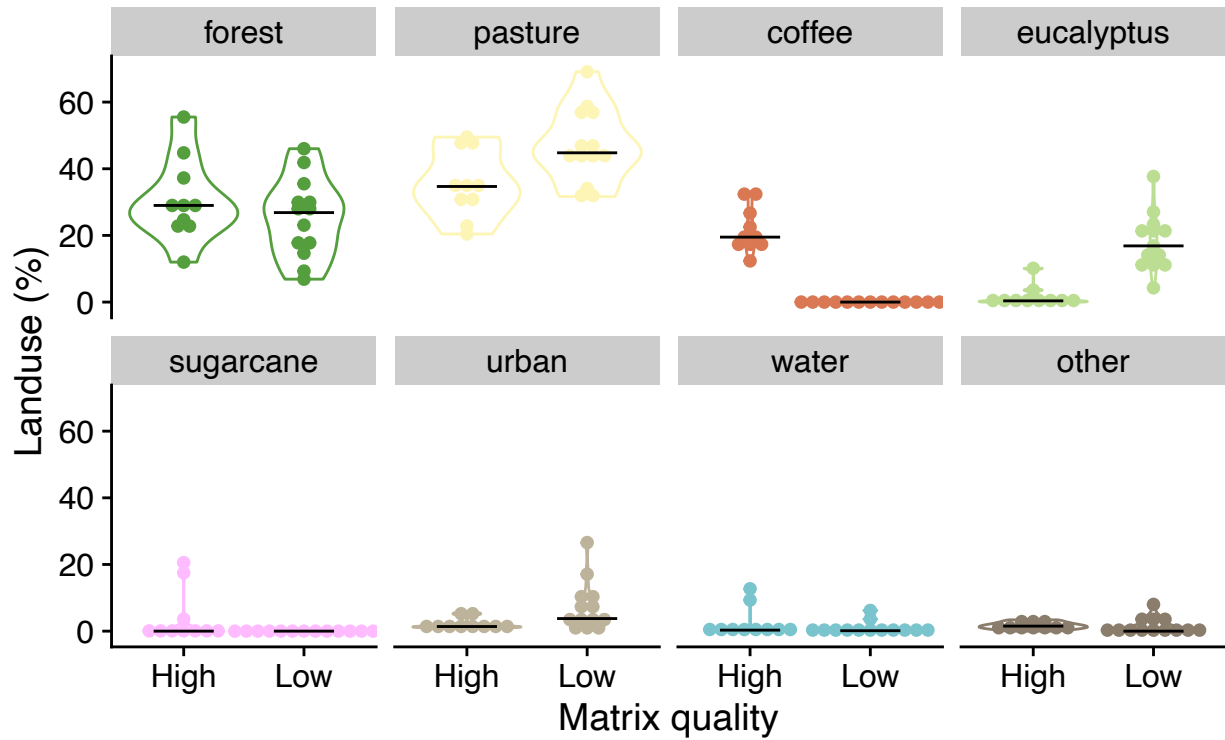
Figure S2.2: Proportions of landuse types among high- and low-quality landscapes
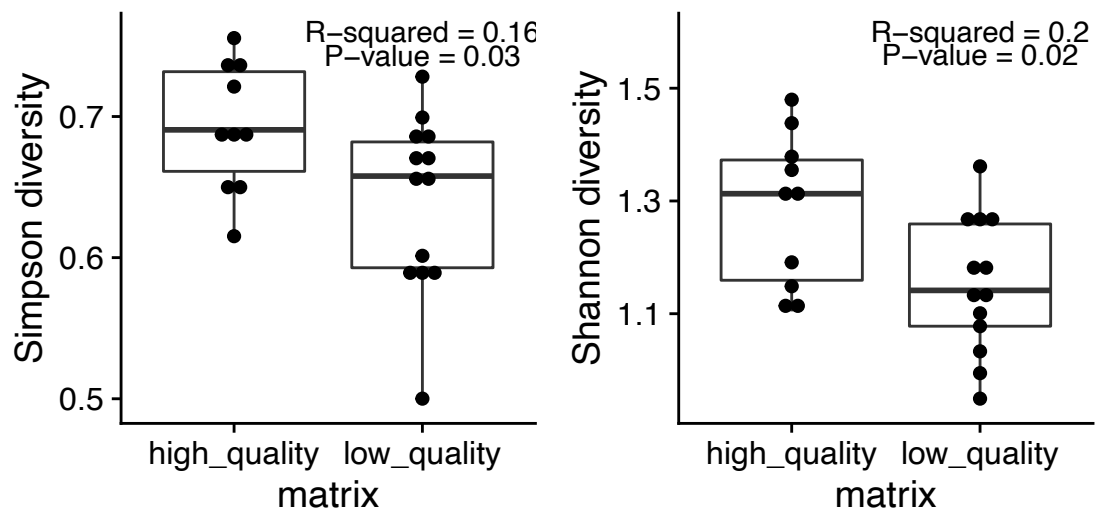
Figure S2.3: Simpson and Shannon diversity indexes for land uses in landscapes from both high- and low-quality matrix regions.
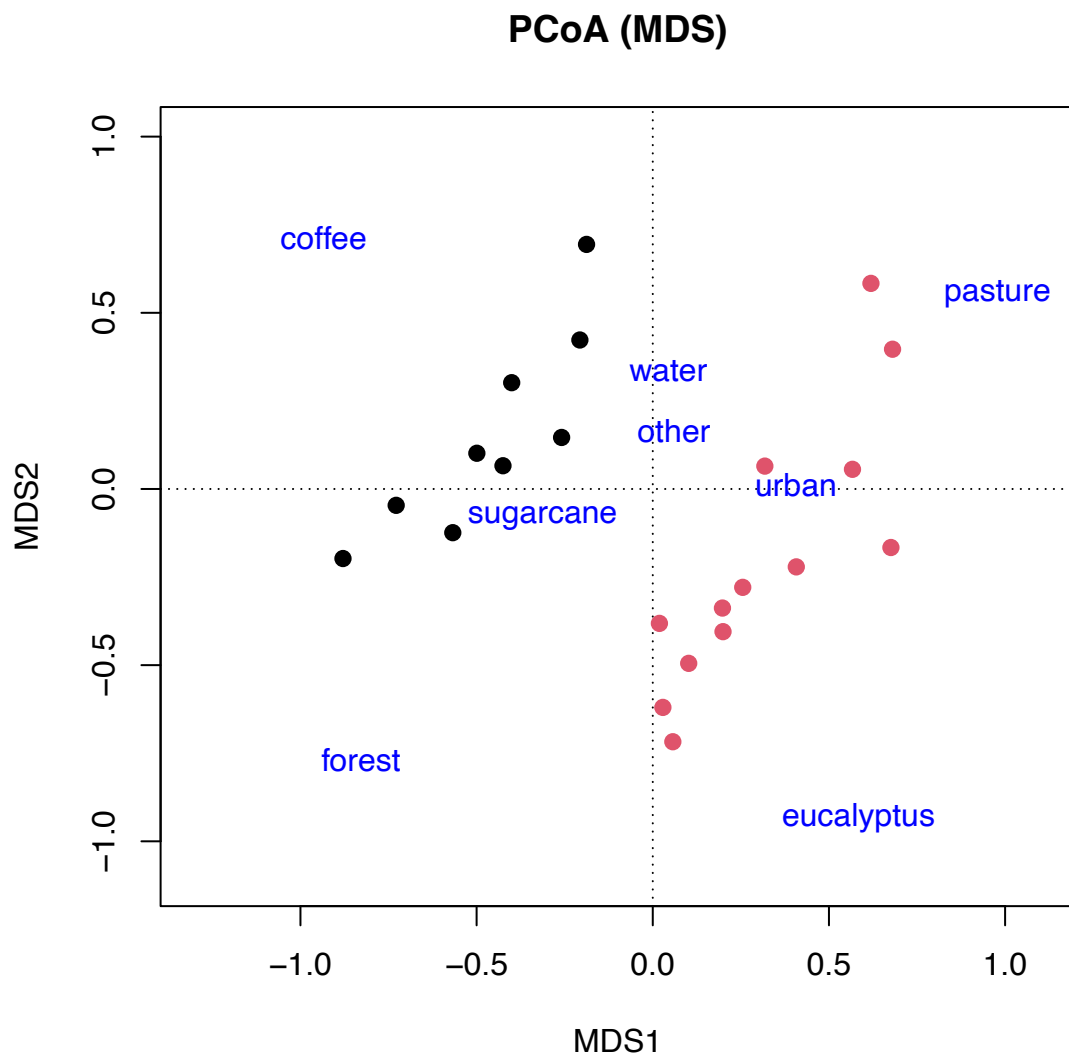
PCoA (MDS)

Figure S2.4: First 2 axes of the PCoA results for the composition of land use types among landscapes from the high-quality matrix (black dots) and low-quality matrix (red dots) regions.
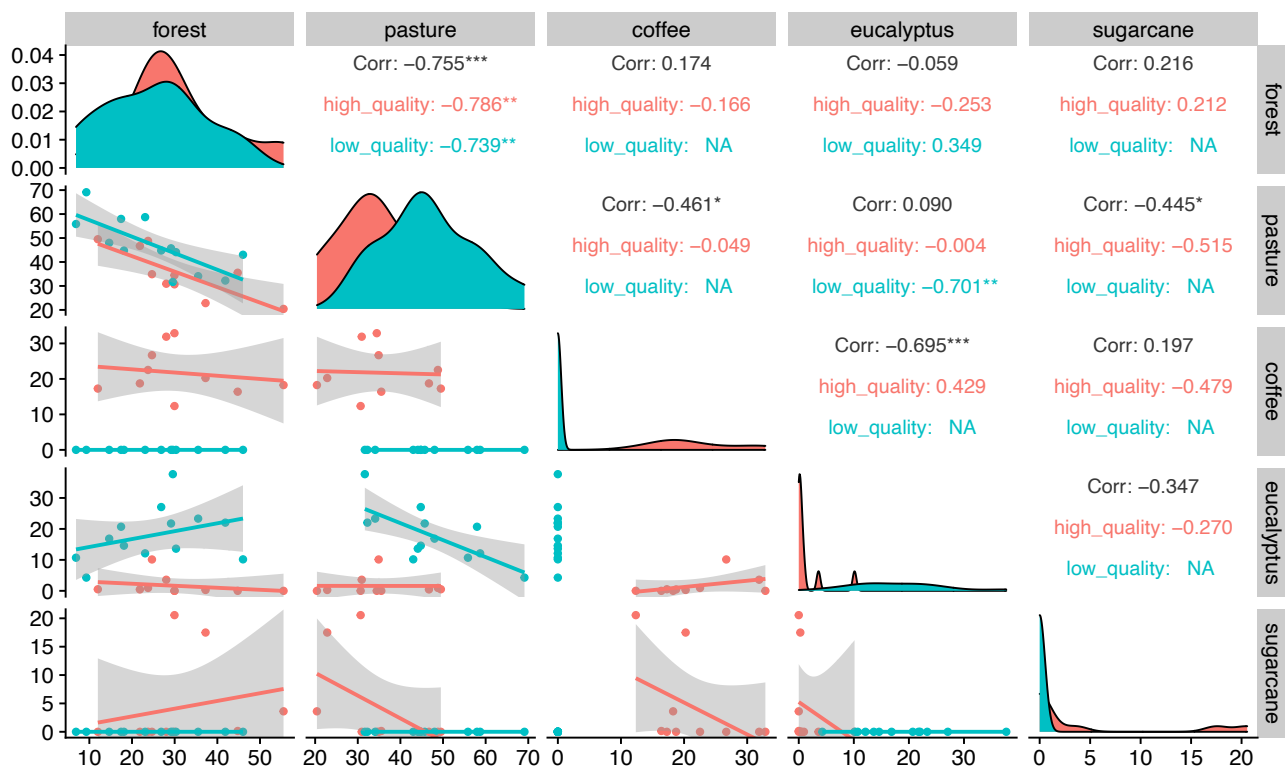
Figure S2.5: Correlation among percentages of landuse types.

2. Relationships among forest cover variables

We calculated Pearson correlation coefficients for forest cover variables in each matrix quality region (Figure S2.6). Also, we ploted the range of local forest cover (400 m) within the landscapes to see how local forest cover varies among landscapes in both regions (Figure S2.7).
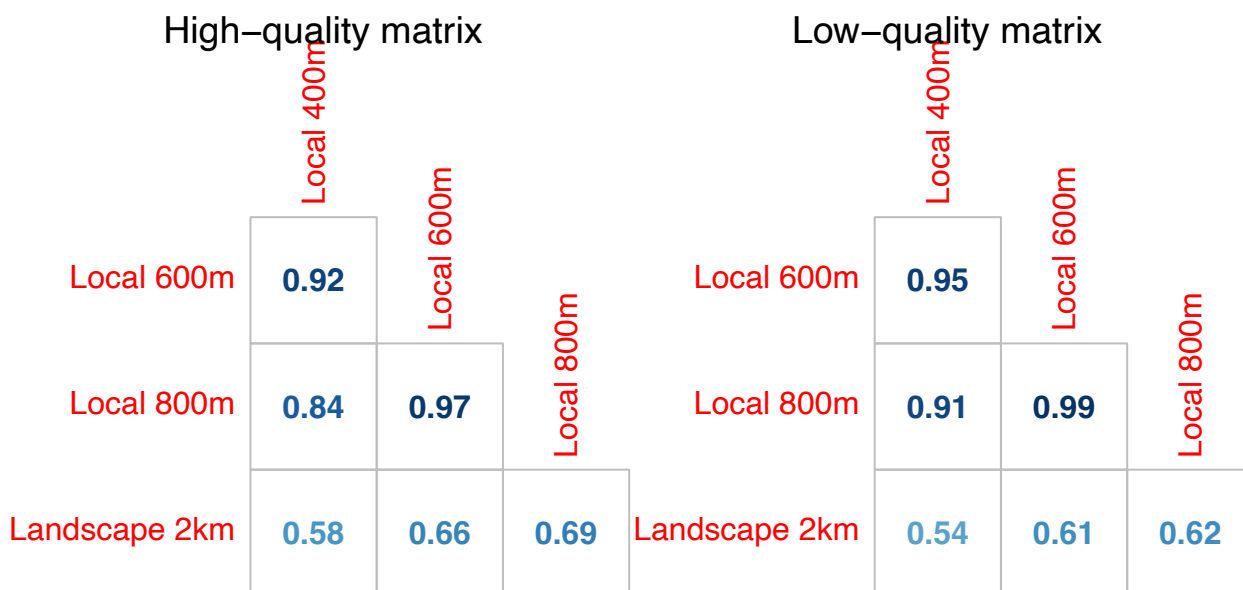

Figure S2.6: Correlations among forest cover variables in the high-quality (left) and low-quality matrix (right) landscapes.
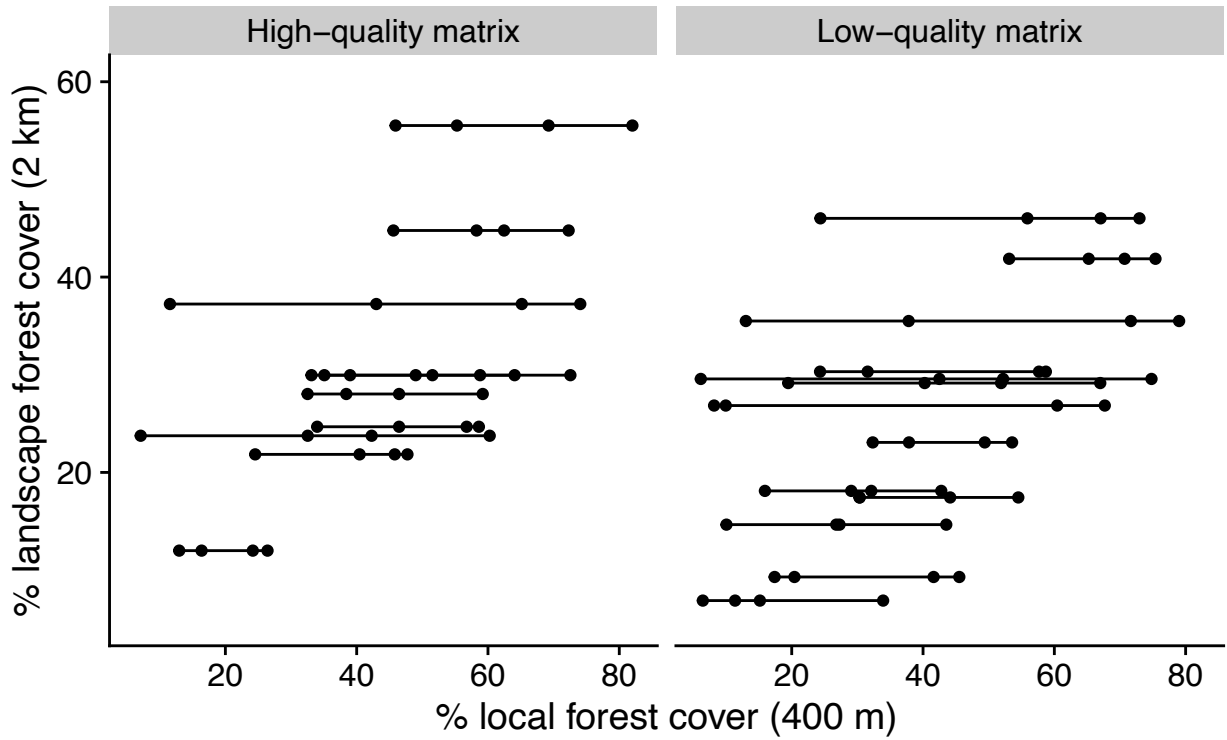
Figure S2.7: Range of local forest cover (buffer 400 m) within each landscape (buffer 2 km) for both landscapes with different matrix quality. Each line represent a landscape and the dots area the local forest cover for each sampling site.

3. Scale of effects for local forest cover

We ran different models with each local forest cover variable and selected the scale of effect using AIC model selection and the R^2 of the models. The models follow the specification presented in the paper (*Modeling* section), except that here we did not include trait variables, i.e. we only modeled the occurrence of species according to forest cover.

We used `lme4` package (Bates *et al.* (2015)) to perform a GLMM with binomial (proportion) distribution. An example of the code for each assemblage is as follows:

```
model <- glmer(cbind(occor, n.visit-occor) ~
               local.cover + (local.cover|sp) +
               (1|landscape:sp) + (1|site:sp) +
               (1|landscape) + (1|site),
               family=binomial, data=high.spe)
```

In Figure S2.8, we present the occurrence probability predicted for the models with different local forest cover scales for all the assemblages. Predictions were quite similar and decreased with forest cover for the specialists, especially in the low-quality matrix region, and increased or remained flat for the generalists.

Table S2.2: Overal and marginal r-squares and model comparisons with Akaike Information Criterion (AIC) for models with different local forest cover scales as predictor for the specialist and generalists species in both regions with different matrix qualities. For the terms see Table 1 (main text). dAIC is the difference in Akaike Information Criterion to the best model; df are the degrees of freedom.

| Model	Total	fixed	env.sp	lands.sp	site.sp	lands	site	AIC dAIC	df
Forest specialist species									
Low-quality matrix									
400m	64.3	7.5	42.9	6.2	3.3	1.0	3.4	0.00	9
600m	63.9	6.2	43.1	6.2	3.4	0.9	4.1	10.03	9
800m	63.9	6.0	43.0	6.3	3.5	1.0	4.1	18.08	9
High-quality matrix									
400m	56.6	1.3	44.3	7.5	1.8	0.7	1.1	0.00	9
600m	56.8	1.0	44.2	7.5	1.8	0.9	1.3	8.57	9
800m	56.6	0.6	44.3	7.4	1.9	0.9	1.4	12.40	9
Forest generalist species									
Low-quality matrix									
400m	46.6	0.1	39.7	3.5	2.5	0.0	0.9	0.00	9
600m	46.6	0.0	39.1	3.6	3.0	0.0	0.9	20.27	9
800m	46.5	0.0	39.0	3.6	3.0	0.0	0.9	22.54	9
High-quality matrix									
400m	44.1	0.0	37.0	2.2	3.6	0.6	0.7	11.24	9
600m	44.3	0.0	37.5	2.0	3.4	0.6	0.7	2.45	9
800m	44.3	0.1	37.5	2.0	3.5	0.6	0.7	0.00	9
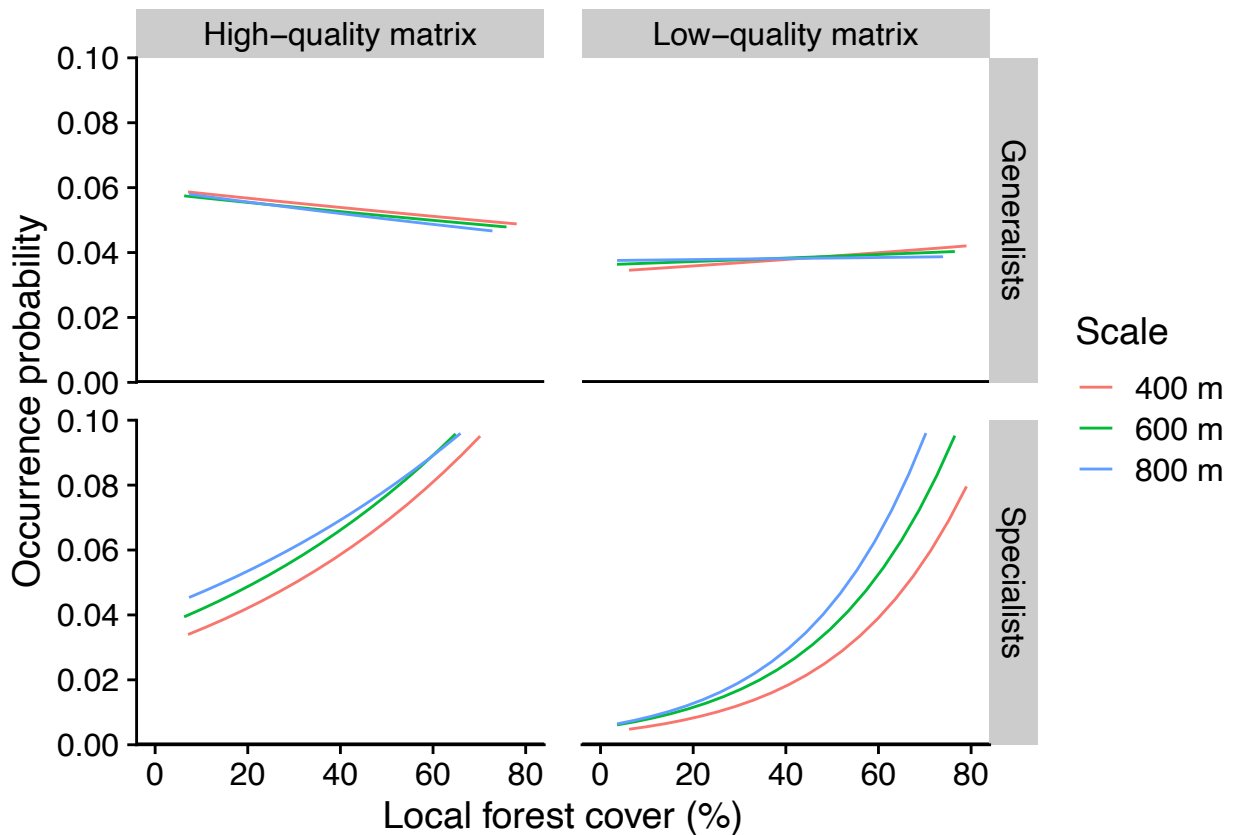
Figure S2.8: Predictions of the models with different local forest cover scales (lines) for specialists and generalists in both regions.

Residual correlations among species

We evaluated the residuals by Kendall correlations among species and among sites for the 400 m models using the predictions for site:sp random effects (Observation Level Random Effect), following the code provided by Miller, Damschen & Ives (2018). Codes for the species names are presented in the dataset available.

Below we show models residual correlation plots for the specialists in the high-quality matrix landscape. All the other assemblages presented similar results.

Range of species correlations: -0.41, 0.46.
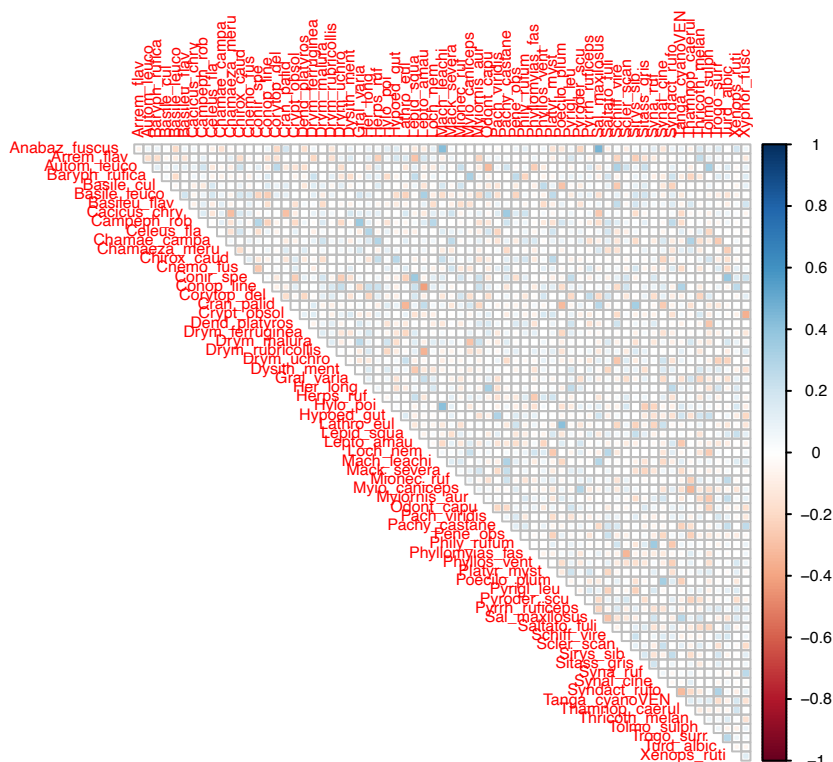
Range of sites correlations: -0.25, 0.31.

Figure S2.9: Species residual Kendall correlations for the specialist species in the coffee matrix region.
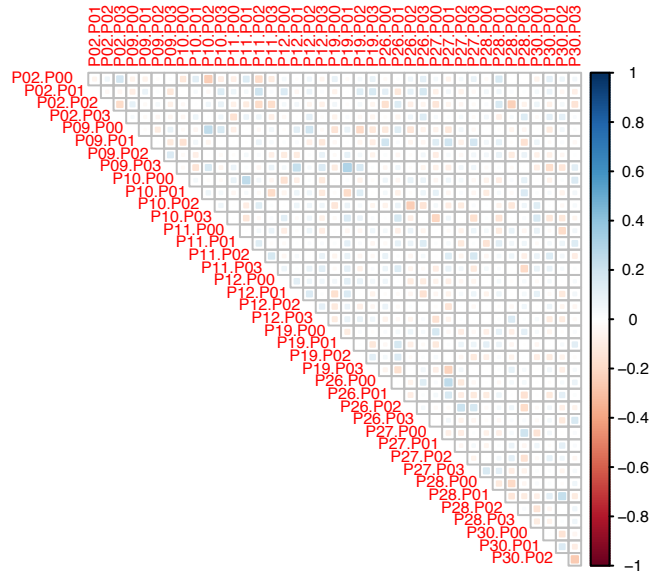
Figure S2.10: Sites residual Kendall correlations for the specialist species in the coffee matrix region.
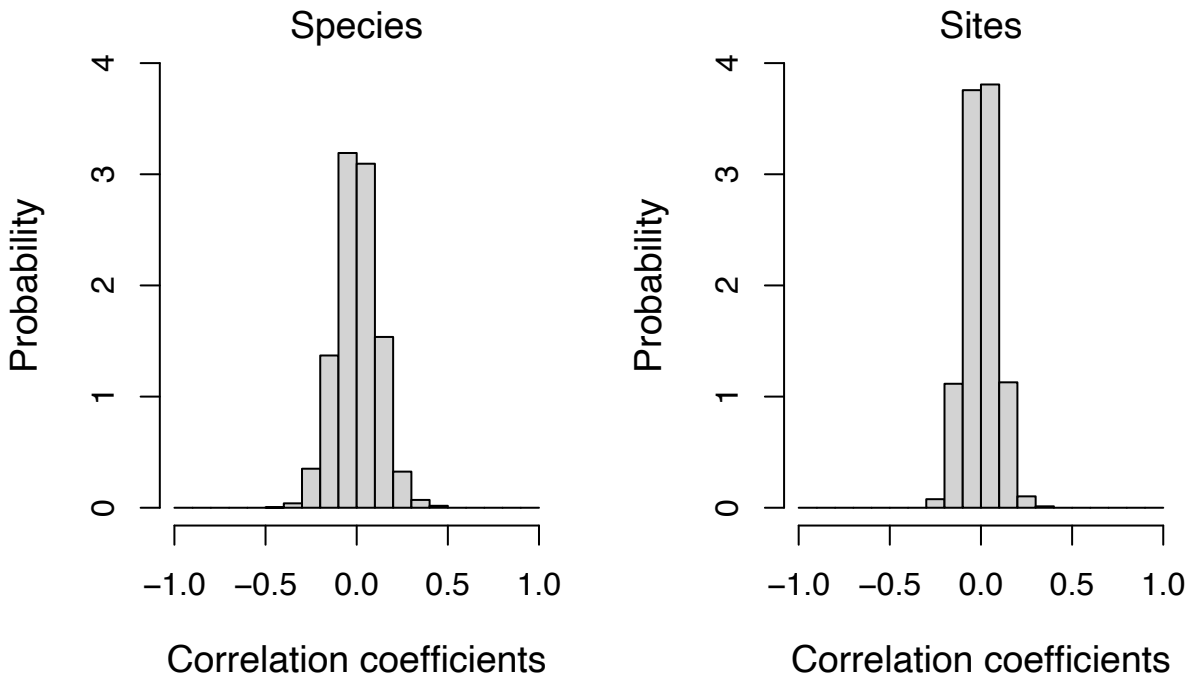
Figure S2.11: Histograms of the residual Kendall correlations for the specialists species in the coffee matrix region.

4. Including landscape forest cover

After selecting the local forest cover of 400 m radius buffer around each site for all datasets, we included the landscape forest cover (2 km radius buffer around the centroid of the landscape) in the model.

The R syntax example of this model area as follows:

```
model <- glmer(cbind(occor, n.visit-occor) ~
                local.400 + landscape.2k +
```

Table S2.3: Variance Inflation Factor index for the variables of local forest cover and landscape forest cover.

	Local	Landscape
Specialists		
Coffee	1.26	1.26
Pasture	1.04	1.04
Generalists		
Coffe	1.13	1.13
Pasture	1.15	1.15

```
    (local.400 + landscape.2k |sp) +
    (1|landscape:sp) + (1|site:sp) +
    (1|landscape) + (1|site),
family=binomial, data=high.spe)
```

Before analysing results, we evaluated possible colinearity between local and landscape forest cover using the Variance Inflation Factor with the code provided by John Lefcheck (https://jonlefcheck. net/2012/12/28/dealing-with-multicollinearity-using-variance-inflation-factors/). With VIF we found no evidence of collinearity between the forest cover scales (Table S2.3).

Predictions of the models are present in Figure S2.12. It is important to notice the differences in 20 and 40% landscape forest cover predictions for the specialists in the low-quality matrix.
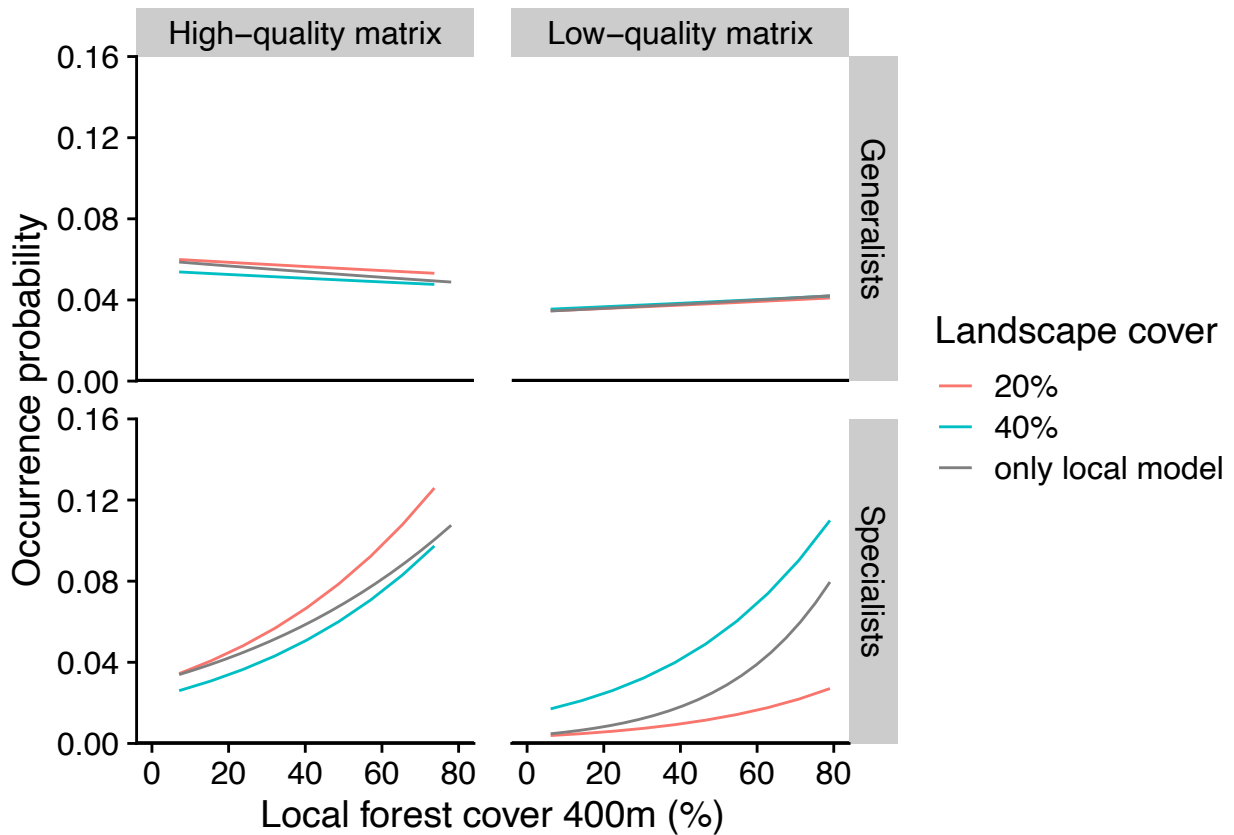

Figure S2.12: Predictions of the models without (gray lines) and with landscape forest cover scales (20 percent cover in red and 40 percent cover in blue lines) for specialists and generalists in both regions.

References

Barros, F.M., Martello, F., Peres, C.A., Pizo, M.A. & Ribeiro, M.C. (2019). Matrix type and landscape attributes modulate avian taxonomic and functional spillover across habitat boundaries in the Brazilian Atlantic Forest. *Oikos* **128**, 1600–1612.

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Rodrigues, C.B., Taniwaki, R.H., Lane, P., Lima, W. de P. & Ferraz, S.F. de B. (2019). Eucalyptus Short-Rotation Management Effects on Nutrient and Sediments in Subtropical Streams. *Forests* **10**, 519.

Appendix 3: Additional models results

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2022-05-02

1. Models with traits

Specification of the models: We used `lme4` package to perform a GLMM with binomial (proportion) distribution. An example of the code for each dataset are as follows:

```
mhigh.spe <- glmer(cbind(occor, n.visit-occor) ~
                   forest_site400*lbody_size +
                   forest_site400*nest +
                   forest_site400*diet +
                   forest_site400*lower_stratum +
                   forest_land*lbody_size +
                   forest_land*nest +
                   forest_land*diet +
                   forest_land*lower_stratum +
                   (forest_site400 + forest_land|sp) +
                   (1|landscape:sp) + (1|site:sp) +
                   (lbody_size + nest + diet + lower_stratum|landscape) +
                   (lbody_size + nest + diet + lower_stratum|site),
                   family=binomial, data=high.spe,
                   nAGQ = 1, control = glmerControl(optimizer = "bobyqa",
                             optCtrl = list(maxfun = 500000)))
```

We ran separate models for each assemblage and trait. Afterwards, we ran one model with the combination of the traits body mass, diet, nest type and % of lower strata use. Table S3.1 shows the marginal R^2 of all models terms.

2. Models coeficients

Tables S3.2, S3.3, S3.4, and S3.5 show the coefficients for each model.

Table S3.1: Overall and marginal R-squared of trait models in each dataset. For the marginal R-squared terms see Table 2 (main text).

Model	Total	trait*env	env|sp	lands:sp	site:sp	trait|lands	trait|site
Specialists							
High quality							
Combined	57.6	10.0	36.8	6.7	0.7	1.3	2.2
body mass	56.8	7.7	38.9	6.7	1.6	0.8	1.1
nest type	56.8	4.6	41.9	6.8	1.5	0.6	1.4
main diet	57.4	4.5	42.5	6.5	1.6	1.0	1.3
% frugivory	56.8	4.4	42.4	6.8	1.6	0.5	1.1
% insetivory	56.7	3.8	42.9	6.8	1.6	0.5	1.1
% lower strata	56.7	1.5	45.0	6.8	1.4	0.7	1.4
foraging stratum	56.7	2.0	44.5	6.5	1.5	0.8	1.3
hand-wing	56.6	1.6	44.9	6.8	1.2	0.5	1.6
Low quality							
Combined	71.9	22.2	39.9	3.8	1.0	0.9	4.0
body mass	70.5	15.8	45.6	3.8	2.4	0.1	2.7
nest type	71.0	17.3	44.5	3.9	2.2	0.0	3.1
main diet	71.4	18.4	43.8	3.7	2.5	0.4	2.5
% frugivory	71.3	17.2	45.1	3.8	2.6	0.0	2.6
% insetivory	71.3	18.4	44.0	3.8	2.6	0.1	2.5
% lower strata	71.1	15.5	46.2	3.8	1.9	0.4	3.2
foraging stratum	70.7	17.0	44.5	3.9	2.3	0.3	2.6
hand-wing	70.9	14.0	47.6	3.8	2.4	0.1	2.9
Generalists							
High quality							
Combined	46.2	7.4	31.9	1.3	0.9	1.6	3.1
body mass	44.7	0.2	37.8	1.6	2.9	0.6	1.5
nest type	44.6	0.6	37.4	1.7	3.1	0.6	1.1
main diet	45.8	5.2	33.7	1.5	1.7	1.1	2.7
% frugivory	44.5	0.5	37.4	1.5	3.6	0.7	0.8
% insetivory	44.4	3.2	34.8	1.2	3.7	0.9	0.7
% lower strata	44.5	1.3	36.7	1.5	3.6	0.7	0.7
foraging stratum	44.4	1.9	35.8	1.7	3.2	0.7	1.0
hand-wing	44.4	3.0	34.9	1.6	3.5	0.6	0.8
Low quality							
Combined	47.4	7.5	33.3	2.3	0.9	1.0	2.4
body mass	47.1	0.8	39.7	2.7	2.2	0.4	1.2
nest type	46.7	1.0	39.3	3.1	2.1	0.0	1.1
main diet	47.1	5.3	35.2	2.8	1.9	0.5	1.5
% frugivory	47.0	0.4	40.0	2.9	2.4	0.3	0.9
% insetivory	46.7	1.6	38.7	3.0	2.4	0.2	0.9
% lower strata	47.0	0.9	39.5	3.1	2.1	0.1	1.3
foraging stratum	47.0	1.2	39.2	2.9	2.4	0.1	1.1
hand-wing	46.7	2.5	37.8	3.0	2.4	0.1	0.9

Table S3.2: Fixed effects coefficients for the model of specialists in high-quality matrix landscapes.

effect	term	estimate	std.error	statistic	p.value
fixed	(Intercept)	-2.72	0.98	-2.78	0.01
fixed	forest_site400	0.83	0.33	2.49	0.01
fixed	lbody_size	-0.62	0.28	-2.22	0.03
fixed	nestclosed	0.32	0.67	0.48	0.63
fixed	nestopen_semi	-0.28	0.56	-0.50	0.62
fixed	dietinsectivorous	0.07	0.83	0.09	0.93
fixed	dietonivorous	-1.00	1.25	-0.81	0.42
fixed	lower_stratum	0.18	0.23	0.78	0.44
fixed	forest_land	-0.36	0.41	-0.87	0.38
fixed	forest_site400:lbody_size	-0.03	0.09	-0.30	0.76
fixed	forest_site400:nestclosed	-0.38	0.19	-1.98	0.05
fixed	forest_site400:nestopen_semi	-0.24	0.17	-1.36	0.17
fixed	forest_site400:dietinsectivorous	-0.28	0.29	-0.97	0.33
fixed	forest_site400:dietonivorous	-0.35	0.44	-0.80	0.42
fixed	forest_site400:lower_stratum	0.01	0.07	0.10	0.92
fixed	lbody_size:forest_land	0.00	0.10	0.04	0.97
fixed	nestclosed:forest_land	0.30	0.22	1.35	0.18
fixed	nestopen_semi:forest_land	0.31	0.19	1.61	0.11
fixed	dietinsectivorous:forest_land	-0.04	0.33	-0.11	0.91
fixed	dietonivorous:forest_land	0.45	0.47	0.95	0.34
fixed	lower_stratum:forest_land	0.00	0.08	-0.03	0.98

Table S3.3: Fixed effects coefficients for the model of specialists in low-quality matrix landscapes.

effect	term	estimate	std.error	statistic	p.value
fixed	(Intercept)	-5.46	1.03	-5.33	0.00
fixed	forest_site400	1.06	0.36	2.94	0.00
fixed	lbody_size	-0.21	0.32	-0.67	0.50
fixed	nestclosed	0.70	0.78	0.90	0.37
fixed	nestopen_semi	-0.12	0.69	-0.18	0.86
fixed	dietgranivorous	0.13	1.82	0.07	0.95
fixed	dietinsectivorous	1.27	0.82	1.54	0.12
fixed	lower_stratum	0.36	0.28	1.28	0.20
fixed	forest_land	1.42	0.44	3.22	0.00
fixed	forest_site400:lbody_size	0.05	0.09	0.51	0.61
fixed	forest_site400:nestclosed	-0.39	0.22	-1.78	0.07
fixed	forest_site400:nestopen_semi	-0.06	0.20	-0.29	0.77
fixed	forest_site400:dietgranivorous	-0.41	0.61	-0.67	0.50
fixed	forest_site400:dietinsectivorous	-0.40	0.28	-1.45	0.15
fixed	forest_site400:lower_stratum	0.02	0.09	0.18	0.86
fixed	lbody_size:forest_land	0.01	0.12	0.04	0.96
fixed	nestclosed:forest_land	-0.59	0.28	-2.10	0.04
fixed	nestopen_semi:forest_land	-0.16	0.27	-0.62	0.54
fixed	dietgranivorous:forest_land	-0.03	0.73	-0.04	0.96
fixed	dietinsectivorous:forest_land	-0.38	0.34	-1.10	0.27
fixed	lower_stratum:forest_land	-0.15	0.12	-1.24	0.22

Table S3.4: Fixed effects coefficients for the model of generalists in high-quality matrix landscapes.

effect	term	estimate	std.error	statistic	p.value
fixed	(Intercept)	-3.45	0.55	-6.29	0.00
fixed	forest_site400	0.37	0.19	2.01	0.04
fixed	lbody_size	0.08	0.27	0.29	0.77
fixed	nestclosed	0.20	0.61	0.32	0.75
fixed	nestopen_semi	0.20	0.53	0.38	0.71
fixed	dietgranivorous	-0.91	0.86	-1.06	0.29
fixed	dietinsectivorous	1.00	0.50	2.00	0.05
fixed	dietnectarivorous	-0.12	0.75	-0.16	0.88
fixed	dietonivorous	0.14	0.67	0.21	0.83
fixed	lower_stratum	0.36	0.17	2.06	0.04
fixed	forest_land	-0.11	0.22	-0.50	0.62
fixed	forest_site400:lbody_size	0.05	0.09	0.61	0.54
fixed	forest_site400:nestclosed	-0.43	0.20	-2.12	0.03
fixed	forest_site400:nestopen_semi	-0.22	0.17	-1.28	0.20
fixed	forest_site400:dietgranivorous	-0.61	0.35	-1.75	0.08
fixed	forest_site400:dietinsectivorous	-0.13	0.18	-0.75	0.46
fixed	forest_site400:dietnectarivorous	-0.16	0.27	-0.61	0.54
fixed	forest_site400:dietonivorous	-0.50	0.25	-2.04	0.04
fixed	forest_site400:lower_stratum	0.04	0.05	0.71	0.48
fixed	lbody_size:forest_land	-0.01	0.10	-0.09	0.93
fixed	nestclosed:forest_land	0.18	0.21	0.88	0.38
fixed	nestopen_semi:forest_land	0.07	0.17	0.38	0.71
fixed	dietgranivorous:forest_land	0.68	0.36	1.87	0.06
fixed	dietinsectivorous:forest_land	-0.13	0.19	-0.65	0.51
fixed	dietnectarivorous:forest_land	-0.11	0.28	-0.40	0.69
fixed	dietonivorous:forest_land	0.06	0.27	0.22	0.83
fixed	lower_stratum:forest_land	-0.03	0.06	-0.58	0.56

Table S3.5: Fixed effects coefficients for the model of generalists in low-quality matrix landscapes.

effect	term	estimate	std.error	statistic	p.value
fixed	(Intercept)	-4.23	0.49	-8.66	0.00
fixed	forest_site400	0.26	0.20	1.32	0.19
fixed	lbody_size	0.22	0.26	0.83	0.41
fixed	nestclosed	0.79	0.59	1.33	0.18
fixed	nestopen_semi	0.55	0.50	1.10	0.27
fixed	dietgranivorous	0.87	1.12	0.78	0.44
fixed	dietinsectivorous	1.06	0.48	2.20	0.03
fixed	dietnectarivorous	-0.19	0.76	-0.25	0.80
fixed	dietonivorous	0.39	0.64	0.62	0.54
fixed	lower_stratum	0.24	0.18	1.33	0.18
fixed	forest_land	0.04	0.18	0.25	0.81
fixed	forest_site400:lbody_size	0.03	0.10	0.32	0.75
fixed	forest_site400:nestclosed	-0.52	0.21	-2.45	0.01
fixed	forest_site400:nestopen_semi	-0.26	0.17	-1.49	0.14
fixed	forest_site400:dietgranivorous	0.55	0.39	1.41	0.16
fixed	forest_site400:dietinsectivorous	0.02	0.19	0.12	0.90
fixed	forest_site400:dietnectarivorous	0.09	0.30	0.30	0.77
fixed	forest_site400:dietonivorous	-0.05	0.23	-0.21	0.84
fixed	forest_site400:lower_stratum	-0.10	0.06	-1.62	0.11
fixed	lbody_size:forest_land	0.00	0.09	-0.05	0.96
fixed	nestclosed:forest_land	0.27	0.18	1.46	0.14
fixed	nestopen_semi:forest_land	0.20	0.15	1.37	0.17
fixed	dietgranivorous:forest_land	-0.48	0.34	-1.42	0.15
fixed	dietinsectivorous:forest_land	-0.21	0.17	-1.23	0.22
fixed	dietnectarivorous:forest_land	-0.26	0.28	-0.94	0.35
fixed	dietonivorous:forest_land	-0.25	0.20	-1.27	0.21
fixed	lower_stratum:forest_land	0.07	0.06	1.17	0.24

Table S3.6: Variance Inflation Factor index for combined traits models in each dataset.

| | Specialists | | Generalists | |
parameter	High-quality	Low-quality	High-quality	Low-quality
forest.local	1.24	1.04	1.17	1.17
body_mass	1.23	1.08	1.15	1.15
nest_closed	1.78	1.43	2.37	2.37
nest_open_semi	2.15	1.99	1.96	1.96
diet_insectivorous	1.83	1.94	2.16	2.16
diet_onivorous	1.83	1.49	2.04	2.04
lower_strata	1.37	NA	2.22	2.22
diet_granivorous	1.18	1.19	1.15	1.15
forest.landscape	NA	1.16	1.20	1.20
diet_nectarivorous	NA	NA	2.46	2.46

3. Models diagnostic

Variance Inflation Factor of the model parameters for each dataset in Table S3.6.

Example of the residual diagnostic of the model with the combined traits (main diet, body mass, nest type and % of lower strata use) for the forest specialists in high-quality matrix landscapes. The models' diagnostics for the other assemblages were all similar and can be checked in this Rmd file.

Residual correlations among species and sites

Below we present the Kendall correlations for the residuals among species and sites for the models using the predictions for `site:sp` random effect (Observation Level Random Effect). For the residual correlations we followed the code provided by Miller, Damschen & Ives (2018).

Range of species correlations: -0.4, 0.43. Range of sites correlations: -0.3, 0.27.
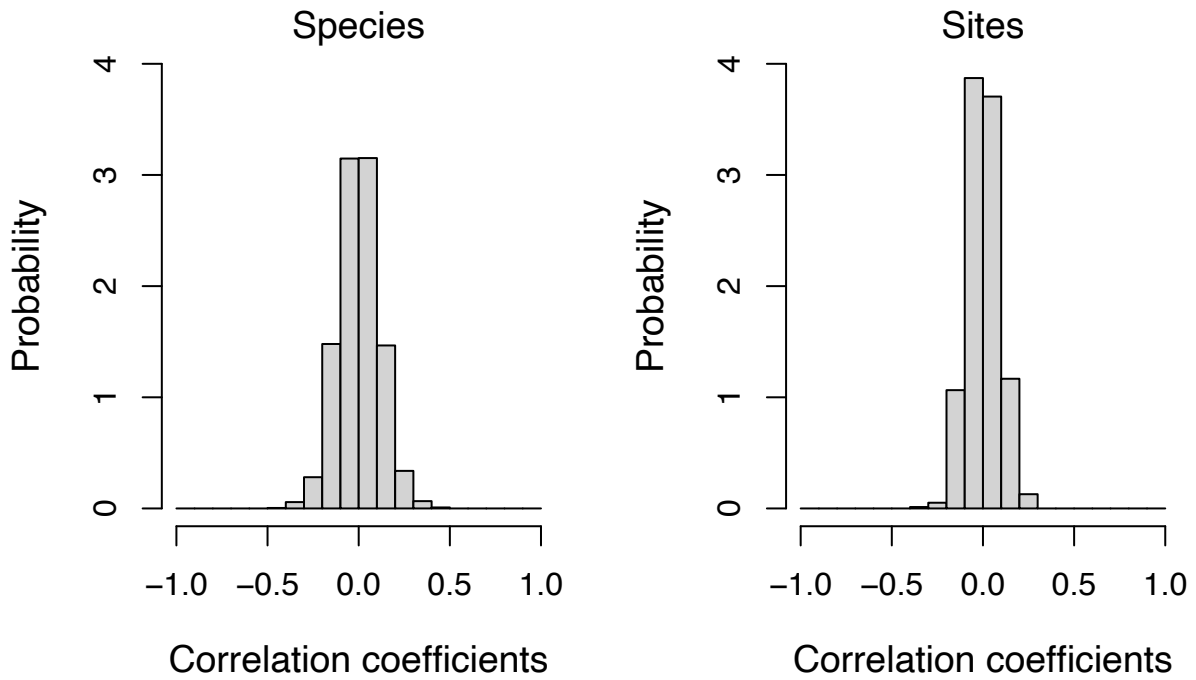
Figure S3.1: Species residual Kendall correlations for the specialist species in high-quality matrix landscapes.

Figure S3.2: Sites residual Kendall correlations for the specialist species in high-quality matrixlandscapes.
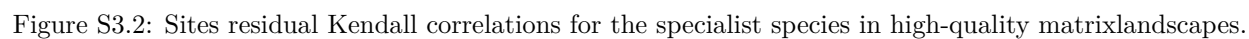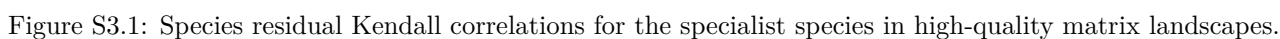
Figure S3.3: Histograms of the residual Kendall correlations for the specialists species in high-quality matrix landscapes.

Residual diagnostic

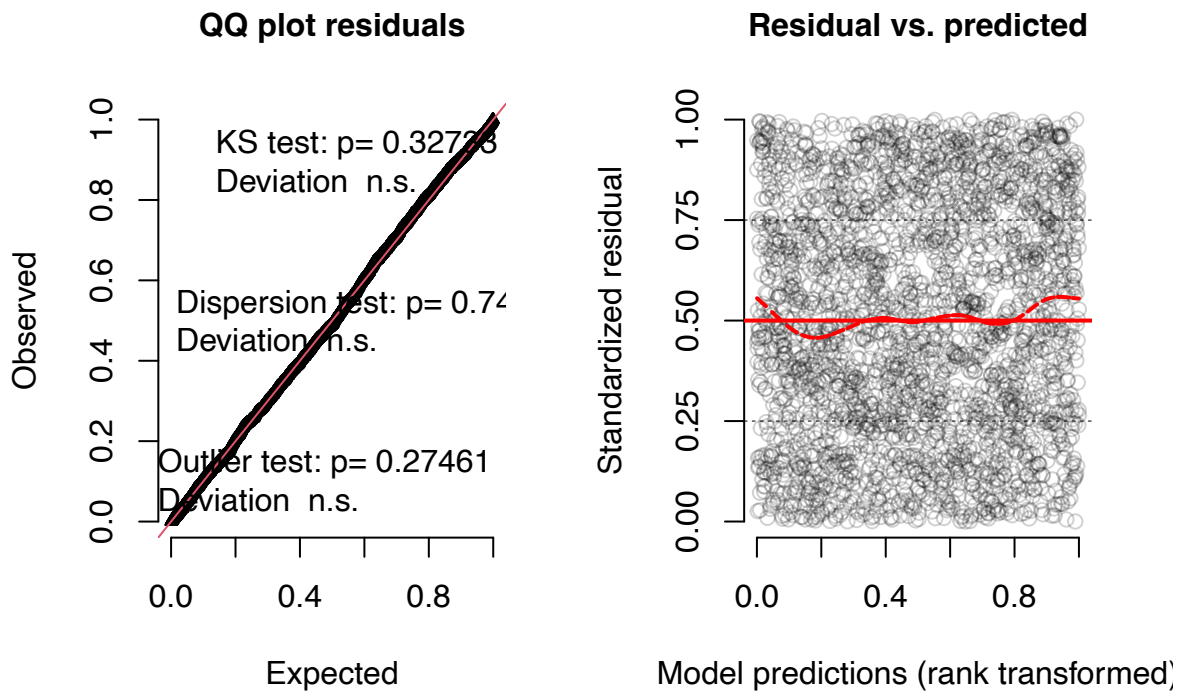We used DHARMa package (Hartig (2018)) for the diagnostic of quantile residuals.

DHARMa residual diagnostics

Figure S3.4: Plots for model diagnostic form DHARMa package.

Residuals against predictors:
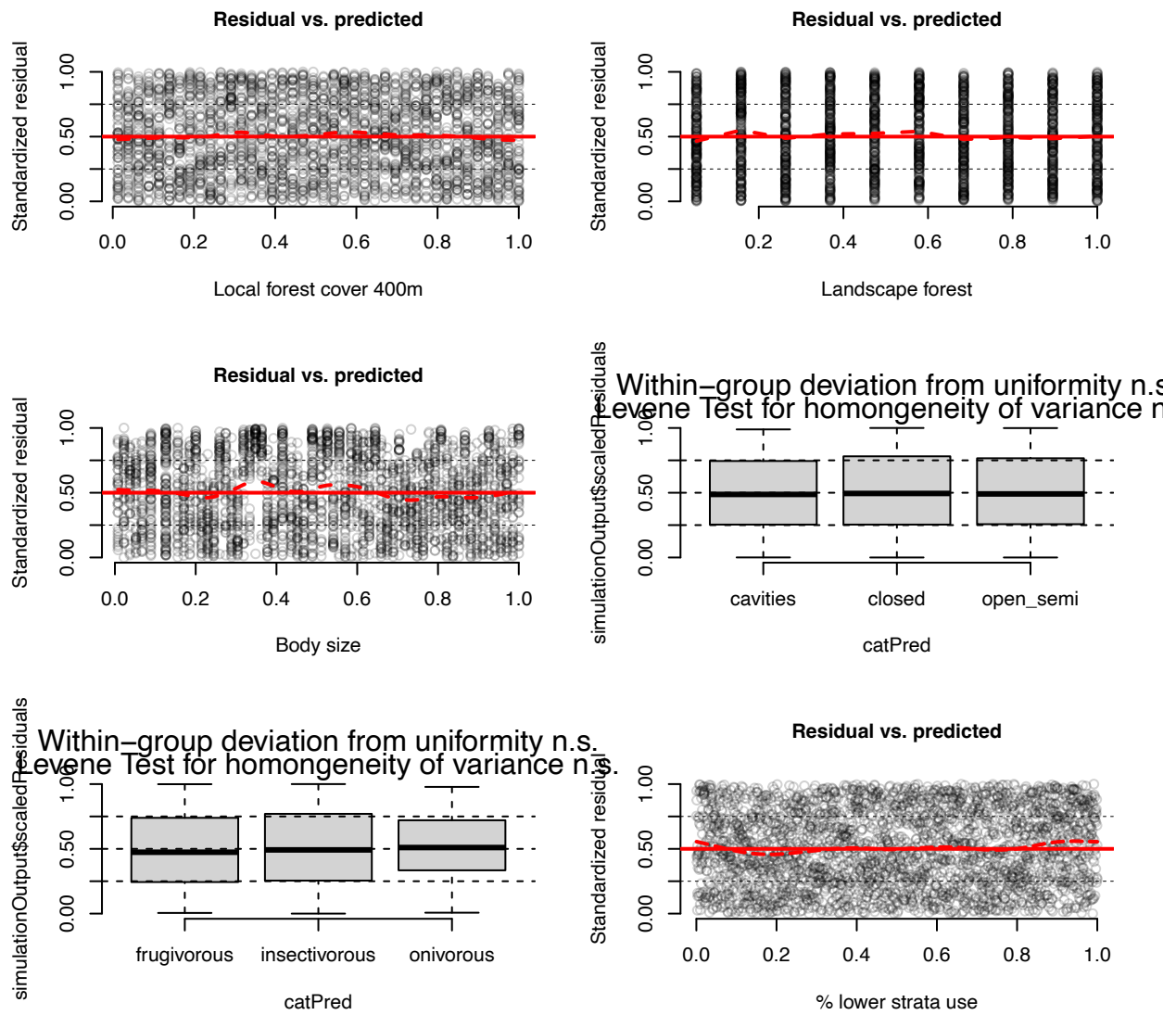
Figure S3.5: More for model diagnostic form DHARMa package.

Predictions for each species local forest cover

Landscape forest cover was fixed in 30%.
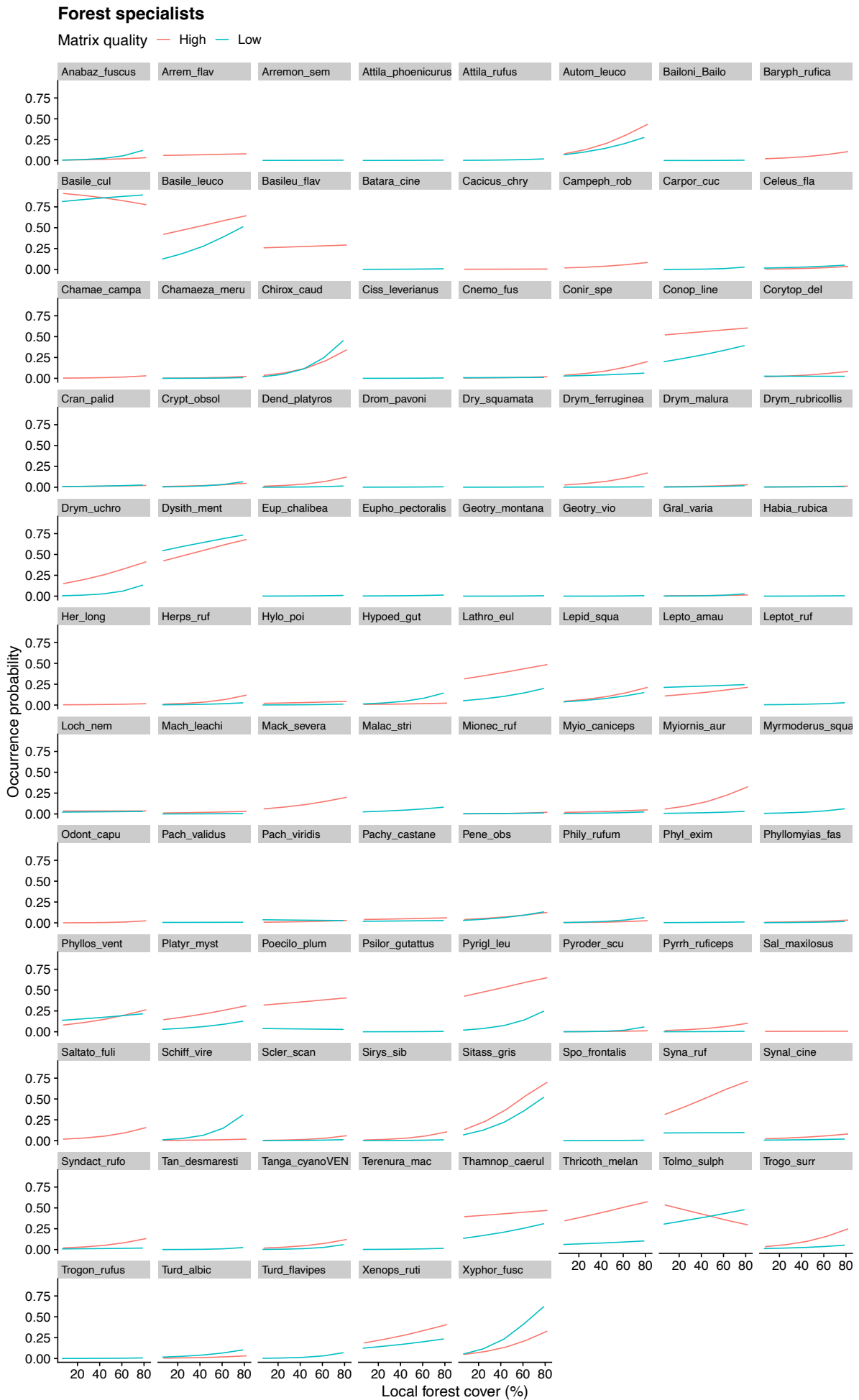
Figure S3.6: Forest specialist birds.
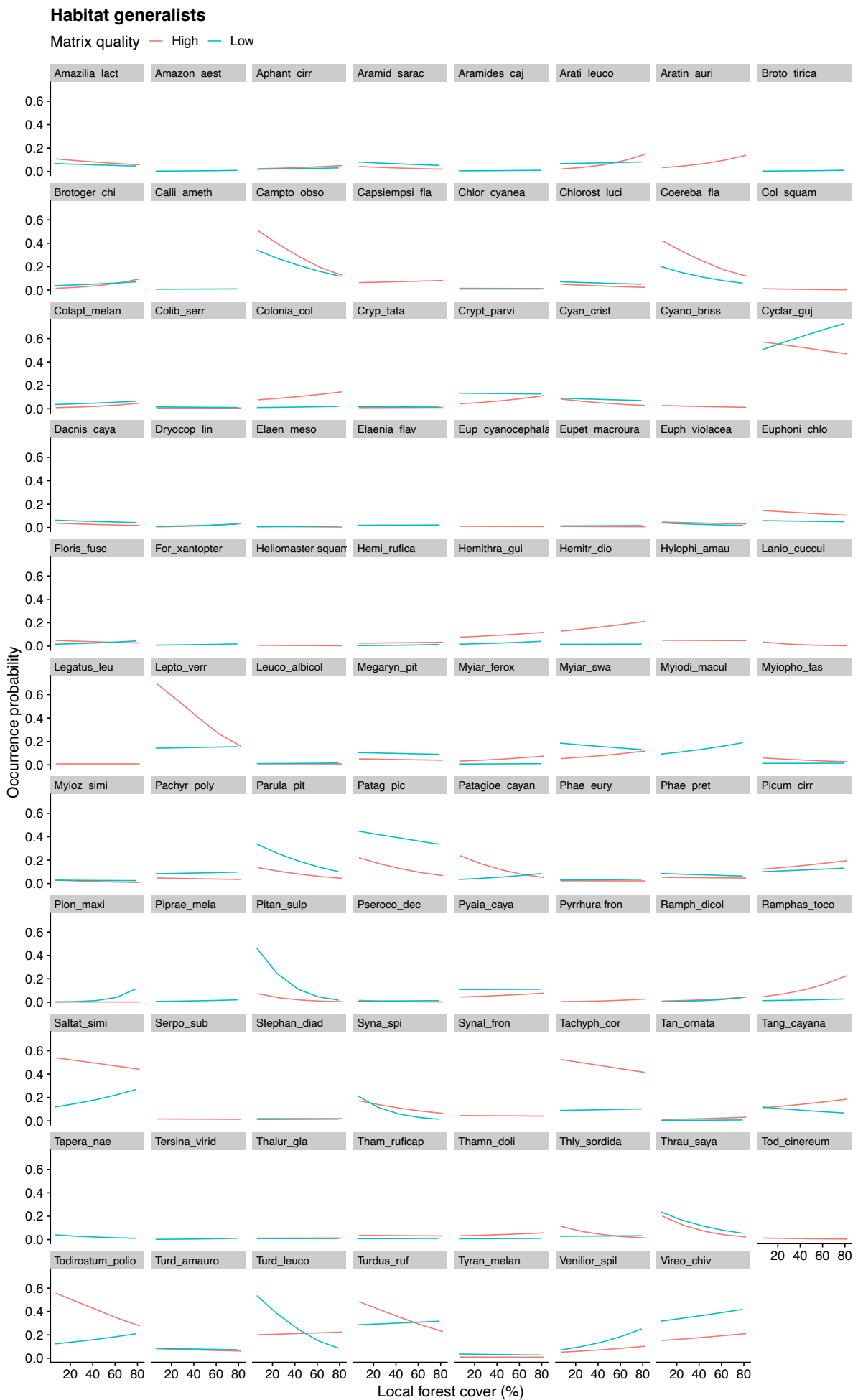
Figure S3.7: Forest specialist birds.

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References

Hartig, F. (2018). DHARMa: Residual Diagnostics for Hierarchical (Multi-Level / Mixed) Regression Models.

Miller, J.E.D., Damschen, E.I. & Ives, A.R. (2018). Functional traits and community composition: A comparison among community-weighted means, weighted correlations, and multilevel models. *Methods in Ecology and Evolution* **0**.

Appendix 4: Robustness analysis with species that occur at both high and low-quality landscapes

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Given that bird species pool are slightly different in both regions (see Appendix 1), the results we found comparing both high- and low-quality landscapes could be confounded by groups os species that respond differently but doesn't occur at both regions. In order to check for the robustness of our results, we performed separate analysis with only those species that occur in both regions, **57 forest specialists** (61.3% of all specialists) and **64 forest generalists** (73.6% of all generalists), and compared them with the results presented in the main text with all species.

The analyses were done with the combined trait models, the same presented at Figure 2 and 3 in the main text.

We found that even with the same groups of species analyzed, we get very similar results for the differences between high- and low-quality matrix landscapes, which reinforce that the drawned inferences regarding habitat loss responses remains the same regardless of the exclusion of 'unique' species in a given a region.

1. Datasets

Separating only species that occur at both regions.

Table S3.1: Checking the number of species in all 4 assemblages datasets.

assemblage	N_of_species
High-quality specialists	57
Low-quality specialists	57
High-quality generalists	64
Low-quality generalists	64

2. Local and landscape forest cover effects

Comparing effect sizes and 95% IC for fixed effects forest cover a local and landscape scale for each dataset: the original and the subsets of the same species (1). We see that estimates almost didn't change with the dataset.
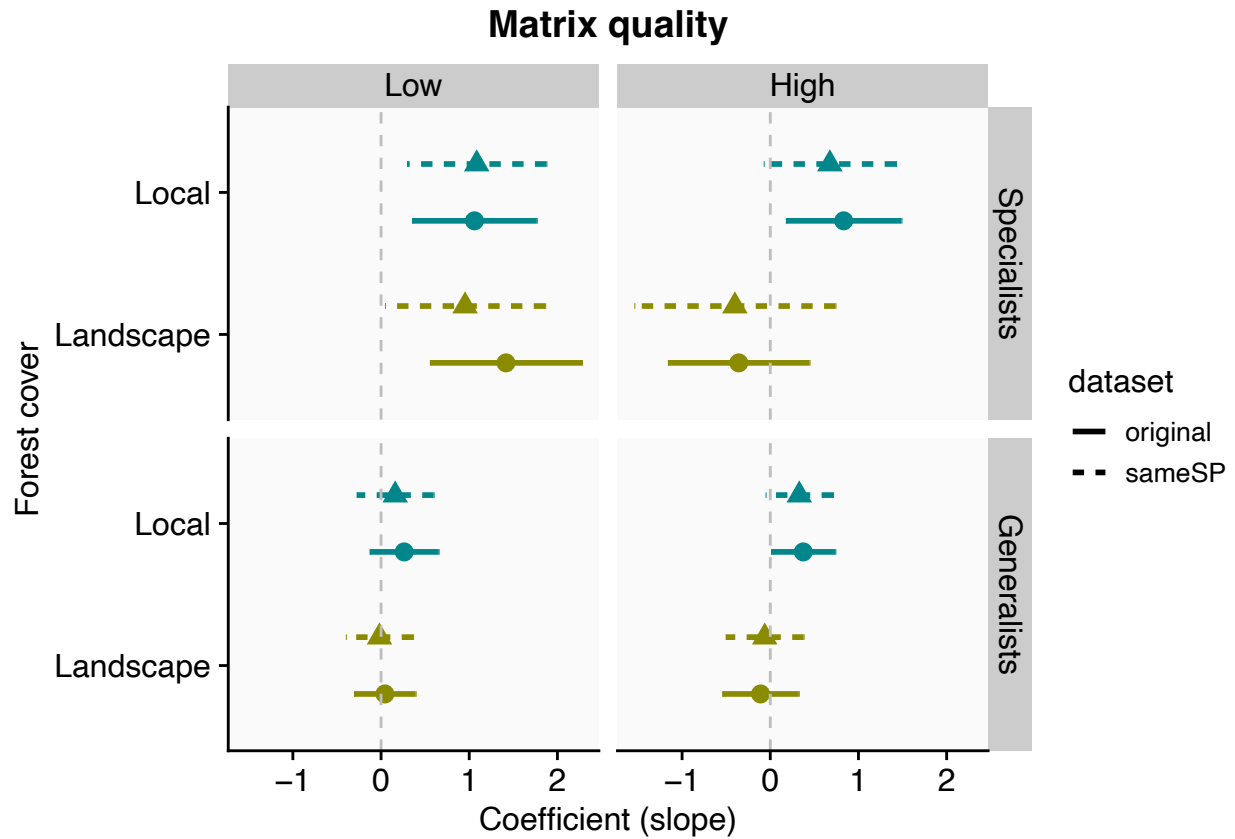

Figure S3.1: Comparing effect sizes (and 95 percent confidence intervals) for forest cover at local and landscape scale for both datasets: original with all species (triangles and continuous lines) and the subset of species that occur at both regions (circles and dashed lines).

3. R² models

Comparing partial R^2 of the models' terms in both datasets, the original and the subsets of the same species (2). Qualitatively, we see that R^2 almost didn't change with the dataset, expect for specialists in low-quality matrix landscapes where fixed effects (trait*env) decreased from 22% to 17%.
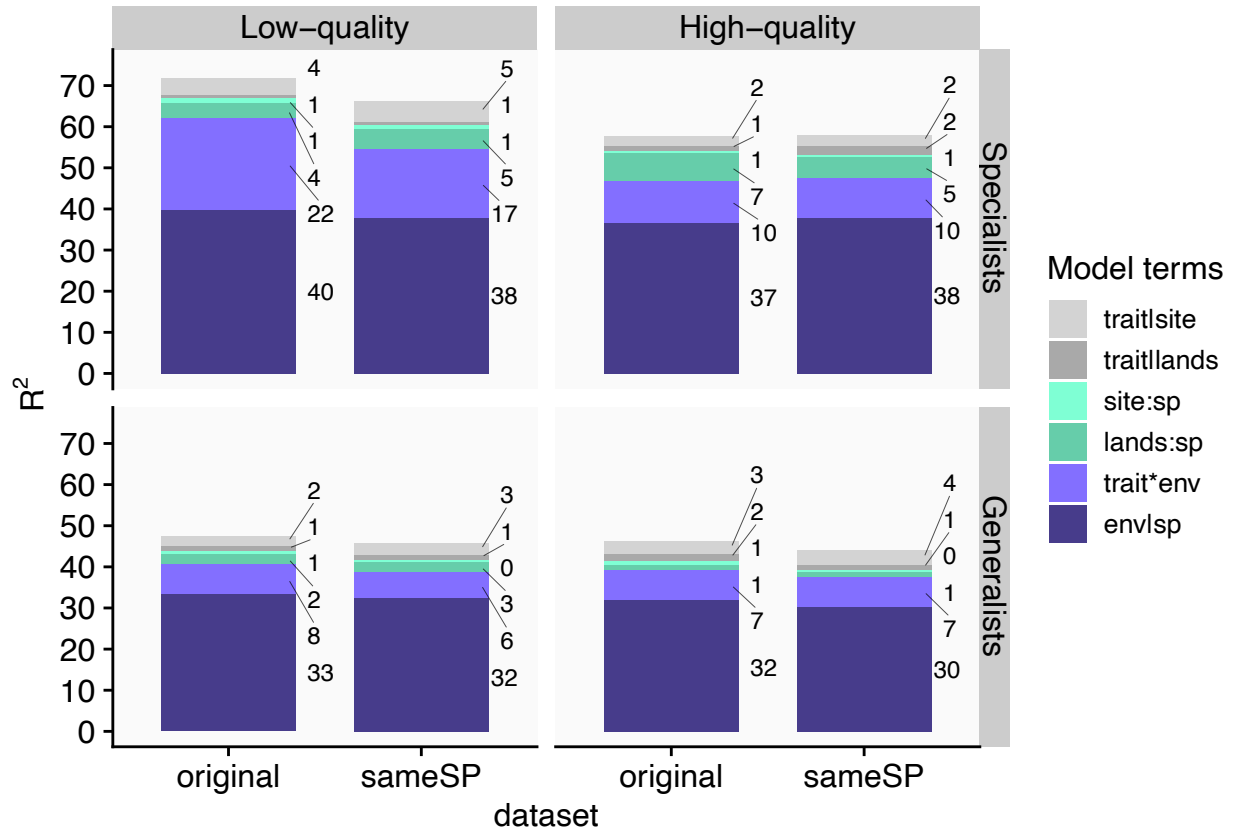
Figure S3.2: Comparing partial R-squares for models terms in both datasets: original with all species (left) and the subset of species that occur at both regions (right).

4. Predictions for each species local forest cover

Predictions of species occurrence probability with forest cover at the local scale for the species that occur at both regions with models fitted for both datasets: the original and the subsets of the same species for forest specialists (3) and habitat generalists (4). Landscape forest cover was fixed in 30%.
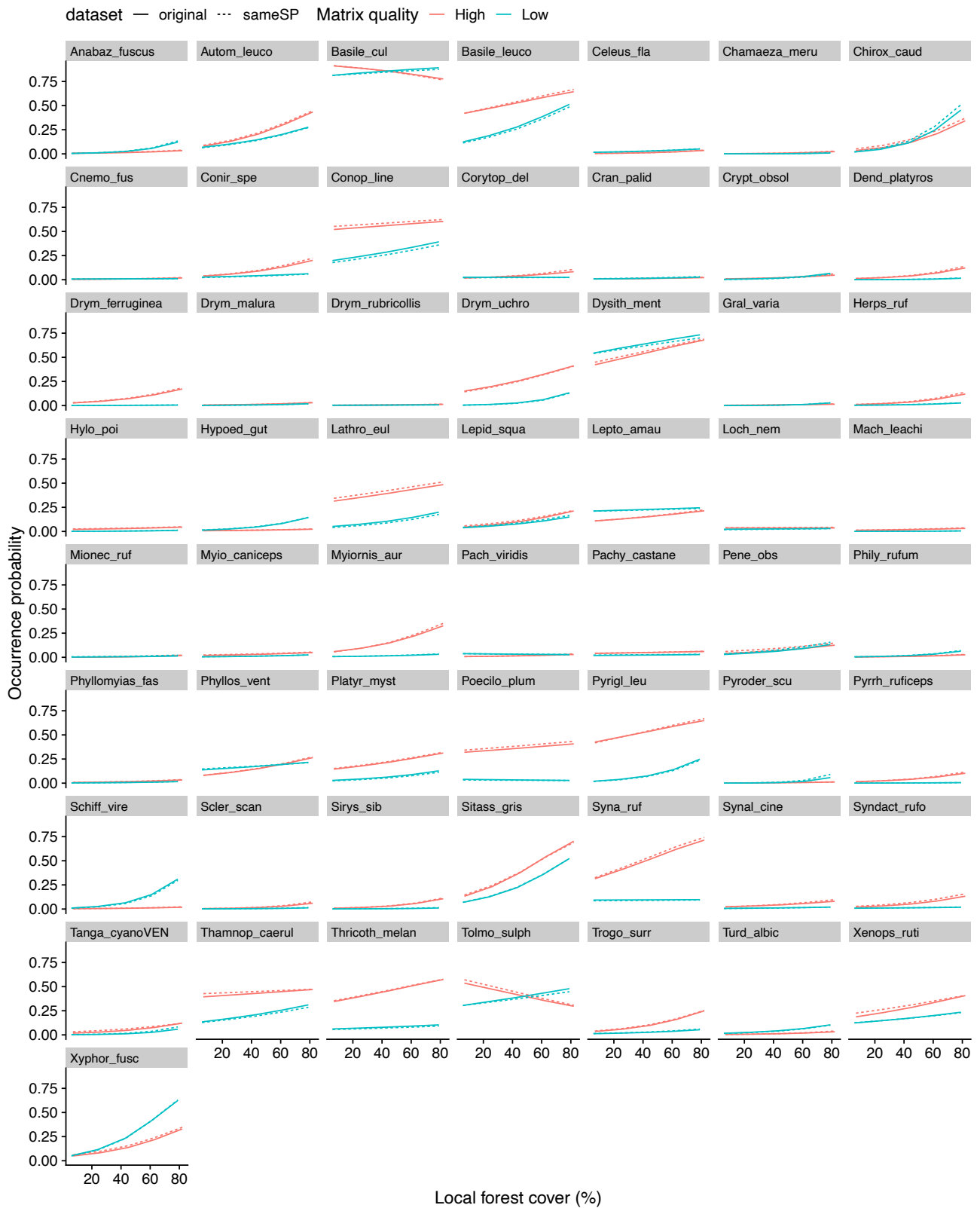
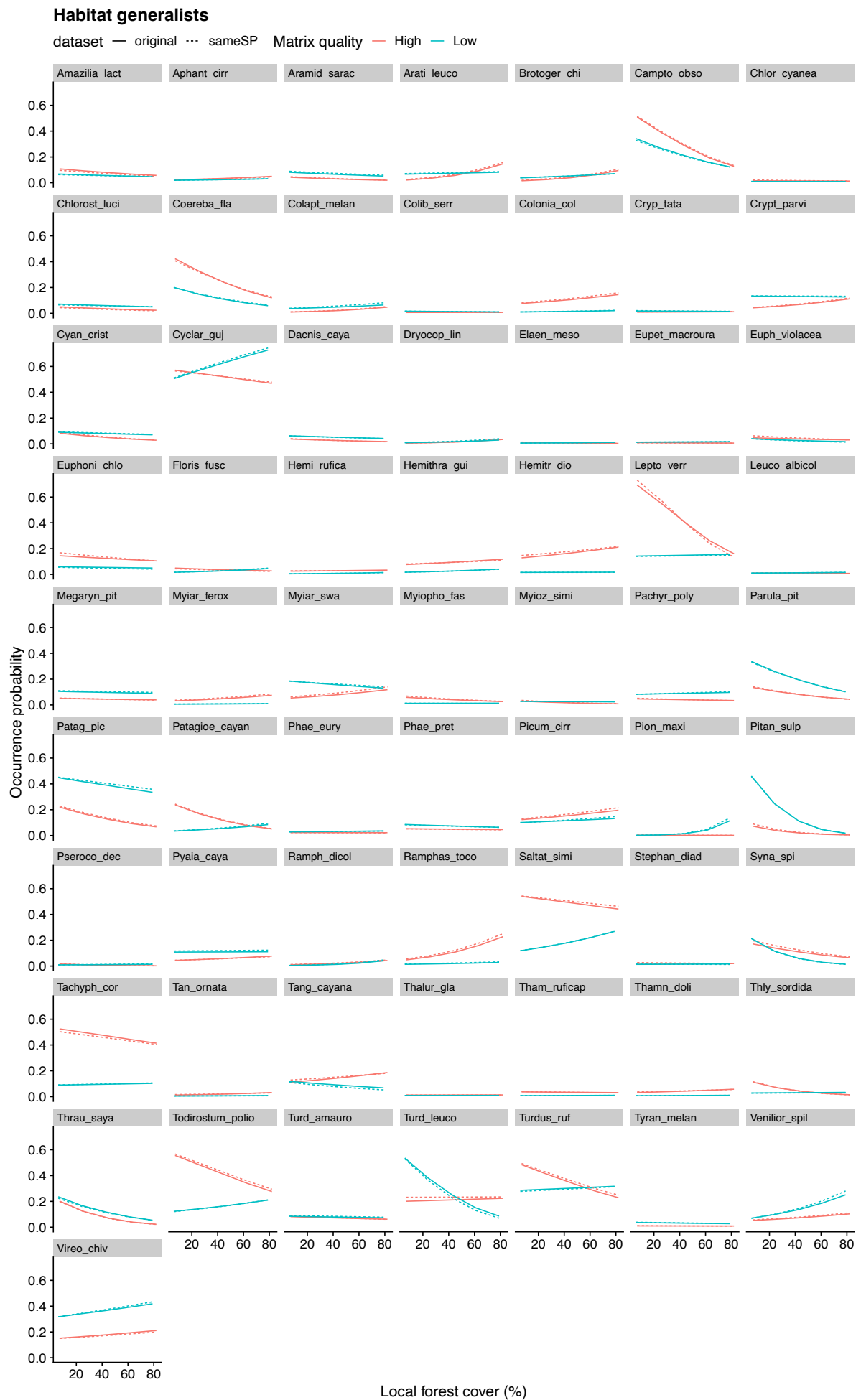Figure S3.3: Predictions for forest specialist birds.

Habitat generalists

Figure S3.4: Predictions for habitat generalist birds.