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Aboveground mammal and invertebrate exclusions
cause consistent changes in soil food webs of two
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Appendix 1–4

Appendix 1

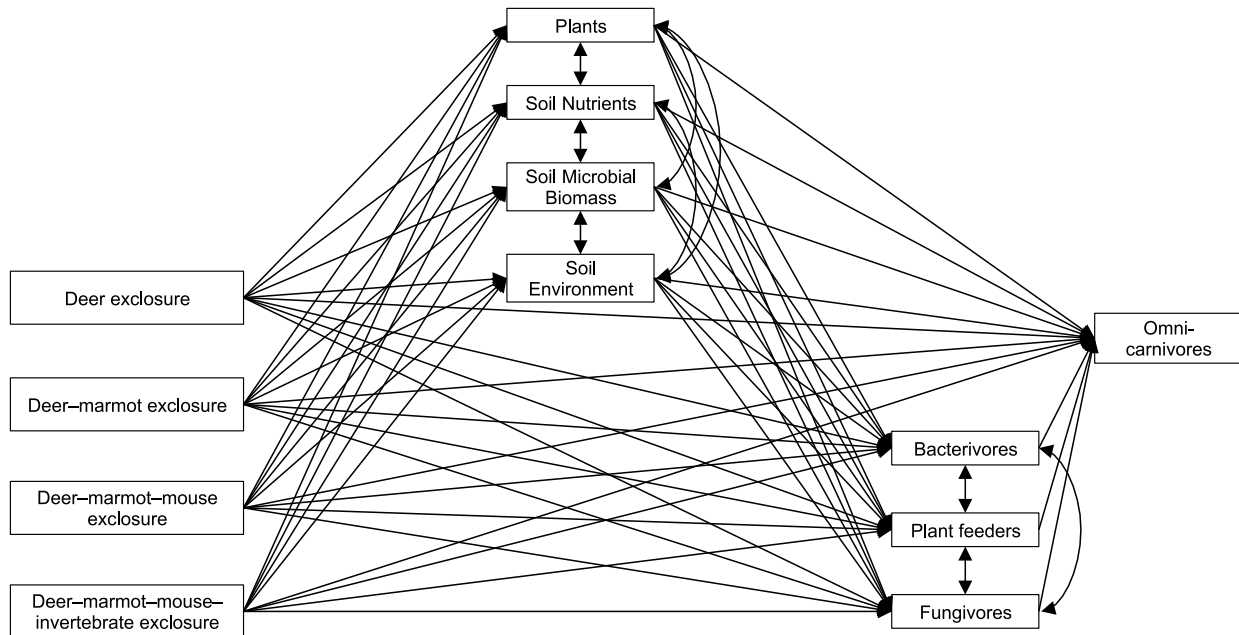


Figure A1. Initial SEM of the effects of the exclusion of differently sized aboveground animals on plants, soil nutrients, soil microbial biomass, soil environment, and the abundance of bacterivorous, plant-feeding, fungivorous and omni-carnivorous nematodes. Rectangles denote variables included in the model. Single-headed arrows denote effects and their directions. Double-headed arrows indicate residual covariances, which represent an unexplained relationship between two variables. The five levels of animal exclusion treatment are modeled as four dummy variables. These four variables are thus compared to the control plots to which all mammals and invertebrates had access. The model contains three types of hypotheses: i) direct effects of exclusion treatments on plants, soil nutrients, soil microbial biomass, soil environment, and the abundances of the different nematode feeding types; ii) indirect effects of exclusion treatments on the abundance of the different nematode feeding types via changes in plants, soil nutrients, soil microbial biomass, and soil environment; iii) indirect effects of exclusion treatments on omni-carnivorous nematode abundance via changes in the abundance of nematodes from lower trophic levels (fungivores, plant feeders, bacterivores).

Appendix 2

Table A1. Mean abundance per vegetation type and aboveground animal exclusion treatment and total abundance of nematode genera and families. Values are number of nematodes per 100 g of dry soil, rounded to the next integer. Animals excluded; No.: none, De.: deer and chamois, Ma.: marmots and hares, Mo.: mice and voles, In.: invertebrates.

Nematode taxon	Short-grass vegetation					Tall-grass vegetation					Total
	No.	De.	De.Ma.	De.Ma. Mo	De.Ma. Mo.In.	No.	De.	De.Ma.	De.Ma. Mo	De.Ma. Mo.In.	
Bacterivores											
<i>Acrobeles</i>	118	59	87	228	47	50	93	35	19	45	6994
<i>Acrobelloides</i>	871	915	522	663	748	952	767	427	601	817	64930
<i>Acrolobus</i>	0	0	7	0	0	0	0	0	0	0	60
<i>Alaimus</i>	252	392	382	523	436	198	223	205	446	221	29045
<i>Anaplectus</i>	136	101	105	135	240	91	30	41	123	209	10778
<i>Aulolaimus</i>	27	48	0	10	0	0	0	0	7	0	822
<i>Bastiania</i>	172	74	113	300	271	213	87	95	415	214	17171
<i>Bunonema</i>	0	0	0	0	21	0	0	0	0	10	275
<i>Cervidellus</i>	117	298	308	509	287	239	296	61	46	217	21360
<i>Chiloplacus</i>	0	0	0	17	0	0	0	0	0	0	154
<i>Cylindrolaimus</i>	245	113	124	364	60	175	59	35	65	72	11758
<i>Eucephalobus</i>	530	531	1257	1793	1725	580	566	418	530	911	79030
<i>Eumonhystera</i>	547	524	658	1072	957	867	718	756	1391	924	74355
<i>Metateratocephalus</i>	130	119	453	199	64	172	108	107	232	142	15303
<i>Monhystera</i>	1690	2461	3153	2631	3874	1247	2597	1129	3150	4138	231477
<i>Monhystrella</i>	111	99	57	45	75	33	118	76	56	73	6637
<i>Panagrolaimus</i>	39	51	57	23	118	93	31	66	51	158	6121
<i>Paramphidelus</i>	167	30	199	807	225	20	113	63	142	74	16413
<i>Plectus</i>	160	174	172	384	185	372	232	218	191	101	19512
<i>Prismatolaimus</i>	750	816	903	1733	962	726	839	477	673	638	75969
Rhabditidae	164	153	107	768	187	135	125	87	253	120	18645
<i>Teratocephalus</i>	495	1126	1143	1863	961	525	791	540	795	800	80553
<i>Tylocephalus</i>	39	60	111	61	35	32	22	27	130	39	4874
<i>Wilsonema</i>	421	429	217	562	305	261	210	118	316	489	29623
Fungivores											
<i>Aphelenchoides</i>	304	372	312	924	486	441	357	317	398	764	41667
<i>Aphelenchus</i>	252	198	141	123	209	177	99	102	210	143	14675
<i>Diphtherophora</i>	15	0	50	92	70	25	8	23	4	0	2580
<i>Ditylenchus</i>	39	62	107	216	71	75	92	77	68	44	7600
<i>Dorylaimoides</i>	33	100	162	176	142	137	172	139	106	70	11010
<i>Filenchus</i>	1842	3177	3157	4412	4247	2094	3140	3175	5068	3804	301977
Leptonchidae	0	47	0	0	0	0	0	9	0	0	500
<i>Tylencholaimellus</i>	30	0	7	79	144	27	0	9	4	13	2816
<i>Tylencholaimus</i>	396	938	640	725	929	987	956	824	1132	971	75346

Table A1 (continued)

Nematode taxon	Short-grass vegetation					Tall-grass vegetation					Total
	No.	De.	De.Ma.	De.Ma. Mo	De.Ma. Mo.In.	No.	De.	De.Ma.	De.Ma. Mo	De.Ma. Mo.In.	
<u>Plant feeders</u>											
<i>Axonchium</i>	5	0	0	0	0	6	0	3	0	0	130
Criconematidae	27	54	76	16	4	0	0	0	0	4	1618
<i>Dorylaimellus</i>	0	0	6	17	0	0	0	0	0	0	205
<i>Helicotylenchus</i>	303	1140	459	465	429	1643	834	1257	2046	1566	89230
<i>Longidorella</i>	29	23	91	62	26	7	23	3	0	0	2385
<i>Longidorus</i>	9	0	7	7	8	7	0	10	0	0	439
<i>Malenchus</i>	141	788	285	937	367	220	712	207	479	1176	47323
<i>Paratylenchus</i>	582	397	375	453	396	282	917	291	223	623	40632
<i>Pratylenchus</i>	6	9	14	6	95	96	33	27	0	65	3146
<i>Rotylenchus</i>	0	0	0	7	0	0	0	7	0	4	159
<i>Subanguina</i>	0	9	0	0	0	0	0	0	0	0	77
Tylenchidae	5	73	61	80	150	21	64	13	174	116	6645
<i>Tylenchorhynchus</i>	621	522	974	202	641	246	288	293	491	354	41198
<u>Omni-carnivores</u>											
Anatonchidae	0	56	28	32	62	5	26	23	0	45	2495
<i>Aporcelaimellus</i>	5	82	57	89	128	42	108	129	30	62	8942
<i>Aporcelaimus</i>	57	91	152	156	97	92	156	78	134	191	88
<i>Chrysonema</i>	5	6	0	0	0	0	0	0	0	0	6550
<i>Dorydorella</i>	5	35	7	28	42	15	21	25	4	10	10702
<i>Ecumenicus</i>	76	29	96	10	36	6	5	0	0	23	94
<i>Epidorylaimus</i>	170	181	109	466	209	181	182	195	186	315	1719
<i>Eudorylaimus</i>	147	287	312	202	474	139	199	217	225	283	2535
<i>Mesodorylaimus</i>	154	244	275	278	347	159	258	329	461	431	19562
<i>Microdorylaimus</i>	18	116	28	143	46	8	69	32	115	60	22144
Mononchidae	155	26	54	69	37	208	171	151	95	38	25966
Neodiplogasteridae	0	0	52	49	0	5	8	0	0	10	5602
<i>Paraxonchium</i>	8	0	0	0	0	0	0	7	0	0	1118
<i>Pungentus</i>	0	0	46	22	36	23	16	16	4	24	131
<i>Sectonema</i>	14	28	13	49	25	50	15	0	51	51	1671
<i>Thonus</i>	141	148	203	223	300	233	335	263	291	327	2607
<i>Tripyla</i>	0	0	0	0	0	0	10	0	0	0	21879

Appendix 3

Plant and soil responses to aboveground animal exclusions in two vegetation types

Many plant characteristics were affected by our exclusion treatments and/or differed between the vegetation types (Table A2, Fig. A2). There was a significant interaction between the effect of vegetation type and exclusion treatment as well as a significant main effect of exclusion treatment on shoot biomass (Table A2, Fig. A2a). In the short-grass vegetation, shoot biomass gradually increased with progressive exclusions and started to differ significantly from the control plots as soon as both ungulates and medium-sized mammals were excluded. Though excluding ungulates tended to increase biomass in the tall-grass vegetation, none of the pairwise differences between exclusions in this vegetation type were significant. Root biomass was significantly higher in the tall-grass vegetation and decreased when all herbivore groups were excluded (Table A2, Fig. A2b). Plant species richness decreased significantly when all animal groups or all but invertebrates were excluded (Table A2, Fig. A2c). In the short-grass vegetation, fall ADL content of the shoots was higher in plots excluding ungulates and medium-sized mammals than in plots only excluding ungulates (Table A2, Fig. A2d). It did not differ between treatments in the tall-grass vegetation. The patterns for NDF at peak biomass and in the fall were very similar, except that fall levels of this fiber type were higher (Fig. A2e,f). At both times, the lower NDF content in the short-grass vegetation increased with the progressive exclusion of herbivores, while the higher NDF content in the tall-grass vegetation decreased (Table A2). At both times of year, the shoot C content was higher in the tall-grass than in the short-grass vegetation (Table A2, Fig. A2g,h). There was also a main effect of herbivore exclusion treatment on shoot C content, which in July was lower when ungulates were excluded, and decreased again when all animals were excluded (Fig. A2g). By September, shoot C content was lower than the controls only when all animals were excluded (Fig. A2h). The pattern for shoot N content changed over the growing season, and depended on an interaction between vegetation type and exclusion treatment (Table A2). In July, the N content of shoots from the tall-grass vegetation was higher when mammals and invertebrates were excluded compared to control plots and ungulate exclusions, whereas this variable did not differ between treatments in the short-grass vegetation (Fig. A2i). By September, N content was higher in the control than in the ungulate exclusion plots in the short-grass vegetation, and higher when all mammals or all mammals and invertebrates were excluded than in the control plots in the tall-grass vegetation (Fig. A2j).

None of the tested soil nutrients differed significantly between vegetation types or animal exclusion treatments (Table A2). However, C content of the mineral soil layer was higher in the short- than in the tall-grass vegetation and this difference was nearly significant (Table A2, Fig. A3a). Similarly, P content of both the organic and mineral soil layer showed trends of higher values in the short- than in the tall-grass vegetation (Table A2, Fig. A3b,c).

There was a significant effect of exclusion treatment on soil temperature, which gradually decreased as more groups of animals were excluded (Table A2, Fig. A3d). The main effect of exclusion treatment on soil moisture content was nearly significant, with a trend of increased moisture with progressive exclusion of more animal groups (Table A2, Fig. A3e). A nearly significant interaction was observed between the effects of vegetation type and exclusion treatment on soil bulk density (Table A2), caused by an increased bulk density when animals were excluded in the short-grass vegetation and a weaker trend of a decrease in the tall-grass vegetation (Fig. A3f). Soil pH did not significantly differ between vegetation types or exclusion treatments (Table A2).

Soil microbial biomass carbon did not significantly differ between vegetation types or

animal exclusion treatments (Table A2, Fig. A3g). However, there was a non-significant trend of an interaction between vegetation type and exclusion treatment, caused by the fact that microbial biomass in the short-grass vegetation was highest, but in the tall-grass vegetation lowest, in the plots where all mammals were excluded (Fig. A3g).

Table A2. Effects of vegetation type, exclusion treatment and their interaction on vegetation characteristics, soil nutrients, aspects of soil environment and soil microbial biomass. Df: degrees of freedom (numerator, denominator). NDF: Neutral Detergent Fiber. ADL: Acid Detergent Lignin. Diversity: Shannon diversity index. MBC: Microbial Biomass Carbon. VWC: volumetric water content.

Variable	Vegetation			Exclusion			Vegetation × Exclusion		
	df	F	p	df	F	p	df	F	p
<u>Plants</u>									
Shoot biomass (g m ⁻²)	1,12.5	2.90	0.1135	4,64	8.16	<.0001	4,64	2.80	0.0329
Root biomass (g m ⁻²)	1,11.4	14.44	0.0027	4,64	3.09	0.0219	4,64	0.36	0.8337
NDF July (%)	1,15.6	20.12	0.0004	4,61.7	1.09	0.3699	4,61.7	9.41	<.0001
NDF September (%)	1,11.7	16.68	0.0016	4,60.5	1.01	0.4083	4,60.5	8.23	<.0001
ADL July (%)	1,11.8	2.05	0.1781	4,62	0.13	0.9726	4,62	0.64	0.6329
ADL September (%)	1,11.1	0.02	0.8959	4,60.2	1.11	0.3580	4,60.2	2.84	0.0316
Shoot C July (%)	1,9.45	9.14	0.0136	4,62.1	8.01	<.0001	4,62.1	0.49	0.7449
Shoot C September (%)	1,10.8	9.03	0.0122	4,60.7	3.89	0.0070	4,60.8	1.03	0.3985
Shoot N July (%)	1,16.1	0.77	0.3940	4,62.3	2.84	0.0314	4,62.3	5.27	0.0010
Shoot N September (%)	1,16.4	6.37	0.0223	4,60.9	2.04	0.0995	4,60.9	5.09	0.0013
Plant species richness	1,15.8	4.05	0.0616	4,62.9	2.57	0.0465	4,62.9	0.71	0.5863
Plant diversity	1,10.2	0.81	0.3893	4,63	0.32	0.8640	4,63	1.63	0.1789
Plant evenness	1,11.2	0.01	0.9127	4,63.2	0.75	0.5647	4,63.2	1.25	0.2996
<u>Soil nutrients</u>									
Soil C (%) organic layer	1,10.7	0.51	0.4893	4,61.9	0.22	0.9254	4,61.9	1.17	0.3339
Soil C (%) mineral layer	1,10.9	4.84	0.0504	4,64	0.27	0.8973	4,64	0.21	0.9309
Soil N (%) organic layer	1,10.6	0.40	0.5406	4,61.8	0.46	0.7680	4,61.8	1.47	0.2209
Soil N (%) mineral layer	1,10.7	1.40	0.2630	4,64	0.54	0.7057	4,64	1.43	0.2333
Soil P (μg g ⁻¹) organic layer	1,10.9	3.77	0.0785	4,64	1.71	0.1584	4,64	0.53	0.7106
Soil P (μg g ⁻¹) mineral layer	1,10.4	3.79	0.0792	4,64	1.14	0.3464	4,64	0.97	0.4319
<u>Soil environment</u>									
Soil temperature (°C)	1,11	3.00	0.1112	4,64	17.75	<.0001	4,64	1.04	0.3939
Soil moisture (% VWC)	1,10.9	0.09	0.7761	4,64	2.38	0.0611	4,64	1.45	0.2283
pH	1,11	0.29	0.6020	4,64	0.81	0.5232	4,64	0.40	0.8091
Bulk density (g cm ⁻³)	1,11.3	0.50	0.4945	4,64	0.22	0.9236	4,64	2.47	0.0533
<u>Soil microbial community</u>									
MBC (mg kg ⁻¹)	1,11.1	0.03	0.8659	4,64	0.71	0.5906	4,64	2.14	0.0859

Transformations; Bulk density, ADL July, ADL September, soil C mineral layer, soil N mineral layer, soil P organic layer, and MBC: square root. Root biomass: cube root. Soil P mineral layer: log. Plant diversity: squared. Plant evenness: 3rd power. pH: 12th power.

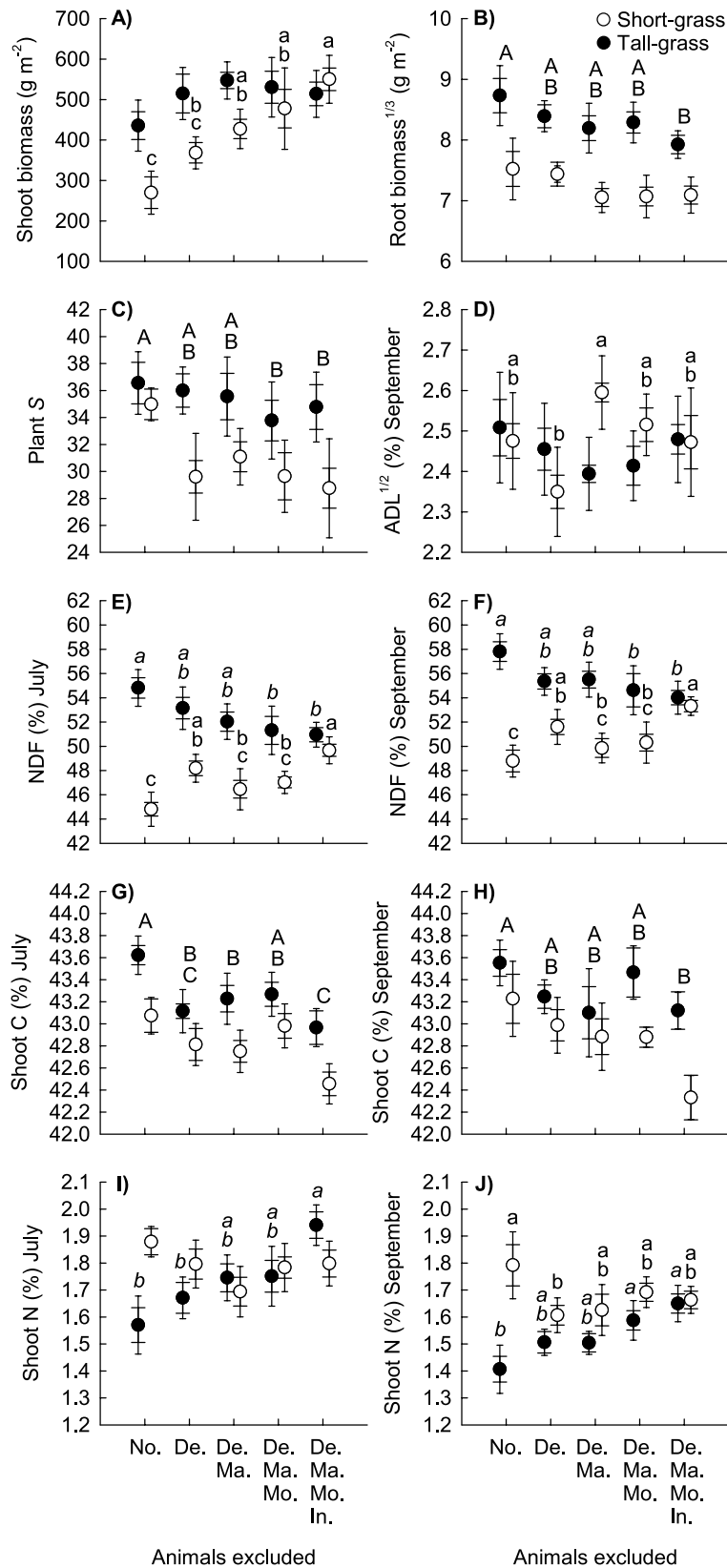


Figure A2. Effects of aboveground mammal and invertebrate exclusions on plant properties in short- and tall-grass vegetation. a) Shoot biomass. b) Root biomass (cube root transformed). c) Plant species richness. d) September shoot Acid Detergent Lignin content (square root transformed). e) July shoot Neutral Detergent Fiber content. f) September shoot Neutral Detergent Fiber content. g) July shoot carbon content. h) September shoot carbon content. i) July shoot nitrogen content. j) September shoot nitrogen content. Animals excluded; No.: none, De.: deer and chamois, Ma.: marmots and hares, Mo.: mice and voles, In.: invertebrates. Mean \pm Cousineau-Morey SE (wide cap - normalized per enclosure setup for treatment comparisons; narrow cap - normalized per grassland for vegetation type comparisons, see Cousineau 2005, Morey 2008). White symbols: short-grass vegetation. Black symbols: tall-grass vegetation. Different capital letters indicate significant main differences between treatments after FDR-adjustment. Different small regular letters indicate significant differences between treatments within short-grass and different small letters in italics indicate differences between treatments within tall-grass after FDR-adjustment.

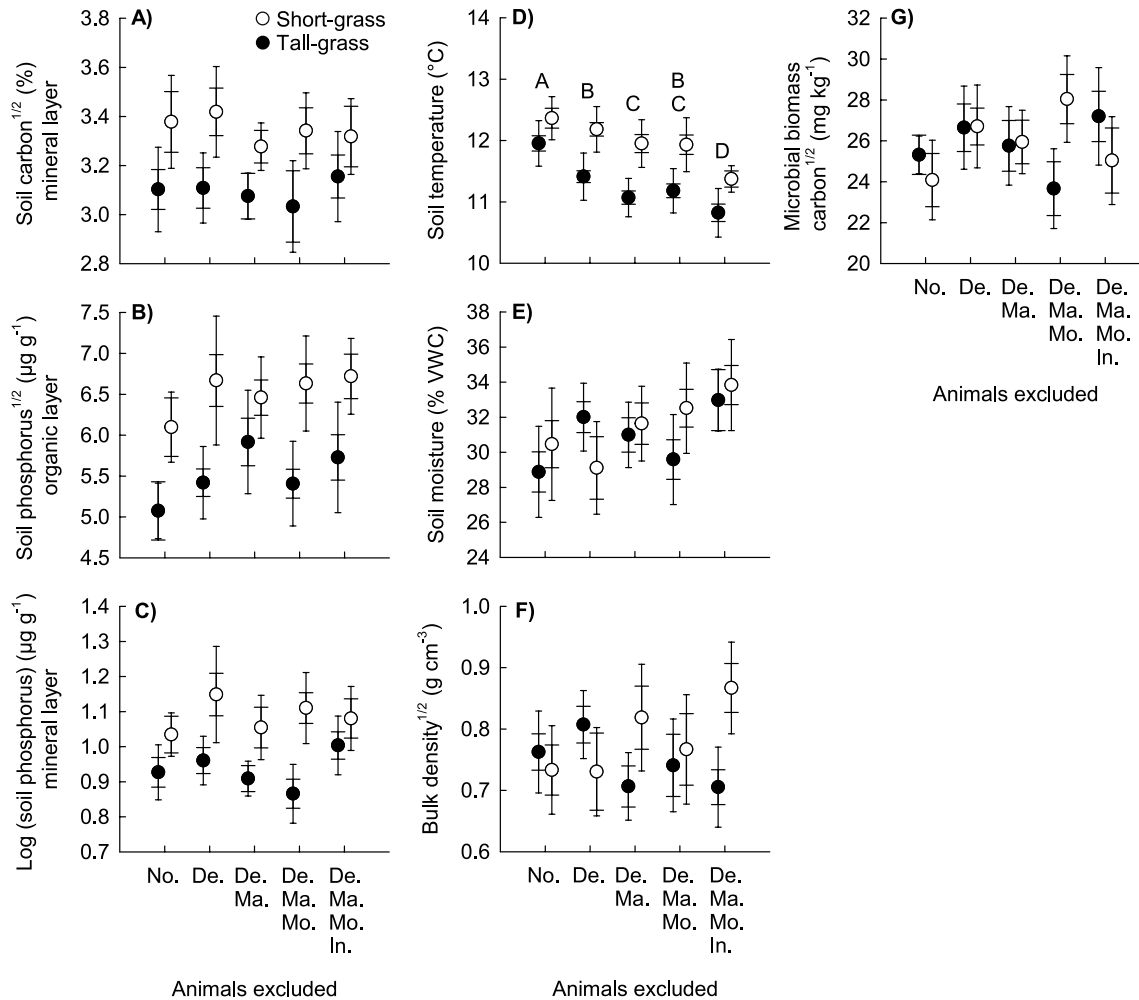


Figure A3. Effects of aboveground mammal and invertebrate exclusions on soil nutrients, abiotic soil properties, and soil microbial biomass in short- and tall-grass vegetation. a) Carbon content of the mineral soil layer (square root transformed). b) Phosphorus content of the organic soil layer (square root transformed). c) Phosphorus content of the mineral soil layer (log transformed). d) Soil temperature. e) Soil moisture content. f) Soil bulk density (square root transformed). g) Soil microbial biomass carbon (square root transformed). VWC: volumetric water content. Animals excluded; No.: none, De.: deer and chamois, Ma.: marmots and hares, Mo.: mice and voles, In.: invertebrates. Mean \pm Cousineau-Morey SE (wide cap - normalized per enclosure setup for treatment comparisons; narrow cap - normalized per grassland for vegetation type comparisons, see Cousineau 2005, Morey 2008). White symbols: short-grass vegetation. Black symbols: tall-grass vegetation.

Appendix 4

Table A3. a) Path coefficients and b) R^2 -values of endogenous variables of the final SEM of the effects of mammal and invertebrate exclusions in the short-grass vegetation (see Fig. 5a).

A) Pathway	Unstandardized coefficient	SE (robust Huber-White)	Z-value	P-value	Standardized coefficient
De. → Plants	1.386	0.261	5.308	0.000	0.549
De.Ma. → Plants	1.618	0.258	6.273	0.000	0.641
De.Ma.Mo. → Plants	1.586	0.301	5.271	0.000	0.628
De.Ma.Mo.In. → Plants	2.437	0.319	7.644	0.000	0.965
De.Ma.Mo. → Micr. biomass	0.565	0.268	2.113	0.035	0.237
De.Ma. → Soil envir.	0.811	0.347	2.337	0.019	0.328
De.Ma.Mo. → Soil envir.	0.683	0.316	2.163	0.031	0.276
De.Ma.Mo.In. → Soil envir.	1.712	0.274	6.238	0.000	0.692
De.Ma.Mo. → Bacterivores	0.715	0.247	2.893	0.004	0.303
Plants → Bacterivores	0.454	0.121	3.742	0.000	0.486
Soil envir. → Bacterivores	-0.192	0.090	-2.132	0.033	-0.201
Plants → Fungivores	0.573	0.094	6.076	0.000	0.607
De. → Plant feeders	0.780	0.261	2.987	0.003	0.312
Nutrients → Plant feeders	0.402	0.127	3.168	0.002	0.398
Micr. biomass → Plant feeders	-0.479	0.135	-3.539	0.000	-0.457
De. → Omni-carnivores	1.364	0.284	4.807	0.000	0.552
De.Ma. → Omni-carnivores	1.072	0.302	3.553	0.000	0.433
De.Ma.Mo. → Omni-carnivores	0.905	0.342	2.648	0.008	0.366
De.Ma.Mo.In. → Omni-carnivores	1.860	0.448	4.149	0.000	0.752
Plants → Omni-carnivores	-0.939	0.168	-5.603	0.000	-0.959
Soil envir. → Omni-carnivores	0.312	0.120	2.610	0.009	0.312
Bacterivores → Omni-carnivores	0.656	0.121	5.415	0.000	0.626
Fungivores → Omni-carnivores	0.359	0.121	2.956	0.003	0.346
Plants ↔ Micr. biomass	-0.193	0.068	-2.832	0.005	-0.331
Nutrients ↔ Micr. biomass	0.615	0.174	3.527	0.000	0.669
Bacterivores ↔ Fungivores	0.274	0.117	2.342	0.019	0.462
Bacterivores ↔ Plant feeders	0.431	0.132	3.277	0.001	0.633
Fungivores ↔ Plant feeders	0.371	0.092	4.033	0.000	0.562
B) Variable	R^2				
Plants	0.611				
Micr. biomass	0.056				
Soil envir.	0.409				
Bacterivores	0.312				
Fungivores	0.368				
Plant feeders	0.245				
Omni-carnivores	0.717				

SE: standard error. De.: Deer enclosure. De.Ma.: Deer–marmot enclosure. De.Ma.Mo.: Deer–marmot–mouse enclosure. De.Ma.Mo.In.: Deer–marmot–mouse–invertebrate enclosure. Micr.: microbial. Envir.: environment.

Table A4. a) Path coefficients and b) R^2 -values of endogenous variables of the final SEM of the effects of mammal and invertebrate exclusions in the tall-grass vegetation (see Fig. 5b).

A) Pathway	Unstandardized coefficient	SE (robust Huber-White)	Z-value	P-value	Standardized coefficient
De. → Plants	1.176	0.307	3.828	0.000	0.480
De.Ma. → Plants	1.299	0.345	3.765	0.000	0.530
De.Ma.Mo. → Plants	1.486	0.371	4.003	0.000	0.606
De.Ma.Mo.In. → Plants	2.231	0.347	6.432	0.000	0.910
De.Ma. → Nutrients	0.738	0.335	2.204	0.028	0.299
De.Ma.Mo. → Micr. biomass	-0.782	0.371	-2.106	0.035	-0.316
De. → Soil envir.	1.155	0.257	4.489	0.000	0.467
De.Ma. → Soil envir.	1.234	0.282	4.374	0.000	0.499
De.Ma.Mo. → Soil envir.	0.945	0.355	2.666	0.008	0.382
De.Ma.Mo.In. → Soil envir.	1.830	0.437	4.187	0.000	0.740
De.Ma. → Bacterivores	-0.974	0.305	-3.197	0.001	-0.392
Plants → Bacterivores	0.365	0.173	2.114	0.035	0.360
Micr. biomass → Bacterivores	-0.247	0.116	-2.128	0.033	-0.246
De.Ma.Mo. → Fungivores	1.041	0.374	2.786	0.005	0.411
De.Ma. → Plant feeders	-0.670	0.201	-3.338	0.001	-0.266
Plants → Plant feeders	0.439	0.130	3.370	0.001	0.428
Micr. biomass → Plant feeders	-0.279	0.107	-2.614	0.009	-0.274
Fungivores → Omni-carnivores	0.405	0.101	3.991	0.000	0.420
Plant feeders → Omni-carnivores	0.221	0.111	1.993	0.046	0.229
Plants ↔ Soil envir.	0.167	0.083	2.007	0.045	0.317
Bacterivores ↔ Fungivores	0.329	0.104	3.170	0.002	0.448
Bacterivores ↔ Plant feeders	-0.260	0.097	-2.681	0.007	-0.399
B) Variable	R^2				
Plants	0.538				
Nutrients	0.089				
Micr. biomass	0.100				
Soil envir.	0.361				
Bacterivores	0.357				
Fungivores	0.169				
Plant feeders	0.343				
Omni-carnivores	0.245				

SE: standard error. De.: Deer enclosure. De.Ma.: Deer–marmot enclosure. De.Ma.Mo.: Deer–marmot–mouse enclosure. De.Ma.Mo.In.: Deer–marmot–mouse–invertebrate enclosure. Micr.: microbial. Envir.: environment.

Table A5. Indirect effects in the final SEM of the effects of mammal and invertebrate exclusions in the short-grass vegetation (see Fig. 5a).

Indirect Effect	Unst. coeff.	SE	Z- value	P- value	St. coeff.
De. → Plants → Bacterivores	0.630	0.205	3.067	0.002	0.267
De.Ma. → Plants → Bacterivores	0.735	0.229	3.210	0.001	0.312
De.Ma.Mo. → Plants → Bacterivores	0.720	0.261	2.757	0.006	0.305
De.Ma.Mo.In. → Plants → Bacterivores	1.106	0.336	3.292	0.001	0.469
De.Ma. → Soil envir. → Bacterivores	-0.156	0.098	-1.586	0.113	-0.066
De.Ma.Mo. → Soil envir. → Bacterivores	-0.131	0.085	-1.546	0.122	-0.056
De.Ma.Mo.In. → Soil envir. → Bacterivores	-0.329	0.161	-2.046	0.041	-0.139
De. → Plants → Fungivores	0.794	0.202	3.937	0.000	0.333
De.Ma. → Plants → Fungivores	0.927	0.200	4.645	0.000	0.389
De.Ma.Mo. → Plants → Fungivores	0.909	0.236	3.851	0.000	0.381
De.Ma.Mo.In. → Plants → Fungivores	1.396	0.264	5.294	0.000	0.585
De.Ma.Mo. → Micr. biomass → Plant feeders	-0.271	0.136	-1.999	0.046	-0.108
De. → Plants → Omni-carnivores	-1.301	0.318	-4.090	0.000	-0.526
De.Ma. → Plants → Omni-carnivores	-1.519	0.317	-4.788	0.000	-0.614
De.Ma.Mo. → Plants → Omni-carnivores	-1.489	0.406	-3.663	0.000	-0.602
De.Ma.Mo.In. → Plants → Omni-carnivores	-2.287	0.499	-4.587	0.000	-0.925
De. → Plants → Bacterivores → Omni-carnivores	0.413	0.150	2.745	0.006	0.167
De.Ma. → Plants → Bacterivores → Omni-carnivores	0.482	0.166	2.912	0.004	0.195
De.Ma.Mo. → Plants → Bacterivores → Omni-carnivores	0.473	0.187	2.531	0.011	0.191
De.Ma.Mo.In. → Plants → Bacterivores → Omni-carnivores	0.726	0.257	2.824	0.005	0.294
De. → Plants → Fungivores → Omni-carnivores	0.285	0.110	2.585	0.010	0.115
De.Ma. → Plants → Fungivores → Omni-carnivores	0.333	0.120	2.780	0.005	0.135
De.Ma.Mo. → Plants → Fungivores → Omni-carnivores	0.326	0.131	2.490	0.013	0.132
De.Ma.Mo.In. → Plants → Fungivores → Omni-carnivores	0.501	0.167	2.996	0.003	0.203
De.Ma. → Soil envir. → Omni-carnivores	0.253	0.109	2.313	0.021	0.102
De.Ma.Mo. → Soil envir. → Omni-carnivores	0.213	0.129	1.654	0.098	0.086
De.Ma.Mo.In. → Soil envir. → Omni-carnivores	0.535	0.199	2.686	0.007	0.216
De.Ma. → Soil envir. → Bacterivores → Omni-carnivores	-0.102	0.064	-1.586	0.113	-0.041
De.Ma.Mo. → Soil envir. → Bacterivores → Omni-carnivores	-0.086	0.057	-1.507	0.132	-0.035
De.Ma.Mo.In. → Soil envir. → Bacterivores → Omni-carnivores	-0.216	0.107	-2.020	0.043	-0.087
De.Ma.Mo → Bacterivores → Omni-carnivores	0.469	0.163	2.871	0.004	0.190

Unst.: unstandardized. Coeff.: coefficient. SE: standard error (robust Huber-White). St.: standardized. De.: Deer enclosure. De.Ma.: Deer–marmot enclosure. De.Ma.Mo.: Deer–marmot–mouse enclosure. De.Ma.Mo.In.: Deer–marmot–mouse–invertebrate enclosure. Micr.: microbial. Envir.: environment.

Table A6. Indirect effects in the final SEM of the effects of mammal and invertebrate exclusions in the tall-grass vegetation (see Fig. 5b).

Indirect Effect	Unst. coeff.	SE	Z- value	P- value	St. coeff.
De. → Plants → Bacterivores	0.429	0.280	1.531	0.126	0.173
De.Ma. → Plants → Bacterivores	0.474	0.310	1.530	0.126	0.191
De.Ma.Mo. → Plants → Bacterivores	0.542	0.352	1.541	0.123	0.218
De.Ma.Mo.In. → Plants → Bacterivores	0.813	0.448	1.816	0.069	0.328
De.Ma.Mo. → Micr. biomass → Bacterivores	0.193	0.121	1.598	0.110	0.078
De. → Plants → Plant feeders	0.517	0.163	3.162	0.002	0.205
De.Ma. → Plants → Plant feeders	0.571	0.181	3.145	0.002	0.227
De.Ma.Mo. → Plants → Plant feeders	0.653	0.199	3.279	0.001	0.259
De.Ma.Mo.In. → Plants → Plant feeders	0.980	0.300	3.267	0.001	0.389
De.Ma.Mo. → Micr. biomass → Plant feeders	0.219	0.106	2.060	0.039	0.087
De.Ma.Mo. → Fungivores → Omni-carnivores	0.421	0.188	2.247	0.025	0.173
De.Ma. → Plant feeders → Omni-carnivores	-0.148	0.085	-1.745	0.081	-0.061
De. → Plants → Plant feeders → Omni-carnivores	0.114	0.062	1.847	0.065	0.047
De.Ma. → Plants → Plant feeders → Omni-carnivores	0.126	0.070	1.792	0.073	0.052
De.Ma.Mo. → Plants → Plant feeders → Omni-carnivores	0.145	0.076	1.898	0.058	0.059
De.Ma.Mo.In. → Plants → Plant feeders → Omni-carnivores	0.217	0.108	2.003	0.045	0.089
De.Ma.Mo. → Micr. biomass → Plant feeders → Omni-carnivores	0.048	0.033	1.447	0.148	0.020

Unst.: unstandardized. Coeff.: coefficient. SE: standard error (robust Huber-White). St.: standardized. De.: Deer exclusion. De.Ma.: Deer–marmot exclusion. De.Ma.Mo.: Deer–marmot–mouse exclusion. De.Ma.Mo.In.: Deer–marmot–mouse–invertebrate exclusion. Micr.: microbial. Envir.: environment.