Pugh & Field (submitted to *Land*) – Supplementary material

Section S1 – systematic literature search

Table S1: Papers identified from a systematic literature search (14/115 searched) **partitioning taxonomic and functional β** into nestedness and turnover components in order to **quantify the impact of disturbances on community dissimilarity**. Local taxo/func = local scale taxonomic/functional β, regional taxo/func = regional scale taxonomic/functional β and continental taxo/func = continental scale taxonomic/functional β. No clear definition for study scales (local, regional or taxonomic) was used due to differences between study systems e.g. aquatic stream habitats to urban greenspaces, instead conclusions were put into the most suitable category. Note that 2/14 studies are experimental and disturbance types, frequencies, intensities and study periods differ greatly between studies. Additionally, most studies focus on a single spatial scale. Search terms used in 'Web of Science' and 'Google Scholar' were; 1) "Beta diversity" AND "Functional" AND "Partitioning" and 2) "Beta diversity" AND "Functional" AND "Disturbance", papers were sorted by relevance and the top 20 were selected and searched by abstract/methods. Additionally, using 'Scite_' papers citing Villéger et al, 2013 (all 45 papers selected) and Baselga, 2010 (top 30 papers selected) in their methods sections were sorted by relevance and searched by abstract/methods. Blue = dominance of nestedness, orange = dominance of turnover and green = both and blank = no clear pattern.

Reference	Disturbance Regime	Traits	Taxa	Local Taxo	Regional Taxo	Continental Taxo	Local Func	Regional Func	Continental Func	Temporal Scale	Study Type
Aspin et al, 2018	Drought	Forty-nine biological (not ecological) functional traits spanning ten grouping features at the genus level (see paper for details)	Stream invertebrates	Drought intensification decreased taxonomic β (distance decay from non-disturbed driven by turnover)	N/A	N/A	Drought intensification decreased functional β (distance decay from non-disturbed driven by turnover and nestedness)	N/A	N/A	18-month period	Experimental
Barbet-Massin and Jetz, 2015	Future climate change scenarios	Foraging type, foraging height, body size, and activity time (diurnal/nocturnal).	Birds	N/A	N/A	No clear pattern	N/A	N/A	No clear pattern	Future predictions of range sizes by 2080-2099	Observational
Barnagaud et al, 2017	Human impact (human influence index)	Nine ecological traits representing six key aspects of bird ecology; diet, habitat use, thermal preference, migration, dispersal and body size (see paper for details)	Birds	N/A	N/A	Increasing human impact reduced turnover indicating biotic homogenisation	N/A	N/A	Increasing human impact reduced turnover indicating functional biotic homogenisation	Current	Observational
Braghin et al, 2018	Lakes associated with dammed (disturbed) rivers versus preserved rivers	Mean body length, habitat preference, feeding type, life span, reproduction and predatory escape response	Zooplankton	Same total dissimilarity in dammed and preserved river lakes but nestedness was higher in the dammed river (loss of species)	N/A	N/A	Lower total dissimilarity in dammed than preserved river lakes and nestedness was higher in the dammed river (loss of functions)	N/A	N/A	Current	Observational
Brice et al, 2017	Urbanisation and flooding	Maximum height, life-form, shade tolerance, wetness coefficient, seed weight, seed bank, reproduction, diaspore morphology, seed buoyancy	Herbaceous communities in riparian forests	Urbanisation led to higher taxonomic β driven by turnover and nestedness, flooding led to lower taxonomic β also driven by turnover and nestedness	N/A	N/A	Urbanisation led to higher functional β driven by turnover and nestedness, flooding led to lower functional β	N/A	N/A	Current	Observational

							also driven by turnover and nestedness				
Closset-Kopp et al, 2018	Managed forest patches versus unmanaged patches	Total cover (tree, shrub and combined layers), cover-weighted mean of shade-casting ability, community specialization index, overstory species litter quality indices, major tree species relative cover, community CSR, proportion of dispersal modes, cover-abundance-weighted means of Ellenberg's indicator values for: light, temperature, continentality, soil pH, soil nutrient, soil moisture and browsing	Understory plant communities	High total dissimilarity between 1970 and 2015 driven by both nestedness and turnover for both managed and unmanaged plots and between soil types	N/A	N/A	High total dissimilarity driven by high nestedness and low turnover indicating functional convergence for both managed and unmanaged plots and between soil types	N/A	N/A	Between 1970 and 2015	Observational
Crabot et al, 2021	Impacts of drying disturbance on historically drying (HD) and recently drying (RD) rivers	Life cycle duration, potential number of cycles per year, reproduction, dispersal, resistance forms, respiration, locomotion and substrate relation	Aquatic invertebrates	In RD (more disturbed) networks taxonomic temporal total dissimilarity higher than HD and driven by turnover which was higher at intermittent (as opposed to perennial) sites, spatial total dissimilarity was also higher in RD networks with high turnover and more turnover in intermittent sites	N/A	N/A	Temporal and spatial functional total dissimilarity was high in RD and HD sites whether perennial or intermittent and was driven primarily by nestedness in all sites	N/A	N/A	2012 to 2015	Observational
Fournier et al, 2018	Urbanisation effects between the regional species pool and urban (allotments, gardens, parks, brownfields and green roofs) species pools	Bees: Phenology start, phenology duration, feeding preferences (lecty), tongue length, inter-tegula distance, nesting mode, social status, type of voltinism and Carabid beetles: Phenology start, phenology duration, feeding preferences, mean and variation in body size, overwintering stage, dispersal mode (wing form), elevational optimum, elevational range and drought tolerance	Carabid beetles and wild bees	N/A	High dissimilarity driven primarily by turnover (taxonomic divergence in species identities) in urban species pools	N/A	N/A	Functional convergence driven primarily by nestedness in urban species pools compared to rural pools (loss of functions)	N/A	Current	Observational
Fu et al, 2019	Phosphorus concentration gradient (total phosphorus)	Growth form, life history, shoot height, stem diameter, specific leaf area, leaf dry mass content, lamina thickness, stem dry mass content, and mean Julian flowering dates and flowering duration	Lake macrophytes	Higher phosphorus decreased taxonomic total dissimilarity and turnover at the transect scale	Higher phosphorus decreased total dissimilarity and turnover at the lake scale	N/A	Higher phosphorus decreased functional total dissimilarity and nestedness at the lake scale	Stronger impact of regional environmental drivers e.g. altitude promoting functional nestedness	N/A	Current	Observational

Leigh et al, 2019	Drought	Eighty-nine fuzzy-coded functional trait categories describing ecological preferences and life-history traits (see paper for details)	Aquatic macro-invertebrates	High total dissimilarity driven by turnover meaning that new colonists were not equivalent to original assemblages	N/A	N/A	High total dissimilarity driven by higher turnover and nestedness than control indicating a loss of functions in disturbed communities	N/A	N/A	2-year period	Experimental
Liu and Wang, 2018	Comparison between lakes connected to the Yangtze river and unconnected (more disturbed) lakes (loss of lateral hydrological connectivity)	Migration type, vertical position, longevity, sexual maturity age of female, fecundity, egg type, maximum body length, body length/body depth, caudal peduncle length/body length, eye diameter/head length, mouth position, diet	Fish	Taxonomic total dissimilarity higher in disconnected lakes and driven primarily by turnover (>70%)	N/A	N/A	Functional total dissimilarity lower than taxonomic and higher in disconnected lakes and driven primarily by nestedness (>70%)	N/A	N/A	Current	Observational
Mathers et al, 2020	Invasive crayfish	Sixty-three biological traits (11 grouping features) and 13 ecological traits (two grouping features) (see paper for details)	Lotic macro-invertebrates	N/A	Increases in taxonomic richness seen in control rivers not seen in invaded rivers	N/A	N/A	Higher functional nestedness in two of three invaded rivers compared to control rivers (loss of functions), third region displayed no change	N/A	Between 1990 and 2013	Observational
Nielsen and Totland, 2014	Old growth forest (least disturbed), young forest (intermediate) and clear cuts (most disturbed)	Used 'Netcarto' to calculate species-level 'ecological functional role' within the networks, by assessing species-level 'network functional role'	Pollination networks	Higher total dissimilarity in disturbed sites but greater turnover in least disturbed sites indicating homogenisation under disturbance	N/A	N/A	No clear pattern but likely a change in functional roles following disturbance	N/A	N/A	Forest: Current, young (13–35 years) and old (>100 years)	Observational
Pereyra et al, 2018	3 land uses; suburban, tobacco monoculture and forest	Reproductive mode, maximum male size (mm), ecomorphological guild of tadpoles, general habitat use of adult frogs and reproductive activity patterns	Anuran amphibians	N/A	Low species total dissimilarity (mainly turnover) between three land use types (<0.25)	N/A	N/A	High functional total dissimilarity (>0.7) between land uses, differences between forests and tobacco monoculture almost entirely nestedness (loss of functions from forest) whereas forest and suburban dissimilarity driven by turnover	N/A	Current	Observational

Section S2 – Determining quadrat size

Six canal towpath site coordinates were selected using a random number generator. At each site 0.25m^2 (0.25mx1m), 0.5m^2 (0.5mx1m), 1m^2 (0.5mx2m), 1.5m^2, 2m^2 and 2.5m^2 quadrats were sampled visually for plant species incidence and abundances (% of three-dimensional quadrat covered by each plant species minus the bare ground cover). Visual estimation of abundances by a single observer (eliminating observer bias) was selected as accuracy is comparable to pin-point and imagery analysis methods (Ringvall et al, 2005; Seefeldt and Booth, 2006; Damgaard, 2014). There was no levelling off in the species-accumulation curve with increasing plot size (Figure-5). However, due to time constraints, some literary evidence (although mixed) for increased visual abundance estimation accuracy with smaller quadrat size and the practicality that many bank engineering sites had dimensions of 0.5mx2m, 1m^2 was selected as the most suitable quadrat size for this study (Sykes et al, 1983; Kenkel and Podani, 1991; Milberg et al, 2008).

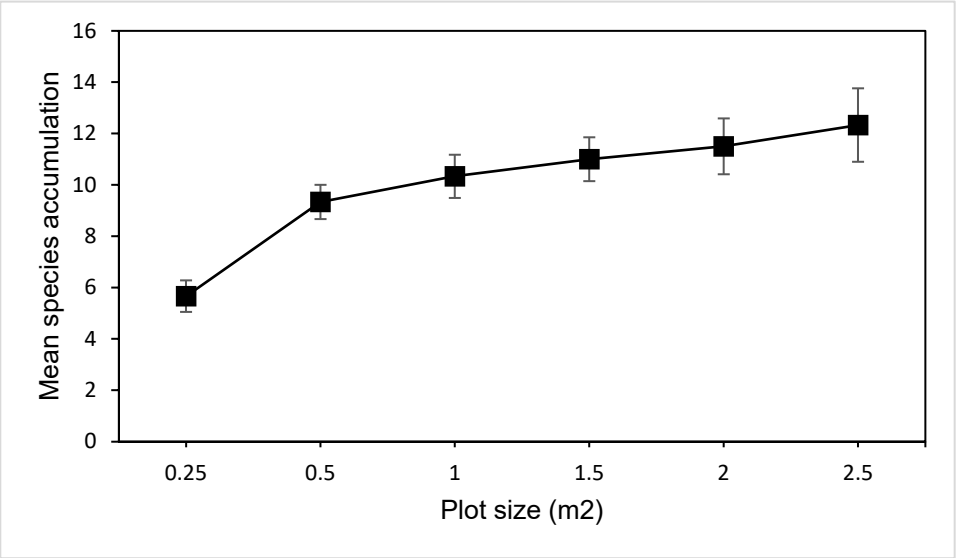

Figure S1*: Mean species accumulation for 6 randomly selected sites along the Basingstoke Canal with increasing quadrat size (0.25m^2 (0.25mx1m), 0.5m^2 (0.5mx1m), 1m^2 (0.5mx2m), 1.5m^2 (0.5mx3m), 2m^2 (0.5mx4m) and 2.5m^2 (0.5mx5m)). One standard error is displayed for each mean accumulation value.*

Section S3 – supplementary figure

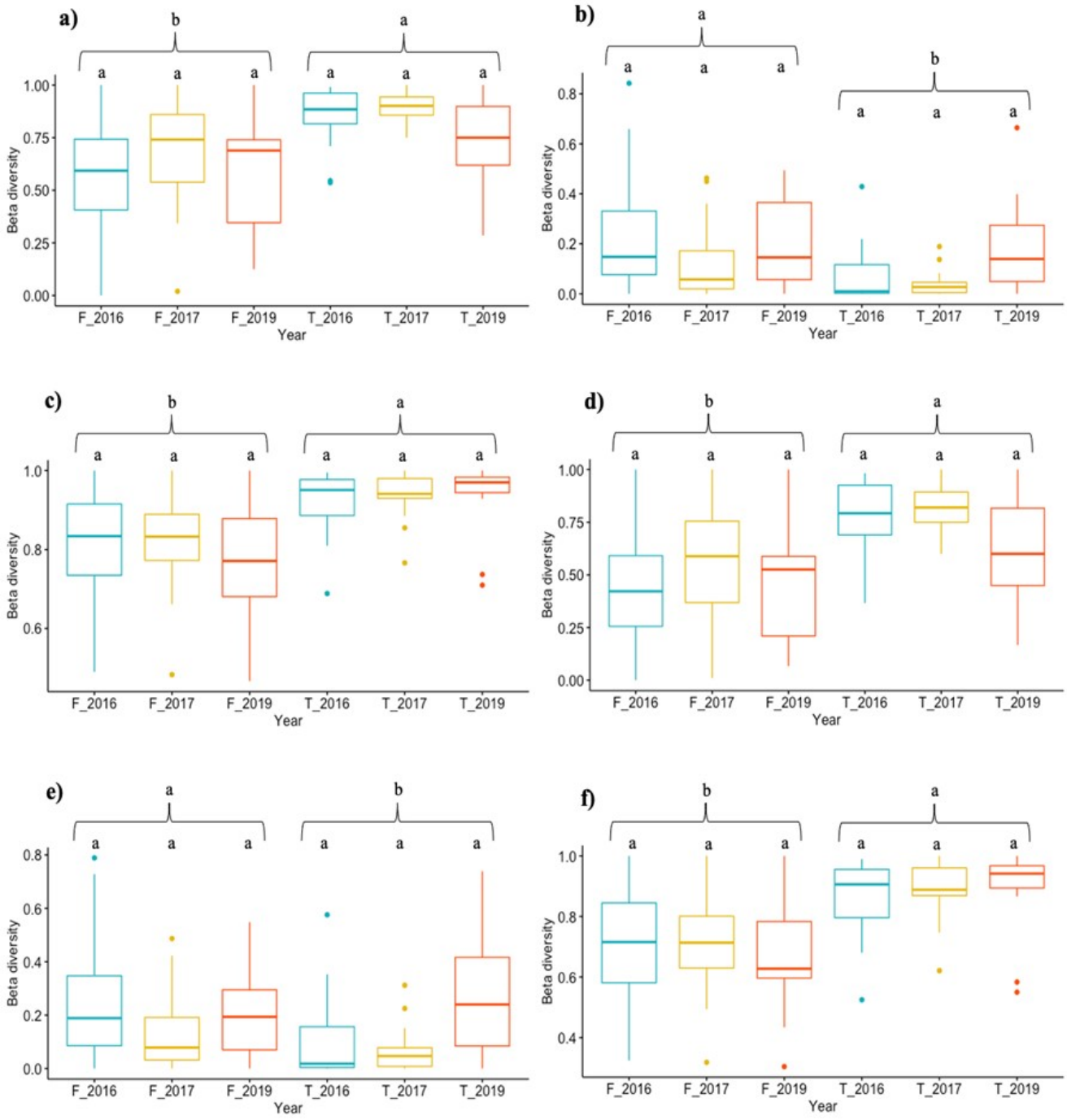

Figure S2*: Box plots displaying significance of a two-way ANOVA with interactions with years (2016, 2017 and 2019) and beta diversity type (functional and taxonomic) as fixed factors and partitioned between-site beta diversity as the response variable (turnover, nestedness-resultant and total dissimilarity) for the Jaccard and Sørensen families of indices. 'F' indicates functional diversity and 'T' indicates taxonomic diversity with 2016 represented in 'blue', 2017 in 'yellow' and 2019 in 'red'. Different letters indicate statistical significance at* $P \leq 0.05$ *between groups. a) Jaccard turnover, b) Jaccard nestedness-resultant, c) Jaccard total dissimilarity, d) Sørensen turnover, e) Sørensen nestedness-resultant and f) Sørensen total dissimilarity.*

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