Supplementary Material

Urban Ecosystems
Original Research Article
Anthropogenic subsidies affect arthropod communities and native litter decomposition in an urban riparian forest
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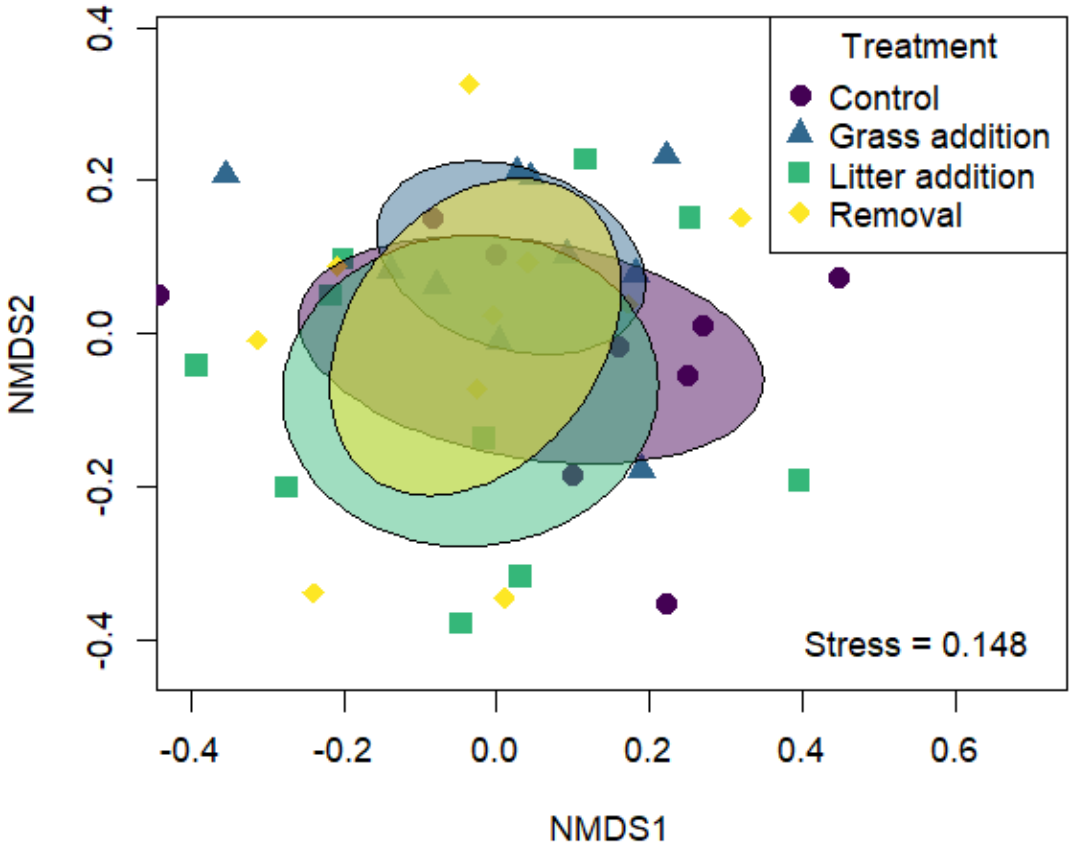

Fig. S1 Two-dimensional nonmetric multidimensional scaling (NMDS) ordination plot (stress = 0.148) showing beetle family-level community composition among treatments. Ellipses represent 95% confidence intervals around the centroid. PERMANOVA: $F = 0.72$, $P = 0.642$, $R^2 = 0.06$, $df = 3$.

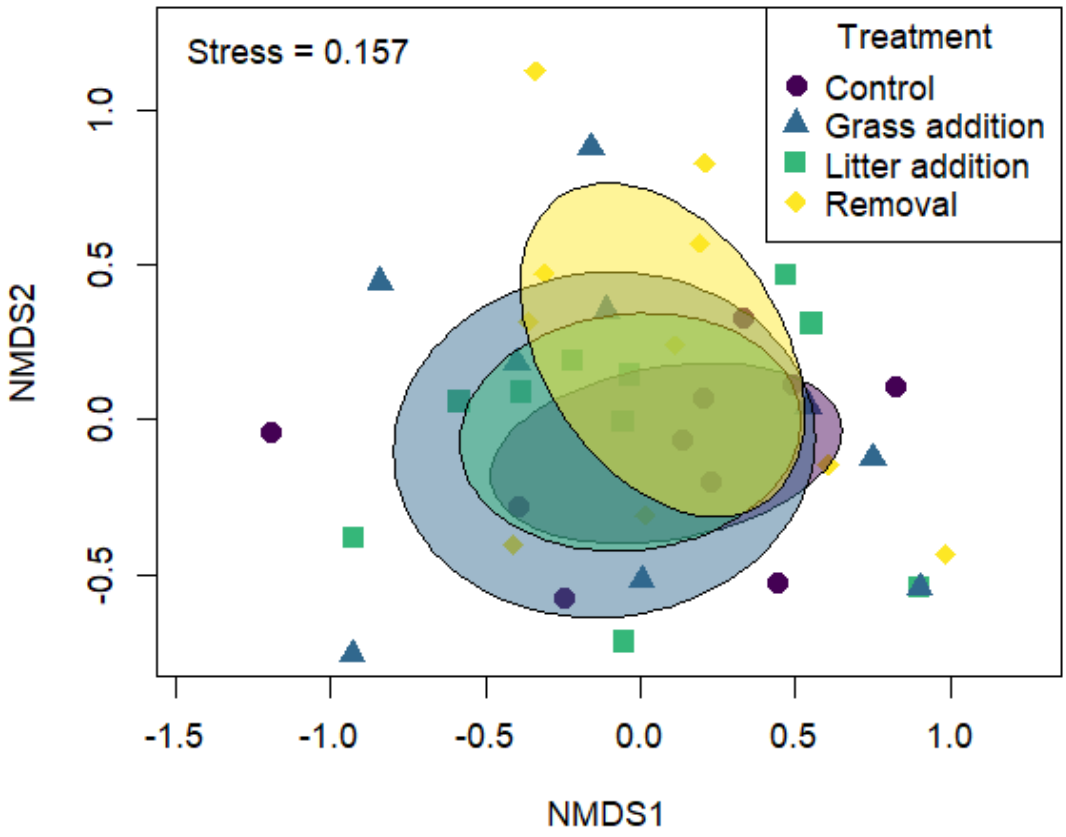

Fig. S2 Two-dimensional nonmetric multidimensional scaling (NMDS) ordination plot (stress = 0.157) showing spider family-level community composition among treatments. Ellipses represent 95% confidence intervals around the centroid. PERMANOVA: $F = 0.87$, $p = 0.590$, $R^2 = 0.07$, $df = 3$.

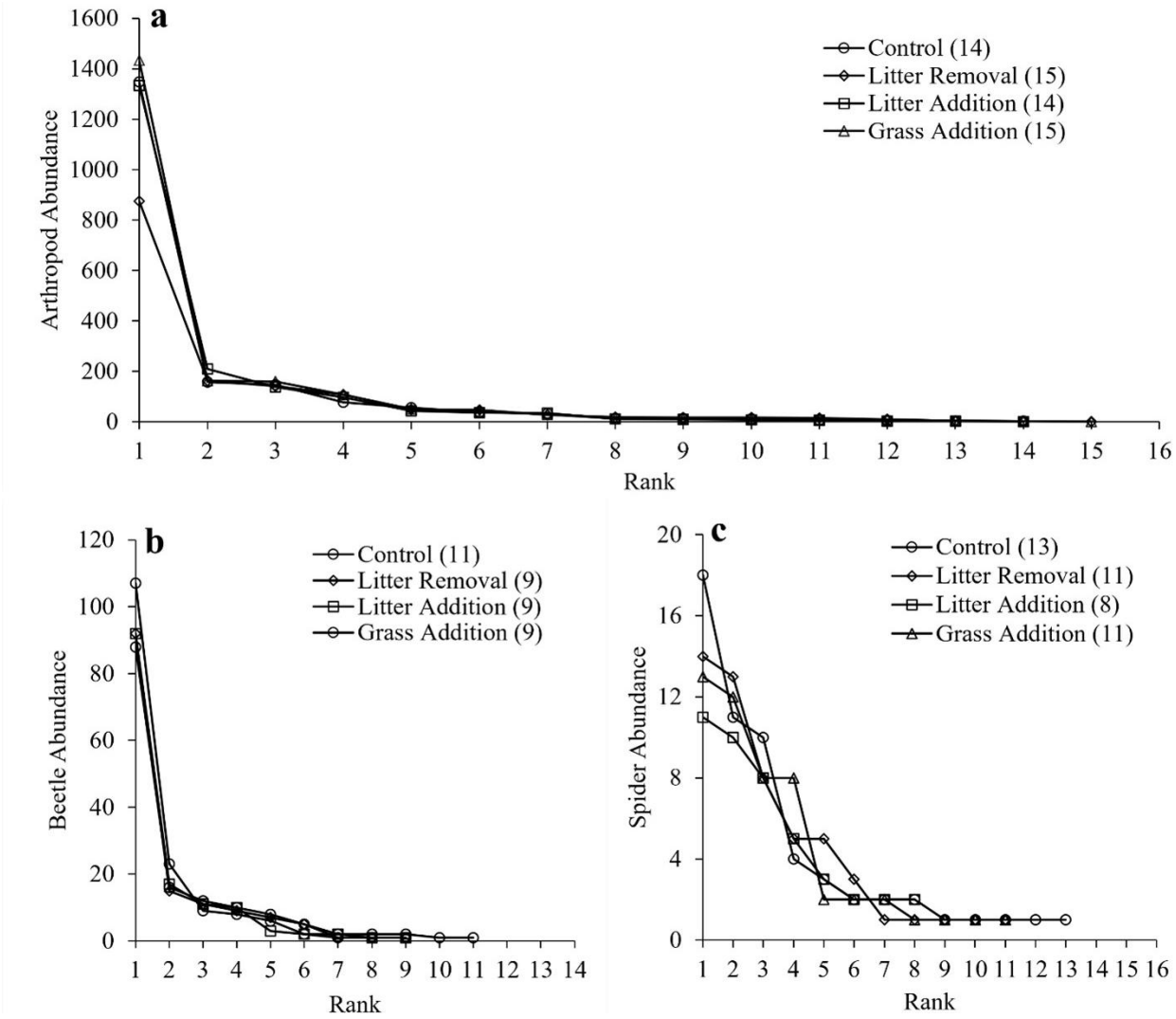

Fig. S3 Rank abundance curves for ground arthropod community. a) The order-level community ranked by abundance. For all treatments, springtails were the highest, followed by ants, beetles, crickets, spiders, and mites. b) Beetle community by family. c) Spider community by family.

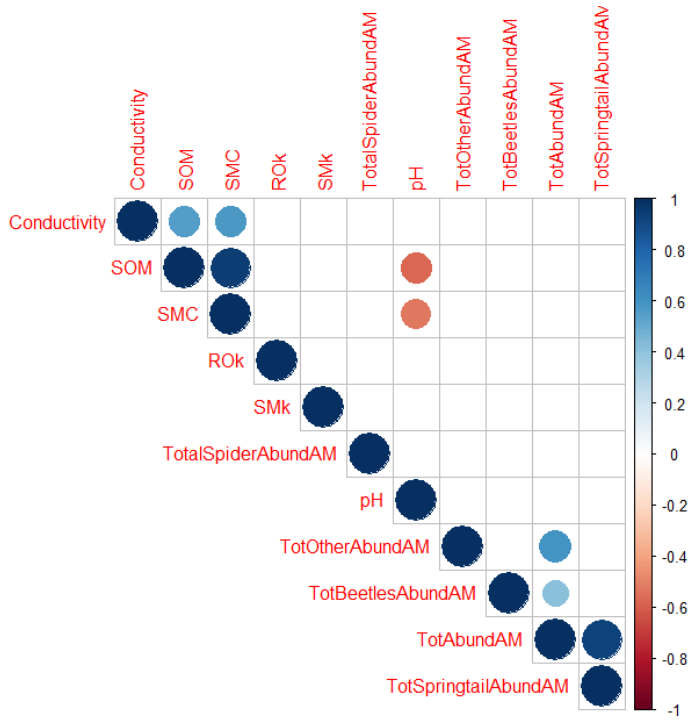

Fig. S4 Correlation table between soil characteristics, abundance responses, and decomposition rate (SOM – soil organic matter, SMC – soil moisture content, ROk – Red Oak decomposition rate (year-1), SMk – Sugar Maple decomposition rate (year-1), total spider abundance, pH, total abundance of other arthropods, total beetle abundance, total abundance overall, total springtail abundance. Correlations were performed for all variables in the figure, but only significant relationships are shown (see Table S20). Significant correlations are indicated with the circles, with the color representing the direction of correlation and circle size corresponding to correlation strength.

Table S1 Pairwise comparisons of treatment levels based on estimated marginal means from the GLMMs for total abundance (negative binomial) and springtail abundance (negative binomial). Tukey adjusted. Significant p values are bold ($p < 0.05$).

Contrast	Estimate	SE	*z*	*p*
Total abundance				
Addition - Control	-0.00	0.09	-0.05	1.000
Addition - Grass	-0.04	0.09	-0.39	0.980
Addition - Removal	0.26	0.09	2.82	**0.025**
Control - Grass	-0.03	0.09	-0.34	0.986
Control - Removal	0.26	0.09	2.87	**0.022**
Grass - Removal	0.30	0.09	3.21	**0.007**
Springtail abundance				
Addition - Control	-0.05	0.12	-0.42	0.975
Addition - Grass	-0.07	0.12	-0.63	0.923
Addition - Removal	0.39	0.12	3.28	**0.006**
Control - Grass	-0.02	0.12	-0.20	0.997
Control - Removal	0.44	0.12	3.70	**0.001**
Grass - Removal	0.46	0.12	3.91	**0.001**

Table S2 Results of the GLMMs for beetle abundance (negative binomial), spider abundance (Poisson), and the abundance of all taxa excluding springtails, beetles and spiders (negative binomial). Treatment and month are the explanatory variables. Addition serves as the reference for treatment and August as the reference for month. Significant p values are bold ($p < 0.05$).

Term	Estimate	SE	*z*	*p*
Beetle abundance				
(Intercept)	1.12	0.14	8.23	**< 0.001**
Treatment				
Control	0.06	0.15	0.43	0.665
Grass	0.10	0.15	0.71	0.478
Removal	-0.00	0.15	-0.01	0.989
Month				
June	1.11	0.12	9.07	**< 0.001**
September	-0.57	0.16	-3.55	**< 0.001**
Spider abundance				
(Intercept)	0.54	0.19	2.91	**0.004**
Treatment				
Control	0.28	0.20	1.40	0.163
Grass	0.17	0.21	0.82	0.410
Removal	0.21	0.21	1.02	0.308
Month				
June	-0.17	0.16	-1.05	0.294
September	-0.49	0.18	-2.74	**0.006**
Others abundance				
(Intercept)	2.86	0.14	20.59	**< 0.001**
Treatment				
Control	-0.17	0.15	-1.17	0.241
Grass	-0.08	0.14	-0.53	0.595
Removal	-0.06	0.14	-0.44	0.663
Month				
June	-0.15	0.12	-1.21	0.225
September	-0.62	0.13	-4.90	**< 0.001**

Table S3 Pairwise PERMANOVA of treatment levels for order-level community composition. Performed using package *pairwiseAdonis* with 999 permutations and Holm adjustments. Significant p values are bold ($p < 0.05$).

Contrast	*p*
Addition - Control	0.821
Addition - Grass	0.987
Addition - Removal	**0.001**
Control - Grass	0.925
Control - Removal	**0.002**
Grass - Removal	**0.002**

Table S4 Orders present over the experimental collections.

Order	Control	Litter Removal	Litter Addition	Grass Addition
Springtails (Collembola)	x	x	x	x
Hymenoptera (Ants)	x	x	x	x
Coleoptera (Beetles)	x	x	x	x
Orthoptera (Crickets)	x	x	x	x
Araneae (Spiders)	x	x	x	x
Acariformes (Mites)	x	x	x	x
Archaeognatha (Bristletails)	x	x	x	x
Opiliones (Harvestmen)	x	x	x	x
Gastropoda (Slugs)	x	x	x	x
Pseudoscorpiones (Pseudoscoprions)	x	x	x	x
Hemiptera (True bugs)	x	x	x	x
Isopoda (Isopods)	x	x	x	x
Diplopoda (Millipedes)	x	x	x	x
Haplotaxida (Earthworms)		x	x	x
Chilopoda (Centipedes)	x			x
Polydesmida (Flat-backed millipedes)		x		

Table S5 Beetle families present over the experimental collections.

Family	Control	Litter Removal	Litter Addition	Grass Addition
Entiminae	x	x	x	x
Carabidae	x	x	x	x
Nitidulidae	x	x	x	x
Staphylinidae	x	x	x	x
Curculioninae	x	x	x	x
Scarabaeidae	x	x	x	x
Scolytinae	x	x	x	x
Ptilidae	x		x	
Mordellidae	x		x	x
Elateridae		x		x
Histeridae				
Tenebrionidae	x			
Morphospecies	x			
Lampyridae		x		

Table S6 Spider families present over the experimental collections.

Family	Control	Litter Removal	Litter Addition	Grass Addition
Agelenidae	x	x	x	x
Hahniidae	x	x	x	x
Phrurolithidae	x	x	x	x
Lycosidae	x	x	x	x
Opiliones	x	x	x	x
Dictynidae	x			x
Gnaphosidae	x		x	x
Tetragnathidae		x		
Linyphiidae		x		
Amaurobiidae	x		x	
Mysmenidae	x			x
Corinnidae	x	x		x
Liocranidae		x		
Thomisidae	x	x		x
Clubionidae	x	x		
Salticidae	x		x	x

Table S7 Results of the GLMMs for percent mass remaining in leaf litter bags in April (Gaussian), August (gamma), and December (Gaussian). Treatment and leaf litter type are the explanatory variables. Addition serves as the reference for treatment and red oak as the reference for leaf litter type. Significant p values are bold ($p < 0.05$).

Term	Estimate	SE	*z*	*p*
April				
(Intercept)	88.30	0.67	131.51	**< 0.001**
Treatment				
Control	0.95	0.77	1.23	0.219
Grass	-1.32	0.77	-1.71	0.087
Removal	-0.96	0.77	-1.24	0.213
Litter Type				
Sugar maple	-3.88	0.55	-7.09	**< 0.001**
August				
(Intercept)	4.48	0.01	572.60	**< 0.001**
Treatment				
Control	0.01	0.01	1.22	0.222
Grass	-0.02	0.01	-1.71	0.087
Removal	-0.01	0.01	-1.25	0.211
Litter Type				
Sugar maple	-0.05	0.01	-7.08	**< 0.001**
December				
(Intercept)	51.53	1.19	43.22	**< 0.001**
Treatment				
Control	2.36	1.37	1.72	0.086
Grass	-1.49	1.37	-1.09	0.278
Removal	-2.41	1.37	-1.76	0.079
Litter Type				
Sugar maple	-5.79	0.97	-5.96	**< 0.001**

Table S8 Results of the GLMM (gamma) for the decomposition rate k ($year^{-1}$). Treatment and leaf litter type are the explanatory variables. Addition serves as the reference for treatment and red oak as the reference for leaf litter type. Significant p values are bold ($p < 0.05$).

Term	Estimate	SE	*z*	*p*
(Intercept)	-1.54	0.03	-46.57	**< 0.001**
Treatment				
Control	-0.05	0.04	-1.41	0.159
Grass	0.05	0.04	1.44	0.149
Removal	0.07	0.04	1.95	0.052
Litter type				
Sugar maple	0.16	0.03	6.07	**< 0.001**

Table S9 Pairwise comparisons of treatment levels based on estimated marginal means from the GLMM (gamma) for the decomposition rate k. Tukey adjusted. Significant p values are bold ($p < 0.05$).

Contrast	Estimate	SE	*z*	*p*
Addition - Control	0.05	0.04	1.41	0.493
Addition - Grass	-0.05	0.04	-1.44	0.473
Addition - Removal	-0.07	0.04	-1.95	0.208
Control - Grass	-0.11	0.04	-2.85	**0.023**
Control - Removal	-0.13	0.04	-3.36	**0.004**
Grass - Removal	-0.02	0.04	-0.50	0.958

Table S10 Results of the GLMMs for soil pH (Gaussian), conductivity (gamma), percent moisture content (Gaussian), and percent organic matter (Gaussian). Treatment and month are the explanatory variables. Addition serves as the reference for treatment and July as the reference for month. Significant p values are bold ($p < 0.05$).

Term	Estimate	SE	*z*	*p*
Soil pH				
(Intercept)	5.09	0.06	85.95	**< 0.001**
Treatment				
Control	-0.05	0.06	-0.87	0.386
Grass	0.00	0.06	0.05	0.961
Removal	-0.13	0.06	-2.10	**0.036**
Month				
October	-0.45	0.04	-10.35	**< 0.001**
Conductivity				
(Intercept)	5.56	0.06	99.88	**< 0.001**
Treatment				
Control	-0.06	0.06	-1.01	0.311
Grass	0.09	0.06	1.55	0.121
Removal	0.00	0.06	0.02	0.987
Month				
October	0.03	0.04	0.73	0.466
Moisture content				
(Intercept)	75.72	3.96	19.13	**< 0.001**
Treatment				
Control	-5.61	3.08	-1.82	0.069
Grass	-0.54	3.08	-0.17	0.862
Removal	-3.06	3.08	-0.99	0.321
Month				
October	6.35	2.18	2.91	**0.004**
Organic matter				
(Intercept)	18.53	1.40	13.21	**< 0.001**
Treatment				
Control	-0.66	1.17	-0.56	0.576
Grass	0.42	1.17	0.35	0.723
Removal	-0.07	1.17	-0.06	0.951
Month				
October	2.16	0.83	2.60	**0.009**

Table S11 Correlation matrix displays the resulting p-values for the Pearson correlation coefficient. Significant p values are bold ($p < 0.05$).

	pH	Conductivity (µS/cm)	Red Oak decomposition rate (year^{-1})	Sugar Maple decomposition rate (year^{-1})	Soil Organic Matter (%)	Soil Moisture (%)	Total abundance	Total abundance of other arthropods	Beetle abundance	Spider abundance	Springtail abundance
pH		0.520	0.462	0.923	**< 0.001**	**< 0.001**	0.298	0.291	0.516	0.994	0.478
Conductivity (µS/cm)	0.520		0.414	0.859	**< 0.001**	**< 0.001**	0.137	0.543	0.055	0.943	0.200
Red Oak decay constant (year-1)	0.462	0.414		0.057	0.294	0.257	0.347	0.882	0.199	0.127	0.349
Sugar Maple decay constant (year-1)	0.923	0.859	0.057		0.907	0.468	0.124	0.102	0.761	0.414	0.213
Soil organic matter (%)	**< 0.001**	**< 0.001**	0.294	0.907		**0.000**	0.587	0.782	0.618	0.405	0.693
Soil moisture (%)	**< 0.001**	**< 0.001**	0.257	0.468	**0.000**		0.905	0.945	0.710	0.527	0.961
Total abundance	0.298	0.137	0.347	0.124	0.587	0.905		**< 0.001**	**0.008**	0.423	**< 0.001**
Total abundance of other arthropods	0.291	0.543	0.882	0.102	0.782	0.945	**< 0.001**		0.169	0.309	0.103
Beetle abundance	0.516	0.055	0.199	0.761	0.618	0.710	**0.008**	0.169		0.565	0.068
Spider abundance	0.994	0.943	0.127	0.414	0.405	0.527	0.423	0.309	0.565		0.353
Springtail abundance	0.478	0.200	0.349	0.213	0.693	0.961	**< 0.001**	0.103	0.068	0.353	