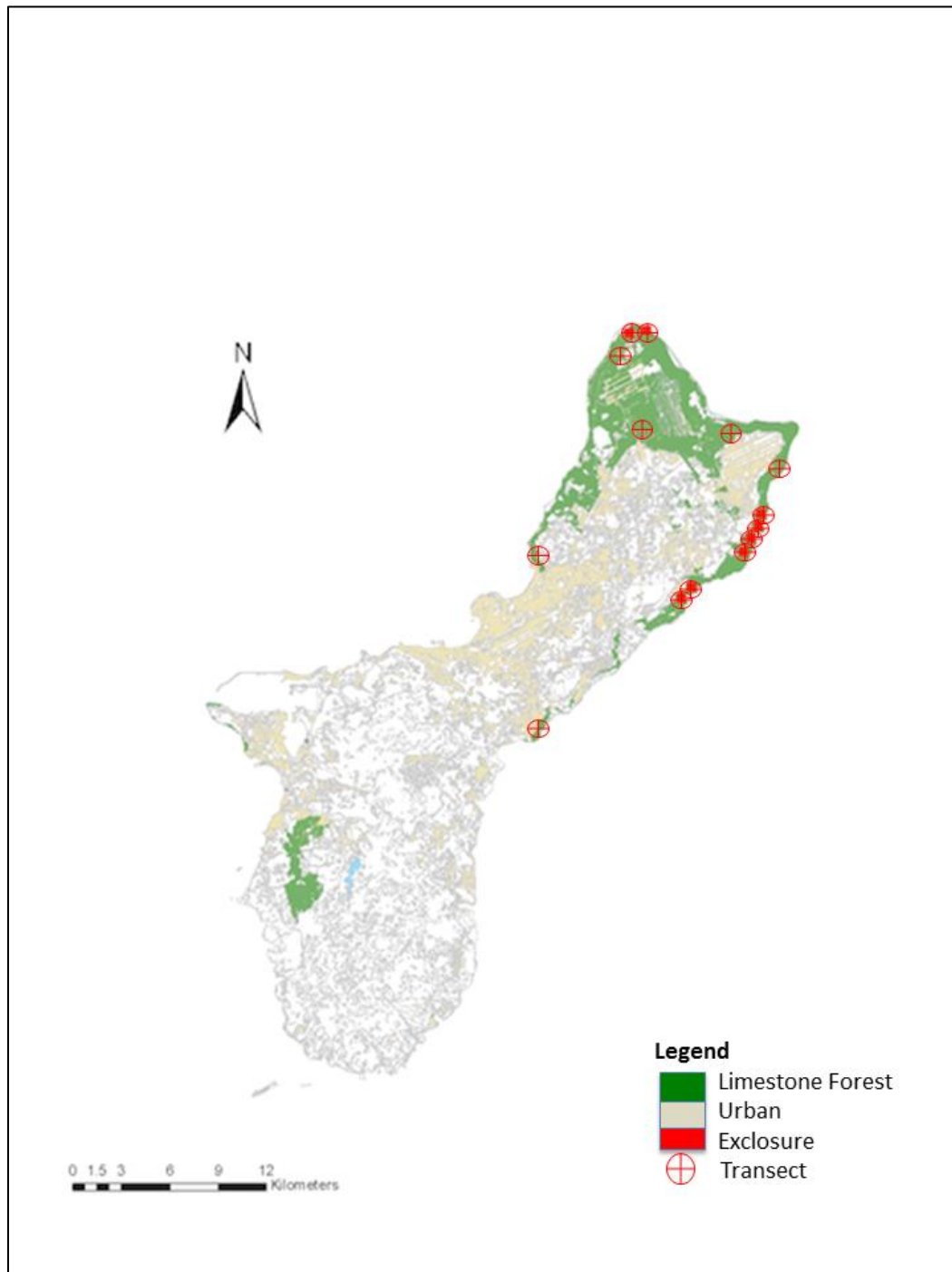


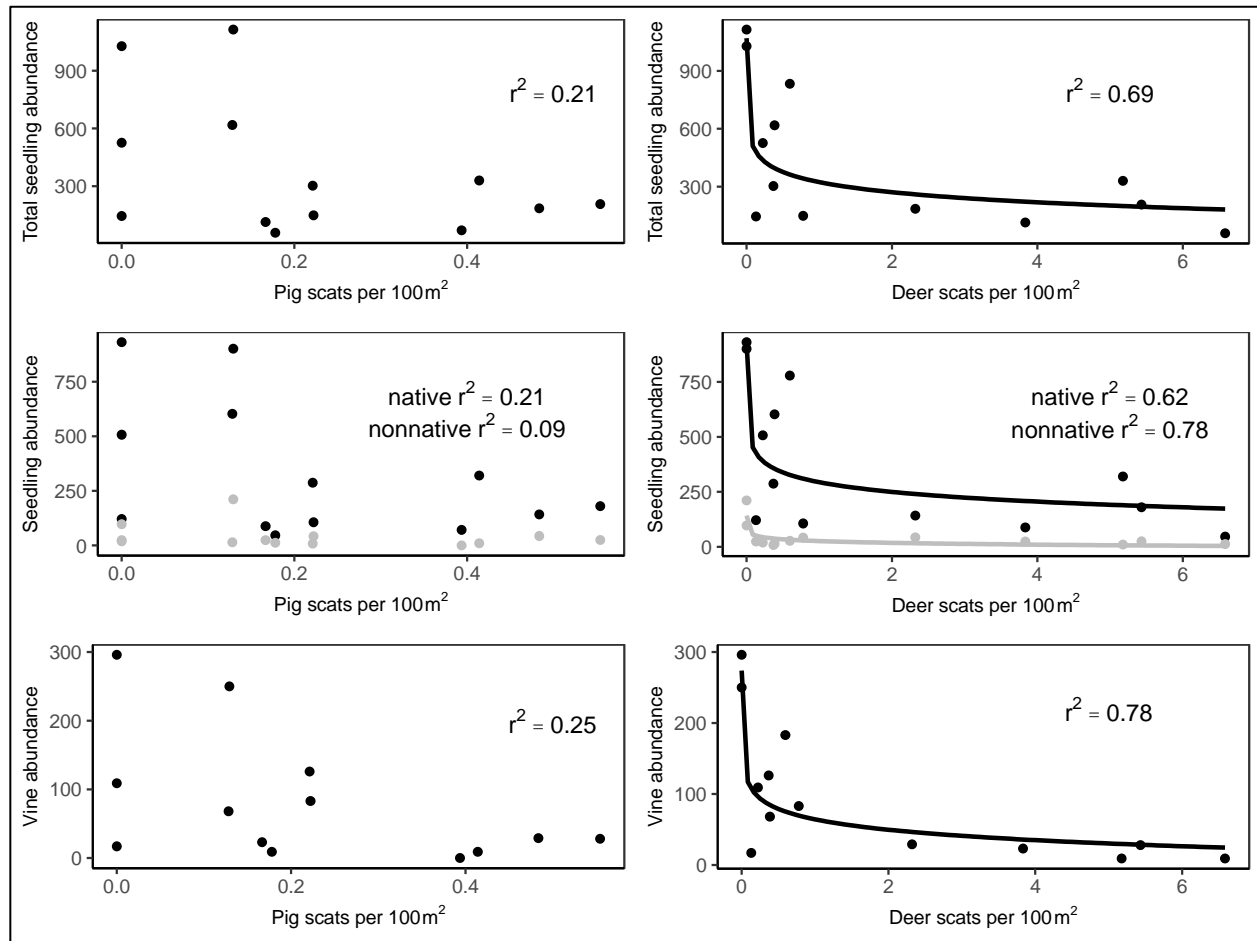
Supplementary information, Gawel et al. RSOS 17051

Supplementary Section 1: Sites



Supplementary Figure 1. Location of eight exclosures and 14 transects in Guam's limestone karst forests.

Supplementary Section 2: Plots after removing highest deer and pig density sites.



Supplementary Figure 2. Results from vegetation and scat surveys dropping site that had highest scats per 100m² ("Race" for pig, and "Tartop" for deer) to determine whether the extreme value was influencing the relationship between scat count and seedling abundance. Best fit lines are only included when the fit was significant at $p=0.05$. A loglinear relationship was a better fit for all of the deer-seedling relationships than a linear fit. Although the scale of the x-axis is smaller, trends are qualitatively the same as those in Figure 4.

Supplementary Section 3: Comparisons of baseline characteristics of seedling plots chosen for fenced and ungulate treatments.

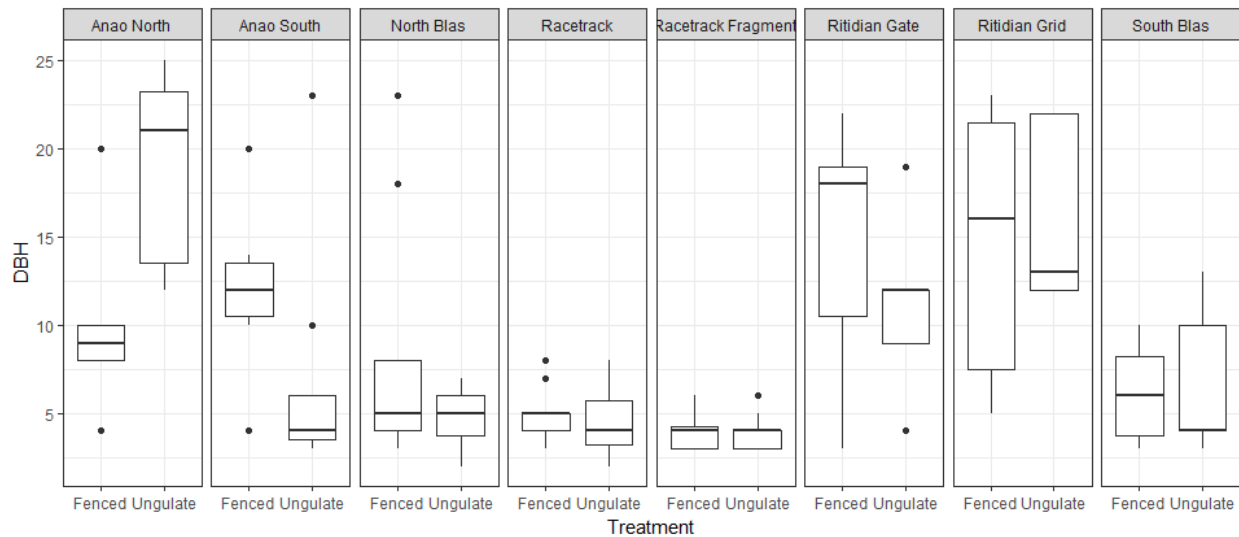
Supplementary Table 1: Comparison of paired plots at each site, using number of adult trees, average diameter at breast height (dbh), canopy cover, and average adult tree height.

Site	Fenced				Unfenced			
	# Adult trees	Avg dbh (cm)	Canopy cover	Avg height (m)	# Adult trees	Avg dbh (cm)	Canopy cover	Avg height (m)
Ritidian Grid	6	14.67	0.82	9.17	5	16.2	0.84	8.3
Ritidian Gate	7	14.57	0.9	8.71	5	11.2	0.85	7.6
Anao North	6	10	0.84	10.6	8	19	0.84	11.06
Anao South	7	12	0.73	9.43	11	6.45	0.79	9.43
North Blas	13	8.23	0.85	7.62	6	4.75	0.82	7.75
South Blas	8	6.13	0.76	6.88	6	6.67	0.74	7.67
Racetrack	14	4.93	0.9	6.21	10	4.93	0.9	6.65
Racetrack Fragment	12	4	0.88	7.46	9	4	0.89	6.67

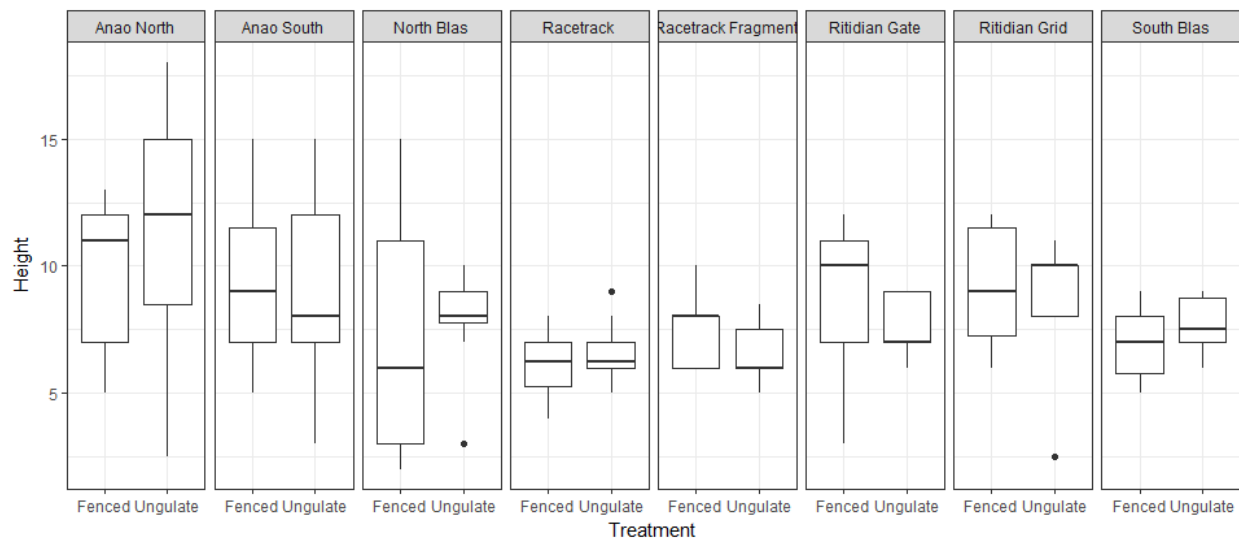
Supplementary Table 2: We used linear mixed effects models with least square means posthoc tests to assess if the number of adult trees, proportion canopy cover, diameter at breast height of adult trees, and adult tree height differed significantly between treatments. We report output from the lsmeans tests below. We determined that these parameters do not differ significantly between seedling plots at each site, indicating plots were similar prior to the experiment.

Parameter	Contrast values (Fenced – Unfenced)				
	Lsmean	Df	SE	t-ratio	p-value
# adult trees	1.63	7	1.21	1.34	0.22
Canopy cover	0.00	7	0.01	0.11	0.92
Height	-0.01	127.77	0.50	-0.02	0.98
DBH	0.48	126.41	0.86	0.56	0.57

A.



B.



Supplementary Figure 3. Comparisons of DBH (a) and height (b) in adult trees in paired plots. While some differences are apparent, no consistent or unidirectional trends exist for either parameter across sites.

Supplementary Table 3. We included qualitative descriptions of the sites in the table below.

Site		Fenced	Unfenced/Ungulate
Ritidian Grid	Substrate	Solid karst formations in southeast corner of plot, large amounts of <i>Ochrosia oppositifolia</i> leaf litter	Mostly flat with scattered limestone rocks 10-20 cm in diameter, mixed leaf litter
	Slope	0	0
	Species of adult trees	<i>Ochrosia oppositifolia</i> , <i>Aglaia mariannensis</i> , <i>Meiogyne cylindrocarpa</i>	<i>Ochrosia oppositifolia</i> , <i>Psychotria mariana</i> , <i>Cycas micronesica</i>
Ritidian Gate	Substrate	Mostly 5-10cm-diameter rocks with few large, 50-cm-high boulders, <20% exposed red soil	Few large, 50-cm-high boulders, <20% exposed red soil, mostly 5-10cm-diameter rocks
	Slope	0	slight downward slope (<5 degrees) towards NW
	Species of adult trees	<i>Ochrosia oppositifolia</i> , <i>Aglaia mariannensis</i> , <i>Triphasia trifolia</i>	<i>Aglaia mariannensis</i> , <i>Mammea odorata</i> , <i>Ochrosia oppositifolia</i>
Anao North	Substrate	very rocky, no soil visible, rocks from 5 - 50-cm in diameter	very rocky, no soil visible, rocks from 5 - 50-cm in diameter
	Slope	0	0
	Species of adult trees	<i>Ochrosia oppositifolia</i> , <i>Meiogyne cylindrocarpa</i> (<i>Macaranga thompsonii</i> , out of plot, but canopy overhanging plot)	<i>Ochrosia oppositifolia</i> , <i>Cycas micronesica</i> , <i>Macaranga thompsonii</i>
Anao South	Substrate	60% of ground cover is large rocks >20cm in diameter, some (~20% substrate) exposed red dirt	very rocky, loose rocks 10-50cm in diameter, small amounts (~10-15%) of exposed red dirt
	Slope	flat	slight downward slope (<5 degrees) towards east
	# adult trees	7	11
	Species of adult trees	<i>Mammea odorata</i> , <i>Aglaia mariannensis</i> , <i>Meiogyne cylindrocarpa</i> , <i>Ochrosia oppositifolia</i>	<i>Mammea odorata</i> , <i>Ochrosia oppositifolia</i> , <i>Cynometra ramiflora</i> , <i>Meiogyne cylindrocarpa</i>

Site		Fenced	Unfenced/Ungulate
North Blas	Substrate	very rocky, no soil visible, rocks approx. 50cm in diameter	very rocky, no soil visible, rocks approx. 50cm in diameter
	Slope	slight slope (<5 degs) downward towards NE, tower karst intermittent on all sides	in slight depression between towers of karst on north and south sides
	Species of adult trees	<i>Aglaia mariannensis</i> , <i>Cynometra ramiflora</i> , <i>Morinda citrifolia</i> , <i>Macaranga thompsonii</i> , <i>Syzigium thompsonii</i>	<i>Aglaia mariannensis</i> , <i>Meiogyne cylindrocarpa</i> , <i>Mammea odorata</i>
South Blas	Substrate	very rugged, large, solid rocks on south side of plot, no soil showing	rugged, no soil showing
	Slope	0	0
	Species of adult trees	<i>Meiogyne cylindrocarpa</i> , <i>Ochrosia mariannensis</i>	<i>Meiogyne cylindrocarpa</i> , <i>Ochrosia mariannensis</i> , <i>Macaranga thompsonii</i>
Racetrack	Substrate	moderate karst, scattered boulders 0.5-m in diameter	moderate karst, scattered boulders and rocks 0.2 to 0.5-m in diameter
	Slope	0	0
	Species of adult trees	<i>Eugenia reinwardtiana</i>	<i>Eugenia reinwardtiana</i> , <i>Meiogyne cylindrocarpa</i>
Racetrack Fragment	Substrate	very rocky, high amount of <i>Eugenia</i> leaf litter	very rocky, high amount of <i>Eugenia</i> leaf litter
	Slope	0	0
	Species of adult trees	<i>Eugenia reinwardtiana</i> , <i>Aglaia mariannensis</i>	<i>Eugenia reinwardtiana</i>

Supplementary Section 4: Model selection for linear models of vegetation characteristics explained by pig and deer scat abundance.

Supplementary Table 4. Total seedlings

	K	AICc	Δ AICc
Deer	3	206.06	0.00
Deer + Pigs	4	209.55	3.49
Pigs	3	211.90	5.84

Supplementary Table 5. Native seedlings

	K	AICc	Δ AICc
Deer	3	202.53	0.00
Deer + Pigs	4	205.93	3.40
Pigs	3	208.26	5.73

Supplementary Table 6. Exotic seedlings

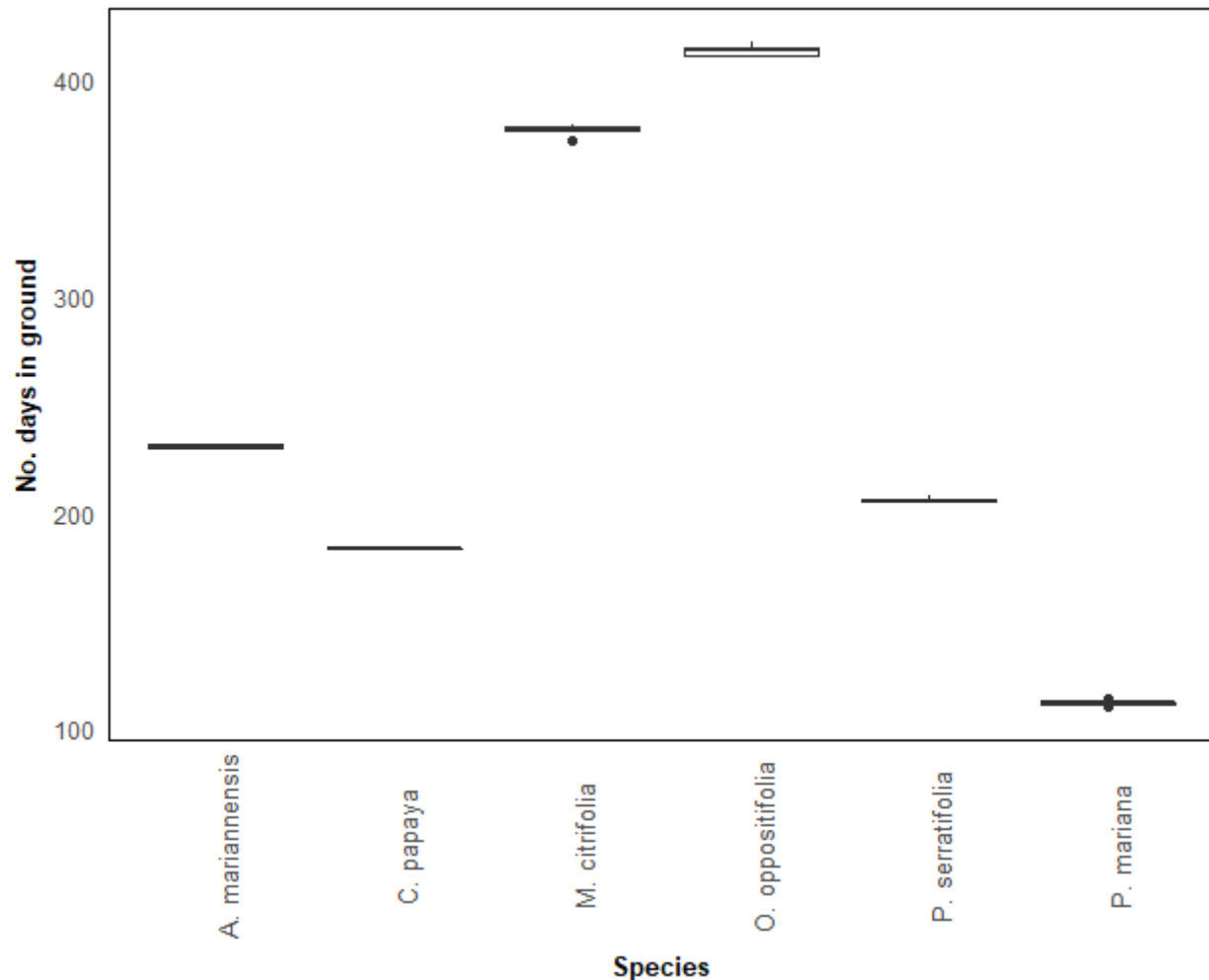
	K	AICc	Δ AICc
Deer	3	156.83	0.00
Pigs	3	159.64	2.81
Deer + Pigs	4	160.80	3.97

Supplementary Table 7. Vines

	K	AICc	Δ AICc
Deer	3	167.50	0.00
Deer + Pigs	4	171.35	3.85
Pigs	3	174.59	7.09

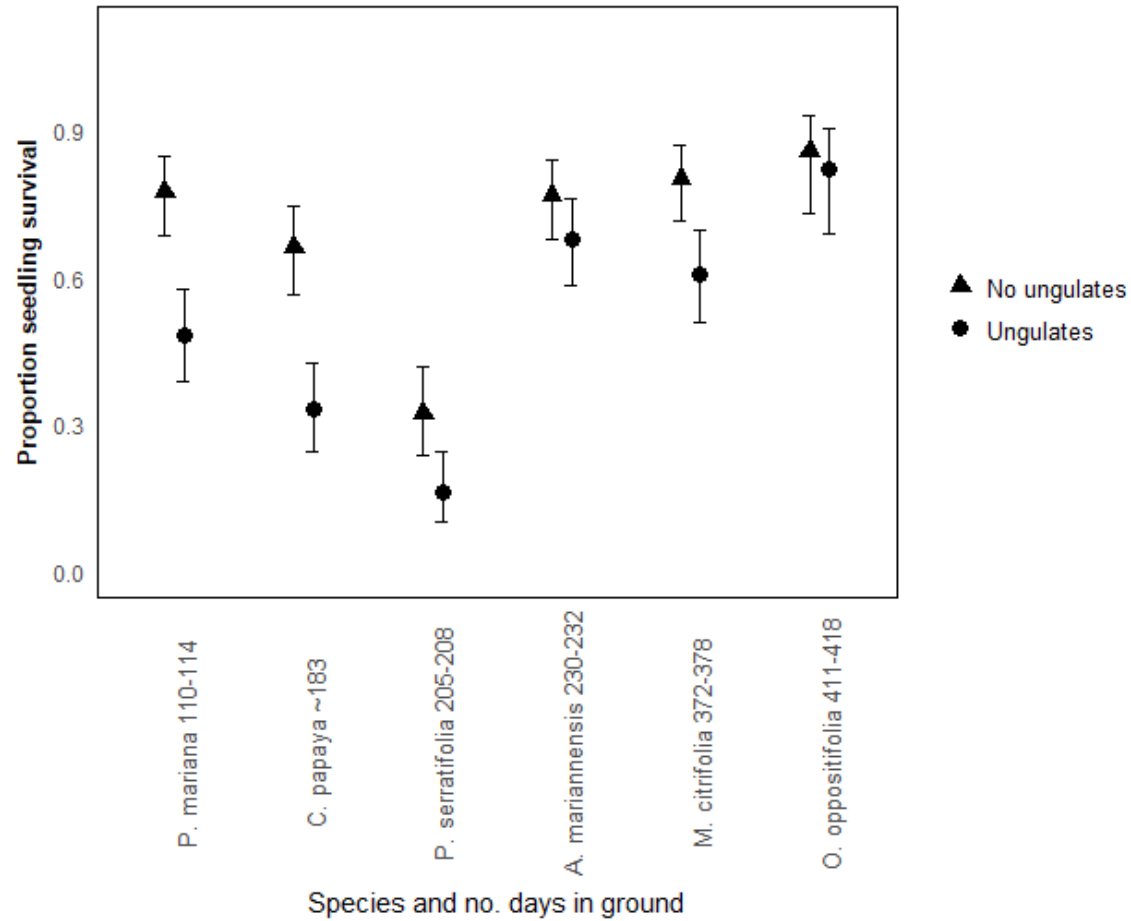
Supplementary Section 5: Clarification on role of time in ground for planted seedlings.

Planting dates were staggered based on species. Because outplanting dates corresponded to species ready for outplanting, and since there are six species, we see that the time a seedling was in the ground fell tightly into six discrete groups, see boxplot below:



Supplementary Figure 4. Boxplot showing number of days seedlings of a certain species were in the ground (date recorded – date planted).

Therefore, to show that the number of days a seedling was in the ground did not affect differences in survival between treatments in a significant way, we created the following plot. It is similar to figure 1 of the manuscript, except species are ordered based on time they were in the ground (least number of days on the left, most on the right).



Supplementary Figure 5. Proportion of seedlings that survived in fenced versus unfenced plots for six tree species, showing that time in ground did not decrease survival or increase treatment effect.