Relative Importance of Plant Species Composition and Environmental Factors in Affecting Soil Carbon Stocks of Alpine Pastures (NW Italy)

Simone Ravetto Enri 1,*, Fabio Petrella 2, Fabrizio Ungaro 3, Laura Zavattaro 4, Andrea Mainetti 1,5, Giampiero Lombardi 1,† and Michele Lonati 1,†

Abstract: Alpine pastures are agricultural systems with a high provision of ecosystem services, which include carbon (C) stocking. Particularly, the soil organic C (SOC) stocks of Alpine pastures may play a pivotal role in countering global climate change. Even if the importance of pasture SOC has been stated by several research studies, especially by comparing different land uses, little is known about the role of plant species composition. We studied a wide sample of 324 pastures in the north-western Italian Alps by performing coupled vegetation and soil surveys. Climatic (i.e., mean annual precipitation), topographic (i.e., elevation, slope, southness), vegetation (i.e., the first three dimensions of a non-metric multidimensional scaling—NMDS), and soil (i.e., pH) parameters were considered as independent variables in a generalised linear model accounting for SOC stocks in the 0–30 cm depth. Pasture SOC was significantly affected by precipitation (positively) and by pH (negatively) but not by topography. However, the higher influence was exerted by vegetation through the first NMDS dimension, which depicted a change in plant species along a thermic-altitudinal gradient. Our research highlighted the remarkable importance of vegetation in regulating SOC stocks in Alpine pastures, confirming the pivotal role of these semi-natural agricultural systems in the global scenario of climate change.

Keywords: grassland; elevation; forage; mountain; pH; precipitation; slope; vegetation

1. Introduction

Mountain pastures can provide many ecosystem services, such as provisioning services (e.g., biodiversity, forage), regulation and maintenance services (e.g., water purification, soil retention), and cultural services (e.g., nature-based recreation, eco-tourism) [1,2]. Among regulation services, carbon (C) stocking is of particular relevance [3]. Carbon stocking is a key process, able to reduce the amount of atmospheric CO$_2$ originated by anthropogenic emissions [4]. Therefore, the role of land uses efficient in C stocking, namely, able to counteract current climate change, is becoming essential worldwide. Indeed, the land sinks represent the main reduction factor in the global C balance by removing about one fourth of the total emitted C [5]. Part of the C is stocked in the above ground biomass (especially in woodlands), but a major portion is allocated in the soil [6]. Soil organic carbon (SOC) mainly derives from the stocking of atmospheric CO$_2$ fixed by plants through photosynthesis and its amount can vary depending on site conditions, biotic factors, including vegetation composition, and anthropic management [7].
Although the importance of SOC stocking in slowing global warming has been widely studied [4, 8], little is known about the role of Alpine pastures and the variability of SOC stocks related to climatic, environmental, and vegetation features e.g., [9]. Specifically, several research studies compared different land uses (e.g., grasslands, forests, arable crops) in terms of their ability to stock C in the European Alps, but the importance of botanical composition within pastures has not been explored yet. It is worth mentioning that Alpine pastures in Europe are composed by a huge variety of plant species and habitats, determined by different topographic (elevation, slope, aspect), abiotic (climate, bedrock type), and biotic (pastoral management, first of all, which directly affects soil fertility) conditions [10, 11].

The present study aimed at evaluating the relative importance of various abiotic and biotic (i.e., vegetation) drivers in affecting SOC stocks in a wide sample of pastures in the western Italian Alps.

2. Materials and Methods

The study was conducted in a wide number of Alpine valleys within the Piedmont region, north-western Italy (Figure 1), characterised by contrasting climatic, topographic, vegetation, and soil conditions. Between years 2000 and 2007, we surveyed 324 grassland sites, encompassing a wide geographical and ecological range. The survey sites were ascribable to 54 different vegetation types (sensu Cavallero et al. [12]; see Appendix A). All the grasslands were grazed by cattle during summers, generally with lenient stocking rates.

Figure 1. Location of the 324 survey sites in north-western Italian Alps. Each black dot represents a site.
Elevation, slope, and southness of the sites were computed using a digital terrain model at 5-m resolution [13]. Mean annual precipitation was assessed at each site using a 1-km resolution raster obtained by interpolating the long-time data series (1977–2007) of 386 weather stations spread all over the region [14]. Spatial analyses were carried out with QGIS v.3.16 LTR software [15].

At each site, the composition of grassland vegetation was determined with the vegetation point-quadrat method [16] along 25-m transects and at 50-cm intervals. To account for species richness more accurately, the list of all occasional species not recorded along the transect but occurring in a 1-m buffer area around was completed as well [17,18]. Nomenclature followed Landolt et al. [19]. Then, the relative abundance of every species was calculated as the proportion in percentage of the frequency of occurrence of each species on the sum of the frequencies of all the species in each transect. A value of 0.3% was attributed to all occasional species [17]. Species relative abundances were used to perform a non-metric multidimensional scaling (NMDS) to take the vegetation composition of each survey into account in further analyses. The number of dimensions of the NMDS was defined after checking the goodness of stress value, while Bray–Curtis was specified as dissimilarity index and 100 maximum random starts were set. Species relative abundances were also used to compute some plant community variables, namely: Landolt’s indicator values for temperature (T), humus (H), soil moisture (F), and soil nutrients (N) [19], the pastoral value (PV, which is a proxy for forage productivity and quality [16]), and Shannon diversity index [20]. These plant community variables together with species richness, were included in the NMDS biplots as supplementary variables.

A soil pit was dug close to each vegetation transect for soil description and sampling. The volumetric content (%) of coarse fragments, i.e., particles larger than 2 mm and smaller than 25 cm diameter, was visually assessed. Then, a soil sample of each horizon observed within the 0–30 cm depth interval was collected and transported to the laboratory. Samples were analysed for pH (soil:water = 1:2.5) according to standard soil analysis procedures [21] and an average pH value, weighted on the depth (in cm) of each observed horizon, was calculated. Organic C content was determined as well, using Walkley–Black titration [22].

Bulk density was estimated according to the following pedotransfer function, specifically calibrated for ‘permanent grasslands’ land use of the Alpine soil region [23]:

\[
BD = 1.565081 - 0.3946467 \times SOC - 0.0103851 \times Skel
\]

where \(BD\) is the bulk density derived from the pedotransfer function and SOC and Skel are the % of OC and coarse fragments in the soil samples, respectively. Whenever Skel proportion was above 10%, the following correction was applied [24]:

\[
BD_c = BD \times \left[ 1 - 1.67 \times \left( \frac{Skel}{100} \right)^{3.39} \right]
\]

where \(BD_c\) is the corrected bulk density, referred to the fine earth fraction, and Skel is the coarse fragment content by mass. The OC, BD, and Skel values were used to assess the SOC stocks at each site as the sum of SOC values of all \(i\) horizons found within the first 30 cm, weighted on their relative depth (in cm):

\[
SOC_{stock} = \sum_{i=1}^{n} (OC_i \times BD_i \times depth_i \times (1 - Skel_i) \times 100)
\]

Precipitation among the climatic variables, elevation, slope, and southness among the topographic ones, the components of the NMDS for vegetation, and soil pH were included in a generalized linear model to predict C stock. Previous to run the model, all variables were tested for autocorrelation, and standardised in order to compare the resulting \(\beta\) scores. Being SOC stock a continuous variable, the Gaussian and Gamma distributions were applied and the best fitting one, i.e., that one showing the lowest Akaike Information
Criterion [25], was retained. Statistical analyses were carried out in R environment, version 3.5.2 [26], using ‘goeveg’ [27], ‘vegan’ [28], and ‘glmmTMB’ [29] packages.

3. Results and Discussion

3.1. Climate, Topography, and Vegetation Features

Mean annual precipitation of the studied sites ranged from 727 to 1574 mm, thus including dry to wet climatic conditions. The altitude, slope, and aspect ranged, respectively, between 988 and 2688 m a.s.l., between 0.4 and 49.8°, and between 1.1 and 179.7°. Such a wide range of topographic conditions, combined with different soils and varying effects of livestock grazing, determined a huge variability of ecological conditions and consequently a considerably high species richness. Indeed, we recorded more than 685 plant species in total and about 35 species per transect. The descriptive statistics of climatic, topographic, and vegetation features of the sites are reported in Table 1.

Table 1. Climatic, topographic, and vegetation descriptors of the 324 sites. SE, standard error of the mean; Landolt’s indicators: F, soil moisture; N, soil nutrients; H, humus; T, temperature.

| Variable             | Min   | 25%  | Median | 75%  | Max   | Mean  | SE    |
|----------------------|-------|------|--------|------|-------|-------|-------|
| **Climate**          |       |      |        |      |       |       |       |
| Precipitation [mm y⁻¹]| 726.9 | 900.4| 962.3  | 1103.5| 1574.1| 1008.2| 8.88  |
| **Topography**       |       |      |        |      |       |       |       |
| Elevation [m a.s.l.] | 988   | 1813 | 2094   | 2329 | 2688  | 2041  | 20.0  |
| Slope [°]            | 0.4   | 12.9 | 20.8   | 28.8 | 49.8  | 20.9  | 0.57  |
| Southness [°]        | 1.1   | 78.7 | 124.9  | 155.9| 179.7 | 111.9 | 2.91  |
| **Vegetation**       |       |      |        |      |       |       |       |
| Species richness     | 9     | 26   | 35     | 44   | 62    | 35    | 0.7   |
| Shannon index        | 1.3   | 3.2  | 3.7    | 4.1  | 5.0   | 3.6   | 0.04  |
| Landolt’s F          | 1.6   | 2.3  | 2.6    | 2.9  | 4.2   | 2.6   | 0.02  |
| Landolt’s N          | 1.6   | 2.2  | 2.4    | 2.7  | 4.7   | 2.5   | 0.02  |
| Landolt’s H          | 1.9   | 3.0  | 3.2    | 3.4  | 4.9   | 3.2   | 0.02  |
| Landolt’s T          | 1.9   | 1.9  | 2.3    | 2.7  | 3.9   | 2.3   | 0.03  |
| **Pastoral Value**   | 20.9  | 34.4 | 40.6   | 46.3 | 73.1  | 41.2  | 0.51  |

Being 0.16 the stress value of the first three dimensions of the NMDS, i.e., less than 0.20, the fitting was considered satisfactory [30]. The supplementary variables included in the NMDS biplot improved the understanding of such a complex and variable vegetation, by highlighting its ecological trends in terms of plant community indices (Figure 2). Plant species were arranged on the first NMDS dimension according to a thermic-altitudinal gradient (Figure 2a), with thermophilic low-altitude species on the left side (such as *Bromus erectus* Huds., *Brachypodium rupestre* (Host) Roem. & Schult., *Lathyrus pratensis* L., *Plantago media* L., and *Rosa canina* aggr.) and those typical of cold, high-altitude environments on the right side (such as *Alchemilla pentaphyllea* L., *Carex curvula* All., *Leucanthemopsis alpina* (L.) Heywood, *Phyteuma globularifolium* Sternb. & Hoppe, and *Salix herbacea* L.). The arrow of Landolt’s T confirmed this gradient, being left-directed and close to the horizontal axis. The second dimension was related to the storage of dead organic material (as outlined by Landolt’s H arrow), with species growing on soils poor in humus in the upper part of the graph (such as *Anthyllis vulneraria* L., *Helianthemum oelandicum* (L.) Dum. Cours., *Helicotrichon sedenense* (DC.) Holub, *Onobrychis montana* DC., and *Sesleria caerulea* (L.) Ard.) and species found on soils with higher humus content at the bottom (such as *Calluna vulgaris* (L.) Hull, *Potentilla erecta* (L.) Raeusch., *Carex pallescens* L., *Agrostis capillaris* L., *Poa chaixii* Vill.). Finally, the distribution of the species on the third dimension showed a positive gradient of soil nutrient and forage quality, as shown by the position of Landolt’s N and PV arrows, respectively. Indeed, in Figure 2b the species typical of nutrient rich environments, such as *Taraxacum officinale* s.l., *Peucedanum ostruthium* (L.) W.D.J. Koch, *Poa pratensis* L., *Geranium sylvaticum* L., and *Silene vulgaris* (Moench) Garcke, were in the upper part of the biplot, while those typical of nutrient-poor pastures, such as *Festuca paniculata*
(L.) Schinz & Thell., *C. vulgaris*, *Vaccinium myrtillus* L., *Chamaecytisus hirsutus* (L.) Link, and *Gymnadenia conopsea* (L.) R. Br., were at the bottom.

Figure 2. Cont.
3.2. Soil Features

The soil pH encompassed both acidic and basic soil conditions, ranging from 3.3 to 8.3 (Table 2). Soil C stock in the investigated pastures ranged between 1.9 and 234.9 t ha\(^{-1}\), with an average value of 87.8 t ha\(^{-1}\). Such values were higher when compared to those of other land uses (arable lands: 52.6 ± 5.56; permanent crops: 41.4 ± 2.06; woodlands: 71.4 ± 2.10; t ha\(^{-1}\) ± standard error), which were recorded with the same methods in the same region during a previous trial [23]. Rodríguez-Murillo [31] and Hoffmann et al. [32]
found similar SOC contents in Spanish and Swiss pastures, respectively. Another recent study conducted by Ferré et al. [33] on Italian alpine grasslands reported lower values of C stocks. However, this trial was carried out in a single 1.5-ha study area characterised by a limited variability of ecological conditions, and the related outcomes should be considered with caution consequently. Canedoli et al. [3] in north-western Italy and Liefeld et al. [34] in Switzerland reported lower C stocks compared to our trial, but at the same time they highlighted higher SOC values in grasslands than in the woodlands and the arable lands, respectively, highlighting a similar trend. This may be due to the accumulation of OC in the upper soil horizons, which is particularly relevant in well-managed alpine pastures if compared to forests [35]. Indeed, the positive role of Alpine grasslands as CO$_2$ sinks may be exerted only with an active and balanced pastoral management, thus avoiding both overgrazing and abandonment [36,37]. Other research studies located in the European Alps reported SOC amounts characterised by wide variability, but they did not consider the role of differing plant species composition in determining the variations of soil bio-chemical features [38,39].

### Table 2. Soil descriptors of the 324 sites. SE, standard error of the mean.

| Variable                        | Min  | 25%  | Median | 75%  | Max  | Mean | SE  |
|---------------------------------|------|------|--------|------|------|------|-----|
| pH                              | 3.3  | 4.6  | 5.0    | 5.8  | 8.3  | 5.3  | 0.06|
| Coarse fragment content [%]     | 0.0  | 6.8  | 15.9   | 25.8 | 70.0 | 18.5 | 0.81|
| Bulk density [t m$^{-3}$]        | 0.2  | 0.7  | 0.9    | 1.0  | 1.2  | 0.8  | 0.01|
| Soil organic carbon [t ha$^{-1}$]| 1.9  | 59.2 | 87.8   | 112.8| 234.9| 87.8 | 2.09|

#### 3.3. Modelling Soil Organic Carbon Stocks

Data analysed through generalised linear model with Gaussian distribution showed a lower Akaike information criterion when compared to Gamma one (3237 vs. 3287) thus the relative model results were retained. Model outputs highlighted the relative importance of each factor in affecting SOC stocks (Table 3), providing new knowledge through a comprehensive approach concerning the role of vegetation in C bio-cycling of European Alpine pastures, which was scantily focused till present. Among the selected variables, those exerting a significant influence on SOC stocks were precipitation, vegetation (particularly, the first dimension of the NMDS), and soil pH. Conversely, elevation, slope, and southness showed non-significant effects as well as the second and third NMDS dimensions. The limited importance of southness and slope confirmed the outcomes of a previous trial [40], which, however, reported significant negative effects of both elevation and precipitation. In the present study, the precipitation showed a positive influence on SOC, likely due to an indirect effect on biomass production, which is generally associated to higher C stocks [41].

### Table 3. Results of the generalized linear model accounting for the stock of soil organic carbon. NMDS, non-metric multidimensional scaling; SE, standard error; ***, $p < 0.001$; **, $p < 0.01$.

|          | $\beta$ Score | SE   | $p$ Value | Sig. |
|----------|---------------|------|-----------|------|
| (Intercept) | 87.787        | 1.928| <0.001    | ***  |
| Precipitation | 9.994        | 2.515| <0.001    | ***  |
| Elevation  | 7.619         | 4.206| 0.070     |      |
| Slope     | 0.241         | 2.325| 0.917     |      |
| Southness | 0.182         | 2.237| 0.935     |      |
| NMDS1     | –11.782       | 4.068| 0.004     | **   |
| NMDS2     | –3.611        | 2.897| 0.213     |      |
| NMDS3     | –1.991        | 2.219| 0.370     |      |
| pH        | –8.574        | 2.752| 0.002     | **   |

However, vegetation was found to be the most important driver, as highlighted by the highest $\beta$ score. Its negative sign showed that higher SOC stocks were recorded in pastures with higher proportions of those species distributed on the left side of Figure 2a, i.e., in
pastures rich in plants typical of warm, low-altitude, species-rich environments. Similar to precipitation, species typical of warmer pastures (proxied by Landolt’s T value) may be associated to greater biomass production, with positive effects on SOC content [41]. Species richness may exert a positive influence on C stocking as well, since it generally corresponds to a diversity of root systems (characterised by differing depts, biomasses, C storages, etc.) and to an enhanced soil microbial diversity (which improves SOC transformation and degradation), which indirectly influences decomposition processes [42,43]. Surprisingly, a significant effect of the second dimension of NMDS (i.e., a vegetational proxy of soil humus content) on SOC was not observed. This may depend on humus type, which could affect SOC content but is not taken into account by Landolt’s H [19,44]. However, further investigations are needed to clarify this relationship. Finally, the lack of a significant effect of the third dimension of NMDS (related to soil fertility) was likely expected. Indeed, in this study, the pastures with low Landolt’s N and PV, i.e., with low soil fertility due to undergrazing [45], were encroached by shrubs, such as C. vulgaris, V. myrtillus, and C. hirsutus. Likely, the low biochemical quality of shrub litter delayed its decomposition and allowed higher organic matter accumulations in the topsoil [37]. However, the effect of shrub proliferation at a depth greater than the 30 cm considered here was partially unclear since the low root turnover of shrubs compared to grasses should have reduced the C inputs in the soil.

As for pH, larger amounts of SOC were recorded in soils with an acidic reaction, confirming the remarkable importance of pH in affecting SOC stocks in Alpine grasslands [46], probably because low pH is associated to high SOC contents, or mineralisation is reduced at low pH [47,48].

According to our results, the SOC stocking of Alpine pastures, generally managed under extensive grazing regimes, was predominantly influenced by the vegetation rather than by abiotic factors. More specifically, we observed a remarkable role of warm-pasture species (such as B. erectus), which might have a limited interest as fodder resource (in terms of quantity and quality [49]), but which can definitely have a remarkable weight on carbon stocks. Dry pastures, which generally host large proportions of such plants, are widely represented in the Alps. For instance, the dry grasslands dominated by B. rupestre, F. paniculata, or F. ovina aggr. cover more than 50% of the pasture area in Piedmont Region [12]. The importance of alpine pastures in SOC stocking was in general confirmed, as the observed values were generally higher compared to other land uses. Thus, pasture conservation policies should be encouraged, such as through specific PES (payments for ecosystem services) [50]. In the current scenario of climate change, the abundance of warm grassland species will likely increase in the future years [51], and a shift at higher elevations would be expected. Consequently, an increase of SOC stocks in Alpine pastures might be observed but, precipitation being a relevant factor affecting C cycling as well, a targeted monitoring should be carried out to take the complex and spatially heterogeneous patterns of climate change into account [52,53].

Future research should be addressed to monitor the possible effects of management intensity, for instance of different stocking rates or grazing regimes. Moreover, the SOC stocking ability of permanent pasture should be compared with that of mountain hay meadows. An extension would be advisable to lowland grasslands too, where the species richness and diversity are generally lower compared to the mountain ones, and which are generally more intensively managed in terms of number of exploitations per year and fertilisation.

4. Conclusions

The novel results of this study carried out in a huge range of ecological conditions highlighted the relevant importance of grassland species composition in affecting soil C stock of Alpine soils, while topographic attributes had negligible effects. More specifically, dry pastures (which also generally host rare plants and a high species richness) stocked more carbon in the upper soil horizons. Among abiotic factors, precipitation positively
affected soil organic carbon stocks, likely through an indirect effect due to the increased herbage biomass. Conversely, lower SOC values were found on acidic soils, where mineralization might be hampered. Future conservation strategies should aim to consider the role of such extensively managed pastures, which can be found in the Alpine region, and of the dry grassland species in enhancing this ecosystem service.

**Author Contributions:** Conceptualization, F.P., G.L. and M.L.; Methodology, S.R.E., F.P., F.U., G.L. and M.L.; Investigation, F.P., F.U., G.L. and M.L.; Data Curation, S.R.E., F.P., F.U., A.M.; Writing—Original Draft Preparation, S.R.E., F.P., F.U., L.Z., A.M., G.L. and M.L.; Writing—Review and Editing, S.R.E., A.M., G.L. and M.L.; Supervision, G.L., M.L.; Project Funding Acquisition, P.F., G.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by SUPER-G project (EU Horizon 2020 programme) grant number 774124.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** We would prefer to exclude this statement since the study did not involve humans.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** The authors want to thank Andrea Cavallero for inspiring and coordinating the work, Lucia Crosetto for her essential help, and all students and researchers who contributed to fieldwork, laboratory analyses, and data handling. This work contributes to the SUPER-G project (funded under EU Horizon 2020 programme; grant number 774124).

**Conflicts of Interest:** The authors declare no conflict of interest.

**Appendix A**

**Table A1.** List of vegetation types (*sensu* Cavallero et al. [12]) surveyed in the 324 pastures. The dominant plant species and the number of surveys performed per each vegetation type is provided.

| Vegetation Type | Surveys |
|-----------------|---------|
| *Agrostis schraderana* | 2 |
| *Alchemilla gr. alpina* | 1 |
| *Alchemilla gr. vulgaris* | 5 |
| *Alchemilla pentaphyllea* | 5 |
| *Alopecurus gerardi* | 2 |
| *Brachypodium caespitosum/rupestre* | 18 |
| *Briza media* | 1 |
| *Bromus erectus* | 11 |
| *Calamagrostis villosa* | 1 |
| *Carex curvula* | 4 |
| *Carex fimbriata* | 2 |
| *Carex foetida* | 3 |
| *Carex fusca* | 2 |
| *Carex humilis* | 2 |
| *Carex rupestris* | 2 |
| *Carex sempervirens* | 5 |
| *Carex tendae* | 1 |
| *Dactylis glomerata* | 10 |
| *Dryas octopetala* | 1 |
| *Elyna myosuroides* | 1 |
| *Festuca gr. halleri* | 1 |
| *Festuca gr. ovina* | 18 |
| *Festuca gr. rubra and Agrostis tenuis* | 41 |
| *Festuca gr. violacea* | 14 |
| *Festuca paniculata* | 21 |
Table A1. Cont.

| Vegetation Type               | Surveys |
|-------------------------------|---------|
| Festuca scabriculmis          | 5       |
| Hedysarum brigantiacum        | 2       |
| Helianthemum nummularium      | 3       |
| Helianthemum oelandicum       | 1       |
| Helictotrichon parlatorei     | 5       |
| Ligusticum mutellina          | 2       |
| Luzula alpino-pilesa          | 1       |
| Molinia arundinacea           | 1       |
| Molinia coerulea              | 1       |
| Nardus stricta                | 53      |
| Onobrychis montana            | 10      |
| Petasites hybridus            | 1       |
| Phleum alpinum                | 1       |
| Plantago alpina               | 1       |
| Poa alpina                    | 2       |
| Poa violacea                  | 7       |
| Polygonum bistorta            | 2       |
| Polygonum viviparum           | 3       |
| Rumex alpinus                 | 1       |
| Salix herbacea                | 2       |
| Scirpus sylvaticus            | 1       |
| Sesleria varia                | 7       |
| Stipa pennata                 | 2       |
| Taraxacum officinale          | 1       |
| Trifolium alpinum and Carex sempervirens | 26 |
| Trifolium thalii              | 2       |
| Trisetum flavescens           | 4       |
| Vaccinium gaultherioides      | 2       |
| Vaccinium myrtillus           | 1       |
| Total                         | 324     |

Table A2. List of plant species recorded in the 324 vegetation transects. The species code displayed in the biplots of the non-metric multidimensional scaling (NMDS), the number and proportion of transects where the species was found, and the average species relative abundance (SRA) are reported.

| Species Name                      | Species Code | Transects | % | SRA  |
|-----------------------------------|--------------|-----------|---|------|
| Abies alba                        | 1            | 0%        | 0.30|
| Acer pseudoplatanus               | 2            | 1%        | 0.50|
| Achillea erba-rotta               | 2            | 1%        | 0.30|
| Achillea macrophylla              | 1            | 0%        | 2.84|
| Achillea millefolium aggr.        | Achmill      | 133       | 41%| 0.30|
| Achillea moschata                 | 1            | 0%        | 2.29|
| Achillea nana                     | 3            | 1%        | 0.66|
| Achmatherum calamagrostis         | 2            | 1%        | 0.63|
| Acinos alpinus                    | Acialpi      | 26        | 8% | 0.30|
| Aconitum napellus                 | 3            | 1%        | 2.29|
| Adenostyles leucophylla           | 1            | 0%        | 4.04|
| Argoposidum podagria              | 4            | 1%        | 4.03|
| Agrostis alpina                   | Agralpi      | 52        | 16%| 4.05|
| Agrostis canna                    | 1            | 0%        | 6.29|
| Agrostis capillaris               | Agrcapi      | 125       | 39%| 2.25|
| Agrostis rupestris                | Agrrupu      | 33        | 10%| 8.63|
| Agrostis schneideriana            | 16           | 5%        | 0.44|
### Table A2. Cont.

| Species Name               | Species Code | Transects | %  | SRA |
|----------------------------|--------------|-----------|----|-----|
| *Ajuga genevensis*         |              | 5         | 2% | 0.37|
| *Ajuga pyramidalis*        |              | 10        | 3% | 0.84|
| *Ajuga reptans*            |              | 8         | 2% | 2.12|
| *Alchemilla alpina aggr.*  | Alcalpi      | 59        | 18%| 8.66|
| *Alchemilla pyramidalis*   | Alcpent      | 26        | 8% | 2.91|
| *Alchemilla vulgaris aggr.*| Alcvulg      | 126       | 39%| 0.30|
| *Allium carinatum*         |              | 1         | 0% | 0.45|
| *Allium lusitanicum*       |              | 2         | 1% | 7.06|
| *Allium narcissiflorum*    |              | 2         | 1% | 0.30|
| *Allium oleraceum*         |              | 2         | 1% | 0.77|
| *Allium schoenoprasum*     |              | 8         | 2% | 0.40|
| *Allium sphaerocephalon*   |              | 6         | 2% | 0.30|
| *Alnus viridis*            |              | 9         | 3% | 4.12|
| *Alopecurus alpinus*       | Alloalpi     | 50        | 15%| 0.30|
| *Alyssum alyssoides*       |              | 2         | 1% | 0.47|
| *Alyssum montanum*         |              | 4         | 1% | 0.30|
| *Anacamptis pyramidalis*   |              | 1         | 0% | 0.65|
| *Androsace obtusifolia*    |              | 10        | 3% | 1.88|
| *Androsace vitaliana*      |              | 8         | 2% | 1.88|
| *Androsace adfinis*        |              | 3         | 1% | 0.42|
| *Anemone baldensis*        |              | 5         | 2% | 1.53|
| *Anemone narcissiflora*    | Anenarc      | 28        | 9% | 1.54|
| *Anemone nemorosa*         |              | 6         | 2% | 1.06|
| *Anemone ranunculoides*    |              | 1         | 0% | 0.30|
| *Angelica sylvestris*      |              | 1         | 0% | 0.64|
| *Antennaria carpathica*    |              | 8         | 2% | 0.63|
| *Antennaria dioica*        | Antdioi      | 61        | 19%| 1.86|
| *Anthericum lilio*         |              | 9         | 3% | 3.05|
| *Anthoxanthum odoratum aggr.*| Antodor    | 180       | 56%| 5.54|
| *Anthriscus sylvestris*    |              | 2         | 1% | 4.00|
| *Anthyllis montana*        |              | 2         | 1% | 1.53|
| *Anthyllis vulneraria*     | Antvuln      | 41        | 13%| 0.30|
| *Aphanes arcensis*         |              | 1         | 0% | 0.30|
| *Arabidopsis thaliana*     |              | 1         | 0% | 0.38|
| *Arabis alpina*            |              | 5         | 2% | 0.30|
| *Arabis auriculata*        |              | 1         | 0% | 0.31|
| *Arabis ciliata*           | Aracili      | 21        | 6% | 0.55|
| *Arabis hirsuta*           |              | 8         | 2% | 0.30|
| *Arctium minus*            |              | 1         | 0% | 3.67|
| *Arctium nemorosum*        |              | 1         | 0% | 0.30|
| * Arenaria biflora*        |              | 1         | 0% | 0.43|
| *Arenaria ciliata*         |              | 14        | 4% | 1.03|
| *Arenaria serpyllifolia aggr.*| Armalpi    | 33        | 10%| 2.60|
| *Armeria alpina*           |              | 8         | 2% | 0.88|
| *Arnica montana*           | Arnmont      | 88        | 27%| 1.63|
| *Arrhenatherum elatius*    |              | 7         | 2% | 0.54|
| *Artemisia absinthium*     |              | 5         | 2% | 6.40|
| *Artemisia campestris*     |              | 2         | 1% | 0.30|
| *Artemisia glacialis*      |              | 2         | 1% | 0.91|
| *Asperula cynanchica*      |              | 6         | 2% | 0.30|
| *Asperula purpurea*        |              | 1         | 0% | 2.24|
| *Asphodelus macrocarpus*   |              | 13        | 4% | 0.76|
| *Aster alpinus*            |              | 15        | 5% | 1.73|
| *Aster bellidiflora*       |              | 12        | 4% | 2.36|
| *Astragalus alpinus*       |              | 8         | 2% | 0.30|
### Table A2. Cont.

| Species Name                | Species Code | Transects | % | SRA |
|-----------------------------|--------------|-----------|----|-----|
| Astragalus australis        | 1            | 0%        | 5.56 |
| Astragalus cicer            | 1            | 0%        | 3.93 |
| Astragalus danicus          | 6            | 2%        | 0.30 |
| Astragalus glycyphyllos     | 2            | 1%        | 0.67 |
| Astragalus monspessulanus   | 11           | 3%        | 0.30 |
| Astragalus penduliflorus    | 3            | 1%        | 0.93 |
| Astragalus sempervirens     | 4            | 1%        | 0.65 |
| Astrantia major             | Astmino      | 5%        | 0.86 |
| Athamanta cretensis         |              | 1         | 0%  | 0.30 |
| Athyrium filix-femina       | Aveflex      | 2         | 1%  | 5.02 |
| Avenella flexuosa           |              | 109       | 34% | 0.30 |
| Barbarea intermedia         |              | 4         | 1%  | 0.68 |
| Bartisia alpina             | Baralpi      | 23        | 7%  | 0.30 |
| Bellis perennis             |              | 2         | 1%  | 0.30 |
| Berberis vulgaris           |              | 2         | 1%  | 0.30 |
| Betula pendula              |              | 4         | 1%  | 0.45 |
| Biscutella laevigata        | Bislaev      | 75        | 23% | 0.42 |
| Botrychium lunaria          | Botluna      | 30        | 9%  | 14.56 |
| Brachypodium rupestre       | Brarupe      | 55        | 17% | 2.10 |
| Briza media                 | Brimedi      | 35        | 11% | 16.75 |
| Bromus erectus              | Broerec      | 20        | 6%  | 0.30 |
| Bromus inermis              |              | 1         | 0%  | 0.30 |
| Buglossoides arvensis       |              | 1         | 0%  | 0.70 |
| Bunium bulbocastanum        | Bunbulb      | 20        | 6%  | 0.30 |
| Buphthalmum salicifolium    |              | 1         | 0%  | 0.30 |
| Bupleurum falcatum          |              | 2         | 1%  | 1.80 |
| Bupleurum ranunculoides     | Bupranu      | 25        | 8%  | 1.30 |
| Calamagrostis arundinacea   |              | 2         | 1%  | 0.30 |
| Calamagrostis varia         |              | 1         | 0%  | 26.21 |
| Calamagrostis villosa       |              | 1         | 0%  | 10.26 |
| Callanthemum coriandrifolium|              | 1         | 0%  | 3.82 |
| Calluna vulgaris            | Calvulg      | 34        | 10% | 0.69 |
| Campanula barbata           |              | 16        | 5%  | 0.30 |
| Campanula cochlearifolia    |              | 1         | 0%  | 0.88 |
| Campanula excisa            |              | 1         | 0%  | 0.68 |
| Campanula glomerata         |              | 6         | 2%  | 0.61 |
| Campanula persicifolia      |              | 5         | 2%  | 0.96 |
| Campanula rhomboidalis      |              | 1         | 0%  | 0.87 |
| Campanula scheuchzeri       | Camsche      | 167       | 52% | 0.58 |
| Capsella bursa-pastoris     |              | 6         | 2%  | 0.30 |
| Cardamine alpina            |              | 1         | 0%  | 0.68 |
| Cardamine resedifolia       |              | 10        | 3%  | 3.47 |
| Cardaminopsis halleri       |              | 3         | 1%  | 1.02 |
| Carduus defloratus          | Cardefl      | 82        | 25% | 14.18 |
| Carex acuta                 |              | 1         | 0%  | 0.99 |
| Carex aterrima              |              | 5         | 2%  | 1.14 |
| Carex atrata                |              | 2         | 1%  | 4.27 |
| Carex caryophyllea          | Carcary      | 23        | 7%  | 9.78 |
| Carex curvula               | Carcurv      | 18        | 6%  | 7.62 |
| Carex echinata              |              | 1         | 0%  | 1.11 |
| Carex ericetorum            |              | 3         | 1%  | 20.51 |
| Carex finibrata             |              | 2         | 1%  | 4.94 |
| Carex flacca                |              | 3         | 1%  | 16.27 |
| Carex flavo aggr.           |              | 3         | 1%  | 17.45 |
| Carex foetida               |              | 15        | 5%  | 3.50 |
| Species Name          | Species Code | Transects | % | SRA |
|----------------------|--------------|-----------|---|-----|
| Carex hirta          | 1            | 0%        | 8.19 |
| Carex humilis        | 17           | 5%        | 1.43 |
| Carex leporina       | 11           | 3%        | 31.43 |
| Carex nigra          | 3            | 1%        | 1.72 |
| Carex ornithopoda    | 17           | 5%        | 2.52 |
| Carex pallescens     | Carpell      | 6%        | 4.77 |
| Carex panicosa       | 4            | 1%        | 1.90 |
| Carex paniculata     | 1            | 0%        | 2.34 |
| Carex parviflora     | 4            | 1%        | 1.46 |
| Carex pauciflora     | 2            | 1%        | 5.01 |
| Carex pilulifera     | 3            | 1%        | 1.19 |
| Carex rosae          | 7            | 2%        | 16.43 |
| Carex rupestris      | 4            | 1%        | 8.81 |
| Carex sempervirens   | Carsemp      | 207       | 64% | 1.08 |
| Carex spicata        | 1            | 0%        | 3.40 |
| Carex tendae         | 7            | 2%        | 0.30 |
| Carlina acanthifolia | 1            | 0%        | 1.05 |
| Carlina acaulis      | Caracau      | 70        | 22% | 0.63 |
| Carlina vulgaris     | 2            | 1%        | 1.68 |
| Carum carvi          | Carcarv      | 30        | 9%  | 0.30 |
| Castanea sativa      | 1            | 0%        | 0.76 |
| Centaurea nervosa    | Cennerv      | 18        | 6%  | 0.66 |
| Centaurea nigra      | 11           | 3%        | 0.90 |
| Centaurea scabiosa   | 15           | 5%        | 1.38 |
| Centaurea triumfetti | 16           | 5%        | 0.77 |
| Centaurea uniflora   | Cenunif      | 64        | 20% | 0.30 |
| Cephalanthera longifolia |         | 2        | 1%  | 0.98 |
| Cerastium arvense    | Cerarve      | 123       | 38% | 1.91 |
| Cerastium cerastoides| 2            | 1%        | 0.79 |
| Cerastium fontanum   | Cerfont      | 27        | 8%  | 0.73 |
| Cerinthe glabra      | 3            | 1%        | 0.30 |
| Cerinthe minor       | 2            | 1%        | 2.26 |
| Chaerophyllum hirsutum| Chahirs    | 29        | 9%  | 3.31 |
| Chamamecistus hirsutus| Chahirr   | 31        | 10% | 0.75 |
| Chenopodium bonus-henricus |      | 15       | 5%  | 0.62 |
| Cirsium acaule       | 6            | 2%        | 0.30 |
| Cirsium arvense      | 1            | 0%        | 0.50 |
| Cirsium eriophorum   | 5            | 2%        | 0.91 |
| Cirsium palustre     | 3            | 1%        | 0.42 |
| Cirsium spinosissimum| Cirspin      | 26        | 8%  | 0.40 |
| Cirsium vulgare      | 8            | 2%        | 1.05 |
| Clinopodium vulgare  | 10           | 3%        | 0.39 |
| Coeloglossum viride  | Coeviri      | 19        | 6%  | 0.78 |
| Colchicum alpinum    | 1            | 0%        | 0.32 |
| Colchicum autumnale  | 11           | 3%        | 0.30 |
| Conopodium majus     | 1            | 0%        | 0.30 |
| Corylus avellana     | 1            | 0%        | 0.30 |
| Cotoneaster integerrimus |         | 3        | 1%  | 0.30 |
| Crataegus monogyna   | 2            | 1%        | 0.89 |
| Crepis aerea         | 4            | 1%        | 1.20 |
| Crepis conyzifolia   | Crecony      | 39        | 12% | 1.57 |
| Crepis paludosus     | 2            | 1%        | 2.39 |
| Crocus albiflorus    | Croalbi      | 64        | 20% | 1.45 |
| Crucia glabra        | Cruglab      | 50        | 15% | 0.85 |
| Crucia laevipes      | 4            | 1%        | 0.30 |
| Species Name | Species Code | Transects | %  | SRA |
|--------------|--------------|-----------|----|-----|
| Crupina vulgaris | 1            | 0%        | 0.30 |
| Cryptogramma crispa | 2          | 1%        | 0.63 |
| Cuscuta epithymum | 1          | 0%        | 1.55 |
| Cynosurus cristatus | 7          | 2%        | 0.67 |
| Cytisopyl tum sessilifolium | 2       | 1%        | 0.30 |
| Cytisus scoparius | 3            | 1%        | 5.75 |
| Dactylis glomerata | Dacglom     | 50        | 15% | 0.30 |
| Dactylorhiza maculata | 4         | 1%        | 0.30 |
| Dactylorhiza majalis | 1           | 0%        | 0.34 |
| Dactylorhiza sambucina | Dacsamb  | 18        | 6%  | 4.32 |
| Danthonia decumbens | 15         | 5%        | 0.30 |
| Daphne mezereum | 13           | 4%        | 1.64 |
| Daucus carota | 2            | 1%        | 3.00 |
| Deschampsia cespitosa | 7          | 2%        | 0.50 |
| Dianthus carthusianorum | 13       | 4%        | 0.57 |
| Dianthus deltoides | 8            | 2%        | 1.43 |
| Dianthus recurvus | 12           | 4%        | 0.74 |
| Dianthus pavanus | Diapavo     | 112       | 35% | 0.30 |
| Dianthus superbus | 3            | 1%        | 1.15 |
| Dianthus sylvestris | 7           | 2%        | 0.30 |
| Digitalis grandiflora | 2          | 1%        | 0.30 |
| Doronicum grandiflorum | 2         | 1%        | 0.36 |
| Draba aizoides | 9            | 3%        | 5.86 |
| Dryas octopetala | 9            | 3%        | 0.30 |
| Dryopteris filix-mas | 5           | 2%        | 0.30 |
| Echinops ritro | 1            | 0%        | 0.30 |
| Echium vulgare | 3            | 1%        | 0.30 |
| Elymus repens | 1            | 0%        | 4.73 |
| Elyna myosuroides | 15           | 5%        | 0.30 |
| Emepetrum hermaphroditum | 1        | 0%        | 0.30 |
| Epilobium angustifolium | 4          | 1%        | 2.40 |
| Epilobium fleischeri | 1           | 0%        | 0.76 |
| Epilobium montanum | 1            | 0%        | 0.30 |
| Epilobium palustre | 2            | 1%        | 3.81 |
| Equisetum arvense | 1            | 0%        | 0.41 |
| Eriophorum angustifolium | 3        | 1%        | 1.71 |
| Eriophorum latifolium | 2          | 1%        | 5.88 |
| Eriophorum scheuchzeri | 1          | 0%        | 0.96 |
| Eririchium nanum | 1            | 0%        | 0.30 |
| Eryngium campestre | 1            | 0%        | 0.92 |
| Erysimum jugicola | 6            | 2%        | 0.30 |
| Erysimum virgatum | 2            | 1%        | 0.78 |
| Euphorbia cyparissias | 5           | 2%        | 1.98 |
| Euphorbia dulcis | 3            | 1%        | 0.47 |
| Euphrasia alpina | 16           | 5%        | 0.30 |
| Euphrasia hirtella | 1            | 0%        | 0.83 |
| Euphrasia minima | Eupmini     | 19        | 6%  | 1.03 |
| Euphrasia roskoviana | 1           | 0%        | 0.83 |
| Euphrasia stricta | 12           | 4%        | 0.30 |
| Festuca arundinacea | 5           | 1%        | 2.83 |
| Festuca dimorpha | 2            | 1%        | 3.50 |
| Festuca dimorpha | 2            | 1%        | 3.34 |
Table A2. Cont.

| Species Name                | Species Code | Transects | %  | SRA    |
|-----------------------------|--------------|-----------|----|--------|
| Festuca filiformis          | 6            | 2%        | 15.64 |
| Festuca flavescens          | 2            | 1%        | 4.60  |
| Festuca gigantea            | 3            | 1%        | 5.93  |
| Festuca halleri aggr.       | 13           | 4%        | 8.66  |
| Festuca ovina aggr.         | Fesovin      | 160       | 49% | 12.36  |
| Festuca paniculata          | Fespauli     | 62        | 19% | 3.99   |
| Festuca pratensis           | 4            | 1%        | 4.90  |
| Festuca quadriflora         | Fesquad      | 24        | 7%  | 10.26  |
| Festuca rubra               | Fesrubr      | 163       | 50% | 11.50  |
| Festuca scabrilimus         | 17           | 5%        | 8.90  |
| Festuca violacea aggr.      | Fesviol      | 82        | 25% | 0.40   |
| Fourraea alpina             | 9            | 3%        | 0.95  |
| Fragaria vesca              | 8            | 2%        | 0.71  |
| Fraxinus excelsior          | 3            | 1%        | 0.36  |
| Fritillaria tuberaformis    | 4            | 1%        | 3.28  |
| Galea fragfara              | 2            | 1%        | 9.84  |
| Galeopsis ladanum           | 1            | 0%        | 0.30  |
| Galeopsis pubescens         | 1            | 0%        | 0.71  |
| Galeopsis tetrahedron       | 5            | 2%        | 16.67 |
| Galium laevigatum           | 1            | 0%        | 1.32  |
| Galium lucidum aggr.        | 21           | 6%        | 1.77  |
| Galium mollugo aggr.        | 22           | 7%        | 0.98  |
| Galium pusillum aggr.       | 60           | 19%       | 0.98  |
| Galium rubrum aggr.         | 40           | 12%       | 0.90  |
| Galium verum               | 37           | 11%       | 5.39  |
| Gentiana cinerea            | 2            | 1%        | 1.54  |
| Gentiana germanica          | 17           | 5%        | 2.36  |
| Gentiana pliosa             | 7            | 2%        | 1.31  |
| Gentiana tinctoria          | 12           | 4%        | 0.93  |
| Gentiana acutis aggr.       | Genacau      | 89        | 27% | 0.34   |
| Gentiana campestris aggr.   | Gencamp      | 26        | 8%  | 0.30   |
| Gentiana cracitana          | 1            | 0%        | 0.36  |
| Gentiana lutea              | 23           | 7%        | 0.77  |
| Gentiana nivalis            | 3            | 1%        | 0.36  |
| Gentiana punctata aggr.     | 6            | 2%        | 0.30  |
| Gentiana purpurea           | 1            | 0%        | 0.52  |
| Gentiana ramosa             | 3            | 1%        | 0.63  |
| Gentiana verna              | Genvern      | 53        | 16% | 0.30   |
| Geranium molle              | 2            | 1%        | 0.34  |
| Geranium pyrenaicum         | 4            | 1%        | 1.67  |
| Geranium sylvaticum         | Gersylv      | 34        | 10% | 2.43   |
| Geum montanum               | Geumont      | 128       | 40% | 0.30   |
| Geum rivale                 | 1            | 0%        | 1.03  |
| Globularia bisnagarica      | 8            | 2%        | 2.45  |
| Globularia cordifolia       | 14           | 4%        | 6.24  |
| Gnaphalium hoppeanum        | 2            | 1%        | 0.65  |
| Gnaphalium norvegicum       | 2            | 1%        | 1.56  |
| Gnaphalium supinum          | 17           | 5%        | 0.52  |
| Gnaphalium sylvaticum       | 4            | 1%        | 0.41  |
| Gymnadenia conopsea         | Gymcono      | 26        | 8%  | 1.94   |
| Gymnocarpum dryopteris      | 1            | 0%        | 0.30  |
| Gyposophila repens          | 5            | 2%        | 10.97 |
| Hedysarum hedsaroides       | 6            | 2%        | 0.30  |
| Helianthemum apenninum      | 2            | 1%        | 4.69  |
| Helianthemum nummularium    | Helnumm      | 85        | 26% | 3.05   |
| Species Name                      | Species Code | Transects | %  | SRA |
|----------------------------------|--------------|-----------|----|-----|
| Helianthemum oelandicum aggr.    | Heloela      | 32        | 10%| 14.45 |
| Helicotrichon parlatorei         |              | 16        | 5% | 3.59 |
| Helicotrichon pratense           |              | 16        | 5% | 1.45 |
| Helicotrichon pubescens          |              | 12        | 4% | 4.24 |
| Helicotrichon sedenense          | Helsede      | 23        | 7% | 0.30 |
| Helicotrichon sempervirens       |              | 1         | 0% | 2.32 |
| Helicotrichon versicolor         | Helvers      | 19        | 6% | 0.30 |
| Helleborus foetidus              |              | 1         | 0% | 4.24 |
| Heracleum sphyondylism           |              | 7         | 2% | 1.18 |
| Hieracium angustifolium          | Heangu       | 23        | 7% | 0.30 |
| Hieracium aurantiacum            |              | 1         | 0% | 0.61 |
| Hieracium cymosum               |              | 5         | 2% | 1.04 |
| Hieracium glanduliferum          | Hieglan      | 56        | 17%| 1.40 |
| Hieracium lactuecella            | Hielact      | 55        | 16%| 1.07 |
| Hieracium muorum aggr.           | Hiemuro      | 26        | 8% | 0.30 |
| Hieracium peletierianum          |              | 2         | 1% | 1.98 |
| Hieracium pilosella              | Hiepiro      | 55        | 17%| 0.54 |
| Hieracium piloselloides         |              | 5         | 2% | 0.54 |
| Hieracium pilosum               |              | 2         | 1% | 0.35 |
| Hieracium prenanthoides         |              | 5         | 2% | 1.06 |
| Hieracium pseudopilosella        |              | 2         | 1% | 0.89 |
| Hieracium saussureoides          |              | 1         | 0% | 0.30 |
| Hieracium tomentosum            |              | 8         | 2% | 0.49 |
| Hieracium valdeplosum           |              | 3         | 1% | 0.30 |
| Hieracium villosum              |              | 1         | 0% | 1.27 |
| Hippocrepis comosa               | Hipcomo      | 39        | 12%| 0.57 |
| Holcus lanatus                   |              | 3         | 1% | 1.54 |
| Homogyne alpina                 | Homalpi      | 35        | 11%| 0.30 |
| Huperzia selago                  |              | 1         | 0% | 2.02 |
| Hypericum maculatum             |              | 13        | 4% | 0.79 |
| Hypericum perforatum            |              | 11        | 3% | 0.48 |
| Hypericum richeri               | Hyprich      | 66        | 20%| 0.30 |
| Hypochaeris maculata            |              | 10        | 3% | 1.15 |
| Hypochaeris radicata            |              | 1         | 0% | 0.77 |
| Hypochaeris uniflora            | Hypunif      | 25        | 8% | 0.30 |
| Jasione montana                 |              | 1         | 0% | 3.96 |
| Juncus articulatus              |              | 2         | 1% | 3.85 |
| Juncus filiformis               |              | 1         | 0% | 0.89 |
| Juncus jacquinii                |              | 5         | 2% | 2.59 |
| Juncus trifidus                 | Juntrif      | 53        | 16%| 4.71 |
| Juncus triglumis                |              | 1         | 0% | 0.30 |
| Juniperus communis              |              | 6         | 2% | 1.14 |
| Juniperus nana                  | Junnana      | 40        | 12%| 0.88 |
| Knautia arvensis                |              | 11        | 3% | 0.30 |
| Knautia dipsacifolia            |              | 1         | 0% | 1.52 |
| Knautia mollis                  |              | 10        | 3% | 0.30 |
| Koeleria hirsuta                |              | 1         | 0% | 0.30 |
| Koeleria macrantha              |              | 1         | 0% | 1.60 |
| Koeleria pyramidata             |              | 8         | 2% | 2.21 |
| Koeleria vallesiana             |              | 2         | 1% | 1.10 |
| Lactuca perennis                |              | 3         | 1% | 0.30 |
| Larix decidua                   |              | 13        | 4% | 1.12 |
| Laserpitium gallicum            |              | 3         | 1% | 1.32 |
| Laserpitium halleri             |              | 3         | 1% | 0.80 |
| Laserpitium latifolium          |              | 16        | 5% | 2.90 |
| Species Name                              | Species Code | Transects | %  | SRA |
|-------------------------------------------|--------------|-----------|----|-----|
| Laserpitium siler                         | 3            | 1%        | 1.14 |
| Lathyrus heterophyllus                    | 2            | 1%        | 1.63 |
| Lathyrus pratensis                        | Latprat      | 28        | 9%  | 3.28 |
| Lathyrus sphacelus                        | 2            | 1%        | 2.49 |
| Lavandula angustifolia                    | 8            | 2%        | 1.28 |
| Leontodon autumnalis                      | 3            | 1%        | 1.81 |
| Leontodon crispus                         | 6            | 2%        | 5.05 |
| Leontodon helveticus                      | Leohelv      | 77        | 24% | 0.30 |
| Leontodon hirtus                          | 1            | 0%        | 2.51 |
| Leontodon hispidus                        | Leohisp      | 89        | 27% | 1.33 |
| Leontopodium alpinum                      | 9            | 3%        | 0.77 |
| Leucanthemopsis alpina                    | Leualpi      | 21        | 6%  | 1.33 |
| Leucanthemum atratum aggr.                | Leuatra      | 19        | 6%  | 2.76 |
| Leucanthemum vulgare aggr.                | Leuvulg      | 56        | 17% | 6.53 |
| Ligusticum melitellina                    | 17           | 5%        | 2.23 |
| Ligusticum mutellinoides                  | 6            | 2%        | 0.30 |
| Lilium bulbiferum                         | 4            | 1%        | 0.30 |
| Lilium martagon                           | 6            | 2%        | 0.53 |
| Linum alpinum                             | 7            | 2%        | 1.29 |
| Linum strictum                            | 7            | 2%        | 0.30 |
| Linum tenuifolium                         | 1            | 0%        | 0.30 |
| Listera ovata                             | 1            | 0%        | 1.41 |
| Lloydia serotina                         | 2            | 1%        | 1.10 |
| Loiseleuria procumbens                    | 7            | 2%        | 1.51 |
| Lolium multiflorum                        | 2            | 1%        | 1.91 |
| Lotus corniculatus                        | Lotcorn      | 185       | 57% | 5.35 |
| Luzula alpinaoplosa                       | Luzalpi      | 23        | 7%  | 1.22 |
| Luzula campestris aggr.                   | Luzcamp      | 88        | 27% | 2.76 |
| Luzula lutea                              | Luzlute      | 44        | 14% | 1.17 |
| Luzula luzuloides                         | 4            | 1%        | 2.42 |
| Luzula nivea                              | 13           | 4%        | 1.30 |
| Luzula sieberi                            | 16           | 5%        | 0.71 |
| Luzula spicata aggr.                      | Luzspic      | 42        | 13% | 0.61 |
| Maianthemum bifolium                      | 3            | 1%        | 0.30 |
| Malus domesticica                         | 1            | 0%        | 2.44 |
| Medicago lupulina                         | 6            | 2%        | 0.30 |
| Medicago sativa                           | 1            | 0%        | 1.93 |
| Meum athamanticum                        | Meuatha      | 36        | 11% | 0.30 |
| Minuartia austria                         | 1            | 0%        | 1.19 |
| Minuartia capillacea                      | 3            | 1%        | 0.46 |
| Minuartia larcifolia                     | 4            | 1%        | 1.54 |
| Minuartia recurva                         | 1            | 0%        | 0.96 |
| Minuartia sedoides                        | 10           | 3%        | 0.80 |
| Minuartia verna                           | Minvern      | 23        | 7%  | 43.12 |
| Molinia arundinacea                       | 1            | 0%        | 24.20 |
| Molinia caerulea                          | 3            | 1%        | 0.58 |
| Myosotis alpestris                        | Myoalpe      | 69        | 21% | 0.60 |
| Myosotis arvensis                         | 16           | 5%        | 0.30 |
| Myosotis ramosissima                      | 1            | 0%        | 0.30 |
| Myosotis sylvatica                        | 1            | 0%        | 0.30 |
| Myrrhis odorata                           | 1            | 0%        | 0.56 |
| Narcissus radiiflorus                     | 3            | 1%        | 13.68 |
| Nardus stricta                            | Narstri      | 175       | 54% | 0.30 |
| Nepeta nepetella                          | 1            | 0%        | 0.33 |
| Nigritella rhellicani                     | Nigrhel      | 26        | 8%  | 2.04 |
Table A2. Cont.

| Species Name                        | Species Code | Transects | %  | SRA |
|-------------------------------------|--------------|-----------|----|-----|
| Odontites luteus                    |              | 1         | 0% | 7.84|
| Onobrychis montana                  | Onomont      | 39        | 12%| 0.76|
| Onobrychis vicifolia                |              | 1         | 0% | 1.58|
| Ononis crisata                      |              | 3         | 1% | 1.20|
| Ononis natrix                       |              | 5         | 2% | 0.30|
| Orchis mascula                      |              | 1         | 0% | 0.30|
| Orchis militaris                    |              | 1         | 0% | 0.30|
| Orchis tridentata                   |              | 4         | 1% | 0.30|
| Orchis ustulata                     |              | 7         | 2% | 1.37|
| Oreochloa seslerioides              |              | 2         | 1% | 1.02|
| Ornithogalum umbellatum             | Ornnumbe     | 35        | 11%| 2.73|
| Oxytropis campestris                |              | 4         | 1% | 0.96|
| Oxytropis helvetica                 |              | 12        | 4% | 0.39|
| Oxytropis laponica                  |              | 4         | 1% | 3.05|
| Oxytropis neglecta                  |              | 5         | 2% | 1.56|
| Paradisea liliastrum                |              | 13        | 4% | 0.34|
| Parnassia palustris                 |              | 5         | 2% | 0.30|
| Pastinaca sativa                    |              | 1         | 0% | 0.61|
| Pedicularis cenisia                 |              | 7         | 2% | 0.99|
| Pedicularis comosa                  |              | 1         | 0% | 0.30|
| Pedicularis foliosa                 |              | 2         | 1% | 0.61|
| Pedicularis gyroflexa               | Pedgyro      | 37        | 11%| 0.77|
| Pedicularis kernerii                |              | 7         | 2% | 0.63|
| Pedicularis rosea                   |              | 2         | 1% | 0.64|
| Pedicularis rostratospicata         | Pedrost      | 20        | 6% | 0.44|
| Pedicularis tuberosa                |              | 5         | 2% | 0.62|
| Pedicularis verticillata            |              | 3         | 1% | 41.28|
| Petasites hybridus                  |              | 1         | 0% | 0.53|
| Peucedanum oreoselinum              |              | 2         | 1% | 1.31|
| Peucedanum ostruthodium             | Peuostr      | 18        | 6% | 0.89|
| Phleum phleoides                    |              | 2         | 1% | 2.68|
| Phleum pratense                     |              | 4         | 1% | 4.61|
| Phleum rhaeticum                    | Phlrhae      | 112       | 35%| 0.91|
| Phyteuma betonicifolium             | Phybeto      | 89        | 27%| 2.53|
| Phyteuma globularifolium            | Phyglob      | 18        | 6% | 1.23|
| Phyteuma hemisphaericum             | Phyhem       | 21        | 6% | 1.19|
| Phyteuma micheli                   | Phymich      | 30        | 9% | 0.85|
| Phyteuma orbicularis                | Phyorbi      | 43        | 13%| 0.38|
| Phyteuma ovatum                     |              | 5         | 2% | 0.30|
| Phyteuma scheuchzeri                |              | 1         | 0% | 0.62|
| Phyteuma scorzonerifolium           |              | 6         | 2% | 0.30|
| Phyteuma spicatum                   |              | 1         | 0% | 0.30|
| Picea abies                         |              | 1         | 0% | 0.30|
| Picris hieracioides                 |              | 1         | 0% | 0.66|
| Pimpinella major                    |              | 9         | 3% | 1.36|
| Pimpinella saxifraga                |              | 14        | 4% | 0.64|
| Pinguicula alpina                   |              | 1         | 0% | 0.30|
| Pinguicula vulgaris                 |              | 1         | 0% | 0.30|
| Pinus mugo                          |              | 5         | 2% | 0.30|
| Pinus sylvestris                    |              | 3         | 1% | 4.27|
| Plantago alpina aggr.               | Plaalpi      | 130       | 40%| 1.89|
| Plantago atrata                     |              | 7         | 2% | 3.27|
| Plantago fuscescens                 | Plafusc      | 32        | 10%| 1.09|
| Plantago lanceolata                 | Plalanc      | 21        | 6% | 0.91|
| Plantago major                      |              | 8         | 2% | 2.11|
| Species Name                  | Species Code | Transects | %  | SRA |
|------------------------------|--------------|-----------|----|-----|
| Plantago media               | Plamedi      | 25        | 8% | 0.39|
| Platanthera bifolia         |              | 4         | 1% | 0.30|
| Platanthera chlorantha      |              | 1         | 0% | 4.82|
| Poa alpina                  | Poaalpi      | 175       | 54%| 3.00|
| Poa annua aggr.             |              | 9         | 3% | 1.52|
| Poa bulbosa                 |              | 1         | 0% | 0.30|
| Poa cenisia                 |              | 1         | 0% | 3.42|
| Poa chaixii                 | Poachai      | 27        | 8% | 0.30|
| Poa minor                   |              | 1         | 0% | 0.30|
| Poa nemoralis              |              | 3         | 1% | 3.01|
| Poa pratensis              | Poaprat      | 27        | 8% | 2.33|
| Poa trivialis              |              | 6         | 2% | 4.85|
| Poa variagata               | Poavari      | 68        | 21%| 0.51|
| Polygonata alpestris        | Polalpe      | 23        | 7% | 0.30|
| Polygonata alpina           |              | 1         | 0% | 0.30|
| Polygonata amarella         |              | 2         | 1% | 1.79|
| Polygonata chamaebuxis      |              | 3         | 1% | 0.37|
| Polygonata vulgaris         | Polvulg      | 21        | 6% | 0.30|
| Polygonatum verticillatum   |              | 2         | 1% | 1.23|
| Polygonum alpinum           |              | 4         | 1% | 0.30|
| Polygonum aviculare         |              | 1         | 0% | 3.28|
| Polygonum bistorta          | Polbist      | 85        | 26%| 3.20|
| Polygonum viviparum         | Polvivi      | 84        | 26%| 0.30|
| Populus tremula             |              | 1         | 0% | 0.30|
| Potentilla alba             | Potaure      | 36        | 11%| 2.83|
| Potentilla crantzii         | Poteran      | 49        | 15%| 3.37|
| Potentilla erecta           | Poterec      | 51        | 16%| 0.30|
| Potentilla fruticosa        |              | 1         | 0% | 1.76|
| Potentilla grandiflora      | Potgran      | 115       | 35%| 0.97|
| Potentilla intermedia       |              | 2         | 1% | 1.35|
| Potentilla neumanniana      | Potneum      | 19        | 6% | 1.64|
| Potentilla reptans          |              | 2         | 1% | 0.53|
| Potentilla ripaestris       |              | 3         | 1% | 0.69|
| Potentilla valderia         |              | 2         | 1% | 0.95|
| Primula farinosa            |              | 1         | 0% | 0.30|
| Primula hirsuta             |              | 1         | 0% | 2.24|
| Primula pedemontana        |              | 2         | 1% | 0.74|
| Primula veris               | Priveri      | 42        | 13%| 0.30|
| Prunella alpina             |              | 1         | 0% | 0.45|
| Prunella grandiflora        |              | 7         | 2% | 1.83|
| Prunella lacinata           |              | 1         | 0% | 1.28|
| Prunella vulgaris           |              | 9         | 3% | 0.30|
| Prunus avium                |              | 1         | 0% | 0.30|
| Prunus domestica            |              | 1         | 0% | 0.30|
| Prunus spinosa              |              | 2         | 1% | 0.36|
| Pseudorchis albida          | Psealbi      | 28        | 9% | 2.73|
| Pteridium aquilinum         |              | 5         | 2% | 0.39|
| Pulmonaria australis        |              | 6         | 2% | 0.30|
| Pulmonaria officinalis      |              | 1         | 0% | 1.19|
| Pulsatilla alpina           | Pulalpi      | 37        | 11%| 0.30|
| Pulsatilla halleri          |              | 1         | 0% | 0.90|
| Pulsatilla vernalis         |              | 7         | 2% | 1.26|
| Pyroloa minor               |              | 1         | 0% | 0.30|
| Pyroloa rotundifolia        |              | 1         | 0% | 0.30|
| Species Name                        | Species Code | Transects | % | SRA |
|------------------------------------|--------------|-----------|---|-----|
| Quercus pubescens                  |              | 1         | 0%| 0.30|
| Ranunculus aconitifolius           |              | 3         | 1%| 2.02|
| Ranunculus acris                   | Ranacri      | 18        | 6%| 1.49|
| Ranunculus bulbosus                |              | 12        | 4%| 2.07|
| Ranunculus kuepferi                | Rankuep      | 53        | 16%| 2.26|
| Ranunculus montanus aggr.          | Ranmont      | 168       | 52%| 0.37|
| Ranunculus platanifolius           |              | 2         | 1%| 0.62|
| Ranunculus repens                  |              | 1         | 0%| 0.76|
| Ranunculus sequieri                |              | 1         | 0%| 0.30|
| Rhamnus alpina                    |              | 1         | 0%| 0.30|
| Rhamnus pumila                    |              | 1         | 0%| 2.71|
| Rhinanthus alectorolophus          |              | 16        | 5%| 1.15|
| Rhinanthus glacialis               | Rhiglac      | 34        | 10%| 0.92|
| Rhodiola rosea                     |              | 3         | 1%| 0.97|
| Rhododendron ferrugineum           | Rhofer       | 45        | 14%| 0.30|
| Rorippa islandica                  |              | 1         | 0%| 0.42|
| Rosa aggr.                         | Rosaggr      | 25        | 8%| 0.30|
| Rubus aggr.                        |              | 1         | 0%| 1.93|
| Rubus idaeus                       |              | 8         | 2%| 0.71|
| Rumex acetas                       | Rumacet      | 72        | 22%| 0.59|
| Rumex acetosella                   |              | 13        | 4%| 2.15|
| Rumex alpestris                    |              | 9         | 3%| 6.42|
| Rumex alpinus                      |              | 15        | 5%| 1.35|
| Rumex obtusifolius                 |              | 6         | 2%| 2.15|
| Rumex scutatus                     |              | 8         | 2%| 0.74|
| Saxifraga aizoides                 |              | 3         | 1%| 1.43|
| Saxifraga aizoides                 |              | 2         | 1%| 6.90|
| Saxifraga brachyphylla             |              | 1         | 0%| 0.30|
| Saxifraga brachyphylla             |              | 2         | 1%| 1.55|
| Saxifraga caerulea                 |              | 1         | 0%| 1.15|
| Saxifraga caerulea                 |              | 2         | 1%| 0.30|
| Saxifraga oppositifolia            |              | 1         | 0%| 0.36|
| Saxifraga paniculata               |              | 9         | 3%| 0.30|
| Saxifraga purpurea                 |              | 3         | 1%| 0.67|
| Scabiosa columbaria aggr.          | Scacolu      | 42        | 13%| 0.49|
| Scabiosa columbaria aggr.          |              | 4         | 1%| 23.40|
| Scirpus sylvaticus                 |              | 1         | 0%| 0.30|
| Scorzoneria austriae               |              | 1         | 0%| 0.30|
| Scrophularia canina                |              | 1         | 0%| 1.41|
| Scutellaria alpina                 |              | 5         | 2%| 1.40|
| Securigera varia                   |              | 3         | 1%| 0.37|
| Sedum acre                         |              | 4         | 1%| 0.30|
| Sedum album                        |              | 1         | 0%| 1.87|
| Sedum alpestr                      |              | 5         | 2%| 0.49|
| Species Name                | Species Code     | Transects | %  | SRA |
|----------------------------|------------------|-----------|----|-----|
| Sedum anacampseros         |                  | 17        | 5% | 0.66|
| Sedum rupestre aggr.       |                  | 6         | 2% | 0.30|
| Selaginella selaginoides    |                  | 2         | 1% | 0.42|
| Sempervivum arachnoideum   | Semarac          | 23        | 7% | 1.38|
| Sempervivum montanum       |                  | 11        | 3% | 0.70|
| Sempervivum tectorum       |                  | 12        | 4% | 0.52|
| Senecio doronicum          | Sendooro         | 29        | 9% | 0.64|
| Senecio incanus            | Seninca          | 33        | 10%| 0.30|
| Senecio jacobaea           |                  | 1         | 0% | 0.30|
| Senecio ovatus             |                  | 1         | 0% | 0.30|
| Senecio viscosus           |                  | 1         | 0% | 1.40|
| Seseli annuum              |                  | 1         | 0% | 0.63|
| Seseli libanotis           |                  | 4         | 1% | 9.34|
| Sesleria caerulea          | Sescaer          | 39        | 12%| 1.13|
| Sibbaldia procumbens       | Sibproc          | 22        | 7% | 1.01|
| Silene acaulis             | Silacau          | 37        | 11%| 0.60|
| Silene dioica              |                  | 4         | 1% | 0.30|
| Silene flos-cuculi         |                  | 1         | 0% | 0.48|
| Silene flos-jovis          |                  | 16        | 5% | 0.30|
| Silene latifolia           |                  | 1         | 0% | 0.64|
| Silene nutans              | Silnuta          | 59        | 18%| 0.30|
| Silene oitites             |                  | 3         | 1% | 0.37|
| Silene rupestris           |                  | 9         | 3% | 0.30|
| Silene saxifraga           |                  | 1         | 0% | 0.50|
| Silene viscaria            |                  | 2         | 1% | 1.25|
| Silene vulgaris            | Silvulg          | 28        | 9% | 1.27|
| Solidanella alpina         | Solalpi          | 49        | 15%| 0.55|
| Solidago virgaurea         |                  | 16        | 5% | 0.30|
| Sorbus aria                |                  | 10        | 3% | 0.30|
| Sorbus aucuparia           |                  | 5         | 2% | 0.98|
| Stachys officinalis        | Staprad          | 28        | 9% | 0.63|
| Stachys recta              |                  | 9         | 3% | 1.09|
| Stellaria graminea         |                  | 4         | 1% | 0.97|
| Stellaria holostea         |                  | 1         | 0% | 1.57|
| Stellaria media            |                  | 1         | 0% | 20.33|
| Stipa pennata aggr.        |                  | 3         | 1% | 0.30|
| Tanacetum vulgare          |                  | 2         | 1% | 0.52|
| Taraxacum laevisatum s. l.|                  | 8         | 2% | 1.03|
| Taraxacum officinale aggr. |                  | 13        | 4% | 4.46|
| Taraxacum officinale s. l.| Taroffi          | 47        | 15%| 0.30|
| Tephrosferis aurantiaca    |                  | 1         | 0% | 5.85|
| Teucrium chamaedrys        |                  | 13        | 4% | 1.54|
| Teucrium montanum          |                  | 4         | 1% | 0.53|
| Teucrium scorodonia        |                  | 4         | 1% | 0.30|
| Thalictrum aquilegfolium   |                  | 1         | 0% | 0.50|
| Thalictrum minus aggr.     |                  | 6         | 2% | 0.36|
| Thesium alpinum            |                  | 7         | 2% | 0.79|
| Thesium linophyllum aggr.  |                  | 1         | 0% | 0.45|
| Thlaspi alpestre           | Thalpe           | 19        | 6% | 2.24|
| Thymus serpyllum aggr.     | Thyserp          | 151       | 47%| 0.30|
| Tofieldia calyculata       |                  | 1         | 0% | 0.30|
| Tragopogon dubius          |                  | 1         | 0% | 0.45|
| Tragopogon pratensis       |                  | 15        | 5% | 0.30|
| Traunsteinera globosa      |                  | 3         | 1% | 6.49|
| Trichophorum cespitosum    |                  | 2         | 1% | 2.49|
| Trifolium alpestre         | Trialpe          | 25        | 8% | 12.62|
Table A2. Cont.

| Species Name                | Species Code | Transects n | SRAn % | SRA  |
|-----------------------------|--------------|-------------|--------|------|
| Trifolium alpinum           | Trialpi      | 108         | 33%    | 0.30 |
| Trifolium aureum            | 1            | 0%          |        | 0.59 |
| Trifolium badium            | Tribadi      | 28          | 9%     | 3.57 |
| Trifolium hybridum          | 1            | 0%          |        | 12.91|
| Trifolium medium            | 2            | 1%          |        | 1.70 |
| Trifolium montanum          | Trimont      | 30          | 9%     | 3.17 |
| Trifolium pallecescens      | 3            | 1%          |        | 1.22 |
| Trifolium pannonicum        | 6            | 2%          |        | 2.16 |
| Trifolium pratense          | Triprat      | 147         | 45%    | 2.40 |
| Trifolium repens            | Trirepe      | 55          | 17%    | 6.03 |
| Trifolium thalii            | Trithal      | 34          | 10%    | 10.48|
| Triglochin palustris         | 1            | 0%          |        | 0.97 |
| Trinia glauca               | 4            | 1%          |        | 0.80 |
| Trisetum distichophyllum    | 1            | 0%          |        | 4.81 |
| Trisetum flavescens         | Triflav      | 51          | 16%    | 1.60 |
| Trollius europaeus          | Troeuro      | 30          | 9%     | 0.42 |
| Tulipa australis            | 6            | 2%          |        | 1.19 |
| Tussilago farfara           | 1            | 0%          |        | 1.25 |
| Urtica dioica               | 15           | 5%          |        | 3.18 |
| Vaccinium gaultherioides    | Vacgaul      | 60          | 19%    | 2.36 |
| Vaccinium myrtillus         | Vacmyrt      | 68          | 21%    | 1.49 |
| Vaccinium vitis-idaea       | 2            | 1%          |        | 3.16 |
| Valeriana celtica           | 5            | 2%          |        | 0.30 |
| Valerianella locusta        | 1            | 0%          |        | 0.52 |
| Veratrum album              | Veralbu      | 60          | 19%    | 0.88 |
| Verbascum densiflorum       | 5            | 2%          |        | 0.30 |
| Verbascum lychnitis         | 6            | 2%          |        | 0.38 |
| Verbascum thapsus           | 6            | 2%          |        | 1.87 |
| Veronica allionii           | Veralli      | 53          | 16%    | 0.66 |
| Veronica alpina             | Veralpi      | 19          | 6%     | 0.30 |
| Veronica aphylla            | 1            | 0%          |        | 0.30 |
| Veronica arvensis           | 4            | 1%          |        | 2.28 |
| Veronica bellidoides        | 5            | 2%          |        | 1.34 |
| Veronica chamaedrys         | Vercham      | 23          | 7%     | 0.47 |
| Veronica fruticulosa aggr.  | Verofti      | 3           | 1%     | 1.50 |
| Veronica officinalis        | Verofti      | 20          | 6%     | 0.30 |
| Veronica prostrata          | 1            | 0%          |        | 0.70 |
| Veronica serpyllifolia      | 4            | 1%          |        | 0.57 |
| Veronica verna              | 1            | 0%          |        | 1.99 |
| Vicia cracca                | 13           | 4%          |        | 0.30 |
| Vicia hirsuta               | 1            | 0%          |        | 1.34 |
| Vicia onobrychioides        | 2            | 1%          |        | 2.67 |
| Vicia sativa                | 2            | 1%          |        | 1.44 |
| Vicia sepium                | 2            | 1%          |        | 0.30 |
| Vicia villosa               | 1            | 0%          |        | 0.30 |
| Vincetoxicum hirsundinaria  | 13           | 4%          |        | 0.30 |
| Viola arvensis              | 1            | 0%          |        | 0.61 |
| Viola biflora               | 9            | 3%          |        | 1.32 |
| Viola calcarata             | Viocalc      | 89          | 27%    | 2.00 |
| Viola canina                | 4            | 1%          |        | 0.30 |
| Viola odorata               | 1            | 0%          |        | 0.30 |
| Viola palustris             | 1            | 0%          |        | 0.30 |
| Viola pinnata               | 1            | 0%          |        | 0.52 |
| Viola ruminiana             | 3            | 1%          |        | 0.30 |
| Viola suavis                | 2            | 1%          |        | 0.35 |
| Viola thomasiana            | 5            | 2%          |        | 0.39 |
| Viola tricolor              | 16           | 5%          |        | 0.30 |
29. Magnusson, A.; Skaug, H.; Nielsen, A.; Berg, C.; Kristensen, K.; Maechler, M.; van Bentham, K.; Bolker, B.; Sadat, N.; Lüdecke, D.; et al. *GlmntMB: Generalized Linear Mixed Models Using Template Model Builder*; R Foundation for Statistical Computing: Vienna, Austria, 2021.

30. Clarke, K.R.; Warwick, R.M. *Change in Marine Communities: An Approach to Statistical Analysis and Interpretation*; PRIMER-E Ltd.: Plymouth, UK, 1994; Volume 2, pp. 117–143.

31. Rodríguez-Murillo, J.C. Organic Carbon Content under Different Types of Land Use and Soil in Peninsular Spain. *Biol. Fertil. Soils* 2001, 33, 53–61. [CrossRef]

32. Hoffmann, U.; Hoffmann, T.; Jurasinski, G.; Glatzel, S.; Kuhn, N.J. Assessing the Spatial Variability of Soil Organic Carbon Stocks in an Alpine Setting (Grindelwald, Swiss Alps). *Geoderma* 2014, 232–234, 270–283. [CrossRef]

33. Ferré, C.; Caccianiga, M.; Zanzottera, M.; Comolli, R. Soil–Plant Interactions in a Pasture of the Italian Alps. *J. Plant Interact.* 2020, 15, 39–49. [CrossRef]

34. Meyer, S.; Leifeld, J.; Bahn, M.; Fuhrer, J. Free and Protected Soil Organic Carbon Dynamics Respond Differently to Abandonment in an Alpine Setting (Grindelwald, Swiss Alps). *Soil Biol. Biochem.* 2016, 39, 15–26. [CrossRef]

35. Guidi, C.; Vesterdal, L.; Gianelle, D.; Rodeghiero, M. Changes in Soil Organic Carbon and Nitrogen Following Forest Expansion on Grassland in the Southern Alps. *For. Ecol. Manag.* 2008, 328, 103–116. [CrossRef]

36. Meyer, S.; Leifeld, J.; Bahn, M.; Fuhrer, J. Free and Protected Soil Organic Carbon Dynamics Respond Differently to Abandonment of Mountain Grassland. *Biogeochemistry* 2012, 9, 853–865. [CrossRef]

37. García-Pausas, J.; Romanya, J.; Montané, F.; Rios, A.I.; Taull, M.; Rovira, P.; Casals, P. Are soil carbon stocks in mountain grasslands compromised by land-use changes? In *High Mountain Conservation in a Changing World*; Springer: Cham, Switzerland, 2017; pp. 207–230.

38. Djukic, I.; Zehetner, F.; Tatzber, M.; Gerzabek, M.H. Soil Organic-Matter Stocks and Characteristics along an Alpine Elevation Gradient. *J. Plant Nutr. Soil Sci.* 2010, 173, 30–38. [CrossRef]

39. Kopáček, J.; Kaňa, J.; Šantrůčková, H. Pools and Composition of Soils in the Alpine Zone of the Tatra Mountains. *Biologia* 2006, 61, 535–549. [CrossRef]

40. García-Pausas, J.; Casals, P.; Camarero, L.; Huguet, C.; Sebastia, M.-T.; Thompson, R.; Romanya, J. Soil Organic Carbon Storage in Mountain Grasslands of the Pyrenees: Effects of Climate and Topography. *Biogeochemistry* 2007, 82, 279–289. [CrossRef]

41. Yang, Y.; Fang, J.; Ma, W.; Smith, P.; Mohammad, A.; Wang, S.; Wang, W.E.I. Soil Carbon Stock and Its Changes in Northern China’s Grasslands from 1980s to 2000s. *Glob. Change Biol.* 2010, 16, 3036–3047. [CrossRef]

42. Steinbeiss, S.; Beßler, H.; Engels, C.; Temperton, V.M.; Buchmann, N.; Roscher, C.; Kreutziger, Y.; Baade, J.; Habekost, M.; Gleixner, G. Plant Diversity Positively Affects Short-Term Soil Carbon Storage in Experimental Grasslands. *Glob. Change Biol.* 2008, 14, 2937–2949. [CrossRef]

43. Tian, F.-P.; Zhang, Z.-N.; Chang, X.-F.; Sun, L.; Wei, X.-H.; Wu, G.-L. Effects of Biotic and Abiotic Factors on Soil Organic Carbon in Semi-Arid Grassland. *J. Soil Sci. Plant Nutr.* 2016, 16, 1087–1096. [CrossRef]

44. Kukuls, I.; Nikodemus, O.; Kasparinskis, R.; Zigure, Z. Humus Forms, Carbon Stock and Properties of Soil Organic Matter in Forests Formed on Dry Mineral Soils in Latvia. *Est. J. Earth Sci.* 2020, 69, 63–75. [CrossRef]

45. Pittarello, M.; Lonati, M.; Gorlier, A.; Perotti, E.; Probo, M.; Lombardi, G. Plant Diversity Positively Affects Short-Term Soil Carbon Storage in Experimental Grasslands. *Glob. Change Biol.* 2010, 16, 3036–3047. [CrossRef]

46. Liao, K.; Wu, S.; Zhu, Q. Can Soil PH Be Used to Help Explain Soil Organic Carbon Stocks? *Clean Soil Air Water* 2016, 44, 1685–1689. [CrossRef]

47. Curtin, D.; Campbell, C.A.; Jalili, A. Effects of Acidity on Mineralization: PH-Dependence of Organic Matter Mineralization in Weakly Acidic Soils. *Soil Biol. Biochem.* 1998; 30, 57–64. [CrossRef]

48. Sapek, B. Impact of soil pH on nitrogen mineralization in grassland soils. In *Progress in Nitrogen Cycling Studies*; Springer: Cham, Switzerland, 1996; pp. 271–276.

49. Pornero, C.; Basso, E.; Macolino, S. Pasture Botanical Composition and Forage Quality at Farm Scale: A Case Study. *Ital. J. Agron.* 2019, 14, 214–221. [CrossRef]

50. Rodríguez-Ortega, T.; Olazola, A.M.; Bernaúes, A. A Novel Management-Based System of Payments for Ecosystem Services for Targeted Agri-Environmental Policy. *Ecosyst. Serv.* 2018, 34, 74–84. [CrossRef]

51. Theurillat, J.-P.; Guisan, A. Potential Impact of Climate Change on Vegetation in the European Alps: A Review. *Clim. Change* 2001, 50, 77–109. [CrossRef]

52. Sun, Q.; Miao, C.; Duan, Q. Changes in the Spatial Heterogeneity and Annual Distribution of Observed Precipitation across China. *J. Clim.* 2017, 30, 9399–9416. [CrossRef]

53. Masson-Delmotte, V.; Zhai, P.; Pirani, A.; Connors, S.L.; Péan, C.; Berger, S.; Caud, N.; Chen, Y.; Goldfarb, L.; Gomis, M.I.; et al. (Eds.) *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Cambridge University Press: Cambridge, UK, 2021.