



# Supplementary material of “Simulation of Multi-Species Plant Communities in Perturbed and Nutrient-Limited Grasslands: Development of the Growth Model ModVege”

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## 1 ModVege model

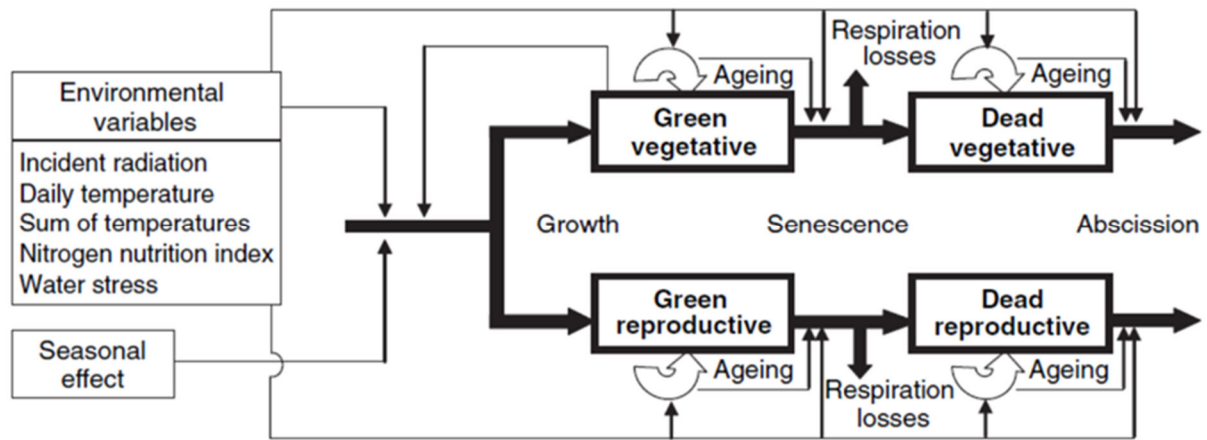


Figure S1. Overview of the ModVege model [25].

## 2 CoSMo suitability functions

### 2.1 Grazing (animal preferences) and mowing (days for restarting growth)

$$SfLiking_i(t) = \begin{cases} 0 & \text{if cut or during } SL_i \\ L_i \cdot (1 + [(2 \cdot SCP_i(t) - 3) \cdot SCP_i(t)^2]) & \text{if grazing} \\ 1 & \text{otherwise} \end{cases}$$

$L_i$  is the animal liking coefficient, ranging from 0 (highest liking) to 1 (lowest liking). A shock length ( $SL$ ) corresponds to the ability in terms of number of days to restart after cutting or grazing, computed by:

$$SL_i = \left\lceil 48 \cdot (f_{restart,i} - 1)^2 + 2 \right\rceil$$

where  $f_{restart,i}$  is the restart capacity of group/species  $i$ , 1 indicating the highest restart capacity and 0 the lowest.

### 2.2 Phenology

$$SfPhenology_i(t) = \begin{cases} 0 & \text{if annual species, which reached maturity or self-seeding} \\ 1 & \text{otherwise} \end{cases}$$

### 2.3 Air temperature

$$SfTemperature_i(t) = \begin{cases} 0 & \text{if } T(t) < T_{0,i} \text{ or } T(t) \geq 40 \\ \frac{T(t) - T_{0,i}}{T_{1,i} - T_{0,i}} & \text{if } T_{0,i} \leq T(t) < T_{1,i} \\ 1 & \text{if } T_{1,i} \leq T(t) < T_{2,i} \\ \frac{40 - T(t)}{40 - T_{2,i}} & \text{if } T_{2,i} \leq T(t) < 40 \end{cases}$$

$T(t)$  is the current air temperature ( $^{\circ}\text{C}$ ).

#### 2.4 Light interception

$$SfRad_i(t) = 0.5 + 0.25 \cdot \left( \frac{LAI_{max,i} - LAI_{community}(t)}{LAI_{max,i} + LAI_{community}(t)} + \frac{H_{max,i} - H_{community}(t)}{H_{max,i} + H_{community}(t)} \right)$$

$LAI_{max,i}$  is the maximum leaf area index for group/species  $i$  ( $\text{m}^2 \text{m}^{-2}$ ),  $LAI_{community}(t)$  is the current leaf area index for the community ( $\text{m}^2 \text{m}^{-2}$ ),  $H_{max,i}$  is the maximum height for group/species  $i$  (m) and  $H_{community}(t)$  is the current height for the community (m).

The current leaf area index for the community is calculated as follows:

$$LAI_{community}(t) = SLA_{community} * \frac{BM_{GV}(t)}{10} * PercentLAM_{community}$$

where  $SLA_i$  is the specific leaf area of group/species  $i$  ( $\text{m}^2 \text{g}^{-1}$ ),  $PercentLAM_{community}$  is the percentage of laminae in the green vegetative compartment of group/species  $i$  (0-1),  $BM(t)$  is the biomass at time  $t$  of all compartments ( $\text{kg DM ha}^{-1}$ ),  $BD_i$  is the mean bulk density of all compartments for group/species  $i$  ( $\text{g DM m}^{-3}$ ) and  $BM_{GV}$  is the biomass at time  $t$  of the green vegetative compartment ( $\text{kg DM ha}^{-1}$ ), calculated as follows:

$$H_{community}(t) = \frac{BM(t)}{BD_{community}} \cdot 10$$

#### 2.5 Water availability

$$SfWater_i(t) = \frac{SfPAW_i(t) + SfRoots_i(t)}{2}$$

$SfPAW_i(t)$  is the factor representing the effect of water availability for group/species  $i$  (0-1, unitless), calculated as follows:

$$SfPAW_i(t) = \max \left( 0; \frac{DT_i - 1}{DT_i} + \frac{SWC(t)}{DT_i} \right)$$

where  $DT_i$  is the drought tolerance of group/species  $i$  (0-1, unitless, the higher the value the higher the tolerance).

$SWC(t)$  is the current soil water content in the rooted zone simulated for the community at time step  $t$  and expressed as percentage of plant available water ( $PAW = \text{volumetric } SWC \text{ at field capacity } [FC] - \text{volumetric } SWC \text{ at permanent wilting point } [PWP]$ ).

$SfRoots_i(t)$  is the root deepening potential for group/species  $i$  (0-1, unitless), calculated as follows:

$$SfRoots_i(t) = \max \left( 0; \frac{RD_{\max,i} - RD_i(t)}{RD_{\max,i}} \right)$$

where  $RD_{\max,i}$  is the maximum rooting depth for group/species  $i$  (cm) and  $RD_i(t)$  is the current rooting depth for group/species  $i$  (cm). The latter is derived by the shoot-root ratio of each species  $i$  ( $shootRootRatio_i$ ) and the current height (cm) for group/species  $i$  ( $H_i(t)$ ):

$$RD_i(t) = shootRootRatio_i \cdot H_i(t)$$

## 2.6 Nitrogen availability

$$SfNitrogen_i(t) = \max (0; \min(SfNAv_i(t); SfNReq_i(t)))$$

$SfNAv_i(t)$  is the factor representing the nitrogen availability for group/species  $i$  (0-1, unitless), calculated as:

$$SfNAv_i(t) = \begin{cases} SMF(t) \cdot \frac{TF(t)}{8.1225} & \text{if not legume} \\ 1 & \text{if legume} \end{cases}$$

where  $SMF(t)$  is the soil moisture factor at time  $t$ , and  $TF(t)$  is the temperature response at time  $t$ . The term  $SMF(t)$  is calculated as:

$$SMF(t) = \begin{cases} 0 & \text{if } SWC < SWC_{WP} \\ \frac{SWC(t) - SWC_{WP}}{0.08} & \text{if } SWC_{WP} \leq SWC < SWC_{WP} + 0.08 \\ 1 & \text{if } SWP + 0.08 \leq SWC < SWC_S - 0.1 \\ 0.6 + 4 \cdot (SWC_S - SWC(t)) & \text{if } SWC_S - 0.1 \leq SWC \leq SWC_S \end{cases}$$

where  $SWC_S$  is the soil water content at saturation ( $m^3 m^{-3}$ ),  $SWC_{WP}$  is the soil water content at wilting point ( $m^3 m^{-3}$ ) and  $SWC(t)$  is the water content of the topsoil (0-0.3 m depth) at time  $t$  ( $m^3 m^{-3}$ ), estimated from the water reserve ( $WR_i(t)$ ) and the water holding capacity for group/species  $i$  ( $WHC_i$ ) both in mm:

$$SWC(t) = \frac{WR_i(t) \cdot SWC_S}{WHC_i}$$

under the assumption that

$$\frac{WR_i(t)}{WHC_i} = \frac{SWC(t)}{SWC_S}.$$

The term  $TF(t)$  is equal to (0-1, unitless):

$$TF(t) = 2.85 \cdot \frac{T(t)-20}{10}$$

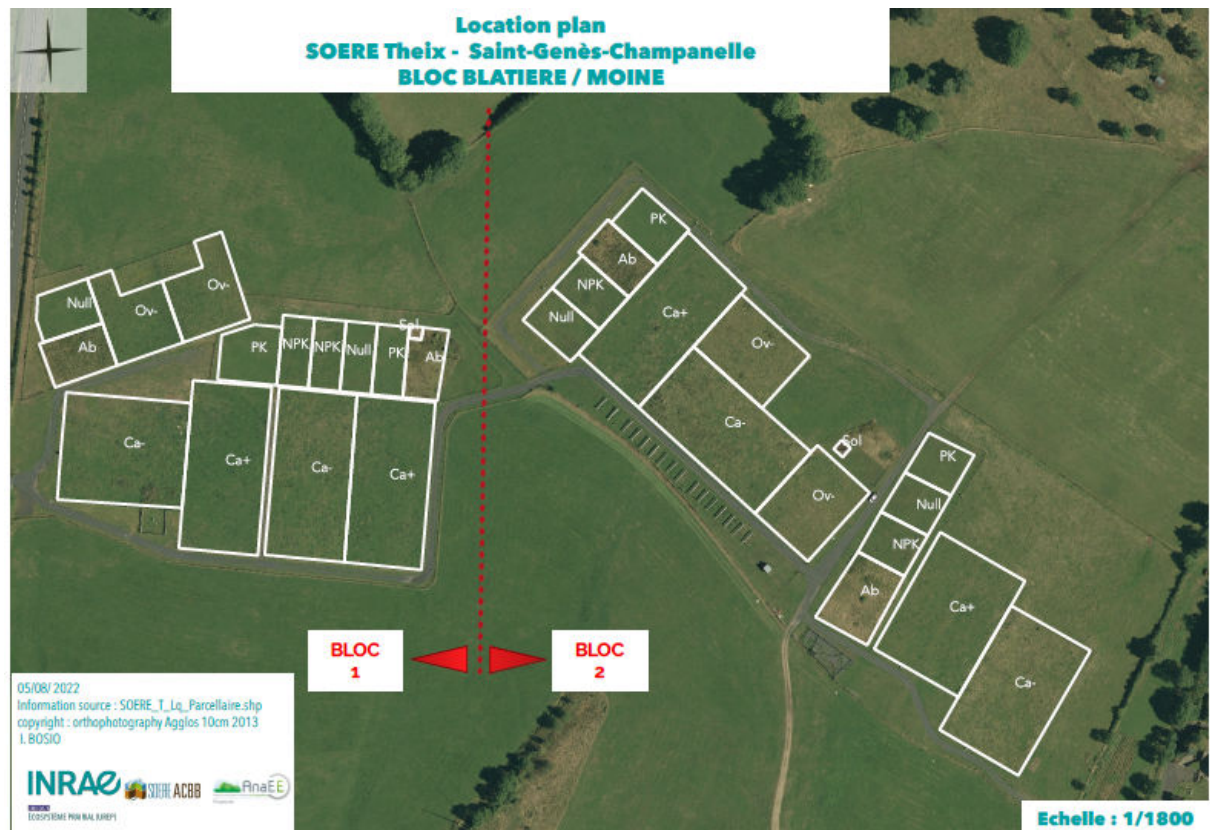
where  $T(t)$  is the current temperature (°C).

The term  $SfNReq_i(t)$  is calculated as:

$$SfNReq_i(t) = \begin{cases} \frac{RGRLAI_{community}(t) - RGRLAI_{i,max}}{1} \cdot \frac{LNC_{i,opt}}{2} & \text{if vegetative development} \\ & \text{elsewhere} \end{cases}$$

where  $RGRLAI_{i,max}$  is the maximum relative growth rate of green leaf area index for group/species  $i$  ( $m^2 m^{-2} d^{-1}$ ),  $LNC_{i,opt}$  is the optimal leaf N concentration of group/species  $i$  (g N  $m^{-2}$ ) and  $RGRLAI_{community}(t)$  is the relative growth rate of green leaf area index for the community at time  $t$  ( $m^2 m^{-2} d^{-1}$ ), equal to  $LAI_{community}(t) - LAI_{community}(t-1)$ .

### 3 Study-site



**Figure S2.** Map of the study-site. Located in the French commune of Saint-Genès-Champanelle, the site of Theix (45° 43' N, 03° 01' E, 880 m a.s.l.) belongs to the SOERE-ACBB platform (<http://www.soere-acbb.com>) and includes block 1 (*BLOC Blatière*) and block 2 (*BLOC Moine*). Each treatment is repeated twice in each block. Data from the NPK (fully fertilised and mown), NULL (unfertilised and mown) and Ab (abandoned) plots were used as a block mean, while data from the PK (partly fertilised and mown) plots and the cattle (Bo-, Bo+) and sheep (Ov-) grazed plots were not used in this study.

#### 4 Experimental data

**Table S1.** Total number of plant species detected in the study period (2006-2018) in three treatments NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks.

Block \ Treatment	NPK	Null	Ab
1	35	51	38
2	40	49	35

**Table S2.** Dry matter biomass data (kg ha<sup>-1</sup>) collected from 2006 to 2018 in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (doy: day of year). Grey cells indicate the determination at the end of the winter.

Year	Block 1						Block 2					
	Sampling date (doy)	NPK	Sampling date (doy)	Null	Sampling date (doy)	Ab	Sampling date (doy)	NPK	Sampling date (doy)	Null	Sampling date (doy)	Ab
2006	147	5731	142	3646	144	3253	142	6012	142	2818	144	3558
	200	4311	200	2409	200	6742	199	3721	199	1450	199	4576
	289	2283	289	1231	289	5668	289	2597	289	995	289	4615
2007	60	139	60	64	-	-	60	94	60	103	-	-
	142	6882	142	4590	143	4318	142	5920	142	5035	143	4325
	206	4326	206	2985	213	5781	206	3880	206	2973	213	6822
2008	288	3281	288	1982	-	-	288	2770	288	1559	-	-
	78	139	78	64	76	5038	78	52	78	29	76	3468
	170	8961	171	6110	172	8104	171	8097	171	6031	172	5942
2009	217	4584	218	1832	218	8117	217	3414	217	2472	218	5833
	286	1016	287	403	287	5119	287	495	287	134	287	4163
	71	40	71	10	70	5200	71	27	71	5	70	4752
2010	145	6311	145	3277	-	-	145	6048	145	3849	-	-
	201	3097	201	1263	-	-	201	1821	201	673	-	-
	285	2511	285	619	-	-	285	1953	285	425	-	-
2011	61	11	61	0	63	6921	61	2	61	0	63	4724
	145	6069	145	2695	146	5147	145	6012	145	2232	145	5066
	201	4700	201	2874	201	7735	201	3720	201	1688	201	8062
2012	286	3363	286	1508	-	-	286	1753	286	953	-	-
	54	21	54	6	54	7033	54	14	54	0	54	5487
	144	5880	144	2854	144	6057	144	4568	144	1745	144	4830
2013	200	1601	200	498	201	5674	200	1171	200	450	201	3868
	283	2193	283	642	-	-	283	2468	283	571	-	-
	68	28	68	12	65	4996	68	69	68	18	65	3643
2014	135	4958	144	2727	145	4670	145	4822	145	1913	145	5234
	198	3558	199	2301	201	8560	199	3342	199	1380	200	8228
	288	1175	289	221	289	5603	289	768	289	197	289	7225
2015	71	4	71	2	63	4296	71	4	71	0	63	3789
	148	4430	151	2222	149	5476	151	5853	149	1521	149	6340
	197	3093	198	1461	198	6655	198	2199	198	733	198	7004
2016	288	3338	288	1590	290	6798	288	2392	288	883	290	7635
	55	161	55	21	57	4611	55	63	55	3	57	3775
	145	5565	146	2609	147	6903	146	4680	146	2401	147	6796
2017	202	3009	203	1538	203	6756	203	2113	203	1442	203	6592
	286	2200	287	843	287	5306	287	2247	287	878	287	4124
	57	129	57	17	65	3498	57	85	57	8	65	2258
2018	145	6933	146	3404	148	5500	146	5213	146	2867	148	3736
	201	444	202	180	202	4057	202	136	202	110	202	3652
	285	1735	287	735	286	4462	286	1470	286	542	286	3670
2019	57	23	57	0	57	3020	57	29	57	0	57	1620



2017	145	6077	146	2239	146	3548	146	4957	146	2026	146	3462
	201	3898	202	1798	202	4790	202	3023	202	1496	202	5132
	291	196	292	84	292	5620	292	215	292	152	292	4121
	58	6	58	0	58	3142	58	7	58	2	58	2133
	141	4640	142	1346	142	3347	142	4688	142	1737	142	2784
	205	3332	206	1669	205	4499	206	3043	206	1464	205	4312
	289	843	290	111	289	4597	290	586	290	166	289	3636
	60	6	60	0	60	2093	60	2	60	0	60	1852
	143	5026	143	1417	143	4397	143	4439	143	1594	143	4342
	204	3673	204	1021	204	3006	204	1906	204	717	204	3657
	288	507	288	111	288	2868	288	350	288	63	288	2316

**Table S3.** Relative abundance of plant (grass) functional types (A, B, b) in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (doy: day of year)

Year	Functional typology	Block 1						Block 2					
		NPK		Null		Ab		NPK		Null		Ab	
		Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance
2006	A		0.10		0.10		0.12		0.66		0.57		0.56
	B	124	0.40	123	0.60	124	0.33	122	0.24	123	0.26	123	0.19
	b		0.50		0.30		0.55		0.10		0.17		0.25
2007	A		0.08		0.20		0.16		0.51		0.49		0.56
	B	124	0.60	124	0.58	123	0.40	122	0.38	124	0.32	123	0.31
	b		0.32		0.22		0.44		0.11		0.19		0.13
2008	A		0.06		0.15		0.25		0.60		0.64		0.67
	B	121	0.44	124	0.52	121	0.32	119	0.28	121	0.16	118	0.23
	b		0.50		0.34		0.43		0.12		0.20		0.10
2009													
2010	A		0.04		0.21		0.29		0.52		0.49		0.59
	B	118	0.32	117	0.47	131	0.32	117	0.28	117	0.26	131	0.30
	b		0.64		0.32		0.39		0.20		0.25		0.11
2011	A		0.07		0.19		0.21		0.46		0.41		0.50
	B	124	0.42	123	0.46	130	0.37	122	0.34	123	0.31	132	0.40
	b		0.51		0.35		0.42		0.20		0.28		0.10
2012	A		0.07		0.26		0.24		0.44		0.42		0.53
	B	124	0.44	124	0.40	127	0.38	123	0.34	124	0.30	126	0.40
	b		0.49		0.34		0.38		0.22		0.28		0.07
2013	A		0.07		0.19		0.24		0.40		0.33		0.57
	B	127	0.43	128	0.49	137	0.32	126	0.40	126	0.38	136	0.30
	b		0.50		0.32		0.44		0.20		0.29		0.13
2014	A		0.05		0.25		0.22		0.39		0.31		0.59
	B	124	0.47	125	0.47	134	0.38	121	0.39	124	0.38	134	0.32
	b		0.48		0.28		0.40		0.22		0.31		0.09
2015	A		0.10		0.25		0.25		0.48		0.29		0.62
	B	127	0.44	129	0.40	136	0.33	126	0.24	127	0.31	133	0.29
	b		0.46		0.35		0.42		0.28		0.40		0.09
2016	A		0.03		0.27		0.22		0.43		0.28		0.65
	B	120	0.49	124	0.44	139	0.41	120	0.34	123	0.33	126	0.27
	b		0.48		0.29		0.37		0.23		0.39		0.08
2017	A		0.03		0.23		0.28		0.40		0.31		0.74
	B	123	0.48	124	0.52	130	0.26	122	0.34	123	0.34	129	0.17
	b		0.49		0.25		0.46		0.26		0.35		0.09
2018	A		0.08		0.24		0.35		0.39		0.26		0.75
	B	120	0.45	122	0.55	158	0.32	117	0.34	120	0.49	125	0.15
	b		0.48		0.21		0.33		0.27		0.25		0.10



**Table S4.** Relative abundance of plant species (represented by grasses, legumes and forbs) in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (doy: day of year). Dashes (-) indicate absence of the species or mean relative abundance below the threshold value of 0.04 (4%).

Taxonomic group	Species	Year	Block 1						Block 2					
			NPK		Null		Ab		NPK		Null		Ab	
			Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance	Survey date (doy)	Relative abundance
Grass	<i>Alopecurus pratensis</i>	2006	-	-	-	-	123	0.06	122	0.15	123	0.19	123	0.49
		2007	-	-	-	-	124	0.09	122	0.11	124	0.12	124	0.40
		2008	-	-	-	-	121	0.17	119	0.19	121	0.14	121	0.56
		2009	-	-	-	-	-	-	-	-	-	-	-	-
		2010	-	-	-	-	117	0.22	117	0.27	117	0.15	117	0.48
		2011	-	-	-	-	123	0.16	122	0.23	123	0.10	123	0.45
		2012	-	-	-	-	124	0.20	123	0.27	124	0.14	124	0.49
		2013	-	-	-	-	126	0.20	126	0.26	126	0.12	126	0.43
		2014	-	-	-	-	124	0.18	121	0.26	124	0.09	124	0.52
		2015	-	-	-	-	127	0.20	126	0.27	127	0.04	127	0.42
		2016	-	-	-	-	123	0.16	120	0.25	123	0.07	123	0.42
		2017	-	-	-	-	123	0.18	122	0.25	123	0.09	123	0.44
		2018	-	-	-	-	120	0.19	117	0.23	120	0.08	120	0.45
	<i>Arrhenatherum elatius</i>	2006	-	-	-	-	123	0.02	-	-	-	-	123	0.02
		2007	-	-	-	-	124	0.00	-	-	-	-	124	0.07
		2008	-	-	-	-	121	0.00	-	-	-	-	121	0.05
		2009	-	-	-	-	-	-	-	-	-	-	-	-
		2010	-	-	-	-	117	0.04	-	-	-	-	117	0.13
		2011	-	-	-	-	123	0.01	-	-	-	-	123	0.12
		2012	-	-	-	-	124	0.01	-	-	-	-	124	0.11
		2013	-	-	-	-	126	0.08	-	-	-	-	126	0.10
		2014	-	-	-	-	124	0.07	-	-	-	-	124	0.11
		2015	-	-	-	-	127	0.10	-	-	-	-	127	0.10
		2016	-	-	-	-	123	0.10	-	-	-	-	123	0.07
		2017	-	-	-	-	123	0.07	-	-	-	-	123	0.07
		2018	-	-	-	-	120	0.13	-	-	-	-	120	0.09
	<i>Dactylis glomerata</i>	2006	-	-	-	-	123	0.03	-	-	-	-	-	-
		2007	-	-	-	-	124	0.05	-	-	-	-	-	-
		2008	-	-	-	-	121	0.09	-	-	-	-	-	-
		2009	-	-	-	-	-	-	-	-	-	-	-	-
		2010	-	-	-	-	117	0.11	-	-	-	-	-	-
		2011	-	-	-	-	123	0.12	-	-	-	-	-	-
		2012	-	-	-	-	124	0.08	-	-	-	-	-	-

	<i>Elymus repens</i>	2013	-	-	-	-	126	0.01	-	-	-	-	-	-
		2014	-	-	-	-	124	0.05	-	-	-	-	-	-
		2015	-	-	-	-	127	0.04	-	-	-	-	-	-
		2016	-	-	-	-	123	0.03	-	-	-	-	-	-
		2017	-	-	-	-	123	0.01	-	-	-	-	-	-
		2018	-	-	-	-	120	0.00	-	-	-	-	-	-
		2006	124	0.27	123	0.10	123	0.43	-	-	-	-	123	0.05
		2007	124	0.19	124	0.09	124	0.43	-	-	-	-	124	0.04
		2008	121	0.29	124	0.11	121	0.40	-	-	-	-	121	0.00
		2009						-						
		2010	118	0.40	117	0.09	117	0.36	-	-	-	-	117	0.08
		2011	124	0.36	123	0.07	123	0.36	-	-	-	-	123	0.10
		2012	124	0.34	124	0.06	124	0.34	-	-	-	-	124	0.07
		2013	127	0.34	128	0.07	126	0.37	-	-	-	-	126	0.09
		2014	124	0.31	125	0.02	124	0.35	-	-	-	-	124	0.09
		2015	127	0.31	129	0.03	127	0.36	-	-	-	-	127	0.07
		2016	120	0.31	124	0.08	123	0.27	-	-	-	-	123	0.07
		2017	123	0.30	124	0.07	123	0.32	-	-	-	-	123	0.07
		2018	120	0.33	122	0.05	120	0.19	-	-	-	-	120	0.08
	<i>Festuca arundinacea</i>	2006	124	0.04	123	0.11	123	0.16	-	-	123	0.05	-	-
		2007	124	0.16	124	0.07	124	0.16	-	-	124	0.06	-	-
		2008	121	0.12	124	0.13	121	0.11	-	-	121	0.04	-	-
		2009						-						
		2010	118	0.09	117	0.10	117	0.09	-	-	117	0.05	-	-
		2011	124	0.12	123	0.11	123	0.12	-	-	123	0.06	-	-
		2012	124	0.11	124	0.09	124	0.12	-	-	124	0.06	-	-
		2013	127	0.12	128	0.10	126	0.02	-	-	126	0.06	-	-
		2014	124	0.11	125	0.11	124	0.04	-	-	124	0.07	-	-
		2015	127	0.12	129	0.16	127	0.03	-	-	127	0.06	-	-
		2016	120	0.12	124	0.21	123	0.04	-	-	123	0.09	-	-
		2017	123	0.10	124	0.22	123	0.01	-	-	123	0.12	-	-
		2018	120	0.13	122	0.19	120	0.02	-	-	120	0.10	-	-
	<i>Holcus lanatus</i>	2006	-	-	123	0.01	-	-	122	0.06	-	-	123	0.18
		2007	-	-	124	0.01	-	-	122	0.11	-	-	124	0.31
		2008	-	-	124	0.04	-	-	119	0.16	-	-	121	0.23
		2009						-						
		2010	-	-	117	0.03	-	-	117	0.08	-	-	117	0.03
		2011	-	-	123	0.05	-	-	122	0.09	-	-	123	0.01
		2012	-	-	124	0.07	-	-	123	0.06	-	-	124	0.02
		2013	-	-	128	0.07	-	-	126	0.08	-	-	126	0.00
		2014	-	-	125	0.10	-	-	121	0.07	-	-	124	0.00
		2015	-	-	129	0.10	-	-	126	0.11	-	-	127	0.01
		2016	-	-	124	0.14	-	-	120	0.07	-	-	123	0.01
		2017	-	-	124	0.12	-	-	122	0.04	-	-	123	0.00
		2018	-	-	122	0.13	-	-	117	0.07	-	-	120	0.00
	<i>Lolium multiflorum</i>	2006	124	0.00	-	-	-	-	-	-	-	-	-	-
		2007	124	0.14	-	-	-	-	-	-	-	-	-	-
		2008	121	0.14	-	-	-	-	-	-	-	-	-	-
		2009						-						
		2010	118	0.04	-	-	-	-	-	-	-	-	-	-

<i>Lolium perenne</i>	2011	124	0.04	-	-	-	-	-	-	-	-	-	-
	2012	124	0.05	-	-	-	-	-	-	-	-	-	-
	2013	127	0.08	-	-	-	-	-	-	-	-	-	-
	2014	124	0.12	-	-	-	-	-	-	-	-	-	-
	2015	127	0.12	-	-	-	-	-	-	-	-	-	-
	2016	120	0.14	-	-	-	-	-	-	-	-	-	-
	2017	123	0.12	-	-	-	-	-	-	-	-	-	-
	2018	120	0.11	-	-	-	-	-	-	-	-	-	-
	2006	-	-	-	-	-	-	122	0.17	123	0.13	-	-
	2007	-	-	-	-	-	-	122	0.17	124	0.16	-	-
	2008	-	-	-	-	-	-	119	0.16	121	0.20	-	-
	2009	-	-	-	-	-	-	-	-	-	-	-	-
	2010	-	-	-	-	-	-	117	0.05	117	0.09	-	-
	2011	-	-	-	-	-	-	122	0.04	123	0.10	-	-
	2012	-	-	-	-	-	-	123	0.08	124	0.12	-	-
	2013	-	-	-	-	-	-	126	0.04	126	0.08	-	-
	2014	-	-	-	-	-	-	121	0.05	124	0.12	-	-
	2015	-	-	-	-	-	-	126	0.03	127	0.13	-	-
	2016	-	-	-	-	-	-	120	0.03	123	0.15	-	-
	2017	-	-	-	-	-	-	122	0.03	123	0.15	-	-
	2018	-	-	-	-	-	-	117	0.03	120	0.11	-	-
<i>Poa pratensis</i>	2006	124	0.26	123	0.26	123	0.30	122	0.16	123	0.14	123	0.25
	2007	124	0.19	124	0.22	124	0.28	122	0.18	124	0.17	124	0.18
	2008	121	0.14	124	0.17	121	0.23	119	0.14	121	0.03	121	0.15
	2009	-	-	-	-	-	-	-	-	-	-	-	-
	2010	118	0.11	117	0.12	117	0.17	117	0.17	117	0.16	117	0.23
	2011	124	0.18	123	0.14	123	0.22	122	0.24	123	0.16	123	0.24
	2012	124	0.18	124	0.14	124	0.23	123	0.26	124	0.20	124	0.25
	2013	127	0.18	128	0.16	126	0.25	126	0.29	126	0.24	126	0.25
	2014	124	0.20	125	0.17	124	0.21	121	0.29	124	0.22	124	0.13
	2015	127	0.18	129	0.10	127	0.14	126	0.13	127	0.16	127	0.14
	2016	120	0.20	124	0.17	123	0.17	120	0.22	123	0.21	123	0.14
<i>Poa trivialis</i>	2017	123	0.22	124	0.22	123	0.19	122	0.24	123	0.21	123	0.12
	2018	120	0.17	122	0.19	120	0.06	117	0.23	120	0.23	120	0.05
	2006	-	-	123	0.02	-	-	-	-	-	-	-	-
	2007	-	-	124	0.02	-	-	-	-	-	-	-	-
	2008	-	-	124	0.09	-	-	-	-	-	-	-	-
	2009	-	-	-	-	-	-	-	-	-	-	-	-
	2010	-	-	117	0.06	-	-	-	-	-	-	-	-
	2011	-	-	123	0.10	-	-	-	-	-	-	-	-
	2012	-	-	124	0.11	-	-	-	-	-	-	-	-
	2013	-	-	128	0.10	-	-	-	-	-	-	-	-
	2014	-	-	125	0.11	-	-	-	-	-	-	-	-
<i>Trisetum</i>	2015	-	-	129	0.18	-	-	-	-	-	-	-	-
	2016	-	-	124	0.06	-	-	-	-	-	-	-	-
	2017	-	-	124	0.03	-	-	-	-	-	-	-	-
	2018	-	-	122	0.01	-	-	-	-	-	-	-	-
	2006	-	-	-	-	-	-	122	0.05	123	0.10	-	-
<i>Trisetum</i>	2007	-	-	-	-	-	-	122	0.03	124	0.10	-	-
	2008	-	-	-	-	-	-	119	0.04	121	0.09	-	-

Legume	<i>Trifolium repens</i>	2009						-					
		2010	-	-	-	-	-	117	0.06	117	0.08	-	-
		2011	-	-	-	-	-	122	0.07	123	0.07	-	-
		2012	-	-	-	-	-	123	0.07	124	0.11	-	-
		2013	-	-	-	-	-	126	0.09	126	0.10	-	-
		2014	-	-	-	-	-	121	0.12	124	0.10	-	-
		2015	-	-	-	-	-	126	0.17	127	0.16	-	-
		2016	-	-	-	-	-	120	0.15	123	0.20	-	-
		2017	-	-	-	-	-	122	0.16	123	0.18	-	-
		2018	-	-	-	-	-	117	0.18	120	0.15	-	-
		2006	-	-	123	0.16		-	-	123	0.09		
		2007	-	-	124	0.28		-	-	124	0.15		
		2008	-	-	124	0.19		-	-	121	0.26		
		2009						-					
		2010	-	-	117	0.30		-	-	117	0.19		
		2011	-	-	123	0.26		-	-	123	0.25		
		2012	-	-	124	0.26		-	-	124	0.14		
		2013	-	-	128	0.25		-	-	126	0.13		
		2014	-	-	125	0.25		-	-	124	0.15		
		2015	-	-	129	0.16		-	-	127	0.22		
		2016	-	-	124	0.02		-	-	123	0.07		
		2017	-	-	124	0.05		-	-	123	0.07		
		2018	-	-	122	0.13		-	-	120	0.07		
Forb	<i>Achillea millefolium</i>	2006	-	-	123	0.05	-	-	122	0.12	123	0.05	
		2007	-	-	124	0.03	-	-	122	0.13	124	0.06	
		2008	-	-	124	0.01	-	-	119	0.08	121	0.05	
		2009						-					
		2010	-	-	117	0.03	-	-	117	0.06	117	0.04	
		2011	-	-	123	0.03	-	-	122	0.04	123	0.07	
		2012	-	-	124	0.05	-	-	123	0.02	124	0.04	
		2013	-	-	128	0.05	-	-	126	0.05	126	0.07	
		2014	-	-	125	0.06	-	-	121	0.03	124	0.08	
		2015	-	-	129	0.07	-	-	126	0.07	127	0.08	
		2016	-	-	124	0.10	-	-	120	0.07	123	0.07	
		2017	-	-	124	0.12	-	-	122	0.06	123	0.06	
		2018	-	-	122	0.16	-	-	117	0.10	120	0.12	
		2006	-	-	-	-	123	0.00	-	-	-	-	-
		2007	-	-	-	-	124	0.00	-	-	-	-	-
		2008	-	-	-	-	121	0.00	-	-	-	-	-
		2009						-					
		2010	-	-	-	-	117	0.00	-	-	-	-	-
		2011	-	-	-	-	123	0.00	-	-	-	-	-
		2012	-	-	-	-	124	0.00	-	-	-	-	-
		2013	-	-	-	-	126	0.01	-	-	-	-	-
		2014	-	-	-	-	124	0.04	-	-	-	-	-
		2015	-	-	-	-	127	0.03	-	-	-	-	-
		2016	-	-	-	-	123	0.14	-	-	-	-	-
		2017	-	-	-	-	123	0.11	-	-	-	-	-
		2018	-	-	-	-	120	0.26	-	-	-	-	-
	<i>Galium aparine</i>												

<i>Stellaria media</i>	2006	124	0.10	-	-	-	-	122	0.08	-	-	-	-
	2007	124	0.03	-	-	-	-	122	0.02	-	-	-	-
	2008	121	0.01	-	-	-	-	119	0.01	-	-	-	-
	2009						-						
	2010	118	0.02	-	-	-	-	117	0.03	-	-	-	-
	2011	124	0.01	-	-	-	-	122	0.05	-	-	-	-
	2012	124	0.02	-	-	-	-	123	0.03	-	-	-	-
	2013	127	0.03	-	-	-	-	126	0.04	-	-	-	-
	2014	124	0.03	-	-	-	-	121	0.01	-	-	-	-
	2015	127	0.01	-	-	-	-	126	0.00	-	-	-	-
	2016	120	0.05	-	-	-	-	120	0.08	-	-	-	-
	2017	123	0.14	-	-	-	-	122	0.13	-	-	-	-
	2018	120	0.13	-	-	-	-	117	0.06	-	-	-	-
<i>Taraxacum officinale</i>	2006	124	0.32	123	0.29	-	-	122	0.22	123	0.25	-	-
	2007	124	0.29	124	0.28	-	-	122	0.25	124	0.18	-	-
	2008	121	0.31	124	0.26	-	-	119	0.21	121	0.19	-	-
	2009						-						
	2010	118	0.35	117	0.27	-	-	117	0.29	117	0.23	-	-
	2011	124	0.28	123	0.23	-	-	122	0.24	123	0.19	-	-
	2012	124	0.29	124	0.22	-	-	123	0.20	124	0.20	-	-
	2013	127	0.24	128	0.20	-	-	126	0.15	126	0.19	-	-
	2014	124	0.23	125	0.18	-	-	121	0.17	124	0.17	-	-
	2015	127	0.25	129	0.20	-	-	126	0.21	127	0.15	-	-
	2016	120	0.18	124	0.21	-	-	120	0.12	123	0.14	-	-
	2017	123	0.12	124	0.18	-	-	122	0.09	123	0.12	-	-
	2018	120	0.13	122	0.14	-	-	117	0.12	120	0.14	-	-
<i>Urtica dioica</i>	2006	-	-	-	-	123	0.00	-	-	-	-	123	0.01
	2007	-	-	-	-	124	0.00	-	-	-	-	124	0.01
	2008	-	-	-	-	121	0.00	-	-	-	-	121	0.01
	2009						-						
	2010	-	-	-	-	117	0.01	-	-	-	-	117	0.05
	2011	-	-	-	-	123	0.02	-	-	-	-	123	0.08
	2012	-	-	-	-	124	0.03	-	-	-	-	124	0.05
	2013	-	-	-	-	126	0.05	-	-	-	-	126	0.13
	2014	-	-	-	-	124	0.05	-	-	-	-	124	0.16
	2015	-	-	-	-	127	0.10	-	-	-	-	127	0.26
	2016	-	-	-	-	123	0.10	-	-	-	-	123	0.30
	2017	-	-	-	-	123	0.10	-	-	-	-	123	0.30
	2018	-	-	-	-	120	0.15	-	-	-	-	120	0.33



## 5 Model parameters

**Table S5.** ModVege parameters common to all functional types or species [25].

Parameter	Description	Block 1			Block 2		
		NPK	Null	Ab	NPK	Null	Ab
WR	Water reserve (mm)	60	60	60	60	60	60
Alpha_PAR	Light extinction coefficient	0.044	0.044	0.044	0.044	0.044	0.044
Tbase	Base temperature subtracted each day for the calculation of plant development (°C)	0	0	0	0	0	0
T0	Temperature threshold for photosynthesis activation (°C)	4	4	4	4	4	4
T1	Optimal temperature for growth (°C)	10	10	10	10	10	10
T2	Temperature threshold for growth decline (°C)	20	20	20	20	20	20
rho_GV	Bulk density of GV (g m <sup>-3</sup> )	850	850	850	850	850	850
percentLAM	Fraction of leaf of laminae in GV	0.68	0.68	0.68	0.68	0.68	0.68
Rho_GR	Bulk density of GR (g m <sup>-3</sup> )	300	300	300	300	300	300
K_VS	Senescence coefficient DV (°C d <sup>-1</sup> )	0.002	0.002	0.002	0.002	0.002	0.002
Kl_VS	Abscission coefficient DV (°C d <sup>-1</sup> )	0.001	0.001	0.001	0.001	0.001	0.001
Rho_VS	Bulk density of DV (g m <sup>-3</sup> )	500	500	500	500	500	500
K_RS	Senescence coefficient DR (°C d <sup>-1</sup> )	0.001	0.001	0.001	0.001	0.001	0.001

Kl_RS	Abscission coefficient of DR ( $^{\circ}\text{C d}^{-1}$ )	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Rho_RS	Bulk density of DR ( $\text{g m}^{-3}$ )	150	150	150	150	150	150
gammaGV	Respiratory C loss during senescence of GV	0.4	0.4	0.4	0.4	0.4	0.4
gammaGR	Respiratory C loss during senescence of GR	0.2	0.2	0.2	0.2	0.2	0.2
RUEmax	Maximum radiation use efficiency ( $\text{g MJ}^{-1}$ )	3	3	3	3	3	3
maxOMDgv	Maximum OMD for GV	0.9	0.9	0.9	0.9	0.9	0.9
minOMDgv	Minimum OMD for GV	0.75	0.75	0.75	0.75	0.75	0.75
maxOMDgr	Maximum OMD for GR	0.9	0.9	0.9	0.9	0.9	0.9
minOMDgr	Minimum OMD for GR	0.65	0.65	0.65	0.65	0.65	0.65
meanOMDdv	Mean OMD for DV	0.4	0.4	0.4	0.4	0.4	0.4
meanOMDdr	Mean OMD for DR	0.2	0.2	0.2	0.2	0.2	0.2

GV: green vegetative compartment; DV: dry vegetative compartment; GR: green reproductive compartment; DR: dry reproductive compartment; OMD: organic matter digestibility.

**Table S6.** Functional type-specific parameters of ModVege [25].

Functional type	Parameter	Description	Block 1			Block 2		
			NPK	Null	Ab	NPK	Null	Ab
A	ST1	Onset of the reproductive phase (°C-d)	600	600	600	600	600	600
	ST2	End of the reproductive phase (°C-d)	1200	1200	1200	1200	1200	1200
	IN	Soil nutritional index	0.85	0.85	0.85	0.85	0.85	0.85
	WHC	Water holding capacity (mm)	200	200	200	200	200	200
	MinSEA	Maximum value of the winter growth factor	0.8	0.8	0.8	0.8	0.8	0.8
	MaxSEA	Maximum value of the summer growth factor	1.2	1.2	1.2	1.2	1.2	1.2
	W_GV	Initial biomass of GV (kg ha <sup>-1</sup> )	1219.96	1219.96	1219.96	1219.96	1219.96	1219.96
	SLA	Specific leaf area (m <sup>2</sup> g <sup>-1</sup> )	0.044	0.044	0.044	0.044	0.044	0.044
	LLS	Leaf lifespan (°C-d)	500	500	500	500	500	500
	W_GR	Biomass of GR (kg ha <sup>-1</sup> )	151.13	151.13	151.13	151.13	151.13	151.13
	W_DV	Biomass of DV (kg ha <sup>-1</sup> )	645.6	645.6	645.6	645.6	645.6	645.6
	W_DR	Biomass of DR (kg ha <sup>-1</sup> )	62.35	62.35	62.35	62.35	62.35	62.35
	Ini_AGE_GV	Initial value of age (°C-d)	267.76	267.76	267.76	267.76	267.76	267.76
	Ini_AGE_GR	Initial value of age (°C-d)	2006.55	2006.55	2006.55	2006.55	2006.55	2006.55
	Ini_AGE_DV	Initial value of age °C-d)	288.35	288.35	288.35	288.35	288.35	288.35

	Ini_AGE_DR	Initial value of age (°C-d)	1461.04	1461.04	1461.04	1461.04	1461.04	1461.04
	ST1	Onset of the reproductive phase (°C-d)	700	700	700	700	700	700
	ST2	End of the reproductive phase (°C-d)	1350	1350	1350	1350	1350	1350
	IN	Soil nutritional index	0.90	0.90	0.90	0.90	0.90	0.90
	WHC	Water holding capacity (mm)	100	100	100	100	100	100
	MinSEA	Maximum value of the winter growth factor	0.7	0.7	0.7	0.7	0.7	0.7
	MaxSEA	Maximum value of the summer growth factor	1.3	1.3	1.3	1.3	1.3	1.3
B	W_GV	Initial biomass of GV (kg ha <sup>-1</sup> )	1070.33	1070.33	1070.33	1070.33	1070.33	1070.33
	SLA	Specific leaf area (m <sup>2</sup> g <sup>-1</sup> )	0.025	0.025	0.025	0.025	0.025	0.025
	LLS	Leaf lifespan (°C-d)	800	800	800	800	800	800
	W_GR	Biomass of GR (kg ha <sup>-1</sup> )	218.08	218.08	218.08	218.08	218.08	218.08
	W_DV	Biomass of DV (kg ha <sup>-1</sup> )	493.70	493.70	493.70	493.70	493.70	493.70
	W_DR	Biomass of DR (kg ha <sup>-1</sup> )	80.64	80.64	80.64	80.64	80.64	80.64
	Ini_AGE_GV	Initial value of age (°C-d)	310.79	310.79	310.79	310.79	310.79	310.79
	Ini_AGE_GR	Initial value of age (°C-d)	1936.77	1936.77	1936.77	1936.77	1936.77	1936.77
	Ini_AGE_DV	Initial value of age °C-d)	330.92	330.92	330.92	330.92	330.92	330.92
	Ini_AGE_DR	Initial value of age (°C-d)	1339.93	1339.93	1339.93	1339.93	1339.93	1339.93
b	ST1	Onset of the reproductive phase (°C-d)	600	600	600	600	600	600

ST2	End of the reproductive phase (°C-d)	1100	1100	1100	1100	1100	1100
IN	Soil nutritional index	0.9	0.9	0.9	0.9	0.9	0.9
WHC	Water holding capacity (mm)	100	100	100	100	100	100
MinSEA	Maximum value of the winter growth factor	0.7	0.7	0.7	0.7	0.7	0.7
MaxSEA	Maximum value of the summer growth factor	1.3	1.3	1.3	1.3	1.3	1.3
W_GV	Initial biomass of GV (kg ha <sup>-1</sup> )	1364.65	1364.65	1364.65	1364.65	1364.65	1364.65
SLA	Specific leaf area (m <sup>2</sup> g <sup>-1</sup> )	0.035	0.035	0.035	0.035	0.035	0.035
LLS	Leaf lifespan (°C-d)	830	830	830	830	830	830
W_GR	Biomass of GR (kg ha <sup>-1</sup> )	155.16	155.16	155.16	155.16	155.16	155.16
W_DV	Biomass of DV (kg ha <sup>-1</sup> )	588.85	588.85	588.85	588.85	588.85	588.85
W_DR	Biomass of DR (kg ha <sup>-1</sup> )	63.29	63.29	63.29	63.29	63.29	63.29
Ini_AGE_GV	Initial value of age (°C-d)	300.77	300.77	300.77	300.77	300.77	300.77
Ini_AGE_GR	Initial value of age (°C-d)	2012.35	2012.35	2012.35	2012.35	2012.35	2012.35
Ini_AGE_DV	Initial value of age °C-d)	316.61	316.61	316.61	316.61	316.61	316.61
Ini_AGE_DR	Initial value of age (°C-d)	1477.65	1477.65	1477.65	1477.65	1477.65	1477.65

\* A: *Alopecurus pratensis*, *Holcus lanatus*, *Lolium multiflorum*, *Lolium perenne*; B: *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca arundinacea*, *Poa pratensis*; b: *Elymus repens*, *Trisetum flavescens*, *Poa trivialis*. Source: [24].

**Table S7.** ModVege parameters specific to each plant species (forbs and legume), either from the calibration performed in this study (Cal), based on published ranges, or from the published literature (Lit). Sources: [20, 25, 60–62].

Parameter	Description	Reference	Forbs				Legume	
			<i>Achillea millefolium</i>	<i>Galium aparine</i>	<i>Stellaria media</i>	<i>Taraxacum officinale</i>	<i>Urtica dioica</i>	<i>Trifolium repens</i>
ST1	Onset of the reproductive phase (°C-d)	Cal	850	800	600	600	800	800
ST2	End of the reproductive phase (°C-d)	Cal	1550	1200	1100	1100	1200	1200
IN	Soil nutritional index	Cal	0.8	0.9	0.9	0.9	0.9	0.9
WHC	Water holding capacity (mm)	Cal	100	100	100	100	100	100
MinSEA	Maximum value of the winter growth factor	Cal	0.7	0.7	0.7	0.7	0.7	0.7
MaxSEA	Maximum value of the summer growth factor	Cal	1.3	1.3	1.3	1.3	1.3	1.3
W_GV	Initial biomass of GV (kg ha <sup>-1</sup> )	Cal	1000	1144	1000	1000	1144	1000
SLA	Specific leaf area (m <sup>2</sup> g <sup>-1</sup> )	Cal/Lit	0.017	0.048	0.030	0.048	0.023	0.018
LLS	Leaf lifespan (°C-d)	Cal	800	800	800	800	800	800
W_GR	Biomass of GR (kg ha <sup>-1</sup> )	Cal	150	196	150	150	196	150
W_DV	Biomass of DV (kg ha <sup>-1</sup> )	Cal	500	535	500	500	535	500
W_DR	Biomass of DR (kg ha <sup>-1</sup> )	Cal	60	75	60	60	75	60
Ini_AGE_GV	Initial value of age (°C-d)	Cal	357.28	302	357.28	357.28	302	357.28
Ini_AGE_GR	Initial value of age (°C-d)	Cal	1783.87	1961	1783.87	1783.87	1961	1783.87
Ini_AGE_DV	Initial value of age (°C-d)	Cal	376.45	321	376.45	376.45	321	376.45

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Ini_AGE_DR	Initial value of age (°C-d)	Cal	1209.46	1383	1209.46	1209.46	1383	1209.46
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**Table S8.** CoSMo parameters common to all functional types or species (Cal: calibrated; Def: set to default value).

Parameters	Description	Reference	Block 1			Block 2		
			NPK	Null	Ab	NPK	Null	Ab
IncOpt	Optimal leaf nitrogen concentration (g m <sup>-2</sup> )	Cal	2	2	2	2	2	2
AnimalLiking	Liking of grazing animals for a plant type or species	Def	0	0	0	0	0	0
RestartCapacity	Capacity to restart after mowing	Cal	0.8	0.8	0.8	0.8	0.8	0.8



**Table S9.** Functional type specific CoSMo parameters (calibrated).

Functional type	Parameter	Description	Block 1			Block 2		
			NPK	Null	Ab	NPK	Null	Ab
A	Legume	Legume species	False	False	False	False	False	False
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	0.52	0.52	0.52	0.52	0.52	0.52
	DT	Drought tolerance	0.59	0.64	0.68	0.64	0.58	0.75
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	12.04	12.04	12.04	12.04	12.04	12.04
	MaxHeight	Maximum canopy height (m)	1.5	1.5	1.5	1.5	1.5	1.5
	MaxRootingDepth	Maximum rooting depth (m)	1	1	1	1	1	1
	Shoot/root ratio	Shoot-root ratio	0.67	0.67	0.67	0.67	0.67	0.67
B	Legume	Legume species	False	False	False	False	False	False
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	0.39	0.39	0.39	0.39	0.39	0.39
	DT	Drought tolerance	0.63	0.63	0.60	0.62	0.61	0.58
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	9.12	9.12	9.12	9.12	9.12	9.12
	MaxHeight	Maximum canopy height (m)	1.64	1.64	1.64	1.64	1.64	1.64
	MaxRootingDepth	Maximum rooting depth (m)	1.4	1.4	1.4	1.3	1.3	1.3
	Shoot/root ratio	Shoot-root ratio	0.85	0.85	0.85	0.79	0.79	0.79
b	Legume	Legume species	False	False	False	False	False	False

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rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	0.55	0.55	0.55	0.55	0.55	0.55
DT	Drought tolerance	0.64	0.60	0.62	0.58	0.57	0.60
LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	12.77	12.77	12.77	12.77	12.77	12.77
MaxHeight	Maximum canopy height (m)	1.74	1.74	1.74	1.74	1.74	1.74
MaxRootingDepth	Maximum rooting depth (m)	1	1	1	1	1	1
Shoot/root ratio	Shoot-root ratio	0.57	0.57	0.57	0.57	0.57	0.57

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**Table S10.** CoSMo parameters specific to each plant species (calibrated).

Taxonomic group	Species	Parameter	Description	Reference	Block 1			Block 2		
					NPK	Null	Ab	NPK	Null	Ab
Grass	<i>Alopecurus pratensis</i>	Legume	Legume species	-	-	-	False	False	False	False
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	0.52	0.52	0.52	0.52
		DT	Drought tolerance	Cal	-	-	0.70	0.54	0.55	0.73
		LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	5	5	5	5
		MaxHeight	Maximum canopy height (m)	Cal	-	-	1.1	1.1	1.1	1.1
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	1.2	1.2	1.2	1.2
		Shoot/root ratio	Shoot-root ratio	Cal	-	-	1.09	1.09	1.09	1.09
	<i>Arrhenatherum elatius</i>	Legume	Legume species	-	-	-	False	-	-	False
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	0.39	-	-	0.39
		DT	Drought tolerance	Cal	-	-	0.50	-	-	0.40
		LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	4.5	-	-	5
		MaxHeight	Maximum canopy height (m)	Cal	-	-	1.2	-	-	1.1
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	1.5	-	-	1.2
		Shoot/root ratio	Shoot-root ratio	Cal	-	-	1.25	-	-	1.09
Dactylis glomerata	<i>Dactylis glomerata</i>	Legume	Legume species	-	-	-	False	-	-	-

<i>Elymus repens</i>	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	0.39	-	-	-
	DT	Drought tolerance	Cal	-	-	0.73	-	-	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	5	-	-	-
	MaxHeight	Maximum canopy height (m)	Cal	-	-	1.1	-	-	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	1.1	-	-	-
	Shoot/root ratio	Shoot-root ratio	Cal	-	-	1	-	-	-
	Legume	Legume species	-	False	False	False	-	-	False
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.55	0.55	0.55	-	-	0.55
	DT	Drought tolerance	Cal	0.65	0.60	0.82	-	-	0.80
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	5	5	5	-	-	5
	MaxHeight	Maximum canopy height (m)	Cal	1	1	1	-	-	1
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1	1	1	-	-	1
	Shoot/root ratio	Shoot-root ratio	Cal	1	1	1	-	-	1
	Legume	Legume species	-	False	False	False	-	-	False
<i>Festuca arundinacea</i>	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.39	0.39	0.39	-	-	0.39
	DT	Drought tolerance	Cal	0.65	0.61	0.80	-	-	0.62
	LAI <sub>max</sub>	Maximum leaf area	Cal	5	5	5	-	-	5

<i>Holcus lanatus</i>		index (m <sup>2</sup> m <sup>-2</sup> )							
	MaxHeight	Maximum canopy height (m)	Cal	1	1	1	-	-	1
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1	1	1	-	-	1
	Shoot/root ratio	Shoot-root ratio	Cal	1	1	1	-	-	1
	Legume	Legume species	-	-	False	False	False	-	-
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	0.52	0.52	0.52	-	-
	DT	Drought tolerance	Cal	-	0.84	0.80	0.87	-	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	6	6	6	-	-
	MaxHeight	Maximum canopy height (m)	Cal	-	0.4	0.4	0.4	-	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	-	1	1	1	-	-
<i>Lolium multiflorum</i>	Shoot/root ratio	Shoot-root ratio	Cal	-	2.5	2.5	2.5	-	-
	Legume	Legume species	-	False	-	-	-	-	-
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.52	-	-	-	-	-
	DT	Drought tolerance	Cal	0.73	-	-	-	-	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	5	-	-	-	-	-
	MaxHeight	Maximum canopy height (m)	Cal	0.8	-	-	-	-	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1	-	-	-	-	-

<i>Lolium perenne</i>	Shoot/root ratio	Shoot-root ratio	Cal	1.25	-	-	-	-	-
	Legume	Legume species	-	-	-	-	False	False	-
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	-	0.52	0.52	-
	DT	Drought tolerance	Cal	-	-	-	0.65	0.72	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	-	5	5	-
	MaxHeight	Maximum canopy height (m)	Cal	-	-	-	0.8	0.8	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	-	1	1	-
	Shoot/root ratio	Shoot-root ratio	Cal	-	-	-	1.25	1.25	-
<i>Poa pratensis</i>	Legume	Legume species	-	False	False	False	False	False	False
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.39	0.39	0.39	0.39	0.39	0.39
	DT	Drought tolerance	Cal	0.63	0.60	0.82	0.62	0.63	0.79
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	5.5	5	5	5	5	5
	MaxHeight	Maximum canopy height (m)	Cal	1	1	1	1	1	1
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1	1	1	1	1	1
	Shoot/root ratio	Shoot-root ratio	Cal	1	1	1	1	1	1
	Legume	Legume species	-	-	False	-	-	-	-
<i>Poa trivialis</i>	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	0.55	-	-	-	-

Legume	<i>Trisetum flavescens</i>	DT	Drought tolerance	Cal	-	0.72	-	-	-	-
		LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	5	-	-	-	-
		MaxHeight	Maximum canopy height (m)	Cal	-	0.7	-	-	-	-
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	1	-	-	-	-
		Shoot/root ratio	Shoot-root ratio	Cal	-	1.43	-	-	-	-
		Legume	Legume species	-	-	-	-	False	False	-
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	-	0.55	0.55	-
		DT	Drought tolerance	Cal	-	-	-	0.68	0.68	-
		LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	-	5	5	-
		MaxHeight	Maximum canopy height (m)	Cal	-	-	-	0.8	0.8	-
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	-	1	1	-
		Shoot/root ratio	Shoot-root ratio	Cal	-	-	-	1.25	1.25	-
	<i>Trifolium repens</i>	Legume	Legume species	-	-	True	-	-	True	-
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	0.5	-	-	0.5	-
		DT	Drought tolerance	Cal	-	0.76	-	-	0.83	-
		LAI <sub>max</sub>	Maximum leaf area	Cal	-	6	-	-	5	-

Forb	<i>Achillea millefolium</i>		index (m <sup>2</sup> m <sup>-2</sup> )						
		MaxHeight	Maximum canopy height (m)	Cal	-	0.3	-	-	0.3
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	1.2	-	-	1.2
		Shoot/root ratio	Shoot-root ratio	Cal	-	4	-	-	4
		Legume	Legume species	-	-	False	-	False	False
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	0.5	-	0.5	0.5
		DT	Drought tolerance	Cal	-	0.67	-	0.65	0.67
	<i>Galium aparine</i>	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	5	-	5	5
		MaxHeight	Maximum canopy height (m)	Cal	-	0.8	-	0.8	0.8
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	1.1	-	1.1	1.1
		Shoot/root ratio	Shoot-root ratio	Cal	-	1.38	-	1.38	1.38
		Legume	Legume species	-	-	-	False	-	-
		rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	0.44	-	-
		DT	Drought tolerance	Cal	-	-	0.55	-	-
	<i>Galium aparine</i>	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	6	-	-
		MaxHeight	Maximum canopy height (m)	Cal	-	-	1.2	-	-
		MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	1.2	-	-



<i>Stellaria media</i>	Shoot/root ratio	Shoot-root ratio	Cal	-	-	1	-	-	-
	Legume	Legume species	-	False	-	-	False	-	-
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.4	-	-	0.4	-	-
	DT	Drought tolerance	Cal	0.71	-	-	0.60	-	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	5	-	-	5	-	-
	MaxHeight	Maximum canopy height (m)	Cal	0.8	-	-	0.8	-	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1	-	-	1	-	-
	Shoot/root ratio	Shoot-root ratio	Cal	1.25	-	-	1.25	-	-
<i>Taraxacum officinale</i>	Legume	Legume species	-	False	False	-	False	False	-
	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	0.5	0.5	-	0.5	0.5	-
	DT	Drought tolerance	Cal	0.85	0.80	-	0.83	0.80	-
	LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	6	6	-	6	6	-
	MaxHeight	Maximum canopy height (m)	Cal	0.4	0.4	-	0.4	0.4	-
	MaxRootingDepth	Maximum rooting depth (m)	Cal	1.2	1.2	-	1.2	1.2	-
	Shoot/root ratio	Shoot-root ratio	Cal	3	3	-	3	3	-
	Legume	Legume species	-	-	-	False	-	-	False
<i>Urtica dioica</i>	rgrLAI <sub>max</sub>	Maximum LAI increase (m <sup>2</sup> d <sup>-1</sup> )	Cal	-	-	0.44	-	-	0.44

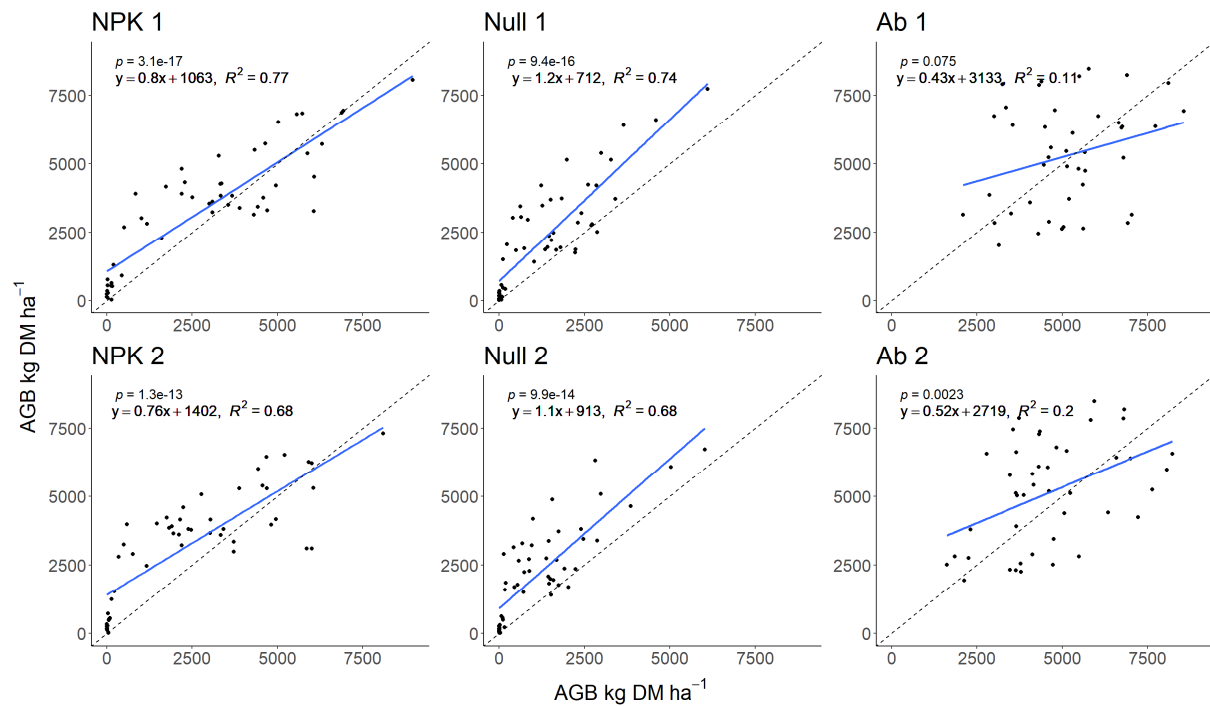
DT	Drought tolerance	Cal	-	-	0.75	-	-	0.79
LAI <sub>max</sub>	Maximum leaf area index (m <sup>2</sup> m <sup>-2</sup> )	Cal	-	-	6	-	-	6
MaxHeight	Maximum canopy height (m)	Cal	-	-	1	-	-	1
MaxRootingDepth	Maximum rooting depth (m)	Cal	-	-	1	-	-	1
Shoot/root ratio	Shoot-root ratio	Cal	-	-	1	-	-	1

## 6 Results

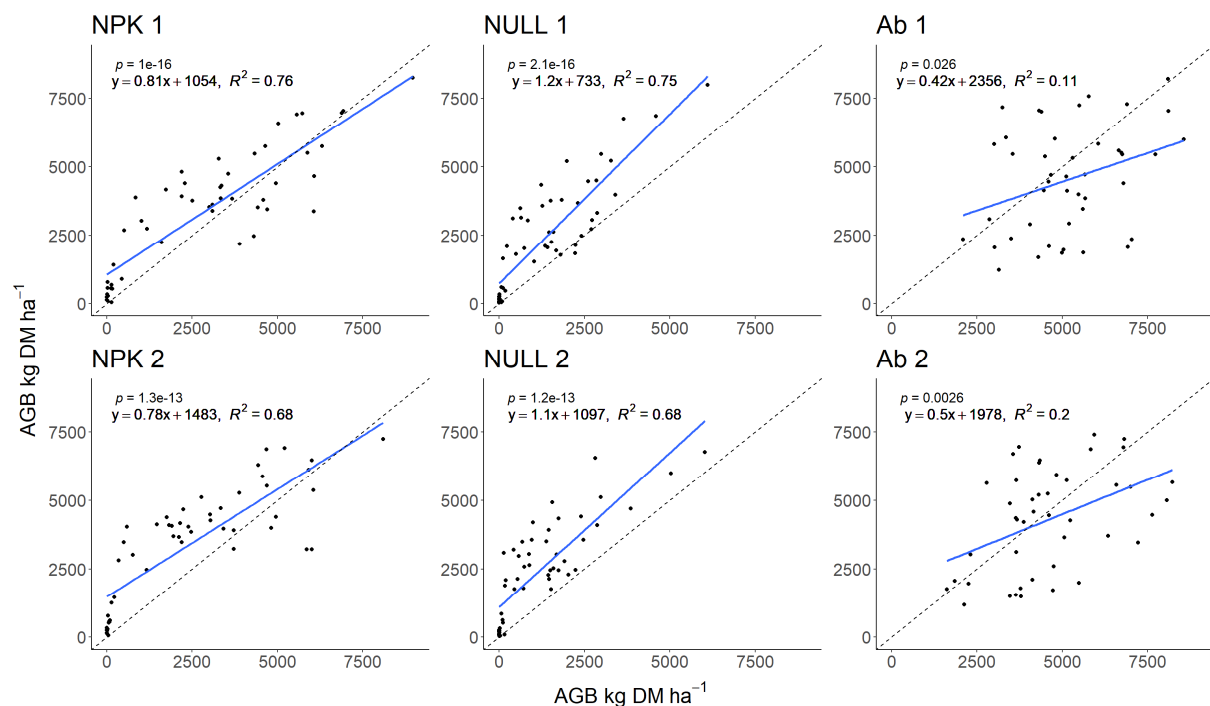
### 6.1 Performance metrics and scatterplots

**Table S11.** Performance metrics for the evaluation of alternative modelling solutions for the simulation of aboveground biomass. *R*=linear correlation coefficient; *RRMSE*: root mean square error; *RMAE*: root mean absolute error; *CRM*: coefficient of residual mass.

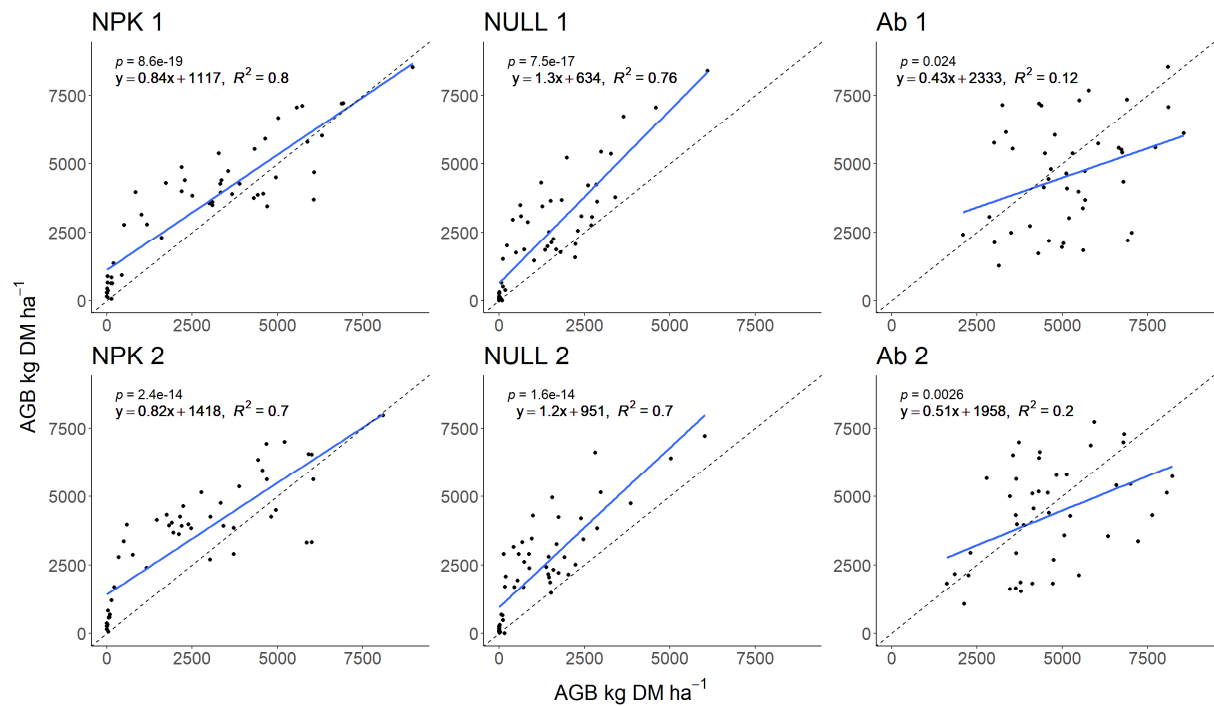
Modelling solution	Treatment	<i>R</i>	<i>RRMSE</i> (%)	<i>RMAE</i> (%)	<i>CRM</i>	Mean of observations (kg DM ha <sup>-1</sup> )	Mean of simulations (kg DM ha <sup>-1</sup> )
ModVege	Block 1						
	NPK	0.88	42.9	33.5	-0.17	2871	3354
	Null	0.72	125.1	82.9	-0.69	1397	2363
	Ab	0.34	39.5	31.4	-0.03	5204	5381
	Block 2						
	NPK	0.82	60.7	49.0	-0.33	2448	3257
	Null	0.82	120.0	87.9	-0.86	1186	2211
	Ab	0.45	42.2	36.4	-0.11	4617	5141
ModVege-CoSMo (FG)	Block 1						
	NPK	0.87	44.3	35.3	-0.18	2871	3377
	Null	0.87	106.4	78.1	-0.77	1397	2470
	Ab	0.33	40.7	33.2	0.12	5204	4539
	Block 2						
	NPK	0.82	64.7	53.4	-0.39	2448	3409
	Null	0.82	120.0	87.9	-0.86	1186	2210
	Ab	0.44	40.6	33.7	0.07	4617	4303
ModVege-CoSMo (Species)	Block 1						
	NPK	0.89	43.5	34.3	-0.23	2871	3534
	Null	0.87	103.3	74.6	-0.72	1397	2401
	Ab	0.34	40.6	33.5	0.12	5204	4575
	Block 2						
	NPK	0.84	63.8	52.2	-0.39	2448	3415
	Null	0.84	129.3	97.6	-0.97	1186	2336
	Ab	0.44	40.7	33.7	0.07	4617	4290



**Figure S3.** ModVege: comparison of simulated and observed aboveground biomass (AGB) in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (1, 2).



**Figure S4.** ModVege-CoSMo (plant functional groups): comparison of simulated and observed aboveground biomass (AGB) in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (1, 2).



**Figure S5.** ModVege-CoSMo (plant species): comparison of simulated and observed aboveground biomass (AGB) in three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (1, 2).

**Table S12.** Performance metrics for the evaluation of ModVege-CoSMo for the simulation of the relative abundance of plant (grass) functional types. *R*=linear correlation coefficient; *RRMSE*: root mean square error; *RMAE*: root mean absolute error; *CRM*: coefficient of residual mass.

Functional typology	Treatment	<i>R</i>	<i>RRMSE</i> (%)	<i>RMAE</i> (%)	<i>CRM</i>	Mean of observations	Mean of simulations
A	Block 1						
	NPK	0.53	28.7	22.0	-0.01	0.07	0.07
	Null	0.78	15.7	11.9	0.03	0.21	0.20
	Ab	0.76	16.5	13.8	-0.05	0.24	0.25
	Block 2						
	NPK	0.89	9.0	6.5	-0.03	0.47	0.49
	Null	0.89	15.3	10.5	0.05	0.40	0.37
	Ab	0.04	15.7	13.1	-0.08	0.59	0.64
B	Block 1						
	NPK	0.21	13.8	7.9	0.03	0.45	0.43
	Null	0.49	12.2	9.4	-0.02	0.49	0.50
	Ab	0.04	14.8	10.8	-0.04	0.35	0.36
	Block 2						
	NPK	0.31	16.3	10.6	0.03	0.33	0.32
	Null	0.48	23.8	18.9	-0.12	0.32	0.36
	Ab	0.26	35.4	30.4	0.18	0.27	0.22
b	Block 1						
	NPK	0.53	13.5	7.2	-0.03	0.49	0.50
	Null	0.12	16.1	13.7	0.02	0.30	0.29
	Ab	0.70	12.5	9.4	0.06	0.42	0.39
	Block 2						
	NPK	0.95	9.2	7.0	0.02	0.20	0.20
	Null	0.82	14.4	9.3	0.03	0.28	0.27
	Ab	0.28	36.1	32.0	-0.30	0.11	0.14
Community	Block 1						
	NPK	0.96	16.8	10.0	0.00	0.33	0.33
	Null	0.93	15.9	12.6	0.00	0.33	0.33
	Ab	0.85	14.4	10.9	0.00	0.33	0.33
	Block 2						
	NPK	0.95	12.8	8.9	0.00	0.33	0.33
	Null	0.74	21.0	14.9	0.00	0.33	0.33
	Ab	0.93	24.7	19.7	0.00	0.33	0.33

**Table S13.** Performance metrics for the evaluation of ModVege-CoSMo for the simulation of the relative abundance of plant species. *R*=linear correlation coefficient; *RRMSE*: root mean square error; *RMAE*: root mean absolute error; *CRM*: coefficient of residual mass.

Performance metric	Treatment	Grasses												Legumes	Forbs					Community	
		<i>Alopecurus pratensis</i>	<i>Arrhenatherum elatius</i>	<i>Dactylis glomerata</i>	<i>Elymus repens</i>	<i>Festuca arundinacea</i>	<i>Holcus lanatus</i>	<i>Lolium multiflorum</i>	<i>Lolium perenne</i>	<i>Poa pratensis</i>	<i>Poa trivialis</i>	<i>Trisetum flavescens</i>	Mena		<i>Trifolium repens</i>	<i>Achillea millefolium</i>	<i>Galium aparine</i>	<i>Stellaria media</i>	<i>Taraxacum officinale</i>		<i>Urtica dioica</i>
R	Block 1																				
	NPK	-	-	-	0.27	0.32	-	0.42	-	0.23	-	-	0.89	-	-	-	0.38	0.85	-	0.91	0.88
	Null	-	-	-	0.32	0.58	0.92	-	-	0.16	0.05	-	0.61	0.90	0.54	-	-	0.80	-	0.92	0.62
	Ab	0.50	0.87	0.76	0.86	0.91	-	-	-	0.76	-	-	0.91	-	-	0.73	-	-	0.57	0.64	0.89
	Block 2																				
	NPK	0.52	-	-	-	-	0.37	-	0.90	0.53	-	0.80	0.86	-	0.35	-	0.27	0.74	-	0.83	0.83
RRMSE (%)	Null	0.65	-	-	-	0.69	-	-	0.28	0.67	-	0.04	0.71	0.38	0.11	-	-	0.60	-	0.85	0.53
	Ab	0.11	0.44	-	0.15	-	-	-	-	0.48	-	-	0.91	-	-	-	-	-	0.82	0.82	0.87
	Block 1																				
	NPK	-	-	-	15.5	38.0	-	54.5	-	26.6	-	-	27.1	-	-	-	1344	16.2	-	36.7	30.1
	Null	-	-	-	50.5	51.2	44.7	-	-	45.5	75.7	-	42.8	62.2	84.8	-	-	12.4	-	30.2	52.2
	Ab	35.6	46.3	80.0	11.4	35.7	-	-	-	23.6	-	-	36.6	-	-	1424	-	-	84.3	116.4	42.2

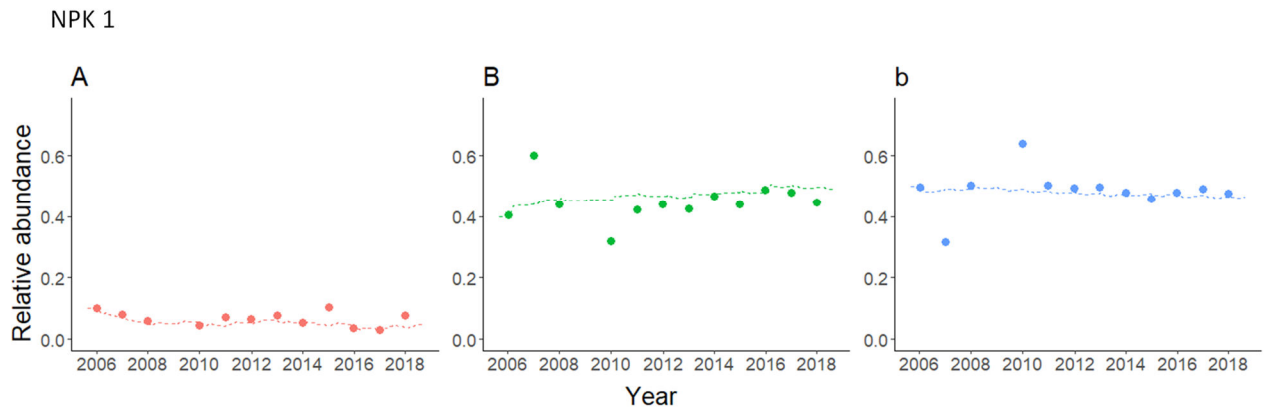
		NPK	28.4	-	-	-	-	37.5	-	34.2	21.2	-	41.2	33.3	-	63.3	-	114.7	31.1	-	51.3	37.5
		Null	38.6	-	-	-	56.2	-	-	24.1	24.9	-	36.4	33.3	76.5	36.4	-	-	22.8	-	27.3	27.9
		Ab	12.4	65.9	-	61.1	-	-	-	-	36.2	-	-	40.2	-	-	-	-	-	56.5	56.5	46.0
RMAE (%)	Block 1																					
	NPK	-	-	-	11.8	25.9		37.1		20.9	-	-	19.8	-	-	-	1250	12.6	-	31.1	23.2	
	Null	-	-	-	40.3	39.8	37.7	-	-	39.6	62.5	-	42.8	49.3	75.1	-	-	9.8	-	24.5	38.8	
	Ab	26.7	32.7	52.7	8.5	25.8	-	-	-	17.8	-	-	21.4	-	-	112.9		-	72.5	92.5	28.4	
	Block 2																					
	NPK	24.0	-	-	-	-	31.6	-	28.5	16.9	-	36.2	24.9	-	51.5	-	86.8	24.1	-	39.8	29.5	
	Null	34.1	-	-	-	36.1	-	-	18.9	17.1	-	27.4	24.8	62.1	27.0	-	-	18.0	-	20.4	20.3	
	Ab	8.0	60.9	-	45.9	-	-	-	28.0	-	-	25.6	-	-	-	-	-	-	50.1	50.1	28.5	
CRM	Block 1																					
	NPK	-	-	-	0.00	0.24	-	0.26	-	-0.18	-	-	0.04	-	-	-	-0.82	0.06	-	-0.08	0.00	
	Null	-	-	-	0.09	0.14	-0.08	-	-	-0.26	0.21	-	0.00	0.19	-0.65	-	-	0.00	-	-0.13	0.00	
	Ab	0.23	-0.18	0.36	0.06	0.15	-	-	-	-0.13	-	-	0.07	-	-	-0.92		-	-0.20	-0.56	0.00	
	Block 2																					
	NPK	0.19	-	-	-	-	0.00	-	0.00	-0.03	-	0.06	0.05	-	-0.48	-	0.87	-0.20	-	-0.11	0.00	
	Null	-0.18	-	-	-	0.23	-	-	-0.07	-0.08	-	0.09	-0.03	0.06	-0.15	-	-	0.10	-	0.03	0.00	
	Ab	-0.03	0.82	-	-0.45	-	-	-	-	0.04	-	-	0.05	-	-	-	-	-	-0.03	-0.03	0.00	
Mean/sum of observations	Block 1																					
	NPK	-	-	-	0.31	0.11	-	0.09	-	0.19	-	-	0.70	-	-	-	0.05	0.25	-	0.30	1.00	
	Null	-	-	-	0.07	0.13	0.07	-	-	0.17	0.08	-	0.45	0.19	0.06	-	-	0.22	-	0.28	1.00	
	Ab	0.17	0.05	0.05	0.35	0.08	-	-	-	0.20	-	-	0.90	-	-	0.05		-	0.05	0.10	1.00	
	Block 2																					
	NPK	0.23	-	-	-	-	0.10	-	0.07	0.21	-	0.08	0.69	-	0.07	-	0.05	0.19	-	0.31	1.00	
	Null	0.11	-	-	-	0.07	-	-	0.13	0.18	-	0.12	0.61	0.15	0.07	-	-	0.18	-	0.25	1.00	
	Ab	0.46	0.09	-	0.07	-	0.07	-	-	0.18	-	-	0.87	-	-	-	-	-	0.14	0.14	1.00	
Mean/sum of simulation	Block 1																					
	NPK	-	-	-	0.31	0.09	-	0.07	-	0.22	-	-	0.69	-	-	-	0.09	0.23	-	0.32	1.00	
	Null	-	-	-	0.06	0.11	0.07	-	-	0.22	0.06	-	0.45	0.15	0.11	-	-	0.22	-	0.33	1.00	
	Ab	0.13	0.06	0.03	0.33	0.06	-	-	-	0.23	-	-	0.84	-	-	0.10		-	0.06	0.16	1.00	



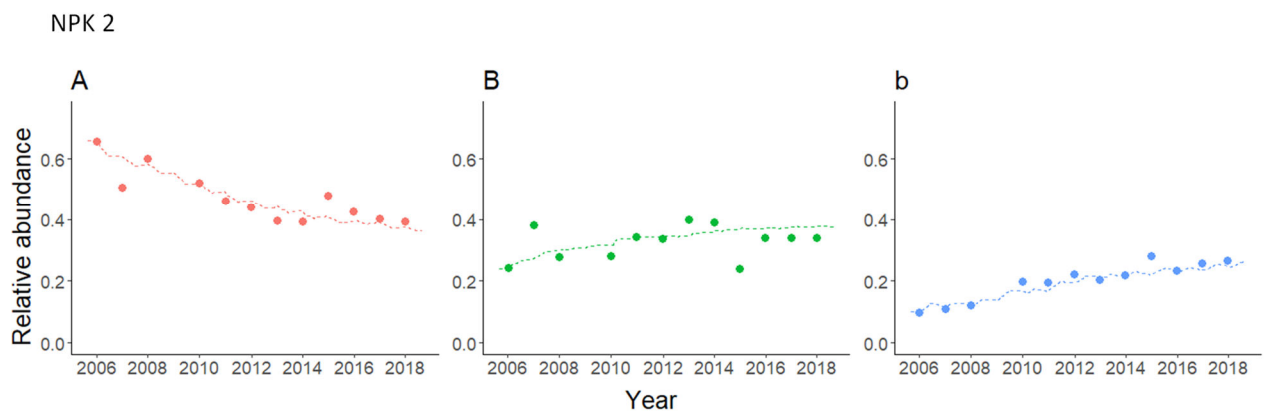
Block 2																				
NPK	0.23	-	-	-	-	0.08	-	0.07	0.21	-	0.10	0.64	-	0.07	-	0.05	0.19	-	0.31	1.00
Null	0.13	-	-	-	0.05	-	-	0.14	0.19	-	0.11	0.62	0.14	0.08	-	-	0.16	-	0.24	1.00
Ab	0.48	0.09	-	0.10	-	0.02	-	-	0.17	-	-	0.86	-	-	-	-	-	0.15	0.15	1.00

## 6.2 Changes in relative abundances

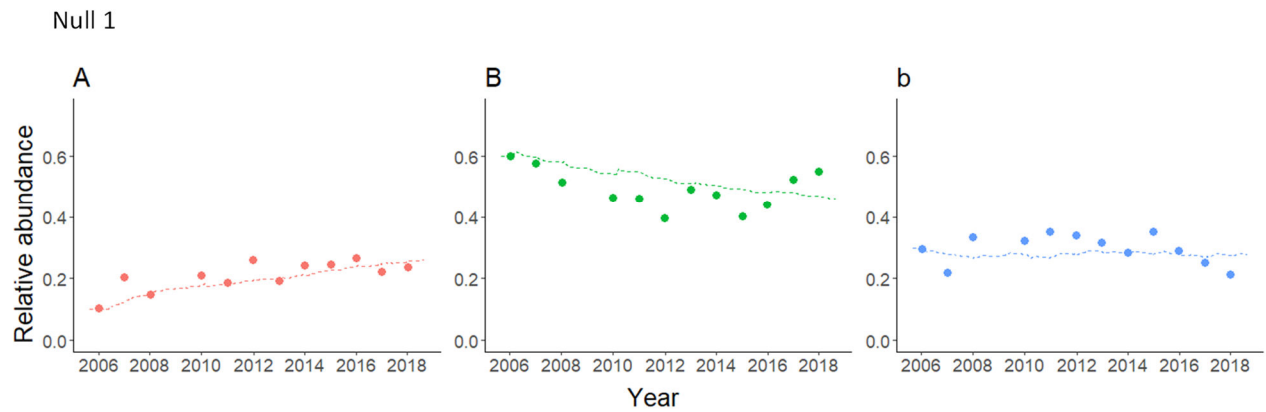
### 6.2.1 Plant functional types



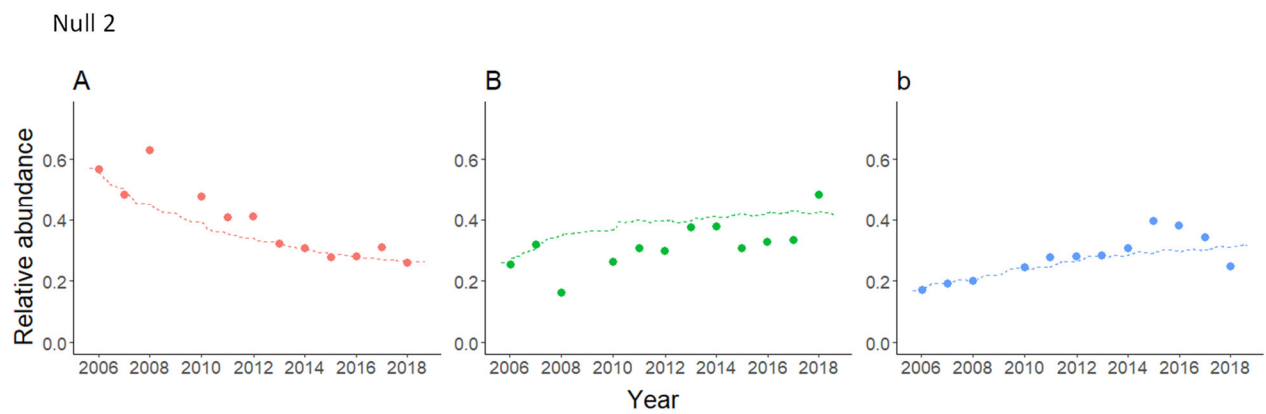
**Figure S5.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment NPK (fertilised) of block 1.



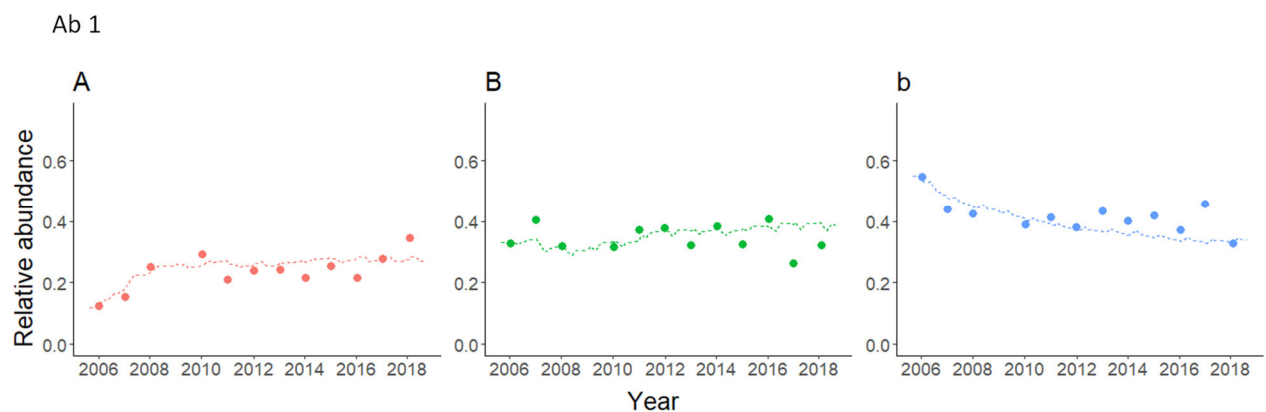
**Figure S6.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment NPK (fertilised) of block 2.



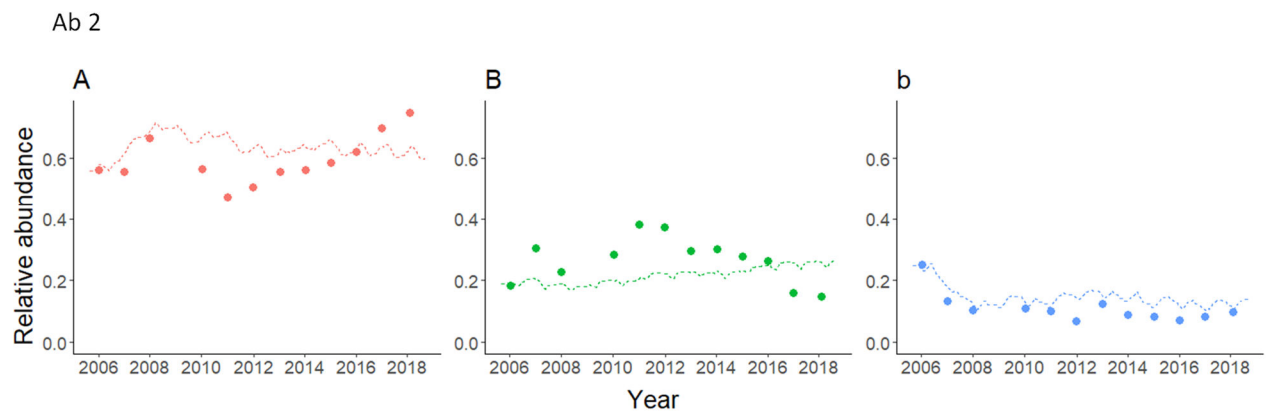
**Figure S7.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment Null (unfertilised) of block 1.



**Figure S8.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment Null (unfertilised) of block 2.

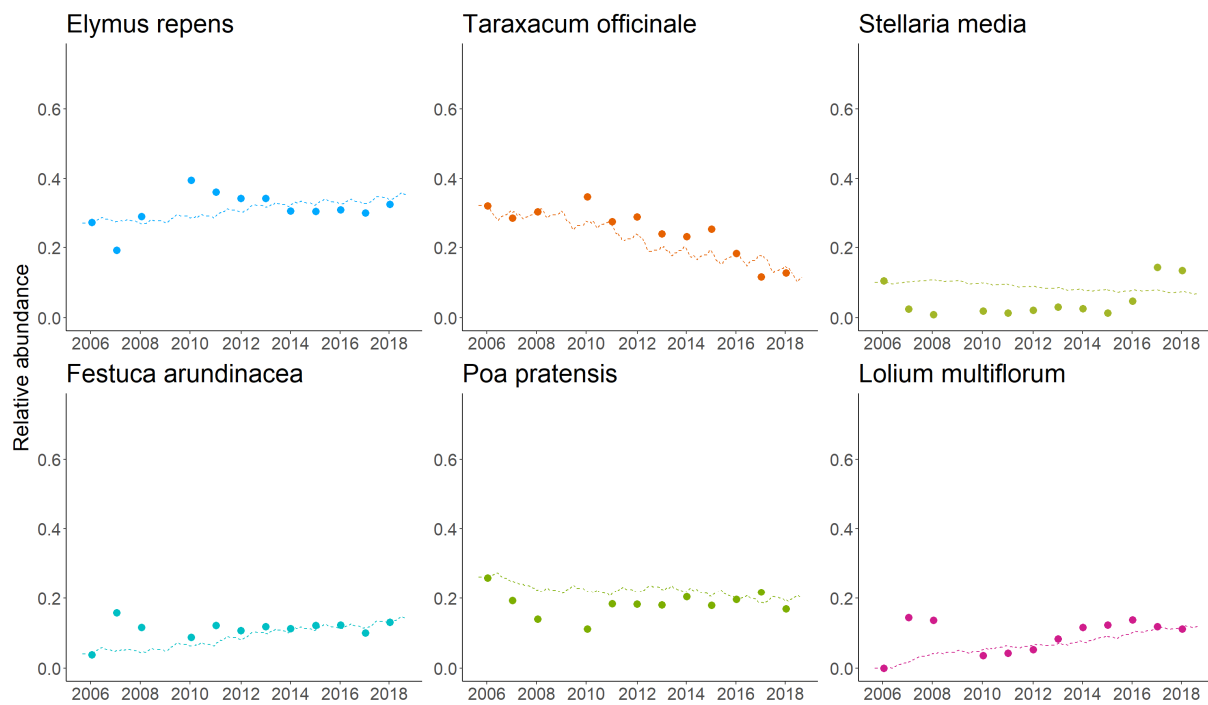


**Figure S9.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment Ab (abandoned) of block 1.

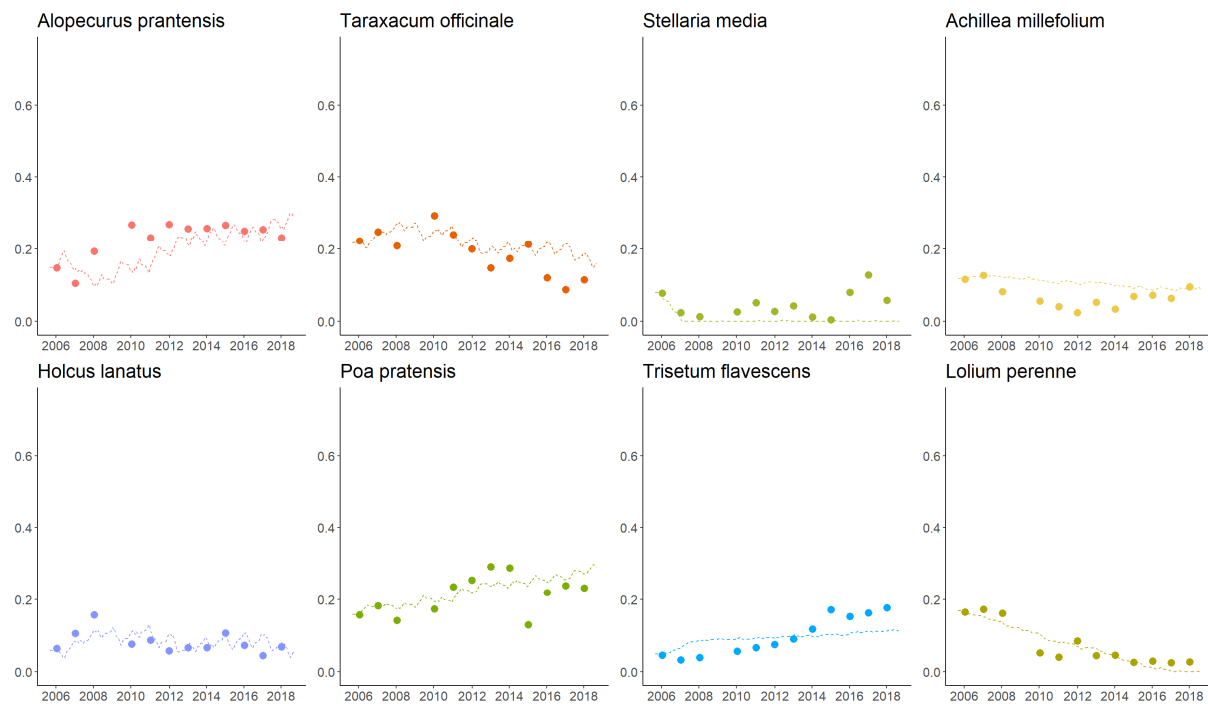


**Figure S10.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant (grass) functional types in the treatment Ab (abandoned) of block 2.

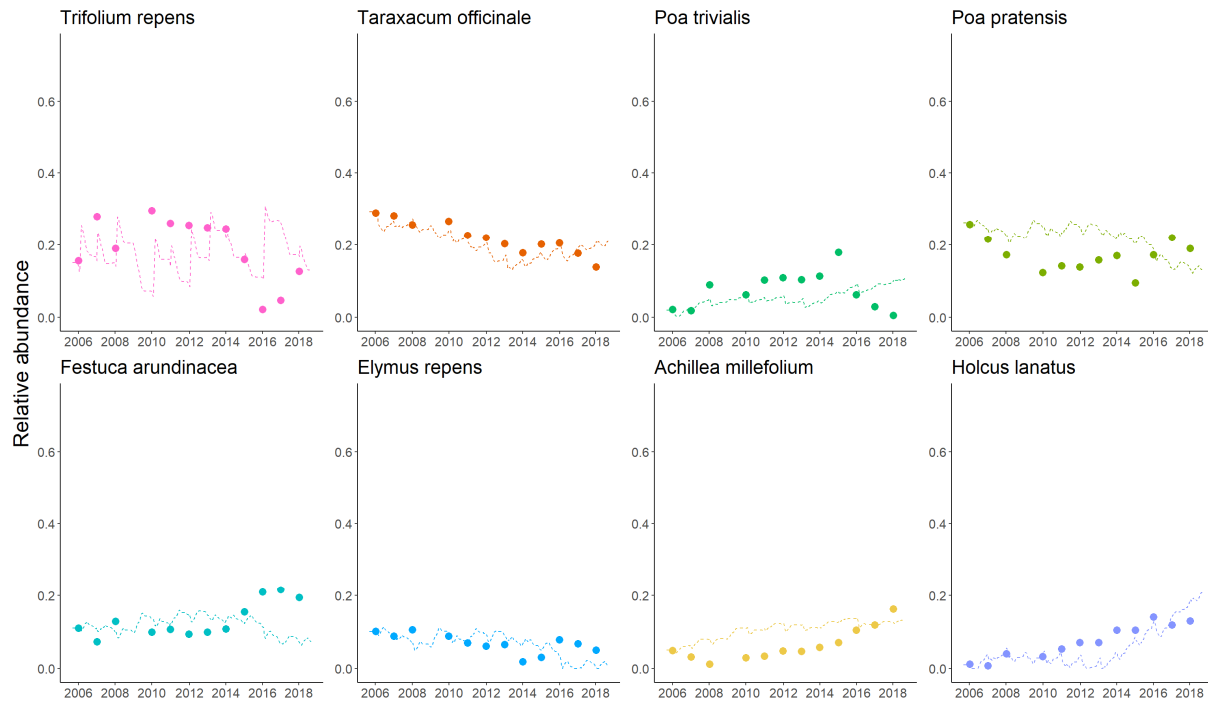
## 6.2.2 Plant species



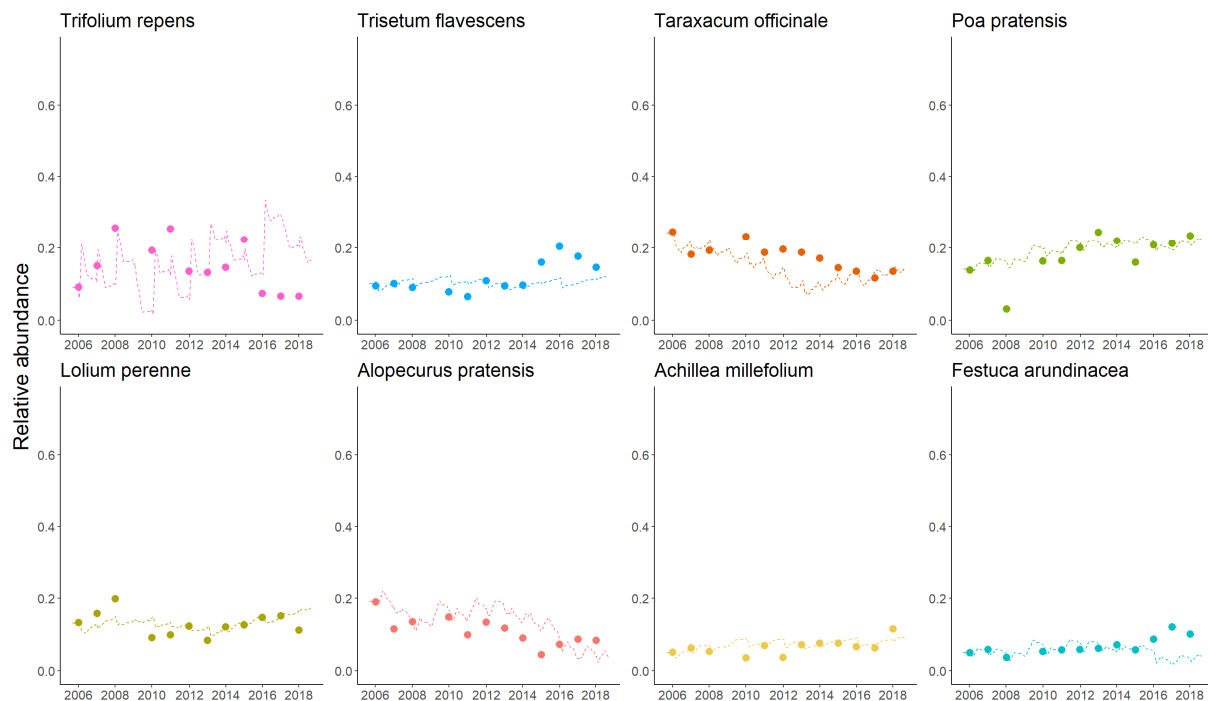
**Figure S11.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment NPK (fertilised) of block 1.



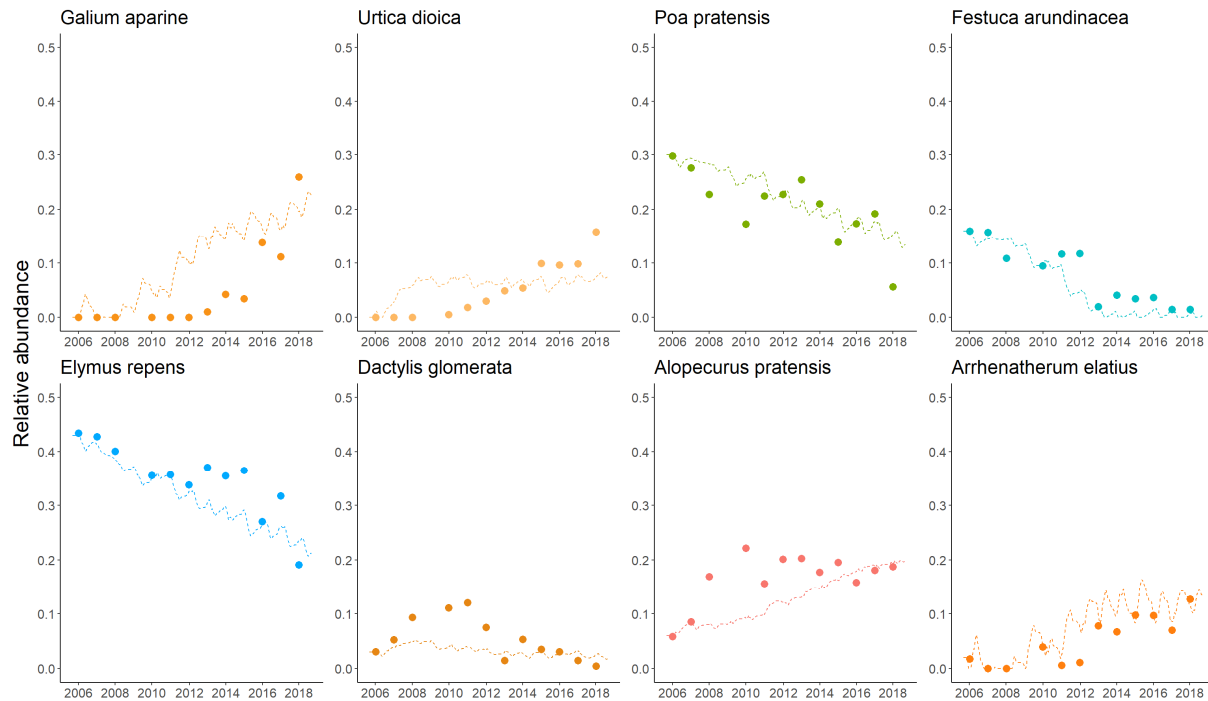
**Figure S12.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment NPK (fertilised) of block 2.



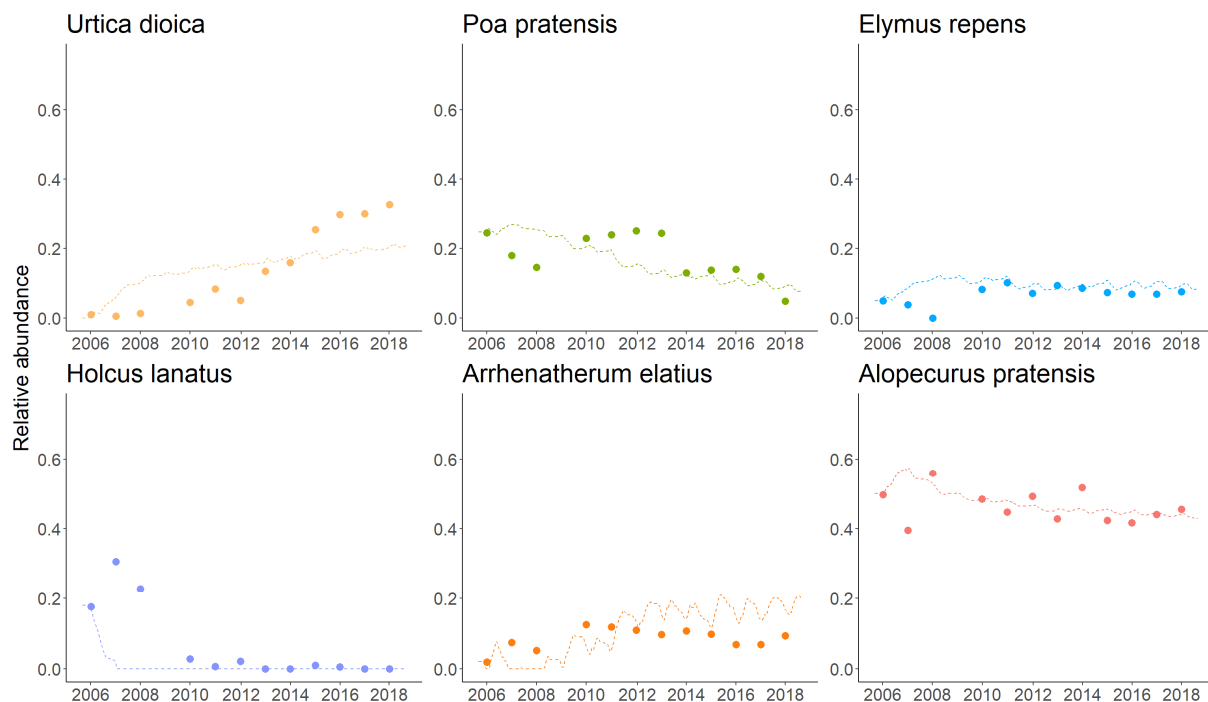
**Figure S13.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment Null (unfertilised) of block 1.



**Figure S14.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment Null (unfertilised) of block 2.



**Figure S15.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment Ab (abandoned) of block 1.

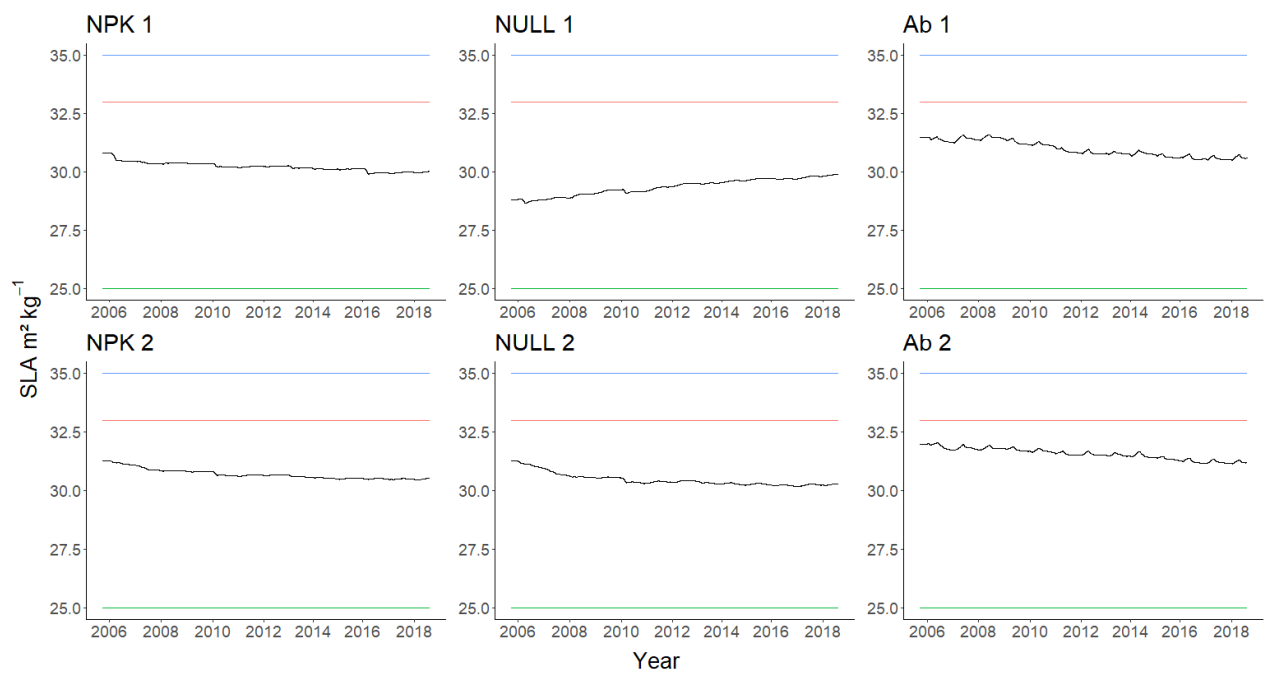


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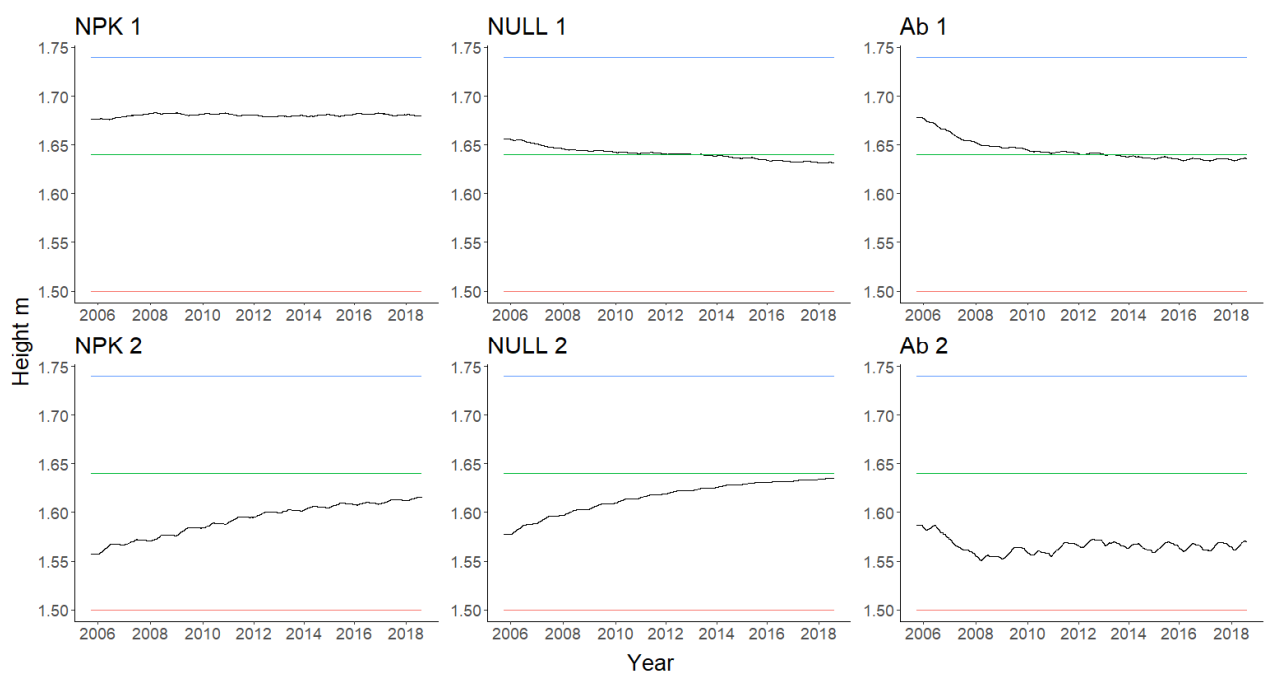
**Figure S16.** Observed (dots) and ModVege-CoSMo simulated (lines) fluctuations in the relative abundance of plant species in the treatment Ab of block 2.



### 6.2.3 Community traits



**Figure S17.** Daily changes in the specific leaf area (SLA) of the community during the simulation period compared to the fixed values set for the plant (grass) functional types (A: red line; B: green line; b: blue line) present in the community (horizontal lines, overlapping for the same values) for three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (1, 2).



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**Figure S18.** Daily changes in the height of the community during the simulation period compared to the fixed values set for the plant (grass) functional types (A: red line; B: green line; b: blue line) present in the community (horizontal lines, overlapping for the same values) for three treatments (NPK: fertilised; Null: unfertilised; Ab: abandoned) and two blocks (1, 2).