Appendix – *Figures*

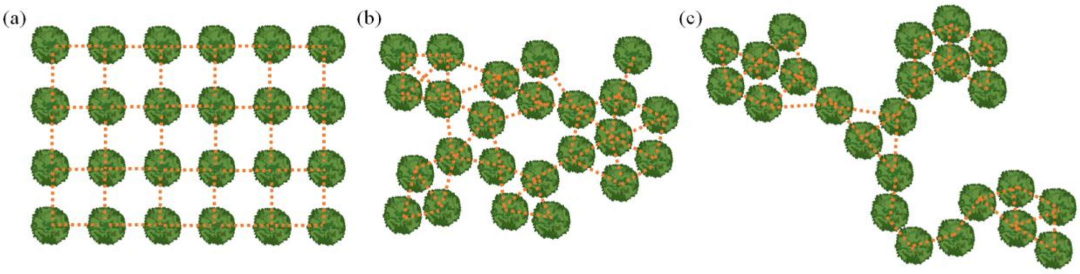

Figure S1. Sketch of woodland landscapes with differing dispersal properties for a tree dwelling species that is able to cross a small distance on open ground (orange links). (a) Trees are regularly spaced as they might be in a tree farm. (b) Trees are more randomly distributed with smaller and larger gaps, e.g. natural forest. (c) Clusters of trees are separated by large distances and connected by narrow lanes, e.g. fragmented habitats.

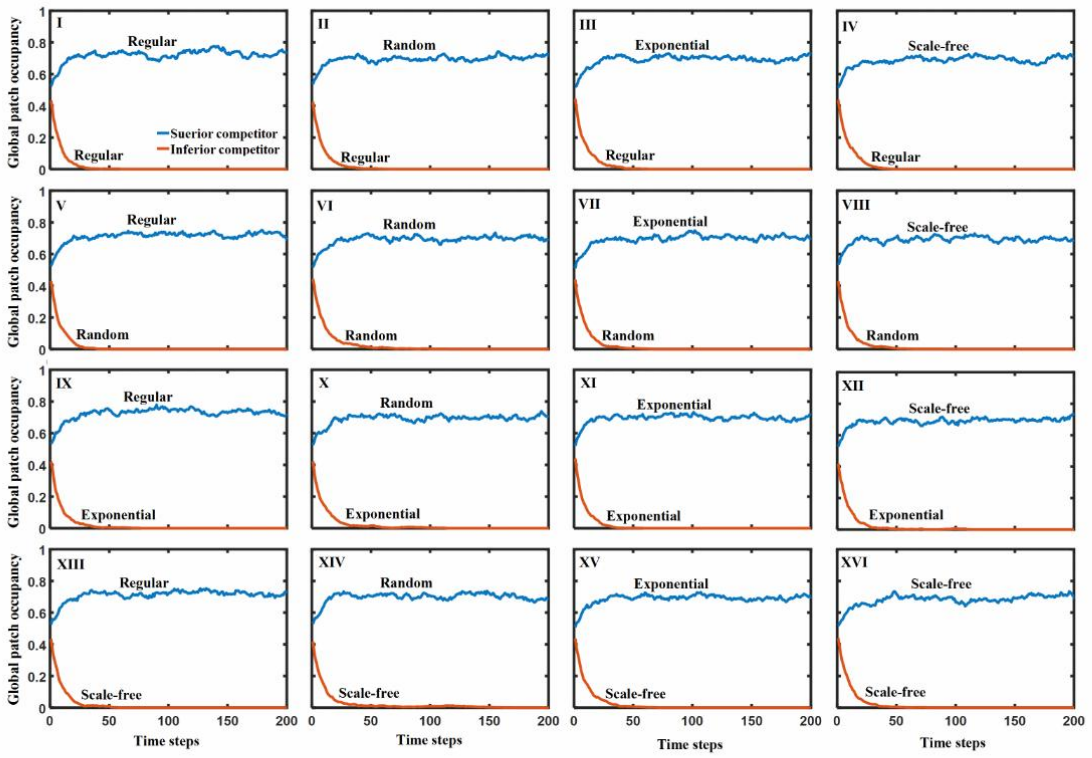

Figure S2. Patch dynamics of a community of two competitors where competitive displacement is allowed. The superior competitor always drives the inferior competitor to extinction regardless of the heterogeneity of their dispersal networks (see labels in plots) and whether they disperse on different dispersal networks. Networks contain 1024 patches and 2048 links, colonization and extinction rates are the same for both species: c=e=0.05.

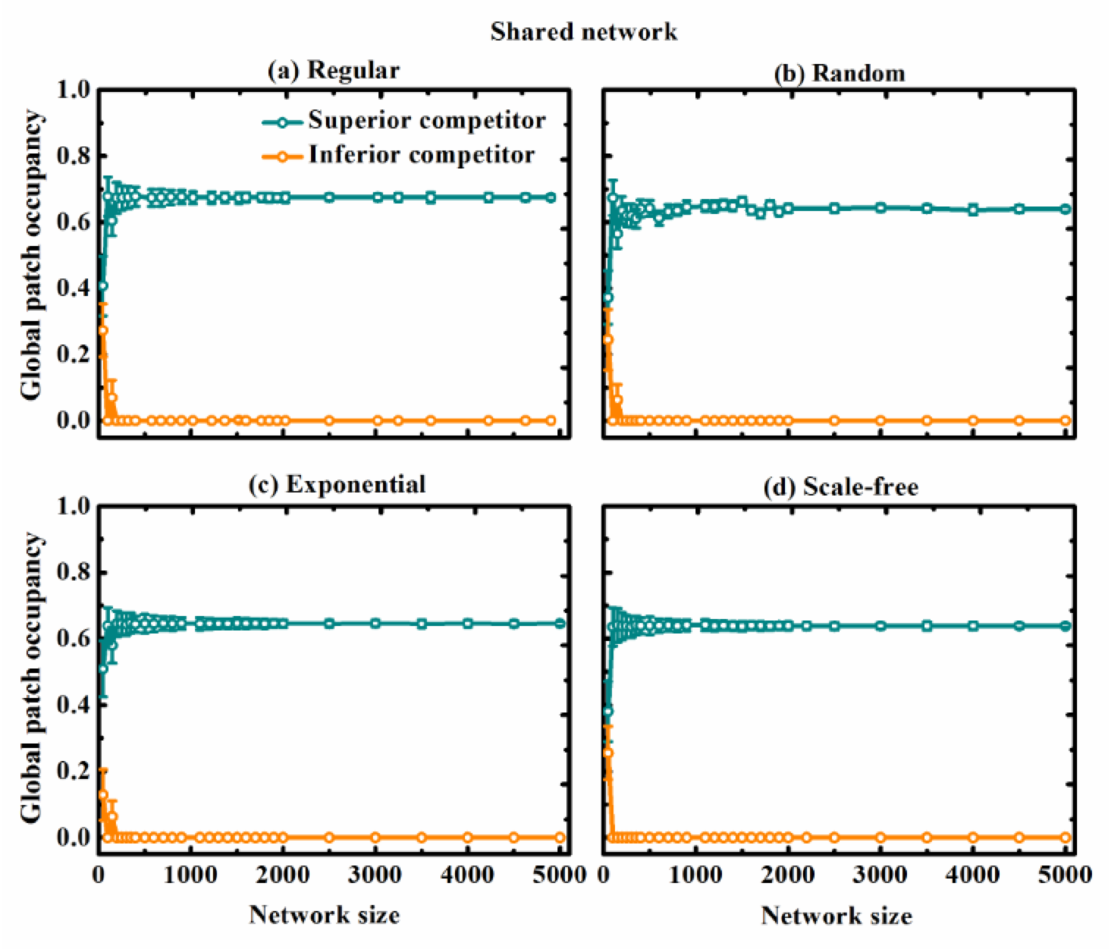

Figure S3. Steady-state patch occupancy (mean ± SD of 100 replicates) of two competing species on shared dispersal networks against network size. Regardless of the level of heterogeneity within the network (see *Methods*), increasing network size favors the superior competitor on shared networks, while the inferior competitor is driven to extinction. All networks have the same average degree $\bar{k}$=4, colonization and extinction rates are the same for both species: c=e=0.05.

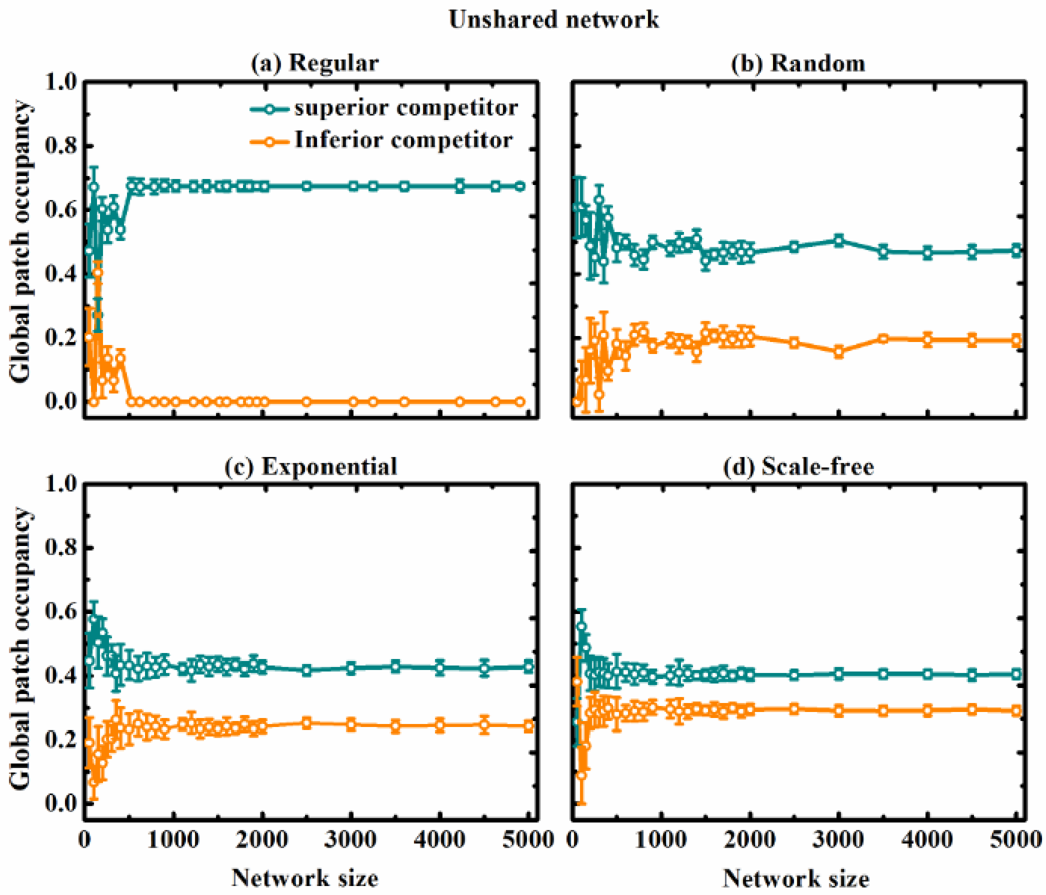

Figure S4. Steady-state patch occupancy (mean ±SD of 100 replicates) of two competing species on unshared dispersal networks against network size. Increasing the level of heterogeneity in these dispersal networks favors the inferior competitor and thus promotes species coexistence. All networks have the same average degree $\bar{k}$=4, colonization and extinction rates are the same for both species: c=e=0.05.

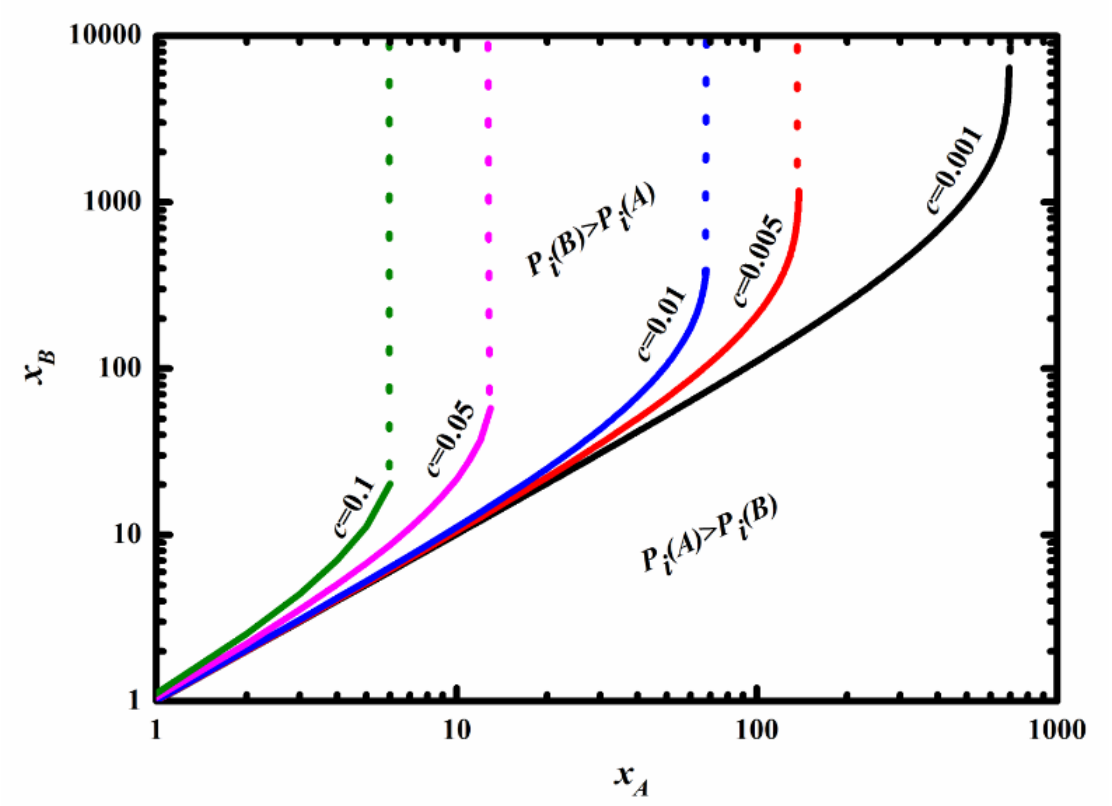

Figure S5. Threshold curves (colored lines; see Eq. 5) at which the inferior competitor B ($P_i(B)$) has the same probability to colonize an unoccupied patch as the superior competitor A ($P_i(A)$). The inferior competitor B is more likely to be able to colonize the unoccupied patch when it occupies more of the sites linking to it (x_B) than the superior species A (top left region). However, once the number of sites occupied by species A linking to the unoccupied site (x_A) exceeds a certain threshold (determined by the colonization rate c), species A can have a better chance to colonize the site (bottom right region).

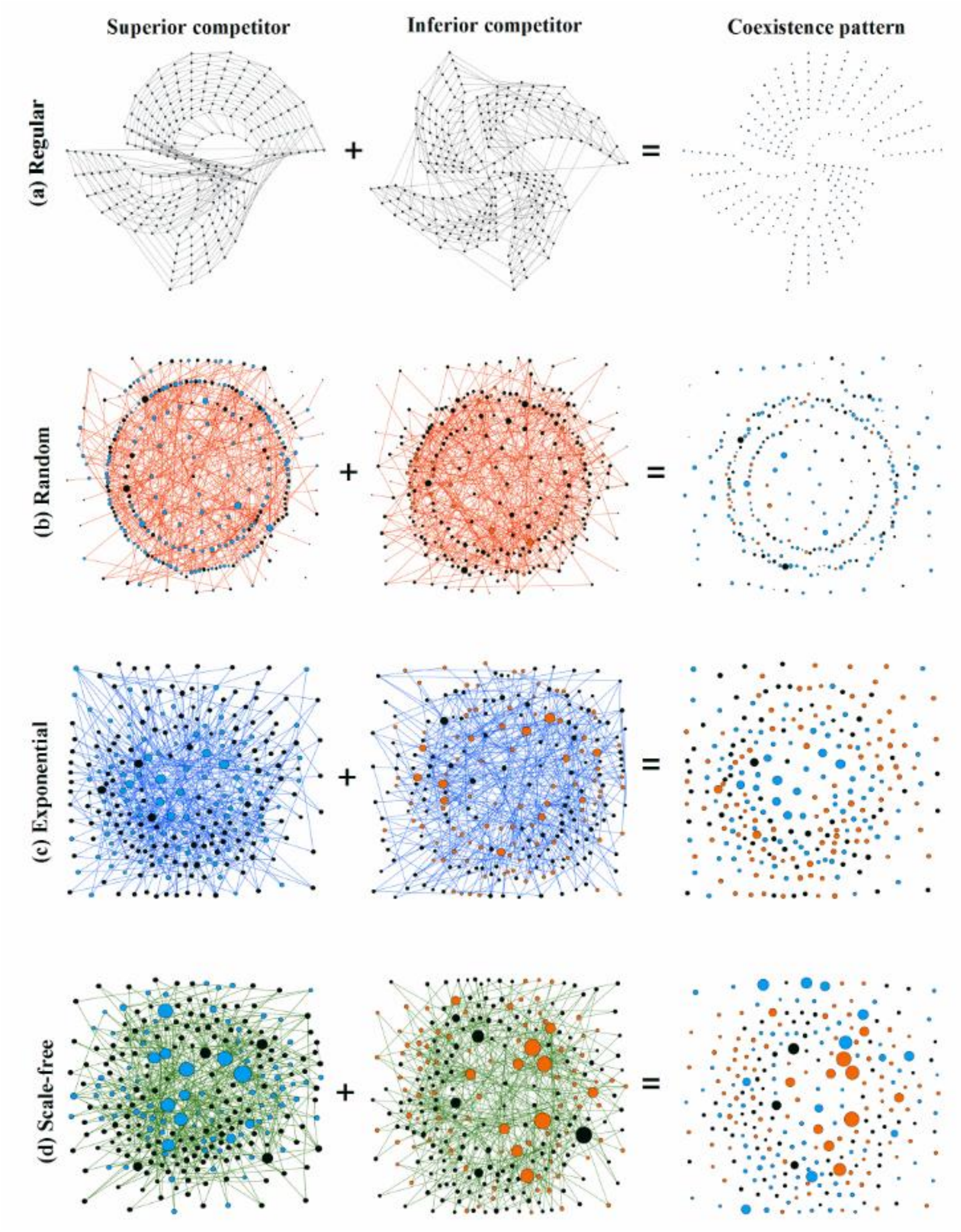

Figure S6. Coexistence patterns for two competitors on unshared networks (256 patches and 512 links) with the same heterogeneity at *t*=10,000. Species form spatially aggregated clusters around nodes of high degree (indicated by node size; black nodes are empty patches, otherwise node color indicates species). Colonization and extinction rates for both species *c*=*e*=0.05.

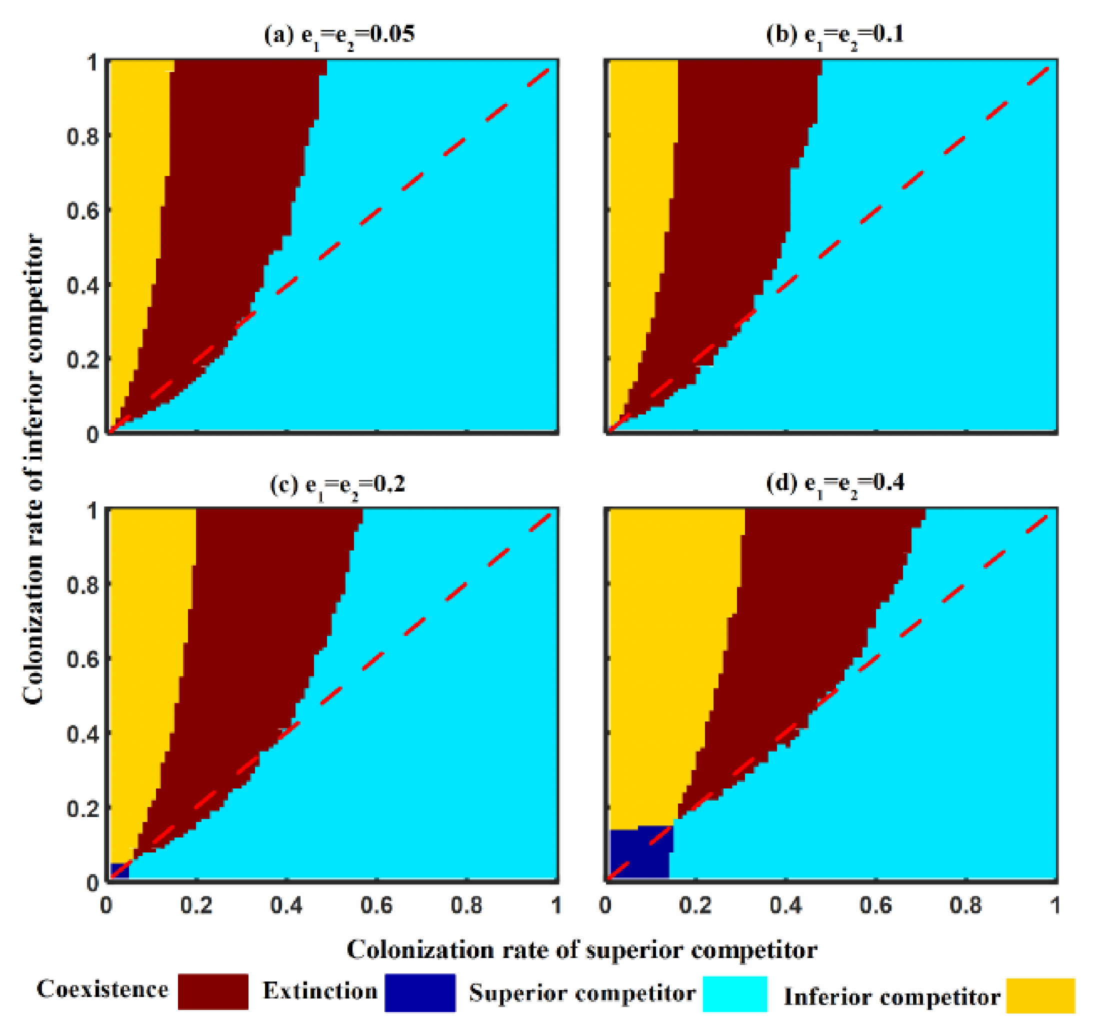

Figure S7. Effects of colonization rates on the competitive outcome between two species on unshared scale-free networks (containing 1024 patches and 2048 links). Coexistence is possible at intermediate levels of the colonization rate of the superior competitor.

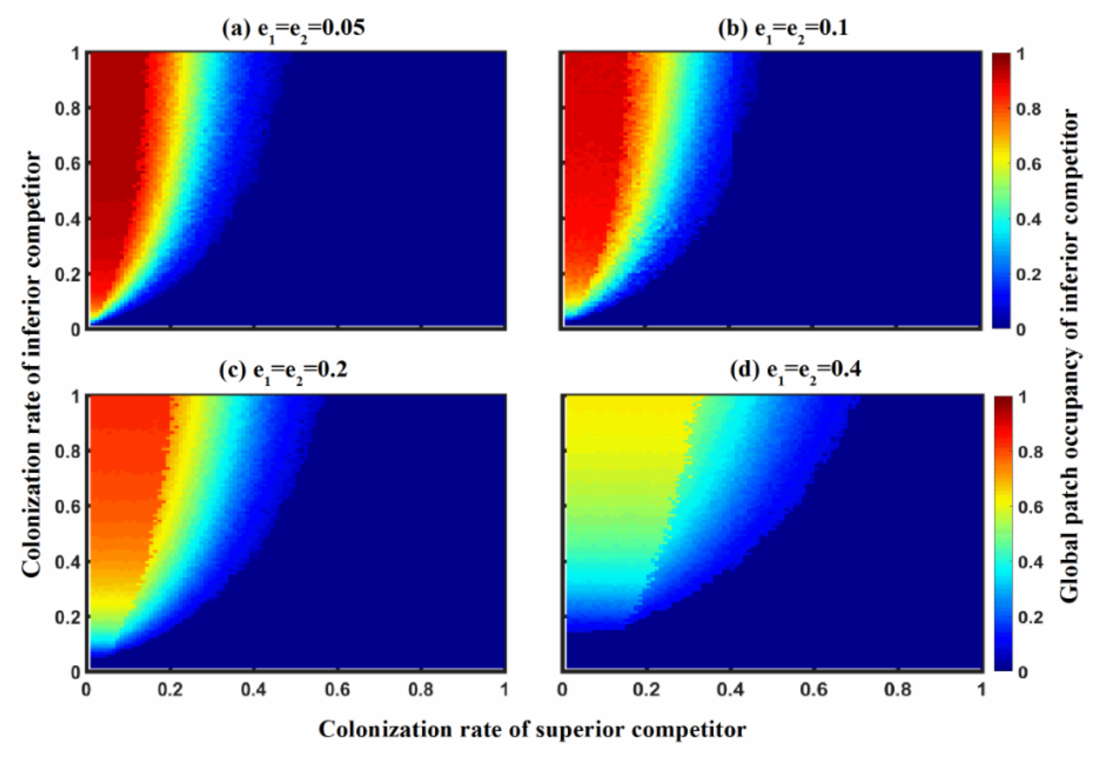

Figure S8. Interactive effects of variation in both species colonization rates on global patch occupancy of the inferior competitor at steady state in unshared scale-free dispersal networks, corresponding to Fig. S7.

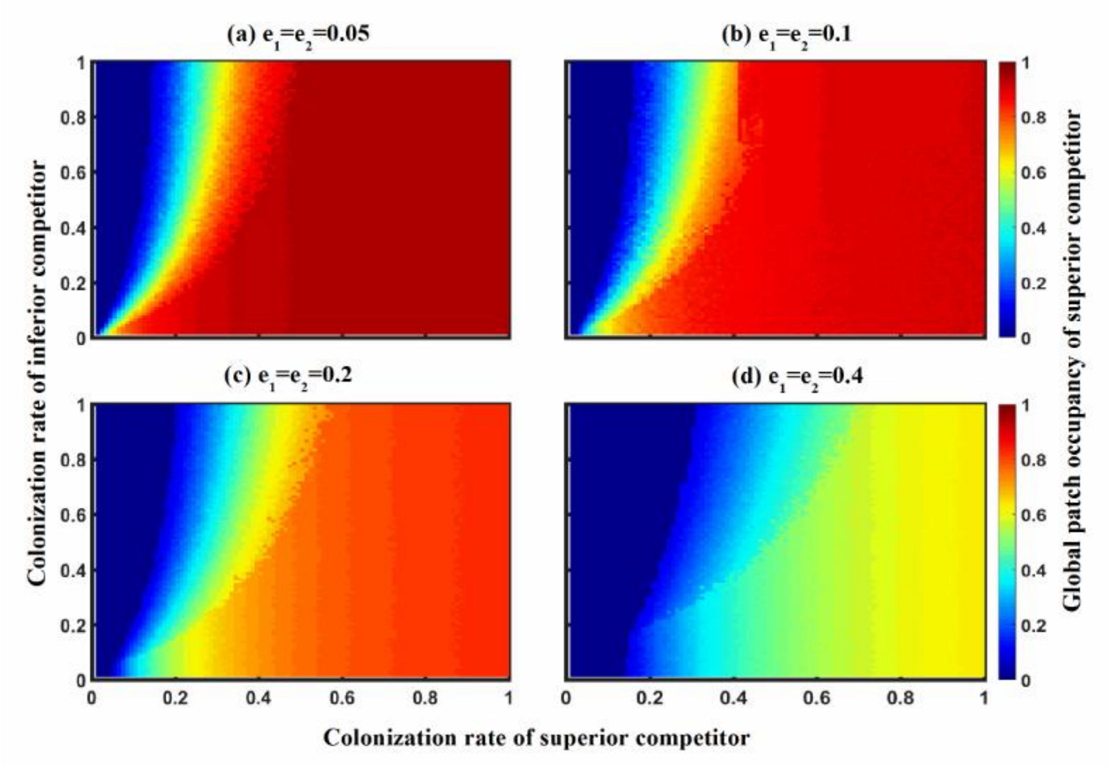

Figure S9. Interactive effects of variation in both species colonization rates on global patch occupancy of the superior competitor at steady state in unshared scale-free dispersal networks, corresponding to Fig. S7.

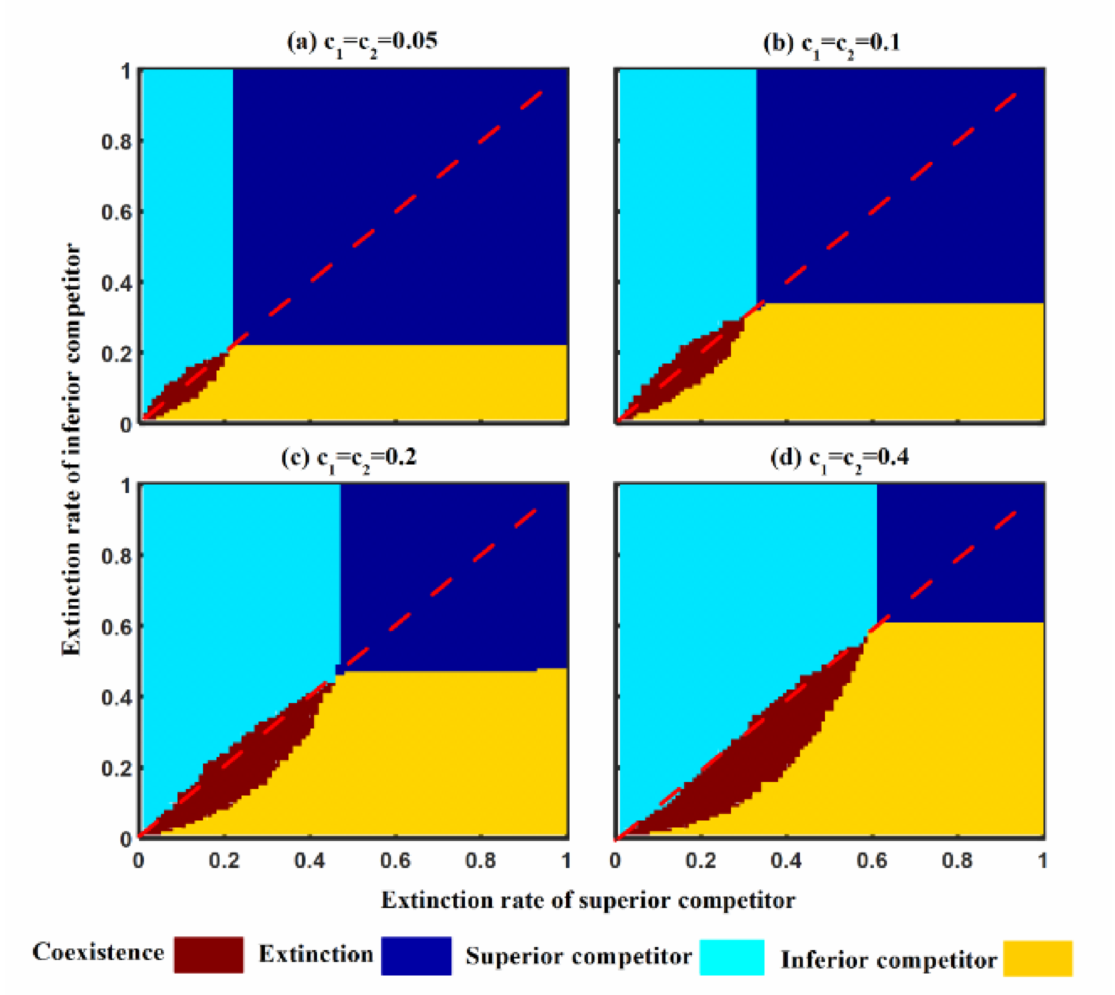

Figure S10. Effects of extinction rates on the competitive outcomes between two species on unshared scale-free dispersal networks (1024 patches and 2048 links). Both species become extinct when their extinction rates exceed a certain threshold determined by the colonization rate. Outside of this region, each species dominates when its extinction rate is much lower than that of the other species. A region of coexistence occurs when extinction rates are similar.

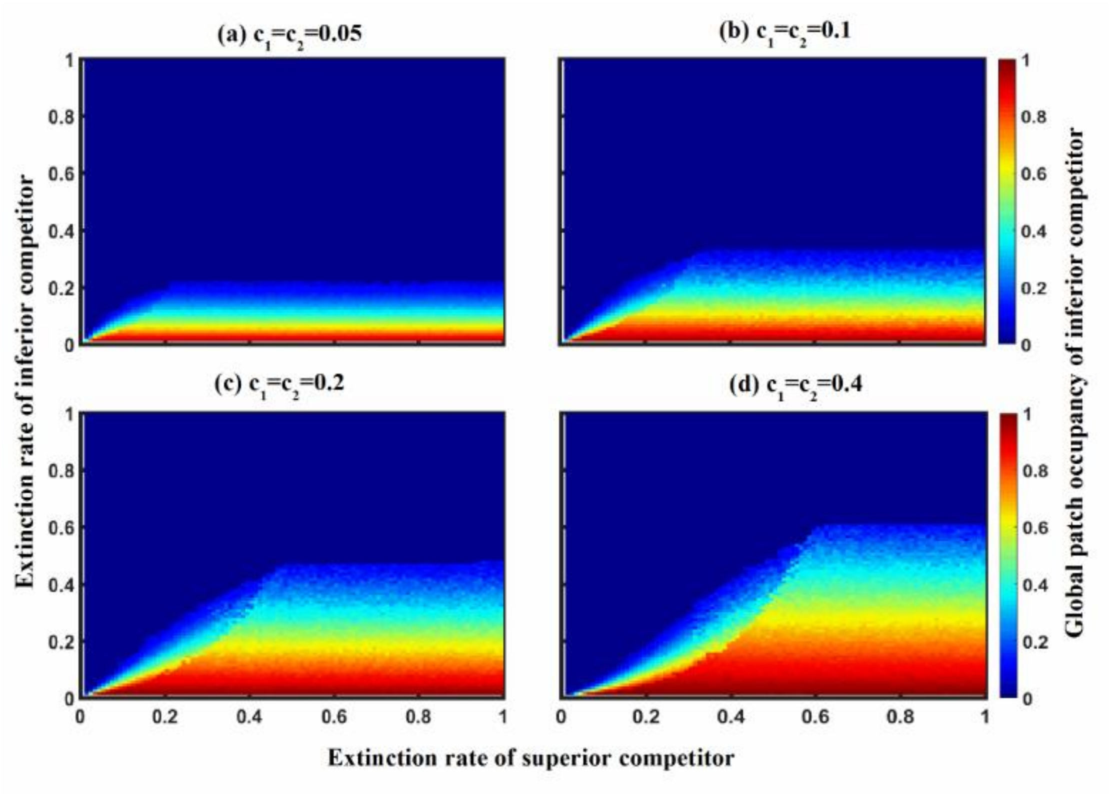

Figure S11. Interactive effects of variation in both species extinction rates on global patch occupancy of the inferior species at steady state in unshared scale-free dispersal networks, corresponding to Fig. S10.

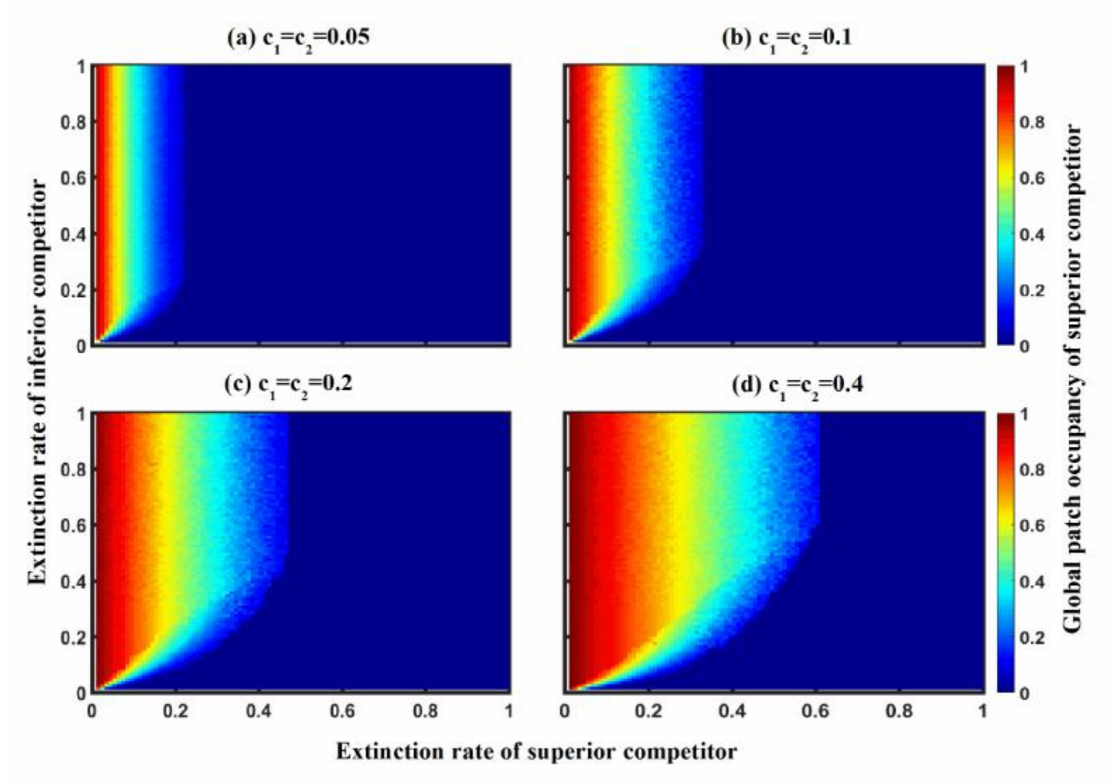

Figure S12. Interactive effects of variation in both species extinction rates on global patch occupancy of the superior species at steady state in unshared scale-free dispersal networks, corresponding to Fig. S10.

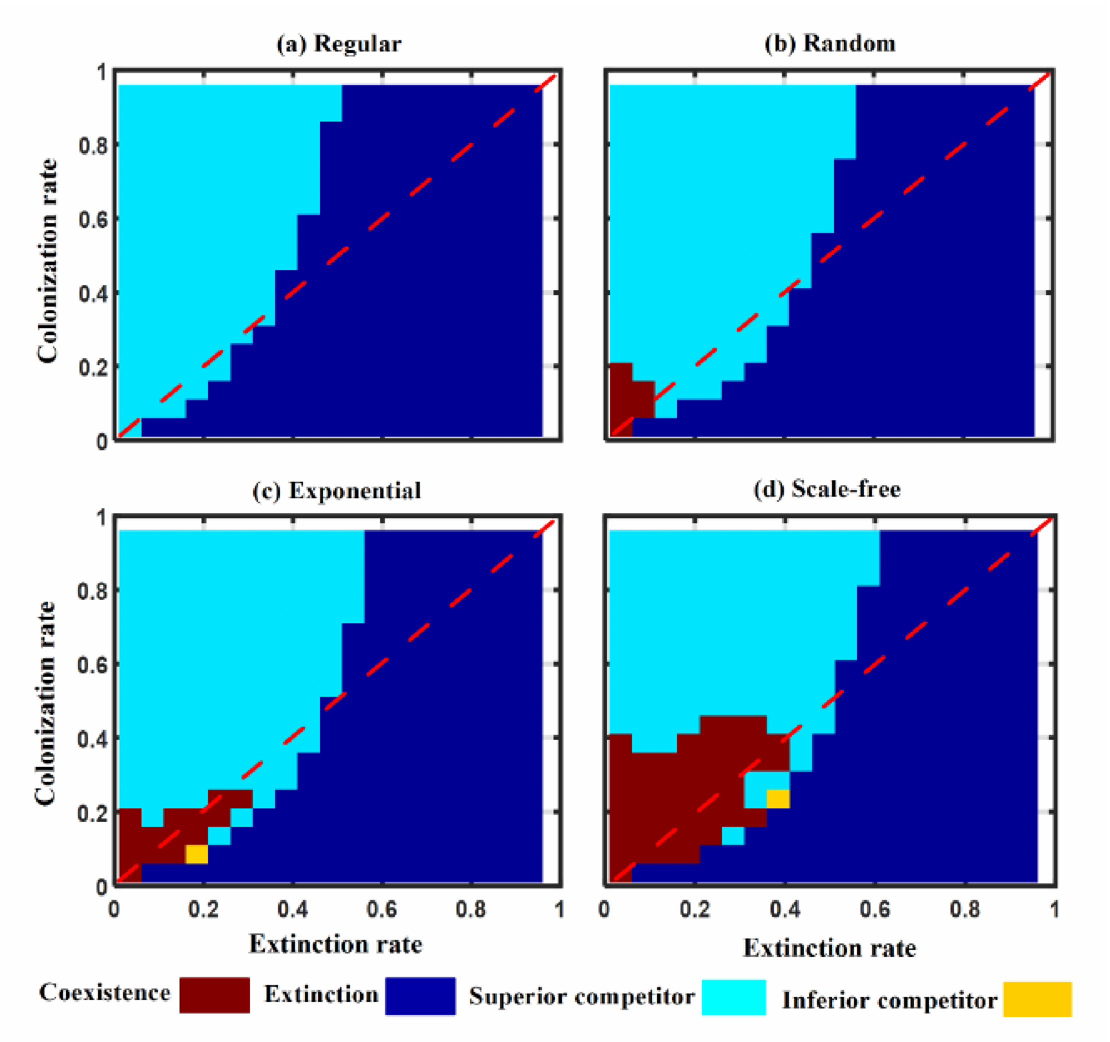

Figure S13. Competitive outcomes between two species with the same colonization and extinction rates on unshared dispersal networks (1024 patches and 2048 links) of different levels of heterogeneity. In general, the superior competitor excludes the inferior species unless both species become extinct. As network heterogeneity increases, a coexistence region emerges at low to intermediate colonization and extinction rates.

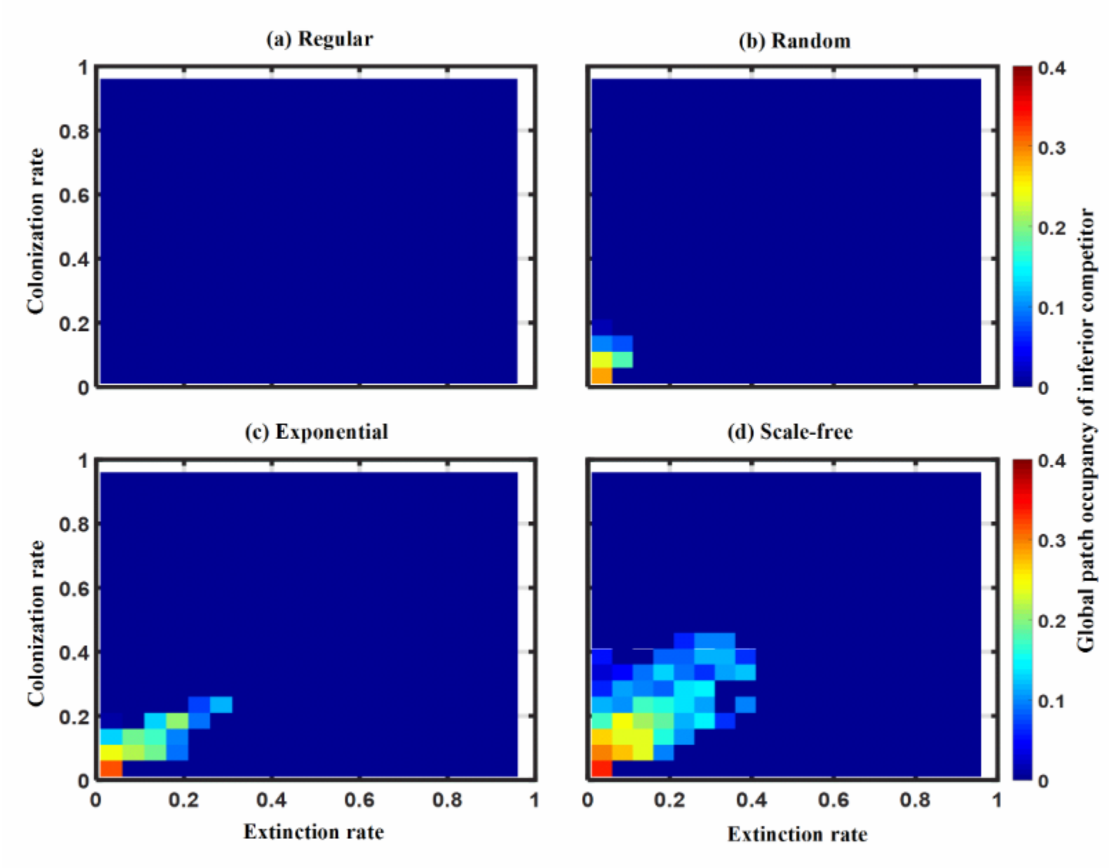

Figure S14. Interactive effects of variation in both extinction and colonization rates for two competing species on global occupancy of the inferior species at steady state in unshared dispersal networks, corresponding to Fig. S13.

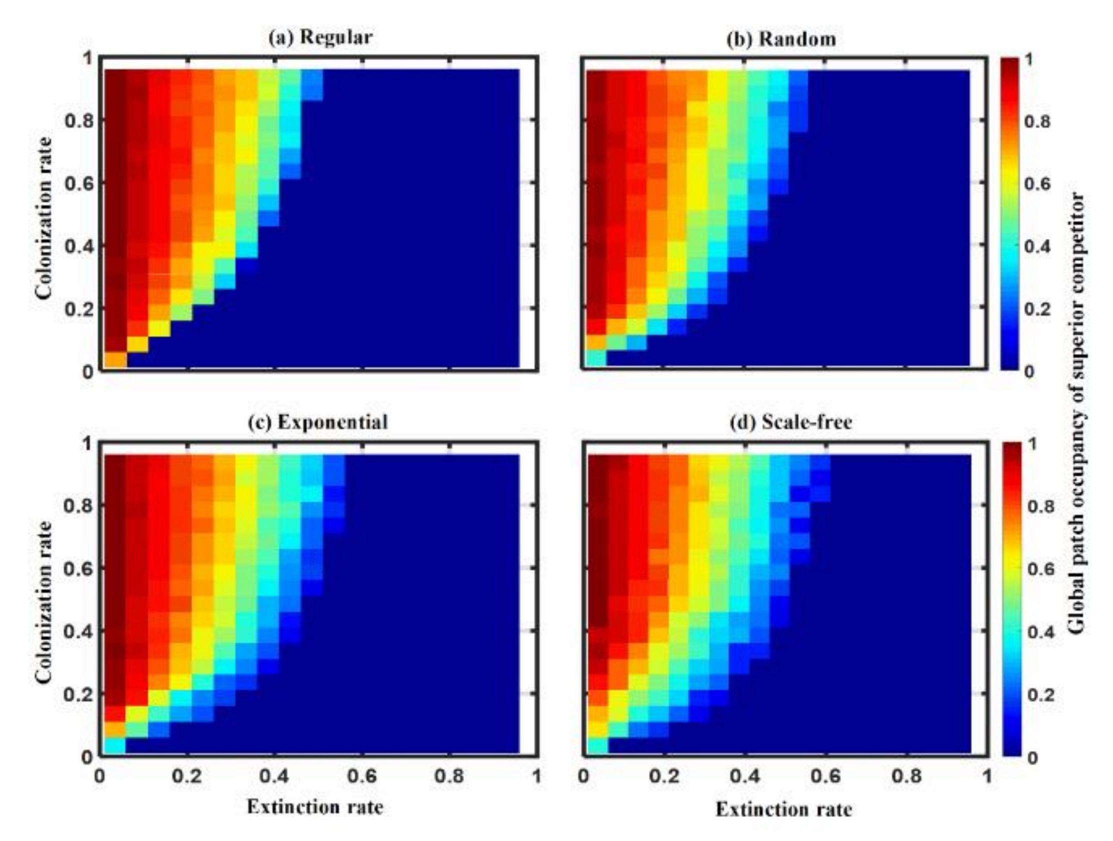

Figure S15. Interactive effects of variation in both extinction and colonization rates for two competing species on global occupancy of the superior species at steady state in unshared dispersal networks, corresponding to Fig. S13.

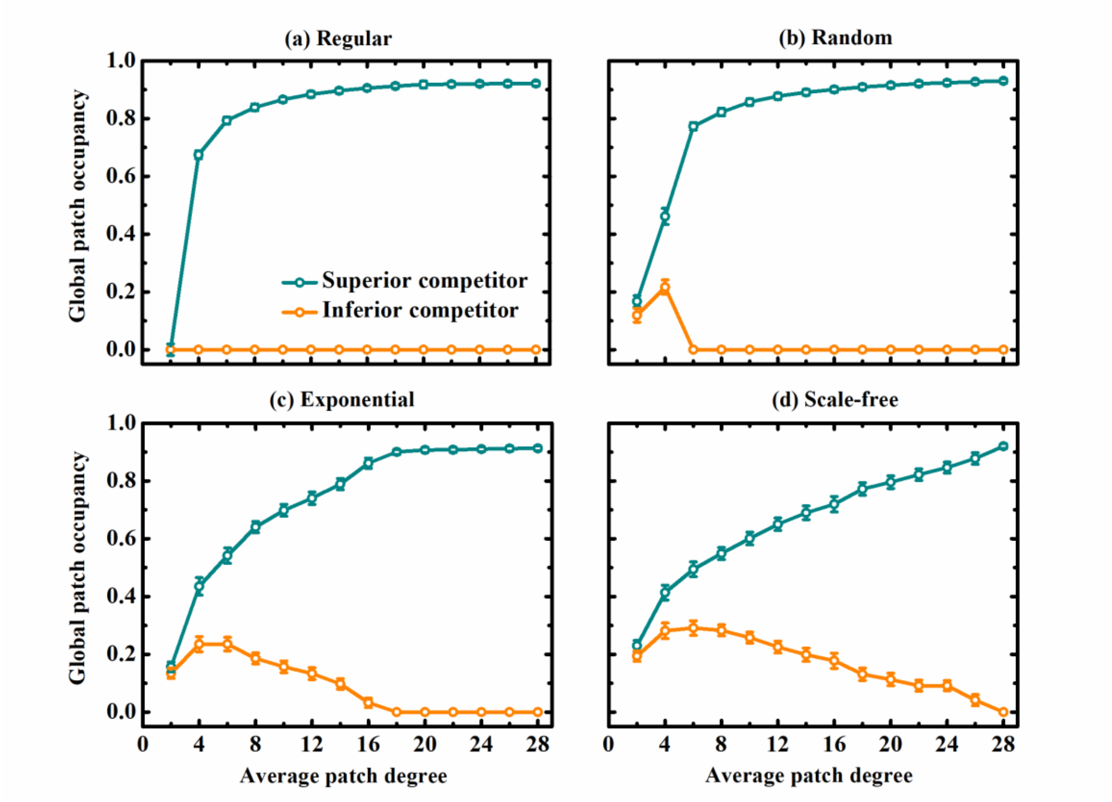

Figure S16. Effect of increasing average patch degree on global patch occupancy (mean ± SD of 100 replicates) of two competitors. Panels (b-d): species coexistence is possible at low to intermediate average degree on unshared heterogeneous networks, and the coexistence region expands as levels of network heterogeneity increase. Networks contain 1024 patches, colonization and extinction rates are the same for both species: $c=e=0.05$.

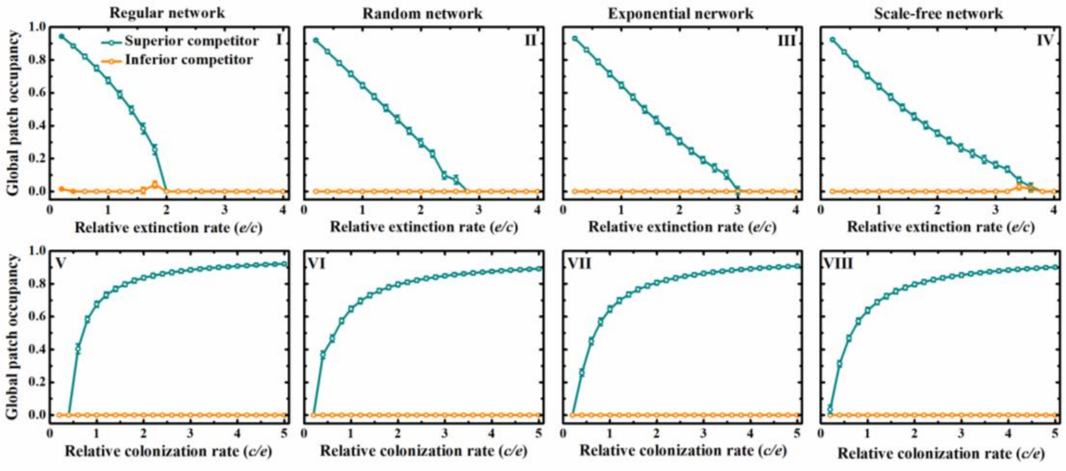

Figure S17. Effects of relative extinction (I-IV: *e*/*c* at fixed *c*=0.05) and colonization rate (V-VIII: *c*/*e* at fixed *e*=0.05) on global patch occupancy (mean ± standard deviation SD of 100 replicates) of two competing species on shared dispersal networks (1024 patches with 2048 links). The superior competitor always excludes the inferior species regardless of network heterogeneity.

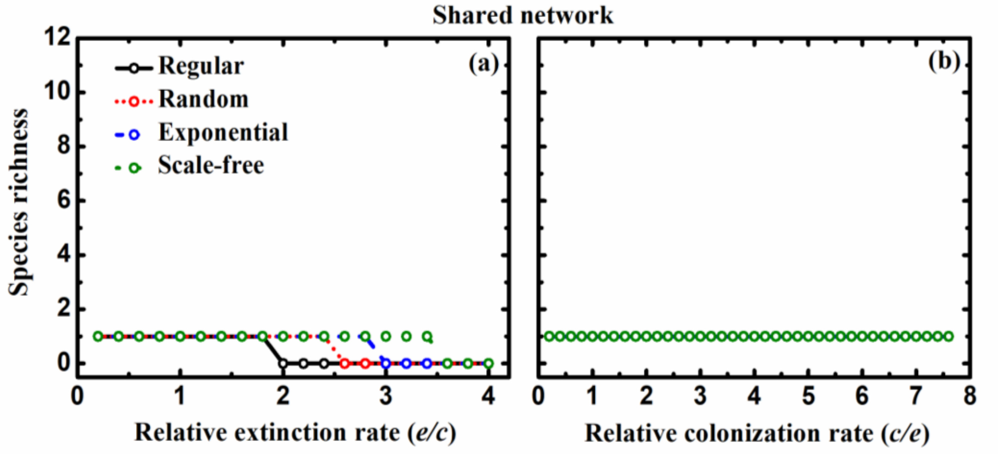

Figure S18. Effects of relative extinction (*e*/*c* at fixed *c*=0.05) and colonization rate (*c*/*e* at fixed *e*=0.05) on the number of coexisting species at steady state (mean ± SD of 100 replicates) on shared dispersal networks (1024 patches with 2048 links). All species are assumed to have the same colonization and extinction rates. Competition between the species results in monoculture in shared networks regardless of dispersal network heterogeneity.

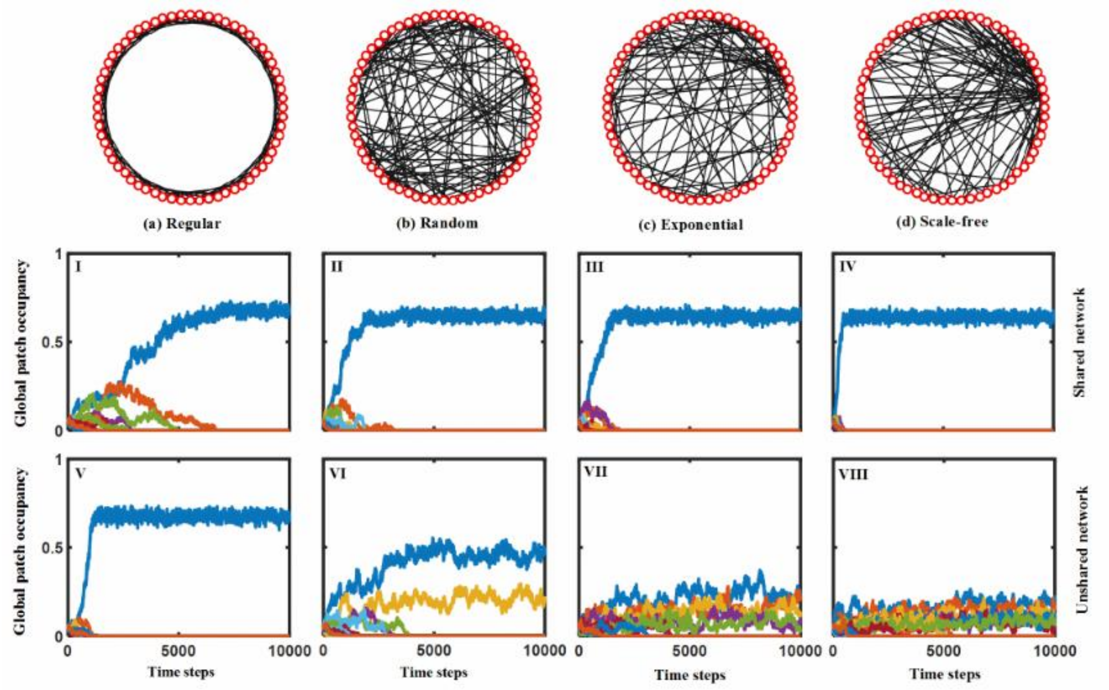

Figure S19. Patch dynamics of a competitive community (initially consisting of 16 species) in shared and unshared dispersal networks (1024 patches with 2048 links) with the same heterogeneity. Long term coexistence is possible only on unshared heterogeneous networks. More species can coexist as the level of heterogeneity in these networks increases. For display purposes, networks in panels (a-d) only consist of 64 patches and 128 links. Colonization and extinction rates for all species are the same: c=e=0.05.

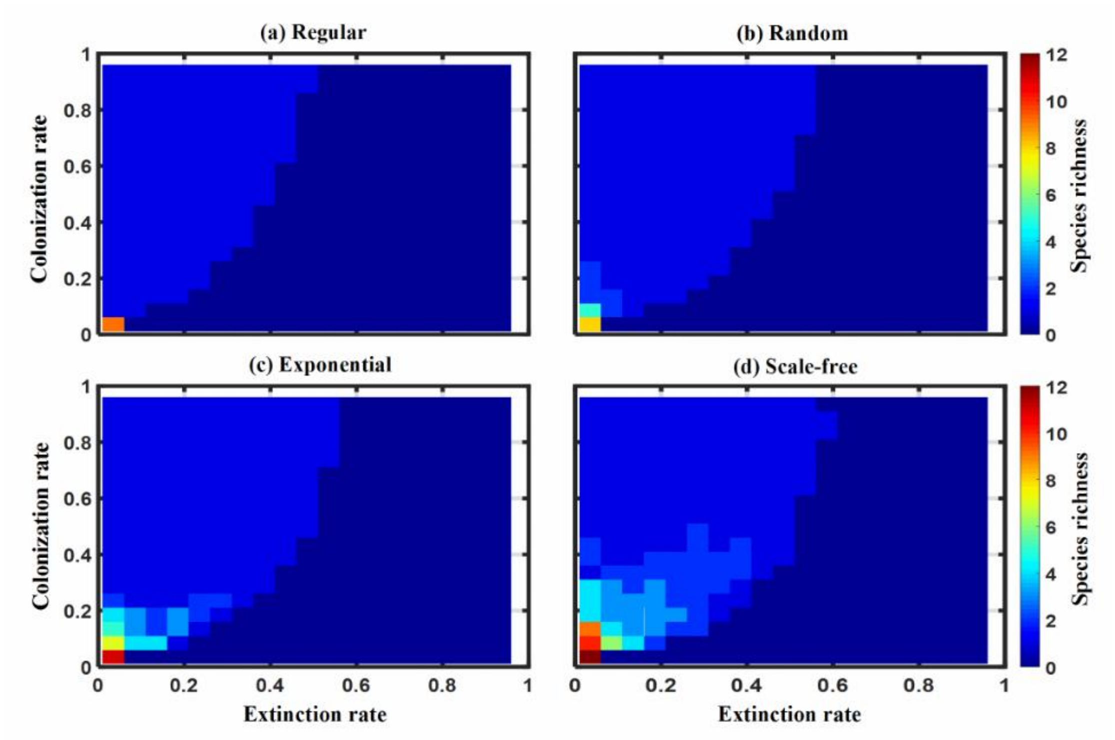

Figure S20. Species richness emerging from competitive communities of 20 species with the same colonization and extinction rates on unshared dispersal networks containing 1024 patches and 2048 links. As network heterogeneity increases, a region emerges at low colonization and extinction rates where a diverse community is possible.

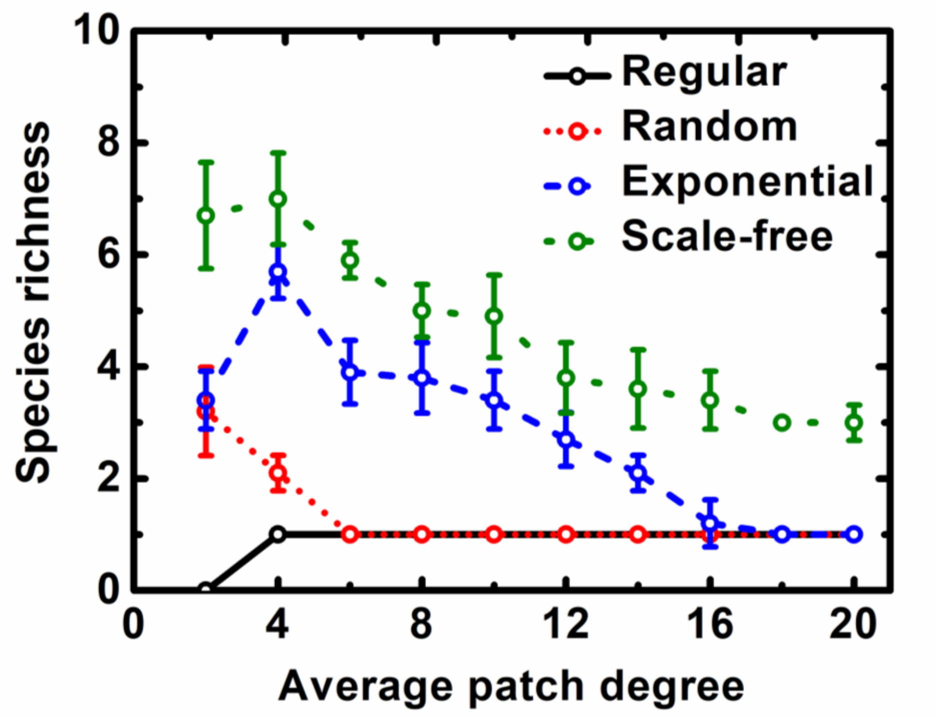

Figure S21. Effect of increasing average patch degree on the number of species that can co-exist (mean ± SD of 100 replicates) on unshared dispersal networks. Only one species can be supported on a regular dispersal network. As dispersal network heterogeneity increases, more species can be supported, but the number of coexisting species generally declines with average degree. All species have the same demography: c=e=0.05.

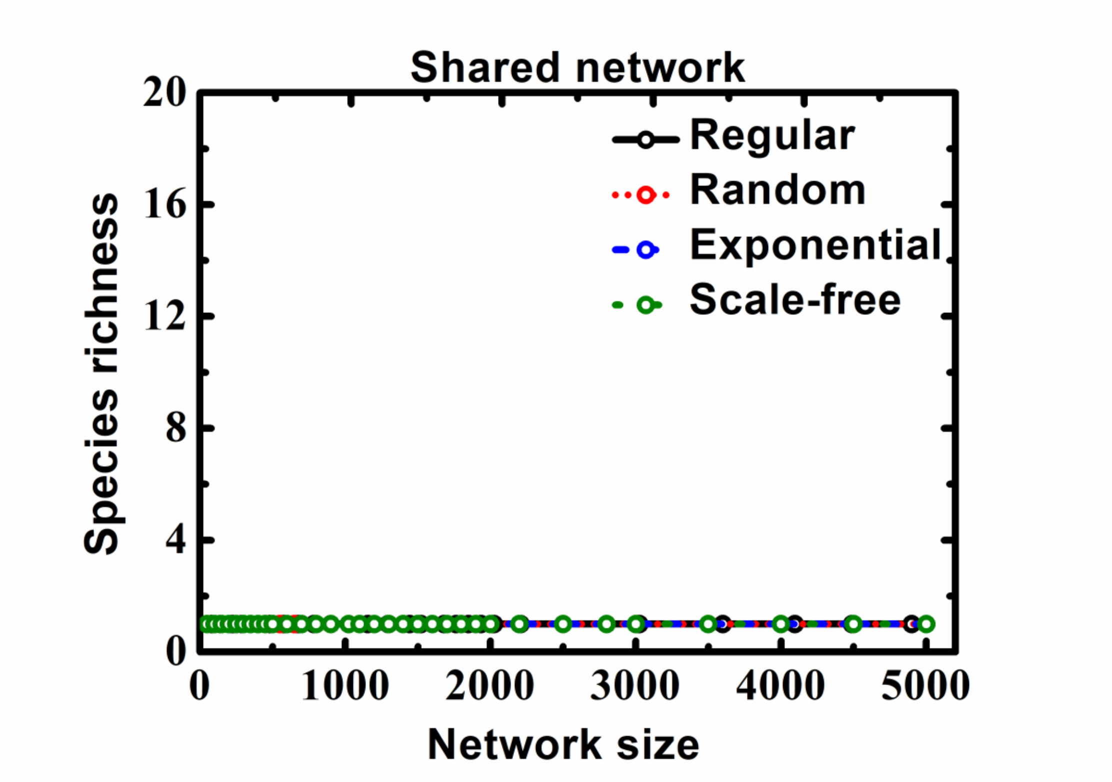

Figure S22. Species-area relationship for competitive communities on shared dispersal networks. Regardless of network size, only the best competitor can survive when dispersal networks are shared (cf. Fig. 5).

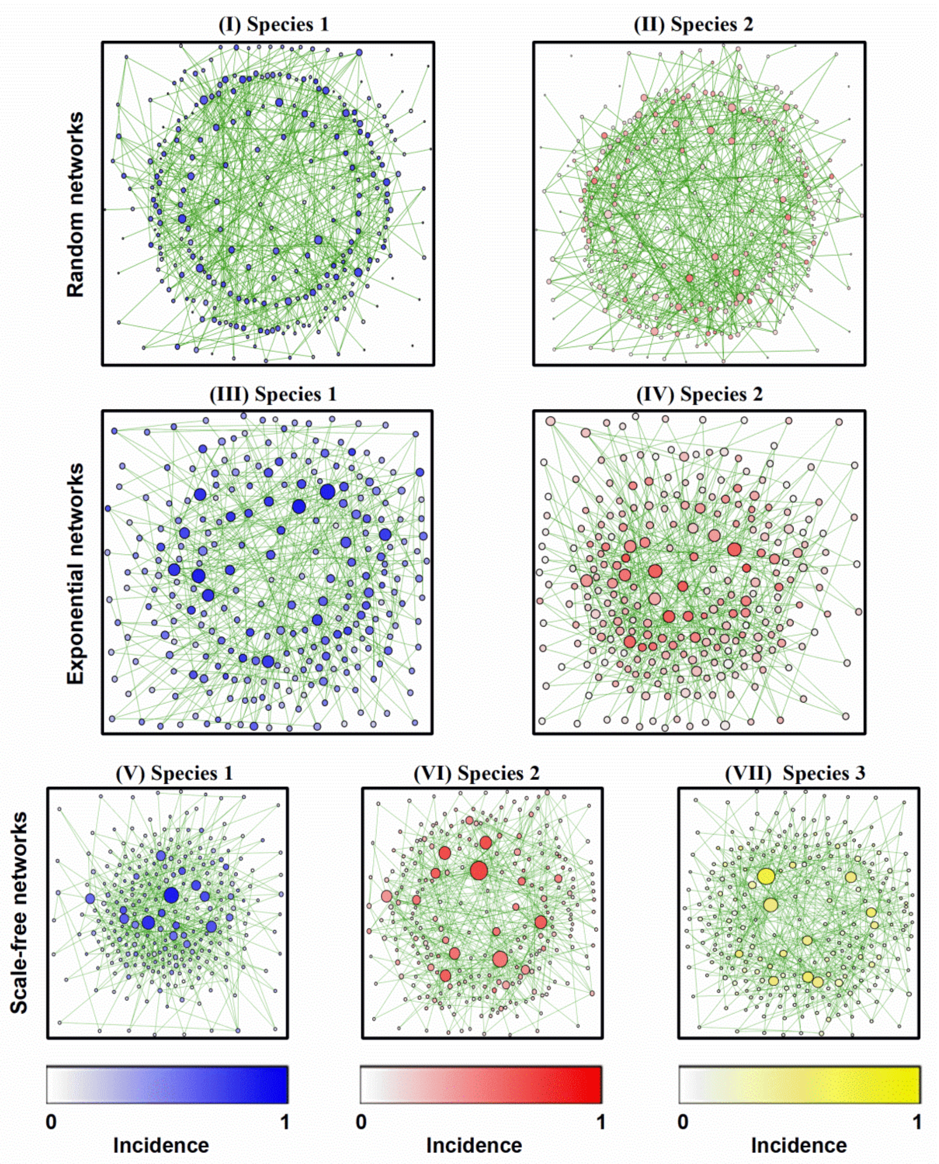

Figure S23. Patterns of species incidence on patches relative to their degree (indicated by node size) on unshared dispersal networks. Two species are able to coexist on random and exponential networks, while three species survive on scale-free networks. Incidence is calculated as the proportion of time steps (from t=5000~10000 time steps) that a patch is occupied by a given species along the dynamics. Networks contain 256 patches and 512 links, colonization and extinction rates are the same for all species: c=e=0.05.

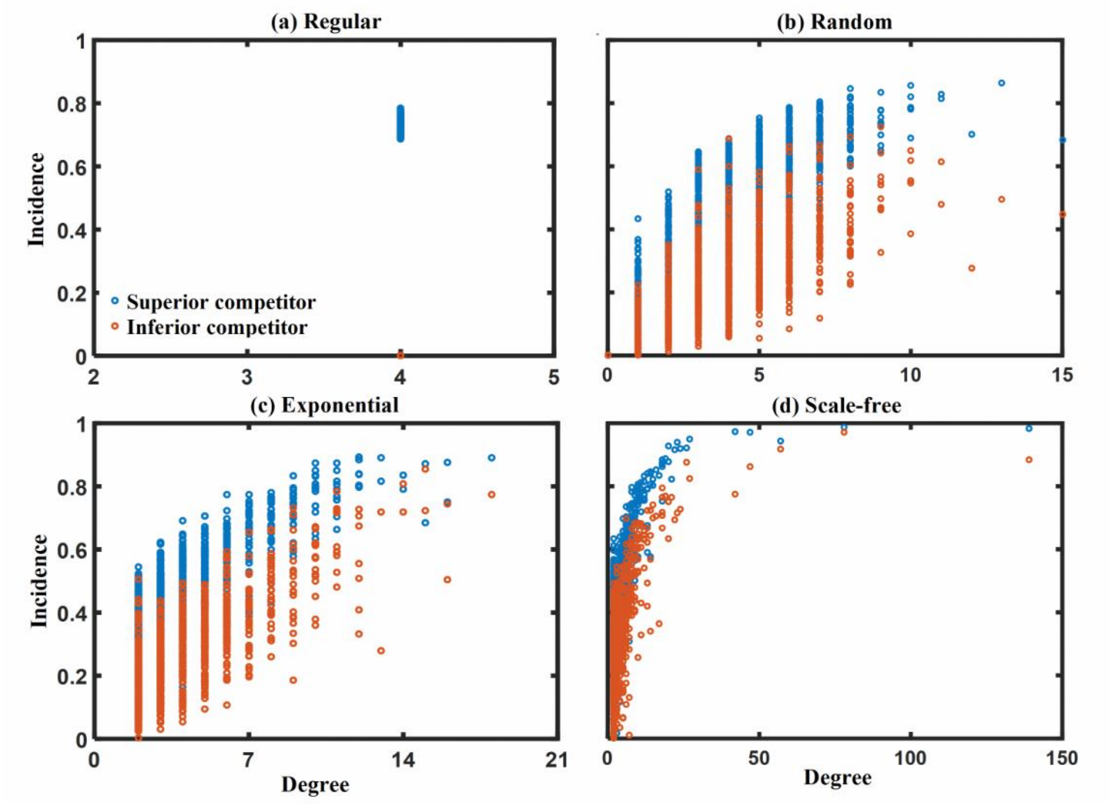

Figure S24. Species incidence on a patch against degree for a two-species competitive community with unshared dispersal networks. On regular networks, only one species can survive. For heterogeneous networks the superior competitor has greater incidence across all degrees but coexistence is possible. Incidence is positively correlated with degree for both species. Networks contain 1024 patches and 2048 links, colonization and extinction rates are the same for both species: $c=e=0.05$.

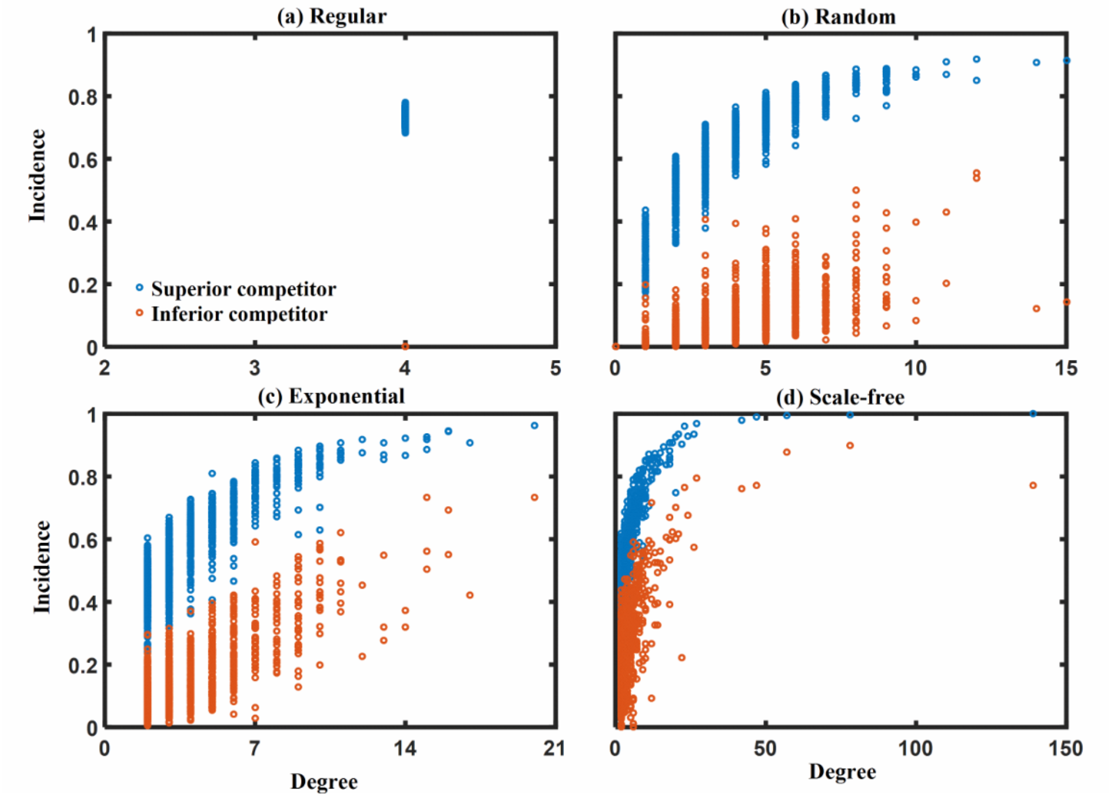

Figure S25. Species incidence on a patch against degree for a two-species competitive community with unshared dispersal networks. Increasing colonization and extinction rates (c=e=0.1) favors the superior competitor but do not otherwise change the trends observed in Fig. S24.

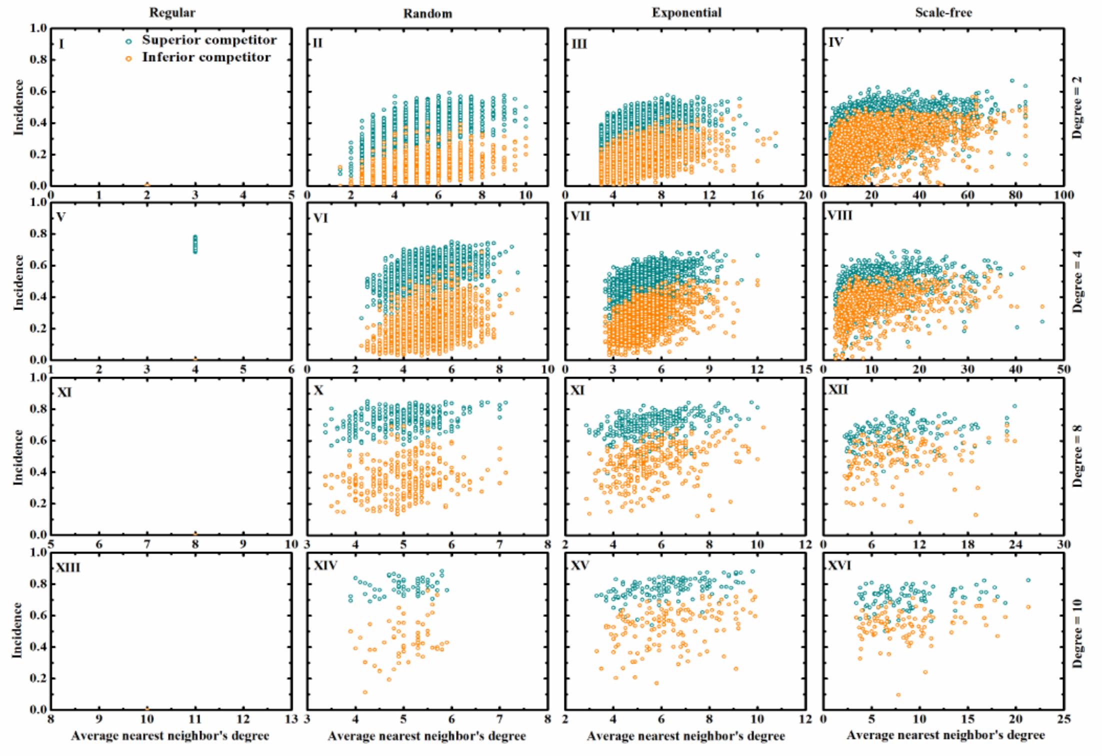

Figure S26. Species incidence on a patch against the average degree of its nearest neighbors for a two-species system with unshared dispersal networks. The nearest neighbors of a patch are those directly linked to it. In coexistence regions, the superior competitor has higher incidence than the inferior competitor regardless of degree. Networks contain 1024 patches and 2048 links, colonization and extinction rates are the same for both species: c=e=0.05, and results are obtained by averaging 10 replicates.

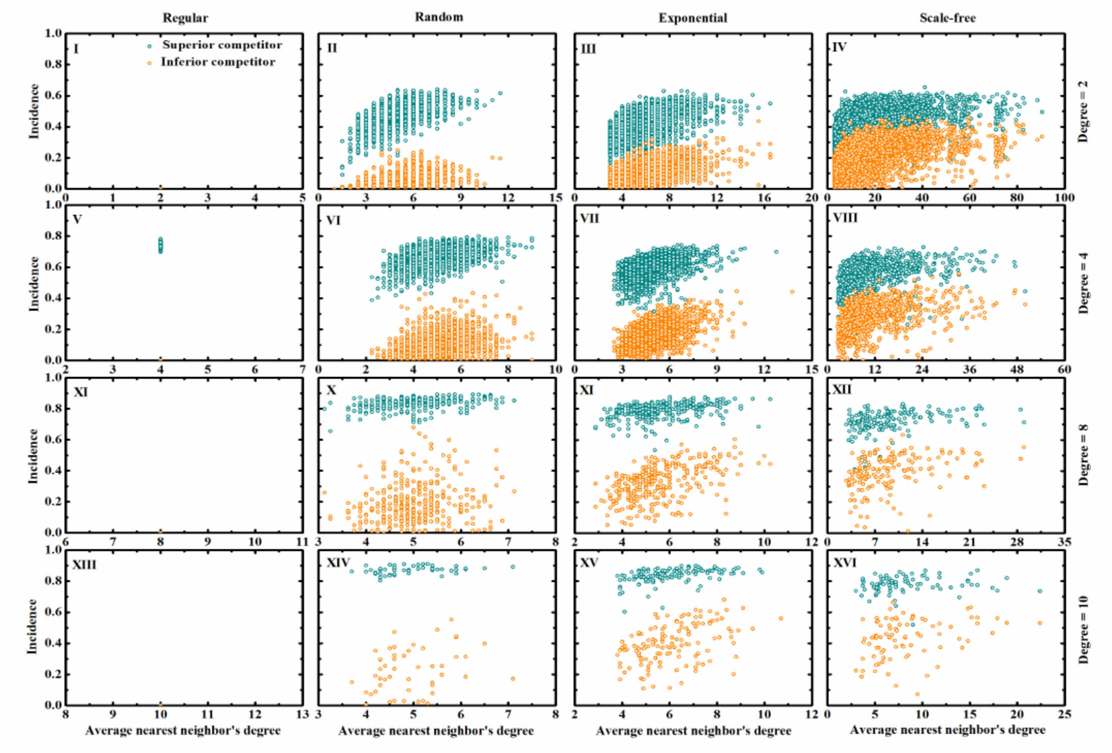

Figure S27. Species incidence on a patch against the average degree of its nearest neighbors for a two-species system with unshared dispersal networks. Again increasing the colonization and extinction rates (c=e=0.1) favors the superior competitor which achieves higher incidence (cf. Fig. S26).