Appendix A.

Additional information on sampling methodologies

Estimation of tree crop size

At the beginning of the fruiting season, each year, we visually estimated the number of standing fruits on each fruiting tree within the study plot by using a semi-logarithmic scale (*Fruit Abundance Index,* FAI: 1= 1-10 fruits; 2 = 11-100; 3 = 101-1000; 4 = 1001-10000; 5 > 10000). Crop sizes of all trees within the study plot were extrapolated from their FAI ranks, considering the mean value for each rank calculated by using an allometric function fitted to the actual crop size of a sub-sample of trees ($y = 1.765^{(1.924\ FAI)}$; $R^2 = 0.80$; N = 136; Herrera et al. 2011). These trees, representing a balanced number between different study species, were selected across the entire study plot and included from individuals embedded in dense forest patches to trees isolated within pastures. Their actual crop size was calculated before the fruit consumption by birds began, by counting the number of fruits on 15 branches (arbitrarily distributed through the whole crown) and the total number of branches per tree. The individual crop size was estimated by multiplying the average number of fruits per branch by the number of branches per tree (see Martínez et al. 2014 for a similar procedure).

Bird censuses

We performed bird censuses in the study plot to quantify the abundance of frugivorous birds (thrushes) during the fruiting season. Direct observations of thrushes in different sampling cells were made from five different vantage positions in elevated outcrops, located along the central axis of the plot (Appendix A: Fig. 1). The cumulative observation time was of 103, 105, 156 and 215 h for 2008, 2009, 2010 and 2011, respectively. Observations were made from October to February, allocated between stations in a balanced number of 1-h observation periods across each season. In each observation period, the observer, with the help of 8 × 30 binoculars, counted and identified at the species level all thrushes seen (or heard) in different sectors of the area surveyed. Bird sightings were assigned to the different geo-referenced sampling cells covered from each vantage position, with the help of printed maps. In some cases, the consecutive sightings of a given species could have corresponded to the same individuals remaining within, or successively entering a given cell. In these doubtful cases, we considered as independent those sightings separated by at least five minutes. Also, the sightings potentially corresponding to a given individual bird in different cells – or in the same cell on different days – were considered to be as valid as those from different individuals. Due to the elevated location of the vantage positions (ca 70 m of elevation gradient) and the patchy and sparse structure of forest cover, a high visual and/or acoustic detectability of thrushes was achieved across almost the entire plot, even in those cells at a considerable distance away. However, due to the denser forest canopy and topographical features, bird detectability was lower in some of the easternmost cells of the plot (Appendix A: Fig. 1) and therefore, complementary bird observation was accomplished from positions within the forest in these areas (see García & Martínez, 2012 and García et al., 2013 for similar procedure). Twelve forest point-count positions were established, each corresponding to the intersection of a group of four cells (Appendix A: Fig. 1). Observations were made in 10 min periods, recording any thrush heard or seen within the four surrounding cells. Cumulative observation time from each point count was 165, 110, 195 and 230 min for 2008, 2009, 2010 and 2011, respectively. Rather than assessing the actual size of bird populations, our goal was to provide a measure of bird abundance in functional terms, i.e. an estimation of the total activity of frugivorous thrushes throughout the season in the study plot. For this, we used the number of birds (thrushes) per 10-h of observation, estimated as the cumulative number of birds heard or seen in each cell through the season, divided by the total observation time for each cell. Weighting by total observation time per cell enabled the comparison of abundance between cells, correcting for overestimation in those cells observed from different positions and thus accounting for longer observation times, and also between years with different observation efforts.

Classification of big trees

We classified under the category of “big tree” any individual tree simultaneously meeting two requirements:

A) Its top outgrew the average forest canopy by being, at least, 1.5 m taller than the surrounding individuals. We visually assessed this fact in the field. We considered that this height difference might lead these trees to act as milestones, as the forest canopy height is rather homogeneous in the study area (author´s personal observation).

B) The diameter of its crown was wider than 7 m, assessed from the orthophotomap. We considered that this diameter size differentiated a tree from surrounding individuals, as the mean tree crown diameter on the study plot is 3.88 ± 0.04 m (calculated for a subsample of 2407 trees measured in the field; author’s unpublished data).

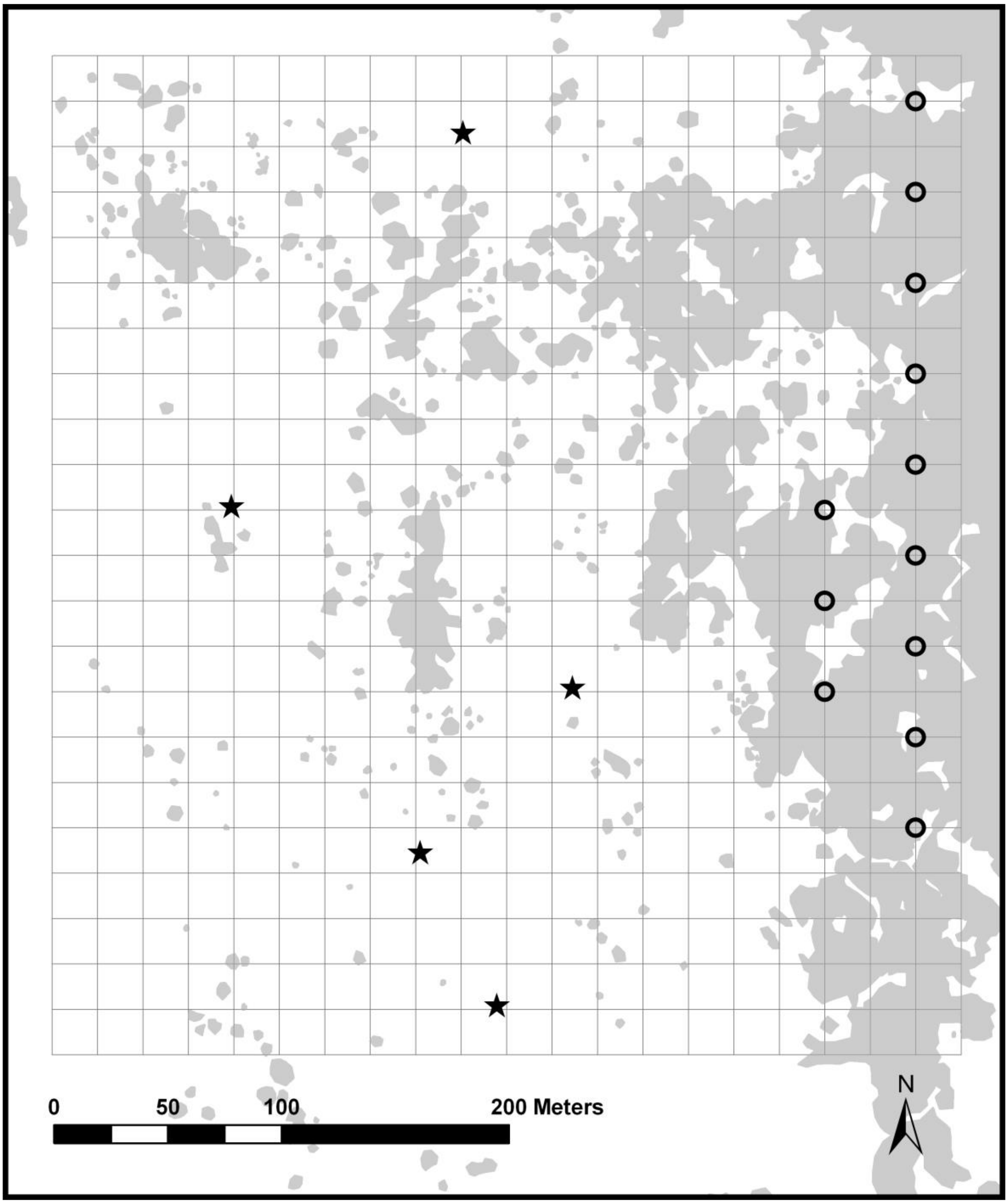

Fig. 1. Map of the study plot, subdivided into 20 × 20 m cells, showing the extent of forest cover (gray area), and the vantage (black stars) and point-count (circles) positions for bird observation.

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Appendix B

Correlation values between forest cover and fruit abundance

Table 1. Pearson´s correlation coefficient (*r*) between forest cover and fruit abundance, for both the complete data set and for only those cells devoid of big trees, are shown for the study years.

Year	All cells	Big tree cells excluded
2008	0.46	0.41
2009	0.68	0.64
2010	0.57	0.51
2011	0.67	0.63

Table 2. Pearson´s correlation coefficient (*r*) between forest cover and fruit abundance, considered at high and low levels of both variables, are shown for the study years.

Year	Low forest cover	High forest cover	Low fruit abundance	High fruit abundance
2008	0.47	-0.01	0.61	0.61
2009	0.47	0.19	0.51	0.27
2010	0.55	-0.01	0.34	0.20
2011	0.45	0.18	0.57	0.37

Table 3. Pearson´s correlation coefficient (*r*) between forest cover and fruit abundance, considered at high and low levels of both variables, are shown for the study years, considering only those cells not presenting big trees.

Year	Low forest cover	High forest cover	Low fruit abundance	High fruit abundance
2008	0.47	0.11	0.62	0.29
2009	0.47	0.25	0.58	0.27
2010	0.55	0.17	0.37	0.28
2011	0.45	0.36	0.59	0.48

Appendix C.

Additional analyses after excluding cells presenting big trees.

Zero-Inflated GLMs

Table 1. Effects of Forest cover and Fruit abundance on bird abundance considering only those cells not presenting big trees (n = 390). Independent Zero-Inflated GLMs were performed for each study year. Maximum likelihood estimates, their standard errors, the values of the *z* statistic and *p* values are shown. McFadden's R^2 value is shown for all models.

2008				$R^2 = 0.21$
	Estimate	Std. Error	z	*p*
Intercept	5.453	0.005	1025.1	< 0.001
Forest cover	0.506	0.004	111.8	< 0.001
Fruit abundance	0.113	0.007	16.2	< 0.001
Forest cover × fruit abundance	-0.028	0.005	-5.8	< 0.001
2009				$R^2 = 0.28$
	Estimate	Std. Error	z	*p*
Intercept	5.808	0.004	1325.2	< 0.001
Forest cover	0.502	0.004	113.7	< 0.001
Fruit abundance	0.469	0.005	96.9	< 0.001
Forest cover × fruit abundance	-0.264	0.004	-69.3	< 0.001
2010				$R^2 = 0.08$
	Estimate	Std. Error	z	*p*
Intercept	5.066	0.006	805.8	< 0.001
Forest cover	0.326	0.007	48.4	< 0.001
Fruit abundance	0.155	0.006	25.4	< 0.001
Forest cover × fruit abundance	-0.149	0.005	-27.1	< 0.001
2011				$R^2 = 0.29$
	Estimate	Std. Error	z	*p*
Intercept	5.479	0.005	1094.1	< 0.001
Forest cover	0.749	0.005	156.3	< 0.001
Fruit abundance	0.325	0.005	70.6	< 0.001
Forest cover × fruit abundance	-0.237	0.003	-82.5	< 0.001

Spatial simultaneous autoregressive models

As the sampling design of our study is based on different adjacent cells of the study plot (Appendix A: Fig. 1), our analyses may be influenced by spatial trends existing in studied variables (Legendre 1993). Because of that reason, the effects of forest cover and fruit abundance on bird abundance may have been estimated incorrectly in the Zero-Inflated GLMs due to presence of spatial autocorrelation in the response variable (Keitt et al. 2002). Thus, to check for consequences of spatial constraints in the previous models, we fitted simultaneous autoregressive models (SAR; Keitt et al. 2002). Zero-Inflated GLMs are models controlling for excessive zero values in the response variable, thus we also performed SAR models excluding *open* cells (those with no forest cover), as these were responsible for increasing the frequency of zero values (Fig. 1 in the main text). SAR models were performed with SAM 3.0 software (Rangel et al. 2006).

Table 2. Results of spatial simultaneous autoregressive (SAR) models verifying the effects of forest cover, fruit abundance and the interaction term between them on the abundance of frugivorous birds, considering sampling cells devoid of big trees (N = 390). Independent SAR models were performed for each study year. The values of the partial regression coefficients, their standard errors, the values of the *t* statistic and *p* values are shown, together with the proportion of variance explained (R^2).

2008				$R^2 = 0.43$
	Estimate	Std. Error	t	*p*
Intercept	-0.312	0.922	-0.339	0.735
Forest cover	1.240	0.228	5.429	< 0.001
Fruit abundance	1.145	0.127	9.064	< 0.001
Forest cover × fruit abundance	-0.467	0.123	-3.803	< 0.001
2009				$R^2 = 0.56$
	Estimate	Std. Error	t	*p*
Intercept	-1.487	0.892	-1.667	0.096
Forest cover	1.698	0.151	11.245	< 0.001
Fruit abundance	1.145	0.197	5.823	< 0.001
Forest cover × fruit abundance	-0.593	0.110	-5.397	< 0.001
2010				$R^2 = 0.34$
	Estimate	Std. Error	t	*p*
Intercept	0.856	0.912	0.939	0.348
Forest Cover	1.212	0.143	8.459	< 0.001
Fruit abundance	0.876	0.148	5.932	< 0.001
Forest cover × fruit abundance	-0.455	0.090	-4.580	< 0.001
2011				$R^2 = 0.48$
	Estimate	Std. Error	t	*p*
Intercept	-0.678	0.872	-0.788	0.437
Forest Cover	1.625	0.145	11.245	< 0.001
Fruit abundance	0.822	0.168	4.900	< 0.001
Forest cover × fruit abundance	-0.378	0.076	-5.000	< 0.001

Table 3. Results of spatial simultaneous autoregressive (SAR) models verifying the effects of forest cover, fruit abundance and the interaction term between them on the abundance of frugivorous birds, considering sampling cells presenting forest cover but devoid of big trees (N = 260). Independent SAR models were performed for each study year. The values of the partial regression coefficients, their standard errors, the values of the *t* statistic and *p* values are shown, together with the proportion of variance explained (R^2).

2008				$R^2 = 0.42$
	Estimate	Std. Error	t	*p*
Intercept	-0.048	1.028	-0.046	0.963
Forest cover	1.047	0.250	5.921	< 0.001
Fruit abundance	0.956	0.161	4.195	< 0.001
Forest cover × fruit abundance	-0.433	-0.190	-2.555	0.011
2009				$R^2 = 0.55$
	Estimate	Std. Error	t	*p*
Intercept	-0.398	0.978	-0.407	0.684
Forest cover	1.361	0.176	7.720	< 0.001
Fruit abundance	0.884	0.218	4.060	< 0.001
Forest cover × fruit abundance	-0.530	0.150	-3.525	< 0.001
2010				$R^2 = 0.25$
	Estimate	Std. Error	t	*p*
Intercept	3.796	1.012	3.749	< 0.001
Forest Cover	0.994	0.169	5.886	< 0.001
Fruit abundance	0.695	0.173	4.017	< 0.001
Forest cover × fruit abundance	-0.343	0.128	-2.680	0.008
2011				$R^2 = 0.48$
	Estimate	Std. Error	t	*p*
Intercept	0.869	0.955	0.911	0.363
Forest Cover	1.337	0.171	7.831	< 0.001
Fruit abundance	0.595	0.186	3.193	0.002
Forest cover × fruit abundance	-0.327	0.103	-3.163	0.002

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Appendix D.

Between-year variations in fruit and frugivorous bird abundance

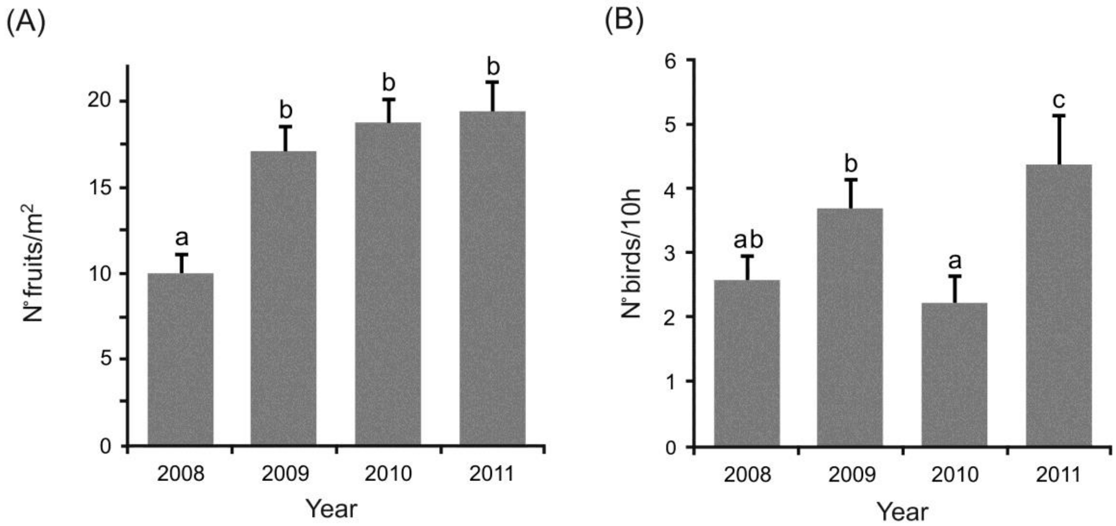

Fig. 1. (A) Mean fruit abundance per m^2 (± Standard Error, SE) across years. (B) Mean abundance of frugivorous birds per cell (nº birds/10h, ± SE) across years. In both parameters, years with significant differences are denoted with different letters (between groups differences *t* test in the GLM).