LANDSCAPE AND VEGETATION SUCCESSION OF AN ABANDONED ALPINE PASTURE – PERSPECTIVES FOR RECULTIVATION OF THE LAFENBERG ALM, STYRIA

DIPLOMA THESIS

submitted by

TOBIAS KÖSTL

SUPERVISORS:

Univ. Prof. Dr. Wolfgang Holzner

CSc. Ing. Prof. Vilém Podrázský

Department of Integrative Biology and Biodiversity Research
University of Natural Resources and Applied Life Sciences Vienna
and
Czech University of Life Sciences Prague

January 2010

ACKNOWLEDGEMENTS

An dieser Stelle möchte ich mich bei allen Menschen, die auf irgendeine Art und Weise zum Entstehen dieser Arbeit beigetragen haben, herzlich bedanken.

Ganz besonderer Dank gilt meinem Betreuer, Uni.-Prof. Dr. Wolfgang Holzner, der mich auf jede nur erdenkliche Weise unterstützte und mir jederzeit bereitwillig seine kostbare Zeit zur Verfügung stellte. Besonders bei der Bestimmung einiger kritischer Herbarbelege konnte ich mich auf seine Hilfe verlassen.

Die zeitaufwändigen Vegetations- und Geländeaufnahmen konnten nur durch die großzügige finanzielle Unterstützung des Naturpark Sölktäler durchgeführt werden. Zu ganz speziellem Dank bin ich Fr. Mag[a]. Bettina Maurer vom Naturpark-Team verpflichtet, da sich mich nicht nur mit Mengen an Literatur und Kontakten versorgt hat, sondern auch mit ihrer geduldigen Hilfe die Entstehung der Vegetationskarte mit GIS-Software überhaupt erst möglich gemacht hat.

Den Grundeigentümern, besonders Fr. Baronesse Gabriele von Tschischky, möchte ich sowohl für die Benützung der Alm als Studienfläche als auch für die Bereitstellung der Almhütte bedanken.

Dem zuständigen Jäger, Hr. Johann Pircher, bin ich ebenfalls zu Dank verpflichtet. Großzügigerweise hat er mir die Jagdhütte überlassen, die mir als wichtiger Standpunkt für meine Aufnahmen und Untersuchungen gedient hat. Ebenfalls zu erwähnen sind die Benutzung der Forststrasse, die Mitfahrgelegenheiten sowie die zahllosen persönlichen Gespräche, in denen er mir die Besonderheiten der Alm nähergebracht hat.
Hr. Otto Denoth hat mir freundlicherweise seine Zeit geopfert und mich mit Unterlagen über das Ziegenprojekt in Mutten (Ch) versorgt.

Zu guter Letzt möchte ich meinen Eltern danken, die mir über meine gesamte Ausbildung hinweg jede nur erdenkliche Unterstützung zukommen ließen, ohne mich je unter Druck zu setzten oder auf irgendeine Art und Weise einzuschränken. Diese Unterstützung geht weit über das Finanzielle hinaus und hat wesentlich zum Gelingen dieser Arbeit beigetragen.

Index

1 INTRODUCTION

Central European cultural landscape is the product of agricultural utilization for centuries with the objective of food production. Traditional farming has unintentionally created a highly diversified and richly structured landscape that serves as a habitat for numerous open-land species. Due to low productivity and often remote location of alpine pastures there was the necessity to utilize even low-yielding sites. Changes in land tenure, separation of forest and pasture and development of fertilizer and machinery strongly increased the productivity and led to a step-wise intensification of alpine pasture systems (SCHOLLE et al. 2004). As a result there is an ongoing segregation of utilization into intensively used sites with high yields on the one side and fallows on the other side. The increasing orientation of agriculture towards the world market is additionally amplifying this process.

The processes of over-utilization on the one hand and under-utilization on the other hand result in a drastically reduction of high-quality alpine pastures. These open and half-open landscapes are however not only of tremendous importance as habitats for numerous, partially endangered species but also have considerable socio-cultural functions. They also form the background for tourism, which represents an indispensable source of income for several regions in Austria.

Due to changing framework conditions and society neither the preservation of landscape nor the creation of identity can be seen as an ancillary service of agriculture that is free of charge any more.

Society has to become aware of the functions and benefits of alpine farming and needs to reach a consensus concerning the coverage of the costs and possible ways of implementation of measures to preserve it. To be successful in a long term it is essential to create a synthesis of the goals of nature conservation, society and agriculture.

As a result of abandonment of pastoral systems natural succession is taking place, and the result is, in most cases, forest. The loss of open pastures over the last decades causes the necessity to reutilize and recultivate abandoned pastures, either by targeted grazing or mechanical measures (SPATZ 1994).

To achieve sustained success it’s inevitable to break with the ancient idea to exclude humans when thinking about nature conservation. Especially in labile, man-made ecosystems sustainable integration of humankind may be the key to success.

This work has been financed by the Natural Park Sölktäler and can be seen as an extension to the LEADER-project “Almpflegeplan im Naturpark Sölktäler”. In the scope of this projekt not only Lafenberg Alm but also several other alpine pastures have been inspected by the Umweltbüro Klagenfurt. Additionally the land owners have been provided with an obligatory catalogue of management measures. This catalogue, called “Naturschutzplan auf der Alm”, lists all measures that have to be taken to recultivate pastures and to improve biodiversity. There is also a list of aid money provided for each of the given measures.

My work is going more into detail concerning the plant species composition and size distribution of the plant communities on Lafenberg Alm. The incentive to write this work was not least the opportunity to do research in this beautifull landscape. Also the possibility to travel to Switzerland to have a closer look on some goat-related projects was an additional motivation.
Nevertheless, the basic aspect was the chance to contribute to the conservation of the typical alpine cultural landscape with all its important functions for society, biodiversity and culture.

2 PURPOSE AND AIMS OF THE STUDY

The thesis is consisting of two major parts.
The aim of the first part of the thesis is the recording of the actual state of the alpine pasture Lafenberg Alm. This part is of special interest for the Natural Park Sölktäler, because the documentation may serve as reference for further investigations and the results may help to understand the effect of different revitalization measures on plant species composition and the distribution of certain plant communities.

The hypothesis is:

Management of the Lafenberg Alm has been abandoned several decades ago, but gradual under-utilization works for a much longer period, as ancient maps proof.
The abandonment of former alpine pastures results in an overall decrease in biodiversity due to a unification of the ecosystem. This pasture-deterioration also affects the wildlife and game species abundance and diversity.

The second part deals with different possibilities and methods to revitalize and ameliorate abandoned and already overgrown alpine pastures. Special emphasis is given to the reduction of shrubs and trees by targeted grazing with goats. Possibilities and limitations of this approach are illustrated by the help of one case study.

Questions to consider with this respect are:

Are goats able to significantly reduce the density of shrubbery in abandoned alpine pasture ecosystems?
What are the limits of the application of goats for landscape management and which problems may arise?

3 METHODOLOGY

In part one, vegetation surveys were carried out from 16th - 28th July 2009. Due to time restraints the surveys were only carried out once. Maybe some plant species, especially the very early flowering ones, are missing in the recordings and therefore have not been considered in the report. Nevertheless, due to the uniform vegetation and low species number this singular assessment should be sufficient.

A general problem which may arise on surveys carried out on pastoral ecosystem is the fact that tasty plants are quite often browsed whereas unpalatable plants are left over. In this case there was no cattle kept on these sites before, but there is evidence for grazing activity by game species.

Plants were mostly identified on-site, with just a few exceptions that have been sampled. The identification of some inconclusive specimen was carried out in the herbarium of the Institute of Botany (Boku Vienna).

Scientific and German plant names refer to “Exkursionsflora von Österreich” by FISCHER et al. (2008).

At first a visual subdivision of the Alm into more or less homogenous vegetation types was performed. Following the rules of minimum-area-method there was a relevé taken in each of the types. To make sure that also very rare species have been recorded, floristic investigations have been carried out on similar sites. These investigations were not however complete surveys according to Braun-Blanquet. The plants detected outside the relevé have been recorded and added to the plant list.

Every sample plot was located using a GPS navigation device and afterwards inserted to the vegetation map.

Symbol	Number of individuals	Coverage
r	Rare, one specimen	Significantly under 1 %
+	Few (2 to 5) specimen	Up to 1 %
1	Some (6 to 50) specimen	Up to 5 %
2	Many (more than 50) specimen	Up to 5 %
	-	6 up to 25 %
3	-	26 up to 50 %
4	-	51 up to 75 %
5	-	76 up to 100 %

Table 1: Dominance-scaling according to Braun-Blanquet

To increase the accuracy of the estimated value 2 there is an extension according to REICHELT & WILLMANS (1973):

Symbol	Number of individuals	Coverage
2 m	Many (more than 50) specimen	Up to 5 %
2 a	-	5 up to 15 %
2 b	-	15 up to 25 %

Table 2: Appendix to the dominance-scaling according to Braun-Blanquet

The altitude was measured by comparison of GPS-coordinates and the digital relief map, whereas exposition and inclination was measured with a compass. Parameters such as soil moisture, organic layer depth and soil depth have been only estimated.

To ensure the vegetation recordings were as complete as possible, very small or very heterogeneous vegetation types and sites of minor importance as pastures like bogs, coarse debris and brooks were investigated, too.

The next step was the creation of a vegetation map with GIS-software (ArcGIS® 9 by ESRI, copyright © 2008). The map shows the different vegetation types and their size distribution compared to the overall area of the Alm. A monochrome-orthophoto was the basis for the map, but due to the poor quality of the aerial photograph (medium resolution, no infra-red layer, many areas covered by shadows) photographs from the sites had to be additionally taken to create a complete and exact map.

The development of a map that shows the exact size of the different vegetation communities was a matter of particular interest to the Natural Park. Data about the actual state form the basis for future comparative studies which can be carried out to evaluate the efficiency of revitalization measures or the change in plant communities due to natural succession.

Each site is also discussed concerning its revitalisation potential, the most promising revitalisation techniques and general site potential. There is also a description of its environmental function, as a habitat for flora and fauna and its meaning for game species.
Game species and their demands in terms of forage and habitat are shortly described. Also the relations, potential conflicts and positive correlations between hunting, forestry and pasturing are shortly discussed.

In the second part, literature and internet information was surveyed to compare different revitalization techniques and their applicability. The main source for the technical solutions was the book “Almen bewirtschaften” from AIGNER et al 2003.
All revitalization methods have been compared in terms of financial feasibility, technical operability and their environmental and ecological soundness.
Regarding the chapter “Targeted Grazing” publications from RAHMANN (2000, 2009) served as the basis for comparisons. However, most important informations and data were collected during a journey to Chur (Ch) and the personal interview with Mr. Otto Denoth, a teacher at the Agricultural School Plantahof in the Canton Grisons in Western Switzerland. Mr. Denoth carried out several projects dealing with the suitability of goats for landscape management. He also coordinated a project concerning the ability of goats to fight shrubs and trees (especially green alders) on an abandoned alpine pasture in Ober-Mutten (Ch). This report enabled by the kind and willing support of Mr. Otto Denoth, who also provided all the records concerning Switzerland.

As an overall conclusion individual site conditions and best-suited measures are opposed to each other. These measures are opposed also to the official measures , that have been elaborated by the Umweltbüro Klagenfurt and are carried out by the farmer Mr. Maderebner.

4 Basic site description

4.1 LOCATION

The Natural Park Sölktäler, overall size 277 km², is the largest Natural Park in Styria and was officially established in 1982. The municipality of St.Nikolai and parts of the municipalities of Großsölk and Kleinsölk are situated in the Natrual Park. The park borders are from Gumpeneck and then southwards to the Sölkpass, turning west over the summit of Deichselspitze (the highest summit in the Natural Park with 2.684m) and turning north again. The western border is also the border of the municipality of Kleinsölk, and the northern end is defined by the confluence of the Kleinsölkbach and Großsölkbach.

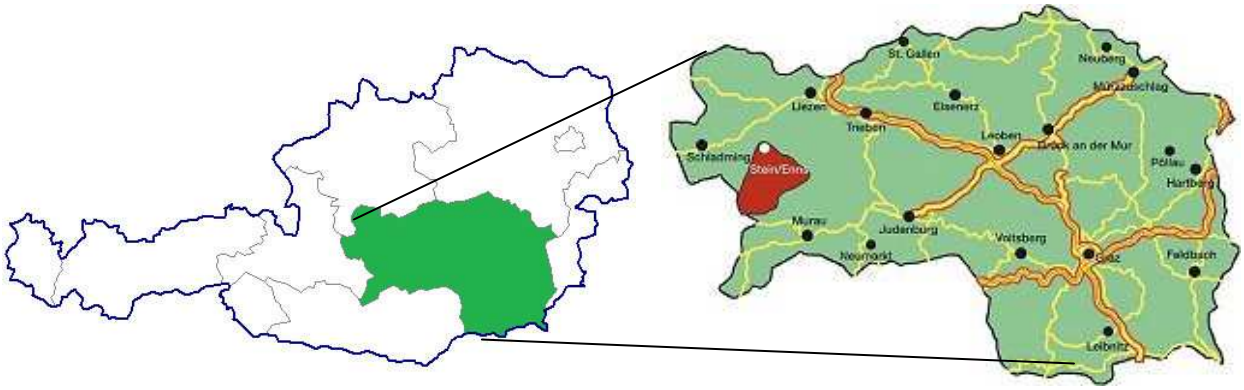


Fig. 1: Location of the Natural Park Sölktäler, Styria

4.2 DESCRIPTION OF THE RESEARCH LOCATION

The property of Lafenberg Alm with an overall size of 174 ha, from which 18 ha are declared as proper pastures, goes in a north-south direction below the ridge which is connecting the two summits of Kochofen and Spateck. The Alm is accessible via a forest road which is about 4 kilometres long. On the Alm there is one newly built alpine hut, and one additional building which was used as stable in former times. There are also the remains of two more huts which burned down several decades ago. The Alm has its lower borders in 1.400 m a.s.l. and its upper borders along the ridge in 1.700 m a.s.l.. Most of the area can be described as strongly under-utilized; there is only a small spot of grassland below the old stables that are prone to over-utilization due to its grassland character. Permanent utilization was abandoned 30 years ago, and since then maintenance works such as mowing are carried only sporadically.

In the year 2009 a local farmer, Mr. Maderebener resumed utilization. He began on June 5th with 21 cows and horses (which corresponds to 22,6 GVE according to the ÖPUL) and ended pasturing at the beginning of September.

Fig. 2: Historical map from the year 1787 from the Josephinische Landesaufnahme

Looking at the picture above, it becomes apparent that the pastures not only covered the vast part of Lafenberg Alm, but also large parts from Schladminger Alm on the other side of the ridge. This is known due to a lack of trees. It is doubtful to what extend this map deviates from real aspect, but the contour lines seem to be correct. Therefor it can serve as a window into past. Unfortunately there are no records on the numbers of animals kept on the pastures in this time, but it seems to be in accordance with the assumption of Prof. Holzner that Alpine farming had reached its zenith in the Late Middle Ages (HOLZNER et al. 2007).

Recordings from the Agrarbehörde Stainach from the years 1974 and 1986 show that the number of animals was already quite low at this time. Underutilization must have begun several decades earlier in history, probably following the transformation of an agricultural society into an industrialized society, which would be concordant with the overall trend in Austria (WALLNER et al. 2007 in HOLZNER 2007.)

1974		**Actual drive**	**Permanent live stock**
Cows	Kühe	5	8
Oxen	Ochsen	4	-
Bulls	Stiere	-	-
Young cattle	Jungvieh	3	5
Calves	Kälber	2	2
Horses	Pferde	-	2
Sheep	Schafe	14	14
Goats	Ziegen	-	-
Pigs	Schweine	2	3

Table 3: Numbers of animals on the Lafenberg Alm in the year 1974

1986		**Actual drive**
Cows	Kühe	-
Female young cattle	Galtrinder	-
Horses	Pferde	-
Sheep/Goats	Schafe/Ziegen	68

Table 4: Numbers of animals on the Lafenberg Alm in the year 1986

4.3 GEOLOGICAL BACKGROUND

The Natural Park Sölktäler is part of the crystalline region of the mountain range of the Niedere Tauern. To the north the crystalline borders the Enns valley with phyllites as its main constituents. North of the Enns valley the Nördliche Kalkalpen are adjacent, including some of the highest summits of Styria.

The dominating part of the Natural Park consists of mica schist and gneiss, with some marble-stone inclusions concentrated in northern region.

These mica schist and gneiss originate from sands and clays that were sedimentated about 350 mill. y.b.p. in the seas. The sediments were pressed into great depths through the drift of the tectonic plate of the former African continent against the former European continent. The sediments were transformed under the influence of high temperature and pressure into mica schist. Under even higher temperatures and pressures mica schist is converted into gneiss, which is very hard and much heavier compared to the schistose structure of mica schist (BECKER 1989).

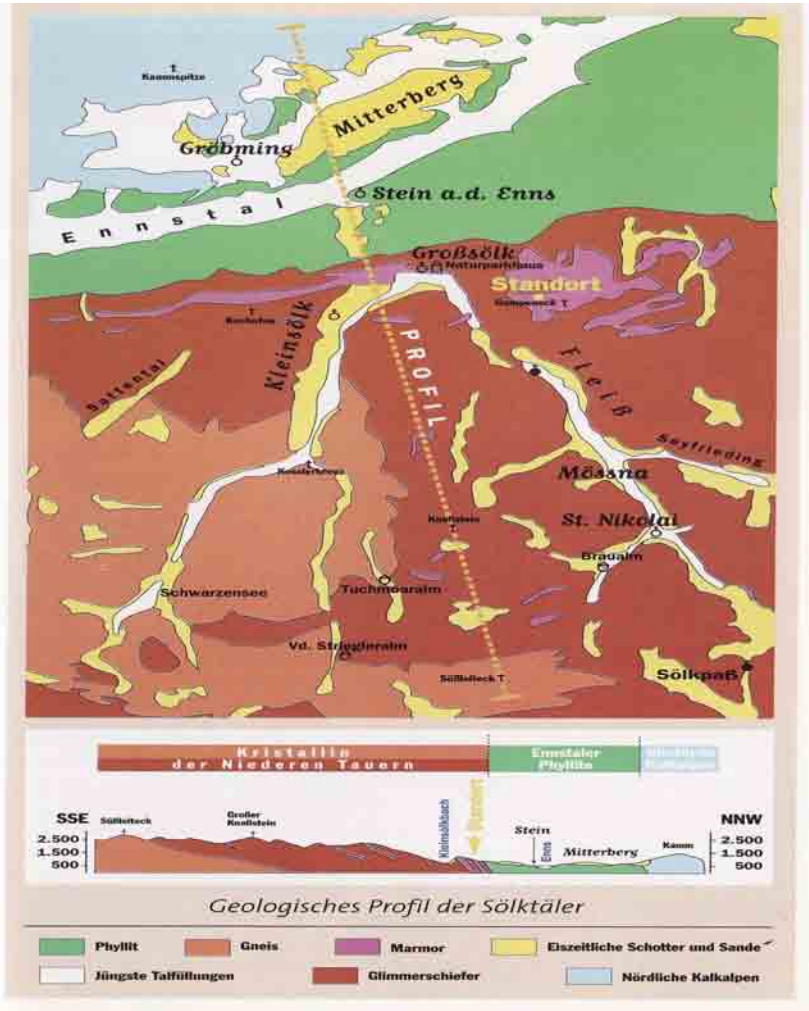


Fig. 3: Geological profile of the Sölk valleys

Both Sölk valleys, the smaller and the larger one, are typical trough valleys formed by the movement of glaciers during the last ice ages. At the bottom of the valleys there are longitudinal faults where large shiftings and uplifts have taken place. It is very common that these faults are traced by water courses, because such broken material is much more susceptible to be eroded and washed away by water than solid rock material. In the smaller Sölk valley it is the river Kleinsölkbach, which originates from the Schwarzensee, which flows into the Großsölkbach. The river Großsölk itself flows after a few kilometres into the river Enns in the municipality Ratten.

Figure 4 illustrates the geomorphologic basis for the actual aspect of the Lafenberg Alm and also other sites with similar characteristics. The primarily steep slopes were covered by glaciers during the last ice age which was about 12.000 y.b.p. At a certain point the slope was not able to hold the load of the ice shield which began to met off

from the valleys uphill. Along a fault line the slope slid downwards and got caught at the swell of the corrie. This fault line is even visible today as the rock face which proceeds parallel to the ridge.

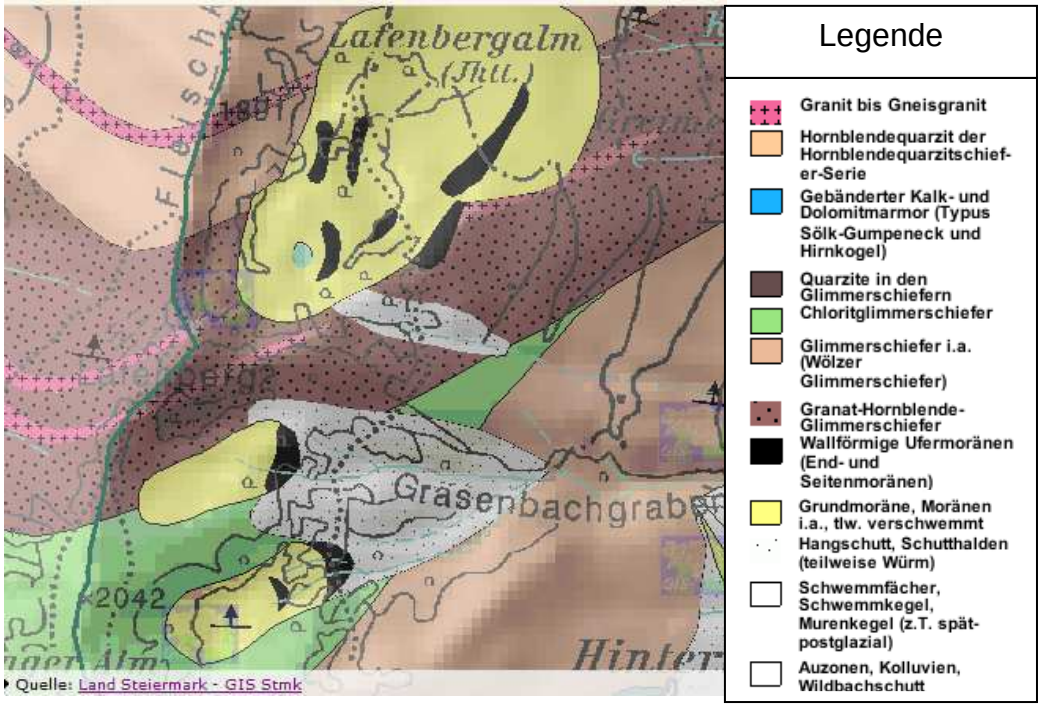


Fig. 4: Geological map of Lafenberg Alm in a scale of 1:500.000, map and modified legend from GIS-Steiermark 2009.

On the front of such land slides there can be found quite often bare rock material which was push ahead, called moraine. In depressions on such slides, it´s quite common for earth masses to form lakes. Also on Lafenberg Alm, water body, swampy sites and rocky debris at the front of the landslide can be found.

The part roughness of the slope can be traced back to a process called detraction, which describes the draft of ice masses on lee-sides of Mountains, which leads to a pull-out effect of rocks rather than a milling effect (KAUFMANN 2005).

4.4 CLIMATIC CONDITIONS

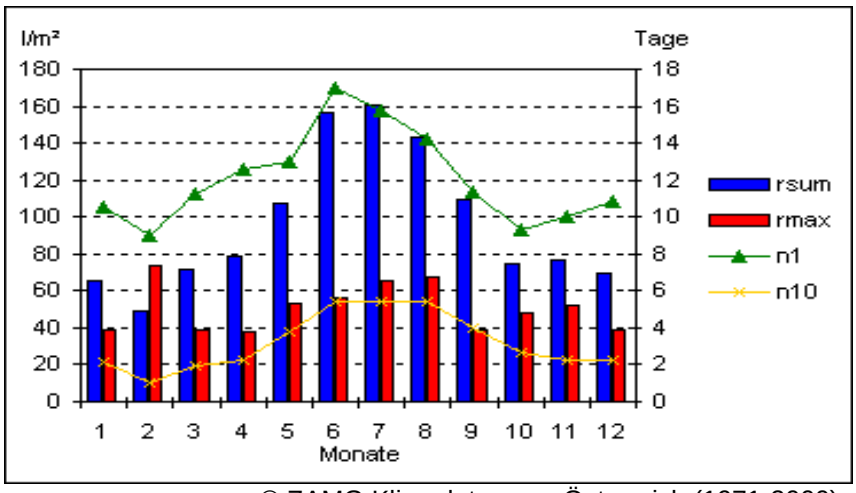


Fig. 5: Precipitation diagram for the course of one year

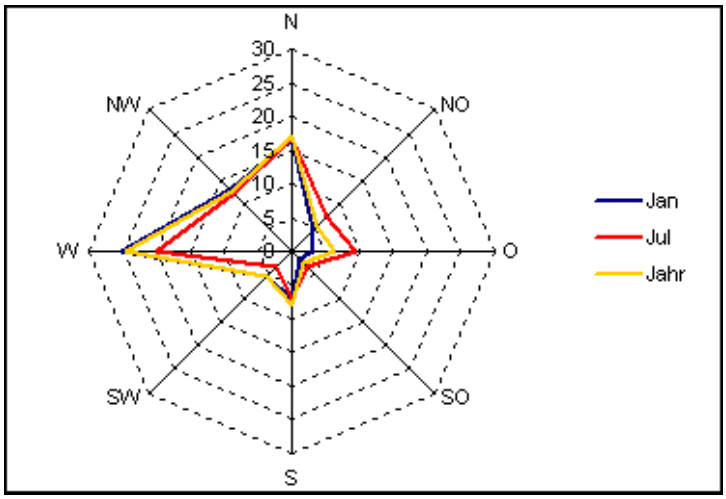
The annual course of precipitation in the municipality of Kleinsölk, which is just a few kilometres from the Alm in straight line distance, shows a distribution that is typical for the Central Alpine Region. A peak in precipitation amount is recorded in summer time, whereas during winter the lowest amount of precipitation falls which is displayed in the diagram above.

The total amount of precipitation for one year is 1162.4 l/m², which agrees with the general precipitation pattern of this region.

The altitude difference, which is likely to be reflected in a slightly different amount and distribution of precipitation, has to be ignored at this point due to missing data.

This difference can be put back to the fact that moist air is rising along the mountains and precipitating at a certain height. This leads to a concentration in rainfall up in the mountains.

Apart from the prevailing wind system there is also a diurnal wind pattern driven by the temporary different heating of the valley and mountain tops. In the morning hours there are anabatic winds prevailing, which can be described as valley breeze, whereas in the evening hours the pattern reverses and the prevailing winds are katabatic ones, these are called mountain breezes. The prevailing wind direction is from West to North West, which manifests itself in snow distribution and vegetation patterns, and is also displayed in the following diagram.



© ZAMG Klimadaten von Österreich (1971-2000)
Fig. 6: Prevailing wind direction in the municipality of Kleinsölk

4.5 SOILS (after KAUFMANN 2005)

Soil and vegetation patterns are determined at least partly by microclimatic conditions, which are determined by geomorphologic features such as exposition, altitude and inclination. The ridge is strongly exposed to solar radiation and wind, so during winter there is little snow coverage, which results in a high susceptibility to frost. Also the diurnal variations in temperature are very high. This exposition also results in an increased rate of evapotranspiration, therefore plants are especially prone to being damaged by frost-driven desiccation. Plants growing under such conditions have special adaptations to resist frost and desiccation such as hair-like appendices or nanism. Typical soils under such conditions are dry ranker.

Below the ridge along the walls of the trough valley most of the precipitation is falling, and in case of snow, is accumulating due to the lee-exposition of the slopes of Lafenberg Alm. The high amounts of precipitation and the long snow coverage are resulting in water-logging in depressions. These high amounts of precipitation also strongly influence the plant species composition. Typical soils for water-logged sites and a cool climate are pseudogley or planosols. Aditionally the genesis of swamps is typical for such sites.

In the closed forest belt the soils are typically podsols, and large amounts of water are being caught in the biomass and the forest itself.

5 RESULTS

5.1 VEGETATION SURVEYS

Number	Scientific name	English name	German name
1	Sphagno-Nardetum (ass.nov.)	Boggy mat grass mosaic	Borstgras-Flachmoor-Mosaik
2	Alnetum viridis	Green alder shrubbery	Grünerlen-Gebüsch
3	Vaccinio-Rhododendretum ferruginei pinetosum mugii	Dwarf pine krummholz	Latschen-Krummholz
4	Nardetum	Mat grass sward	Strenger Bürstlingsrasen
5	Rhododendretum ferruginei	Rhododendron-Blueberry shrubbery	Alpenrosen-Schwarzbeer-Gebüsch
6	Larici-Piceetum	Larch-Spruce forest	Lärchen-Fichten-Wald
7	Vaccinio-Callunetum	Heather-Blueberry heath	Ericaceaen-Heide
8	Vaccinietum uliginosi	Dwarf-shrub-Woodrush heath	Ericaceaen-Simsen-Heide
9	Rumicetum alpini	Alpine dock-Nettle forb	Ampfer-Lägerflur
10	Empetro-Vaccinietum gaultherioidis	Coarse debris vegetation	Felsblockvegetation
11	Athyretum alpestris	Tall herb community	Hochstaudenflur
12	Eriophoretum scheuchzeri	Cotton grass-mat grass sward	Wollgras-Bürstlingsrasen
13	Salicion herbaceae	Dip vegetation	Schneetälchenvegetation
14	Festuca varia-Poa alpina-Nardus Mosaik	Crest vegetation	Grat-Vegetationsmosaik
15	Cardamino-Montion	Spring vegetation	Quellflur

Table 5: Vegetation communities with numbers and names (scientific, English and German) of each survey

5.2 PLANT COMMUNITIES

5.2.1 BOGGY MAT GRASS MOSAIC

Survey Number: 1

Coordinates: 33 T 0418050
5248042

Date of sampling: 16.07.2009

Sample plot size: 16 m²

Sea level: 1600 m.a.s

Species:

Sphagnum sp. 5, *Vaccinium myrtillus* 3, *Vaccinium gaultherioides* 3, *Nardus stricta* 3, *Polytrichum strictum* 2 b, *Melampyrum pratense* 2 m, *Carex nigra* 2 m, *Juncus filiformis* 2 m, *Carex echinata* 2 m, *Homogyne alpina* 1, *Potentilla erecta* 1, *Trichophorum cespitosum* 1, *Eriophorum vaginatum* 1, *Avenella flexuosa* 1, *Anthoxanthum alpinum* 1, *Eriophorum angustifolium* +, *Larix decidua* +, *Picea abies* r

Additional species:

Veratrum album, Sorbus aucuparia, Rhododendron ferrugineum, Juncus trifidus, Deschampsia cespitosa, Vaccinium vitis-idaea, Athyrium distentifolium, Rhytidiadelphus triquetrus, Carex pallescens

Fig. 7: Mat grass – Ericaceae mosaic on a former forest stand

5.2.1.1 SITE DESCRIPTION

The open strip is about 400 m in length and about 120 m in width. The exposition is 30° N-E and the inclination is about 35° in the upper p art and about 25° in the lower part.
This vegetation type is a potential forest system disturbed by a natural force, in this case dust avalanches that went off frequently (the last ones were in 2003 and 2005) (pers. remark of Hans Pircher). Though there was not much snow found at the site but only trunks pulled out of the soil completely this is a typical indication for a dust avalanche event. The trees had no “time” to break because of the high velocity of the blast preceding the avalanche. The bulk of snow masses was trapped in a depression about three hundred meters above the open strip. Parts of the snow masses were lifted upon an air cushion created in the depression and headed downwards in form of a dust avalanche. Some small trees resisted this event because of their high flexibility in the juvenile phase and are reaching now heights of about 3 meters.
The uppermost part of this site is a gentle slope, followed be the middle, steeper part, where water tends to flow following gravity and, therefore, is drier than the lower part with a smaller inclination and where water is able to accumulate.
Generally spoken soils in this open strip are more humid compared to soils in the forest, where less water is reaching the soil due to interception process and larger amounts of soil water taken out by tree roots. Not even higher evapotranspiration due to higher temperatures during day time and more wind than in forest stands is able to significantly reduce soil humidity.
The whole area is covered with small sized, shallow dips where the tree roots were anchored in the soil before the avalanche teared them out of soil. In these dips, water is accumulating so there are now many small ponds. The depressions and ponds are dominated by mosses, especially by *Sphagnum sp*. and some grass species such as *Carex nigra, Juncus trifidus and Eriophorum vaginatum*. Between the depressions the small elevations have drier soils, where *Nardus stricta* and *Deschampsia cespitosa* are able to grow, but the ground is still covered by mosses such as *Polytrichum strictum*. In the upper part of the slope there is a higher dominance of *Rhododendron ferrugineum* compared to the lower part where *Vaccinium* species are dominating the shrub layer. As a former forest stand vegetation is similar to the undergrowth of the typical Larici-Piceetum Ellenberg et. Klötzli 1972, but the site has even more characteristics of a fen, which is indicated by the presence of cotton grass, sphagnum-mosses and several

Carex species. Therefore, the synonym Sphagno-Nardetum (ass.nov.) would be more adequate.

Fig. 8: Numerous dust avalanches keep open this forest aisle since decades

5.2.2 GREEN ALDER SHRUBBERY

Survey number: 2

Coordinates: 33 T 0417837
5247500

Date of sampling: 16.07.2009

Sample plot size: 100 m²

Sea level: 1750 m.a.s

Species:

Alnus viridis 3, *Athyrium distentifolium* 3, *Stellaria nemorum* 2 a, *Vaccinium myrtillus* 2 a, *Calamagrostis villosa* 2 m, *Deschampsia cespitosa* 2 m, *Rumex alpestris* 2 m, *Saxifraga stellaris* 2 m, *Thelypteris limbosperma* 1, *Silene vulgaris* 1, *Avenella flexuosa* 1, *Anthoxanthum alpinum* 1, *Rhododendron ferrugineum* 1, *Homogyne alpina* 1

Additional species:

Gentiana pannonica

5.2.2.1 SITE DESCRIPTION

Depressions with long snow coverage or especially humid stands do not show the best conditions for forests to re-establish themselves. Due to almost no competition in growth height these stands are occupied quickly by green alder. Within few decades large areas can be completely covered by this phytocoenosis (AIGNER et al., 2003)
Although growing conditions completely change inside this shrubbery from an open land climate to a forest climate, plant composition is not completely different compared to open shrub land. Factors like air and soil humidity, light intensity and temperature are different inside the stand. Shade tolerant species are increasing in frequency and dominance whereas light demanding species are disappearing. Within few years relatively thick humus layers are able to develop due the foliage dropped by the alders in autumn. On many sites dwarf shrubs such as *Vaccinium* and *Rhododendron* are growing, but if soils are humid then fern species are dominating the understory.
Green alder shrubbery or Alnetum viridis Braun-Blanquet 1918 tends to spread from higher elevation downwards and only has the chance to establish if there is no or just low grazing or pasturage stress. Although leaves of green alder is a part of the diets of red deer and roe deer and even horses sometimes eat parts from the plants, regular grazing activity will not be sufficient to significantly damage such a stand.

Fig. 9: Alpine “jungle” formed by green alder – a common view on abandoned alpine pastures

5.2.3 DWARF PINE KRUMMHOLZ

Survey number: 3

Coordinates: 33 T 0417645
5247959

Date of sampling: 16.07.2009

Sample plot size: 100 m²

Sea level: 1700 m.a.s

Species:

Vaccinium myrtillus 4, *Pinus mugo* 2 b, *Melampyrum pratense* 2 m, *Vaccinium vitis-idaea* 2 m, *Avenella flexuosa* 2 m, *Cetraria islandica* 2 m, *Cladonia rangiferina* 2 m, *Hylocomium splendens* 2 m, *Pleurozium schreberi* 2 m, *Polytrichum formosum* 2 m, *Luzula sylvatica* 2m, *Calamagrostis villosa* 2m, *Vaccinium gaultherioides* 1, *Lycopodium annotinum* 1, *Rhizocarpon geographicum* 1, *Cladonia pyxidata* 1, *Cladonia arbuscula* 1, *Homogyne alpina* +, *Rhododendron ferrugineum* +

Additional species: *Picea abies , Larix decidua*

Fig.10: Dwarf pine krummholz on coarse debris with dense undergrowth of various Ericaceae

5.2.3.1 SITE DESCRIPTION

This association can be described as a Vaccinio-Rhododendretum ferruginei pinetosum mugii Braun-Blanquet 1939 and is likely to be an advanced stage of the Vaccinio-Rhododendretum (SCHARFETTER 1993, S.23). The fact that there are at least a few individuals of *Larix decidua* and *Picea abies* within the stand indicates that this site would be located wihin the potential timber zone but because of the coarse boulders in the ground tree growth is restricted to isolated spots.

Dwarf pines are well adapted to grow at the timber line. They do not have one primary stem but several equal, highly flexible branches. Typically dwarf pine shrubbery is even thicker than green alder shrubbery but has more or less larger gaps that are covered by different *Vaccinium*-species. The undergrowth is dominated by pure stands of *Vaccinium myrtillus*, *Vaccinium vitis-idaea* and *Rhododendron ferrugineum,* which form a strongly toothed mosaic.

Under the branches and dwarf shrubs shade-tolerant plants such as mosses and lichens are dominating the ground vegetation. Where soils are deep enough even grassy plants are able to grow.

Such stands grow much slower than green alder shrubbery and need many decades to form thick stands. Areas covered by dwarf pines have probably never been used as pastures or these areas have been abandoned a long time ago. Contrary to the green alder shrubbery there is almost no litter accumulating on the ground and soils are very similar to soils in blueberry-tundra. Functions of this plant community as a habitat for wildlife and game species and protection against natural hazards are similar to green alders.

Usually on sites covered by *Pinus mugo* snow coverage is not so high, because otherwise the fungus *Herpotrichia nigra* would badly damage the stand (SCHARFETTER 1993).

5.2.4 MAT GRASS SWARD

Survey number: 4

Coordinates: 33 T 0417949
5248170

Date of sampling: 20.07.2009

Sample plot size: 25 m²

Sea level: 1600 m.a.s.

Species:

Rumex alpestris 3, *Nardus stricta* 2 b, *Hypericum maculatum* 2 a, *Achillea millefolium* 2 m, *Carex leporina* 2 m, *Juncus filiformis* 2 m, *Lysimachia nemorum* 2 m, *Potentilla erecta* 2 m, *Agrostis tenuis* 1, *Cerastium cerastoides* 1, *Festuca rubra agg.* 1, *Myosotis nemorosa* 1, *Potentilla anglica* 1, *Trifolium pratense* 1, *Trifolium repens* 1, *Veronica serpyllifolia subsp. humifusa* 1, *Campanula scheuchzeri* +, *Luzula luzuloides* r, *Phleum alpinum* +, *Ranunculus acris* +, *Stellaria graminea* +

Additional species:

Gnaphalium norvegicum, Geum montanum, Alchemilla vulgaris, Thymus pulegioides, Hieracium aurantiacum, Hieracium pilosella; Gymnadenia conopsea

Fig. 11: Open pasture - a rare view on Lafenberg Alm

5.2.4.1 SITE DESCRIPTION

These sites are obviously former pasture relics from times when this area was still managed. Dominated by grass plants and sorrel the quality of the meadow is relatively high. The high abundance of sorrel is probably a consequence of the high content of nutrients that where introduced through the excrements of cattle. Although there is some variation in grass species diversity, *Nardus stricta* is the dominant grass species which is typical for the Nardion strictae Braun-Blanquet 1926.

If there is no intervention such as pasturing or mowing at all shrubs and woody species will start to invade from the surroundings and finally overtake this area. Tree seedlings are able to germinate and grow much better compared to the shady conditions in dwarf shrubbery (pers. remark of Wolfgang Holzner). Gymnosperm diversity is highest on this site of all phytocoenosis representing Lafenberg property. Because of the higher number of flowers and the shorter vegetation there is also a higher number of butterflies and other insect species compared to a tundra area.

Amelioration would also improve the habitat of game species. Red deer and other typical grazer species feed on *Nardus stricta* at most in very early stage where the shoots are still soft and palatable. Older plants are completely disdained by both game species and domestic browsers. Improvement of plant species composition is of interest for hunters and farmers.

5.2.5 RHODODENDRON-BLUEBERRY SHRUBBERY

Survey number: 5

Coordinates: 33 T 0417688
5247620

Date of sampling: 20.07.2009

Sample plot size: 25 m²

Sea level: 1750 m.a.s

Species:

Rhododendron ferrugineum 4, *Sphagnum spec.* 4, *Polytrichum strictum* 2 b, *Hylocomium splendens* 2 a, *Pleurozium schreberi* 2a, *Vaccinium myrtillus* 2 a, *Homogyne alpina* 2 a, *Avenella flexuosa* 2 a, *Oxalis acetosella* 2 m, *Veratrum album* 1, *Athyrium distentifolium* 1,

Leontodon helveticus 1, *Melampyrum pratense* 1, *Deschampsia cespitosa* 1, *Blechnum spicant* +

Additional species: *Nardus stricta*

Fig. 12: Rusty-leaved alpenrose is dominating the aspect on large parts of the Alm

5.2.5.1 SITE DESCRIPTION

The association Rhododendron ferruginei Rübel (1911) is characterized through a very low variety in plant species and a homogenous appearance. A similar characterization is given by Braun-Blanquet 1927 in his version of the Vaccinio-Rhododendretum ferruginei.

According to Hartl 1965 this phytocoenosis is typical for shady, humid, concave slopes with N, N-E or N-W orientated exposition and is naturally free of trees because of the long durance of snow coverage and frequent avalanches in these troughs. Would there be the possibility to prevent the avalanches, trees would be able to colonize this biotope. Other authors (HOLZNER 2007, ELLENBERG 1996) state that

Rhododendron-Vaccinium dominated dwarf shrubbery is the typical undergrowth in the subalpine spruce-larch forest and secondary, anthropogenic deforested.

The counterpart of this type is the sun exposed, dry scotch-heather tundra on convex, S orientated ridges.

There are many slightly different variations of this type of vegetation, depending on the depth of soil, degree of humidity, snow coverage…

On Lafenberg Alm this vegetation type is almost free of trees and reaches the ridge with an altitude of about 1800m a.s.l. The reasons for this distribution are the prevailing winds from west. Due to the north-south orientation of the mountain ridge snow is transported by winds from the westerly slopes upon the ridge and deposited on the easterly slopes of Lafenberg. On the westerly slopes of the ridge trees are growing up to the ridge, whereas on the other side closed forest ends about 200m lower.

This snow coverage is crucial for the growth of *Rhododendron ferrugineum*, because it is highly susceptible to exsiccation due to frost in winter or early spring when it becomes snow-free too early. Also its generally low frost resistance and sensitivity to wind push this vegetation type into special, protected sites (ELLENBERG 1996).

In between the shrubs there are only scattered grassy plants spread over the area.

5.2.6 LARCH-SPRUCE FOREST

Survey number: 6

Coordinates: 33 T 0418046
5247671

Date of sampling: 21.07.2009

Sample plot size: 100 m²

Sea level: 1600 m.a.s

Species:

Vaccinium myrtillus 3, *Larix decidua* 3, *Picea abies* 3, *Blechnum spicant* 2 b, *Calamagrostis villosa* 2 a, *Oxalis acetosella* 2 m, *Homogyne alpina* 2 m, *Avenella flexuosa* 2 m, *Luzula luzuloides* 1,

Additional species:

Cetraria islandica, Cladonia fimbriata, Cladonia pyxidata, Evernia divaricata, Hylocomium spendens, Hypogymmia physodes, Lycopodium annotinum, Rhytidiadelphus triquetrus, Pleurozium schreberi, Pseudevernia furfuracea, Usnea filipendula

Fig. 13: Light-flooded, sparse forests with rich undergrowth form a passable habitat for several game species

5.2.6.1 SITE DESCRIPTION

According to Ellenberg et Klötzli (1972) this forest is a typical exponent of the association of Larici-Piceetum.

The subalpine spruce-larch forest is the potential vegetation type of the altitudinal belt of the lower subalpine zone between 1500 m and 2000 m a.s.l. Typical features of this phytocoenosis are a fragmented canopy, crowns closed down to the ground, poor phytodiversity within ground vegetation (only a few, dominant species such as *Vaccinium myrtillus, Calamagrostis villosa, Blechnum spicant*) Due to climatic conditions the decomposition of litter is very slow which favours podsolization of soils (ELLENBERG 1996). With increasing altitude the ratio of tree species composition changes towards larch.

Larger gaps were mainly created through natural disasters such as wildfires, landslides, avalanches or pests. In former times these gaps were kept open by large herds of herbivores such as red deer and wisent. Humans learned to use this open space for their own purpose. If management is completely abandoned nearly all pastures below timber line will return into this climax stadium after centuries, except

sites that are not suitably for forest growth (too dry, too humid, frequent avalanches, shallow soils…).

Animals that spend the summer on alpine pastures use forests or groups of trees to seek shelter from heat, insects or heavy thunder storms.

Forests are also important habitats for game species and wildlife. For example Capercaillie (*Tetrao urogallus*) needs this kind of half open forest stand with standing dead wood and a rich shrub layer where they can find berries and shelter. Black grouse (*Tetrao tetrix*), which partly lives in scattered tree stands near the timber line and even above, has similar demands (WOKAC 2001).

Also larger mammals such as roe deer, red deer, hare, pine marten, foxes…are living at least partly inside of the forests.

An important indicator for the ecological value of such a forest is besides a rich shrub layer the amount of standing and lying deadwood. Standing deadwood provides caves and nesting places for a number of birds.

5.2.7 HEATHER-BLUEBERRY HEATH

Survey number: 7

Coordinates: 33 T 0417953
5247542

Date of sampling: 21.07.2009

Sample plot size: 25 m²

Sea level: 1650 m.a.s

Species:

Calluna vulgaris 3, *Vaccinium myrtillus* 3, *Vaccinium vitis-idaea* 2 a, *Blechnum spicant* 2 a, *Luzula sylvatica* 2 a, *Avenella flexuosa* 2 m, *Melampyrum pratense* 2 m, *Melampyrum sylvaticum* 2 m, *Arnica montana* 1, *Deschampsia cespitosa* 1, *Homogyne alpina* 1, *Vaccinum gaultherioides 1, Phyteuma betonicifolium* +, *Phyteuma persicifolium* +, *Athyrium distentifolium* +, *Rhododendron ferrugineum* +, *Potentilla erecta* +, *Silene vulgaris* +, *Juniperus communis subsp. alpina* r

Additional species:

Diphasium alpinum, Prenanthes purpurea

5.2.7.1 SITE DESCRIPTION

The Vaccinio-callunetum Braun-Blanquet et Jenny (1926) is typical for warm, dry slopes with medium inclination and S-W, S, S-E exposition. SCHARFETTER 1993 describes this association as a variety of the Vaccicnio-Rhododendretum nardetosum Schweingruber 1972.

On Lafenberg this association is only underpart because there are just small patches covered by this type of vegetation.

Nevertheless, it should be preserved as an important part of the mosaic-like ecosystem which should be the final goal from a nature conservation point of view. Due to its microclimatic conditions it represents an important habitat for reptiles such as adder (*Vipera berus*) or common lizard (*Zootoca vivipara*). Also insects find in the relatively high amount of flowering plants a good food supply and work themselves as an important food supply for bats and several bird species.

Fig. 14: Meagre and dry site with typical heather-habitus

5.2.8 DWARF SHRUB-WOOD RUSH-HEATH

Survey number: 8

Coordinates: 33 T 0417631
5247290

Date of sampling: 22.07.2009

Sample plot size: 25 m²

Sea level: 1750m a.s.l.

Species:

Vaccinium myrtillus 2 b, *Vaccinium gaultherioides* 2 b, *Polytrichum commune* 2 b, *Pleurozium schreberi* 2 b, *Calluna vulgaris* 2 a, *Luzula luzuloides* 2 a, *Potentilla erecta* 2 a, *Nardus stricta* 2 a, *Melampyrum sylvaticum* 2 a, *Homogyne alpina* 2 a, *Vaccinium vitis-idaea* 2 a, *Avenella flexuosa* 2 m, *Campanula barbata* 1, *Anthoxanthum alpinum* 1, *Melampyrum pratense* 1, *Phyteuma persicifolium* +, *Ranunculus villarsii* +, *Leontodon helveticus* +, *Hieracium alpinum* +

5.2.8.1 SITE DESCRIPTION

According to Braun-Blanquet et Jenny (1926) this sub-association Vaccinietum uliginosi is part of the association Empetro-Vaccinietum gaultherioides. *Empetrum hermaphroditum* has not been found in this area but can be seen as a secondary floristic element, so the name *Vaccinium* heath would be more adequate in this case. Similar to the Vaccinio Callunetum this vegetation type can be found predominately on southerly exposed slopes with medium inclination and shallow soils.

Also the floristic composition is similar, only scotch heather is not so dominant. SCHARFETTER 1993 describes this phytocoenosis as a succession stage of former pastures dominated by *Nardus stricta* with a co-dominance of *Luzula luzuloides* and *Vaccinium myrtillus*.

As a potential mountain pasture this vegetation type could play a larger role, because it covers several hectares. Looking at the total area of Lafenberg estate this is also one of the more valuable sites in terms of fodder plants and more promising sites in terms of revitalisation efforts, because there is a good percentage of grassy plants in between already. Cows could be found predominantly on this sites picking out single plants during the summer time.

Fig. 15: Ericaceae – dominated heath on dry, south orientated slopes with deep soils

5.2.9 ALPINE DOCK–NETTLE FORB

Survey number: 9
Coordinates: missing
Date of sampling: 22.07.2009
Sample plot size: 16 m²
Sea level:
Species:
Rumex alpinus 4, *Urtica dioica* 2 b, *Galeopsis tetrahit* 2 a, *Galeopsis bifida* 2 a, *Trifolium pratense* 2 a, *Poa supina* 1, *Achillea millefolium* 1, *Ranunculus repens* 1, *Stellaria nemorum* 1, *Agrostis tenuis* 1, *Hypericum maculatum* 1, *Festuca rubra agg.* +

5.2.9.1 SITE DESCRIPTION

This Rumicetum alpine Beger (1922) is a very typical tall forb community on (former) grasslands used as pastures. This vegetation type, which is characterized by a high abundance of alpine dock (*Rumex alpinus*), common nettle (*Urtica dioica*) and other indicator plants for a high content of nutrients, is mainly of anthropo-zoogenic origin.

There are some examples of this vegetation type growing on resting places of chamois and other herbivore species, too.

Fig. 16: Nitrophilic plant community that is accompanying alpine huts regularly

Especially around alpine huts, on former milking spots where excrements, especially urine, because faeces could be removed easily, of cattle accumulated over time, nutrient contents in soils increased drastically (ELLENBERG 1996). These ranky patches are mostly located on flat terrain and on upheavals where ruminants preferentially settle down for rumination.

An alternative name of *Rumex alpinus* is monk's rhubarb in former times because poor people or farmers used sorrel in many ways. For example the leaves were cooked and mashed and eaten as spinach or were used as fodder for pigs, whereas the stipes were cooked and eaten as a sauce such as rhubarb. Another synonym is butter dock because leaves were also used to wrap and conserve butter. Also the use of dried leaves as toilet paper must not be underestimated.

WINTER (2005) quotes *Rumex* species as microhabitats that can harbour more than 100 insect species, including beetles, bugs, caterpillars,bumblebees and wild bees, whereas nettles serve as a mean of existence as a food supply for various butterfly species. Furthermore these ranky patches do not only bear different vegetation types

but also the excrements themselves serve as a habitat and food resource for several insect species (HOLZNER et KRIECHBAUM 2001)

The following vegetation types were not surveyed in the same extends like the previous ones. Either they are too heterogeneous to allow a reasonable recording of vegetation according to Braun-Blanquet or too small-scaled to play an important role as an utilizable area. Nevertheless they are important components of the ecosystem and harbour many special faunistic and floristic elements.
I restricted myself to look at different examples (if any more) of each type and to list the most dominant and characteristic plants and give a short description.

5.2.10 COARSE DEBRIS VEGETATION

Survey number: 10

Species:

Empetrum nigrum, Loiseleuria procumbens, Rhizocarpon geographicum, Rhododendron ferrugineum, Vaccinium gaultherioides, Vaccinium myrtillus, Vaccinium vitis-idaea

Fig. 17: Boulders create special microclimatic conditions that favour thermophilic plants and animals

5.2.10.1 SITE DESCRIPTION

On boulders this type occurs only on a few spots, particularly on some rocks below the ridge and on some rock falls. The only life forms that are able to grow on bare rock are lichens. In fissures some organic material is able to accumulate and on this organic layer phanerogams are able to grow. Also in the periphery of dwarf pine shrubbery this vegetation can be found frequently, where the underground is often formed by large boulders, in this case by a moraine or as the result of a rockfall long time ago. This phytocoenosis can be defined as Empetro-Vaccinetum gaultherioidis Braun-Blanquet et Jenny (1926) and is an important feeding place for capercaillie, black grouse and other birds species that feed on berries.

The entrances to the cave systems below this rockfall are important hunting grounds for some araneid species. They build their nets directly in front of the gaps and catch insects that fly into the cave system.

But also small mammals, birds and reptiles appreciate this richly structured habitat for shelter, resting place and even to raise the offspring.

5.2.11 TALL HERB COMMUNITY

Survey number: 11

Species:

Athyrium distentifolium, Athyrium filix-femina, Calamagrostis villosa, Chaerophyllum hirsutum, Deschampsia cespitosa, Galeopsis bifida, Galeopsis speciosa, Gentiana pannonica, Poa chaixii, Poa hybrida, Ranunculus aconitifolius, Rubus idaeus, Thelypteris limbosperma, Veratrum album

5.2.11.1 SITE DESCRIPTION

This vegetation type can be nearest allocated to Athyretum alpestris SCHMID (1923). Tall forb communities usually colonize steep (up to 35°), humid slopes with more or less frequent avalanches. One prerequisite for the development of tall forbs is accumulation of soil material that is rich in nutrients in dips or depressions. This is one of the main differences to the anthropo-zoogenic Rumicetum alpine, which can also be found on ridges. (WEGENER 1998)

There are different reasons for the absence of trees on sites with apparently good growth conditions. Frequent avalanches and shallow soils upon boulder tips are not best suited for trees and the permanent, intense shading by the tall forbs hinders tree seedlings from germinating. (KARNER et MUCINA in: GRABHERR et MUCINA 1993). Tall forbs are very often, like on most sites on Lafenberg Alm, adjacent to *Alnetum viridis* communities or even merge into them, because due to the nitrogen-fixing ability of symbiotic microorganism *Frankia* (VARMA et KHARKWAL 2009), which lives in tree root nodules of different *Alnus* species, soils have a higher content of Nitrogen.This content is, however, not that high as expected due to intense elution (KARNER et MUCINA in: GRABHERR et MUCINA 1993).

Fig. 18: Beautiful flowering specimen of Gentiana pannonica

5.2.12 COTTTON GRASS-MAT GRASS SWARD

Survey number: 12

Species:

Avenella flexuosa, Eriophorum scheuchzeri, Homogyne alpina, Melampyrum pratense, Nardus stricta, Sphagnum sp., Vaccinium gaultherioides, Vaccinium myrtillus

Fig. 19: Heath with the striking white inflorescence of cotton grass

5.2.12.1 SITE DESCRIPTION

Even from a distance the white seed heads covered in a fluffy mass of cotton can be seen and form a contrast to the prevailing monotonous shades of green. The optical most dominant plant is *Eriophorum scheuchzeri,* which is a good indicator for waterlogged sites. These fens are very poor in nutrients, especially in nitrogen and nitrates, so plants have to find strategies to overcome this lack of nutrients. *Eriophorum scheuchzeri* for example is penetrating with its roots layers of its own dead leaves and caulis (ELLENBERG 1996, S 504). Also the dominance of various *Sphagnum* species is a typical sign for bogs or fens

Such a high abundance of *Eriophorum scheuchzeri* can be found only in one place in the second cirque of Lafenberg Alm. It has a size of about 300 m² and is situated on a small crest in the N-E orientated slope. On the boggy sites in the avalanche aisle there are also some scattered individuals, anywhere else it is missing, though the site conditions would be fitting on several sites. This association can be described as Eriophoretum scheuchzeri (Rübel 1911) Fries 1913.

Due to its small size and lack of valuable fodder plants for browsers this site may be just relevant in terms of aesthetics and landscape and habitat diversity, even as an important food source for black grouse in spring time (KLAUS and BRUCHHOLZ 1987).

Fig. 20: Beautiful scenery dominated by cotton grass looking south along the Small Sölktal

5.2.13 DIP VEGETATION

Survey number: 13

Species:

Anthoxanthum alpinum, Carex canescens, Carex echinata, Carex nigra, Eriophorum vaginatum, Nardus stricta, Sphagnum sp., Viola palustris

Fig. 21: One of numerous oligotroph dips panelled by *Spagnum* and *Carex* species

5.2.13.1 SITE DESCRIPTION

Bogs form in depressions or holes in moraine areas without discharge and where water cannot infiltrate into the soil (ELLENBERG 1996). Depending on their size these dips can carry water throughout the whole year or fall dry during summer time. The permanent water-logged parts are mostly covered by species from the genus *Sphagnum*, passing into a sedgemoore and finally into heath which is dominated by *Nardus stricta* and *Vaccinium* species. Especially sedges are gladly eaten by horses because of the high silica content incorporated into the leaves (pers. remark of Prof. Holzner).

The water-logged bogs and dips are important as a habitat for several amphibian species living in the subalpine zone such as *Triturus alpestris*, *Salamandra atra*, *Bufo bufo* and *Rana temporaria*. Amphibians again are important players in the food chain in each stage of their development, for example for predaceous species such as *Vipera berus*.

As a watering place for animals such dips are not well suited because on the one hand there is the risk of infection with liver fluke and on the other hand these dips are very cold throughout he year so animals drinking from it can suffer colic. Another threat is

given when the dips reach a certain depth, because in the peripheral zone of such bogs the mossy ground seems to be stable but suddenly backs down and may become a deadly trap.

And, finally, there may be a conflict between utilization and nature conservation. Animals will significantly influence the nutrient balance of these ecosystems by dropping their dung in or besides the oligotroph dips. The increase of the nutrient content and the damages caused by hooves are a threat to this sensitive biotope. As a result, utilization as a pasture and as a watering place is contradictory to the goals of nature conservation and though should be desisted.

Fig. 22: Permanent water body forming at the foot of a moraine

5.2.14 CREST VEGETATION

Survey number: 14

Species:

Aconitum napellus, Alchemilla vulgaris, Anthoxanthum alpinum, Campanula scheuchzeri, Carex brunnescens, Deschampsia cespitosa, Festuca varia, Geum montanum, Homogyne alpina, Nardus stricta, Oreochloa disticha, Phleum alpinum, Poa alpina, Ranunculus montanus, Saponaria pumila, Sempervivum montanum, Veronica alpina

Fig. 23: East-orientated crest vegetation above the alpine hut about 1.800m a.s.l.

5.2.14.1 SITE DESCRIPTION

The tesselated, mosaic-like vegetation on the crest is caused by snow coverage varying on small scale. It is too inhomogeneous to be characterized in just one assessment. It would be too extensive and needless for the purpose of this study to characterize each individual, small-scaled type.

There are two flocks of sheep that are migrating every few days along this crest between two alpine pastures (northern and southern from Lafenberg Alm). The crest has an altitude of about 1800 m a.s.l. and is orientated N-S.

The vegetation is shaped by grass tufts with very short lawn inbetween. The tufts are mostly ignored by sheep because they have pointed leaves which sting the sensitive sheep's noses. One very typical species with this feature is *Festuca varia*. On the other hand the soft and lush leaves of *Poa alpina* forming lawns in between the tufts are eaten by sheeps willingly. On the meadow-like parts *Nardus stricta* is dominant and there are growing also some flowering plants.

Due to the temporary high sheep density (one flock has about 20 and the other one about 30 individuals) there are large amounts of excrements concentrated on a small

strip. On these accumulation spots tall-forb species such as *Aconitum napellus* occur frequently.

On the east-orientated slope below the ridge meadows with highly abundant *Nardus stricta* are dominating the aspect.

Potentially, this area would be a passable pasture for cattle but it only covers a negligible area. Another problem would be the fact that the animals would have to climb up and down an altitude difference of about 400 m every day to reach watering places and shelter.

5.2.15.1 SPRING VEGETATION

Survey number: 15

Species:

Achillea millefolium, Alchemilla vulgaris., Athyrium distentifolium, Cardamine rivularis Carduus personata, Chaerophyllum hirsutum, Epilobium alsinifolium, Hypericum maculatum, Lysimachia nemorum, Myosotis decumbens, Petasites albus, Rumex alpestris, Rumex alpinus, Senecio subalpinus, Urtica dioica, Veronia beccabunga

Fig. 24: Typical accompanying plant community along a brooklet below the alpine hut

5.2.15.1 SITE DESCRIPTION

This is another vegetation type that occurs only twice on the Lafenberg Alm. Plant species composition does not allow a classification to one specific association.
Green alders tend to colonize these water bearing channels from above spreading along watercourses, only permanent grazing activity may prevent this problem arise. Potentially there may develop either tall forbs, but, again, grazing may impede this process.

5.3 MAP

The digitalization of the singular polygons has been carried out in a scale of 1:2.000.

The reference point of the plant community **Alpine dock-nettle forb** is missing due to an error during the assesment of the coordinates.

In the following diagramm the exact size distribution of each community is displayed.

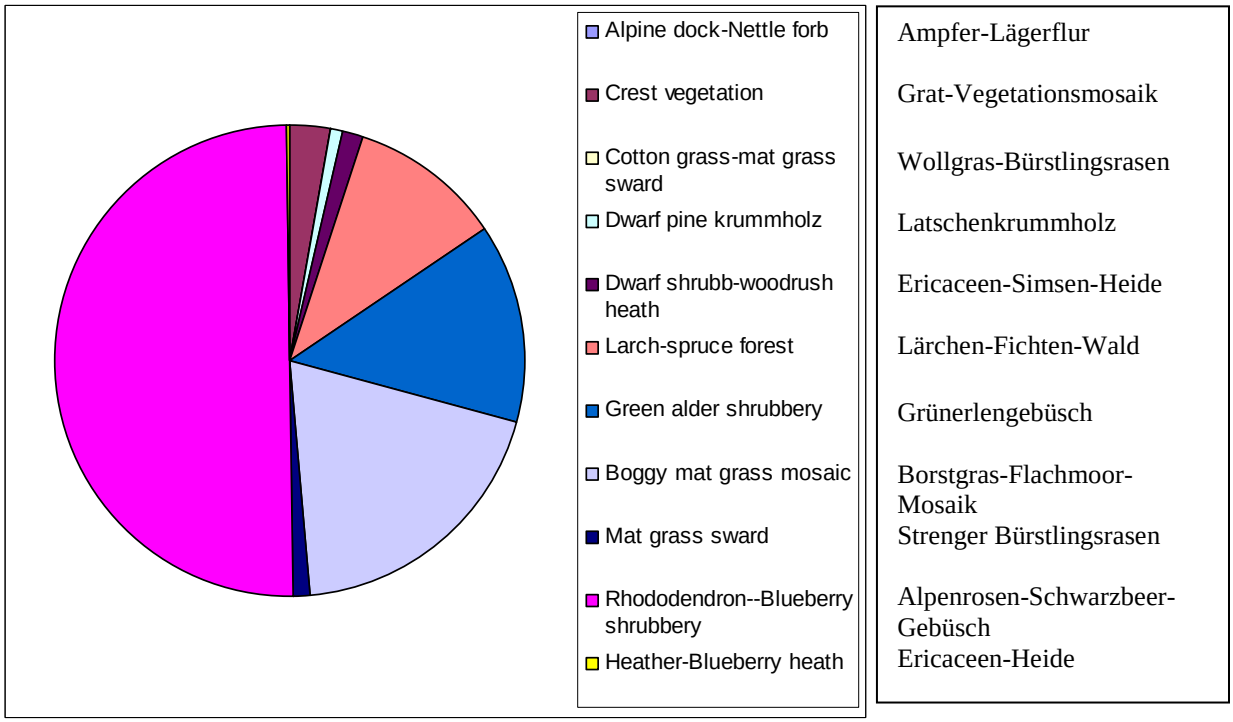


Fig. 25: Size distribution diagramm for each plant community

Number	Plant community	Pflanzengesellschaft	Size (m²)
9	Alpine dock-Nettle forb	Ampfer-Lägerflur	194,185
14	Crest vegetation	Grat-Vegetationsmosaik	39170,15
12	Cotton grass-mat grass sward	Wollgras-Bürstlingsrasen	1148,604
3	Dwarf pine krummholz	Latschenkrummholz	13438,799
8	Dwarf shrubb-woddrush heath	Ericaceen-Simsen-Heide	19272,989
6	Larch-spruce forest	Lärchen-Fichten-Wald	153835,505
2	Green alder shrubbery	Grünerlengebüsch	194549,299
1	Mat grass-Ericaceae mosaic	Borstgras-Flachmoor-Mosaik	284924,257
4	Mat grass sward	Strenger Bürstlingsrasen	15022,729
5	Rhododendron-blueberry shrubbery	Alpenrosen-Schwarzbeer-Gebüsch	725767,34
7	Heather-Blueberry-Heath	Ericaceen-Heide	2470,163
	Overall size	**Gesamtfläche**	**1449794,02**

Table 6: Surface area of the individual plant communities

6 GAME MANAGEMENT

Only 660ha of Austrian forests can be described as primeval forests, all other forests have been managed at least once by humans. Species composition and age patterns of nearly all landscapes in Austria can be hardly described as semi-natural, and natural disturbances, especially hazards such as avalanches and wildfires, are suppressed as far as possible. Also the eradication of nearly all large predator species forces humankind into the position of being responsible for care and management of wildlife species. Abandonment of one management form will have impacts on the other forms as well.

Hunting has direct effects on species diversity and though a high responsibility for the welfare of the ecosystem. There is also a strong connection to nature conservation and its goals.

In the following chapter interactions between mountain pasturing, forestry and game management and the way how these different management approaches can influence each other will be discussed. Also the most prominent game species, their demands to the habitat and their interactions with the ecosystem will be shortly outlined.

6.1 ROE DEER

Roe deer (*Capreolus capreolus*) is a typical example for the feeding type selective browser. In the rumen of roe deer there is only a low density of cellulose-decomposing bacteria. They need fodder that is rich in nutrients but low in cellulose, such as buds, shoots, leaves, herbs, fruits and flowers whereas grass and other plants rich in fibres are mostly despised. According to BUBENIK 1984 at least 20 % of the total amount of fodder should be covered with woody fodder, tough and rich in tannins.

Due to its diet roe deer is still able to nourish even after the exhausting rutting season in summer and to build up reserves. During winter time physiology adapts to the decrease in food supply, as a result the rumen volume and the number of villi decreases. Buds and shoots are still eaten when they are available, but generally metabolism switches to burning the fat from the mast period in autumn.

6.2 RED DEER

Red deer (*Cervus elaphus*), in contrary to roe deer, represents the intermediate type, with a browsing diet with strong tendencies towards grazing. The rumen is very complex and able to react to different environmental conditions in terms of food supply. In case of free selectable fodder at least 50% of total fodder is covered by grasses and plants rich in fibres. If the demand of fibres cannot be met with the available supply, this demand has to be satisfied by peeling off the bark of trees. Also a certain amount of proteins has to be ingested, and this demand can be met by browsing on buds, shoots, herbs, flowers and fruits, similar to roe deer. If there is not enough supply in this plants or parts of plants, damages in silviculture will be the result (WAGENKNECHT 1994, S 80).

Red deer make high demands on their habitat. It needs meadows that fulfil their grazing demands and shrubbery to fulfil their browsing demands, thicket where it can rest and watering places. The undergrowth should consist of herbs and dwarf shrubs such as *Vaccinium* species, because they serve as important nourishment in winter. The consumption of bark is a normal behaviour for red deer, and if environmental conditions are sufficient, serious damages will not occur.

6.3 CHAMOIS

In terms of food demands chamois (*Rupicapra rupicapra*) is very similar to roe deer, at least during summer time. As a selective browser it prefers fodder that is rich in nutrients and proteins such as buds, shoots, berries and leaves from various *Ericaceae*. In winter time it changes its feeding behaviour towards grazing. Various Gramineae and alpine azalea (*Loiseleuria procumbens*), which can be found on snow-free, south-facing slopes and wind-exposed ridges, are amended with apical shots of larch, spruce, and pine (even dwarf pine) (WOKAC 2001). Damages caused by chamois mostly occur when ski mountaineers and other alpine winter sports disturb the animals and force them to descend and take shelter in the forest belt. There they are directly competing with roe deer and red deer for winter fodder.

Even though chamois has very similar feeding habits as goats and sheep they are not directly competing for food because chamois have in mostly any case the possibility to migrate to higher altitudes. For hunters this migration may pose a problem, because

animals may, at the same time, cross the boarders of the hunting grounds, so there may be an economic loss through wrong pasture management.

Pasturing cattle and horses are not facing a threat in terms of feeding competition, because cattle pastures are situated significantly below the steep pastures of chamois. Even goats and sheep, which have similar climbing abilities and feeding habits as chamois, pose only a threat when live stock density is far exceeding reasonable numbers.

According to NERL et al. (1995) typical features of good chamois habitats are alpine meadows above the timberline that are interconnected with interspersed dwarf pine krummholz and green alder shrubbery to take shelter. Also sparsely wooded slopes below sheer rock walls that are interspersed with rocks, meadows, troughs and dwarf shrubs are part of an “ideal” habitat. On Lafenberg Alm only these additional features can be found because the alpine meadows on the ridge do not belong to the property any more. Although there is no sedentary game population solitary animals can be frequently seen on Lafenberg Alm strolling through the green alder shrubberies. (pers. remark by Hans Pircher, 2009).

6.4 CAPERCAILLIE

As the largest representative of the subfamily Tetraonidae and of all European galliforms the Capercaillie or Wood Grouse (*Tetrao urogallus*) has its distribution in the boreal forests. It inhabits coniferous and mixed forests from the lowlands up to the timberline. Even more important than tree species composition for the habitat is the Taiga-like structure. Capercaillies are adapted to forest–climax vegetation in the form of interstitial and thin old-growth forests. Feeding habits, mode of movement, reproduction and advertisement are aligned to primeval forests, mountain forests at the timber line or forests in the borderland of bogs. Another very important habitat feature next to a sufficient existence of Ericaceae is richness in boardelines.

Along borderlines all the needs of Capercaillies are met:

+ A rich choice of insects, especially ants, that is crucial for the chicks
+ A rich undergrowth of trees provides shelter from predators
+ Lateral insolation that provides necessary warmth for the prosperity of the chicks

+ Favoured inhabitancies such as dust bathes, moult places, roosting trees and trees that facilitate a free take-off accumulate at borderlines

To ensure a good livestock the existence of sufficient food sources is crucial. In the first weeks chicks exclusively feed on insects and larvae. Later in summer they also feed on berries and other fruits. When shrubs are completely covered by snow they have to meet their food demands with needles, buds and shoots of conifers.
In figure 25 KLAUS et BRUCHHOLZ (1987) show the changes in principal food in the course of the seasons.

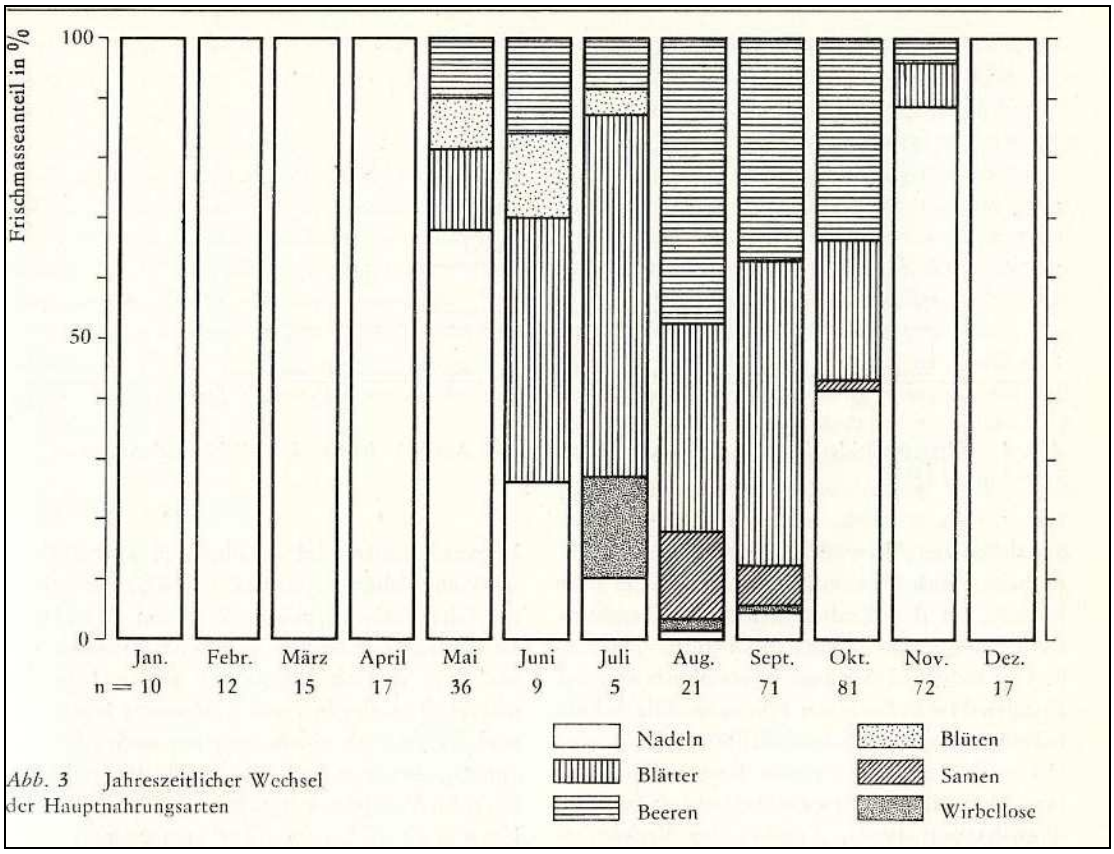


Fig. 26: Seasonal change in food preferences for capercaillie

A complete food supply includes following fodder plants in descending preference order: *Vaccinium myrtillus, Vaccinium vitis-idea, Empetrum nigrum, Melampyrum sp., Eriophorum sp*. and several *Cyperacaea*. In autumn also fruits such as beechnuts, acorns, rosehips cover a considerably part of the food supply. Before and during the egg-laying season hens and during moult both adults significantly increase their uptake in insects (especially ants).

Reasons for a decline in capercaillie populations are complex and manifold. Besides climatic changes towards a more continental climate with rain-laden summers deterioration of habitats is the driving force. Shortening of rotation periods clear cut practice, large even-aged monocultures, an increase in vermin and increasing disturbance through tourism especially in winter time are the main factors that degrade the habitat quality for capercaillie (KLAUS et. BRUCHHOLZ).

6.5 BLACK GROUSE

Black grouse (*Tetrao tetrix*) needs more open and more humid biotopes than capercaillies, but they share their need for borderlines and dwarf shrubs, especially Ericaceae-rich undergrowth. Open landscape and closed forests are avoided whereas half-open and rich structured habitats are preferred.

Courtship places are mainly located in avalanche aisles, clearings, heath or other open areas that are dry and flat and are often occupied for decades.

The food spectrum is concordant to capercaillies', but black grouse is even more euryphagous, that means that they have a wide food spectrum. Chicks and breeding hens are primary feeding on insects and larvae, whereas adults feed on berries, needles, buds, shoots, mosses, lichens, grasses…

During winter time, unlike capercaillies, black grouse feeds on buds of *Sorbus aucuparia,* shoots of larch and even needles of dwarf pine. In spring they often exclusively feed on flowers of *Eriophorum sp.*. This confirms the assumption that black grouse prefers boggy habitats.

Black grouse responds to a deterioration of their habitats even stronger than capercaillies do. Bogs are drained and reforested with monocultures of spruce, former alpine pastures are abandoned and start to be overgrown by trees. High densities of deer drastically reduce the fraction of *Sorbus aucuparia* and dwarf-shrubs rich in berries.

Also an increase in vermin, winter and summer tourism and the deterioration of bogs through drainage and eutrophication partake in reduction of black grouse population.

(KLAUS et BRUCHHOLZ 1987)

7 REVITALIZATION MEASURES

Pastures in the sub-alpine zone are areas kept open by pastoral agriculture. If grazing activity or mowing is reduced or abandoned natural succession will take place until a climax stadium is reached (apart from natural disasters and disturbances such as pests, avalanches, landslides…). For the most parts this climax community will be forest, except on sites where trees cannot grow (too shallow soils, moorland, accretion zones around water bodies, special bedrock chemistry e.g. Serpentin, permanent disturbances e.g. in avalanche aisles). After the last ice age when there have been large herds of herbivores some areas where forests had been cleared through wildfires or avalanches it is likely that “grassland” was able to establish and even expand through grazing and trampling activity of the animals (WALLNER et al. in: HOLZNER et al. 2007)

AIGNER et al. stated some principles for revitalization and maintenance of pastures:

+ Particular attention should be paid to the best sites.
  Efforts to preserve these sites are generally low but of highest economical importance in the long term.
+ Measures should be just applied on sites that are worth it.
  On sites with strong overgrow without valuable forage plants, on moors or wetlands, on steep slopes or avalanche aisles efforts are very high and the outcome generally low. These sites should be abandoned and left for nature
+ Single interventions should be combined.
  Measures carried out solely do often not show the desired effects, but combined with others they can achieve one’s aims.
+ Create large and connected pastures
  One large, continuous pasture is easier to manage than several small ones
+ Maintenance work should happen in time and continuously
  Frequent and timely carried out maintenance is better than one big, extensive revitalization. Revitalization does only make sense if there is frequent and consecutive maintenance.

+ Coordination of measures and utilization

  Utilization must be adapted to the improvement of the pasture quality. If the quality of a pasture is increased, the number of animals and the periods of utilization and protection have to be adapted, otherwise animals will not be able to tap the full potential of the pasture.

+ Consideration of site conditions

  Special conditions and natural background have to be respected if a sustainable improvement and utilization should be achieved.

There are plenty of possibilities to revitalize or recultivate an abandoned alpine pasture. Which technique is best suited is strongly depending on several factors such as degree of succession, geomorphology, accessibility of the Alm, the existence of subsidies for certain measures, ecological importance of the area… Usually work in high altitudes requires proper planning and preparation because the sites are in most cases remote and difficult to reach.

It is very important to define exactly the actual state of a site and if its worth to put any efforts into it, because as mentioned before work in sub-alpine or alpine terrain can be very hard and working materials often have to be carried for longer distances and along steep slopes.

Further maintenance is essential for any revitalization efforts, because lacking maintenance leads to a decrease in pasture quality in the first place. Proper management in this term mean not only the right choice of animal, but also the right number and in the right time to keep them on alpine and subalpine pastures. Also elaborated infrastructure such as fences, watering places and shelter is vital to achieve a good pasture status.

In some cases there may be some additional, graver intervention required. Drainage of swampy meadows, irrigation of dry sites, liming and manuring, sowing of special seed mixtures are possibilities but on has to be aware that each in intervention into the water-, pH- and nutrient balance of soils may have severe and complex impacts on the environment. The use of natural and ecologically sustainable tools for landscape management should be favoured anyway to changes in soil chemistry. The most obvious way to manage and maintain a pasture is to use animals to do the work, more precisely to implement their natural fondness for certain plants and part of plants to change the abundance of some undesirable plants.

Of course, every intervention into the ecosystem Alm has to come to an agreement with the stakeholders, notably the owner of the land, the farmer, the forester, the hunter in charge and the local nature conservation delegate. All these parties are somehow involved into the management of alpine pastoral systems and their interests have to be protected.

7.1 CONTROLLED BURNING

The use of fire for clearing forests or scrublands is a very old practice used by humans for several thousands of years. Compared to many other ecosystems that even depend on frequent natural wildfires, subalpine and alpine vegetation is affected by natural wildfires only very scarcely. Generally climate is too humid to allow large-scale fires, but under special conditions (long periods without rain, strong winds and "dry thunderstorms") subalpine coniferous forests can catch fire after lightning. Due to the high content of resins conifers are prone to crown fires and do not have any adaptations to resist the fire. On the other hand subalpine or alpine heath has only a very low risk to be burned naturally because there is almost no fuel to facilitate the spreading of a surface fire. In case of controlled burning sound planning and perfect conditions are evitable to achieve good results.
As a tool for landscape management there are two basic approaches: the laminar burning of vegetation (living or dead) and the burning of plant residues from clearings concentrated on a few spots. Both approaches are restricted through the federal law and the federal law on nature conservation.

According to §13 of the Styrian Federal Law on Nature Conservation 1976 it is forbidden to … burn ground vegetation on extensive or unused sites … between March 25th and October 15th above 1500m a.s.l.

According to §4 of the Federal Law BGBL . 405/1993.

…the punctual burning of biogenic materials outside of facilities is prohibited between May 1st and September 15th …

If fire is used to remove above-ground vegetation according to AIGNER et al 2003 there are several factors that have to be taken into consideration

+ Soils must not be too shallow

+ Soils must not be dried out completely
+ The slope must not exceed a certain inclination because the risk of erosion
+ Fire should move with the wind, so that the durance of high temperature on one spot is as short as possible
+ The measure should be carried out only on small plots (max. ½ hectare)
+ After burning there may be necessary an after-treatment such as sowing or manuring.

HUBER et al. made an experiment testing the impact of prescribed burning on subalpine pastures on species diversity of vegetation, insects and spiders. It was proven that *Calluna vulgaris* and *Juniperus communis* significantly suffer and decrease in their abundance. Shrubs such as *Vaccinum myrtillus, Vaccinium vitis-idaea* and *Rhododendron ferrugineum* are in fact badly damaged but show the ability to resprout shortly after burning. Whether the top soil layer with its soil organisms and subsurface plant organs is damaged is depending on the depth and durance of the heat. This can be regulated by burning the site with or against the wind direction. If soils are dry the blaze is able to reach deeper layers and damage biomass.

Looking at animals, but especially spiders and insects, there can be made clear statements on the impact of fires on species diversity. The chance to escape and survive the fire is decreasing with decreasing body size and mobility. Nevertheless, long range changes in species number and composition are more likely to be caused by the change of the habitat than through the direct effect of fire itself.

Plants with rhizomes, tap roots and sub-soil stolons are clearly favoured over bunch grasses and plants that build rosettes, which are very sensitive to fire. Ash is rich in nutrients but deplete of nitrogen because it is being volatilized in fire. Pioneer species may take advantage of these easily available nutrients and colonize burned areas quickly. Ashes and with them nutrients and even upper soil may be eroded both by water and wind if conditions are unfavourable. Also due to the resprouting ability of some dwarf-shrubs it can be useful to sow seeds to reach a desired fodder plant composition (AIGNER et al. 2003).

However, due to the small range of possibilities where burning forms a sustainable and feasible alternative in landscape management, “prescribed burning” won’t become more important in future.

7.2 SOWING

Even though sowing is an important tool for erosion control and prevention in ecological engineering, also its importance for alpine pasture revitalization is not negligible. Sowing can be basically seen as a complementary or additional measure following preliminary steps to change/improve the qualitative composition of a pasture. Of particular importance are knowledge about and the consideration of external constrains (altitude, inclination, exposition, humidity, soil type and depth, bedrock material) because all these factors may effect the success of sowing efforts.

Principally there are two types of sowing: Tilling and No-till sowing.
The first approach is mainly applied following severe measures such as clearing, levelling, milling and mulching. Tilling practices are limited to large site where the use of machinery is possible, which clearly limits the capability of this approach. AIGNER et al. discriminate different ways to sow the seeds.

+ Seeds are covered with a thin layer of straw (one or two layer, about 300 to 400g/m²). Under the straw-layer seeds are protected against exsiccation and being eaten by animals and are able to create a closed sod. On very steep or wind-exposed slopes straw mats can be even more appropriate to protect the seeds.
+ Seeds are intermingled with water, soil or turf, fertilizer and a special bonding emulsion. This mixture is then spread over the area. This technique is especially appropriate on sites with shallow, poor soils. There is need for special machinery and expert knowledge and therefore not the cheapest way.
+ Seeds are spread very late in autumn just before snowfall. Directly after snowmelt in spring, when soils reach the right temperature, seeds are able to germinate. It is very important not to sow too early because a few warm days in late autumn are enough for the seeds to germinate and the plants may freeze off.
+ Seeds are coated with a special layer that contains nutrients and trace elements. This coating has also hygroscopic properties and though accelerating the germination process. Another advantage is that the

coated seeds are heavier and not so susceptible to be carried away by winds any more. Also the diameter and weight differences between different kinds of seeds are smoothened to certain extend and prevents segregation of the seed mixture.

No-till sowing, as the second approach, is applied on the “uncultivated” soil on gaps from preliminary, manually operated clearings. This technique is rather adequate for smaller sites or mosaic-like structured clearings. It is also possible to sow the seeds directly before animals are driven on the fenced area. Animals will incorporate the seeds into the soil with their hoofs. This approach is also called hoof-cultivation and is a kind of hybrid between tilling and no-tilling approach.

AIGNER et al. elaborate a statement of the costs for sowing:

Method	Effort	Costs in €/ha
Seeds for sites up to 1400m a.s.l.	40 to 80 kg/ha 4,40 to 5,50 €/kg	180.- to 440.-
Seeds for sites up to 1700m a.s.l.	80 to 180 kg/ha 4,70 to 6,00 €/kg	380.- to 1.080.-
Seeds for sites above 1700m a.s.l.	100 to 140 kg/ha 11 to 13 €/kg	1.100.- to 1.820 .-
Working hours	Sowing with a special machine 1 to 2 h/ha	30.- to 55.-
Straw (without seeds)	5.000 kg/ha	880.-
Working hours	Work with a blower 15 h/ha	490.-
Spreading with a spraying device (without seeds)	5 to 6 h/ha, requires water supply	2.180.-
Secondary sowing	20 to 60 kg/ha 4,40 €/kg	90.- to 265.-

Table 7: Costs for seeds and sowing

Acid bedrock		Basic bedrock	
Plant name	Ratio in%	Plant name	Ratio in %
Festuca nigrescens	16,0	*Festuca nigrescens*	15,0
Festuca rubra	25,0	*Festuca rubra*	20,0
Agrostis capillaris	8,0	*Agrostis capillaris*	5,0
Holcus lanatus	1,0	*Alopecurus pratensis*	3,0
Anthoxanthum odoratum	2,0	*Lolium perenne*	5,0
Poa nemoralis .	1,0	*Poa pratensis*	15,0
Phleum pratense	5,0	*Phleum pratense*	6,0
Alopecurus pratensis	2,0	*Dactylis glomerata*	6,0
Lolium perenne	5,0	*Trifolium repens*	13,0
Poa pratensis	10,0	*Lotus corniculatus*	10,0
Festuca pratensis	5,0	*Anthyllis vulneraria ssp. alpina*	2,0
Trifolium repens	15,0		
Lotus corniculatus	5,0		

Table 8: Seed-mixture for sites below timberline up to 1.700m a.s.l.
(ReNatura Montan M1 und M2, Zusammensetzung: Dr. Lichtenegger, Dr. Krautzer, Pflanzennamen nach ADLER et al. 1994) AIGNER et al. 2003 Almen bewirtschaften S 102

7.3 CLEARING

Clearing is not only the removal of trees and shrubs but also of dwarf shrubs and even grass. Whereas in former times all forms of clearings were carried out by hand, different kind of machines can facilitate these works nowadays. The most common tools were hatchets, hand saws and clearing scythe. There are several advantages of these “primitive” tools

+ Their low weight, so they can be carried easily for longer distances to remote sites
+ They work without fuel and are very cheap in to maintain.
+ Relative low costs of the tools and their simple construction. In case of a break-down forest workers or farmers were in most cases able to fix a broken tool right on site and could continue work quickly.

Regardless of the advantages of the “good old tools” modernisation makes work much easier for farmers. Although modern tools are heavier, more expensive and need fuel, they substantially reduce working time and labour.

To enable the use of “heavy machinery” the sites must be reachable at least with tractors, because not only machines but also fuel and oil have to be brought to the site.

For the removal of trees and shrubs such as green alder or dwarf pine chainsaws are best suited. Shrubs with a small diameter can be cut with a brush cutter, which is an adaptation of a string trimmer with a metal disc that can cope with stems with diameters up to 10 cm. Other possibilities to clear dwarf shrubs are cutter mower and rotary mower, but their use is restricted to a certain inclination of the slope.

Another important point has to be taken into consideration: the removal of the residues. The best way to cope with the plant residues is according to AIGNER et al. controlled burning. They give several recommendations for secure and conservative proceeding:

+ The burning has to be announced at the local fire brigade and the local authority
+ Legal requirements have to be kept (see above under Controlled burning)
+ Burning should be carried out only under appropriate weather conditions (no wind, plant residues should be dry and barren, soils should be slightly humid)
+ Spreading of the fire has to be prevented
+ It is better to make several small than one big accumulation of residues
+ Larger sites have to be sowed afterwards
+ woody materials with a high content in resins (dwarf pine, juniper) are burning best when they are fresh

Clearing with brush cutter	Time expenditure (h/ha)	Labour and machine cost (€/ha excl. UST)
Low efforts (slightly overgrown, 10 to 30% coverage)		Brush cutter(2,5 kW) and working time (11,5 €/h)
Clearing	15 to 20	170.- to 230.-
Removal and burning	20 to 30	180.- to 270.-
Total	35 to 50	350.- to 500.-
Middle efforts (30 to 60% coverage)		
Clearing	20 to 30	230.- to 345.-
Removal and burning	30 to 45	270.- to 405.-
Total	50 to 75	500.- to 750.-
High efforts (> 60% coverage)		
Clearing	30 to 40	345.- to 460.-
Removal and burning	45 to 60	405.- to 540.-
Total	75 to 100	750.- to 1.000.-

Table 9: Time expenditure and costs for clearing of dwarf shrubs (Alpine rose, Blueberry, Juniper, Scotch heather) AIGNER et al. 2003 Almen bewirtschaften

Clearing with chain saw	Time expenditure (h/ha)	Labour and machine cost (€/ha excl. UST)
Low efforts (slightly overgrown, 10 to 30% coverage)		Chain saw (3,5 kW) and working time (12,3 €/h)
Clearing	10 to 30	120.- to 370.-
Removal and burning	15 to 45	135.- to 405.-
Total	25 to 75	255.- to 775.-
Middle efforts (30 to 60% coverage)		
Clearing	30 to 60	370.- to 740.-
Removal and burning	45 to 90	405.- to 810.-
Total	75 to 150	775.- to 1.550.-
High efforts (> 60% coverage)		
Clearing	60 to 100	740.- to 1.230.-
Removal and burning	90 to 150	810.- to 1.350.-
Total	150 to 250	1550.- to 2.580.-

Table 10: Time expenditure and costs for clearing of krummholz (Dwarf pine, green alder)

7.4 FLAIL MOWING

The use of a flail mower may be appropriate to clear larger areas from dwarf shrubs such as *Calluna vulgaris* or *Rhododendron ferrugineum*. Vertically rotating flails that are fixed on a cylinder and moving by centrifugal forces are chopping the aerial parts and spreading them equally over the area. The chopped material can decompose quickly and work as a fertilization. As an amendatory measure sowing of suitable seed-mixtures should be done immediately after flailing because dwarf shrubs tend to resprout to a certain extend.
The goal from a nature conservation point of view would be a small-structured mosaic, but this technique is better suited for larger areas with small inclinations and low floor unevenness. So this technique may be not the best choice for a sensitive way of working on a richly structured site.

7.5. MILLING

This technique is generally applied on former clearings or on strongly overgrown sites. Milling is very similar to flail mowing, looking at the basic technical principles. Again there is a rotating cylinder but there are rigid steel cogs instead of flails assembled around the cylinder. This cylinder is rotating very fast and can be pressed on the ground with the hydraulic system of the carrier machine, which can be a tractor or a caterpillar. The steel cogs are able to crush stems, stools and even boulders to a depth about 20cm. Because of the complete destruction of the sod subsequent sowing is essential.
This is a severe intervention and should not be carried out on sites with inclinations above 20% or shallow soils (AIGNER et al. 2003). From an ecological perspective there are the same concerns as for milling.

7.6 FERTILIZATION

Fertilization can be seen a measure to increase the harvest on existing pastures or as a preparative on sites, that have been burned, milled or flailed before. Anyhow, fertilization must be applied carefully, because this is a severe intervention into the

chemical soil-water-plant-atmosphere relationship. Wrong or immoderate fertilization can have a wide range of consequences concerning flora and fauna, so careful investigations should be carried out before.

An ancient way to bring nutrients on the pastures is channelling. In former times channels parallel to the contour lines were excavated and in spring melt water was spread via these ditches all over the pastures. Melt water is rich in minerals and nutrients because snow crystals grow around microscopic dust particles (pers. remark of Wolfgang Holzner). On Lafenberg Alm there are still reamains of such a ditch visible.

Fertilization only makes sense when the sites are grazed down evenly or mowed in time (AIGNER et al. 2003), otherwise undesired plants such as tall forbs may dominate the site very quickly. Generally alpine pastures are fertilized by animals which drop their dung in a more or less accidentally. For extensively used pastures well rotten manure from stables on the Alm or compost are best suited for fertilization.

7.7 TARGETED GRAZING

7.7.1 FENCING

Fencing stands for pasture revitalization and management carried out by animals. Fences help farmers to keep their animals where they should be. Either competent shepherds are able to control their herds using cattle dogs but there are only few people left nowadays that know this ancient business and are willing to do this very special and challenging work.

Fences are physical barriers that keep animals outside or inside a desired area. These fences can be made of wood, iron or both combined, with or without electricity; their construction is depending on the purpose of the fence and the properties of the fenced animals. Some animals, such as red deer or goats, can easily overcome barriers 1,20m in height, whereas others are very robust or have a thick fur so they do not feel the electric shock of an electrical fence.

Permanent fences have to be placed carefully because moving snow masses (both avalanches and slowly sliding snow layers) during winter can easily break the pales. To renew a permanent fence every year is economically not feasible because permanent systems are more expensive and more elaborate to construct than mobile ones. For

the most animals electrical fences with portable solar-fed batteries are the most practicable and cost-effective solution.
One should always keep in mind that maintenance of existing pastures is much easier than to recultivate overgrown sites. Sound pasture management is even able to increase the yield, improve the quality of a pasture and to extend the period of pasturing (AIGNER et al. 2003).

Irrespective to the species of the grazing animal the husbandry has to be concordant with the primary requirements to the animals. If these requirements are met and there is a sound management plan, there can be a significant saving of money and labour, which is shown in the following diagram:

7.7.2 DAIRY PRODUCTION ON ALPINE PASTURES

Husbandry of animals kept for dairy production is very demanding,

+ Animals have to be driven to the stable and back to the pastures every day to milk them.
+ There are high requirements to hygiene, and there is also a demand for reliable, safe water supply with good quality water.
+ There need to be a sound infrastructure to process the milk, and everything has to be done under strict guidelines, if the products should be sold.
+ There is also the need for purchaser for the dairy products. They can be sold directly on the Alm or they can be delivered to local markets or tradespeople.
+ People who process the milk need much knowledge and experience and must be willing to do this heavy work for often inadequate payment.

Generally spoken animals kept for milk production do not need to be fenced because they are craving to get milked, so they will return willingly to the keeper every day exactly for the same time. If there is some additional feeding of minerals there won't be any problems to bring them to the stables, regardless if it's cattle, sheep or goats.
But there are some restrictions to the use of these animals for landscape management and "weed control". Many plants considered as "problem"-species or weeds contain bitter or poisonous constituents. Even if animals can eat these plants without harm,

which is especially valid for goats, the bitter agents and tannins can be found even in the milk and though make it inedible.

Another problem is the mostly remote location of the alpine cabin, which may lead to difficulties concerning the pick-up service for the milk. If the alpine cabin is too remote or if there is no proper road there is only the possibility to direct disposal to hikers and tourists. This is generally a good strategy to run alpine farming in a sustainable and ecologically and economically sound way. But as mentioned above there is the need for people who are willing to do this work which is somehow a contradiction to the modern way of life.

7.7.3 MEAT PRODUCTION ON ALPINE PASTURES

Animals kept for meat production can be managed in a less labour-intensive way compared to dairy production. In most cases purchaser who buy meat have stronger interest in meat from young animals, more precisely from calves, lamb and fawn.

Husbandry of animals kept for this purpose don't need to be looked after them every day, especially when they are free ranging. But regular visits from the farmer are important to check if the animals are healthy or in a good shape. These visits, where the farmer should provide the animals with salt and minerals, are also important not to loose the relationship to his animals. It also frequently happens that animals fall down and hurt themselves or are struck by lightning.

This is the cheapest and probably the most animal friendly way to fatten up young animals. Fodder quality and nutrient content is highest in the first weeks of summer and so young animals have optimal conditions to grow healthy and strong.

Animals kept for meat production are also not best suited for landscape management, because on sites that have to be recultivated good fodder plants are generally rare, and animals are often feeding below their optimum. That's why the increment of meat is suboptimal, but this deficit can be compensated through keeping them additionally for some time in the stables. It could have been proved that animals that spent the summer on alpine pastures are able to compensate the retarded growth in higher altitudes within a short time in stables afterwards.

7.7.4 FEEDING TYPES

Feeding habits of animals are determined by the “design” of their digestive tract and the anatomy of their mouthparts and vice versa. Cows are completely different from horses concerning the way how to grab the plants and to digest them. Even similar animals as sheep and goats differ in their feeding habits. Ungulates (cows, sheep, goats, roe deer and red deer) are ruminants; they have a very complex digestion system, whereas hindgut fermenters (horse, hare) have a rather simple one. The physiology of the digestion system manifests itself in very typical feeding habits.

7.7.4.1 CATTLE

Domestication of cows is likely to have happened after domestication of sheep and goats, about 8.500 y.b.p. The forebear of the modern European cattle (*Bos primigenius primigenius*) was the wild cattle or aurochs (*Bos primigenius*) (PHILLIPS 2001). Pristine wild cattle, which have been eradicated in the beginning of the 16th century in Poland, had a very massive body and were very strong and agile at the same time. Domestication of cattle was probably not an easy task compared to goats or sheep due to their size and temperament (HERRE et al., 1990).

Cattle are typical grazers that require a certain amount of crude fibre and cellulose. The major part of the food requirements is met by grassy plants, mainly Gramineae, and also deciduous trees with soft leaves and flowers of Ericaceae are not despised.

But the browsing activity of cattle on woody plants is hardly sufficient to repress upcoming trees and shrubs. Only in a very early stage when plants are eaten together with grassy plants there may be a certain retarding effect.

However, the effects of weight and the claws of cattle on woody plants must not be underestimated (WOKAC 2001).

Cattle grab the whole plant as a bundle together with close-by herbs with its tongue and rip it off. This technique does not allow an exact selection of fodder plants compared to sheep or goats, which very often feed on certain plant organs. Undesired plants are only avoided if they are growing in groups. This feeding behaviour creates an evenly grazed pasture with groups of undesired plants, which can easily be removed with machinery or by hand.

Depending on the primary production aim of cattle there are different pasturing systems concerning age and sex structure of the herd, the required quality of the pasture and husbandry of the animals. The two main products are dairy products and meat.

Dairy farming on alpine pastures requires some basic factors:

+ Infrastructure that is necessary to process the milk and to house farming personnel and animals
+ Permanent, secure and sufficient water supply
+ Purchaser and consumer who buy the milk and other dairy products

7.7.4.2 SHEEP

Sheep are closely related to goats, both belong to the subfamily Caprinae. But sheep have, contrary to goats, similar feeding habits to cattle, but are more selective in terms of fodder plants. The smaller and narrower heads enable sheep to select young shoots and tasty plant parts. Alike cattle, sheep keep a pasture evenly short, except poisonous plants (Ferns, *Veratrum album, Aconitum sp.*), very aromatic and stinging plants and typical tall forb plants (*Urtica dioica, Rumex sp.*) (WOKAC 2001).
Sheep gnaw the sod very low, sometimes they even tear out the whole plants including the roots (DOBOS 2000). Their foraging can be compared to a lawn-mower.
As a “tool” for maintenance work sheep are suitable only to a limited extent. Problematic plants in terms of edibility such as *Nardus stricta* and *Deschampsia cespitosa* are avoided by sheep and would be able to spread. Also for repressing of shrubs and trees sheep are not suited (HOFER et al 2002).

7.7.4.3 GOATS

Goats (*Capra hircus*) have been domesticated around 10.000 y.b.p and are besides dogs the oldest domestic animal (RAHMANN 2009). All today’s breeds can be traced back to the Bezoar goat (*Caprea aegagrus aegagrus*), which has its original distribution in the mountains of Middle East and Asia Minor (SCHRÖDER 1995). For poor people goats were crucial animals due to their natural adaptation to poor habitats and their robustness throughout all continents and times. The “cow of the poor man” needs less

space due to their smaller size compared to cows or horses and, thus, need less food. Despite its role as a supplier for meat and milk, even as a draft animal, goats never had such importance in agriculture like cows or sheep.

In contrary in developing countries goats often form the livelihood for many people (RAHMANN 2009).

RAHMANN (2000) puts down their specific suitability for scrub clearance and landscape maintenance to physiological, morphological and ethological characteristics. Their physique and digestion system determine the range of application, whereas their behaviour pattern limits this range in terms of appropriate animal care.

In the wild goats prefer dry, mountainous and forested areas that can be located around the timberline (at least during summer time). Goats are not very sensitive to high or low temperatures, but they do not like rain and take shelter if they can.

Concerning their feeding behaviour goats are similar to roe deer. They have a very wide range, but are highly selective at the same time. The bigger the choice the more selective they get. The menu consists of grasses, herbs, ferns, mosses, shoots, buds, twigs, leaves, bark, seeds and fruits, which mean that goat habitats have to be highly diverse concerning species diversity.

If goats have the choice and opportunity up to 60% of their food demand is covered by leaves and could even rise with advancing age of the herb layer. The cleaved upper lip enables goats to select vey small plants or parts of plants or to browse even on twigs with thorns (RAHMANN 2009). Additionally goats show a behaviour called “facultative Bipedie”, which is unique within all working animals. To reach higher plants or leaves they can draw themselves up to their hindlimbs.

All these properties qualify goats notably for landscape management and scrub clearance.

But goats are not suited to share their pasture with cows or other animals because they despise sites where that have been grazed or even entered before (WOKAC 2001).

The timing of management measures such as browsing is of significant importance, because different plant parts have different amounts of nutrients in the course of the year and determine the intensity and amounts of browsing, as shown in the following diagram:

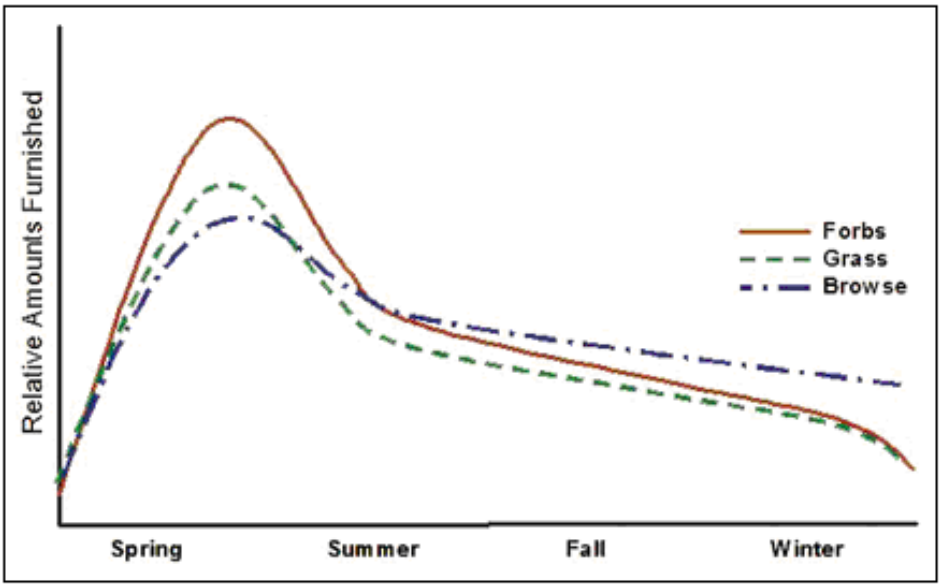


Fig. 27: Seasonal trends in protein, minerals, and vitamins in forest and rangeland forages

To effectively fight woody plants on pastures it is quite important to find the right balance between size of the paddock (or designated area) and number of animals. If the size of the site is too small or the food supply is not sufficient, there is the threat of overgrazing with all its negative after-effects, or may even result in the outbreak of the goats. Also proper timing, durance and interval are vital for successfully “weed control”. To get optimal results pasturing should start as early as possible in the year when the shoots are young and resprouting ability is weakened most (PERRENOUD et al. 2006).

Fig. 28: Degraded hedgerow on a permanent goat-paddock in the Canton Grisons

If the goats are intended to stay for a longer time on one site there should be a portion of at least 30 % covered by grassland besides shrubs and trees to meet the demand of goats for forage variety (RAHMANN 2000)

8 REVITALIZATION PROJECT IN MUTTEN (CH)

In the year 2002 in the municipality Mutten in the Canton Grisons (Graubünden) Mr. Otto Denoth set up a project together with several local farmers that considers all the qualities of goat farming. Mr Denoth works as a consultant at the agricultural school Plantahof in the Canton Grisons. A former pasture in 1.900 m a.s.l. has been abandoned some decades ago, and as a result of this Green Alder (*Alnus viridis*) invaded in this site and formed a wide thicket up to 2 metres in height.

8.1 PROJECT SETUP

The site was divided in paddocks with a size of about 1.5ha each. The goats, which all have been juvenile, non-lactating animals, were provided by a local goat farmer. There was not only one, specific race used but a mixture of several, ancient Swiss breeds such as the Gämsfärbige Gebirgsziege, Walliser Schwarzhalsziege, Stiefelgeiss and Pfauenziege. These breeds are very robust and adapted to life in the (sub-) alpine region very well.

The 30 animals were kept in one paddock for 3 month and a local herdsman from Mutten took care of them during summer. The paddock was bordered with an electric fence with two wires. There had also been a permanent water supply, which was one of the basic requirements for the project. It was not necessary to built additional shelter, because there was plenty of thicket and shrubbery on the site.

The project was only realizable because the Canton Grisons and the municipality agreed to bear the costs for the fences (about 2.500 CHF ~ 1.600 €) and local forestry offered hand to the farmers.

8.2 RESULTS

As expected, the goats completely degraded the alders by climbing on the stems, peeling off the bark and browsing on the twigs, leaves and bark. None of the animals felt ill during their stay in the paddock, which is also an important success.

The dead plant residues were cut with chain saws and burned directly onsite. There was the plan to keep cattle already in the following year, but actually this was not the

case. Anyway, the undergrowth had needed some time to recover, and so did also some of the green alders. Some plants had survived and started to resprout, but this was anything but unexpected. The cows would have been able to browse on the delicate, lush leaves growing directly over the ground.

But even after 6 years there had been no pasturing with cattle, and because green alders started growing strong again the farmers decided to drive goats again on this site to clear it finally. But this goal can only be reached if there is permanent, sound pasture management ongoing.

Fig. 29: Browsed area on the right, unmanaged site on the left

Fig. 30: Resprouting green alder after several years

8.3 DISCUSSION AND OUTLOOK

There are also some other projects dealing with landscape management with goats in the near surroundings of Thusis (Ch). Mr. Denoth also supervises a project in Bot Danisch in the municipality of Bonaduz in the Canton Grisons. Bot Danisch is a small hill in the valley which is under pastural use for several centuries. But the very meagre site is starting to get overgrown with shrubs due to undergrazing. Goats are ment to solve this problem and reduce maintenance cost drastically. These projects in Switzerland are possible because the Cantons are willing to support the idea of using goats as an alternative tool in landscape management. The Canton Grisons is willing to pay 500 CHF (~ 330€) per goat per year to substitute the costs and to motivate the farmer.

Generally, the government of Switzerland is well aware of its prosperity in natural resources and beautiful landscape and is willing to support any efforts to preserve this wealth. Even farmers living in very remote areas get subsidies to continue their way of living in the alpine region. Also young families are subsidized if they decide to move to rural settlements.

At the moment a farmer gets about 2 CHF (~1,2 €) for one litre of goat milk if he delivers the milk to a community dairy, which proceeds and sells dairy products locally (pers. remark of Mr. Otto Denoth).

This backing from government is inevitable to enable such a small-scaled agricultural system. But there must also be the attitude of people to buy these products. Many people in Austria do not have any relationship towards goat milk or meat, because of its specific taste. But people in rural landscapes never stopped consuming these products and consider them as “normal” groceries. If there is no acceptance and therefore no purchasers for dairy products or meat from goats, even the best sound management is doomed to failure.

Goat products have to reach the status of a delicacy, some goods produced under ecological sound conditions, maybe even certified with a label for organic farming. Even it looks difficult to reach this point, it succeeded even once several years ago. Sheep meat and dairy products, especially cheese, had a low tolerance in the population in the past, but due to sound marketing strategies and the elevation into the status of a delicacy it’s not a problem to sell sheep products nowadays.

This acceptance for goat meat is important to enhance the use of goats for landscape management. Dairy production and landscape management are difficult to reconcile because dairy production presuppose proper infrastructure for milk proceeding, the possibility for delivery of milk and cheese and at least one person who runs all the workings. Also the quantity and quality of milk from goats used for landscape management cannot be considered as constant. To state some reasons, nutrient supply may be not optimal when feeding on bark, twigs and leafs for a certain time. Also the fact that bitter plant constituents such as bitterns and tannins could be detected in the milk excludes these goats from a reasonable source of milk.

Mr Denoth advises to use goats that are non-lactating, either not yet or not anymore. Especially the use of young goats that can be sold for meat production afterwards are one possibility to combine a positive economic outcome and landscape management. But there has to be done careful husbandry, veterinary care and the possibility of live stock losses due to diseases and other external factors.

9 VEGETATION

9.1 VEGETATION DEVELOPMENT

The two panorama views show the Lafenberg Alm in southern direction. Both photos just show one half of the Alm, whereas the second half is located below the ridge in the back. The first photograph show the Alm in its present state (July 2009), whereas the second photographs were made in the year 1966. Under closer examination it becomes apparent that changes in the aspect are barely visible at first sight. The only obvious changes are the huts, which are cognizable today only in some leftovers of the foundation walls. But husbandry must have been abandoned already once in history because both huts look dilapidated already for some time on ht ephotograph from 1966.

Dock–dominated vegetation around the huts (f) have already existed at that time, they even seem to have been more widespread, because there was dairy production in former times (pers. comm. of Mr. Hans Pircher)

On the slope below the new hat there are structures parallel to the contour lines, called “Viehgangeln” (g). This phenomenon indicates the presence of cattle and can be explained by the fact that cattle prefer to graze in parallel position to the contour lines. STAHR et al. (1999) posts that the digestion performance is strongly influenced by the inclination of the digestion system. A certain inclination can even do harm to the animals.

Animals without alpine experience are often loosing weight in their first time on alpine pastures, until they learn how to keep their digestion system in balance. The heavy weight of cattle and their repetitive migration pattern result in a formation of steps parallel to the contour lines.

The avalanche aisle has more or less the same size and shape as today, which is also coherent. On the old photograph the last avalanche event was obviously a few years ago because there are many young trees growing there (e).

After comparison (a) of the shape of both aisles it seems as if the recent avalanches headed further downwards than before. Trees at the lower end of the aisle are significantly denser in the old photographs compared to the actual ones. Nowadays

avalanches have an open strip without almost any obstacles in their way and will maybe reach a bit further every time.

Evidence for pasturing is also given by a lower density of dwarf shrubs in the front of the photographs (b). As a result of undergrazing dwarf shrubs such as *Vaccinium myrtillus* and *Vaccinium gaultherioides* are spreading as the first signs of natural reforestation. Another evidence for former grazing activity is the lower density of trees in the small grove in the lower part of the Alm (d). Cattle usually like to remain around or inside such groves because on the one hand they give shelter in case of thunder storms or strong winds, on the other hand insects are less annoying. The permanent presence of cattle retards tree regeneration through trampling and striking with their horns.

Looking at the ridge it becomes apparent that the size of the areas covered by green alder shrubberies (c) has also significantly increased during the last forty years. This could be put back to the abandonment of pasturing with sheep. Sheep usually do not have any problems to climb steep slopes to graze down vegetation. Without any grazing stress green alders spread quickly and are now covering about 13 % of the overall area on the Alm, with an upward tendency.

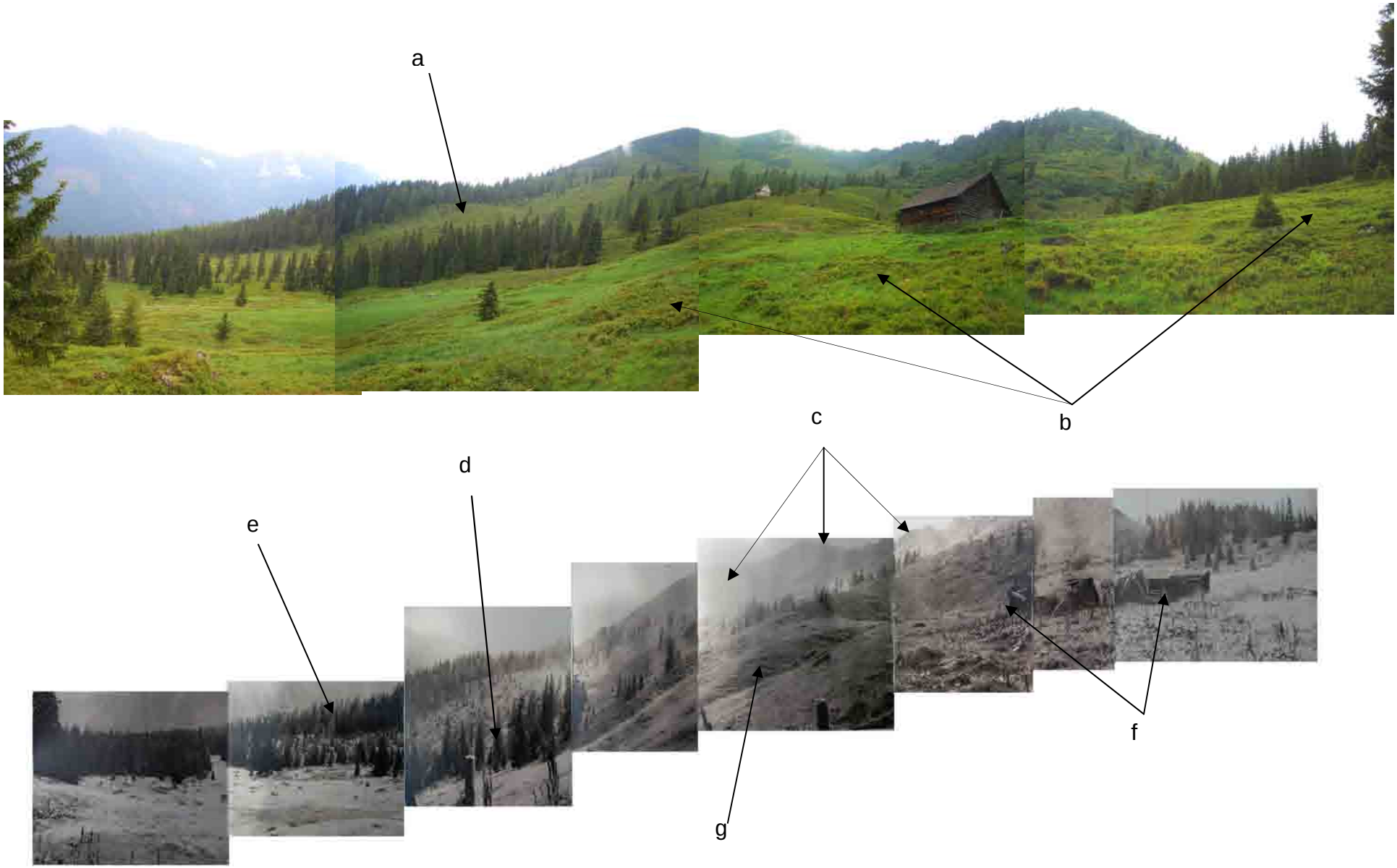


Fig 31. Comparison of two panoramic photographs from 1966 and 2009

9.2 POSSIBILITIES FOR RECULTIVATION

Because of the heterogeneity of Lafenberg Alm a general “master plan” for revitalization is not feasible. Depending on the exposition, inclination and relief some sites show a higher potential as pastures than others.

Starting with the most promising sites, the mat-grass swards, **Nardetum strictae**, below the old hut are the last remains of former pastures. On closer examination of the panoramic photograph from the year 1966 larger parts of the south-eastern parts of the Alm were covered by a probably similar plant community, which is nowadays mostly covered by dwarf shrubs.

This type of a strict mat grass meadow is a relatively low-yielding association (with 10 to 20 dt/ha) and medium fodder quality. Species diversity is relatively low compared to a mild *Nardetum*. Most of the plants that dominate this association can be described as plants typically growing on sites with poor nutrient supply and extensive utilization (*Hypericum maculatum, Nardus stricta, Vaccinium myrtillus)*. At least *Nardus stricta* has its ecological optimum on sites with better nutrient supply, but there it would be replaced due to pressure of competition (AICHINGER 1953).

Re-intensification of pasturing and/or manuring may change the species composition towards a red fescue (*Festuca rubra agg*.) – common bent (*Agrostis capillaris*) dominated grassland. High dominances of *Agrostis tenuis* and *Festuca rubra agg*. indicate a higher content of bio-available nitrogen in the soil, whereas a high content of sesquioxides and strong acidification of the soils are favouring the dominance of *Nardus stricta* (BOHNER 1999). With a change in species composition there is also an improvement in yield and fodder quality.

ELLMAUER et. al. (1993) posts that manuring of mat grass swards can propagate a colourful, herbaceous meadow such as Crepido-Festucetum commutatae Lüdi (1948). To improve the quality of this site resumption of extensive pasturing with cows would be the most promising way.

On the other hand badly managed pasturing can lead to damages both in species composition and in soil structure. The total size of this phytocoenosis is relatively small, and too many GVE kept there will lead to compaction and erosion of soils and, because of the excrements, accumulation of nutrients and an unfavourable change in species composition will be the result. Plants such as nettle and sorrel will be dominating and significantly reduce the quality of this pasture.

Looking at the **Vaccinietum uliginosi** revitalisation potential can be described as medium to high. The site has a southern exposition with medium inclination which facilitates the application of several revitalization techniques. Mowing, done with finger-bar mower or brush cutter, or maybe burning the whole area can be a promising way to reduce the amount of shrubs, but also feeding and trampling pressure of cattle kept in paddocks can be a reasonable way to reduce the dominance of *Calluna* and *Vaccinium* species in favour of grassy plants.
DI Legener speaks of manuring with dung as an appropriate way to change species composition towards a higher proportion of herbs and valuable grass species such as *Poa alpina* and *Phleum alpinum.* Manuring and trampling stress can be best applied via extensive pasturing.

For the **Vaccinio callunetum**, revitalization measures and potential as a pasture are more or less the same as for the Vaccinietum-uliginosi due to similar site conditions and plant species composition. But the small size of the site and also its importance as a habitat for various animals should exclude it from to any amelioration efforts.

The boggy mat-gras mosaic, **Sphagno-Nardetum**, which covers the avalanche aisle with its high content of Ericaceae, is similar to the typical ground vegetation in the sub-alpine Larch-Spruce forest (Larici-Piceetum), not least because this site is a forest stand without trees. The potential for this site as a pasture is questionable. Even though there are only few valuable grass species growing in between the shrubs, the site has a good inclination and exposition, whereas in the lower part of the aisle the high water content of the soil shows just moderate conditions for qualitative pastures. The high frequency of avalanches brings advantages but also disadvantages. Snow masses are hindering the forest from spreading, but on the other hand, any permanent structures such as fences or watering troughs are destroyed, too.
But the removal of shrubs may have an undesired side effect. The absence of plants, in this case chamaephyte such as *Rhododendron* and *Vaccinium spec*. which usually transport a certain amount of water trough transpiration from the soil into the atmosphere; may result in additional water logging. The higher-than-average amounts of water on this site mainly result from the absence of trees that catch precipitation and let it evaporate without hitting the ground.

There are many small ditches spread all over the aisle that carry water through out the year. Mosses form a closed carpet and when walking on this site one gets the impression to move on a fen.

Nevertheless, the Umweltbüro Klagenfurt, which elaborated the official revitalization program for Lafenberg Alm, chooses this site to carry out revitalization measures. The aisle should be divided into three rectangular, equal-sized paddocks, in which cows will be kept intensively in a rotational cycle. The only preparatory measures are the clearing of some young trees and of the remains of the last avalanche. Trampling stress and browsing activity should repress dwarf shrubs and promote the growth of grassy plants. It is doubtful that this measure will have the desired effects, because due to the water-logging, trampling stress may do severe harm to soils. Especially under moist conditions effects of compaction are particularly severe. In the worst case, compaction, degradation and erosion may be the result of these measures.

The second site designated for revitalization measures is the dwarf shrub mosaic in the upper part of the aisle. There the inclination is quite low and soil moisture is just locally high. As preparatory measures mowing with the brush-cutter will be carried out, and the water-logged sites will be fenced out. Also a fixed watering place in form of a trough will be built. The desired result should be a pasture-dwarf-shrub-mosaic

Revitalisation of sites covered by the association **Alnetum viridis** can be quite costly because heavy machines such as moulding cutters or excavators are not suitable to work on steep, slippery slopes. Manual clearing on the other hand is very time consuming and costly. There is also the problem of large amounts of plant material. Another disadvantage of manual cutting of alders with chainsaw or brush cutter is the strong re-sprouting impulse set free by cutting the stems. Even cutting them in winter will not have the desired effects because most of the nutrients are stored in the roots, therefor re-sprouting cannot be hindered.

A reasonable approach to clear such stands is the “use” of goats. With their ability to shed off and digest the bark of many woody plants they are effectively able to kill the alders.

There are two possibilities to utilize the skills of goats. When the bark is properly removed around the stem, the flow of water from the roots upwards and the flow of nutrients downwards are interrupted and the upper parts of the plant are drying out, whereas the roots are lacking in nutrients. This means that the plant is completely

dying off and not able to re-sprout any more. Dead stems can now be removed with chainsaws and burned when they are dry, of course in compliance with the regulations concerning burning (see also in Revitalization methods).

Another possibility would be to cut the stems and to bring the goats to the site when the alders start to re-sprout. Otto Denoth from Plantahof in Chur successfully carried out a pasturing experiment with goats (see in the previous chapter).

This approach could also work with other animals such as cattle, because in very young stages leaves of alders can be browsed easily by cows (HOLZNER, 2007)

Both methods can only work if the goats are managed properly, that means that they have to be fenced, they have to be there in the right time, the number of goats per unit must be in relation to the size of the site, they need a permanent water supply and a diversified diet, because goats get bored very quickly (pers. remark of Otto Denoth, 2009).

Best suited for landscape management would be a group of young and old non-lactating goats because the quality of milk suffers when goats feed on bark or other bitter fodder.

There are sites where clearing does not make sense, on slopes which are too steep, too humid or with snow coverage for long periods of time. Although there is a complete loss of pasture and green alders will invade also into “good sites” when not stopped in time green alder shrubbery is an important habitat and shelter for wildlife and game species.

Green alders can also have important protective functions like slope stabilization by their roots and by that preventing landslides. On the other hand snow masses cannot be fixed effectively because the branches are very flexible and get pressed down so there is no avalanche prevention. There is also a higher water uptake by the plants and this storage effect can work, in some cases, as an important early torrent control tool. At least at unfavourable sites green alders should be preserved to fulfil their ecological functions and to be part of a rich structured pasture ecosystem.

A plant community that poses a threat to many abandoned alpine pastures is the **Rhododendretum ferruginei-pinetosum mugii**, or dwarf-pine-krummholz.

Dwarf pines show only a weak ability to re-sprout, meaning that revitalisation efforts are generally not so high compared to green alder shrubbery. The most promising way to clear a dwarf pine stand is to cut the branches by hand using chain saws and afterwards burning the residues under suitable conditions. Dwarf pine can be burned

directly after cutting because of the high content of raisin which is very flammable, whereas green alders have to be dried completely before burning to prevent strong smoke development.
In this special case the dwarf-pine-krummholz forms just a negligible part of the Alm, and due to the geomorphological background of the site any revitalization efforts are pointless. Also the fact that this association is situated in a NATURA 2000 area would not allow clearing anyway.
The coarse boulders in the understorey build many gaps in between which can seriously harm animals when the step into such crevices.

More than 50 % of the overall area is covered by dwarf-shrubbery dominated by *Rhododendron ferrugineum*, **Rhododenretum ferruginei**. Although the distribution of this association is limited to sites with secure and sufficient snow coverage, it may pose the largest threat to Lafenberg Alm in terms of overgrowth with woody plants.
Revitalisation has to be carried out manually with the help of a brush cutter and string trimmer, because the uneven terrain would not allow the use of heavy machinery. Animals kept in paddocks as a solitary measure can not effectively repress the shrubs because Rhododendron is somewhat poisonous and, therefore avoided by cows, horses and even goats.
Even blueberry shrubs are not palatable for cows (except the flowering parts) in significant amounts, only goats and roe deer partly feed on the leaves.
Site conditions can be described as very hostile for the establshment tree seedlings, because germination and successive growth are repressed, so that the threat of being overgrown with trees is not urgent.
Revitalisation efforts on these sites can be promising, which is, of course, depending on the site conditions. Nevertheless, at least on the steep parts where animals are hardly able to climb, Rhododendron will prevail, and the only way to deal with this plant is to stop its invasion onto remaining sites with a potential as pastures. If pastures are managed without greater discontinuities, spreading of Rhododendron will be slowed down significantly.

Inside the closed forest, in this case **Larici Piceetum,** there is no real potential for any kind of revitalization efforts. These forests are the local climax vegetation and all the “artificial” vegetation types in this altitude will pass through several succession stages

and end up in this association, if it is a potential forest stand. Efforts should be concentrated on sites where the cost-benefit ratio is more promising.

Dock forbs, **Rumicetum alpinae**, are quite common on alpine pastures.
If they do not occur in too large extent, which is usually not the case, it is pointless to try to recultivate these areas. On alpine pastures concentration of nutrients on one particular spot is better than dissipation because if they are spread all over the pastures higher nutrient content would change species composition in a possibly unfavourable way. This may be the case, but should not be generalized, though. In certain cases this change in nutrients and therefore species composition can be desired. But it is necessary to hinder the dock from spreading what can be a quite difficult task.
One possibility to fight dock would be to treat it with the “chemical hammer”, but it is questionable if this is a promising way. If dock is only cut it will resprout again and again, but there is the possibility to drive goats onto this area when the docks are flowering. Cows have been observed trampling on flowering dock plants and eating from the plants, which caused such a severe damage that they didn’t grow in large extents in the following years (pers. remark of Hans Kolb).

10 POSSIBLE CONFLICTS WITH GAME ANIMALS

Deer can cause harm to forest stands in different ways, and all of them are based on their natural behaviour. If damages increase to level at which the owner suffers significant economical losses, failing game- and habitat management has to be blamed. Poorly managed game population can have negative effects on both, forestry and pasturing.

10.1 BROWSING

Besides barking, browsing damages are the most severe ones caused by larger herbivores in forests. Roe deer prefers browsing on the apical shoots, including the buds, whereas red deer often just nibbles off the needles and spares the buds. Thus roe deer causes the most severe damages by browsing, because especially young plants are suffering and even perish, if the buds are removed consequently. Browsing damages significantly increase if there is lack of grasses, herbs and shrubs, especially in winter and spring.

10.2 BARKING

Barking describes the behaviour of deer peeling off the bark from trees. Young, soft bark has similar nutritional values as fresh, mid-quality grass and consists of nutrients, vitamins and about 50 – 60% of water. During the vegetation period the bark peels off easily compared to the dormant period, so damages caused during summer are way more severe than during winter. Especially prone to barking are the tree species *Picea abies, Pseudotsuga menziesii, Fraxinus excelsior, Fagus sylvatica, Pinus spec*. and *Abies alba*. Fungi such as *Heterobasidion annosum* are able to enter the wood-body through the wounds and can cause severe damage to the wood quality, which is then also more susceptible to wind or snow break or to infestation of the bark beetle (WAGENKNECHT 1994, S 80).

To keep the damages caused by barking and browsing within a tolerable level, game density has to be regulated and managed in terms of age structure, sex ratio and population density. And, of course, habitat conditions have to be enhanced in a way that there is minimal disturbance, the creation of sufficient natural browsing areas with

high quality fodder plants and, in some cases, additional feeding. The habitat should be as complete as possible, so that the animals do not lack in any of their required natural resources.
Additional feeding during winter time has effects on the barking behaviour of red deer. Hay especially rich in fibres will reduce the necessity to feed on bark, whereas silage fodder, which is too lush and rich in nutrients, increases the demand for fibrous supplements.

10.3 STRIKING AND FRAYING

Striking describes the behaviour of deer to strike small trees or scrubs with their antlers, mainly in the Brunst period. Fraying describes the process of removing the velvet from the mature antlers by striking against small trees or scrubs. Even though a frayed tree is mostly killed, both behaviours do marginal harm to forestry compared to barking. These damages cannot be reduced or controlled anyway.

10.4 FODDER COMPETITION

If there is a high density of red deer in an alpine pasture ecosystem there may arise conflicts between farmers and hunters. Red deer, as a grazing species, needs a certain amount of grass to cover its nutrient demand. In spring time the first rush of grassy plants are very important aliments, but as a result of this grazing activity the “maturity” of the pastures will be delayed by two to three weeks. This delay poses a significant shortening of the pasturing period available for cattle and, by that, an economic loss.
For red reed, which prefers short, fresh grass, cultivated pastures are much more attractive than abandoned pastures, which are avoided as far as a possible.

11 SUMMARY

The vegetation of Lafenberg Alm (Styria, Austria), an alpine pasture abandoned 30 years ago, has been recorded in July 2009. 15 communities were distinguished, 9 of them have been recorded according to Braun-Blanquet (1928).
Each community has been discussed with regard to its potential as a pasture and the best suited measure to achieve this state. Also its value as a habitat for game species and other wildlife has been mentioned. Using GIS-software, a vegetation map was created.

A total number of 130 plants on an area of 170 ha indicate the alarming development of former pastoral systems being extensified or abandoned. The results are loss of biodiversity and uniform and poor plant communities. This depletion of plant species diversity is the result of a loss of habitat diversity and has direct impacts on the faunistic diversity of this anthropogenic ecosystem.
Invasion of trees and dwarf shrubs, but also of non-palatable grassy plants and poisonous plants is strongly site-depending and has to be evaluated for each site individually. But as also intensified utilization would have negative effects on species diversity, the perspective should be a sound management adapted to biotic and abiotic site conditions.

Without any measures the subalpine larch-spruce-forest will recapture practically the whole area. A vast part of the Alm is already covered by rhododendron-shrubbery, and although conditions for germination of tree seeds are suboptimal in this shady environment, forest will slowly reestablish.

Another consequence of this unification of landscape and vegetation is a deterioration of habitat conditions for several wildlife species, especially in respect of fodder supply. Under certain conditions forest damages caused by game species can be the consequence. But also the devaluation of the site as a hunting ground may cause economic losses due to emigration of valuable game species.

In the second part several revitalization measures are compared to each other in terms of economic feasibility, technical applicability and environmental impact. Which measure is best suited is strongly site depending and has to be elaborated carefully.
Special emphasis is given to targeted grazing with goats as a revitalization technique. The general suitability as well as the possibilities and limitations of the use of goats are discussed on the basis of on case study from Switzerland.

There are several studies that show that goats are an alternative way to reduce shrubs and trees from arid grasslands. But there are just scarce studies dealing with the reclamation of overgrown pastures in the alpine environment.
Principally goats are able to reduce density and number of woody plants significantly, if some important basic requirements are kept. Due to their physiology goats have a special feeding behaviour. They need a certain spectrum of different fodder plants to cover their nutrient demands. Goats are very agile and it is a difficult task to fence goats into a paddock. Permanent water supply, shelter, mineral supply and periodic health checks are basic requirements for proper results. Another important point to consider is the handling of the animal products thereby incurred. Dairy production and landscape management are difficult to reconcile due to fluctuations in quality and quantity, and there are also some technical and personnel aspects to be considered. On the other hand the acceptance for kid meat is relatively low among population. The use of “unproductive” goats that are either not yet or no more-lactating can be made economically feasible by subsidies.

12 ZUSAMMENFASSUNG

Die Zielsetztung dieser Diplomarbeit war einerseits die Erstellung einer Vegetationskarte. Diese bildet die Grundlage für eventuelle zukünftige Studien. Andererseits wurden verschiedene Möglichkeiten zur Revitaliserung verbrachter Almflächen aufgelistet und einander in Hinblick auf Wirtschaftlichkeit, technische Durchführbarkeit und naturschutzfachliche Verträglichkeit gegenübergestellt. Besonderes Augenmerk wurde auf gezielte Beweidung mit Ziegen als Möglichkeit der Zwergstrauch- und Gehölzbekämpfung gelegt.
Auch die Zusammenhänge zwischen Forstwirtschaft, Landwirtschaft, Naturschutz und Jagdwirtschaft als potenzielle Nutzer des Bergraums, sowie deren Auswirkungen auf die jeweils anderen Parteien wurden besprochen. Insbesondere die Jagd als Geldquelle und auch als regulierende Größe im Ökosystem wurde besprochen.

Die Vegetation sowie die Standortbedingungen wurde im Zeitraum von drei Wochen Ende Juli 2009 aufgenommen. Zuerst wurde die Alm in vegetationsökologisch ähnliche Vegetationstypen unterteilt, aus denen dann jeweils eine möglichst homogene Aufnahmefläche gewählt wurde. Die Pflanzen wurden nach der Methode von Braun-Blanquet (1928) aufgenommen. Aus Zeitgründen und wegen der relativen Einheitlichkeit der Vegetationstypen wurde jeweils nur eine komplette Aufnahme mit Ermittlung der Standortkoordinaten, Seehöhe und Aufnahmefläche durchgeführt. Zur Vervollständigung der Artenliste wurden aus jeder Großgruppe noch zusätzliche Pflanzenuntersuchungen gemacht, und anfallende Arten den jeweiligen Pflanzengesellschaften als „zusätzlich gefunden“ hinzugefügt. Um das Gesamtbild zu vervollständigen wurden auch Vegetationsgesellschaften beschrieben, die auf Grund ihrer kleinen Verbreitung als potenizieller Weidestandort nicht in Frage kommen oder wegen ihrer Heterogenität nicht nach Braun-Blanquet aufgenommen werden konnten. Hier wurden alle gefundenen Pflanzenarten notiert und die Standortbedingungen grob umrissen.
Anhand der Vegetationsgruppen und der Standortbedingungen wurden für jede Vegetationseinheit das Potenzial als Weide und ihre Bedeutung als Habitat für Tierarten besprochen.
Nach der Unterteilung in vegetationsökologisch einheitliche Gruppen wurden diese mit Hilfe von GIS-Software digitalisiert und eine Karte auf der Basis eines Orthophotos

erstellt. Anschließend konnten die einzelnen Großgruppen exakt nach ihrer Größe aufgelistet werden.
Die einzelnen Revitalisierungsmaßnahmen wurden anhand von Literaturnachweisen behandelt. Zur Möglichkeit der Ziegenbeweidung wurden die Hinweise vor Ort in Thusis im Kanton Graubünden (Ch) gesammelt. Daten und Unterlagen betreffend das Ziegenbeweidungsprojekt Mutten (Ch) wurden mir dort dankeswerter weise von Hr. Otto Denoth zur Verfügung gestellt.

Ingesamt wurde die Alm in neun Großgruppen und sechs Untergruppen unterteilt. Etwa 50 % der Gesamtfläche sind von Alpenrosengebüsch bedeckt. Diese Flächen sind als Weide völlig unbrauchbar, da kaum nutzbare Futerplanzen in diesen Beständen vorkommen und auch der Almrausch, wie schon der Name sagt, schwach giftig ist. Aufgrund der langen Schneebedeckung dieser Standorte und der starken Beschattung im Inneren des Bestandes wird jedoch auch das Baumwachstum stark gehemmt. Eine Revitalisierung hängt stark vom Gelände des Standorts ab; ließe sich jedoch am besten mit Motorsense und Freischneider bewerkstelligen.

Die flächenmäßig zweitgrößte Gesellschaft ist das Bürstlings-Ericaceen-Mosaik. Borstgras und verschiedene Zwergsträucher bilden eine eng verzahnte, mosaik-artige Gefüge, in dem sich die Dominanz der einzelnen Arten je nach kleinräumig unterschiedlichen Standortbedingungen Unterscheiden. Auf anmoorigen Flächen dominiert das Borstgras mit eingetreuten Sauergräsern und dem Scheiden-Wollgras, auf kleinen Kuppen dominieren hingegen Heidelbeere und Rauschbeere. Hier sind Revitalisierungsmaßnahmen am aussichtsreichsten, da das Gelände dieser Gesellschaften meist einigermaßen eben und nicht besonders hochwüchsig ist.

Etwa ein Fünftel der Almfläche ist bereits mit Grünerlen zugewachsen. Besonders auf steilen, wasserzügigen Rinnen und feuchten Schatthängen kann diese Pflanzengesellschaft zu einem Problem werden. Aufgrund des oftmals steilen Geländes werden diese Flächen am wenigsten von Rindern beweidet, was zur Ausbildung von Hochstaudenfluren führt und in Grünerlengebüsch endet. Ob diese Flächen renaturiert werden sollten, hängt davon ab, ob sie nach den durchgeführten Maßnahmen beweidet werden können. Bleibt eine Beweidung nach Revitalisierungsmaßnahmen aus, wird die Grünerle diese Flächen relativ rasch wieder

erobern. Bei der Schwendung von Grünerlengebüschen stellen Ziegen aufgrund ihrer Physiologie und Fressgewohnheiten eine Alternative zu maschinellen Lösungen dar. Dies belegt unter anderem die Studie aus Mutten in der Schweiz, wo Ziegen innerhalb eines Almsommers auf eine Fläche von 1,5 ha nahezu alle Grünerlen zum Absterben brachten.

10 % der Almfläche sind bereits von Lärchen-Fichtenwald bedeckt, der für die subalpine Stufe über silikatischem Gestein typisch ist. Revitalisierungsmaßnahmen machen hier keinen Sinn, da dieser halb-offene, lichte Baumbestand einerseits ein wichtiges Weideelement darstellt, andererseits für viele Wildtiere als Lebensraum fungiert. Zwar stellt der Wald als Ende der Sukzessionskette eine Bedrohung für Weideflächen dar, spielt jedoch aufgrund der sehr langsamen Wiederbewaldung in der akuten Weidepflege zurzeit nur eine untergeordnete Rolle.

Die übrigen Flächen setzen sich aus kleinflächigen Vegetationstypen wie Alpenampfer-Flur, strenger Bürstlingsrasen, Heidkraut-Schwarzbeer-Tundra, Wollgras-Bürstlingsrasen, subalpine Matten, Quellfluren und Schneetälchen-vegetation zusammen.

Zur Revitalisierung dieser unterschiedlich stark verbrachten Flächen stehen mehrere Möglichkeiten zur Verfügung. Zielführend wäre wohl nur eine Kombination aus mehreren Maßnahmen, die vorbereitend oder ergänzend auf einander abgestimmt sein sollten. Ausschlaggebend für jeden Revitalisierungsversuch wäre jedoch eine genau Kentnis der Standortbedingungen und ein weiterführendes Management nach den Maßnahmen. Werden Flächen nicht, entsprechend ihrer Wüchsigkeit, richtig beweidet, ist eine Über- oder Unterbeweidung die Folge, und damit eine Verschlechterung der Weidequalität.
Ob nun das Schwenden von Bäumen und Zwergsträuchern hänidsch oder maschinell erfolgen soll, hängt von mehreren Faktoren ab: Zugänglichkeit des Standortes, Hangneigung, Relief, Wuchstypus der zu bekämpfenden Pflanzen, Vorhadensein etwaiger Fördergelder und verfügbares Kapital schränken die Möglichkeiten meist stark ein. Als umweltverträgliche und ökologische Alternative zu maschinellen Möglichkeiten kann die gezielte Beweidung genannt werden. Gelingt es, das Fressverhalten und die Vorlieben von Weidetieren so einzusetzen, dass die Weidepflege durch die Tiere

selbstständig durchgeführt wird, können ansehnliche Erfolge erzielt werden. Wichitg ist jedoch, die Tiere nicht als Werkzeug zu betrachten, denn das kann schwerwiegende, gesundheitliche Folgen für das Vieh haben.

Als besonders geeinget für die Bekämpfung von Bäumen und Büschen haben sich Ziegen erwiesen. Da sie die Fähigkeit besitzen, bitterstoffreiches Futter verdauen zu können und ausserdem ausgezeichnete Kletterfähigkeit aufweisen, können Ziegen durch das Schälen von Rinde und dem Verbiss von Zweigen und Blättern Bäumen schwere Schäden zufügen, die nicht selten zum Absterben der Pflanze führen. Durch das Unterbinden des Saftflußes von den Wurzel aufwärts und der Nährstoffe zu den Wurzel stirbt die Pflanze durch stammumgreifendes Entfernen der Rinde komplett ab. So wird auch die oftmals problematische Fähigkeit zum Wiederaustrieb unterbunden.

Es gibt jedoch auch einige Einschränkungen für den Einsatz von Ziegen in der Landschaftspflege. Die zu bearbeitenden Flächen benötigen eine permante Wasserversorgung sowie einen Unterstand, und es kann mitunter schwierig sein, eine Gruppe Ziegen einzuzäunen, wenn ihnen irgendetwas in ihrer Koppel fehlt. Auch die regelmäßige Kontrolle der Gesunheit der Tiere sowie die zusätzliche Versorgung mit Mineralstoffen müssen gesichert sein. Zu guter Letzt muß die Frage geklärt sein, was mit den tierischen Produkten wie Milch und Fleisch geschieht. Milchproduktion mit Ziegen, die zur Landschaftspflege eingesetzt werden, ist problematisch, da starke Schwankungen in Qualität und Quantität der Milch zu erwarten sind. Auch muß Personal vorhanden sein, um die Melkarbeiten durchzuführen. Was die Fleischproduktion angeht, ist die gesellschaftliche Akzeptanz in weiten Teilen Österreichs zu gering, um eine gesicherte Abnahme erwarten zu können. Am ehesten eignen sich Jung- und Alttiere, bzw. Ziegen, die sich vor oder nach der Laktationsphase befinden.

Unter geeigneten Umständen könnte die Weiderevitalisierung mit Ziegen eine nachhaltige und umweltverträgliche Alternative zu herkömlichen Methoden zur Gehölzbekämpfung darstellen, die oftmals eine große Balstung für das Ökosystem darstellen.

Auch die Jagd als Nutzer des Bergraumes und oft bedeutende Geldquelle für den Grundbesitzer soll nicht außer Acht gelassen werden.

Bei zu hohen Bestandsdichten von Reh- und Rotwild und ungenügendem Nahrungsangebot ist die Gefahr von Forstschäden sehr groß. Auf der anderen Seite

bietet eine verbrachte und mit Almrausch verwachsene Alm keine Nahrungsgrundlage und zwingt das Wild zur Abwanderung. Dieser Verlust von jagdbarem Wild stellt eine deutliche Entwertung des Reviers und damit eine Verminderung der Jagdpacht dar.

Ein reich strukturiertes und eng verzahntes Netzwerk aus guten Weideflächen, Zwergsträuchern und Baumgruppen hingegen befriedigt nicht nur die Bedürfnisse von Weidetieren, sondern schafft auch Lebensräum für viele Tierarten. So stellt die Zusammenarbeit aus Naturschutz, Weidewirtschaft, Forstwirschaft und Jagd die Grundlage für eine nachhaltige und rentable Bewirtschaftung von Almen dar. Leider sieht man sich jedoch oft mit gegenseitigem Unverständnis und Vorurteilen konfrontiert, die eventuelle Revitalisierungs- und Beweidungsmaßnahmen von vornherein ausschließen.

Der Abbau dieser Vorurteile soll das erklärte Ziel von Forschung und Wissenschaft sein, da die Wahl der Methoden und deren Ausführung immer noch den Ortsansässigen obliegen. In diesem Sinne versteht sich auch diese Arbeit. Alle beschriebenen Methoden sind als Möglichkeiten, bestenfalls als Vorschläge anzusehen, wie die Lafenberg-Alm wieder in eine wirtschaftlich und naturschutzfachlich vernünftige Nutzung genommen werden kann.

13 ABSTRACT

Diese Diplomarbeit beschäftigt sich mit der Vegetationsanalyse und Möglichkeiten zur Rekultivierung einer aufgelassenen Alm im Naturpark Sölktäler. Nach der Nutzungsaufgabe vor etwa 30 Jahren begannen die vormaligen Weideflächen mit Zwergsträuchern und Bäumen zuzuwachsen. Um den aktuellen Sukzessionsgrad zu erfassen und um Grundlagen für zukünftige, vergleichende Studien zu schaffen wurde die Alm im Juli 2009 vegetationsökologisch untersucht Für jede Pflanzengesellschaft wurden eventuelle Revitalisierungs-maßnahmen abgehandelt und einander bezüglich ihrer Wirtschaftlichkeit, technischen Durchführbarkeit und naturschutzfachlichen Verträglichkeit gegenübergestellt. Besonderes Augenmerk wurde auf die mögliche Verwendung von Ziegen zur Landschaftspflege gelegt. Ihre Anwendbarkeit wurde anhand einer Fallstudie diskutiert. Mit ordentlicher Planung stellen Ziegen eine effektive Maßnahme zur Revitalisierung von verbrachten Almflächen dar, wenn man nach einer nachhaltigen und umweltverträglichen Methode sucht.

This thesis deals with vegetation analysis and possibilities for reclamation of an abandoned alpine pasture in the Natural Park Sölktäler. Due to the abandonment of management 30 years ago the former pastures are being gradually overgrown by dwarf shrubs and trees. To estimate the actual state of succession and as a basis for future studies vegetation was subdivided into homogenous groups, which then have been recorded in terms of abundance and dominance. The results have been used to create a vegetation map which shows the exact distribution and proportion compared to the overall size of the Alm. All the recordings have been carried out within three weeks in July 2009. For every plant community also suitable revitalisation measures have been discussed and weighted up against each other in terms of economic feasibility, technical applicability and environmental soundness. Also the potential as a pasture and the meaning as a habitat for wildlife have been discussed for each group. A special emphasis was given to the use of goats as a tool for landscape management. Their applicability was discussed with help of one case study. With proper planning goats can be an effective measure to recultivate overgrown alpine pastures, if there is an interest in sustainable and ecologically low-impact management.

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15 TABLE OF FIGURES

16 LIST OF TABLES

17 APPENDIX

Plant names		
Latin	**English**	**German**
Achillea millefolium	Milfoil	Schafgarbe
Aconitum napellus	Aconite	Blauer Eisenhut
Agrostis tenuis	Bent grass	Rot-Straußgras
Alchemilla vulgaris	Lady´s mantle	Frauenmantel
Alnus viridis	Green alder	Grün-Erle
Anthoxanthum odoratum	Vernal grass	Gewöhnliches Ruchgras
Anthoxanthum alpinum	Vernal grass	Alpen-Ruchgras
Arnica montana	Mountain arnica	Arnika
Athyrium distentifolium	Alpine lady fern	Gebirgs-Frauenfarn
Athyrium filix-femina	Common lady fern	Gewöhnlicher Frauenfarn
Avenella flexuosa	Wavy hair grass	Drahtschmiele
Blechnum spicant	Deer fern	Rippenfarn
Calamagrostis villosa	Reed grass	Wolliges Reitgras
Calluna vulgaris	Common heather	Besenheide
Campanula barbata	Bearded bellflower	Bärtige Glockenblume
Campanula scheuchzeri	Scheuchzers bellflower	Scheuchzers Glockenblume
Cardamine rivularis	River-cress	Gebirgs-Wiesenschaumkraut
Carduus personata	Great marsh thistle	Kletten-Ringdistel
Carex brunnescens	Brownish sedge	Bräunliche Segge
Carex canescens	Grey sedge	Grau-Segge
Carex echinata	Star sedge	Igel-Segge
Carex leporina	Hare sedge	Hasen-Segge
Carex nigra	Black sedge	Braun-Segge
Carex pallescens	Pale sedge	Bleich-Segge
Carex pilulifera	Pill sedge	Pillen-Segge
Cerastium cerastoides	Mouse-ear chickweed	Dreigriffel-Hornkraut
Cetraria islandica	Iceland moss	Island-Moos
Chaerophyllum hirsutum	Hairy chervil	Wimper-Kälberkopf
Cladonia arbuscula	Cup lichen	Fahlgelbe Rentierflechte
Cladonia fimbriata	Trumpet cup lichen	Trompetenflechte
Cladonia pyxidata	Cup lichen	Echte Becherflechte
Cladonia rangiferina	Reindeer lichen	Echte Rentierflechte
Deschampsia cespitosa	Tussock grass	Gewöhnliche Rasenschmiele
Diphasium alpinum	Alpine running pine	Alpen-Bärlapp
Empetrum nigrum	Black crowberry	Zweihäusige Krähenbeere
Epilobium alsinifolium	Chickweed willowherb	Mieren-Weideröschen
Eriophorum angustifolium	Common cottongrass	Schmalblatt-Wollgras
Eriophorum scheuchzeri	Alpine cottongrass	Alpen-Wollgras
Evernia divaricata	Evernia	Sparrige Evernie (Flechte)
Festuca rubra agg.	Red fescue	Rot-Schwingel
Festuca varia	Fescue	Bunt-Schwingel
Galeopsis bifida	Bifid hemp-nettle	Zweizipfeliger Hohlzahn
Galeopsis speciosa	Large-flowered hemp-nettle	Bunt-Hohlzahn
Galeopsis tetrahit	Common hemp-nettle	Dorn-Hohlzahn
Gentiana pannonica	Brown gentian	Pannonischer Enzian
Geum montanum	Alpine aven	Berg-Nelkenwurz
Gnaphalium norvegicum	Heath cudweed	Norwegisches Ruhrkraut
Gymnadenia conopsea	Fragrant orchid	Mücken-Händelwurz

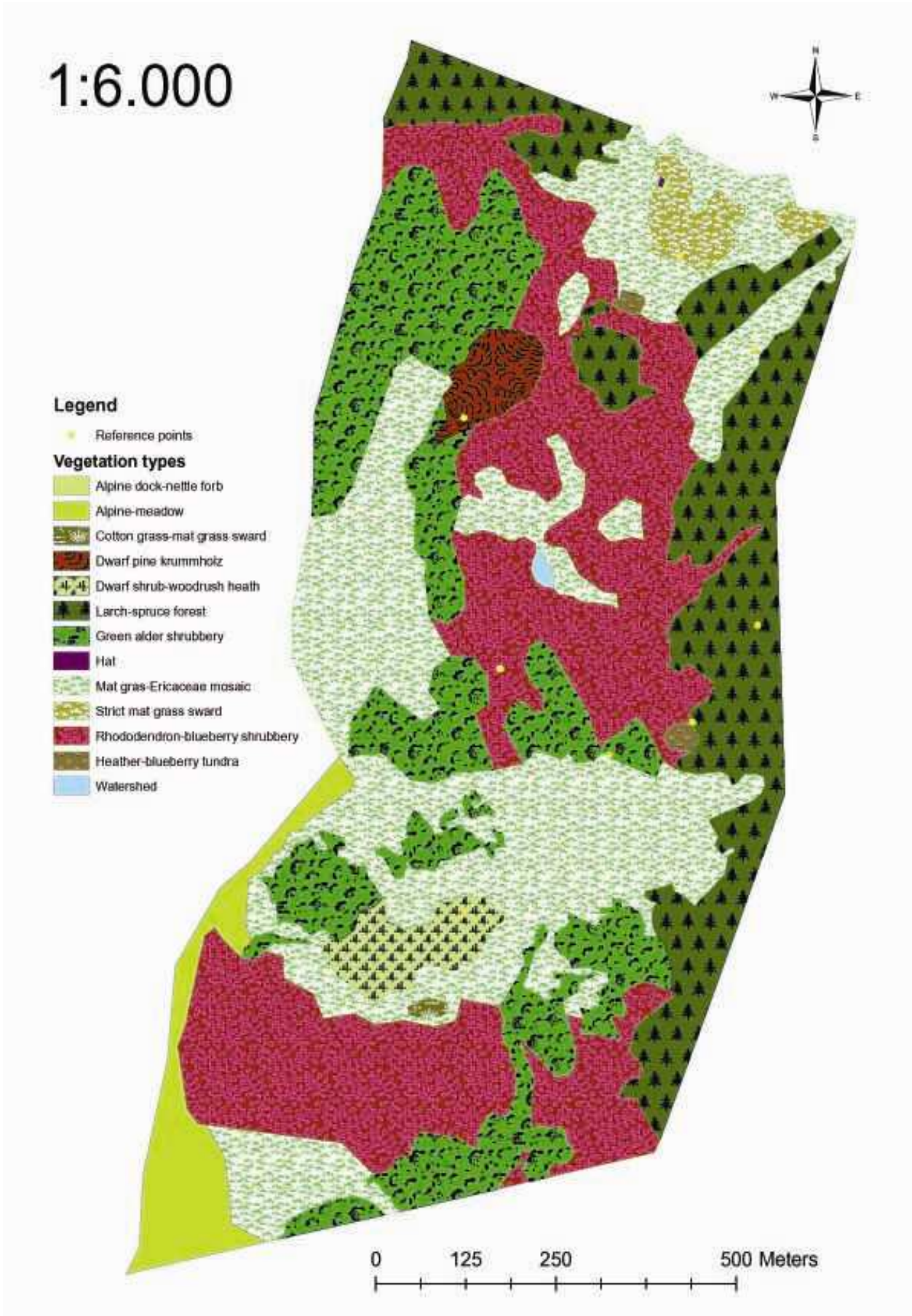
Hieracium alpinum	Alpine hawkweed	Alpen-Habichtskraut
Hieracium aurantiacum	Orange hawkweed	Orange-Habichtskraut
Hieracium pilosella	Mouseear hawkweed	Kleines Habichtskraut
Homogyne alpina	Alpine coltsfoot	Alpen-Brandlattich
Hylocomium splendens	Stair-step moss	Etagenmoos
Hypericum maculatum	Imperforate St.John´s-wort	Flecken-Johanniskraut
Hypogymnia physodes	Hypogymnia	Blasenflechte
Juncus filiformis	Thread rush	Faden-Simse
Juncus trifidus	Highland rush	Dreiblatt-Simse
Juniperus communis subsp. alpina	Alpine juniper	Zwerg-Wacholder
Larix decidua	Larch	Lärche
Leontodon helveticus	Hawkbit	Schweizer Löwenzahn
Loiseleuria procumbens	Trailing azalea	Gemsheide
Luzula luzuloides	White woodrush	Weißliche Hainsimse
Luzula sylvatica	Great woodrush	Gewöhnliche Groß-Hainsimse
Lycopodium annotinum	Stiff clubmoss	Schlangen-Bärlapp
Lysimachia nemorum	Yellow pimpernel	Wald-Gilbweiderich
Melampyrum pratense	Common cow-wheat	Gewöhnlicher Wachtelweizen
Melampyrum sylvaticum	Small cow-wheat	Berg-Wachtelweizen
Myosotis decumbens	Procumbent forget-me-not	Niederliegendes Vergissmeinnicht
Myosotis nemorosa	Grove forget-me-not	Gebirgs-Vergissmeinnicht
Nardus stricta	Mat grass	Borstgras
Oreochloa disticha	Moor grass	Kopfgras
Oxalis acetosella	Common wood-sorrel	Wald-Sauerklee
Petasites albus	White butterbur	Weiß-Pestwurz
Phleum alpinum	Alpine cat´s-tail	Alpen-Lieschgras
Phyteuma betonicifolium	Rampion	Betonien-Teufelskralle
Phyteuma persicifolium	Rampion	Steirische Teufelskralle
Picea abies	Norway spruce	Fichte
Pinus mugo	Dwarf pine	Latsche
Pleurozium schreberi	Schrabers moss	Rotstängelmoos
Poa alpina	Alpine meadow-grass	Alpen-Rispengras
Poa chaixii	Broad-leaved meadow-grass	Wald-Rispengras
Poa hybrida	Hybrid meadow-grass	Gebüsch-Rispengras
Polytrichum formosum	Bank haircup	Schönes Widertonmoos
Polytrichum strictum	Strict haircup	Steifblättrige Frauenhaar
Polytrichum commune	Common haircup	Goldenes Frauenhaar
Potentilla anglica	Trailing bormentill	Englisches Fingerkraut
Potentilla erecta	Tormentill	Aufrechtes Fingerkraut
Prenanthes purpurea	Rattlesnake root	Hasenlattich
Pseudevernia furfuracea	Tree moss	Baumflechte
Ranunculus acris	Meadow buttercup	Scharfer Hahnenfuß
Ranunculus aconitifolius	Aconite buttercup	Eisenhut-Hahnenfuß
Ranunculus montanus	Mountain buttercup	Berg-Hahnenfuß
Ranunculus repens	Creeping buttercup	Kriech-Hahnenfuß
Ranunculus villarsii	Grenier´s buttercup	Grenier-Hahnenfuß
Rhizocarpon geographicum	Map lichen	Landkartenflechte
Rhododendron ferrugineum	Rusty-leaved alpine rose	Rostrote Alpenrose
Rhytidiadelphus triquetrus	Shaggy moss	Kleiner Runzelbruder (Moos)
Rubus idaeus	Raspberry	Himbeere
Rumex acetosella subsp.	Red sorrel	Zwerg-Sauerampfer

acetosella		
Rumex alpestris	Garden sorrel	Berg-Sauerampfer
Rumex alpinus	Alpine dock	Alpen-Ampfer
Saponaria pumila	Soapwort	Zwerg-Seifenkraut
Saxifraga stellaris	Star saxifrage	Stern-Steinbrech
Sempervivum montanum	Mountain houseleek	Berg-Hauswurz
Senecio subalpinus	Subalpine ragworts	Berg-Greiskraut
Silene vulgaris	Bladder campion	Aufgeblasenes Leinkraut
Sorbus aucuparia	European rowan	Eberesche
Sphagnum sp.	Peat moss	Torfmoos
Stellaria graminea	Grasslike starwort	Gras-Sternmiere
Stellaria nemorum	Wood stitchwort	Wald-Sternmiere
Thelypteris limbosperma	Mountain fern	Berg-Farn
Thymus pulegioides	Wild thyme	Gewöhnlicher Arznei-Quendel
Trichophorum cespitosum	Deer-hair sedge	Rasen-Haarbinse
Trifolium pratense	Red clover	Rot-Klee
Trifolium repens	White clover	Weiß-Klee
Urtica dioica	Common nettle	Große Brennnessel
Usnea filipendula	Fishbone beard lichen	Gewöhnlicher Baumbart
Vaccinium myrtillus	Bilberry	Schwarzbeere
Vaccinium vitis-idaea	Lingonberry	Preiselbeere
Vaccinum gaultherioides	Northern bilberry	Alpen-Rauschbeere
Veratrum album	White hellebore	Weißer Germer
Veronia beccabunga	Brooklime	Bach-Ehrenpreis
Veronica alpina	Alpine speedwell	Alpen-Ehrenpreis
Veronica serpyllifolia	Thyme-leaved speedwell	Quendel-Ehrenpreis
Viola palustris	Alpine marsh violet	Sumpf-Veilchen

Plant species	Survey number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Achillea millefolium				2m					1						&
Aconitum napellus														&	
Agrostis tenuis				1					1						
Alchemilla vulgaris				&										&	&
Alnus viridis		3													
Arnica montana							1								
Anthoxanthum alpinum	1	1						1					&	&	
Athyrium distentifolium	&	3			1		+				&				&
Athyrium filix-femina											&				
Avenella flexuosa	1	1	2m		2a	2m	2m	2m				&			
Blechnum spicant					+	2b	2a								
Calamagrostis villosa		2m	2m			2a					&				
Calluna vulgaris							3	2a							
Campanula barbata								1							
Campanula scheuchzeri				+										&	
Cardamine rivularis															&
Carduus personata															&
Carex brunnescens														&	
Carex canescens													&		
Carex echinata	2m												&		
Carex leporina				2m											
Carex nigra	2m												&		
Carex pallescens	&														
Cerastium cerastioides				1											
Cetraria islandica			2m			&									
Chaerophyllum hirsutum											&				&
Cladonia arbuscula			1			&									
Cladonia fimbriata						&									
Cladonia pyxidata			1			&									
Cladonia rangiferina			2m			&									
Deschampsia cespitosa	&	2m			1		1				&			&	
Diphasium alpinum							&								
Empetrum nigrum										&					
Epilobium alsinifolium															&
Eriophorum angustifolium	+														
Eriophorum scheuchzeri	1											&	&		
Evernia divaricata						&									
Festuca rubra agg.				1					+						
Festuca varia														&	
Galeopsis bifida									2a		&				
Galeopsis speciosa											&				
Galeopsis tetrahit									2a						

Gentiana pannonica		&									&				
Geum montanum				&										&	
Gnaphalium norvegicum				&											
Gymnadenia conopsea				&											
Hieracium alpinum								+							
Hieracium aurantiacum				&											
Hieracium pilosella				&											
Homogyne alpina	1	1	+		2a	2m	1	2a				&		&	
Hylocomium splendens			2m		2a	&									
Hypericum maculatum				2a					1						&
Hypogymmia physodes						&									
Juncus filiformis	2m			2m											
Juncus trifidus	&														
Juniperus communis subsp. alpina							r								
Larix decidua	+		&			3									
Leontodon helveticus					1			+							
Loiseleuria procumbens										&					
Luzula luzuloides				r		1		2a							
Luzula sylvatica			2m				2a								
Lycopodium annotinum			1			&									
Lysimachia nemorum				2m											&
Melampyrum pratense	2m		2m		1		2m	1				&			
Melampyrum sylvaticum							2m	2a							
Myosotis decumbens															&
Myosotis nemorosa				1											
Nardus stricta	3			2b	&			2a				&	&	&	
Oreochloa disticha														&	
Oxalis acetosella					2m	2m									
Petasites albus															&
Phleum alpinum				+										&	
Phyteuma betonicifolium							+								
Phyteuma persicifolium							+	+							
Picea abies	r		&			3									
Pinus mugo			2b												
Pleurozium schreberi			2m		2a	&		2b							
Poa alpina														&	
Poa chaixii											&				
Poa hybrida											&				
Poa supina									1						
Polytrichum formosum			2m												
Polytrichum strictum	2b				2b										
Polytrichum commune								2b							
Potentilla anglica				1											

Potentilla erecta	1			2m			+	2a							
Prenanthes purpurea							&								
Pseudevernia furfuracea						&									
Ranunculus acris				+											
Ranunculus aconitifolius											&				
Ranunculus montanus														&	
Ranunculus repens									1						
Ranunculus villarsii								+							
Rhizocarpon geographicum			1							&					
Rhododendron ferrugineum	&	1	+		4		+			&					
Rhytidiadelphus triquetrus	&					&									
Rubus idaeus											&				
Rumex acetosella subsp. acetosella															
Rumex alpestris		2m		3											&
Rumex alpinus									4						&
Saponaria pumila														&	
Saxifraga stellaris		2m													
Sempervivum montanum														&	
Senecio subalpinus															&
Silene vulgaris		1					+								
Sorbus aucuparia	&														
Sphagnum sp.	5				4							&	&		
Stellaria graminea				+											
Stellaria nemorum		3							1						
Thelypteris limbosperma		1									&				
Thymus pulegioides				&											
Trichophorum cespitosum	1														
Trifolium pratense				1					2a						
Trifolium repens				1											
Urtica dioica									2b						&
Usnea filipendula						&									
Vaccinium myrtillus	3	2a	4		2a	3	3	2b		&		&			
Vaccinium vitis-idaea	&		2m				2a	2a		&					
Vaccinum gaultherioides	3		1				1	2b		&		&			
Veratrum album	&				1						&				
Veronia beccabunga															&
Veronica alpina														&	
Veronica serpyllifolia				1											
Viola palustris													&		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N
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Legend
Reference points
Vegetation types
Alpine dock-nettle forb
Alpine-meadow
Cotton grass-mat grass sward
Dwarf pine krummholz
Dwarf shrub-woodrush heath
Larch-spruce forest
Green alder shrubbery
Hat
Mat gras-Ericaceae mosaic
Strict mat grass sward
Rhododendron-blueberry shrubbery
Heather-blueberry tundra
Watershed
0
125
250
500 Meters