Post-fire vegetation dynamics along a 1200m long elevational gradient in central-Alpine Switzerland

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INTRODUCTION

Climate change will result in a shift of environmental conditions among which effects of increased drought are likely to aggravate the risk of forest fires, even in regions where forests are not adapted to repeated fire. The central-Alpine valleys are considered such a region: fires currently occur infrequently and with moderate intensity, and ignition is strongly related to the density of human settlement (Zumbrunnen 2009). In the Valais, a forest-fire set by arson destroyed an area of 300ha of forest during the summer heat wave of 2003. The burn was 600-1000m wide and ranged from 900 to 2100m a.s.l at the timberline (Moser et al. 2010). Due to its extension along an environmental gradient, the re-colonisation by plants was monitored for four years (2004-2007) in order to study: (1) which species dominate early after a stand-replacing fire, (2) how species richness evolves, and (3) which factors influence species richness.

METHODS

The burn traversed belts of Scotch pine (Pinus sylvestris), Norway Spruce (Picea abies), and European Larch (Larix decidua) forests. We examined early succession of plant species assemblages with respect to richness and its explanatory variables on permanently installed sample plots (n=153, 200m^2 each) along a rectangular grid with a mesh size of 125m. From 2004 to 2007, species composition was assessed annually using the Londo coverage code. Several environmental variables such as soil depth, ash layer after one year, slope, aspect and dead wood quantity were measured in the field; others, like distance to the forest edge and distance to forest roads, were derived from aerial photos using GIS facilities. Regression analyses were conducted using R version 2.11.0 (R Development Core Team 2010).

RESULTS

Species richness rapidly evolved from an average of 32 species per plot one year after the fire (2004) to 55 species in the fourth year following the burn (2007). The re-colonisation speed was different with respect to the wide elevational range (Fig. 1). Towards the timberline, species numbers exceeded 50 per plot already short after the fire and increased moderately towards an average of 67 species within the next three monitoring years. In contrast, species numbers of lower elevated plots were low, with 26 species early after the fire, but numbers doubling until 2007. By multiple regression analyses, we found the most influential variables to be altitude, distance to the intact forest and ash layer shortly after the fire, coarsely representing fire intensity. The latter variable was most relevant in the first and second year after the fire when places with large ash layer hosted fewer plants than other sites. Most conspicuously, species that have dominated larger areas after the fire were

Funaria hygrometrica, Saponaria ocymoides, Epilopium angustifolium, Euphorbia cyparissias, and Blitum virgatum.

DISCUSSION

Our study gives detailed insight into the re-colonisation dynamics early after forest fire in a region where such events are infrequent and species are presumably not fire-adapted. Species richness rapidly grew in numbers and exceeded the richness of adjacent intact forests only after two years (Wohlgemuth and Moser 2009). Richness was largest close to the timberline, in proximity to the intact forest and where the fire intensity was low. The rapid boost in species richness can be explained by the temporally competition-free space and by the large species pool known in this area (Wohlgemuth 1998). Among the plants dominating early after the burn only one species, namely the moss Funaria hygrometrica, is known to characteristically appear after fire. All other dominant species are considered winners: that is, they are good early colonisers, but not fire adapted.

Further analyses will take into consideration possible differences in plant assemblages that may originate from the variation in dispersal traits.

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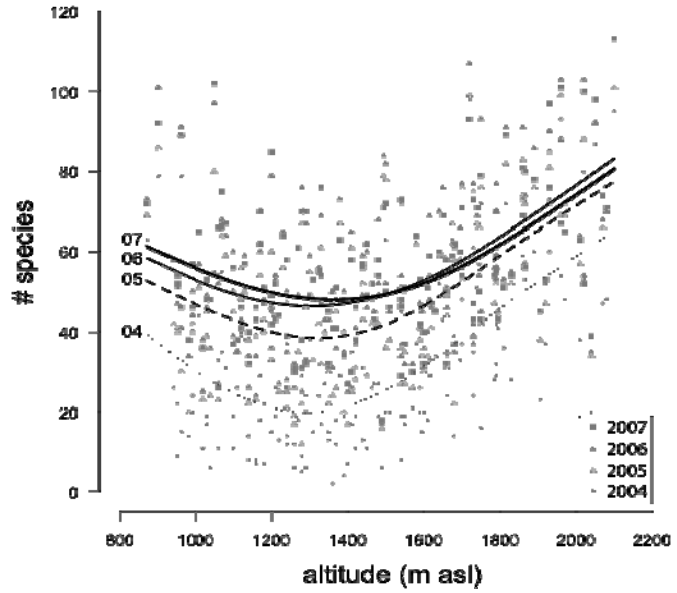

Fig. 1. Numbers of plant species of 153 permanent sampling plots and regression lines derived from generalized additive models (GAM) using altitude as the single explanatory variable with Gaussian distribution type.