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Influence of *Robinia pseudoacacia* L. on plant communities in Swiss forests

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Résumé

Dans cette étude nous avons analysé l'influence de l'espèce invasive Robinier faux-acacia (*Robinia pseudoacacia*) sur les communautés végétales de forêts en Suisse romande. Un modèle de distribution de l'espèce en Suisse a été fait pour décrire sa niche écologique. De plus nous avons comparé les sites avec et sans *R. pseudoacacia* du point de vue de leur composition spécifique et de leurs caractéristiques écologiques (l'humus, la richesse en espèces, la canopée, le recouvrement et la fréquence des espèces et certains traits biologiques des espèces). Le modèle de distribution nous a montré que l'aire de répartition de robinier s'étend à l'ensemble du Plateau suisse et aux vallées alpines jusqu'à 1000 m, avec une large amplitude écologique (conditions sèches ou humides). Les résultats montrent que les sites avec *R. pseudoacacia*, comparés aux sites sans, ont un humus montrant une meilleure incorporation de la matière organique, plus de lumière, qu'il y a plus d'espèces nitrophiles et avec un recouvrement de la strate herbacée plus important, en particulier avec le développement des lianes. Compte tenu de sa large amplitude écologique, *R. pseudoacacia* est susceptible d'envahir presque toutes les forêts de basses et moyennes altitudes. Par sa symbiose avec des bactéries fixatrices d'azote, il change la chimie du sol par l'augmentation de l'azote et les conditions du sous-bois par son feuillage clair qui laisse passer plus de lumière. Ceci implique une modification de la flore du sous-bois, en favorisant les espèces nitrophiles et les lianes, qui peuvent mettre en danger les espèces oligotrophes. Il est donc important de ne pas favoriser cette espèce et de lutter dès que possible pour éviter son développement dans les forêts.

Abstract

In this study we analysed the influence of the invasive species Black Locust (*Robinia pseudoacacia*) on forest plant communities in Western Switzerland. A species distribution model in Switzerland was developed to describe its ecological niche. Moreover we compared sites with and without *R. pseudoacacia* to the point of view of their species composition and their ecological characteristics (humus, species richness, canopy, frequency and cover of species, biological traits). The distribution model showed that the potential distribution area of *R. pseudoacacia* extends to the whole Swiss Plateau and alpine valleys up to 1000 m with large ecological amplitude (dry or wet habitats). The results showed that sites with *R. pseudoacacia*, compared to sites without, have a humus with a better incorporation of organic matter, more light, more nitrophilous species, and a higher cover of the herb layer, particularly with vines. Considering its large ecological amplitude, *R. pseudoacacia* is susceptible to invade almost all the lowland forests. By its symbiosis with nitrogen-fixing bacteria, it modifies the soil chemistry by increasing nitrogen content, and undergrowth conditions because of its light foliage. This modifies undergrowth plant species composition, with more nitrophilous species and vines, what can potentially endanger oligotrophic species. It is therefore important to not encourage this species and to fight it as soon as possible to prevent its development in the forests.

Introduction

Invasions of exotic species are among the most significant problems, from a global point of view, in natural ecosystems (Parker et al. 1999). Recent reviews on the homogenization of the world's ecosystems have shown that not only islands and disturbed sites are affected, but mainland areas and little disturbed ecosystems are often invaded and dominated by the same newly established species too (Ehrenfeld & Scott 2001). It is considered that invasive species may be a cause of decline and extinction of native species (Coblentz 1990; Vitousek et al.1997; Zalba et al. 2000). Moreover, major changes often occur when a non-native species acquires a new function in the ecosystem (Vitousek & Walker 1989), which can lead either to loss or alteration of plant communities (Simberloff 1991; Ruesink et al. 1995).

The nitrogen-fixing ability and the vegetative reproduction of Black locust (*Robinia pseudoacacia* L.) are characteristics frequently found in invasive plants (Daehler 1998). This species is considered one of the top 100 of invasive woody species in the world (Cronk and Fuller 1995) and, now, the second most abundant deciduous tree on Earth (Boring & Swank 1984). It is native from North America and was introduced in Europe as an ornamental plant, in 1601 by J. Robin in France (Keresztesi 1988). Its very durable wood makes it an important timber producer (Keresztesi 1988), utilized for a diverse range of products including panelling construction boards, firewood, fence posts and livestock forage (Keresztesi1980). Therefore *R. pseudoacacia* is rated as the most important tree species for agro-forestry systems because of its multiple uses. *R. pseudoacacia* is usually planted close to dwellings where previous natural forests had been removed by deforestation (Viorel Blujdea et al. 2011). *R. pseudoacacia* is shade intolerant, so it is associated with cleared areas, old pastures, road sides, burned areas, river banks and cities or gardens (Chapman 1935; Ogden 1961; Boring and Swank 1984; Bormann et al. 1993).

By its ability to fix nitrogen, to grow quickly, to reproduce vegetatively and to form dense, monospecific stands, it may supplant native tree species (Mehrhoff et al. 2003) and change plant communities. Many studies have shown the impact of nitrogen fixation on the soil (eg. Stock et al 1995; Von Holle et al. 2006; Yelenik et al. 2004). But, as far as we know, none has investigated the impact it has on the plant community of the forest understorey (shrubs and herbs).

The aim of this study is to analyse the impact of *R. pseudoacacia* on the community of forests by linking plant inventories in pairs of plots dominated or not by *R. pseudoacacia*. Differences in species composition and differences in species cover between sites were considered. We hypothesize that nitrophilous species are more common and have a higher cover in stands dominated by *R. pseudoacacia*, what could have consequences on distribution of oligotrophic species in forest understorey.

Methods

Species distribution model

To understand the ecological niche of *R. pseudoacacia* (necessary environmental conditions for growth) and to obtain a map of its potential distribution, we did a distribution model with BIOMOD2 (Thuiller et al. 2009) and ArcGIS (ESRI®), according to Guisan & Zimmermann (2000) and Guisan & Thuiller (2005). Data about present occurrences were from www.data.gbif.org, the state of Valais (Département des forêts et du paysage, www.vs.ch), Infoflora (www.infoflora.ch) and from other isolated observations. Twelve environmental variables (WSL: Swiss Federal Institute for Forest, Snow and Landscape Research) were used to generate environmental profiles for our local distribution model and to calculate the importance of the environmental variables in the species distribution model (Fig. 1).

Study sites

The study sites areas were located in Western Switzerland (Cantons de Vaud and Valais). The climate of Vaud is humid and temperate. The average rainfall is around 1000 mm per year and mean annual temperature around 9°C in lowland. Valais has a more sub-continental, with lower annual average rainfall, around 600 mm, for similar annual temperatures (Swiss Federal Office of Meteorology and Climatology, www.MeteoSwiss.ch). On the basis of available occurrences and by looking at forests in landscape, we prospected for stands of *R. pseudoacacia*. The stands had to meet the following criteria to be retained: presence of *R. pseudoacacia* with a minimal cover of 25% in 100 m^2 of forest, without hedge effect, and an another very close forest of 100 m^2 without *R. pseudoacacia* but with similar ecological conditions (substrate, slope, aspect). Altogether, we found 27 sites, corresponding to 54 plots: 27 with *R. pseudoacacia* and 27 without. 16 sites were in Vaud and 11 sites in Valais. The field observations were carried out between June and August 2013.

Field measurements

In plot was defined as a square of 10 x 10 meters. We used a spherical densiometer to measure forest canopy opening from each corner of the square in direction of the centre (Lemmon 1956) and determined the type of humus (Ponge 2011). For that, the thickness of the horizons OL (not or little fragmented litter), OF (mixture of fragmented litter and pellets of organic material), OH (only pellets of organic material) and A (organo-mineral material) were measured if present; the humus was then classified according to the respective importance of the horizons in one of the nine categories: from the very active Mull, with rapid incorporation of organic matter (value 1), to the Mor, with very slow mineralization and absence of incorporation to mineral material (value 9). The topographical values as slope, elevation and aspect were recorded. The point method (Mueller-Dombois and Ellenberg 1974) was used to measure the species cover of understorey and low shrubs: The measuring tape was placed every two meters in the square (four lines of 10 m), and species contacts with a 1m-long stick were recorded every 20 centimetres, for a total of 200 points (converted in % cover). Finally, we completed the species list for the whole plot in the three layers (herbs, shrubs and trees) and we estimated visually species cover with a scale in eight classes (Braun-Blanquet 1964; Table 1).

Statistical analyses

The estimations of plant cover were converted in numerical values (numerical dominance) for subsequent analyses (Table 1). The bellowing analyses follow suggestions of Borcard et al. (2011). Principal component analysis (PCA) and redundancy analysis (RDA) are linear methods that preserve the Euclidean distance between sites, normally not adapted for analysis with plant species covers. But the Hellinger's transformation of the data was used according to Legendre and Gallagher (2001). A PCA was performed to identify possible shifts between plots of each site: incomplete data set, excluding the tree layer was used to avoid a direct effect of the constant presence of *R. pseudoacacia* in half of the plots. This allowed us to identify the influence of this species on understorey. The plots were distributed in groups by a clustering analysis based on a matrix of similarity.

The ecological factors collected in the field, canopy (arithmetical means of canopy opening in each corner), slope, aspect and humus type, or from GIS climatic layers (ddeg300, sum of degree day above 3°C) were the explicative variables in the RDA. For this analyse, we kept only the cover herbs species to study the response of the undergrowth to canopy structure and composition. The significance of axes were tested using a permutation test.

The significance of the global shift between plots of a same pair (with and without *R. pseudoacacia*) along the first three axes of PCA was tested by multivariate analysis of variance (MANOVA) by differences of axis scores between plots in sites against the intercept.

As *R. pseudoacacia* enriches the soil with nitrogen (eg. Stock et al 1995; Von Holle et al. 2006; Yelenik et al. 2004), we used the mean ecological indicator values of N (nutrient availability, mainly nitrogen; Landolt et al. 2010) of each relevé (only understorey) to compare the difference in nutrient availability between the relevés with and without *R. pseudoacacia*. Their respective cover weighted the importance of the species in the mean. The means of pairs of plots were compared with a paired t-test. We did the same analyses for functional traits as the maximal size (H_{max}; according Aeschimann et al. 2004), the specific leaf area (SLA; data from www.leda-traitbase.org, http://www.try-db.org and literature), humus type and canopy. The number of understorey species and the total species cover in understorey (measured by the point method) in each site were compared with the same analysis.

Finally, the frequency (number of occurrences) and the mean cover of each species in the pairs of relevés were calculated. We retained only the species that were present in six or more relevés and which had in at least in one relevé a frequency of three or more.

Results

Potential distribution of R. pseudoacacia

The species distribution model showed that *R. pseudoacacia* has a large ecological amplitude: from plains up to 1000 m, in the Plateau and alpine valleys (annexe 1). The most important variables in the model were annual degree-days (calculated above 3 °C), the minimal temperature and the distance to lake and watercourses (ddeg300, tmin, dist_laceau, Fig. 1). The threshold of degree-days and minimal temperature of suitable area correspond approximately to a mean annual temperature above 5°C.

Species composition

The clustering analyse of relevés revealed three distinct groups of plots that approximately correspond to three climatic conditions in three regions: Plateau, Chablais and Valais. The pairs of plots were generally maintained together. For the PCA with tree (Fig. 2a) the first axis explained 8.77% of the total variance in species composition. The second axis explained 7.98% of the variance. The plot showed a coherent shift between the plots of a same pair. The shift was highly significant with a MANOVA (p-value < 0.0001). The first axis of the PCA without tree layer explained 9.12% of the total variance and the second axis 7.63% (Fig. 2b). There is less difference between plots but the shift testing was still highly significance (p-value < 0.0001) according to the MANOVA.

Redundancy analysis (RDA) underlined the importance of humus (Fig. 3). The RDA was significant according to the permutation test (p-value < 0.001). The projection of ecological variables onto the RDA revealed that the first axis was negatively correlated with degree-day, slope and humus. And the canopy was positively correlated with the second axis. The graph showed a shift between plots with *R. pseudoacacia* and without correlated with the canopy and humus.

Species and site characteristics

The differences between the plots with and without *R. pseudoacacia* were significant only for the ecological indicator value for nutrient availability (N, p-value = 0.004), total cover of understorey (p-value = 0.002) and the humus type (p-value < 0.0001) (Table 2). This means that there were more nitrophilous species in the sites with *R. pseudoacacia*, with more active humus on the soil and a higher cover of understorey. For the functional traits (SLA and size), the canopy and the species richness, the difference was not significant (p-value > 0.05) (Table 2).

Species cover according point method

Clematis vitalba was the species with the largest mean difference (diff. cov = 16.85%) of species cover, followed by *Aegopodium podagraria* and *Mercurialis perennis* (Table 3). *Clematis vitalba*, as herb and shrub, *Galium aparine* and *Rubus fruticosus* were noticeable as well for the important difference of presence in plots with and without *R. pseudoacacia* (Table. 3). On the contrary, *Polygonatum multiflorum* and *Fagus sylvatica* had a higher cover in plots without *R. pseudoacacia*, although *P. multiflorum* was more frequent in *R. pseudoacacia* stands. We noticed also that the nitrogen indices (N) of species were 4 to 5 for frequent species with *R. pseudoacacia*.

Discussion

Robinia pseudoacacia grows very quickly, survives to drought and harsh winters. It tolerates infertile and acidic soils (Miller et al 1987). This explains its wide distribution: from the Swiss lowlands up to mountain slopes (~1000 m; www.infoflora.ch). In Switzerland, the model predicts suitable areas mainly on the Plateau and in Alpine valleys up to an elevation corresponding approximately to a mean annual temperature of 5°C. This corresponds to the present distribution of the species in Switzerland, which can be observed from wet forests in lowlands to slopes with southern aspect in the driest region of the country (central Alps in Valais with annual sum of precipitations 570 mm; www.infoflora.ch). The third variable (distance to lake and watercourses; Fig. 1) shows that this species grows better at the edge of lakes and rivers because of the disturbed environment with available space and light. The very high importance of degree-days in models and observations demonstrated that cold is the main constrain to *R. pseudoacacia*, which invades potentially a lot of ecosystems with different climates, environments, soils, etc., as already demonstrated by several studies on invasive species with large ecological amplitude (eg. Fumanal et al. 2008).

The clustering analysis based on species composition revealed three groups of sites (Fig.1 a and b). The groups corresponded approximately to three climatic conditions, or three geographical regions: The Plateau (annual sum of precipitations ~1000 mm), the Valais (central Alps, <700 mm) and the Chablais (intermediate position and climate). Some plots switched from one group to another according to the presence or absence of *R. pseudoacacia*, but most of the pairs were included in the same group. Hence, species composition of the plots is firstly explained by climatic conditions, and secondly by presence or absence of *R. pseudoacacia*.

In the PCA analysis, pairs of plots showed coherent and significant shift along the second axis. The differentiation was particularly regularly oriented in the PCA with tree layer (Fig. 2a), what is clearly explained by the constant presence of *R. pseudoacacia* in the tree layer of half of the plots. But the preservation of a significant shift in the PCA without tree layer (Fig. 2b) is due to differences in the composition of the herb and shrub layers in pairs of plots, although they were systematically set geographically very close to each other and in similar ecological conditions. This shows that the presence of *R. pseudoacacia* clearly influences forest understorey.

The RDA analysis highlighted the importance of the ecological variables degree-days, canopy, slope and humus to explain species composition in forest undergrowth (Fig. 2). The variable degree-days was the most important, and structured composition according to climatic conditions (corresponding mainly to elevation and geographic region in our study area). But directions of the arrows for canopy and humus were coherent with the general shift observed in pairs of sites with and without *R. pseudoacacia*. Hence, the species shift from absence to presence of *R. pseudoacacia* is related to a decreasing density of canopy, although not significant according to the t-test, and to an improve of humus quality, as low values of humus corresponds to good humus quality (mull) and high values to humus with a bad incorporation of organic matter (mor; Ponge 2011).

R. pseudoacacia is symbiotic with nitrogen-fixing bacteria (Bormann et al. 1993) and we expected that changes would correspond to the presence of more nitrophilous species. This was confirmed by the higher frequency and/or cover of *Galium aparine*, *Aegopodium podagraria* and *Rubus fructicosus* (Table 3) under the canopy of *R. pseudoacacia*. The corresponding type of humus in these stands was most frequently mesomull than hemimoder that was most frequently in plots without *R. pseudoacacia*. Humus type, which characterizes the distribution of organic matter in a soil profile (Brêthes et al. 1995), depends on the diversity of animal groups in the soil: the more soil fauna is diversified in forms and sizes, the more plant litter is rapidly incorporated into the soil (Ponge 2000). But the diversity of soil fauna depends firstly on the litter quality (nitrogen content). Therefore, there is a virtuous cycle: *R. pseudocacia* increases nitrogen content in soil (Bormann et al. 1993), this favours nitrophilous species and increases nitrogen content of the other species, this produces a nitrogen-rich litter, which is better incorporated in soil and delivers quickly nitrogen to the soil (Gobat et al. 2010). The development of this cycle modifies the humus type from hemimoder to mesomull.

Another species group, which showed a cover increase in *R. pseudoacacia* stands, is vines such as *Clematis vitalba* and *Hedera helix*. This is related to the general increase of understorey cover and shows that the luminosity is higher in sites with *R. pseudoacacia*, although canopy cover was not significantly different as measured with the densiometer. But the thinness of the leaves, clearly leaving more light going through the limb than native species, the low number of branches in the lower canopy and maybe the phenomenon of timidity at the top of this species brings more light to understorey without necessarily having more or larger gaps.

Luminosity and nitrogen availability may affect SLA of species in understorey, what was only marginally significant in our results (p-value = 0.0851). But the values of SLA were from databases, often measured in unknown situations, and there is a very high intraspecific variability of SLA values in understorey (Reich et al. 1997). SLA differences ought to be evaluated with more relevés and especially with measurements directly on samples from the considered stands.

The difference of species richness was not significant between the two types of sites, in opposition to stands colonised by another invasive tree, *Prunus serotina*, in Oise region (France; Chabrerie et al. 2007). But, it does not mean that *R. pseudoacacia* does not affect local species richness. As our results showed, species cover increased in *R. pseudoacacia* stands, compared to ecologically similar stands, with a strong development of vines and nitrophilous herbs. It is very likely that these species eliminate by competition some oligotrophic species (Lévêque 2004*)* as *Polygonatum multiflorum*, which has a higher cover in site without *R. pseudoacacia* (Table 3). As oligotrophic species are globally more often threatened than nitrophilous ones (Moser et al. 2002), the invasion of *R. pseudoacacia* in forests has the potential to increase species rarity of some oligotrophic species, especially combined with general nitrogen deposition by pollution (NABEL 2013), which independently tends to increase proportion of nitrophilous species (Draeger 2011; Kohli 2011). Our results are not able to directly show an impact of *R. pseudoacacia* on rare or threatened species, because the comparison in species cover was limited to frequent species, with presences in at least six plots. Hence, rare species were by definition excluded of the analyses and many more sites, selected around rare species, would be necessary to evaluate more exactly this potential impact. But this would require a huge time investment to find the right sites.

This study showed that *R. pseudoacacia* settle potentially almost everywhere in lowlands and mountain up to 1000 m, as far as mean annual temperature is above 5°C, with a large ecological amplitude. It means that forests with particular ecological conditions (e.g., wet forests or alluvial forests along river, dry forests on slopes), which often include rare and endangered species, are concerned too. Climate change will very probably extend its available area in the future towards higher elevations (Walkovszky 1998). *R. pseudoacacia* strongly modifies soil chemistry, by increasing nitrogen content, and understorey conditions, because of its light foliage. Therefore, it is able to change the understorey plant composition in climactic forests of Central Europe. Nitrophilous species and vines gradually invade the forest and potentially threaten oligotrophic and short-growing plants. The anthropogenic disturbances of landscapes facilitate the spread and development of *R. pseudoacacia* (Lee et al. 2004), and it is still too often favoured or even planted. However, once it has developed stands in the tree layer, the difficulty to eradicate it was many times demonstrated (e.g., Muller 2004), and even colonisation of new areas is difficult to stop. In northern part of Switzerland, *R. pseudoacacia* is still sparse but it should be monitored more closely in order to avoid further invasions, any use in forest management has to be banned and efforts have to be invested to eradicate it, or at least to contain its invasion. Otherwise biodiversity in Central European forests might dramatically change in the future on large areas.

Figures

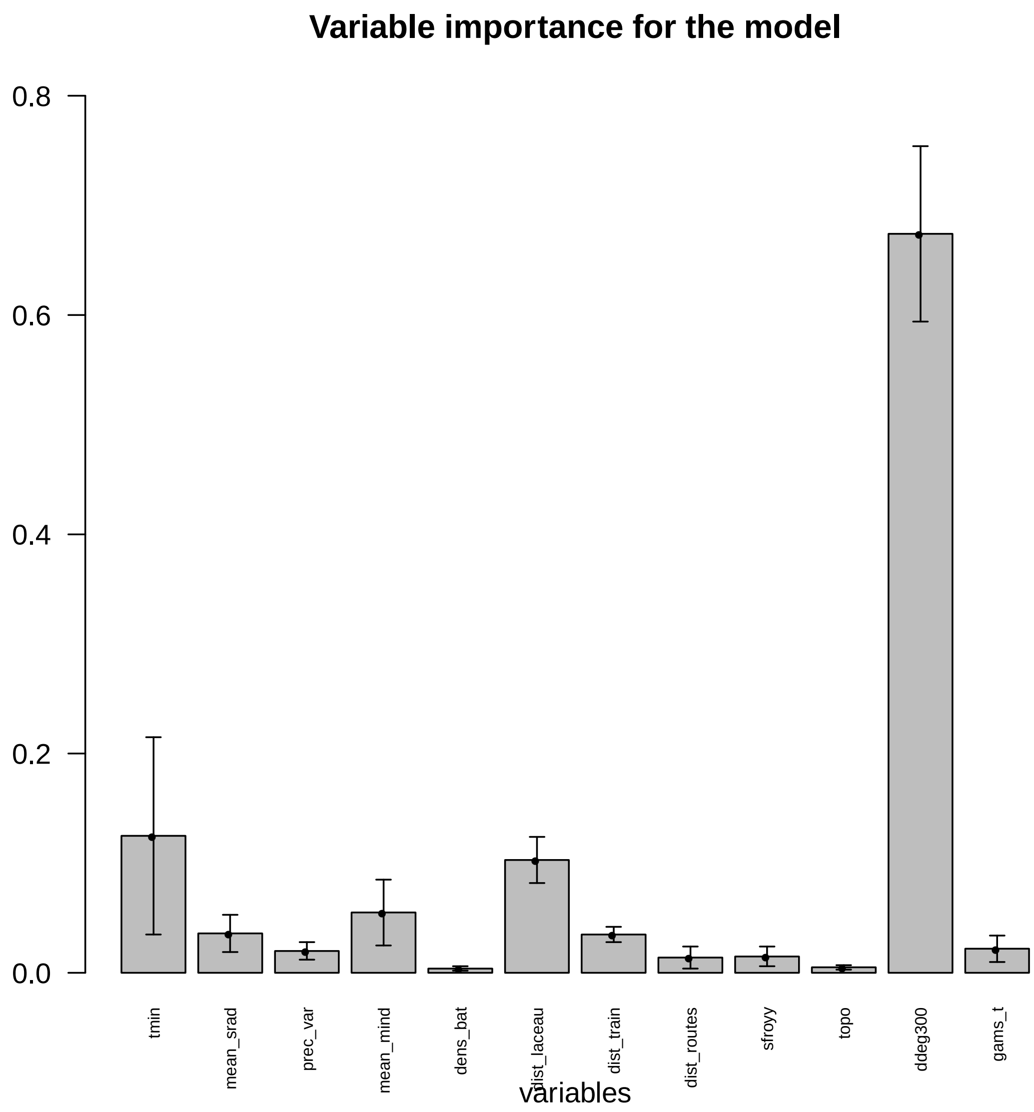
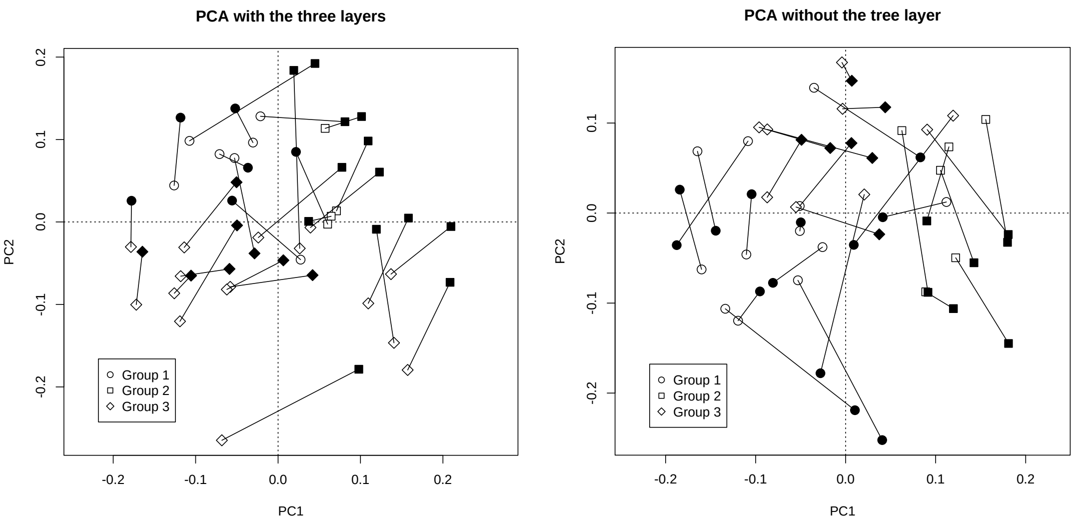


Figure 1: Environmental variable importance in the species distribution model of *R. pseudoacacia*. The 12 environmental variables are: tmin: Minimal annual temperature; mean srad: Annual mean of daily average of potential short wave radiation; prec. var.: Variance of precipitations; mean mind: Mean of monthly moisture index; dens. bat.: Density of building;

dist. laceau: Distance to lake and watercourse; dist. train: Distance to railway; dist. routes: Distance to routes; sfroyy: Average number of frost days during the growing season (core 90% of the vegetation period, the days with a mean daily temperature above 3°C); topo: Topographic position (concave to convexe); ddeg300: Annual degree-day; gams t: Continentality index of Gams (general seasonality of climate derived from annual precipitation and mean annual temperature).



a b

Figure 2: PCA of plots based on species (a) with tree and (b) without tree layer. The pairs of plots are joined. The black symbols represent the plots with *R. pseudoacacia* and the white without *R. pseudoacacia*. Group: groups of plots according to a hierarchical clustering.

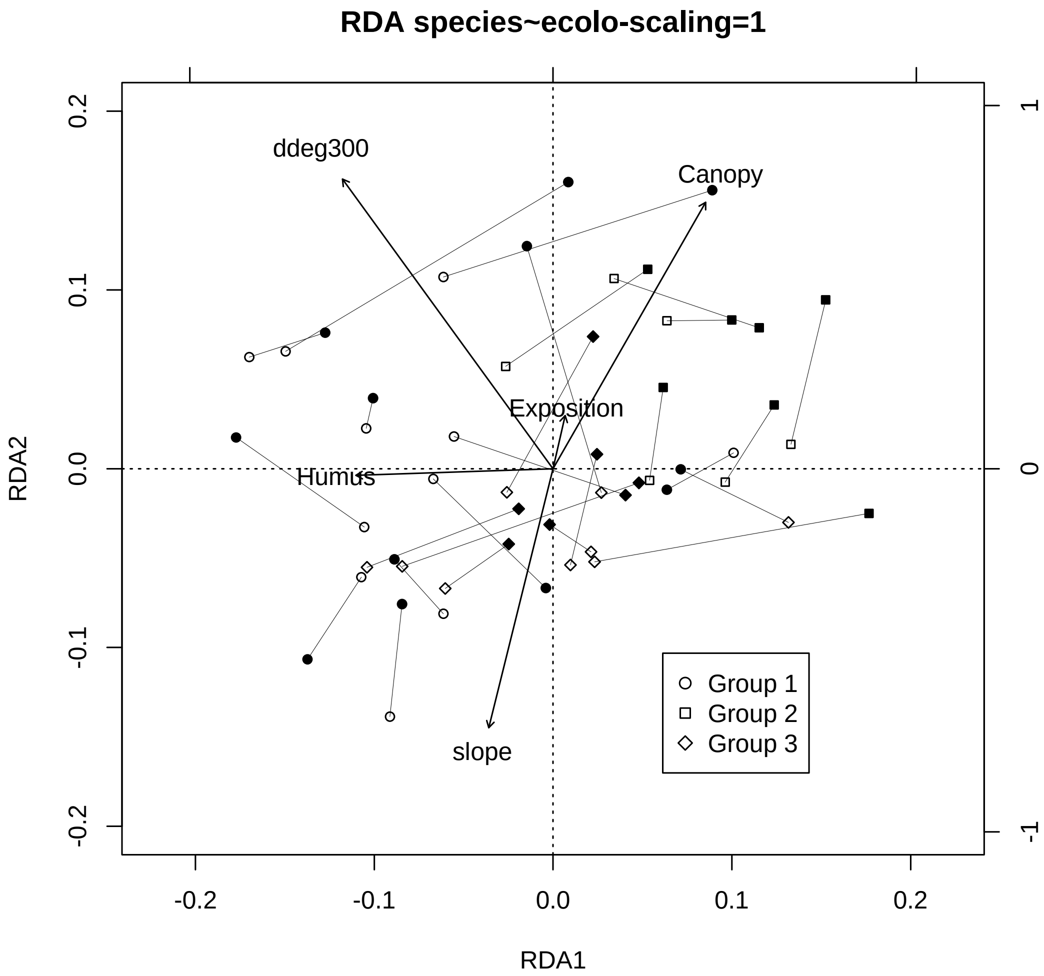


Figure 3: RDA of plots, considering only undergrowth (herb and shrub layers) with the ecological variables ddeg300 (degree day), canopy, humus type, slope and exposition. The pairs of plots are joined. The black symbols represent the plots with *R. pseudoacacia* and the white without *R. pseudoacacia*. Groups: groups of sites according a hierarchical clustering.

Tables

Table 1: Scale used for plant cover estimates in the field, with corresponding cover (Braun-Blanquet 1964) and the transformations used in the analyses.

Cover classes	% Plant coverage	Values used in the analyses
r	One individual	1
+	<1%	2
1	1-4%	3
2a	5-14%	4
2b	15-24%	5
3	25-49%	6
4	50-75%	7
5	>75%	8

Table 2: Standardized mean differences of variables for the two types of plots [95%Wald CI] and p-values of the paired t-test. Canopy is the measured proportion of gaps in the tree layer. H_{max} is the maximum size of the understorey plants. Species richness is the number of different species in plots. SLA is the specific leaf area [mm^2/mg]. Total cover is the total species cover of undergrowth. N is an index (1-5) of nutrient availability (mainly nitrogen; Landolt et al. 2010).

Variables	**Standardized mean difference [95%Wald CI]**	**P-value (paired t-test)**
Canopy	0.218 [-0.315; 0.751]	0.2379
Humus	-2.901 [-3.503; -2.436]	**< 0.0001**
Total cover	0.724 [0.191; 1.257]	**0.0025**
Species richness	0.387 [-0.145; 0.921]	0.1454
H_{max}	0.372 [-0.160; 0.906]	0.1486
SLA	0.353 [-0.179; 0.887]	0.0851
N	0.157 [0.054; 0.261]	**0.0043**

Table 3: Difference of species frequency (nb of occurrences in the plots; Freq.) and mean species cover (measured by point method, in %; Cov_mean) in the plots with (a) and without *R. pseudoacacia* (b). Species are sorted according to the difference of mean cover (diff. mean). N is the ecological indicator value (1-5) for nutrient availability (mainly nitrogen; Landolt et al. 2010). B after species is the shrub and H the understorey layers. We retained only the species that were present in six or more relevés and who had in at least one plot a cover of three or more.

Species	Freq_a	Freq_b	Mean Cov. A %	Mean Cov. B %	Diff. Cov. %	N
Clematis.vitalba.H	10	4	19.60	2.75	16.85	3
Aegopodium.podagraria.H	3	5	24.33	12.70	11.63	**4**
Mercurialis.perennis.H	3	3	15.67	5.33	10.33	3
Galium.aparine.H	6	0	5.75	0.00	5.75	**5**
Rubus.fructicosus.H	16	10	10.53	4.90	5.63	**4**
Clematis.vitalba.B	13	4	6.81	1.50	5.31	3
Corylus.avellana.B	15	16	9.73	5.22	4.51	3
Robinia.pseudoaccacia.B	12	0	4.29	0.00	4.29	**4**
Rubus.fructicosus.B	16	11	13.94	10.55	3.39	**4**
Hedera.helix.H	18	21	29.31	26.71	2.59	3
Brachypodium.sylvaticum.H	8	4	9.19	7.63	1.56	3
Prunus.avium.B	8	7	4.31	2.86	1.46	3
Lamium.galeobdolon.H	10	7	6.00	4.64	1.36	3
Hedera.helix.B	3	4	1.67	0.63	1.04	3
Abies.alba.B	4	3	2.00	1.00	1.00	3
Crataegus.monogyna.B	9	9	2.00	1.06	0.94	3
Ligustrum.vulgare.H	7	8	2.86	2.00	0.86	3
Juglans.regia.B	3	4	1.83	1.00	0.83	**4**
Stachys.sylvatica.H	7	6	8.57	7.83	0.74	**4**
Acer.platanoides.B	3	3	1.00	0.67	0.33	3
Allium.ursinum.H	4	3	1.13	0.83	0.29	3
Alliaria.petiolata.H	4	2	1.75	1.50	0.25	**5**
Juglans.regia.H	4	5	0.88	0.80	0.08	**4**
Cornus.sanguinea.H	9	9	1.72	1.67	0.06	3
Lonicera.xylosteum.H	2	4	1.00	1.00	0.00	3
Carpinus.betulus.B	4	3	1.88	2.00	-0.13	3
Acer.platanoides.H	3	4	1.67	1.88	-0.21	3
Picea.abies.B	2	4	1.00	1.25	-0.25	3
Viburnum.opulus.B	4	4	2.13	2.38	-0.25	3
Acer.pseudoplatanus.H	8	8	1.44	1.75	-0.31	3
Fraxinus.excelsior.B	15	13	2.07	2.38	-0.32	3
Acer.campestre.H	2	4	0.50	0.88	-0.38	3
Corylus.avellana.H	6	4	1.75	2.13	-0.38	3
Lonicera.xylosteum.B	12	11	3.42	3.91	-0.49	3
Prunus.avium.H	5	4	0.80	1.38	-0.58	3
Fraxinus.excelsior.H	15	14	3.87	4.46	-0.60	3
Acer.campestre.B	4	5	1.63	2.80	-1.18	3
Ligustrum.vulgare.B	6	8	5.08	6.56	-1.48	3
Cornus.sanguinea.B	12	10	6.08	7.80	-1.72	3
Acer.pseudoplatanus.B	10	8	2.80	4.63	-1.83	3
Fagus.sylvatica.B	9	9	3.28	7.50	-4.22	3
Fagus.sylvatica.H	4	6	1.63	7.42	-5.79	3
Polygonatum.multiflorum.H	5	2	1.70	8.00	-6.30	3

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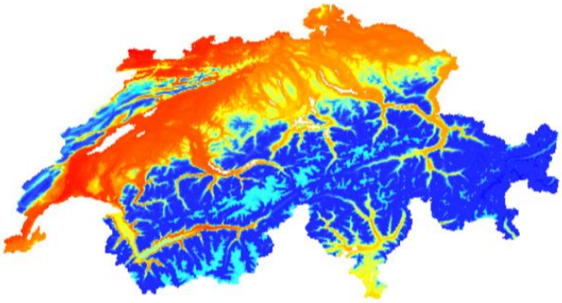
Annexes



Annexe1: Map of model projection of *Robinia pseudoacacia* in Switzerland. Red: more probable presence, to blue: less probable presence.

Annexe 2: Table of species cover (with visual estimation) of the 54 plots. Each plot code contains the indication of presence (a) or absence (b) of *Robinia pseudoacacia* and the region in which the stand is located (vd, Vaud, up to east extremity of Lake of Geneva; ch, Chablais, Rhone valley in upland of Lake of Geneva, up to Martigny; vs, Central Valais, with low annual precipitations). NO-ISFS is the official code of the species in Switzerland (www.infoflora.ch). Tree (A), shrub (B) and herb (H) layers are indicated after species name for trees and shrubs species.

Annexe 2 Species recorded in the 27 pairs of plots, with cover according to Braun-Blanquet (1964).

Code	Species	1a_vd	1b_vd	2a_vd	2b_vd	3a_vd	3b_vd	4a_vd	4b_vd	5a_vd	5b_vd	6a_vd	6b_vd	7a_vd	7b_vd	8a_vd	8b_vd	9a_vd	9b_vd	10a_vd	10b_vd	11a_vd	11b_vd	12a_vd	12b_vd	13a_ch	13b_ch	14a_ch	14b_ch	15a_ch	15b_ch	16a_ch	16b_ch	1a_vs	1b_vs	2a_ch	2b_ch	3a_ch	3b_ch	4a_vs	4b_vs	5a_vs	5b_vs	6a_vs	6b_vs	7a_vs	7b_vs	8a_vs	8b_vs	9a_vs	9b_vs	10a_vs	10b_vs	11a_vs	11b_vs
	Site	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11
	Region	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	vd	ch	ch	ch	ch	ch	ch	ch	ch	vs	vs	ch	ch	ch	ch	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs	vs
Code	**Species**																																																						
100	Abies alba A																3							2a	2b					2b		2a								2a															
100	Abies alba B															2a	2a				+			1	1						1	1	1					2a	1																
100	Abies alba H																							r			r			r								+	+						r										
300	Acer campestre A	2b			1	2b			1								2a							1		2a												1														2a	2a		
300	Acer campestre B	+				+	2a	+								1	1	1			2a				+			1											1													1	1		
300	Acer campestre H	+	r				1	r	r							+	1		+		1	r		1														+			+												+		
600	Acer opalus A																										2b																												
700	Acer platanoides A	3	4																																																				
700	Acer platanoides B																	2a			+		1			1	1	2a	2a			1																2a							
700	Acer platanoides H	r	r		r		r														+	1	1						1		r	1	+			r	r	+																+	
800	Acer pseudoplatanus A				4	+	3					1	2b	2a			2a	2b	2a			2b		2b	2a							2a							2b																
800	Acer pseudoplatanus B	2a	+			+	2b	+	+		r	+	1	2a		+	1	2a	1			1	4	2a	2a			2a				1						1	1									2a	1					2a	
800	Acer pseudoplatanus H	3	1			+	+		r		r		+	+	+		+	1	+			1	1	+	+					r		1										+						1						1	+
1700	Achillea millefolium H																																											r											
6300	Adoxa moschatellina H								+																																														
6800	Aegopodium pdagraria H			2a	3	3		r						2b	1																			+			+														2b				
10400	Ajuga reptans H																																				r																		
22100	Alliaria petiolata H					r	+	+	1			1	+	1					r															1																					
24800	Allium ursinum H	r	r	+	r	+	r	r	+					+		r		+							r		1			1		1																							
25200	Alnus glutinosa B										2a	1																												2a	2a														
25200	Alnus glutinosa H										1	r																																											
25300	Alnus incana B																																														1	1	1						
25300	Alnus incana H																																														+								
33600	Anemone nemorosa H	r	r			r	r									+				r							+						+							1		+								+					
33700	Anemone ranunculoides H		r																																																				
42200	Arctium lapa H																																	2a																+					
45900	Arrhenatehrum elatius H																											r																											
48000	Artemisia vulgaris H																																																	2a					
48200	Arum maculatum H	+	r	r	r			r	r						r			+				r			r							r																							
48300	Aruncus dioicus H																					2b																																	
51200	Asplenium septentrionale H																																											+											
51400	Asplenium trichomanes H															r																																							
55700	Athyrium filix-femina																																							+															
59200	Berberis vulgaris B																																		r											2a	2a		2b						
59200	Berberis vulgaris H																																														1					2a			
60400	Betula pendula A										3																									1	2a			2b	3			2b					2a		2b		2b	2b	
60400	Betula pendula B																																							+				2a					2a		1				
60400	Betula pendula H																																											+											
64200	Brachypodium sylvaticum H	+	r									+			1						+			1	1		1	2a						1		+	2a			2a	1			2a		+				2a		1			
65700	Bromus erectus H																											r																		4		3							
71400	Calamagrostis varia H																											2a																											
77100	Campanula rotundifolia H																																											+											
77600	Campanula trachelium H															+																																							
81100	Cardaria draba H																																	+																					
83100	Carex alba H																									1	1		+									2a	4																
86100	Carex digitata H														+												1											2a																	
87500	Carex flacca H		r																		+																			+			4												
88800	Carex humilis H																																														r								
96900	Carpinus betulus A	+														2a			4	2a		3	2a							2a	4							2a	2a																

		1a_vd	1b_vd	2a_vd	2b_vd	3a_vd	3b_vd	4a_vd	4b_vd	5a_vd	5b_vd	6a_vd	6b_vd	7a_vd	7b_vd	8a_vd	8b_vd	9a_vd	9b_vd	10a_vd	10b_vd	11a_vd	11b_vd	12a_vd	12b_vd	13a_ch	13b_ch	14a_ch	14b_ch	15a_ch	15b_ch	16a_ch	16b_ch	1a_vs	1b_vs	2a_ch	2b_ch	3a_ch	3b_ch	4a_vs	4b_vs	5a_vs	5b_vs	6a_vs	6b_vs	7a_vs	7b_vs	8a_vs	8b_vs	9a_vs	9b_vs	10a_vs	10b_vs	11a_vs	11b_vs
96900	Carpinus betulus B	+														+	1	1	2b			2a				1													1																
96900	Carpinus betulus H	+															1	1				+				1				+																									
97200	Castanea sativa A																															1	4				2b																		
97200	Castanea sativa B																							r							1										2a														
97200	Castanea sativa H																						r										+																						
100000	Centaurea scabiosa H																																														r								
108200	Chelidonium majus H													+			r																	+								2a													
113500	Circaea lutetiana H																																							+															
116400	Clematis vitalba A	1	1					+		1		1		2b	2a											2a								2a				2b								2b				2a					
116400	Clematis vitalba B		r									1			+	1	1									1		1						2b			2a	1						+		2b		2a		2a		3	2a	2a	
116400	Clematis vitalba H	+	+	3	+	+						+					2a																	4												2a		1		2a		2a		3	1
118800	Convallaria majalis H																																				r																	
119600	Cornus mas H																																											1											
119700	Cornus sanguinea A					2b																																																	
119700	Cornus sanguinea B					2b				1	2a	4	2a	1	1	+	1							2b		2a	2a	2a						1	1			1	2a		2a		4			2a		1	1	2a	2a	2b	2a	2a	
119700	Cornus sanguinea H	r				1				1	+	+	+		1	+	+							1	+	1								+	1			1		+	+		2a			1	1	+	+	r	+	1	+	1	
121600	Corylus avellana A	3	1		2a	1		+		+										2b															2b		2a																	
121600	Corylus avellana B	1	3		3	2b	1	2b	r	2a	2a		3	3	2a	2a	+	2b	1	2a	2a	2b		2b		4		4	1	1	1	+	2a	2a	2b	2a	1	2b	2a	1		2b	2b						2b	1	1		2b	1	2a
121600	Corylus avellana H	1	+		+	r	r	1		+	r		r		+	+	r	+	+	r	1	1		1	+			1		+			+	1	1			r		+	+		+										2b	+	r
122400	Crataegus monogyna B	1			2b											2a		1	2a	+	1			2a		2a	2a	2a	1	1				+	+			2b	2a			1	1										1	1	
122400	Crataegus monogyna H	r	r													+	r		+		1						+	1	+													+										1		+	
123100	Crepis biennis H																											+																										
124800	Crepis pyrenaica H																											r																										
131800	Dactylis glomerata H																+											+																										
134800	Deschampsia cespitosa H										2a																																											
143500	Dryopteris filix-mas H															r																1								1				1											
146460	Elymus caninus H					r	+		r						+																																								
149600	Epipactis atrorubens H																																											r											
149800	Epipactis helledorine aggr. H																																													+	r								
150800	Equisetum hyemale H									+	r	2a																																										
151500	Equisetum telmateia H						r					r	+												+																1														
159000	Euonymus europaeus B			+				1		1	2a	1	1			1			+					1																														
159000	Euonymus europaeus H							+			1	+	+	r	+																																							
159900	Euphorbia dulcis H		r		r									+													r	r																									
165000	Fagus sylvatica A															3				2a	2a	3	5		4		5	3	3	3	2a	3				2b									2b										
165000	Fagus sylvatica B	r	2a												3	2a			+		1	2a		2a	1		1	2a		2a		2a	2a					2a						3	5										
165000	Fagus sylvatica H														+					+	1	+	1	+	1		3		2a	1		+	+											1	+										
170200	Festuca rubra aggr. H																											2a																										
173800	Fragaria vesca H															+																								1				+		+	+		+						r
174000	Frangula alnus A										4																																											
174000	Frangula alnus B										1																								+																			
174000	Frangula alnus H										+																																					r						
174200	Fraxinus excelsior A		2a		+	1		2a	2a	1	1	2b	3	1			2a	3	2b		2b	4	2a	3			2b	2b							1	2a		2a	2a		2b	2b	4					1						2b	3
174200	Fraxinus excelsior B	+	+			+	+	+		+	+	+	+		1	+	1	1	1	1	2a			1	+	2a	2a	1	1		3	2b	1	1				1	2a	1	2a		1	1		2a		+						1	1
174200	Fraxinus excelsior H	1	+				r	+	r		+	r		r	1	1	+	+	+	+	2a	1	1	+	1	1	1	1	1	+	1	2a	1		1	1	1	2b	2a	2a	1	1	1	+				+	1					1	1
176500	Galeopsis bifida H																																																			+		
176600	Galeopsis ladanum H																																											r											
177100	Galeopsis tetrahit H																																			r	+																	
177400	Galium album H		r							r																																		+											
177600	Galium aparine H		r	2a		+				+		1	1	1																				+																				
178900	Galium mollugo H																																										+										+		+
179300	Galium odoratum H															+							+	1	3							+	+			1	r																	+
179800	Galium pumilum H																																											2a											
180400	Galium sylvaticum H																																											+											

		1a_vd	1b_vd	2a_vd	2b_vd	3a_vd	3b_vd	4a_vd	4b_vd	5a_vd	5b_vd	6a_vd	6b_vd	7a_vd	7b_vd	8a_vd	8b_vd	9a_vd	9b_vd	10a_vd	10b_vd	11a_vd	11b_vd	12a_vd	12b_vd	13a_ch	13b_ch	14a_ch	14b_ch	15a_ch	15b_ch	16a_ch	16b_ch	1a_vs	1b_vs	2a_ch	2b_ch	3a_ch	3b_ch	4a_vs	4b_vs	5a_vs	5b_vs	6a_vs	6b_vs	7a_vs	7b_vs	8a_vs	8b_vs	9a_vs	9b_vs	10a_vs	10b_vs	11a_vs	11b_vs
188600	Geranium pyrenaicum H								r							1																				+																			
188800	Geranium robertianum H							r				1																								1							+							+		r	r	r	
189300	Geranium sylvaticum H																																										+												
189700	Geum urbanum H					+	1		r			1		+														1	r							+	r			1				+										+	
194000	Hedera helix A	+	2a				+	3							1	1	1	2a	3	2a		2a				2a		2b	2b	1	2a	2a	2a		2a	2a		2b	2b	2a											2a				2b
194000	Hedera helix B	r	+				r	+	1					r	1		+	1			1			1		1		+	2a		2a		1	r		1		1		1						1		1						1	2a
194000	Hedera helix H	2a	4		r	r	1	4	4			+		1	2a	1	4	5	4		4	2a	2a	3	3	3	4	4	3		1	1	+	4	3	2b	1	3	1	1						2a	1	2b	2a		2b		1	3	4
197900	Hepatica nobilis H																			2a									+							2a	1					1							+				1		
198600	Heracleum sphondilium H		r						r																											1																			
202600	Hieracium murorum H																																																r						
203400	Hieracium pilosella H																																											+											
208800	Humulus lupulus A											+																																											
208800	Humulus lupulus B									2a					1																			+																					
208800	Humulus lupulus H										1																																	r											
213300	Ilex aquifolium B																								2a							+									r														
213300	Ilex aquifolium H																								r								+																						
213800	Impatiens parviflora H							1	+			+	+	+											r																														
217500	Juglans regia A		+			1	1																												2b																				
217500	Juglans regia B			1		1	1																		2a					2a	2a	1		1	+															1	1				
217500	Juglans regia H		+			r	+	r													+			r	+					1	1	1		+	1															+	+		r	1	
220400	Juniperus communis H																																														1								
225800	Lamium galeobdolon H	+	+	1	2a	+	+	r	+			r		2b	1	+		r	r	+	1		1	+	+			+		r		2a																		1		+	+	1	r
227000	Lapsana communis H											+																r												r															
227200	Larix decidua A																	3																														2b							
231200	Lathyrus vernus H																																											r											
233100	Leontodon hispidus H																											+																											
238100	Ligustrum vulgare B										1					1			1	2a	1			1	+	2a	2a	1							r			2a	2b				2b				1				+	2a	2b	1	1
238100	Ligustrum vulgare H										1				1	1			+	1	+			1	1	1	+	+				+		+				1	1				1	+	r		+		+			+	1	+	1
244000	Lonicera periclymenum H									+																																													1
244200	Lonicera xylosteum B	2a	+		1			1		1	1	1		1	2a	2b			1	2a	1			1		2a	2a	2a							2a			1	2a	2a	2a	+	1				2a	1	2a		2a		2b	2b	
244200	Lonicera xylosteum H	r												r		1				1															1			1	1		+	+					1	+						+	
252800	Malus domestica A																																																			2b			
252800	Malus domestica B																																																			2a			
252800	Malus domestica H																																																			+			
256500	Melampyrum pratense H																																														4		4		2b				
256900	Melica nutans H																																	+												+									
257900	Melittis melissophyllum H																							r																															
259100	Mercurialis perennis H		r		2a	r	r	r	1									2a	1																	3	1																		
259800	Millum effusum H											r																																											
265700	Mycelis muralis H															r																					r																		
270100	Neottia nidus-avis H															r																			r														r						
281600	Orchis purpurea H																r																																						
283400	Ornithogalum pyrenaicum H			+	r	r	r																																																
287300	Oxalis acetosella H																															+																							
292600	Paris quadrifolia H				r						r				r							+		r																		r													
293200	Parthenocissus quinquefolia H																																	r																					
302400	Phyteuma spicatum H																					r																																	
302800	Picea abies A																			4	3		1			2a			2a	2b	2b	2b	3						2b					3	2b										
302800	Picea abies B															+										1		2a		2a									2b						+								2a		1
302800	Picea abies H																				+																								r				+						
304900	Pinus cembra A																																							2a															
306100	Pinus sylvestris A														2a											1												3	4					3	3	4	5	2b	5	4	4		3		2b
306100	Pinus sylvestris B																																													2a			2a	1					
309200	poa annua H																												+																										

		1a_vd	1b_vd	2a_vd	2b_vd	3a_vd	3b_vd	4a_vd	4b_vd	5a_vd	5b_vd	6a_vd	6b_vd	7a_vd	7b_vd	8a_vd	8b_vd	9a_vd	9b_vd	10a_vd	10b_vd	11a_vd	11b_vd	12a_vd	12b_vd
310500	Poa nemoralis H											r	r	+	+						1				
313400	Polygonatum multiflorum H					r								+		+	r	1				r		1	
313500	Polygonatum odoratum H							r							r									r	
317100	Populus alba A																								
317100	Populus alba B																								
317100	Populus alba H																								
317400	Populus nigra A				2a	1							2a												
317400	Populus nigra B																								
317500	Populus tremula A																								
325500	Primula acaulis H	r																							
326000	Primula elatior H				r					r						r				r				1	
327200	Primule veris H																r								
328400	Prunus avium A	2a							5				1			2a									
328400	Prunus avium B	+					1		+			+	1	+	2a	1	+			3	2a				
328400	Prunus avium H	+	r				r		r			r	r			+				1	1				
329400	Prunus laurocerasus B							+																	
329500	Prunus mahaleb A																								
329500	Prunus mahaleb B																								
329500	prunus mahaleb H																								
330300	Prunus spinosa B	+	r													1									
330300	Prunus spinosa H	+			r																				
332800	Pulmonaria obscura H				+															r					
335900	Quercus petraea A							2a							3				4	2a					
335900	Quercus petraea B										+													+	
335900	Quercus petraea H																	r						+	+
336000	Quercus pubescens A																								
336000	Quercus pubescens B																								
336000	Quercus pubescens H																								
336100	Quercus robur A															2a					1				
336100	Quercus robur B																								
336100	Quercus robur H	r	r													r					1				
337300	Ranunculus auricomus H													r											
346300	Ribes rubrum B						1																		
346300	Ribes rubrum H						r																		
346500	Robinia pseudoaccacia A	2b		5		4		4		3		4		3		3		4		3		3		3	
346500	Robinia pseudoaccacia B			2b												1									
346500	Robinia pseudoaccacia H															r									
349900	Rosa rubiginosa B																		1		1	+			
349900	Rosa rubiginosa H																		+	r	+	+			
352200	Rubus caesius H	+																							
353100	Rubus fructicosus B		+			+		r	1	2b	1	2a	2a	2a	2b	1				3	1		+	+	1
353100	Rubus fructicosus H		1	2b		3		r	r	+		1	1	1	2a	+			+	3	2a	r	1	+	+
362800	Salix alba A									2b															
362800	Salix alba B						1																		
363700	Salix caprea A									2a															
368300	Sambucus nigra B					1								2a				1							
368300	Sambucus nigra H																	r							
369100	sanicula europaea H																								
379700	Scirpus sylvaticus H						+			3	1		2a												1
397300	Silene vulgaris H																								
401000	Solidago canaedris H																								
401100	Solidago gigantea H									2a	+														
401400	Solidago virgaurea H																								
402200	Sorbus aria B																								

		13a_ch	13b_ch	14a_ch	14b_ch	15a_ch	15b_ch	16a_ch	16b_ch	1a_vs	1b_vs	2a_ch	2b_ch	3a_ch	3b_ch	4a_vs	4b_vs	5a_vs	5b_vs	6a_vs	6b_vs	7a_vs	7b_vs	8a_vs	8b_vs	9a_vs	9b_vs	10a_vs	10b_vs	11a_vs	11b_vs
310500	Poa nemoralis H																														
313400	Polygonatum multiflorum H	+	1	r				r				r										1		r			2a			r	r
313500	Polygonatum odoratum H					+				+																			r		
317100	Populus alba A									3	2a																				
317100	Populus alba B									r																					
317100	Populus alba H									+	r																				
317400	Populus nigra A										3													3							
317400	Populus nigra B																							2a							
317500	Populus tremula A																2a														
325500	Primula acaulis H																														
326000	Primula elatior H																														
327200	Primule veris H											r	r																		
328400	Prunus avium A	2a			3						3									2b		2a		2b		2b	2a		2b	2b	2a
328400	Prunus avium B	+	1	2a	2a						+	1		1			1					2a		2b		2a	1			1	+
328400	Prunus avium H	+	+		1					+	+		+	+						1		1	+	+	+	+	+		+	+	
329400	Prunus laurocerasus B																														
329500	Prunus mahaleb A																	2a													
329500	Prunus mahaleb B																		2a	1		2a		2a			1				
329500	prunus mahaleb H																					+	+	+	+						
330300	Prunus spinosa B																					2a									
330300	Prunus spinosa H									+													+								
332800	Pulmonaria obscura H																														
335900	Quercus petraea A																														
335900	Quercus petraea B																														
335900	Quercus petraea H										+			r																	
336000	Quercus pubescens A	2b											2a									2b				+	2b		2b		
336000	Quercus pubescens B												1							2a		2a	1		1	1			2a		
336000	Quercus pubescens H																			r		1	1		1	+	+		r		
336100	Quercus robur A	2a	2b				2a																								
336100	Quercus robur B	1																													
336100	Quercus robur H			+		+	r										+														
337300	Ranunculus auricomus H																														
346300	Ribes rubrum B																														
346300	Ribes rubrum H																														
346500	Robinia pseudoaccacia A	3		3		5		4		4		4		4		5		4		4		3		3		4		4		3	
346500	Robinia pseudoaccacia B					+				2b				2a		2a				2b		2a		2b		2b		3		2a	
346500	Robinia pseudoaccacia H					+														2a		1				1		2a			
349900	Rosa rubiginosa B													r									+	1					1		
349900	Rosa rubiginosa H																														
352200	Rubus caesius H									2a																					
353100	Rubus fructicosus B	3	3	1		2b	2a	2a								1	1	1	2a			2a		2a		3	1				2a
353100	Rubus fructicosus H	+	1	1		1	1	1				+		1		4	1	1				1		1		1	1	1	+	2b	1
362800	Salix alba A										1																				2a
362800	Salix alba B																														
363700	Salix caprea A																			2a											
368300	Sambucus nigra B									+		3						3								2b	3			2a	
368300	Sambucus nigra H											1																			1
369100	sanicula europaea H												r																		
379700	Scirpus sylvaticus H	+															4														
397300	Silene vulgaris H									+																					
401000	Solidago canaedris H									1																					
401100	Solidago gigantea H			r																						2a					
401400	Solidago virgaurea H																						2a		1						
402200	Sorbus aria B														1				2a												

		1a_vd	1b_vd	2a_vd	2b_vd	3a_vd	3b_vd	4a_vd	4b_vd	5a_vd	5b_vd	6a_vd	6b_vd	7a_vd	7b_vd	8a_vd	8b_vd	9a_vd	9b_vd	10a_vd	10b_vd	11a_vd	11b_vd	12a_vd	12b_vd	13a_ch	13b_ch	14a_ch	14b_ch	15a_ch	15b_ch	16a_ch	16b_ch	1a_vs	1b_vs	2a_ch	2b_ch	3a_ch	3b_ch	4a_vs	4b_vs	5a_vs	5b_vs	6a_vs	6b_vs	7a_vs	7b_vs	8a_vs	8b_vs	9a_vs	9b_vs	10a_vs	10b_vs	11a_vs	11b_vs
402300	Sorbus aucuparia B							2a																																															
406800	Stachys sylvatica H			4		+	1	r				+		2a		+		+		r	+	+	2a	+	2a		r	+				2a	+			+	r																		+
407800	Stellaria media H															r																																							
411200	Tamus communis B																							2b																															
411200	Tamus communis H							r			+				+		r							3	+	r	+		+				r			+				+		+										1			
413100	Taraxacum officinale H																							r				r						+																					
421400	Tilia cordata A																													2a	1					2a	5				2b														
421400	Tilia cordata B																														2a					+					2a														
421400	Tilia cordata H																																								+														
421500	Tilia platyphyllos A						+															4	2a									2a	2b																				3		
421500	Tilia platyphyllos B																					2b										1	2a																				2a		
421500	Tilia platyphyllos H																										+						+																						
422100	Torilis japonica H																																				1																		
426000	Trifolium medium H																																																				1		
426300	Trifolium montanum H																																														+								
429400	trisetum flavescens H					+																																																	
432800	Ulmus glabra A														3																									2a															
432800	Ulmus glabra B														2a																								2b																
432800	Ulmus glabra H																				1																		1																
433400	Urtica dioica H			3		1		r		r				r																				1								+								1	1			+	
444300	Viburnum lantana B																							2a	2a	2a	2a	2a	1						1			1													1				
444300	Viburnum lantana H																				+			1	1			1	r						+		r	1		r											1				
444400	Viburnum opulus B											r	2a		2a													2a			1	1			2a											1	1	2a	2a				2a		
444400	Viburnum opulus H										r		+		+								r		1							+			+			1									1	1	1				+		1
445000	Vicia cracca H																																											1	r										
445400	Vicia dumetorum H																																			1	r																		
451000	Viola odorata H																																			1	+																		
451600	Viola reichenbachiana H																												+																										

Annexe 3 Environmental factors measured in the stands.

	Site	Region	Robinia	Elevation [m]	Slope [°]	Exposition [°]	Canopy	Humus
1a_vd	1	vd	Yes	405	0	0	8	hemimoder
1b_vd	1	vd	No	405	0	0	7.75	hemimoder
2a_vd	2	vd	Yes	393	0	0	17.75	mesomull
2b_vd	2	vd	No	393	0	0	11	hemimoder
3a_vd	3	vd	Yes	395	0	0	9.25	mesomull
3b_vd	3	vd	No	395	0	0	10.25	hemimoder
4a_vd	4	vd	Yes	389	0	0	6.25	hemimor
4b_vd	4	vd	No	397	0	0	8.25	oligomull
5a_vd	5	vd	Yes	456	0	0	11.25	mesomull
5b_vd	5	vd	No	440	0	0	10.25	mesomull
6a_vd	6	vd	Yes	443	0	0	9.25	mesomull
6b_vd	6	vd	No	425	0	0	5.75	hemimoder
7a_vd	7	vd	Yes	439	0	0	6.75	mesomull
7b_vd	7	vd	No	446	0	0	7.75	hemimoder
8a_vd	8	vd	Yes	448	0	0	9	mesomull
8b_vd	8	vd	No	445	0	0	5.25	hemimoder
9a_vd	9	vd	Yes	461	45	44	4	mesomull
9b_vd	9	vd	No	474	45	43	4.75	hemimoder
10a_vd	10	vd	Yes	497	0	0	5.75	mesomull
10b_vd	10	vd	No	495	0	0	5.5	hemimoder
11a_vd	11	vd	Yes	560	45	62	3	mesomull
11b_vd	11	vd	No	551	10	66	3.5	hemimoder
12a_vd	12	vd	Yes	585	41	37	6	mesomull
12b_vd	12	vd	No	567	12	34	7.75	hemimoder
13a_ch	13	ch	Yes	438	0	0	8.5	mesomull
13b_ch	13	ch	No	426	0	0	4.25	hemimoder
14a_ch	14	ch	Yes	427	23	312	9.25	mesomull
14b_ch	14	ch	No	437	0	0	4.5	hemimoder
15a_ch	15	ch	Yes	474	15	322	4	mesomull
15b_ch	15	ch	No	473	11	329	5.5	hemimoder
16a_ch	16	ch	Yes	484	10	217	5.75	mesomull
16b_ch	16	ch	No	469	12	223	5.25	hemimoder
1a_vs	1	vs	Yes	485	0	0	12	mesomull
1b_vs	1	vs	No	485	0	0	7	hemimoder
2a_ch	2	ch	Yes	461	45	138	4.25	mesomull
2b_ch	2	ch	No	534	32	122	4.25	mesomull
3a_ch	3	ch	Yes	464	0	0	5.5	mesomull
3b_ch	3	ch	No	451	0	0	7	hemimoder
4a_vs	4	vs	Yes	472	0	0	6.25	mesomull
4b_vs	4	vs	No	478	0	0	5.75	hemimoder
5a_vs	5	vs	Yes	769	0	0	6.5	mesomull
5b_vs	5	vs	No	754	0	0	7.25	hemimoder
6a_vs	6	vs	Yes	959	64	198	4.25	mesomull
6b_vs	6	vs	No	975	39	195	4.25	hemimoder
7a_vs	7	vs	Yes	620	0	0	10	mesomull
7b_vs	7	vs	No	613	0	0	10.75	hemimoder
8a_vs	8	vs	Yes	587	0	0	7.25	mesomull
8b_vs	8	vs	No	577	0	0	10.5	hemimoder
9a_vs	9	vs	Yes	496	0	0	4.5	mesomull
9b_vs	9	vs	No	515	0	0	7.25	hemimoder
10a_vs	10	vs	Yes	907	36	290	6.5	mesomull
10b_vs	10	vs	No	934	61	325	4.25	hemimoder
11a_vs	11	vs	Yes	651	0	0	7	mesomull
11b_vs	11	vs	No	652	0	0	6.25	hemimoder