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

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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 counteracting 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 multid imensional 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.

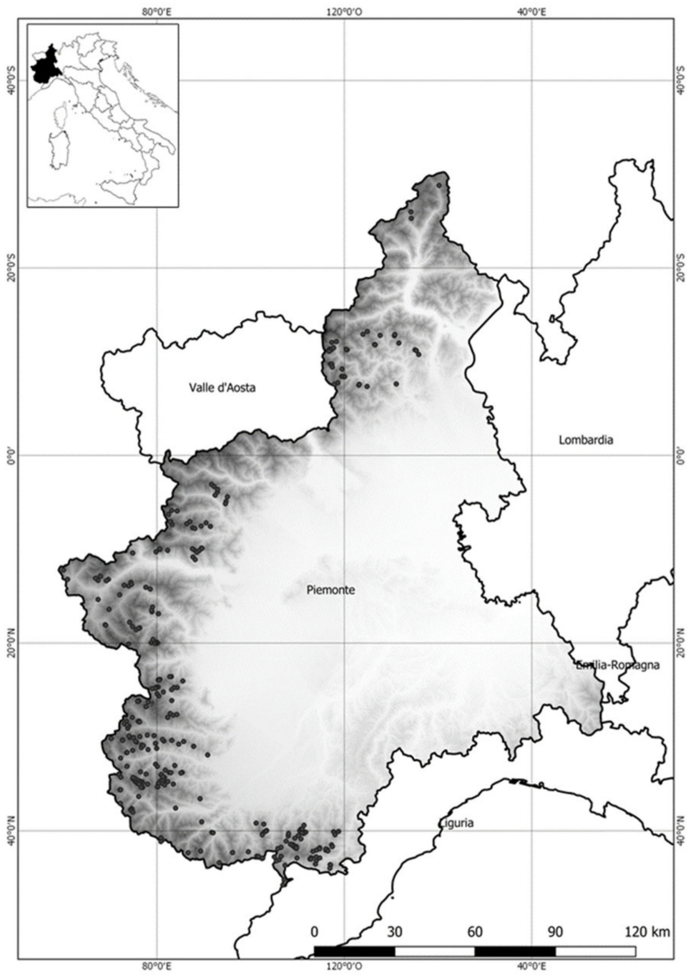


Figure 1. Location of the 324 survey sites in north-western Italian Alps. Each black dot represents a site.

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]:

$$BD = 1.565081 - 0.3946467 \times \mathrm{SOC} - 0.0103851 \times Skel$$

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 *BDc* 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):

$$\mathrm{SOC}_{stock} = \sum_{i=1}^{n} (OC_i \times BD_i \times depth_i \times (1 - Skel_i) \times 100)$$

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 β 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

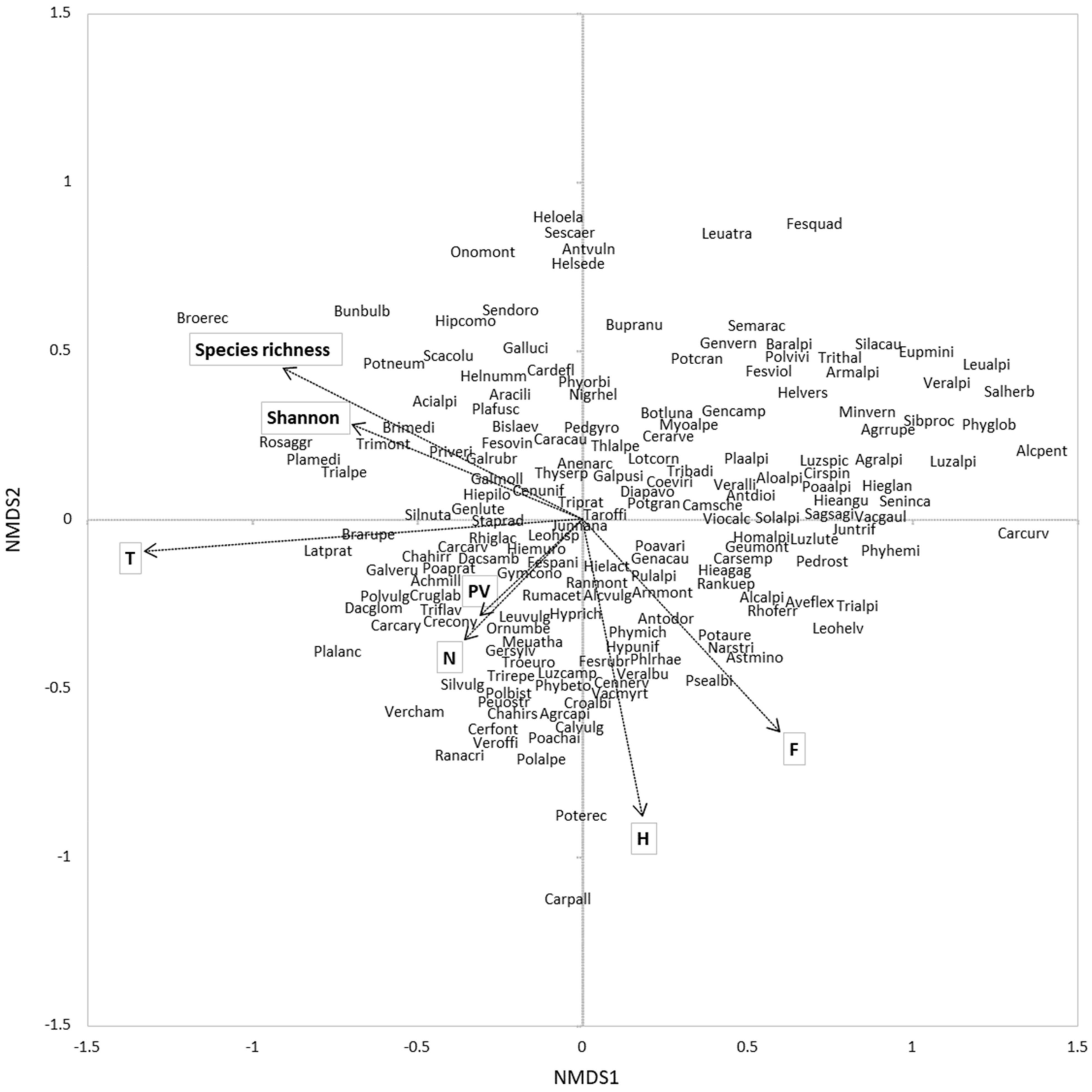
Mean annual precipitation of the studied sites ranged from 727 to 1574 mm, thus including dry to wet climatic conditions. The altitude, slope, and aspect ranged, respectively, between 988 and 2688 m a.s.l., between 0.4 and 49.8°, and between 1.1 and 179.7°. Such a wide range of topographic conditions, 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

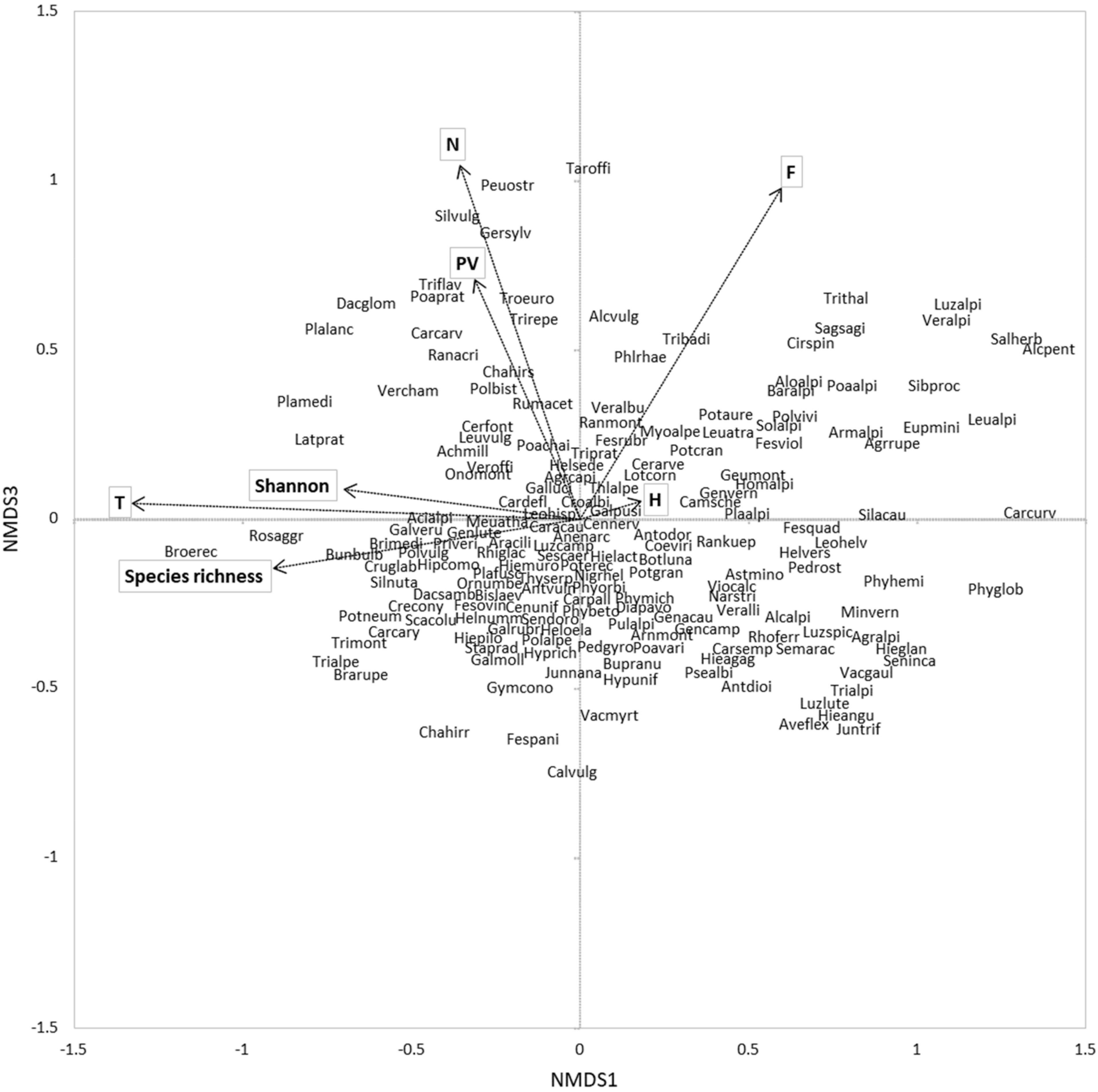
Being 0.16 the stress value of the first three dimensions of the NMDS, i.e., less than 0.20, the fitting was considered satisfactory [30]. The supplementary variables included in the NMDS biplot improved the understanding of such a complex and variable vegetation, by highlighting its ecological trends 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., *Helictotrichon 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.



(**a**)

Figure 2. *Cont*.



(**b**)

Figure 2. Biplots of the non-metric multidimensional scaling (NMDS): (**a**) first and second dimensions, (**b**) first and third dimensions. Stress value for the three dimensions: 0.16. Only species recorded in more than 5% of the surveys are displayed and identified by a species code (see Appendix A for the complete species and code list). Dashed arrows represent passive variables: biodiversity (species richness and Shannon diversity index), Landolt's indicator values (F, soil moisture; H, humus; N, soil nutrients; T, temperature), and pastoral value (PV).

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 scantly 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; ***, $p < 0.001$; **, $p < 0.01$.

	β 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 β 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 30% 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.

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

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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-pilosa	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
		n	%	
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
Achnatherum calamagrostis		2	1%	0.63
Acinos alpinus	Acialpi	26	8%	0.30
Aconitum napellus		3	1%	2.29
Adenostyles leucophylla		1	0%	4.04
Aegopodium podagraria		4	1%	4.03
Agrostis alpina	Agralpi	52	16%	4.05
Agrostis canina		1	0%	6.29
Agrostis capillaris	Agrcapi	125	39%	2.25
Agrostis rupestris	Agrrupe	33	10%	8.63
Agrostis schraderiana		16	5%	0.44

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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 pentaphyllea	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	Aloalpi	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 carpatica		8	2%	0.63
Antennaria dioica	Antdioi	61	19%	1.86
Anthericum liliago		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 arvensis		1	0%	0.30
Arabidopsis thaliana		1	0%	0.38
Arabis allionii		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.		7	2%	0.31
Armeria alpina	Armalpi	33	10%	2.60
Armeria arenaria		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 bellidiastrum		12	4%	2.36
Astragalus alpinus		8	2%	0.30

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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		5	2%	0.86
Astrantia minor	Astmino	21	6%	0.30
Athamanta cretensis		1	0%	0.30
Athyrium filix-femina		2	1%	5.02
Avenella flexuosa	Aveflex	109	34%	0.30
Barbarea intermedia		4	1%	0.68
Bartsia 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
Callianthemum coriandrifolium		1	0%	3.82
Calluna vulgaris	Calvulg	34	10%	0.69
Campanula barbata		16	5%	0.30
Campanula cochleariifolia		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 fimbriata		2	1%	4.94
Carex flacca		3	1%	16.27
Carex flava aggr.		3	1%	17.45
Carex foetida		15	5%	3.50

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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	Carpall	20	6%	4.77
Carex panicea		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 triumfettii		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
Chamaecytisus 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 aurea		4	1%	1.20
Crepis conyzifolia	Crecony	39	12%	1.57
Crepis paludosa		2	1%	2.39
Crocus albiflorus	Croalbi	64	20%	1.45
Cruciata glabra	Cruglab	50	15%	0.85
Cruciata laevipes		4	1%	0.30

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
Crupina vulgaris		1	0%	0.30
Cryptogramma crispa		2	1%	0.63
Cuscuta epithymum		1	0%	1.55
Cynosurus cristatus		7	2%	0.67
Cytisophyllum 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		12	4%	0.50
Daucus carota		2	1%	3.00
Deschampsia cespitosa		7	2%	1.64
Dianthus carthusianorum		13	4%	0.57
Dianthus deltoides		8	2%	1.43
Dianthus furcatus		12	4%	0.74
Dianthus pavonius	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
Empetrum 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
Erigeron alpinus		11	3%	0.30
Erigeron annuus		1	0%	0.60
Erigeron uniflorus		10	3%	3.09
Eriophorum angustifolium		3	1%	1.71
Eriophorum latifolium		2	1%	5.88
Eriophorum scheuchzeri		1	0%	0.96
Eritrichium 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 rostkoviana		1	0%	0.83
Euphrasia stricta		12	4%	0.30
Fagus sylvatica		2	1%	2.83
Festuca arundinacea		2	1%	5.50
Festuca dimorpha		2	1%	3.34

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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	Fespani	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 scabriculmis		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 tubaeformis		4	1%	3.28
Gagea fragifera		2	1%	9.84
Galeopsis ladanum		1	0%	0.30
Galeopsis pubescens		1	0%	0.71
Galeopsis tetrahit		5	2%	16.67
Galium laevigatum		1	0%	1.32
Galium lucidum aggr.	Galluci	21	6%	1.77
Galium mollugo aggr.	Galmoll	22	7%	0.98
Galium pusillum aggr.	Galpusi	60	19%	0.98
Galium rubrum aggr.	Galrubr	40	12%	0.90
Galium verum	Galveru	37	11%	5.39
Genista cinerea		2	1%	1.54
Genista germanica		17	5%	2.36
Genista pilosa		7	2%	1.31
Genista tinctoria		12	4%	0.93
Gentiana acaulis aggr.	Genacau	89	27%	0.34
Gentiana campestris aggr.	Gencamp	26	8%	0.30
Gentiana cruciata		1	0%	0.36
Gentiana lutea	Genlute	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
Gymnocarpium dryopteris		1	0%	0.30
Gypsophila repens		5	2%	10.97
Hedysarum hedysaroides		6	2%	0.30
Helianthemum apenninum		2	1%	4.69
Helianthemum nummularium	Helnumm	85	26%	3.05

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
Helianthemum oelandicum aggr.	Heloela	32	10%	14.45
Helictotrichon parlatorei		16	5%	3.59
Helictotrichon pratense		16	5%	1.45
Helictotrichon pubescens		12	4%	4.24
Helictotrichon sedenense	Helsede	23	7%	0.30
Helictotrichon sempervirens		1	0%	2.32
Helictotrichon versicolor	Helvers	19	6%	0.30
Helleborus foetidus		1	0%	4.24
Heracleum sphondylium		7	2%	1.18
Hieracium angustifolium	Hieangu	23	7%	0.30
Hieracium aurantiacum		1	0%	0.61
Hieracium cymosum		5	2%	1.04
Hieracium glanduliferum	Hieglan	56	17%	1.40
Hieracium lactucella	Hielact	55	16%	1.07
Hieracium murorum aggr.	Hiemuro	26	8%	0.30
Hieracium peletierianum		2	1%	1.98
Hieracium pilosella	Hiepilo	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 valdepilosum		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

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
Laserpitium siler		3	1%	1.14
Lathyrus heterophyllus		2	1%	1.63
Lathyrus pratensis	Latprat	28	9%	3.28
Lathyrus sphaericus		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%	0.57
Leontopodium alpinum		9	3%	1.33
Leucanthemopsis alpina	Leualpi	21	6%	0.77
Leucanthemum atratum aggr.	Leuatra	19	6%	0.62
Leucanthemum vulgare aggr.	Leuvulg	56	17%	6.53
Ligusticum mutellina		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 alpinopilosa	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 domestica		1	0%	2.44
Medicago lupulina		6	2%	0.30
Medicago sativa		1	0%	1.93
Meum athamanticum	Meuatha	36	11%	0.30
Minuartia austriaca		1	0%	1.19
Minuartia capillacea		3	1%	0.46
Minuartia laricifolia		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
		n	%	
Odontites luteus		1	0%	7.84
Onobrychis montana	Onomont	39	12%	0.76
Onobrychis viciifolia		1	0%	1.58
Ononis cristata		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	Ornumbe	35	11%	2.73
Oxytropis campestris		4	1%	0.96
Oxytropis helvetica		12	4%	0.39
Oxytropis lapponica		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 kerneri		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 ostruthium	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 globulariifolium	Phyglob	18	6%	1.23
Phyteuma hemisphaericum	Phyhemi	21	6%	1.19
Phyteuma michelii	Phymich	30	9%	0.85
Phyteuma orbiculare	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

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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 variegata	Poavari	68	21%	0.51
Polygala alpestris	Polalpe	23	7%	0.30
Polygala alpina		1	0%	0.30
Polygala amarella		2	1%	1.79
Polygala chamaebuxus		3	1%	0.37
Polygala 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		2	1%	0.30
Potentilla argentea		2	1%	2.97
Potentilla aurea	Potaure	36	11%	2.83
Potentilla crantzii	Potcran	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 rupestris		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
Pritzelago alpina		1	0%	0.45
Prunella grandiflora		7	2%	1.83
Prunella laciniata		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
Pyrola minor		1	0%	0.30
Pyrola rotundifolia		1	0%	0.30

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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 seguieri		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	Rhoferr	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 acetosa	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
Sagina saginoides	Sagsagi	20	6%	0.30
Salix breviserrata		2	1%	0.30
Salix foetida		1	0%	0.30
Salix glaucosericea		1	0%	0.30
Salix hastata		1	0%	0.30
Salix helvetica		2	1%	6.90
Salix herbacea	Salherb	35	11%	4.93
Salix reticulata		5	2%	5.08
Salix retusa		11	3%	2.30
Salix serpillifolia		4	1%	2.52
Salvia pratensis		13	4%	0.92
Sanguisorba minor		13	4%	1.29
Sanguisorba officinalis		6	2%	0.50
Saponaria ocymoides		7	2%	1.99
Satureja montana		2	1%	0.30
Saxifraga aizoides		1	0%	1.55
Saxifraga bryoides		2	1%	0.30
Saxifraga exarata aggr.		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
Scilla bifolia		4	1%	23.40
Scirpus sylvaticus		1	0%	0.30
Scorzonera austriaca		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 alpestre		5	2%	0.49

Table A2. *Cont.*

Species Name	Species Code	Transects		SRA
		n	%	
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	Sendoro	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 otites		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
Soldanella 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		6	2%	0.69
Stachys pradica	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 laevigatum s. l.		8	2%	1.03
Taraxacum officinale aggr.		13	4%	4.46
Taraxacum officinale s. l.	Taroffi	47	15%	0.30
Tephroseris aurantiaca		1	0%	5.85
Teucrium chamaedrys		13	4%	1.54
Teucrium montanum		4	1%	0.53
Teucrium scorodonia		4	1%	0.30
Thalictrum aquilegiifolium		1	0%	0.50
Thalictrum minus aggr.		6	2%	0.36
Thesium alpinum		7	2%	0.79
Thesium linophyllon aggr.		1	0%	0.45
Thlaspi alpestre	Thlalpe	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		SRA
		n	%	
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 pallescens		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 bellidioides		5	2%	1.34
Veronica chamaedrys	Vercham	23	7%	0.47
Veronica fruticulosa aggr.		3	1%	1.50
Veronica officinalis	Veroffi	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		4	1%	1.44
Vicia sepium		2	1%	0.30
Vicia villosa		1	0%	0.30
Vincetoxicum hirundinaria		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 riviniana		3	1%	0.30
Viola suavis		2	1%	0.35
Viola thomasiana		5	2%	0.39
Viola tricolor		16	5%	0.30

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