Ecosystem size and complexity dictate riverine biodiversity Supplementary Information for:

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Contents

Fish community data

Hokkaido, Japan

We used data from the Hokkaido Freshwater Fish Database HFish[1], monitoring data at protected watersheds[2,3], and primary data collected from literature[4], which collectively cover the entire Hokkaido island. Data were collected from summer to fall. We screened data through the following procedure:

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1. We listed recorded fish species and re-organized species names to be consistent across the data sets.
2. We selected sampling sites based on the following criteria: (1) surveys were conducted with netting and/or electrofishing, (2) surveys were designed to collect a whole fish community, (3) sites contained reliable coordinates (sites with coordinates identical at 3 decimal degrees were treated as the same site), and (4) sites did not involve unidentified species that are rarely observed in the data set ($<$ 100 sites occurrence).
3. For sites with multiple visits (i.e., temporal replicates), we used the latest-year observation at each sampling site to minimize variation in sampling efforts among sites. Surveys that occurred in the same year were aggregated into a single observation.
4. We confined sites to those with the latest observation year of $\geq$ 1990. Although the data set contained observations from 1953, we added this restriction to align the observation period with the data set in the Midwest, US.
5. Four genera (Lethenteron, Pungitius, Rhinogobius, and Tribolodon) were treated as species groups (i.e., spp.) as taxonomic resolutions varied greatly among data sources.

Midwest, US

We assembled fish community data collected by the Iowa Department of Natural Resources, Illinois Environmental Protection Agency and Illinois Department of Natural Resources, Minnesota Pollution Control Agency, and Wisconsin Department of Natural Resources. These data sets cover most of Upper Mississippi (HUC 2, region 07) and the part of Great Lakes (HUC 2, region 04), Missouri (HUC 2, region 10), and Ohio (HUC 2, region 05). Data were collected from summer to fall with electrofishing (backpack, barge-type, or boat-mounted) and supplemental netting at some locations. We screened data through the following procedure:

1. We used data of the Upper Mississippi (HUC 2, region 07) and Great Lakes basins (HUC 2, region 04) as most sites are included in these regions.
2. We removed records of unidentified species, hybrid species, and commercial species that are apparently absent in the wild (e.g., goldfish).
3. We used the latest observation at each sampling site to minimize variation in sampling efforts among sites.

Tables

Table S1 List of fish species in Hokkaido, Japan

List of fish species in Hokkaido, Japan that are included in our statistical analysis. 52 species are ordered alphabetically with the number of sites present and % occupancy out of 2592 sites.

Species	Number of sites present	Occupancy (%)
Acanthogobius lactipes	63	2.43
Anguilla japonica	1	0.04
Carassius buergeri subsp. 2	4	0.15
Carassius cuvieri	24	0.93
Carassius sp.	213	8.22
Channa argus	3	0.12
Cottus amblystomopsis	48	1.85
Cottus hangiongensis	94	3.63
Cottus nozawae	833	32.14
Cottus sp. ME	25	0.96
Cyprinus carpio	50	1.93
Gasterosteus aculeatus	147	5.67
Gnathopogon caerulescens	1	0.04
Gnathopogon elongatus elongatus	2	0.08
Gymnogobius breunigii	29	1.12
Gymnogobius castaneus complex	145	5.59
Gymnogobius opperiens	85	3.28
Gymnogobius petschiliensis	2	0.08
Gymnogobius urotaenia	290	11.19
Hucho perryi	61	2.35
Hypomesus nipponensis	170	6.56
Hypomesus olidus	8	0.31
Lefua nikkonis	20	0.77
Lethenteron spp.	731	28.20
Leucopsarion petersii	3	0.12
Luciogobius guttatus	3	0.12
Misgurnus anguillicaudatus	212	8.18
Noemacheilus barbatulus	1590	61.34
Oncorhynchus gorbuscha	27	1.04
Oncorhynchus keta	150	5.79
Oncorhynchus masou masou	1417	54.67
Oncorhynchus mykiss	462	17.82
Oncorhynchus nerka	6	0.23
Opsariichthys platypus	1	0.04
Osmerus dentex	7	0.27
Phoxinus percnurus sachalinensis	68	2.62
Plecoglossus altivelis altivelis	111	4.28
Pseudorasbora parva	94	3.63
Pungitius spp.	285	11.00
Rhinogobius spp.	175	6.75
Rhodeus ocellatus ocellatus	22	0.85
Salangichthys microdon	11	0.42
Salmo trutta	15	0.58
Salvelinus fontinalis	2	0.08
Salvelinus leucomaenis leucomaenis	625	24.11
Salvelinus malma	274	10.57

Species	Number of sites present	Occupancy (%)
Salvelinus malma miyabei	2	0.08
Silurus asotus	7	0.27
Spirinchus lanceolatus	7	0.27
Tribolodon spp.	1163	44.87
Tridentiger brevispinis	135	5.21
Tridentiger obscurus	7	0.27

Table S2 List of fish species in Midwest, US

List of fish species in Midwest, US that are included in our statistical analysis. 159 species are ordered alphabetically with the number of sites present and % occupancy out of 3998 sites.

Species	Number of sites present	Occupancy (%)
Acipenser fulvescens	7	0.18
Alosa pseudoharengus	1	0.03
Ambloplites rupestris	707	17.68
Ameiurus melas	868	21.71
Ameiurus natalis	665	16.63
Ameiurus nebulosus	30	0.75
Amia calva	95	2.38
Ammocrypta clara	12	0.30
Aphredoderus sayanus	76	1.90
Aplodinotus grunniens	208	5.20
Campostoma anomalum	1347	33.69
Campostoma oligolepis	125	3.13
Carpiodes carpio	128	3.20
Carpiodes cyprinus	234	5.85
Carpiodes velifer	82	2.05
Catostomus commersonii	2931	73.31
Centrarchus macropterus	5	0.13
Chrosomus eos	336	8.40
Chrosomus neogaeus	103	2.58
Clinostomus elongatus	97	2.43
Cottus bairdii	467	11.68
Cottus carolinae	6	0.15
Cottus cognatus	38	0.95
Crystallaria asprella	1	0.03
Ctenopharyngodon idella	19	0.48
Culaea inconstans	1531	38.29
Cyprinella lutrensis	269	6.73
Cyprinella spiloptera	780	19.51
Cyprinella venusta	2	0.05
Cyprinella whipplei	33	0.83
Cyprinus carpio	946	23.66
Dorosoma cepedianum	208	5.20
Erimystax x-punctatus	13	0.33
Erimyzon oblongus	63	1.58
Erimyzon sucetta	10	0.25
Esox americanus vermiculatus	117	2.93
Esox lucius	957	23.94
Esox masquinongy	20	0.50
Etheostoma asprigene	10	0.25
Etheostoma blennioides	1	0.03
Etheostoma caeruleum	195	4.88
Etheostoma chlorosomum	4	0.10
Etheostoma crossopterum	4	0.10
Etheostoma exile	261	6.53
Etheostoma flabellare	843	21.09
Etheostoma gracile	15	0.38
Etheostoma kennicotti	1	0.03
Etheostoma microperca	20	0.50

Species	Number of sites present	Occupancy (%)
Etheostoma nigrum	2546	63.68
Etheostoma proeliare	2	0.05
Etheostoma spectabile	121	3.03
Etheostoma squamiceps	4	0.10
Etheostoma zonale	321	8.03
Fundulus diaphanus	3	0.08
Fundulus dispar	4	0.10
Fundulus notatus	282	7.05
Fundulus olivaceus	42	1.05
Hiodon alosoides	3	0.08
Hiodon tergisus	16	0.40
Hybognathus hankinsoni	576	14.41
Hybognathus nuchalis	24	0.60
Hybopsis amnis	1	0.03
Hypentelium nigricans	682	17.06
Hypophthalmichthys molitrix	14	0.35
Hypophthalmichthys nobilis	3	0.08
Ichthyomyzon castaneus	51	1.28
Ichthyomyzon fossor	35	0.88
Ichthyomyzon gagei	6	0.15
Ichthyomyzon unicuspis	9	0.23
Ictalurus punctatus	413	10.33
Ictiobus bubalus	90	2.25
Ictiobus cyprinellus	129	3.23
Ictiobus niger	41	1.03
Labidesthes sicculus	64	1.60
Lepisosteus oculatus	13	0.33
Lepisosteus osseus	25	0.63
Lepisosteus platostomus	58	1.45
Lepomis cyanellus	1575	39.39
Lepomis gibbosus	290	7.25
Lepomis gulosis	43	1.08
Lepomis humilis	356	8.90
Lepomis macrochirus	1051	26.29
Lepomis megalotis	186	4.65
Lepomis microlophus	19	0.48
Lethenteron appendix	122	3.05
Lota lota	266	6.65
Luxilus chrysocephalus	198	4.95
Luxilus cornutus	1784	44.62
Lythrurus fumeus	6	0.15
Lythrurus umbratilis	224	5.60
Macrhybopsis aestivalis	1	0.03
Macrhybopsis hyostoma	3	0.08
Macrhybopsis storeriana	10	0.25
Micropterus dolomieu	748	18.71
Micropterus punctulatus	15	0.38
Micropterus salmoides	987	24.69
Minytrema melanops	41	1.03
Morone americana	2	0.05
Morone chrysops	65	1.63
Morone mississippiensis	16	0.40

Species	Number of sites present	Occupancy (%)
Moxostoma anisurum	288	7.20
Moxostoma carinatum	8	0.20
Moxostoma duquesni	103	2.58
Moxostoma erythrurum	709	17.73
Moxostoma macrolepidotum	737	18.43
Moxostoma valenciennesi	85	2.13
Neogobius melanostomus	13	0.33
Nocomis biguttatus	1287	32.19
Notemigonus crysoleucas	377	9.43
Notropis anogenus	10	0.25
Notropis atherinoides	207	5.18
Notropis blennius	16	0.40
Notropis boops	9	0.23
Notropis buccatus	47	1.18
Notropis chalybaeus	11	0.28
Notropis dorsalis	1088	27.21
Notropis heterodon	28	0.70
Notropis heterolepis	187	4.68
Notropis hudsonius	81	2.03
Notropis nubilus	58	1.45
Notropis percobromus	167	4.18
Notropis rubellus	63	1.58
Notropis stramineus	975	24.39
Notropis texanus	20	0.50
Notropis volucellus	81	2.03
Notropis wickliffi	10	0.25
Noturus exilis	34	0.85
Noturus flavus	479	11.98
Noturus gyrinus	447	11.18
Noturus nocturnus	38	0.95
Oncorhynchus mykiss	55	1.38
Oncorhynchus tshawytscha	1	0.03
Opsopoeodus emiliae	3	0.08
Perca flavescens	622	15.56
Percina caprodes	337	8.43
Percina carprodes semifasciata	7	0.18
Percina evides	16	0.40
Percina maculata	888	22.21
Percina phoxocephala	259	6.48
Percina sciera	2	0.05
Percopsis omiscomaycus	21	0.53
Phenacobius mirabilis	259	6.48
Phoxinus erythrogaster	417	10.43
Pimephales notatus	1784	44.62
Pimephales promelas	1535	38.39
Pimephales vigilax	84	2.10
Pomoxis annularis	61	1.53
Pomoxis nigromaculatus	376	9.40
Pylodictis olivaris	73	1.83
Rhinichthys atratulus	1120	28.01
Rhinichthys cataractae	627	15.68
Rhinichthys obtusus	449	11.23

Species	Number of sites present	Occupancy (%)
Salmo trutta	399	9.98
Salvelinus fontinalis	369	9.23
Sander canadensis	39	0.98
Sander vitreus	367	9.18
Scaphirhynchus platorynchus	8	0.20
Semotilus atromaculatus	2776	69.43
Umbra limi	1600	40.02

Figures

Figure S1 Influence of ecosystem size ($p_d = 0.1$, $\sigma_h = 1$, $\sigma_l = 0.01$)

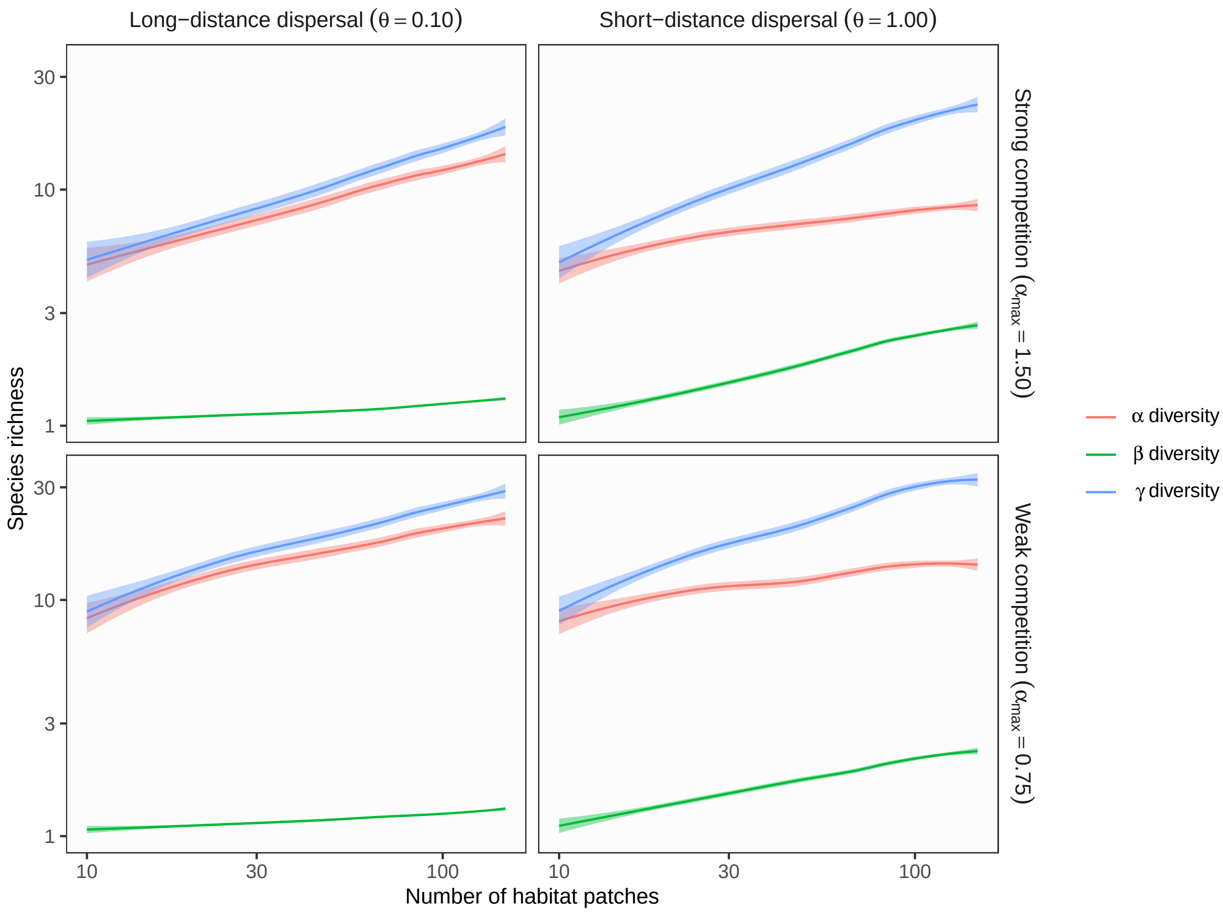

Figure S1 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) exceeds local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 0.01$.

Figure S2 Influence of ecosystem size ($p_d = 0.1$, $\sigma_h = 1$, $\sigma_l = 1$)

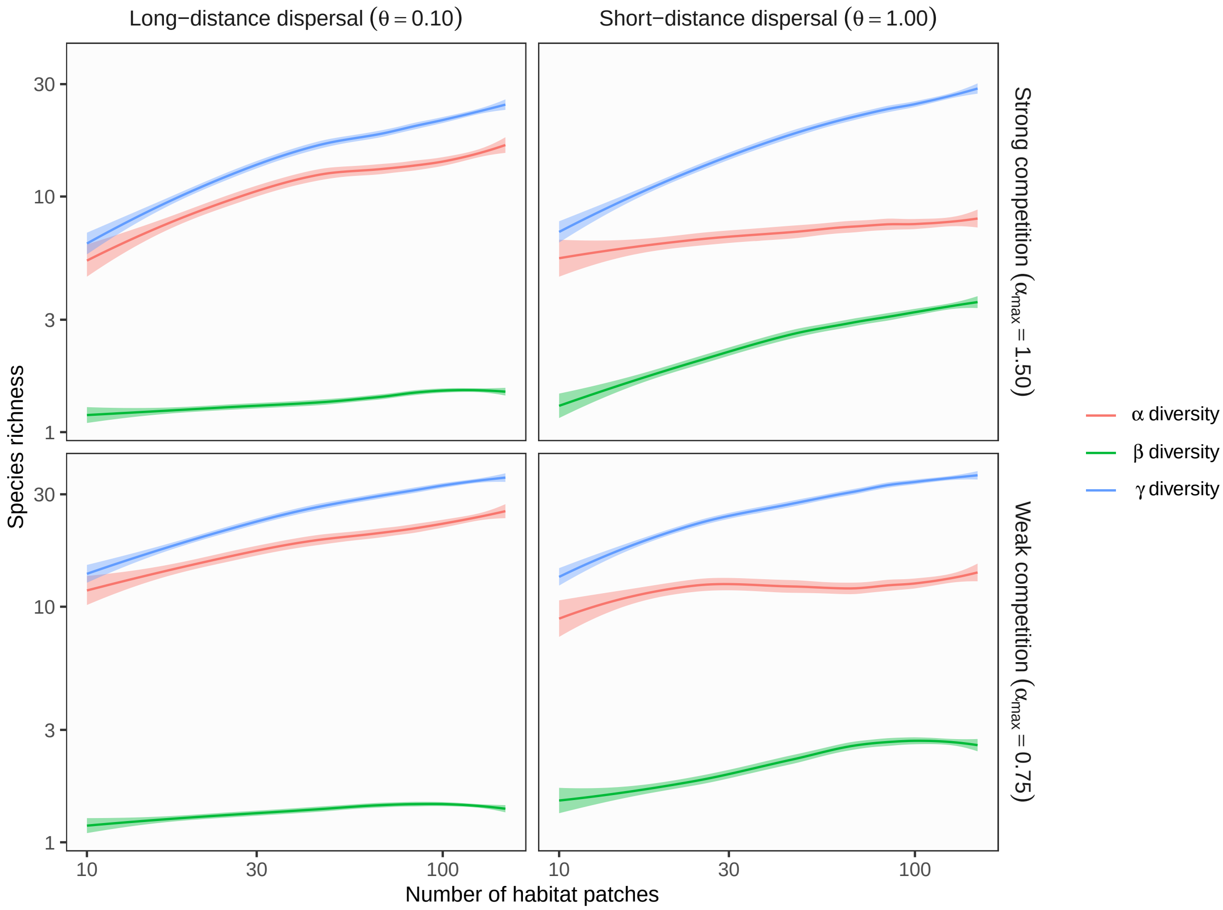

Figure S2 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 1$.

Figure S3 Influence of ecosystem size ($p_d = 0.1$, $\sigma_h = 0.01$, $\sigma_l = 0.01$)

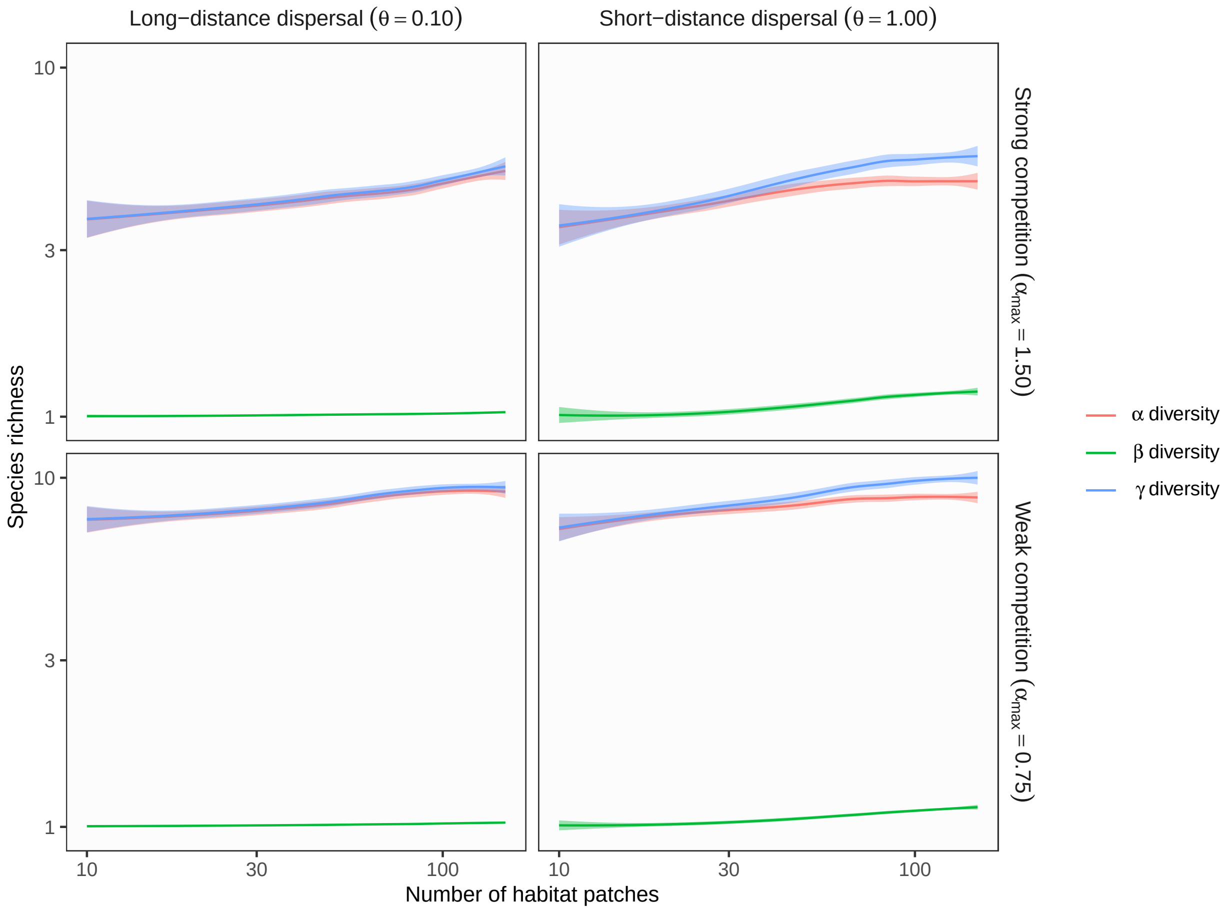

Figure S3 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 0.01$.

Figure S4 Influence of ecosystem size ($p_d = 0.1$, $\sigma_h = 0.01$, $\sigma_l = 1$)

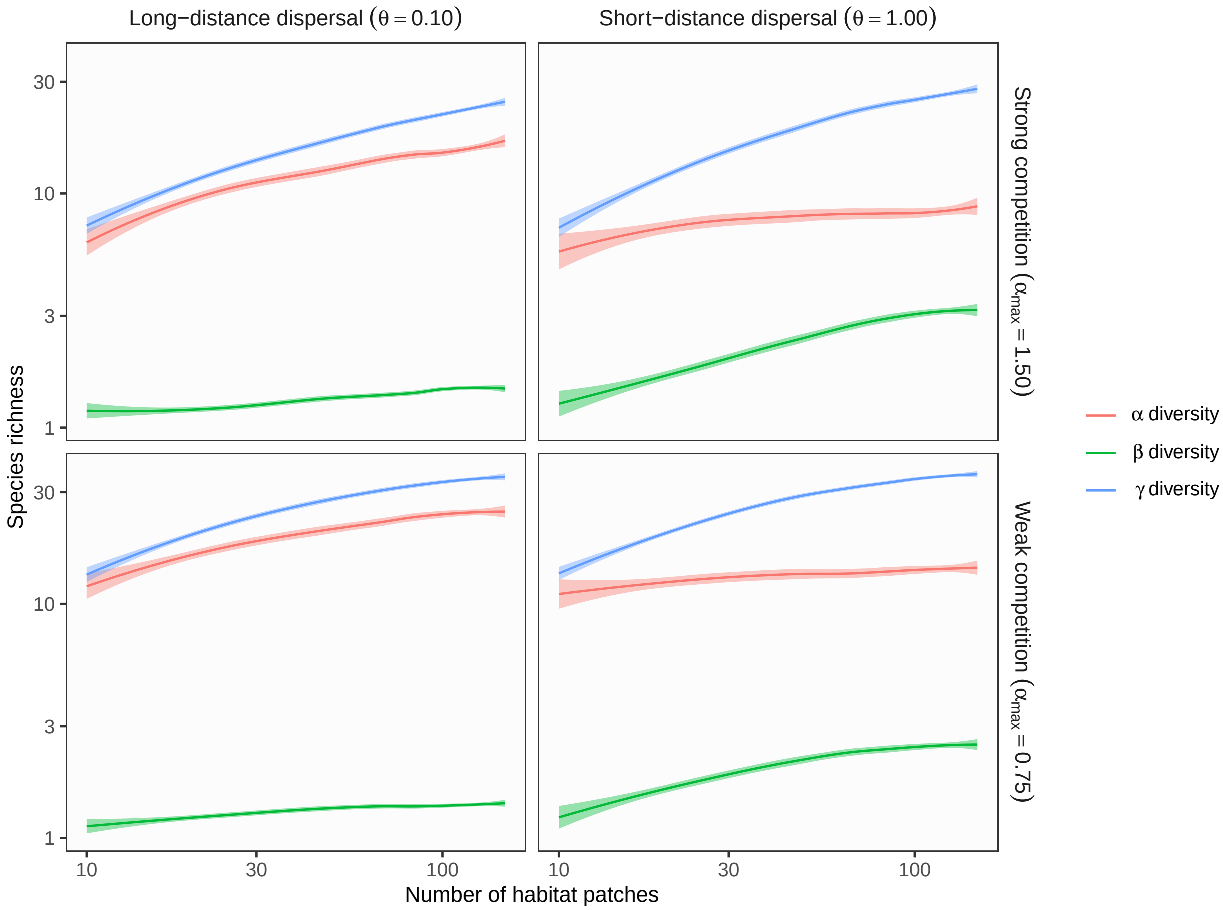

Figure S4 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is less than local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 1$.

Figure S5 Influence of ecosystem size ($p_d = 0.01$, $\sigma_h = 1$, $\sigma_l = 1$)

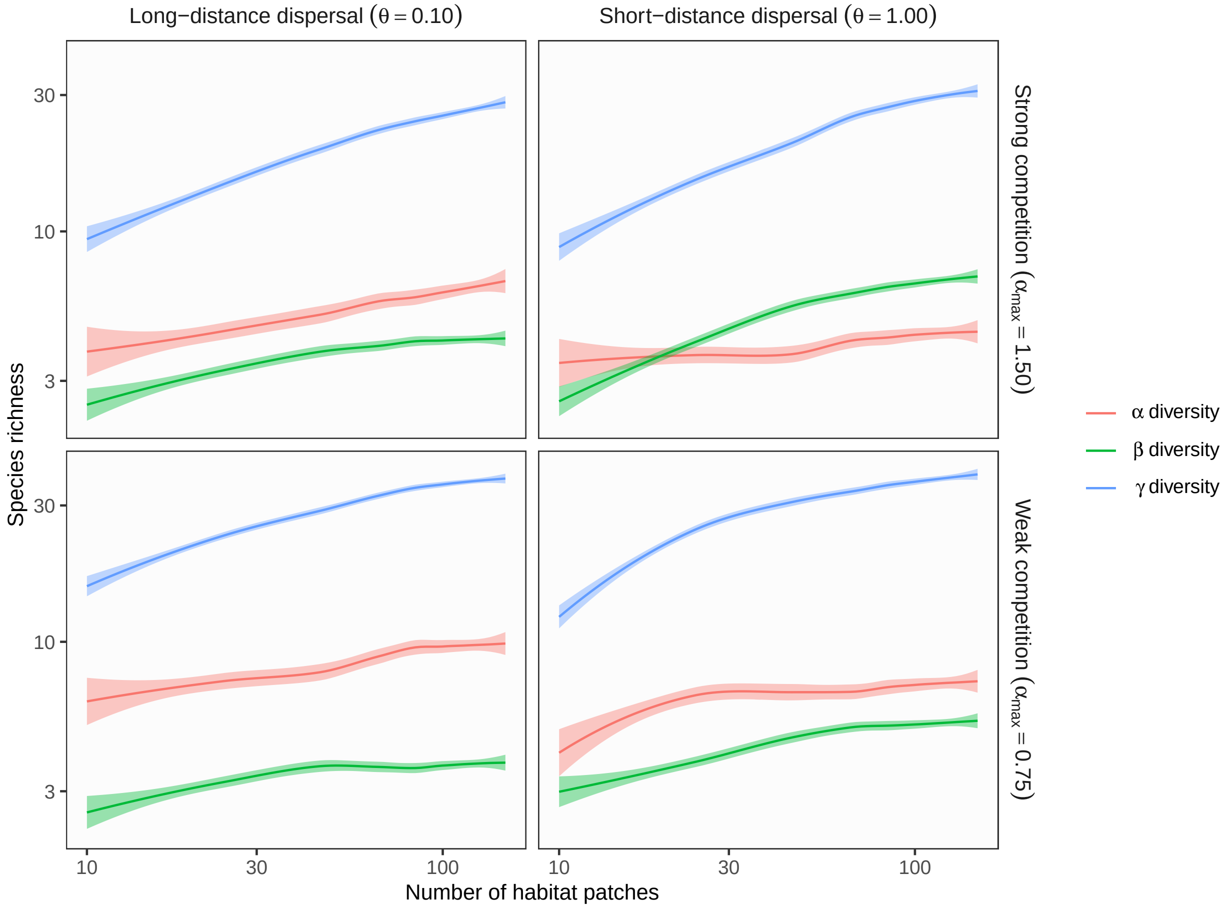

Figure S5 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 1$.

Figure S6 Influence of ecosystem size ($p_d = 0.01$, $\sigma_h = 0.01$, $\sigma_l = 0.01$)

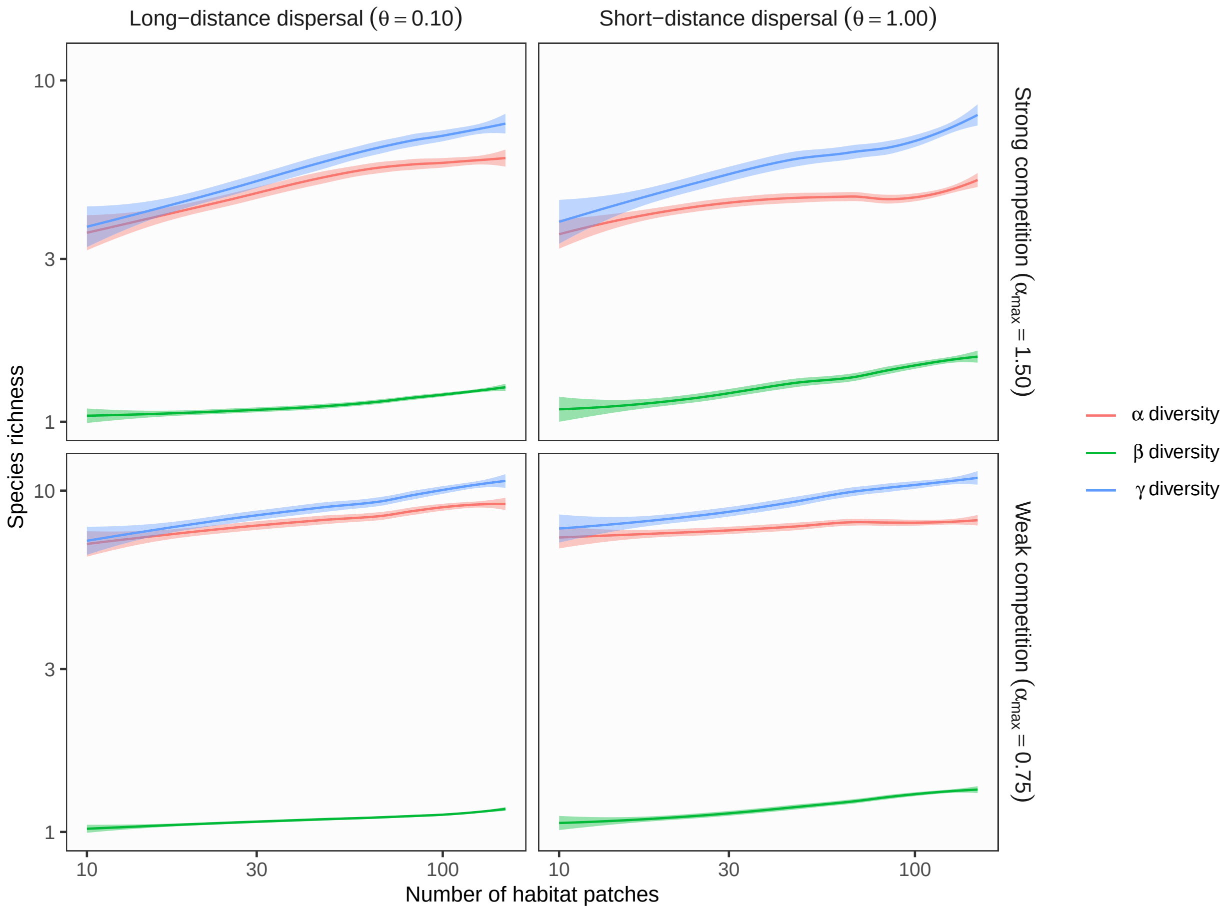

Figure S6 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 0.01$.

Figure S7 Influence of ecosystem size ($p_d = 0.01$, $\sigma_h = 0.01$, $\sigma_l = 1$)

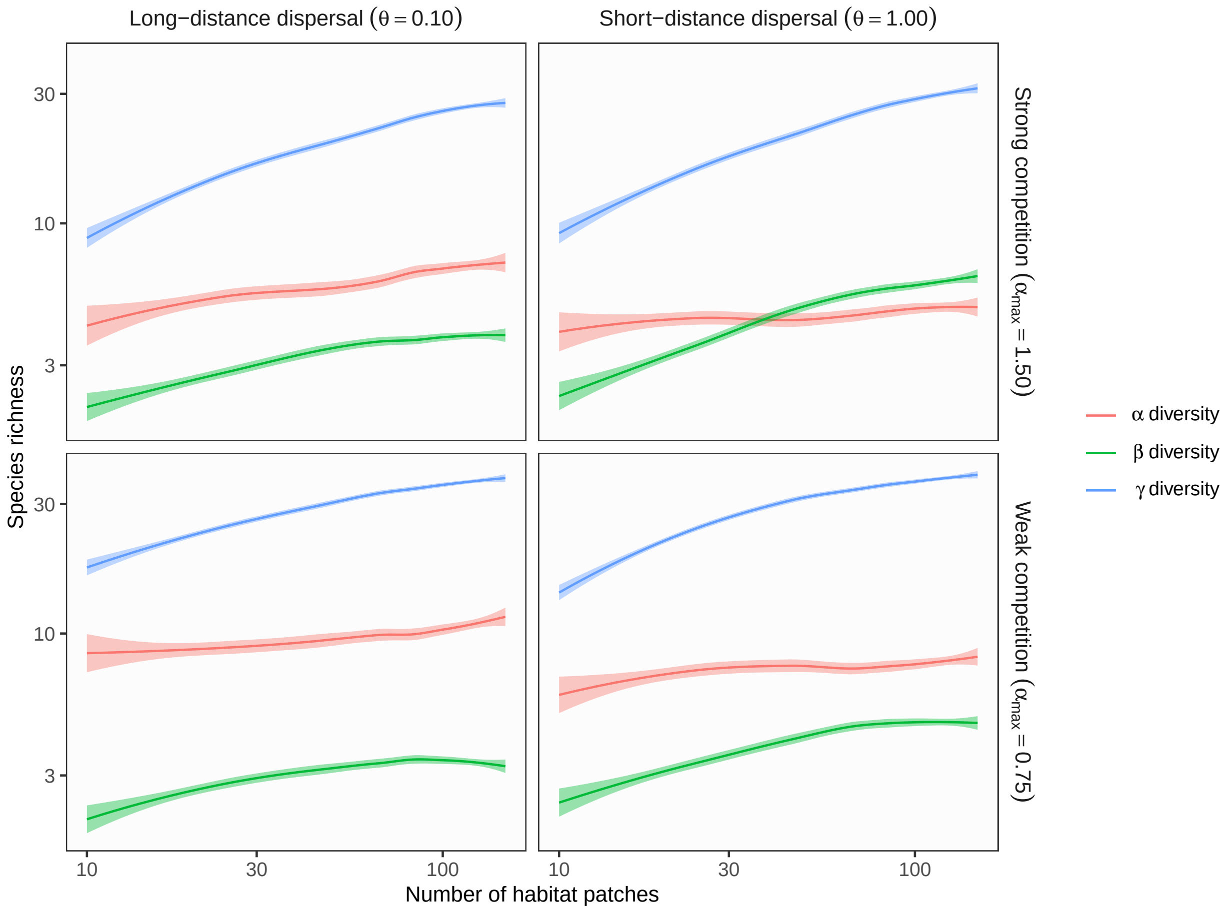

Figure S7 Theoretical predictions for ecosystem size influences (the number of habitat patches) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is less than local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 1$.

Figure S8 Influence of ecosystem complexity ($p_d = 0.1$, $\sigma_h = 1$, $\sigma_l = 0.01$)

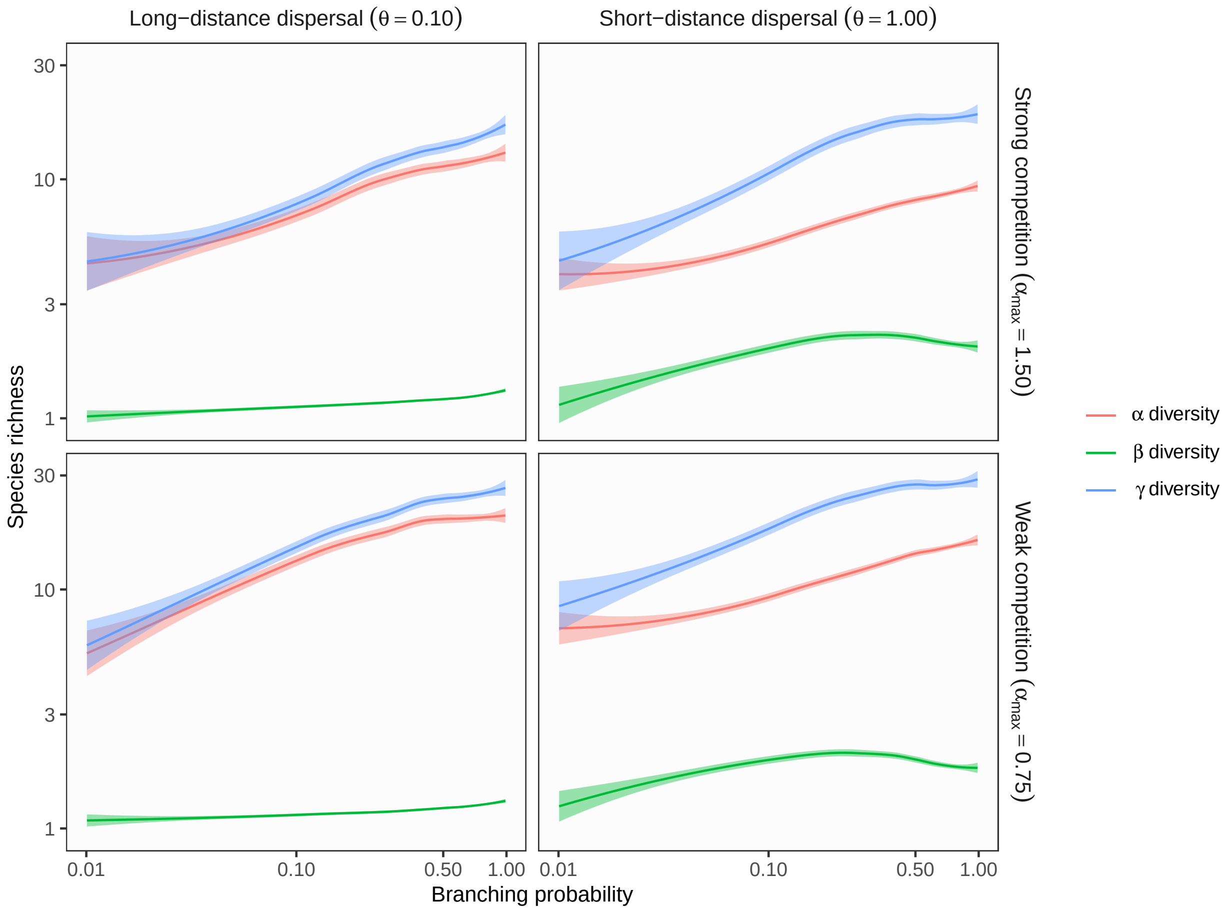

Figure S8 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) exceeds local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 0.01$.

Figure S9 Influence of ecosystem complexity ($p_d = 0.1$, $\sigma_h = 1$, $\sigma_l = 1$)

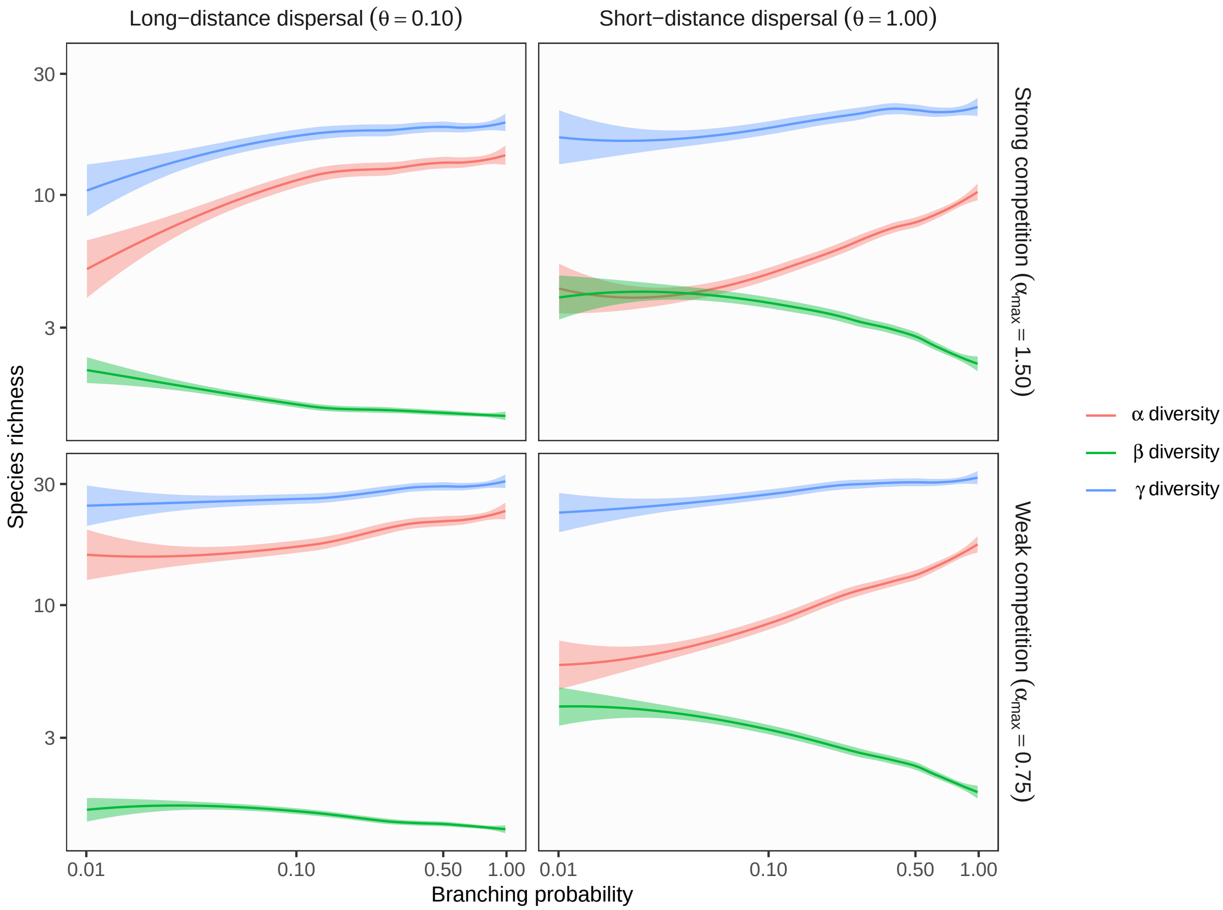

Figure S9 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 1$.

Figure S10 Influence of ecosystem complexity ($p_d = 0.1$, $\sigma_h = 0.01$, $\sigma_l = 0.01$)

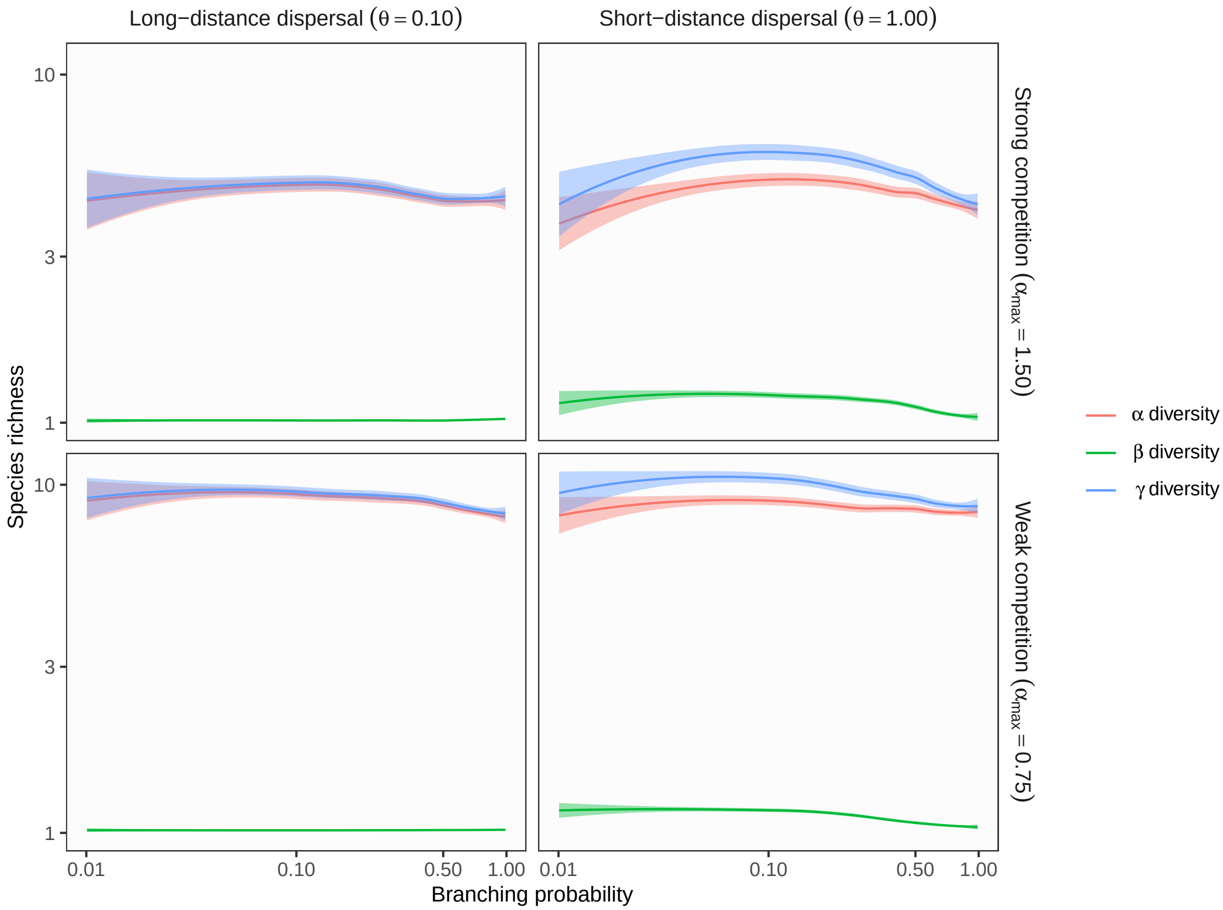

Figure S10 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 0.01$.

Figure S11 Influence of ecosystem complexity ($p_d = 0.1$, $\sigma_h = 0.01$, $\sigma_l = 1$)

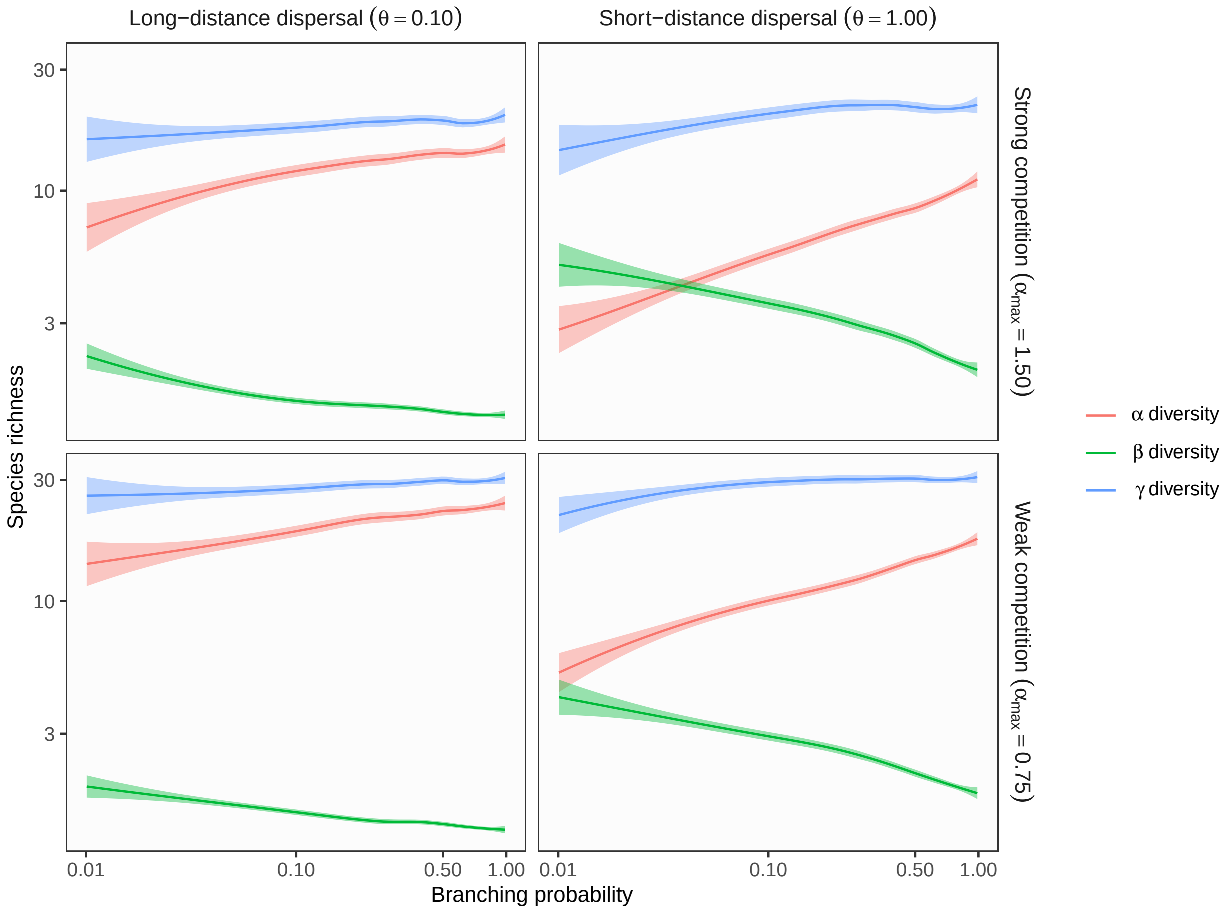

Figure S11 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is less than local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.1$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 1$.

Figure S12 Influence of ecosystem complexity ($p_d = 0.01$, $\sigma_h = 1$, $\sigma_l = 1$)

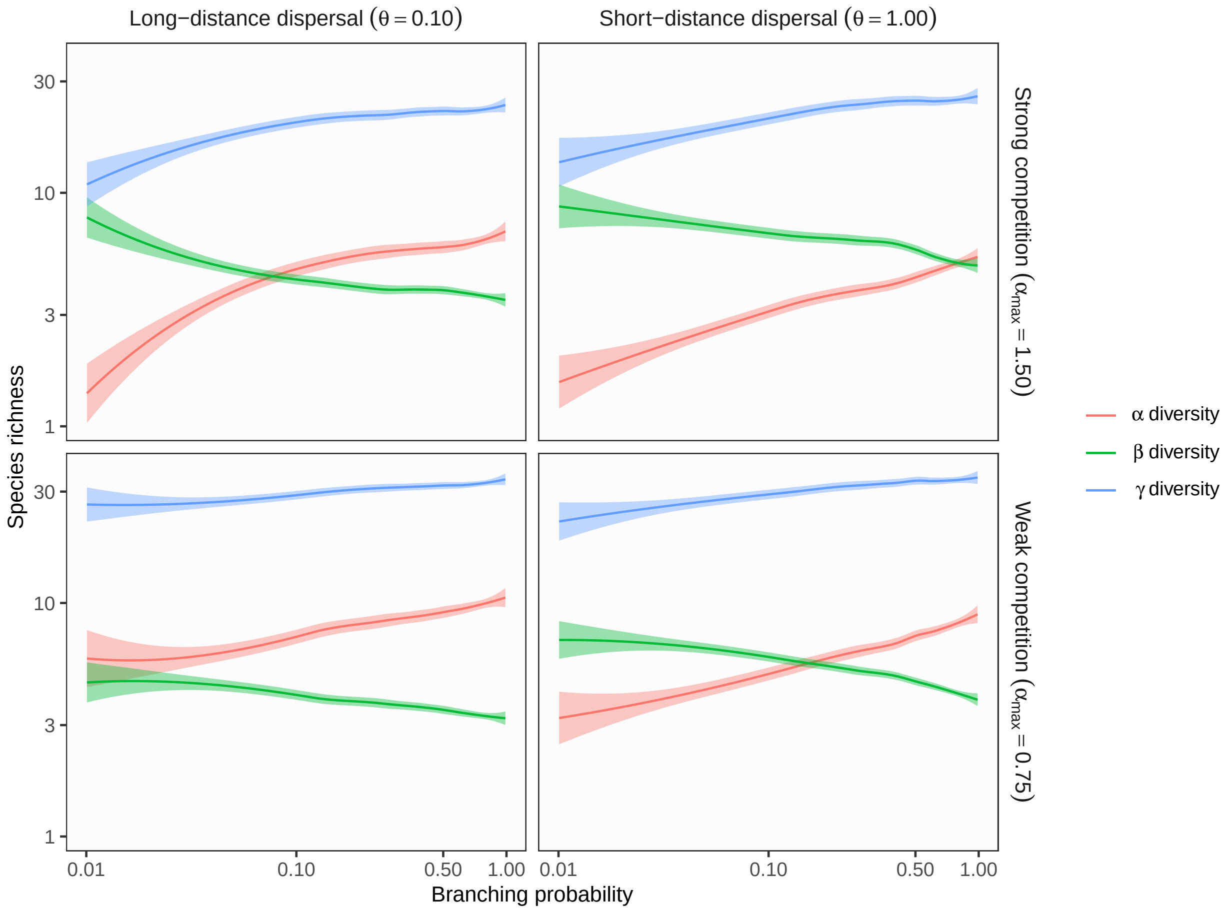

Figure S12 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 1$; local environmental noise $\sigma_l = 1$.

Figure S13 Influence of ecosystem complexity ($p_d = 0.01$, $\sigma_h = 0.01$, $\sigma_l = 0.01$)

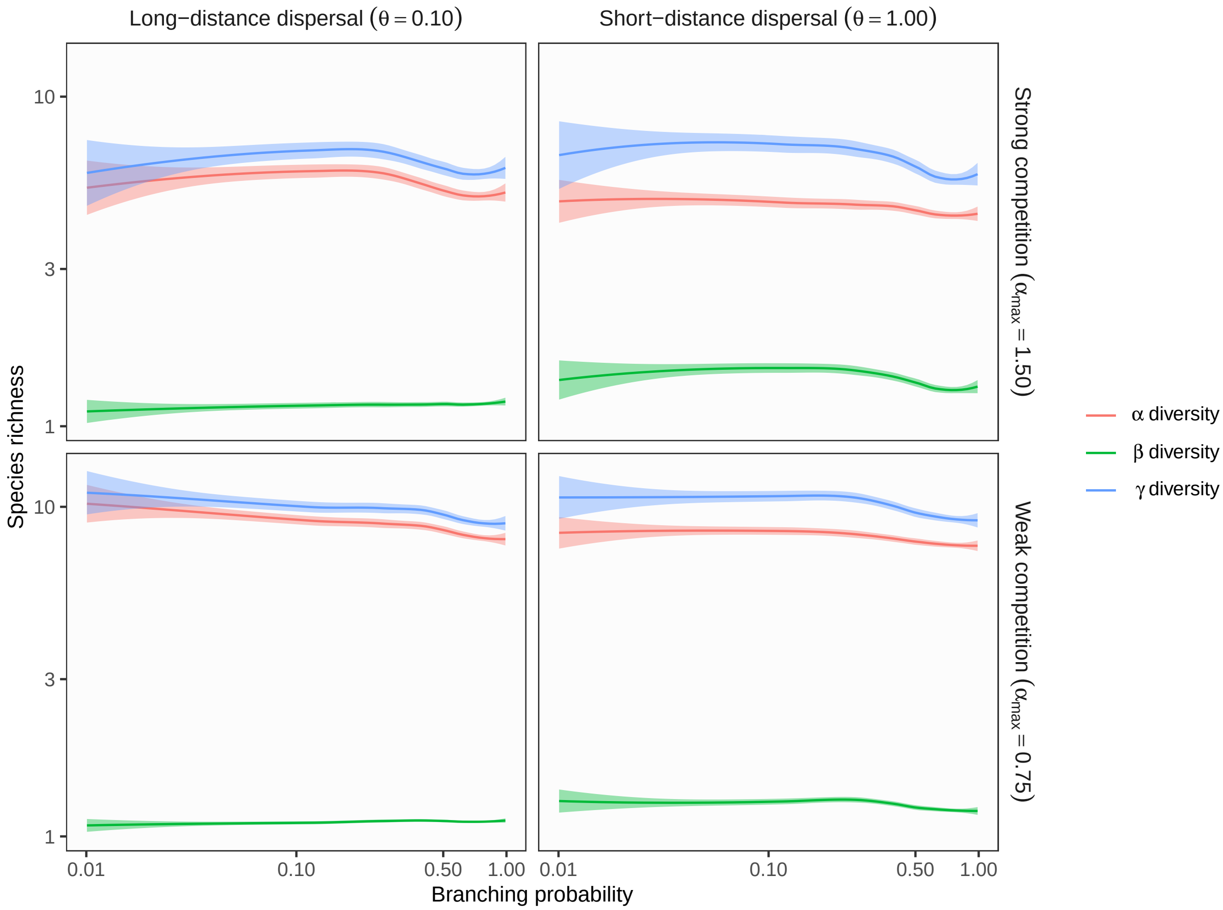

Figure S13 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is equal to local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 0.01$.

Figure S14 Influence of ecosystem complexity ($p_d = 0.01$, $\sigma_h = 0.01$, $\sigma_l = 1$)

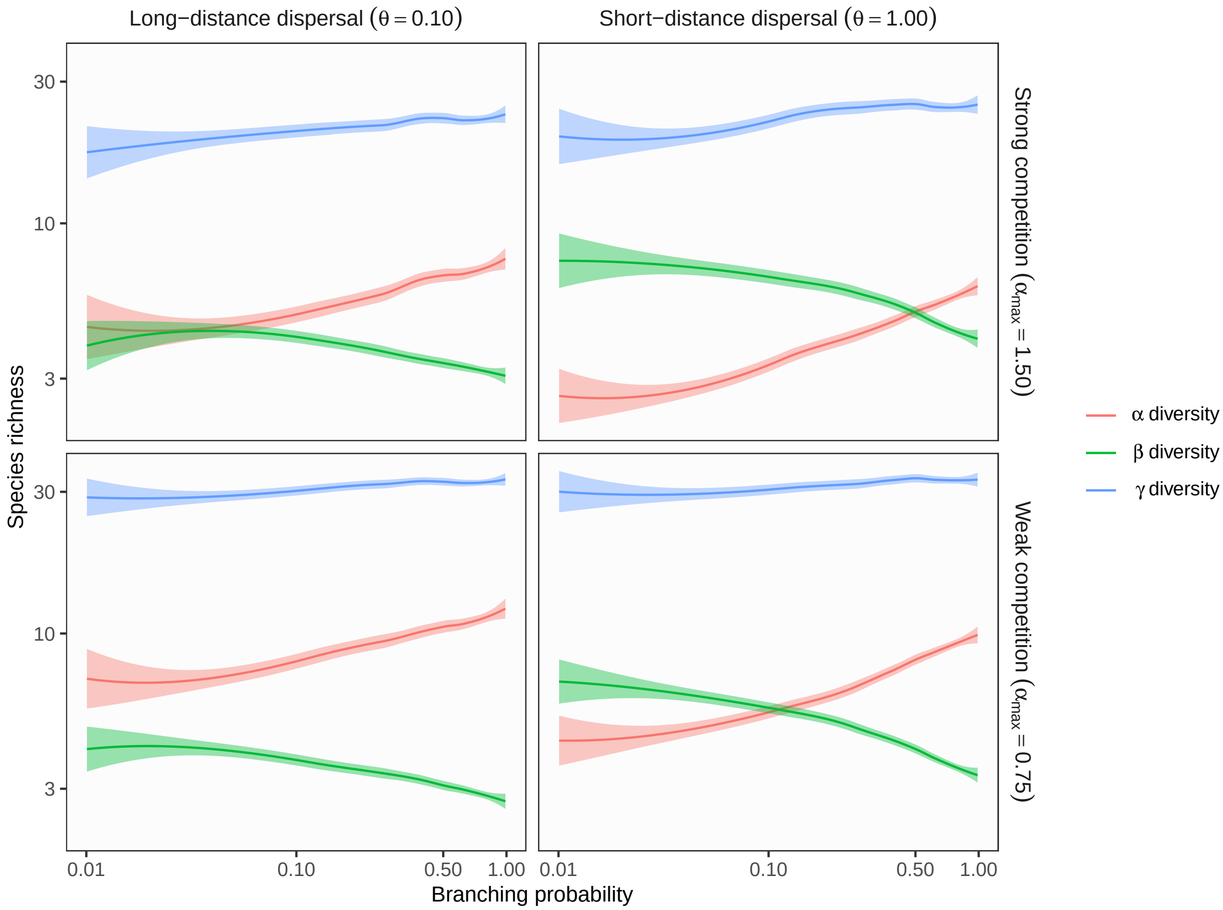

Figure S14 Theoretical predictions for ecosystem complexity influences (branching probability) on α, β, and γ diversity in branching networks. In this simulation, environmental variation at headwaters (σ_h) is less than local environmental noise (σ_l). Lines and shades are loess curves fitted to simulated data and its 95% confidence intervals. Each panel represents different ecological scenarios under which metacommunity dynamics were simulated. Rows represent different competition strength. Competitive coefficients (α_{ij}) were varied randomly from 0 to 1.5 (top, strong competition) or 0.75 (bottom, weak competition). Columns represent different dispersal scenarios. Two dispersal parameters were chosen to simulate scenarios with long-distance (the rate parameter of an exponential dispersal kernel $\theta = 0.10$) and short-distance dispersal ($\theta = 1.0$). Other parameters are as follows: dispersal probability $p_d = 0.01$; environmental variation at headwaters $\sigma_h = 0.01$; local environmental noise $\sigma_l = 1$.

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