Tree demographic strategies largely overlap across succession in Neotropical wet and dry forest communities

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ECOLOGY

Appendix S1

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1. Data Handling

a) Sarapiquí

We use data from 7 secondary forest (SF) and 2 old growth forest (OGF) plots, each 1 ha in size (50 x 200 m). The minimum dbh is 5 cm. In 4 SF and 2 OGF plots, there is an additional census interval with sapling data (1-5 cm) from 0.5 ha (5 transects of 5 x 200 m per plot; Lindero Sur: 0.25 ha, 5 transects of 5 x 100 m). Lindero Sur new plot was not considered. We removed 22 duplicate entries in the 2017 census. We used last noted species names in case they changed or were missing. We removed lianas. In Cuatro Ríos, we corrected one x-coordinate (deemed 50 instead of 80). In Lindero Sur, y-coordinates exceeding 100 were subtracted 100. We discarded 42 remnant trees (22 in Finca el Bejuco, 9 in Lindero Sur, 6 in Tirimbina, 3 in Lindero el Peje secundario, 2 in Cuatro Ríos).

b) Tirimbina

We use data from four SF plots (Manú & Aceituno 1.16 ha, Bottarrama 1.6 ha, Arrozal 1987-2003 0.3 ha, 2006-2017 1.44 ha). Minimum dbh is generally 5 cm, but varies (see Table S1). We corrected species affiliation for three entries (1-63-35: Chrysoplyllum brenesii, 4-34-38: Beilschmiedia costaricensis, 4-53-35 Cestrum microcalyx) and treeID for one entry (subplot 74 in Arrozal does not exist; correct treeID for 4-74-35-1 is 4-73-35-1).

c) Carbono

We use data from 12 OGF plots each 0.5 ha in size. We only use plots from residual soils (plots L (flat) and P (slopes)) to be consistent with the Sarapiquí and Tirimbina secondary forest data. Minimum dbh is 10 cm. For one census interval, there is additional information on sapling data (1-10 cm) from one subplot per plot (0.01 ha each). We excluded trees with negative coordinates.

d) Agua Salud

We use data from 104 plots (referred to as transects) each 0.1 ha in size (20 x 50 m). Transects 1-4 were not considered due to differences in sampling design. Minimum dbh is 5 cm for one half of each transect and 1 cm for the other half. For 10 transects (73, 74, 79, 80, 91, 92, 97-100) exact age since abandonment could only be estimated to be between 50 and 80 years. We used an age of 50 years in 2009 for our analyses.

e) BCNM

We use data from 8 SF plots each 0.32 ha in size except Saino (0.18 ha). Minimum dbh is 5 cm. We removed 3 duplicate entries. We corrected census year = 2102 to 2002.

f) BCI

We use data from one 50 ha OGF plot. Minimum dbh is 1 cm. Trees with no dbh measurement but status “alive” were not considered. We used the mean census date of the census year in case the exact date of measurement was missing. We discarded trees with unknown location.

g) Yucatán Permanent plots

We use data from 9 SF plots each 0.1 ha (20 x 50 m) in size. Minimum dbh is generally 5 cm and 1 cm for ten 30 m² subplots per plot.

h) Yucatán Conglomerates

We use data from 20 SF plots, referred to as conglomerates. Each conglomerate consists of 4 circular 400 m² plots (11.28 m in radius) within a circular area of 1 ha. Minimum dbh is generally 7.5 cm and 2.5 cm for one 80 m² concentric subplot per plot. We corrected typing errors in conglomerate, plot, individual or stem numbers in 526 entries. We corrected a typing error in dbh measurement in 1 entry. We excluded 4 conglomerates and 7 subplots due to exceeding numbers of typing errors.

i) Oaxaca

We use data from 17 SF and 8 OGF plots each 0.04 ha (20 x 20 m) or 0.05 ha (20 x 25 m) in size (see Table S1). Minimum dbh is 5 cm for 25% (OGF) or 50% (SF) of each plot, 2.5cm for additional 50% (OGF) or 25% (SF) of each plot and 1 cm for the rest of each plot. OGF plots that were established on soils derived from limestone were not considered in order to be consistent with SF plots. We excluded lianas. Trees outside of plot borders were discarded. Trees noted dead but alive again in later censuses were omitted from those censuses until again noted alive.

2. Canopy layer assignment

Trees were assigned to one of three canopy layers following the approach of Purves et al. (2008) and Bohlman and Pacala (2012). To do this, plots were divided into subplots of different size (see Table S1). Within each subplot, trees were sorted by size and assigned to the top canopy layer (layer 1) until the cumulative area of their crowns exceeded the subplot area. For the smallest tree to enter layer 1 (i.e. the top canopy layer), we checked whether >50% of its crown area would 'fit' into layer 1. If this was the case, we assigned it to layer 1, otherwise, we assigned it to layer 2. Smaller trees were assigned to layer 2 until the cumulative area of their crowns exceeded the subplot area, and so on. For each tree, we calculated its crown area from common (i.e. the same for all species) site-specific allometries.

For Costa Rica, the dbh – crown area allometric relationship was calculated based on measurements from 574 trees located in the Lindero el Peje secundario plot from the Sarapiquí dataset (Eqn 1).

(Equation 1) $$crown\ area\ (m^2) = 0.048 * dbh\ (mm)^{1.205}$$

For Panama, the allometric equation from Bohlman and Pacala (2012) was used (Eqn 2).

(Equation 2) $$crown\ area\ (m^2) = 0.036 * dbh\ (mm)^{1.281}$$

For Oaxaca, 29.662 crown area and dbh observations from 3,828 individuals were used to calculate allometric equations. Separate allometries were derived for trees (28,587 obs. from 3,609 individuals, Eqn 3) and cacti (1,075 from 219 individuals, Eqn 4).

(Equation 3) $$crown\ area\ (m^2) = 188.630 * ba\ (m^2)^{0.578}$$

(Equation 4) $$crown\ area\ (m^2) = 29.633 * ba\ (m^2)^{0.858}$$

For Yucatán, the tree allometry from Oaxaca was used (Eqn 3).

Table S1: All plots and census intervals used along with information on key references, previous land use, stand age, minimum dbh and areas.

Site	Dataset	Key references	Plot	Previous land use	Census interval	Stand age (years)	Minimum dbh (cm)	Area (ha)	Minimum dbh subplots (cm)	Area subplots (ha)	Subplot area for canopy layer assignment (m²)
Costa Rica	Tirimbina	Chazdon et al. (2007)	Arrozal	Rice cultivation	1987-1992	1-6	5	0.30			100
		Chazdon et al. (2010)		(1 year)	1992-1998	6-12	5	0.30			100
					1998-2003	12-17	5	0.30			100
					2008-2013	22-27	5	1.44			800
					2013-2017	27-31	5	1.44			800
			Aceituno	Cleared but not	1990-1995	18-23	5	1.16			800
				used	1998-2003	26-31	5	1.16			800
					2008-2013	36-41	5	1.16			800
					2013-2017	41-45	5	1.16			800
			Botarrama	Cleared but not	1990-1995	28-33	10	1.60			800
				used	1998-2003	36-41	10	1.60			800
					2003-2008	41-46	10	1.60			800
					2008-2013	46-51	5	1.60			800
					2013-2017	51-55	5	1.60			800
			Manú	Cleared but not	1990-1995	30-35	10	1.16			800
				used	1998-2003	38-43	10	1.16			800
					2003-2008	43-48	10	1.16			800
					2008-2013	48-53	5	1.16			800
					2013-2017	53-57	5	1.16			800
	Sarapiquí	Letcher and Chazdon	Finca el Bejuco	Pasture	2006-2011	12-17	5	1.00	1	0.50	625
		(2009)			2011-2016	17-22	5	1.00			625
		Chazdon et al. (2011)	Juan Enriquez	Pasture	2006-2011	12-17	5	1.00	1	0.50	625
					2011-2016	17-22	5	1.00			625
			Lindero Sur	Pasture	1997-2002	12-17	5	1.00			625
					2002-2007	17-22	5	1.00			625
					2007-2012	22-27	5	1.00	1	0.25	625
			Tirimbina	Pasture	1997-2002	15-20	5	1.00			625
					2002-2007	20-25	5	1.00			625
					2007-2012	25-30	5	1.00			625
					2012-2017	30-35	5	1.00			625
			Lindero el Peje	Pasture	1997-2002	20-25	5	1.00			625
			Secundario		2002-2007	25-30	5	1.00			625
					2007-2012	30-35	5	1.00	1	0.50	625
					2012-2017	35-40	5	1.00			625

Site	Dataset	Key references	Plot	Previous land use	Census interval	Stand age (years)	Minimum dbh (cm)	Area (ha)	Minimum dbh subplots (cm)	Area subplots (ha)	Subplot area for canopy layer assignment (m²)
Costa Rica	Sarapiquí		Cuatro Ríos	Pasture	1997-2002	25-30	5	1.00			625
					2002-2007	30-35	5	1.00			625
					2007-2012	35-40	5	1.00			625
					2012-2017	40-45	5	1.00			625
			Lindero el Peje Primario	-	2007-2012	OGF	5	1.00	1	0.50	625
					2012-2017	OGF	5	1.00			625
			Selva Verde	-	2007-2012	OGF	5	1.00	1	0.50	625
					2012-2017	OGF	5	1.00			625
	Carbono	Clark and Clark (2000)	L1-L6, P1-P6 (12 plots total)	-	1997-2002	OGF	10	0.50 (each)			625
					2002-2007	OGF	10	0.50 (each)			625
					2007-2012	OGF	10	0.50 (each)	1	0.01 (each)	625
					2012-2016	OGF	10	0.50 (each)			625
Panama	Agua Salud	van Breugel et al. (2013) Lai et al. (2017)	Transects 5-104, 131-134	Pasture, shifting cultivation	2009-2014	1-55	5	0.10 (each)	1	0.05 (each)	1000
	BCNM	Denslow and Guzman (2000)	Saino	Pasture, swidden agriculture	2001-2011	30-40	5	0.18			800
			Pedro Gomez	Pasture, swidden agriculture	2001-2011	30-40	5	0.32			800
			Enders	Plantation	2001-2011	50-60	5	0.32			800
			Foster	Pasture, swidden agriculture	2001-2011	50-60	5	0.32			800
			Poacher's Point	Pasture, swidden agriculture	2001-2011	80-90	5	0.32			800
			Bohio	Pasture	2001-2011	80-90	5	0.32			800
			Barbour	Pasture	2001-2011	110-120	5	0.32			800
			Pearson	Pasture	2001-2011	110-120	5	0.32			800
	BCI	Hubbell and Foster (1983)	BCI	-	1985-1990	OGF	1	50.00			976.5625
		Condit (1998)			1990-1995	OGF	1	50.00			976.5625
		Hubbell et al. (1999)			1995-2000	OGF	1	50.00			976.5625

Site	Dataset	Key references	Plot	Previous land use	Census interval	Stand age (years)	Minimum dbh (cm)	Area (ha)	Minimum dbh subplots (cm)	Area subplots (ha)	Subplot area for canopy layer assignment (m²)
Panama	BCI		BCI		2000-2005	OGF	1	50.00			976.5625
					2005-2010	OGF	1	50.00			976.5625
					2010-2015	OGF	1	50.00			976.5625
Yucatán	Permanent Plots	Saenz-Pedroza et al. (2020)	3A	Slash-and-burn agriculture	2009-2014	3-8	5	0.10	1	0.03	100
			3B		2009-2014	3-8	5	0.10	1	0.03	100
			5C		2009-2014	5-10	5	0.10	1	0.03	100
			15B		2005-2010	14-19	5	0.10	1	0.03	100
					2010-2015	19-24	5	0.10	1	0.03	100
			15C		2005-2010	15-20	5	0.10	1	0.03	100
					2010-2015	20-25	5	0.10	1	0.03	100
			17A		2005-2010	16-21	5	0.10	1	0.03	100
					2010-2015	21-26	5	0.10	1	0.03	100
			60B		2005-2010	50-55	5	0.10	1	0.03	100
					2010-2015	55-60	5	0.10	1	0.03	100
			60A		2005-2010	55-60	5	0.10	1	0.03	100
					2010-2015	60-65	5	0.10	1	0.03	100
			60C		2005-2010	60-65	5	0.10	1	0.03	100
					2010-2015	65-70	5	0.10	1	0.03	100
	Conglomerate Data	Hernández-Stefanoni et al. (2014)	6-9, 11-17, 19, 25-32	Slash-and-burn agriculture	2013-2018	10-85	7.5	0.16 (each)	2.5	0.032	400
Oaxaca	Nizanda	Lebrija-Trejos et al. (2008) Pérez-García et al. (2010) Lebrija-Trejos et al. (2010) Lebrija-Trejos et al. (2011) Muñoz et al. (2021)	MAR	Few years of cultivation without pasture use	2004-2009	4-9	5	0.04	2.5 / 1	0.02 / 0.01	100
			TOB		2006-2011	4-9	5	0.04	2.5 / 1	0.02 / 0.01	100
					2011-2016	9-14	5	0.04	2.5 / 1	0.02 / 0.01	100
			TOA		2008-2013	5-10	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	10-15	5	0.04	2.5 / 1	0.02 / 0.01	100
			HIL		2003-2008	5-10	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	10-15	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	15-20	5	0.04	2.5 / 1	0.02 / 0.01	100
			DIA		2003-2008	7-12	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	12-17	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	17-22	5	0.04	2.5 / 1	0.02 / 0.01	100

Site	Dataset	Key references	Plot	Previous land use	Census interval	Stand age (years)	Minimum dbh (cm)	Area (ha)	Minimum dbh subplots (cm)	Area subplots (ha)	Subplot area for canopy layer assignment (m²)
Oaxaca			FID	Few years of cultivation without pasture use	2003-2008	9-14	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	14-19	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	19-24	5	0.04	2.5 / 1	0.02 / 0.01	100
			ABE		2003-2008	10-15	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	15-20	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	20-25	5	0.04	2.5 / 1	0.02 / 0.01	100
			BES		2003-2008	11-16	5	0.04	2.5 / 1	0.02 / 0.01	100
			ESS		2003-2008	16-21	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	21-26	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	26-31	5	0.04	2.5 / 1	0.02 / 0.01	100
			ISC		2004-2009	19-24	5	0.04	2.5 / 1	0.02 / 0.01	100
					2009-2014	24-29	5	0.04	2.5 / 1	0.02 / 0.01	100
					2014-2018	29-33	5	0.04	2.5 / 1	0.02 / 0.01	100
			ISP		2003-2008	23-28	5	0.04	2.5 / 1	0.02 / 0.01	100
					2009-2014	29-34	5	0.04	2.5 / 1	0.02 / 0.01	100
					2014-2018	34-38	5	0.04	2.5 / 1	0.02 / 0.01	100
			RIC		2003-2008	30-35	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	35-40	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	40-45	5	0.04	2.5 / 1	0.02 / 0.01	100
			MAL		2003-2008	36-41	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	41-46	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	46-51	5	0.04	2.5 / 1	0.02 / 0.01	100
			SEP		2003-2008	40-45	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	45-50	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	50-55	5	0.04	2.5 / 1	0.02 / 0.01	100
			DIV		2005-2010	56-61	5	0.04	2.5 / 1	0.02 / 0.01	100
			JUL		2005-2010	60-65	5	0.04	2.5 / 1	0.02 / 0.01	100
					2010-2015	65-70	5	0.04	2.5 / 1	0.02 / 0.01	100
			LE1	-	2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125

Site	Dataset	Key references	Plot	Previous land use	Census interval	Stand age (years)	Minimum dbh (cm)	Area (ha)	Minimum dbh subplots (cm)	Area subplots (ha)	Subplot area for canopy layer assignment (m²)
Oaxaca			LE2	Few years of cultivation without pasture use	2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
			LPA		2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
			ISA		2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
			SEL		2003-2008	OGF	5	0.04	2.5 / 1	0.02 / 0.01	100
					2008-2013	OGF	5	0.04	2.5 / 1	0.02 / 0.01	100
					2013-2018	OGF	5	0.04	2.5 / 1	0.02 / 0.01	100
			TEM		2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
			ZA1		2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
			ZA2		2008-2013	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125
					2013-2018	OGF	5	0.05	2.5 / 1	0.0375 / 0.0125	125

Table S2: Number of observations, individuals and species that we calculated demographic rates for in early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) for the four sites.

	ESF					**LSF**					**OGF**				
	Nr. of observations			**Nr. of individuals**	**Nr. of species**	**Nr. of observations**			**Nr. of individuals**	**Nr. of species**	**Nr. of observations**			**Nr. of individuals**	**Nr. of species**
	Growth	**Mortality**	**Recruitment**			**Growth**	**Mortality**	**Recruitment**			**Growth**	**Mortality**	**Recruitment**		
Costa Rica	17,387	22,526	1,053	14,662	348	16,411	18,876	86	7,093	334	11,975	13,578	236	5,636	329
Panama	18,783	28,968	9,186	39,812	324	5,158	6,264	479	7,375	334	1,102,739	1,278,550	153,821	265,141	304
Yucatán	4,628	5,596	248	5,447	131	3,737	4,234	101	3,775	123	-	-	-		-
Oaxaca	1,381	2,036	275	1,198	82	1,318	1,730	119	955	76	1,758	2,093	116	1,149	89

Table S3: Number of species included in hypervolume calculations for early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) and, in parentheses, the number of species excluded from hypervolume calculations due to few observations or mortality rates of 0 or 1 for the four sites for the hypervolume spanning growth and mortality.

	ESF			**LSF**			**OGF**		
	Layer 1	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**
Costa Rica	52 (3)	98 (30)	58 (15)	32 (13)	88 (5)	72 (26)	78 (16)	107 (19)	46 (6)
Panama	61 (22)	99 (28)	75 (24)	18 (2)	50 (13)	68 (11)	159 (7)	234 (0)	245 (4)
Yucatán	40 (13)	23 (23)	22 (8)	22 (17)	26 (14)	40 (15)			
Oaxaca	5 (3)	14 (9)	7 (2)	9 (4)	19 (12)	23 (11)	5 (10)	23 (11)	28 (9)

Table S4: Number of species included in hypervolume calculations for early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) and, in parentheses, the number of species excluded from hypervolume calculations due to recruitment rates of 0 for the four sites for the hypervolume spanning growth and recruitment.

	ESF			**LSF**			**OGF**		
	Layer 1	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**
Costa Rica	27 (18)	67 (41)	39 (34)	8 (37)	31 (72)	20 (78)	45 (49)	81 (45)	36 (16)
Panama	77 (7)	119 (8)	96 (2)	6 (14)	29 (34)	57 (22)	164 (2)	229 (5)	243 (6)
Yucatán	20 (33)	29 (17)	17 (13)	14 (25)	27 (13)	24 (31)			
Oaxaca	8 (0)	22 (1)	9 (0)	6 (7)	18 (13)	22 (12)	11 (4)	24 (10)	25 (12)

Table S5: Number of species included in hypervolume calculations for early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) and, in parentheses, the number of species excluded from hypervolume calculations due to few observations, mortality rates of 0 or 1 or recruitment rates of 0 for the four sites for the hypervolume spanning mortality and recruitment.

	ESF			LSF			OGF		
	Layer 1	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**	**Layer 1**	**Layer 2**	**Layer 3**
Costa Rica	25 (30)	44 (84)	31 (42)	7 (38)	16 (87)	14 (84)	38 (56)	47 (79)	33 (19)
Panama	56 (27)	94 (33)	75 (23)	5 (15)	23 (40)	48 (31)	157 (9)	222 (12)	241 (8)
Yucatán	19 (34)	15 (31)	14 (16)	9 (30)	12 (28)	21 (34)			
Oaxaca	5 (3)	12 (19)	7 (2)	4 (9)	11 (20)	13 (21)	4 (11)	15 (19)	22 (15)

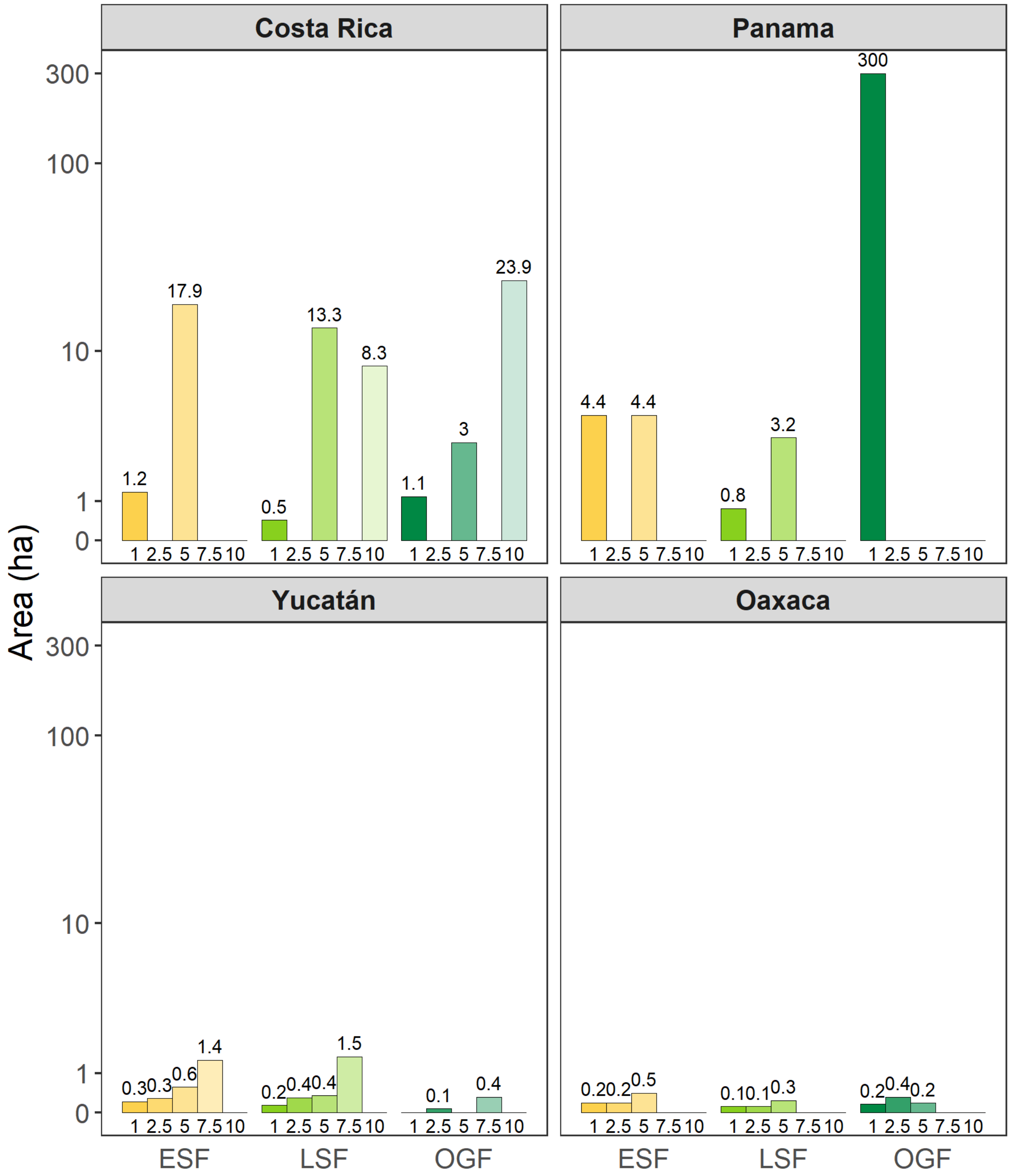

Figure S1: Sampling areas per minimum dbh threshold (cm) for early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) for the four sites. Sampling area corresponds to the plot area * number of census intervals, e.g. OGF in Panama consists of 6 census intervals of the 50-ha plot at Barro Colorado Island, which has a minimum dbh threshold of 1 cm. In Yucatán, data from OGF was not available to sufficient extent and therefore not used subsequently.

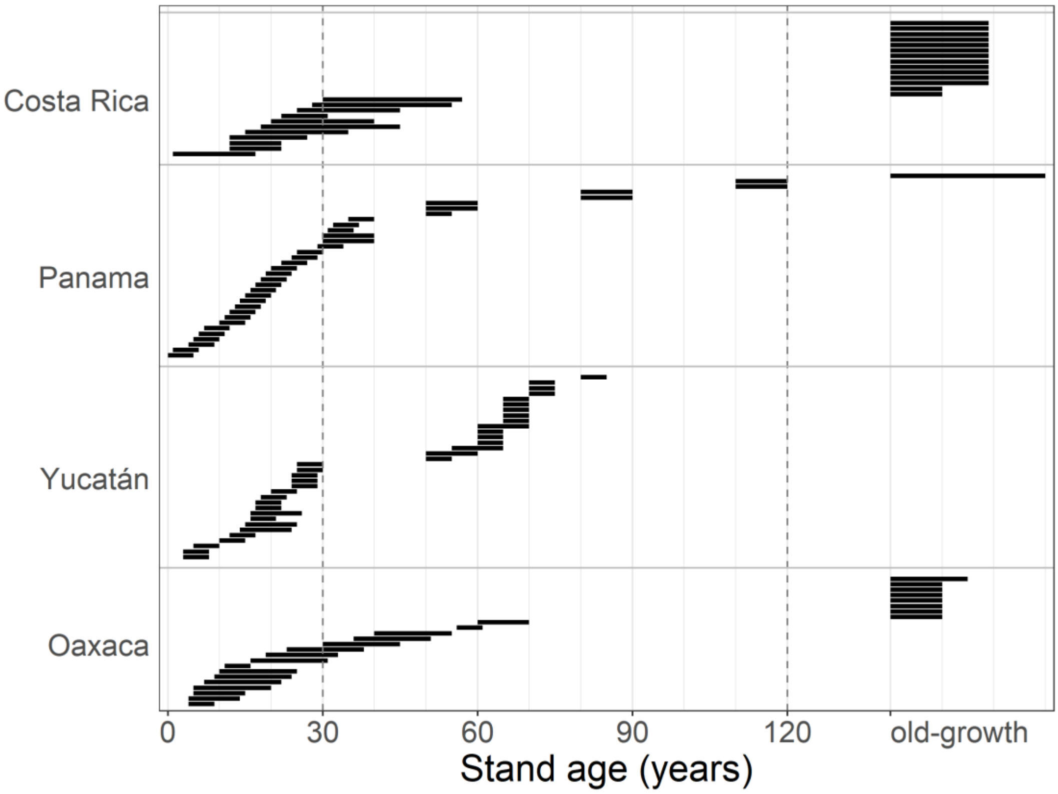

Figure S2: Stand age and census intervals of all plots included in this study. Each horizontal line corresponds to one or (in case there were too many) multiple plots in the chronosequence. Details are given in Table S1.

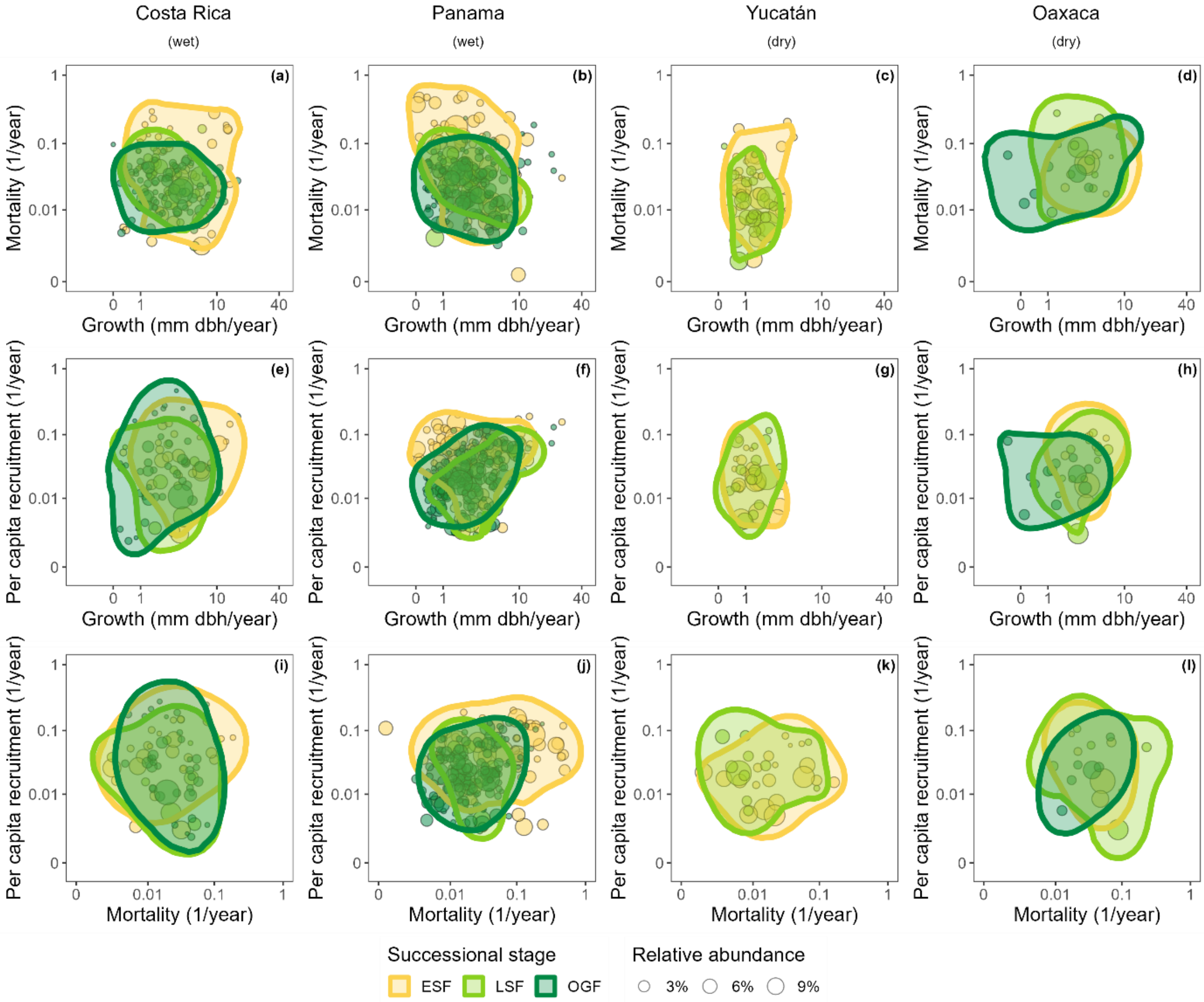

Figure S3: Demographic spaces for different pairs of demographic rates (a-d: growth-mortality, e-h: growth-recruitment, i-l: mortality-recruitment) for all sites and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest) represented by two-dimensional hypervolumes. All axes are log-transformed (Ln). **Growth and mortality rates are from individuals assigned to canopy layer 1**. Hypervolume boundaries represent the smallest volume that captures a fraction of 80% of the total Gaussian probability densities. All species contributed equally to the hypervolume calculation. Points represent species, point sizes indicate relative abundances within the successional stage.

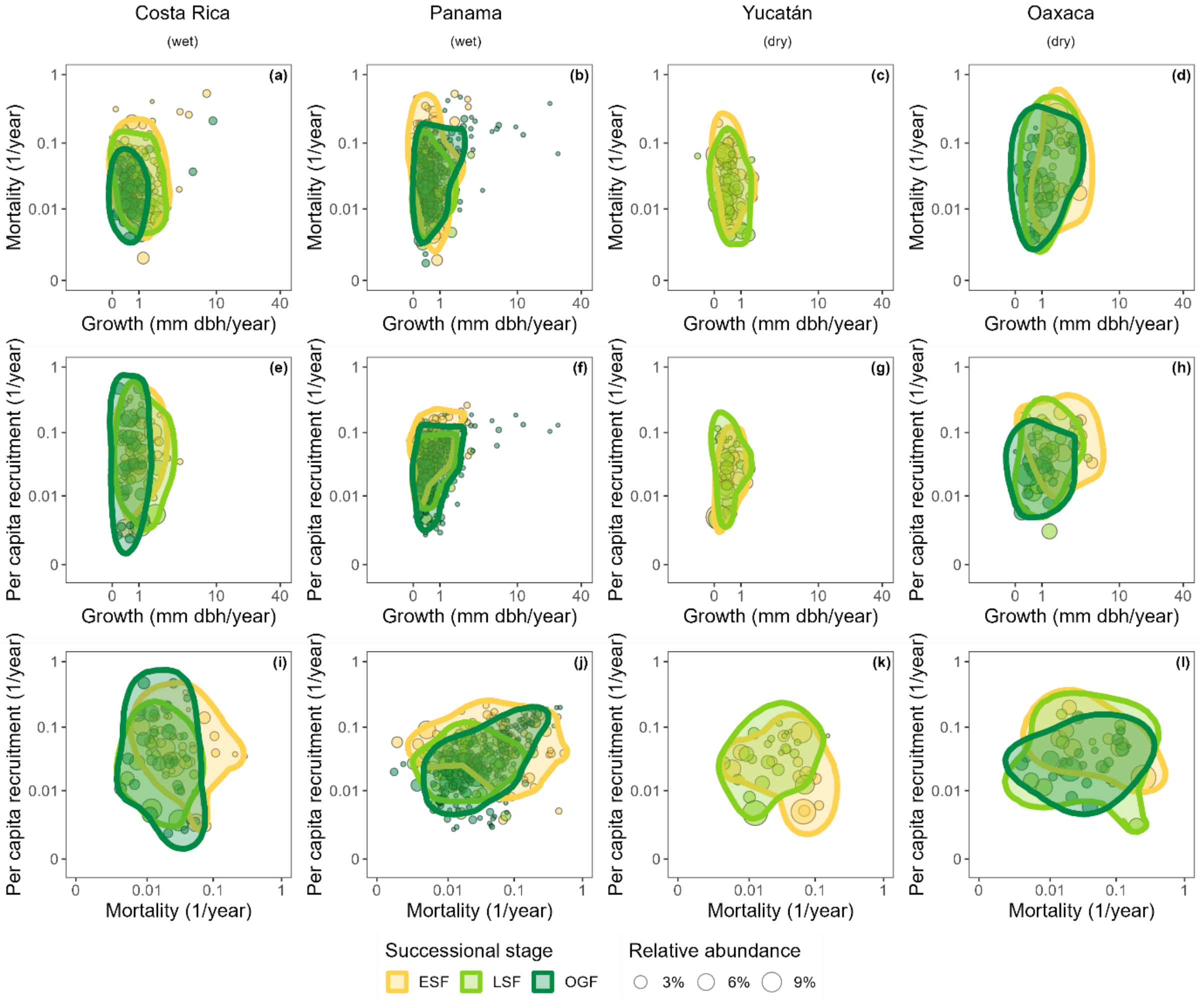

Figure S4: Demographic spaces for different pairs of demographic rates (a-d: growth-mortality, e-h: growth-recruitment, i-l: mortality-recruitment) for all sites and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest) represented by two-dimensional hypervolumes. All axes are log-transformed (Ln). **Growth and mortality rates are from individuals assigned to canopy layer 3.** Hypervolume boundaries represent the smallest volume that captures a fraction of 80% of the total Gaussian probability densities. All species contributed equally to the hypervolume calculation. Points represent species, point sizes indicate relative abundances within the successional stage.

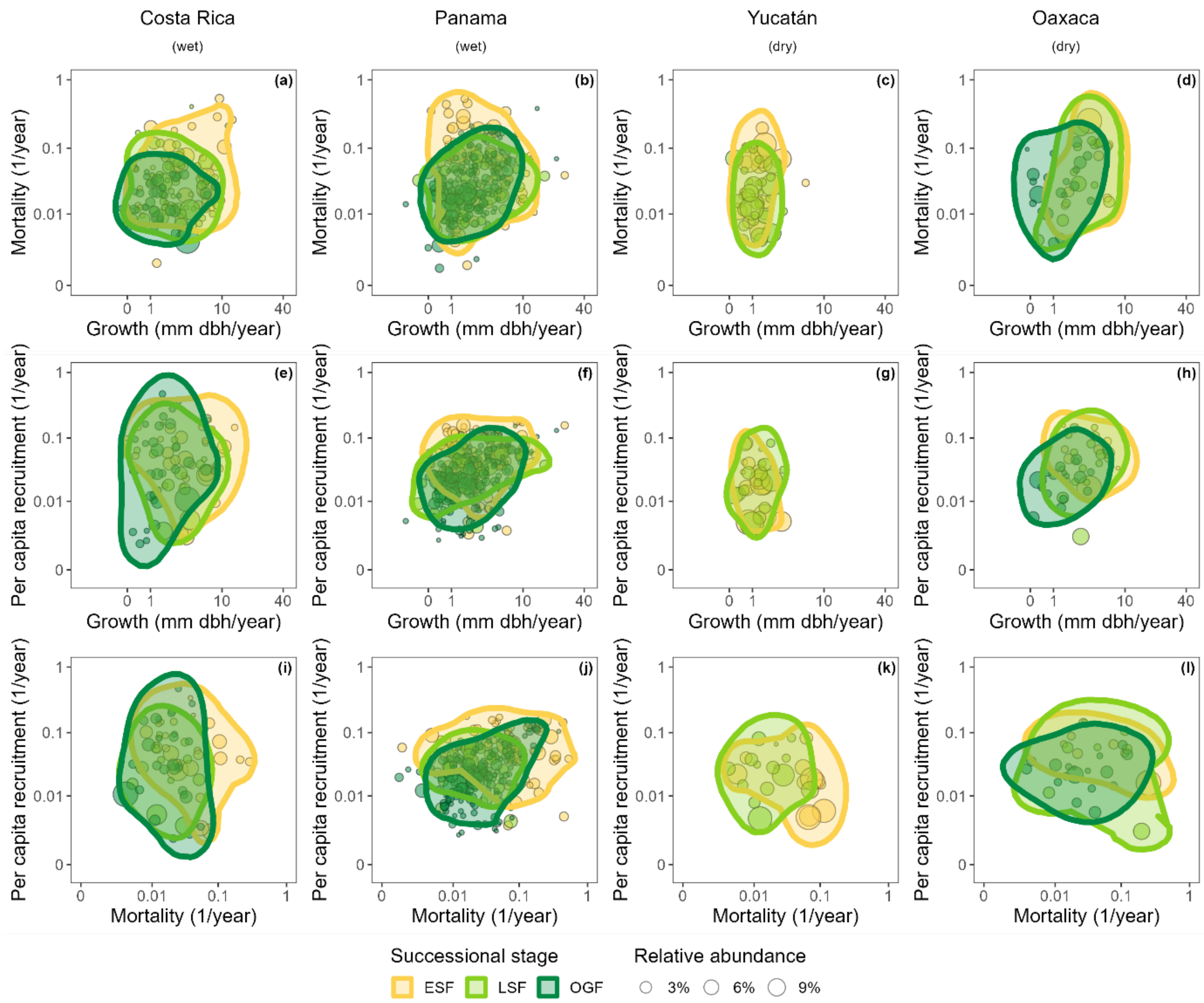

Figure S5: Demographic spaces for different pairs of demographic rates (a-d: growth-mortality, e-h: growth-recruitment, i-l: mortality-recruitment) for all sites and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest) represented by two-dimensional hypervolumes. All axes are log-transformed (Ln). **Growth rates are from individuals assigned to canopy layer 1; mortality rates are from individuals assigned to canopy layer 3**. Hypervolume boundaries represent the smallest volume that captures a fraction of 80% of the total Gaussian probability densities. All species contributed equally to the hypervolume calculation. Points represent species, point sizes indicate relative abundances within the successional stage.

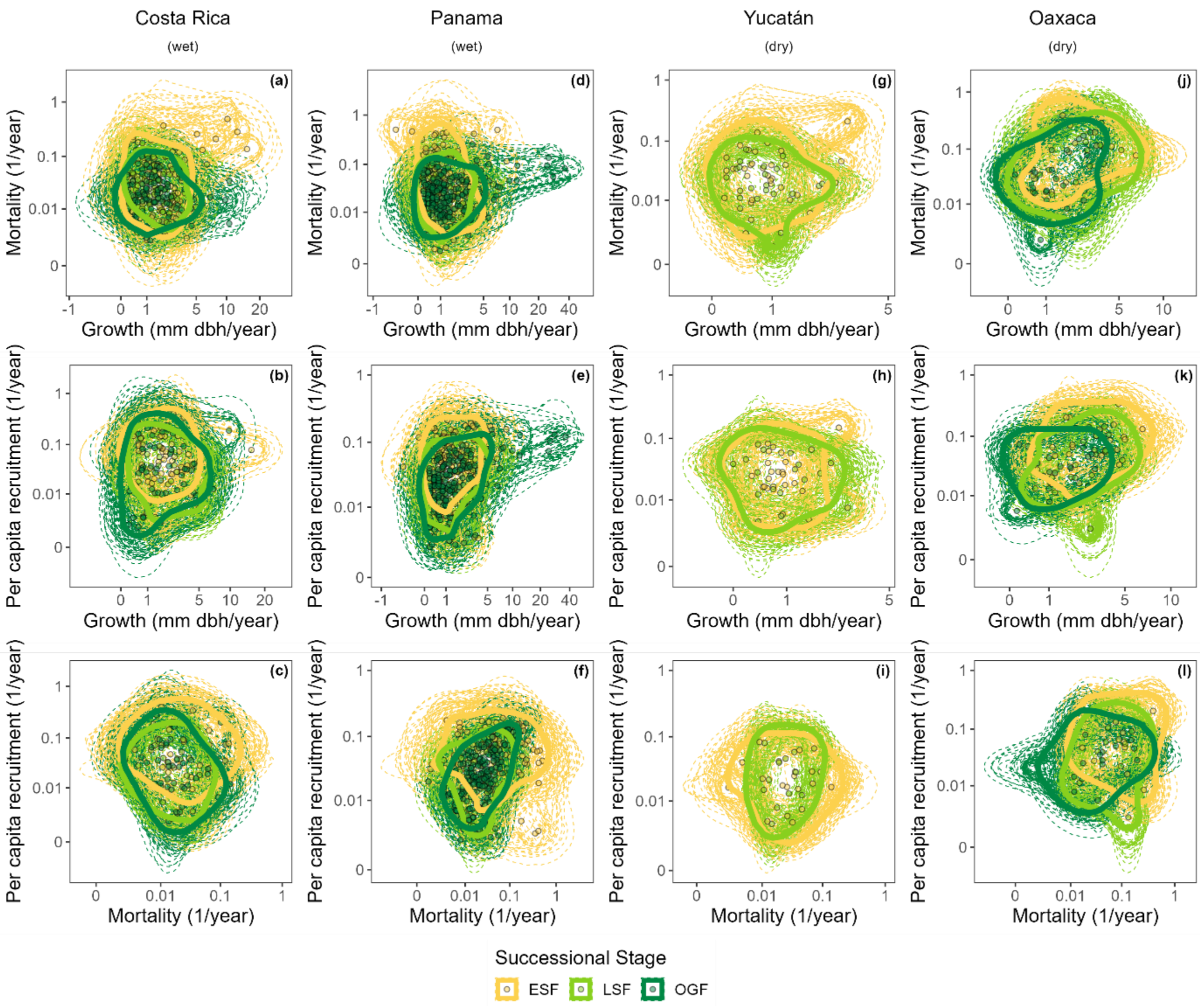

Figure S6: Original and rarefied demographic spaces for different pairs of demographic rates (a-d: growth-mortality, e-h: growth-recruitment, i-l: mortality-recruitment) for all sites and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest) represented by two-dimensional hypervolumes. All axes are log-transformed (Ln). Growth and mortality rates are from individuals assigned to canopy layer 2. Hypervolume boundaries represent the smallest volume that captures a fraction of 80% of the total Gaussian probability densities. All species contributed equally to the hypervolume calculation. Bold solid lines are the original demographic spaces; each dashed line is one of 100 bootstrap replicates with 10 randomly drawn species; points represent species.

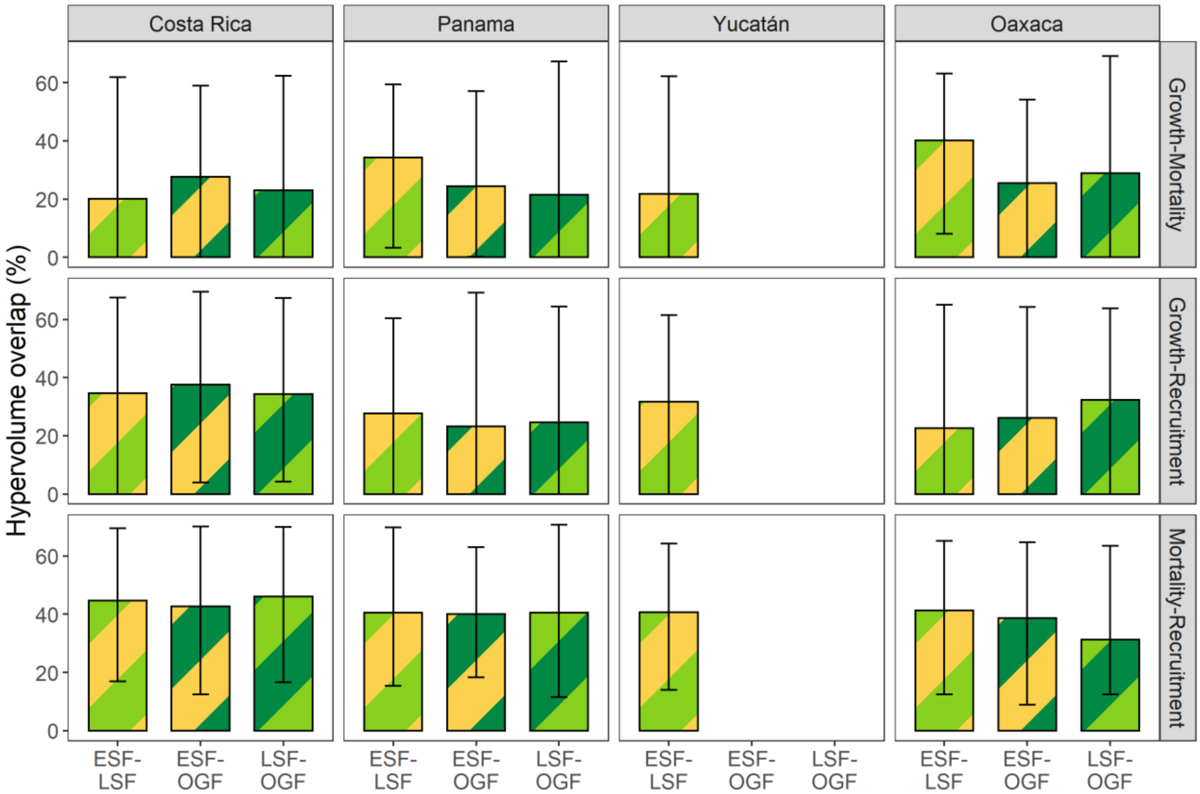

Figure S7: Overlap statistics of the two-dimensional hypervolumes (i.e. areas) representing the ranges of demographic strategies for different pairs of demographic rates and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest). Colored bars represent the median rarefied and bootstrapped values, error bars represent 95% confidence intervals (r = 100 replicates, n = 10 species).

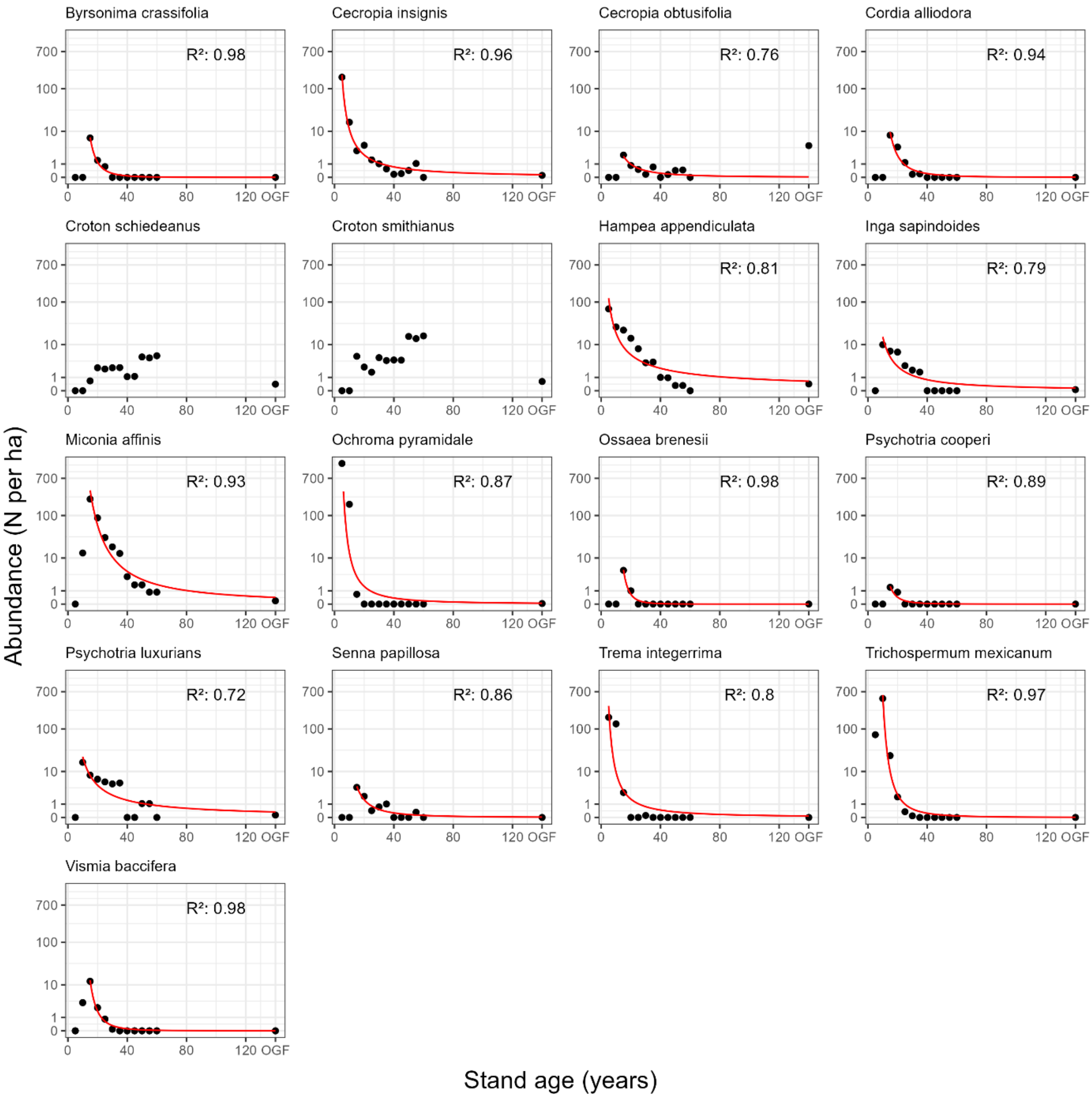

Figure S8: Observed (points) and modelled (red lines) abundances over time of individual species within the high mortality group exclusive to wet early successional forests in Costa Rica along with R^2 values for the models. Models are of the form Ln(abundance) = a × stand age^b. Parameters a and b were estimated using the *nls* R function. For model parameter estimation, we only used data points from the highest abundance onwards.

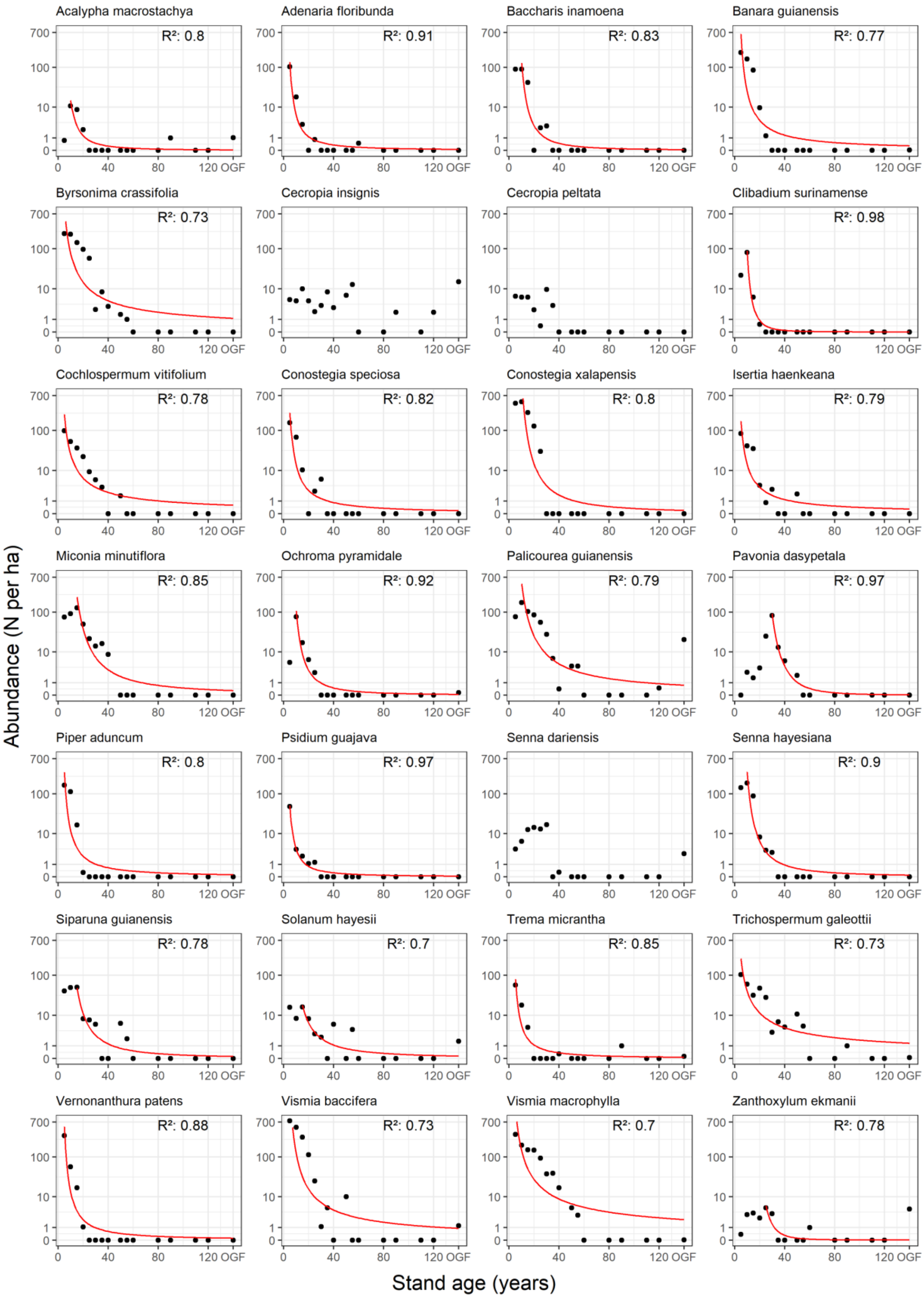

Figure S9: Observed (points) and modelled (red lines) abundances over time of individual species within the high mortality group exclusive to wet early successional forests in Panama along with R^2 values for the models. Models are of the form Ln(abundance) = a × stand age^b. Parameters a and b were estimated using the *nls* R function. For model parameter estimation, we only used data points from the highest abundance onwards.

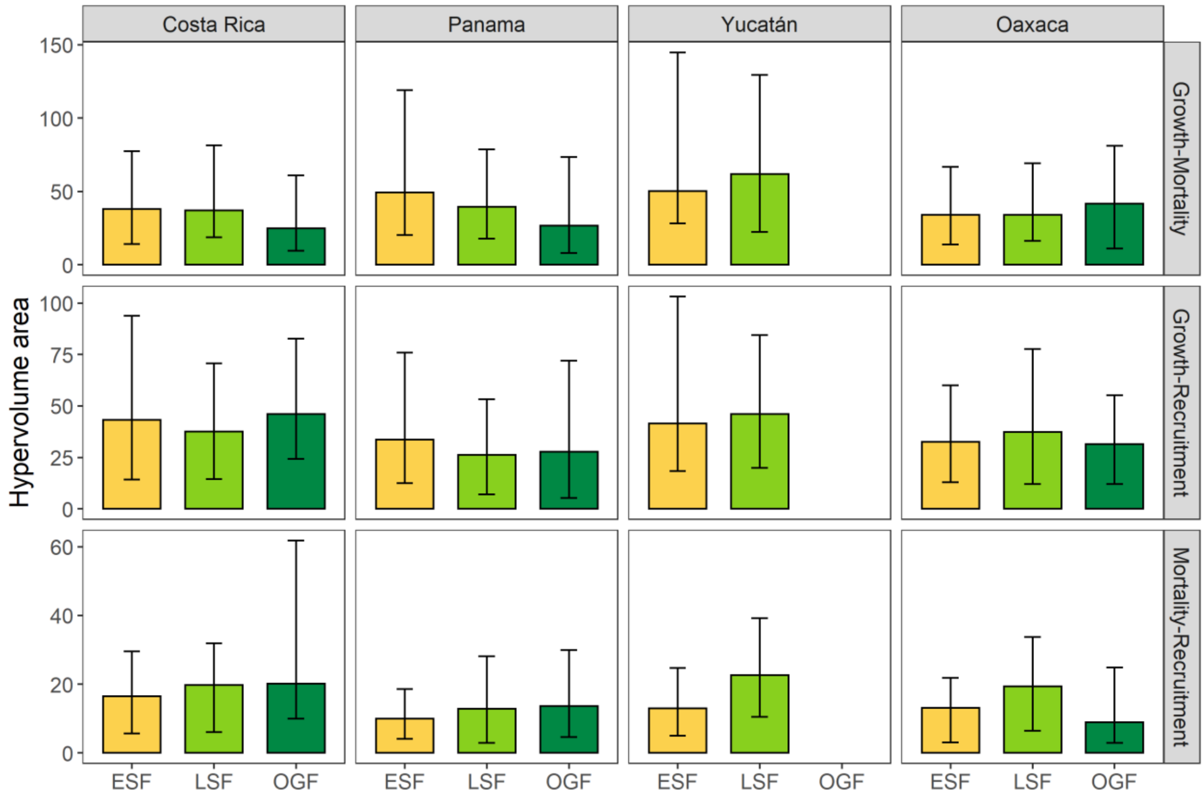

Figure S10: Areas of the two-dimensional hypervolumes representing the ranges of demographic strategies for different pairs of demographic rates and successional stages (ESF = early successional forest, LSF = late successional forest, OGF = old-growth forest). Colored bars represent the median rarefied and bootstrapped values, error bars represent 95% confidence intervals (r = 100 replicates, n = 10 species).

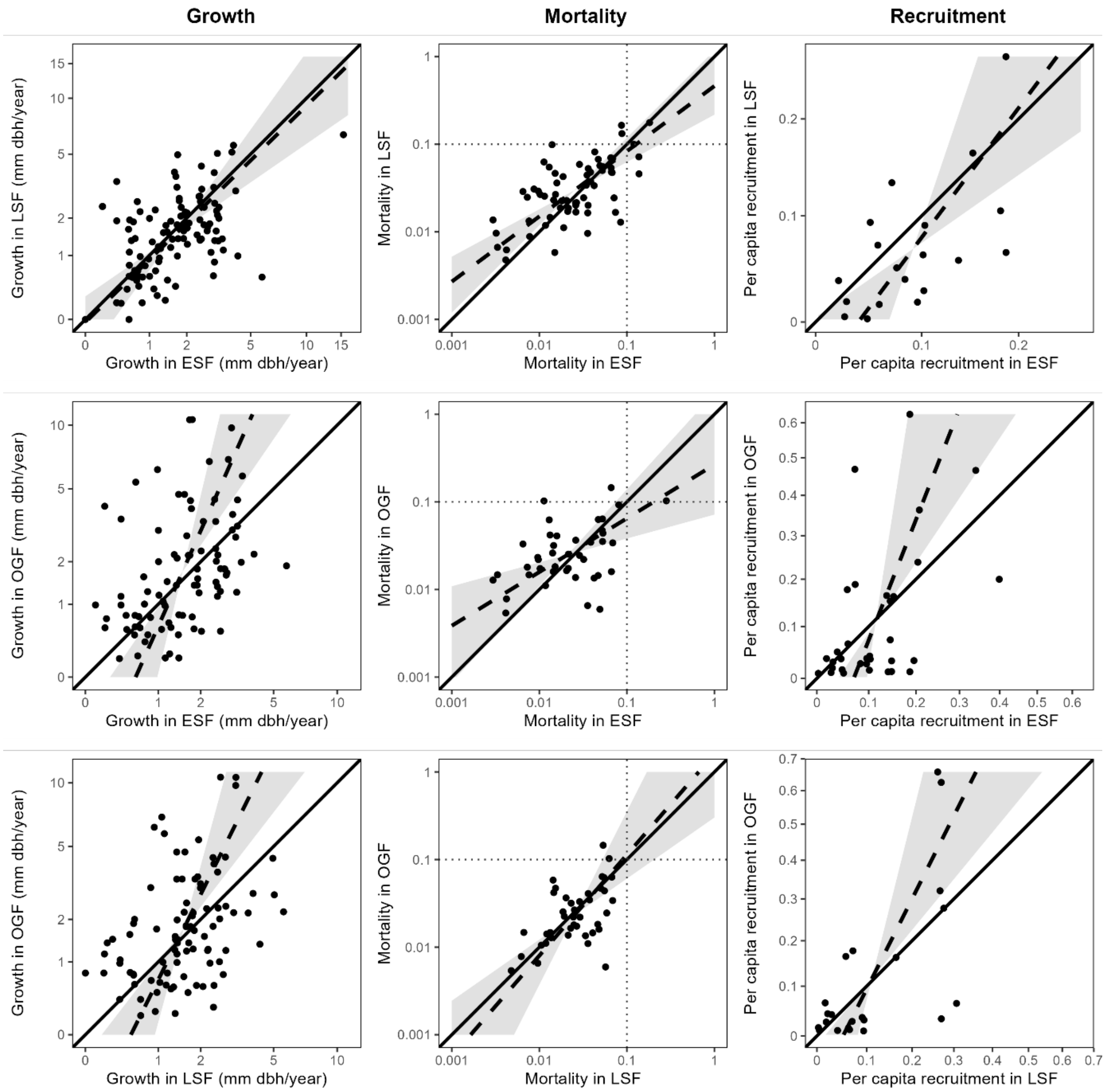

Figure S11: Major axis regressions for species' demographic rates in early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) in **Costa Rica**. Each point represents a species and its demographic rate in the respective successional stage. Solid lines represent the 1:1-line, dashed lines represent the regression lines and areas highlighted in grey represent the confidence intervals. Growth and mortality rates are from canopy layer 2. Only species with at least 5 observations for growth and survival in both successional stages were included, respectively.

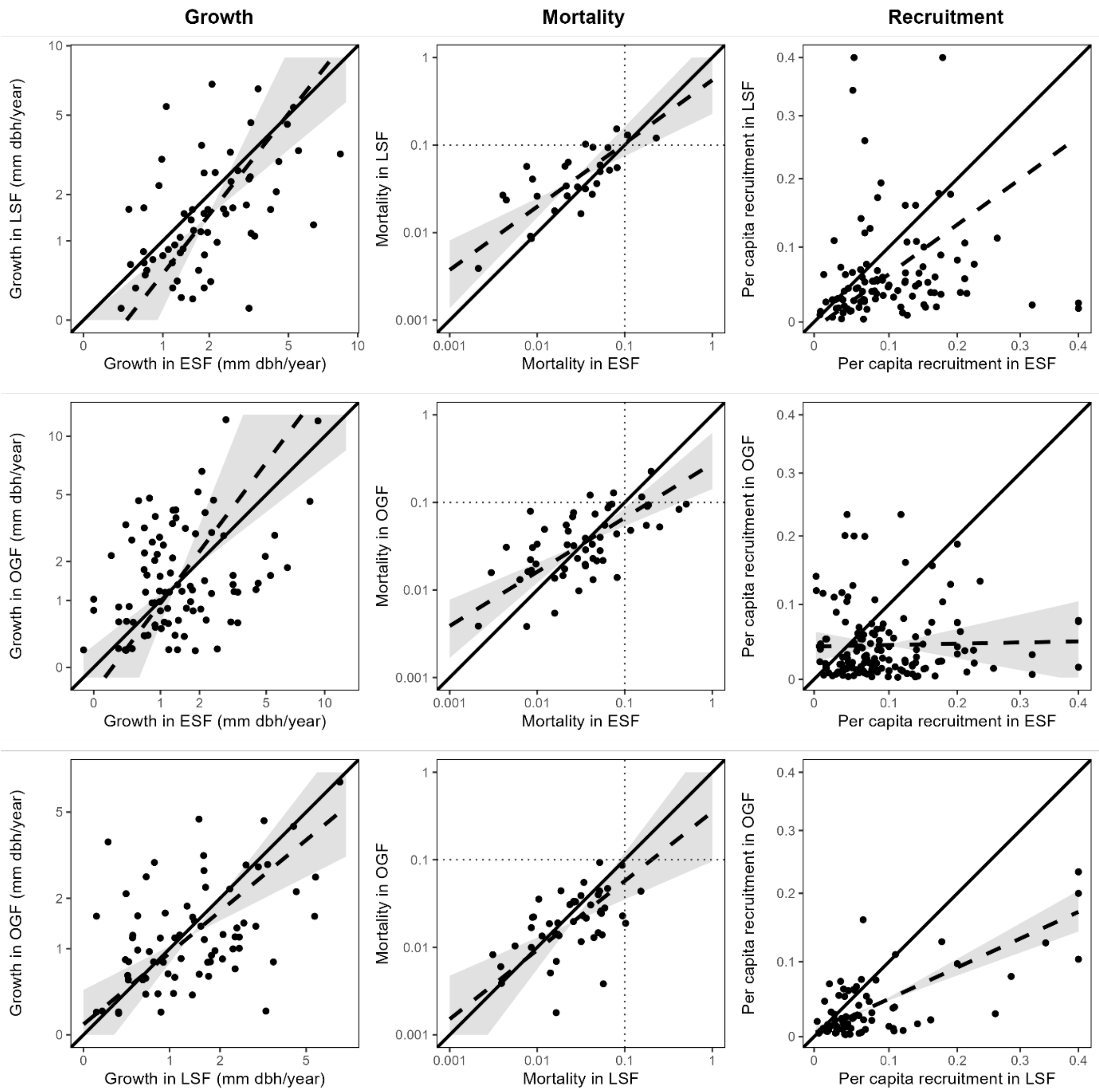

Figure S12: Major axis regressions for species' demographic rates in early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) in **Panama**. Each point represents a species and its demographic rates in the respective successional stage. Solid lines represent the 1:1-line, dashed lines represent the major axis regression lines and areas highlighted in grey represent the confidence intervals. Growth and mortality rates are from canopy layer 2. Only species with at least 5 observations for growth and survival in both successional stages were included, respectively. If no confidence intervals are given, the model was not statistically significant (i.e., the variables are unrelated, $p \geq 0.05$).

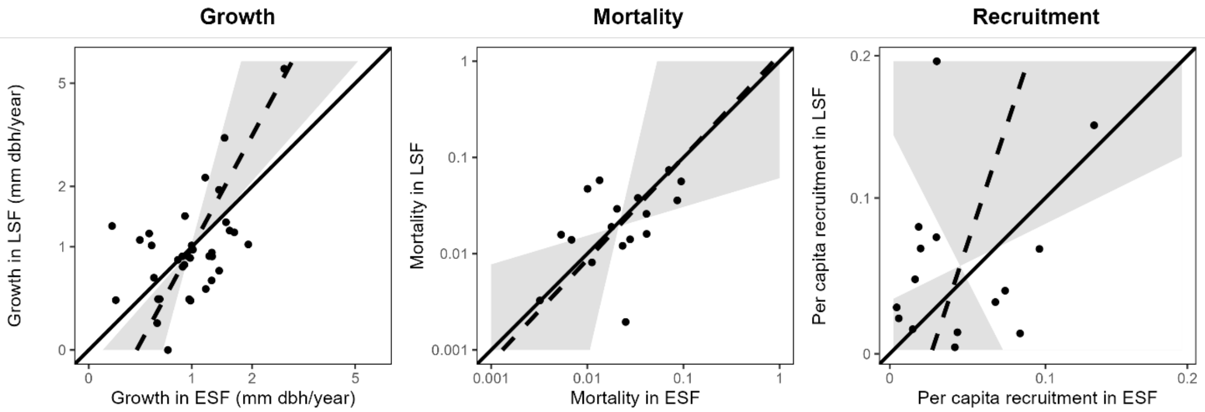

Figure S13: Major axis regressions for species' demographic rates in early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) in **Yucatán**. Each point represents a species and its demographic rate in the respective successional stage. Solid lines represent the 1:1-line, dashed lines represent the regression lines and areas highlighted in grey represent the confidence intervals. Growth and mortality rates are from canopy layer 2. Only species with at least 5 observations for growth and survival in both successional stages were included, respectively.

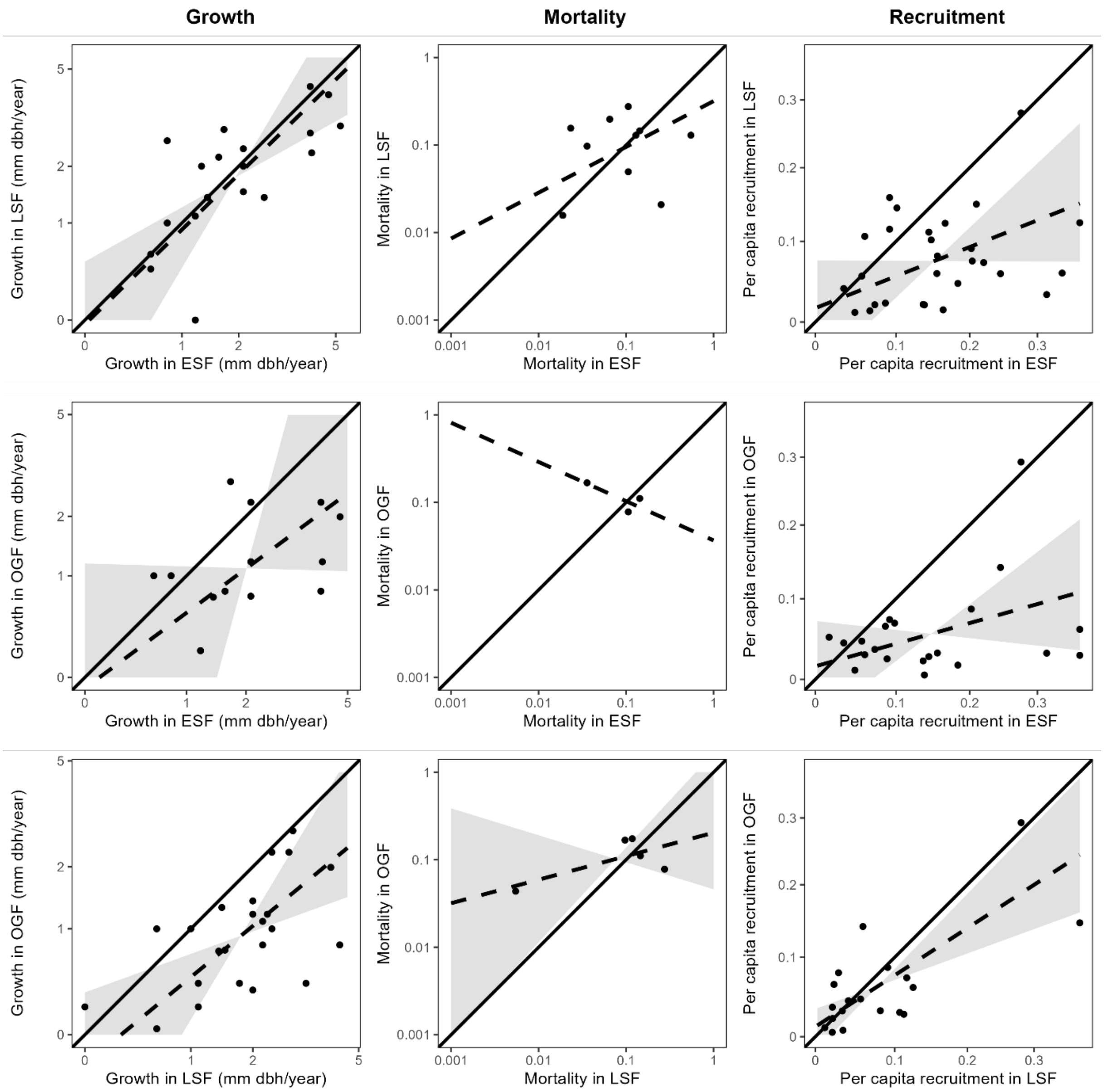

Figure S14: Major axis regressions for species' demographic rates in early successional forests (ESF), late successional forests (LSF) and old-growth forests (OGF) in **Oaxaca**. Each point represents a species and its demographic rate in the respective successional stage. Solid lines represent the 1:1-line, dashed lines represent the regression lines and areas highlighted in grey represent the confidence intervals. Growth and mortality rates are from canopy layer 2. Only species with at least 5 observations for growth and survival in both successional stages were included, respectively. If no confidence intervals are given, the model was not statistically significant (i.e., the variables are unrelated).

References

Bohlman, Stephanie, and Stephen Pacala. “A Forest Structure Model That Determines Crown Layers and Partitions Growth and Mortality Rates for Landscape-Scale Applications of Tropical Forests.” *Journal of Ecology* 100, no. 2 (2012): 508–18. https://doi.org/10.1111/j.1365-2745.2011.01935.x.

Chazdon, Robin L., Anne Chao, Robert K. Colwell, Shang-Yi Lin, Natalia Norden, Susan G. Letcher, David B. Clark, Bryan Finegan, and J. Pablo Arroyo. “A Novel Statistical Method for Classifying Habitat Generalists and Specialists.” *Ecology* 92, no. 6 (2011): 1332–43.

Chazdon, Robin L., Bryan Finegan, Robert S. Capers, Beatriz Salgado-Negret, Fernando Casanoves, Vanessa Boukili, and Natalia Norden. “Composition and Dynamics of Functional Groups of Trees During Tropical Forest Succession in Northeastern Costa Rica.” *Biotropica* 42, no. 1 (2010): 31–40. https://doi.org/10.1111/j.1744-7429.2009.00566.x.

Chazdon, Robin L., Susan G. Letcher, Michiel van Breugel, Miguel Martínez-Ramos, Frans Bongers, and Bryan Finegan. “Rates of Change in Tree Communities of Secondary Neotropical Forests Following Major Disturbances.” *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 362, no. 1478 (2007): 273–89. https://doi.org/10.1098/rstb.2006.1990.

Clark, D.B, and D.A Clark. “Landscape-Scale Variation in Forest Structure and Biomass in a Tropical Rain Forest.” *Forest Ecology and Management* 137, 1-3 (2000): 185–98. https://doi.org/10.1016/S0378-1127(99)00327-8.

Condit, Richard. *Tropical Forest Census Plots: Methods and Results from Barro Colorado Island, Panama and a Comparison with Other Plots*. Berlin: Springer-Verlag Berlin, 1998.

Denslow, Julie S., and Sandra Guzman. “Variation in Stand Structure, Light and Seedling Abundance Across a Tropical Moist Forest Chronosequence, Panama.” *Journal of Vegetation Science* 11, no. 2 (2000): 201–12. https://doi.org/10.2307/3236800.

Hernández-Stefanoni, José, Juan Dupuy, Kristofer Johnson, Richard Birdsey, Fernando Tun-Dzul, Alicia Peduzzi, Juan Caamal-Sosa, Gonzalo Sánchez-Santos, and David López-Merlín. “Improving Species Diversity and Biomass Estimates of Tropical Dry Forests Using Airborne LiDAR.” *Remote Sensing* 6, no. 6 (2014): 4741–63. https://doi.org/10.3390/rs6064741.

Hubbell, Stephen P., and Robin Foster. “Diversity of Canopy Trees in a Neotropical Forest and Implications for Conservation.” In *Tropical Rain Forest: Ecology and Management*. Edited by S. L. Sutton, T. C. Whitmore and A. C. Chadwick, 25–41. Special publication of the British Ecological Society. Oxford: Blackwell Scientific, 1983.

Hubbell, Stephen P., Robin B. Foster, Sean T. O'Brien, Kyle E. Harms, Richard Condit, B. Wechsler, S. Joseph Wright, and S. Loo de Lao. “Light-Gap Disturbances, Recruitment Limitation, and Tree Diversity in a Neotropical Forest.” *Science* 283, no. 5401 (1999): 554–57. https://doi.org/10.1126/science.283.5401.554.

Lai, Hao Ran, Jefferson S. Hall, Benjamin L. Turner, and Michiel van Breugel. “Liana Effects on Biomass Dynamics Strengthen During Secondary Forest Succession.” *Ecology* 98, no. 4 (2017): 1062–70. https://doi.org/10.1002/ecy.1734.

Lebrija-Trejos, Edwin, Frans Bongers, Eduardo A. Pérez-García, and Jorge A. Meave. “Successional Change and Resilience of a Very Dry Tropical Deciduous Forest Following Shifting Agriculture.” *Biotropica* 40, no. 4 (2008): 422–31. https://doi.org/10.1111/j.1744-7429.2008.00398.x.

Lebrija-Trejos, Edwin, Eduardo A. Pérez-García, Jorge A. Meave, Frans Bongers, and Lourens Poorter. “Functional Traits and Environmental Filtering Drive Community Assembly in a Species-Rich Tropical System.” *Ecology* 91, no. 2 (2010): 386–98. https://doi.org/10.1890/08-1449.1.

Lebrija-Trejos, Edwin, Eduardo A. Pérez-García, Jorge A. Meave, Lourens Poorter, and Frans Bongers. “Environmental Changes During Secondary Succession in a Tropical Dry Forest in Mexico.” *Journal of Tropical Ecology* 27, no. 5 (2011): 477–89. https://doi.org/10.1017/S0266467411000253.

Letcher, Susan G., and Robin L. Chazdon. “Rapid Recovery of Biomass, Species Richness, and Species Composition in a Forest Chronosequence in Northeastern Costa Rica.” *Biotropica* 41, no. 5 (2009): 608–17. https://doi.org/10.1111/j.1744-7429.2009.00517.x.

Muñoz, Rodrigo, Frans Bongers, Danaë M. A. Rozendaal, Edgar J. González, Juan M. Dupuy, and Jorge A. Meave. “Autogenic Regulation and Resilience in Tropical Dry Forest.” *Journal of Ecology* 109, no. 9 (2021): 3295–3307. https://doi.org/10.1111/1365-2745.13749.

Pérez-García, Eduardo A., Jorge A. Meave, José Luis Villaseñor, J. Alberto Gallardo-Cruz, and Edwin E. Lebrija-Trejos. “Vegetation Heterogeneity and Life-Strategy Diversity in the Flora of the Heterogeneous Landscape of Nizanda, Oaxaca, Mexico.” *Folia Geobotanica* 45, no. 2 (2010): 143–61. https://doi.org/10.1007/s12224-010-9064-7.

Purves, Drew W., Jeremy W. Lichstein, Nikolay Strigul, and Stephen W. Pacala. “Predicting and Understanding Forest Dynamics Using a Simple Tractable Model.” *Proceedings of the National Academy of Sciences of the United States of America* 105, no. 44 (2008): 17018–22. https://doi.org/10.1073/pnas.0807754105.

Saenz-Pedroza, Irving, Richard Feldman, Casandra Reyes-García, Jorge A. Meave, Luz Maria Calvo-Irabien, Filogonio May-Pat, and Juan M. Dupuy. “Seasonal and Successional Dynamics of Size-Dependent Plant Demographic Rates in a Tropical Dry Forest.” *PeerJ* 8 (2020): e9636. https://doi.org/10.7717/peerj.9636.

van Breugel, Michiel, Jefferson S. Hall, Dylan Craven, Mario Bailon, Andres Hernandez, Michele Abbene, and Paulo van Breugel. “Succession of Ephemeral Secondary Forests and Their Limited Role for the Conservation of Floristic Diversity in a Human-Modified Tropical Landscape.” *PloS one* 8, no. 12 (2013): e82433. https://doi.org/10.1371/journal.pone.0082433.