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abstract protons faster from the cytoplasmic than from the periplasmic side. The rate of proton abstraction must be reversed for NO intermediates, perhaps because a high pK_a value prohibits protonation from a donor loaded from the cytoplasm (33, 34). How these intricate processes are spatially and temporally coordinated on an atomic scale remains open. The structure will, however, facilitate focused site-directed mutagenesis and functional experiments that will contribute to a better understanding of the fundamental HCO reaction and of redox-driven proton translocation processes in general.

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- This work was supported by the Max Planck Society, the Deutsche Forschungsgemeinschaft (SFB 472), and the Cluster of Excellence Macromolecular Complexes Frankfurt. We thank the staffs of the Swiss Light Source and the European Synchrotron Radiation Facility for assistance. Coordinates and structure factors of *cbb3* oxidase of *P. stutzeri* have been deposited under the pdb accession code 3MK7, the nucleotide sequences under gene bank accession number HM130676.

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Figs. S1 to S3

Table S1

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20 January 2010; accepted 4 June 2010

Published online 24 June 2010;

10.1126/science.1187303

Include this information when citing this paper.

Asymmetric Density Dependence Shapes Species Abundances in a Tropical Tree Community

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The factors determining species commonness and rarity are poorly understood, particularly in highly diverse communities. Theory predicts that interactions with neighbors of the same (conspecific) and other (heterospecific) species can influence a species' relative abundance, but empirical tests are lacking. By using a hierarchical model of survival for more than 30,000 seedlings of 180 tropical tree species on Barro Colorado Island, Panama, we tested whether species' sensitivity to neighboring individuals relates to their relative abundance in the community. We found wide variation among species in the effect of conspecific, but not heterospecific, neighbors on survival, and we found a significant relationship between the strength of conspecific neighbor effects and species abundance. Specifically, rare species suffered more from the presence of conspecific neighbors than common species did, suggesting that conspecific density dependence shapes species abundances in diverse communities.

An understanding of the causes of commonness and rarity in ecological communities is essential for determining how communities are structured and for designing

effective strategies for biodiversity conservation (1–3). However, such understanding has eluded scientists (3–5), particularly in highly diverse communities such as tropical forests (6), where hundreds of species coexist with abundances that vary by several orders of magnitude. In these communities, individuals that are surrounded by neighbors of the same species (that is, conspecifics) often exhibit lower growth and survival (7–11). This phenomenon is attributed to shared natural enemies or strong intraspecific competition for resources (12, 13). Many studies have emphasized the importance of such negative density dependence (NDD) for species coexistence

(14–17), yet little attention has been paid to variation among species in the strength of NDD experienced and the possible consequences of that variation for determining species abundances (11).

The strength of NDD that is experienced by a species, defined here as the degree to which an individual's probability of survival is reduced by the addition of a conspecific neighbor, could, in theory, be positively or negatively related, or unrelated, to species abundance in natural communities. First, rare species may be rare because they suffer more when local densities are high (11), resulting in a positive relationship between the effect of conspecific neighbors and species abundance in the community (that is, more-common species are less negatively affected by conspecifics). Alternatively, rare species may occur at densities that are too low to sustain viable populations of specialist enemies (18) and thus may be less affected by density dependence than more-common species are (19). Another possibility is that the strength of NDD varies among species but shows no relationship to species abundance in the community. Species abundance is influenced by a number of factors, including habitat affinity (2), regeneration requirements (20), and resource use (21), which could override the effect of NDD on abundance. Landscape-scale processes, such as predator satiation and long-distance seed dispersal (22, 23), may further decouple the relationship between species abundance and NDD, which typically acts over smaller spatial scales [<30 m (11)].

To evaluate these competing hypotheses, we used a hierarchical Bayesian approach (24)

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to analyze recently collected data from 20,000 1-m² seedling plots in the lowland tropical forest of Barro Colorado Island (BCI), Panama. We specifically evaluated how survival was influenced by the density and identity of neighboring seedlings and trees. A key challenge in quantifying interspecific variation within diverse plant communities is that many species occur at extremely low densities, making it infeasible to collect sufficient data for meaningful statistical analyses at the species level for most species (25). Previous studies of density dependence have dealt with this by limiting analyses to the most abundant species in the community [for example (15, 16)] or lumping species into broad functional groups [for example, (8)] or abundance classes [for example, (11)]. In contrast, our hierarchical (that is, mixed model) approach allows us to quantify the distribution of density-dependent effects and their relationship to abundance across the entire community, including rarer species, while properly accounting

for differences in sample size, and thus confidence (25), among the 180 tree species encountered. We used a two-level hierarchical model in which individual survival is a species-specific function of the density of conspecific and heterospecific neighbors, and species-level parameters are functions of species abundance in the community (26). We also included shade tolerance as a species-level covariate in the model, because shade tolerance may influence both species abundance and the strength of NDD in tropical tree communities (27, 28). In this way, we not only quantified the strength and variation of NDD for the community but also tested whether variation in the effect of neighbors among species is related to differences in relative abundance or life-history strategy (specifically, shade tolerance).

We found significant variation in the strength of NDD among tree species in the BCI forest (Fig. 1). At the community level, both conspecific seedling and conspecific adult neighbors had a significant negative effect on the probabil-

ity of seedling survival (Table 1). The strength of conspecific neighbor effects varied widely among species but was overwhelmingly negative (Fig. 1, A and B, and table S2). In contrast, effects of heterospecific seedling and adult neighbors were close to zero, with community-level means weakly positive (Fig. 1, C and D, and table S2). Compared with the variation in conspecific neighbor effects, heterospecific neighbor effects varied little among species (Fig. 1). Thus, our results suggest a limited role for heterospecific density in driving patterns of seedling survival, although heterospecific neighbors may have stronger effects at later life stages.

A significant portion of the variation among species in conspecific neighbor effects was explained by species abundance in the community. The effect of conspecific neighbors on survival was significantly and positively related to species abundance, with less-common species experiencing stronger NDD (Table 1 and Fig. 2). This relationship was found for both seedling and adult neighbors, with stronger statistical support at the seedling stage (Table 1). In principle, these relationships might be driven by shade tolerance, because light-demanding species are expected to be both rarer and more vulnerable to natural enemy attack than shade-tolerant species are (29). However, we found that species shade tolerance explained little of the variation in the strength of conspecific neighbor effects (Table 1). Conversely, effects of heterospecific neighbors were not related to species abundance in the community but were related to shade tolerance (Table 1), which is consistent with the fact that light-demanding species are more sensitive to shading by neighbors. Thus, our results indicate that species interactions with conspecific, but not heterospecific, neighbors influence species relative abundance, and this relationship is not explained by variation in species shade tolerance.

In the BCI tree community, species abundances range over more than four orders of magnitude (table S1). Our results indicate that this variation can be explained, in part, by variation in the strength of NDD experienced by species. These results suggest that local-scale density dependence constrains a species' abundance in a community and that these constraints vary among species. In our system, the most common species are those whose seedling survival is minimally affected by the local density of conspecific neighbors. In contrast, species having a strong impact on themselves typically occur at lower abundances.

Negative conspecific effects have been linked to abundance in a previous study of native and invasive species in a temperate old field (a post-agriculture successional community) (30), in which abundance was negatively related to the rate and degree to which species accumulated host-specific pathogens in the soil. Our results indicate that the extent to which species inhibit their own regeneration shapes species abundances not only during succession and invasion, but also in intact systems. In addition, given that previous studies of NDD have typically focused on the most common

Fig. 1. (A to D) Distribution of effects of conspecific and heterospecific neighbors on seedling survival. Histogram bars are based on posterior means of coefficients for 180 tree species in central Panama. Bars to the left of the dashed zero line indicate species whose survival is reduced by increasing density of neighbors. The same scale is used for the x axis in all panels to facilitate comparisons.

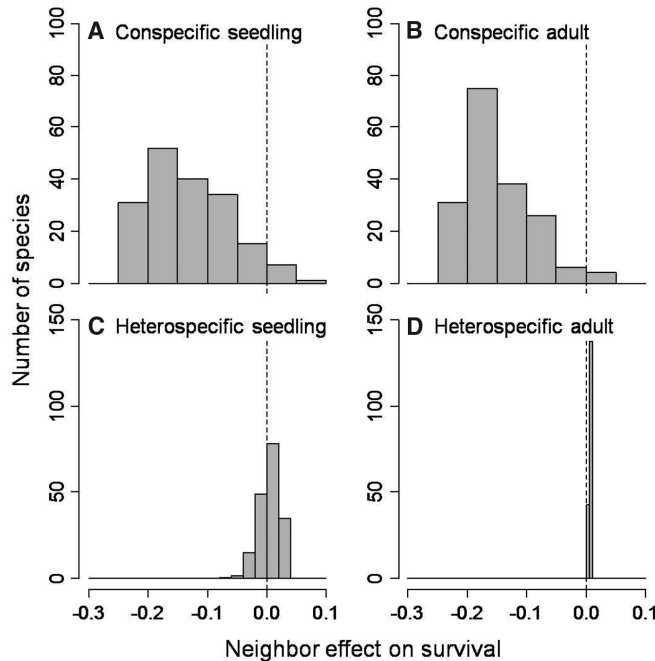
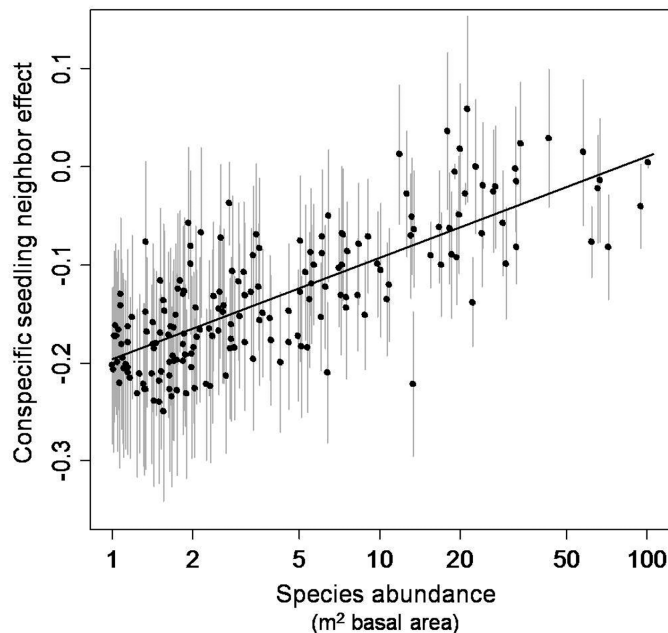


Table 1. Coefficient means (± 1 SD) from the hierarchical Bayesian model of seedling survival. Survival was modeled as a function of the density of neighboring conspecific (CON) and heterospecific (HET) seedlings (S) and adult tree basal area (BA). The probability of survival (p) for a seedling of species j in plot k was modeled as $\text{logit}(p_{j,k}) = \beta_{0j} + \beta_{1j} \times \text{CONS}_{j,k} + \beta_{2j} \times \text{HETS}_{j,k} + \beta_{3j} \times \text{CONBA}_{j,k} + \beta_{4j} \times \text{HETBA}_{j,k} + \phi_k$, where ϕ_k is a random effect for seedling plot. Values for each parameter (β_m) varied among species, and were modeled as functions of size-weighted species abundance (ABUND) and shade tolerance (SHADE), where $\beta_{mj} = \gamma_{m0} + \gamma_{m1} \times \text{ABUND}_j + \gamma_{m2} \times \text{SHADE}_j$. Means were calculated from posterior distributions. Bold values are significantly different from zero (based on 95% credible intervals). Species information and species-specific estimates are presented in tables S1 and S2.

Survival model parameters	Intercept (γ_0)	Species-level predictors	
		Abundance (γ_1)	Shade tolerance (γ_2)
Intercept (β_0)	-1.464 (0.285)	0.120 (0.146)	0.598 (0.141)
Conspecific seedling effect (β_1)	-0.133 (0.036)	0.045 (0.019)	-0.029 (0.016)
Heterospecific seedling effect (β_2)	0.005 (0.006)	-0.004 (0.003)	0.013 (0.005)
Conspecific adult effect (β_3)	-0.150 (0.037)	0.032 (0.019)	0.008 (0.023)
Heterospecific adult effect (β_4)	0.006 (0.001)	-0.001 (0.001)	0.001 (0.001)

Fig. 2. The mean strength of conspecific NDD exhibited by individual tree species on BCI (points; vertical gray lines show ± 1 SD) is significantly related to size-weighted species abundances in the 50-ha Forest Dynamics Plot. The overall relationship fitted by the hierarchical Bayesian model is strongly positive (black line), indicating that rare species experience stronger density dependence than common species do.



species in the community, which we show exhibit the least NDD, our results indicate that past studies probably underestimated both the variation and the mean strength of density dependence in plant communities.

The mechanisms underlying the observed NDD are an important area for future investigation. In tropical forests, negative effects of conspecific neighbors are commonly thought to result primarily from density-dependent, host-specific natural enemies (12, 13), with several studies suggesting that soil pathogens play a key role at the seedling stage (23). Recent field and growing-house experiments on a subset of the species analyzed here found that soil pathogens were key drivers of density dependence, with a significant relationship between species sensitivity to negative plant-soil feedbacks and species abundance in the forest (31), which is consistent with the results presented here. Strong intraspecific competition for shared resources could, in theory, also contribute to density dependence, but probably plays a small role in explaining the patterns we found, because competition between seedlings has been shown to be weak or nonexistent in tropical forests (32). Within communities, differences among species in vulnerability to natural enemies could relate in part to the degree to which species are well adapted to the local environment; that is, species at the edge of their habitat tolerances may be more vulnerable to or less able to recover from attack. Regardless of the specific mechanisms operating, the clear negative effect of conspecific neighbor densities across the community emphasizes the importance of local-scale interactions in driving spatial patterns of survival and shaping species abundances in tropical forests.

The significant variation in NDD among species reported here and its relationship to abundance suggest that theoretical models of plant communities should incorporate this asymmetry.

Current models that include NDD almost invariably assume that it is identical in strength across all species (33). One such model, the symmetric density-dependent neutral model (34), nonetheless succeeds in providing a good fit to the species-abundance curve for the BCI tree community and other tropical forests, but recent studies show that fits to species abundance distributions are not strong tests of theoretical models, because models with different underlying mechanisms can provide equally good fits (21, 35). That we found the strength of NDD to be related to species abundance confirms that the variation in NDD is not only statistically significant but also biologically meaningful. This underscores the need to incorporate species asymmetry into future theoretical efforts (33). Understanding of the processes structuring diverse communities may be better advanced by shifting focus away from the shape of the species-abundance curve to assessing what determines the position of species on the curve (35).

Our results also have important implications for biodiversity conservation. Understanding the drivers of species abundance is critical for identifying and protecting rare species that have an inherently higher risk of extinction (2). Previous efforts to identify key traits that correlate with species rarity have had limited success (3, 5). The results here suggest that such studies should look beyond morphological and physiological traits to include species sensitivity to biotic interactions, namely, the degree to which species inhibit their own regeneration.

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Fig. S1
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12 April 2010; accepted 10 June 2010

Published online 24 June 2010;

10.1126/science.1190772

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Asymmetric Density Dependence Shapes Species Abundances in a Tropical Tree Community

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Published 24 June 2010 on *Science Express*
DOI: 10.1126/science.1190772

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Materials and Methods

Data collection - The study was conducted in the predominantly old-growth, lowland, moist tropical forest of the Barro Colorado Island 50-ha Forest Dynamics Plot, Panama (BCI FDP) (S1). The BCI FDP is part of the Center for Tropical Forest Science, a global network of large-scale demographic tree plots (S2). Within the BCI FDP, all saplings and adult trees ≥ 1 cm DBH (diameter at 1.3 m above ground) have been mapped, measured and identified to species at ~ 5 yr intervals (S3). In 2001, we initiated an annual census of free-standing woody seedlings (≥ 20 cm tall and < 1 cm DBH) in 20,000 1×1 m² quadrats spaced at 5-m intervals within the BCI FDP (S4-6). Using data on 30,975 seedlings of all 180 tree species encountered in the initial seedling census (see Table S1), we examined the probability of a seedling surviving from 2001 to 2006 as a function of the density and identity of neighboring seedlings and trees.

Neighbor densities - Seedling neighbor density was calculated as number of conspecific and heterospecific seedlings within the same 1×1 m seedlings plot as the focal individual. Shrub and liana seedlings, which are monitored in the censuses, were included in calculations of heterospecific neighbor densities, but only tree seedlings were included as focal individuals in the analysis. We used data from the BCI FDP 2000 tree census (S7) to calculate basal area of trees ≥ 1 cm DBH within 30 m of each focal seedling. The cut-off of 30 m was selected because previous studies from this forest have shown that conspecific neighbor effects drop off quickly with distance and are typically not significant beyond 30 m (S8). Seedling plots within 30 m of the edge of the 50-ha FDP were excluded from the analysis.

Since the effect of neighboring trees on seedling survival is expected to decline with distance, we performed preliminary analyses to quantify the decay with distance. We first calculated the sum of the basal area of trees ≥ 1 cm DBH in 1-m bands around each focal seedling out to a distance of 30 m. We then used a generalized linear model (GLM) with binomial errors to model seedling survival from 2001 to 2006 as a function of conspecific and heterospecific seedling neighbors and the basal area of conspecific and heterospecific trees in each of the thirty 1-m bands. The values for neighbor effects in each 1-m band are shown in Fig. S1. Visual inspection of the results suggested an exponential decay in adult neighbor effect with distance, of the form:

$$\alpha * \sum [BA * \exp(-\beta * \text{distance})]$$

Because of parameter trade-offs between the total effect of neighbors (α) and the decay with distance (β), it was difficult to simultaneously estimate both values. Thus, we determined the optimal value for the exponential decay by comparing models with differing values for β . We compared models using the values of β listed in Table S3. AIC values indicated that $\beta=0.2$ gave the best fit (Table S3, Fig. S1).

Species abundance - The abundance of each species in the community was calculated as the sum of the basal area (cross-sectional area of the trunk) of individuals ≥ 1 cm DBH within the entire BCI 50-ha Forest

Dynamics Plot, based on diameter measurements taken in the 2000 census (see Supplementary Table 1). We chose to use basal area as a measure of abundance since it correlates significantly with numerical abundance ($r=0.60$, $P<0.001$; log-log scale), but is a better descriptor of the amount of space and resources a species is using. Further, it is not as influenced by differences in size class distributions (S9), which tend to be skewed and vary with life history strategy in tropical tree communities (S10). Values of size-weighted species abundance (basal area) were log-transformed before entering the model.

Shade tolerance - Shade tolerance is mediated by a trade-off between growth and survival (S10-S12), with light demanding species having higher mortality and growth rates than shade tolerant species. Therefore, we used the first axis of a principle components analysis (PCA) of growth and mortality rates for species in the BCI plot as an index of species' shade tolerance (see Supplementary Table 1). We used the mean mortality and growth rates from 2000 to 2005 for saplings 1-5 cm DBH reported in Condit *et al.* (S13). Shade tolerance was significantly correlated with numerical abundance ($r=0.30$, $P<0.001$), largely due to variation in size class distributions with life history strategy, as mentioned above (i.e., shade-tolerant species have more saplings in the understory than light-demanding species). However, using size-weighted species abundance removed the correlation between shade tolerance and abundance ($r=-0.02$, $P=0.80$).

Survival model - We used a hierarchical Bayesian approach (S14) that allowed for variation among species in the effects of conspecific and heterospecific neighbors on survival. Our hierarchical model included both individual-level and species-level regressions. In the individual-level regression, survival (s) of an individual seedling i , of species j , in plot k , over the 5-yr study period was modeled as a function of the neighborhood densities of conspecific (CONS) and heterospecific (HETS) seedlings and conspecific (CONBA) and heterospecific (HETBA) adult trees:

$$s_{ijk} = \text{Bernoulli}(p_{jk}), \quad (1)$$

$$\text{logit}(p_{jk}) = \beta_{0j} + \beta_{1j} \cdot \text{CONS}_{jk} + \beta_{2j} \cdot \text{HETS}_{jk} + \beta_{3j} \cdot \text{CONBA}_{jk} + \beta_{4j} \cdot \text{HETBA}_{jk} + \phi_k, \quad (2)$$

which includes a random effect for seedling plot, where $\phi_k \sim \text{Normal}(0, \sigma_\phi)$. The random plot effect was incorporated to control for spatial autocorrelation (i.e. non-independence) in survival of seedlings within 1-m² quadrats.

In the species-level regression, the vector of coefficients (β_{0-4} , from eq. 2) of each species j was modeled as a function of species' log abundance in the community (ABUND) and shade-tolerance (SHADE):

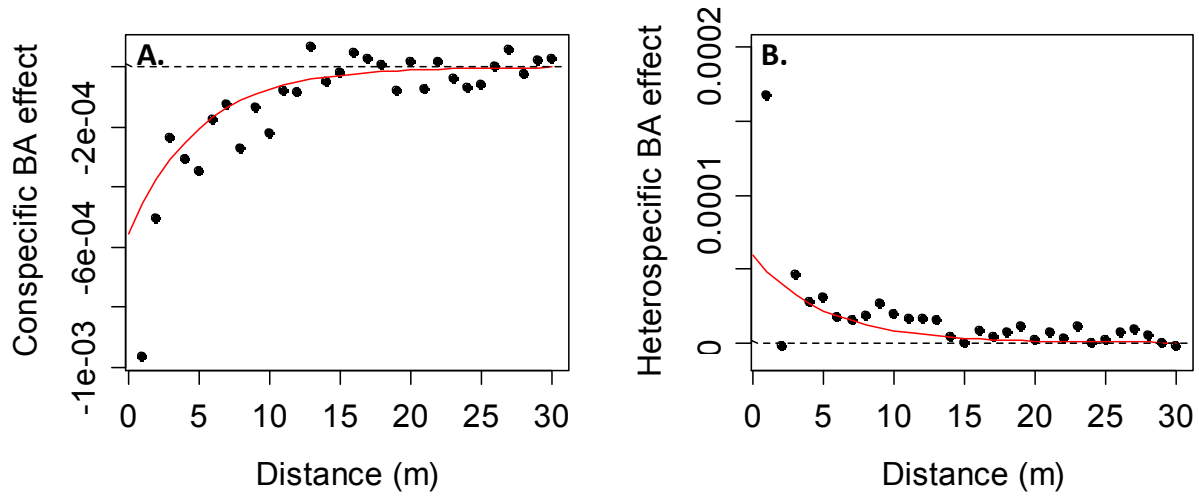
$$\beta_{mj} = \gamma_{m0} + \gamma_{m1} \cdot \text{ABUND}_j + \gamma_{m2} \cdot \text{SHADE}_j + \sum_{\beta} \quad (3)$$

where values of β_j are modeled using a multivariate normal distribution with the covariance matrix, \sum_{β} , modeled using a scaled inverse-Wishart distribution (S14). All individual- and species-level coefficients were assigned non-informative priors, and were recentered prior to entering the model in order to reduce correlations and

speed convergence of the Gibbs sampling algorithm (S14). Model simulations were run in WinBUGS 1.4.3 (S15). We assessed convergence by running two independent chains with differing initial values and using the Gelman-Rubin statistic, as modified by Brooks and Gelman (S16). The model was run for 50,000 iterations and convergence was confirmed. We then ran the model for an additional 100,000 iterations, which were used to calculate the mean, standard deviation and 95% credible intervals of parameter estimates from the posterior distribution.

FIGURES

Fig. S1 Distance decay of conspecific (A) and heterospecific (B) neighbor effects on seedling survival from 2001 to 2006 in the Barro Colorado Island 50 ha Forest Dynamics Plot, Panama. Points represent estimated effects for 1-m bands from a generalized linear model and red lines show an exponential decay with distance equal to $\exp(-0.2 \cdot \text{distance})$.



TABLES

Table S1. Tree species included in the analysis of density dependent seedling survival. Species code refers to the Center for Tropical Forest Science (CTFS) 6-letter unique code assigned to each species. Number of seedlings is based on the 2001 seedling census, and number of trees and basal area are based on the 2000 census of trees ≥ 1 cm DBH in the Barro Colorado Island 50-ha Forest Dynamics Plot, Panama. Shade tolerance index was calculated based on sapling growth and mortality rates, with more positive values indicating higher shade-tolerance (see Methods for details). More information about each species can be found at:

<https://ctfs.arnarb.harvard.edu/webatlas/>.

Species code	Species	Family	No. seedlings	No. trees ≥ 1 cm DBH	Basal area trees ≥ 1 cm DBH (m ²)	Shade tolerance index
ACALMA	<i>Acalypha macrostachya</i>	Euphorbiaceae	7	43	0.08	-1.70
ADE1TR	<i>Adelia triloba</i>	Euphorbiaceae	23	161	2.54	-0.67
AEGIPA	<i>Aegiphila panamensis</i>	Verbenaceae	6	62	0.47	-0.47
ALCHCO	<i>Alchornea costaricensis</i>	Euphorbiaceae	43	228	10.84	-2.58
ALCHLA	<i>Alchornea latifolia</i>	Euphorbiaceae	2	2	0.03	-0.48
ALIBED	<i>Alibertia edulis</i>	Rubiaceae	68	356	0.27	0.62
ALLOPS	<i>Allophylus psilospermus</i>	Sapindaceae	43	111	0.70	-0.52
ALSEBL	<i>Alseis blackiana</i>	Rubiaceae	1250	7867	70.16	1.11
AMAICO	<i>Amaioua corymbosa</i>	Rubiaceae	5	26	0.06	0.70
ANACEX	<i>Anacardium excelsum</i>	Anacardiaceae	25	24	31.24	-0.18
ANDIIN	<i>Andira inermis</i>	Fabaceae	1	284	0.99	1.84
ANNOSP	<i>Annona spraguei</i>	Annonaceae	21	134	0.94	-3.40
APEIME	<i>Apeiba membranacea</i>	Tiliaceae	39	269	32.58	-1.00
APEITI	<i>Apeiba tibourbou</i>	Tiliaceae	6	30	0.96	-2.34
ARDIFE	<i>Ardisia standleyana</i>	Myrsinaceae	7	99	0.10	1.19
ASPICR	<i>Aspidosperma spruceanum</i>	Apocynaceae	187	478	9.65	1.28
AST2GR	<i>Astronium graveolens</i>	Anacardiaceae	20	76	3.94	0.53
BEILPE	<i>Beilschmiedia pendula</i>	Lauraceae	5693	2318	31.46	0.63
BROSAL	<i>Brosimum alicastrum</i>	Moraceae	365	900	27.80	1.15
CALOLO	<i>Calophyllum longifolium</i>	Clusiaceae	235	1130	7.29	-0.03
CASEAC	<i>Casearia aculeata</i>	Flacourtiaceae	62	420	0.70	1.12
CASEAR	<i>Casearia arborea</i>	Flacourtiaceae	12	139	7.32	-0.32
CASESY	<i>Casearia sylvestris</i>	Flacourtiaceae	5	150	1.39	-0.07
CASSEL	<i>Cassipourea elliptica</i>	Rhizophoraceae	102	1007	3.26	1.09
CAVAPL	<i>Cavanillesia platanifolia</i>	Bombacaceae	3	21	25.51	-0.24

CECRIN	<i>Cecropia insignis</i>	Cecropiaceae	67	716	20.24	-4.77
CECROB	<i>Cecropia obtusifolia</i>	Cecropiaceae	18	101	1.14	-4.27
CEDROD	<i>Cedrela odorata</i>	Meliaceae	5	8	0.15	-0.87
CEIBPE	<i>Ceiba pentandra</i>	Bombacaceae	2	54	56.60	-1.67
CELTSC	<i>Celtis schippii</i>	Ulmaceae	3	122	1.06	0.81
CHA2SC	<i>Chamguava schippii</i>	Myrtaceae	32	381	0.33	0.61
CHR2AR	<i>Chrysophyllum argenteum</i>	Sapotaceae	179	671	4.49	1.05
CHR2CA	<i>Chrysophyllum cainito</i>	Sapotaceae	286	134	5.24	0.36
COCCCO	<i>Coccoloba coronata</i>	Polygonaceae	40	114	0.64	1.42
COCCMA	<i>Coccoloba manzinellensis</i>	Polygonaceae	14	401	0.56	2.07
CORDAL	<i>Cordia alliodora</i>	Boraginaceae	75	94	4.50	-2.14
CORDBI	<i>Cordia bicolor</i>	Boraginaceae	107	765	15.73	-0.79
CORDLA	<i>Cordia lasiocalyx</i>	Boraginaceae	257	1282	6.14	-0.26
COU2CU	<i>Coussarea curvigemma</i>	Rubiaceae	134	2079	2.94	0.69
CROTBI	<i>Croton billbergianus</i>	Euphorbiaceae	382	358	1.73	-3.79
CUPALA	<i>Cupania latifolia</i>	Sapindaceae	8	43	0.74	-0.77
CUPARU	<i>Cupania rufescens</i>	Sapindaceae	19	94	0.13	0.90
CUPASY	<i>Cupania seemannii</i>	Sapindaceae	50	1212	1.66	1.69
DENDAR	<i>Dendropanax arboreus</i>	Araliaceae	6	103	6.21	0.00
DES2PA	<i>Desmopsis panamensis</i>	Annonaceae	1103	11291	7.81	0.65
DIO2AR	<i>Diospyros artanthifolia</i>	Ebenaceae	36	87	0.44	0.67
DIPTPA	<i>Dipteryx oleifera</i>	Fabaceae	48	45	18.71	0.73
DRYPST	<i>Drypetes standleyi</i>	Euphorbiaceae	618	2193	12.46	1.17
ERY2MA	<i>Erythroxylum macrophyllum</i>	Erythroxylaceae	79	245	0.42	0.06
ERY2PA	<i>Erythroxylum panamense</i>	Erythroxylaceae	15	102	0.05	1.11
EUGECO	<i>Eugenia coloradoensis</i>	Myrtaceae	184	655	2.91	0.53
EUGEGA	<i>Eugenia galalonensis</i>	Myrtaceae	397	1581	1.05	1.16
EUGENE	<i>Eugenia nesiotica</i>	Myrtaceae	452	515	2.38	1.52
EUGEOE	<i>Eugenia oerstediana</i>	Myrtaceae	1909	1926	6.22	0.15
FARAOC	<i>Faramea occidentalis</i>	Rubiaceae	3394	26754	60.87	0.66
GAR2IN	<i>Garcinia intermedia</i>	Clusiaceae	485	4409	5.37	1.13
GAR2MA	<i>Garcinia madruno</i>	Clusiaceae	71	374	0.50	1.06
GENIAM	<i>Genipa americana</i>	Rubiaceae	2	70	1.38	1.60
GUAPST	<i>Guapira standleyana</i>	Nyctaginaceae	28	165	12.14	0.82
GUARGR	<i>Guarea grandifolia</i>	Meliaceae	9	66	1.87	0.36
GUARGU	<i>Guarea guidonia</i>	Meliaceae	286	1838	16.05	0.56
GUARSP	<i>Guarea fuzzy</i>	Meliaceae	62	1037	2.15	0.21
GUATDU	<i>Guatteria dumetorum</i>	Annonaceae	32	1038	17.27	-0.13
GUAZUL	<i>Guazuma ulmifolia</i>	Sterculiaceae	7	61	5.41	-2.17
GUETFO	<i>Guettarda foliacea</i>	Rubiaceae	22	303	1.97	0.65
GUSTSU	<i>Gustavia superba</i>	Lecythidaceae	407	753	21.31	0.99

HAMPAP	<i>Hampea appendiculata</i>	Malvaceae	52	27	0.52	-2.72
HASSFL	<i>Hasseltia floribunda</i>	Flacourtiaceae	14	543	5.09	0.00
HEISAC	<i>Heisteria acuminata</i>	Olacaceae	14	106	0.31	0.73
HEISCO	<i>Heisteria concinna</i>	Olacaceae	59	953	9.80	0.70
HERRPU	<i>Herrania purpurea</i>	Sterculiaceae	25	511	0.41	1.58
HIRTAM	<i>Hirtella americana</i>	Chrysobalanaceae	3	30	0.09	0.39
HIRTTR	<i>Hirtella triandra</i>	Chrysobalanaceae	339	4760	23.21	0.82
HURACR	<i>Hura crepitans</i>	Euphorbiaceae	9	105	65.69	0.72
HYERAL	<i>Hieronyma alchorneoides</i>	Euphorbiaceae	11	78	11.58	-0.40
INGACO	<i>Inga thibaudiana</i>	Fabaceae	17	55	0.34	-0.17
INGAFA	<i>Inga laurina</i>	Fabaceae	18	75	0.84	0.14
INGAGO	<i>Inga goldmanii</i>	Fabaceae	10	341	1.78	0.40
INGAM2	<i>Inga multijuga</i>	Fabaceae	59	154	1.32	-0.17
INGAMA	<i>Inga marginata</i>	Fabaceae	953	398	6.54	-1.70
INGAMI	<i>Inga oerstediana</i>	Fabaceae	2	3	0.09	0.10
INGAPE	<i>Inga pezizifera</i>	Fabaceae	3	120	0.64	0.30
INGAQU	<i>Inga nobilis</i>	Fabaceae	23	663	1.99	0.83
INGAS1	<i>Inga acuminata</i>	Fabaceae	259	368	1.08	-0.23
INGASA	<i>Inga sapindoides</i>	Fabaceae	39	250	1.79	0.20
INGASP	<i>Inga spectabilis</i>	Fabaceae	4	17	0.76	-0.86
INGAUM	<i>Inga umbellifera</i>	Fabaceae	46	830	1.25	0.69
INGAVE	<i>Inga vera</i>	Fabaceae	8	0	0.00	-0.17
JAC1CO	<i>Jacaranda copaia</i>	Bignoniaceae	17	264	41.91	-1.94
LACIAG	<i>Lacistema aggregatum</i>	Flacourtiaceae	245	1404	1.34	0.45
LACMPA	<i>Lacmellea panamensis</i>	Apocynaceae	32	98	1.60	0.59
LAETTH	<i>Laetia thamnia</i>	Flacourtiaceae	25	451	0.88	0.04
LICAHY	<i>Licania hypoleuca</i>	Chrysobalanaceae	11	127	0.50	1.08
LICAPL	<i>Licania platypus</i>	Chrysobalanaceae	13	282	0.87	0.52
LINDLA	<i>Lindackeria laurina</i>	Flacourtiaceae	2	70	2.12	-0.34
LONCLA	<i>Lonchocarpus heptaphyllus</i>	Fabaceae	63	734	6.48	0.58
LUEHSE	<i>Luehea seemannii</i>	Tiliaceae	51	217	18.88	-1.14
MACRGL	<i>Macrocnemum roseum</i>	Rubiaceae	1	91	1.80	1.35
MALMSP	<i>Mosannonna garwoodii</i>	Annonaceae	32	436	0.64	1.50
MAQUCO	<i>Maquira guianensis</i>	Moraceae	9	1460	4.10	0.88
MAYTSC	<i>Maytenus schippii</i>	Celastraceae	5	81	0.69	1.13
MICOAF	<i>Miconia affinis</i>	Melastomataceae	31	375	0.51	-1.29
MICOAR	<i>Miconia argentea</i>	Melastomataceae	102	600	2.46	-3.30
MICOEL	<i>Miconia elata</i>	Melastomataceae	1	17	0.04	-1.10
MICOHO	<i>Miconia hondurensis</i>	Melastomataceae	5	55	0.19	-0.39
MYRCGA	<i>Myrcia gatunensis</i>	Myrtaceae	14	48	0.17	0.24
MYROFR	<i>Myrospermum frutescens</i>	Fabaceae	5	13	0.66	0.26

NECTCI	<i>Nectandra cissiflora</i>	Lauraceae	22	197	0.99	0.46
NECTGL	<i>Nectandra lineata</i>	Lauraceae	136	98	0.80	-0.68
NECTPU	<i>Nectandra purpurea</i>	Lauraceae	2	75	0.14	0.09
OCHRPY	<i>Ochroma pyramidale</i>	Bombacaceae	1	9	0.56	-1.07
OCOTCE	<i>Ocotea cernua</i>	Lauraceae	67	222	0.84	0.57
OCOTOB	<i>Ocotea oblonga</i>	Lauraceae	95	148	2.30	-1.61
OCOTPU	<i>Ocotea puberula</i>	Lauraceae	33	138	1.53	-0.58
OCOTWH	<i>Ocotea whitei</i>	Lauraceae	2407	429	19.96	-0.78
OLMEAS	<i>Trophis caucana</i>	Moraceae	81	175	0.85	-0.67
ORMOCR	<i>Ormosia coccinea</i>	Fabaceae	6	88	0.89	1.40
ORMOMA	<i>Ormosia macrocalyx</i>	Fabaceae	11	107	0.75	1.53
PENTMA	<i>Pentagonia macrophylla</i>	Rubiaceae	3	308	0.24	0.87
PEREXA	<i>Perebea xanthochyma</i>	Moraceae	5	242	0.63	0.72
PHOECI	<i>Cinnamomum triplinerve</i>	Lauraceae	82	61	1.50	-0.07
PICRLA	<i>Picramnia latifolia</i>	Picramniaceae	245	1047	1.50	0.42
PIPEA1	<i>Piper arboreum</i>	Piperaceae	2	22	0.02	0.05
PIPERE	<i>Piper reticulatum</i>	Piperaceae	10	123	0.34	0.23
PLA1PI	<i>Platymiscium pinnatum</i>	Fabaceae	230	147	8.81	-0.60
PLA2EL	<i>Platypodium elegans</i>	Fabaceae	28	124	12.18	-0.36
POSOLA	<i>Posoqueria latifolia</i>	Rubiaceae	4	72	0.75	1.40
POULAR	<i>Poulsenia armata</i>	Moraceae	7	1404	26.08	-0.66
POURBI	<i>Pourouma bicolor</i>	Cecropiaceae	22	59	0.96	-1.58
POUTRE	<i>Pouteria reticulata</i>	Sapotaceae	1616	1401	18.05	0.56
POUTST	<i>Pouteria stipitata</i>	Sapotaceae	9	71	1.62	0.66
PRI2CO	<i>Prioria copaifera</i>	Fabaceae	94	1382	64.31	1.33
PROTCO	<i>Protium costaricense</i>	Burseraceae	28	758	2.66	0.13
PROTPA	<i>Protium panamense</i>	Burseraceae	122	2899	3.57	0.95
PROTSP	<i>Protium confusum</i>	Burseraceae	1	4	0.01	0.10
PROTTE	<i>Protium tenuifolium</i>	Burseraceae	449	2853	18.48	0.63
PSE1SE	<i>Pseudobombax septenatum</i>	Bombacaceae	1	16	4.27	-0.02
PSIDFR	<i>Psidium friedrichsthalianum</i>	Myrtaceae	3	53	0.15	0.94
PSYCG3	<i>Psychotria grandis</i>	Rubiaceae	3	46	0.06	-0.95
PTERRO	<i>Pterocarpus rohrii</i>	Fabaceae	62	1464	3.57	0.77
QUARAS	<i>Quararibea asterolepis</i>	Bombacaceae	3187	2200	99.24	1.05
QUASAM	<i>Quassia amara</i>	Simaroubaceae	2	131	0.33	1.12
RANDAR	<i>Randia armata</i>	Rubiaceae	771	1003	5.03	0.84
SAPIAU	<i>Sapium glandulosum</i>	Euphorbiaceae	3	40	2.55	-2.27
SIMAAM	<i>Simarouba amara</i>	Simaroubaceae	255	1230	17.58	-1.25
SIPAPA	<i>Siparuna pauciflora</i>	Monimiaceae	35	315	0.53	0.29
SLOATE	<i>Sloanea terniflora</i>	Elaeocarpaceae	7	493	6.51	1.60
SOLAHA	<i>Solanum hayesii</i>	Solanaceae	8	50	0.33	-3.18

SPONMO	<i>Spondias mombin</i>	Anacardiaceae	2	83	5.11	-1.73
SPONRA	<i>Spondias radlkoferi</i>	Anacardiaceae	86	260	8.03	-1.13
STERAP	<i>Sterculia apetala</i>	Sterculiaceae	7	56	6.29	0.05
SWARS	<i>Swartzia simplex</i>	Fabaceae	1163	5554	12.34	1.85
SYMPGL	<i>Symphonia globulifera</i>	Clusiaceae	14	160	1.82	-0.14
TAB1GU	<i>Tabebuia guayacan</i>	Bignoniaceae	15	69	9.11	1.04
TAB1RO	<i>Tabebuia rosea</i>	Bignoniaceae	59	245	6.04	-0.19
TAB2AR	<i>Tabernaemontana arborea</i>	Apocynaceae	140	1506	28.61	0.80
TACHVE	<i>Tachigali versicolor</i>	Fabaceae	384	2485	14.57	-0.19
TALINE	<i>Talisia nervosa</i>	Sapindaceae	11	747	0.68	2.01
TALIPR	<i>Talisia princeps</i>	Sapindaceae	77	633	0.43	1.47
TERMAM	<i>Terminalia amazonia</i>	Combretaceae	1	47	4.06	0.58
TET2PA	<i>Tetragastris panamensis</i>	Burseraceae	1557	4230	31.38	0.79
THEVAH	<i>Thevetia ahouai</i>	Apocynaceae	7	74	0.15	0.46
TOCOPI	<i>Tocoyena pittieri</i>	Rubiaceae	2	7	0.57	-0.30
TREMMI	<i>Trema micrantha</i>	Ulmaceae	1	28	1.55	-2.56
TRI2PA	<i>Trichilia pallida</i>	Meliaceae	30	519	2.57	0.07
TRI2TU	<i>Trichilia tuberculata</i>	Meliaceae	1440	11977	93.23	0.61
TRIPCU	<i>Triplaris cumingiana</i>	Polygonaceae	28	259	4.60	-0.65
TROPRA	<i>Trophis racemosa</i>	Moraceae	41	285	1.01	0.77
TURPOC	<i>Turpinia occidentalis</i>	Staphyleaceae	8	72	2.37	-0.87
UNONPI	<i>Unonopsis pittieri</i>	Annonaceae	164	656	4.69	0.13
VIROSE	<i>Virola sebifera</i>	Myristicaceae	47	1615	21.84	0.47
VIROSP	<i>Virola multiflora</i>	Myristicaceae	2	47	2.13	0.01
VIROSU	<i>Virola surinamensis</i>	Myristicaceae	17	200	23.24	0.04
VISMBA	<i>Vismia baccifera</i>	Clusiaceae	11	55	0.07	-1.65
VOCHF	<i>Vochysia ferruginea</i>	Vochysiaceae	5	21	0.87	-1.21
XYL1MA	<i>Xylopia macrantha</i>	Annonaceae	130	1220	4.37	0.69
ZANTBE	<i>Zanthoxylum ekmanii</i>	Rutaceae	21	234	16.84	-3.52
ZANTP1	<i>Zanthoxylum panamense</i>	Rutaceae	24	143	4.03	-0.58
ZANTPR	<i>Zanthoxylum acuminatum</i>	Rutaceae	4	116	1.13	-0.62
ZUELGU	<i>Zuelania guidonia</i>	Flacourtiaceae	3	36	0.42	-0.26

Table S2. Estimates of species parameters from the hierarchical Bayesian model of seedling survival. Posterior parameter means (1 s.d.) are presented for the effects of conspecific and heterospecific seedling density and adult basal area on seedling survival in the forest on Barro Colorado Island, Panama. See Table S1 for full species names.

Species code	Intercept	Conspecific seedling	Heterospecific seedling	Conspecific adult	Heterospecific adult
ACALMA	-2.651 (0.862)	-0.142 (0.078)	-0.011 (0.019)	-0.209 (0.106)	0.005 (0.003)
ADE1TR	-1.599 (0.636)	-0.123 (0.064)	-0.004 (0.017)	-0.17 (0.085)	0.006 (0.002)
AEGIPA	-1.59 (0.77)	-0.18 (0.074)	0.005 (0.017)	-0.207 (0.093)	0.007 (0.002)
ALCHCO	-3.445 (0.762)	0.012 (0.071)	-0.037 (0.023)	-0.099 (0.107)	0.002 (0.003)
ALCHLA	-2.322 (0.872)	-0.162 (0.083)	0.001 (0.018)	-0.166 (0.098)	0.006 (0.002)
ALIBED	-0.945 (0.672)	-0.211 (0.081)	0.015 (0.017)	-0.189 (0.088)	0.008 (0.002)
ALLOPS	-1.833 (0.638)	-0.165 (0.07)	0.004 (0.017)	-0.196 (0.086)	0.006 (0.002)
ALSEBL	1.947 (0.361)	-0.082 (0.054)	-0.011 (0.016)	-0.046 (0.048)	0.005 (0.002)
AMAICO	-1.044 (0.917)	-0.221 (0.087)	0.02 (0.019)	-0.194 (0.102)	0.008 (0.002)
ANACEX	-2.192 (0.699)	-0.003 (0.063)	-0.008 (0.018)	-0.054 (0.08)	0.004 (0.002)
ANDIIN	-0.829 (0.917)	-0.204 (0.093)	0.031 (0.021)	-0.138 (0.101)	0.008 (0.003)
ANNOSP	-3.692 (0.877)	-0.058 (0.076)	-0.039 (0.025)	-0.182 (0.119)	0.003 (0.004)
APEIME	-1.955 (0.583)	0.024 (0.062)	-0.028 (0.019)	0.001 (0.069)	0.003 (0.002)
APEITI	-3.271 (0.865)	-0.081 (0.078)	-0.025 (0.021)	-0.167 (0.105)	0.004 (0.003)
ARDIFE	-1.415 (0.832)	-0.206 (0.091)	0.024 (0.02)	-0.15 (0.098)	0.008 (0.003)
ASPICR	-0.479 (0.391)	-0.135 (0.058)	0.02 (0.014)	-0.094 (0.029)	0.006 (0.002)
AST2GR	-0.329 (0.658)	-0.173 (0.067)	0.015 (0.017)	-0.188 (0.083)	0.007 (0.002)
BEILPE	-1.686 (0.072)	-0.015 (0.004)	0.007 (0.01)	-0.031 (0.009)	0.004 (0.001)
BROSAL	-1.351 (0.4)	-0.058 (0.053)	0.013 (0.012)	-0.06 (0.037)	0.005 (0.002)
CALOLO	-0.821 (0.492)	-0.131 (0.057)	0.011 (0.015)	-0.162 (0.065)	0.005 (0.002)
CASEAC	-1.042 (0.677)	-0.198 (0.081)	0.022 (0.018)	-0.161 (0.088)	0.008 (0.002)
CASEAR	-1.915 (0.675)	-0.079 (0.062)	-0.004 (0.017)	-0.114 (0.081)	0.005 (0.002)
CASESY	-2.048 (0.791)	-0.132 (0.076)	0.004 (0.018)	-0.133 (0.089)	0.006 (0.002)
CASSEL	-0.456 (0.587)	-0.199 (0.071)	0.023 (0.017)	-0.199 (0.079)	0.008 (0.002)
CAVAPL	-1.793 (0.777)	-0.025 (0.062)	-0.008 (0.017)	-0.07 (0.084)	0.004 (0.002)
CECRIN	-3.776 (0.907)	0.058 (0.095)	-0.064 (0.032)	-0.153 (0.141)	0 (0.005)
CECROB	-3.523 (0.914)	-0.067 (0.086)	-0.046 (0.027)	-0.237 (0.132)	0.003 (0.005)
CEDROD	-2.177 (0.813)	-0.164 (0.079)	-0.002 (0.018)	-0.191 (0.096)	0.006 (0.002)
CEIBPE	-1.793 (0.843)	0.015 (0.074)	-0.025 (0.02)	-0.111 (0.099)	0.003 (0.003)
CELTSC	-1.884 (0.848)	-0.144 (0.084)	0.011 (0.018)	-0.098 (0.093)	0.007 (0.002)
CHA2SC	-0.641 (0.716)	-0.227 (0.081)	0.021 (0.018)	-0.221 (0.095)	0.008 (0.002)
CHR2AR	-0.75 (0.578)	-0.136 (0.068)	0.008 (0.014)	-0.084 (0.074)	0.006 (0.002)
CHR2CA	-1.032 (0.51)	-0.123 (0.063)	-0.003 (0.012)	-0.077 (0.056)	0.006 (0.002)

COCCCO	-0.335 (0.746)	-0.227 (0.084)	0.025 (0.018)	-0.181 (0.096)	0.008 (0.002)
COCCMA	-0.077 (0.839)	-0.249 (0.092)	0.038 (0.022)	-0.185 (0.104)	0.009 (0.003)
CORDAL	-2.189 (0.606)	-0.087 (0.065)	-0.024 (0.018)	-0.184 (0.09)	0.004 (0.003)
CORDBI	-1.767 (0.522)	-0.062 (0.057)	-0.006 (0.015)	-0.145 (0.073)	0.004 (0.002)
CORDLA	-1.479 (0.558)	-0.132 (0.061)	0.006 (0.014)	-0.186 (0.074)	0.006 (0.002)
COU2CU	-0.699 (0.589)	-0.177 (0.066)	0.018 (0.016)	-0.194 (0.08)	0.007 (0.002)
CROTBI	-3.786 (0.556)	-0.038 (0.042)	-0.035 (0.023)	-0.22 (0.118)	0.003 (0.004)
CUPALA	-2.022 (0.78)	-0.152 (0.073)	-0.001 (0.017)	-0.195 (0.091)	0.006 (0.002)
CUPARU	-1.432 (0.769)	-0.202 (0.086)	0.021 (0.019)	-0.166 (0.092)	0.008 (0.002)
CUPASY	-0.368 (0.666)	-0.213 (0.079)	0.029 (0.019)	-0.16 (0.091)	0.008 (0.002)
DENDAR	-2.26 (0.751)	-0.068 (0.068)	-0.003 (0.018)	-0.074 (0.084)	0.005 (0.002)
DES2PA	-0.301 (0.476)	-0.152 (0.055)	0.02 (0.013)	-0.202 (0.07)	0.007 (0.002)
DIO2AR	-1.545 (0.701)	-0.186 (0.081)	0.018 (0.018)	-0.162 (0.091)	0.007 (0.002)
DIPTPA	-1.903 (0.56)	-0.049 (0.06)	0.007 (0.014)	-0.083 (0.055)	0.005 (0.002)
DRYPST	-0.586 (0.363)	-0.064 (0.059)	-0.005 (0.011)	0.007 (0.03)	0.006 (0.002)
ERY2MA	-1.071 (0.626)	-0.181 (0.069)	0.013 (0.017)	-0.206 (0.088)	0.007 (0.002)
ERY2PA	-1.611 (0.811)	-0.199 (0.092)	0.023 (0.02)	-0.147 (0.1)	0.008 (0.003)
EUGECO	-1.093 (0.552)	-0.154 (0.064)	0.018 (0.016)	-0.155 (0.075)	0.006 (0.002)
EUGEGA	-0.453 (0.558)	-0.226 (0.07)	0.028 (0.017)	-0.207 (0.08)	0.008 (0.002)
EUGENE	-0.014 (0.576)	-0.196 (0.073)	0.017 (0.014)	-0.134 (0.081)	0.008 (0.002)
EUGEOE	-0.515 (0.384)	-0.101 (0.04)	0.004 (0.009)	-0.203 (0.067)	0.006 (0.001)
FARAOC	-0.749 (0.246)	-0.076 (0.036)	0.014 (0.008)	-0.189 (0.038)	0.005 (0.001)
GAR2IN	0.565 (0.644)	-0.21 (0.072)	0.029 (0.019)	-0.231 (0.089)	0.008 (0.002)
GAR2MA	-0.319 (0.744)	-0.24 (0.083)	0.027 (0.019)	-0.22 (0.095)	0.008 (0.002)
GENIAM	-1.255 (0.872)	-0.173 (0.088)	0.024 (0.019)	-0.111 (0.097)	0.008 (0.002)
GUAPST	-1.544 (0.629)	-0.071 (0.064)	0.006 (0.016)	-0.057 (0.074)	0.005 (0.002)
GUARGR	-0.747 (0.753)	-0.185 (0.073)	0.014 (0.017)	-0.195 (0.089)	0.007 (0.002)
GUARGU	-0.508 (0.448)	-0.1 (0.053)	0.004 (0.013)	-0.104 (0.057)	0.006 (0.001)
GUARSP	-0.787 (0.634)	-0.179 (0.069)	0.012 (0.015)	-0.199 (0.079)	0.007 (0.002)
GUATDU	-0.908 (0.556)	-0.063 (0.057)	-0.009 (0.016)	-0.059 (0.065)	0.004 (0.002)
GUAZUL	-2.718 (0.781)	-0.05 (0.067)	-0.024 (0.02)	-0.16 (0.1)	0.003 (0.003)
GUETFO	-2.348 (0.707)	-0.117 (0.08)	0.009 (0.019)	-0.082 (0.088)	0.006 (0.002)
GUSTSU	-1.118 (0.329)	-0.138 (0.045)	0.025 (0.015)	-0.171 (0.034)	0.006 (0.002)
HAMPAP	-2.652 (0.741)	-0.116 (0.073)	-0.027 (0.021)	-0.231 (0.108)	0.004 (0.004)
HASSFL	-1.868 (0.695)	-0.089 (0.064)	-0.001 (0.016)	-0.102 (0.079)	0.005 (0.002)
HEISAC	-0.747 (0.793)	-0.222 (0.082)	0.021 (0.018)	-0.207 (0.095)	0.008 (0.002)
HEISCO	-0.813 (0.553)	-0.12 (0.058)	0.013 (0.015)	-0.132 (0.07)	0.006 (0.002)
HERRPU	-1.014 (0.761)	-0.212 (0.091)	0.028 (0.02)	-0.149 (0.096)	0.008 (0.003)
HIRTAM	-1.52 (0.875)	-0.195 (0.086)	0.015 (0.018)	-0.178 (0.098)	0.007 (0.002)
HIRTTR	-0.717 (0.443)	-0.069 (0.054)	0 (0.011)	-0.087 (0.055)	0.005 (0.001)
HURACR	-1.209 (0.691)	-0.014 (0.063)	0.002 (0.017)	-0.05 (0.082)	0.004 (0.002)

HYERAL	-2.509 (0.726)	-0.028 (0.064)	-0.011 (0.018)	-0.053 (0.085)	0.004 (0.002)
INGACO	-1.863 (0.733)	-0.169 (0.076)	0.005 (0.017)	-0.171 (0.09)	0.007 (0.002)
INGAFA	-0.953 (0.737)	-0.199 (0.074)	0.013 (0.017)	-0.213 (0.09)	0.007 (0.002)
INGAGO	-0.818 (0.719)	-0.185 (0.072)	0.015 (0.017)	-0.201 (0.085)	0.007 (0.002)
INGAM2	-1.56 (0.637)	-0.165 (0.069)	0.008 (0.016)	-0.182 (0.085)	0.007 (0.002)
INGAMA	-1.475 (0.431)	-0.086 (0.05)	-0.01 (0.01)	-0.23 (0.067)	0.005 (0.002)
INGAMI	-1.904 (0.916)	-0.182 (0.086)	0.011 (0.019)	-0.17 (0.101)	0.007 (0.002)
INGAPE	-1.112 (0.861)	-0.199 (0.08)	0.016 (0.018)	-0.203 (0.097)	0.007 (0.002)
INGAQU	-1.492 (0.675)	-0.153 (0.073)	0.016 (0.017)	-0.127 (0.084)	0.007 (0.002)
INGAS1	-1.328 (0.605)	-0.174 (0.068)	0.003 (0.012)	-0.196 (0.079)	0.007 (0.002)
INGASA	-1.314 (0.626)	-0.161 (0.068)	0.012 (0.016)	-0.175 (0.079)	0.007 (0.002)
INGASP	-2.539 (0.849)	-0.125 (0.077)	-0.006 (0.018)	-0.148 (0.098)	0.006 (0.002)
INGAUM	-0.124 (0.73)	-0.222 (0.077)	0.02 (0.018)	-0.228 (0.091)	0.008 (0.002)
INGAVE	-1.472 (0.819)	-0.203 (0.08)	0.011 (0.018)	-0.218 (0.097)	0.007 (0.002)
JAC1CO	-2.37 (0.752)	0.029 (0.07)	-0.031 (0.021)	-0.09 (0.099)	0.002 (0.003)
LACIAG	-1.203 (0.67)	-0.224 (0.078)	0.025 (0.018)	-0.229 (0.089)	0.007 (0.002)
LACMPA	-1.693 (0.67)	-0.148 (0.073)	0.016 (0.017)	-0.14 (0.082)	0.007 (0.002)
LAETTH	-1.098 (0.702)	-0.192 (0.072)	0.013 (0.018)	-0.216 (0.087)	0.007 (0.002)
LICAHY	-0.734 (0.779)	-0.218 (0.084)	0.024 (0.019)	-0.184 (0.094)	0.008 (0.002)
LICAPL	-1.444 (0.74)	-0.17 (0.078)	0.013 (0.018)	-0.155 (0.088)	0.007 (0.002)
LINDLA	-2.272 (0.81)	-0.108 (0.071)	-0.002 (0.018)	-0.125 (0.089)	0.006 (0.002)
LONCLA	-1.107 (0.567)	-0.134 (0.062)	0.022 (0.018)	-0.188 (0.077)	0.006 (0.002)
LUEHSE	-2.985 (0.703)	0.018 (0.066)	-0.024 (0.02)	-0.034 (0.086)	0.003 (0.003)
MACRGL	-1.028 (0.881)	-0.176 (0.083)	0.023 (0.019)	-0.135 (0.095)	0.007 (0.002)
MALMSP	-0.74 (0.746)	-0.213 (0.086)	0.026 (0.019)	-0.161 (0.092)	0.008 (0.002)
MAQUCO	-0.069 (0.741)	-0.184 (0.072)	0.018 (0.018)	-0.186 (0.086)	0.007 (0.002)
MAYTSC	-1.155 (0.825)	-0.193 (0.086)	0.022 (0.018)	-0.152 (0.094)	0.008 (0.002)
MICOAF	-1.683 (0.688)	-0.169 (0.071)	-0.006 (0.018)	-0.229 (0.093)	0.006 (0.003)
MICOAR	-3.077 (0.713)	-0.069 (0.072)	-0.035 (0.021)	-0.212 (0.11)	0.003 (0.004)
MICOEL	-2.053 (0.883)	-0.173 (0.08)	-0.002 (0.018)	-0.221 (0.102)	0.006 (0.003)
MICOHO	-2.118 (0.843)	-0.153 (0.083)	-0.006 (0.018)	-0.144 (0.093)	0.006 (0.002)
MYRCGA	-0.922 (0.76)	-0.215 (0.082)	0.016 (0.018)	-0.211 (0.093)	0.008 (0.002)
MYROFR	-1.866 (0.812)	-0.163 (0.08)	0.01 (0.018)	-0.148 (0.093)	0.007 (0.002)
NECTCI	-0.932 (0.713)	-0.191 (0.075)	0.01 (0.016)	-0.174 (0.086)	0.007 (0.002)
NECTGL	-2.524 (0.654)	-0.117 (0.072)	-0.009 (0.016)	-0.127 (0.085)	0.006 (0.002)
NECTPU	-1.839 (0.892)	-0.179 (0.086)	0.011 (0.018)	-0.173 (0.1)	0.007 (0.002)
OCHRPY	-2.414 (0.887)	-0.136 (0.077)	-0.006 (0.018)	-0.176 (0.098)	0.006 (0.002)
OCOTCE	-1.314 (0.648)	-0.182 (0.074)	0.015 (0.017)	-0.166 (0.085)	0.007 (0.002)
OCOTOB	-2.04 (0.634)	-0.128 (0.065)	-0.004 (0.017)	-0.23 (0.088)	0.005 (0.003)
OCOTPU	-2.08 (0.665)	-0.128 (0.067)	-0.001 (0.017)	-0.158 (0.083)	0.006 (0.002)
OCOTWH	-2.508 (0.154)	-0.028 (0.011)	-0.015 (0.014)	-0.032 (0.016)	0.003 (0.002)

OLMEAS	-2.059 (0.624)	-0.131 (0.07)	-0.006 (0.018)	-0.155 (0.087)	0.006 (0.002)
ORMOCR	-0.298 (0.861)	-0.232 (0.086)	0.029 (0.019)	-0.196 (0.099)	0.008 (0.002)
ORMOMA	-1.043 (0.785)	-0.197 (0.087)	0.026 (0.019)	-0.138 (0.096)	0.008 (0.002)
PENTMA	-0.671 (0.866)	-0.231 (0.086)	0.024 (0.019)	-0.211 (0.099)	0.008 (0.002)
PEREXA	-1.656 (0.81)	-0.172 (0.085)	0.014 (0.018)	-0.14 (0.097)	0.007 (0.002)
PHOECI	-1.769 (0.616)	-0.145 (0.069)	0.004 (0.016)	-0.153 (0.08)	0.006 (0.002)
PICRLA	-1 (0.57)	-0.168 (0.065)	0.019 (0.016)	-0.195 (0.08)	0.007 (0.002)
PIPEA1	-2.088 (0.891)	-0.173 (0.087)	0.008 (0.018)	-0.159 (0.1)	0.007 (0.002)
PIPERE	-2.336 (0.803)	-0.149 (0.085)	0.007 (0.018)	-0.122 (0.095)	0.007 (0.002)
PLA1PI	-1.624 (0.487)	-0.1 (0.054)	-0.008 (0.013)	-0.164 (0.067)	0.005 (0.002)
PLA2EL	-1.956 (0.593)	-0.051 (0.059)	-0.008 (0.017)	-0.094 (0.073)	0.004 (0.002)
POSOLA	-0.424 (0.881)	-0.228 (0.086)	0.029 (0.02)	-0.19 (0.099)	0.008 (0.002)
POULAR	-1.82 (0.724)	-0.021 (0.062)	-0.014 (0.018)	-0.082 (0.086)	0.004 (0.002)
POURBI	-2.893 (0.795)	-0.099 (0.072)	-0.016 (0.019)	-0.152 (0.095)	0.005 (0.003)
POUTRE	-0.214 (0.091)	-0.005 (0.007)	0.011 (0.011)	-0.142 (0.023)	0.006 (0.001)
POUTST	-1.745 (0.761)	-0.142 (0.078)	0.011 (0.017)	-0.113 (0.088)	0.007 (0.002)
PRI2CO	-1.103 (0.449)	-0.023 (0.055)	0.004 (0.014)	0 (0.011)	0.005 (0.002)
PROTCO	-1.152 (0.65)	-0.149 (0.065)	0.005 (0.016)	-0.16 (0.081)	0.006 (0.002)
PROTPA	-0.591 (0.606)	-0.179 (0.069)	0.021 (0.017)	-0.175 (0.08)	0.007 (0.002)
PROTSP	-1.361 (0.896)	-0.207 (0.085)	0.012 (0.018)	-0.205 (0.098)	0.007 (0.002)
PROTTE	-0.226 (0.362)	-0.093 (0.048)	0.011 (0.012)	-0.129 (0.048)	0.006 (0.001)
PSE1SE	-1.708 (0.82)	-0.108 (0.068)	0.002 (0.017)	-0.123 (0.088)	0.006 (0.002)
PSIDFR	-1.387 (0.848)	-0.204 (0.088)	0.022 (0.019)	-0.168 (0.1)	0.008 (0.002)
PSYCG3	-2.191 (0.867)	-0.167 (0.081)	-0.002 (0.018)	-0.199 (0.1)	0.006 (0.002)
PTERRO	-1.001 (0.612)	-0.147 (0.067)	0.013 (0.015)	-0.134 (0.078)	0.007 (0.002)
QUARAS	-0.294 (0.062)	0.004 (0.005)	-0.012 (0.01)	0.005 (0.005)	0.004 (0.002)
QUASAM	-0.644 (0.894)	-0.227 (0.087)	0.025 (0.019)	-0.197 (0.101)	0.008 (0.002)
RANDAR	-0.459 (0.482)	-0.153 (0.055)	0.015 (0.01)	-0.16 (0.068)	0.007 (0.002)
SAPIAU	-2.571 (0.854)	-0.084 (0.071)	-0.024 (0.021)	-0.186 (0.1)	0.004 (0.003)
SIMAAM	-1.503 (0.534)	-0.09 (0.065)	-0.003 (0.015)	-0.192 (0.068)	0.004 (0.002)
SIPAPA	-0.923 (0.715)	-0.209 (0.078)	0.014 (0.017)	-0.21 (0.089)	0.007 (0.002)
SLOATE	-0.65 (0.758)	-0.144 (0.072)	0.023 (0.018)	-0.107 (0.086)	0.007 (0.002)
SOLAHA	-3.822 (0.945)	-0.077 (0.082)	-0.034 (0.024)	-0.187 (0.121)	0.003 (0.004)
SPONMO	-2.269 (0.82)	-0.071 (0.068)	-0.02 (0.02)	-0.156 (0.096)	0.004 (0.003)
SPONRA	-2.005 (0.577)	-0.071 (0.058)	-0.011 (0.016)	-0.148 (0.079)	0.004 (0.002)
STERAP	-2.097 (0.732)	-0.07 (0.067)	-0.006 (0.016)	-0.077 (0.075)	0.005 (0.002)
SWARS	0.156 (0.604)	-0.222 (0.073)	0.04 (0.02)	-0.206 (0.082)	0.008 (0.002)
SYMPGL	-1.831 (0.721)	-0.107 (0.077)	-0.008 (0.019)	-0.056 (0.086)	0.005 (0.002)
TAB1GU	-1.41 (0.674)	-0.105 (0.068)	0.014 (0.018)	-0.094 (0.083)	0.006 (0.002)
TAB1RO	-1.51 (0.585)	-0.103 (0.06)	-0.002 (0.016)	-0.136 (0.075)	0.005 (0.002)
TAB2AR	-0.619 (0.496)	-0.099 (0.057)	0.016 (0.016)	-0.14 (0.067)	0.006 (0.002)

TACHVE	-0.591 (0.347)	-0.09 (0.033)	-0.007 (0.011)	-0.135 (0.059)	0.005 (0.002)
TALINE	-0.325 (0.874)	-0.235 (0.092)	0.036 (0.021)	-0.17 (0.101)	0.009 (0.003)
TALIPR	-0.322 (0.746)	-0.239 (0.087)	0.031 (0.02)	-0.198 (0.095)	0.008 (0.003)
TERMAM	-1.404 (0.827)	-0.128 (0.071)	0.01 (0.017)	-0.119 (0.086)	0.006 (0.002)
TET2PA	-0.094 (0.239)	-0.082 (0.037)	0.006 (0.009)	-0.074 (0.017)	0.005 (0.001)
THEVAH	-1.271 (0.794)	-0.21 (0.083)	0.018 (0.018)	-0.196 (0.097)	0.008 (0.002)
TOCOPI	-2.239 (0.863)	-0.147 (0.081)	0.002 (0.018)	-0.15 (0.095)	0.006 (0.002)
TREMMI	-3.18 (0.916)	-0.073 (0.074)	-0.027 (0.022)	-0.175 (0.109)	0.004 (0.003)
TRI2PA	-1.184 (0.661)	-0.157 (0.067)	0.009 (0.016)	-0.181 (0.083)	0.006 (0.002)
TRI2TU	0.135 (0.282)	-0.041 (0.043)	-0.002 (0.008)	-0.03 (0.022)	0.004 (0.001)
TRIPCU	-1.278 (0.623)	-0.12 (0.06)	-0.005 (0.016)	-0.166 (0.079)	0.005 (0.002)
TROPRA	-1.12 (0.68)	-0.184 (0.076)	0.015 (0.017)	-0.155 (0.086)	0.007 (0.002)
TURPOC	-2.678 (0.765)	-0.091 (0.07)	-0.008 (0.018)	-0.124 (0.092)	0.005 (0.002)
UNONPI	-1.702 (0.539)	-0.1 (0.061)	-0.002 (0.015)	-0.072 (0.073)	0.005 (0.002)
VIROSE	-2.493 (0.658)	0 (0.068)	-0.004 (0.019)	0.002 (0.082)	0.004 (0.002)
VIROSP	-1.801 (0.841)	-0.132 (0.074)	0.005 (0.017)	-0.139 (0.091)	0.006 (0.002)
VIROSU	-2.093 (0.716)	-0.019 (0.064)	-0.005 (0.017)	-0.052 (0.073)	0.004 (0.002)
VISMBA	-2.887 (0.789)	-0.13 (0.078)	-0.014 (0.02)	-0.18 (0.102)	0.005 (0.003)
VOCHFÉ	-2.196 (0.811)	-0.127 (0.075)	-0.01 (0.018)	-0.166 (0.097)	0.005 (0.002)
XYL1MA	0.019 (0.578)	-0.184 (0.066)	0.015 (0.017)	-0.183 (0.08)	0.007 (0.002)
ZANTBE	-3.413 (0.873)	0.036 (0.08)	-0.045 (0.026)	-0.136 (0.123)	0.001 (0.004)
ZANTP1	-2.462 (0.67)	-0.075 (0.066)	-0.008 (0.018)	-0.1 (0.083)	0.005 (0.002)
ZANTPR	-1.46 (0.832)	-0.167 (0.073)	0.003 (0.018)	-0.211 (0.094)	0.006 (0.002)
ZUELGU	-2.046 (0.821)	-0.159 (0.08)	0.004 (0.018)	-0.166 (0.093)	0.006 (0.002)

Table S3. AIC values for generalized linear models of seedling survival as a function of adult neighbor basal area, with the effects of adult neighbors declining exponentially with distance as $\exp(-\beta \cdot \text{distance})$. The value of β that produced the lowest AIC value (i.e. the best fit to the data) is in bold. Δ AIC is the difference in AIC between the given model and the best fit model.

<u>Distance decay (β)</u>	<u>AIC</u>	<u>Δ AIC</u>
0	40015	410
0.1	39650	45
0.2	39605	0
0.3	39721	116
0.4	39853	248
0.5	39958	353
0.6	40036	431
0.7	40093	488
0.8	40136	531
0.9	40169	564
1	40195	590
1.5	40272	667
2	40313	708
3	40359	754

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