New Phytologist

***New Phytologist* Supporting Information**

Article title: Role of tree size in moist tropical forest carbon cycling and water deficit responses
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The following Supporting Information is available for this article:

Fig. S1 Size scaling of stem density, aboveground live biomass C, aboveground woody productivity, and woody mortality using biomass allometries from Chave *et al.* (2005).

Fig. S2 Size scaling of mean individual biomass C, individual diameter growth, individual biomass C growth, and stem mortality rate.

Fig. S3 Size scaling of stem density, aboveground live biomass C, aboveground woody productivity, and woody mortality on a nonlinear scale.

Table S1 List of species classified as deciduous in this study along with source of deciduous observation.

Table S2 Ecosystem-level C variables for all three sites during non-El Niño census periods using biomass allometries from Chave *et al.* (Chave *et al.*, 2005).

Table S3 Adjusted woody mortality values for the 1981-85 Barro Colorado Island census period.

Table S4 Demographic rates and C cycle variables by size class for each site and census period.

Table S5 Fitted parameters corresponding to Figure 1.

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Methods S1 Methods for classifying deciduous species.

Methods S2 Corrections applied to forest census data and exclusion of outliers.

Methods S3 Demographic variables.

Fig. S1 Size-related variation in **(a)** stem density, **(b)** aboveground live biomass C ($C_{ag,live}$), **(c)** aboveground woody productivity ($ANPP_{stem}$), and **(d)** woody mortality (M) at all three sites during the focal non-El Niño census periods (Table 1) using biomass allometries from Chave *et al.*, (2005). Totals for each size bin are divided by the width of the size bin (cm) such that relationships depict how these variables change with diameter on a linear scale. Dashed lines indicate a non-significant trend. Vertical lines depict 95% confidence intervals based on bootstrapping over subplots.

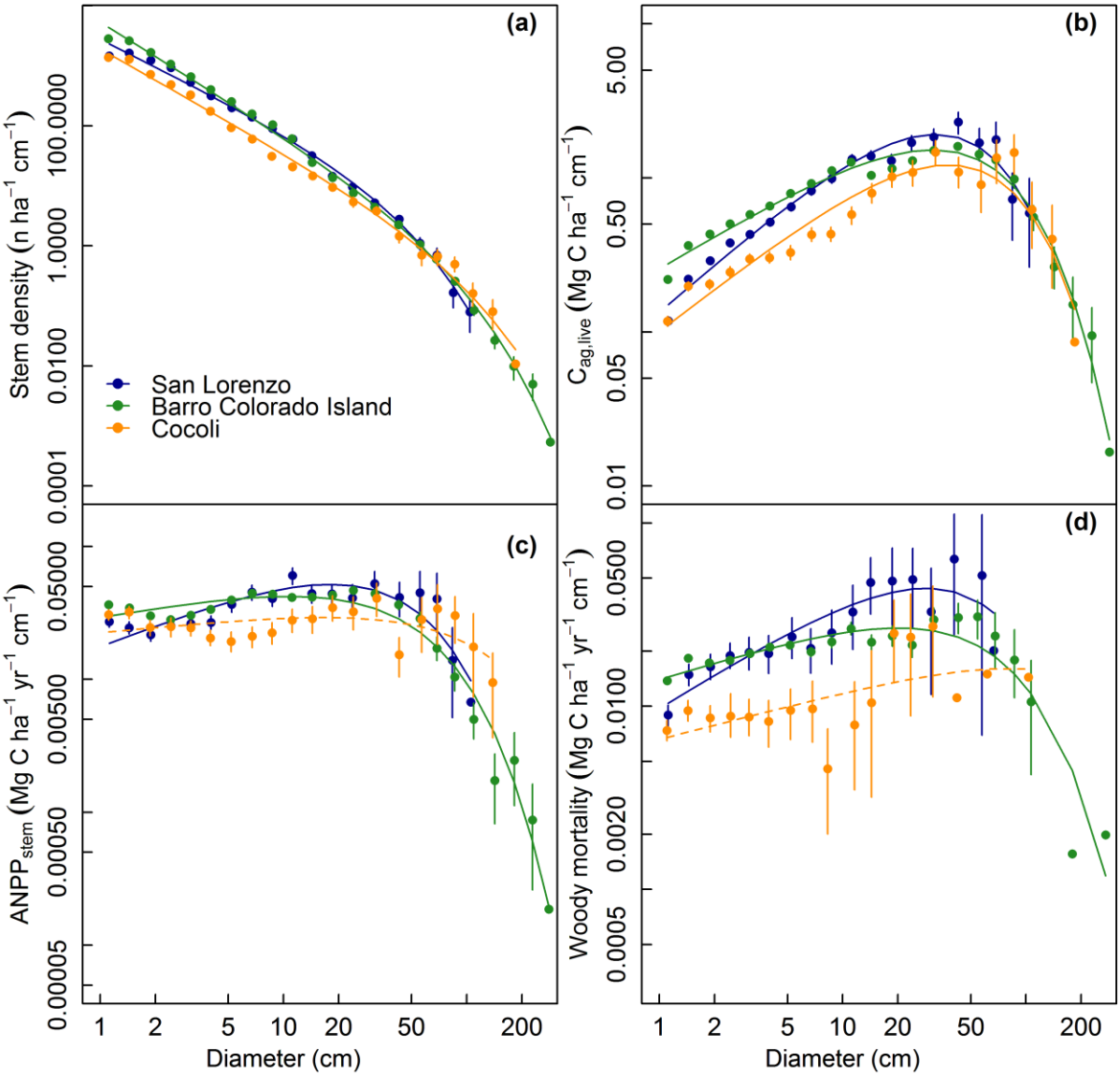

Fig. S2 Size scaling of **(a)** individual live biomass C, **(b)** individual biomass C growth, **(c)** individual diameter growth, and **(d)** stem mortality rate. Mean individual $C_{ag,live}$ is based on censuses from 1994 (Cocoli), 1995 (Barro Colorado Island), or 1996 (San Lorenzo). Growth and stem mortality are based on overlapping non-El Niño census periods at Cocoli (1994-1997), Barro Colorado Island (1990-1995), and San Lorenzo (1996-1997). Fit parameters and statistics are given in Table S5. Vertical lines depict 95% confidence intervals based on bootstrapping over subplots.

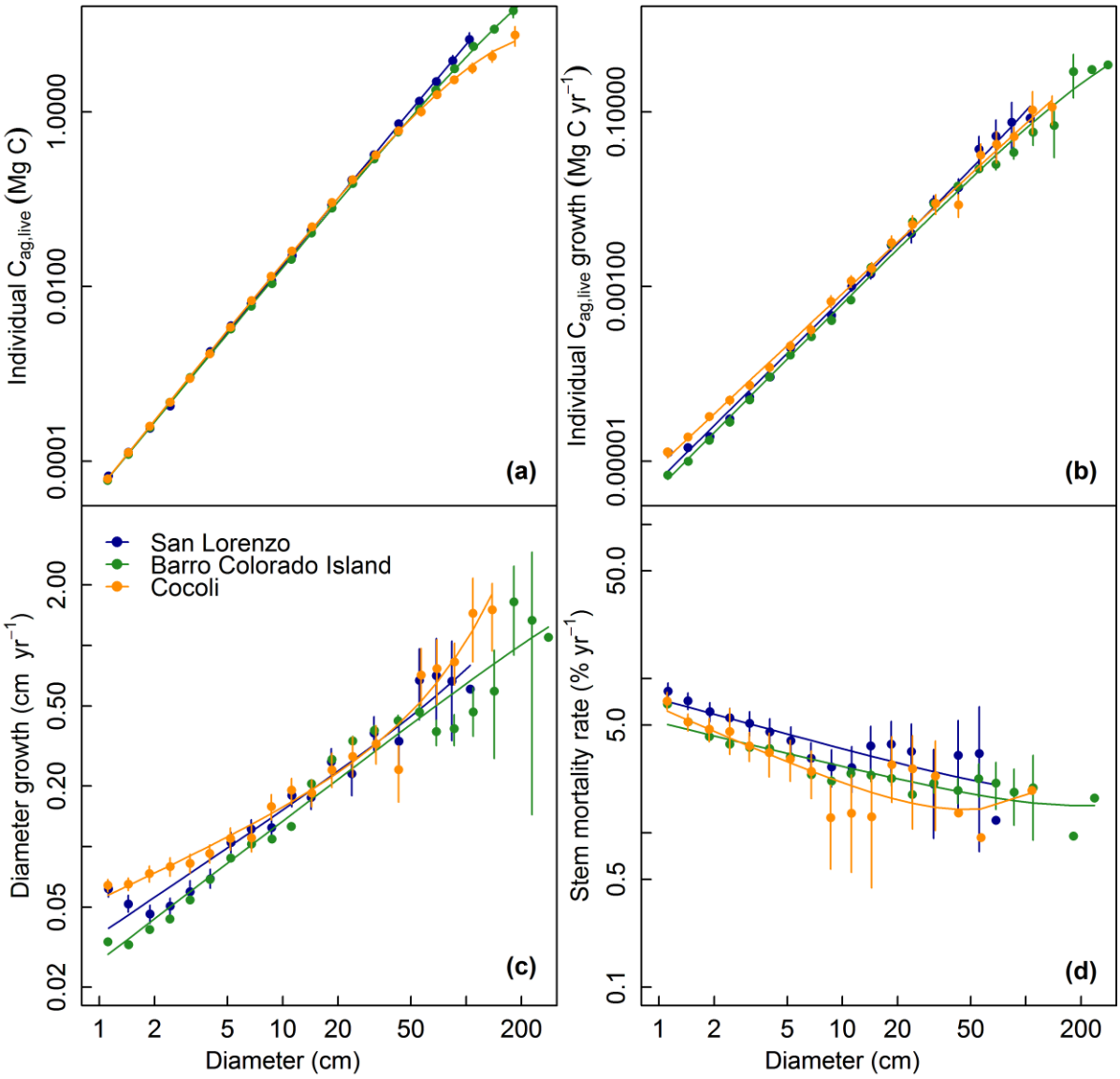

Fig. S3 Size-related variation in **(a)** stem density, **(b)** aboveground live biomass C ($C_{ag,live}$), **(c)** aboveground woody productivity ($ANPP_{stem}$), and **(d)** woody mortality (M) at all three sites during the focal non-El Niño census periods (Table 1). Totals for each size bin have not been divided by the width of the size bin (cm), in contrast to Figure 1. Vertical lines depict 95% confidence intervals based on bootstrapping over subplots.

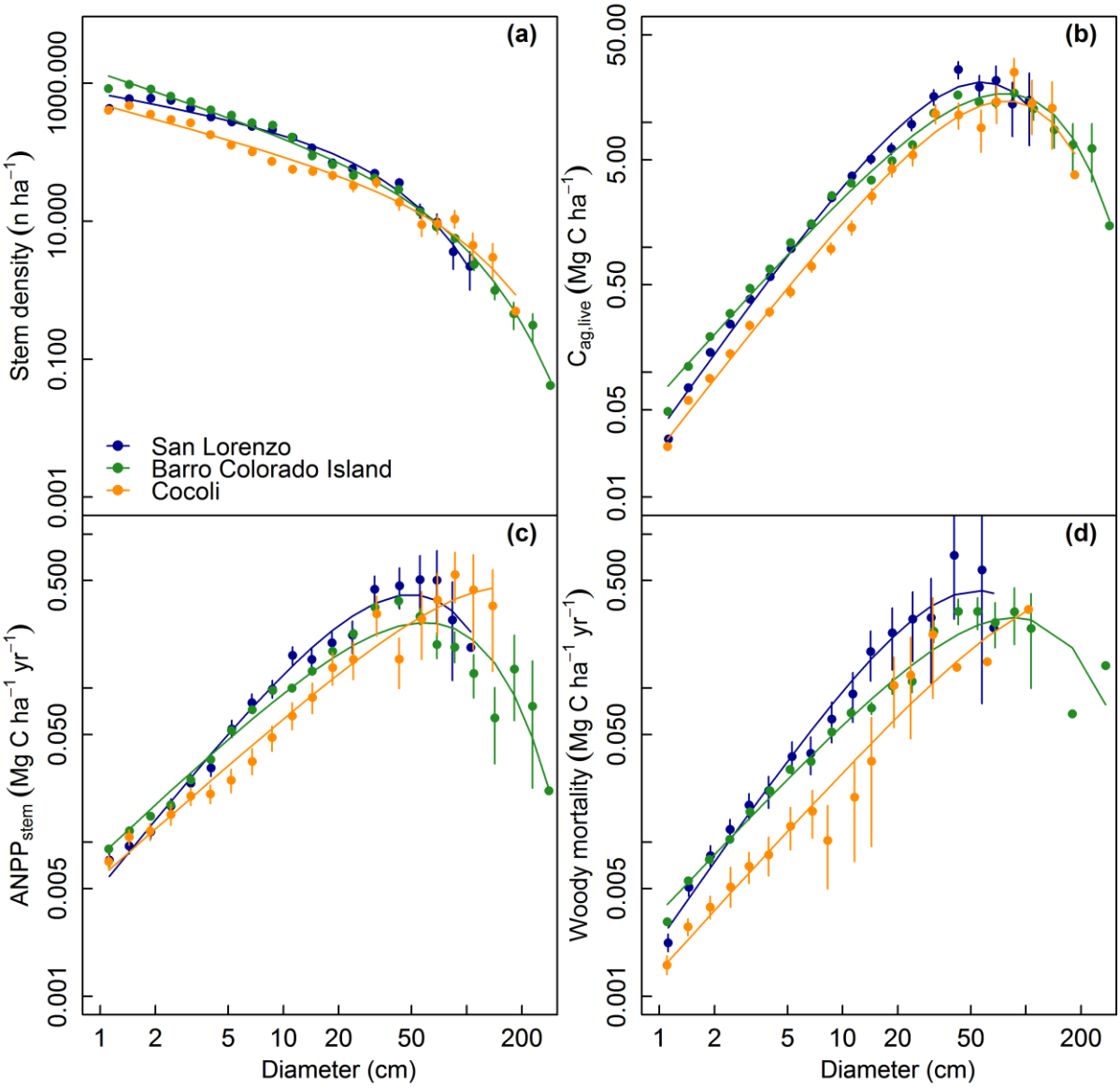

Table S1 List of species classified as deciduous in this study along with source of deciduous observation.

Family	*Species*	Species code	Source*	Deciduousness**
Fabaceae-mimosoideae	*Acacia melanoceras*	acacme	2	DF
Fabaceae-mimosoideae	*Acacia riparia*	acacri	2	DB
Fabaceae-papilionoideae	*Acosmium panamense*	acospa	2	DF
Rubiaceae	*Alseis blackiana*	alsebl	2	DF
Anacardiaceae	*Anacardium excelsum*	anacex	2	DB
Fabaceae-papilionoideae	*Andira inermis*	andiin	1	D
Annocaceae	*Annona spraguei*	annosp	2	DF
Rubiaceae	*Pittoniotis trichantha*	antitr	2	DF
Malvaceae	*Apeiba membranacea*	apeime	2	DF
Malvaceae	*Apeiba tibourbou*	apeiti	2	DF
Bignoniaceae	*Arrabidaea chica*	arrach	2	DB
Apocynaceae	*Aspidosperma spruceanum*	aspicr	1	D
Anacardiaceae	*Astronium graveolens*	ast2gr	2	DB
Moraceae	*Brosimum alicastrum*	brosal	2	DB
Moraceae	*Brosimum utile*	brosut	2	DB
Burseraceae	*Bursera simaruba*	burssi	2	DO
Fabaceae-mimosoideae	*Calliandra magdalenae*	callma	2	DB
Meliaceae	*Carapa guianensis*	caragu	2	DB
Fabaceae-caesalpinioideae	*Cassia moschata*	cas1mo	2	DB
Salicaceae	*Casearia arborea*	casear	2	DB
Salicaceae	*Casearia guianensis*	casegu	2	DF
Rhizophoraceae	*Cassipourea elliptica*	cassel	1	D
Moraceae	*Castilla elastica*	castel	2	DF
Malvaceae	*Cavanillesia platanifolia*	cavapl	2	DO
Cucurbitaceae	*Cayaponia granatensis*	cayagr	2	DB
Urticaceae	*Cecropia longipes*	cecrlo	2	DF
Meliaceae	*Cedrela odorata*	cedrod	2	DB
Malvaceae	*Ceiba pentandra*	ceibpe	2	DO
Fabaceae-mimosoideae	*Chloroleucon mangense*	chloma	2	DB
Cochlospermaceae	*Cochlospermum vitifolium*	cochvi	2	DF
Combretaceae	*Combretum decandrum*	combde	2	DF
Combretaceae	*Combretum fruticosum*	combfr	2	DF
Boraginaceae	*Cordia alliodora*	cordal	2	DF
Boraginaceae	*Cordia bicolor*	cordbi	2	DF
Boraginaceae	*Cordia lasiocalyx*	cordla	2	DB
Lecythidaceae	*Couratari guianensis*	courpa	2	DB
Sapindaceae	*Cupania latifolia*	cupala	1	D
Fabaceae-papilionoideae	*Cymbosema roseum*	cymbro	2	DB
Fabaceae-papilionoideae	*Dalbergia retusa*	dalbre	1	D
Fabaceae-papilionoideae	*Dipteryx oleifera*	diptpa	2	DB
Putranjivaceae	*Drypetes standleyi*	drypst	2	DB
Fabaceae-papilionoideae	*Dussia sp.6*	duss6	2	DF
Fabaceae-papilionoideae	*Erythrina costaricensis*	ery1co	1	D
Cucurbitaceae	*Fevillea cordifolia*	fevico	2	DB
Moraceae	*Ficus americana*	ficuam	2	DB
Moraceae	*Ficus benjamina*	ficube	2	DB
Moraceae	*Ficus brevibracteata*	ficubr	2	DB
Moraceae	*Ficus bullenei*	ficubu	2	DB
Moraceae	*Ficus colubrinae*	ficuc1	2	DB
Moraceae	*Ficus costaricana*	ficuc2	2	DB
Moraceae	*Ficus citrifolia*	ficuci	2	DB
Moraceae	*Ficus dugandii*	ficudu	2	DB
Moraceae	*Ficus insipida*	ficuin	2	DB
Moraceae	*Fiucs maxima*	ficuma	2	DB
Moraceae	*Ficus nymphaeifolia*	ficuny	2	DB
Moraceae	*Ficus obtusifolia*	ficuob	2	DB
Moraceae	*Ficus apollinaris*	ficup1	2	DB
Moraceae	*Ficus paraensis*	ficupa	2	DB
Moraceae	*Ficus pertusa*	ficupe	2	DB
Moraceae	*Ficus popenoei*	ficupo	2	DB
Moraceae	*Ficus tonduzii*	ficuto	2	DB
Moraceae	*Ficus trigonata*	ficutr	2	DB
Moraceae	*Ficus yoponensis*	ficuyo	2	DB
Fabaceae-papilionoideae	*Fissicalyx fendleri*	fissfe	2	DB
Fabaceae-papilionoideae	*Flemingia strobilifera*	flemst	2	DB
Rubiaceae	*Genipa americana*	geniam	2	DF
Fabaceae-papilionoideae	*Gliricidia sepium*	glirse	2	DB
Lamiaceae	*Gmelina arborea*	gmelar	2	DB
Nyctaginaceae	*Guapira standleyana*	guapst	1	D
Malvaceae	*Guazuma ulmifolia*	guazul	1	D
Malvaceae	*Hampea appendiculata*	hampap	1	D
Chrysobalanaceae	*Hirtella americana*	hirtam	1	D
Humiriaceae	*Humiriastrum diguense*	humidi	2	DB
Euphorbiaceae	*Hura crepitans*	huracr	2	DF

Family	*Species*	Species code	Source*	Deciduousness**
Fabaceae-papilionoideae	*Hymenolobium mesoamericanum*	hym1me	2	DB
Fabaceae-mimosoideae	*Inga goldmanii*	ingago	2	DB
Fabaceae-mimosoideae	*Inga mucuna*	ingam1	2	DB
Fabaceae-mimosoideae	*Inga polita*	ingap1	2	DB
Fabaceae-mimosoideae	*Inga pauciflora*	ingapa	2	DB
Bignoniaceae	*Jacaranda caucana*	jac1ca	1	D
Bignoniaceae	*Jacaranda copaia*	jac1co	2	DB
Caricaceae	*Jacaratia spinosa*	jac2sp	1	D
Lythraceae	*Lafoensia punicifolia*	lafopu	2	DB
Fabaceae-papilionoideae	*Lennea viridiflora*	lennvi	2	DF
Chrysobalanaceae	*Licania platypus*	licapl	2	DB
Fabaceae-papilionoideae	*Lonchocarpus heptaphyllus*	loncla	2	DF
Malvaceae	*Luehea seemannii*	luehse	2	DF
Malvaceae	*Luehea speciosa*	luehsp	2	DF
Moraceae	*Maclura tinctoria*	maclti	2	DB
Clusiaceae	*Marila laxiflora*	mar1la	2	DF
Chrysobalanaceae	*Maranthes panamensis*	marapa	2	DB
Sapindaceae	*Matayba apetala*	mataap	1	D
Fabaceae-mimosoideae	*Mimosa pudica*	mimopu	2	DF
Malvaceae	*Mortoniodendron anisophyllum*	mortan	2	DF
Fabaceae-papilionoideae	*Mucuna mutisiana*	mucumu	2	DB
Fabaceae-papilionoideae	*Myrospermum frutescens*	myrofr	1	D
Lauraceae	*Nectandra cissiflora*	nectci	1	D
Malvaceae	*Ochroma pyramidale*	ochrpy	1	D
Fabaceae-papilionoideae	*Ormosia macrocalyx*	ormoma	1	D
Fabaceae-caesalpinioideae	*Peltophorum pterocarpum*	pel1in	2	DF
Euphorbiaceae	*Pera arborea*	peraar	2	DB
Fabaceae-papilionoideae	*Platymiscium pinnatum*	pla1pi	1	D
Fabaceae-papilionoideae	*Platypodium elegans*	pla2el	1	D
Apocynaceae	*Plumeria rubra*	plumac	2	DF
Malvaceae	*Pachira quinata*	pochqu	2	DO
Malvaceae	*Pachira sessilis*	pochse	1	D
Urticaceae	*Pourouma bicolor*	pourbi	2	DF
Malvaceae	*Pseudobombax septenatum*	pse1se	2	DO
Fabaceae-papilionoideae	*Pterocarpus rohrii*	pterro	1	D
Malvaceae	*Quararibea asterolepsis*	quaras	2	DB
Euphorbiaceae	*Sapium glandulosum*	sapiau	2	DF
Fabaceae-caesalpinioideae	*Schizolobium parahyba*	schipa	1	D
Fabaceae-caesalpinioideae	*Senna dariensis*	sennda	2	DB
Elaeocarpaceae	*Sloanea meianthera*	sloam1	2	DB
Elaeocarpaceae	*Sloanea terniflora*	sloate	2	DB
Anacardiaceae	*Spondias mombin*	sponmo	2	DO
Anacardiaceae	*Spondias purpurea*	sponpu	2	DO
Anacardiaceae	*Spondias radlkoferi*	sponra	2	DF
Malvaceae	*Sterculia apetala*	sterap	2	DF
Fabaceae-papilionoideae	*Swartzia simplex_var.ochnacea*	swars2	2	DF
Meliaceae	*Swietenia macrophylla*	swiema	2	DB
Bignoniaceae	*Tabebuia guayacan*	tab1gu	2	DO
Bignoniaceae	*Tabebuia ochracea*	tab1oc	2	DO
Bignoniaceae	*Tabebuia rosea*	tab1ro	2	DF
Anacardiaceae	*Tapirira guianensis*	tapigu	2	DB
Verbenaceae	*Tectona grandis*	tectgr	2	DB
Combretaceae	*Terminalia amazonia*	termam	2	DB
Combretaceae	*Terminalia oblonga*	termob	2	DB
Burseraceae	*Trattinnickia aspera*	tratas	2	DO
Cannabaceae	*Trema micrantha*	tremmi	1	D
Meliaceae	*Trichilia hirta*	tri2hi	1	D
Malvaceae	*Trichospermum galeottii*	tri4ga	2	DF
Polygonaceae	*Triplaris cumingiana*	tripcu	1	D
Myristicaceae	*Virola sebifera*	virose	1	D
Salicaceae	*Xylosma chlorantha*	xyl2ch	2	DF
Rutaceae	*Zanthoxylum ekmanii*	zantbe	2	DF
Rutaceae	*Zanthoxylum panamense*	zantp1	2	DF
Rutaceae	*Zanthoxylum acuminatum*	zantpr	2	DF
Rutaceae	*Zanthoxylum setulosum*	zantse	2	DF
Salicaceae	*Zuelania guidonia*	zuelgu	2	DF

*Sources: 1- Condit et al. 2000; 2- S.J. Wright or O. Calderon, personal observation.

** DB, brevideciduous; DO, Obligately deciduous; DF, facultatively deciduous; D, Deciduous not specified

Table S2 Ecosystem-level C variables for all three sites during non-El Niño census periods using allometries from Chave et al. (2005).

		$C_{,ag,live}$ (95% CIs) (Mg C ha^{-1})	$ANPP_{stem}$ (95% CIs) (Mg C ha^{-1} yr^{-1})	*M* (95% CIs) (Mg C ha^{-1} yr^{-1})	Net biomass C change (95% CIs) (Mg C ha^{-1} yr^{-1})
Cocoli	1994*-97	146 (128,163)	3.66 (3.16,4.23)	1.21 (0.71,2.49)	2.46(1.08,3.20)
Barro Colorado Island	1990-95*	160 (152,167)	3.22 (3.09,3.36)	2.83 (2.48,3.29)	0.38(-0.14,0.74)
	non-El Niño mean	160	3.72	3.07	0.64
San Lorenzo	1996*-97	157 (141,175)	3.76 (3.25,4.31)	2.92 (2.06,4.23)	0.84 (-0.62,1.80)
	non-El Niño mean	160	3.02	3.14	-0.11

Shown are records for our focal census periods (Table 1) and the mean for all non-El Niño census periods.
*indicates year for which $C_{,ag,live}$ is reported.
$C_{ag,live}$, live aboveground biomass C; $ANPP_{stem}$, woody productivity; *M*, woody mortality.

Table S3 Adjusted woody mortality values for the 1981-1985 Barro Colorado Island census periods.

Size Class* (mm)	$f_{\Delta HOM,}$	C_{85}:C_{81}	$M_{corrected}$ (Mg C yr^{-1})	*M* (Mg C yr^{-1})
10-13	0	-	0.132	0.132
13-16.5	0	-	0.228	0.228
16.5-21.5	0	-	0.329	0.329
21.5-27.5	0	-	0.328	0.328
27.5-36	0	-	0.820	0.820
36-46	0	-	0.940	0.940
46-59.5	0	-	0.785	0.785
59.5-76.5	0	-	1.66	1.66
76.5-100	0	-	2.06	2.06
100-127.5	0	-	3.01	3.01
127.5-164	0	-	3.84	3.84
164-212.5	0.0080	2.18	7.26	7.19
212.5-273	0.0367	2.75	11.22	10.54
273-369	0.11	1.49	17.90	17.01
369-500	0.25	1.16	31.06	29.87
500-625	0.41	0.88	24.55	25.79
625-765	0.51	0.75	19.70	22.59
765-982.5	0.60	0.65	19.55	24.76
982.5-1261.5	0.59	0.60	30.07	39.45
1261.5-1636	0.53	0.65	18.69	22.91
1636-2100.5	0.44	0.67	20.84	24.48
2100.5-2724.5	0.50	0.69	13.69	16.24
2724.5-3501	0.13	0.65	0.00	0.00

*Size classes are defined based on 1981 diameter.
$f_{\Delta HOM}$, fraction of stems in each size class with a height of measurement change from 1981-85; C_{85}:C_{81}, ratio of biomass C in 1985 to 1981; *M*, woody mortality; $M_{corrected}$, woody mortality after corrections were applied as described in Methods S2.

Table S4 Demographic rates and C cycle variables by size class for each site and census period.

			Demography				C flux (Mg C ha^{-1} yr^{-1})		
	Census period	size class (cm)	Initial stem density (ha^{-1})	Diameter growth rate (mm yr^{-1})	m_{stem} (% yr^{-1})	$C_{ag,live}$	Net biomass C change	$ANPP_{stem}$	M
Cocoli	1994-1997	≥1	2563 (2454,2668)	-	4.34 (3.94,4.81)	120 (105,132)	1.89 (0.90,2.72)	3.07 (2.63,3.52)	1.18 (0.61,1.99)
		1-10	2282 (2180,2383)	0.804 (0.77,0.85)	4.67 (4.22,5.18)	2.97 (2.97,2.80)	0.125 (0.10,0.14)	0.193 (0.18,0.21)	0.0675 (0.06,0.08)
		10-50	244 (228,259)	2.35 (2.13,2.56)	1.91 (1.40,2.49)	37.0 (33.3,40.7)	0.262 (-0.03,0.55)	0.901 (0.78,1.03)	0.639 (0.42,0.89)
		≥50	37 (32,43)	9.09 (7.74,10.56)	0.451 (0,1.21)	80.0 (65.8,95.6)	1.50 (0.61,2.27)	1.97 (1.53,2.44)	0.473 (0,1.27)
	1997-1998	≥1	2564 (2451,2675)	-	6.44 (5.66,7.35)	126 (111,142)	-0.908 (-4.24,1.31)	2.28 (1.76,2.81)	3.18 (1.19,6.27)
		1-10	2283 (2177,2386)	1.05 (1.00,1.10)	6.96 (6.05,7.97)	3.03 (2.86,3.20)	0.150 (0.12,0.18)	0.249 (0.23,0.27)	0.0990 (0.08,0.12)
		10-50	243 (229,259)	1.66 (1.38,1.97	2.34 (1.50,3.32)	37.4 (33.8,41.2)	-0.273 (-0.90,0.29)	0.809 (0.60,1.10)	1.08 (0.62,1.71)
		≥50	38 (33,44)	5.25 (3.27,7.43)	1.86 (0.00,4.42)	85.8 (71.2,101.7)	-0.785 (-3.71,1.28)	1.22 (0.81,1.69)	2.00 (0.00,5.28)
Barro Colorado Island	1981-1985*	≥1	5250 (5212,5289)	-	4.20 (4.12,4.28)	-	0.700 (-0.86,1.07)	5.55 (5.34,5.77)	4.86 (4.51,6.40)
		1-10	4815 (4774,4853)	0.93 (0.93,0.96)	4.28 (4.20,4.37)	-	0.308 (0.29,0.32)	0.507 (0.49,0.51)	0.199 (0.19,0.21)
		10-50	400 (395,407)	3.49 (3.41,3.57)	3.33 (3.18,3.52)	-	0.627 (0.54,0.82)	2.23 (2.15,2.30)	1.60 (1.41,1.68)
		≥50	35 (33,36)	11.5 (10.5,12.5)	3.18 (2.70,3.65)	-	-0.236 (-1.90,0.05)	2.82 (2.59,3.04)	3.06 (2.82,4.69)
	1985-1990	≥1	5437 (5396,5476)	-	3.81 (3.74,3.87)	132 (125,139)	2.06 (1.62,2.43)	4.46 (4.21,4.69)	2.40 (2.11,2.74)
		1-10	5005 (4964,5048)	0.79 (0.78,0.80)	3.94 (3.88,4.00)	6.32 (6.23,6.39)	0.389 (0.39,0.40)	0.544 (0.54,0.55)	0.155 (0.15,0.16)
		10-50	402 (396,408)	2.65 (2.59,2.71)	2.38 (2.27,2.50)	46.7 (45.6,47.7)	0.628 (0.53,0.73)	1.63 (1.58,1.69)	1.00 (0.92,1.08)
		≥50	30 (28,31)	9.30 (8.62,9.99)	1.99 (1.71,2.34)	79.1 (72.1,85.6)	1.04 (0.65,1.42)	2.28 (2.07,2.54)	1.24 (0.98,1.57)
	1990-1995	≥1	5727 (5687,5770)	-	4.24 (4.17,4.30)	136 (129,143)	0.322 (-0.14,0.70)	2.76 (2.62,2.91)	2.43 (2.04,2.85)
		1-10	5284 (5239,5325)	0.517 (0.51,0.53)	4.41 (4.34,4.48)	7.12 (7.04,7.20)	0.156 (0.15,0.17)	0.335 (0.33,0.34)	0.179 (0.17,0.18)
		10-50	412 (406,418)	2.31 (2.26,2.37)	2.25 (2.14,2.37)	46.1 (45.1,47.2)	0.425 (0.34,0.52)	1.33 (1.29,1.38)	0.906 (0.83,0.98)
		≥50	31 (30,33)	4.57 (4.25,4.92)	2.02 (1.69,2.37)	82.5 (75.7,90.2)	-0.260 (-0.75,0.11)	1.09 (0.95,1.22)	1.35 (0.99,1.74)
	1995-2000	≥1	5342 (5298,5383)	-	4.16 (4.10,4.22)	136 (129,143)	0.149 (-0.35,0.55)	2.85 (2.70,3.01)	2.70 (2.31,3.21)
		1-10	4894 (4853,4933)	0.569 (0.56,0.58)	4.32 (4.26,4.39)	7.02 (6.93,7.10)	0.116 (0.11,0.12)	0.309 (0.30,0.31)	0.193 (0.19,0.20)
		10-50	418 (411,424)	2.29 (2.24,2.34)	2.52 (2.41,2.62)	46.7 (45.8,47.7)	0.337 (0.25,0.43)	1.32 (1.28,1.36)	0.984 (0.91,1.06)
		≥50	31 (29,33)	5.29 (4.93,5.67)	1.84 (1.51,2.17)	82.1 (75.6,88.7)	-0.304 (-0.75,0.12)	1.22 (1.07,1.38)	1.53 (1.13,1.98)
	2000-2005	≥1	4985 (4946,5026)	-	3.84 (3.78,3.92)	138 (131,146)	-0.0908 (-0.49,0.29)	2.75 (2.59,2.95)	2.84 (2.54,3.20)
		1-10	4542 (4504,4580)	0.574 (0.56,0.58)	3.95 (3.89,4.02)	6.83 (6.75,6.91)	0.146 (0.14,0.15)	0.326 (0.32,0.33)	0.180 (0.17,0.18)
		10-50	411 (406,417)	2.26 (2.21,2.31)	2.75 (2.63,2.87)	46.8 (45.8,47.9)	0.117 (0.02,0.22)	1.27 (1.23,1.31)	1.15 (1.07,1.24)
		≥50	32 (30,33)	4.76 (4.48,5.04)	2.27 (1.94,2.61)	84.3 (77.5,92.2)	-0.355 (-0.70,-0.02)	1.15 (0.99,1.35)	1.51 (1.20,1.85)
	2005-2010	≥1	4893 (4838,4946)	-	3.87 (3.79,3.95)	138 (131,146)	-0.0903 (-0.69,0.38)	2.77 (2.66,2.88)	2.86 (2.43,3.46)
		1-10	4457 (4418,4495)	0.660 (0.65,0.67)	3.99 (3.92,4.06)	6.79 (6.71,6.87)	0.184 (0.18,0.19)	0.360 (0.35,0.37)	0.176 (0.17,0.18)
		10-50	404 (398,410)	2.29 (2.23,2.34)	2.66 (2.55,2.77)	46.0 (45.0,47.1)	0.140 (0.05,0.24)	1.29 (1.25,1.34)	1.15 (1.07,1.24)
		≥50	31 (30,33)	5.04 (4.76,5.33)	2.02 (1.69,2.34)	84.7 (78.1,92.6)	-0.414 (-1.02,0.03)	1.12 (1.01,1.23)	1.53 (1.11,2.05)

			Demography				C flux (Mg C ha^{-1} yr^{-1})		
	Census period	size class (cm)	Initial stem density (ha^{-1})	Diameter growth rate (mm yr^{-1})	m_{stem} (% yr^{-1})	$C_{ag,live}$	Net biomass C change	$ANPP_{stem}$	M
San Lorenzo	1996-1997	≥1	4210 (4101,4336)	-	5.32 (4.85,5.83)	144 (130,157)	0.614 (-0.59,1.75)	3.44 (2.98,3.95)	2.83 (1.89,3.95)
		1-10	3687 (3579,3802)	0.674 (0.64,0.71)	5.64 (5.15,6.13)	6.45 (6.23,6.69)	0.130 (0.09,0.17)	0.333 (0.31,0.36)	0.204 (0.17,0.24)
		10-50	493 (475,512)	2.27 (2.10,2.44)	3.11 (2.55,3.74)	67.1 (62.3,71.7)	-0.154 (-0.85,0.46)	1.64 (1.46,1.84)	1.79 (1.20,2.41)
		≥50	30 (25,35)	6.78 (5.11,8.83)	1.96 (0.41,3.59)	69.9 (56.7,84.1)	0.638 (-0.27,1.45)	1.47 (1.01,1.94)	0.833 (0.17,1.64)
	1997-1998	≥1	3987 (3870,4101)	-	4.88 (4.49,5.29)	144 (132,157)	2.51 (1.42,3.44)	4.47 (3.91,5.11)	1.97 (1.29,2.80)
		1-10	3472 (3369,3577)	0.981 (0.94,1.02)	5.22 (4.76,5.69)	6.39 (6.13,6.63)	0.306 (0.27,0.34)	0.478 (0.45,0.51)	0.172 (0.14,0.20)
		10-50	484 (465,503)	2.76 (2.56,2.96)	2.65 (2.06,3.29)	65.9 (61.7,70.3)	0.847 (0.11,1.43)	2.26 (2.00,2.53)	1.41 (0.88,2.03)
		≥50	31 (26,36)	6.33 (4.89,7.93)	1.18 (0.00,2.97)	71.9 (58.6,85.1)	1.35 (0.54,2.07)	1.73 (1.19,2.33)	0.382 (0.00,0.96)
	1998-2009	≥1	4023 (3919,4139)	-	3.29 (3.16,3.43)	146 (132,161)	-0.290 (-0.35,-1.05)	2.67 (2.44,2.92)	2.96 (2.42,3.67)
		1-10	3504 (3394,3613)	0.711 (0.68,0.74)	3.41 (3.29,3.55)	6.45 (6.20,6.70)	0.303 (0.27,0.32)	0.426 (0.40,0.45)	0.123 (0.12,0.14)
		10-50	488 (468,508)	2.21 (2.07,2.35)	2.54 (2.32,2.79)	66.0 (61.7,70.6)	0.108 (-0.18,0.32)	1.48 (1.34,1.62)	1.37 (1.21,1.63)
		≥50	31 (26,36)	3.71 (3.14,4.25)	2.28 (1.56,3.11)	74.0 (60.8,89.6)	-0.702 (-1.41,-0.09)	0.764 (0.59,0.98)	1.47 (0.96,2.07)

Grey shading indicates census periods with major El Niño event.
**Recruitment refers to growth into entire census periods.
*Values for the Barro Colorado Island 1981-85 census period are estimated as described in Methods S2.
m_{stem}, stem mortality rate; $C_{ag,live}$, live aboveground biomass C; $ANPP_{stem}$, woody productivity; M, woody mortality.

Table S5 Fitted parameters corresponding to Figure 1 and Figure S1.

				$\log_e(a)$		*b*		*c*	
Variable	**Site**	**R^2**	**Adj. R^2**	**est. (95%CI)**	**p**	**est. (95%CI)**	**p**	**est. (95%CI)**	**p**
Stem density	Cocoli	0.99	0.99	7.56 (7.27, 7.86)	<0.001	-1.71 (-1.86, -1.55)	<0.001	-0.0144 (-0.0190, -0.0097)	<0.001
	Barro Colorado Island	1.00	1.00	8.60 (8.37, 8.82)	<0.001	-1.87 (-1.98, -1.77)	<0.001	-0.0187 (-0.0209, -0.0165)	<0.001
	San Lorenzo	1.00	1.00	7.95 (7.70, 8.19)	<0.001	-1.48 (-1.63, -1.33)	<0.001	-0.0346 (-0.0415, -0.0277)	<0.001
Individual Biomass C	Cocoli	1.00	1.00	-9.93 (-10.00,-9.86)	<0.001	2.62 (2.59,2.66)	<0.001	-0.0102 (-0.0113, -0.0091)	<0.001
	Barro Colorado Island	1.00	1.00	-9.94 (-9.99,-9.88)	<0.001	2.55 (2.53,2.57)	<0.001	-0.0035 (-0.0040,-0.0030)	<0.001
	San Lorenzo	1.00	1.00	-9.93 (-9.99,-9.88)	<0.001	2.56 (2.53,2.60)	<0.001	-0.0009 (-0.0024,0.0006)	0.23
Aboveground C ($C_{ag,live}$)	Cocoli	0.92	0.91	-2.37 (-2.62,-2.11)	<0.001	0.92 (0.79,1.05)	<0.001	-0.0246 (-0.0287, -0.0205)	<0.001
	Barro Colorado Island	0.97	0.96	-1.38 (-1.58, -1.17)	<0.001	0.67 (0.58, 0.77)	<0.001	-0.0220 (-0.0240, -0.0200)	<0.001
	San Lorenzo	0.95	0.95	-1.99 (-2.20, -1.77)	<0.001	1.08 (0.95, 1.21)	<0.001	-0.0355 (-0.0416,-0.0294)	<0.001
Diameter growth	Cocoli	0.97	0.97	-2.92 (-3.12, -2.71)	<0.001	0.42 (0.30, 0.53)	<0.001	0.0104 (0.0061, 0.0147)	<0.001
	Barro Colorado Island	0.96	0.96	-3.61 (-3.87, -3.35)	<0.001	0.70 (0.58, 0.81)	<0.001	-0.0004 (-0.0029, 0.0022)	0.76
	San Lorenzo	0.96	0.95	-3.31 (-3.57, -3.06)	<0.001	0.61 (0.46, 0.77)	<0.001	0.0023 (-0.0049, 0.0094)	0.51
Individual Biomass C Growth	Cocoli	1.00	1.00	-11.63 (-11.85,-11.42)	<0.001	1.98 (1.86,2.10)	<0.001	-0.0008 (-0.0052,0.0037)	0.73
	Barro Colorado Island	1.00	0.99	-12.22 (-12.48,-11.97)	<0.001	2.12 (2.01,2.24)	<0.001	-0.0029 (-0.0054,-0.0004)	0.03
	San Lorenzo	1.00	1.00	-12.01 (-12.26,-11.75)	<0.001	2.07 (1.91,2.22)	<0.001	0.0022 (-0.0049,0.0093)	0.52
Stem productivity ($ANPP_{stem}$)	Cocoli	0.34	0.27	-3.79 (-4.08, -3.49)	<0.001	0.06 (-0.10, 0.23)	0.44	-0.0063 (-0.0125, -0.0001)	0.05
	Barro Colorado Island	0.96	0.96	-3.46 (-3.76, -3.16)	<0.001	0.14 (0.01, 0.28)	0.04	-0.0195 (-0.0225, -0.0166)	<0.001
	San Lorenzo	0.82	0.80	-3.89 (-4.16, -3.62)	<0.001	0.49 (0.32, 0.65)	<0.001	-0.0294 (-0.0369, -0.0219)	<0.001
Mortality rate (m_{stem})	Cocoli	0.71	0.66	1.86 (1.46, 2.26)	<0.001	-0.53 (-0.78, -0.29)	<0.001	0.0114 (-0.0005, 0.0234)	0.06
	Barro Colorado Island	0.82	0.80	1.65 (1.44, 1.85)	<0.001	-0.29 (-0.39, -0.19)	<0.001	0.0015 (-0.0010, 0.0040)	0.23
	San Lorenzo	0.72	0.68	2.00 (1.66, 2.33)	<0.001	-0.33 (-0.56, -0.09)	0.01	0.0015 (-0.0135, 0.0166)	0.83
Woody mortality (M)	Cocoli	0.39	0.30	-5.17 (-5.62, -4.72)	<0.001	0.30 (0.03, 0.58)	0.03	-0.0064 (-0.0203, 0.0076)	0.34
	Barro Colorado Island	0.83	0.82	-4.30 (-4.64, -3.96)	<0.001	0.27 (0.12, 0.43)	0.002	-0.0144 (-0.0182, -0.0107)	<0.001
	San Lorenzo	0.79	0.76	-4.65 (-4.97, -4.33)	<0.001	0.69 (0.46, 0.92)	<0.001	-0.0279 (-0.0426, -0.0133)	0.001

Table S6 Fitted parameters corresponding to Figure 2.

Functional Group	Site	R^2	R^2 adj.	$\log_e$ (a) (95% CI)	p-value	b (95% CI)	p-value
Deciduousness* (excluding DB)	Cocoli	0.69	0.64	-0.16 (-0.50,0.18)	0.29	0.15 (0.05,0.26)	0.01
	Barro Colorado Island	0.74	0.69	-0.08 (-0.30,0.14)	0.43	0.11 (0.04,0.18)	0.006
	San Lorenzo	0.87	0.84	0.03 (-0.02,0.09)	0.17	0.04 (0.02,0.06)	0.002
Deciduousness* (including DB)	Cocoli	0.87	0.84	-0.12 (-0.39,0.15)	0.32	0.21 (0.13,0.29)	<0.001
	Barro Colorado Island	0.87	0.85	-0.12 (-0.35,0.10)	0.23	0.18 (0.11, 0.25)	<0.001
	San Lorenzo	0.90	0.88	-0.02 (-0.17,0.13)	0.71	0.14 (0.09, 0.19)	0.001
Wood Density	Cocoli	0.76	0.72	0.77 (0.61,0.93)	<0.001	-0.09 (-0.13,-0.04)	0.004
	Barro Colorado Island	0.77	0.74	0.66 (0.58,0.74)	<0.001	-0.04 (-0.07,-0.02)	0.004
	San Lorenzo	0.03	-0.16	0.56 (0.51,0.61)	<0.001	0.003 (-0.02,0.02)	0.71
Moisture Association	Cocoli	0.71	0.66	-0.28 (-0.65,0.08)	0.10	-0.17 (-0.28,-0.06)	0.009
	Barro Colorado Island	0.10	-0.05	0.66 (0.26,1.07)	0.007	-0.04 (-0.16,0.08)	0.45
	San Lorenzo	0.67	0.60	1.12 (0.79,1.45)	<0.001	0.14 (0.03,0.25)	0.03

*Analyses were run both including and excluding brevideciduous species (DB) as deciduous.

Methods S1 Methods for classifying deciduous species

A formal census occurred in 1997 and 1999, when all non-palm canopy species (those reaching ≥30cm DBH) with >1 individual were surveyed for deciduousness at all three sites (Condit *et al.*, 2000), yielding a list of deciduous canopy species. Understory species were not surveyed because they are seldom deciduous, with only one known exception (*Erythrina costaricensis*) on Barro Colorado Island (Frankie *et al.*, 1974; Wright, 1991; Condit *et al.*, 2000). A local botanist found no additional exceptions in a list of species comprising 90% of the understory stems at Cocoli and San Lorenzo (Rolando Perez, personal communication).

Furthermore, SJW and Osvaldo Calderón drew on 63 years of experience in central Panama to score the leaf habit of 965 species as evergreen (850 species), brevideciduous (64), facultatively deciduous (42), or obligately dry season deciduous (10). Obligately dry season deciduous species drop all leaves at the beginning of the dry season. Facultatively deciduous species drop leaves steadily as the dry season develops. Obligately and faculatively deciduous species leaf out near the beginning of the next rainy season. *Erythrina costaricensis* is brevideciduous in the late rainy season. All other brevideciduous species drop all leaves during the dry season and leaf out a few days (*Anacardium excelsum*) to six weeks (*Jacaranda copaia*) later under ongoing dry season drought and well before the next rainy season begins.

It is probable that this approach overestimates deciduousness in the understory, as many species become more deciduous in larger size classes (Condit *et al.*, 2000); however, if anything this biases our results in the opposite direction of our conclusions. Furthermore, some deciduous species are only briefly deciduous—sometimes (rarely) during the wet season; nevertheless, in most cases, deciduousness is a drought adaptation.

Methods S2 Corrections applied to forest census data and exclusion of outliers

Aligning stem IDs across censuses

At all three sites, as individual stems were not tagged for multiple-stemmed trees, their growth and mortality could not be estimated until an algorithm was developed to align stems between censuses. This algorithm was run following the application of a taper correction (see Methods) to ensure that those stems that experienced a height of measurement change over the census interval would have comparable diameter measurements. All stems were first sorted from largest to smallest DBH. For each tag, if the number of stems changed between censuses,

indicating a mortality event, then the algorithm tested different possibilities for stem death and selected the combination that returned the minimum sum of absolute differences. A stem was not permitted to align with another if that match resulted in a shrinkage of more than 15%, and a multiplicative penalty of 5 was applied to negative matches in order to incentivize growth over the less likely possibility of shrinking. Stems were also matched by the algorithm in cases where a large stem had broken and resprouted (indicated by the code 'R' in the census data) or if the number of stems ≥ 10 cm changed between censuses. If a tree had too many stems for the algorithm to handle (true for ≤4 trees per census interval), only stems ≥10 cm were matched, and smaller stems remained sorted from largest to smallest DBH.

To test this alignment, we ran the algorithm using the Barro Colorado Island censuses from 2010 and 2015, during which each individual stem was tagged and tracked. For 89% of stems, the alignment produced by the algorithm matched the actual stem alignment. To determine whether the algorithm causes an underestimation of growth rates, we ran a paired t-test and found that although the growth values that resulted from the algorithm alignment were significantly lower ($t=-4.7$; $df = 198420$; $p<0.001$), the mean of differences was trivial enough (-0.0028 mm yr^{-1}; CIs: -0.004,-0.002) to support the use of this algorithm in cases of untagged stems.

Precision and rounding

For the first two Barro Colorado Island censuses, measurement precision was only 0.5 cm for stems ≤5 cm (as opposed to 0.1cm for larger stems in the first two censuses and all stems in later censuses). To adjust for this, measurements for all stems <5.5 cm were rounded to the nearest 0.5 cm.

Removal of growth outliers

To reduce the impact of outliers that likely reflect measurement errors, we excluded stems that grew more than 75 mm yr^{-1} or those that fell more than four standard deviations above the mean for each size class. Negative outliers were accounted for by excluding stems with a DBH measurement that fell more than four standard deviations below its initial DBH based on a linear model used to estimate standard deviation of DBH (Muller-Landau *et al.*, 2006). When

calculating $ANPP_{stem}$, instead of excluding outliers, we replaced values by the C gain of each outlier's size class using the same 23 approximately log-even bins used in subsequent analyses.

There were several instances of large buttressed stems with missing DBH measurements at Cocoli in 1997 (n=12), Barro Colorado Island in 1985 (n=13), and San Lorenzo in 1997 (n=6). For these, we estimated DBH by calculating total growth between the previous and subsequent censuses and allocating it proportionally between the two census periods based on the mean proportion of growth in each census period for the size class, where stems were divided into size classes using 23 log-even bins.

Estimating C balance for first Barro Colorado Island census period

Estimation of C balance for the first census period required a correction for the fact that stems with buttresses or other irregularities (0.51% of all stems; 16% of stems ≥20cm DBH) were measured at breast height, rather than above buttresses, in the first Barro Colorado Island census. For *M*, we broke stems into 23 approximately log-even size bins and determined the fraction of stems in each size class that had a HOM (height of measurement) change from 1981-1985 ($f_{\Delta HOM,}$ Table S3). For that subset of stems, the ratio of biomass C in 1985 to 1981 (C_{85}:C_{81}) was calculated to produce a corrected estimate of *M* that assumes that the cohort of stems that died had the same fraction of stems with buttresses and the same error introduced by those buttresses as stems that survived:

$$M_{corrected} = M * (1 - f_{\Delta HOM}) + M * f_{\Delta HOM} * (C_{85}/C_{81}) \quad [1]$$

Stem productivity ($ANPP_{stem}$) was corrected by replacing the C gain for each individual that changed its HOM with the average C gain of its size class during the 1981-1985 census period based on its 1985 HOM, using the same size bins as $M_{corrected}$. Using the calculation stated previously, net biomass C change was determined for the first Barro Colorado Island census interval using these corrected *M* and $ANPP_{stem}$ estimations.

Methods S3 Demographic variables.

Census data were used to calculate growth and mortality. Stem diameter growth rate (mm yr^{-1}) and stem $C_{ag,live}$ growth rate (Mg C yr^{-1}) were calculated for each stem by dividing its change in DBH and C, respectively, between two consecutive census periods by the change in time between these censuses using exact measurement dates. Mean Individual $C_{ag,live}$ (Mg C) was

estimated by calculating the mean C in each size class for the initial census period of the census interval using 23 log-even bins. Growth outliers were excluded as detailed in Methods S2.

Annual stem mortality rate (m_{stem}; % yr^{-1}) was calculated using the following equation (Sheil *et al.*, 1995):

$$m_{stem} = \left[1 - \left(\frac{N_t}{N_0}\right)^{1/t}\right] \times 100, \quad [2]$$

Here, N_0 is the number of live stems in the initial census, and N_t is the number of stems that remained alive in the subsequent census at time t (in years), calculated as the census interval for the N_0 stems based on the mean of exact census dates. Stems whose DBH fell below the 1 cm threshold due to stem breaks were counted as dead (Muller-Landau *et al.*, 2006). The stem mortality rate values reported here differ from individual tree mortality rate values, which would not count an individual as dead until all stems have died. Ninety-five percent confidence intervals were estimated for all variables by bootstrapping across 10 x 10 m subplots.

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