Supplementary Materials

Field Methods

Canopy status/crown class was measured using standard forestry definitions (from DeYoung, 2020; Helms, 1998):

Dominant: Crowns that extend clearly above the general level of the canopy and receive full light from above and at least 2/3 of the sides. Our even aged stands had few dominant trees.

Codominant: Crowns that reach the level of the canopy and receive direct light from above but normally not from all sides (typically < 2/3).

Intermediate: Crowns that reach intermediate heights in the canopy. They receive light from above, but generally not from the sides. These trees are shorter than dominant and codominant trees and sometimes but not always taller than suppressed trees.

Suppressed: Crowns that reach low or intermediate heights in the canopy and are shaded from directly above as well as from the sides so do not receive direct light. When differentiating between suppressed and intermediate crowns, we checked for presence/absence of branches and foliage from neighboring trees directly above the growing tip of the tree.

Note: For many analyses (as noted in Methods and Results), codominant and dominant trees were grouped together and intermediate and suppressed trees were grouped together.

Year since tree death was estimated using a combination of factors including visual status of tree tissues (needles, bark, branches, phloem), apparent age of *S. noctilio* signs (including oviposition sites and emergence holes), and the presence and age of co-colonizers and their galleries. This was a rough estimate intended to allow for some assessment of the timing of attack in a given stand and to allow us to confirm whether *S. noctilio* was present in the stand in the current year. These data were not intended to provide firm time of death estimates for purposes of modeling spread or the timing of mortality.

Presence of co-colonizers varied substantially by location. Forests in native range *Pinus* range (Spain and North America) had higher diversity of co-colonizers. In South Africa and Argentina, the same two or three were often seen over and over. Climate, and thus weathering and decay rates varied substantially between sites, even within the same country. Time since death assessments were always made by comparing condition of dead trees in a stand to others in the same stand, and by conferring with local foresters and collaborators when possible. Trees that had been dead for longer than three years were often difficult to distinguish and often assigned a category of, e.g., “3+” to represent that uncertainty. These were coded for analysis by assigning the most recent possible year of death, e.g. in the case above “3”. The following is a general list of types of features we looked for when assigning year of death:

0: Very recent tree death, brown needles still attached to tree, sometimes fresh oviposition sites (current season) or new emergence holes. Some trees died in the first season of attack, while others died the following year when adults were emerging. Xylem at base of tree normally still resinous and wet, not fully dried out. These trees could be considered to undergoing the process of death but to have passed the "point of no return".

1: Death during previous season. Browned needles often fallen, but branches have usually not lost all twigs and bark. Oviposition sites from previous season, and emergence holes may be fresh or from previous season. Phloem starting to dry, xylem no longer wet near base of tree. Commonly observed colonizers: *Pissodes nemorensis* galleries, bark beetles.

2: Trees that have been dead for two years have more weathering. Oviposition sites appear weathered, with drippings sometimes becoming difficult to see. Emergence holes generally appear weathered. Depending on site location and climate, tree may be starting to lose branches and bark, and wood is dry (in arid climates) or starting to decay (in wetter climates). Signs of Cerambicidae common at this stage.

3+: Oviposition sites and emergence holes weathered, oviposition sites often difficult to locate. Bark falling from tree, phloem dried/gone. Distinguishing 3 year old mortality from 4, 5, or more becomes quite difficult; trees with substantial decay often assigned 3+ unless other data were available to pinpoint year of death (e.g., stands in Spain with tagged trees that had previously been surveyed for *S. noctilio* attack and mortality). Sometimes stands contained trees that had clearly been dead longer than the primary 3-year old trees (e.g., substantial decay and moss growth, etc.) and these were assigned an older date. Beyond 3 years, many trees starting to fall.

Supplemental Table I. Select stand level variables collected and calculated in (a) Argentina, (b) South Africa, (c) Spain and (d) North America.

a.			All Trees				Trees with Sirex				
Country	Species	Transect	mean DBH	BA	stems ha^{-1}	Prop supp	mean DBH	% stems lost	MVT	% BA lost	stems ha^{-1}
Argentina	PICO	AR15AM011	23.80	65.43	1423.11	0.13	16.40	11.00	23.10	5.22	156.54
		AR15AM031	21.27	86.38	2323.71	0.20	13.75	20.00	16.79	8.36	464.74
		AR14BU020	19.64	60.26	1859.61	0.10	16.38	31.43	125.19	21.85	584.45
		AR15CS021	22.33	80.06	1968.35	0.40	19.45	36.00	151.73	27.32	708.61
		AR14EF010	23.17	34.87	761.94	0.10	20.16	12.14	60.39	9.20	92.52
		AR14EF030	21.53	45.91	1240.03	0.03	17.55	11.43	17.47	7.59	141.72
		AR14FO010	20.86	72.13	2022.52	0.12	17.38	25.77	85.43	17.88	521.14
		AR15PN011	18.55	46.10	1625.54	0.23	15.09	17.00	63.72	11.25	276.34
		AR14RO010	21.71	43.33	1143.51	0.08	17.65	13.57	21.21	8.97	155.19
		AR15SJ011	31.74	24.25	266.37	0.23	24.35	6.00	23.82	3.53	15.98
		AR15SP011	26.74	78.34	1352.81	0.47	23.49	54.00	223.80	41.68	730.52
		AR15SP021	22.07	54.81	1332.23	0.40	18.74	15.00	67.23	10.82	199.84
		AR15SP051	21.86	52.51	1360.88	0.33	21.79	8.00	59.83	7.95	108.87
		AR15SO031	26.35	38.45	668.85	0.17	17.87	3.00	7.34	1.38	20.07
		AR15TA021	18.45	44.77	1623.40	0.13	18.71	10.00	69.35	10.28	162.34
	PIPO	AR15AM021	26.80	83.22	1321.17	0.23	10.67	3.00	0.00	0.48	39.64
		AR15AM041	23.67	88.10	1823.59	0.37	10.80	5.00	0.04	1.04	91.18
		AR14BU1a0	25.84	36.30	632.16	0.17	16.13	3.33	0.51	1.30	21.07
		AR14BU1b0	23.51	90.82	1943.89	0.10	13.48	3.85	1.10	1.26	74.76
		AR15CS011	26.54	119.38	2009.02	0.27	18.78	9.00	17.26	4.50	180.81
		AR14EF020	30.42	50.94	681.90	0.03		0.00	0.00		0.00
		AR14FO020	22.42	74.32	1775.05	0.27	14.10	4.29	0.00	1.70	76.07
		AR14FO030	22.87	75.18	1747.67	0.10	20.15	5.71	26.71	4.44	99.87
		AR15PN021	19.82	62.84	1859.79	0.27	13.60	8.00	20.47	3.77	148.78
		AR15SJ021	20.60	79.49	2040.77	0.47	11.58	16.00	15.99	5.05	326.52
		AR15SP031	24.66	80.64	1592.33	0.20	16.96	7.00	4.17	3.31	111.46
		AR15SP041	26.26	99.29	1711.09	0.20	18.56	14.00	31.45	7.00	239.55
		AR15SP061	51.57	77.48	358.88	0.07	25.54	5.00	0.55	1.23	17.94
		AR15SO011	25.74	81.50	1481.36	0.13	12.44	5.00	1.06	1.17	74.07
		AR15SO021	22.74	87.24	2018.09	0.17	18.27	3.00	9.09	1.94	60.54
		AR15TA011	25.62	75.90	1379.52	0.13	17.26	2.50	6.81	1.13	34.49

b.			All Trees				Trees with Sirex				
Country	Species	Stand Code	mean DBH	BA	stems ha^{-1}	Prop supp	mean DBH	% stems lost	MVT	% BA lost	stems ha^{-1}
South Africa	PIPA	SA13HVC27	18.75	48.50	1663.18	0.07	11.72	11.75	2.00	4.60	195.42
		SA13HVE31	19.61	52.23	1612.68	0.13	11.78	11.75	1.68	4.24	189.49
		SA18HLA108	22.90	39.60	927.97	0.10	11.60	3.00	0.00	0.77	27.84
		SA18HLA14a	19.44	43.33	1399.64	0.13	8.94	2.00	0.00	0.42	27.99
		SA18HLA75	21.13	53.37	1442.01	0.10	12.93	4.00	0.06	1.50	57.68
		SA18HLB31a	22.39	49.07	1191.72	0.20	12.80	3.00	0.02	0.98	35.75
		SA18HLH35	22.13	51.37	1204.31	0.23	8.55	6.00	0.01	0.90	72.26
		SA14HBV12a	26.28	48.50	869.70	0.20	18.80	9.00	8.31	4.60	78.27
		SA14HBV1b	24.09	42.76	908.72	0.27	19.42	19.00	45.83	12.35	172.66
		SA14HBW10a	22.10	49.36	1223.05	0.23	13.07	7.00	0.26	2.45	85.61
		SA14HBW12b	20.25	42.04	1269.09	0.23	14.83	3.00	7.79	1.61	38.07
		SA14HBW23b	24.44	33.57	690.44	0.07	15.13	0.54	0.73	0.21	3.73
		SA14HBW24a	20.67	37.88	1089.17	0.17	7.20	1.00	0.00	0.12	10.89
		SA14HBW26c	21.74	35.58	928.69	0.17	12.39	7.23	0.38	2.35	67.18
		SA14HBW28	21.41	49.07	1272.37	0.33	11.23	4.00	0.04	1.10	50.89
		SA14HBX23a	20.75	26.11	755.20	0.13		0.00	0.00		0.00
		SA14HBX28a	23.46	37.88	842.81	0.17	16.25	12.00	21.37	5.76	101.14
		SA18LWB005a	19.87	58.25	1700.60	0.33	10.24	13.00	1.97	3.45	221.08
		SA18LWC14	19.27	51.65	1570.93	0.27	13.93	12.00	31.56	6.26	188.51
		SA18RHA5a	19.20	58.25	1894.31	0.13	14.66	22.00	57.22	12.83	416.75
		SA18RHB15	18.51	46.20	1614.80	0.20	10.85	4.00	0.52	1.37	64.59
		SA18RHC3	20.15	40.75	1239.38	0.13	14.37	14.00	21.56	7.12	173.51
		SA18RHE36	20.44	48.50	1335.04	0.30	16.46	26.00	107.12	16.86	347.11
		SA18RHF12b	22.63	46.77	1116.22	0.10	14.88	6.00	3.58	2.60	66.97
		SA18RHF22b	20.95	46.20	1264.66	0.13	14.63	9.00	20.62	4.39	113.82
		SA18RHR22	18.82	52.80	1785.62	0.20	11.89	3.50	2.07	1.40	62.50
		SA18RHR27b	21.30	46.77	1283.49	0.03	7.51	0.50	0.00	0.06	6.42
		SA13SP16a	32.56	17.60	207.18	0.00		0.00	0.00		0.00

b. continued			All Trees				Trees with Sirex				
Country	Species	Transect	mean DBH	BA	stems ha^{-1}	Prop supp	mean DBH	% stems lost	MVT	% BA lost	stems ha^{-1}
South Africa	PIRA	SA14BEL13a	27.06	39.46	641.73	0.27	15.00	1.00	0.08	0.31	6.42
		SA14BEL14	22.28	42.18	973.30	0.33	11.42	5.00	3.18	1.31	48.67
		SA14BEL24	23.61	40.46	862.08	0.30	10.50	2.00	0.00	0.40	17.24
		SA14BRS5	32.73	33.43	383.69	0.20		0.00	0.00		0.00
		SA14BUL15a	21.97	32.43	810.82	0.27	18.20	1.00	3.43	0.69	8.11
		SA14HBT54	37.23	52.51	454.35	0.33	18.50	1.00	0.00	0.25	4.54
		SA14HBV13a	36.56	53.23	482.69	0.17	16.80	1.00	0.00	0.21	4.83
		SA14HBV1a	21.71	41.90	1073.57	0.20	14.20	16.00	16.51	6.85	171.77
		SA14HBW14d	21.88	32.14	780.34	0.43	11.98	4.00	0.32	1.20	31.21
		SA14HBW21a	22.76	35.01	818.95	0.17	11.93	3.00	0.00	0.83	24.57
		SA14HBW21b	24.68	43.33	843.87	0.23	14.03	4.00	0.34	1.29	33.75
		SA14HBW27a	18.44	55.81	1880.74	0.33	10.96	8.00	7.26	2.83	150.46
		SA14HBW30b	21.67	48.78	1247.12	0.13	11.17	11.00	0.01	2.92	137.18
		SA14HBX23b	22.44	32.14	774.17	0.20		0.00	0.00		0.00
		SA14JOJ10a	28.18	37.45	583.53	0.03	8.40	1.00	0.00	0.09	5.84
		SA14JOJ10c	24.16	23.96	497.13	0.10		0.00	0.00		0.00
		SA14KEM14	15.80	28.41	1318.14	0.30	5.30	2.00	0.00	0.22	26.36
		SA14KRF11a	24.96	25.54	493.28	0.20	16.67	6.00	12.10	2.67	29.60
		SA14KRF15a	30.53	31.28	409.32	0.13		0.00	0.00		0.00
		SA14RUH7	20.92	21.24	589.04	0.23		0.00	0.00		0.00
		SA14RUM13	21.78	26.11	673.78	0.20		0.00	0.00		0.00
		SA14WIC27a	22.60	41.90	941.71	0.53	14.21	14.00	8.76	5.54	131.84
		SA14WIC69a	28.11	54.38	724.64	0.37	13.10	16.00	3.86	3.47	115.94
	PITA	SA14HBT55a	40.89	46.20	338.96	0.03	42.00	0.50	4.46	0.53	1.69

c.			All Trees				Trees with Sirex				
Country	Species	Transect	mean DBH	BA	stems ha^{-1}	Prop supp	mean DBH	% stems lost	MVT	% BA lost	stems ha^{-1}
Spain	PIPI	SP14CS010	20.30	43.90	1268.12	0.43	14.65	15.71	36.49	8.19	199.28
		SP14PP020	25.96	27.55	493.56	0.13		0.00	0.00		0.00
		SP14PP030	17.96	21.81	781.72	0.37		0.00	0.00		0.00
		SP13OUpx1	14.64	79.20	4297.76	0.30	6.50	0.48	0.24	0.09	20.56
		SP13OUpx11	24.60	39.89	827.02	0.00		0.00	0.00		0.00
		SP13OUpx10	23.03	37.30	881.56	0.00		0.00	0.00		0.00
		SP13OUpx12	15.09	78.05	3933.46	0.27	8.84	6.34	1.35	2.18	249.44
		SP14OUpx2	18.28	57.39	2131.89	0.11		0.00	0.00		0.00
		SP14OUpx3	18.93	47.06	1601.87	0.18		0.00	0.00		0.00
		SP13OUpx4	22.77	32.43	781.89	0.00		0.00	0.00		0.00
		SP14OUpx5	15.65	44.48	1951.02	0.55	8.06	4.31	0.00	1.14	84.10
		SP14OUpx6	22.94	53.37	1252.72	0.05		0.00	0.00		0.00
		SP14OUpx7	16.94	49.93	1953.54	0.39	8.50	3.67	0.01	0.92	71.69
		SP13OUpx8	14.93	83.79	4438.51	0.27	9.80	5.66	6.39	2.44	251.24
		SP14OUpx9	15.59	45.63	2024.98	0.55	7.38	3.31	0.00	0.74	66.94
	PIRA	SP14BE030	22.86	36.16	820.34	0.40	9.55	1.43	0.03	0.25	11.72
		SP13BE020	21.61	33.86	852.63	0.17	13.41	1.00	0.13	0.39	8.53
		SP13BE010	16.67	38.74	1599.38	0.23	10.46	4.75	5.89	1.87	75.97
		SP14CS020	31.28	36.44	460.98	0.03		0.00	0.00		0.00
		SP13BEnz1	33.42	33.57	373.82	0.00		0.00	0.00		0.00
		SP13BEnz10	18.44	50.28	1487.46	0.63	10.67	9.57	11.16	3.20	142.28
		SP13BEnz11	30.94	36.44	465.80	0.00		0.00	0.00		0.00
		SP13BEnz12	19.30	58.25	1819.76	0.30	10.55	10.00	2.15	2.99	181.98
		SP13BEnz2	18.17	55.10	1857.26	0.49	10.62	12.00	6.23	4.10	222.87
		SP14BEnz3	27.63	26.69	404.39	0.26	17.00	2.38	0.83	0.90	9.63
		SP14BEnz4	26.87	28.20	446.62	0.38	15.43	4.44	3.95	1.46	19.85
		SP14BEnz5	25.55	28.53	472.61	0.36	12.23	6.67	0.00	1.53	31.51
		SP13BEnz6	31.22	27.55	351.45	0.00		0.00	0.00		0.00
		SP14BEnz7	30.03	30.50	412.12	0.13	22.10	2.08	1.76	1.13	8.59
		SP14BEnz8	27.68	40.17	631.61	0.24	17.40	3.45	0.10	1.36	21.78
		SP14BEnz9	27.90	37.88	569.86	0.38	23.80	1.92	8.59	1.40	10.96
		SP14PP010	21.19	47.64	1284.16	0.17	13.70	5.71	0.00	2.39	73.38
	PISY	SP13BC010	28.25	47.06	723.90	0.00	19.00	1.25	1.97	0.57	9.05
		SP14BC020	22.04	69.73	1695.67	0.37	16.13	4.29	13.99	2.30	72.67
		SP13FA010	19.09	56.82	1885.70	0.10	11.67	5.75	3.67	2.15	108.43
		SP14FA020	17.77	24.39	909.46	0.33		0.00	0.00		0.00
		SP14FA030	18.98	49.36	1669.04	0.13	5.70	1.43	0.01	0.13	23.84

d.			All Trees				Trees with Sirex				
Country	Species	Transect	mean DBH	BA	stems ha^{-1}	Prop supp	mean DBH	% stems lost	MVT	% BA lost	stems ha^{-1}
United States	PIRE	US15BL010	14.54	23.53	1282.03	0.43	9.50	1.00	2.14	0.43	12.82
		US17BR010	30.08	32.14	435.65	0.07	12.97	3.00	0.00	0.56	13.07
		US15FL030	21.87	62.27	1590.83	0.20	16.42	13.00	24.86	7.33	206.81
		US14FL010	19.51	57.08	1845.48	0.22	13.71	2.73	2.65	1.35	50.30
		US15HC010	24.89	63.99	1292.83	0.03	10.55	2.00	0.00	0.36	25.86
		US15HC020	21.20	56.53	1547.22	0.03	9.90	2.00	0.00	0.44	30.94
		US16NW010	32.78	12.05	138.69	0.03	18.73	3.00	3.14	0.98	4.16
		US16NW020	24.06	36.16	753.73	0.10	15.67	6.00	4.25	2.54	45.22
		US16NW030	26.79	45.63	784.53	0.00	17.28	8.00	0.36	3.33	62.76
		US16NW040	28.25	53.66	819.19	0.07		0.00	0.00		0.00
		US17PW010	34.27	41.61	434.10	0.13	24.45	2.00	0.00	1.02	8.68
	PISY	US15BL020	16.47	24.68	1081.59	0.10	9.70	1.00	0.98	0.35	10.82
		US15FL020	24.17	31.28	644.73	0.27	15.60	12.00	7.57	5.00	77.37

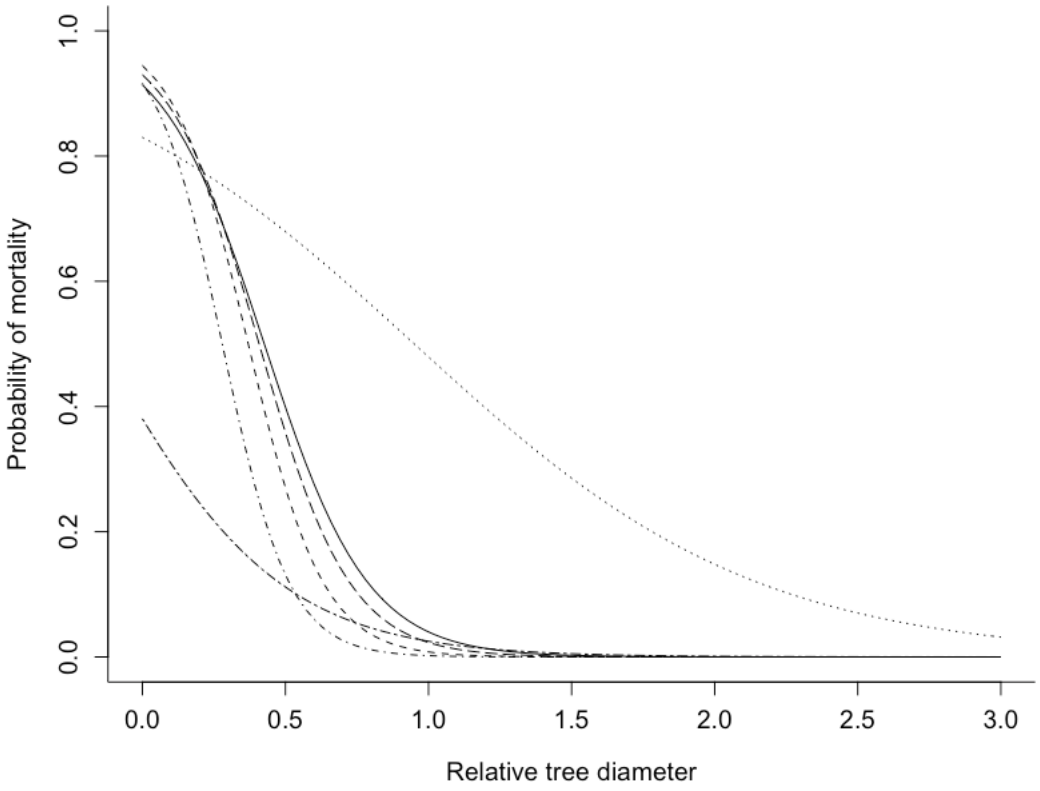
Supplemental Table II. Correlation matrix of stand-level attributes (1-7) and damage from *S. noctilio* (8-12)[i]. Bold indicates significant at 0.05 level.

	DBH	QMD	Basal area	Trees ha^{-1}	Proportion suppressed	NN1	NN2	*S. noctilio* DBH	% trees with *S. noctilio*	*S. noctilio* trees ha^{-1}	Basal area lost
1. DBH											
2. QMD	**1**[ii]										
3. Basal area	-0.07	-0.07									
4. Trees ha^{-1}	**-0.64**	**-0.64**	**0.68**								
5. Proportion suppressed	**-0.35**	**-0.3**	0.13	**0.27**							
6. NN1	**0.67**	**0.67**	**-0.49**	**-0.71**	**-0.31**						
7. NN2	**0.75**	**0.75**	**-0.54**	**-0.77**	**-0.29**	**0.92**					
8. *S. noctilio* DBH	**0.67**	**0.66**	0.03	**-0.4**	**-0.21**	**0.4**	**0.44**				
9. % trees with *S. noctilio*	**-0.23**	**-0.21**	**0.43**	**0.34**	**0.35**	**-0.36**	**-0.39**	0.18			
10. *S. noctilio* trees ha^{-1}	**-0.37**	**-0.35**	**0.57**	**0.56**	**0.35**	**-0.49**	**-0.54**	0.02	**0.95**		
11. Basal area lost	-0.09	-0.1	**0.25**	0.15	0.15	-0.19	**-0.21**	**0.31**	**0.87**	**0.81**	
12. MVT	-0.09	-0.1	**0.26**	**0.17**	**0.19**	**-0.2**	**-0.21**	**0.34**	**0.7**	**0.69**	**0.97**

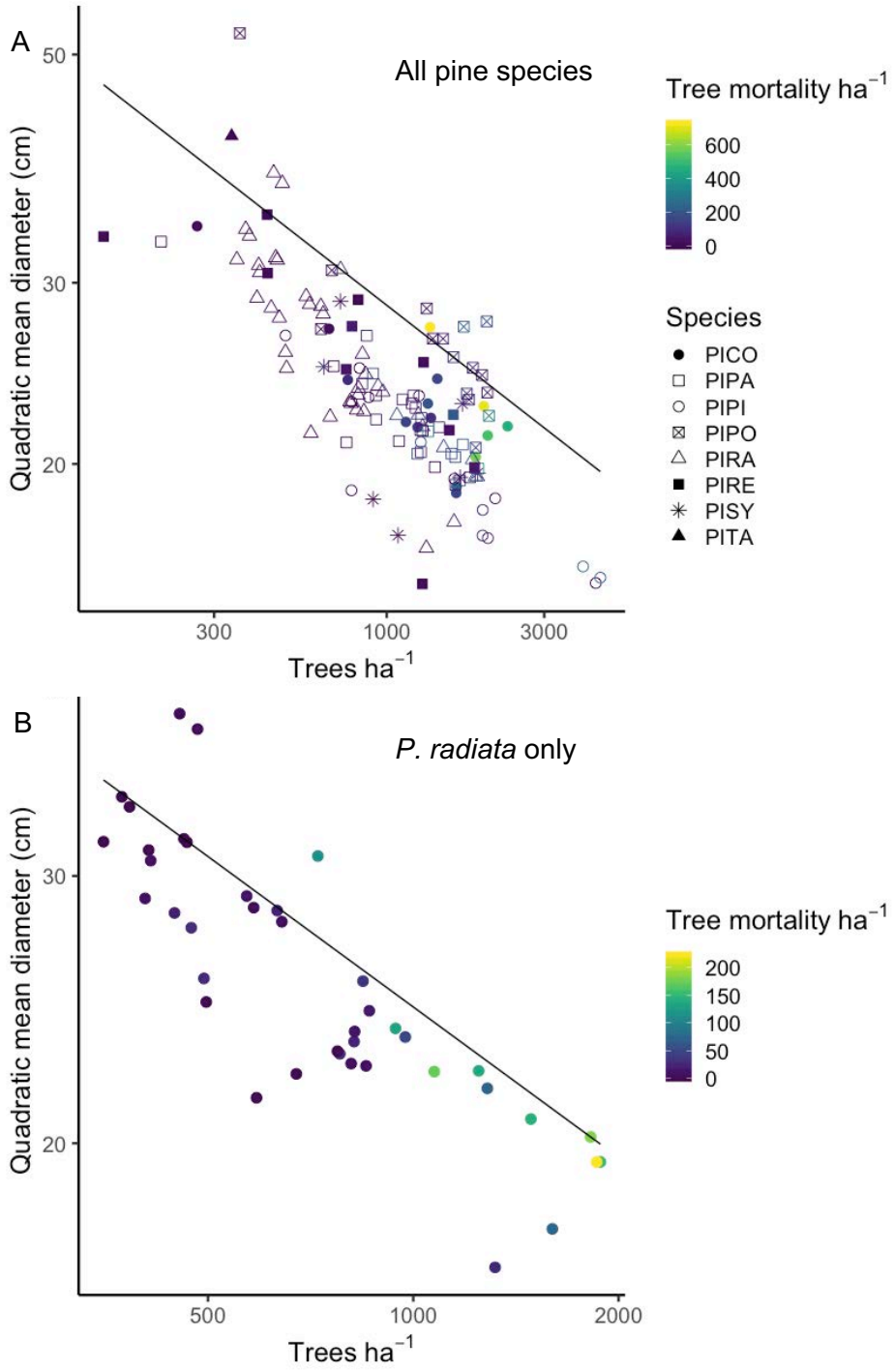
[i]Detailed variable descriptions: 1. DBH: diameter at breast height (arithmetic mean); 2. QMD: quadratic mean diameter, $\sqrt{\frac{\sum D_i^2}{n}}$, where D_i= DBH of *i*th tree, *n* = number of trees in stand; 3. Basal area: (m2 ha^{-1}) measured with 10-BAF prism; 4. Trees ha^{-1}: number of stems per hectare; 5. Proportion suppressed: proportion of trees in the stand with suppressed crowns; 6. NN1: distance (m) to the closest neighboring tree ≥ 5 cm DBH; 7. NN2: distance (m) to the second closest neighboring tree ≥ 5 cm DBH; 8. *S. noctilio* DBH: diameter at breast height of trees attacked by *S. noctilio* (arithmetic mean); 9. % trees with *S. noctilio*: square root of the percentage of trees in stand with signs of *S. noctilio* attack; 10. *S. noctilio* trees ha^{-1}: square root of the number of trees per hectare with signs of *S. noctilio* attack; 11. Basal area lost: percent of total stand basal area lost due to *S. noctilio*- associated tree mortality; 12. MVT: estimated number of vigorous trees ha^{-1} (defined as those with DBH $> 0.9 \cdot$ Average DBH for the stand) lost due to *S. noctilio*. [ii]Unrounded correlation= 0.9969.

Supplemental Table III. Estimated slopes and intercepts from 90th quantile regression (where x = log (trees ha^{-1}) and y = log (quadratic mean diameter). Estimates computed for all stands combined and for all stands of each pine species separately (see Figures 9a-b).

Species	Code	Slope	Intercept
All		-0.25	5.08
P. radiata	PIRA	-0.33	5.48
P. contorta	PICO	-0.20	4.65
P. ponderosa	PIPO	-0.42	6.43
P. patula	PIPA	-0.26	4.96
P. pinaster	PIPI	-0.28	5.09
P. resinosa	PIRE	-0.30	5.39
P. sylvestris	PISY	-0.27	5.13



Supplemental Figure I. For all tree species, probability of mortality was highest for the smallest trees in a stand and decreased with increasing relative tree diameter. Combined logistic regression shown in Figure 4. This figure shows separate logistic regression curves for each of the following tree species, from left to right: *P. sylvestris*, *P. pinaster*, *P. radiata*, *P. resinosa*, *P. patula*, *P. contorta*.



Supplemental Figure II. Approximate self-thinning boundaries as estimated by 90th quantile regressions of quadratic mean diameter vs. trees ha^{-1} (both log-transformed). Upper panel includes all pine species in the study. Lower panel is *P. radiata* alone. See Table 3 for regression coefficients, including separate estimates for each species.