

Supplementary Information for

Non-native plants erode the stabilizing effects of biodiversity

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Table S1 | List of 7 plant traits in this study

Trait name	Abbreviation	Trait dimension	Unit
Specific leaf area	SLA	Economic trait	m ² kg ⁻¹
Plant height	Height	Size trait	m
Diaspore mass	Diaspore mass	Size trait	mg
Leaf area	Leaf area	Size trait	mm ²
Stem specific density	SSD	Economic trait	g cm ⁻³
Leaf nitrogen concentration	Leaf N	Economic trait	mg g ⁻¹
Leaf dry matter content	LDMC	Economic trait	g g ⁻¹

Table S2 | Site information for NEON communities included in this study. siteID indicates the NEON site identifier. latitude and longitude indicate site coordinates in decimal degrees, and elevation_m indicates site elevation in metres above sea level. Temperature is mean annual temperature in °C, and Precipitation is mean annual precipitation in mm yr⁻¹, both calculated for 2001–2024. Years denotes the observation duration used to estimate temporal stability. Quadrats and Plots denote the numbers of quadrats and plots retained for analysis at each site, respectively.

siteID	latitude	longitude	elevation_m	Temperature	Precipitation	Years	Quadrats	Plots
ABBY	45.759	-122.34	471.498	10.17	1854.08	6	208	33
BARR	71.265	-156.532	5.379	-9.99	176.66	6	196	33
BART	44.054	-71.292	430.439	6.28	1274.15	8	264	33
BLAN	39.083	-77.979	142.585	13.31	1094.51	7	190	24
BONA	65.172	-147.511	431.298	-3.44	286.57	6	196	33
CLBJ	33.384	-97.604	299.391	18.52	855.68	4	248	33
CPER	40.823	-104.725	1640.006	9.19	386.68	9	264	33
DCFS	47.181	-99.126	561.288	5.08	508.42	6	198	33
DEJU	63.882	-145.751	511.643	-2.76	262.70	6	258	33
DELA	32.534	-87.811	25.658	18.63	1445.15	7	275	36
DSNY	28.08	-81.412	19.292	23.32	1512.82	7	262	33
GRSM	35.668	-83.492	841.333	13.47	1521.80	7	261	33
GUAN	17.968	-66.863	116.41	25.78	1591.79	7	211	27
HARV	42.457	-72.237	220.676	9.31	1270.11	8	264	33
HEAL	63.878	-149.25	661.967	-3.26	381.26	7	260	33
JERC	31.192	-84.465	41.974	19.58	1468.27	6	264	33
JORN	32.605	-106.833	1325.343	15.98	250.11	6	260	33
KONA	39.162	-96.619	330.467	13.29	876.39	6	198	33
KONZ	39.096	-96.571	390.908	13.27	881.35	6	261	33
LAJA	18.029	-67.075	21.098	25.81	1731.99	6	250	33
LENO	31.822	-88.185	12.985	19.07	1508.60	6	260	33
MLBS	37.393	-80.533	1052.602	11.91	1275.63	6	156	26
MOAB	38.247	-109.388	1836.561	10.24	342.84	5	229	33
NIWO	40.048	-105.568	3332.265	3.47	471.97	8	246	33
NOGP	46.788	-100.914	558.356	6.02	437.46	6	256	33
OAES	35.411	-99.061	511.315	15.93	680.62	6	261	33
ONAQ	40.18	-112.482	1749.292	9.99	387.61	6	262	33
ORNL	35.952	-84.28	283.326	14.86	1433.28	7	267	34
OSBS	29.695	-81.977	32.094	21.50	1395.69	7	238	32
PUUM	19.571	-155.311	1619.781	20.17	1805.61	5	137	23
RMNP	40.19	-105.513	2738.774	4.28	464.37	7	189	33
SCBI	38.888	-78.151	351.409	13.25	1089.42	7	256	32
SERC	38.883	-76.546	11.276	14.32	1178.93	7	264	33

SJER	37.104	-119.734	388.336	16.55	537.91	6	204	33
SOAP	37.033	-119.264	1208.427	13.44	650.30	4	182	32
SRER	31.854	-110.862	1066.936	18.21	361.14	7	263	33
STEI	45.784	-90.034	500.084	5.33	879.97	6	263	33
STER	40.469	-103.024	1360.61	10.51	435.71	8	80	10
TALL	32.927	-87.417	114.042	18.29	1431.63	8	264	33
TEAK	37.003	-119.028	2244.595	11.04	588.58	4	91	22
TOOL	68.614	-149.493	817.964	-9.25	203.93	6	198	33
TREE	45.491	-89.566	459.297	5.58	872.21	6	232	29
UKFS	39.044	-95.198	310.386	13.68	1000.38	5	258	33
UNDE	46.237	-89.526	514.848	4.73	888.50	7	264	33
WOOD	47.138	-99.244	586.039	5.03	509.09	7	264	33
WREF	45.833	-121.965	577.904	8.99	1942.65	5	193	33
YELL	44.947	-110.539	2057.767	2.55	506.15	4	108	18

Table S3 | Site-level information for NutNet communities included in the analyses. site_code indicates the site identifier. Country indicates the country where each site is located. latitude and longitude indicate site coordinates in decimal degrees. Temperature is mean annual temperature in °C, and Precipitation is mean annual precipitation in mm yr⁻¹, both calculated for 2001–2024. Years denotes the observation duration used to estimate temporal stability, and N denotes the number of local communities retained at each site.

site_code	Country	latitude	longitude	Temperature	Precipitation	Years	N
chilcas.ar	Argentina	-36.276	-58.266	15.81	961.95	12	3
marc.ar	Argentina	-37.715	-57.425	14.74	892.83	8	7
potrok.ar	Argentina	-51.916	-70.407	7.41	290.99	10	3
bogong.au	Australia	-36.874	147.254	11.52	1171.37	17	3
burrawan.au	Australia	-27.736	151.139	19.42	626.91	12	3
ethamc.au	Australia	-23.756	138.474	24.51	206.41	6	3
ethass.au	Australia	-23.639	138.399	24.49	212.24	7	3
kidman.au	Australia	-16.108	130.953	27.34	825.39	7	3
kiny.au	Australia	-36.2	143.75	16.02	396.22	13	3
mtca.au	Australia	-31.782	117.611	18.05	303.58	16	4
nilla.au	Australia	-36.896	146.007	14.24	911.98	9	3
ping.au	Australia	-32.496	116.973	16.93	435.22	9	3
pinj.au	Australia	-27.531	152.923	20.14	1051.24	5	3
yarra.au	Australia	-33.614	150.738	17.50	945.91	11	4
lagoas.br	Brazil	-20.983	-51.799	25.34	1219.48	8	3
cowi.ca	Canada	48.809	-123.63	9.36	1503.10	18	3
koffler.ca	Canada	44.024	-79.536	7.88	908.40	14	9
azi.cn	China	33.67	101.87	0.24	714.84	5	3
azitwo.cn	China	33.58	101.53	-0.96	720.31	5	5
kilp.fi	Finland	69.057	20.875	-2.42	576.13	10	4
saana.fi	Finland	69.037	20.843	-2.40	571.08	10	4
cereep.fr	France	48.28	2.66	12.44	632.45	11	3
badlau.de	Germany	51.392	11.878	10.11	542.09	10	3
bayr.de	Germany	49.917	11.583	8.93	685.51	9	4
jena.de	Germany	50.938	11.528	9.35	622.82	11	3
pape.de	Germany	53.086	7.473	10.45	791.33	7	1
ahth.is	Iceland	65.133	-19.672	1.31	914.51	4	3
amlr.is	Iceland	65.133	-19.672	1.31	914.51	4	3
thth.is	Iceland	65.901	-17.089	2.25	707.15	4	3
tmlr.is	Iceland	65.901	-17.089	2.25	707.15	4	3
kibber.in	India	32.32	78.01	-2.67	412.10	8	3
burren.ie	Ireland	53.072	-8.993	10.19	1187.51	6	3
neba.jp	Japan	35.232	137.662	12.74	1756.27	5	7

hustai.mn	Mongolia	47.667	105.968	0.49	300.13	3	4
veluwe.nl	Netherlands	52.027	5.808	10.84	807.29	7	5
sval.no	Norway	78.69	16.447	-6.14	275.80	5	6
vargrass.no	Norway	70.328	29.54	0.79	652.51	3	9
varheath.no	Norway	70.328	29.54	0.79	652.51	3	9
comp.pt	Portugal	38.829	-8.791	18.00	692.99	10	3
drake.za	South Africa	-28.961	29.268	13.80	811.26	6	6
gilb.za	South Africa	-29.284	30.292	16.85	867.12	5	3
summ.za	South Africa	-29.812	30.716	19.62	955.09	4	6
ukul.za	South Africa	-29.67	30.401	17.89	897.17	15	6
frue.ch	Switzerland	47.114	8.541	8.25	1262.29	8	3
valm.ch	Switzerland	46.631	10.372	2.44	1142.38	15	3
ains_dn.uk	United Kingdom	53.59	-3.07	10.25	954.18	4	6
hero.uk	United Kingdom	51.411	-0.639	10.84	764.35	12	3
lancaster.uk	United Kingdom	53.986	-2.628	9.30	1514.79	10	3
rook.uk	United Kingdom	51.406	-0.644	10.84	765.22	8	3
sereng.tz	Tanzania	-2.429	34.857	21.04	869.29	5	3
arch.us	US	27.17	-81.218	23.49	1482.40	10	3
barta.us	US	42.245	-99.652	9.10	642.59	4	3
bldr.us	US	39.972	-105.234	7.74	443.38	9	2
bnbt.us	US	39.597	-95.086	13.00	948.39	8	3
bnch.us	US	44.277	-121.968	7.27	1396.45	17	3
cbgb.us	US	41.785	-93.385	10.25	902.69	16	6
cdcr.us	US	45.425	-93.212	6.91	783.47	18	5
cdpt.us	US	41.206	-101.643	10.20	501.12	17	6
cedr.us	US	45.404	-93.201	6.96	784.09	7	3
chur_dn.us	US	47.179	-88.615	5.79	899.64	3	4
doane.us	US	40.695	-96.854	11.54	740.13	7	6
elliott.us	US	32.875	-117.052	17.19	298.55	15	3
glcr.us	US	41.339	-96.14	10.71	779.60	3	3
hall.us	US	36.872	-86.702	14.96	1382.27	8	3
hart.us	US	42.724	-119.498	8.49	267.88	6	3
hnvr.us	US	43.699	-72.23	7.18	1159.36	4	3
hopl.us	US	39.013	-123.06	13.36	1072.80	15	3
kbs.us	US	42.409	-85.391	10.06	980.63	9	5
konz.us	US	39.071	-96.583	13.29	881.99	16	3
lake.us	US	43.385	-95.181	7.99	780.41	5	3
look.us	US	44.205	-122.128	7.83	1507.65	17	3
lubb.us	US	33.6	-101.898	16.52	456.52	7	3
medan.us	US	39.528	-77.041	12.79	1167.31	6	6
mcla.us	US	38.864	-122.406	14.79	833.34	15	3

moab.us	US	38.782	-109.652	11.70	249.62	4	3
msla.us	US	46.665	-114.001	6.32	379.50	8	5
msla_2.us	US	46.665	-114.001	6.32	379.55	8	5
msla_3.us	US	46.665	-114.002	6.32	379.57	8	5
msum.us	US	46.87	-96.454	5.97	623.81	7	6
sage.us	US	39.43	-120.24	8.00	822.62	7	3
saline.us	US	39.05	-99.1	12.77	627.98	10	3
sandhill.us	US	34.957	-79.518	16.79	1229.26	5	3
sava.us	US	33.344	-81.651	18.56	1170.35	6	2
sedg.us	US	34.7	-120.017	14.21	414.15	11	6
sevi.us	US	34.359	-106.69	13.55	242.65	16	5
sgs.us	US	40.817	-104.767	9.14	386.48	15	3
shps.us	US	44.257	-112.205	5.50	383.69	17	4
sier.us	US	39.236	-121.284	16.02	960.33	15	5
smith.us	US	48.207	-122.625	10.65	780.77	14	3
spin.us	US	38.132	-84.503	13.55	1294.43	18	3
temple.us	US	31.044	-97.349	20.16	849.56	13	4
trel.us	US	40.075	-88.829	12.02	1059.28	10	3
tyso.us	US	38.519	-90.565	13.90	1063.42	3	4
unc.us	US	36.008	-79.02	15.61	1191.15	5	3
wupatki.us	US	35.584	-111.513	11.35	316.03	3	3

Table S4 | Sensitivity of invasion-mediated weakening of species richness–stability relationships to minimum observation length.

Dataset	min_years	Invasion status	n_obs	n_site	n_plot	Estimate interaction	Std error	<i>P</i> value	Direction
NEON	3	Binary	10713	47	1467	-0.11	0.02	<0.001	Weakening
NEON	4	Binary	9774	47	1428	-0.10	0.02	<0.001	Weakening
NEON	5	Binary	8313	47	1324	-0.11	0.03	<0.001	Weakening
NEON	6	Binary	6717	45	1133	-0.12	0.03	<0.001	Weakening
NEON	7	Binary	5319	42	918	-0.10	0.03	0.002	Weakening
NEON	8	Binary	3704	34	639	-0.10	0.04	0.005	Weakening
NEON	3	Continuous	10705	47	1467	-0.06	0.02	<0.001	Weakening
NEON	4	Continuous	9774	47	1428	-0.05	0.02	<0.001	Weakening
NEON	5	Continuous	8313	47	1324	-0.04	0.02	0.017	Weakening
NEON	6	Continuous	6717	45	1133	-0.04	0.02	0.048	Weakening
NEON	7	Continuous	5319	42	918	-0.02	0.02	0.326	Weakening
NEON	8	Continuous	3704	34	639	-0.03	0.02	0.206	Weakening
NutNet	3	Binary	368	95	NA	-0.33	0.13	0.014	Weakening
NutNet	4	Binary	332	89	NA	-0.16	0.14	0.244	Weakening
NutNet	5	Binary	293	79	NA	0.01	0.14	0.966	None
NutNet	6	Binary	252	69	NA	-0.05	0.15	0.737	Weakening
NutNet	7	Binary	229	64	NA	-0.08	0.16	0.593	Weakening
NutNet	8	Binary	202	55	NA	-0.12	0.18	0.514	Weakening
NutNet	3	Continuous	368	95	NA	-0.20	0.07	0.003	Weakening
NutNet	4	Continuous	332	89	NA	-0.17	0.07	0.01	Weakening
NutNet	5	Continuous	293	79	NA	-0.13	0.07	0.06	Weakening
NutNet	6	Continuous	252	69	NA	-0.12	0.07	0.086	Weakening
NutNet	7	Continuous	229	64	NA	-0.13	0.07	0.073	Weakening
NutNet	8	Continuous	202	55	NA	-0.14	0.08	0.074	Weakening

For each dataset, models were refitted after retaining local communities with at least 3–8 years of observations. Community stability was modeled as the response variable, species richness as the focal predictor, and invasion as either a binary invaded/non-invaded contrast or a continuous invasion-intensity gradient. n_obs indicates the number of local communities analyzed, corresponding to quadrats in NEON and subplots in NutNet; n_site and n_plot indicate the number of sites and plots, with n_plot applying only to NEON. The interaction estimate represents the species richness $\times$ invasion effect, with negative values indicating that invasion weakened the richness–stability relationship.

Table S5 | Coverage of database-measured and imputed plant functional trait records in NEON and NutNet.

Trait	NEON measured (%)	NEON imputed (%)	NutNet measured (%)	NutNet imputed (%)
SLA	42.80	57.20	54.50	45.50
Plant height	53.10	46.90	72.50	27.50
Diaspore mass	58.70	41.30	70.90	29.10
Leaf area	35.70	64.30	47	53
SSD	9.50	90.50	7.70	92.30
Leaf N	32.50	67.50	39.80	60.20
LDMC	26.10	73.90	38.90	61.10
Overall	36.90	63.10	47.30	52.70

Values indicate the percentage of species-by-trait records obtained from database measurements or phylogenetically informed imputation. Overall percentages were calculated across all seven functional traits. SLA, specific leaf area; SSD, stem specific density; Leaf N, leaf nitrogen concentration; LDMC, leaf dry matter content.

Table S6 | Author contribution matrix based on the Nutrient Network Authorship Rubric. Contributions of each author to the manuscript are shown according to the Nutrient Network (NutNet) Authorship Rubric. Author contributions to individual tasks are marked with “x”.

Co-author	Developed and framed research question(s)	Analyzed data	Contributed to data analyses	Wrote the paper	Contributed to paper writing	Site-level coordinator	Nutrient Network Coordinator
Pu Yan	x	x		x			
Yani Meng			x		x		
Yan Yang			x		x		
Jane A. Catford	x		x		x	x	
Ming Ni			x		x		
Cleber Ten Caten			x		x		
Nevyn Neal			x		x		
Elizabeth Borer	x		x		x		x
Shaopeng Li			x		x		
Eric W. Seabloom	x		x		x		x
Ingrid Slette			x		x		x
Jonathan D. Bakker			x		x	x	
Kari Anne Bråthen					x	x	
Lars A. Brudvig					x	x	
Miguel N. Bugalho					x	x	
Marc W. Cadotte					x	x	
Maria C. Caldeira					x	x	
Clinton Carbutt					x	x	
Thomas W. Crowther			x		x		

Co-author	Developed and framed research question(s)	Analyzed data	Contributed to data analyses	Wrote the paper	Contributed to paper writing	Site-level coordinator	Nutrient Network Coordinator
Kendi Davies					x	x	
Ian Donohue					x	x	
Ciara Dwyer					x	x	
Nico Eisenhauer					x	x	
Anu Eskelinen					x	x	
Nicole Hagenah			x		x		
Sylvia Haider					x	x	
Yann Hautier					x	x	
Erika I. Hersch-Green					x	x	
Anke Jentsch					x	x	
Ingibjörg S. Jónsdóttir			x		x	x	
Kevin P. Kirkman					x	x	
Johannes M. H. Knops					x	x	
Sally E. Koerner			x		x		
Lauri Laanisto					x	x	
Luciola Lannes					x	x	
Ylva Lekberg					x	x	
Miaojun Ma					x	x	
Andrew S. MacDougall					x	x	
Petr Macek					x	x	
Jason P. Martina					x	x	
Holly M. Martinson					x	x	

Co-author	Developed and framed research question(s)	Analyzed data	Contributed to data analyses	Wrote the paper	Contributed to paper writing	Site-level coordinator	Nutrient Network Coordinator
Damaris Matten			x		x		
Jonathan Millett					x	x	
Joslin L. Moore					x	x	
Ranjan Muthukrishnan			x		x		
Rebecca Nelson			x		x		
Harry Olde Venterink					x	x	
Pablo L. Peri					x	x	
Edwin T. Pos			x		x		
Sally A. Power					x	x	
Xavier Raynaud					x	x	
Zhengwei Ren					x	x	
Anita C. Risch					x	x	
Nicholas G. Smith					x	x	
Ciska Veen					x	x	
Risto Virtanen			x		x		
Pengfei Zhang					x	x	
Kai Zhu			x		x		
Daijiang Li	x	x		x			

Note. “Developed and framed research question(s)” indicates originating the idea for the current analysis of Nutrient Network data or contributing substantially to the conceptual framing during early manuscript development. “Analyzed data” indicates generating conceptual, statistical, or mathematical models, figures, tables, maps, or Network-scale datasets used in the manuscript. “Contributed to data analyses” indicates providing comments, suggestions, or code for data analysis. “Wrote the paper” indicates writing the majority of at least one manuscript section. “Contributed to paper writing” indicates providing suggestions on manuscript structure, ideas, text, citations, links to new literature areas, or copy editing. “Site-level coordinator” indicates coordinating data collection, proofing, and submission of data for at least one site used in this

manuscript. “Nutrient Network Coordinator” indicates substantial contribution to network-level activities, defined as more than 300 hours per year, including management of network data, recruiting and assisting new sites, and securing funding for network-level management activities. This matrix is intended for author-team verification before final submission.

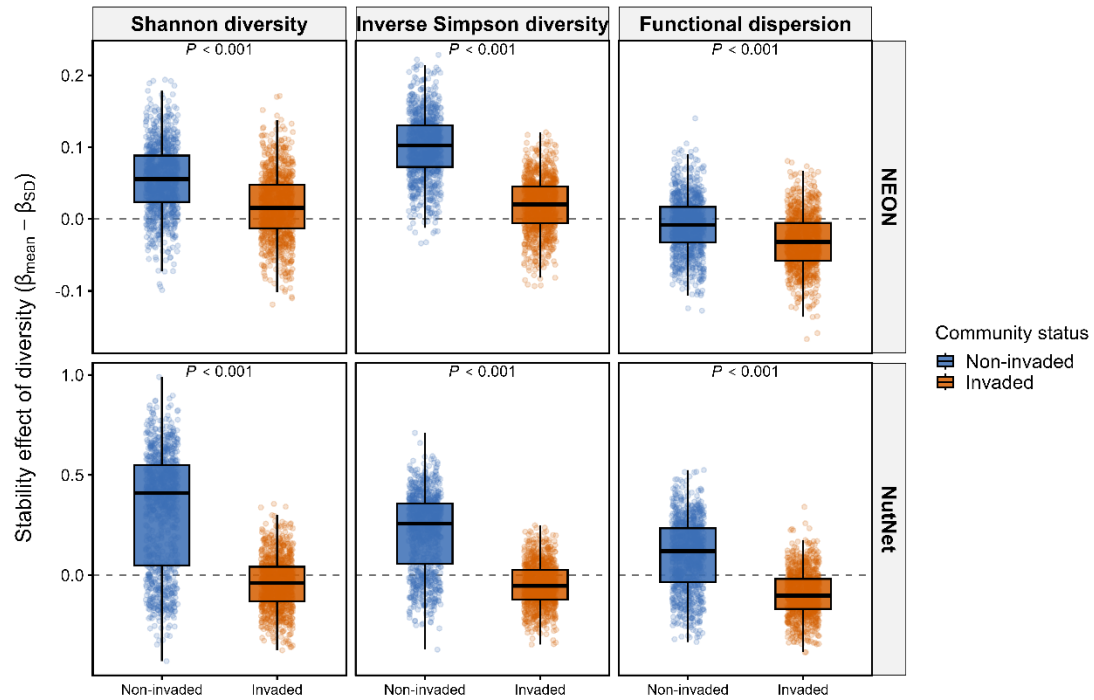


Fig. S1 | Non-native species consistently weaken the stabilizing effects of multiple diversity dimensions across NEON and NutNet. Each panel shows the stability effect of diversity, calculated as $\beta_{\text{mean}} - \beta_{\text{SD}}$, where β_{mean} and β_{SD} denote the effects of diversity on log-transformed temporal mean productivity and temporal SD, respectively. Slopes were estimated from 999 bootstrap resamples after standardizing variables within each diversity–productivity relationship. Positive values indicate that diversity increases temporal mean productivity more strongly than temporal SD, corresponding to a stabilizing effect, whereas negative values indicate a relatively stronger effect on temporal SD than on the mean. Points represent bootstrap estimates, and boxplots summarize the distributions for non-invaded and invaded communities. Blue indicates non-invaded communities and orange indicates invaded communities. P values are based on paired Wilcoxon signed-rank tests comparing non-invaded and invaded communities across bootstrap iterations. Overall, invasion consistently weakened the stabilizing effects of diversity across multiple diversity dimensions.

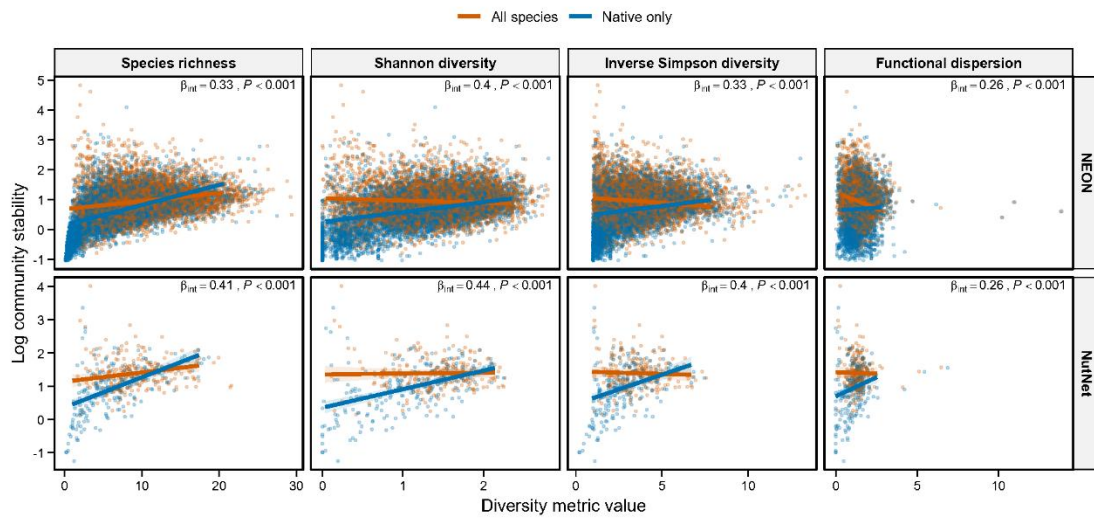


Fig. S2 | Non-native species weaken multiple biodiversity–stability relationships within invaded local communities. We restricted this complementary analysis to local communities containing non-native species and compared biodiversity–stability relationships calculated using all species with those calculated using only native species from the same local communities. Panels show relationships between four biodiversity metrics—species richness, Shannon diversity, inverse Simpson diversity and functional dispersion—and log-transformed community temporal stability across NEON and NutNet. Orange points and lines represent all-species communities, whereas blue points and lines represent native-only components after excluding non-native species. Points represent local communities; solid lines show fixed-effect predictions from linear mixed-effects models; and shaded areas indicate 95 confidence intervals. Models were fitted using standardized log-transformed community stability and standardized biodiversity metrics, whereas axes show the original biodiversity values and log-transformed community stability for visualization. All models included climate principal components as covariates. NEON models included random intercepts for plots nested within sites and paired local communities; NutNet models included random intercepts for sites and paired local communities. Statistical annotations show standardized interaction coefficients (β_{int}) and P values testing whether biodiversity–stability slopes differed between all-species communities and native-only components. Across both datasets, native-only components generally showed steeper positive biodiversity–stability relationships than all-species communities, indicating that the inclusion of non-native species weakened the stabilizing effect of biodiversity within invaded communities.

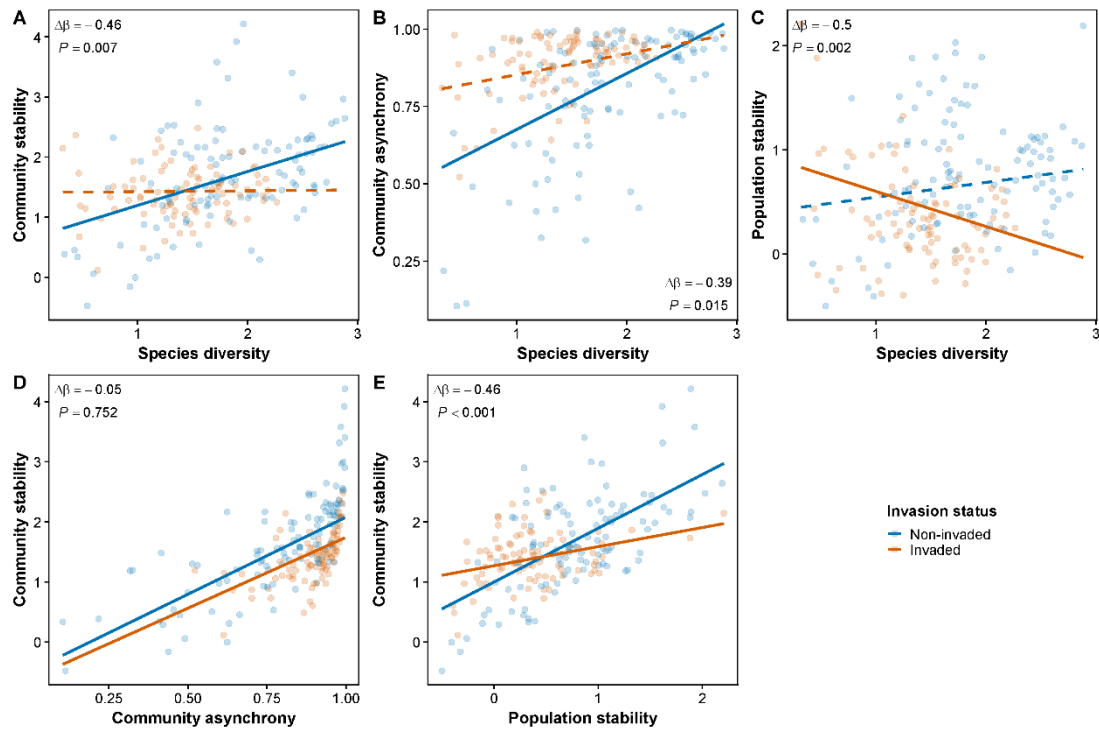


Fig. S3 | Sensitivity analysis of binary invasion effects on biodiversity–stability relationships in non-U.S. NutNet communities. Relationships among species diversity, community stability, population stability and community asynchrony in NutNet after excluding U.S. sites, based on 199 local communities from 50 non-U.S. sites. Panels show relationships between (A) species diversity and community stability, (B) species diversity and community asynchrony, (C) species diversity and population stability, (D) community asynchrony and community stability, and (E) population stability and community stability. Points represent local communities; lines show fitted relationships from linear mixed-effects models with site identity included as a random intercept. Colors distinguish non-invaded and invaded communities. Solid and dashed lines indicate significant and non-significant within-group slopes, respectively. Statistics report the difference in slope between invaded and non-invaded communities ($\Delta\beta$). **Because NutNet and NEON both include U.S. sites, we repeated the NutNet analysis after excluding U.S. sites to test whether the observed patterns were driven by geographic overlap between the two networks.**

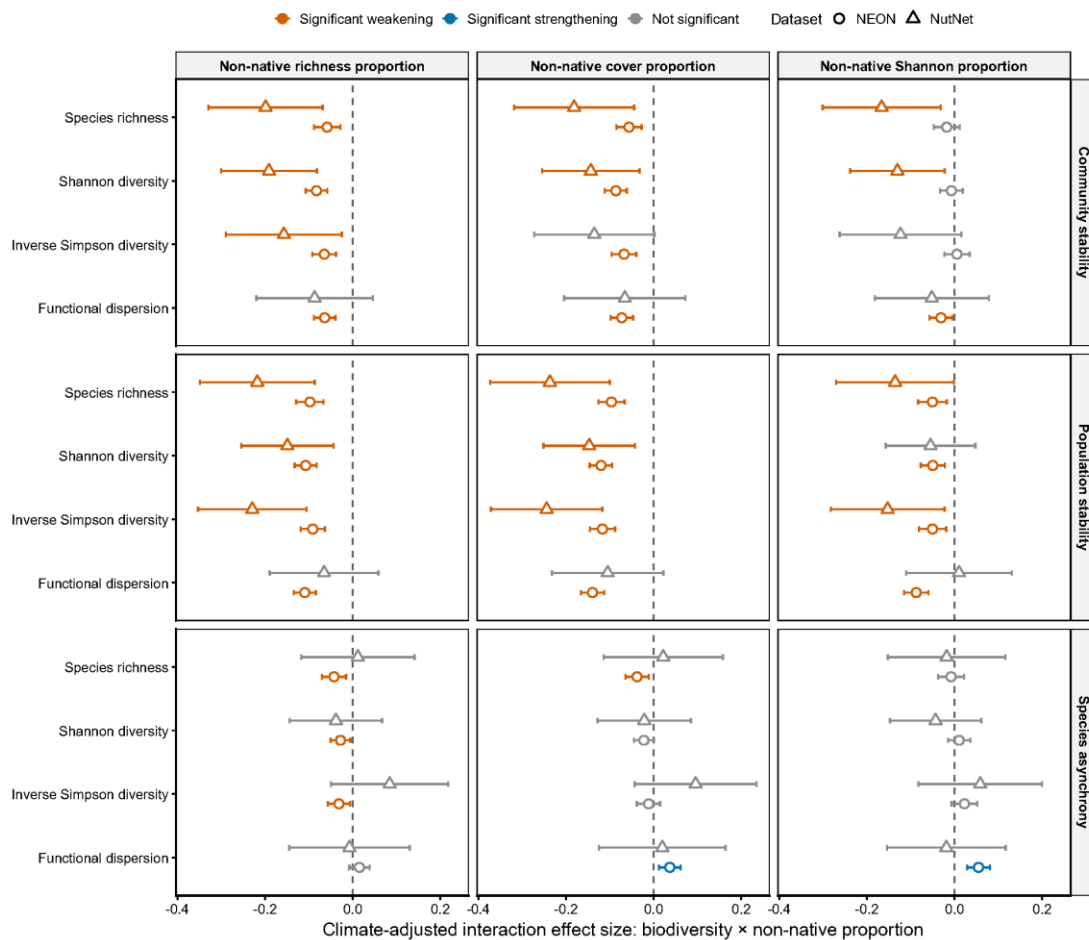


Fig. S4 | Non-native species proportions modulate biodiversity–stability relationships across NEON and NutNet communities. Points show standardized biodiversity × non-native proportion interaction coefficients from climate-adjusted linear mixed-effects models testing whether biodiversity–stability relationships changed with increasing non-native species proportion. Models included climate principal-component axes as covariates, with random intercepts for plot nested within site in NEON and for site in NutNet. Biodiversity metrics include species richness, Shannon diversity, inverse Simpson diversity and functional dispersion. Non-native proportion was quantified using richness, cover and Shannon diversity. Response variables include community stability, population stability and species asynchrony. NEON and NutNet are shown together within each panel and distinguished by symbol shape (circle, NEON; triangle, NutNet). Negative interaction coefficients indicate that the effect of biodiversity weakened as non-native proportion increased, whereas positive coefficients indicate strengthening. Error bars show 95 confidence intervals. The dashed vertical line denotes zero interaction effect. Colours indicate significant weakening, significant strengthening or non-significant effects.

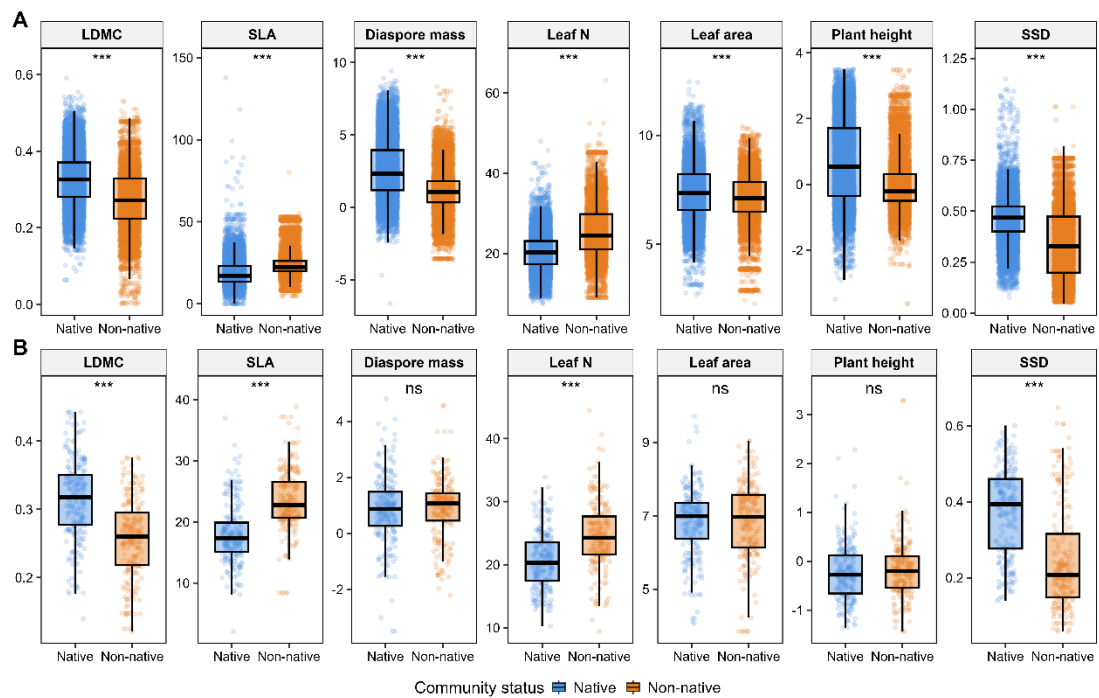


Fig. S5 | Differences in trait values between native and non-native species across NEON (A) and NutNet (B) plant communities. Within each community, species were classified as native or non-native according to local (site-level) status, because a species may be native in one region but non-native in another. Trait values were calculated separately for the native and non-native subcommunities as abundance-weighted means, using species' relative abundance within each subcommunity as weights. Boxplots show medians and interquartile ranges (whiskers = $1.5 \times$ IQR), and points represent individual communities. Significance is indicated by stars based on Benjamini–Hochberg-adjusted P values from Wilcoxon rank-sum tests conducted separately for each trait ($P < 0.05$, $P < 0.01$, $P < 0.001$). Trait units and abbreviations are as follows: LDMC, leaf dry matter content (g g^{-1}); SLA, specific leaf area ($\text{m}^2 \text{kg}^{-1}$); Diaspore mass (mg); Leaf N, leaf nitrogen concentration (mg g^{-1}); Leaf area (mm^2); Plant height (m); and SSD, stem specific density (g cm^{-3}).

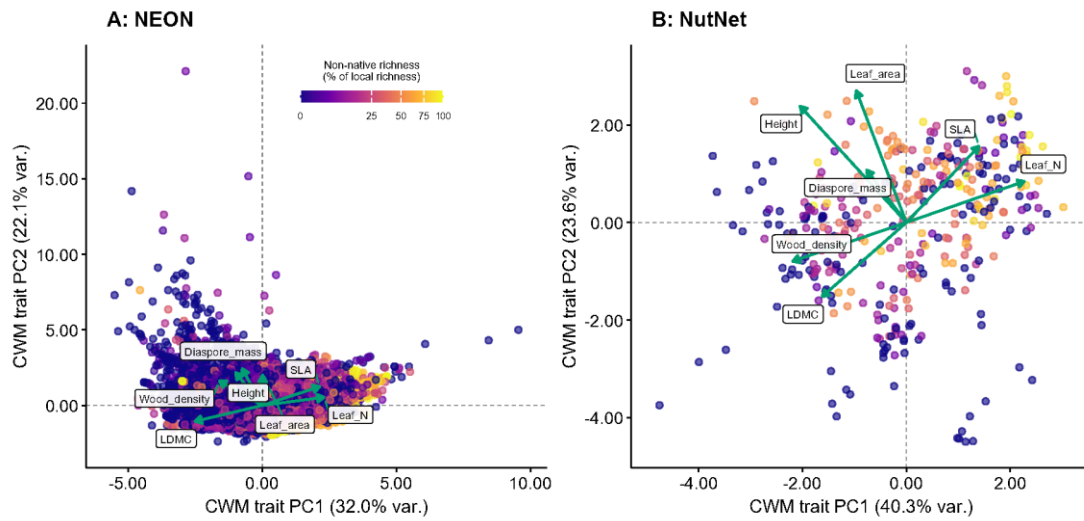


Fig. S6 | Principal component analysis of community-weighted mean traits in NEON and NutNet. Each point represents one community and is coloured by invasion intensity, quantified as the proportion of species richness contributed by non-native species. Arrows indicate trait loadings on the first two principal component axes. In both datasets, PC1 captures a major gradient in community trait composition from conservative to acquisitive strategies. These ordinations provide the basis for the analyses shown in Fig. 3B and 3D.

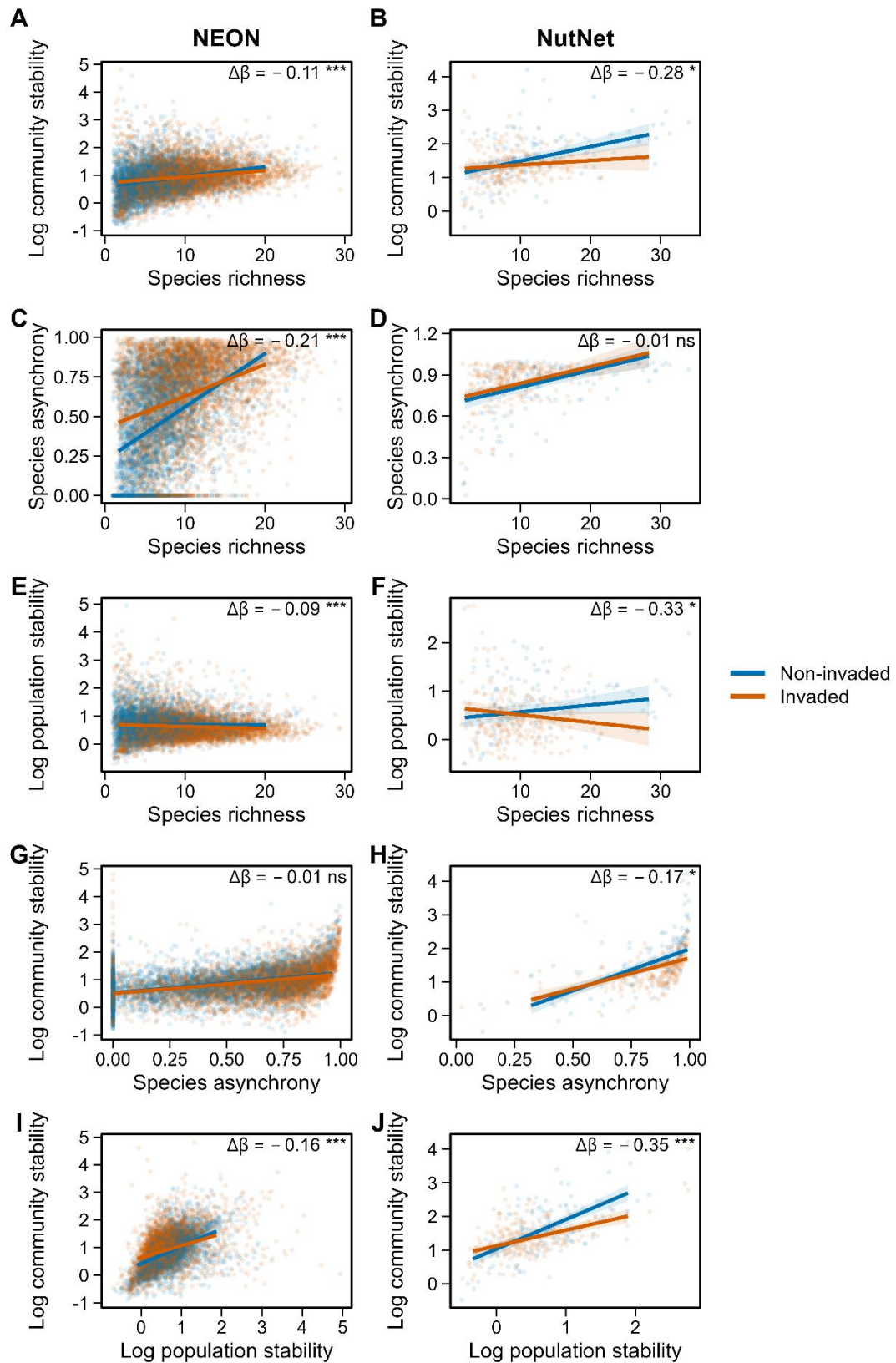


Fig. S7 | Invasion weakens diversity–stability relationships and their stabilizing pathways across NEON (A-E) and NutNet (F-J) communities. Relationships among species richness, community stability, species asynchrony and population stability in NEON quadrats (top row) and

NutNet subplots (bottom row). Columns show, from left to right, relationships between species richness and community stability, species richness and species asynchrony, species richness and population stability, species asynchrony and community stability, and population stability and community stability. Blue points and lines represent non-invaded communities, whereas orange points and lines represent invaded communities. Points represent local communities; solid lines show fixed-effect predictions from linear mixed-effects models; and shaded areas indicate 95 confidence intervals. Models were fitted using standardized transformed response and predictor variables, with log transformation applied to community stability and population stability. Axes show the transformed plotting scales used for visualization. All models included 2001–2024 climate principal components as covariates. NEON models included random intercepts for plots nested within sites, whereas NutNet models included random intercepts for sites. Statistical annotations show the standardized slope difference between invaded and non-invaded communities ($\Delta\beta = \beta_{\text{Invaded}} - \beta_{\text{Non-invaded}}$); significance is indicated as $P < 0.05^*$, $P < 0.01^{**}$, and $P < 0.001^{***}$.

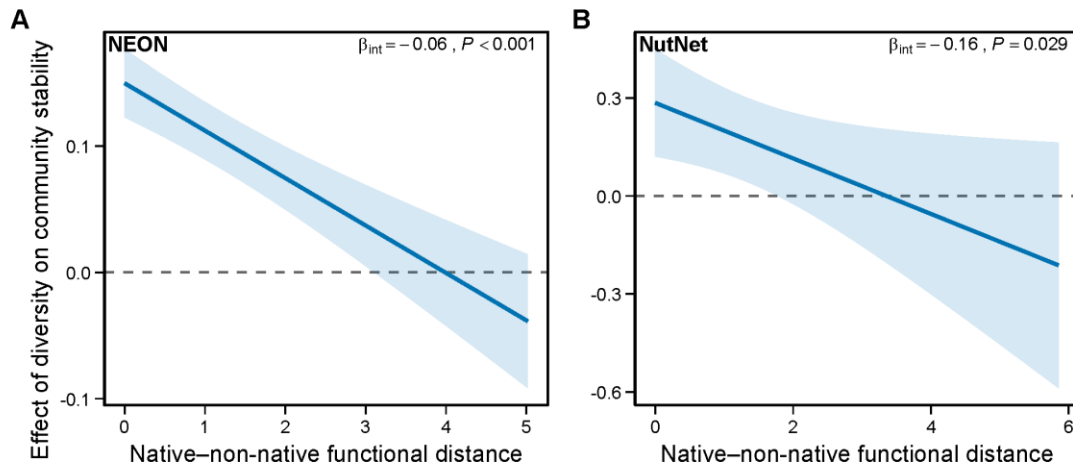


Fig. S8 | Native–non-native functional distance modulates the effect of species diversity on community stability across NEON and NutNet communities. The figure shows how the standardized effect of species diversity on community stability changes along the native–non-native functional distance gradient in NEON and NutNet. Species diversity was quantified using Shannon diversity. Functional distance was calculated as the Euclidean distance between the centroids of native and non-native subcommunities in a three-dimensional trait ordination space constructed from community-weighted mean traits. Community stability was log-transformed and standardized before analysis. Shaded areas indicate 95 confidence intervals, and horizontal dashed lines indicate zero effect. Statistical annotations in the upper-right corner show standardized interaction coefficients (β_{int}) and associated P values. Models included climate principal components as covariates when available; NEON models additionally included plots nested within sites as random effects.

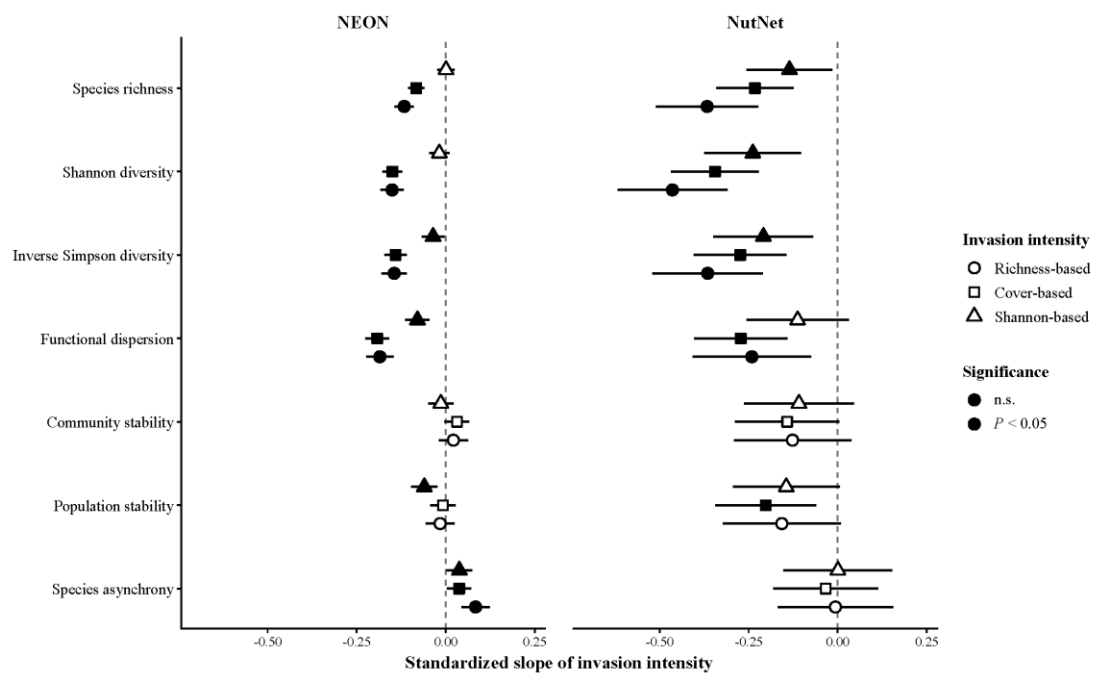


Fig. S9 | Direct associations of invasion intensity with diversity and stability components across NEON and NutNet. Forest plots show standardized slopes from linear mixed-effects models relating invasion intensity to plant diversity and stability components in NEON and NutNet. Response variables are ordered from diversity metrics to stability components, including species richness, Shannon diversity, inverse Simpson diversity, functional dispersion, community stability, population stability and species asynchrony. Three invasion-intensity metrics were examined: the proportional contribution of non-native species to local species richness, cover and Shannon diversity, shown by different point shapes. Filled points indicate significant slopes ($P < 0.05$), and open points indicate non-significant slopes. Horizontal bars show 95% confidence intervals. NEON models included random intercepts for site and plot identity, whereas NutNet models included a random intercept for site identity. Community stability and population stability were log-transformed before standardization. This analysis shows that invasion intensity was consistently associated with reduced diversity, whereas community stability often changed little, indicating that the weakening of biodiversity–stability relationships reflects a shift in how diversity contributes to stability rather than a simple direct decline in stability itself.

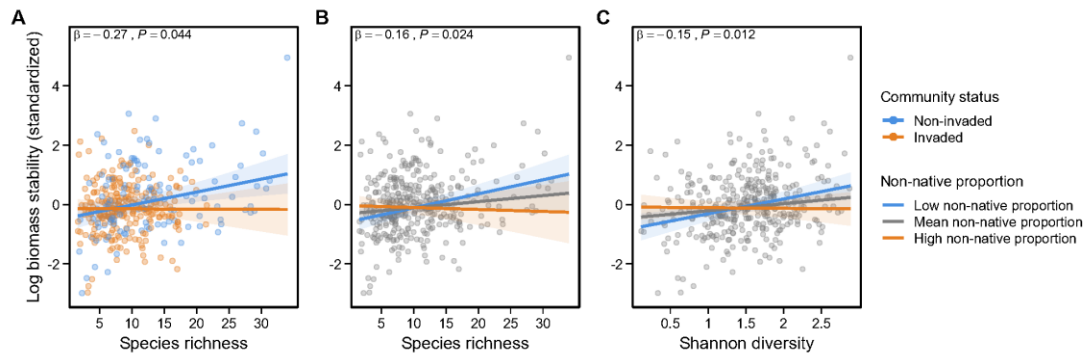


Fig. S10 | Invasion weakens diversity–stability relationships based on NutNet biomass data.

Relationships between plant diversity and aboveground biomass stability across NutNet control plots. A, Relationship between species richness and biomass stability in non-invaded and invaded communities. B, Moderating effect of non-native richness proportion on the richness–stability relationship. C, Moderating effect of non-native Shannon proportion on the Shannon diversity–stability relationship. Biomass stability was defined as the temporal mean divided by the temporal standard deviation of annual subplot biomass, then log-transformed and standardized before analysis. Points represent subplot-level observations; solid lines show fixed-effect predictions from linear mixed-effects models; and shaded areas indicate 95 confidence intervals. All models included two climate principal components to control for climatic variation and site identity as a random intercept. Negative interaction terms indicate that increasing non-native proportion weakens the positive association between plant diversity and biomass stability. Statistical annotations show standardized interaction coefficients and associated *P* values.

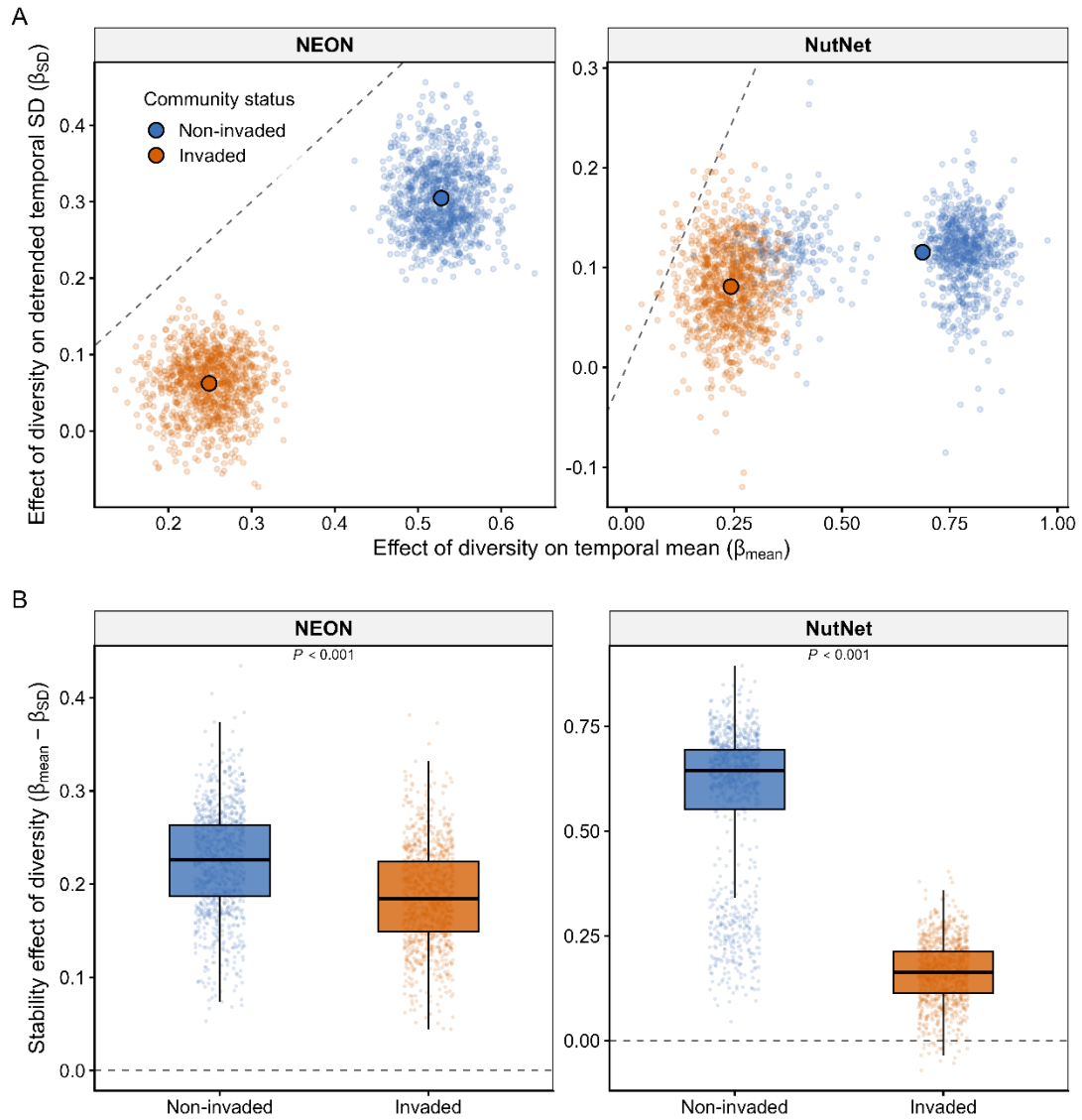


Fig. S11 | Detrended mean-variability decomposition of the species richness-stability relationship. Each point represents one bootstrap estimate of the standardized effect of species richness on the temporal mean and detrended temporal standard deviation of community cover, estimated separately for non-invaded and invaded local communities in NEON and NutNet. A, Two-dimensional mean-variability space. The x axis shows the effect of species richness on temporal mean (β_{mean}), and the y axis shows the effect of species richness on detrended temporal standard deviation (β_{SD}). Filled points with black outlines indicate group centroids. The dashed 1:1 line indicates equal effects on temporal mean and temporal variability. B, Net stability effect of species richness, calculated as $\beta_{\text{mean}} - \beta_{\text{SD}}$. Higher values indicate a stronger stabilizing effect of richness through increasing temporal mean and/or reducing detrended temporal variability. Boxplots show bootstrap distributions, with points representing individual bootstrap estimates. P values indicate tests comparing invaded and non-invaded communities within each dataset.

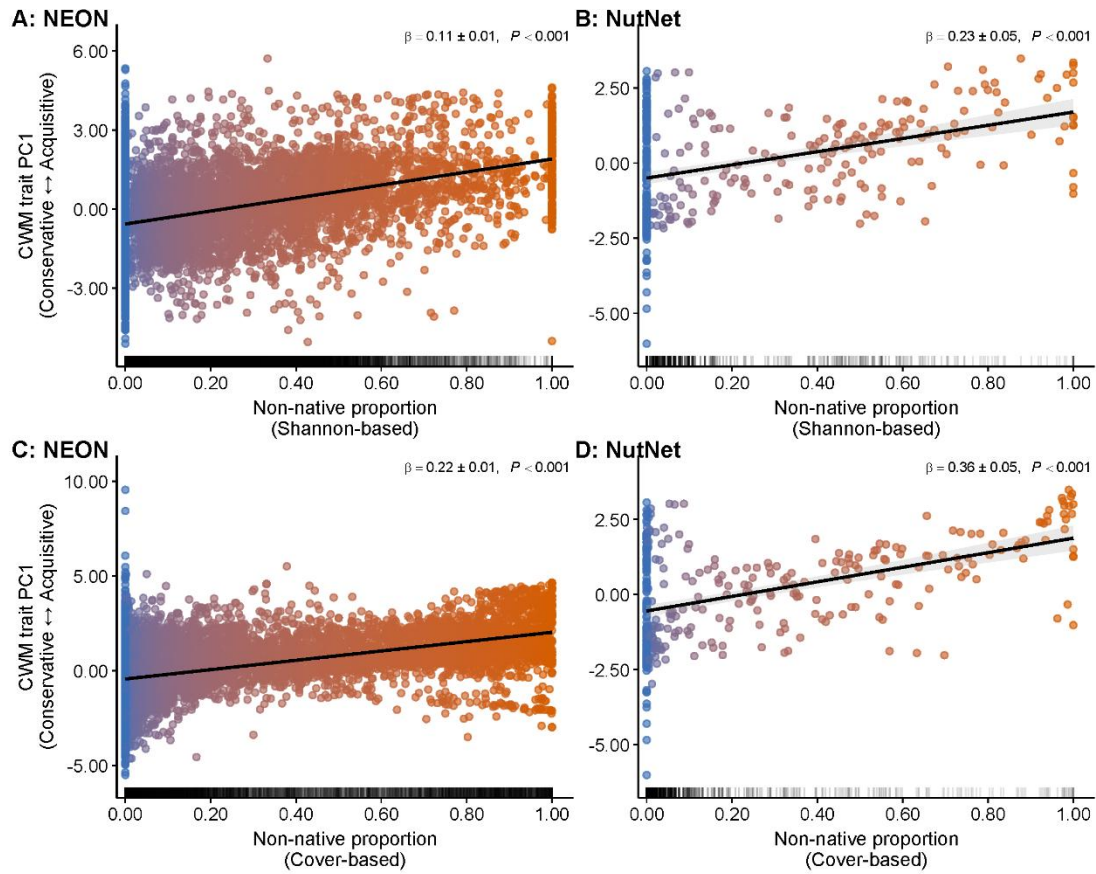


Fig. S12 | Consistent shifts in community trait composition along invasion gradients when invasion intensity is quantified using alternative metrics. Invasion intensity was quantified as the proportional contribution of non-native species to community Shannon diversity (A, B) or to total plant cover (C, D), rather than by non-native species richness as in Fig. 3. The y-axis shows the first principal component (PC1) of community-weighted mean (CWM) trait composition, representing a major axis from conservative to acquisitive trait combinations. Each point represents one local community, with point colour indicating invasion intensity. Solid lines show fitted relationships from linear mixed-effects models and shaded areas indicate 95 confidence intervals. Statistical annotations show standardized effect estimates and corresponding *P* values. The qualitatively consistent relationships across alternative invasion-intensity metrics indicate that the positive association between non-native dominance and acquisitive community trait composition is robust to how invasion intensity is quantified.