SUPPLEMENTARY INFORMATION

Landscape Ecology

Landscape contexts shape the effects of local factors on the predation of artificial bird nests in cocoa agroforests

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Appendix A. Scale of landscape effects.

Considering that the effect of landscape variables on biodiversity depends on the spatial scale at which predictors are measured (i.e. the so-called “scale of landscape effects”; sensu Fahrig 2013; Jackson and Fahrig 2015), we estimated native forest cover, number of forest fragments and total forest cover (native forest cover and cocoa cover) within seven different-sized buffers (i.e., landscapes), ranging from 400- to 1000-m radius. Thus, we obtained landscapes of 50.24 ha (400 m), 78.50 ha (500 m), 113.04 ha (600 m), 153.86 ha (700 m), 200.96 ha (800 m), 254.34 ha (900 m) and 314 ha (1000 m). We used Linear Models to identify the landscape size most appropriate to analyze the effect of each landscape variable on the number of predated nests. Following Fahrig (2013) and Jackson and Fahrig (2015), the scale of effect of each landscape predictor was simply defined as the landscape size in which the landscape-response relationship was strongest (i.e., with the highest R^2 and the lowest p-value).

Table A1. Results of association between landscape size and the strength of the relationship (highest R^2 and the lowest p-value) between each landscape variable (native forest cover, number of forest fragments and total forest cover) and response variable (number of predated nest).

Landscape metric	**Buffer size (m)**	**R^2**	**P-value**
Native forest cover	**400**	**0.02**	**0.10**
Native forest cover	500	0.01	0.14
Native forest cover	600	0.02	0.12
Native forest cover	700	0.01	0.15
Native forest cover	800	0.01	0.16
Native forest cover	900	0.01	0.15
Native forest cover	1000	0.01	0.20
Number of forest fragments	400	0.00	0.83
Number of forest fragments	500	0.00	0.76
Number of forest fragments	600	0.01	0.46
Number of forest fragments	700	0.05	0.21
Number of forest fragments	800	0.00	0.88

Number of forest fragments	**900**	**0.05**	**0.19**
Number of forest fragments	1000	0.01	0.51
Total forest cover	**400**	**0.03**	**0.32**
Total forest cover	500	0.02	0.38
Total forest cover	600	0.02	0.42
Total forest cover	700	0.02	0.45
Total forest cover	800	0.01	0.53
Total forest cover	900	0.00	0.65
Total forest cover	1000	0.00	0.79

References

Fahrig L (2013) Rethinking patch size and isolation effects: the habitat amount hypothesis. Journal of Biogeography 40: 1649–1663.

Jackson HB, Fahrig L (2015) Are ecologists conducting research at the optimal scale? Global Ecology and Biogeography 24: 52–63.

Appendix B. Correlation matrix between environmental variables used to assess predation of artificial nests in cocoa agroforests.

Based on the results of the correlation test, we decided not to use the variable 'number of forest fragments' in the statistical models due to its high correlation with the percentage of native forest cover (r = - 0.60).

Table B1. Correlation matrix used to evaluate the correlation between region, local and landscape variables. The value of the correlation coefficient using Pearson's test is presented in each cell.

	Native forest cover	Total Forest cover	Number of forest fragments	Number of understory plants	Number of shade trees	Canopy openness	Number of cocoa trees	Region	Stratum
Native forest cover	1.00	0.43	-0.60	-0.08	0.45	0.33	-0.14	-0.40	0.00
Total forest cover	0.43	1.00	0.07	-0.24	0.13	0.33	0.12	-0.55	0.00
Number of forest fragments	-0.60	0.07	1.00	-0.36	-0.52	0.14	-0.12	0.10	0.00
Number of understory plants	-0.08	-0.24	-0.36	1.00	0.30	-0.38	0.20	0.24	0.00
Number of shade trees	0.45	0.13	-0.52	0.30	1.00	0.22	0.17	-0.29	0.00
Canopy openness	0.33	0.33	0.14	-0.38	0.22	1.00	-0.27	-0.21	0.00
Number of cocoa trees	-0.14	0.12	-0.12	0.20	0.17	-0.27	1.00	-0.14	0.00

Region	-0.40	-0.55	0.10	0.24	-0.29	-0.21	-0.14	1.00	0.00
Stratum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Appendix C. Goodness-of-fit test for parsimonious models

For each model, we indicated AICc value and AICc weight (wi). We also tested the assumptions of the residuals of best models through an advanced diagnostic approach using the 'simulateResiduals' function from the 'DHARMa' package (Hartig and Lohse 2020). This function used the tests of normality (KS test), overdispersion (Dispersion test), and outliers (Outlier test) to assess the adequacy of each model. Significance values ($P \leq 0.05$) indicate that the model did not meet the respective assumption (Da Silva et al. 2022). In the right-hand plot, we conducted a visual analysis to assess the homogeneity of the residuals' variances with respect to the predicted variable. The presence of a red curve in this plot may indicate the lack of homogeneity in variances (Da Silva et al. 2022).

Table C.1 Best models (ΔAIC ≤ 2) used to explain the effect of several environmental predictors on the number of predated nests in 30 cocoa agroforests. We also indicated the AICc value of null model.

Models	AICc	ΔAICc	wi
Model 1= Stratum	558.98	0.00	0.06
Model 2= Region + Stratum	559.68	0.69	0.04
Model 3= Total forest cover : Number of cocoa trees + Stratum	560.10	1.11	0.03
Model 4= Total forest cover + Stratum	560.24	1.25	0.03
Model 5= Native forest cover : Number of understory plants + Stratum + Region	560.42	1.43	0.03
Model 6= Stratum + Number of understory plants	560.70	1.71	0.02
Null model=	562.31	3.33	0.01

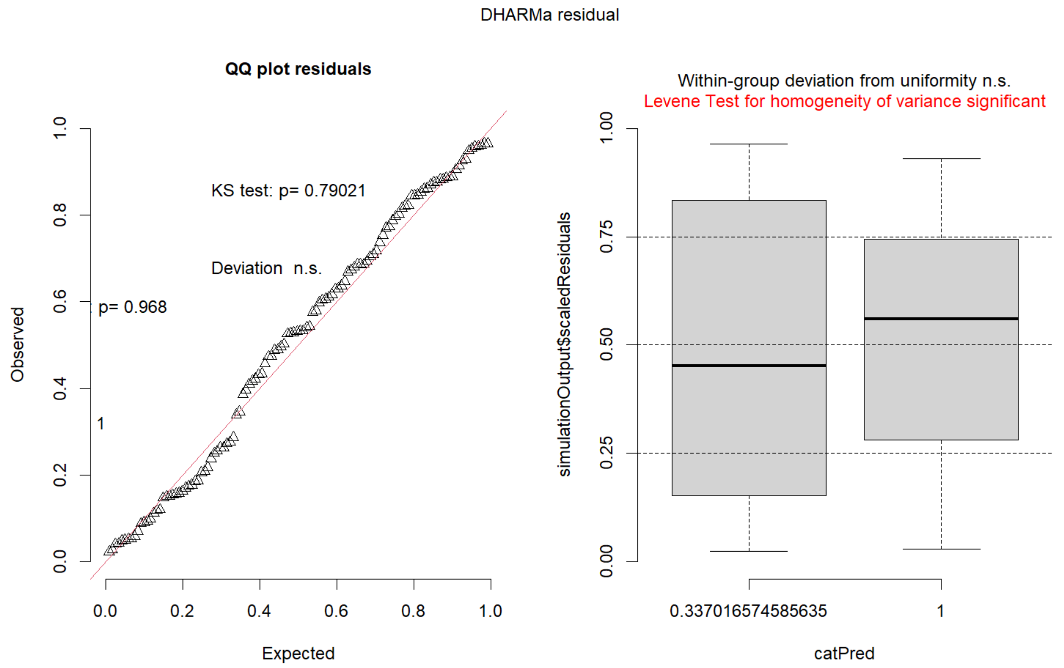

Figure C.1 - Adequacy test of the residuals of model 1.

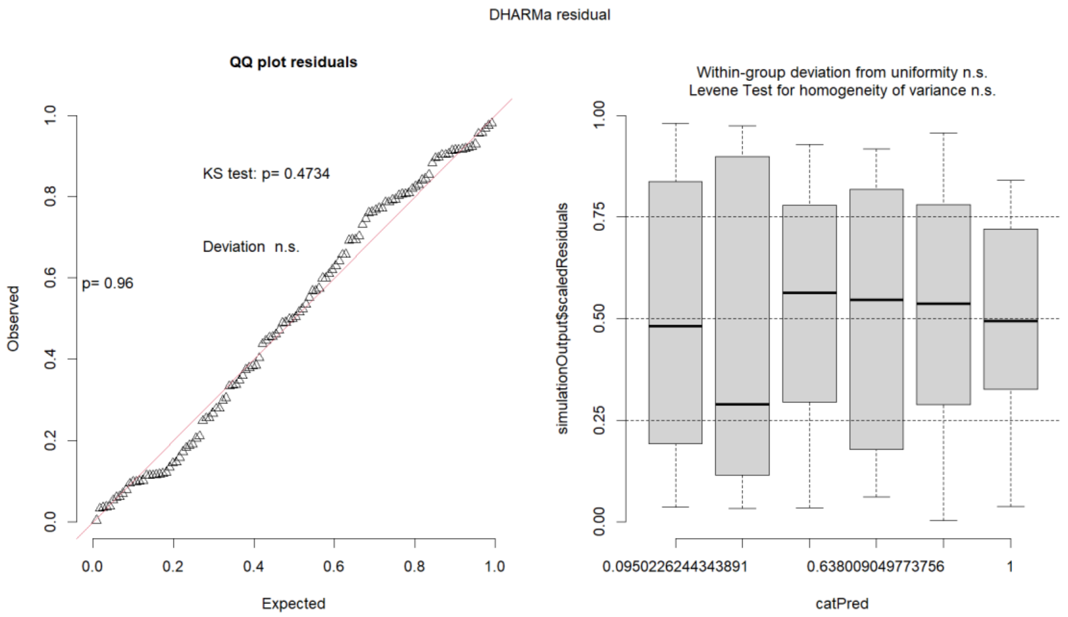

Figure C.2 - Adequacy test of the residuals of model 2.

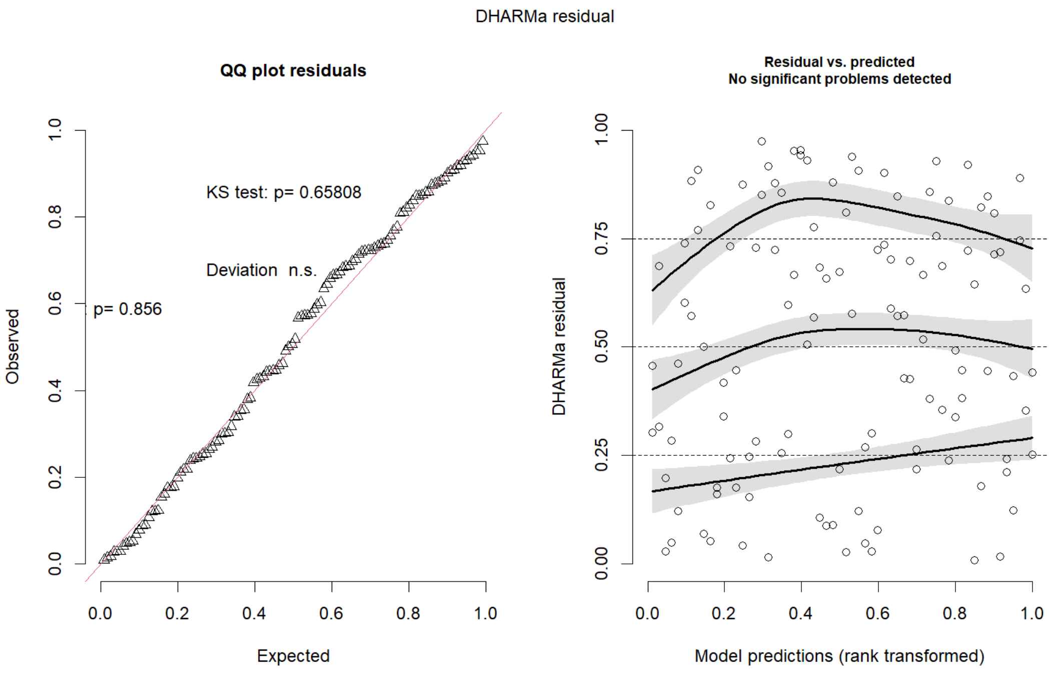

Figure C.3 - Adequacy test of the residuals of model 3.

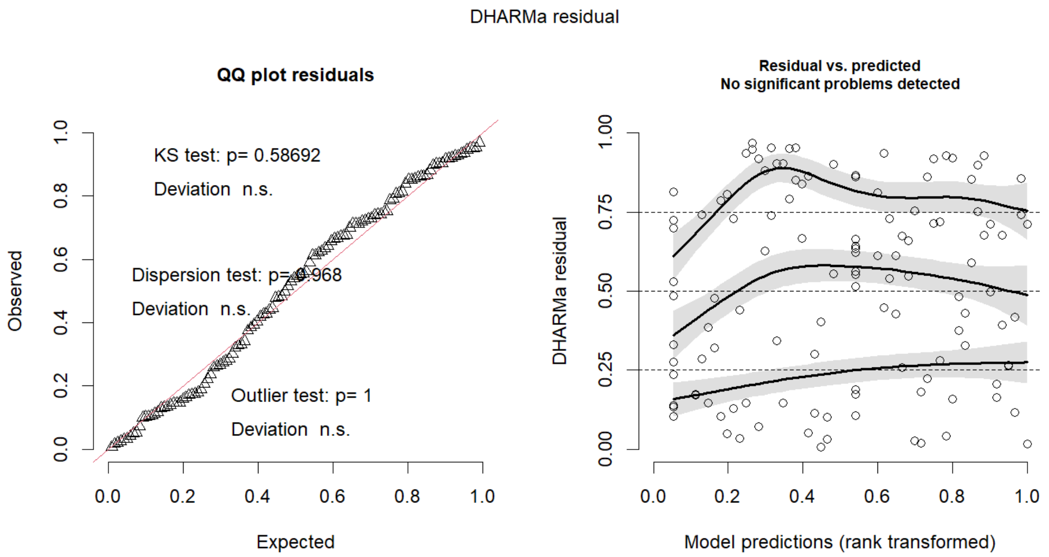

Figure C.4 - Adequacy test of the residuals of model 4.

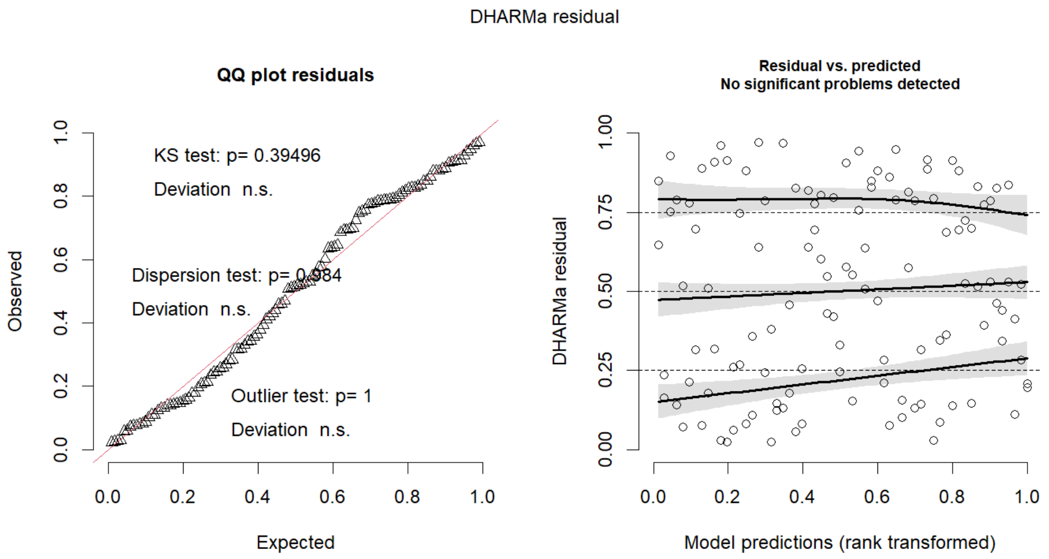

Figure C.5 - Adequacy test of the residuals of model 5.

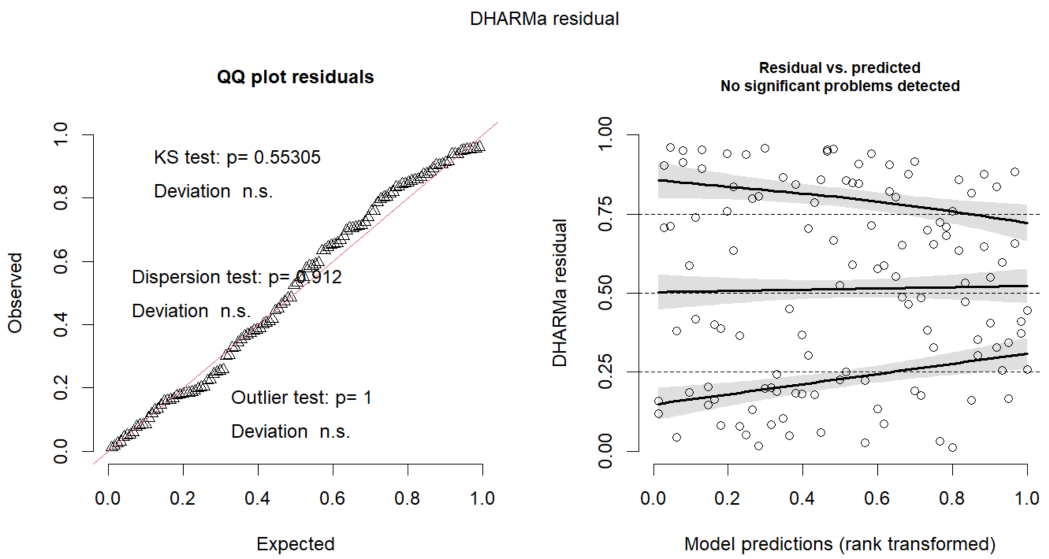

Figure C.6 - Adequacy test of the residuals of model 6.

References

Da Silva FR, Gonçalves-Souza T, Paterno GB, Provete DB, Vancine MH (2022) Análises ecológicas no R. Nupeea : Recife, PE 978-85-7917-564-0.

Hartig F, Lohse L (2020) DHARMa: Residual Diagnostics for Hierarchical (Multi-Level / Mixed) Regression Models.

Appendix D. Overdispersion test

We tested the presence of overdispersion using the 'check_overdispersion' function from the 'performance' package (Lüdecke et al. 2021) in R software (R Development Core Team 2023). This function use a chi-squared distribution and the dispersion ratio value to assess the presence of overdispersion in the model (Da Silva et al. 2022). P- value $\leq$ 0.5 indicates presence of overdispersion (Da Silva et al. 2022).

Table D.1 Overdispersion test on residues of best models (ΔAIC $\leq$ 2) used to explain the effect of several environmental predictors on number of predated nests.

Models	dispersion ratio	Pearson's Chi-Squared	P-value
Model 1= Stratum	0.818	94.915	0.924
Model 2= Region + Stratum	0.857	97.655	0.863
Model 3= Total forest cover : Number of cocoa trees + Stratum	0.868	98.136	0.839
Model 4= Total forest cover + Stratum	0.831	95.592	0.906
Model 5= Native forest cover : Number of understory plants + Stratum + Region	0.901	99.976	0.764
Model 6= Stratum + Number of understory plants	0.823	94.652	0.917

References

Da Silva FR, Gonçalves-Souza T, Paterno GB, Provete DB, Vancine MH (2022) Análises ecológicas no R. Nupeea : Recife, PE 978-85-7917-564-0.

Lüdecke D, Ben-Shachar MS, Patil I, Waggoner P, Makowski D (2021) performance: An R package for assessment, comparison and testing of statistical models. Journal of Open Source Software: 6(60).

R Core Team (2023) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Appendix E. Spatial autocorrelation test

We examined the presence of spatial autocorrelation on residuals of best models ($\Delta AIC \leq 2$) by applying the Moran's I test (Legendre 1993), utilizing the geographic coordinates (latitude and longitude) of the sampling locations where data were collected. Subsequently, we constructed an inverse distance matrix with zero diagonals to account for spatial relationships when conducting the Moran's I test on the residuals of the generalized linear model (GLMM), following the approach outlined in Guisan et al. (2017). In this method, values of $P \leq 0.05$ indicate spatial autocorrelation (Gittleman and Kot 1990).

Table E.1 Spatial autocorrelation test on residues of best models used to explain the effect of several environmental predictors on number of predated nests.

Models	P-value	Moran’s I
Model 1= Stratum	0.403	-0.085
Model 2= Region + Stratum	0.278	-0.100
Model 3= Total forest cover : Number of cocoa trees + Stratum	0.589	-0.067
Model 4= Total forest cover + Stratum	0.518	-0.073
Model 5= Native forest cover : Number of understory plants + Stratum + Region	0.301	-0.097
Model 6= Stratum + Number of understory plants	0.341	-0.092

References

Gittleman JL, Kot M (1990) Adaptation: statistics and a null model for estimating phylogenetic effects. Syst. Zool 39: 227–241.

Guisan A, Thuiller W, Zimmermann NE (2017) Habitat suitability and distribution models: with applications in R. Cambridge University Press.

Legendre P (1993) Spatial autocorrelation: trouble or new paradigm? Ecology 74: 1659–1673.