

Kelemen A., Lazzaro L., Besnyői V., Albert Á.-J., Konečná M., Dobay G., Memelink I., Adamec V., Götzenberger L., de Bello F., Le Bagousse-Pinguet Y. & Lepš J. (2015): Net outcome of competition and facilitation in a wet meadow changes with plant's life stage and community productivity. – *Preslia* 87: 347–361.

**Electronic Appendix 1.** – Detailed description of differences in vegetation among plots according to the long-term treatment combinations.

## Materials and methods

The transplanting took place in 2000, six years after the start of the long-term management experiment on the site; the plots already differed according to the treatment applied. As the experiment was regularly monitored, we have used two types of data available to characterize the differences among plots in the year 2000: (1) species composition monitored in the central 1x1m square, where presence of all the species of vascular plants and mosses was recorded, and their cover visually estimated; (2) biomass of the central 0.5x0.5m square clipped immediately after finishing the transplant experiment (i.e. early July), where the total dry weight of all vascular plants was measured (notice that biomass data are obviously available for the mown plots only).

Data on the species composition were analyzed using the Redundancy analysis (Šmilauer and Lepš 2014), with  $\log(x+1)$  transformation of the cover values. The options centering by species with no standardization by samples were applied. All three experimental factors (mowing, fertilization, *Molinia caerulea* removal) were used as explanatory variables. This analysis was accompanied by separate analyses, where each factor was used as the sole explanatory variable, and the other two factors considered as covariables, with the latter analyses providing the amount of variability in species composition explained by each of the factors. Unlike in the previous ordination analyses (Lepš 1999, 2014), *Molinia* was kept in the analyses (unlike in the previous analyses, we are not interested in the effect of *Molinia* removal, but in the extent of differences among plots under various treatments). Canoco 5 software was used for all the analyses (ter Braak & Šmilauer 2012). The data on the total biomass were analysed by the Two-way ANOVA.

## Results

The species composition differed among the treatments (Fig. 1) with all the factors had significant effect ( $p < 0.05$ ). The explanatory power of fertilization was the highest importance (explaining 21.7% of total variation), followed by mowing (10.7%) and *Molinia* removal (7.6%). The effect of removal was mainly due to presence of *Molinia* in unremoved plots (the proportions of the other species did not change). The fertilized plots were dominated by few competitive tall species, often grasses (*Festuca rubra*, *Holcus lanatus*). Most of the species were confined to unfertilized mown plots, particularly the small species (including our experimental species, *Prunella vulgaris*) and all the mosses.

The biomass in 2000 was nearly twice higher in fertilized than in unfertilized plots, the removal has no effect on the total biomass (which means that the removed species biomass was completely replaced by the other species).

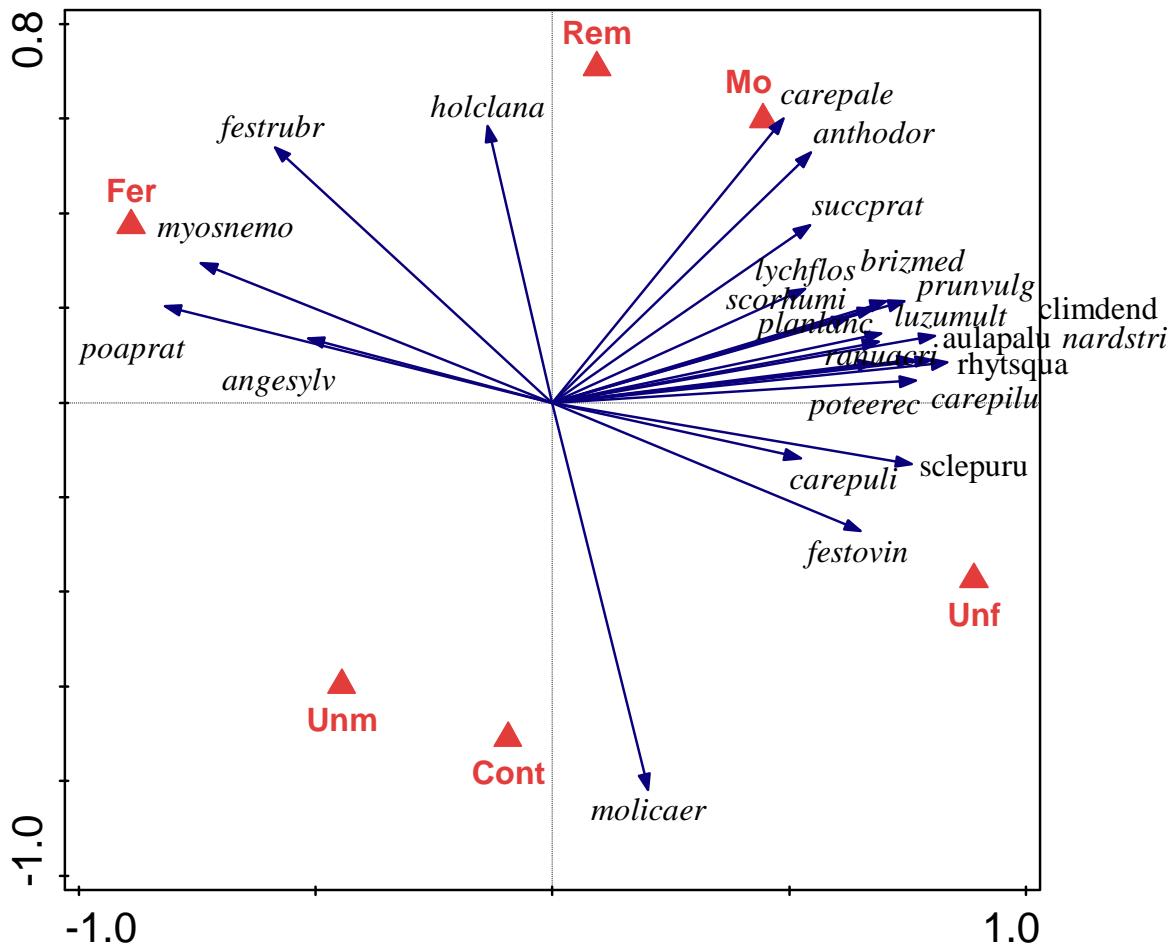


Fig. 1. Results of RDA of species composition in  $1 \times 1$  m plots during the time of experiment in the year 2000. The experimental factors (all significant) are shown as red triangles, and labeled as follows: Unm – unmown, Mo – mown, Unf – unfertilized, Fer – fertilized, Cont – control (unemoved), Rem – removed. The first (horizontal) axis explains 25.2% and the second 9.9% of total variability. Species are shown as arrows, labels of mosses are not in italics. Only the best fitting species are shown. Vascular plants: angesylv – *Angelica sylvestris*, anthodor – *Anthoxanthum odoratum*, brizmed – *Briza media*, carepale – *Carex pallescens*, carepuli – *Carex pilulifera*, festovin – *Festuca ovina*, festrubr – *Festuca rubra*, holclana – *Holcus lanatus*, luzumult – *Luzula multiflora*, lychflos – *Lychnis flos-cuculi*, molicaer – *Molinia caerulea*, myosnemo – *Myosotis nemorosa*, nardstri – *Nardus stricta*, planlanc – *Plantago lanceolata*, poa\_prat – *Poa pratensis*, poteerec – *Potentilla erecta*, prunvulg – *Prunella vulgaris*, ranaucer – *Ranunculus acer*, scorhumi – *Scorzonera humilis*, succprat – *Succisa pratensis*. Mosses: aulapalu – *Aulacomnium palustre*, climdend – *Climacium dendroides*, rhytsqua – *Rhytidiadelphus squarrosus*, sclepuru – *Scleropodium purum*.

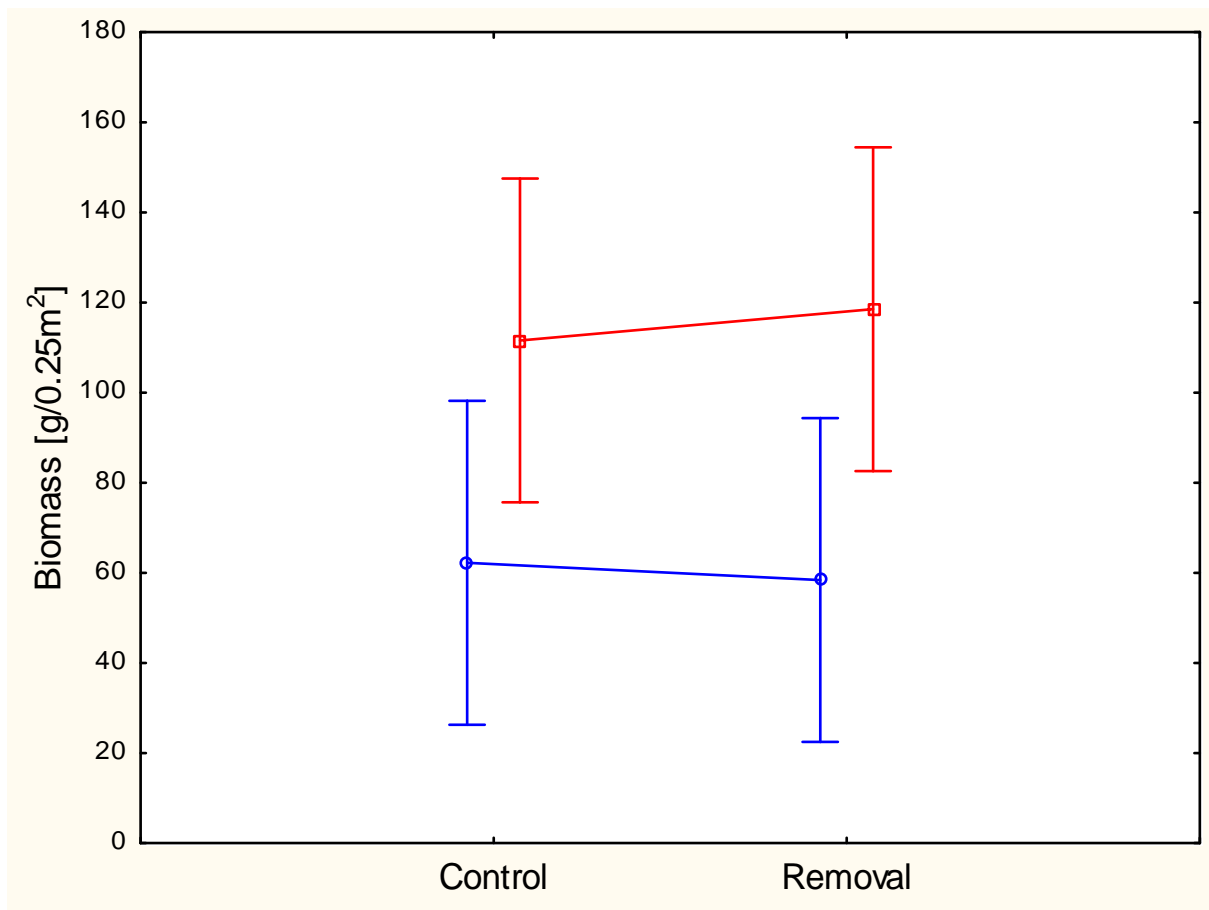


Fig. 2. Above-ground biomass (dry weight per 0.5x0.5m experimental plot) in the mown experimental plots. Fertilized plots are in red, unfertilized in blue. The vertical bars are the confidence intervals. The effect of fertilization is highly significant ( $F_{1,8}=12.3$ ;  $p=0.008$ ), the effect of removal and interaction are non-significant.

## References

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**Electronic Appendix 2.** – Stepwise forward selection results for models (GLMMs) for survival. T0-T1 – first sampling period; T1-T2 – second sampling period.

Term	Df	AIC	logLik	Likelihood ratio test statistic	P-values based on parametric bootstrap	Choice of the term
<b>T0-T1</b>						
STEP 1						
<i>Survival ~ +1 (null model)</i>	2	326.7	-161.4			
Survival ~ Removal	3	328.7	-161.4	0	0.984	Not-included
Survival ~ Mowing	3	328.7	-161.3	0.065	0.806	Not-included
Survival ~ Fertilization	3	327.7	-160.8	1.056	0.294	Not-included
Survival ~ Species	4	170.8	-81.4	159.89	<b>0.001</b>	Included
Survival ~ Surrounding	3	321.9	-158.0	6.804	<b>0.008</b>	Not-included
STEP 2						
<i>Survival ~ Species</i>	4	170.8	-81.4			
Survival ~ Species + Removal	5	172.8	-81.4	0.002	0.958	Not-included
Survival ~ Species + Mowing	5	172.8	-81.4	0.06	0.830	Not-included
Survival ~ Species + Fertilization	5	171.8	-80.9	1.009	0.335	Not-included
Survival ~ Species + Surrounding	5	156.1	-73.0	16.754	<b>0.001</b>	Included
STEP 3						
<i>Survival ~ Species + Surrounding</i>	5	156.1	-73.0			
Survival ~ Species + Surrounding + Removal	6	158.1	-73.0	0.003	0.954	Not-included
Survival ~ Species + Surrounding + Mowing	6	158.0	-73.0	0.062	0.839	Not-included
Survival ~ Species + Surrounding + Fertilization	6	157.1	-72.5	0.993	0.342	Not-included
STEP 4						
<i>Survival ~ Species + Surrounding</i>	5	156.1	-73.0			
Survival ~ Species + Surrounding + Species*Surrounding	7	156.8	-71.4	3.331	0.197	Not-included
<b>T1-T2</b>						
STEP 1						
<i>Survival ~ +1 (null model)</i>	2	101.5	-48.7			
Survival ~ Removal	3	102.8	-48.4	0.652	0.438	Not-included
Survival ~ Mowing	3	101.5	-47.8	1.939	0.1564	Not-included
Survival ~ Fertilization	3	103.5	-48.7	0.012	0.9504	Not-included
Survival ~ Species	4	88.5	-40.2	17.001	<b>0.001</b>	Included
Survival ~ Surrounding	3	102.5	-48.3	0.927	0.3425	Not-included
STEP 2						
<i>Survival ~ Species</i>	4	88.5	-40.2			
Survival ~ Species + Removal	5	89.6	-39.8	0.901	0.339	Not-included
Survival ~ Species + Mowing	5	88.1	-39.0	2.386	0.111	Not-included
Survival ~ Species + Fertilization	5	90.3	-40.1	0.193	0.669	Not-included
Survival ~ Species + Surrounding	5	90.5	-40.2	0.001	0.987	Not-included

**Electronic Appendix 3.** –Mean proportion of surviving individuals in experimental plots with different treatments. Abbreviations: Fert. –fertilization; Mow. – mowing; Remov. – removal of dominant species; SURR. – surrounding; g – gap; v – presence of vegetation; LYSIMACHIA –*Lysimachia vulgaris*; PLANTAGO –*Plantago lanceolata*; PRUNELLA –*Prunella vulgaris*; T0-T1 – first sampling period; T1-T2 – second sampling period (in x-marked cases no individuals were present at T1).

TREATMENT			SURR.	LYSIMACHIA		PLANTAGO		PRUNELLA	
Fert.	Mow.	Remov.		T0-T1	T1-T2	T0-T1	T1-T2	T0-T1	T1-T2
no	no	no	g	0.17	1.00	1.00	1.00	0.83	1.00
no	no	no	v	0.50	1.00	1.00	0.83	1.00	1.00
no	no	yes	g	0.00	x	1.00	1.00	0.67	1.00
no	no	yes	v	0.33	0.50	1.00	1.00	0.83	1.00
no	yes	no	g	0.00	x	1.00	1.00	0.83	1.00
no	yes	no	v	0.67	0.25	1.00	1.00	1.00	1.00
no	yes	yes	g	0.17	1.00	1.00	1.00	1.00	1.00
no	yes	yes	v	0.83	0.40	1.00	1.00	0.83	1.00
yes	no	no	g	0.33	1.00	1.00	1.00	1.00	1.00
yes	no	no	v	0.33	1.00	1.00	1.00	0.83	1.00
yes	no	yes	g	0.17	0.00	1.00	1.00	0.83	0.80
yes	no	yes	v	0.33	1.00	1.00	0.83	1.00	1.00
yes	yes	no	g	0.00	x	0.67	1.00	0.83	0.80
yes	yes	no	v	0.17	1.00	1.00	0.83	0.83	1.00
yes	yes	yes	g	0.00	x	1.00	1.00	0.83	0.60
yes	yes	yes	v	0.17	1.00	1.00	1.00	1.00	1.00
<b>Total</b>			<b>g</b>	<b>0.11</b>	<b>0.75</b>	<b>0.96</b>	<b>1.00</b>	<b>0.85</b>	<b>0.90</b>
			<b>v</b>	<b>0.42</b>	<b>0.77</b>	<b>1.00</b>	<b>0.94</b>	<b>0.92</b>	<b>1.00</b>

**Electronic Appendix 4.** – Complete model design and results of Mixed Effect Nested ANOVA for above-ground biomass.

	SS	Df <sub>num</sub>	Df <sub>den</sub>	F	p
Intercept	120.78	1	16.36	279.41	< <b>0.001</b>
Species	11.68	1	16.46	58.63	< <b>0.001</b>
Surrounding	28.14	1	16.20	97.58	< <b>0.001</b>
Fertilization	0.28	1	16.42	0.65	0.430
Mowing	1.04	1	16.41	2.41	0.139
Removal	0.76	1	16.42	1.77	0.200
Species*Surrounding	3.46	1	13.06	11.14	<b>0.005</b>
Species*Fertilization	0.04	1	16.60	0.20	0.660
Surrounding*Fertilization	1.89	1	16.36	6.57	<b>0.020</b>
Species*Mowing	0.00	1	16.62	0.00	0.981
Surrounding*Mowing	0.29	1	16.36	1.02	0.326
Fertilization*Mowing	0.04	1	16.38	0.10	0.755
Species*Removal	0.76	1	16.27	3.82	0.067
Surrounding*Removal	0.46	1	16.35	1.60	0.223
Fertilization*Removal	0.09	1	16.45	0.21	0.648
Mowing*Removal	0.07	1	16.46	0.17	0.680
Species*Surrounding*Fertilization	0.43	1	13.06	1.40	0.257
Species*Surrounding*Mowing	0.15	1	13.06	0.49	0.493
Species*Fertilization*Mowing	0.10	1	16.58	0.53	0.474
Surrounding*Fertilization*Mowing	0.42	1	16.28	1.45	0.244
Species*Surrounding*Removal	0.98	1	13.06	3.17	0.097
Species*Fertilization*Removal	0.06	1	16.56	0.32	0.575
Surrounding*Fertilization*Removal	0.12	1	16.45	0.42	0.521
Species*Mowing*Removal	0.48	1	16.55	2.41	0.139
Surrounding*Mowing*Removal	0.11	1	16.44	0.40	0.531
Fertilization*Mowing*Removal	1.43	1	16.44	3.30	0.087
Species*Surrounding*Fertilization*Mowing	0.10	1	13.06	0.34	0.569
Species*Surrounding*Fertilization*Removal	0.51	1	13.06	1.65	0.221
Species*Surrounding*Mowing*Removal	0.25	1	13.06	0.83	0.377
Species*Fertilization*Mowing*Removal	0.11	1	16.47	0.57	0.457
Surrounding*Fertilization*Mowing*Removal	0.09	1	16.44	0.32	0.575
Species*Surrounding*Fertilization*Mowing*Removal	0.00	1	13.06	0.02	0.867
Plot(Fertilization*Mowing*Removal)	7.06	16	1.86	2.45	0.341
Surrounding*Plot(Fertilization*Mowing*)	4.70	16	13.06	0.94	0.548
Species*Plot(Fertilization*Mowing*Removal)	3.23	16	13.08	0.65	0.794
Species*Surrounding*Plot(Fertilization*Mowing*Removal)	4.05	13	79.00	2.95	<b>0.001</b>
Error	8.35	79			

**Electronic Appendix 5.** – Complete model design and results of Mixed Effect Nested ANOVA for root-shoot ratio.

	SS	Df <sub>num</sub>	Df <sub>den</sub>	F	p
Intercept	37.24	1	16.40	368.27	<0.001
Species	2.15	1	16.43	30.21	<0.001
Surrounding	3.35	1	16.63	79.19	<0.001
Fertilization	0.01	1	16.43	0.12	0.737
Mowing	0.08	1	16.42	0.84	0.374
Removal	0.03	1	16.42	0.27	0.610
Species*Surrounding	0.51	1	13.13	10.18	0.007
Species*Fertilization	0.16	1	16.48	2.20	0.157
Surrounding*Fertilization	0.28	1	16.81	6.71	0.019
Species*Mowing	0.01	1	16.50	0.08	0.785
Surrounding*Mowing	0.07	1	16.81	1.75	0.204
Fertilization*Mowing	0.05	1	16.40	0.48	0.496
Species*Removal	0.01	1	16.32	0.14	0.714
Surrounding*Removal	0.12	1	16.79	2.83	0.111
Fertilization*Removal	0.01	1	16.45	0.15	0.708
Mowing*Removal	0.01	1	16.45	0.10	0.753
Species*Surrounding*Fertilization	0.13	1	13.12	2.61	0.130
Species*Surrounding*Mowing	0.01	1	13.13	0.11	0.745
Species*Fertilization*Mowing	0.02	1	16.48	0.24	0.632
Surrounding*Fertilization*Mowing	0.01	1	16.71	0.23	0.640
Species*Surrounding*Removal	0.15	1	13.12	3.08	0.103
Species*Fertilization*Removal	0.00	1	16.46	0.03	0.863
Surrounding*Fertilization*Removal	0.07	1	16.90	1.59	0.225
Species*Mowing*Removal	0.07	1	16.45	1.00	0.332
Surrounding*Mowing*Removal	0.05	1	16.89	1.18	0.292
Fertilization*Mowing*Removal	0.36	1	16.43	3.52	0.079
Species*Surrounding*Fertilization*Mowing	0.00	1	13.12	0.02	0.893
Species*Surrounding*Fertilization*Removal	0.13	1	13.13	2.71	0.124
Species*Surrounding*Mowing*Removal	0.01	1	13.12	0.29	0.600
Species*Fertilization*Mowing*Removal	0.00	1	16.42	0.00	0.956
Surrounding*Fertilization*Mowing*Removal	0.00	1	16.88	0.06	0.808
Species*Surrounding*Fertilization*Mowing*Removal	0.06	1	13.12	1.21	0.291
Plot(Fertilization*Mowing*Removal)	1.65	16	6.21	1.57	0.297
Surrounding*Plot(Fertilization*Mowing*)	0.68	16	13.12	0.86	0.619
Species*Plot(Fertilization*Mowing*Removal)	1.16	16	13.17	1.46	0.248
Species*Surrounding*Plot(Fertilization*Mowing*Removal)	0.65	13	79.00	1.44	0.161
Error	2.73	79			

**Electronic Appendix 6.** – Mean above-ground biomass values of individuals (g; SE) in experimental plots with different treatments. Abbreviations: Fert. –fertilization; Mow. – mowing; Remov. – removal of dominant species; SURR. – surrounding: g – gap; v – presence of vegetation; PLANTAGO –*Plantago lanceolata*; PRUNELLA –*Prunella vulgaris*; Abovg. – above-ground biomass; Belowg. – below-ground biomass.

TREATMENT			SURR.	PLANTAGO		PRUNELLA	
Fert.	Mow.	Remov.		Abovg.	Belowg.	Abovg.	Belowg.
no	no	no	g	1.28±0.31	0.16±0.03	0.31±0.14	0.06±0.02
no	no	no	v	0.29±0.11	0.06±0.01	0.07±0.02	0.03±0.01
no	no	yes	g	1.15±0.44	0.17±0.06	0.41±0.17	0.09±0.03
no	no	yes	v	0.14±0.11	0.04±0.02	0.04±0.02	0.02±0.01
no	yes	no	g	0.54±0.16	0.1±0.02	0.36±0.2	0.09±0.04
no	yes	no	v	0.23±0.04	0.06±0.01	0.06±0.02	0.03±0.01
no	yes	yes	g	3.26±0.8	0.3±0.05	0.34±0.11	0.08±0.02
no	yes	yes	v	0.11±0.05	0.04±0.02	0.09±0.06	0.03±0.02
yes	no	no	g	0.92±0.11	0.15±0.03	0.07±0.05	0.02±0.01
yes	no	no	v	0.05±0.01	0.02±0.01	0.04±0.01	0.02±0.01
yes	no	yes	g	1.27±0.15	0.19±0.03	0.12±0.09	0.03±0.02
yes	no	yes	v	0.1±0.04	0.03±0.01	0.04±0.02	0.02±0.01
yes	yes	no	g	0.9±0.11	0.16±0.02	0.55±0.13	0.11±0.02
yes	yes	no	v	0.13±0.04	0.03±0.01	0.07±0.02	0.03±0.01
yes	yes	yes	g	0.92±0.2	0.12±0.03	0.3±0.17	0.07±0.02
yes	yes	yes	v	0.04±0.02	0.02±0.01	0.03±0.01	0.02±0.01



**Electronic Appendix 7.** – Stepwise selection results for models (GLMMs) for *Plantago lanceolata* flowering.

Term	Df	AIC	logLik	Likelihood ratio test statistic	P-values based on parametric bootstrap	Choice of the term
STEP 1						
<i>Flowering ~ +1 (null model)</i>	2	105.1	-50.5			
Flowering ~ Removal	3	106.2	-50.1	0.847	0.364	Not-included
Flowering ~ Mowing	3	106.8	-50.4	0.211	0.671	Not-included
Flowering ~ Fertilization	3	106.8	-50.4	0.211	0.690	Not-included
Flowering ~ Surrounding	3	77.8	-35.9	29.233	<b>0.002</b>	Included
STEP 2						
<i>Flowering ~ Surrounding</i>	3	77.8	-35.9			
Flowering ~ Surrounding + Removal	4	78.8	-35.4	1.062	0.350	Not-included
Flowering ~ Surrounding + Mowing	4	79.6	-35.8	0.264	0.695	Not-included
Flowering ~ Surrounding+ Fertilization	4	79.6	-35.8	0.264	0.686	Not-included

**Electronic Appendix 8.** – Mean proportion of flowering *Plantago lanceolata* individuals (out of the surviving individuals) in experimental plots with different treatments. Abbreviations: Fert. – fertilization; Mow. – mowing; Remov. – removal of dominant species; SURR. – surrounding: g – gap; v – presence of vegetation.

TREATMENT			SURR.	PROP. FLOWERING INDIVIDUALS
Fert.	Mow.	Remov.		
no	no	no	g	0.67
no	no	no	v	0.00
no	no	yes	g	0.33
no	no	yes	v	0.17
no	yes	no	g	0.17
no	yes	no	v	0.00
no	yes	yes	g	0.67
no	yes	yes	v	0.00
yes	no	no	g	0.83
yes	no	no	v	0.00
yes	no	yes	g	0.50
yes	no	yes	v	0.00
yes	yes	no	g	0.33
yes	yes	no	v	0.00
yes	yes	yes	g	0.67
yes	yes	yes	v	0.00
			<b>g</b>	<b>0.52</b>
<b>Total</b>			<b>v</b>	<b>0.02</b>