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The higher the summit, the higher the diversity changes – Results of a long-term monitoring project in the Dolomites

Abstract

Climate warming provokes changes in species diversity, abundance and community composition with time, especially at high altitudes. Long-term observations are indispensable to record these changes and to predict the consequences. Within a long-term monitoring project in the western Dolomites, plant species diversity and frequency were investigated after 5, 7, and 14 years along an elevation gradient, including four summits from the treeline ecotone (2199 m a.s.l.) to the lower alpine – (2463 m a.s.l.), upper alpine – (2757 m a.s.l.) and subnival zone (2893 m a.s.l.). Summit areas and permanent plots of 1 m² were analysed. After 14 years, the highest increases in species numbers were detected at the highest summit. Frequency of most species increased in the m² plots at the lower and upper alpine summits. At the treeline ecotone most species showed a decreasing frequency while competitive graminoids and species with a montane-centred distribution increased. Interestingly, mean frequency decreased also at the highest summit when comparing the first and the last census, but cushion plants were able to considerably enhance their occurrence during this period. At all summits, the newcomers were found to be of more thermophilic character compared to the resident species.

Keywords: climate change, elevation gradient, frequency, GLORIA, permanent plots, resampling

Introduction

In the temperate zone of Europe, diversity of plant species was found to increase at the summits from the treeline ecotone to the subnival-nival zone, especially during the last decades (Walther et al. 2005, Gottfried et al. 2012, Pauli et al. 2012, Wipf et al. 2013, Cannone & Pignatti 2014, and citations therein). The mean increase amounted to +0.56 species per year and summit (Pauli et al. 2012). Alpine environments react to climate warming by upward migration of species from lower altitudes (Grabherr et al. 1994, Walther et al. 2005, Erschbamer et al. 2006, 2009, 2011, Lenoir et al. 2008, Frei et al. 2010, Stöckli et al. 2011, Gottfried et al. 2012). Range shifts caused by global warming (Chen et al. 2011) may provoke changes in the dominance of species within communities and new assemblages may be formed (Walther 2004, Kullmann 2006). Major changes in biodiversity may affect not only the number of species *per se* but may raise problems for the survival of rare and endemic species (Dirnböck et al. 2011). In certain regions such as the Mediterranean mountains, a decreasing tendency of diversity at summits was already highlighted (Pauli et al. 2012) with species losses on average of -0.2 species per year and summit. Also for the temperate zone losses of species richness were predicted in the long term (Walther 2010, Dirnböck et al. 2011, IPCC 2014). Investigating permanent plots at Mt. Schrankogel in the Central Austrian Alps, Pauli et al. (2007)

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revealed a remarkable decrease in the cover of subnival species in the course of 10 years and an increase of competitive alpine species. Certain species already present at the site enlarge their populations (‘filling' of open space) and/or outpost populations of species from lower altitudes expand vertically and horizontally (Grabherr et al. 1995: ‘filling' rather than ‘moving'). The ‘filling' processes enhance competition phenomena (Alexander et al. 2015) and change entire communities (Vittoz et al. 2008, Britton et al. 2009).

Resampling of plots is the common approach to investigate changes in species number and composition (Grabherr et al. 1994, Walther et al. 2005, Erschbamer et al. 2006, 2009, 2011, Holzinger et al. 2008). In this paper, we present the results of summit and permanent plot (m²) resampling after 5, 7 and 14 years in the Dolomites. After 7 years, an increase of thermophilic species at the treeline ecotone up to the upper alpine zone was already demonstrated (Erschbamer et al. 2011), showing new arrivals of montane-centred species at the lower summits. With the resampling after 14 years we expected significant changes at all the summits according to the trends highlighted by Gottfried et al. (2012) and Pauli et al. (2012), i.e. a continuation of the thermophilization and further increases of species numbers at the summit areas. At the small scale (m² plot scale) we expected first indications of competitive processes, mainly at the treeline ecotone and the lower alpine zone, i.e. a decrease in species numbers and an increase in the frequency of competitive species. The following questions should be clarified:
Do species numbers increase continuously throughout time?
Do ‘filling' processes occur?
Does the presence of endemic species change throughout the years?
Can thermophilization trends be confirmed?
Does a reorganization of communities occur?

Study area

The study is part of the project GLORIA (Global Observation Research Initiative in Alpine Environments, www.gloria.ac.at). The investigated target region is called IT_ADO. In 2001, four summits were selected in the western Dolomites (Trentino-South Tyrol region, northern Italy) according to the GLORIA protocol (Pauli et al. 2001, 2004, 2015). Three summits are located in the Latemar group (N46°19'-N46°23', E11°33'), the fourth and highest summit lies in the Sella group. Official names of the summits were hardly available, therefore artificial names were given: ‘Grasmugl' (GRM 2199 m a.s.l.) at the treeline ecotone, Do Peniola (PNL 2463 m) at the lower alpine zone, ‘Ragnaroek' (RNK 2757 m a.s.l.) at the upper alpine zone and ‘Monte Schutto' (MTS 2893 m a.s.l.) at the subnival zone. Geologically, the summits GRM, PNL and RNK consist of Latemar limestone (Leonardi 1967, Bosellini 1998); MTS has dolomitic rocks (Hauptdolomit, Bosellini 1998). GRM is located in the contact zone between Latemar limestone and volcanic rocks (Augitporphyr, Vardabasso 1930).

Material and Methods

The sampling protocol followed the GLORIA methods (Pauli et al. 2001, 2004, 2015), using a cluster of 3 x 3 m at each aspect per summit, 5 m below the highest summit point (Fig. 1). The corner quadrats of the cluster were marked permanently, resulting in 4 plots of 1 m² numbered according the aspect in the tables of the Appendix. If topographically possible, a total of 16 permanent plots per summit was installed. In each

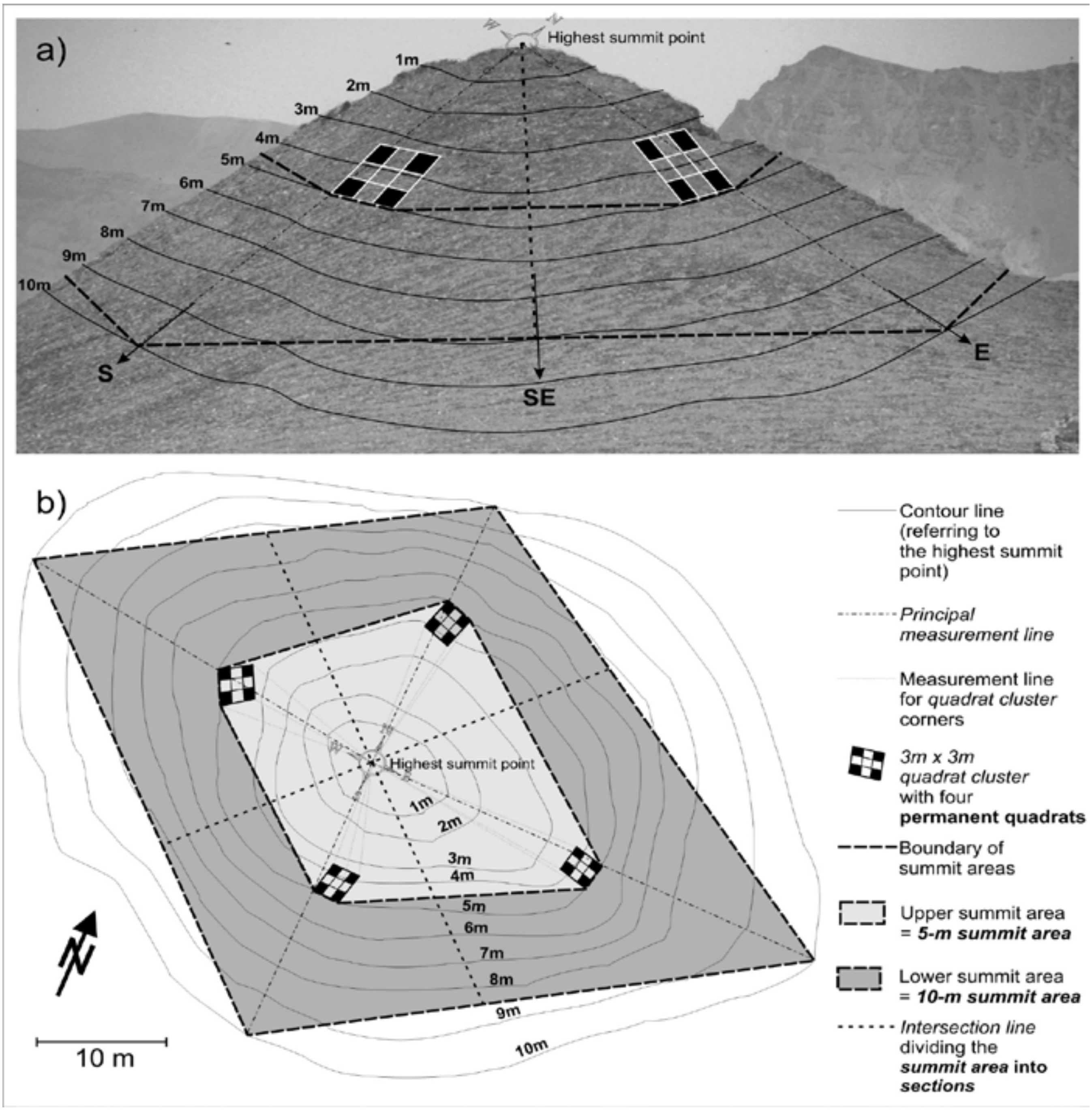


Fig. 1: Sampling design per summit according to the guidelines of GLORIA (Pauli et al. 2001, 2004, 2015); a) oblique view with schematic contour lines; b) top view with the 3 x 3 m clusters at the 5 m contour line and the 8 summit area sections down to the 10 m contour line.

permanent plot, frequency was determined using a frame divided into 100 subplots. Presence/absence of species was recorded per subplot; total frequency per quadrat was given in % of the 100 subplots. In addition, species number and composition were determined also at the scale of the eight summit area sections (Fig. 1), from the highest point down the 10 m contour line. Here, the abundance of the species was estimated by a semi-quantitative scale. Data were collected in July and August 2001 and resampled in 2006, 2008 and 2015. In this paper we consider only vascular species. Nomenclature follows Flora Europaea (http://rbg-web2.rbge.org.uk/FE/fe.html). Endemic species for the Eastern Alps (E-Alps) and the entire Alps were defined according to Aeschimann et al. (2004).

Data were analysed at the summit area scale and at the 1 m² plot scale. Altitudinal ranks of the species were specified according to Aeschimann et al. (2004) and Fischer et al. (2008) and are shown in Table 1. Mean ranks were calculated for resident species, i.e. species present 2001 and 2015, and newly arrived species. Species frequencies per census were summed up and frequency increase/decrease was checked per species. Only those species will be mentioned which had frequency increases of ≥45 subplots per summit. 'Filling' was tested using the occurrences of the species and their changes at the eight summit area sections (Fig. 1). A species can have up to eight records per summit and year. For each summit and year, the occurrences were calculated. Then, the sum of occurrences of the first census in 2001 were subtracted from the sum of occurrences of the respective summit at each following census. The changes were correlated with time; calculations of the Pearson's correlation coefficient and its confidence intervals were performed in EXCEL.
All other statistics were performed using IBM SPSS 21.0 for Windows or R. Normal distribution of the data was checked by the Kolmogorov-Smirnov-test. Means were compared by parametric (T-test) and non-parametric tests (Mann-Whitney-U-test).
Frequency data were analysed using a detrended canonical correspondence analysis (DCA) within the programme CANOCO 4.0. The following procedures were selected: detrended by segments, no transformations, no downweighting of species, no weighting of variables and no variables deleted.

Table 1: Altitudinal ranks of the species (Aeschimann et al. 2004, Fischer et al. 2008).

RANK	DESCRIPTION
1	species with nival distribution centre
2	alpine and nival species which do not descend to the treeline
3	alpine centred species which do not descend to the montane zone
4	alpine centred species which descend to the montane zone or species distributed from the treeline ecotone to the alpine zone
5	species centred at the treeline ecotone or distributed from the montane to the alpine zone
6	species centred at the montane zone or distributed from the montane zone to the treeline ecotone

Results

Summit areas

In 2015, a total of 235 species (Appendix 1) was recorded at the four summits of the target region IT_ADO, comprising 16 endemic species of the E-Alps and 9 endemic species of the Alps (sub-endemics included). Total species richness at the summit areas increased along the elevation gradient with time (Fig. 2), linearly at RNK and MTS and non-linearly at GRM and PNL. Significant differences resulted between the summits ($p = 0.046$), with highest increases of ca. 64 % since the beginning of the monitoring at the highest, subnival summit MTS, 25 % at the upper alpine summit RNK, 13 % at the lower alpine summit PNL and 9 % at the treeline ecotone summit GRM. The increase in species numbers was significantly higher (+4.3 ±0.6) during the first 7 years (2001-2008) compared to the last 7 years (2008-2015; +2.2 ±0.7; $p = 0.045$).

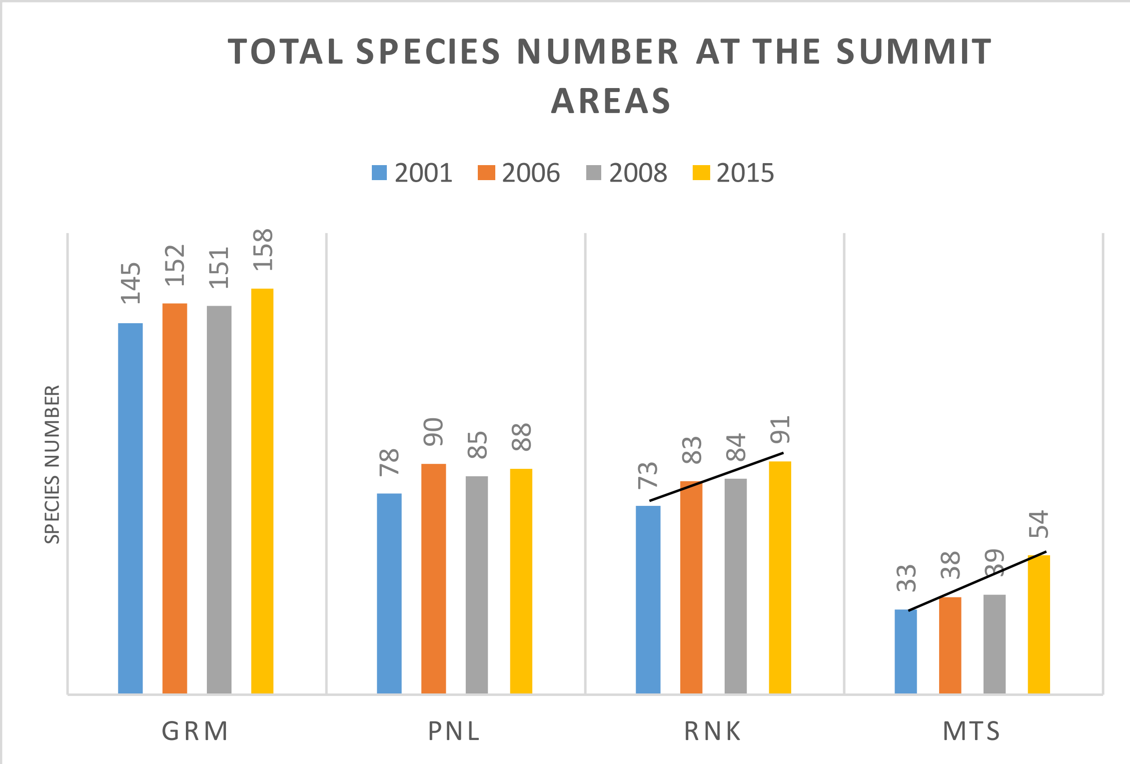
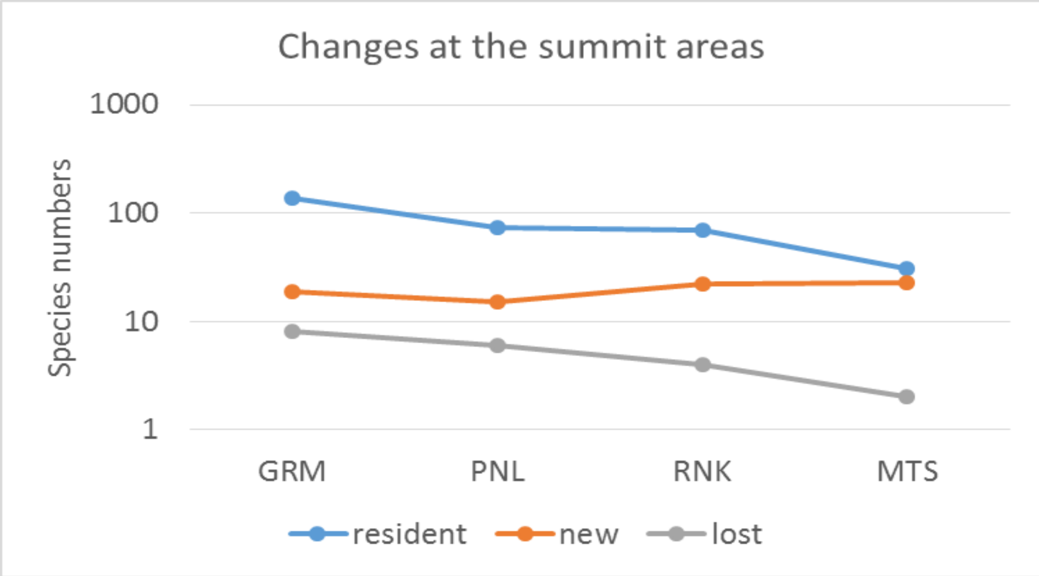


Fig. 2: Total number of species per census at the summit areas of the four GLORIA summits in the western Dolomites. Only RNK and MTS showed a linear increase from 2001 onwards.

The number of newcomers from the beginning of the monitoring until 2015 was higher at the higher summits (22 species at RNK, 23 species at MTS) and the number of lost species decreased with altitude (Fig. 3, Appendix 2). The yearly increase in species numbers at the summits varied between +0.7 (PNL) and +0.9 species per year (GRM) at the lower summits and +1.3 (RNK) and +1.5 (MTS) at the higher summits. Among the newcomers, several endemic species of the E-Alps (Appendix 1) arrived, such as *Soldanella minima* at PNL, *Draba hoppeana* and *Festuca norica* at RNK, *Achillea oxyloba* and *Phyteuma sieberi* at MTS. The next populations of *Achillea oxyloba* and *Phyteuma sieberi* at MTS were recorded 15 m below the 10 m contour line (data not shown). For the new arrivals at the other two summits no indications about the distance of the next populations are available. Only one of the endemic species of the E-Alps disappeared (PNL: *Festuca varia*).
Considering the changes of species occurrences per summit, a filling process was detected with significantly increasing occurrences with time at all summits (Fig. 4, Pearson's r = 0.68).

Comparing the mean altitudinal ranks of the resident species with that of the new arrivals, a thermophilization can be observed, i.e. the mean ranks of the newcomers being significantly higher than that of the resident species (Fig. 5), with exceptions of the PNL summit areas.



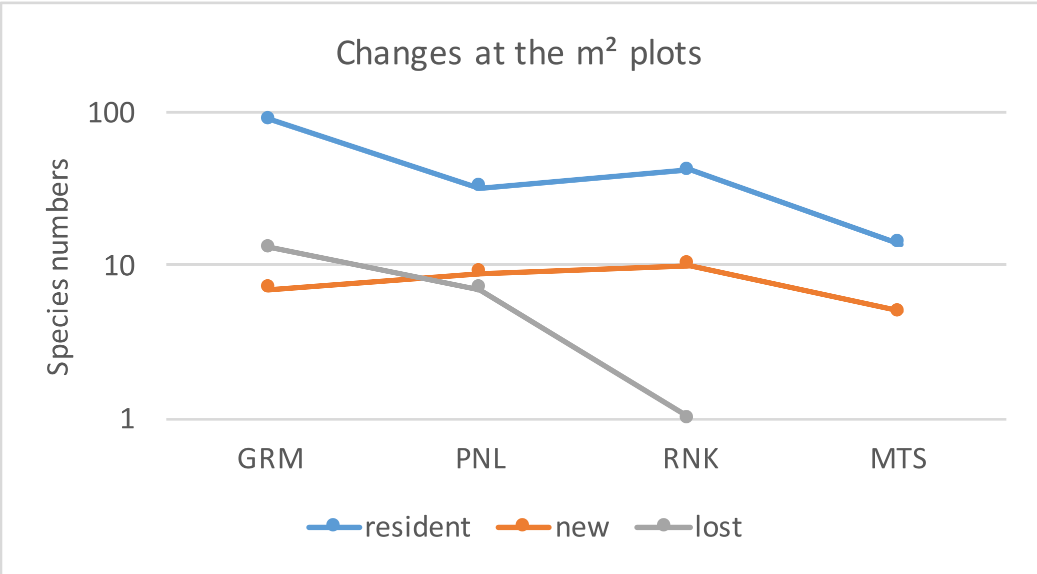


Fig. 3: Number of resident, new and lost species at the summit areas (upper graph) and at the m² plots (lower graph). Y-axis: logarithmic scale of the species numbers. X-axis: the four GLORIA summits in the western Dolomites.

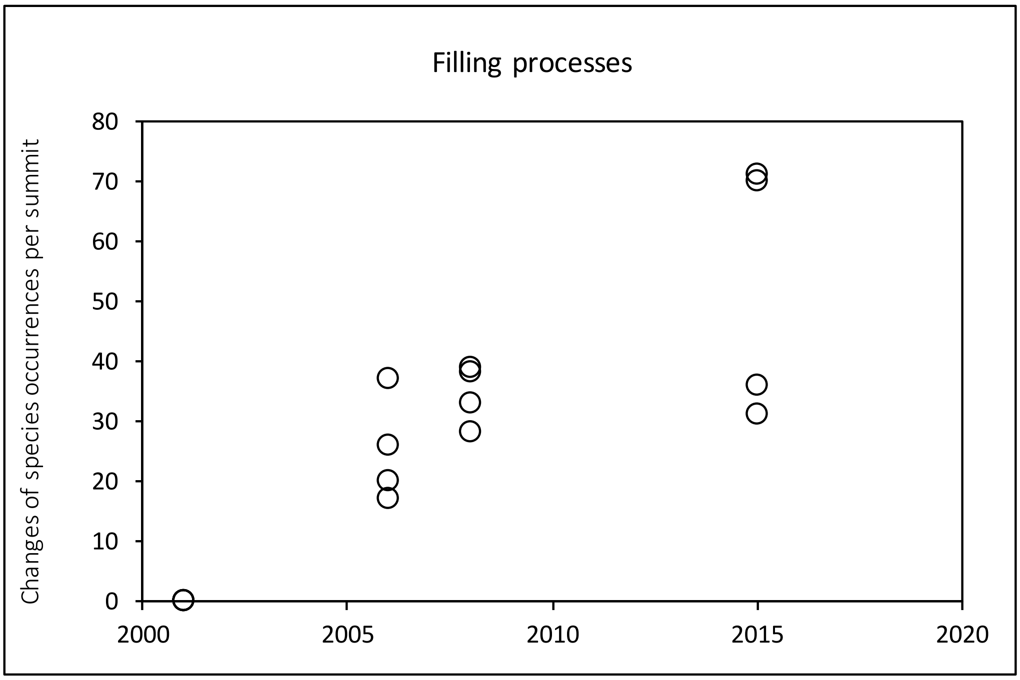


Fig. 4: Filling processes at the summits: changes of species occurrences at the three censi (2006, 2008 and 2015) in comparison to the occurrences in 2001. At all summits the occurrences increased with time (Pearson's r = 0.68).

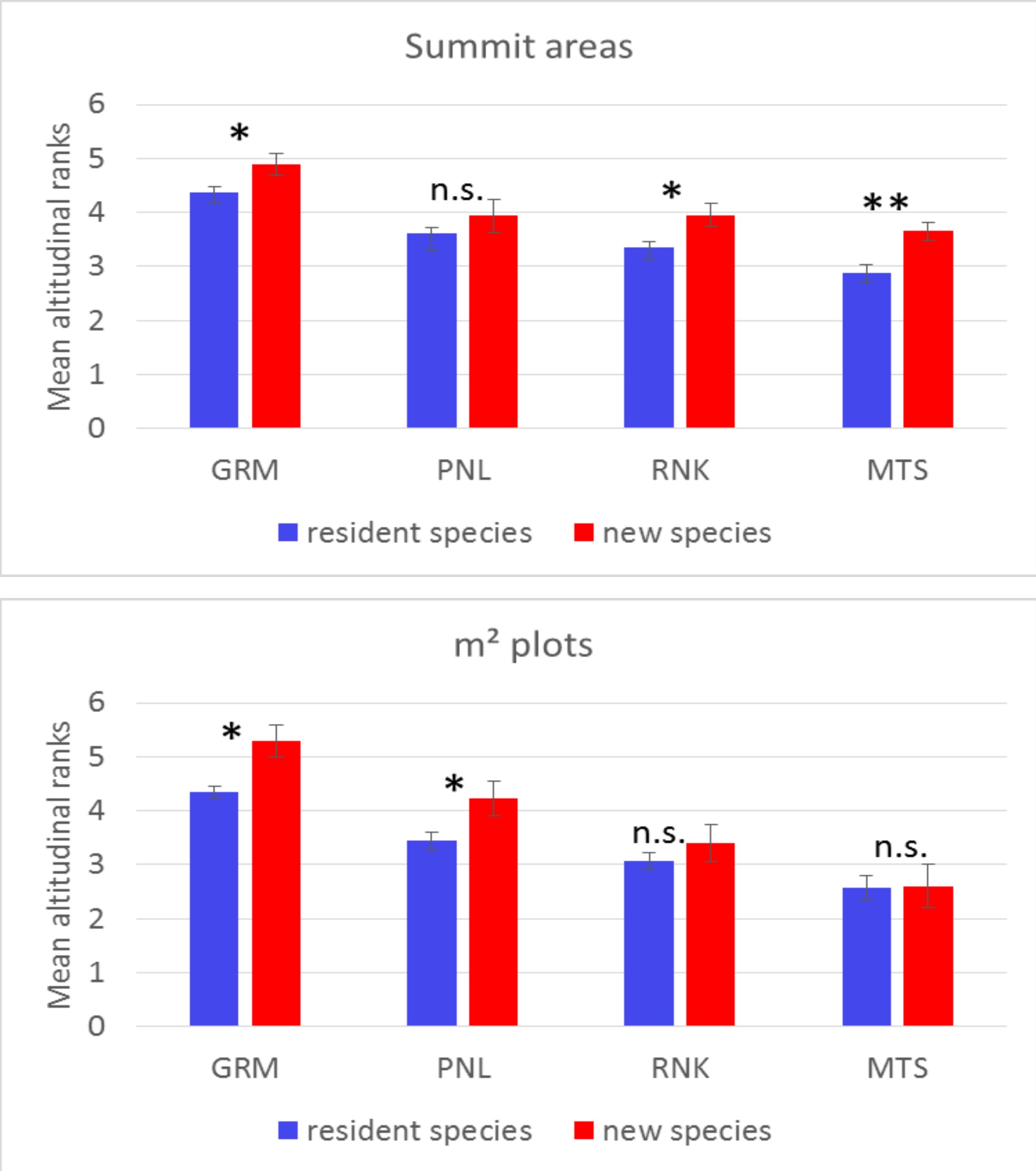


Fig. 5: Mean altitudinal ranks and standard error of the resident species (i.e. species present 2001 and 2015) and the new species in 2015 at the summit areas (upper graph) and at the m² plots (lower graph) at the four GLORIA summits in the western Dolomites. * $p < 0.05$; ** $p < 0.01$; n.s. not significant.

4.2 1 m² plots

Changes in species numbers at the m² scale were less pronounced than at the summit area scale (Appendix 2 and 3) but the pattern of new and lost species was quite similar at both the scales. At MTS, no species was lost during the period of 14 years, at RNK only *Phyteuma sieberi*, an endemic of the E-Alps disappeared. However, this species was still present at the summit area of RNK.

The altitudinal ranks of the new species significantly exceeded the ranks of the resident species at GRM and PNL (Fig. 5). At RNK and MTS the differences were not statistically significant. At PNL and RNK, newcomers were most abundant at the southern aspect. At GRM and MTS no preferential aspect of the new colonizers was detected.

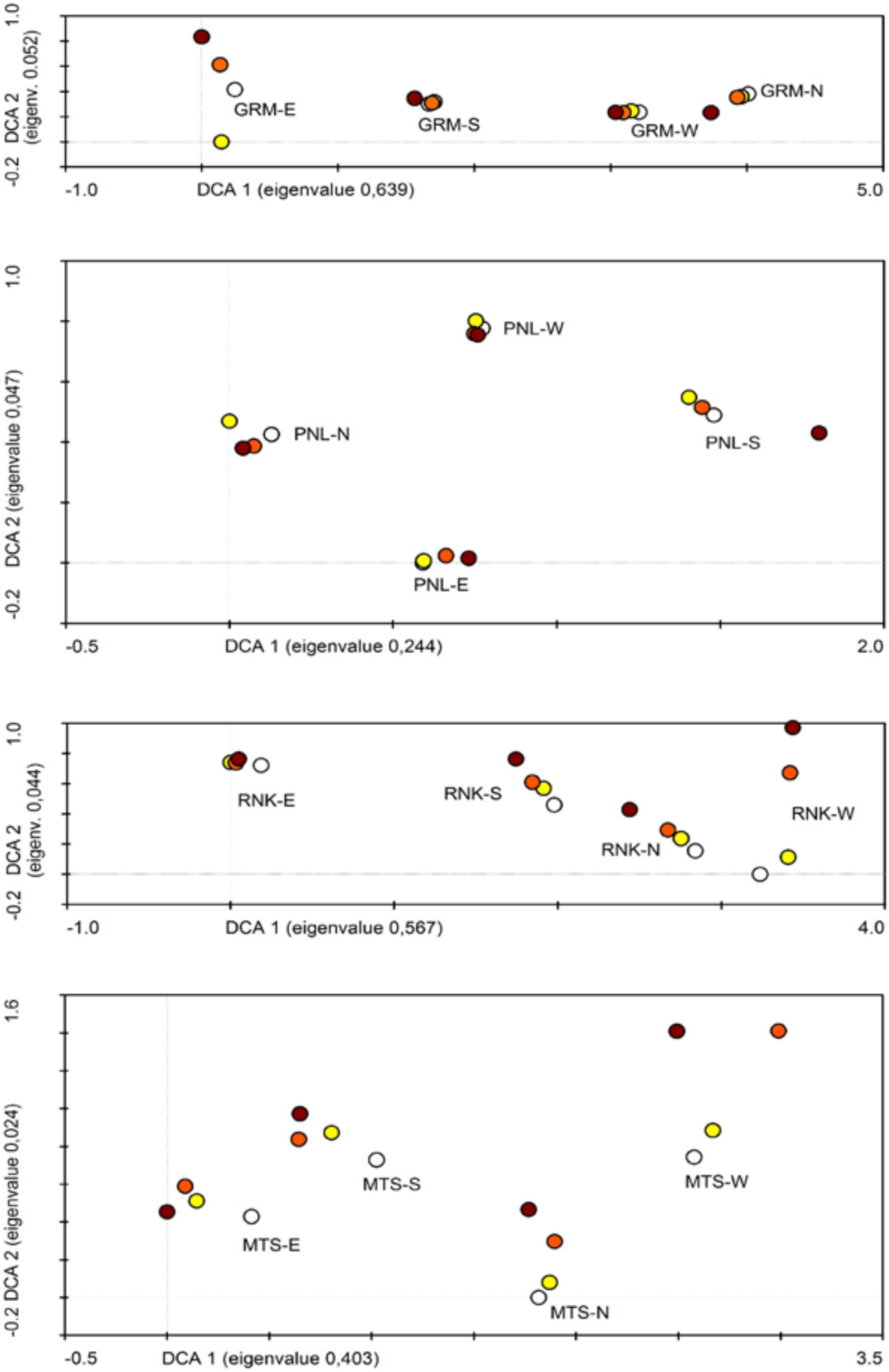


Fig. 6: Ordination (DCA, axis 1 and 2) of the frequencies at the four main aspects of the summits GRM, PNL, RNK, and MTS in the western Dolomites: white circles = census in 2001, yellow = 2006, red = 2008, dark red = 2015. The distance between the censi can be regarded as a measure for community changes per aspect (N, E, S, W = north, east, south, west).

Community deviations were visible at all the summits (Fig. 6), though no synchronous movement of the plots per summit can be observed. Most pronounced deviations occurred at the eastern aspect of GRM and to a lower extend also at the northern aspect (Fig. 6). From 2001 to 2015, several species of this summit showed a decreasing frequency while competitive graminoids and montane/treeline species enhanced their occurrence (*Calamagrostis varia, Carex ornithopoda* ssp. *ornithopoda, Carex sempervirens, Erica herbacea, Festuca norica, F. quadriflora, F. varia, Hedysarum hedysaroides, Pinus cembra, Polygala chamaebuxus, Rhododendron ferrugineum, Salix retusa*, and *Sesleria albicans*, Appendix 4_1). At PNL highest deviations were found at the southern aspect, at RNK at the western aspect (Fig. 6). At these two summits, total frequency sum increased throughout the years (Appendix 4_2). Here, alpine grassland and scree species became more dominant with highest frequency increases at PNL for: *Anthyllis vulneraria* ssp. *alpestris*, *Campanula cochlearifolia, Carex firma, Dryas octopetala, Euphrasia salisburgensis,* and *Helianthemum oelandicum* ssp. *alpestre* (Appendix 4_2); at RNK for *Arenaria ciliata* ssp. *ciliata, Erigeron uniflorus, Festuca alpina, Minuartia sedoides, Polygonum viviparum, Saxifraga exarata* ssp. *moschata, Sesleria sphaerocephala, Thlaspi rotundifolium* ssp. *rotundifolium* and *Thymus praecox* ssp. *polytrichus* (Appendix 4_3). At MTS, community changes were rather high at all aspects when the censi of 2001 and 2015 are compared (Fig. 6). Total sum of frequencies slightly decreased in 2015. However, cushions of *Minuartia sedoides* increased considerably their frequencies. Increases were recognized also for *Saxifraga sedoides* and *Silene acaulis*, although to a lower extend (Appendix 4_4).

Discussion

The overall increase in diversity found also in the fourth census is in line with previous censi (Erschbamer et al. 2011) and with the ongoing changes at summits of the temperate mountain regions in Europe (Gottfried et al. 2012, Pauli et al. 2012, Wipf et al. 2013). The highest summits RNK and MTS revealed a linear increase of species numbers with highest gains compared to the first sampling, i.e., highest numbers of new arrivals and fewest species losses. Thus, we confirm the hypothesis of Vittoz et al. (2009) that communities at highest summits respond quickly to warming due to abundantly available niches for colonization and probably also due to facilitative interactions of the resident species (Callaway et al. 2002). The high increases in our study area are diametrically opposite to the results of Rosbakh et al. (2014) who recorded a decrease in species richness and plant cover during the past 50 years in high alpine plots located in the Berchtesgaden Alps (Germany). In contrast, we found more fluctuations from one census to the other and a lower number of newcomers at the lower summits. From the high turnover especially at the m² plots we deduce that competitive processes play a major role at the lowest summit. Here, montane- and treeline-centred species extend their dominance on the expense of weaker subalpine and alpine grassland species. As a consequence, a reforestation especially of the eastern aspect might occur in the near future, accompanied with the disappearance of the alpine pioneer grassland species at the northern aspect. The grasslands at the southern and western aspect might withstand the reforestation for a longer time due to the presence of highly dominant graminoids such as *Festuca varia* and *Carex sempervirens*. Both species expanded considerably during the investigation period. Knowledge of specific interactions (Farrer et al. 2014, Alexander et al. 2015) and plant demography (Marcante et al. 2009, Treurnicht et al. 2016) is hardly available for alpine-nival species. Thus, future research should concentrate on these topics to explain ongoing processes.

The increasing temperatures (IPCC 2014) reduce the environmental harshness at the higher summits. As a consequence, new species invade and/or resident species enhance their occurrences. At the sparsely colonized higher summits, sufficient gaps are available for newcomers and local extensions. We have clearly shown that filling processes occur at all the summit areas along the elevation gradient: abundances of most of the species increased from one census to the other at the summit area scale. Although at the m^2 plots of the highest summit MTS, frequency of most species slightly decreased, filling processes were detected also there: the dominant cushion species *Minuartia sedoides, Saxifraga sedoides* and *Silene acaulis* enhanced their abundances. This is in line with the results of Alatalo & Little (2014), showing that *S. acaulis* responded quickly to ameliorating conditions.

The mean increase of +1 species per year in the whole study area and the highest increase of +1.5 species per year at MTS were considerably higher compared to the mean increase of +0.56 species per year calculated at the European dimension after the first 7 years by the GLORIA project (Gottfried et al. 2012). This may be attributed to the high diversity in the Dolomites. From our data we recognized a significantly higher species increase during the first 7 years in contrast to the last 7-year-period which might be driven by different temperature conditions during these two periods. Detailed analyses of temperature data and correlations with the species data still have to be performed.

One of the major issues of climate warming effects in mountains is the upward shift of species from lower to higher altitudes. Gottfried et al. (2012) called this process 'thermophilization'. Our data from the GLORIA site in the Dolomites confirm this hypothesis. The mean altitudinal ranks of the newcomers were – in most cases – significantly higher than those of the resident species. Of course, the result has to be interpreted with caution because we do not know if the new colonizers will establish permanently. Short-term responses might give already a strong signal (Stanisci et al. 2014), but they might lead also to inconsistent predictions (Alatalo et al. 2014). All in all, species upward movement is a complex process and results are still controversial. Gottfried et al. (2012) found a correlation between thermophilization and increases in June temperature minima (Pearson's $r = 0.501$, $p = 0.028$) for the GLORIA summits across Europe, whereas Grytnes et al. (2014) did not detect any relation between local temperatures and species changes. They concluded that the upward moving species were 'not particularly warmth demanding'. To clarify this debate, long term monitoring in permanent plots over several decades is indispensable.

Endemic species were expected to be the most endangered group among the alpine resident species, in the Alps and at a global scale (Kazakis et al. 2007, Pickering et al. 2008, Halloy et al. 2010, Dirnböck et al. 2011, Stanisci et al. 2011, Noroozi et al. 2011). At our GLORIA site in the Dolomites, hardly any endemic species was lost in the course of 14 years (exception: one E-Alps endemic species disappeared at PNL). On the contrary, several endemics were recorded among the newcomers at both the sampling scales.

After 14 years, pronounced community changes were not detected in the study area. However, depending on aspect and altitude, deviations of the species composition were recognizable. There is particular evidence that community changes might mainly occur due to effects of new species combinations (Alexander et al. 2015). Undoubtedly, further empirical studies on interactions of resident species versus newcomers will be necessary. In addition to changing climate conditions and neighbour effects, disturbances by wild ungulates or hiking people might also be relevant for community shifts at steep and unstable summit slopes such as at PNL (Erschbamer et al. 2011). At the highest summits RNK and MTS, melting of the permafrost might be an additional factor governing colonization dynamics in the future.

Conclusions

The high increase of species at the highest summits is a clear signal for ameliorating environmental conditions. At the highest summits we forecast that the filling processes may prevail also during the next decades. These rough summits might be less endangered by diversity losses due to their complex topography (Opedal et al. 2015). Here, species may track more easily their niches and find microsites where they are absent today. In contrast, at the lowest summit, dominant graminoid species as well as woody treeline species will outcompete the weaker alpine herbs. Here, we expect the most pronounced community changes with reforestations in the future. For climate change projections, screenings of the growth and reproduction dynamics of alpine-nival species and experiments to study interactions between resident and newcomers are indispensable.

Zusammenfassung

Speziell auf den höchsten Gipfeln der Alpen bewirkt die fortschreitende Klimaerwärmung eine Veränderung der Artenvielfalt und der Abundanzen. Langzeitprojekte sind notwendig, um die Konsequenzen dieser Veränderungen zu ergründen und Prognosen für die Zukunft zu erstellen. Ein Beispiel dafür ist das Projekt GLORIA (www.gloria.ac.at), bei dem in den westlichen Dolomiten vier ausgewählte Gipfeln in 2199 m, 2463 m, 2757 m und 2893 m Meereshöhe, d.h. entlang des Höhengradienten vom Waldgrenzökoton, über die untere- und obere alpine- bis in die subnivale Höhenstufe, untersucht wurden. Diversität und Häufigkeit der Arten wurden nach 5, 7 und 14 Jahren in den Gipfelflächen und in Dauerflächen von 1 m² Größe aufgenommen. Nach 14 Jahren zeigte sich der höchste Artenanstieg auf dem höchsten Gipfel. Die Frequenzen der meisten Arten erhöhten sich vor allem auf den beiden Gipfeln der unteren und oberen alpinen Stufe. Am Gipfel des Waldgrenzökotons verringerten sich die Frequenzen der meisten Arten bis zum Jahr 2015. Im Gegensatz dazu nahmen jedoch einige konkurrenzkräftige Grasartige und Arten mit montanem Verbreitungsschwerpunkt sehr stark zu. Interessanterweise sanken die Frequenzen größtenteils auch auf dem subnivalen Gipfel, mit Ausnahme jener der Polsterpflanzen, die sich beträchtlich ausdehnten. Die Neuankömmlinge aller Gipfel zeichnen sich im Vergleich zu den bereits vorhandenen Arten vor allem durch ihren thermophileren Charakter aus. Während der nächsten Jahrzehnte erwarten wir eine Zunahme dieses Thermophilisierungstrends auf allen Gipfeln, eine teilweise Wiederbewaldung des niedrigsten Gipfels und einen kontinuierlichen Anstieg der Diversität und der Frequenzen auf den höchsten Gipfeln.

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Appendix 1: Species list of the GLORIA summits in the western Dolomites (IT_ADO) and indication of the endemic species: E-Alps = endemic in the Eastern Alps, Alps = endemic or subendemic in the Alps (Aeschimann et al. 2004). Nomenclature according to Flora Europaea (http://rbg-web2.rbge.org.uk/FE/fe.html).

SPECIES	ENDEMIC SPECIES	
	E-ALPS	ALPS
Achillea clavennae L.		
Achillea oxyloba (DC.) Sch.Bip. subsp. oxyloba	+	
Acinos alpinus (L.) Moench subsp. alpinus		
Aconitum lycoctonum subsp. neapolitanum (Ten.) Nyman		
Aconitum napellus L. subsp. tauricum (Wulfen) Gáyer		
Agrostis alpina Scop.		
Alchemilla vulgaris agg.		
Androsace helvetica (L.) All.		
Androsace obtusifolia All.		
Anemone baldensis L.		
Antennaria carpatica (Wahlenb.) Bluff & Fingerh.		
Anthoxanthum odoratum L. subsp. alpinum (Á. & D.Löve) Jones & Melderis		
Anthyllis vulneraria subsp. alpestris (Hegetschw.) Asch. & Graebn.		
Arabis alpina L. subsp. alpina		
Arabis caerulea (All.) Haenke		+
Arabis pumila Jacq. subsp. stellulata (Bertol.) Nyman		
Arctostaphylos alpinus (L.) Spreng.		
Arctostaphylos uva-ursi (L.) Spreng.		
Arenaria ciliata L. subsp. ciliata		
Arnica montana L.		
Artemisia genipi Weber		+
Asplenium trichomanes-ramosum L.		
Aster alpinus L.		
Aster bellidiastrum (L.) Scop.		
Astragalus australis (L.) Lam.		
Athamanta cretensis L.		
Avenula versicolor (Vill.) M.Laínz		
Bartsia alpina L.		
Biscutella laevigata L. subsp. laevigata		
Botrychium lunaria (L.) Sw.		
Calamagrostis varia (Schrad.) Host		
Campanula barbata L.		
Campanula cochlearifolia Lam.		
Campanula scheuchzeri Vill.		
Carduus defloratus L.		
Carex atrata L. subsp. atrata		
Carex bicolor All.		
Carex capillaris L.		
Carex curvula All. subsp. rosae Gilomen		
Carex ericetorum Pollich		
Carex firma Host		
Carex montana L. subsp. montana		
Carex mucronata All.		
Carex ornithopoda Willd. subsp. ornithopoda		
Carex ornithopoda Willd. subsp. ornithopodioides (Hausm.) Nyman		
Carex parviflora Host		

SPECIES	ENDEMIC SPECIES	
	E-ALPS	ALPS
Carex rupestris All.		
Carex sempervirens Vill.		
Carlina acaulis L.		
Centaurea triumfetti All.		
Centaurea uniflora subsp. nervosa (Willd.) Bonnier & Layens		
Cerastium fontanum Baumg. subsp. fontanum		
Cerastium uniflorum Clairv.		
Chaerophyllum villarsii W.D.J.Koch		
Chamorchis alpina (L.) Rich.		
Clematis alpina (L.) Mill. subsp. alpina		
Coeloglossum viride (L.) Hartm.		
Cotoneaster integerrimus Medik.		
Crepis aurea (L.) Cass. subsp. aurea		
Crepis jacquinii Tausch subsp. kerneri (Rech.f.) Merxm.		
Crepis terglouensis (Hacq.) A.Kern.	+	
Crocus vernus (L.) Hill subsp. albiflorus (Kit.) Asch. & Graebn.		
Cystopteris fragilis (L.) Bernh.		
Daphne mezereum L.		
Daphne striata Tratt.		+
Deschampsia flexuosa (L.) Trin.		
Dianthus superbus L.		
Doronicum clusii (All.) Tausch subsp. clusii		+
Draba aizoides L.		
Draba dolomitica Buttler	+	
Draba dubia Suter		
Draba hoppeana Rchb.		+
Draba tomentosa Clairv.		
Dryas octopetala L.		
Erica herbacea L.		
Erigeron alpinus L.		
Erigeron glabratus Hoppe & Hornsch. ex Bluff & Fingerh.		
Erigeron uniflorus L.		
Euphrasia minima Jacq. ex DC. subsp. minima		
Euphrasia salisburgensis Funck		
Festuca alpina Suter		
Festuca halleri All. subsp. halleri		+
Festuca intercedens (Hack.) Lüdi ex Bech.		+
Festuca norica (Hack.) K.Richt.	+	
Festuca quadriflora Honck.		
Festuca varia Haenke	+	
Galium anisophyllon Vill.		
Galium mollugo L.		
Gentiana acaulis L.		
Gentianella anisodonta (Borbás) Á.Löve & D.Löve		
Gentiana brachyphylla Vill. subsp. brachyphylla		
Gentiana brachyphylla Vill. subsp. favratii (Rittener) Tutin		
Gentiana clusii E.P.Perrier & Songeon		

SPECIES	ENDEMIC SPECIES	
	E-ALPS	ALPS
Gentiana nivalis L.		
Gentianella tenella (Rottb.) B"rner		
Gentiana terglouensis Hacq. subsp. terglouensis	+	
Gentiana verna L. subsp. verna		
Geranium sylvaticum L.		
Geum montanum L.		
Geum reptans L.		
Gnaphalium hoppeanum W.D.J.Koch		
Gymnadenia conopsea (L.) R.Br.		
Gymnadenia odoratissima (L.) Rich.		
Gypsophila repens L.		
Hedysarum hedysaroides (L.) Schinz & Thell.		
Helianthemum nummularium (L.) Mill. subsp. grandiflorum (Scop.) Schinz & Thell.		
Helianthemum oelandicum (L.) DC. subsp. alpestre (Jacq.) Breistr.		
Hieracium lactucella Wallr.		
Hieracium murorum agg.		
Hieracium villosum Jacq.		
Hippocrepis comosa L.		
Homogyne alpina (L.) Cass.		
Huperzia selago (L.) Bernh. ex Schrank & Mart. subsp. selago		
Hypochoeris uniflora Vill.		
Juncus trifidus L. subsp. monanthos (Jacq.) Asch. & Graebn.		
Juncus trifidus L. subsp. trifidus		
Juniperus communis L. subsp. alpina (Suter) C$Kelak.		
Knautia longifolia (Waldst. & Kit.) W.D.J.Koch		
Kobresia myosuroides (Vill.) Fiori		
Larix decidua Mill.		
Leontopodium alpinum Cass. subsp. alpinum		
Leontodon hispidus L.		
Leontodon montanus Lam. subsp. montanus		
Leontodon pyrenaicus Gouan subsp. helveticus (Mérat) Finch & P.D.Sell		
Ligusticum mutellinoides (Crantz) Vill.		
Lilium martagon L.		
Linaria alpina (L.) Mill.		
Loiseleuria procumbens (L.) Desv.		
Lotus corniculatus L.		
Luzula alpina Hoppe		
Luzula alpinopilosa (Chaix) Breistr.		
Luzula lutea (All.) DC.		
Luzula luzuloides (Lam.) Dandy & Wilmott		
Luzula spicata (L.) DC.		
Luzula sylvatica (Huds.) Gaudin		
Minuartia cherlerioides (Hoppe) Bech. subsp. cherlerioides	+	
Minuartia sedoides (L.) Hiern		
Minuartia verna (L.) Hiern subsp. verna		
Myosotis alpestris F.W.Schmidt		
Nigritella nigra (L.) Rchb.f. subsp. nigra		

SPECIES	ENDEMIC SPECIES	
	E-ALPS	ALPS
Oxyria digyna (L.) Hill		
Oxytropis campestris (L.) DC. subsp. campestris		
Oxytropis jacquinii Bunge		+
Paederota bonarota (L.) L.	+	
Papaver alpinum subsp. rhaeticum (Ler. ex Gremli) Nyman	+	
Parnassia palustris L.		
Pedicularis rosea Wulfen subsp. rosea		
Pedicularis rostratocapitata Crantz		
Pedicularis tuberosa L.		
Pedicularis verticillata L.		
Phyteuma hemisphaericum L. subsp. hemisphaericum		
Phyteuma sieberi Spreng.	+	
Picea abies (L.) H.Karst. subsp. abies		
Pinguicula alpina L.		
Pinus cembra L.		
Poa alpina L.		
Poa cenisia All. subsp. cenisia		
Poa minor Gaudin		
Polygala alpestris Rchb.		
Polygala chamaebuxus L.		
Polygonatum verticillatum (L.) All.		
Polygonum viviparum L.		
Potentilla aurea L. subsp. aurea		
Potentilla crantzii (Crantz) Beck ex Fritsch		
Potentilla nitida L.		
Primula elatior (L.) Hill		
Pritzelago alpina (L.) Kuntze subsp. alpina		
Pseudorchis albida (L.) A. & A. Löve & D. Löve subsp. albida		
Pulmonaria angustifolia L.		
Pulsatilla alpina (L.) Delarbre subsp. apiifolia (Scop.) Nyman		
Pulsatilla vernalis (L.) Mill.		
Ranunculus montanus Willd.		
Ranunculus seguieri Vill. subsp. seguieri		
Rhamnus pumilus Turra		
Rhododendron ferrugineum L.		
Rhododendron hirsutum L. & Rhododendron x intermedium Tausch		
Rosa pendulina L.		
Rubus saxatilis L.		
Sagina saginoides (L.) H.Karst. subsp. saginoides		
Salix alpina Scop.		
Salix breviserrata Flod.		
Salix hastata L.		
Salix herbacea L.		
Salix reticulata L.		
Salix retusa L.		
Salix serpillifolia Scop.		
Saxifraga aizoides L.		

SPECIES	ENDEMIC SPECIES	
	E-ALPS	ALPS
Saxifraga androsacea L.		
Saxifraga caesia L.		
Saxifraga exarata Vill. subsp. moschata (Wulfen) Cavill.		
Saxifraga facchinii W.D.J.Koch	+	
Saxifraga oppositifolia L. subsp. oppositifolia		
Saxifraga paniculata Mill.		
Saxifraga sedoides L. subsp. sedoides		
Saxifraga squarrosa Sieber	+	
Scabiosa lucida Vill.		
Scorzonera aristata Ramond ex DC.		
Sedum atratum L.		
Selaginella selaginoides (L.) Link		
Senecio abrotanifolius L. subsp. abrotanifolius		
Sesleria albicans Kit. ex Schult.		
Sesleria ovata (Hoppe) A.Kern.		
Sesleria sphaerocephala Ard.	+	
Silene acaulis (L.) Jacq. subsp. acaulis		
Silene rupestris L.		
Silene uniflora Roth subsp. glareosa (Jord.) Chater & Walters		
Silene vulgaris (Moench) Garcke subsp. vulgaris		
Soldanella alpina L.		
Soldanella minima Hoppe	+	
Solidago virgaurea L.		
Sorbus aucuparia L.		
Sorbus chamaemespilus (L.) Crantz		
Taraxacum sp. in ADO		
Thalictrum aquilegiifolium L.		
Thesium alpinum L.		
Thlaspi rotundifolium (L.) Gaudin, non Tineo subsp. rotundifolium		+
Thymus praecox Opiz subsp. polytrichus (A.Kern. ex Borbás) Jalas		
Trifolium alpinum L.		
Trifolium pratense L. subsp. nivale Arc.		
Trifolium repens L.		
Trisetum argenteum (Willd.) Roem. & Schult.		
Trollius europaeus L.		
Vaccinium myrtillus L.		
Vaccinium uliginosum L. subsp. microphyllum Lange		
Vaccinium vitis-idaea L. subsp. vitis-idaea		
Valeriana elongata Jacq.	+	
Valeriana montana L.		
Valeriana saxatilis L. subsp. saxatilis		
Valeriana supina Ard.		
Valeriana tripteris L.		
Veratrum album L.		
Veronica alpina L.		
Veronica aphylla L.		
Veronica fruticans Jacq.		
Viola biflora L.		

Appendix 2: New and lost species in 2015 compared to 2001 at the summit areas of the four GLORIA summits in the western Dolomites.

CHANGES AT THE SUMMIT AREAS (2001-2015)		
SUMMIT	NEW ARRIVALS	SPECIES LOST
GRM	Aconitum napellus ssp. tauricum	Aconitum lycoctonum ssp. neapolitanum
	Asplenium trichomanes ssp. ramosum	Cystopteris fragilis
	Carex mucronata	Doronicum clusii ssp. clusii
	Centaurea uniflora ssp. nervosa	Hieracium lactucella
	Chaerophyllum villarsii	Hippocrepis comosa
	Erigeron alpinus	Luzula alpino-pilosa
	Erigeron glabratus	Solidago virgaurea
	Euphorbia salisburgensis	Taraxacum sp.
	Gentiana brachyphylla ssp. brachyphylla	
	Gentiana clusii	
	Gymnadenia odoratissima	
	Larix decidua	
	Luzula alpina	
	Luzula sylvatica	
	Minuartia verna ssp. verna	
	Primula elatior	
	Pseudorchis albida	
	Thalictrum aquilegifolium	
	Trifolium repens	
PNL	Artemisia genipi	Festuca varia
	Carduus defloratus	Carex ornithopoda
	Carex capillaris	Gymnadenia conopsea
	Carex ornithopoda ssp. ornithopodioides	Poa cenisia
	Chamorchis alpina	Potentilla crantzii
	Cystopteris fragilis	Salix hastata
	Draba tomentosa	
	Festuca intercedens	
	Galium mollugo	
	Gentiana brachyphylla ssp. favratii	
	Larix decidua	
	Poa minor	
	Silene uniflora ssp. glareosa	
	Soldanella alpina	
	Soldanella minima	
RNK	Achillea clavennae	Acinos alpinus
	Alchemilla vulgaris	Crepis jacquinii ssp. kerneri
	Androsace helvetica	Draba dubia
	Androsace obtusifolia	Saxifraga paniculata
	Antennaria carpatica	
	Draba hoppeana	
	Erigeron alpinus	
	Euphrasia minima	
	Festuca intercedens	
	Festuca norica	

CHANGES AT THE SUMMIT AREAS (2001-2015)		
SUMMIT	NEW ARRIVALS	SPECIES LOST
	Gentiana nivalis	
	Helianthemum nummularium ssp. grandiflorum	
	Hieracium murorum	
	Hieracium villosum	
	Juniperus communis ssp. alpina	
	Leontodon hispidus	
	Leontodon montanus	
	Luzula spicata	
	Oxytropis campestris	
	Salix alpina	
	Saxifraga aizoides	
	Silene uniflora ssp. glareosa	
MTS	Achillea oxyloba	Leontodon pyrenaicus
	Arabis alpina	Sesleria ovata
	Aster bellidiastrum	
	Campanula scheuchzeri	
	Carex bicolor	
	Carex capillaris	
	Carex firma	
	Carex ornithopoda ssp. ornithopodioides	
	Crepis jacquinii ssp. kerneri	
	Dryas octopetala	
	Erigeron uniflorus	
	Festuca intercedens	
	Gnaphalium hoppeanum	
	Homogyne alpina	
	Leontodon montanus	
	Phyteuma sieberi	
	Polygonum viviparum	
	Salix hastata	
	Salix reticulata	
	Salix retusa	
	Saxifraga caesia	
	Trisetum argenteum	
	Veronica alpina	

Appendix 3: New and lost species in 2015 compared to 2001 at the m² plots of the four GLORIA summits in the western Dolomites.

CHANGES AT THE m² PLOTS (2001-2015)		
SUMMIT	NEW ARRIVALS	SPECIES LOST
GRM	Asplenium trichomanes ssp. ramosum	Campanula barbata
	Carex ericetorum	Carex atrata ssp. atrata
	Euphrasia salisburgensis	Festuca halleri
	Gymnadenia conopsea	Hieracium murorum
	Hieracium villosum	Leontopodium alpinum
	Lilium martagon	Leontodon pyrenaicus
	Pulsatilla alpina ssp. apiifolia	Pinguicula alpina
		Potentilla aurea
		Pulsatilla vernalis
		Salix serpyllifolia
		Scorzonera aristata
		Taraxacum sp.
		Thesium alpinum
PNL	Astragalus australis	Agrostis alpina
	Campanula cochleariifolia	Draba dubia
	Gentiana anisodonta	Erigeron uniflorus
	Gentiana brachyphylla ssp. favratii	Euphrasia minima ssp. minima
	Hierarcium murorum	Festuca alpina
	Larix decidua	Leontopodium alpinum
	Pedicularis rosea ssp. rosea	Pritzelago alpina ssp. alpina
	Poa alpina	
	Sesleria albicans	
RNK	Draba dolomitica	Phyteuma sieberi
	Euphrasia salisburgensis	
	Gentiana brachyphylla ssp. brachyphylla	
	Gentiana tenella	
	Juniperus communis ssp. alpina	
	Kobresia myosuroides	
	Linaria alpina	
	Saxifraga squarrosa	
	Sedum atratum	
	Veronica fruticans	
MTS	Arabis coerulea	
	Erigeron uniflorus	
	Papaver alpinum ssp. rhaeticum	
	Polygonum viviparum	
	Saxifraga androsacea	

Appendix 4_1: Frequencies of the species (%) at the m^2 plots of GRM (2199 m a.s.l.) in 2001 and 2015. Σ = sum of all frequencies per 16 plots in 2001 and 2015, respectively. In brown: species which increased in frequency by > 45 subplots in 2015. For species abbreviations see Appendix 4_5.

	2001																Σ	2015																Σ
	1-GRM-E11	1-GRM-E13	1-GRM-E31	1-GRM-E33	1-GRM-N11	1-GRM-N13	1-GRM-N31	1-GRM-N33	1-GRM-S11	1-GRM-S13	1-GRM-S31	1-GRM-S33	1-GRM-W11	1-GRM-W13	1-GRM-W31	1-GRM-W33	2001	4-GRM-E11	4-GRM-E13	4-GRM-E31	4-GRM-E33	4-GRM-N11	4-GRM-N13	4-GRM-N31	4-GRM-N33	4-GRM-S11	4-GRM-S13	4-GRM-S31	4-GRM-S33	4-GRM-W11	4-GRM-W13	4-GRM-W31	4-GRM-W33	2015
AGROALPI	.	.	8	.	15	3	1	.	27	50	.	19	82	59	40	87	391	.	.	.	.	21	13	1	.	36	32	5	29	63	52	5	63	320
ANEMBALD	2	.	.	.	10	.	.	.	.	.	.	.	7	1	41	28	89	.	.	.	.	26	.	.	.	.	.	.	.	2	6	22	12	68
ANTECARP	.	.	.	.	.	3	2	.	.	.	.	.	13	11	.	15	44	.	.	.	.	1	4	1	.	.	.	.	.	6	4	.	7	23
ANTHODAL	.	.	.	.	.	.	.	.	.	9	.	.	.	.	15	1	25	.	.	.	.	.	.	.	.	.	1	.	.	.	.	21	.	22
ANTHVUAL	.	.	.	.	.	.	.	.	.	2	2	.	.	3	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	1	5
ARCTALPI	8	16	.	40	1	.	.	.	.	.	.	.	.	.	.	.	65	4	1	.	9	7	.	.	.	.	.	.	.	.	.	.	.	21
ARENCILI	.	.	.	.	.	10	.	4	.	.	.	.	.	.	.	.	14	.	.	.	.	4	1	.	2	.	.	.	.	.	.	.	.	7
ASPLTRIC	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
AVENVERS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	7	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	20	24
BARTALPI	2	.	8	.	4	.	1	.	.	7	.	.	12	27	11	15	87	.	.	.	.	6	.	.	.	.	11	.	.	13	14	9	2	55
BISCLALA	.	.	.	.	.	.	.	.	.	5	2	3	.	12	23	.	45	.	.	.	.	.	.	.	.	.	4	1	.	.	.	6	.	11
BOTRLUNA	.	.	.	.	.	.	.	.	.	1	.	4	.	.	.	.	5	.	.	.	.	.	.	.	.	.	1	1	3	.	.	.	.	5
CALAVARI	13	4	50	62	.	.	.	.	.	.	.	.	.	.	.	.	129	17	42	87	90	.	.	.	.	.	.	.	.	.	.	.	.	236
CAMPBARB	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CAMPSCHE	6	.	19	6	20	2	15	2	19	45	36	22	53	52	47	13	357	8	2	9	2	48	5	37	2	40	43	39	29	40	53	23	9	389
CARDDEFL	.	.	.	.	.	.	.	.	6	14	.	5	.	.	.	.	25	.	.	.	.	.	.	.	.	.	3	.	1	.	.	.	.	4
CAREATAT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CARECAPI	.	.	.	.	52	25	55	62	.	.	.	.	55	15	16	24	304	.	.	.	.	38	23	14	32	.	.	.	.	5	23	.	7	142
CAREERIC	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	4	.	.	.	.	9
CAREFIRM	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
CAREORO1	7	6	3	3	7	5	.	2	.	11	.	2	21	36	4	11	118	7	2	2	2	18	19	.	13	3	29	12	22	39	49	21	24	262
CARERUPE	.	.	.	.	.	40	24	2	.	.	.	.	25	22	.	2	115	.	.	.	.	.	47	45	14	.	.	.	.	.	.	.	.	106
CARESEMP	7	2	.	.	.	.	5	.	40	66	32	18	28	59	26	35	318	1	.	.	.	8	9	21	.	64	89	37	26	36	49	23	48	411
CARLACAU	.	.	.	.	.	.	.	.	.	27	.	3	.	.	.	.	30	.	.	.	.	.	.	.	.	9	34	.	.	.	.	.	.	43
CERAFONT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	6
CHAMALPI	.	.	.	.	.	.	6	4	.	.	.	.	.	.	.	.	10	.	.	.	.	3	.	9	7	.	.	.	.	.	.	.	.	19
CLEMALPI	27	4	33	12	.	.	.	.	.	.	.	.	.	.	.	.	76	41	10	24	14	.	.	.	.	.	.	.	.	.	.	.	.	89
COELVIRI	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	1	4	.	.	.	.	8	.	3	6	.	.	.	.	.	.	.	.	17
CREPJAKE	.	.	.	.	30	36	63	51	.	.	.	.	10	23	.	1	214	.	.	.	.	38	56	62	54	.	.	.	.	1	7	.	.	218
CROCVEAL	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2
DAPHSTRI	4	.	21	13	.	.	.	.	.	5	.	9	.	.	.	.	52	3	.	6	8	.	.	.	.	.	7	.	8	.	.	.	.	32
DESCFLEX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
DRYAOCTO	26	.	.	.	93	56	89	89	.	.	.	.	22	56	.	10	441	11	.	.	.	68	78	79	92	.	.	.	.	4	21	.	3	356
ERICHERB	68	30	81	62	.	.	.	.	56	58	30	66	.	.	.	.	451	90	48	41	46	.	.	.	.	94	83	56	80	.	.	.	.	538
ERIGUNIF	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EUPHMINI	.	.	.	.	13	26	9	5	.	.	.	.	3	11	1	2	70	.	.	.	.	4	.	5	3	.	.	.	.	.	3	.	.	15
EUPHSALI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	7	.	.	.	.	.	.	.	.	.	.	18
FESTHAHA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FESTNORI	11	25	39	26	.	.	.	.	46	84	32	36	.	.	38	5	342	6	1	61	24	.	.	.	.	56	80	59	37	.	.	94	14	432
FESTQUAD	2	.	.	.	77	52	53	70	.	.	.	.	77	89	25	59	504	2	1	.	.	85	58	76	78	.	.	.	.	91	99	.	63	553

	2001																Σ	2015																Σ
	1-GRM-E11	1-GRM-E13	1-GRM-E31	1-GRM-E33	1-GRM-N11	1-GRM-N13	1-GRM-N31	1-GRM-N33	1-GRM-S11	1-GRM-S13	1-GRM-S31	1-GRM-S33	1-GRM-W11	1-GRM-W13	1-GRM-W31	1-GRM-W33	2001	4-GRM-E11	4-GRM-E13	4-GRM-E31	4-GRM-E33	4-GRM-N11	4-GRM-N13	4-GRM-N31	4-GRM-N33	4-GRM-S11	4-GRM-S13	4-GRM-S31	4-GRM-S33	4-GRM-W11	4-GRM-W13	4-GRM-W31	4-GRM-W33	2015
FESTVARI	.	.	.	.	.	.	.	.	12	11	47	44	.	.	.	.	114	.	.	.	.	.	.	.	.	45	15	74	71	.	.	.	.	205
GALIANIS	1	2	43	11	.	.	.	.	.	4	2	13	.	.	.	.	76	.	2	28	17	.	.	.	.	.	7	2	8	.	.	.	.	64
GENTACAU	1	.	.	.	.	.	.	.	11	19	6	6	.	.	.	5	48	.	.	.	.	.	.	.	.	17	15	.	6	.	2	.	.	40
GENTANIS	.	.	.	.	10	21	1	2	.	.	.	.	6	1	2	5	48	.	.	.	.	10	9	.	10	.	11	3	4	6	3	4	12	72
GENTVEVE	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.	.	17	.	.	.	.	.	.	.	.	.	.	.	.	3	30	.	14	47
GERASYLV	.	.	15	6	.	.	.	.	.	.	.	2	.	.	.	.	23	.	.	21	18	.	.	.	.	.	.	.	6	.	.	.	.	45
GYMNCONO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	4
HEDYHEDY	10	.	4	.	60	28	39	35	32	64	42	66	94	62	95	83	714	.	4	.	.	88	64	57	51	51	60	32	43	93	56	86	80	765
HELIOEAL	2	.	14	.	.	.	.	.	32	39	12	26	.	.	.	.	125	.	.	.	.	.	.	.	.	29	24	26	13	.	.	.	.	92
HIERMUMU	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HIERVILL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	4
HOMOALPI	.	.	.	.	.	.	.	.	.	.	.	.	1	.	30	4	35	.	.	.	.	.	1	.	.	.	.	.	.	1	.	11	4	17
HUPESESE	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
HYPOUNIF	.	.	.	.	.	.	.	.	3	.	.	.	.	.	8	.	11	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	5
JUNCTRTR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	29	23	52	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32	29	61
JUNICOAL	71	99	98	100	.	.	.	.	.	.	8	.	.	.	.	.	376	69	99	99	100	.	.	1	.	.	.	.	.	.	.	.	.	368
KOBRMYOS	.	.	.	.	20	22	3	13	1	20	11	19	54	71	40	57	331	.	.	.	.	26	47	.	8	3	15	12	19	46	58	.	45	279
LEONALAL	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LEONHISP	.	.	.	.	.	.	.	.	.	.	.	.	4	1	47	25	77	.	.	.	.	.	.	.	.	.	.	3	.	14	3	38	37	95
LEONPYHE	.	.	.	.	.	.	.	.	.	.	.	.	13	2	.	21	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LILIMART	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
LOTUCORN	.	.	.	.	.	.	.	.	8	32	.	3	.	.	.	.	43	.	.	.	.	.	.	.	.	17	12	.	.	.	.	.	.	29
LUZULUTE	.	.	.	.	.	.	.	.	2	2	.	.	.	.	86	31	121	.	.	.	.	.	.	.	.	.	.	.	.	.	.	67	39	106
LUZULUZU	.	17	.	6	.	.	.	.	.	.	22	.	.	.	2	.	47	.	12	.	2	3	.	.	.	.	.	30	.	.	.	.	.	47
MYOSALPE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	42	.	42	.	.	.	.	.	.	.	.	1	.	1	.	1	3	18	.	24
NIGRNINI	.	.	.	.	.	.	.	.	6	.	.	.	2	5	.	3	16	.	.	.	.	.	.	.	.	5	7	2	.	2	2	.	4	22
OXYTJACQ	.	.	.	.	.	.	1	13	.	.	.	.	.	6	.	9	29	.	.	.	.	.	13	2	12	.	.	.	.	.	5	.	.	32
PARNPALU	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	2	7	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	2
PEDITUBE	.	.	.	.	.	.	.	.	.	6	3	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	6	2	.	.	.	.	.	8
PEDIVERT	.	.	.	.	13	2	4	.	.	.	.	3	38	50	24	20	154	.	.	.	.	14	5	7	.	.	.	.	.	3	7	.	5	41
PHYTSIEB	.	.	.	.	34	20	1	20	.	.	.	.	.	.	.	.	75	.	.	.	.	.	21	.	10	.	.	.	.	.	.	.	.	31
PINGALPI	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PINUCEMB	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	46	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
POAALPIX	.	.	.	.	.	.	.	.	.	.	4	.	.	.	1	2	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	12	27
POLYALPE	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	2	.	.	.	2	.	.	5
POLYCHAM	.	.	26	10	.	.	.	.	18	67	4	30	.	.	.	.	155	5	.	22	20	.	.	.	.	56	95	15	69	.	.	.	.	282
POLYVERT	.	.	7	24	.	.	.	.	.	.	.	.	.	.	.	.	31	.	.	5	27	.	.	.	.	.	.	.	.	.	.	.	.	32
POLYVIVI	1	1	.	.	90	92	73	77	7	5	13	3	84	71	52	65	634	.	.	.	.	65	80	43	70	9	6	3	6	83	65	35	52	517
POTEAUAU	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
POTECRAN	.	.	.	.	.	.	.	.	1	14	7	2	3	14	41	40	122	.	3	.	.	.	.	.	.	3	15	.	.	3	15	19	40	98
PULMANGU	.	.	.	.	.	.	.	.	.	9	3	9	.	.	.	.	21	.	.	.	.	.	.	.	.	.	13	.	11	.	.	.	.	24
PULSALPI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
PULSVERN	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	2001																Σ	2015																Σ
	1-GRM-E11	1-GRM-E13	1-GRM-E31	1-GRM-E33	1-GRM-N11	1-GRM-N13	1-GRM-N31	1-GRM-N33	1-GRM-S11	1-GRM-S13	1-GRM-S31	1-GRM-S33	1-GRM-W11	1-GRM-W13	1-GRM-W31	1-GRM-W33	2001	4-GRM-E11	4-GRM-E13	4-GRM-E31	4-GRM-E33	4-GRM-N11	4-GRM-N13	4-GRM-N31	4-GRM-N33	4-GRM-S11	4-GRM-S13	4-GRM-S31	4-GRM-S33	4-GRM-W11	4-GRM-W13	4-GRM-W31	4-GRM-W33	2015
RANUMONT	10	2	3	.	.	3	.	9	9	18	.	15	95	85	56	82	387	7	4	1	.	.	5	2	24	3	8	2	4	69	24	40	47	240
RHODFERR	34	56	50	25	.	.	.	.	.	.	.	.	.	.	.	.	165	50	77	86	50	.	.	.	.	.	.	.	.	.	.	.	.	263
RHODHIRS	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	3
ROSAPEND	.	4	6	12	.	.	.	.	.	.	.	.	.	.	.	.	22	.	8	9	13	.	.	.	.	.	.	.	.	.	.	.	.	30
RUBUSAXA	.	.	1	26	.	.	.	.	.	.	.	.	.	.	.	.	27	.	1	.	36	.	.	.	.	.	.	.	.	.	.	.	.	37
SALIRETI	.	.	.	.	21	12	2	5	.	.	.	.	49	30	52	44	215	.	.	.	.	48	6	2	5	.	.	.	.	40	19	10	29	159
SALIRETU	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	.	.	.	30	7	10	38	.	.	.	.	.	.	.	.	85
SALISERP	.	.	.	.	26	9	8	33	.	.	.	.	.	.	.	.	76	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SAXICAES	.	.	.	.	16	43	1	29	.	.	.	.	.	.	.	.	89	.	.	.	.	3	20	1	11	.	.	.	.	.	.	.	.	35
SAXIPANI	.	.	.	.	28	23	.	4	.	.	.	.	.	.	.	.	55	.	.	.	.	9	14	.	7	.	.	.	.	.	.	.	.	30
SCABLUCI	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	8	5	.	.	.	.	.	13
SCORARIS	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SELASELA	.	.	.	.	10	2	5	1	.	.	.	.	3	6	.	.	27	.	.	.	.	4	4	3	4	.	.	.	.	.	.	.	.	15
SESLALBI	50	62	27	35	51	16	52	14	27	23	29	41	97	97	54	90	765	49	50	3	4	84	40	75	32	55	34	43	55	98	99	56	74	851
SESLSPHA	.	.	.	.	3	10	.	1	.	.	.	.	.	.	.	.	14	.	.	.	.	.	10	4	6	.	.	.	.	.	.	.	.	20
SILEACAC	.	.	.	.	73	67	35	60	.	.	.	.	.	8	.	.	243	.	.	.	.	60	48	32	54	.	.	.	.	.	2	.	.	196
SILERUPE	.	.	.	.	.	.	.	.	.	.	8	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	3
SILEVUVU	.	.	.	.	.	.	.	.	2	.	10	.	.	.	.	.	12	.	.	.	.	.	.	.	.	3	.	4	.	.	.	.	.	7
SOLDALPI	.	.	.	.	.	.	.	.	.	.	1	1	1	.	2	3	8	.	.	.	.	1	.	.	.	.	.	.	.	1	1	5	3	11
TARANN00	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
THESALPI	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
THYMPRPO	.	.	.	.	.	.	.	.	36	26	10	13	.	.	.	.	85	.	.	.	.	.	.	.	.	40	20	7	15	.	.	.	.	82
TROLEURO	.	.	.	.	.	.	.	.	.	.	.	.	2	.	30	.	32	.	.	.	.	.	.	.	.	.	.	.	.	1	.	49	.	50
VACCMYRT	.	.	8	21	.	.	.	.	.	.	.	.	.	.	.	.	29	.	.	2	23	.	.	.	.	.	.	.	.	.	.	.	.	25
VACCULMI	.	46	62	78	14	.	49	.	.	.	.	.	28	51	.	14	342	.	12	51	89	10	.	52	3	.	.	.	.	29	54	.	7	307
VACCVIVI	3	24	30	41	.	.	.	.	.	.	.	.	.	.	.	.	98	4	20	9	15	.	.	.	.	.	.	.	.	.	.	.	.	48
VALETRIP	.	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	17	.	.	.	.	.	.	.	.	.	.	.	.	.	17
VIOLBIFL	.	.	.	.	14	8	3	.	.	.	.	.	22	2	68	16	133	.	.	.	.	20	4	4	2	.	.	2	.	32	4	81	21	170
																	10844																	10707

Appendix 4_2: Frequencies of the species species (%) at the m² plots of PNL (2463 m a.s.l.) in 2001 and 2015. ∑ = sum of all frequencies per 14 plots in 2011 and 2015, respectively. In brown: species which increased in frequency by > 45 subplots in 2015. For species abbreviations see Appendix 4_5

	2001														Σ	2015														Σ
SPECIES	1-PNL-E11	1-PNL-E31	1-PNL-E33	1-PNL-N11	1-PNL-N13	1-PNL-N31	1-PNL-N33	1-PNL-S11	1-PNL-S13	1-PNL-S31	1-PNL-S33	1-PNL-W11	1-PNL-W13	1-PNL-W33	2001	4-PNL-E11	4-PNL-E31	4-PNL-E33	4-PNL-N11	4-PNL-N13	4-PNL-N31	4-PNL-N33	4-PNL-S11	4-PNL-S13	4-PNL-S31	4-PNL-S33	4-PNL-W11	4-PNL-W13	4-PNL-W33	2015
ACHICLAV	.	2	.	1	.	.	.	.	.	.	.	.	.	.	3	1	3	1	2	.	.	4	.	.	.	.	.	.	.	11
AGROALPI	.	.	2	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ANTHVUAL	.	9	3	.	.	.	.	1	1	.	.	8	2	1	25	5	27	5	2	.	2	.	3	23	6	11	20	17	6	127
ARABPUST	.	.	.	.	.	.	.	1	.	1	1	3	.	.	6	.	.	.	.	.	.	.	5	.	1	.	2	.	1	9
ARENCICI	.	3	8	5	1	3	3	2	16	.	26	4	7	7	85	.	.	7	.	2	1	3	10	23	15	3	2	.	.	66
ASTRAUST	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
BARTALPI	.	.	.	.	.	3	.	.	.	.	.	.	.	.	3	.	.	.	.	.	5	.	.	.	.	.	.	.	.	5
BOTRLUNA	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
CAMPCOCH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	26	16	.	.	.	46
CAREFIRM	31	39	11	36	32	11	5	.	2	1	16	4	35	37	260	30	42	5	56	31	21	12	1	3	5	44	8	51	53	362
CARERUPE	2	47	42	52	81	65	54	46	87	59	13	64	24	47	683	11	43	45	48	80	68	51	22	79	47	20	68	30	50	662
CREPJAKE	.	5	.	.	2	1	.	.	.	.	.	.	.	.	8	2	8	.	.	3	4	.	.	.	.	.	.	.	.	17
DRABAIZO	1	.	1	.	.	.	2	.	.	.	1	.	.	.	5	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2
DRABDUBI	.	.	.	.	.	.	.	.	.	.	1	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
DRYAOCTO	35	52	5	53	78	62	50	.	.	.	.	11	22	21	389	41	46	7	65	77	73	51	.	.	.	.	26	38	31	455
ERIGUNIF	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EUPHMINI	.	4	2	15	5	10	1	7	14	1	9	2	6	7	83	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EUPHSALI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	6	2	2	10	.	12	42	.	26	2	5	3	117
FESTALPI	4	9	3	.	7	3	.	.	.	2	2	.	.	4	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FESTQUAD	.	7	4	25	6	4	3	2	.	.	.	38	19	3	111	.	7	.	15	10	.	.	1	2	.	1	33	13	1	83
GALIANIS	.	.	.	.	.	.	.	2	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
GENTANIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
GENTBR S	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
GENTTETE	7	.	1	2	1	.	.	.	.	.	.	.	.	2	13	4	.	.	.	1	.	.	.	.	.	.	.	.	.	5
HEDYHEDY	6	.	.	8	.	.	.	.	.	.	1	1	.	.	16	8	.	.	4	.	.	.	.	.	.	2	.	.	.	14
HELIOEAL	5	8	.	.	.	.	2	27	76	6	63	20	33	30	270	7	14	7	.	.	.	4	36	71	14	63	40	41	53	350
HIERMURO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
JUNICOAL	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	2
LARIDECI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
LEONALAL	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MINUCHCH	.	2	5	.	.	.	.	.	.	.	.	.	.	2	9	.	1	3	.	.	.	.	.	.	.	.	.	.	2	6
MINUSEDO	.	.	.	.	.	.	.	.	6	.	.	.	.	.	6	.	.	.	.	.	.	.	.	1	.	1	.	.	.	2
MINUVEVE	.	.	3	.	.	.	.	3	1	.	5	4	.	2	18	.	.	.	.	1	.	.	1	7	4	.	1	.	.	14
OXYTJACQ	1	.	.	7	9	25	20	.	1	.	3	6	5	5	82	.	.	.	18	12	37	14	.	2	1	6	6	14	8	118
PEDIRORO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	10	2	.	.	.	.	.	.	.	.	14
PEDIROST	.	.	.	4	16	3	.	.	.	.	.	.	.	.	23	3	.	.	.	.	.	.	.	.	2	.	.	.	.	5
PHYTSIEB	19	16	8	18	10	24	2	1	16	20	17	2	10	1	164	14	17	4	21	12	19	4	.	19	1	.	7	9	1	128
POAALPIX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	.	13
POLYVIVI	45	33	21	39	20	34	9	10	38	8	14	29	24	26	350	34	26	19	24	13	26	5	14	22	7	9	32	16	13	260
POTENITI	19	1	.	3	.	2	2	25	8	46	18	2	1	4	131	24	1	.	.	.	.	3	19	10	50	19	1	.	.	127
PRITALAL	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

SPECIES	2001														Σ	2015														Σ
	1-PNL-E11	1-PNL-E31	1-PNL-E33	1-PNL-N11	1-PNL-N13	1-PNL-N31	1-PNL-N33	1-PNL-S11	1-PNL-S13	1-PNL-S31	1-PNL-S33	1-PNL-W11	1-PNL-W13	1-PNL-W33	2001	4-PNL-E11	4-PNL-E31	4-PNL-E33	4-PNL-N11	4-PNL-N13	4-PNL-N31	4-PNL-N33	4-PNL-S11	4-PNL-S13	4-PNL-S31	4-PNL-S33	4-PNL-W11	4-PNL-W13	4-PNL-W33	2015
SALISERP	.	.	.	.	2	.	.	.	.	2	.	.	.	.	4	.	.	.	.	.	.	.	.	.	3	1	.	.	.	4
SAXICAES	4	.	.	11	12	28	11	.	6	.	.	2	17	26	117	.	.	4	8	18	32	12	.	8	.	2	3	16	23	126
SAXISQUA	2	.	.	.	.	.	.	.	7	.	.	.	.	13	22	8	.	.	.	.	.	.	.	10	.	2	.	2	24	46
SESLALBI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	3	5	.	.	12
SESLSPHA	53	26	23	38	7	28	12	30	73	26	57	52	63	51	539	64	37	22	24	4	36	15	26	66	33	48	35	51	44	505
SILEACAC	2	.	.	7	.	36	6	.	.	.	.	.	8	26	85	3	1	.	5	3	16	6	1	.	.	.	.	6	20	61
VEROAPHY	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
Σ of all frequencies															3557															3783

Appendix 4_3: Frequencies of the species (%) at the m² plots of RNK (2757 m a.s.l.) in 2001 and 2015. Σ = sum of all frequencies per 15 plots in 2001 and 2015, respectively. In brown: species which increased in frequency by > 45 subplots. For species abbreviations see Appendix 4_5.

SPECIES	2001															Σ	2015															Σ
	1-RNK-E11	1-RNK-E13	1-RNK-E31	1-RNK-E33	1-RNK-N11	1-RNK-N13	1-RNK-N31	1-RNK-N33	1-RNK-S11	1-RNK-S13	1-RNK-S31	1-RNK-S33	1-RNK-W11	1-RNK-W31	1-RNK-W33	2001	4-RNK-E11	4-RNK-E13	4-RNK-E31	4-RNK-E33	4-RNK-N11	4-RNK-N13	4-RNK-N31	4-RNK-N33	4-RNK-S11	4-RNK-S13	4-RNK-S31	4-RNK-S33	4-RNK-W11	4-RNK-W31	4-RNK-W33	2015
ACHIOXOX	.	.	.	.	.	.	.	.	1	.	4	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
ARABALAL	.	.	.	.	.	.	.	.	.	.	.	.	4	1	1	6	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	2
ARABPUST	3	7	1	4	.	.	.	.	.	.	.	.	.	1	.	16	.	6	5	14	1	.	2	2	.	2	.	.	5	1	1	39
ARENCICI	.	3	3	4	.	.	.	2	.	.	.	.	.	7	.	19	.	4	4	9	6	5	6	22	1	15	11	.	.	.	.	83
ARTEGENI	5	5	4	6	11	31	1	18	58	14	22	4	1	.	.	180	1	2	1	4	38	46	3	30	18	11	20	16	12	.	.	202
BOTRLUNA	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	5
CAMPSCHE	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	3	.	.	.	.	.	2	.	.	3	15	3	1	.	.	.	24
CAREOROR	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	3	4	.	.	.	.	.	.	.	.	.	14	.	.	.	.	18
CAREPARV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
CARERUPE	67	.	.	.	.	.	.	.	.	.	16	.	.	.	.	83	65	.	.	.	.	.	.	.	.	.	35	2	.	.	.	102
CERAUNIF	.	1	.	6	57	68	29	14	1	11	.	.	15	1	14	217	.	.	.	4	36	32	26	4	.	12	.	.	33	4	18	169
DRABAIZO	8	1	.	.	.	2	.	1	24	21	36	22	.	.	.	115	11	3	.	2	6	17	.	5	22	32	23	15	.	.	.	136
DRABDOLO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	3
DRABDUBI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
DRABTOME	.	.	1	.	.	.	.	.	.	.	.	.	2	.	.	3	.	.	.	.	.	1	.	.	.	.	.	.	3	.	.	4
ERIGUNIF	1	1	.	.	.	2	1	2	12	21	12	8	.	.	.	60	3	.	.	1	19	16	5	4	24	35	30	29	5	.	1	172
EUPHSALI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
FESTALPI	.	2	1	1	8	26	.	14	.	31	.	18	.	.	.	101	.	.	.	.	25	48	12	45	7	48	1	29	.	.	.	215
FESTQUAD	.	.	.	.	.	.	.	.	9	.	42	.	.	.	.	51	.	.	.	.	.	.	.	.	15	.	46	.	.	.	.	61
GENTANIS	.	.	.	.	.	.	.	.	2	5	.	.	.	.	.	7	.	.	.	.	.	.	.	.	3	4	2	.	.	.	.	9

SPECIES	2001															Σ	2015															Σ
	1-RNK-E11	1-RNK-E13	1-RNK-E31	1-RNK-E33	1-RNK-N11	1-RNK-N13	1-RNK-N31	1-RNK-N33	1-RNK-S11	1-RNK-S13	1-RNK-S31	1-RNK-S33	1-RNK-W11	1-RNK-W31	1-RNK-W33	2001	4-RNK-E11	4-RNK-E13	4-RNK-E31	4-RNK-E33	4-RNK-N11	4-RNK-N13	4-RNK-N31	4-RNK-N33	4-RNK-S11	4-RNK-S13	4-RNK-S31	4-RNK-S33	4-RNK-W11	4-RNK-W31	4-RNK-W33	2015
GENTBRBR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
GENTTENE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	7	4	22	.	.	.	.	33
GENTTETE	.	.	2	2	.	.	.	.	.	1	9	2	.	.	.	16	2	1	3	1	.	.	.	.	3	.	3	1	.	.	.	14
GENTVEVE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
GEUMREPT	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	2
JUNICOAL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
KOBRMYOS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
LIGUMUTE	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	7
LINAALPI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	3
MINUCHCH	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	3
MINUSEDO	3	4	.	7	1	6	2	40	39	27	7	2	.	.	.	138	.	6	3	9	4	18	4	46	50	35	15	4	.	.	.	194
MINUVEVE	.	.	.	.	.	.	.	1	3	.	1	.	.	.	.	5	.	.	.	.	.	.	.	.	8	1	11	.	.	.	.	20
OXYTJACQ	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	13
PAPAALRH	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	15	3	9	27
PHYTSIEB	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
POAALPIX	3	.	.	3	75	71	18	38	83	86	89	70	12	6	8	562	.	.	.	.	86	76	12	20	23	74	75	56	45	35	23	525
POLYVIVI	34	32	28	35	.	.	.	.	.	.	39	16	.	.	.	184	45	36	40	51	.	.	.	.	.	.	60	10	.	.	.	242
POTECRAN	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
POTENITI	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	6	.	1	.	.	.	.	.	.	1	.	1	8	.	.	.	11
PRITALAL	.	1	1	2	18	15	17	12	2	7	8	4	2	1	14	104	.	.	3	.	7	7	3	5	1	.	.	.	22	17	19	84
SALISERP	51	39	7	10	.	.	.	.	2	.	.	2	.	.	.	111	57	39	11	14	.	.	.	.	5	.	1	2	.	.	.	129
SAXICAES	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.	3	.	3	3	6	.	.	.	.	2	1	.	.	.	.	.	15
SAXIEXMO	.	.	.	.	.	.	.	.	.	9	1	13	.	.	.	23	.	.	.	.	2	5	.	9	5	28	3	25	.	.	.	77
SAXIOPOP	.	5	1	9	3	3	3	8	2	15	2	8	1	.	7	67	.	.	2	8	3	.	5	4	.	13	1	6	3	.	7	52
SAXISESE	.	.	4	5	3	2	.	12	.	.	.	.	.	.	2	28	.	.	4	2	4	.	.	.	.	.	.	.	.	.	9	19
SAXISQUA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
SEDUATRA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	1	.	.	.	7	.	.	.	.	.	8
SESLALBI	.	.	.	.	.	.	.	.	26	.	.	.	.	.	.	26	.	.	.	.	.	.	.	.	48	.	2	.	.	.	.	50
SESLSPHA	26	23	29	42	3	10	2	17	30	20	7	20	1	.	.	230	16	32	46	62	3	8	3	32	26	23	3	28	2	4	.	288
SILEACAC	7	.	23	.	.	.	.	.	15	.	8	11	.	.	.	64	10	.	30	1	.	.	1	.	27	4	18	9	.	.	2	102
TARANN00	.	.	.	1	.	.	.	.	21	5	75	6	1	.	.	109	.	.	.	.	.	.	.	.	6	3	47	1	12	1	.	70
THLARORO	.	.	.	1	.	.	.	.	.	.	2	.	3	6	.	12	.	.	.	.	.	.	.	.	.	.	.	.	29	66	.	95
THYMPRPO	.	.	.	.	.	.	.	.	11	.	9	.	.	.	.	20	.	.	.	.	.	.	.	.	41	.	64	4	.	.	.	109
VEROAPHY	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	15	.	7	.	.	.	.	22
VEROFRUT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	1	8	4	.	.	.	.	13
Σ of all frequencies																2600																3479

Appendix 4_4: Frequencies of the species (%) at the m² plots of MTS (2893 m a.s.l.) in 2001 and 2015. Σ = sum of all frequencies per 15 plots in 2001 and 2015, respectively. In brown: species which increased in frequency by > 45 subplots. For species abbreviations see Appendix 4_5.

	2001															Σ	2015															Σ
SPECIES	1-MTS-E11	1-MTS-E13	1-MTS-E31	1-MTS-E33	1-MTS-N11	1-MTS-N13	1-MTS-N31	1-MTS-N33	1-MTS-S11	1-MTS-S13	1-MTS-S31	1-MTS-S33	1-MTS-W11	1-MTS-W13	1-MTS-W33	2001	4-MTS-E11	4-MTS-E13	4-MTS-E31	4-MTS-E33	4-MTS-N11	4-MTS-N13	4-MTS-N31	4-MTS-N33	4-MTS-S11	4-MTS-S13	4-MTS-S31	4-MTS-S33	4-MTS-W11	4-MTS-W13	4-MTS-W33	2015
ARABCAER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	.	.	.	.	.	.	1	.	.	7
ARABPUST	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
CERAUNIF	13	3	5	36	21	3	3	6	13	25	21	33	.	3	.	185	3	3	2	16	52	20	22	7	3	7	5	21	1	5	.	167
DRABDOLO	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	6	.	.	.	.	3	.	1	.	.	.	.	.	.	1	11	16
DRABHOPP	8	5	5	21	1	.	2	.	31	60	33	40	.	.	.	206	8	4	1	9	18	.	10	1	20	42	29	44	.	.	.	186
DRABTOME	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	3	8	2	.	.	.	.	.	.	.	.	1	.	.	.	1	12
POAALPIX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	2
MINUSEDO	68	90	12	13	.	.	.	.	1	2	6	1	.	1	.	194	64	83	41	54	.	.	3	.	10	6	7	13	.	.	1	282
MINUVEVE	63	48	81	90	.	.	.	.	18	48	47	45	.	.	.	440	60	76	59	56	2	9	1	1	27	27	33	28	.	1	1	381
PAPAALRH	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	3	2	.	.	.	9
POAALPIX	.	2	10	20	.	.	.	.	4	30	4	10	.	.	.	80	.	1	5	16	.	5	.	.	15	55	2	2	.	2	.	103
POAALPIX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
PRITALAL	28	59	60	76	67	5	39	6	27	80	35	76	5	2	7	572	5	25	30	24	98	50	49	8	4	38	7	33	2	1	1	375
SALISERP	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
SAXIANDR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	4	2	.	.	.	.	.	.	2	.	11
SAXIFACC	.	3	.	.	.	1	.	.	.	.	.	.	.	1	4	9	.	.	.	.	4	7	.	2	.	.	1	1	2	2	4	23
SAXIOPOP	.	.	.	.	2	.	4	1	2	5	15	3	.	5	10	47	.	.	.	.	3	.	6	1	3	8	8	4	.	2	12	47
SAXISESE	15	15	28	80	.	.	5	3	6	23	4	12	.	.	.	191	13	15	29	67	.	.	10	4	12	31	18	27	.	3	1	230
SILEACAC	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16	37	3	.	.	.	.	.	.	.	6	.	.	.	.	.	46
Σ of all frequencies																1951																1907

Appendix 4_5: Abbreviation of all species of IT_ADO, mentioned at the Appendix 4_1 to 4_4.

ACHICLAV = *Achillea clavennae* L.; ACHIOXOX = *Achillea oxyloba* (DC.) Sch.Bip. subsp. *oxyloba*; ACINALAL = *Acinos alpinus* (L.) Moench subsp. *alpinus*; ACONLYNE = *Aconitum lycoctonum* subsp. *neapolitanum* (Ten.) Nyman; ACONNATA = *Aconitum napellus* L. subsp. *tauricum* (Wulfen) Gáyer; AGROALPI = *Agrostis alpina* Scop.; ALCHVUVU = *Alchemilla vulgaris* agg.; ANDRHELV = *Androsace helvetica* (L.) All.; ANDROBTU = *Androsace obtusifolia* All.; ANEMBALD = *Anemone baldensis* L.; ANTECARP = *Antennaria carpatica* (Wahlenb.) Bluff & Fingerh.; ANTHODAL = *Anthoxanthum odoratum* L. subsp. *alpinum* (Á. & D.Löve) Jones & Melderis; ANTHVUAL = *Anthyllis vulneraria* subsp. *alpestris* (Hegetschw.) Asch. & Graebn.; ARABALAL = *Arabis alpina* L. subsp. *alpina*; ARABCAER = *Arabis caerulea* (All.) Haenke; ARABPUST = *Arabis pumila* Jacq. subsp. *stellulata* (Bertol.) Nyman; ARCTALPI = *Arctostaphylos alpinus* (L.) Spreng.; ARCTUVA- = *Arctostaphylos uva-ursi* (L.) Spreng.; ARENCICI = *Arenaria ciliata* L. subsp. *ciliata*; ARNIMONT = *Arnica montana* L.; ARTEGENI = *Artemisia genipi* Weber; ASPLTRIC = *Asplenium viride* Huds.; ASTEALPI = *Aster alpinus* L.; ASTEBELL = *Aster bellidiastrum* (L.) Scop.; ASTRAUST = Astragalus australis (L.) Lam.; ATHACRET = *Athamanta cretensis* L.; AVENVERS = *Avenula versicolor* (Vill.) M.Laínz; BARTALPI = *Bartsia alpina* L.; BISCLALA = *Biscutella laevigata* L. subsp. *laevigata*; BOTRLUNA = *Botrychium lunaria* (L.) Sw.; CALAVARI = *Calamagrostis varia* (Schrad.) Host; CAMPBARB = *Campanula barbata* L.; CAMPCOCH = *Campanula cochleariifolia* Lam.; CAMPSCHE = *Campanula scheuchzeri* Vill.; CARDDEFL = *Carduus defloratus* L.; CAREATAT = *Carex atrata* L. subsp. *atrata*; CAREBICO = *Carex bicolor* All.; CARECAPI = *Carex capillaris* L.; CARECURO = *Carex curvula* All. subsp. *rosae* Gilomen; CAREERIC = *Carex ericetorum* Pollich; CAREFIRM = *Carex firma* Host; CAREMOMO = *Carex montana* L. subsp. *montana*; CAREMUCR = *Carex mucronata* All.;

CAREORO1 = *Carex ornithopoda* Willd. subsp. *ornithopoda*; CAREOROR = *Carex ornithopoda* Willd. subsp. *ornithopodioides* (Hausm.) Nyman; CAREPARV = *Carex parviflora* Host; CARERUPE = *Carex rupestris* All.; CARESEMP = *Carex sempervirens* Vill.; CARLACAU = *Carlina acaulis* L.; CENTTRIU = *Centaurea triumfetti* All.; CENTUNNE = *Centaurea uniflora* subsp. *nervosa* (Willd.) Bonnier & Layens; CERAFOFO = *Cerastium fontanum* Baumg. subsp. *fontanum*; CERAUNIF = *Cerastium uniflorum* Clairv.; CHAEVILL = *Chaerophyllum villarsii* W.D.J.Koch; CHAMALPI = *Chamorchis alpina* (L.) Rich.; CLEMALAL = *Clematis alpina* (L.) Mill. subsp. *alpina*; COELVIRI = *Coeloglossum viride* (L.) Hartm.; COTOINTE = *Cotoneaster integerrimus* Medik.; CREPAUAU = *Crepis aurea* (L.) Cass. subsp. *aurea*; CREPJAKE = *Crepis jacquinii* Tausch subsp. *kerneri* (Rech.f.) Merxm.; CREPTERG = *Crepis terglouensis* (Hacq.) A.Kern.; CROCVEAL = *Crocus vernus* (L.) Hill subsp. *albiflorus* (Kit.) Asch. & Graebn.; CYSTFRAG = *Cystopteris fragilis* (L.) Bernh.; DAPHMEZE = *Daphne mezereum* L.; DAPHSTRI = *Daphne striata* Tratt.; DESCFLEX = *Deschampsia flexuosa* (L.) Trin.; DIANSUPE = *Dianthus superbus* L.; DOROCLCL = *Doronicum clusii* (All.) Tausch subsp. *clusii*, DRABAIZO = *Draba aizoides* L.; DRABDOLO = *Draba dolomitica* Buttler; DRABDUBI = *Draba dubia* Suter; DRABHOPP = *Draba hoppeana* Rchb.; DRABTOME = *Draba tomentosa* Clairv.; DRYAOCTO = *Dryas octopetala* L.; ERICHERB = *Erica herbacea* L.; ERIGALPI = *Erigeron alpinus* L.; ERIGGLAB = *Erigeron glabratus* Hoppe & Hornsch. ex Bluff & Fingerh.; ERIGUNIF = *Erigeron uniflorus* L.; EUPHMIMI = *Euphrasia minima* Jacq. ex DC. subsp. *minima*; EUPHSALI = *Euphrasia salisburgensis* Funck; FESTALPI = *Festuca alpina* Suter; FESTHAHA = *Festuca halleri* All. subsp. *halleri*; FESTINTE = *Festuca intercedens* (Hack.) Lüdi ex Bech.; FESTNORI = *Festuca norica* (Hack.) K.Richt.; FESTQUAD = *Festuca quadriflora* Honck.; FESTVARI = *Festuca varia* Haenke; GALIANIS = *Galium anisophyllon* Vill.; GALIMOLL = *Galium mollugo* L.; GENTACAU = *Gentiana acaulis* L.; GENTANIS = *Gentianella anisodonta* (Borbás) Á.Löve & D.Löve; GENTBRBR = *Gentiana brachyphylla* Vill. subsp. *brachyphylla*; GENTBRFA = *Gentiana orbicularis* Schur; GENTCLUS = *Gentiana clusii* E.P.Perrier & Songeon; GENTNIVA = *Gentiana nivalis* L.; GENTTENE = *Gentianella tenella* (Rottb.) Börner; GENTTETE = *Gentiana terglouensis* Hacq. subsp. *terglouensis*; GENTVEVE = *Gentiana verna* L. subsp. *verna*; GERASYLV = *Geranium sylvaticum* L.; GEUMMONT = *Geum montanum* L.; GEUMREPT = *Geum reptans* L.; GNAPHOPP = *Gnaphalium hoppeanum* W.D.J.Koch; GYMNCONO = *Gymnadenia conopsea* (L.) R.Br.; GYMNODOR = *Gymnadenia odoratissima* (L.) Rich.; GYPSREPE = *Gypsophila repens* L.; HEDYHEDY = *Hedysarum hedysaroides* (L.) Schinz & Thell.; HELINUGR = *Helianthemum nummularium* (L.) Mill. subsp. *grandiflorum* (Scop.) Schinz & Thell.; HELIOEAL = *Helianthemum oelandicum* (L.) DC. subsp. *alpestre* (Jacq.) Breistr.; HIERLACT = *Hieracium lactucella* Wallr.; HIERMUMU = *Hieracium murorum* agg.; HIERVILL = *Hieracium villosum* Jacq.; HIPPCOMO = *Hippocrepis comosa* L.; HOMOALPI = *Homogyne alpina* (L.) Cass.; HUPESESE = *Huperzia selago* (L.) Bernh. ex Schrank & Mart. subsp. *selago*; HYPOUNIF = *Hypochoeris uniflora* Vill.; JUNCTRMO = *Juncus trifidus* L. subsp. *monanthos* (Jacq.) Asch. & Graebn.; JUNCTRTR = *Juncus trifidus* L. subsp. *trifidus*; JUNICOAL = *Juniperus communis* L. subsp. *nana* Syme; KNAULONG = *Knautia longifolia* (Waldst. & Kit.) W.D.J.Koch; KOBRMYOS = *Kobresia myosuroides* (Vill.) Fiori; LARIDECI = *Larix decidua* Mill.; LEONALAL = *Leontopodium alpinum* Cass. subsp. *alpinum*; LEONHISP = *Leontodon hispidus* L.; LEONMOMO = *Leontodon montanus* Lam. subsp. *montanus*; LEONPYHE = *Scorzoneroides helvetica* (Mérat) Holub; LIGUMUTE = *Ligusticum mutellinoides* (Crantz) Vill.; LILIMART = *Lilium martagon* L.; LINAALPI = *Linaria alpina* (L.) Mill.; LOISPROC = *Loiseleuria procumbens* (L.) Desv.; LOTUCORN = *Lotus corniculatus* L.; LUZUALP2 = *Luzula alpina* Hoppe; LUZUALPI = *Luzula alpinopilosa* (Chaix) Breistr.; LUZULUTE = *Luzula lutea* (All.) DC.; LUZULUZU = *Luzula luzuloides* (Lam.) Dandy & Wilmott; LUZUSPIC = *Luzula spicata* (L.) DC.; LUZUSYLV = *Luzula sylvatica* (Huds.) Gaudin; MINUCHCH = *Minuartia cherlerioides* (Hoppe) Bech. subsp. *cherlerioides*; MINUSEDO = *Minuartia sedoides* (L.) Hiern; MINUVEVE = *Minuartia verna* (L.) Hiern subsp. *verna*; MYOSALPE = *Myosotis alpestris* F.W.Schmidt; NIGRNINI = *Nigritella nigra* (L.) Rchb.f. subsp. *nigra*; OXYRDIGY = *Oxyria digyna* (L.) Hill; OXYTCACA = *Oxytropis campestris* (L.) DC. subsp. *campestris*; OXYTJACQ = *Oxytropis jacquinii* Bunge; PAEDBONA = *Paederota bonarota* (L.) L.; PAPAALRH = *Papaver alpinum* subsp. *rhaeticum* (Ler. ex Gremli) Nyman; PARNPALU = *Parnassia palustris* L.; PEDIRORO = *Pedicularis rosea* Wulfen subsp. *rosea*; PEDIROST = *Pedicularis rostratocapitata* Crantz; PEDITUBE = *Pedicularis tuberosa* L.; PEDIVERT = *Pedicularis verticillata* L.; PHYTHEHE = *Phyteuma hemisphaericum* L. subsp. *hemisphaericum*; PHYTSIEB = *Phyteuma sieberi* Spreng.; PICEABAB = *Picea abies* (L.) H.Karst. subsp. *abies*; PINGALPI = *Pinguicula alpina* L.; PINUCEMB = *Pinus cembra* L.; POAALPIX = *Poa alpina* L.; POACECEX = *Poa cenisia* All. subsp. *cenisia*; POAMINOX = *Poa minor* Gaudin; POLYALPE = *Polygala alpestris* Rchb.; POLYCHAM = *Polygala chamaebuxus* L.; POLYVERT = *Polygonatum verticillatum* (L.) All.; POLYVIVI = *Polygonum viviparum* L.; POTEAUAU = *Potentilla aurea* L. subsp. *aurea*; POTECRAN = *Potentilla crantzii* (Crantz) Beck ex Fritsch; POTENITI = *Potentilla nitida* L.; PRIMELAT = *Primula elatior* (L.) Hill; PRITALAL = *Pritzelago alpina* (L.) Kuntze subsp. *alpina*; PSEUALAL = *Pseudorchis albida* (L.) A. & A. Löve & D. Löve subsp. *albida*; PULMANGU = *Pulmonaria angustifolia* L.; PULSALAP = *Pulsatilla alpina* (L.) Delarbre subsp. *apiifolia* (Scop.) Nyman; PULSVERN = *Pulsatilla vernalis*

(L.) Mill.; RANUMONT = *Ranunculus montanus* Willd.; RANUSESE = *Ranunculus seguieri* Vill. subsp. *seguieri*; RHAMPUMI = *Rhamnus pumila* Turra; RHODFERR = *Rhododendron ferrugineum* L.; RHODHIRS = *Rhododendron hirsutum* L. and *Rhododendron* x *intermedium* Tausch; ROSAPEND = *Rosa pendulina* L.; RUBUSAXA = *Rubus saxatilis* L.; SAGISASA = *Sagina saginoides* (L.) H.Karst. subsp. *saginoides*; SALIALPI = *Salix alpina* Scop.; SALIBREV = *Salix breviserrata* Flod.; SALIHAST = *Salix hastata* L.; SALIHERB = *Salix herbacea* L.; SALIRETI = *Salix reticulata* L.; SALIRETU = *Salix retusa* L.; SALISERP = *Salix serpillifolia* Scop.; SAXIAIZO = *Saxifraga aizoides* L.; SAXIANDR = *Saxifraga androsacea* L.; SAXICAES = *Saxifraga caesia* L.; SAXIEXMO = *Saxifraga exarata* Vill. subsp. *moschata* (Wulfen) Cavill.; SAXIFACC = *Saxifraga facchinii* W.D.J.Koch, SAXIOPOP = *Saxifraga oppositifolia* L. subsp. *oppositifolia*; SAXIPANI = *Saxifraga paniculata* Mill.; SAXISESE = *Saxifraga sedoides* L. subsp. *sedoides*; SAXISQUA = *Saxifraga squarrosa* Sieber; SCABLUCI = *Scabiosa lucida* Vill.; SCORARIS = *Scorzonera aristata* Ramond ex DC.; SEDUATRA = *Sedum atratum* L.; SELASELA = *Selaginella selaginoides* (L.) Link; SENEABAB = *Senecio abrotanifolius* L. subsp. *abrotanifolius*; SESLALBI = *Sesleria albicans* Kit. ex Schult.; SESLOVAT = *Sesleria ovata* (Hoppe) A.Kern.; SESLSPHA = *Sesleria sphaerocephala* Ard.; SILEACAC = *Silene acaulis* (L.) Jacq. subsp. *acaulis*; SILERUPE = *Silene rupestris* L.; SILEUNGL = *Silene uniflora* Roth subsp. *glareosa* (Jord.) Chater & Walters; SOLDALPI = *Soldanella alpina* L.; SOLDMINI = *Soldanella minima* Hoppe; SOLIVIRG = *Solidago virgaurea* L.; SORBAUCU = *Sorbus aucuparia* L.; SORBCHAM = *Sorbus chamaemespilus* (L.) Crantz; TARANN00 = T*araxacum* sp.; THALAQU = *Thalictrum aquilegiifolium* L.; THESALPI = *Thesium alpinum* L.; THLARORO = *Thlaspi rotundifolium* (L.) Gaudin, non Tineo subsp. *rotundifolium*; THYMPRPO = *Thymus praecox* subsp. *polytrichus* (A.Kern. ex Borbás) Jalas; TRIFALPI = *Trifolium alpinum* L.; TRIFPRNI = *Trifolium pratense* L. subsp. *nivale* Arc.; TRIFREPE = *Trifolium repens* L.; TRISARGE = *Trisetum argenteum* (Willd.) Roem. & Schult.; TROLEURO = *Trollius europaeus* L.; VACCMYRT = *Vaccinium myrtillus* L.; VACCULMI = *Vaccinium uliginosum* L. subsp. *microphyllum* Lange; VACCVIVI = *Vaccinium vitis-idaea* L. subsp. *vitis-idaea*; VALEELON = *Valeriana elongata* Jacq.; VALEMONT = *Valeriana montana* L.; VALESASA = *Valeriana saxatilis* L. subsp. *saxatilis*; VALESUPI = *Valeriana supina* Ard.; VALETRIP = *Valeriana tripteris* L.; VERAALBU = *Veratrum album* L.; VEROALPI = *Veronica alpina* L.; VEROAPHY = *Veronica aphylla* L.; VEROFRUT = *Veronica fruticans* Jacq.; VIOLBIFL = *Viola biflora* L.