

Supplementary Material S3.1:

Chapter 3: Diversity and trait composition of moths respond to land-use intensity in grasslands: Generalists replace specialists

Jule Mangels, Konrad Fiedler, Florian D. Schneider, Nico Blüthgen

Tab. S3.1.1: Land-use intensification (LUI) index and the strength of the components grazing, mowing and fertilization on the observed plots. Grazing is specified as the number of livestock-units and hectare times the number of days per year, mowing as the number of cuts per year and fertilization as the application of Nitrogen (kg) per hectare.

Region	Plot	LUI	Grazing	Mowing	Fertilization
Alb	AEG01	1.94	0	2	40
Alb	AEG02	2.52	0	2	96
Alb	AEG03	1.41	0	2	1.15
Alb	AEG04	1.88	100.68	1	40
Alb	AEG05	1.93	126.99	1	40
Alb	AEG06	1.99	162.89	1	40
Alb	AEG07	0.43	25.93	0	0
Alb	AEG08	1.44	156.3	1	0
Alb	AEG09	0.67	62.95	0	0
Hainich	HEG01	3.02	118.55	2	138
Hainich	HEG02	2.1	0	1	75
Hainich	HEG03	2.88	0	2	138
Hainich	HEG04	2.23	80.58	2	54
Hainich	HEG05	2.58	117.78	2	84
Hainich	HEG06	1.57	76.22	2	0
Hainich	HEG07	1.13	180.38	0	0
Hainich	HEG08	1.13	180.38	0	0
Hainich	HEG09	0.68	65.33	0	0
Schorfheide	SEG01	1.39	0	2	0
Schorfheide	SEG02	1.39	0	2	0
Schorfheide	SEG03	1.39	0	2	0
Schorfheide	SEG04	0.94	124.04	0	0
Schorfheide	SEG05	0.98	0	1	0
Schorfheide	SEG06	1.36	258.21	0	0
Schorfheide	SEG07	1.66	387.69	0	0
Schorfheide	SEG09	1.93	520	0	0

Tab. S3.1.2: Numerical scoring of used life-history traits.

Trait	Scoring
Size (dispersal ability)	Wingspan [mm]
Larval feeding niche	1 = narrow specialist, 2 = moderate specialist, 3 = moderate generalist, 4 = wide generalist
Voltinism (reproduction)	1 = semivoltine, 2 = univoltine, 3 = multivoltine
Hibernation stage (development)	1 = egg, 2 = larva, 3 = pupa, 4 = adult
Distribution	Occurrence in six European climate zones (arctic, boreal, continental, Atlantic, alpine and Mediterranean): 1 = one zone → 6 = six zones
Conservation status	1 = critically endangered, 2 = endangered, 3 = vulnerable, 4 = near threatened, 5 = least concern

Tab. S3.1.3: Results of constrained ordination (dbRDA) analyses of species composition (expressed as Bray-Curtis similarity matrix of sqrt-transformed moth species counts) across all regions, and for each region separately, with land-use components as tested environmental factors.

	<i>df</i>	<i>Variance</i>	<i>F</i>	<i>P</i>
all regions				
Region	2	1.822	4.532	0.001
LUI	1	0.254	0.985	0.448
Grazing	1	0.648	2.683	0.004
Mowing	1	0.376	1.485	0.109
Fertilization	1	0.247	0.956	0.469
Alb				
LUI	1	0.357	2.131	0.008
Grazing	1	0.181	0.938	0.524
Mowing	1	0.264	1.460	0.126
Fertilization	1	0.284	1.595	0.077
Hainich				
LUI	1	0.233	1.538	0.045
Grazing	1	0.145	0.890	0.620
Mowing	1	0.211	1.366	0.144
Fertilization	1	0.213	1.379	0.115
Schorfheide				
LUI	1	0.222	0.852	0.478
Grazing	1	0.650	3.442	0.021
Mowing	1	0.533	2.558	0.099

Tab. S3.1.4: Results of null model based on abundance-weighted mean (μ_i) of the land-use gradient values and its components and random distribution of μ_{null} values, fixing the total number of plots in which the species occurs.

Species	LUI			Grazing			Mowing			Fertilization		
	μ_i	μ_{null}	P	μ_i	μ_{null}	P	μ_i	μ_{null}	P	μ_i	μ_{null}	P
<i>Acompsia cinerella</i>	0.89	1.65	0.001	71.12	115.40	0.176	0.43	1.13	0.046	0.16	28.14	0.032
<i>Aethes hartmanniana</i>	1.26	1.64	0.152	135.41	112.62	0.319	0.33	1.12	0.092			
<i>Aethes smeathmanniana</i>	1.57	1.68	0.394	195.11	111.24	0.12	0.33	1.11	0.098			
<i>Agapeta hamana</i>	1.78	1.67	0.132	76.60	112.01	0.051	1.47	1.11	0.002	41.49	28.62	0.024
<i>Agapeta zoegana</i>	0.78	1.67	0.004	63.05	109.81	0.278	0.18	1.10	0.034			
<i>Agriphila inquinatella</i>	0.67	1.67	0	49.66	110.92	0.128	0.12	1.12	0.006			
<i>Agriphila straminella</i>	2.17	1.67	0	98.02	113.51	0.083	1.49	1.12	0	66.32	28.56	0
<i>Agriphila tristella</i>	1.54	1.66	0.095	100.78	111.73	0.273	0.91	1.11	0.053	31.09	28.80	0.354
<i>Agrotis cinerea</i>	0.59	1.64	0	39.23	111.59	0.068	0.09	1.11	0.01			
<i>Agrotis exclamationis</i>	1.63	1.66	0.394	72.06	113.10	0.01	1.14	1.11	0.384	34.74	28.38	0.137
<i>Amphipoea fucosa</i>	1.94	1.67	0.052	89.53	114.83	0.233	1.44	1.12	0.071	50.31	28.81	0.024
<i>Apamea lithoxylaea</i>	1.23	1.66	0.031	79.84	112.67	0.277	0.67	1.12	0.126	23.10	28.62	0.411
<i>Apamea monoglypha</i>	1.49	1.67	0.043	77.93	114.32	0.022	1.03	1.12	0.266	23.27	28.59	0.219
<i>Apamea sublustris</i>	1.73	1.68	0.459	81.40	114.48	0.317	1.14	1.14	0.482			
<i>Aproaerema anthyllidella</i>	1.15	1.67	0.075	60.83	111.32	0.244	1	1.10	0.47			
<i>Arctia caja</i>	1.60	1.67	0.34	55.46	110.68	0.034	1.33	1.11	0.122	28.47	28.38	0.473
<i>Autographa gamma</i>	2.21	1.67	0.022	120.95	116.53	0.432	1.33	1.13	0.328	73.56	27.91	0.008
<i>Axylia putris</i>	2.14	1.67	0.018	121.41	115.65	0.414	1.63	1.10	0.063	58.5	28.55	0.036
<i>Bryotropha terrella</i>	1.49	1.67	0.14	88.46	111.42	0.225	1.04	1.11	0.382	21.91	29.27	0.228
<i>Celypha lacunana</i>	1.52	1.67	0.076	61.06	113.53	0	1.18	1.12	0.394	23.41	29.11	0.196
<i>Celypha rufana</i>	2.08	1.66	0.041	78.00	112.81	0.255	1.18	1.12	0.36	70.64	28.52	0.004
<i>Celypha striana</i>	1.94	1.68	0.139	102.50	113.08	0.457	1.33	1.11	0.185	51	29.29	0.088
<i>Ceramica pisi</i>	2.02	1.67	0.132	240.58	113.65	0.027	1	1.12	0.483			
<i>Cerapteryx graminis</i>	1.07	1.65	0.06	8.64	112.44	0.027	1.33	1.13	0.198			
<i>Charanyca trigrammica</i>	0.72	1.65	0	39.81	115.60	0.013	0.25	1.10	0.002	8.6	28.86	0.075
<i>Chiasmia clathrata</i>	1.33	1.67	0	76.77	112.96	0.024	0.95	1.12	0.125	13.74	28.97	0.008
<i>Chrysoteuchia culmella</i>	1.62	1.67	0.268	69.62	113.48	0.001	1.52	1.11	0	23.30	28.79	0.162
<i>Cnephasia asseclana</i>	1.53	1.67	0.204	57.16	114.28	0.016	1.05	1.12	0.364	38.55	28.96	0.171
<i>Cnephasia stephensiana</i>	1.26	1.68	0.075	156.33	110.50	0.21	0.27	1.11	0.036			
<i>Crambus hamella</i>	1.42	1.66	0.266	36.48	108.64	0.115	1.5	1.13	0.205			
<i>Crambus lathoniellus</i>	1.61	1.66	0.401	79.13	112.64	0.146	1.25	1.11	0.256	30.76	28.62	0.424
<i>Crambus perlellus</i>	1.72	1.66	0.242	64.45	113.09	0	1.43	1.11	0.001	35.05	28.56	0.107
<i>Crambus pratellus</i>	0.84	1.68	0	34.39	113.31	0.01	0.48	1.11	0.018	9.441	29.17	0.086
<i>Deltote bankiana</i>	1.57	1.66	0.373	119.01	113.31	0.414	1.45	1.12	0.15	12.55	29.19	0.219
<i>Deltote deceptor</i>	0.75	1.66	0	59.88	110.99	0.202	0.13	1.11	0.009			
<i>Diaphora mendica</i>	1.74	1.67	0.282	81.04	111.52	0.134	0.94	1.13	0.191	41.88	28.82	0.077
<i>Epirrhoe alternata</i>	1.34	1.66	0.012	60.46	113.67	0.013	1.06	1.12	0.337	15.88	28.46	0.077
<i>Epirrhoe tristata</i>	1.77	1.66	0.312	72.47	112.76	0.215	1.43	1.11	0.173	37.02	28.88	0.273
<i>Eucosma balatonana</i>	1.83	1.67	0.246	120.49	112.52	0.394	0.89	1.11	0.25	51	28.83	0.075
<i>Eucosma cana</i>	0.99	1.68	0.003	76.92	114.69	0.245	0.22	1.10	0.012	15.33	28.25	0.223
<i>Eupithecia icterata</i>	1.33	1.65	0.192	29.63	116.17	0.068	0.67	1.13	0.283			
<i>Eupithecia satyrata</i>	1.01	1.65	0.014	73.56	115.45	0.251	0.33	1.13	0.025			
<i>Eupithecia subfuscata</i>	1.62	1.67	0.383	44.09	112.47	0.006	1.2	1.10	0.392	40.42	28.90	0.169

Species	LUI			Grazing			Mowing			Fertilization		
	μ_i	μ_{null}	P	μ_i	μ_{null}	P	μ_i	μ_{null}	P	μ_i	μ_{null}	P
<i>Eupithecia subumbrata</i>	1.62	1.67	0.435	49.51	111.08	0.074	1	1.13	0.443	50.14	28.77	0.096
<i>Gandaritis pyraliata</i>	1.34	1.64	0.221	48.74	114.87	0.158	1.2	1.10	0.465			
<i>Hada plebeja</i>	0.90	1.66	0	55.95	113.63	0.074	0.38	1.12	0.017	12.15	28.10	0.128
<i>Hoplodrina blanda</i>	1.48	1.67	0.282	112.82	114.17	0.451	1.25	1.13	0.3			
<i>Hoplodrina octogenaria</i>	1.74	1.67	0.323	97.11	114.12	0.304	1.16	1.12	0.482	45	29.29	0.058
<i>Idaea aversata</i>	1.25	1.67	0.069	71.95	113.38	0.228	0.58	1.10	0.062	24.67	28.77	0.42
<i>Idaea biselata</i>	2.43	1.66	0.012	114.33	115.56	0.422	1.6	1.11	0.204			
<i>Lathronympha strigana</i>	1.69	1.67	0.453	134.40	114.47	0.29	1	1.12	0.383	31.91	28.44	0.374
<i>Macrothylacia rubi</i>	2.09	1.68	0.142	99.64	111.39	0.494	1	1.10	0.478			
<i>Malacosoma castrensis</i>	1.54	1.67	0.335	124.34	115.68	0.395	0.6	1.11	0.134			
<i>Melanchra persicariae</i>	1.57	1.65	0.427	148.74	112.07	0.25	1.33	1.13	0.223			
<i>Mesoligia furuncula</i>	2.32	1.67	0	114.35	114.76	0.477	1.44	1.12	0.095	81.11	28.71	0
<i>Mythimna albipuncta</i>	2.61	1.66	0	151.04	112.13	0.229	1.5	1.11	0.11			
<i>Mythimna conigera</i>	1.16	1.67	0.003	130.65	113.70	0.311	0.4	1.12	0.005	3.05	28.65	0.016
<i>Mythimna ferrago</i>	1.86	1.68	0.115	82.37	112.50	0.161	1.08	1.11	0.377	50.17	28.58	0.01
<i>Mythimna pallens</i>	1.78	1.67	0.056	124.44	112.92	0.217	1.21	1.12	0.141	33.89	28.75	0.128
<i>Noctua comes</i>	1.35	1.67	0.163	47.03	111.29	0.11	1.17	1.12	0.496			
<i>Noctua interposita</i>	2.59	1.65	0.003	59.28	114.03	0.199	2	1.13	0			
<i>Noctua pronuba</i>	1.53	1.66	0.064	53.95	112.79	0	1.15	1.11	0.388	29.61	28.96	0.448
<i>Ochropleura plecta</i>	1.75	1.67	0.165	93.22	112.71	0.112	1.19	1.11	0.242	34.67	28.54	0.144
<i>Oligia latruncula</i>	1.64	1.67	0.464	98.31	110.27	0.495	1.14	1.06	0.437			
<i>Oligia strigilis</i>	1.51	1.67	0.215	127.88	112.49	0.336	1	1.12	0.422	13.40	28.32	0.118
<i>Oligia versicolor</i>	2.57	1.66	0	55.86	110.96	0.089	1.73	1.11	0.024	108.87	28.82	0
<i>Oncocera semirubella</i>	1.08	1.66	0	136.11	114.45	0.3	0.18	1.10	0.002	4.22	28.41	0.018
<i>Ostrinia nubilalis</i>	1.95	1.67	0.061	77.78	114.75	0.163	1.57	1.13	0.012	49.14	29.05	0.044
<i>Perizoma alchemillata</i>	1.66	1.67	0.498	75.48	113.19	0.09	1.11	1.11	0.466	39.90	28.96	0.117
<i>Phlogophora meticulosa</i>	2.21	1.66	0.074	152.45	115.52	0.263	1.33	1.10	0.207			
<i>Phragmatobia fuliginosa</i>	1.67	1.67	0.483	114.43	113.01	0.47	1.54	1.11	0	18.37	28.56	0.057
<i>Plutella xylostella</i>	1.53	1.67	0.195	97.54	113.09	0.316	1	1.11	0.368	23.83	28.44	0.336
<i>Pyrausta despicata</i>	1.27	1.67	0.005	71.81	111.65	0.106	1.14	1.11	0.435	3.87	28.43	0.002
<i>Pyrausta purpuralis</i>	0.92	1.67	0.001	84.47	111.33	0.335	0.46	1.12	0.046	0.09	29.00	0.048
<i>Rivula sericealis</i>	1.93	1.68	0.088	53.60	113.56	0.018	1.54	1.12	0.053	51.27	28.54	0.03
<i>Scoparia pyralella</i>	1.72	1.68	0.42	61.59	113.66	0.089	1.56	1.12	0.111	29.05	29.04	0.483
<i>Scopula ornata</i>	0.61	1.68	0	55.14	113.98	0.21	0	1.10	0.031			
<i>Scotopteryx chenopodiata</i>	1.03	1.67	0	80.08	112.46	0.196	0.30	1.11	0	15.08	28.68	0.131
<i>Siona lineata</i>	2.33	1.67	0.011	83.20	110.02	0.378	1.67	1.13	0.101			
<i>Spilosoma lubricipeda</i>	1.85	1.66	0.036	73.42	112.23	0.021	1.55	1.12	0.001	35.34	28.78	0.191
<i>Stenoptilia pterodactyla</i>	1.60	1.66	0.39	108.21	113.59	0.49	0.75	1.13	0.121	34.92	28.90	0.36
<i>Thalpophila matura</i>	1.11	1.67	0.023	84.57	116.06	0.328	0.43	1.11	0.036			
<i>Triodia sylvina</i>	1.01	1.67	0	142.58	112.23	0.275	0.08	1.11	0.001	0	28.61	0.039
<i>Xanthorhoe ferrugata</i>	1.65	1.66	0.478	95.49	112.63	0.288	0.95	1.12	0.183	41.17	28.77	0.081
<i>Xanthorhoe spadicearia</i>	1.14	1.67	0.011	101.64	110.57	0.47	0.43	1.11	0.02	10.43	28.34	0.137
<i>Xestia c-nigrum</i>	2.02	1.67	0	94.49	112.59	0.019	1.23	1.12	0	56.65	28.76	0
<i>Xestia xanthographa</i>	1.05	1.66	0.04	46.16	110.77	0.174	0.78	1.12	0.306			

Tab. S3.1.5: Key parameters of co-variate models to account for effects of season, weather and moonlight on moth catches. Linear models were constructed for species diversity, abundance, species richness, feeding niche, voltinism, hibernation, distribution and conservation status as response variables, relative to temperature, moon and month. The residuals of these models were then used as the response variable in linear models of the different land use factors and experimental region. For the five species traits, the community-weighted means served as response variable.

	<i>df</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>P</i>
Response variable: Species diversity					
Temperature	1	19.460	19.459	58.307	<0.0001
Moon	1	1.7560	1.756	5.262	0.0247
Month	3	8.440	2.813	8.430	<0.0001
Residuals	72	24.029	0.334		
Response variable: Abundance					
Temperature	1	25170.036	25170.036	32.826	<0.0001
Moon	1	6196.589	6196.589	8.081	0.0058
Month	3	28161.737	9387.246	12.243	<0.0001
Residuals	72	55207.586	766.772		
Response variable: Species richness					
Temperature	1	2189.198	2189.198	53.084	<0.0001
Moon	1	142.866	142.866	3.464	0.0668
Month	3	1729.952	576.651	13.983	<0.0001
Residuals	72	2969.278	41.240		
Response variable: Feeding niche					
Temperature	1	2.880	2.880	17.213	<0.0001
Moon	1	3.082	3.082	18.416	<0.0001
Month	3	7.518	2.506	14.977	<0.0001
Residuals	72	12.047	0.167		
Response variable: Voltinism					
Temperature	1	0.091	0.091	1.594	0.2108
Moon	1	0.362	0.362	6.349	0.0140
Month	3	1.736	0.579	10.164	<0.0001
Residuals	72	4.099	0.057		
Response variable: Distribution					
Temperature	1	0.191	0.191	2.171	0.1450
Moon	1	0.017	0.017	0.198	0.6581
Month	3	3.084	1.028	11.68	<0.0001
Residuals	72	6.337	0.088		
Response variable: Conservation status					
Temperature	1	0.014	0.014	0.336	0.5642
Moon	1	0.062	0.062	1.536	0.2192
Month	3	0.218	0.073	1.808	0.1535
Residuals	72	2.898	0.040		

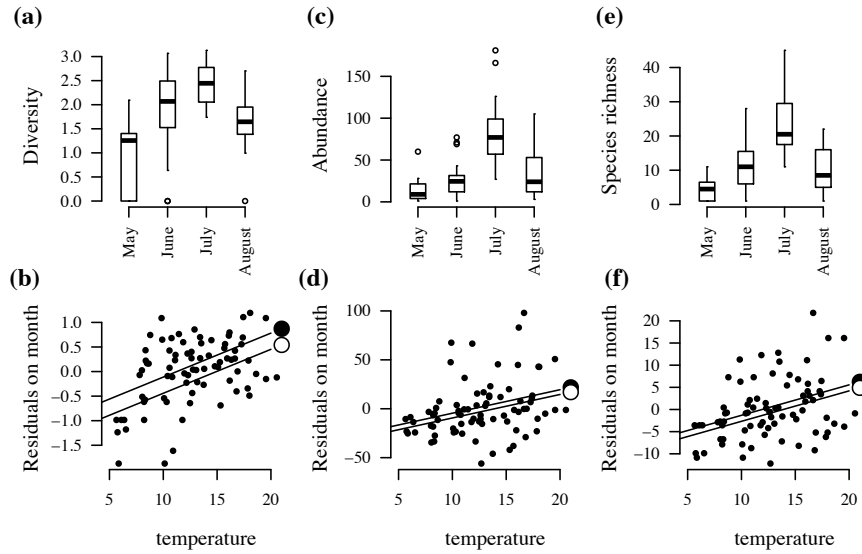


Fig. S3.1.1: Results of the co-variate models; Linear models of species diversity, abundance and species richness relative to month (a, c, e), temperature (x-axis) and moon (model lines represent projections for ○: full moon exposure and ●: no moon exposure) (b, d, f).

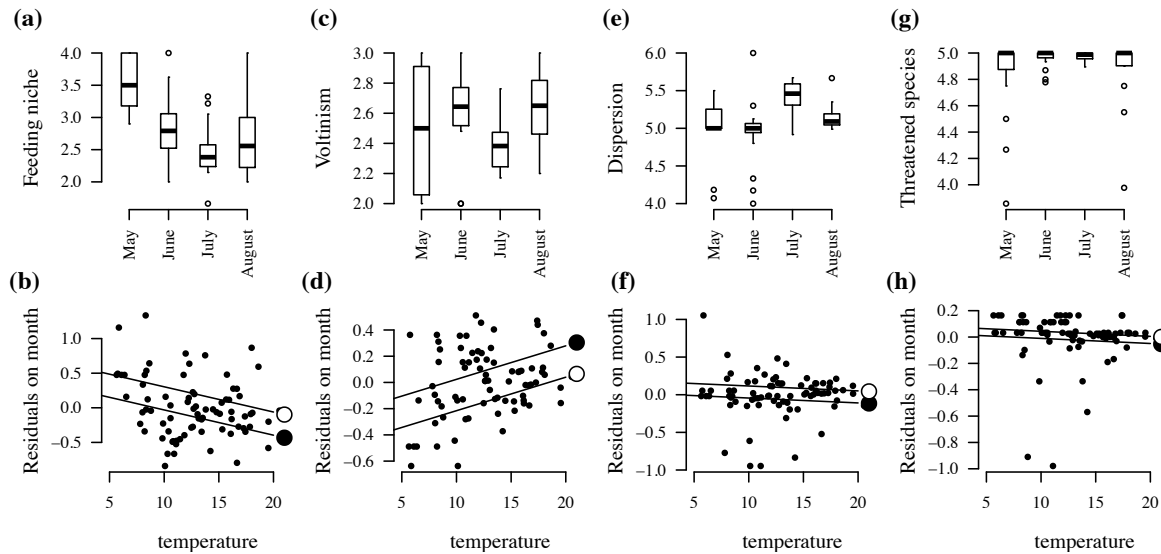


Fig. S3.1.2: Results of the co-variate models; Linear models of community-weighted means of feeding niche, voltinism, hibernation, distribution and conservation status relative to month (a, c, e, g), temperature and moon (b, d, f, h).

Tab. S3.1.6: Results of linear models of species diversity, abundance and species richness (residuals on co-variate models) in response to experimental region as well as land-use intensity index (LUI), its components grazing, mowing and fertilization, and region.

	<i>df</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for species diversity					
LUI	1	0.284	0.284	2.014	0.171
Region	2	0.073	0.036	0.259	0.775
Residuals	21	2.955	0.141		
Grazing	1	0.021	0.021	0.137	0.715
Region	2	0.116	0.058	0.382	0.687
Residuals	21	3.175	0.151		
Mowing	1	0.577	0.577	4.783	0.04
Region	2	0.202	0.101	0.837	0.447
Residuals	21	2.533	0.121		
Fertilization	1	0.072	0.072	0.498	0.488
Area	2	0.19	0.095	0.654	0.53
Residuals	21	3.049	0.145		
Response variable: Residuals on co-variate model for abundance					
LUI	1	997.827	997.827	4.333	0.051
Region	2	231.949	115.975	0.504	0.612
LUI \times Region	2	2054.942	1027.471	4.462	0.026
Residuals	19	4375.625	230.3		
Grazing	1	528.351	528.351	1.556	0.226
Region	2	1.538	0.769	0.002	0.998
Residuals	21	7130.453	339.545		
Mowing	1	2137.778	2137.778	10.31	0.005
Region	2	90.23	45.115	0.218	0.806
Mowing \times Region	2	1492.593	746.297	3.599	0.047
Residuals	19	3939.742	207.355		
Fertilization	1	849.14	849.14	2.827	0.108
Region	2	502.909	251.454	0.837	0.447
Residuals	21	6308.294	300.395		
Response variable: Residuals on co-variate model for species richness					
LUI	1	45.375	45.375	2.708	0.118
Region	2	51.43	25.715	1.535	0.238
Residuals	21	351.838	16.754		
Grazing	1	8.788	8.788	0.443	0.513
Region	2	23.031	11.516	0.58	0.569
Residuals	21	416.824	19.849		
Mowing	1	140.329	140.329	11.43	0.003
Region	2	50.498	25.249	2.057	0.153
Residuals	21	257.82	12.28		
Fertilization	1	16.858	16.858	1.009	0.327
Region	2	80.786	40.393	2.417	0.117
Residuals	21	350.999	16.714		

Tab. S3.1.7: Results of linear models of the residuals of community-weighted mean size, feeding niche, voltinism, hibernation, distribution and conservation status relative to the land-use intensity index (LUI), its components grazing, mowing and fertilization, and region.

	<i>df</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for size					
LUI	1	0.5398	0.5398	0.1678	0.6863
Region	2	14.0625	7.0313	2.185	0.1374
Residuals	21	67.5765	3.2179		
Grazing	1	0.8409	0.8409	0.2606	0.615
Region	2	13.59	6.795	2.1063	0.1467
Residuals	21	67.748	3.2261		
Mowing	1	0	0	0	0.9987
Region	2	13.9773	6.9887	2.1519	0.1412
Residuals	21	68.2016	3.2477		
Fertilization	1	7.6976	7.6976	2.4538	0.1322
Region	2	8.6034	4.3017	1.3713	0.2756
Residuals	21	65.8779	3.137		
Response variable: Residuals on co-variate model for feeding niche					
LUI	1	0.3403	0.3403	7.3571	0.013
Region	2	0.3457	0.1729	3.7373	0.0409
Residuals	21	0.9714	0.0463		
Grazing	1	0.0743	0.0743	1.0819	0.3101
Region	2	0.1416	0.0708	1.0311	0.374
Residuals	21	1.4416	0.0686		
Mowing	1	0.3842	0.3842	7.9746	0.0108
Region	2	0.1332	0.0666	1.3819	0.2752
Mowing \times Region	2	0.2246	0.1123	2.3308	0.1244
Residuals	19	0.9154	0.0482		
Fertilization	1	0.4042	0.4042	9.1299	0.0065
Region	2	0.3235	0.1617	3.653	0.0435
Residuals	21	0.9297	0.0443		
Response variable: Residuals on co-variate model for voltinism					
LUI	1	0.0034	0.0034	0.2132	0.649
Region	2	0.3102	0.1551	9.8551	0.001
LUI \times Region	2	0.1224	0.0612	5.5895	0.0123
Residuals	21	0.3305	0.0157		
Grazing	1	0.0559	0.0559	3.6243	0.0707
Region	2	0.2645	0.1322	8.5792	0.0019
Residuals	21	0.3237	0.0154		
Mowing	1	0.0423	0.0423	4.1499	0.0558
Region	2	0.3363	0.1682	16.4842	<0.0001
Mowing \times Region	2	0.0716	0.0358	3.5093	0.0505
Residuals	19	0.1938	0.0102		
Fertilization	1	0.022	0.022	1.4337	0.2445
Region	2	0.3005	0.1503	9.8104	0.001
Residuals	21	0.3216	0.0153		

	<i>df</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for hibernation					
LUI	1	0.0085	0.0085	1.0515	0.3168
Region	2	0.0037	0.0018	0.2248	0.8006
Residuals	21	0.1706	0.0081		
Grazing	1	2e-04	2e-04	0.0259	0.8736
Region	2	0.0031	0.0015	0.1795	0.837
Residuals	21	0.1795	0.0085		
Mowing	1	0.0043	0.0043	0.5105	0.4828
Region	2	0.0019	0.001	0.114	0.8928
Residuals	21	0.1765	0.0084		
Fertilization	1	0.015	0.015	1.8885	0.1839
Region	2	0.0015	8e-04	0.0949	0.9099
Residuals	21	0.1663	0.0079		
Response variable: Residuals on co-variate model for distribution					
LUI	1	0.0565	0.0565	1.1419	0.2974
Region	2	0.0235	0.0117	0.2372	0.7909
Residuals	21	1.0396	0.0495		
Grazing	1	0.0548	0.0548	1.0974	0.3068
Region	2	0.0154	0.0077	0.1537	0.8584
Residuals	21	1.0494	0.05		
Mowing	1	0.1991	0.1991	4.5559	0.0448
Region	2	0.0026	0.0013	0.0301	0.9704
Residuals	21	0.9178	0.0437		
Fertilization	1	0.0549	0.0549	1.0929	0.3077
Region	2	0.0106	0.0053	0.1052	0.9006
Residuals	21	1.0542	0.0502		
Response variable: Residuals on co-variate model for conservation status					
LUI	1	0.0969	0.0969	13.6599	0.0015
Region	2	0.0328	0.0164	2.3103	0.1264
LUI \times Region	2	0.1905	0.0953	13.4294	<0.0001
Residuals	19	0.1348	0.0071		
Grazing	1	0.0116	0.0116	0.6133	0.4423
Region	2	0.0466	0.0233	1.2338	0.3114
Residuals	21	0.3967	0.0189		
Mowing	1	0.06	0.06	3.7647	0.0659
Region	2	0.06	0.03	1.8804	0.1773
Residuals	21	0.3349	0.0159		
Fertilization	1	0.0348	0.0348	2.1996	0.1529
Region	2	0.0882	0.0441	2.7897	0.0843
Residuals	21	0.332	0.0158		

Tab. S3.1.8: Results of constrained ordination (dbRDA) analyses of species composition (expressed as Bray-Curtis similarity matrix of sqrt-transformed moth species counts) across all regions, and for each region separately, with land-use components as tested environmental factors. In addition to the data of the main analysis of the manuscript, this analysis **includes ecotone species**.

	<i>df</i>	<i>Variance</i>	<i>F</i>	<i>P</i>
All regions				
Region	2	1.918	4.345	0.001
LUI	1	0.269	0.962	0.467
Grazing	1	0.668	2.533	0.006
Mowing	1	0.401	1.459	0.093
Fertilization	1	0.292	1.044	0.37
Alb				
LUI	1	0.332	1.733	0.027
Grazing	1	0.211	1.009	0.46
Mowing	1	0.274	1.371	0.121
Fertilization	1	0.262	1.3	0.144
Hainich				
LUI	1	0.265	1.517	0.032
Grazing	1	0.174	0.928	0.612
Mowing	1	0.251	1.425	0.063
Fertilization	1	0.246	1.387	0.086
Schorfheide				
LUI	1	0.239	0.855	0.484
Grazing	1	0.638	2.99	0.034
Mowing	1	0.536	2.33	0.108

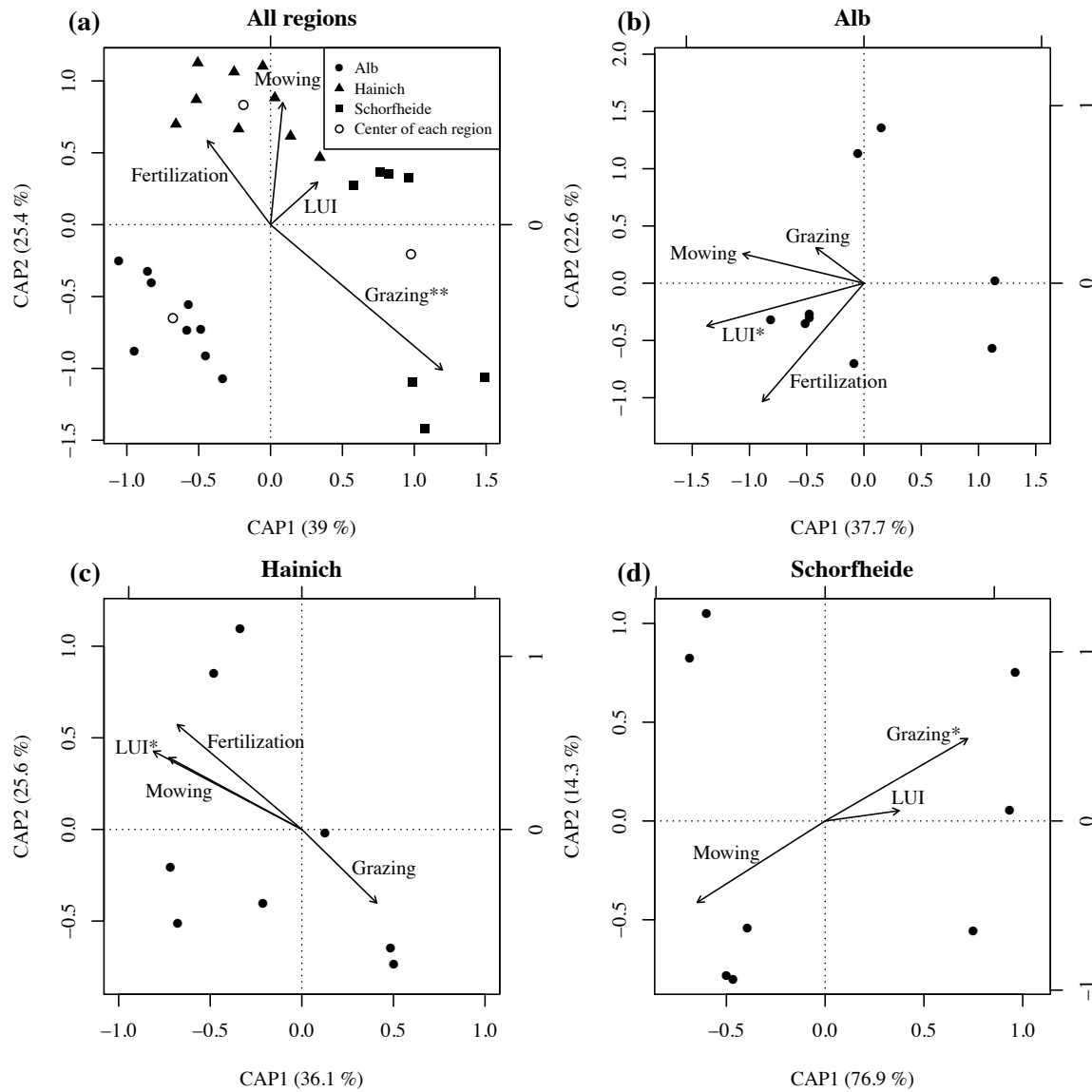


Fig. S3.1.3: Constrained ordination of moth species composition across all observations in all regions (a), and separately for the three regions Schwäbische Alb (b), Hainich (c) and Schorfheide (d). Comparisons of communities were based on quantitative Bray-Curtis distances. Arrows represent the relationship with the respective land-use components. Asterisks indicate a statistically significant effect of the predictor. In addition to the data of the main analysis of the manuscript, this analysis **includes ecotone species**.

Tab. S3.1.9: Results of constrained ordination (dbRDA) analyses of species composition (expressed as Bray-Curtis similarity matrix of sqrt-transformed moth species counts) across all regions, and for each region separately, with land-use components as tested environmental factors. **Data only includes forest species.**

	<i>df</i>	<i>Variance</i>	<i>F value</i>	<i>P</i>
All regions				
Region	2	2.357	3.448	0.001
LUI	1	0.535	1.326	0.115
Grazing	1	0.526	1.302	0.138
Mowing	1	0.442	1.086	0.324
Fertilization	1	0.704	1.775	0.016
Alb				
LUI	1	0.311	0.871	0.648
Grazing	1	0.302	8.84	0.647
Mowing	1	0.401	1.166	0.281
Fertilization	1	0.305	0.852	0.65
Hainich				
LUI	1	0.373	1.257	0.187
Grazing	1	0.425	1.469	0.071
Mowing	1	0.335	1.107	0.364
Fertilization	1	0.377	1.272	0.18
Schorfheide				
LUI	1	0.4	1.09	0.371
Grazing	1	0.6132	1.855	0.024
Mowing	1	0.517	1.493	0.146

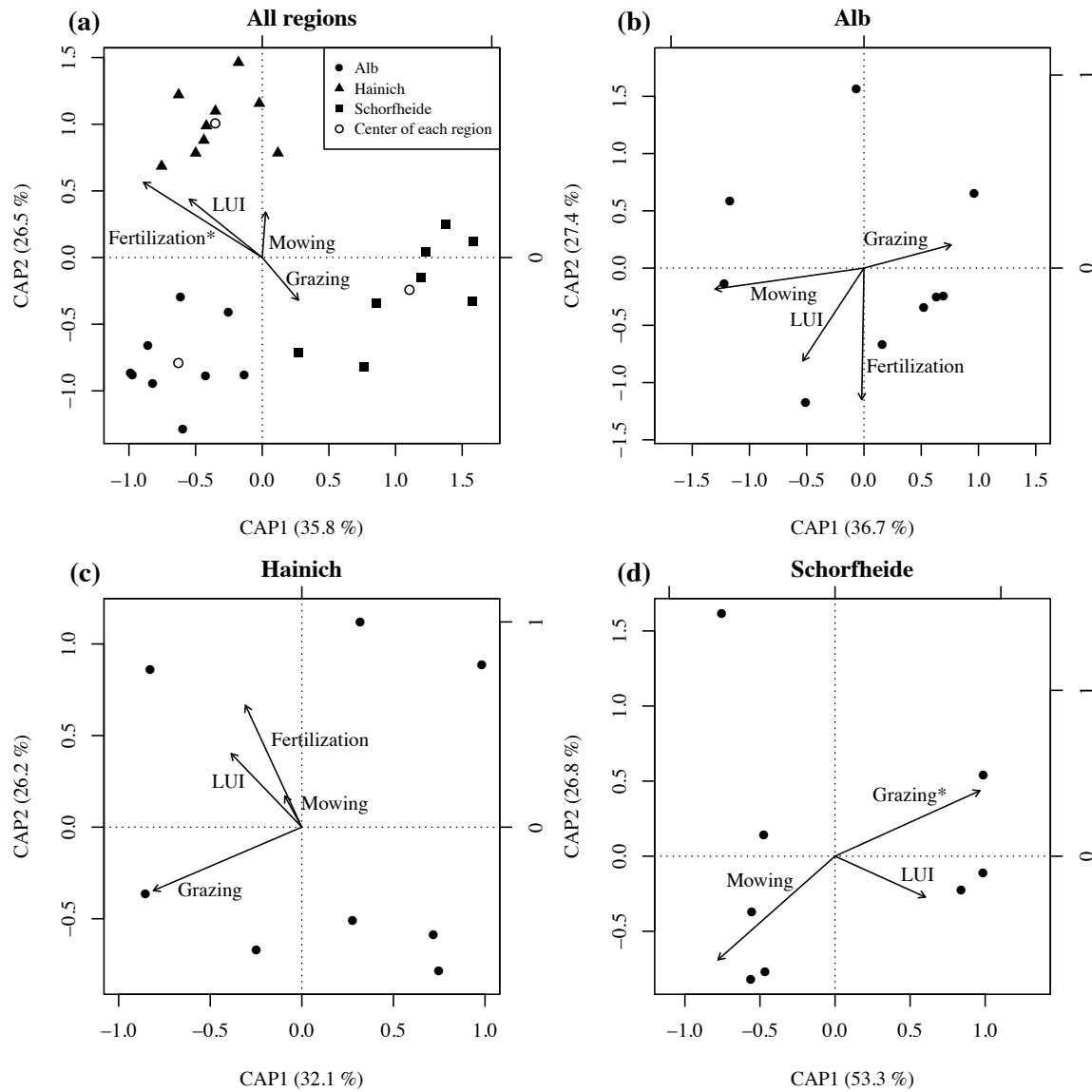


Fig. S3.1.4: Constrained ordination of moth species composition across all observations in all regions (a), and separately for the three regions Schwäbische Alb (b), Hainich (c) and Schorfheide (d). Comparisons of communities were based on quantitative Bray-Curtis distances. Arrows represent the relationship with the respective land-use components. Asterisks indicate a statistically significant effect of the predictor. **Data only includes forest species.**

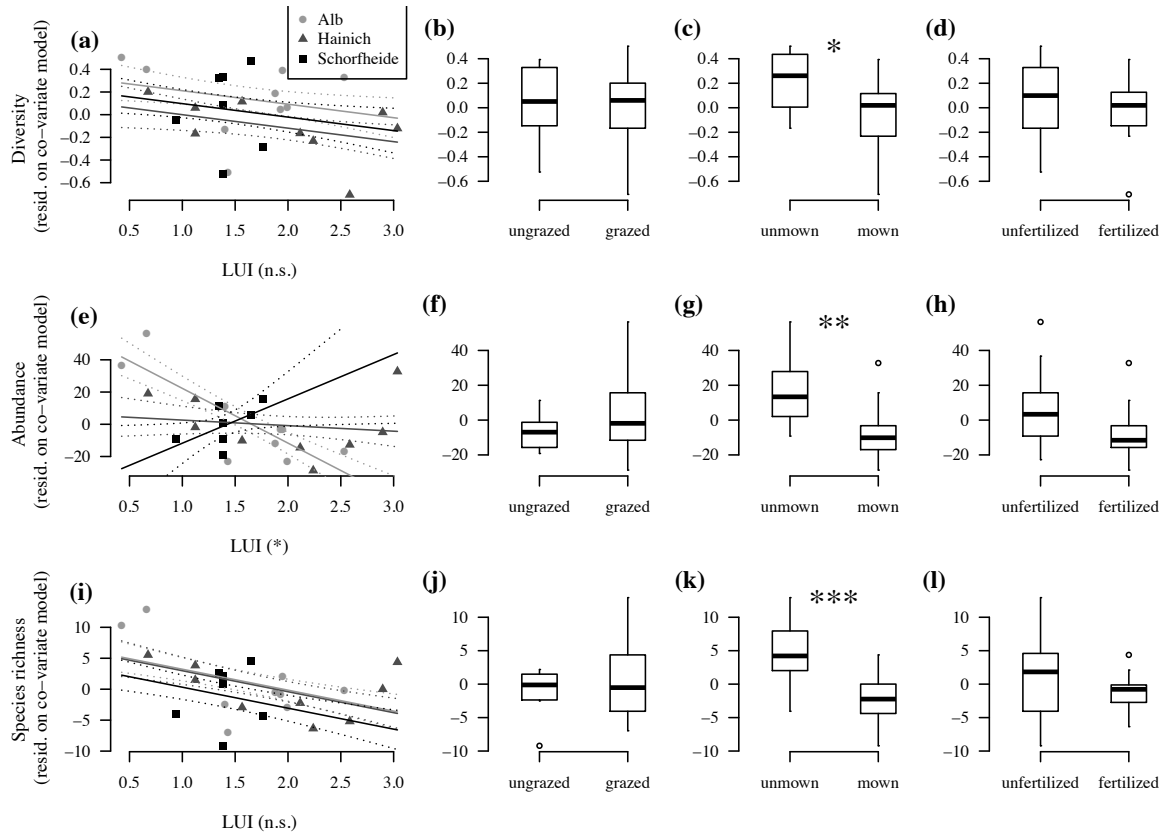
Tab. S3.1.10: Results of linear models of species diversity, abundance and species richness (residuals on co-variate models) in response to experimental region as well as land-use intensity index (LUI), its components grazing, mowing and fertilization, and region. In addition to the data of the main analysis of the manuscript, this analysis **includes ecotone species**.

	<i>df</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for species diversity					
LUI	1	0.2399	0.2399	2.486	0.1298
Region	2	0.1921	0.0961	0.9955	0.3863
Residuals	21	2.0264	0.0965		
Grazing	1	0.0032	0.0032	0.0314	0.8611
Region	2	0.2903	0.1452	1.408	0.2668
Residuals	21	2.1649	0.1031		
Mowing	1	0.4347	0.4347	5.5148	0.0287
Region	2	0.3686	0.1843	2.3385	0.1211
Residuals	21	1.6552	0.0788		
Fertilization	1	0.057	0.057	0.5766	0.4561
Area	2	0.3267	0.1633	1.6534	0.2154
Residuals	21	2.0748	0.0988		
Response variable: Residuals on co-variate model for abundance					
LUI	1	1666.4901	1666.4901	5.8378	0.0259
Region	2	190.9083	95.4542	0.3344	0.7199
LUI × Region	2	2796.1752	1398.0876	4.8976	0.0193
Residuals	19	5423.8078	285.4636		
Grazing	1	667.8781	667.8781	1.505	0.2335
Region	2	90.04	45.02	0.1014	0.904
Residuals	21	9319.4633	443.784		
Mowing	1	3067.3838	3067.3838	13.225	0.0018
Region	2	295.7012	147.8506	0.6375	0.5396
Mowing × Region	2	2307.4631	1153.7315	4.9743	0.0183
Residuals	19	4406.8333	231.9386		
Fertilization	1	1069.6332	1069.6332	2.7382	0.1128
Region	2	804.5708	402.2854	1.0298	0.3744
Residuals	21	8203.1773	390.6275		
Response variable: Residuals on co-variate model for species richness					
LUI	1	97.2055	97.2055	4.0048	0.0585
Region	2	37.5268	18.7634	0.773	0.4743
Residuals	21	509.7184	24.2723		
Grazing	1	17.7328	17.7328	0.6149	0.4417
Region	2	21.0813	10.5406	0.3655	0.6982
Residuals	21	605.6366	28.8398		
Mowing	1	244.1057	244.1057	14.965	9e-04
Region	2	57.7983	28.8991	1.7717	0.1945
Residuals	21	342.5467	16.3117		
Fertilization	1	38.556	38.556	1.5668	0.2244
Region	2	89.1255	44.5628	1.8109	0.1881
Residuals	21	516.7692	24.6081		

Tab. S3.1.11: Results of linear models of the residuals of community-weighted mean size, feeding niche, voltinism, hibernation, distribution and conservation status relative to the land-use intensity index (LUI), its components grazing, mowing and fertilization, and region. In addition to the data of the main analysis of the manuscript, this analysis **includes ecotone species**.

	<i>df</i>	<i>Sum of squares</i>	<i>Mean Squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for size					
LUI	1	0.0309	0.0309	0.0068	0.9352
Region	2	18.3301	9.165	2.0075	0.1593
Residuals	21	95.872	4.5653		
Grazing	1	2.7232	2.7232	0.6022	0.4464
Region	2	16.5426	8.2713	1.829	0.1852
Residuals	21	94.9671	4.5222		
Mowing	1	0.874	0.874	0.1899	0.6674
Region	2	16.7091	8.3546	1.8153	0.1874
Residuals	21	96.6498	4.6024		
Fertilization	1	3.4577	3.4577	0.7629	0.3923
Region	2	15.5978	7.7989	1.7208	0.2032
Residuals	21	95.1775	4.5323		
Response variable: Residuals on co-variate model for feeding niche					
LUI	1	0.2544	0.2544	5.7633	0.0257
Region	2	0.2873	0.1436	3.2543	0.0587
Residuals	21	0.9269	0.0441		
Grazing	1	0.0992	0.0992	1.6242	0.2164
Region	2	0.0865	0.0433	0.7084	0.5038
Residuals	21	1.2828	0.0611		
Mowing	1	0.2352	0.2352	4.331	0.0512
Region	2	0.1323	0.0662	1.2182	0.3179
Residuals	19	1.0319	0.0543		
Fertilization	1	0.2165	0.2165	5.1429	0.034
Region	2	0.3681	0.184	4.3725	0.0259
Residuals	21	0.8839	0.0421		
Response variable: Residuals on co-variate model for voltinism					
LUI	1	0.0062	0.0062	0.5028	0.4861
Region	2	0.2621	0.1311	10.5988	7e-04
Residuals	21	0.2597	0.0124		
Grazing	1	0.0463	0.0463	3.7434	0.0666
Region	2	0.2219	0.111	8.9715	0.0015
Residuals	21	0.2597	0.0124		
Mowing	1	0.0191	0.0191	2.0378	0.1697
Region	2	0.2725	0.1362	14.5515	1e-04
Mowing × Region	2	0.0586	0.0293	3.1278	0.067
Residuals	19	0.1779	0.0094		
Fertilization	1	0.0099	0.0099	0.8585	0.3647
Region	2	0.275	0.1375	11.8785	4e-04
Residuals	21	0.2431	0.0116		

	<i>df</i>	<i>Sum of squares</i>	<i>Mean Squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for hibernation					
LUI	1	0.0192	0.0192	2.3655	0.139
Region	2	0.0058	0.0029	0.3542	0.7059
Residuals	21	0.1706	0.0081		
Grazing	1	0.0016	0.0016	0.1729	0.6817
Region	2	9e-04	4e-04	0.0481	0.9531
Residuals	21	0.1931	0.0092		
Mowing	1	0.0239	0.0239	2.9952	0.0982
Region	2	0.0037	0.0019	0.2317	0.7952
Residuals	21	0.1679	0.008		
Fertilization	1	0.027	0.027	3.9143	0.0611
Region	2	0.0234	0.0117	1.6945	0.2079
Residuals	21	0.1451	0.0069		
Response variable: Residuals on co-variate model for distribution					
LUI	1	0.0612	0.0612	1.7479	0.2004
Region	2	0.0138	0.0069	0.1968	0.8229
Residuals	21	0.7353	0.035		
Grazing	1	0.0346	0.0346	0.9933	0.3303
Region	2	0.0433	0.0217	0.6215	0.5467
Residuals	21	0.7323	0.0349		
Mowing	1	0.1211	0.1211	3.7962	0.0649
Region	2	0.0195	0.0098	0.3061	0.7395
Residuals	21	0.6697	0.0319		
Fertilization	1	0.0556	0.0556	1.5579	0.2257
Region	2	0.0053	0.0027	0.0746	0.9284
Residuals	21	0.7494	0.0357		
Response variable: Residuals on co-variate model for conservation status					
LUI	1	0.0566	0.0566	11.7807	0.0028
Region	2	0.0103	0.0052	1.0734	0.3617
LUI × Region	2	0.1099	0.0549	11.441	5e-04
Residuals	19	0.0912	0.0048		
Grazing	1	0.0128	0.0128	1.1869	0.2883
Region	2	0.0294	0.0147	1.3682	0.2763
Residuals	21	0.2258	0.0108		
Mowing	1	0.0505	0.0505	5.6656	0.0269
Region	2	0.0304	0.0152	1.7079	0.2055
Residuals	21	0.1871	0.0089		
Fertilization	1	0.0346	0.0346	3.7073	0.0678
Region	2	0.0374	0.0187	2.0061	0.1595
Residuals	21	0.196	0.0093		



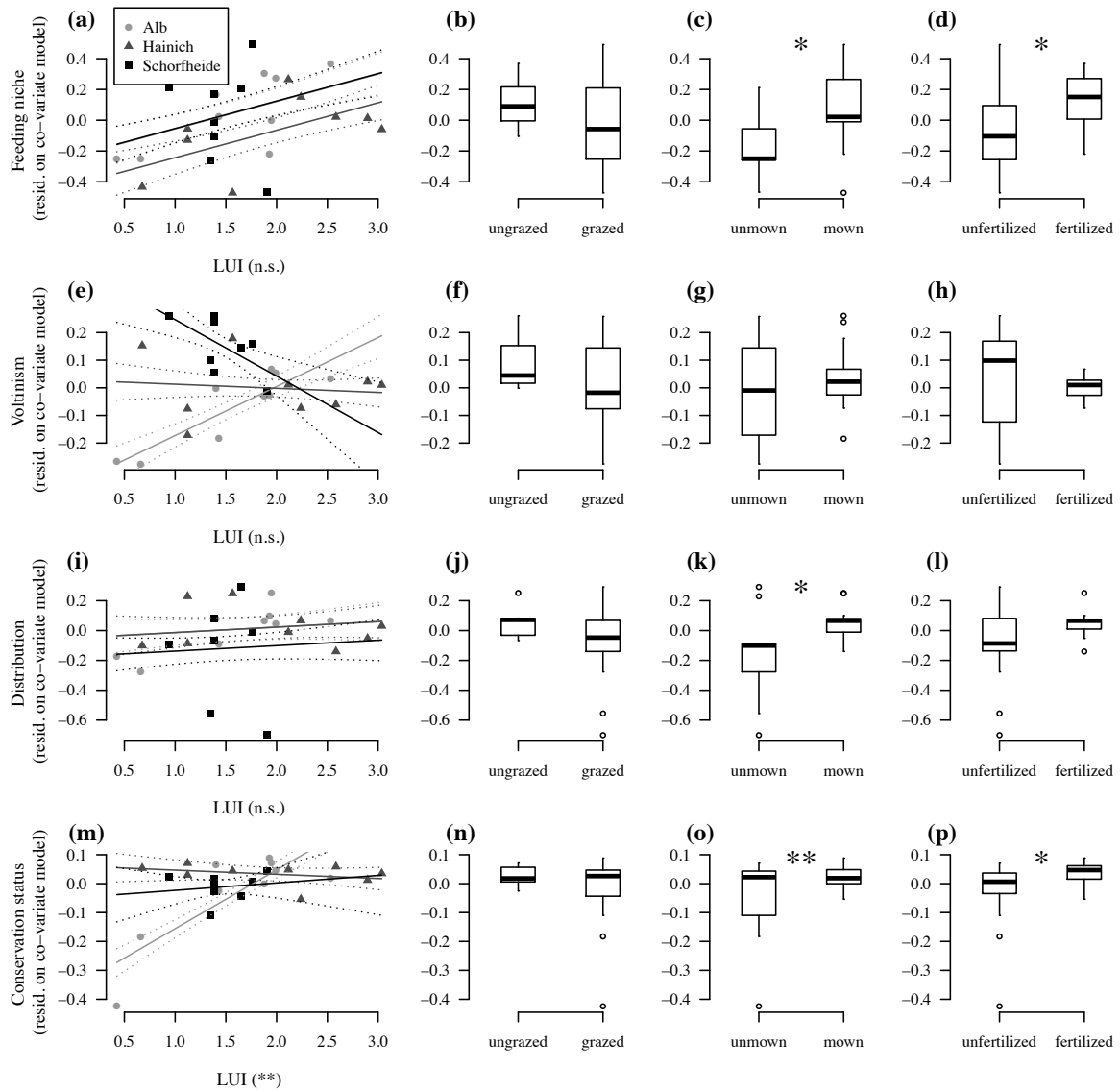


Fig. S3.1.6: Relationship between residuals of traits along the land-use index LUI [(a), (e), (i), (m)] in the three regions Schwäbische Alb, Hainich and Schorfheide. Shown are those four traits with significant results, namely breadth of larval feeding niche, voltinism, distributional range and conservation status. The results are based on a linear model using LUI and region as explanatory variables. Voltinism and vulnerability show a significant interaction effect between LUI and region. The factors Grazing [(b), (f), (j), (n)], Mowing [(c), (g), (k), (o)] and Fertilization [(d), (h), (l), (p)] were additionally examined. In addition to the data of the main analysis of the manuscript, this analysis **includes ecotone species**.

Tab. S3.1.12: Results of linear models of species diversity, abundance and species richness (residuals on co-variate models) in response to experimental region as well as land-use intensity index (LUI), its components grazing, mowing and fertilization, and region. **Data only includes forest species.**

	<i>df</i>	<i>Sum of squares</i>	<i>Mean Squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for species diversity					
LUI	1	0.1645	0.1645	0.7023	0.4115
Region	2	0.156	0.078	0.333	0.7205
Residuals	21	4.919	0.2342		
Grazing	1	0.013	0.013	0.055	0.8168
Region	2	0.2694	0.1347	0.5706	0.5737
Residuals	21	4.9571	0.2361		
Mowing	1	0.5657	0.5657	2.7121	0.1145
Region	2	0.2937	0.1468	0.704	0.5059
Residuals	21	4.3801	0.2086		
Fertilization	1	0.0581	0.0581	0.2467	0.6246
Area	2	0.2349	0.1175	0.4987	0.6143
Residuals	21	4.9465	0.2355		
Response variable: Residuals on co-variate model for abundance					
LUI	1	43.8903	43.8903	0.1458	0.7068
Region	2	2261.438	1130.719	3.7569	0.0422
Residuals	19	5718.4977	300.9736		
Grazing	1	551.9729	551.9729	2.2139	0.1516
Region	2	2236.3014	1118.1507	4.4848	0.0239
Residuals	21	5235.7725	249.3225		
Mowing	1	97.4155	97.4155	0.322	0.5771
Region	2	2113.7331	1056.8665	3.4933	0.0511
Residuals	19	5748.3229	302.5433		
Fertilization	1	890.3118	890.3118	3.3323	0.0822
Region	2	1523.0734	761.5367	2.8503	0.0803
Residuals	21	5610.6617	267.1744		
Response variable: Residuals on co-variate model for species richness					
LUI	1	13.8068	13.8068	1.195	0.2867
Region	2	34.6891	17.3445	1.5012	0.2458
Residuals	21	242.6252	11.5536		
Grazing	1	15.5026	15.5026	1.4174	0.2471
Region	2	45.9346	22.9673	2.0999	0.1474
Residuals	21	229.6839	10.9373		
Mowing	1	19.8124	19.8124	1.8787	0.185
Region	2	49.8426	24.9213	2.3631	0.1187
Residuals	21	221.4661	10.546		
Fertilization	1	0.537	0.537	0.0461	0.832
Region	2	46.1093	23.0546	1.9804	0.163
Residuals	21	244.4748	11.6417		

Tab. S3.1.13: Results of linear models of the residuals of community-weighted mean size, feeding niche, voltinism, hibernation, distribution and conservation status relative to the land-use intensity index (LUI), its components grazing, mowing and fertilization, and region. **Data only includes forest species.**

	<i>df</i>	<i>Sum of squares</i>	<i>Mean Squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for size					
LUI	1	46.7655	46.7655	1.6659	0.2108
Region	2	30.4767	15.2383	0.5428	0.589
Residuals	21	589.5287	28.0728		
Grazing	1	9.854	9.854	0.3293	0.5722
Region	2	28.5212	14.2606	0.4766	0.6275
Residuals	21	628.3957	29.9236		
Mowing	1	4.71	4.71	0.1558	0.6971
Region	2	27.0447	13.5223	0.4472	0.6454
Residuals	21	635.0163	30.2389		
Fertilization	1	62.7016	62.7016	2.2012	0.1528
Region	2	5.8701	2.935	0.103	0.9025
Residuals	21	598.1993	28.4857		
Response variable: Residuals on co-variate model for feedings niche					
LUI	1	0.0043	0.0043	0.0243	0.8775
Region	2	1.506	0.753	4.2827	0.0275
Residuals	21	3.6924	0.1758		
Grazing	1	0.1773	0.1773	0.9777	0.334
Region	2	1.2174	0.6087	3.3568	0.0543
Residuals	21	3.808	0.1813		
Mowing	1	0.0078	0.0078	0.0449	0.8345
Region	2	1.3345	0.6672	3.8393	0.0398
Residuals	19	3.302	0.1738		
Fertilization	1	0.0142	0.0142	0.0958	0.76
Region	2	2.0735	1.0367	6.9891	0.0047
Residuals	21	3.115	0.1483		
Response variable: Residuals on co-variate model for voltinism					
LUI	1	0.1633	0.1633	4.6529	0.0427
Region	2	0.1298	0.0649	1.8484	0.1822
Residuals	21	0.7372	0.0351		
Grazing	1	0.0288	0.0288	0.6616	0.4251
Region	2	0.0873	0.0437	1.0027	0.3838
Residuals	21	0.9142	0.0435		
Mowing	1	0.2632	0.2632	7.4051	0.0136
Region	2	0.0489	0.0245	0.6881	0.5146
Residuals	19	0.6754	0.0355		
Fertilization	1	0.2047	0.2047	5.6142	0.0275
Region	2	0.0598	0.0299	0.8204	0.4539
Residuals	21	0.7657	0.0365		

	<i>df</i>	<i>Sum of squares</i>	<i>Mean Squares</i>	<i>F</i>	<i>P</i>
Response variable: Residuals on co-variate model for hibernation					
LUI	1	0.0018	0.0018	0.0547	0.8173
Region	2	0.1696	0.0848	2.6023	0.0978
Residuals	21	0.6843	0.0326		
Grazing	1	0.0051	0.0051	0.1565	0.6964
Region	2	0.1654	0.0827	2.5349	0.1032
Residuals	21	0.6852	0.0326		
Mowing	1	0.0783	0.0783	2.6126	0.1209
Region	2	0.1476	0.0738	2.461	0.1096
Residuals	21	0.6297	0.03		
Fertilization	1	0.035	0.035	1.1123	0.3036
Region	2	0.1598	0.0799	2.5385	0.1029
Residuals	21	0.6609	0.0315		
Response variable: Residuals on co-variate model for distribution					
LUI	1	0.0032	0.0032	0.0781	0.7826
Region	2	0.0437	0.0219	0.5404	0.5904
Residuals	21	0.8495	0.0405		
Grazing	1	0.0065	0.0065	0.1634	0.6902
Region	2	0.0547	0.0273	0.6875	0.5138
Residuals	21	0.8352	0.0398		
Mowing	1	0.0355	0.0355	0.9135	0.3501
Region	2	0.0443	0.0221	0.5691	0.5745
Residuals	21	0.8166	0.0389		
Fertilization	1	0.0013	0.0013	0.0328	0.8581
Region	2	0.0639	0.0319	0.8071	0.4595
Residuals	21	0.8311	0.0396		
Response variable: Residuals on co-variate model for conservation status					
LUI	1	0.0196	0.0196	2.976	0.1007
Region	2	0.0449	0.0224	3.414	0.0541
Residuals	19	0.1249	0.0066		
Grazing	1	0.0015	0.0015	0.23	0.6365
Region	2	0.0589	0.0295	4.5233	0.0233
Residuals	21	0.1367	0.0065		
Mowing	1	0	0	8e-04	0.9776
Region	2	0.0606	0.0303	4.6563	0.0212
Residuals	21	0.1366	0.0065		
Fertilization	1	0.0356	0.0356	6.1276	0.0219
Region	2	0.0394	0.0197	3.3868	0.0531
Residuals	21	0.1221	0.0058		

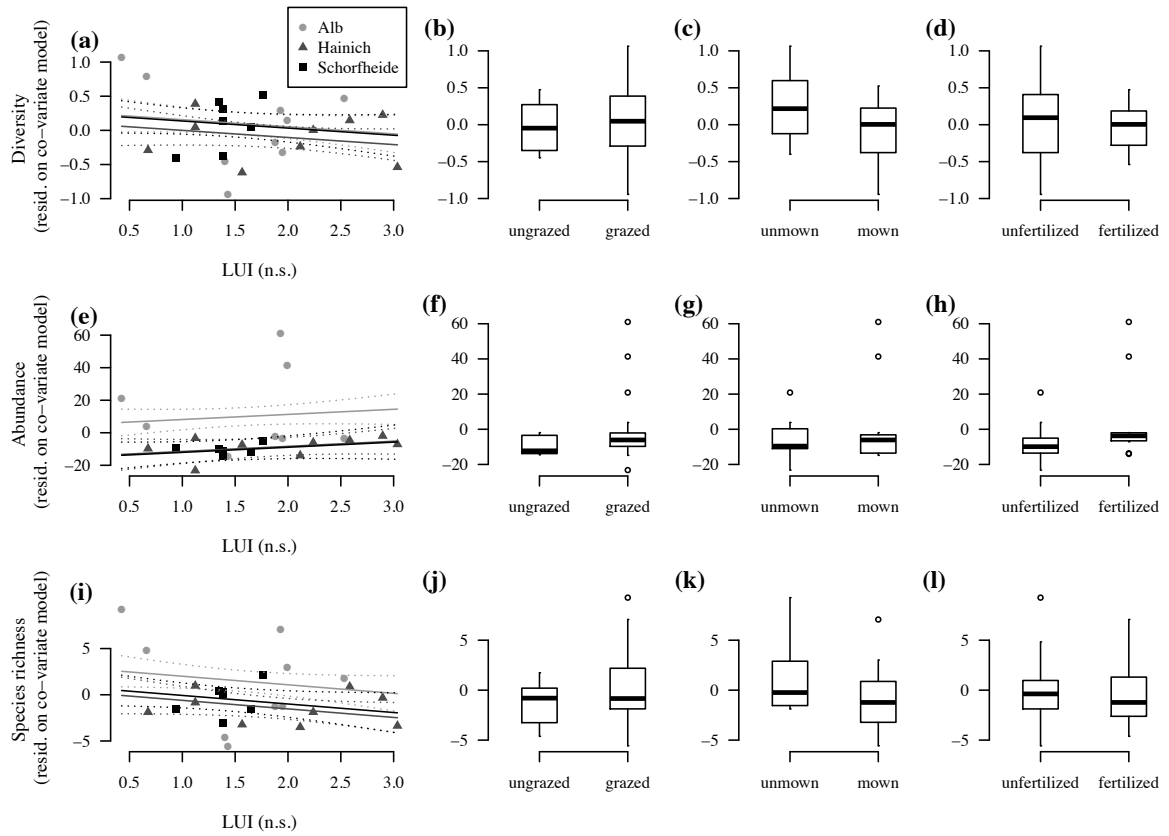


Fig. S3.1.7: Relationship between residuals of moth diversity [(a) – (d)]; abundance [(e) – (h)] and observed species [(i) – (l)] per site along the standardized integrated land-use index LUI [(a), (e), (i)] for the three regions Schwäbische Alb, Hainich and Schorfheide. The results are based on a linear model using LUI and region as explanatory variables, after accounting for variation related to temperature, season and moonlight. The factors grazing mowing and fertilization were examined separately. In contrast to species composition, region had no significant effect in any of the models. **Data only includes forest species.**

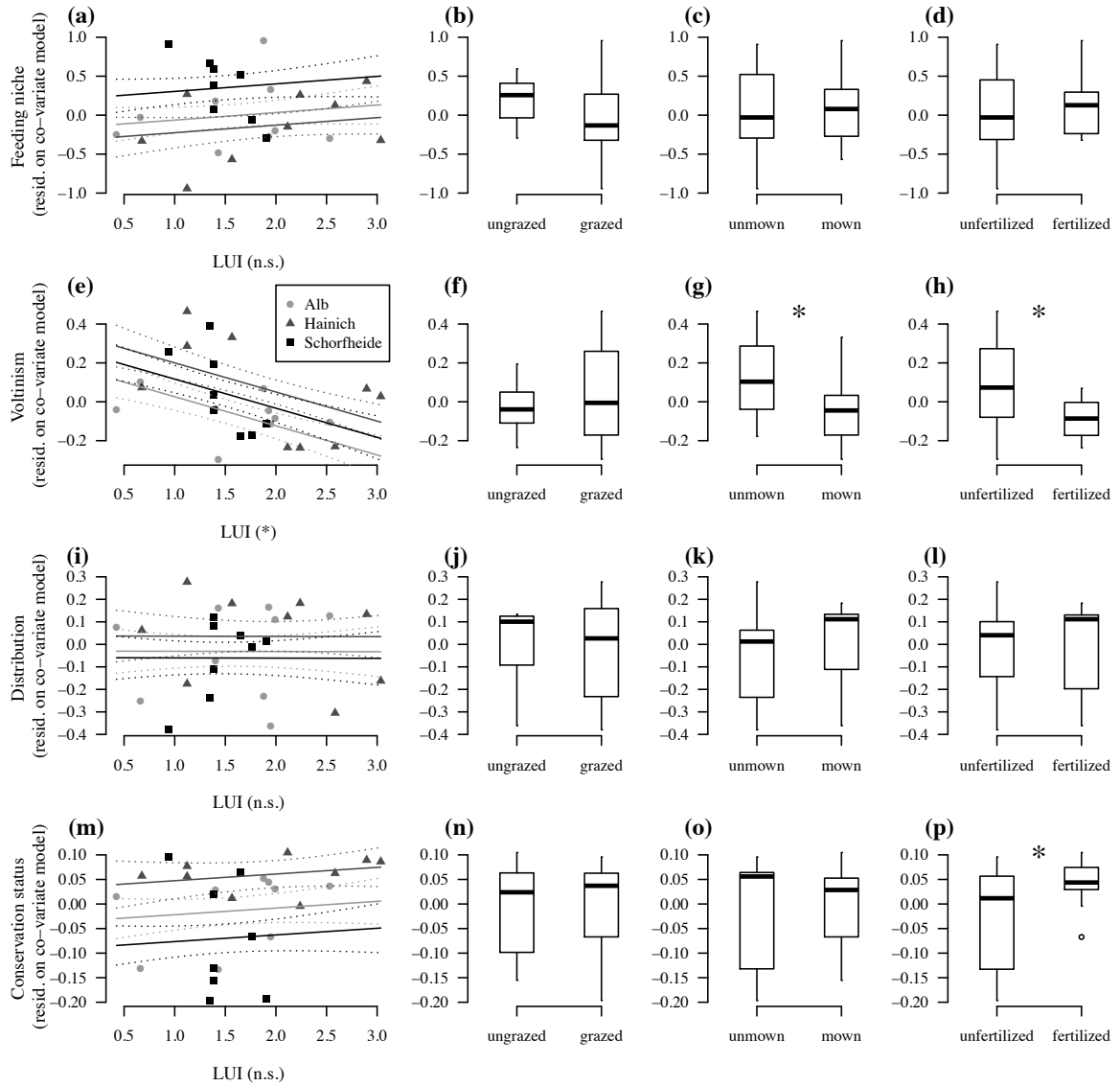


Fig. S3.1.8: Relationship between residuals of traits along the land-use index LUI [(a), (e), (i), (m)] in the three regions Schwäbische Alb, Hainich and Schorfheide. Shown are those four traits with significant results, namely breadth of larval feeding niche, voltinism, distributional range and conservation status. The results are based on a linear model using LUI and region as explanatory variables. Voltinism and vulnerability show a significant interaction effect between LUI and region. The factors Grazing [(b), (f), (j), (n)], Mowing [(c), (g), (k), (o)] and Fertilization [(d), (h), (l), (p)] were additionally examined. **Data only includes forest species.**

Supplementary Data S3.1.1: Distribution of grazing, mowing and fertilization.

Fertilization and mowing were often coupled as management treatments (both occurred on 11 of 26 plots; none occurred on 9 of 26; χ^2 -test of homogeneity: $\chi^2 = 7.617$, $df = 1$, $p = 0.006$). In contrast grazing was significantly negatively associated with mowing (both occurred on 9 of 26 plots; none occurred on 0 of 26; $\chi^2 = 4.108$, $df = 1$, $p = 0.042$), whereas no association appeared between fertilization and grazing (both occurred: 6 of 26 plots, none occurred: 3 of 26; $\chi^2 = 0.92$, $df = 1$, $p > 0.05$).

Table S1.14: Contingency tables for mowing, fertilization and grazing; number of sites shown for each category. Combinations that are more common than expected by chance are highlighted in bold (expected = row total * column total / 150).

(a) Mowing *versus* fertilization

	Mown	Not mown	Total
Fertilized	11	0	11
Unfertilized	6	9	15
Total	17	9	26

(b) Grazing *versus* fertilization

	Grazed	Ungrazed	Total
Fertilized	6	5	11
Unfertilized	12	3	15
Total	18	8	26

(c) Grazing *versus* mowing

	Grazed	Ungrazed	Total
Mown	8	9	17
Not mown	9	0	9
Total	17	9	26

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