

Allegato 4a_1

Trends in the forest line ecotone

Regeneration of mountain pine

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For centuries, the climate-related upper limit of the forest was pushed to lower altitudes by the grazing of domestic animals. A reverse process has started since the establishment of the SNP about 100 years ago,: the forest has progressively extended to higher altitudes, largely undisturbed in the founding period of the SNP, then under the influence of increasing deer numbers, and under the influence of climate change in recent decades. It is generally believed that the spread of the forest is accelerated by global warming and is slowed down by red deer.

The upper forest line in the SNP has a length of around 200 km. The transition between closed forest and alpine grassland is called forest line ecotone and is defined as follows: (a) tree coverage of 1-40%, (b) proportion of boulders and rock up to 40% and (c) above 2200 m a.s.l. The forest limit-ecotone covers an area of about 1,9 km². Through centuries of grazing the timberline was broken and moved downward by a few hundred meters. Generally, it is believed that the natural timberline in the Central Alps is at about 2400 m a.s.l.

Grazing stopped with the foundation of the SNP, and it was expected that the forest would regrow to the natural forest line. When comparing old maps or aerial photos with new ones, the spread of the forest is visible at lower altitudes, but around the tree line, the process seems not to have progressed very far yet.

The regeneration process of mountain pine was investigated in detail on the southwest side of Munt la Schera. The ages of 398 mountain pines of at least 10 cm in height were determined between the current forest limit at 2250 m a.s.l. and the tree line at 2350 m a.s.l. Mountain pines were selected systematically along 14 transects, each 210 m in length. The years of

germination were determined from dendrochronologically identified tree ages. Although the number of mountain pines established per hectare per year varied widely from year to year, a clear trend became visible: a much higher number of mountain pines established themselves between 1955 and 1965 than in the decades before or after.

What could be the reasons? Obvious factors include weather and climate, and ungulates, especially red deer and chamois. The large annual fluctuations are expected to be weather-related, and the longer-term trends could be related to ungulate densities in summer and/or global climate change. The consistently high summer red deer densities from about 1970 could be a possible explanation for the low regeneration of mountain pines after 1975.

Why did only few mountain pines establish themselves before 1950, i.e. when red deer numbers were still low in the park? There are two possible explanations: either the relationship between summer red deer density and mountain pine regeneration is non-linear and/or there are factors which have a significant impact on the regeneration of mountain pines other than red deer. What factors might these be and how big is their influence? In answering these questions non-linear statistical methods such as Generalised Additive Models (GAM) can help.

Data analysis with a GAM has shown that the relationship between influencing factors and mountain pine regeneration are relatively complex. There were three particular findings (fig. 1): First, besides red deer and chamois, mean summer temperature and annual precipitation had a significant influence on the regeneration of the mountain pine (Fig. 1). Second, correlations between influencing factors and establishment of the mountain pine - as usual in ecology - were not linear: In summer, significantly more mountain pines established themselves at red deer densities between 7 and 15 individuals per 100 ha than at higher or lower densities (below 5 or above 19 red deer per 100 ha). Third, a factor becomes the limiting factor if it acts very unfavourably in a year, and other factors become almost irrelevant. For example, if weather conditions and chamois density are very unfavourable, red deer have virtually no influence on the regeneration of the mountain pine.

Even 100 years after grazing, the forest has not yet regrown to its original extent. Particularly in the forest line area, little has happened in the past 100 years. Moreover, global warming is unlikely to accelerate reforestation much. The main reason is that deer have continued to be present at high densities during summer since about 1970. Here, red deer are not all bad for the regeneration of the mountain pine: in the mid-high deer densities around 1960,

significantly more mountain pines were able to establish themselves than in the decades before, when there were few red deer in the SNP.



Figure 1: Influence of red deer, chamois, average summer temperature and annual precipitation on the regeneration of mountain pine in the forest line ecotone of Munt la Schera.

Citation:

KRÜSI, B.O. & P. SIEBER (2013): Entwicklung im Waldgrenzökoton. Verjüngung der Bergföhre. In: H. HALLER, A. EISENHUT & R. HALLER (Hrsg.): Atlas des Schweizerischen Nationalparks. Die ersten 100 Jahre. Nat.park-Forsch. Schweiz 99/1. Bern: Haupt Verlag: 218-219.