Conservation in Alpine Ecosystems: The plant cover of ski runs reflects natural as well as anthropogenic environmental factors

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Die Pflanzendecke von Schipisten als Spiegel natürlicher und menschlich bedingter Einflüsse

1. Introduction

During the last 30 years, skiing has become a mass movement with far-reaching consequences for the landscapes involved. As a result, some of the winter sport communities in the Austrian Alps, stricken by their ecological conscience, have already stopped using brutal methods of ski run construction. Whenever grading seems inevitable, one now tries to find effective measures for revegetation. Very often, however, the bleaky prophesy of "Ski runs as dead aisles in the Alps" (KLÖTZLI and SCHIECHTL, 1979) has already come true. Graded areas at altitudes of more than 1800 m have so far resisted revegetation trials when tools and technology are inadequate.

Nowadays shovel excavators are primarily used instead of graders. They preserve at least parts of the uppermost humus and vegetation layer, and this can be recycled for revegetation (see SCHÖNTHALER, 1985; PRÖBSTL, 1990; HOLAUS and KÖCK, 1992; LICHTENEGGER, 1994a, b). However, the seeds used for sowing on the graded sites were very often not adapted to the harsh conditions in the high mountain environment. Scientists as well as civil engineers

Zusammenfassung

Schipistenplanien verschiedenen Alters, aber auch Abfahrten durch naturnahe subalpine und alpine Pflanzengesellschaften wurden im Rahmen eines Man and Biosphere-Projekts im Gebiet von Obertauern (Salzburg, Österreich) sehr genau hinsichtlich ihres Bewuchses studiert. Mittels pflanzensoziologischer Aufnahmen nach BRAUN-BLANQUET (1964) wurde erhoben, welche Pflanzen in erhöhtem und welche in vermindertem Maße in den stark befahrenen „Natur"-Pisten und in Planien vorkamen.

Es zeigte sich deutlich, daß sich in Höhen über 2025 m ü. d. M. nur mehr wenige angesäte Arten überhaupt halten konnten, während standortstaugliche autochthone Arten in allen Höhenlagen auch dann in den Pisten auftraten, wenn sie nicht oder nur sehr vereinzelt aus der unmittelbaren Kontaktvegetation stammten.

Ältere Ansaaten beherbergen zusehends mehr autochthone Einwanderer und entsprechend weniger Saatgut-Arten als jüngere. Steile Flächen, aber auch länger schneebedeckte Mulden werden von autochthonen Arten bis in Höhen von über 2000 m ü. d. M. leichter besiedelt, während die nicht so gut angepaßten Saatgut-Arten sich in diesen Höhen nur auf flacheren Stellen mit einer gewissen Feinbodenauflage halten können. Arten der im Gebiet weit verbreiteten Haarbinsenmoore, Braunseggen- und Schnabelseggenrieder reagieren sehr empfindlich auf die mechanische Belastung durch den Schibetrieb, und zwar auch ohne Planierung.

Abschließend soll noch einmal hervorgehoben werden, wie wichtig die Erzeugung von Saatgut der pistentauglichen Alpenpflanzen ist, um pistenbedingte Landschafts- und Vegetationsschäden in den Alpen nachhaltig zu beseitigen.

Schlagworte: Ansaat, Reliefabhängigkeit, Renaturierung, Schipistenvegetation, subalpine und alpine Vegetation.

Abstract

The plant cover of graded and non-graded ski runs through semi-natural subalpine and alpine plant communities was carefully studied in the course of a Man and Biosphere project near Obertauern (Salzburg, Austria). With the help of phytosociological relevés (see BRAUN-BLANQUET, 1964), the plant species that occurred on ski tracks more frequently than in the surroundings and those that eventually disappeared from very highly frequented ski runs were determined. To regenerate the vegetation on graded ski slopes, the lift operators had resown them with commercial ready-mixed seeds. At altitudes of more than 2025 m only single species out of the mix had survived. The conditions were too harsh for the lowland taxa. However, some autochthon species occurred very frequently on ski runs at all altitudes, even when they were more or less absent in the surrounding semi-natural vegetation. The more recently graded areas still housed a relatively high number of seeded plants, whereas many of the species sown were absent on older runs or had been partly replaced by autochthon taxa. The seed species were mainly restricted to flat or slightly sloping areas with little or no microrelief and better soil. Skiing activities on non-graded runs across the locally widespread sedge and rush moors had almost completely eliminated a few of the indigenous species in the runs. The importance of breeding those autochthon seeds that have already been proven to cope with the extreme conditions on ski runs is emphasized as a basis for revegetating the ski-damaged landscapes of the Alps.

Key words: Autochthon seeds, altitudinal gradient, revegetation, ski runs, subalpine and alpine vegetation.

have had to learn lessons from many years of struggle and failure. A series of publications shows us that the conversion of other authors' bitter experiences into better results has only been possible in a very restricted way. The local environmental conditions, biotic as well as abiotic, were too different for parallels to be drawn.

The authors of this paper have already reported the sad state of some graded ski runs around the Radstädter Tauern pass (KLUG-PÜMPEL, 1988, 1992; KRAMPITZ, 1989). The phytosociological relevés presented in this paper show the influence of skiing on ungraded as well as on graded ski runs in the north-eastern part of the region. It is noted that, with bad preconditions, i.e. a lack of autochthon seeds, little success is achieved despite intense effort. Constructed and sown down between 1976 and 1984, the whole ski run "A" ("Almabfahrt", see Fig. 1 and map) had to be covered by sewage sludge and excavated soil and then revegetated again from top to bottom in the summers of 1989–91. The relevés reported here were undertaken before the 1989–91 revegetation and serve as a historical record of earlier attempts.

2. Methods and Materials

Vegetation science as well as phytomass studies were used to compare the semi-natural subalpine and alpine plant communities with the artificial vegetation on ski runs. These studies were part of a Man and Biosphere project performed between 1986 and 1989 in the surroundings of Obertauern at the Radstädter Tauern pass, a well known skiing centre in the province of Salzburg, Austria. Geomorphology, soils, climate and vegetation of the area were described by WAGNER and FUCHS (1987), NESTROY (1995), and KLUG-PÜMPEL (1988 and 1992).

In the course of the research, the senior author, B. KLUG, became convinced that more detailed phytosociological research, especially a comparison of graded and ungraded

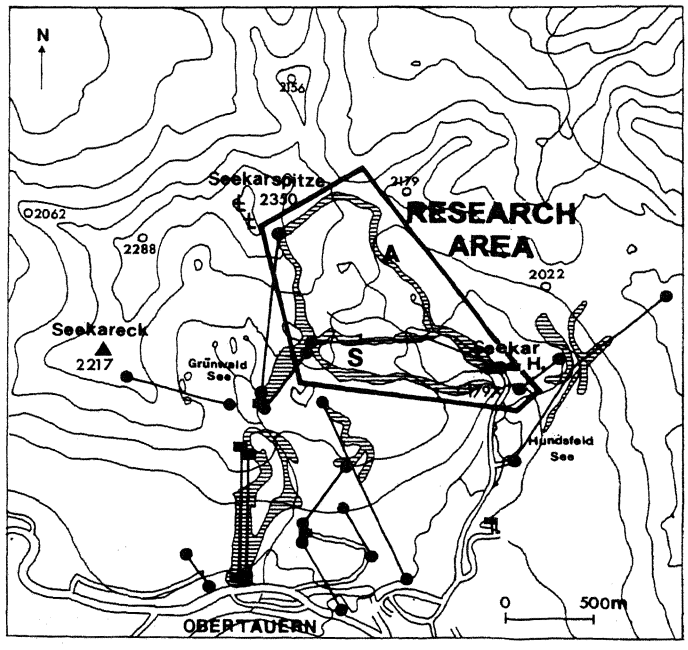


Figure 1: Research area
Ski lifts, cable cars / Aufstiegshilfen
Ski runs and other places with human impact on vegetation / Pisten u. a. Stellen m. gestörter Vegetation
Abbildung 1: Überblick über das Untersuchungsgebiet

ski runs in the north-eastern part of the MaB area (see Fig. 1), would be necessary to gain a correct impression of the region and its problems. Large parts of this area had not been graded and showed the direct impact of skiing on the original semi-natural vegetation. Furthermore, it seemed reasonable to confirm the results of erosion studies (BAUER and STERL, 1989) and snow melting documentation (FRITZ et al., 1989) by vegetation mapping. For these reasons, Ch. KRAMPITZ studied the north-eastern part of the region with the so-called "Almabfahrt" (ski run "A" in Fig. 1) and two shorter runs ("S" in Fig.1). She conducted more than 300 relevés on the ski runs and in the adjacent semi-natural vegetation, mapping the detailed information about the vegetation cover on ski run "A" (KRAMPITZ, 1989). The influence of altitude, microrelief and age of the artificial ski run vegetation as well as the impact of skiing activities on cover percentage and species composition of ungraded ski runs were studied.

2.1 Phytosociological relevés

The total estimate of density and cover percentage made use of the scale in Table I (after BRAUN-BLANQUET, 1964).

Table I: Scale for species abundance (combination of density and cover percentage)
Tabelle I: Artmächtigkeits-Skala

Code	Term	Area of cover, C
r	very rare	very small
+	sparse	small
1	numerous	C ≤ 5 %
2	very numerous	5 < C < 25 %
3	plentiful	25 < C < 50 %
4	plentiful	50 < C < 75 %
5	plentiful	75 < C < 100 %

The sites of relevés in the ski runs practically bordered each other so that the distribution and cover percentage of species could be used to map the whole run. Plant cover, soil and microrelief were chosen to be as homogenous as possible within the area of every relevé. In addition to the variables usually presented in a phytosociological table, the total number of vascular species without seed species (N-s) was also noted. The seed species originated either from the seed mixture used by the lift owners or were imported in the course of ski run construction or management (with soil, dung etc.). Following ADLER et al. (1994), we considered species as belonging to this group when they do not normally occur at the altitude and do not correlate with the environment where they were found.

The ski run relevés are arranged in four tables according to their elevation. Within each table, the relevés are further ranked according to inclination and elevation, where necessary. Special sites such as erosion zones, hollows, ridges and others are not reported in these tables but are presented partly as figures in comparison with their surrounding vegetation.

Each table, divided into seven groups of species, starts with the seed species, A. Not only the species of the seed mixture, s, but also the species imported from lower altitudes in other ways, are recorded here. Group A is further divided into grasses and grass-like species (A.1) and forbs and herbs (A.2). Group B comprises species of moist and well fertilized alpine pastures and tall-herb communities. Group C consists of snow bed species. In group D, showing species of poorer alpine pastures, there are also taxa from open dwarf shrub communities. In group E the dwarf shrubs themselves are recorded as well as other species growing on acid raw humus soils with low nutritional level. Group F includes the species on rocky or stony soils and on scree sites. Moist and wet soils (partly influenced by spring water) are colonized by species of group G.

Originally the species were grouped according to OBERDORFER (1990) or ADLER et al. (1994). However, as many taxa could have been placed in more than one group, presentation was modified to suit local experience.

In the frequency table (Table 5, calculated out of the data set of Tables 1–4) the symbols shown in Table II were used.

Table II: Codes for frequency table
Tabelle II: Bedeutung der Symbole in der Stetigkeitstabelle

Code	present in % of relevés
r	≤ 5
+	> 5 ≤ 10
1	> 10 ≤ 20
2	> 20 ≤ 40
3	> 40 ≤ 60
4	> 60 ≤ 80
5	> 80 ≤ 100

2.2 Inquiries as to historical development of ski runs and seed composition

The family who used the area as a cattle pasture in summer and ran the ski lifts in winter informed us that the southernmost ski run of Seekarspitze ("S" in Fig. 1) was graded and revegetated in 1980, the northern one in 1981/82. The

"Almabfahrt" ("A", the longest and northernmost run of the research area, also documented in the map) was constructed in two steps. The lower half of the run was graded and seeded in 1976, the upper part not earlier than 1984.

Up to 1984, mainly seed mixture (a), for repair work and intermittent revegetation of parts of the runs after 1987–88, mixture (b) in Table III were used.

It was noted that extremely rocky or other slopes hard to recultivate were covered with soil from lower altitudes or with sewage sludge almost every summer. Different seeding methods had been tried; most commonly used were bitumen-straw-cover seeding ("Schiechteln") and hydroseeding. A large number of different fertilizers had also been tried over the years: In the beginning, mineral fertilizers called "Vollkorn grün" and "Vollkorn blau" were used, while smaller areas had also been fertilized with cattle dung where available. From 1984 onward, only biological fertilizers having a high portion of organic material to improve soil conditions and a well-balanced content of slowly-mineralized N as well as P and K and trace elements were applied. A by-product of penicillin production called Biosol has become the one most commonly used. An initial top dressing of 2000 kg/ha is followed by annual doses of 1200 kg/ha. In 1987, a chicken dung product called Bioren was also tested, but only to a very small extent in our research area.

Table III: Seed mixtures mainly used: (a) before 1984, and (b) after 1987–88

Table III: Hauptsächlich verwendetes Saatgut: a) vor 1984, b) nach 1987–88

a)

Festuca rubra s. str.	17 %	*Trisetum flavescens*	1 %
Festuca "fallax" (= *F. nigrescens* s. Adler et al., 1994)	10 %	*Lotus corniculatus*	15 %
Poa pratensis	10 %	*Trifolium repens*	10 %
Dactylis glomerata	5 %	*Trifolium hybridum*	6 %
Phleum pratense	5 %	*Achillea millefolium*	3 %
Arrhenatherum elatius	3 %	*Vicia villosa*	3 %
Festuca pratensis	3 %	*Vicia sativa*	1 %
Agrostis capillaris	3 %	*Trifolium dubium*	1 %
Lolium perenne	3 %	*Plantago lanceolata*	1 %

b)

Festuca rubra s.l.	40 %	*Poa annua*	10 %
Agrostis capillaris	20 %	*Phleum pratense*	14 %
Trifolium repens	11 %	*Trifolium hybridum*	5 %

As recommended by the distributors, 300 kg of the mixtures were applied per hectare.

After the skiing season, in May, all the ski runs had to be treated with a dark coloured phosphate in order to speed up snow melt. In some cases the young seedlings in recently revegetated areas were protected by fences. The cattle, however, could not resist temptation, trampled down the fences and fed on the tender leaflets, destroying all efforts with a few hoof-steps.

It must be noted that the very detailed information on the construction and conservation of the ski runs requested at the beginning of the research is still lacking, and certain assumptions had to be made. Nevertheless it appears that the lift managers had to spend between 100.000 and 200.000 ATS / year for repair and revegetation of the runs.

3. Results

3.1 Altitude as a criterion for greening success

Tables 1 to 4 show species composition and total cover on ski runs for four elevation classes, namely from 1820 to 1880, 1885 to 1915, 1925 to 2025, and 2040 to 2180 m a. s. l.

Comparing Tables 1 and 2, it is seen that from 1880 m upwards some of the sown grass species suffer marked losses (group A1). *Dactylis glomerata*, for instance, falls back from frequency class II to I, *Agrostis capillaris* from IV to III, while *Festuca pratensis* appears only at sites lower than 1880 m (except in one recently, but sparsely greened area at 2165 m). Some seeded forbs also fall back (*Achillea millefolium* from III to +, *Trifolium pratense* from IV to II), whereas snow bed species increase in frequency and total cover.

Table 3 shows a further loss in sown species at altitudes up to 2025 m. *Dactylis glomerata* is completely absent, while clover species as well as *Achillea millefolium* are less frequent than at lower altitudes. However, species common on rocky soils or screes join the plant cover on the ski runs, for instance *Saxifraga* spp. and *Silene* spp. of group F. The plants of poor pastures get sparser and sparser; some species (*Arnica montana, Anthoxanthum alpinum, Ajuga pyramidalis* or *Hieracium lachenalii*) do not appear any more. The dwarf shrubs (group E) which were still present at the lower level are also completely absent at this altitude. The same is true for some species of group B.

At altitudes above 2040 m, further species of group C (e.g. *Leucanthemopsis alpina)* and group F appear *(Arabis alpina* on alkaline soils, *Agrostis rupestris* on acid and stony soils), whereas plants of groups B, D and G also disappear (among

them *Phleum rhaeticum* and *Trifolium pratense* ssp. *nivale*, two species of great value as autochthon "ski run attendants" at lower altitudes).

Table 5 shows the frequency of different species in the four elevation classes. The following species are present at all altitudes in 60–100 % of relevés: *Festuca rubra* s.l., *Poa pratensis*, *Phleum pratense*, and *Trifolium hybridum*. Up to 1880 m also *Agrostis capillaris* is very frequent. Among the forbs, *Trifolium repens* does very well up to 1920 m and *Trifolium pratense* up to 1880 m. Species brought in from lower altitudes never show a frequency higher than 60 %.

The autochthon species *Deschampsia cespitosa*, *Taraxacum officinale* s.l. and *Cerastium cerastoides* are present in 60 to 100 % of all relevés at all altitudes. Up to 1925 m, *Carex nigra*, *Poa supina*, *Alchemilla* spec., *Leontodon helveticus* and *Homogyne alpina* are very frequent. This is true also for *Veronica serpyllifolia* and *Luzula multiflora* up to 1880 m. At higher altitudes, the autochthon species *Gnaphalium supinum*, *Agrostis rupestris* and *Leucanthemopsis alpina* appear very frequently in revegetated ski runs.

The fact that the upper part of ski run "A" was constructed and revegetated 8 years after the lower part may be the reason for a slightly higher frequency of seed species at altitudes between 2040 and 2180 m.

From these data, one might get the impression that species composition on ski runs is mainly a function of altitude. Yet the map of ski run "A" also reveals a marked variation in exposition, inclination and soil conditions within every elevation class (see also BAUER and STERL, 1987). Therefore the altitudinal relations were often distorted by the effects of microrelief or other environmental conditions.

3.2 Other environmental variables influencing the success of greening efforts

3.2.1 Inclination

Between 1820 and 1880 m, sown herbaceous plants are more frequent on flat or only slightly sloped sites. Autochthon species (except those of group B) prevail on steeper slopes, which are less suitable for the seed plants.

From 1885 to 1915 m, snow bed species become more frequent on steep as well as on gentle slopes, whereas *Agrostis rupestris* of group F is especially present on steep and stony slopes of ski runs.

As may be seen on the map, the flat sites between 1925 and 2025 m show marked differences as to substrate quality and structure. On extremely rocky sites with rivulets running across, some of the species usually found under better soil conditions might have dropped out here as a consequence of erosion (see e.g. relevé 199, Table 3). In the highest parts of the research area a general tendency for species number and cover to diminish is noted that is independent of inclination.

3.2.2 Microrelief

The following examples illustrate the situation at directly neighbouring ski run sites with markedly differing greening success. The influence of microrelief (also exerted via different mechanical stress on vegetation by ski edges or ski track rollers or other machines) can be seen at graded as well as at ungraded sites in a ski run.

In Fig. 2, four relevés from the "Seekarspitz" area (Fig. 1, "S") between 1985 and 2000 m are compared. Relevé No. 159 was made in a hollow; No. 160 close beside No. 159 at an evenly sloped site in the run; No. 161 in a semi-natural poor pasture; No. 156 at 6 to 8 m south of the ski run in a dwarf-shrub/pasture-complex. The runs, constructed and revegetated seven years before the investigations, were fertilized using an organic fertilizer according to manufacturer`s instructions. The sown species were restricted to the artificial vegetation on the ski run. At the beginning of the 1980s, there were no autochthon or other suitable seed available. The seeded species were not very abundant in the hollow (relevé 159), whereas several species of pasture and snow beds were able to establish themselves there, although they had not been present next to the ski track previously. These autochthon species may have been attracted by the moisture and fertilization in the hollow, and remained there, well protected against mechanical impacts. It is difficult to determine whether the seeds of those "ski run attendants" had already been present in the diaspore bank of the site or whether they had been imported more recently to their "safe site" by animals, man or any other means of transport.

Fig. 3 shows examples from the same region but between 1975 and 2000 m. Relevé No. 131 originates in a 7 m long, flat drain that ran across the ski run. No. 133 was situated a few meters up the slope but in a ski run section of hardly any microrelief. Both relevés of the adjacent vegetation were made north of the track. No. 245 was situated between big boulders directly below 241. It was noted that the snow melted extremely late here. This snow bed was dominated by *Deschampsia cespitosa*, a species well adapted to long snow cover. At sites like this, *Deschampsia* is not refused by cattle because at these high altitudes it differentiates its rough leaves later than in the lowlands. *Festuca rubra* and other

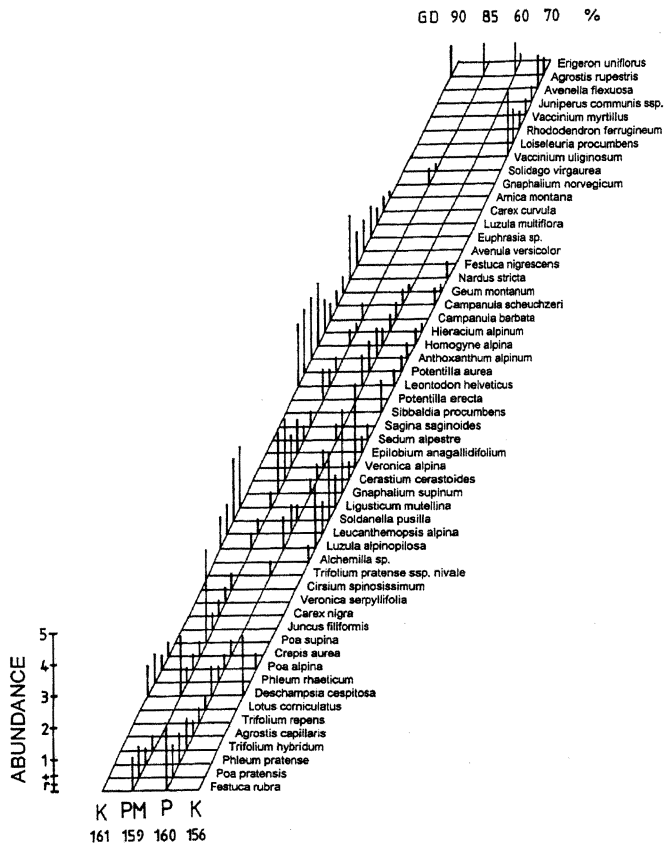


Figure 2: Cover percentage and total cover (GD) of 2 sites on a ski run (P and PM, the latter representing a hollow in the run) and two sites of the neighbouring semi-natural vegetation (K)

Information as to relevés/Information zu den Aufnahmen:

P (No.160)	PM (No.159)	K (No.161)	K (No.156)	
2000 m	2000 m	1995 m	1985 m ü.d.M./a.s.l.	
SE	E	NE	E	Exposition
12°	0–10°	22°	15°	Inclination

Fertilization of ski runs/ Düngung der Pistenstandorte:
1200 kg Biosol/ha.a after / nach 1984

Abbildung 2: Artmächtigkeit und Gesamtdeckung (GD) auf zwei Pistenstandorten P und PM (Mulde) und 2 benachbarten Stellen der Kontaktvegetation K

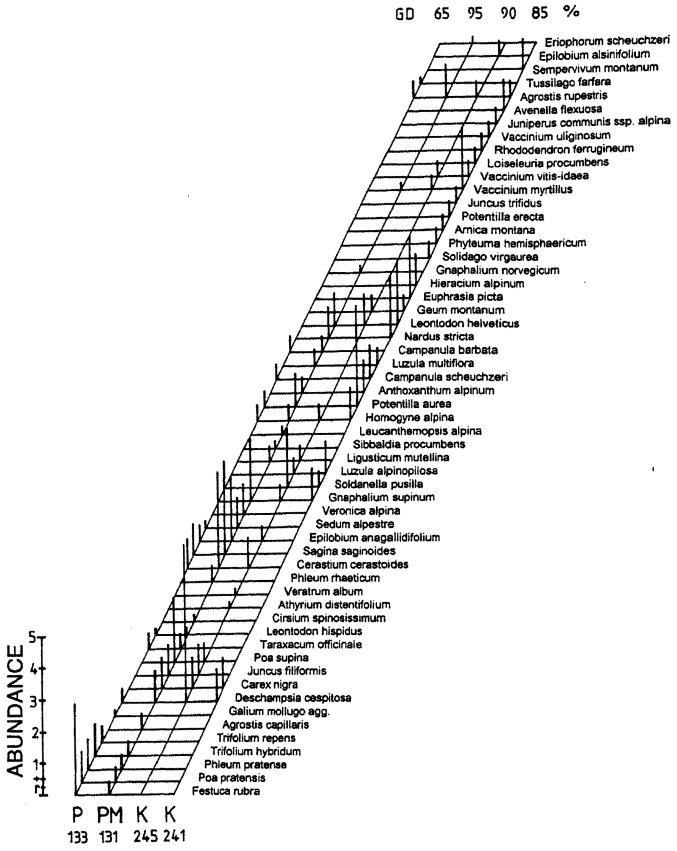


Figure 3: Cover percentage and total cover (GD) of 2 sites on a ski run (P and PM, the latter representing a hollow in the run) and two sites of the neighbouring semi-natural vegetation (K)

Information as to relevés/ Information zu den Aufnahmen:

P (No.133)	PM (No.131)	K (No.245)	K (No.241)	
2000 m	1995 m	1975 m	2000 m ü.d.M./a.s.l.	
SE	SE	NE	SE	Exposition
15°	12°	15°	0/35°	Inclination

Fertilization of ski runs /Düngung der Pistenstandorte:
1200 kg Biosol/ha.a after / nach 1984

Abbildung 3: Artmächtigkeit und Gesamtdeckung (GD) auf zwei Pistenstandorten P und PM (Mulde) und 2 benachbarten Stellen der Kontaktvegetation K

sown species contributed a great deal of cover on the less protected ski run site 133, whereas the hollow was dominated by immigrants from moist pastures and snow beds. Among these were found many of the so-called "ski run attendants" (*Poa supina, Cerastium cerastoides, Sagina saginoides, Gnaphalium supinum).* Some of the poor-pasture species as found in No. 241 had already invaded the hollow (No.131), but not to that extent the evenly sloped ski run (No. 133). *Agrostis rupestris, Luzula multiflora, Potentilla aurea* and *Leontodon helveticus* were particularly worthy of mention.

3.2.3 Mechanical damage to vegetation on ungraded sections of the ski runs

In a cirque at an altitude of 1915 m was a little lake that was slowly being filled by sedimentation. In a former bay of this lake (see map, coordinates P-Q/8-11) were relevés No. 52–54 (Fig. 4) closely neighbouring each other. This area was not graded and has not been fertilized for reasons of water protection. No. 208 was situated nearby to the south-west, No. 185 about 20 m outside the run behind a hummock.

Nos. 53 and 54 show clear traces of mechanical damage.

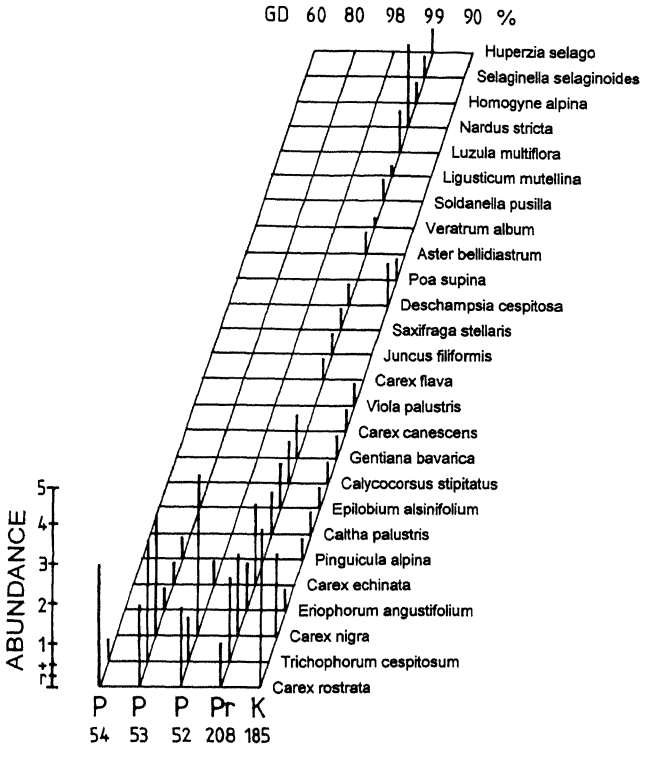


Figure 4: Cover percentage and total cover (GD) at 3 sites on an ungraded ski run and in a neighbouring site comprising the neighbouring natural vegetation of a former lake filled up by sedimentation. Elevation 1915 m a.s.l.; relevés No.P 53 and P 54 clearly show traces of mechanical impact; Pr is situated at the border of the ski run. All sites show little or no inclination; the ski runs are unfertilized in this water conservation area.

Abbildung 4: Artmächtigkeit und Gesamtdeckung (GD) in 3 Bereichen einer nicht planierten Piste und in der angrenzenden Kontaktvegetation K eines verlandenden Karsees in 1915 m ü.d.M. Die Pistenaufnahmen P 53 und P 54 zeigen deutliche Spuren mechanischer Schädigung, Pr zeigt die Verhältnisse am Pistenrand. Alle Aufnahmeflächen sind maximal 5° geneigt; die Pistenflächen aus Gründen des Wasserschutzes ungedüngt.

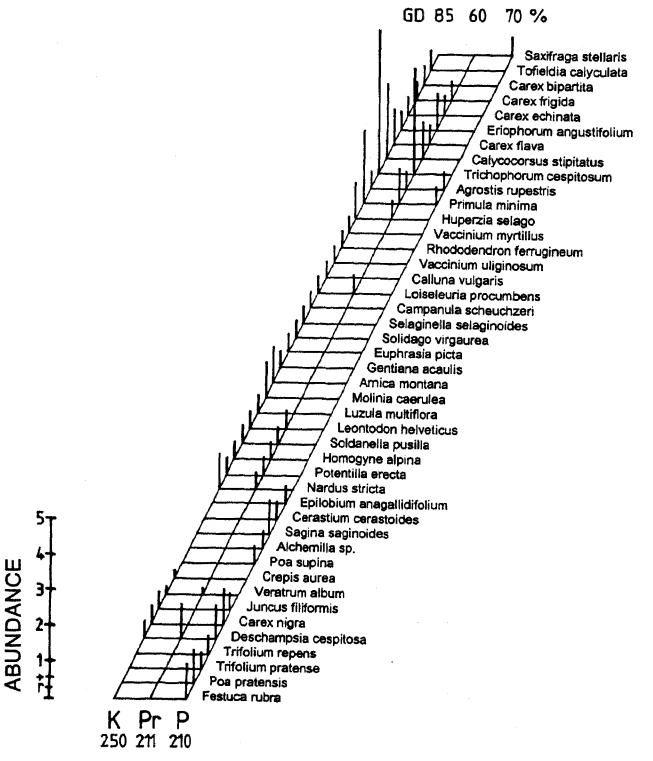


Figure 5: Cover percentage and total cover (GD) on the ski run P, on the mechanically damaged border of the run, Pr, and in the adjacent semi-natural vegetation K. Elevation 1915 m a.s. l. All sites are exposed to the SE, the ski runs show an inclination of 12°, the adjacent vegetation of 15 °. Fertilization was probably restricted to ski run P.

Abbildung 5: Artmächtigkeit und Gesamtdeckung (GD) auf einem Pistenabschnitt P, einem mechanisch geschädigten Pistenrand Pr und in der Kontaktvegetation K in 1915 m ü.d.M. Alle Flächen sind SE-exponiert, die Pistenstandorte 12°, die Kontaktvegetation 15° geneigt. Die Düngung (1200 kg Biosol während der letzten 3 Jahre) dürfte sich auf den Pistenstandort P beschränkt haben.

In the traces of the ski run rollers the bare humic soil came to light. The total cover of 90 % at the undisturbed sites decreased to 60 % at the severely impaired site. The total number of vascular species rose from the centre of the damaged run towards the bordering drier parts. As the border of the ski run formed a transition towards the drier and more stable shore of the lake, the growing conditions were probably better there, and some of the additional species may be due to the better growing conditions. Had there been no mechanical disturbance, *Trichophorum cespitosum, Carex nigra* and *Eriophorum latifolium* would have been present more abundantly in No. 54.

Fig. 5 shows a non-graded section of the ski run which must have been treated with seed and fertilizers several times (located at the map in P 10). The area shows traces of tracked vehicles such as ski run rollers. Relevés No. 211 and 250 were situated side by side in the adjacent semi-natural vegetation. The ski run (210) bordered directly on No. 211. The ski run and its border showed about half the number of species found in the surrounding vegetation (a *Trichophorum* stand). Although we found some typical autochthon indicators of moisture in the run and at its border, *Trichophorum cespitosum* itself was completely absent in the run and had a reduced abundance at the border of the track. The dwarf shrubs, very frequent alongside the ski run, hardly occurred in the run. Instead, the sown species with high affinity to

fertilizers dominated, even species that did not belong to any of the commercial seed mixtures used by the lift owners. Furthermore, there were some autochthon "attendants", indicating fertilizer application and long snow cover. The mechanically damaged border was probably not seeded and fertilized systematically, because many of the components of poor and moist pastures had almost kept the species abundance they had in the adjacent semi-natural vegetation.

3.2.4 Age of the seeded ski run

Recently seeded ski runs show especially sharp differentiation between their plant cover and that of the adjacent communities.

Fig. 6 gives an example from Seekarlift ("S") with a 1-year-old revegetation area. Of course, all specimens of *Pinus mugo* had to be removed from the area before grading and seeding. Thus the "young" ski run could be recognized from afar as a broad track without any woody plants. The seed had received a start fertilization of 2000 kg/ha of organic Biosol fertilizer and 1200 kg/ha in the following year. The vegetation alongside the run ("K" in Fig. 6, relevé No. 219) was separated from the ski run by a steep slope that was 3 to 5 m high and bore hardly any vegetation. Four autochthon species had already been able to establish themselves in the run ("P"), but only one of them, *Deschampsia cespitosa*, was also present in the surrounding vegetation. This and the three other species, *Cerastium cerastoides, Sagina saginoides* and *Epilobium anagallidifolium*, all belonged to the ski run attendants (see KLUG-PÜMPEL, 1992). They are obviously very well suited for the colonization of graded, well fertilized sites at high altitudes. Often they seem to be imported into the ski runs from some distance away. Several species at this site, e.g. *Poa annua, Festuca pratensis* or *Phleum pratense*, were not part of the official seed mixture; they probably originated from other mixtures or were brought in from lower altitudes together with humus, such as *Matricaria matricarioides*. One is inclined to doubt whether in the future species of the surrounding dwarf shrub heaths and poor pastures will become established in those well fertilized graded sites at 1900 m, with immigration of further attendants with high nutritional demands more likely. Probably some day autochthon species as *Deschampsia cespitosa* would dominate the site; however, of all species, this plant is strictly refused or combatted by the lift operators and farmers. It forms tussocks that might affect skiing and, except for the youngest leaves, is refused by cattle.

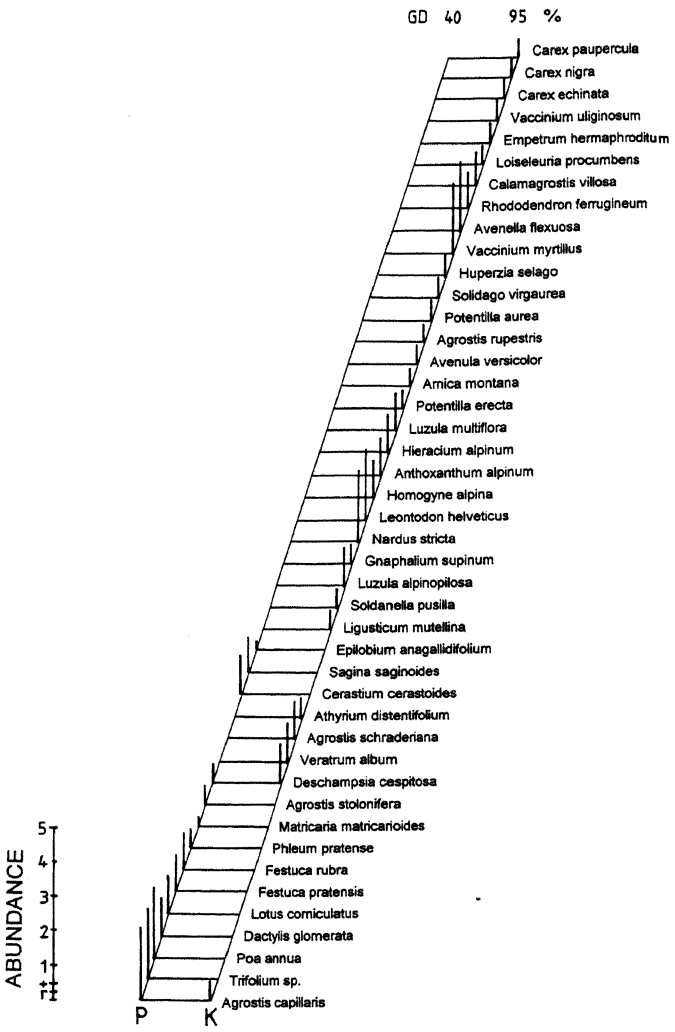


Figure 6: Cover percentage and total cover (GD) of a recently greened ski run P and in the adjacent semi-natural vegetation K. Elevation about 1900 m a. s. l.

Information as to relevés / Information zu den Aufnahmen:
Age of revegetation: 1 year / Alter der Begrünung: ca. 1 Jahr

	P:	K:
Exposition	NE-E	E
Inclination	15–25°	12°

Abbildung 6: Artmächtigkeit und Gesamtdeckung (GD) im Bewuchs einer frisch begrünten planierten Piste P und in der angrenzenden naturnahen Vegetation K auf ca. 1900 m ü. d. M.

Unfortunately, a comparable site nearby with an older seeding could not be found. As year after year some repair or revegetation work had to be done, and was done, at various sections of the runs, it was extremely difficult or even impossible to document in detail the development of the ski runs in question. Thus our estimate of the future development of the 1-year-old greening must be speculative.

The results confirm the data published earlier about other

ski runs of this area. The predominantly acid humic or peaty soils bear a semi-natural vegetation comprising dwarf shrub heaths, alpine pasture communities, sedge and rush marshes, snow-bed and tall-herb as well as scree vegetation. Most species of these communities avoid the conditions on graded and fertilized as well as on mechanically stressed ski runs. *Nardus stricta*, for instance, though dominating wide parts of the region, and the *Vaccinium* dwarf shrubs play hardly any role on the ski runs. But species of well fertilized, snow-moist soils and indicators of an unbalanced water regime reach a considerable abundance and a high frequency on the runs. The ski run attendants are above all *Deschampsia cespitosa, Poa alpina, Cerastium fontanum* et *cerastoides, Potentilla erecta,* and *Epilobium* as well as *Alchemilla* species, *Poa supina, Phleum rhaeticum, Trifolium pratense* ssp. *nivale, Potentilla aurea, Leucanthemopsis alpina* and *Leontodon helveticus.* Besides, species of stony acid soils like *Agrostis rupestris* or of calcareous screes like *Arabis alpina* can be found frequently on these ski runs. Some of these species, however, are too small to be used economically for sustainable revegetation. But one can easily imagine that some others could be cultivated to a greater extent and sold as essential components of future special seed mixtures for high alpine revegetation, i.e. *Poa alpina, Deschampsia cespitosa, Poa supina, Phleum rhaeticum, Agrostis rupestris,* but also *Alchemilla monticola, Ranunculus repens, Leucanthemopsis alpina, Trifolium pratense* ssp. *nivale, Trifolium badium, Silene vulgaris* s.l., or *Arabis alpina,* to name the most frequent ones.

4. Discussion and conclusions

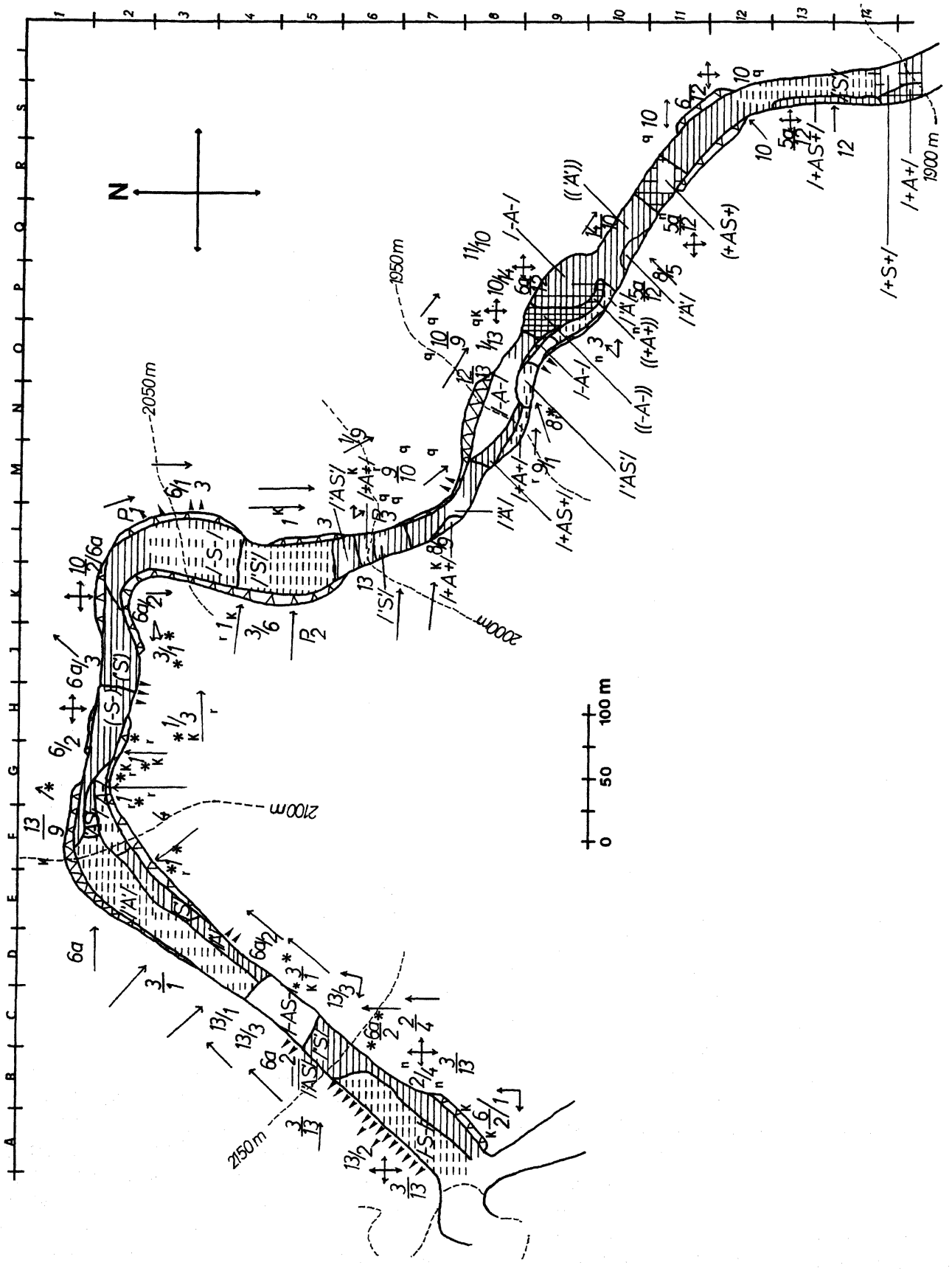
Apart from differences in the overt management procedures of the different lift operators, the general impression is very similar to the results obtained from other ski runs in the same region (KLUG-PÜMPEL, 1988, 1992): As long as exposition, microrelief and therefore micro-climate do not provide serious obstacles, the graded ski runs can be revegetated sufficiently, at least in the lower parts, by traditional means and even with commercial seed mixtures.

In addition to experience in Austria (see e.g. SCHÖNTHALER, 1985 or HOLAUS and KÖCK, 1992), that in Switzerland, too, has shown that raw soils at high altitudes are difficult to revegetate with customary seed mixtures, so that in the end the seed is replaced by naturally immigrating pioneers (STOLZ, 1984; DELARZE, 1994). Such self-healing processes are, however, too slow and cannot protect from erosion without further fertilizing and soil improving measures and a never-ending supervision and support of the development. Thus high altitude revegetation has stayed a challenge, requiring more effective steps to stabilize soils and vegetation on ski runs and other erosion zones.

As one solution one could consider using turfs or seeding with hayseed taken from the surrounding vegetation, or at least application of an additional portion of autochthon seeds in customary mixtures. To revegetate endangered areas as rapidly as possible, some authors have also suggested greening with clonal plant material. The most sensitive phase in the life of a plant, namely germination and the following juvenile development, could be moved from the harsh alpine environment into the laboratory or garden, and this could improve the further survival of the plant material. As performed by URBANSKA and SCHÜTZ (1986) or GRABHERR and HOHENGARTNER (1989), this sort of revegetation is technically possible but very labour intensive and hence expensive.

In the case of Obertauern, the application of sewage sludge as a layer some centimetres thick to the uppermost section of "Almabfahrt" in 1988 did not bring the expected success. This ski run had to be revegetated completely in the years 1990/91. MUHAR (1989) pointed out that different breeds of species commonly used for high alpine seeding react to sewage sludge with marked differences in productivity. This is especially true for *Festuca rubra,* one of the taxa most frequently used for ski run revegetation. The result depends on the quality of the sewage sludge as well as on the quantities used. But compared with the possible hygienic risks, for instance release of pollutants into the land ecosystem and the groundwater, the risk of a depressed phytomass production of *Festuca rubra* seems a harmless side-effect. Like intensive mineral fertilization, sewage sludge also keeps many of the less competitive character species of Nardion and Vaccinion from immigrating into the graded ski runs.

Quality and quantity of the applied materials and methods must therefore be well balanced in order to create a dense plant cover and a stable sward quickly. Autochthon species – immigrated as well as sown – are an important factor in reaching this goal. Especially for graded ski runs at or above the timberline, use of appropriate plant or seed material is still the key criterion. In this regard, the work of numerous specialists and institutions has already initiated a turn of events. In Switzerland, URBANSKA and her students have worked on this problem for at least a decade (cf. URBANSKA 1990), in Southern Tyrol FLORINETH (1988a, b) has performed successful experiments. PARTSCH and the German Young-Gardeners have been pioneers of sustain-


N
0
50
100 m
2100m
2050m
2000m
1950m
2150m
1900m

MAP CAPTIONS

1. Ski runs

1.1 Share of autochthon species with reference to cover percentage

S: Sown species dominate, autochthon species make up less than one third of total cover;

A: Autochthon species dominate, autochthon species amount to more than two thirds of total cover;

AS: Cover of autochthon and sown species similar or equal.

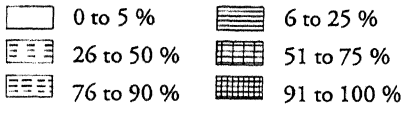
1.2 Absolute number of autochthon species:

- - number of autochthon species low (up to 10);
, , between 11 and 30 autochthon species;
+ + more than 30 autochthon species.

1.3 Cover percentage of mosses:

/ / 0 to 25 % of total cover;
( ) 26 to 50 % of total cover;
(( )) more than 50 % of total cover.

1.4 Symbols of total cover (%):



2. Adjacent natural and semi-natural vegetation

1 Alpine rock and scree vegetation
2 Caricetum curvulae
3 Curvulo-Nardetum
4 Loiseleurietum
5 Rhododendretum
5 a Complex of Rhododendretum and Loiseleurietum
6 Vaccinietum myrtilli
6 a Windswept Vaccinietum with Loiseleuria procumbens
7 Subalpine Pinus mugo-associations
7 a Pinus mugo stands with Sphagnum spp.
7 b Pinus mugo stands with tall herbs
8 Tall herbs/moist shrub vegetation
9 Pastures rich in nutrients
10 Sedge mires
10 a Juncus-jacquinii-stands
10 b Trichophorum cespitosum-associations
10 c Deschampsia cespitosa-Carex nigra-associations
11 Caricetum rostratae
12 Nardetum
13 Snow bed vegetation
14 Vegetation of springs and trickling water
P1 Pioneer vegetation, Silene acaulis dominating
P2 Pioneer vegetation, Juncus trifidus dominating
P3 Pioneer vegetation, Silene vulgaris dominating
* snow bed
n wet or soaked soils
q influence of spring water
r wet rocks
K influence of calcareous rock or water

3. General information

 embankment, slope (peaks in figure showing downhill)

 direction of slope inclination

 slope shows different inclinations

 terraced slope with different inclinations

 impact on semi-natural vegetation by ski run construction measures

LEGENDE ZUR LANDKARTE:

1. Pisten

1.1 Anteil der autochthonen Pflanzen an der Deckung

S : Saatgut-Arten dominieren
Deckungsanteil der autochthonen Arten höchstens 1/3 der Gesamtdeckung

A : Autochthone Arten dominieren;
Deckungsanteil der autochthonen Arten mindestens 2/3 der Gesamtdeckung

AS: Deckungsanteile von autochthonen Arten und Saatgutarten etwa gleich hoch

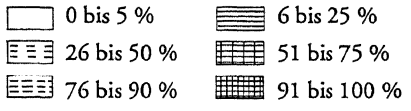
1.2 Absolute Artenzahl (AZ) der autochthonen Pflanzen:

- - AZ gering (höchstens 10 autochthone Arten)
‘ ‘ AZ zwischen 11 und 30
+ + AZ hoch (über 30)

1.3. Anteil der Moose an der Deckung:

/ / 0 bis 25 % der Gesamtdeckung
( ) 26 bis 50 % der Gesamtdeckung
(( )) mindestens 50 % der Deckung

1.4 Gesamtdeckung in %:



2. Kontaktvegetation

1 Alpine Steinrasen und Steinschuttfluren
2 Krummseggenrasen
3 Krummseggen-Borstgrasrasen
4 Gemsheideteppiche
5 Alpenrosenheiden
5a Alpenrosenheiden/Gemsheiden (Komplex)
6 Heidelbeerheiden
6a Heidelbeerheiden/Gemsheiden (Komplex)
7 Subalpine Latschenbestände
8 Hochstauden – Feuchtgebüsche
9 Alpenfettweiden – Lägerfluren
10a Gemsenbinsengesellschaften
10b Haarsimsengesellschaften
10c Kleinseggenrieder mit Rasenschmiele
11 Schnabelseggenrieder
12 Borstgrasrasen
13 Schneetälchengesellschaften
14 Quellflurgesellschaften
P1 Pioniergesellschaft mit Stengellosem Leimkraut
P2 Pioniergesellschaft mit Dreispaltiger Binse
P3 Pioniergesellschaft mit Taubenkropf-Leimkraut
* extrem lange Schneebedeckung
n Bodennässe
q Quellwassereinfluß
r Rieselwasser auf Fels
K Kalkeinfluß

3. Allgemeines

 Böschungsbereich (Spitzen in Darstellung zeigen bergab)

 Hangneigungsrichtung

 Mehrere Neigungen (Bultiges oder unebenes Gelände)

 Stufiger Hang mit mehreren Neigungen

 Beeinflussung/Störung der Kontaktvegetation durch Pistenbau

able revegetation (e.g. PARTSCH, 1980). In Austria one can refer to the publications of SCHÖNTHALER (1985), KÖCK et al. (1989), HOLAUS and KÖCK (1992), KRAUTZER (1993), and LICHTENEGGER (1994 a, b), while the results of KLUG et al. (1995) confirm other authors' opinion that a goodly number of ski run attendant species could be bred and used easily, but at considerable expense.

It will be essential to breed in large quantities the seeds of autochthon plants that have already been proven to be effective in providing sustainable revegetation on graded slopes and ski runs. In this way there may be enough affordable seeds to repair the damage that the ignorance and negligence of former years have caused to landscapes throughout the Alps.

At the same time, since prevention is better – and cheaper – than cure, the impacts of alpine tourism, both winter and summer, have to be limited, including the excessive erosion caused by management failures.

Damage to the acknowledged beauty of the alpine touristic centres will have an adverse effect on national touristic incomes, especially in the periods when there is no snow cover to hide the damage. With 7,2 % of Austrian GDP (SMERAL, 1990) deriving from this source, there is justification for both governmental and private initiatives that aim to support sustainable measures.

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Table 1: Phytosociological relevés representing ski runs at altitudes of 1820 to 1880 m a. s. l.
Tabelle 1: Pflanzensoziologische Aufnahmen in Pisten der Höhenklasse I (1820–1880 m ü. M.)

		Number of relevé				1	1	1			1	2	2	2		1	1	1	1	1	2	2	2	2	2	3	3	1
		Aufnahmenummer	2	3	4	5	6	7	1	8	9	6	7	8	5	0	1	2	3	8	1	2	3	5	9	0	1	4
		Altitude (m a.s.l.)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Meereshöhe (m)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
			2	3	3	6	6	6	2	5	6	7	7	7	4	5	5	5	5	6	6	6	6	7	8	8	8	5
			5	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	0	5	5	5	5	0	0	0	5
		Exposition	–	–	–	–	–	–	SE	NE	E	E	E	E	SE	E	SE	SE	E	SE	E	E	E	E	E	E	E	E
		Inclination(¤)	0	0	0	0	0	0	10	10	10	10	10	10	15	15	15	15	15	15	15	15	15	15	15	15	15	20
		Neigung (¤)																										
		Cover percentage	97	97	90	99	90	80	97	85	93	95	75	90	99	95	98	95	50	85	93	90	90	55	95	95	95	65
		Deckung (%)																										
		Total number of species (N)	32	38	34	23	22	32	31	43	39	19	17	28	19	46	35	44	37	47	36	37	36	28	29	36	36	30
		Gesamtartenzahl (N)																										
		Autochthon species only (N-s)																										
		Artenzahl ohne Saatgut (N-s)	15	21	28	17	11	18	21	34	23	8	4	17	11	36	27	36	30	38	27	22	23	19	19	31	29	21
A.1	s	Festuca rubra s.l.	2	1	1	2	3	2	2	2	2	3	4	2	1	3	+	3	2	2	2	2	2	3	Frequenzy/Stetigkeit			
	s	Poa pratensis	2	1	+	+	2	2	1	+	1		+	2		+	2	+	+		1	2	1	1	3	1	2	2	V
	s	Phleum pratense		+		2	1	2	1	+	1	1	2	1	1	1	1	1	2	2	1	1	+	1	1	+	+	1	V
	s	Agrostis capillaris	1	1	1	+			2	2					1	1		1	1	1		1	+		1	+	1	1	V
	s	Dactylis glomerata	1				+	+			+	+	+		1					+				+	+	+	+		IV
	s	Festuca pratensis	1				+		+		+							+		+			+						II
	s	Festuca ovina				2						+							+					+					II
A.2	s	Trifolium repens	2	2	2	1	1		2	+	3	3		3	1	2	1	2	+	+	2	2	2	+				2	I
	s	Trifolium hybridum	+	+		+	+	1	1		1	2	1	+	+	1	+	2		+	1	+	2	+	2		2	+	V
	s	Trifolium pratense	1	+				+			+		1		2	1	+	r	+	+		r	r	+	2	r	2	+	V
	s	Achillea millefolium	+	1			+	+			1	+	1	+							+	1			+			+	IV
		Ranunculus acris	r	+	+			+				r	r	+			+				+	r	r					+	III
	s	Lotus corniculatus						1	+		1	+	1	1	+	r					+			+					III
		Stellaria graminea					r	+	+		r	1	r	r								+			1		1		III
		Leucanthemum vulgare	+	+			r		+		r	+																	II
		Plantago major	1	1				+			r			+		r					+	+	+		+				II
		Ranunculus repens	2	2				2		+	+			+			+					+	+						II
		Bellis perennis	+	2																		+							II
	s	Plantago lanceolata	+	2	+						r																		I
		Rumex acetosella								+												I							I
		Barbarea vulgaris						r			r		r										r					r	I
		Veronica chamaedrys		+					r			r								+									I
		Galium mollugo											r		r														I
B		Deschampsia cespitosa	1	2	2	4		1	3	1	+			+	2	2	4	1	+	1	+	1	+	+					+
		Poa supina	2	2	1	1		+	3	1	2			1	2	+	3	1	+	1	1	2	1		2	3	1	+	V
		Alchemilla sp.	2	2	2	+		+	+	+	+		r	1	+	1	r	+	+	+	1	1			1		2	+	V
		Taraxacum officinale	+	+			+	+	+	+	+	+	+	+		1	r	+	+	1	+	1	+	+		1	+	+	V
		Carex nigra	+	1	1	+		1	1	+				+	2	+	1	1	+	+	1	1	+		+		+	+	V
		Veronica serpyllifolia	+	1	+	+		1	1	+	1			+	+	1	1	1			+		1			+	+	+	IV
		Juncus filiformis			+	+			2	1					2	+	+	+			+	1			+		2		IV
		Poa alpina		+			+	+				+		+		+	+		+	+	1		+			+	+		III
		Phleum rhaeticum			+				+	+					1	+	+		1					+		2		+	III
		Cerastium fontanum		+			1	+	+		+	r			+	+			1	+		+			+	2	+	+	III
		Ranunculus montanus				+		+		r	+	+		r			+	r		+	+	+	+				+		III
		Crepis aurea		+					+		+			+		r			r	+	+	r				+			III
		Leontodon hispidus	+	+						+	+									1						r	+		III
		Rumex alpestris	+	2	1			+	+	+	+						r			r			+						II
		Rumex alpinus	2	1	+	+			+										r			+					+		II
		Trifolium pratense ssp.nivale	r			+						+	+		+					r			r	+					II
		Peucedanum ostruthium						r		r							r	r			+		r	r			+	+	II
		Viola palustris				+			1								2									+			II
		Cirsium spinosissimum																				1	r	+		+			I
		Veratrum album									+					r	r	r								r	r		I
		Trifolium badium					r														r	r							I
		Athyrium distentifolium								r														r					I
		Viola biflora													1		+		r						r				I
		Salix breviserrata															r		r										I

	Number of relevé				1	1	1			1	2	2	2		1	1	1	1	1	2	2	2	2	2	3	3	1	
	Aufnahmenummer	2	3	4	5	6	7	1	8	9	6	7	8	5	0	1	2	3	8	1	2	3	5	9	0	1	4	
	Altitude (m a.s.l.)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Meereshöhe (m)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
		2	3	3	6	6	6	2	5	6	7	7	7	4	5	5	5	5	6	6	6	6	7	8	8	8	5	
		5	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	0	5	5	5	5	0	0	0	5	
	Exposition	–	–	–	–	–	–	SE	NE	E	E	E	E	SE	E	SE	SE	E	SE	E	E	E	E	E	E	E	E	
	Inclination(¤)	0	0	0	0	0	0	10	10	10	10	10	10	15	15	15	15	15	15	15	15	15	15	15	15	15	20	
	Neigung (¤)																											
	Cover percentage	97	97	90	99	90	80	97	85	93	95	75	90	99	95	98	95	50	85	93	90	90	55	95	95	95	65	
	Deckung (%)																											
	Total number of species (N)	32	38	34	23	22	32	31	43	39	19	17	28	19	46	35	44	37	47	36	37	36	28	29	36	36	30	
	Gesamtartenzahl (N)																											
	Autochthon species only (N-s)																											
	Artenzahl ohne Saatgut (N-s)	15	21	28	17	11	18	21	34	23	8	4	17	11	36	27	36	30	38	27	22	23	19	19	31	29	21	
C	Sagina saginoides		1	1			1	+	+	2			3		2	+	2	+	1	2	2	2	+				+	
	Cerastium cerastoides		+		+		+	1	1	1			+	+		+	1			2	2	2		+	+	2	+	IV
	Epilobium anagallidifolium				1				2	+		-	2		r		1		+	1	2	+		+	+	+	+	IV
	Veronica alpina			+	+		+		+						1		1		+	1	1	+	+	+	+	1		III
	Gnaphalium supinum				+				1				r		r		1	+	+	+					+	1		III
	Sedum alpestre														+	+	1		1	+			+	r	1	+		III
	Soldanella pusilla																+								+	+		II
	Luzula alpinopilosa		+						+															+	1			I
	Leucanthemopsis alpina																	+			+				2		+	I
D	Potentilla aurea			1	+	+		1	1	1	r		+	+	2	+	1	+	1	1	+	+	+					+
	Potentilla erecta		+	1				1	+	+		r		1	2	+	+	+	1				+	+	2	1	+	V
	Leontodon helveticus	+	+	1		+			+						1	r	+	1	1	+	+	+	+	1	1	2		IV
	Homogyne alpina		+	1				+	1	+				+	1	+	+	+	+	+	+		+		+	+	+	IV
	Nardus stricta		+	2	+				1						1	+	+	+	1	+	+			+	1	+	+	IV
	Luzula multiflora		+	+		+	+	+	1						1	+	+	+	1	+		+	+		1	+		III
	Anthoxanthum alpinum			2	+				+						2	+	1		1				+	+	+	+		IV
	Campanula scheuchzeri	r			r					r	r				+	2	+	r	+	r		r	+		+	+	+	III
	Solidago virgaurea ssp.minuta		+	+	+				+		r				r		r	+	+			+	+	+	1	+		III
	Campanula barbata		1							r					+	r	r		+		+		+	+	+		+	III
	Gnaphalium norvegicum		r	+											r		+	r	+					+	+			II
	Arnica montana			+					r						r		r								1			II
	Hieracium alpinum					r			r						r												r	I
	Hieracium lachenalii						r		r										+						r		+	I
	Ajuga pyramidalis														+		r		+								+	I
	Crepis conyzifolia								r									r										I
E	Avenella flexuosa			+					+									+										+
	Hieracium sylvaticum					r												r									+	I
	Vaccinium myrtillus			1														r	+								r	I
F	Tussilago farfara				+			+																				I
	Silene rupestris																		+				+					+
	Thymus praecox ssp.polytr.								+				+					+										+
	Agrostis rupestris												1		+	+	+											+
G	Calycocorsus stipitatus								+	r				+		r	r			+		+						I
	Epilobium alsinifolium									+								r		+	+		r	+				II
	Carex echinata							+	+																	+		I
	Moose	+		1		2	+	1	4	+	1	2	2	+	2	+	2	2	2	1	+	2	1	+	2	2		V

Table 2: Phytosociological relevés representing ski runs at altitudes of 1885 to 1915 m a.s.l.
Tabelle 2: Pflanzensoziologische Aufnahmen in Pisten der Höhenklasse II (1885 –1915 m)

Number of relevé			3	3	4	5	5	6	6	5	4	5	5	4	4	5	4	6	5	
Aufnahmenummer			8	9	4	0	9	0	1	2	7	3	4	1	2	5	8	9	6	
Altitude (m a.s.l.)			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Meereshöhe (m)			8	8	8	8	9	9	9	8	8	8	8	1	4	8	8	9	8	
			8	8	9	9	0	0	0	9	9	9	9	8	2	9	9	1	9	
			5	5	0	5	0	0	0	5	0	5	5	5	5	5	0	5	5	
Exposition			–	–	–	–	–	–	–	SE	SE	S	S	E	E	S	SE	SE	NE	
Inclination (¤)			0	0	0	0	0	0	0	5	8	8	8	10	10	10	12	12	15	
Neigung (¤)																				
Cover percentage			85	90	90	65	75	65	65	80	85	75	40	95	97	65	80	70	70	
Deckung (%)																				
Total number of species (N)			16	22	41	37	24	30	28	41	41	45	19	35	31	48	34	16	58	
Gesamtartenzahl (N)																				
Autochthon species only (N-s)			9	16	33	29	16	23	20	35	37	36	13	28	21	40	28	12	48	
Artenzahl ohne Saatgut (N-s)																				
																				Frequency/Stetigkeit
A.1	s	Festuca rubra s.l.	1		1	2	4	3	4	1	1	3	2	2	1	2	2	1	2	V
	s	Poa pratensis	+	1	2	+	2	1	1	+	+	2	2	+	+	1	1	1	1	V
	s	Phleum pratense	+	1	1	1	1	1	+	1	+	1	1	1	1	+	+		1	V
	s	Agrostis capillaris	+		2	+				1	+	+				+	1		2	III
	s	Dactylis glomerata										+				+			+	I
	s	Festuca ovina												+						+
A.2	s	Trifolium hybridum	+	2	+	+	1	2	1			1	1	+	+	+	r	+	+	V
	s	Trifolium repens	2	2	1	2	1	1	1	1		1	1	+	2	+	r	+	2	V
	s	Lotus corniculatus	+	1	+	+		+	r						r				+	III
	s	Trifolium pratense		+					+	r				+	+					II
		Leucanthemum vulgare					+	r	r			+	r			r				II
		Barbarea vulgaris				r						r								I
		Ranunculus acris													+				r	I
	s	Achillea millefolium												+					+	+
		Plantago major		r															+	+
		Ranunculus repens												+					+	+
		Stellaria graminea	r													+				+
	s	Plantago lanceolata	r															+		+
B		Deschampsia cespitosa	1	+	2	+	1	2	1	2	3	1	+	1	1	2	2	1	+	V
		Poa supina	2	2	2	+		+			1	1	+	2	3		1	+	1	IV
		Carex nigra		+	+		+	1	+	+	1	1		1	+	1	+	1		IV
		Juncus filiformis	+	2	1			+	+		1	1		1	+	1	1	+	+	IV
		Taraxacum officinale		+	+	+	r			+	r	+	+		+	+	r		1	IV
		Alchemilla sp.			+				+	+	+		r	1	1	+	r	+	+	IV
		Poa alpina				+		+	+	+	+	+	+	2	+				+	III
		Leontodon hispidus			r	1	r	r	r			r	r						1	III
		Veronica serpyllifolia	+	+	+			+				+	r	+	2					III
		Ranunculus montanus				r		r				+		+	+					II
		Phleum rhaeticum									1	+		1	+	+	+			II
		Crepis aurea			r					r				+			r		+	II
		Viola palustris			+					+		+				1			+	II
		Rumex alpestris			r							+			+	r			+	II
		Cirsium spinosissimum			r			r			r								+	II
		Cerastium fontanum		+						+		+							+	II
		Rumex alpinus			r				r		+									I
		Peucedanum ostruthium							r		r	r								I
		Trifolium pratense ssp.nivale			+	+													r	I
		Athyrium distentifolium					r			r									r	I
		Aconitum tauricum			r														r	I
		Veratrum album									r					r				I
		Salix breviserrata														r			r	I
		Trifolium badium																	r	+
		Adenostyles alliariae																	r	+

Number of relevé		3	3	4	5	5	6	6	5	4	5	5	4	4	5	4	6	5	
Aufnahmenummer		8	9	4	0	9	0	1	2	7	3	4	1	2	5	8	9	6	
Altitude (m a.s.l.)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Meereshöhe (m)		8	8	8	8	9	9	9	8	8	8	8	1	4	8	8	9	8	
		8	8	9	9	0	0	0	9	9	9	9	8	2	9	9	1	9	
		5	5	0	5	0	0	0	5	0	5	5	5	5	5	0	5	5	
Exposition		–	–	–	–	–	–	–	SE	SE	S	S	E	E	S	SE	SE	NE	
Inclination (¤)		0	0	0	0	0	0	0	5	8	8	8	10	10	10	12	12	15	
Neigung (¤)																			
Cover percentage		85	90	90	65	75	65	65	80	85	75	40	95	97	65	80	70	70	
Deckung (%)																			
Total number of species (N)		16	22	41	37	24	30	28	41	41	45	19	35	31	48	34	16	58	
Gesamtartenzahl (N)																			
Autochthon species only (N-s)		9	16	33	29	16	23	20	35	37	36	13	28	21	40	28	12	48	
Artenzahl ohne Saatgut (N-s)																			
																			Frequency/Stetigkeit
C	Sagina saginoides	1	2	2	+	+	+	1	1		1	1		+	+	2	1	2	V
	Cerastium cerastoides	2	1	3	+				1	+	+		1	1	+	2	1	1	V
	Epilobium anagallidifolium	+	+	1	r		r		1	1	+	r		+	+	+	+	2	V
	Gnaphalium supinum		+	+	+			r	1	1	r		1	+	+	1		+	IV
	Veronica alpina	+	+	1	+				+	+	+	r	+	+		+		r	IV
	Sedum alpestre			+	1				+	+			+	+	+	r		+	III
	Soldanella pusilla					+	+		+	1	+				+	+			III
	Luzula alpinopilosa								+	1			+			+		+	II
	Sibbaldia procumbens									+			+		+	r		r	II
	Leucanthemopsis alpina									+			+						I
	Ligusticum mutellina									+					+				I
D	Potentilla aurea			+	+	r	+	+	1	1	+	+	3	+	1	+		+	V
	Leontodon helveticus				1	+	+	r	2	+	+	+	+	+	1	+		+	IV
	Potentilla erecta			+		+	1	1	1	+	1	+	+		2	+	r	+	IV
	Homogyne alpina				+	+	+	r	1	1	+	r	+		1	r		1	IV
	Nardus stricta		+	+			+	+	1	+			1		1	1		1	III
	Campanula scheuchzeri			+	+				1	+	+		+	+	+	r		+	III
	Luzula multiflora					+	+	+	1	+	+		+		+	+		+	III
	Anthoxanthum alpinum					+	+		1	1			+		+	+		+	III
	Solidago virgaurea s.l.			r		r	+		+	+	+		+	+	+	r		+	IV
	Hieracium alpinum				+				+	+	r		+		+			+	III
	Campanula barbata			r	+					+					+			+	II
	Gnaphalium norvegicum			+	r			+	r									2	II
	Arnica montana						r		+						+				I
	Hieracium lachenalii				r						r								I
	Crepis conyzifolia														r			+	I
	Pulsatilla alba								r										+
	Ajuga pyramidalis			r														+	I
	Euphrasia picta									+					+				I
	Primula minima														+		+		I
	Geum montanum								+										+
	Phyteuma hemisphaericum														+				+
E	Vaccinium myrtillus				r				r						+			r	II
	Avenella flexuosa								+							+		+	I
	Hieracium sylvaticum																	r	+
F	Agrostis rupestris			+					1	1	+		+		+	1	+	+	III
	Tussilago farfara			r							+							+	I
	Silene rupestris														+			r	I
	Saxifraga stellaris																r		+
G	Epilobium alsinifolium	+	+	+						r	+								II
	Calycocorsus stipitatus								+	+	+							r	II
	Carex echinata						+								+				I
	Eriophorum angustifolium										+				+				I
	Trichophorum cespitosum														+				+
	Carex flava														+				+
	Mooses/Moose	2	2	1	3	1	1	+	2	2	2	2	1	+	2	3	4	2	V

Number of relevé		3	3	4	5	5	6	6	5	4	5	5	4	4	5	4	6	5
Aufnahmenummer		8	9	4	0	9	0	1	2	7	3	4	1	2	5	8	9	6
Altitude (m a.s.l.)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Meereshöhe (m)		8	8	8	8	9	9	9	8	8	8	8	1	4	8	8	9	8
		8	8	9	9	0	0	0	9	9	9	9	8	2	9	9	1	9
		5	5	0	5	0	0	0	5	0	5	5	5	5	5	0	5	5
Exposition		–	–	–	–	–	–	–	SE	SE	S	S	E	E	S	SE	SE	NE
Inclination (¤)		0	0	0	0	0	0	0	5	8	8	8	10	10	10	12	12	15
Neigung (¤)																		
Cover percentage		85	90	90	65	75	65	65	80	85	75	40	95	97	65	80	70	70
Deckung (%)																		
Total number of species (N)		16	22	41	37	24	30	28	41	41	45	19	35	31	48	34	16	58
Gesamtartenzahl (N)																		
Autochthon species only (N-s)		9	16	33	29	16	23	20	35	37	36	13	28	21	40	28	12	48
Artenzahl ohne Saatgut (N-s)																		
																		Frequency/Stetigkeit
C	Sagina saginoides	1	2	2	+	+	+	1	1		1	1		+	+	2	1	2	V
	Cerastium cerastoides	2	1	3	+				1	+	+		1	1	+	2	1	1	V
	Epilobium anagallidifolium	+	+	1	r		r		1	1	+	r		+	+	+	+	2	V
	Gnaphalium supinum		+	+	+			r	1	1	r		1	+	+	1		+	IV
	Veronica alpina	+	+	1	+				+	+	+	r	+	+		+		r	IV
	Sedum alpestre			+	1				+	+			+	+	+	r		+	III
	Soldanella pusilla					+	+		+	1	+				+	+			III
	Luzula alpinopilosa								+	1			+			+		+	II
	Sibbaldia procumbens									+			+		+	r		r	II
	Leucanthemopsis alpina									+			+						I
	Ligusticum mutellina									+					+				I
D	Potentilla aurea			+	+	r	+	+	1	1	+	+	3	+	1	+		+	V
	Leontodon helveticus				1	+	+	r	2	+	+	+	+	+	1	+		+	IV
	Potentilla erecta			+		+	1	1	1	+	1	+	+		2	+	r	+	IV
	Homogyne alpina				+	+	+	r	1	1	+	r	+		1	r		1	IV
	Nardus stricta		+	+			+	+	1	+			1		1	1		1	III
	Campanula scheuchzeri			+	+				1	+	+		+	+	+	r		+	III
	Luzula multiflora					+	+	+	1	+	+		+		+	+		+	III
	Anthoxanthum alpinum					+	+		1	1			+		+	+		+	III
	Solidago virgaurea s.l.			r		r	+		+	+	+		+	+	+	r		+	IV
	Hieracium alpinum				+				+	+	r		+		+			+	III
	Campanula barbata			r	+					+					+			+	II
	Gnaphalium norvegicum			+	r			+	r									2	II
	Arnica montana						r		+						+				I
	Hieracium lachenalii				r						r								I
	Crepis conyzifolia														r			+	I
	Pulsatilla alba								r										+
	Ajuga pyramidalis			r														+	I
	Euphrasia picta									+					+				I
	Primula minima														+		+		I
	Geum montanum								+										+
	Phyteuma hemisphaericum														+				+
E	Vaccinium myrtillus				r				r						+			r	II
	Avenella flexuosa								+							+		+	I
	Hieracium sylvaticum																	r	+
F	Agrostis rupestris			+					1	1	+		+		+	1	+	+	III
	Tussilago farfara			r							+							+	I
	Silene rupestris														+			r	I
	Saxifraga stellaris																r		+
G	Epilobium alsinifolium	+	+	+						r	+								II
	Calycocorsus stipitatus								+	+	+							r	II
	Carex echinata						+								+				I
	Eriophorum angustifolium										+				+				I
	Trichophorum cespitosum														+				+
	Carex flava														+				+
	Mooses/Moose	2	2	1	3	1	1	+	2	2	2	2	1	+	2	3	4	2	V

Number of relevé	2	1	1	1	1	1	1	2	2	2	1	1	2	1	2	2	1	2	1	2	1	2		2
Aufnahmenummer	0	9	2	2	2	3	6	6	3	6	6	9	2	3	5	6	5	5	4	2	4	6	6	7
	5	9	8	4	5	0	4	4	6	3	0	4	2	3	3	0	7	8	5	0	9	5	3	3
Altitude (m a.s.l.)	1	1	1	1	1	1	2	1	2	1	2	1	1	2	1	1	2	2	1	1	1	1	1	2
Meereshöhe (m)	9	9	9	9	9	9	0	9	0	9	0	9	9	0	9	9	0	0	9	9	9	9	9	0
	2	3	8	8	8	8	2	8	1	8	0	3	3	0	7	9	0	1	4	4	7	8	5	2
	5	0	0	0	0	5	0	0	5	0	0	0	5	0	5	5	5	0	0	5	0	5	5	5
Exposition	–	–	–	–	–	–	–	SE	SE	SE	SE	SE	E	SE	S	SE	NE	S	E	E	E	SE	SE	S
Inclination (*)	0	0	0	0	0	0	0	5	8	10	12	15	15	15	18	18	18	18	20	20	20	20	22	22
Neigung (*)																								
Cover percentage	35	20	65	40	15	55	50	50	60	10	60	2	75	65	65	65	60	65	70	50	80	60	10	50
Deckung (%)																								
Total number of species (N)	24	5	23	14	11	31	26	23	34	8	34	6	42	20	18	50	38	30	41	23	20	26	7	32
Gesamtartenzahl (N)																								
Autochthon species only (N–s)	18	4	20	8	7	26	20	20	27	6	27	5	34	14	13	44	30	23	36	17	16	20	6	21
Artenzahl ohne Saatgut (N–s)																								

																								Frequenzy/Stetigkeit
C	Sagina saginoides	+			r		1	1	+	+		+		2	1	1	2	1	1	1			1		+	IV
	Cerastium cerastoides	1		+		r	2	+	1	1		+		1	1		1	1	+	1			+			IV
	Gnaphalium supinum						1	1	+	1		+		1	1		1	+	1	+	+	r	1		+	IV
	Epilobium anagallidif.	+				r	1	1	+					2	+		2	1	+	1	+		1		+	III
	Veronica alpina						+		+	+		+		1		+	2	+	1	1			1		+	III
	Sedum alpestre			+				1		1		+		1	r		1	1	1				+		+	III
	Leucanthemopsis alpina						r	+		+		1		+			+	+		r					r	II
	Soldanella pusilla	+								+		+					+	+		+						II
	Luzula alpinopilosa			+						+		1								+		+			+	II
	Sibbaldia procumbens			r						+				+												I
	Ligusticum mutellina							r								+				r						I
D	Leontondon helveticus	+		1	r		+	+	+	r		1		+		+	+	+	1	1	+	+		r		IV
	Potentilla aurea	r		+		r	+			+		1		+	+		+	+	+	1	+	+	+		+	IV
	Homogyne alpina	+		+			+			+		+		+	+	+	+	+	+	1	+	r		-		IV
	Campanula scheuchzeri						r	+		+		+		1	+	1	1	+	1	+	+	r	+		+	IV
	Solidago virgaurea s.l.			r			r	+		+				+			+			r	+	r	r			III
	Campanula barbata			r	r		r	+		+		+			+		+	+	1	+		r	+		+	III
	Hieracium alpinum			r		r	+	r		+		+		+			+			+	+				r	III
	Anthroxanthum alpinum	+		1					+			1						+	+	+					+	II
	Luzula multiflora			+			+										+	+		1		+				II
	Mardus stricta	+		+					+		+	+								+						II
	Gnaphalium norvegicum			1										+			1		r	+	r		+			II
	Geum montanum									r		r					+	+	+		r					II
	Potenilla erecta				+									+			+									I
	Euphrasia picta							+		r							+									I
	Phyteuma hemisphaericum							+		+								r								I
	Crepis conyzifolia																		+				+			+
	Juncus trifidus												+			+										+
	Hieracium lachenalii																r									r
E	Avenella flexuosa			+	+				1											+						I
	Hieracium sylvaticum				r																r					+
F	Agrostis rupestris	+		1		+	+	+	1	1		1		+	+		+	+	+	1	+	2			+	IV
	Saxifraga stellaris	+	2						+				+			2								1		II
	Juncus jacquinii		1								+		+			1								+		II
	Silena vulgaris s.l.		+							r			+			1		r								II
	Silena rupestris				r												1						+		r	I
	Tussilago farfara													+	r											+
	Thymus praecox ssp. polytr.																		+						r	+
	Galium anisophyllum																						r			r
	Oxyria digyna																		+							r
	Gentiana nivalis																								r	r
	Silene acaulis																+									r
	Saxifrage moschata																+									r
G	Epilobium alsinifolium	1					r											r		+						I
	Carex frigida	+						+									+									I
	Calycocorsus stipit.							r																		r
	Carex canescens			+																						r
	Caltha palustris	r																								r
	Mosses/Moose	2	2	3	2	2	1	2	3	4	1	3	+	3	2	2	2	3	2	2	2	3	1	1	+	V

Table 4: Phytosociological relevés representing ski runs at altitudes of 2040 to 2180 m a.s.l.
Tabelle 4: Pflanzensoziologische Aufnahmen auf Pisten der Höhenklasse IV (2040 – 2180 m)

Number of relevé			1	1	1	1	1	1	1	1	1	1	1	1	1	
Aufnahmenummer			0	1	1	1	1	1	2	1	0	1	1	0	2	
			9	0	1	2	7	8	1	3	8	4	9	7	3	
Altitude (m a.s.l.)			2	2	2	2	2	2	2	2	2	2	2	2	2	
Meereshöhe (m)			0	0	0	0	1	1	1	0	0	0	1	0	1	
			6	6	6	6	2	2	6	6	6	7	3	4	8	
			5	5	5	5	0	0	5	5	0	0	0	0	0	
Exposition		–	–	–	-	–	–	–	SE	SE	E	NE	S	NE		
Inclination (¤)			0	0	0	0	0	0	0	5	15	15	18	25	20	
Neigung (¤)																
Cover percentage			60	50	65	8	70	10	4	65	60	12	5	8	75	
Deckung (%)																
Total number of species (N)			31	12	27	10	26	13	10	22	12	15	10	7	27	
Gesamtartenzahl (N)																
Autochthon species only (N-s)			25	7	24	9	21	12	3	17	5	12	6	3	18	
Artenzahl ohne Saatgut (N-s)																
																Frequency/Stetigkeit
A.1	s	Festuca rubra s.l.	2	2	2		+		1	3	3	+	1	2	4	V
	s	Poa pratensis	2	1	2	1	+		1	2	2	+	+	+	2	V
	s	Phleum pratense		+				+	1	+	2	+	+	+	+	IV
	s	Dactylis glomerata							+		+					I
	s	Agrostis capillaris											+			+
	s	Festuca pratensis							+							+
A.2	s	Trifolium hybridum	+	+	r		+			+	+			+	1	IV
	s	Trifolium repens	+							+	r				r	II
		Leucanthemum vulgare	r				r								r	II
	s	Lotus corniculatus		r											+	I
	s	Achillea millefolium					r								+	I
B		Deschampsia cespitosa	+	+	1	2	1	1	1	+	+	1	+	+	+	V
		Taraxacum officinale	r		+		r		r	+		r	r		+	IV
		Stellaria graminea	r								1		r		+	II
		Poa alpina					+			+					+	II
		Poa supina				+	1	+								II
		Carex nigra	+	+												I
		Leontodon hispidus									r				r	I
		Ranunculus montanus					+								r	I
		Crepis aurea					r			r						I
		Cirsium spinosissimum					r								r	I
		Rumex alpinus										r				+
		Athyrium distentifolium					r									+
		Salix breviserrata	r													+
C		Cerastium cerastoides	+	1	2	+	3	+	+	+		+	+		+	V
		Gnaphalium supinum	+	1	2	r	1	+		+	+				+	IV
		Leucanthemopsis alpina	r		+	+	1	1		+		+	r		+	IV
		Epilobium anagallidifolium	r	1		r	+					r	1		+	III
		Veronica alpina	r		1		r			+		r			+	III
		Sagina saginoides	+		1		+			1					+	II
		Sedum alpestre		1	+	+	+								+	II
		Soldanella pusilla	+		+		+									II
		Luzula alpinopilosa	+		+		1	+								II
		Ligusticum mutellina	r		r											+
		Sibbaldia procumbens			r											+
D		Leontodon helveticus	+		r		+	+		r			r			III
		Primula minima	+							+					r	II
		Campanula scheuchzeri		r	+							r				II
		Juncus trifidus	+											+		I
		Homogyne alpina	+				r									I
		Luzula multiflora									+					+
		Potentilla aurea			r											+
		Anthoxanthum alpinum	+													+
		Pulsatilla alba	r													+
		Hieracium sylvaticum													r	+
E		Avenella flexuosa	+													+
F		Agrostis rupestris	2	1	2		1	1		+			+	+	1	IV
		Arabis alpina			r	+				r		+	r		1	III
		Cardamine resedifolia			+			1							r	II
		Senecio incanus ssp.carniolicus					+						r		r	II
		Pritzelago alpina		1	+							+				II
		Saxifraga stellaris					r					r	r			II
		Oxyria digyna				r						r				I
		Saxifraga moschata			+					r						I
		Thymus praecox ssp.polytrichus	r		r											I
		Gentiana nivalis	r													+
		Saxifraga bryoides	r													+
		Tussilago farfara							r							+
		Mosses/Moose	3	3	3	+	3	1		2	1	2	+	+	2	V

Table 5: Frequency of species in 4 different elevation classes
Tabelle 5: Stetigkeit der Arten auf Pisten verschiedener Höhenlage.

Elevation classes/Höhenklassen: I: 1820–1880 m; II: 1885–1915 m; III: 1925–2025 m; IV: 2040–2180 m.											
Elevation class/Höhenklasse			I	II	III	IV					
Number of relevés/Anzahl der Aufnahmen			26	17	24	13					
Mean cover/Mittlere Deckung (%)			87	76	50	38					
Mean number of vascular plant species (N*) Mittl. Anzahl Gefäßpflanzen (N*)			33	33	24	17					
Mean number of autochthon species (N*-s*) Mittl. Anzahl Gefäßpfl. ohne Saatgut (N*-s*)			23	26	19	13					
A.1	s	Festuca rubra s.l.	V	V	V	V					
	s	Poa pratensis	V	V	IV	V					
	s	Phleum pratense	V	V	V	IV					
	s	Agrostis capillaris	IV	III	III	+					
	s	Festuca ovina	I	+	I						
	s	Dactylis glomerata	II	I		I					
	s	Festuca pratensis	II			+					
A.2	s	Trifolium hybridum	V	V	IV	IV					
	s	Trifolium repens	V	V	III	II					
	s	Trifolium pratense	IV	II							
	s	Lotus corniculatus	III	III	I	I					
	s	Achillea millefolium	III	r	+	I					
		Ranunculus acris	III	I	r						
		Plantago major	II	+	r						
		Ranunculus repens	II	+	r						
		Bellis perennis	I								
	s	Plantago lanceolata	I	+							
		Veronica chamaedrys	I								
		Galium mollugo	+		II						
		Rumex acetosella	I		r						
		Barbarea vulgaris	I	I	+						
		Leucanthemum vulgare	II	II	I	II					
		Stellaria graminea	II	+		II					
B		Deschampsia cespitosa	V	V	V	V					
		Taraxacum officinale	V	IV	IV	IV					
		Poa alpina	III	III	III	II					
		Carex nigra	IV	IV	II	I					
		Leontodon hispidus	II	III	III	I					
		Crepis aurea	III	II	II	I					
		Poa supina	V	IV	I	I					
		Ranunculus montanus	III	II	r	I					
		Cirsium spinosissimum	I	II	II	I					
		Juncus filiformis	III	IV	II						
		Alchemilla sp.	V	IV	II						
		Phleum rhaeticum	III	II	II						
		Peucedanum ostruthium	II	I	I						
		Veronica serpyllifolia	IV	III	+						
		Viola palustris	I	II	r						
		Trifolium pratense ssp.nivale	II	I	I						
		Rumex alpestris	II	II	r						
		Rumex alpinus	II	I	r	+					
		Cerastium fontanum	III	II	+						
		Athyrium distentifolium	I	I	r	+					
		Salix breviserrata	+	I	+	+					
		Trifolium badium	I	+	r						
		Veratrum album	I	I							
		Viola biflora	I								
		Aconitum tauricum		I	r						
		Hypericum maculatum	r								
		Aster bellidiastrum			+						
		Adenostyles alliariae	r	+							
C		Cerastium cerastoides	IV	V	IV	V					
		Sagina saginoides	IV	V	IV	II					
		Epilobium anagallidifolium	III	V	III	III					
		Veronica alpina	III	IV	III	III					
		Sedum alpestre	II	III	III	II					
		Gnaphalium supinum	III	IV	IV	IV					
		Sibbaldia procumbens	r	II	I	+					
		Leucanthemopsis alpina	+	I	II	IV					
		Soldanella pusilla	I	III	II	II					
		Luzula alpinopilosa	I	II	II	II					
		Ligusticum mutellina		I	I	I					
D		Leontodon helveticus	IV	IV	IV	III					
		Campanula scheuchzeri	III	III	IV	II					
		Homogyne alpina	IV	IV	IV	I					
		Potentilla aurea	V	V	IV	+					
		Solidago virgaurea	III	IV	III						
		Anthoxanthum alpinum	III	III	II	+					
		Luzula multiflora	IV	III	II	+					
		Potentilla erecta	IV	IV	I						
		Nardus stricta	III	III	II						
		Campanula barbata	II	III	III						
		Hieracium alpinum	I	III	III						
		Gnaphalium norvegicum	II	II	II						
		Hieracium lachenalii	I	I	r						
		Ajuga pyramidalis	I	I							
		Arnica montana	I	I							
		Crepis conyzifolia	+	I	+						
		Pulsatilla alba	r	+		+					
		Geum montanum		+	II						
		Euphrasia picta		I	I						
		Primula minima		I		II					
		Phyteuma hemisphaericum		+	I						
		Juncus trifidus			+	+					
E		Avenella flexuosa	I	I	I	+					
		Vaccinium myrtillus	I	II							
		Hieracium sylvaticum	I	+	+	+					
		Rhododendron ferrugineum	r								
F		Tussilago farfara	+	I	+	+					
		Silene rupestris	+	I	I						
		Thymus praecox ssp.polytrichus	+		+	I					
		Agrostis rupestris	I	III	IV	IV					
		Silene vulgaris s.l.			II						
		Saxifraga stellaris		+	II	II					
		Arabis alpina				III					
		Cardamine resedifolia	r			II					
		Senecio incanus ssp.carniolicus				II					
		Pritzelago alpina				II					
		Saxifraga bryoides				+					
		Saxifraga moschata			r	I					
		Oxyria digyna			r	I					
		Gentiana nivalis			r	+					
		Galium anisophyllum			r						
		Silene acaulis			r						
G		Calycocorsus stipitatus	II	II	r						
		Epilobium alsinifolium	I	II	I						
		Carex echinata	I	I							
		Trichophorum cespitosum		+							
		Carex flava		+							
		Eriophorum angustifolium		I							
		Juncus jacquinii			II						
		Carex frigida			I						
		Carex canescens			r						
		Caltha palustris			r						
		Mooses/Moose			V	V					