Artificial snow on ski pistes: How does the vegetation react to the changed winter environment?

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Introduction

The application of artificial snow is essential for many winter ski resorts. As a reaction to uncertain snow conditions and global warming scenarios, the area treated with artificial snow will increase considerably during the next few years. Possible consequences of a changed winter environment for the vegetation are subject to our study.

Material and Methods

In 13 Swiss ski resorts, we analysed winter conditions under two ski pistes types (natural and artificial snow) and under natural snow. Surveys of the soil surface temperature, measurements of depth, density and composition of the snow cover and vegetation records were carried out. To test whether the snow properties are a determinant of the species composition, we applied indirect ordination methods and analysed the abundance of snowbed and windedge species, which are indicators for extreme snow conditions.

Results

Environmental conditions...

Snow depth and -density on artificial snowed pistes were increased. Soil temperatures were similar to those under undisturbed snow, the snow cover however lasted up to three weeks longer (fig. 1). The snow cover on pistes with natural snow was compressed and shallow, promoting severe soil frosts.

Fig. 1: Snow on ski pistes with artificial snow lasts up to three weeks longer than the natural snow.

... and their influence on vegetation composition

1) Significant variation in DCA site scores was explained by "years with artificial snow" and "use as ski piste" (no fig.)

2) Snowbed and windedge species showed different preferences along the gradient "years of use of artificial snow" (Fig. 2)

3) The longer artificial snow had been used on ski pistes, the more abundant were snowbed species on piste plots (ANOVA $p<0.01$, fig. 3). Windedge species showed the opposite reaction, their abundance was highest on pistes with natural snow and declined with rising time of use of artificial snow (ANOVA $p<0.05$, not shown).

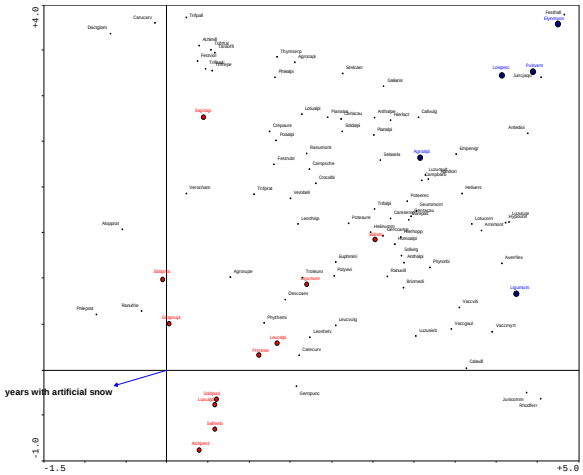

Fig. 2: DCA diagram with snowbed species (red) and windedge species (blue).

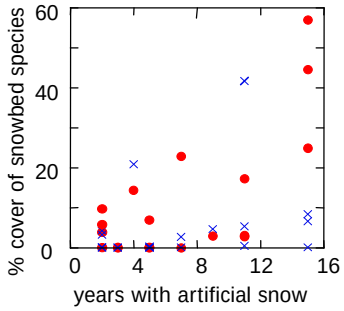

Fig. 3: Snowbed species 'abundance increased on ski pistes with artificial snow (= ● ; × = offpiste control plots).

Conclusions

The preparation of ski pistes has an impact on the vegetation composition
-> This fact needs more attention when planning ski piste infrastructure

Snow properties are important determinants of plant species composition
-> As climate models predict changes in snow patterns, this is an underestimated influence on future species composition

Species groups from habitats with extreme snow regimes show fast and directed changes in abundance when snow properties are changed
-> They may reveal as suitable monitoring units for climate change

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