Figure S1 Air temperature during the experimental period from 2021 to 2022.

The data from 2017 to 2020 were published in Hu et al., 2024.

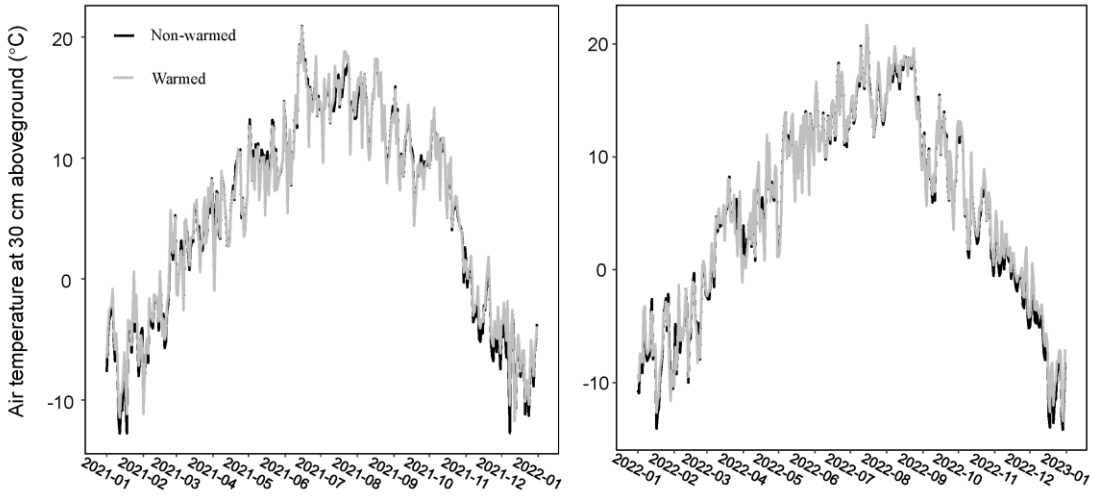


Figure S2 The monthly mean soil moisture in growing season at 5 cm depth during the experimental period from 2017 to 2022.

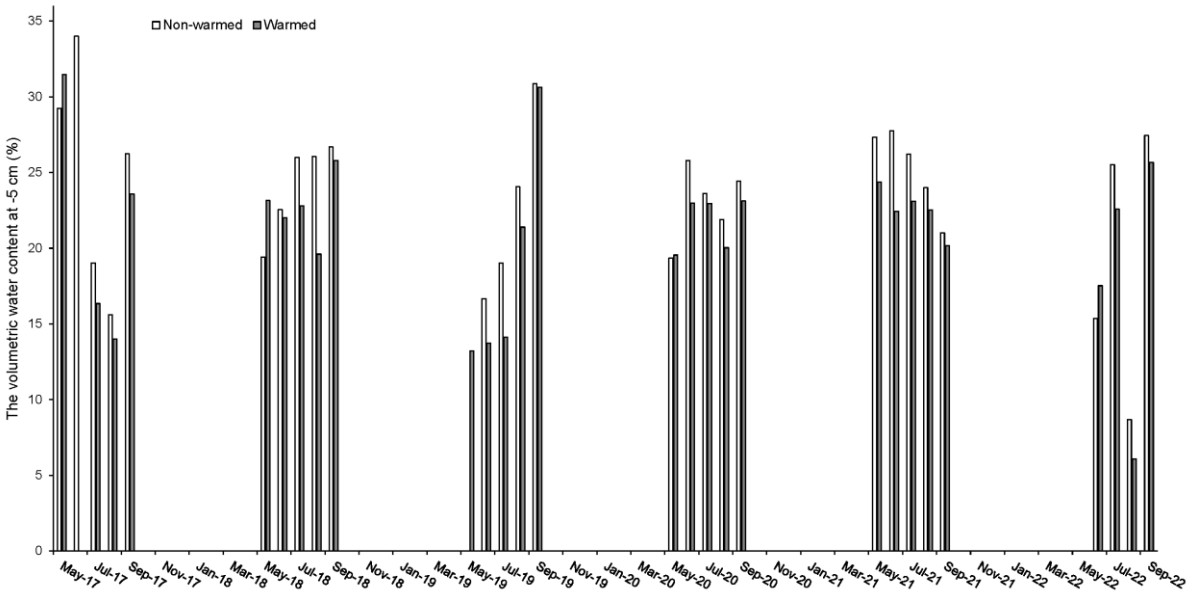


Figure S3 The vapor pressure deficit during the experimental period from 2018 to 2022.

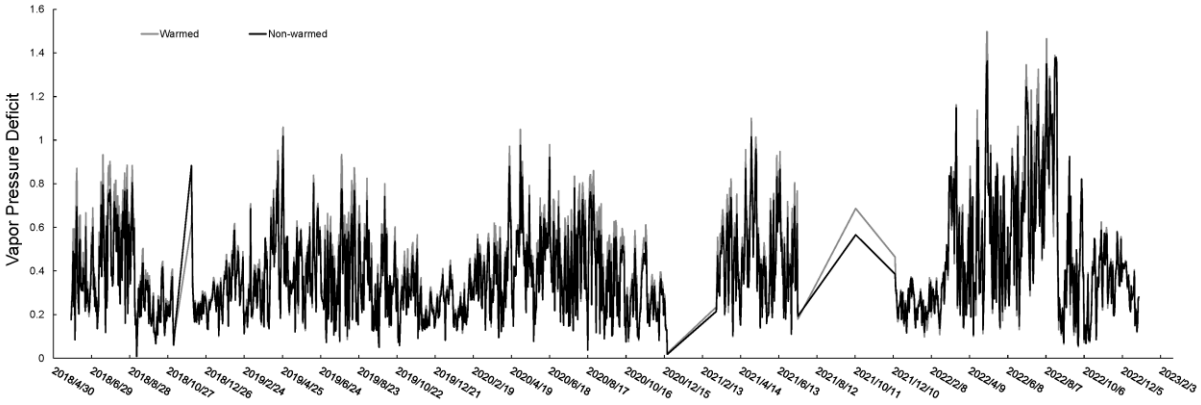


Figure S4 Full structural equation model used in the model selections. Data on overall arthropod species diversity and biomass were used for the analysis.

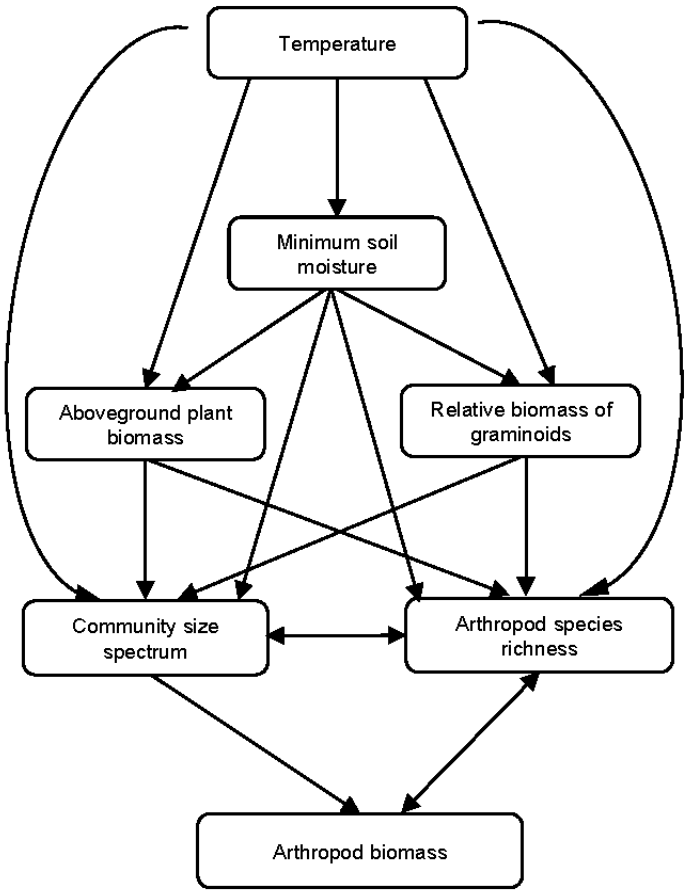


Figure S5 The feeding relationship between plants (belonging to two functional types) and the observed herbivores in both warmed and non-warmed chambers.

The herbivore species in this figure are listed in Supplementary Table S2. The herbivore species, as denoted by the Arabic numbers, were arranged in an ascending order of body mass from left to right.

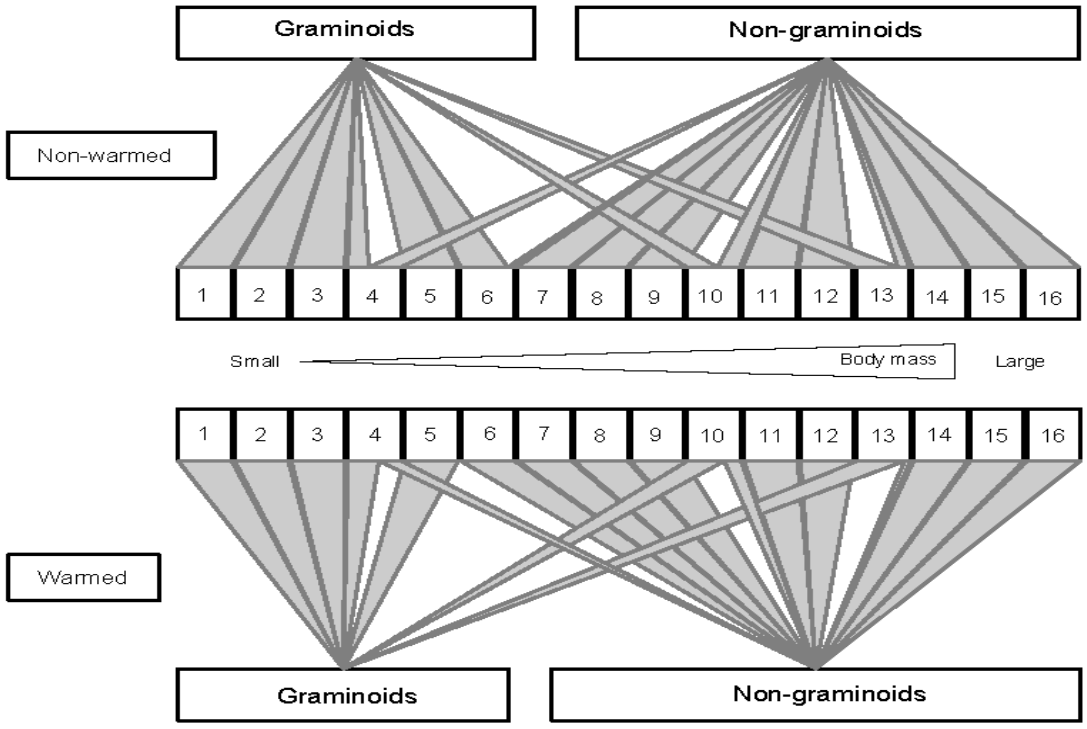


Figure S6 The effect of warming on aboveground plant biomass and relative biomass of graminoids in an alpine meadow. (a) The aboveground biomass, and **(b)** relative biomass of graminoids. The data are shown as mean ± s.e.m. (n = 3). The linear mixed model with treatment as a fixed effect and chamber identity as a random effect was used for statistical analysis. The asterisk represents significant differences (*** $P < 0.001$; * $P < 0.05$). The statistical parameters (F and P value) are shown in Supplementary Table S6. The data from 2017 to 2020 were published in Hu et al., 2024.

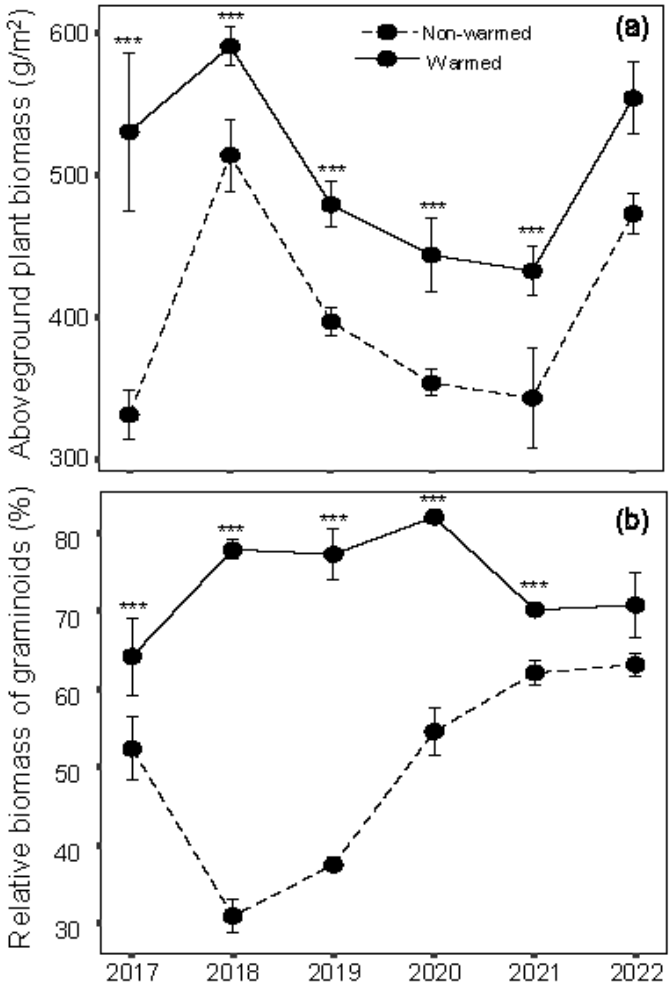


Figure S7 The relationship between days above 0°C and aboveground plant biomass. The data was analyzed by linear mixed model with days above 0°C as fixed factor, and warming and chamber identity as random factors.

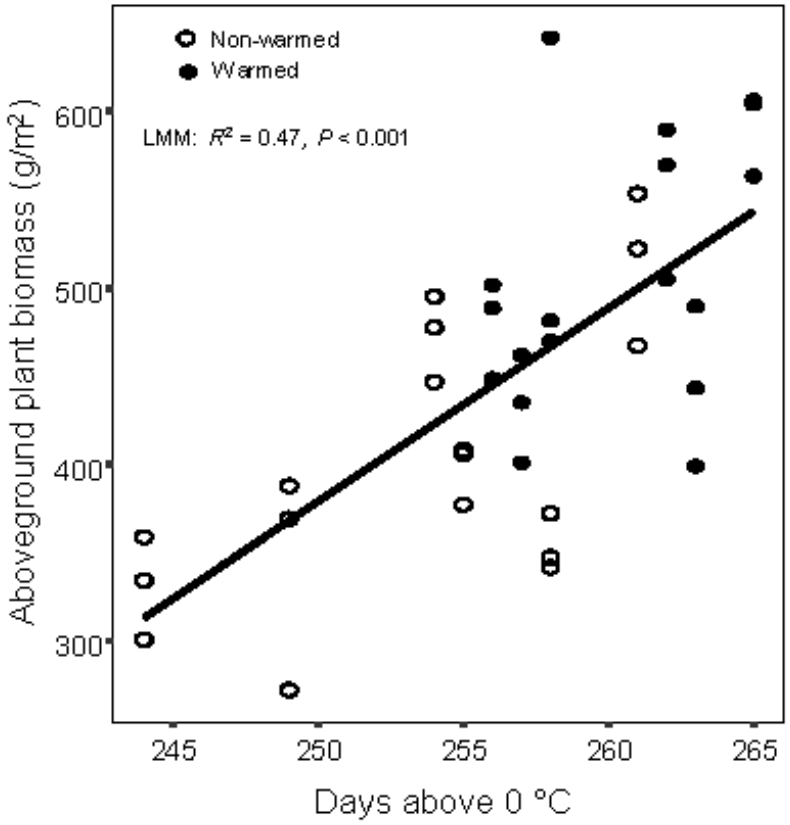
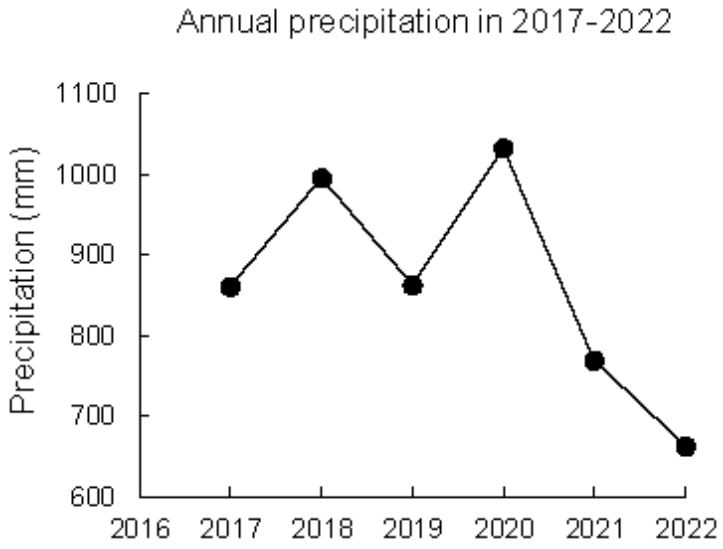


Figure S8 The precipitation during the experimental period from 2017 to 2022.



Supplementary Table 1 Summary of the statistical analyses. Summary of the result of (Generalized) Linear Models determining the effect of experimental warming on the species richness, evenness, species diversity, abundance, community weighted mean size, plant aboveground biomass, relative biomass of graminoids and arthropod community size spectrum.

Response variable	Fixed effect	estimate	F/χ^2	*P*	Error Structure
Arthropod species richness	warming	-0.12	11.3	<0.001	Negative binomial
Arthropod species evenness	warming	-0.44	36.42	<0.001	Gamma
Arthropod species diversity	warming	-0.55	47.88	<0.001	Gamma
Arthropod abundance	warming	0.29	1032	<0.001	Poisson
Arthropod biomass	warming	-0.58	13.07	0.001	Gaussian
Relative biomass of graminoids	warming	0.24	316.11	<0.001	Gaussian
Plant aboveground biomass	warming	103.31	87.55	<0.001	Gaussian
Community size spectrum of arthropods	warming	-0.09	32.62	<0.001	Gaussian
Community weighted mean of body size	warming	-0.89	37.93	<0.001	Gaussian
Abundance of arthropod size <2.218 mg	warming	0.38	55.66	<0.001	Negative binomial
Abundance of arthropod size >2.218 mg	warming	-0.14	12.49	<0.001	Negative binomial
Species richness of arthropod size <2.218 mg	warming	-0.05	1.44	0.23	Negative binomial
Species richness of arthropod size >2.218 mg	warming	-0.2	13.55	<0.001	Negative binomial

Supplementary Table 2 Summary of the slope and statistical parameters of significant abundance-increase species. Summary of the result of Generalized Linear Mixed Models (GLMM) determining the effect of experimental warming on the significant abundance-changed species.

No.	Species name	estimate	χ^2	*P*	Not found in 2022
1	*Atheroides* sp.	1.24	63.37	<0.001	
2	*Neophilaenus* sp.	0.47	11.83	<0.001	
3	*Notostira* sp.	0.82	42.52	<0.001	
4	*Cuerna* sp.	-0.61	4.28	0.039	
5	*Miridae* sp.	0.44	9.41	0.002	
6	*Ligyrocoris sylvestris*	-1.42	20.54	<0.001	×
7	*Nysius* sp.	-0.93	17.11	<0.001	
8	*Chionodes distinctella*	-1.21	15.17	<0.001	×
9	*Oedapis* sp.	-1.11	8.07	0.005	×
10	*Neophilaenus* sp.	0.42	19.33	<0.001	
11	*Lygus pratensis*	-0.25	5.66	0.017	
12	*Pachyprotasis* sp.	-0.83	3.67	0.055	×
13	*Cicadella viridis*	-0.37	12.36	<0.001	
14	*Atrachya menetriesi*	-0.79	9.24	0.002	×
15	*Cryptocephalus* sp.	-1.69	18.83	<0.001	
16	*Epirrhoe pupillata*	-1.06	7.63	0.006	×
17	*Nemophora* sp.	-1.01	4.97	0.026	×
18	*Meromyza brevifasciata*	0.31	6.84	0.009	
19	*Terellia* sp1.	-1.13	11.51	<0.001	×
20	*Ceroxys* sp.	-0.35	5.92	0.015	
21	*Portevinia* sp.	-0.61	7.43	0.006	
22	*Tenthredo nimbata*	-2.08	10.09	0.002	×
23	*Chorthippus apricarius*	-0.81	20.79	<0.001	
24	*Folsomia* sp.	1.09	47.37	<0.001	
25	*Pteromalus* sp.	-0.31	5.47	0.019	
26	*Opiinae* spp.	-0.26	6.99	0.008	
27	*Chironomus novosibiricus*	-0.32	7.88	0.005	×
28	*Pteromalus albipennis*	-0.31	7.68	<0.001	
29	*Chloropidae* sp.	0.22	5.29	0.022	
30	*Sepsis cynipsea*	0.3	8.15	0.004	
31	*Formica beijingensis*	0.17	4.43	0.035	

32	*Nabis* sp.	0.7	25.66	<0.001
33	*Platycheirus aff. nigrofemoratus*	0.2	1846.5	<0.001
34	*Sphaerophoria* sp.	0.3	8.28	0.004
35	*Idiolispa* sp.	-0.43	4.42	0.036
36	*Antispilina* sp.	-0.28	5.3	0.021
37	*Rhagionidae* sp.	-1.41	34.6	<0.001
38	*Scathophaga stercoraria*	-0.5	12.26	<0.001
39	*Dicranomyia* sp.	-0.41	4.97	0.026
40	*Arthropeas* sp.	-1.2	10.1	0.0015
41	*Xysticus concretus*	-0.36	4.04	0.044

Supplementary Table 3 Summary of the result of Generalized Linear Mixed Models determining the potential factor influencing arthropod species diversity and arthropod biomass throughout study period.

Response variable	**Explained variable**	**Estimate**	***F/x2***	***P***
Arthropod species diversity	Mean annual temperature	-0.7	5.69	<0.001
	Annual precipitation	-0.0008	5.42	0.23
	Mean annual temperature: Annual precipitation	0.0005	14.1 4	<0.001
Arthropod biomass	Mean annual temperature	-7.8	4.45	0.035
	Annual precipitation	-0.05	4.82	0.047
	Mean annual temperature: Annual precipitation	0.009	4.27	0.05

Supplementary Table 4 Summary of the result of Generalized Linear Models (GLM with Gamma error structure) determining the potential factor influencing aboveground plant biomass increase. The aboveground plant biomass increase was calculated as the ratio of increased aboveground plant biomass to the aboveground plant biomass in the non-warmed chambers each year. The individual effect was calculated using *glmm.hp* function (glmm.hp package v 0.1-6, Lai et al., 2022).

Dependent variable	**Explained variable**	**Estimate**	***t***	***P***	***Individual effect***
Increase in aboveground plant biomass	Increase in days above 0°C	0.27	43.59	0.0015	0.49
	Increase in relative biomass of graminoids	2.91	19.72	0.032	0.16
	Annual precipitation	0.004	34.8	0.018	0.15
	Increase in days above 0°C: Increase in relative biomass of graminoids	-1.3	-34.8	0.018	0.2

Lai, J., Zou, Y., Zhang, S., Zhang, X., & Mao, L. (2022). *glmm. hp*: an R package for computing individual effect of predictors in generalized linear mixed models. *Journal of Plant Ecology, 15*(6), 1302–1307. https://doi.org/10.1093/jpe/rtac096

Supplementary Table 5 The species found in both warmed and non-warmed chambers from 2017 to 2022.

Year	2017		2018		2019		2020		2021		2022	
Treatment	Non-warmed	Warmed	Non-warmed	Warmed	Non-warmed	Warmed	Non-warmed	Warmed	Non-warmed	Warmed	Non-warmed	Warmed
Siobla sp.			1		1		1	1				
Chloropidae sp.	1	1	1	1	1	1	1	1	1	1	1	1
Tetanocera sp.	1						1	1	1	1	1	1
Atrachya menetriesi	1	1					1	1	1	1	1	1
Miridae sp1.	1	1	1	1			1	1	1	1	1	1
Portevinia dispar	1	1		1	1	1	1		1	1	1	1
Tetrastichinae sp.			1		1	1						
Cryptinae sp.			1	1								
Taxoblenus sp1.			1	1	1	1						
Podalonia affinis			1	1								
Neophilaenus sp.	1	1	1	1	1	1	1	1	1	1	1	1
Lenisa sp.	1	1	1						1	1		
Sympherta sp.	1	1	1	1	1	1	1	1	1	1		
Campopleginae sp1.	1	1	1	1	1	1		1	1	1		
Ctenopelmatinae sp.			1			1					1	1
Linnaemya perinealis	1	1	1	1			1	1	1	1	1	1
Peleteria versuta	1	1	1		1	1			1	1	1	1

Peteina sp.	1	1	1	1	1	1	1	1	1	1		
Sphaerophoria sp.	1	1	1	1	1	1	1	1	1	1	1	1
Melanostoma orientale			1	1	1	1	1	1				
Eupeodes corollae		1	1		1	1	1	1	1	1		
Cheilosia orilliaensis	1	1		1	1	1	1	1	1	1		
Blaesoxipha sp1.	1	1	1	1	1	1	1	1	1	1		
Calliphora vomitoria	1	1	1	1	1	1	1	1	1	1	1	1
Dolichopus sp.	1	1	1	1	1	1	1	1	1	1	1	1
Tenthredo nimbata			1		1	1						
Tenthredo nigropilosa				1				1				
Chrysomela sp.			1				1					
Ancistrocerus albophaleratus	1	1		1								
Ceroxys sp.	1	1	1	1	1	1	1	1	1	1	1	1
Botanophila sp.			1		1	1						
Sciaridae sp.	1	1	1	1	1	1	1	1	1	1		
Notostira elongata	1	1	1	1	1	1	1	1	1	1	1	1
Chlamydatus sp.					1							
Chrysoteuchia sp.	1	1	1	1	1	1	1	1	1	1		
Ligyrocoris sylvestris	1	1	1	1	1	1	1		1	1	1	1
Paragus sp.				1	1	1					1	1

Thaumatomyia sp.	1	1	1	1	1	1	1	1	1	1	1	1
Dicranomyia sp.	1	1	1	1	1	1	1	1	1	1	1	1
Urophora sp.	1										1	
Tettigella viridis	1	1	1	1	1	1	1	1	1	1	1	1
Chorthippus fallax	1	1	1	1	1	1	1	1	1	1	1	1
Nemophora sp.	1	1	1	1	1	1	1	1	1			
Epirrhoe sp.	1		1	1	1	1			1		1	1
Neophilaenus sp1.	1	1	1	1	1	1	1	1	1	1	1	1
Epirrhoe pupillata	1		1		1	1	1	1	1	1		
Crambus perlellus	1								1		1	
Lauxaniidae sp.			1	1		1	1				1	1
Synopeas sp.	1	1	1	1	1	1	1	1	1	1	1	1
Meromyza brevifasciata	1	1	1	1	1	1	1	1	1	1	1	1
Coranus sp.	1	1							1		1	
Dolycoris baccarum	1	1	1	1	1	1	1			1	1	
Paragus haemorrhous	1	1		1	1	1			1	1	1	1
Cecidomyiidae sp1.	1	1	1	1					1	1		
Nysius sp.	1	1	1	1	1	1	1	1	1	1	1	1
Lomechusoides wellenii	1	1			1	1	1	1	1			
Anoscopus sp.	1	1	1	1	1	1	1	1	1		1	1

Alydus calcaratus	1	1	1	1	1	1			1	1	1	1
Scathophaga stercoraria	1	1	1	1	1	1	1	1	1	1	1	1
Coenosia alpicola	1	1	1	1	1	1	1	1	1	1	1	1
Lydina aenea	1	1		1					1			
Sitobion avenae	1	1	1	1	1	1	1	1	1	1	1	1
Agriphila sp.	1	1	1	1	1	1	1	1	1		1	1
Tetanocera elata				1	1	1	1	1	1	1	1	
Chironomidae sp1.	1	1	1	1	1	1			1			
Rhamphomyia sp.	1	1			1	1			1	1	1	1
Chionodes distinctella	1	1	1		1	1	1		1	1		
Rhagionidae sp.	1	1	1		1	1	1		1	1	1	1
Coleophora benestrigatella					1	1						
Taxoblenus sp2.	1	1		1	1				1	1		
Chrysotoxum biguttatum	1	1	1		1	1	1	1	1	1		
Tenthredo nigrita	1	1	1	1	1	1	1	1	1	1	1	1
Celypha flavipalpana	1	1	1	1	1	1	1	1	1	1	1	1
Crambus pascuella			1	1	1	1						
Antrops sp.	1	1	1		1		1		1	1	1	1
Delia sp.			1	1							1	1

Ochsenheimeria urella			1	1	1	1	1	1				
Ceraeochrysa sp.							1			1	1	1
Drymeia hamata			1	1							1	1
Exorista rustica					1	1						
Epermenia sp.	1	1	1	1	1	1	1	1	1	1		
Serica sp.	1	1	1	1	1			1	1		1	
Psilopa sp.	1	1	1	1	1	1	1	1	1	1	1	1
Bombyliidae sp.			1			1	1					
Elachista sp.	1	1	1	1	1	1	1	1	1	1	1	1
Loborhynchapion sp.	1	1	1	1		1	1	1	1		1	
Torymus sp.	1	1	1	1	1		1	1	1			
Tebenna sp.			1	1	1	1	1	1			1	1
Pteromalus sp.	1	1	1	1	1	1	1	1	1	1	1	1
Eristalis arbustorum					1	1	1	1				
Cecidomyiidae sp2.					1	1	1	1				
Cryptocephalus sp.	1	1			1		1		1		1	1
Folsomia sp.	1	1	1	1	1	1	1	1	1	1	1	1
Chaetocnema sahlbergii	1	1							1	1		
Sminthurus sp.	1	1	1	1	1	1	1	1	1	1	1	1
Galerucella tenella	1	1			1				1	1		
Paleosepharia sp.	1	1	1	1	1	1	1	1	1	1		

Hercostomus sp.	1	1					1	1	1	1	1	1
Craspedolepta sp.	1	1	1	1	1	1	1	1	1	1	1	1
Eristalis tenax	1	1	1	1	1	1			1	1		1
Chironomus novosibiricus	1	1	1	1	1	1	1	1	1	1		
Opiinae spp.	1	1	1	1	1	1	1	1	1	1	1	1
Campopleginae sp2.	1	1	1	1	1	1			1	1	1	1
Chironomidae sp.	1	1	1	1	1	1	1	1	1	1	1	1
Melanostoma sp.						1			1	1	1	1
Pimpla sp.	1	1							1	1		
Phyllotreta striolata				1	1	1						
Tetrix bolivari	1	1	1				1		1		1	1
Idiolispa sp.	1	1	1	1	1	1			1	1	1	1
Dinotrema sp.				1			1	1			1	
Platycheirus aff. nigrofemoratus	1	1	1	1	1	1	1	1	1	1		
Nabis sp.	1	1	1	1	1	1	1	1	1	1	1	1
Lonchoptera bifurcata			1	1							1	
Adalia bipunctata	1	1	1		1	1	1	1	1	1	1	1
Sepsis cynipsea	1	1	1	1	1	1	1	1	1	1	1	1
Sarcophagidae sp.					1	1	1	1				

Lygus pratensis mc	1	1	1	1	1	1	1	1	1	1	1	1
Ochlerotatus sp.	1	1	1	1	1	1	1	1	1	1	1	1
Ophion luteus	1	1	1	1	1		1	1	1	1		
Toxonevra saltuum	1	1		1			1	1	1	1	1	
Rachispoda sp.	1	1							1			
Pachyprotasis sp.	1	1	1		1	1	1	1	1	1		
Tenthredo sp1.	1	1							1	1		
Tenthredo sp2.	1	1							1	1	1	1
Schinia cumatilis	1	1										
Campiglossa nigricauda	1	1	1	1	1	1	1	1	1	1	1	1
Apis cerana	1	1	1	1	1	1	1	1	1		1	1
Formica beijingensis	1	1	1	1	1	1	1	1	1	1	1	1
chlorophanus grandis			1	1			1	1				
Tephritis femorallis	1	1	1	1	1	1	1	1	1	1	1	
Coleoptera sp1.					1						1	1
Agonum impressum					1							
Celerio gallii							1					
Empoasca sp.				1								
Thripidae sp.					1	1	1	1			1	1

Campiglossa flavescens	1	1	1	1	1	1	1	1	1	1	1	1
Miarus ajugae				1								
Buprestidae sp.			1	1			1	1			1	1
Amara familiaris		1	1									
Atheroides sp.	1	1			1	1	1	1	1	1	1	1
Terellia sp1	1	1	1	1	1	1	1		1			
Pteromalus albipennis	1	1	1	1	1	1	1	1	1	1	1	1
Oedepis sp2	1	1	1	1	1	1	1	1	1		1	
Cassididae sp.		1										
Gynaephora alpherakii	1											
Cylindromyia brassicaria					1	1					1	1
Aculepeira sp.	1	1	1	1	1	1	1	1	1	1	1	1
Clubiona neglecta	1								1		1	1
Tetragnatha extensa	1		1	1	1	1		1			1	1
Alopecosa pulverulenta	1	1		1			1	1	1	1	1	1
Xysticus concretus	1	1	1	1	1	1	1	1	1	1	1	1

Supplementary Table 6 Details of statistical analyses for figures.

Year	Dependent variable	*Z/F*	*P*	Figure
2017	Arthropod species richness	0.47	0.320	1a
2018	Arthropod species richness	1.90	0.029	1a
2019	Arthropod species richness	1.95	0.026	1a
2020	Arthropod species richness	1.91	0.028	1a
2021	Arthropod species richness	2.22	0.013	1a
2022	Arthropod species richness	2.06	0.020	1a
2017	Arthropod species evenness	0.07	0.527	1b
2018	Arthropod species evenness	1.88	0.03	1b
2019	Arthropod species evenness	2.19	0.014	1b
2020	Arthropod species evenness	1.95	0.026	1b
2021	Arthropod species evenness	2.09	0.018	1b
2022	Arthropod species evenness	2.11	0.017	1b
2017	Arthropod species diversity	-0.05	0.522	1c
2018	Arthropod species diversity	1.90	0.029	1c
2019	Arthropod species diversity	2.22	0.013	1c
2020	Arthropod species diversity	2.07	0.019	1c
2021	Arthropod species diversity	2.13	0.017	1c
2022	Arthropod species diversity	2.16	0.015	1c
2017	Arthropod biomass	-0.74	0.231	2a
2018	Arthropod biomass	1.04	0.148	2a
2019	Arthropod biomass	1.60	0.054	2a
2020	Arthropod biomass	2.14	0.016	2a
2021	Arthropod biomass	1.84	0.033	2a
2022	Arthropod biomass	2.10	0.018	2a
2017	Arthropod abundance	-0.89	0.186	2b
2018	Arthropod abundance	-1.90	0.028	2b
2019	Arthropod abundance	-1.95	0.025	2b
2020	Arthropod abundance	-1.96	0.025	2b
2021	Arthropod abundance	-2.01	0.022	2b
2022	Arthropod abundance	-1.79	0.036	2b
2017	Abundance of arthropods within first-size class	-0.51	0.304	3a
2017	Abundance of arthropods within second-size class	-1.38	0.084	3a
2017	Abundance of arthropods within three-size class	-1.13	0.129	3a
2017	Abundance of arthropods within four-size class	1.06	0.144	3a
2018	Abundance of arthropods within first-size class	-1.83	0.034	3a
2018	Abundance of arthropods within second-size class	-2.01	0.022	3a
2018	Abundance of arthropods within three-size class	0.40	0.345	3a
2018	Abundance of arthropods within four-size class	1.58	0.057	3a

2019	Abundance of arthropods within first-size class	-2.18	0.015	3a
2019	Abundance of arthropods within second-size class	-1.32	0.093	3a
2019	Abundance of arthropods within three-size class	0.87	0.192	3a
2019	Abundance of arthropods within four-size class	2.04	0.021	3a
2020	Abundance of arthropods within first-size class	-1.92	0.027	3a
2020	Abundance of arthropods within second-size class	-1.09	0.139	3a
2020	Abundance of arthropods within three-size class	-0.12	0.547	3a
2020	Abundance of arthropods within four-size class	2.02	0.0217	3a
2021	Abundance of arthropods within first-size class	-1.99	0.023	3a
2021	Abundance of arthropods within second-size class	-1.98	0.024	3a
2021	Abundance of arthropods within three-size class	1.76	0.039	3a
2021	Abundance of arthropods within four-size class	1.24	0.108	3a
2022	Abundance of arthropods within first-size class	-1.91	0.028	3a
2022	Abundance of arthropods within second-size class	-0.22	0.412	3a
2022	Abundance of arthropods within three-size class	1.00	0.15	3a
2022	Abundance of arthropods within four-size class	1.95	0.0259	3a
2017	Arthropod community size spectrum	0.24	0.405	3b
2018	Arthropod community size spectrum	1.61	0.054	3b
2019	Arthropod community size spectrum	2.13	0.017	3b
2020	Arthropod community size spectrum	1.45	0.074	3b
2021	Arthropod community size spectrum	2.09	0.018	3b
2022	Arthropod community size spectrum	1.87	0.031	3b
2017	Arthropod community weighted mean of body size	0.59	0.276	3c
2018	Arthropod community weighted mean of body size	1.93	0.027	3c
2019	Arthropod community weighted mean of body size	2.19	0.014	3c
2020	Arthropod community weighted mean of body size	2.18	0.015	3c
2021	Arthropod community weighted mean of body size	2.01	0.022	3c
2022	Arthropod community weighted mean of body size	2.20	0.014	3c
2017	Species richness of arthropods within first-size class	-0.67	0.25	4
2017	Species richness of arthropods within second-size class	0.91	0.18	4
2017	Species richness of arthropods within three-size class	0.59	0.28	4
2017	Species richness of arthropods within four-size class	0.50	0.31	4
2018	Species richness of arthropods within first-size class	-0.42	0.34	4
2018	Species richness of arthropods within second-size class	-1.19	0.12	4
2018	Species richness of arthropods within three-size class	1.39	0.08	4
2018	Species richness of arthropods within four-size class	2.15	0.02	4
2019	Species richness of arthropods within first-size class	1.49	0.07	4
2019	Species richness of arthropods within second-size class	1.67	0.05	4
2019	Species richness of arthropods within three-size class	0.54	0.29	4
2019	Species richness of arthropods within four-size class	2.02	0.02	4
2020	Species richness of arthropods within first-size class	-0.54	0.29	4
2020	Species richness of arthropods within second-size class	2.19	0.01	4

2020	Species richness of arthropods within three-size class	2.22	0.01	4
2020	Species richness of arthropods within four-size class	2.05	0.02	4
2021	Species richness of arthropods within first-size class	2.00	0.03	4
2021	Species richness of arthropods within second-size class	1.56	0.06	4
2021	Species richness of arthropods within three-size class	1.81	0.04	4
2021	Species richness of arthropods within four-size class	1.94	0.03	4
2022	Species richness of arthropods within first-size class	-0.54	0.29	4
2022	Species richness of arthropods within second-size class	1.88	0.03	4
2022	Species richness of arthropods within three-size class	1.45	0.07	4
2022	Species richness of arthropods within four-size class	1.94	0.03	4
2017	Aboveground plant biomass	92.76	<0.0001	S6a
2018	Aboveground plant biomass	28.35	<0.0001	S6a
2019	Aboveground plant biomass	32.91	<0.0001	S6a
2020	Aboveground plant biomass	19.34	<0.0001	S6a
2021	Aboveground plant biomass	14.34	<0.0001	S6a
2022	Aboveground plant biomass	2.83	0.096	S6a
2017	Relative biomass of graminoids	14.77	<0.0001	S6b
2018	Relative biomass of graminoids	511.98	<0.0001	S6b
2019	Relative biomass of graminoids	254.45	<0.0001	S6b
2020	Relative biomass of graminoids	116.54	<0.0001	S6b
2021	Relative biomass of graminoids	6.21	0.004	S6b
2022	Relative biomass of graminoids	5.73	0.019	S6b