SUPPLEMENTARY INFORMATION

SI Appendix

In this appendix, we evaluate several potential explanations for our failure to detect negative effects of the AHTO on species richness. These include technical failures (edge effects), confounding effects (differences among treatments in the size of their species pools), a failure to satisfy the assumptions of models predicting negative effects of the AHTO (insufficient heterogeneity and insufficient dispersal among local communities) ,and insufficient time to obtain significant extinctions.

Edge effects

Mesocosm experiments like the one conducted in our study are prone to edge effects (28). Indeed, our observations at the last year of the experiment have indicated that some containers were less dense at their margins, particularly at the periphery of the metacommunity. We therefore sampled the plants in each container in a manner that allowed us to test for edge effects on both species richness and species composition (Fig. S1). The results (Figs. S2, S3) indicated that neither richness, nor species composition showed any evidence for edge effects. We conclude that edge effects were not an issue in our experiment.

Differences among treatments in the size of their species pools

Differences in habitat-specific species pools may introduce both negative and positive bias into estimated effects of heterogeneity on species richness. The 'habitats' used in our experiment were known to differ in the size of their species pools (31), but our experiment was explicitly designed to avoid any correlation between habitat heterogeneity and species pool sizes, thereby preventing such bias (see 'Experimental design' in Methods).

Insufficient heterogeneity

The AHTO assumes that increasing heterogeneity reduces the average amount of area available per species. This assumption requires that heterogeneity should be measured as perceived by the species (`functional heterogeneity` sensu 56). Obviously, if species perceive different habitats as effectively similar (due to small differences in ecological conditions and/or large niche widths), increasing the number of habitats is not expected to have a significant effect on species richness.

In this experiment, we applied treatments ('habitats') that have previously been found to be important in determining the composition of the study species (47, 49, 50, 59, 60). Ordination analyses based on the data from the homogeneous metacommunities indicated that the study species were sensitive to at least some of these treatments (Fig. S4). The largest compositional differences were found between shallow and deep soils, and between the NPK treatment and the other treatments under deep soil conditions (Fig. S4). Moreover, our results show that the magnitude of compositional dissimilarity among the eight local communities *within* metacommunities (calculated using the Jaccard index of dissimilarity) increased significantly with increasing heterogeneity (Fig. S5). This result provides a clear evidence that increasing heterogeneity increased the range of ecological conditions as perceived by the study species.

Insufficient dispersal

Another assumption of the AHTO is that individuals are able to disperse among habitats. It is therefore possible that our failure to detect significant negative effects of the AHTO on species richness reflects lack or insufficient seed dispersal among local communities.

To test this possibility, we compared the number of species in isolated local communities (communities in containers of 50x50cm that were blocked for dispersal) with that of local communities of the same habitat that were embedded within heterogeneous metacommunities with H=8 (i.e., communities that were open to dispersal from all other habitats in the metacommunity). Isolated local communities were available for three treatments - Control, NPK, and Clipping, all under deep soil conditions. The results (Fig. S6) showed that local communities embedded within heterogeneous metacommunities had significantly more species than isolated local communities of the same size and treatment. Moreover, for metacommunities with deep soil, local communities embedded within heterogeneous metacommunities had significantly more species than local communities embedded within uniform metacommunities of the same habitat (Fig S7). These findings confirm that both habitat heterogeneity *and* dispersal among habitats were highly effective in our experimental system.

Insufficient extinctions

The proximate process responsible for the negative effect of the AHTO on species richness is species extinctions. Thus, the simplest explanation for our failure to detect a negative effect of the AHTO on species richness might be that the duration of the experiment was not sufficiently long to obtain enough extinctions. The ability of many species to maintain a viable seed bank in the soil contributes to the plausibility of this explanation.

However, a comparison of the average number of species observed in individual containers between the first year and the last year of the experiment revealed a strong and highly significant decline in richness (from an average of 28.12 to 11.29 species per container, Fig 5a). This decline (60%) confirms that the lack of a negative effect of the AHTO on species richness in our experiment could not be attributed to lack of extinctions.

These overall results indicate that our failure to detect a negative effect of the AHTO on species richness cannot be explained by edge effects, differences among habitats in their species pools, failure to generate effective (‘functional') heterogeneity, lack of among-habitat dispersal, or insufficient extinctions.

SI Figures

Figure S1. Design of data collection in the mesocosm metacommunities at the last (fourth) year of the experiment. Species presence-absence data were taken separately in the center (green squares) and the periphery (brown area) of each container in each metacommunity. All analyses except for calculation of extinction rates were performed using the data collected at the centers of the containers. Values in container centers indicate the number of outer edges in the relevant container (used for testing edge effects, see Figs. S2, S3).

Figure S2. Effect of container position within the metacommunity (expressed by the number of outer edges, see Fig. S1) on the number of species at the center (25x25cm area) of the container. A separate analysis was performed for metacommunities representing each of the eight 'habitats'. For each metacommunity we calculated the average number of species in containers of each edge category and these values were averaged over all metacommunities subjected to the relevant habitat. Error bars indicate means ± 2SE. The effect of edge category was not significant ($P > 0.35$) in a two-way ANOVA with habitat type and number of outer edges as main effects.

Figure S3. Effect of container position within the metacommunity (expressed by the number of outer edges, see Fig. S1) on species composition at the center (25x25cm area) of the container. Results shown are NMDS ordination analyses based on the Jaccard index of dissimilarity. Each analysis focuses on 48 containers (six homogeneous metacommunities with eight containers per metacommunity). Colors indicate the number of outer edges in the container (see Fig. S1).

Figure S4. NMDS ordination (based on the Jaccard index of similarity) of species composition in all containers of the homogeneous metacommunities (eight 'habitats' x six metacommunities per habitat x 8 containers per metacommunity = 384 local communities). Colors indicate habitat types. Triangles are centroids of specific habitats (marked by their color), error-bars indicate means ±2 SE of the NMDS axes. Note that in many cases a single dot represents multiple containers.

Figure S5. Effect of habitat heterogeneity on compositional dissimilarity *among local communities within metacommunities*. For each metacommunity we calculated the mean Jaccard index of dissimilarity among all possible pairs of containers and averaged the resulting means over all metacommunities subjected to the relevant level of heterogeneity. Note that, although values of the Jaccard index within a metacommunity are not independent, different metacommunities can be treated as independent observations ($F_{3,91} = 5.93$, $P < 0.001$, One-way ANOVA).

Figure S6. Differences in species richness between isolated local communities (no dispersal) and local communities of the same size and same habitat embedded within heterogeneous metacommunities of H=8. Isolated local communities were available for three treatments - Control, Clipping, and NPK under deep soils. A two-way factorial ANOVA with differences among isolated and non-isolated local communities and treatment as main effects showed that both effects were highly significant (Dispersal: $F_{1,75} = 12.9$, $P < 0.001$; Treatment: $F_{1,75} = 35.7$, $P < 0.001$).

Figure S7. Differences in species richness between local communities embedded within homogeneous metacommunities and local communities of the same size and same habitat embedded within heterogeneous metacommunities of H=8 (*n* = 48 and 11 per habitat type, respectively). A separate comparison was performed for each type of habitat. Error bars indicate ±2SE.

Fig. S1

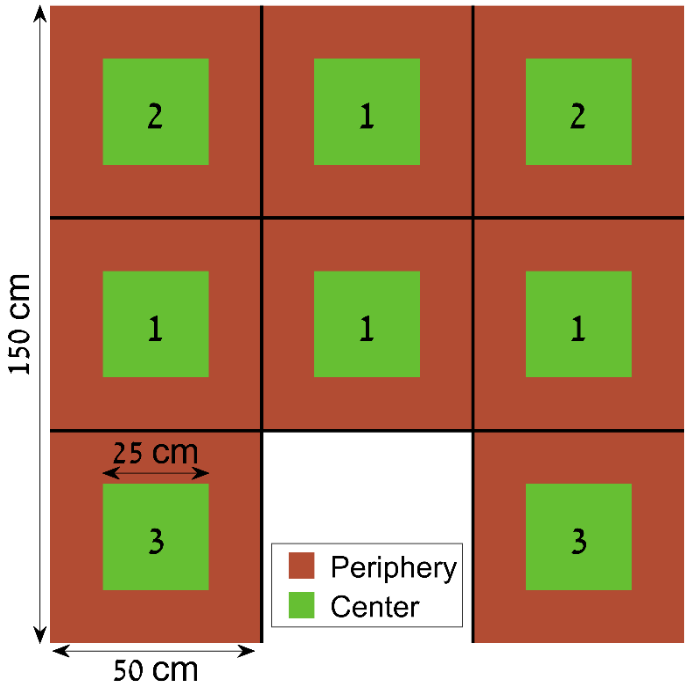
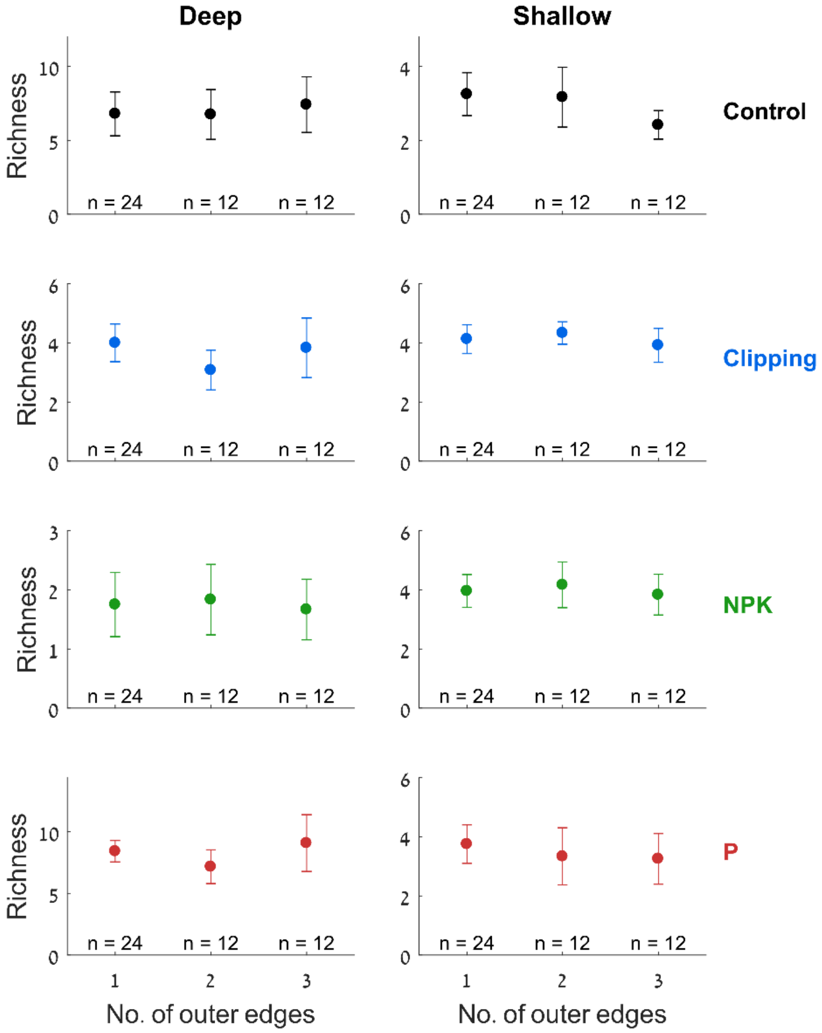


Fig. S2


Deep
Shallow
Control
Clipping
NPK
P
Richness
No. of outer edges
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n = 12
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2
3
0
5
10
2
4
6
1
3

142

Fig. S3

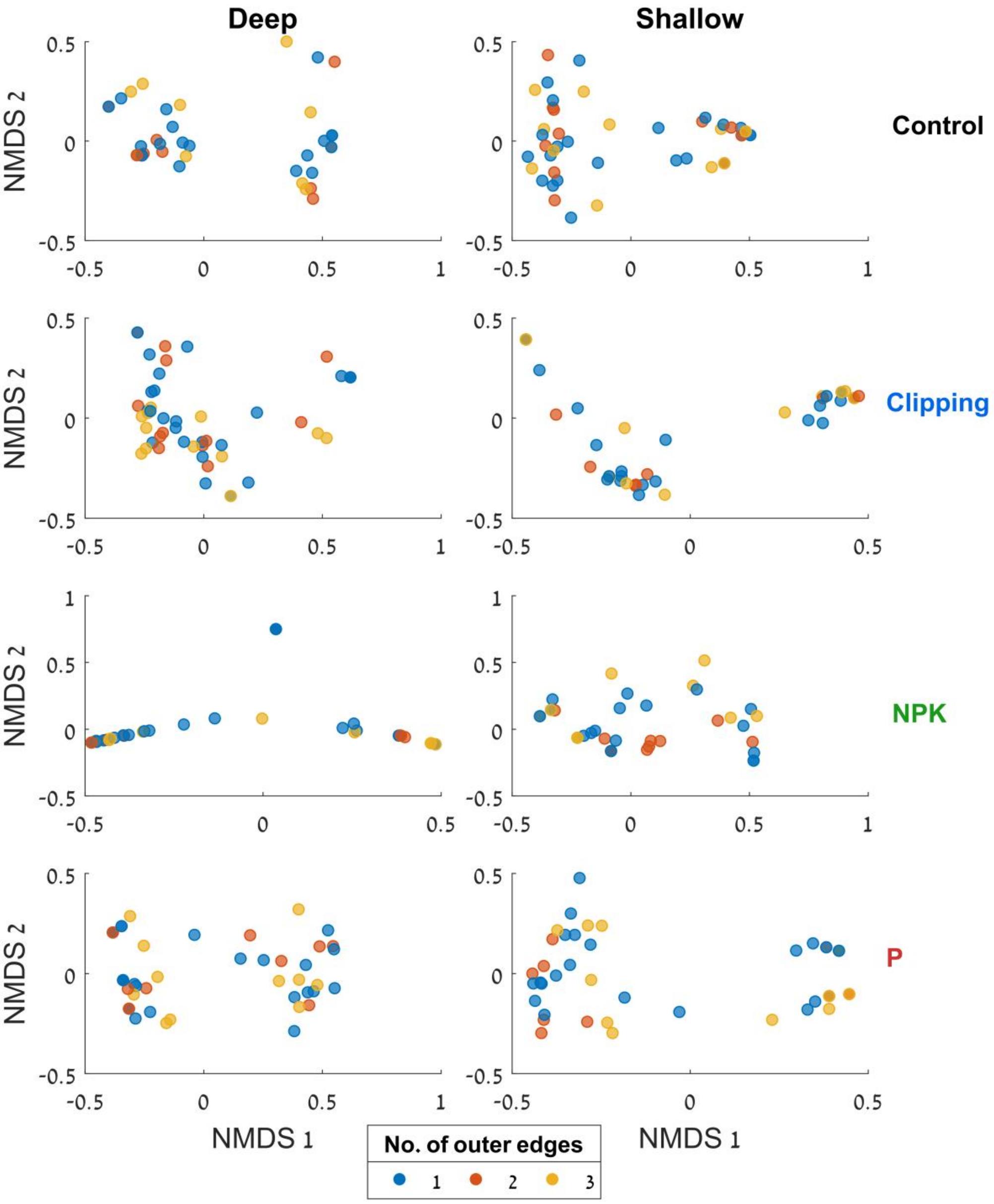

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Fig. S4

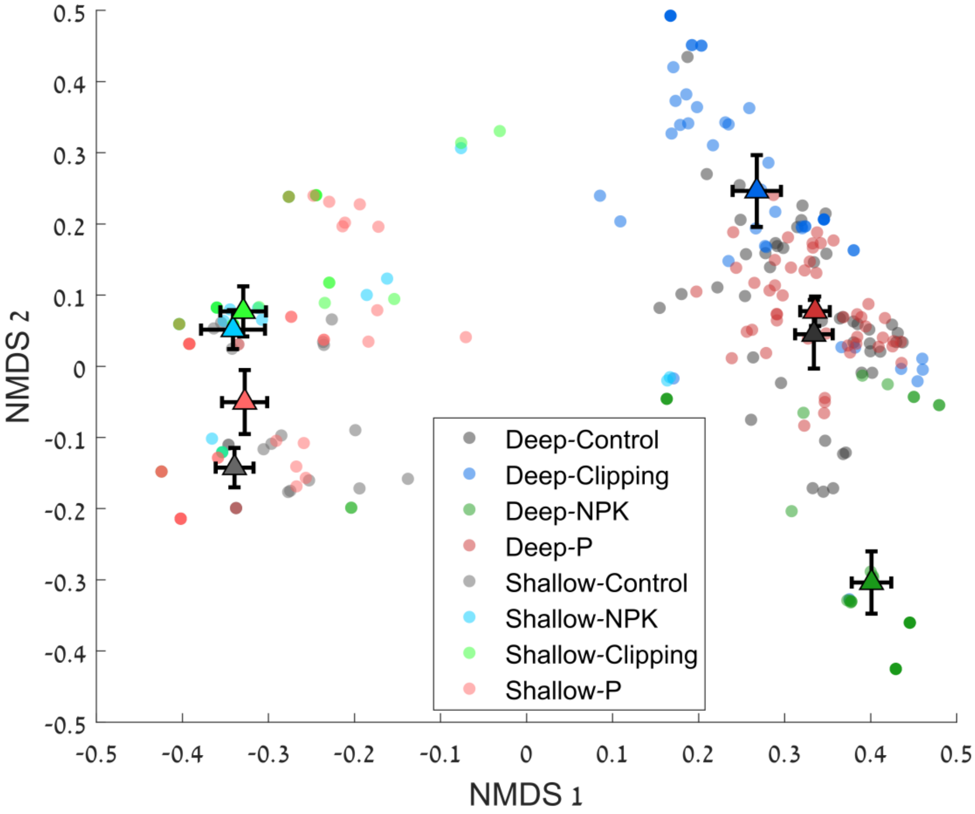

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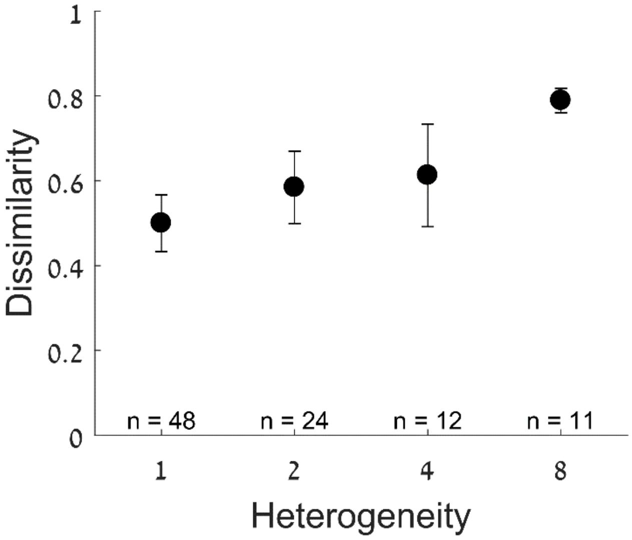
Fig. S5


Dissimilarity
1
0.8
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0.2
0
n = 48
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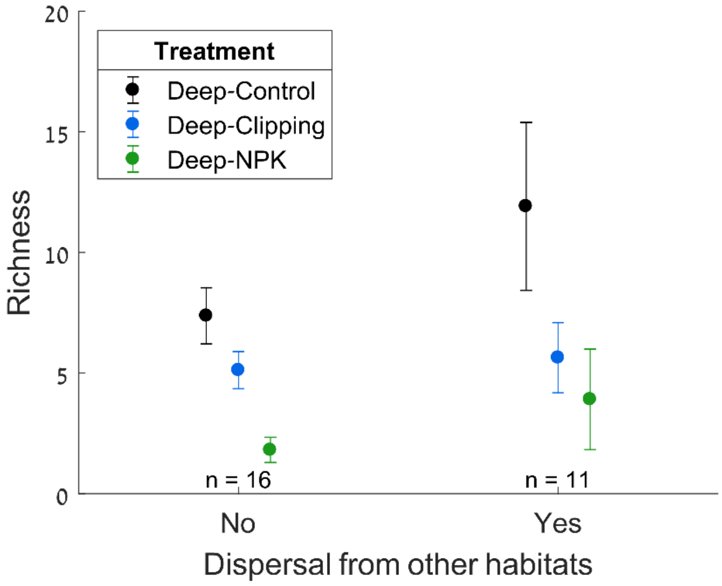
n = 12
n = 11
1
2
4
8
Heterogeneity

Fig. S6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15
10
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Deep-Clipping
Deep-NPK
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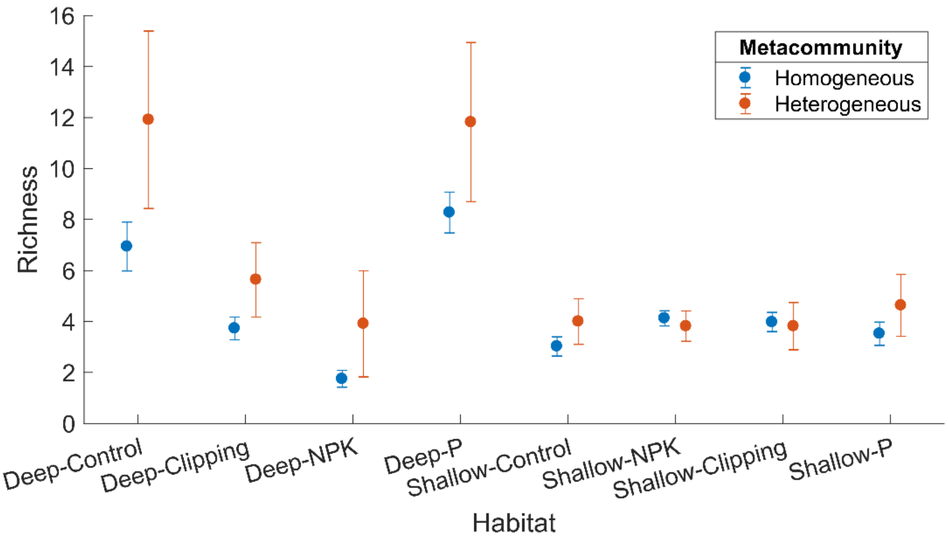
n = 11
No
Yes
Dispersal from other habitats

155 **Fig. S7**



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