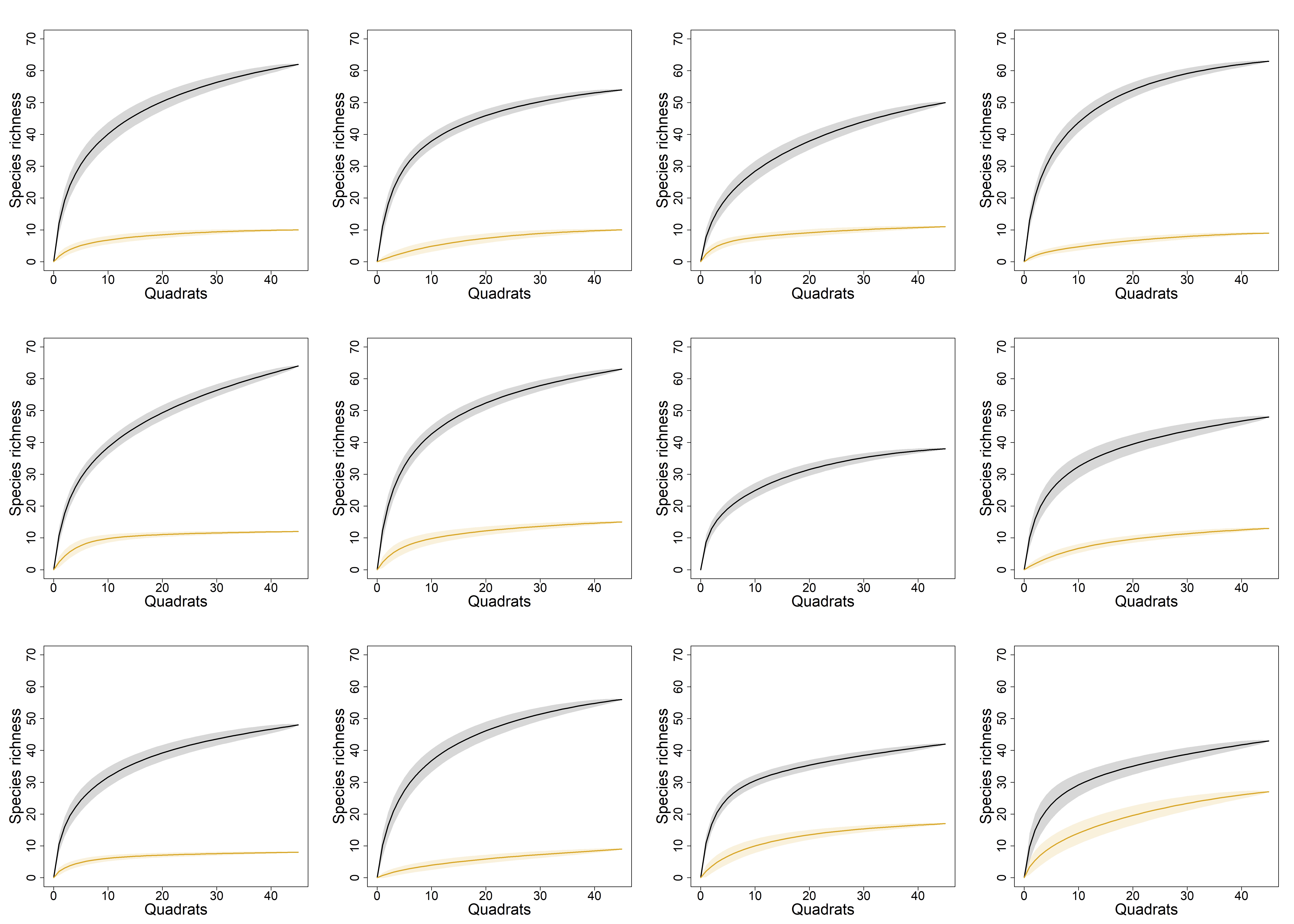
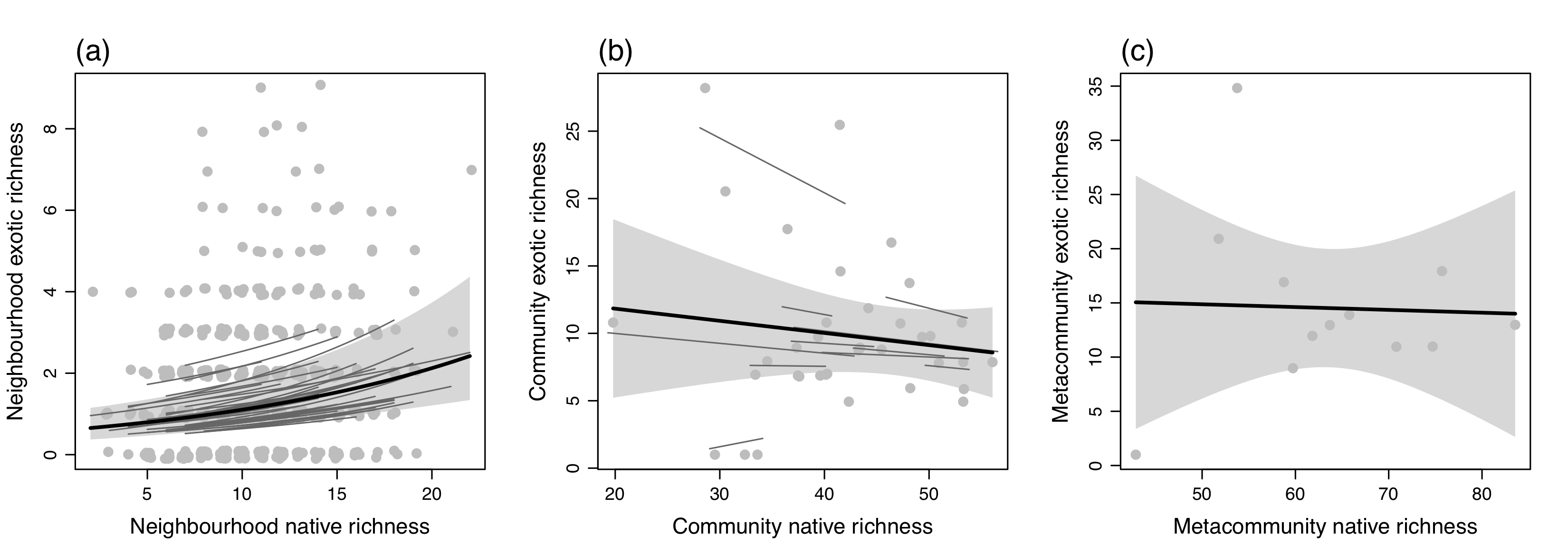
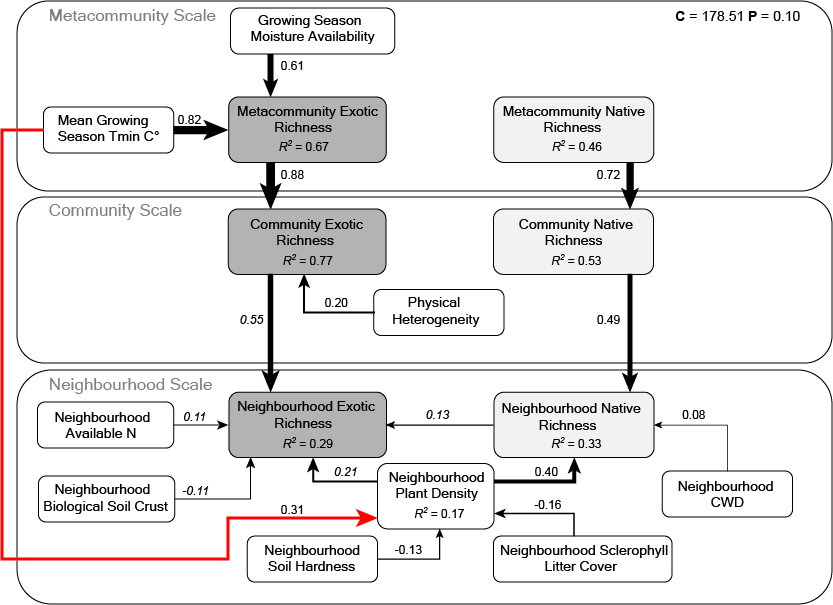
**Figure S1.** Sample-based rarefaction curves of species richness across quadrats for each metacommunity. Black curves depict native species richness while yellow curves depict exotic species richness. Each curve depicts the average of 999 random permutations of quadrats while the grey area represents an interval of one standard deviation.



**Figure S2.** “Raw” NERRs at the (**a**) neighbourhood, (**b**) community and (**c**) metacommunity scales with exotic richness variables fitted as responses. Thick black lines are fitted overall relationships from linear models and light grey envelopes are 95% confidence intervals (CIs). Thin dark grey lines in (**a**) and (**b**) are within-community and among community NERRs, respectively, and were estimated using ‘varying intercepts and slopes’ mixed-effect models.



**Figure S3.** The “native-driven” gmSEM including directed paths from native to exotic richness. Black and red paths indicate positive and negative relationships, respectively. Numerical values adjacent to paths indicate the associated standardised regression coefficients. Italicised numerals indicate that the regression coefficient is in log(units). Line thickness of each path is proportional to the respective regression coefficient. The explained variation (marginal) is included for each response variable (*R2*). Tmin stands for minimum temperature and biocrust stands for biological soil crust. In total, there were 540 observations at the neighbourhood scale, 36 observations at the community scale and 12 observations at the metacommunity scale. The directed separation test indicated that the gmSEM fit the data adequately (Fisher’s C = 178.51; df = 156; *P* = 0.10).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table S1.** Standardised parameter estimates obtained from the component models in the exotic-driven gmSEM. Bold P-values indicate that the predictor was significant ( = 0.05). R2 is the explained variation (marginal) for each response variable. Parameter estimates for neighbourhood exotic richness are presented in *log*(units) and are denoted by *e*. | | | | |  |
| **Response** | **Predictor** | **Estimate** | **SE** | **P** | **R2** |
| **Metacommunity native richness** | Growing season Tmin (°C) | -0.87 | 0.44 | 0.091 | 0.46 |
|  | Moisture availability | -0.11 | 0.45 | 0.818 |  |
|  | Metacommunity exotic richness | 0.48 | 0.48 | 0.356 |  |
|  | Mean distance between communities | -<0.01 | 0.34 | 0.988 |  |
|  |  |  |  |  |  |
| **Metacommunity exotic richness** | Growing season Tmin (°C) | 0.68 | 0.22 | **0.014** | 0.67 |
|  | Moisture availability | 0.66 | 0.24 | **0.024** |  |
|  | Mean distance between communities | -0.05 | 0.24 | 0.848 |  |
|  |  |  |  |  |  |
| **Community native richness** | Metacommunity native richness | 0.72 | 0.14 | **<0.001** | 0.53 |
|  | Physical environment heterogeneity | 0.30 | 0.13 | **0.028** |  |
|  | Soil fertility heterogeneity | 0.03 | 0.12 | 0.816 |  |
|  | Canopy cover heterogeneity | 0.06 | 0.13 | 0.666 |  |
|  | Community exotic richness | -0.20 | 0.13 | 0.152 |  |
|  |  |  |  |  |  |
| **Community exotic richness** | Metacommunity exotic richness | 0.89 | 0.09 | **<0.001** | 0.77 |
|  | Physical environment heterogeneity | 0.17 | 0.09 | 0.064 |  |
|  | Soil fertility heterogeneity | 0.09 | 0.08 | 0.285 |  |
|  | Canopy cover heterogeneity | -0.10 | 0.08 | 0.245 |  |
|  | Distance to remnant edge | -0.01 | 0.09 | 0.868 |  |
|  |  |  |  |  |  |
| **Neighbourhood native richness** | Community native richness | 0.49 | 0.08 | **<0.001** | 0.33 |
|  | Neighbourhood plant density | 0.36 | 0.04 | **<0.001** |  |
|  | Soil potassium | 0.05 | 0.07 | 0.422 |  |
|  | Soil phosphorous | -<0.01 | 0.05 | 0.915 |  |
|  | Soil nitrogen | -0.09 | 0.05 | 0.069 |  |
|  | CWD | 0.07 | 0.04 | 0.055 |  |
|  | Biocrust | -0.05 | 0.04 | 0.246 |  |
|  | Canopy cover | 0.07 | 0.04 | 0.091 |  |
|  | Litter cover | -0.04 | 0.05 | 0.453 |  |
|  | Soil hardness | -<0.01 | 0.04 | 0.936 |  |
|  | Exotic richness | 0.15 | 0.05 | **<0.001** |  |
|  |  |  |  |  |  |
| **Neighbourhood exotic richness** | Community exotic richness | 0.51e | 0.11e | **<0.001** | 0.29 |
|  | Neighbourhood plant density | 0.26e | 0.04e | **<0.001** |  |
|  | Soil potassium | 0.07e | 0.08e | 0.395 |  |
|  | Soil phosphorous | -0.06e | 0.05e | 0.244 |  |
|  | Soil nitrogen | 0.11e | 0.05e | **0.025** |  |
|  | CWD | 0.06e | 0.04e | 0.075 |  |
|  | Biocrust | -0.13e | 0.05e | **0.008** |  |
|  | Canopy cover | -0.03e | 0.05e | 0.439 |  |
|  | Litter cover | 0.06e | 0.06e | 0.286 |  |
|  | Soil hardness | 0.06e | 0.04e | 0.194 |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **Neighbourhood plant density** | Soil potassium | -0.03 | 0.08 | 0.752 | 0.17 |
|  | Soil phosphorous | 0.06 | 0.05 | 0.220 |  |
|  | Soil nitrogen | 0.05 | 0.05 | 0.323 |  |
|  | CWD | -0.07 | 0.04 | 0.083 |  |
|  | Biocrust | -0.08 | 0.05 | 0.091 |  |
|  | Canopy cover | -0.08 | 0.05 | 0.081 |  |
|  | Litter cover | -0.16 | 0.06 | **0.007** |  |
|  | Soil hardness | -0.13 | 0.05 | **0.004** |  |
|  | Growing season Tmin (°C) | 0.31 | 0.13 | **0.040** |  |
|  | Moisture availability | -0.07 | 0.11 | 0.582 |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table S2.** Standardised parameter estimates obtained from the component models in the native-driven gmSEM. Bold P-values indicate that the predictor was significant ( = 0.05). R2 is the explained variation (marginal) for each response variable. Parameter estimates for neighbourhood exotic richness are presented in *log*(units) and are denoted by *e*. | | | | |  |
| **Response** | **Predictor** | **Estimate** | **SE** | **P** | **R2** |
| **Metacommunity native richness** | Growing season Tmin (°C) | -0.54 | 0.30 | 0.105 | 0.38 |
|  | Moisture availability | 0.21 | 0.32 | 0.540 |  |
|  | Mean distance between communities | -0.03 | 0.34 | 0.935 |  |
|  |  |  |  |  |  |
| **Metacommunity exotic richness** | Growing season Tmin (°C) | 0.82 | 0.26 | **0.016** | 0.71 |
|  | Moisture availability | 0.61 | 0.24 | **0.041** |  |
|  | Metacommunity native richness | 0.26 | 0.26 | 0.356 |  |
|  | Mean distance between communities | -0.04 | 0.24 | 0.872 |  |
|  |  |  |  |  |  |
| **Community native richness** | Metacommunity native richness | 0.73 | 0.15 | **<0.001** | 0.50 |
|  | Physical environment heterogeneity | 0.26 | 0.13 | 0.053 |  |
|  | Soil fertility heterogeneity | 0.02 | 0.12 | 0.888 |  |
|  | Canopy cover heterogeneity | 0.09 | 0.13 | 0.499 |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **Community exotic richness** | Metacommunity exotic richness | 0.88 | 0.09 | **<0.001** | 0.77 |
|  | Physical environment heterogeneity | 0.20 | 0.09 | **0.040** |  |
|  | Soil fertility heterogeneity | 0.10 | 0.09 | 0.243 |  |
|  | Canopy cover heterogeneity | -0.11 | 0.09 | 0.194 |  |
|  | Distance to remnant edge | -0.04 | 0.09 | 0.639 |  |
|  | Community native richness | -0.10 | 0.09 | 0.310 |  |
|  |  |  |  |  |  |
| **Neighbourhood native richness** | Community native richness | 0.49 | 0.07 | **<0.001** | 0.31 |
|  | Neighbourhood plant density | 0.40 | 0.04 | **<0.001** |  |
|  | Soil potassium | 0.06 | 0.06 | 0.362 |  |
|  | Soil phosphorous | -<0.01 | 0.04 | 0.828 |  |
|  | Soil nitrogen | -0.08 | 0.05 | 0.115 |  |
|  | CWD | 0.08 | 0.04 | **0.028** |  |
|  | Biocrust | -0.08 | 0.04 | 0.080 |  |
|  | Canopy cover | 0.06 | 0.04 | 0.150 |  |
|  | Litter cover | -0.03 | 0.05 | 0.568 |  |
|  | Soil hardness | <0.01 | 0.04 | 0.868 |  |
|  |  |  |  |  |  |
| **Neighbourhood exotic richness** | Community exotic richness | 0.55e | 0.12e | **<0.001** | 0.31 |
|  | Neighbourhood plant density | 0.21e | 0.05e | **<0.001** |  |
|  | Soil potassium | 0.07e | 0.08e | 0.424 |  |
|  | Soil phosphorous | -0.05e | 0.05e | 0.360 |  |
|  | Soil nitrogen | 0.11e | 0.05e | **0.027** |  |
|  | CWD | 0.06e | 0.03e | 0.107 |  |
|  | Biocrust | -0.11e | 0.05e | **0.022** |  |
|  | Canopy cover | -0.04e | 0.04e | 0.340 |  |
|  | Litter cover | 0.07e | 0.06e | 0.237 |  |
|  | Soil hardness | 0.05e | 0.05e | 0.273 |  |
|  | Neighbourhood native richness | 0.13e | 0.04e | **0.002** |  |
|  |  |  |  |  |  |
| **Neighbourhood plant density** | Soil potassium | -0.03 | 0.08 | 0.752 | 0.17 |
|  | Soil phosphorous | 0.06 | 0.05 | 0.220 |  |
|  | Soil nitrogen | 0.05 | 0.05 | 0.323 |  |
|  | CWD | -0.07 | 0.04 | 0.083 |  |
|  | Biocrust | -0.08 | 0.05 | 0.091 |  |
|  | Canopy cover | -0.08 | 0.05 | 0.081 |  |
|  | Litter cover | -0.16 | 0.06 | **0.007** |  |
|  | Soil hardness | -0.13 | 0.05 | **0.004** |  |
|  | Growing season Tmin (°C) | 0.31 | 0.13 | **0.040** |  |
|  | Moisture availability | -0.07 | 0.11 | 0.582 |  |
|  |  |  |  |  |  |

**Table S3.** Standardised parameter estimates obtained from statistical models of pair-wise relationships for each causal path in the gmSEM framework. Bold P-values indicate that the predictor was significant ( = 0.05). R2 is the explained variation (marginal) for each response variable. Parameter estimates for neighbourhood exotic richness are presented in log(units) and are denoted by e. Random effects were included in pairwise models to represent spatial nesting where appropriate.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Response** | **Predictor** | **Estimate** | **SE** | **R2** | **P** |
| **Metacommunity native richness** | Growing season Tmin (°C) | -0.59 | 0.26 | 0.34 | **0.045** |
|  | Moisture availability | -0.33 | 0.30 | 0.11 | 0.297 |
|  | Mean distance between communities | 0.26 | 0.31 | 0.07 | 0.409 |
|  | Metacommunity exotic richness | -0.04 | 0.32 | <0.01 | 0.910 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **Metacommunity exotic richness** | Growing season Tmin (°C) | 0.53 | 0.27 | 0.28 | 0.074 |
|  | Moisture availability | 0.47 | 0.28 | 0.22 | 0.128 |
|  | Mean distance between communities | 0.05 | 0.32 | <0.01 | 0.880 |
|  | Metacommunity native richness | -0.04 | 0.32 | <0.01 | 0.910 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **Community native richness** | Metacommunity native richness | 0.69 | 0.15 | 0.44 | **0.001** |
|  | Physical environment heterogeneity | 0.27 | 0.14 | 0.07 | 0.071 |
|  | Soil fertility heterogeneity | 0.02 | 0.14 | <0.01 | 0.903 |
|  | Canopy cover heterogeneity | 0.07 | 0.14 | <0.01 | 0.610 |
|  | Community exotic richness | -0.18 | 0.19 | 0.03 | 0.365 |
|  |  |  |  |  |  |
| **Community exotic richness** | Metacommunity exotic richness | 0.90 | 0.09 | 0.75 | **<0.001** |
|  | Physical environment heterogeneity | 0.06 | 0.12 | <0.01 | 0. 616 |
|  | Soil fertility heterogeneity | 0.11 | 0.10 | 0.01 | 0.299 |
|  | Canopy cover heterogeneity | -0.07 | 0.11 | <0.01 | 0.556 |
|  | Distance to remnant edge | -0.32 | 0.18 | 0.07 | 0.095 |
|  | Community native richness | -0.14 | 0.14 | 0.02 | 0.320 |
|  |  |  |  |  |  |
| **Neighbourhood native richness** | Community native richness | 0.40 | 0.08 | 0.15 | **<0.001** |
|  | Neighbourhood plant density | 0.39 | 0.04 | 0.14 | **<0.001** |
|  | Soil potassium | 0.03 | 0.08 | <0.01 | 0.706 |
|  | Soil phosphorous | -0.02 | 0.05 | <0.01 | 0.752 |
|  | Soil nitrogen | -0.01 | 0.05 | <0.01 | 0.792 |
|  | CWD | 0.06 | 0.04 | <0.01 | 0.126 |
|  | Biocrust | -0.07 | 0.05 | <0.01 | 0.124 |
|  | Canopy cover | 0.03 | 0.04 | <0.01 | 0.477 |
|  | Litter cover | -0.03 | 0.05 | <0.01 | 0.504 |
|  | Soil hardness | -0.07 | 0.04 | <0.01 | 0.131 |
|  | Neighbourhood exotic richness | 0.28 | 0.05 | 0.07 | **<0.001** |
|  |  |  |  |  |  |
| **Neighbourhood exotic richness** | Community exotic richness | 0.60e | 0.13e | 0.24 | **<0.001** |
|  | Neighbourhood plant density | 0.25e | 0.04e | 0.04 | **<0.001** |
|  | Soil potassium | 0.09e | 0.09e | <0.01 | 0.289 |
|  | Soil phosphorous | 0.01e | 0.05e | <0.01 | 0.813 |
|  | Soil nitrogen | 0.10e | 0.05e | <0.01 | **0.036** |
|  | CWD | 0.05e | 0.03e | <0.01 | 0.112 |
|  | Biocrust | -0.15e | 0.05e | 0.01 | **0.002** |
|  | Canopy cover | -0.02e | 0.04e | <0.01 | 0.64 |
|  | Litter cover | 0.02e | 0.05e | <0.01 | 0.700 |
|  | Soil hardness | -0.01e | 0.04e | <0.01 | 0.787 |
|  | Neighbourhood native richness | 0.22 | 0.04 | 0.03 | **<0.001** |
|  |  |  |  |  |  |
| **Neighbourhood plant density** | Soil potassium | 0.08 | 0.08 | <0.01 | 0.302 |
|  | Soil phosphorous | 0.07 | 0.05 | <0.01 | 0.155 |
|  | Soil nitrogen | 0.04 | 0.05 | <0.01 | 0.449 |
|  | CWD | -0.06 | 0.04 | <0.01 | 0.113 |
|  | Biocrust | -0.03 | 0.05 | <0.01 | 0.557 |
|  | Canopy cover | -0.10 | 0.04 | <0.01 | **0.020** |
|  | Litter cover | -0.18 | 0.05 | 0.03 | **<0.001** |
|  | Soil hardness | -0.10 | 0.04 | <0.01 | **0.029** |
|  | Growing season Tmin (°C) | 0.37 | 0.10 | 0.12 | **0.005** |
|  | Moisture availability | -0.14 | 0.15 | 0.02 | 0.352 |

**Table S4.** Standardised parameter estimates obtained from missing path analyses for the exotic-driven gmSEM. Bold P-values indicate that the predictor was significant ( = 0.05). Parameter estimates for neighbourhood exotic richness are presented in *log*(units) and are denoted by *e*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Response** | **Predictor** | **Estimate** | **SE** | **P** |
| **Community native richness** | Moisture availability | 0.07 | 0.19 | 0.722 |
| **Community exotic richness** | Moisture availability | 0.05 | 0.12 | 0.709 |
| **Neighbourhood native richness** | Moisture availability | -0.05 | 0.09 | 0.591 |
| **Neighbourhood exotic richness** | Moisture availability | 0.39e | 0.17e | **0.025** |
| **Community native richness** | Growing season Tmin (°C) | -0.01 | 0.23 | 0.975 |
| **Community exotic richness** | Growing season Tmin (°C) | -0.02 | 0.13 | 0.858 |
| **Neighbourhood native richness** | Growing season Tmin (°C) | -0.14 | 0.11 | 0.230 |
| **Neighbourhood exotic richness** | Growing season Tmin (°C) | -0.31e | 0.18e | 0.073 |
| **Neighbourhood plant density** | Mean distance between communities | -0.13 | 0.13 | 0.360 |
| **Community native richness** | Mean distance between communities | 0.15 | 0.15 | 0.337 |
| **Community exotic richness** | Mean distance between communities | 0.04 | 0.11 | 0.734 |
| **Neighbourhood native richness** | Mean distance between communities | 0.11 | 0.09 | 0.221 |
| **Neighbourhood exotic richness** | Mean distance between communities | 0.08e | 0.19e | 0.671 |
| **Metacommunity exotic richness** | Soil fertility heterogeneity | 0.21 | 0.42 | 0.635 |
| **Neighbourhood plant density** | Soil fertility heterogeneity | 0.09 | 0.08 | 0.292 |
| **Metacommunity native richness** | Soil fertility heterogeneity | 0.30 | 0.59 | 0.630 |
| **Neighbourhood native richness** | Soil fertility heterogeneity | 0.01 | 0.07 | 0.865 |
| **Neighbourhood exotic richness** | Soil fertility heterogeneity | -0.01e | 0.07e | 0.854 |
| **Metacommunity exotic richness** | Physical environment heterogeneity | -0.07 | 0.33 | 0.827 |
| **Neighbourhood plant density** | Physical environment heterogeneity | 0.02 | 0.09 | 0.804 |
| **Metacommunity native richness** | Physical environment heterogeneity | -0.27 | 0.44 | 0.559 |
| **Neighbourhood native richness** | Physical environment heterogeneity | 0.03 | 0.07 | 0.688 |
| **Neighbourhood exotic richness** | Physical environment heterogeneity | -0.22e | 0.07e | **0.003** |
| **Metacommunity exotic richness** | Canopy cover heterogeneity | -0.95 | 0.54 | 0.123 |
| **Neighbourhood plant density** | Canopy cover heterogeneity | 0.17 | 0.09 | 0.069 |
| **Metacommunity native richness** | Canopy cover heterogeneity | 0.35 | 1.07 | 0.753 |
| **Neighbourhood native richness** | Canopy cover heterogeneity | -<0.01 | 0.07 | 0.909 |
| **Neighbourhood exotic richness** | Canopy cover heterogeneity | -0.18e | 0.07e | **0.017** |
| **Metacommunity exotic richness** | Distance to remnant edge | -<0.01 | 0.34 | 0.986 |
| **Neighbourhood plant density** | Distance to remnant edge | -0.05 | 0.11 | 0.671 |
| **Metacommunity native richness** | Distance to remnant edge | -0.27 | 0.46 | 0.584 |
| **Community native richness** | Distance to remnant edge | -0.12 | 0.14 | 0.406 |
| **Neighbourhood native richness** | Distance to remnant edge | 0.16 | 0.08 | 0.073 |
| **Neighbourhood exotic richness** | Distance to remnant edge | -0.08e | 0.13e | 0.536 |
| **Metacommunity exotic richness** | Biocrust | 0.17 | 0.39 | 0.683 |
| **Metacommunity native richness** | Biocrust | 0.24 | 0.54 | 0.674 |
| **Community native richness** | Biocrust | 0.26 | 0.21 | 0.232 |
| **Community exotic richness** | Biocrust | -0.02 | 0.14 | 0.871 |
| **Metacommunity exotic richness** | Soil nitrogen | 0.03 | 0.40 | 0.934 |
| **Metacommunity native richness** | Soil nitrogen | 0.77 | 0.46 | 0.140 |
| **Community native richness** | Soil nitrogen | 0.04 | 0.24 | 0.873 |
| **Community exotic richness** | Soil nitrogen | -0.06 | 0.12 | 0.610 |
| **Metacommunity exotic richness** | CWD | -0.06 | 1.27 | 0.962 |
| **Metacommunity native richness** | CWD | 2.10 | 1.53 | 0.218 |
| **Community native richness** | CWD | -0.34 | 0.51 | 0.510 |
| **Community exotic richness** | CWD | 0.05 | 0.33 | 0.873 |
| **Metacommunity exotic richness** | Soil phosphorous | 0.27 | 0.39 | 0.521 |
| **Metacommunity native richness** | Soil phosphorous | -0.47 | 0.55 | 0.424 |
| **Community native richness** | Soil phosphorous | -0.07 | 0.21 | 0.748 |
| **Community exotic richness** | Soil phosphorous | -0.26 | 0.15 | 0.103 |
| **Metacommunity exotic richness** | Soil potassium | 0.55 | 0.31 | 0.114 |
| **Metacommunity native richness** | Soil potassium | -0.47 | 0.59 | 0.456 |
| **Community native richness** | Soil potassium | 0.31 | 0.16 | 0.064 |
| **Community exotic richness** | Soil potassium | -0.17 | 0.12 | 0.161 |
| **Metacommunity exotic richness** | Canopy cover | -1.04 | 0.82 | 0.246 |
| **Metacommunity native richness** | Canopy cover | -1.07 | 1.32 | 0.451 |
| **Community native richness** | Canopy cover | 0.48 | 0.27 | 0.096 |
| **Community exotic richness** | Canopy cover | -0.38 | 0.17 | **0.040** |
| **Metacommunity exotic richness** | Litter cover | -0.34 | 0.83 | 0.690 |
| **Metacommunity native richness** | Litter cover | 1.36 | 1.03 | 0.238 |
| **Community native richness** | Litter cover | -<0.01 | 0.29 | 0.980 |
| **Community exotic richness** | Litter cover | -0.08 | 0.14 | 0.589 |
| **Metacommunity exotic richness** | Soil hardness | 1.46 | 0.43 | **0.012** |
| **Metacommunity native richness** | Soil hardness | 0.75 | 1.54 | 0.644 |
| **Community native richness** | Soil hardness | -0.10 | 0.21 | 0.648 |
| **Community exotic richness** | Soil hardness | 0.15 | 0.14 | 0.307 |
| **Neighbourhood plant density** | Metacommunity exotic richness | -<0.01 | 0.21 | 0.994 |
| **Community native richness** | Metacommunity exotic richness | 0.34 | 0.36 | 0.375 |
| **Neighbourhood native richness** | Metacommunity exotic richness | 0.02 | 0.15 | 0.898 |
| **Neighbourhood exotic richness** | Metacommunity exotic richness | 0.13e | 0.27e | 0.642 |
| **Metacommunity native richness** | Neighbourhood plant density | 0.08 | 0.28 | 0.767 |
| **Community native richness** | Neighbourhood plant density | -0.01 | 0.30 | 0.964 |
| **Community exotic richness** | Neighbourhood plant density | 0.37 | 0.18 | 0.073 |
| **Community exotic richness** | Metacommunity native richness | 0.01 | 0.13 | 0.932 |
| **Neighbourhood native richness** | Metacommunity native richness | <0.01 | 0.13 | 0.977 |
| **Neighbourhood exotic richness** | Metacommunity native richness | 0.35e | 0.16e | **0.024** |
| **Neighbourhood exotic richness** | Community native richness | -0.02e | 0.10e | 0.839 |
| **Neighbourhood native richness** | Community exotic richness | -0.21 | 0.15 | 0.180 |
|  |  |  |  |  |

**Table S5.** Standardised parameter estimates obtained from missing path analyses for the native-driven gmSEM. Bold P-values indicate that the predictor was significant ( = 0.05). Parameter estimates for neighbourhood exotic richness are presented in *log*(units) and are denoted by *e*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Response** | **Predictor** | **Estimate** | **SE** | **P** |
| **Community native richness** | Moisture availability | -0.06 | 0.17 | 0.739 |
| **Community exotic richness** | Moisture availability | 0.08 | 0.12 | 0.517 |
| **Neighbourhood native richness** | Moisture availability | 0.02 | 0.08 | 0.860 |
| **Neighbourhood exotic richness** | Moisture availability | 0.36e | 0.18 | **0.040** |
| **Community native richness** | Growing season Tmin (°C) | -0.17 | 0.18 | 0.388 |
| **Community exotic richness** | Growing season Tmin (°C) | -0.11 | 0.15 | 0.463 |
| **Neighbourhood native richness** | Growing season Tmin (°C) | -0.13 | 0.10 | 0.224 |
| **Neighbourhood exotic richness** | Growing season Tmin (°C) | -0.29 e | 0.18 | 0.105 |
| **Neighbourhood plant density** | Mean distance between communities | -0.13 | 0.13 | 0.360 |
| **Community native richness** | Mean distance between communities | 0.14 | 0.15 | 0.379 |
| **Community exotic richness** | Mean distance between communities | 0.14 | 0.13 | 0.316 |
| **Neighbourhood native richness** | Mean distance between communities | 0.12 | 0.07 | 0.142 |
| **Neighbourhood exotic richness** | Mean distance between communities | 0.04e | 0.19e | 0.821 |
| **Metacommunity native richness** | Soil fertility heterogeneity | 0.39 | 0.57 | 0.515 |
| **Neighbourhood plant density** | Soil fertility heterogeneity | 0.09 | 0.08 | 0.292 |
| **Metacommunity exotic richness** | Soil fertility heterogeneity | 0.12 | 0.44 | 0.802 |
| **Neighbourhood native richness** | Soil fertility heterogeneity | 0.02 | 0.06 | 0.700 |
| **Neighbourhood exotic richness** | Soil fertility heterogeneity | -0.01e | 0.08e | 0.896 |
| **Metacommunity native richness** | Physical environment heterogeneity | -0.31 | 0.43 | 0.502 |
| **Neighbourhood plant density** | Physical environment heterogeneity | 0.02 | 0.09 | 0.804 |
| **Metacommunity exotic richness** | Physical environment heterogeneity | <0.01 | 0.34 | 0.989 |
| **Neighbourhood native richness** | Physical environment heterogeneity | 0.03 | 0.07 | 0.714 |
| **Neighbourhood exotic richness** | Physical environment heterogeneity | -0.25e | 0.08e | **0.001** |
| **Metacommunity native richness** | Canopy cover heterogeneity | -0.21 | 0.89 | 0.819 |
| **Neighbourhood plant density** | Canopy cover heterogeneity | 0.17 | 0.09 | 0.069 |
| **Metacommunity exotic richness** | Canopy cover heterogeneity | -0.91 | 0.55 | 0.150 |
| **Neighbourhood native richness** | Canopy cover heterogeneity | -0.04 | 0.07 | 0.511 |
| **Neighbourhood exotic richness** | Canopy cover heterogeneity | -0.20e | 0.08e | **0.013** |
| **Metacommunity native richness** | Distance to remnant edge | -0.27 | 0.46 | 0.574 |
| **Neighbourhood plant density** | Distance to remnant edge | -0.05 | 0.11 | 0.671 |
| **Metacommunity exotic richness** | Distance to remnant edge | 0.07 | 0.35 | 0.859 |
| **Community native richness** | Distance to remnant edge | -0.15 | 0.14 | 0.292 |
| **Neighbourhood native richness** | Distance to remnant edge | 0.14 | 0.07 | 0.064 |
| **Neighbourhood exotic richness** | Distance to remnant edge | -0.09e | 0.13e | 0.494 |
| **Metacommunity native richness** | Biocrust | 0.31 | 0.53 | 0.570 |
| **Metacommunity exotic richness** | Biocrust | 0.09 | 0.41 | 0.833 |
| **Community native richness** | Biocrust | 0.23 | 0.21 | 0.295 |
| **Community exotic richness** | Biocrust | <0.01 | 0.14 | 0.982 |
| **Metacommunity native richness** | CWD | 2.07 | 1.54 | 0.222 |
| **Metacommunity exotic richness** | CWD | -0.75 | 1.40 | 0.615 |
| **Community native richness** | CWD | -0.40 | 0.52 | 0.451 |
| **Community exotic richness** | CWD | 0.13 | 0.34 | 0.697 |
| **Metacommunity native richness** | Soil phosphorous | -0.31 | 0.54 | 0.581 |
| **Metacommunity exotic richness** | Soil phosphorous | 0.36 | 0.39 | 0.393 |
| **Community native richness** | Soil phosphorous | -0.10 | 0.21 | 0.647 |
| **Community exotic richness** | Soil phosphorous | -0.31 | 0.15 | 0.053 |
| **Metacommunity native richness** | Soil potassium | -0.06 | 0.51 | 0.915 |
| **Metacommunity exotic richness** | Soil potassium | 0.57 | 0.30 | 0.103 |
| **Community native richness** | Soil potassium | 0.14 | 0.16 | 0.397 |
| **Community exotic richness** | Soil potassium | -0.18 | 0.12 | 0.139 |
| **Metacommunity native richness** | Canopy cover | -1.36 | 1.13 | 0.266 |
| **Metacommunity exotic richness** | Canopy cover | -0.83 | 0.95 | 0.416 |
| **Community native richness** | Canopy cover | 0.52 | 0.21 | **0.026** |
| **Community exotic richness** | Canopy cover | -0.35 | 0.18 | 0.068 |
| **Metacommunity native richness** | Litter cover | 1.16 | 1.06 | 0.310 |
| **Metacommunity exotic richness** | Litter cover | -0.75 | 0.87 | 0.419 |
| **Community native richness** | Litter cover | 0.19 | 0.24 | 0.445 |
| **Community exotic richness** | Litter cover | <0.01 | 0.17 | 0.992 |
| **Metacommunity native richness** | Soil hardness | 0.98 | 0.88 | 0.302 |
| **Metacommunity exotic richness** | Soil hardness | 1.42 | 0.50 | **0.030** |
| **Community native richness** | Soil hardness | -0.20 | 0.19 | 0.299 |
| **Community exotic richness** | Soil hardness | 0.14 | 0.14 | 0.317 |
| **Metacommunity native richness** | Soil nitrogen | 0.79 | 0.46 | 0.129 |
| **Metacommunity exotic richness** | Soil nitrogen | -0.24 | 0.47 | 0.632 |
| **Community native richness** | Soil nitrogen | 0.16 | 0.23 | 0.507 |
| **Community exotic richness** | Soil nitrogen | -0.01 | 0.14 | 0.921 |
| **Neighbourhood plant density** | Metacommunity native richness | 0.14 | 0.14 | 0.372 |
| **Community exotic richness** | Metacommunity native richness | 0.16 | 0.15 | 0.329 |
| **Neighbourhood native richness** | Metacommunity native richness | 0.06 | 0.11 | 0.626 |
| **Neighbourhood exotic richness** | Metacommunity native richness | 0.32e | 0.17e | 0.054 |
| **Metacommunity exotic richness** | Neighbourhood plant density | -0.11 | 0.23 | 0.647 |
| **Community native richness** | Neighbourhood plant density | -0.07 | 0.29 | 0.803 |
| **Community exotic richness** | Neighbourhood plant density | 0.35 | 0.19 | 0.098 |
| **Community native richness** | Metacommunity exotic richness | 0.01 | 0.30 | 0.986 |
| **Neighbourhood native richness** | Metacommunity exotic richness | 0.06 | 0.16 | 0.726 |
| **Neighbourhood exotic richness** | Metacommunity exotic richness | -0.08e | 0.26e | 0.754 |
| **Neighbourhood exotic richness** | Community native richness | -0.09e | 0.10e | 0.392 |
| **Neighbourhood native richness** | Community exotic richness | -0.11 | 0.14 | 0.439 |
|  |  |  |  |  |