

Electronic Supplementary Material for the article:

Comparing long-term patterns of spread of native and invasive plants in a successional forest

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Distances from newly colonized plots to individuals in the previous survey before and after making spatial correction

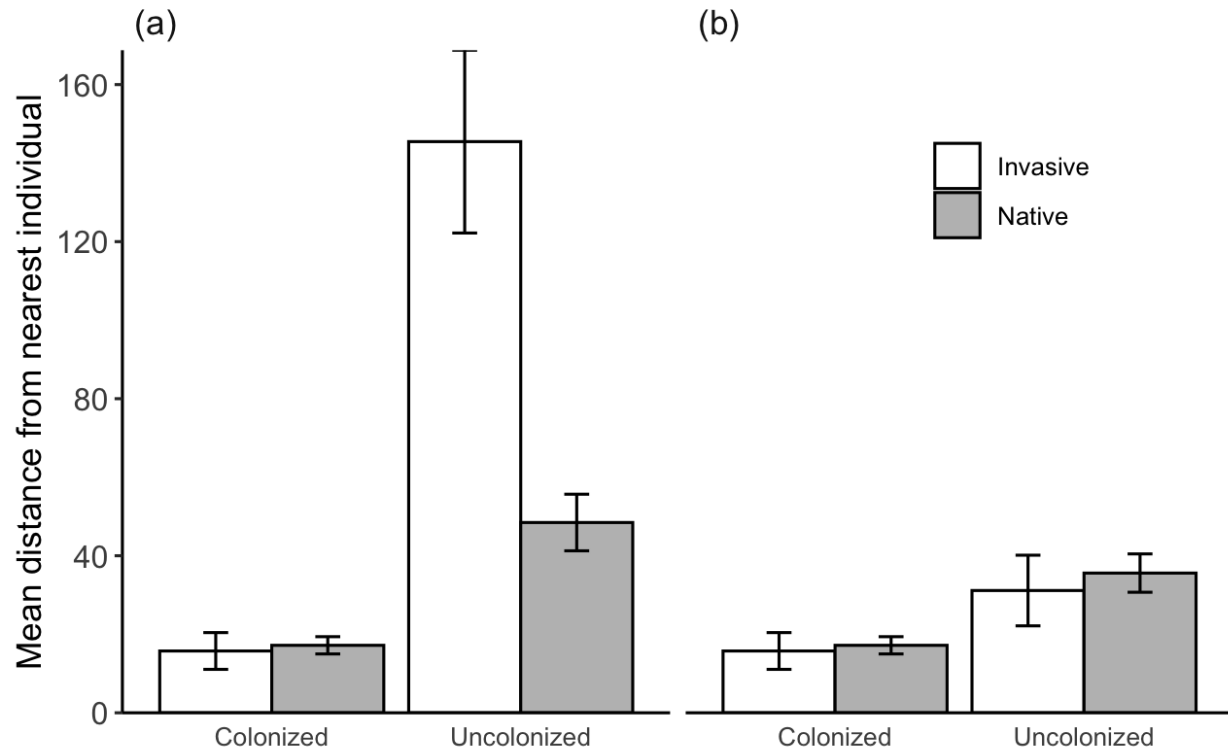


Fig S1 Average distance from newly colonized and uncolonized plots to plots where an individual of the same species was present in the previous survey for natives and invasives before (a) and after (b) removing uncolonized plots that were farther than the farthest newly colonized plot. Average distances were calculated for each species separately from 1962 to 2022 and bars show means $\pm$ 95% CI of those averages ($n = 17$ for invasives, $n = 72$ for natives).

Variable correlations

Table S1 Correlation matrix with plot variables from 1952-2022 used in models to predict whether a plot was newly colonized or never colonized. Correlations with the distances of plots to the nearest individual of each species in each year are not reported.

	Transition	Open	Richness 1952	Richness 1962	Richness 1972	Richness 1982	Richness 1992	Richness 2002	Richness 2012	Richness 2022	Basal Area 1952	Basal Area 1962	Basal Area 1972	Basal Area 1982	Basal Area 1992	Basal Area 2002	Basal Area 2012	Basal Area 2022	Distance to Edge
Transition	1	-0.20	0.38	0.40	0.40	0.46	0.34	0.27	0.18	0.20	-0.09	-0.11	-0.06	-0.11	-0.16	-0.05	-0.01	-0.02	-0.17
Open	-0.20	1	0.28	0.35	0.36	0.44	0.53	0.55	0.47	0.44	-0.43	-0.48	-0.42	-0.28	-0.27	-0.19	-0.20	-0.13	-0.46
Richness 1952	0.38	0.28	1	0.69	0.55	0.52	0.48	0.45	0.33	0.40	-0.31	-0.33	-0.26	-0.21	-0.25	-0.17	-0.16	-0.14	-0.34
Richness 1962	0.40	0.35	0.69	1	0.76	0.66	0.60	0.54	0.38	0.40	-0.29	-0.32	-0.28	-0.21	-0.22	-0.06	-0.06	-0.03	-0.31
Richness 1972	0.40	0.36	0.55	0.76	1	0.76	0.67	0.61	0.42	0.37	-0.30	-0.32	-0.26	-0.21	-0.22	-0.04	-0.02	-0.02	-0.32
Richness 1982	0.46	0.44	0.52	0.66	0.76	1	0.80	0.70	0.54	0.52	-0.36	-0.37	-0.31	-0.26	-0.27	-0.09	-0.08	-0.09	-0.39
Richness 1992	0.34	0.53	0.48	0.60	0.67	0.80	1	0.81	0.62	0.60	-0.33	-0.35	-0.30	-0.22	-0.23	-0.10	-0.13	-0.12	-0.40
Richness 2002	0.27	0.55	0.45	0.54	0.61	0.70	0.81	1	0.71	0.69	-0.36	-0.35	-0.28	-0.17	-0.19	-0.14	-0.17	-0.12	-0.43
Richness 2012	0.18	0.47	0.33	0.38	0.42	0.54	0.62	0.71	1	0.77	-0.31	-0.27	-0.20	-0.10	-0.11	-0.12	-0.18	-0.15	-0.31
Richness 2022	0.20	0.44	0.40	0.40	0.37	0.52	0.60	0.69	0.77	1	-0.33	-0.31	-0.25	-0.16	-0.19	-0.21	-0.23	-0.20	-0.30
Basal Area 1952	-0.09	-0.43	-0.31	-0.29	-0.30	-0.36	-0.33	-0.36	-0.31	-0.33	1	0.93	0.87	0.79	0.71	0.67	0.49	0.41	0.36
Basal Area 1962	-0.11	-0.48	-0.33	-0.32	-0.32	-0.37	-0.35	-0.35	-0.27	-0.31	0.93	1	0.97	0.90	0.83	0.73	0.50	0.43	0.33
Basal Area 1972	-0.06	-0.42	-0.26	-0.28	-0.26	-0.31	-0.30	-0.28	-0.20	-0.25	0.87	0.97	1	0.94	0.86	0.75	0.54	0.49	0.28
Basal Area 1982	-0.11	-0.28	-0.21	-0.21	-0.21	-0.26	-0.22	-0.17	-0.10	-0.16	0.79	0.90	0.94	1	0.94	0.79	0.51	0.50	0.16
Basal Area 1992	-0.16	-0.27	-0.25	-0.22	-0.22	-0.27	-0.23	-0.19	-0.11	-0.19	0.71	0.83	0.86	0.94	1	0.81	0.53	0.50	0.15
Basal Area 2002	-0.05	-0.19	-0.17	-0.06	-0.04	-0.09	-0.10	-0.14	-0.12	-0.21	0.67	0.73	0.75	0.79	0.81	1	0.81	0.75	0.22
Basal Area 2012	-0.01	-0.20	-0.16	-0.06	-0.02	-0.08	-0.13	-0.17	-0.18	-0.23	0.49	0.50	0.54	0.51	0.53	0.81	1	0.93	0.27
Basal Area 2022	-0.02	-0.13	-0.14	-0.03	-0.02	-0.09	-0.12	-0.12	-0.15	-0.20	0.41	0.43	0.49	0.50	0.50	0.75	0.93	1	0.21
Distance to Edge	-0.17	-0.46	-0.34	-0.31	-0.32	-0.39	-0.40	-0.43	-0.31	-0.30	0.36	0.33	0.28	0.16	0.15	0.22	0.27	0.21	1

Table S2 Correlation matrix with plot variables only from 2012-2022 used in models to predict whether a plot was newly colonized or never colonized. Correlations with the distances of plots from the nearest individual of each species in each year are not reported.

	Transition	Open	Richness 2002	Richness 2012	Canopy Openness 2012	Canopy Openness 2022	Nitrate 2012	Nitrate 2022	Calcium 2012	Calcium 2022	Basal Area 2012	Basal Area 2022	Distance to Edge
Transition	1	-0.20	0.27	0.18	-0.09	-0.09	-0.08	-0.10	-0.04	-0.10	-0.01	-0.02	-0.17
Open	-0.20	1	0.55	0.47	0.18	0.28	0.54	0.41	0.48	0.49	-0.20	-0.13	-0.46
Richness 2002	0.27	0.55	1	0.71	0.05	0.06	0.26	0.10	0.37	0.28	-0.17	-0.12	-0.43
Richness 2012	0.18	0.47	0.71	1	0.00	-0.03	0.17	0.09	0.30	0.30	-0.18	-0.15	-0.31
Canopy Openness 2012	-0.09	0.18	0.05	0.00	1	0.62	0.21	0.11	0.15	0.23	-0.20	-0.18	0.08
Canopy Openness 2022	-0.09	0.28	0.06	-0.03	0.62	1	0.35	0.23	0.19	0.35	-0.29	-0.27	-0.20
Nitrate 2012	-0.08	0.54	0.26	0.17	0.21	0.35	1	0.46	0.51	0.52	-0.26	-0.21	-0.34
Nitrate 2022	-0.10	0.41	0.10	0.09	0.11	0.23	0.46	1	0.47	0.58	-0.21	-0.12	-0.31
Calcium 2012	-0.04	0.48	0.37	0.30	0.15	0.19	0.51	0.47	1	0.65	-0.27	-0.19	-0.30
Calcium 2022	-0.10	0.49	0.28	0.30	0.23	0.35	0.52	0.58	0.65	1	-0.28	-0.27	-0.30
Basal Area 2012	-0.01	-0.20	-0.17	-0.18	-0.20	-0.29	-0.26	-0.21	-0.27	-0.28	1	0.93	0.27
Basal Area 2022	-0.02	-0.13	-0.12	-0.15	-0.18	-0.27	-0.21	-0.12	-0.19	-0.27	0.93	1	0.21
Distance to Edge	-0.17	-0.46	-0.43	-0.31	0.08	-0.20	-0.34	-0.31	-0.30	-0.30	0.27	0.21	1

Differences between natives and invasives shown over time

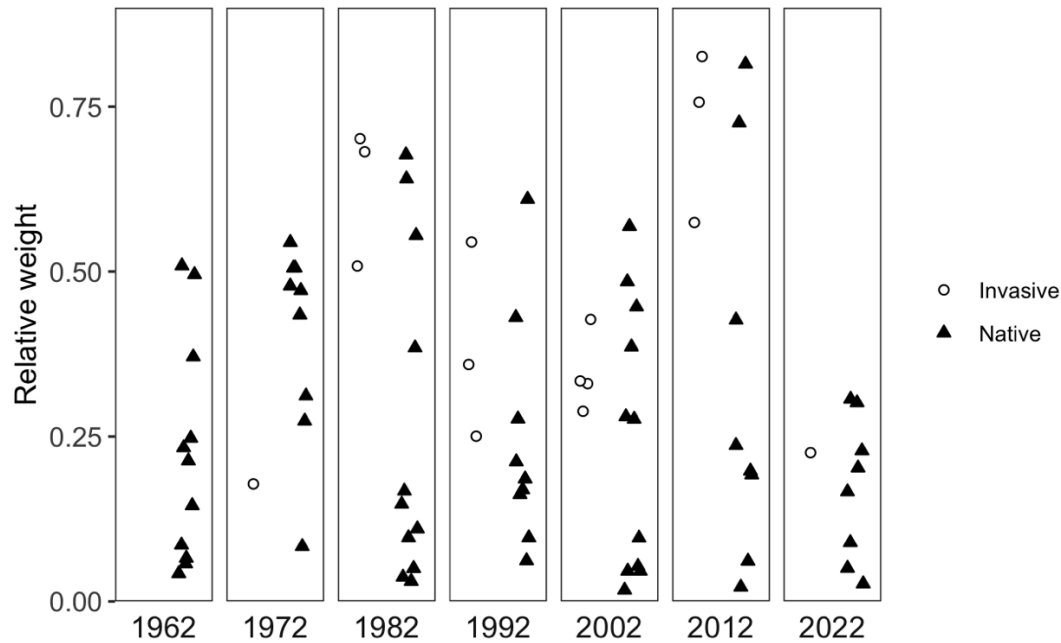


Fig. S2 Relative weight of the open age class for predicting plot colonization by natives and invasives in seven consecutive decades. Each point represents the relative weight from the model of one species spreading in a given year ($n = 67$ for natives, $n = 15$ for invasives).

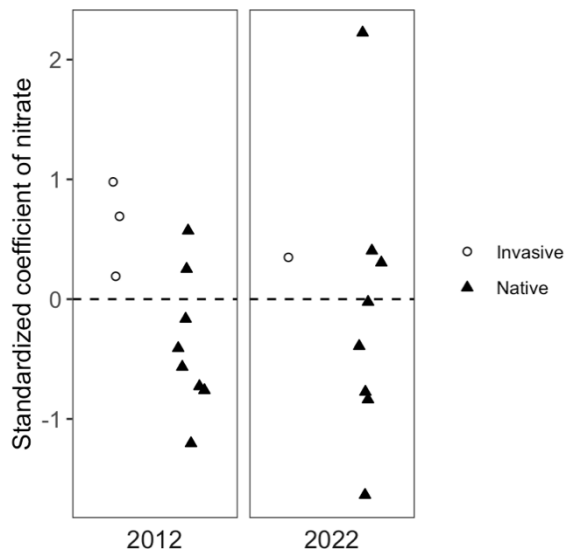


Fig. S3 Standardized coefficient of nitrate from models predicting whether a site was colonized by native and invasive species in 2012 and 2022. Each point represents the standardized regression coefficient from the model of one species spreading in a given year ($n = 4$ for invasives and $n = 16$ for natives).

Relative weights and coefficients from 2012 and 2022

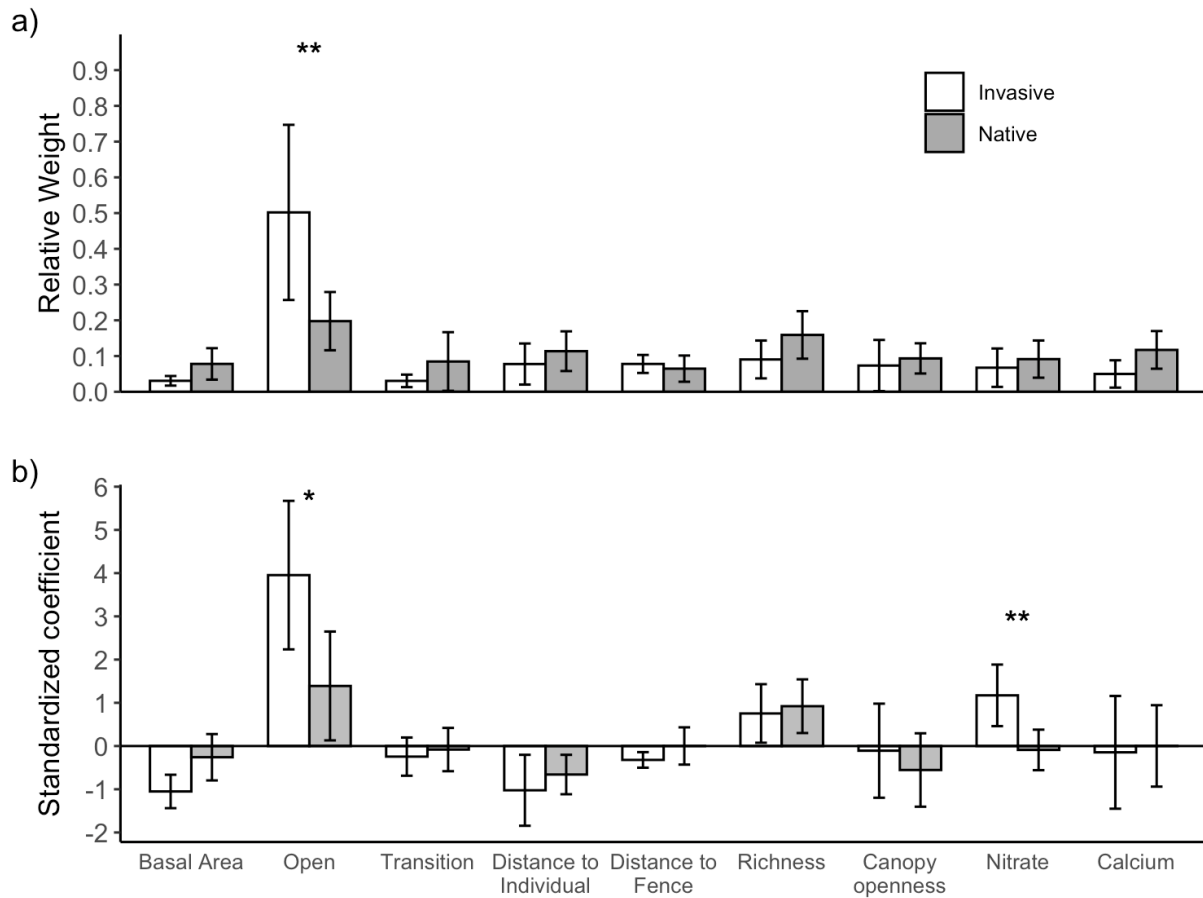


Fig. S4 Relative weights and standardized regression coefficients of predictors used in multiple logistic regression models to predict whether a plot was newly colonized by native and invasive species in 2012 and 2022. Models were run for each species in each year that it was spreading, and bars show means $\pm$ 95% CI ($n = 4$ for invasives and $n = 16$ for natives). Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Mixed model regression results

Table S3 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the mean value of site variables in newly colonized plots (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area (cm ² / m ²)	16.6 *** (2.03)	-1.54 (2.91)	0.158 *** (0.00184)	0.152 (0.150)	2324.7	4263.3
Distance to individual (m)	18.4 *** (4.75)	-6.99 (7.68)	0.059 (0.0787)	0.00790 (0.307)	233.3	164.6
Distance to edge (m) ^c	119.4 *** (8.19)	-49.3 *** (4.87)	0.222 (0.171)	0.305 (0.427)	676.6	301.3
Richness ^c	10.4 *** (0.53)	2.59 *** (0.474)	-0.0451 *** (0.0112)	0.0212 (0.0137)	2.17	2.19
Canopy Openness (%) ^{bc}	8.89 *** (0.573)	0.669 (3.32)	-7.91 *** (1.23)	-0.406 (0.360)	0.0600	0.0319
Nitrate (ppm) ^b	2.41 *** (0.214)	0.972 * (0.379)	1.86 *** (0.179)	0.0182 (0.0791)	0.302	0.112
Calcium (ppm) ^b	155.4 *** (28.3)	76.0 (48.3)	-80.1 * (32.0)	7.83 (10.3)	2744.0	4154.0

^a A dummy variable with 1 = invasive and 0 = native

^b Variable only measured in 2012 and 2022

^c Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix.

Table S4 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the proportion of newly colonized plots in each of three age classes (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Models were binomial generalized linear mixed models and species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time	Origin × Time	Species	Residual
Open ^b	-0.283 *** (0.076)	5.09 *** (1.31)	-0.018 ** (0.00609)	-0.0463 (0.0237)	0.0764	0.0264
Transition ^b	-0.859 *** (0.0456)	-2.69 * (0.873)	-0.00178 (0.000912)	0.00575 (0.00326)	0.0132	0.0213
Forest ^b	-1.55 *** (0.385)	-2.77 ** (1.06)	0.0302 *** (0.00863)	0.0130 (0.0118)	0.0336	0.0245

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

Table S5 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the coefficient of variation of site variables in newly colonized plots (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Coefficients of variation were log-transformed to meet assumptions of normality and species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin $\times$ Time	Species	Residual
Basal Area	-0.360 *** (0.0100)	0.0464386 (0.140)	-0.000331 (0.00203)	0.00783 (0.00744)	0.054	0.116
Distance to individual	0.588 (0.310)	0.275 (0.467)	0.00160 (0.00597)	0.0175 (0.0226)	0.675	0.983
Distance to edge ^c	-0.601 *** (0.0748)	0.456 *** (0.0516)	-0.00225 (0.00151)	-0.00436 (0.00375)	0.063	0.023
Richness	-0.938 *** (0.0642)	-0.231 * (0.0843)	0.00133 (0.00139)	-0.000977 (0.00499)	0.015	0.056
Canopy Openness ^b	-0.471 *** (0.100)	-0.0378 (0.169)	0.430 ** (0.123)	0.0000139 (0.00156)	0.020	0.065
Nitrate ^{bc}	-0.57565 ** (0.171)	-0.855 (0.444)	-1.02 ** (0.336)	0.0469 (0.0855)	0.358	0.134
Calcium ^b	-0.1486 (0.174)	-0.5051 (0.308)	-0.139 (0.142)	-0.0340 (0.0638)	0.204	0.070

^a A dummy variable with 1 = invasive and 0 = native

^b Variable only measured in 2012 and 2022

^c Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix.

Table S6 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on effect size of site variables (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area ^c	-0.369 *** (0.0987)	-0.0514 (0.134)	0.00187 (0.00204)	0.0138 (0.00728)	0.0229	0.149
Open vs. Forest	0.226 * (0.087)	0.738 * (0.293)	0.000536 (0.00155)	-0.00937 (0.00580)	0.0588	0.0557
Transition vs. Forest	0.0756 * (0.0183)	-0.0818 (0.0689)	0.000775 (0.000437)	0.000976 (0.00147)	0.0426	0.0231
Open vs. Transition	0.154 * (0.0633)	0.427 * (0.208)	0.00127 (0.00106)	-0.00247 (0.00403)	0.0363	0.0265
Distance to individual	-0.622 *** (0.116)	0.195 (0.426)	-0.000272 (0.00256)	-0.00998 (0.00913)	0.0434	0.175
Distance to edge	-0.420 ** (0.139)	-0.232 (0.236)	-0.000197 (0.00203)	-0.0159 (0.0102)	0.239	0.108
Richness ^c	0.246 * (0.116)	0.387 * (0.159)	0.00456 (0.00240)	0.0135 (0.00866)	0.0711	0.159
Canopy openness ^b	0.0811 (0.291)	0.0941 (0.279)	-0.0497 * (0.0225)	-0.0641 (0.0605)	0.101	0.144
Nitrate ^b	0.292 (1.88)	1.23 ** (0.344)	-0.00202 (0.0288)	-0.0757 (0.0726)	0.211	0.112
Calcium ^b	0.511 (2.16)	0.372 (0.412)	-0.00132 (0.0331)	0.0436 (0.0877)	0.319	0.187

^a A dummy variable with 1 = invasive and 0 = native

^b Variable only measured in 2012 and 2022

^c Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix.

Table S7 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the relative weight of site variables (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Models were binomial generalized linear mixed models and species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area	-2.36 *** (0.270)	1.75 (0.946)	-0.0110 (0.00628)	-0.0332 (0.0207)	0.0893	1.09
Open ^b	-1.30 *** (0.333)	1.01 *** (0.311)	0.00201 (0.00607)	0.0165 (0.0233)	0.791	0.937
Transition	-1.42 *** (0.335)	-0.231 (0.463)	-0.0185 ** (0.00698)	-0.000194 (0.0262)	0.408	1.40
Distance to individual ^b	-1.92 *** (0.310)	0.00359 (1.19)	-0.00324 (0.00745)	-0.000732 (0.0256)	0.143	1.53
Distance to edge	-2.30 *** (0.270)	1.23 (0.944)	-0.00623 (0.00614)	-0.0145 (0.0206)	0.161	1.02
Richness	-2.54 *** (0.281)	-0.104 (0.303)	0.0161 * (0.00634)	-0.00357 (0.0217)	0.00758	1.26

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

Table S8 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on standardized coefficient estimates for site variables used to predict colonization ($*P < 0.05$, $**P < 0.01$, $***P < 0.001$). Species were included as random effects in each mixed model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin $\times$ Time	Species	Residual
Basal Area ^b	-0.449 (0.494)	-1.87 (1.19)	0.0109 (0.0126)	0.166 (0.112)	0	4.27
Open ^b	3.78 *** (0.991)	2.67 * (1.11)	-0.0374 (0.0227)	-0.0294 (0.0672)	12.1	6.85
Transition ^b	0.965 * (0.416)	-0.235 (0.501)	-0.0175 ** (0.00982)	-0.00651 (0.0348)	0	3.02
Distance to individual	-1.67 *** (0.428)	-1.04 (1.57)	0.0159 (0.00926)	0.0190 (0.0335)	0.727	2.26
Distance to edge ^b	0.109 (0.628)	-0.957 (1.02)	-0.00890 (0.00949)	-0.0284 (0.0372)	4.32	2.37
Richness ^b	0.495 (1.83)	1.04 (1.57)	0.0154 ** (0.00978)	-0.0381 (0.0317)	1.51	1.94

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

Table S9 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the relative weight of predictors in 2012 and 2022 (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Models were binomial generalized mixed models and species were included as random effects in each model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area	-4.86 (3.25)	-0.444 (0.688)	0.0284 (0.0497)	0.0396 (0.152)	0.348	1.07
Open	1.06 (3.22)	1.72 ** (0.711)	-0.0453 (0.0492)	-0.193 (0.148)	0.386	1.04
Transition	0.394 (3.35)	-0.692 (0.726)	-0.0524 (0.0512)	0.0656 (0.159)	0.460	1.11
Distance to individual	-0.803 (0.584)	-0.0266 (0.666)	0.0346 (0.0536)	0.121 (0.148)	0	1.39
Distance to edge	-3.33 (2.99)	0.639 (0.570)	0.00287 (0.0459)	0.00347 (0.130)	0.00	1.00
Richness	-0.576 ** (0.138)	0.0573 (0.672)	0.110 (0.0536)	0.0127 (0.141)	1.06	0.342
Canopy Openness	-8.45 * (3.83)	-0.454 (0.814)	0.0875 (0.0586)	0.216 (0.171)	0.497	1.48
Nitrate	-3.30 (4.00)	-0.285 (0.762)	0.00725 (0.0613)	0.0386 (0.173)	0	1.89
Calcium	-3.36 (1.59)	-0.774 (0.646)	-0.0537 (0.0489)	0.235 (0.117)	0.801	0.178

^a A dummy variable with 1 = invasive and 0 = native

Table S10 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on standardized coefficient estimates for site variables used to predict colonization in 2012 and 2022 (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each mixed model.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area	-1.71 (3.43)	1.43 (8.35)	-0.0304 (0.0526)	-0.0368 (0.132)	0.00	1.11
Open	2.34 (1.82)	1.84 * (0.671)	-0.0556 (0.0652)	-0.147 (0.288)	4.36	1.50
Transition	-1.48 (2.79)	-0.230 (0.556)	-0.0240 (0.0428)	-0.0724 (0.123)	0.145	0.834
Distance to individual	-1.40 (3.09)	-0.181 (0.590)	-0.0317 (0.0475)	-0.221 (0.122)	0	0.943
Distance to edge	-1.11 (2.30)	-0.278 (0.473)	0.0171 (0.0352)	-0.00836 (0.105)	0.129	0.585
Richness	0.00829 (0.414)	-0.168 (0.377)	0.138 * (0.0514)	-0.0203 (0.129)	0.00	1.06
Canopy Openness ^b	-0.53707 (4.22)	0.154 (0.804)	-0.163 * (0.0647)	0.0110 (0.183)	0.00	2.11
Nitrate	0.0555 (1.63)	0.944 ** (0.433)	-0.0483 (0.0492)	-0.00651 (0.0348)	0.00	3.06
Calcium	-1.48 (4.25)	-0.0569 (1.06)	0.0223 (0.0649)	0.245 (0.219)	1.64	1.61

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

Results of analysis without spatial correction

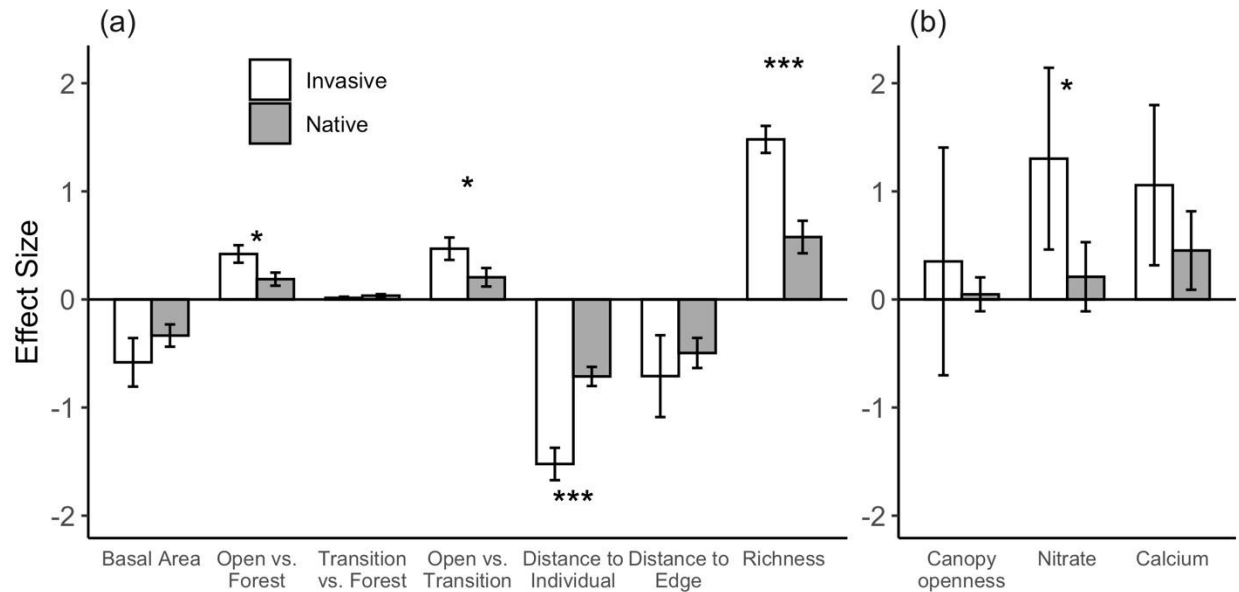


Fig. S5 Effect sizes without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot. Variables were either (a) measured from 1962 to 2022 ($n = 18$ for invasives, $n = 72$ for natives) or (b) measured only in 2012 and 2022 ($n = 4$ for invasives, $n = 16$ for natives). Bars show means of the effect sizes of all species year combinations $\pm$ 95% CI. For the three age class comparisons (Open vs Forest, Transition vs Forest, and Open vs Transition), effect size is the log odds ratio where a larger odds ratio indicates greater odds of colonization for plots in the younger of the two age classes. Effect size for all other variables is Hedges' g . Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table S11 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on effect size of site variables (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each model. Effect sizes were calculated without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal Area ^c	-0.414 ** (0.119)	0.00151 (0.00263)	-0.0000705 (0.00217)	0.0138 (0.0178)	0.121	0.118
Open vs. Forest	0.209 *** (0.0578)	0.253 * (0.0958)	-0.00114 (0.000898)	-0.00108 (0.00355)	0.0380	0.0212
Transition vs. Forest	0.020 (0.0132)	-0.0218 (0.0159)	0.000368 (0.000302)	-0.000520 (0.00105)	0.000252	0.00277
Open vs. Transition	0.210 * (0.0819)	0.281 * (0.124)	-0.000642 (0.00153)	-0.00315 (0.00579)	0.0524	0.0638
Distance to individual	-0.754 *** (0.101)	-0.804 *** (0.173)	0.000212 (0.00143)	-0.00550 (0.00571)	0.130	0.0529
Distance to edge ^c	-0.431 ** (0.143)	-0.595 (0.425)	0.000736 (0.00172)	0.00416 (0.00699)	0.296	0.0763
Richness	0.391** (0.140)	0.901 *** (0.227)	0.00441 (0.00230)	0.00459 (0.00899)	0.205	0.141
Canopy Openness ^{bc}	-0.364 *** (0.106)	0.192 (0.298)	-0.0451 * (0.0155)	-0.0741 (0.0594)	0.171	0.0858
Nitrate ^b	0.428 (1.28)	1.17 * (0.419)	-0.00478 (0.0194)	-0.0354 (0.0871)	0.376	0.129
Calcium ^b	1.07 (1.41)	0.682 (0.447)	-0.0112 (0.0214)	0.0518 (0.0928)	0.419	0.160

^a A dummy variable with 1 = invasive and 0 = native

^b Variable only measured in 2012 and 2022

^c Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

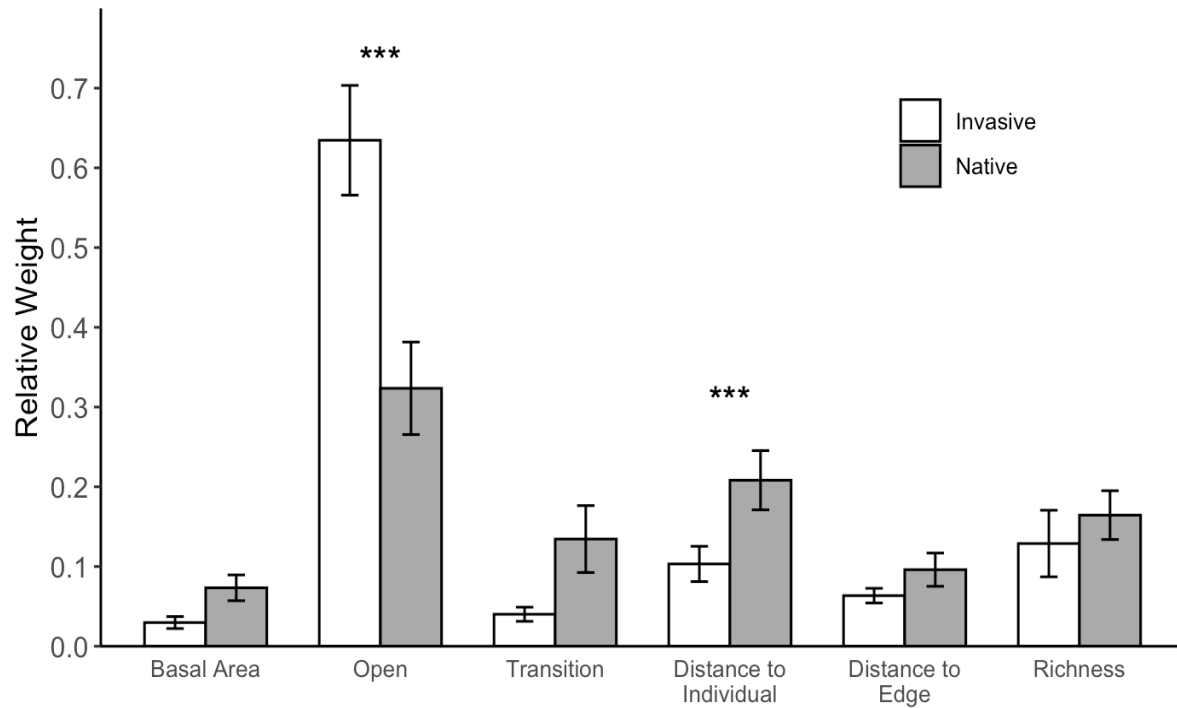


Fig. S6 Relative weights calculated without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot. Relative weights are from models for each species in each year that it was spreading using six variables to predict the likelihood of a plot being colonized or not. Bars show means $\pm$ 95% CI ($n = 17$ for invasives and $n = 72$ for natives). Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table S12 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the relative weight of site variables (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each model. Models were run without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot.

Variable	Estimate (SE)				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal area	-2.64 *** (0.240)	-0.207 (0.841)	-0.00833 (0.00556)	-0.00859 (0.0184)	0.0826	0.854
Open ^b	-1.16 *** (0.314)	1.63 *** (0.351)	0.00311 (0.00741)	0.00296 (0.0205)	1.14	0.729
Transition	-2.00 *** (0.336)	-0.788 (1.16)	-0.0170 * (0.00720)	0.00555 (0.0249)	0.481	1.36
Distance to individual ^b	-2.10 *** (0.333)	-1.95 *** (0.564)	-0.000269 (0.00749)	-0.00154 (0.0270)	0.0913	1.56
Distance to edge	-2.40 *** (0.218)	0.177 (0.761)	-0.00440 (0.00492)	-0.00684 (0.0166)	0.118	0.654
Richness	-2.57 *** (0.261)	-0.409 (0.914)	0.0150 * (0.00604)	0.00327 (0.0200)	0.0981	1.01

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

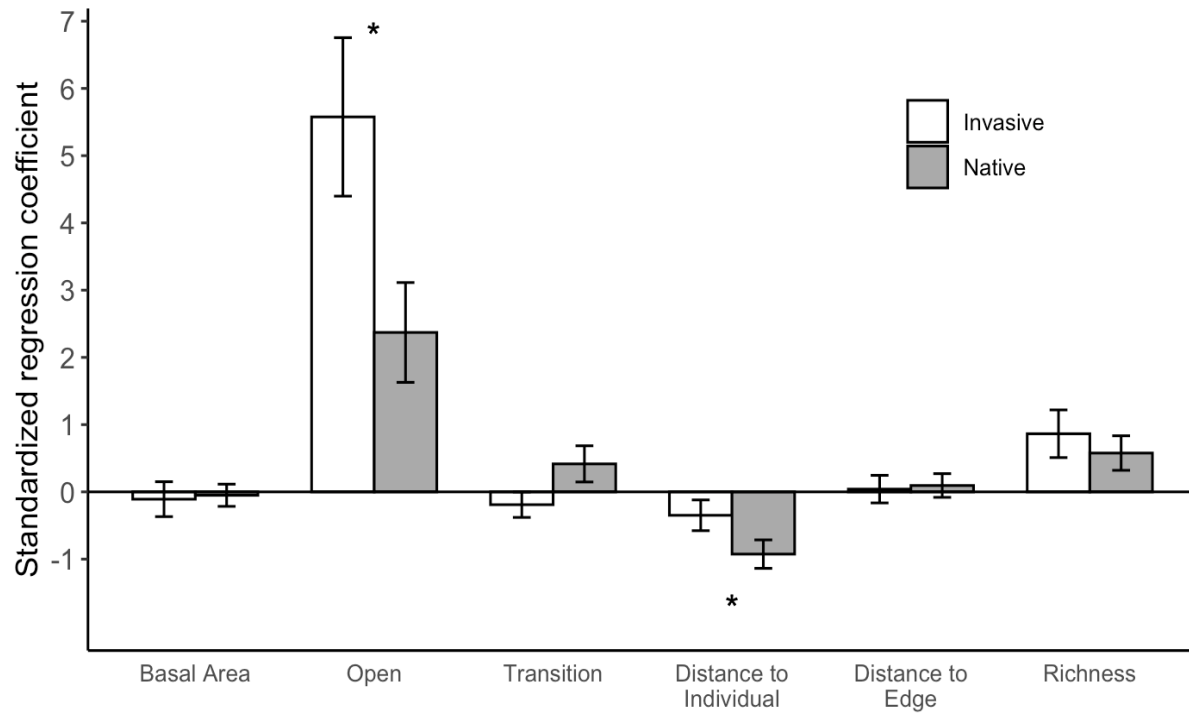


Fig. S7 Standardized regression coefficients without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot. Coefficients are from models for each species in each year that it was spreading using six variables to predict the likelihood of a plot being colonized or not. Bars show means $\pm$ 95% CI ($n = 18$ for invasives and $n = 72$ for natives). Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table S13 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the standardized regression coefficient of site variables used to predict colonization (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each mixed model. Models were run without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot.

Variable	Fixed Effects				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal area ^b	0.0501 (0.167)	0.0491 (0.224)	-0.00412 (0.00354)	0.000789 (0.0128)	0.116	0.361
Open ^b	2.00 * (0.745)	3.10 * (1.25)	0.00865 (0.0113)	-0.0155 (0.0447)	6.55	3.33
Transition	1.01 *** (0.245)	-0.471 (0.292)	-0.0170 ** (0.00563)	0.0183 (0.0195)	0.0759	0.968
Distance to individual	-0.769 *** (0.188)	1.05 * (0.523)	-0.00138 (0.00436)	0.00730 (0.0151)	0.0316	0.587
Distance edge ^b	0.335 (0.170)	0.0140 (0.206)	-0.00669 (0.00387)	0.00124 (0.0135)	0.0464	0.453
Richness	-0.150 (0.245)	0.284 (0.317)	0.0175 ** (0.00534)	-0.0114 (0.0191)	0.193	0.836

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

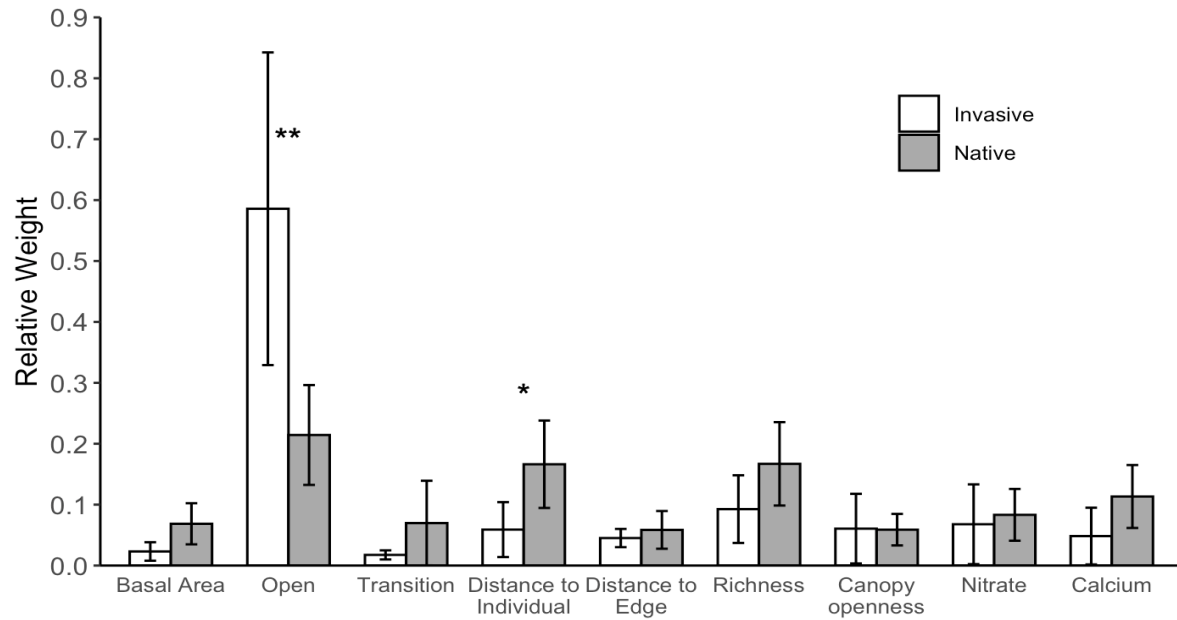


Fig. S8 Relative weights using data from 2012 and 2022 without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot. Relative weights are from models for each species in each year that it was spreading using nine variables to predict the likelihood of a plot being colonized or not. Bars show means $\pm$ 95% CI ($n = 4$ for invasives and $n = 16$ for natives). Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table S14 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the relative weight of site variables in 2012 and 2022 (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each model. Models were run without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot.

Variable	Fixed Effects				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal area	-5.88 (3.08)	-0.738 (0.674)	0.0427 (0.0471)	0.0701 (0.147)	0.419	0.933
Open	-0.110 (3.27)	1.93 ** (0.656)	-0.0237 (0.0501)	-0.187 (0.137)	0.268	0.949
Transition	-1.17 (3.74)	-0.742 (0.789)	-0.0349 (0.0572)	0.000505 (0.174)	0.448	1.416
Distance to individual	0.0662 (0.327)	-0.0341 * (0.0623)	0.000729 (0.00501)	0.0125 (0.0138)	0	0.0119
Distance to edge	-4.38 (2.51)	0.0894 (0.478)	0.0191 (0.0384)	0.0276 (0.108)	0	0.701
Richness	-7.38 * (2.73)	-0.0714 (0.715)	0.0796 (0.0416)	0.0358 (0.152)	0.842	0.651
Canopy openness	-8.71 * (3.78)	-0.204 (0.726)	0.0842 (0.058)	0.241 (0.153)	0.0301	1.59
Nitrate	-4.13 (3.77)	-0.546 (0.718)	0.0203 (0.0578)	0.0797 (0.162)	0	1.59
Calcium	1.48 (2.30)	-0.927 (0.632)	-0.0619 (0.0351)	0.256 (0.121)	0.706	0.454

^a A dummy variable with 1 = invasive and 0 = native

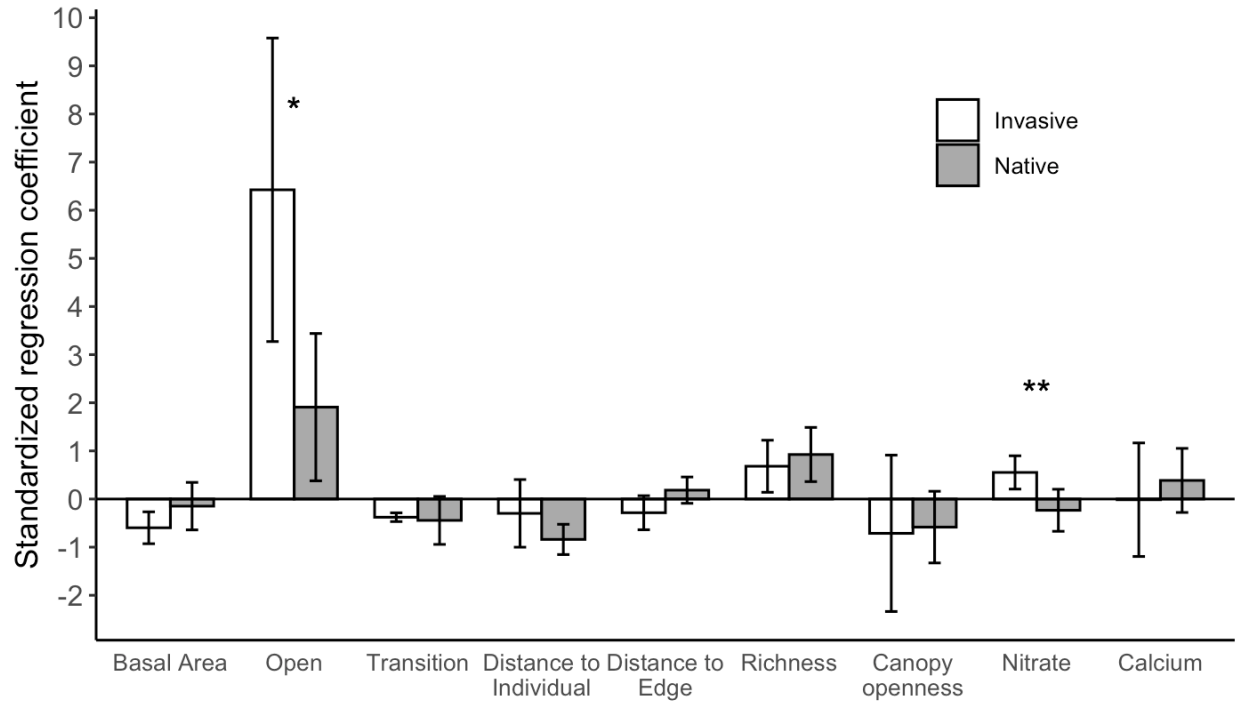


Fig. S9 Standardized regression coefficients from models using data from 2012 to 2022 without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot. Coefficients are from models for each species in each year that it was spreading using six variables to predict the likelihood of a plot being colonized or not. Bars show means $\pm$ 95% CI ($n = 4$ for invasives and $n = 16$ for natives). Asterisks indicate that mixed regression models showed a significant difference between native and invasive species (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table S15 Mixed model regression results testing the effect of species origin, time since the beginning of the study, and the interaction between origin and time on the standardized regression coefficient of site variables used to predict colonization in 2012 and 2022 (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). Species were included as random effects in each mixed model. Models were run without removing uncolonized plots that were farther from plots where a species was present in the previous survey than the farthest newly colonized plot.

Variable	Fixed Effects				Random Effects Variance	
	Intercept	Origin ^a	Time (yrs)	Origin × Time	Species	Residual
Basal area	2.71 (2.33)	-0.642 (0.445)	-0.0439 (0.0357)	-0.021	0.003	0.603
Open	9.88 (8.15)	4.37 * (1.83)	-0.125 (0.125)	0.034	3.518	6.417
Transition	0.133 (2.84)	0.118 (0.542)	-0.00482 (0.0436)	-0.066	0.000	0.904
Distance to individual	-1.37 (2.19)	0.582 (0.412)	0.00824 (0.0336)	-0.137	0.000	0.453
Distance to edge	-0.314 (1.86)	-0.0716 (0.355)	0.00363 (0.0286)	-0.048	0.000	0.388
Richness	-5.82 (3.20)	0.274 (0.602)	0.104 (0.0491)	-0.017	0.000	0.966
Canopy openness ^b	8.66 * (3.250)	-0.965 (0.883)	-0.140 * (0.0495)	-0.182	1.297	0.831
Nitrate	-2.09 (3.02)	0.929 ** (0.298)	0.0285 (0.0487)	-0.056	0.000	0.704
Calcium	1.07 (2.91)	-0.402 (0.799)	-0.0114 (0.0443)	0.238	1.081	0.664

^a A dummy variable with 1 = invasive and 0 = native

^b Breusch-Pagan test indicated significant heteroscedasticity in the model and SE and significance values reported are from Wald tests with a heteroscedasticity-consistent covariance matrix

Differences between age classes

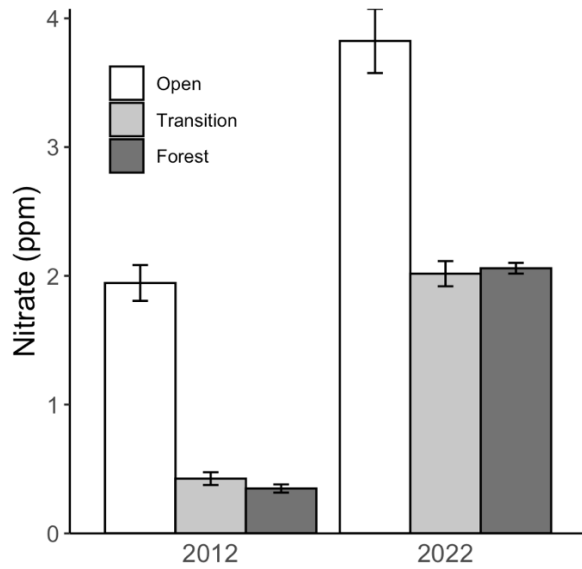


Fig. S10 Soil nitrate in plots with different initial vegetation cover. Bars show means $\pm$ SE. n = 86 for open, n = 180 for transition, n = 484 for forest.

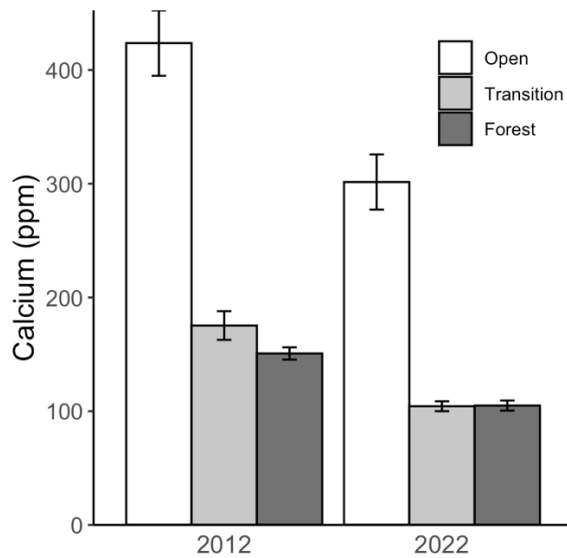


Fig. S11 Soil calcium in plots with different initial vegetation cover. Bars show means $\pm$ SE. n = 86 for open, n = 180 for transition, n = 484 for forest.

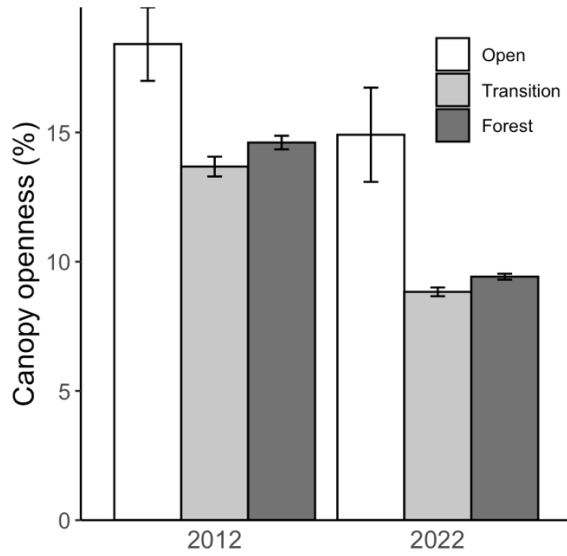


Fig. S12 Canopy openness in plots with different initial vegetation cover. Bars show means $\pm$ SE. $n = 86$ for open, $n = 180$ for transition, $n = 484$ for forest.

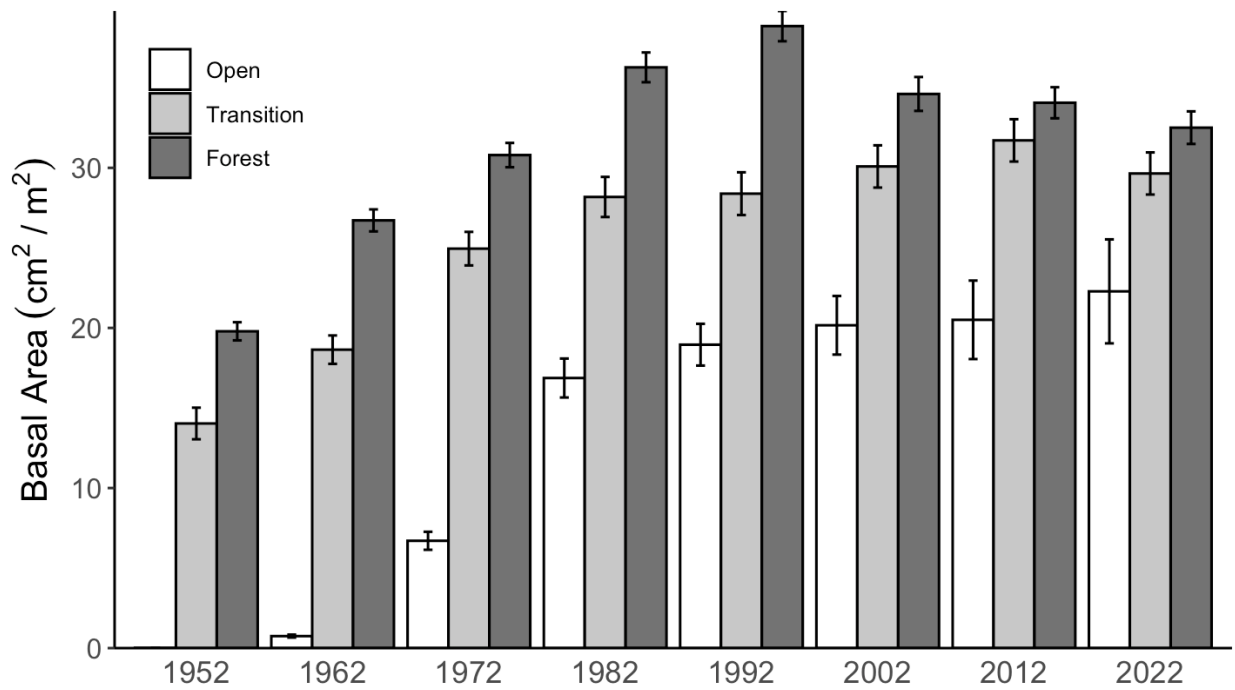


Fig. S13 Basal area in plots with different initial vegetation cover. Bars show means $\pm$ SE. $n = 86$ for open, $n = 180$ for transition, $n = 484$ for forest.

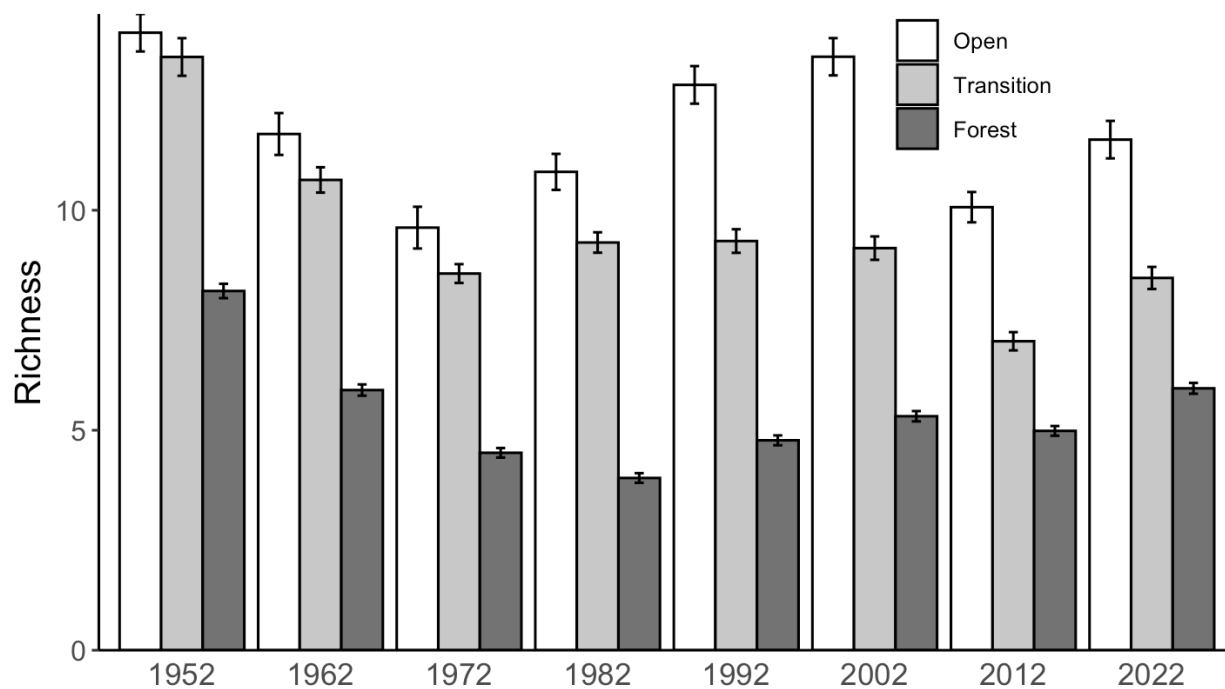


Fig. S14 Species richness in plots with different initial vegetation cover. Bars show means $\pm$ SE. $n = 86$ for open, $n = 180$ for transition, $n = 484$ for forest.

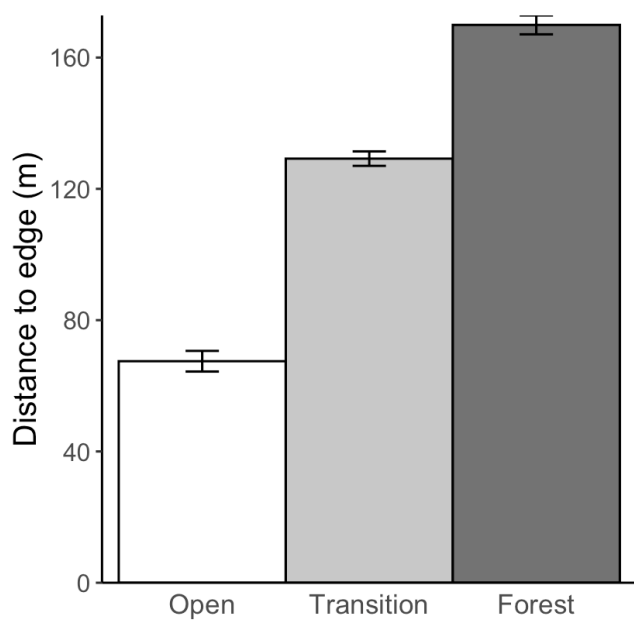


Fig. S15 Distance to the edge of the natural area in plots with different initial vegetation cover. Bars show means $\pm$ SE. $n = 86$ for open, $n = 180$ for transition, $n = 484$ for forest.