

Supplementary Materials

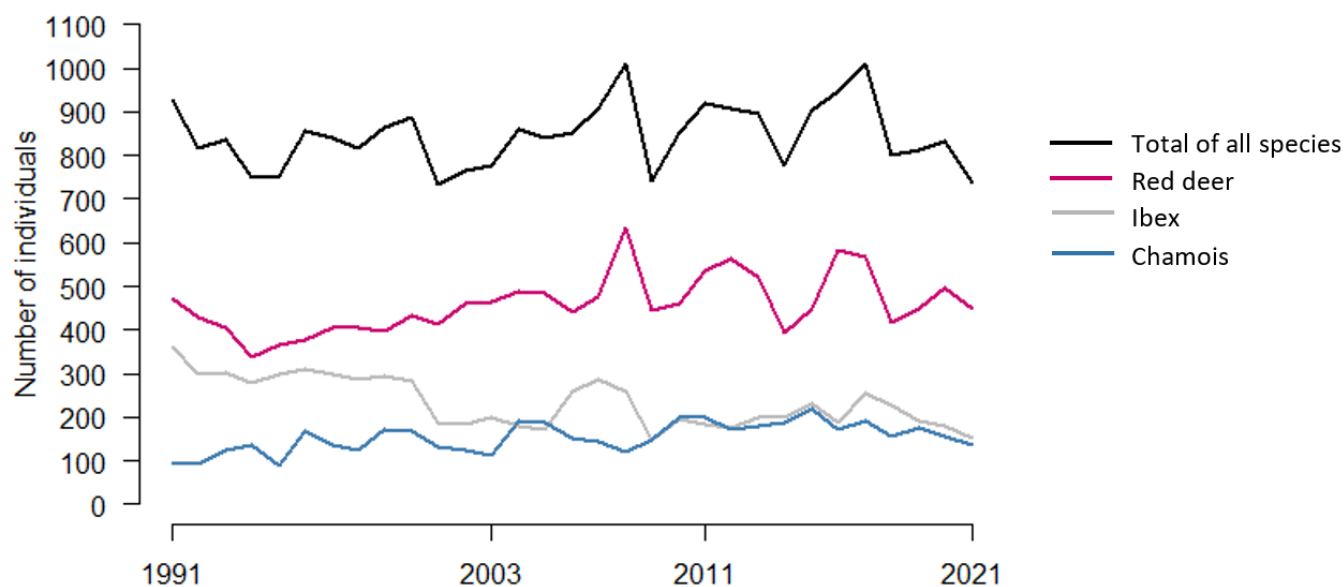


Figure S1. Development of the number of wild ungulates. Annual census counts of red deer (pink), ibex (grey), and chamois (blue), and the total number of all ungulate species (black) in Val Trupchun between 1991 and 2021 (data provided by the Swiss National Park; for a description of methodology, see Anderwald et al. [23]). The four sampling years of the monitoring program are indicated on the x-axis.

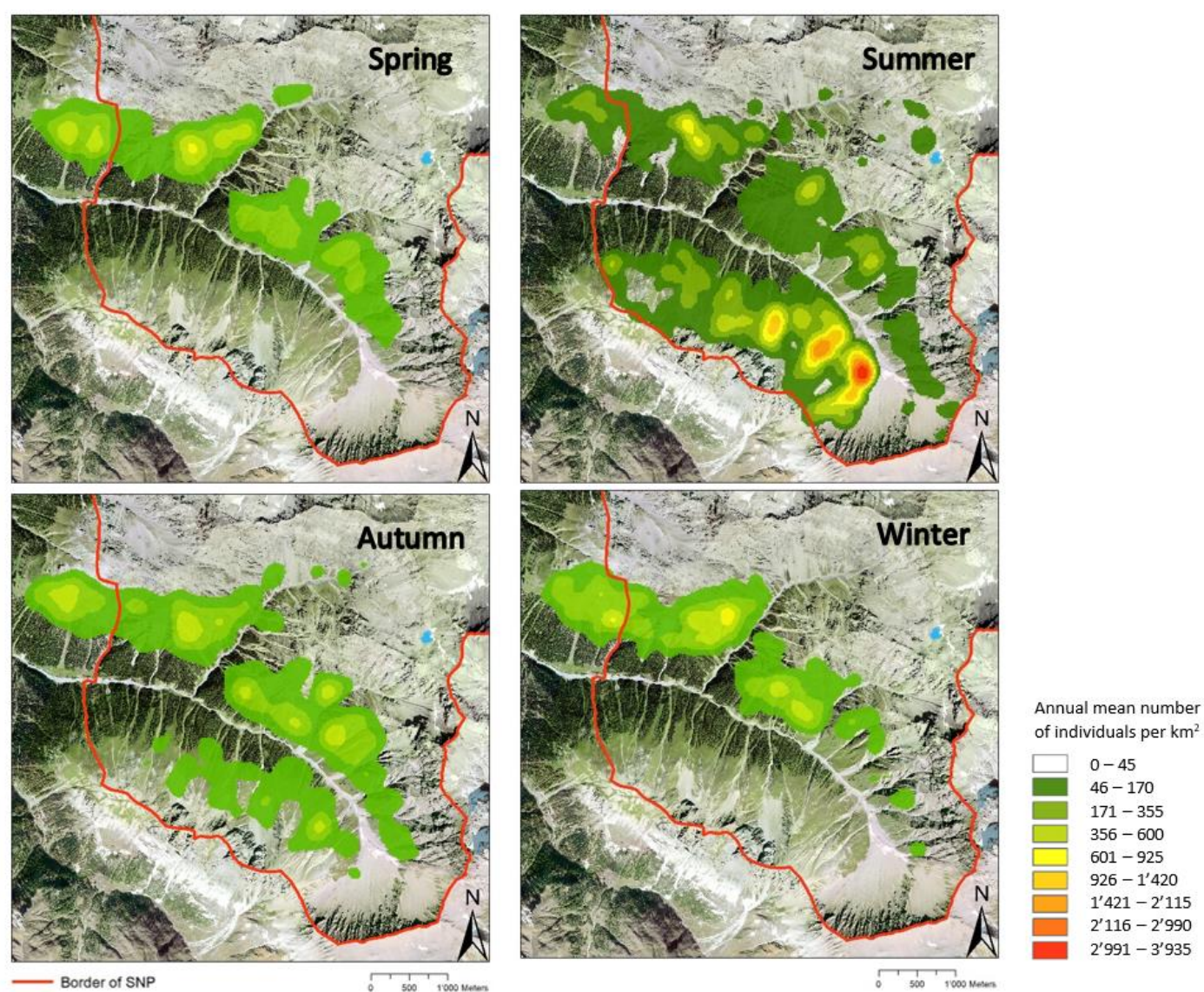


Figure S2. Heatmap of the annual mean number of ungulates (red deer, chamois, and ibex), based on visual observation data from the SNP between 2012 and 2021 (data provided by the Swiss National Park; for a description of methodology, see Anderwald et al. [23]).

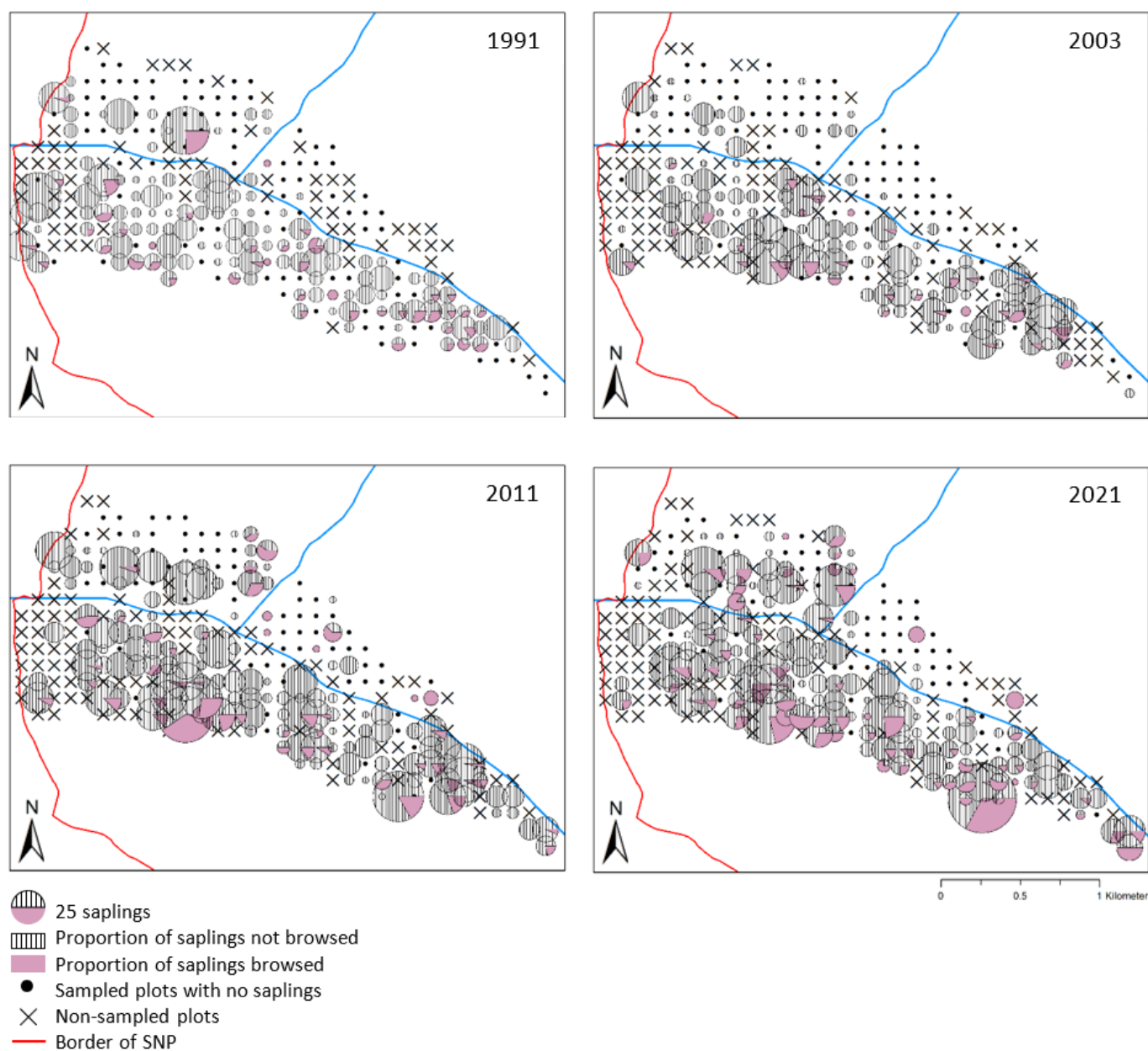


Figure S3. Distribution of sampling plots, numbers of saplings, and proportions of saplings that have been browsed over the four sampling years in Val Trupchun. Pie charts show sampling plots with saplings, dots are sampling plots without saplings, and crosses are plots that were not sampled. Sizes of pie charts represent the number of saplings. Striped patterns of the pie chart indicate saplings that have not been browsed, and pink colored areas indicate saplings that have been browsed.

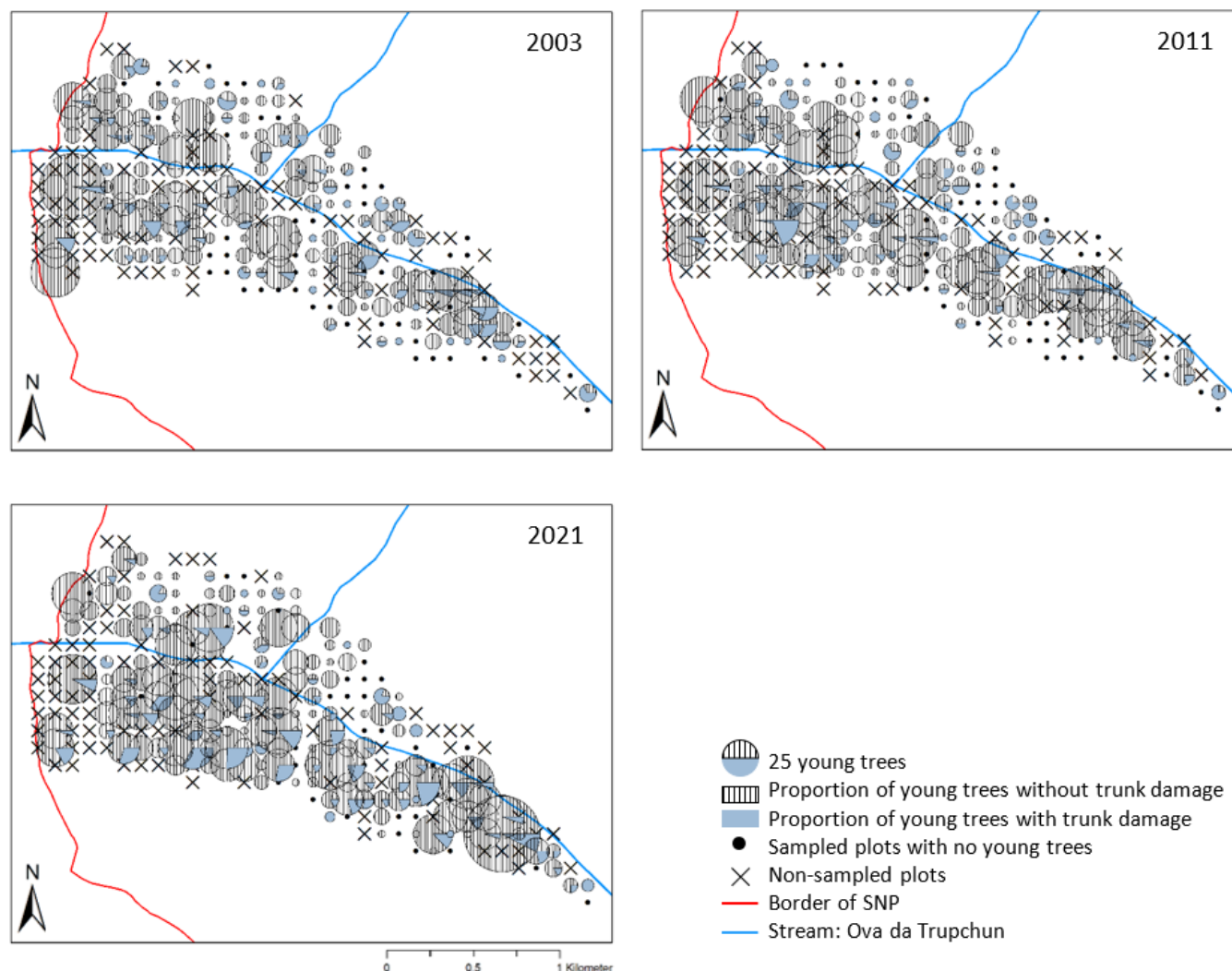


Figure S4. Distribution of sampling plots, numbers of young trees, and proportions of young trees that show trunk damage by wild ungulates over three sampling years in Val Trupchun. Pie charts show plots with young trees, dots are sampling plots without young trees, and crosses are plots that were not sampled. Sizes of pie charts represent the number of young trees. Striped patterns of the pie chart indicate young trees with no damage to their trunks, and blue colored areas indicate young trees with damaged trunks.

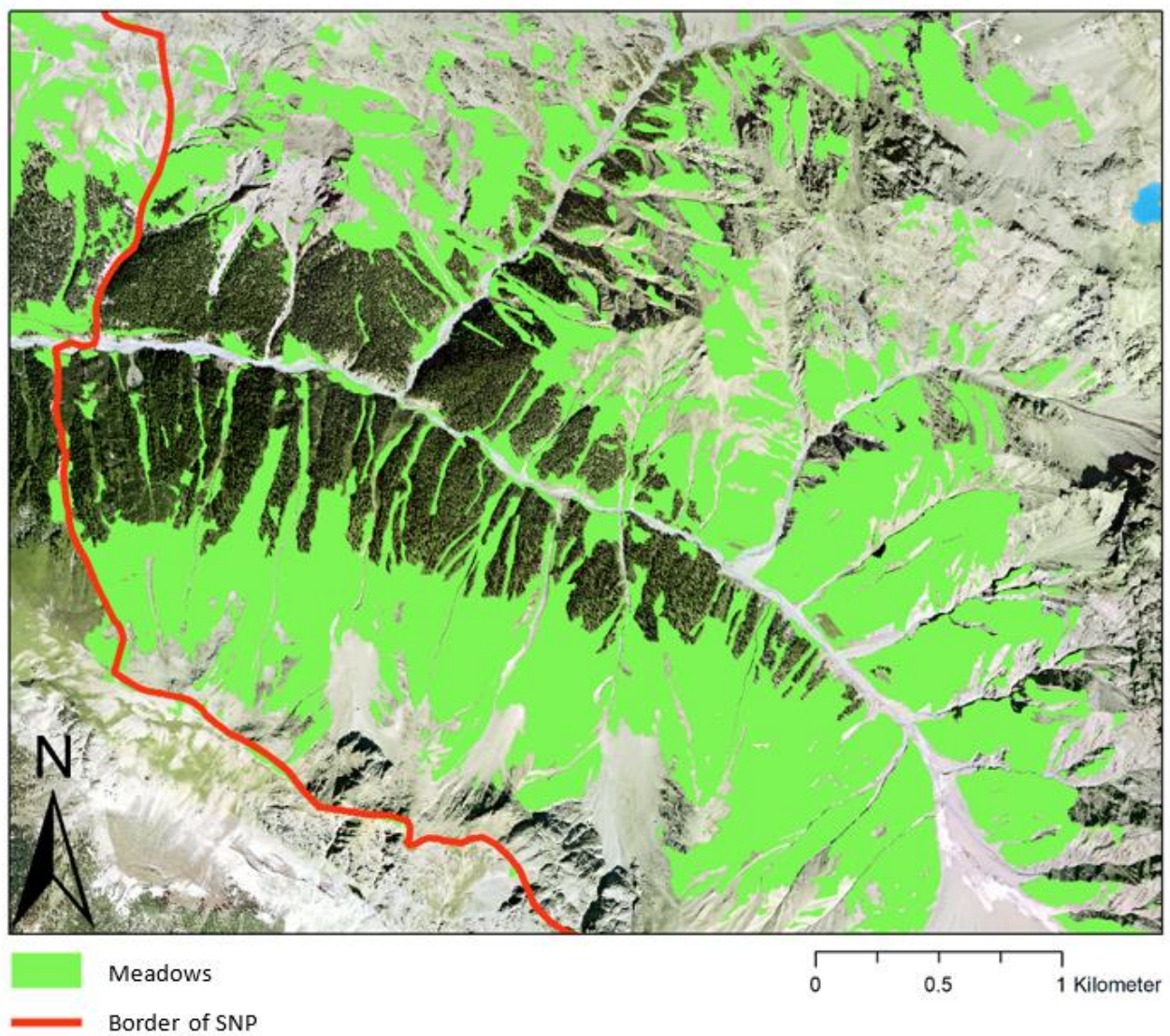


Figure S5. Location of meadows in Val Trupchun [29].

Table S1. Estimated browsing probabilities with 95% compatibility intervals for the different tree species and developmental stages, and for the minimum and maximum values of the numeric predictors. To calculate the browsing probabilities, the values of the variables not in focus were kept on their means (for numeric variables) and on the category with the largest sample size (categorical variables).

Predictor	Estimated browsing probability	95% compatibility interval	
		2.5% quantile	97.5% quantile
Tree species ¹			
Larch	0.15	0.096	0.22
Spruce	0.084	0.046	0.15
Cembra pine	0.019	0.011	0.033
Developmental stage ²			
2	0.049	0.026	0.091
3	0.15	0.096	0.22
4	0.11	0.070	0.17
5	0.13	0.080	0.19
6	0.072	0.041	0.12
Elevation ³			
min.: 1835 m.a.s.l	0.049	0.021	0.12
max.: 2225 m.a.s.l	0.31	0.19	0.48
Northness ³			
-1 (south)	0.31	0.18	0.49
1 (north)	0.12	0.079	0.19
Eastness ³			
-1 (west)	0.087	0.048	0.15
1 (east)	0.21	0.13	0.31
Slope ³			
min.: 16%	0.19	0.10	0.35
max.: 138%	0.093	0.033	0.22
Number of saplings ³			
min.: 1	0.15	0.098	0.23
max.: 112	0.092	0.032	0.25
Average developmental stage ³			
min.: 1.89	0.17	0.099	0.28
max.: 6	0.12	0.060	0.22
Shannon index ³			
min.: 0	0.18	0.12	0.28
max.: 1.27	0.10	0.056	0.18
Distance to next hiking trail ³			
min.: 2 m	0.12	0.068	0.20
max.: 583 m	0.21	0.099	0.41
Distance to next meadow ³			
min.: 0 m	0.15	0.098	0.23
max.: 166 m	0.11	0.038	0.27

¹Point estimates and 95% compatibility intervals refer to developmental stage 3.

²Point estimates and 95% compatibility intervals refer to larch.

³Point estimates and 95% compatibility intervals refer to larch in developmental stage 3.

Table S2. Pearson correlation coefficients of the untransformed model predictors.

	Tree species	Dev. stage	Elev.	North.	East.	Slope	Num. of saplings	Av. dev. stage	Shannon index	Dist. to hiking trail	Dist. to meadow
Tree species	1										
Developmental stage	0.11	1									
Elevation	-0.041	0.017	1								
Northness	-0.14	0.16	0.33	1							
Eastness	-0.050	0.084	0.069	0.11	1						
Slope	-0.0062	-0.019	0.088	-0.0065	-0.0047	1					
Number of saplings	0.0062	0.0052	0.076	0.014	-0.15	0.036	1				
Average developmental stage	0.013	0.54	0.029	0.23	0.14	-0.064	-0.073	1			
Shannon index	-0.032	0.024	-0.097	0.29	0.16	0.064	0.20	-0.025	1		
Distance to next hiking trail	0.0053	-0.078	0.74	0.045	-0.15	0.052	0.19	-0.12	-0.11	1	
Distance to next meadow	0.061	-0.14	-0.39	-0.26	-0.26	-0.040	-0.17	-0.20	-0.11	-0.12	1

Table S3. Total numbers of saplings and numbers of saplings being browsed.

Saplings					
Northeast-exposed slope			Southwest-exposed slope		
Year	Tree species	Total individuals	Browsed individuals	Total individuals	Browsed individuals
1991	Larch	384	52	13	1
	Cembra pine	215	5	1	0
	Spruce	51	0	109	13
	Mountain ash	21	8	0	0
	Upright mountain pine	0	0	7	0
	Total	671	65	130	14
	Ratio of browsed and total individuals in %	9.7%		10.8%	
2003	Larch	443	44	15	0
	Cembra pine	361	8	3	0
	Spruce	42	5	62	0
	Mountain ash	4	1	0	0
	Upright mountain pine	5	0	0	0
	Total	855	58	80	0
	Ratio of browsed and total individuals in %	6.8%		0%	
2011	Larch	623	110	61	26
	Cembra pine	594	13	32	2
	Spruce	43	5	192	4
	Mountain ash	53	9	0	0
	Upright mountain pine	2	0	0	0
	Total	1315	137	285	32
	Ratio of browsed and total individuals in %	10.4%		11.2%	
2021	Larch	637	171	84	29
	Cembra pine	591	19	15	1
	Spruce	72	3	202	27
	Mountain ash	10	0	0	0
	Upright mountain pine	1	0	1	0
	Total	1311	193	302	57
	Ratio of browsed and total individuals in %	14.7%		18.9%	

Table S4. Total numbers of young trees and numbers of young trees with damaged trunks.

Young trees					
Northeast-exposed slope			Southwest-exposed slope		
Year	Tree species	Total individuals	Individuals with trunk damage	Total individuals	Individuals with trunk damage
2003	Larch	769	53	125	12
	Cembra pine	171	19	110	31
	Spruce	85	12	228	11
	Mountain ash	1	0	0	0
	Upright mountain pine	2	0	0	0
	Total	1028	84	463	54
	Ratio of damaged and total individuals in %	8.2%		11.7%	
2011	Larch	918	41	103	8
	Cembra pine	198	37	104	31
	Spruce	117	10	241	14
	Mountain ash	1	0	0	0
	Upright mountain pine	3	0	0	0
	Total	1237	88	448	53
	Ratio of damaged and total individuals in %	7.1%		11.8%	
2021	Larch	1195	103	125	4
	Cembra pine	260	46	81	23
	Spruce	116	13	226	15
	Mountain ash	4	0	0	0
	Upright mountain pine	0	0	3	1
	Total	1575	162	435	43
	Ratio of damaged and total individuals in %	10.3%		9.9%	