Introduction

Forest attributes such as species and age class diversity have been incorporated into forest management as indicators for forest health. However, forest management can only to a certain degree control the state of these attributes. Disturbances such as fire, windthrow, and herbivory are difficult to predict in their severity, frequency, and spatial scale, and they can, despite best management practices, have detrimental effects on the state of a forest. For example, browsing by ungulates (e.g. deer, chamois) is known to alter forest species composition and to hamper forest regeneration (Motta 1999; Côté et al. 2004).

Methods

Sensitivity analysis with the succession model ForClim (Didion et al. 2009) to examine the potential effects of herbivory on the composition and function of mountain forests by investigating:

a) effects of fluctuating browsing intensities as a proxy for the dynamics of ungulate population density (Fig. 1),

b) interactions of browsing with other drivers of forest regeneration including:

- Establishment probability due to abiotic factors (e.g., climate)
- Fraction of seedlings to develop into saplings
- Survival probability of saplings as function of light requirements

Study site: Adelboden (1350 m a.s.l, Picea abies - Fagus sylvatica - Abies alba)

Analysis: Percentage similarity (PS) for tree numbers and Whittaker’s measure (Wβ) for species presence/absence

DBH distributions for selected scenarios:

- reduced regeneration (top left);
- changes in stand type (top & bottom left);
- lower species diversity (top left & right);
- loss of structural diversity and thus associated functions, e.g., protection;

Depending on the factor controlling regeneration success (cf. browsing survival, i.e. in a given year, and overall establishment, i.e. over time), the effects differ strongly: long-term regeneration success is similar in scenarios on top left and bottom right but the resulting stands are quite different.

Results

Figure 2: Stand diameter distributions for selected scenarios from the sensitivity analysis (top center) and the control

- lower species diversity (top left & right);
- changes in stand type (top & bottom left);
- reduced regeneration (top left);
- loss of structural diversity and thus associated functions, e.g., protection;

Figure 1: Tree establishment as a function of browsing intensity over time

Conclusion and Outlook

- in reality further disturbance agents (e.g., windthrow, fire) exacerbating observed effects and lowering the ecosystems’ resilience to recover -> risk of species extinctions
- in the simulation certainty on regular regeneration during periods of low browsing intensity -> in reality controlled by degree of human intervention
- Implications for medium- to long-term forest development, i.e., decades and longer -> loss of structural and species diversity
- Further examination of the interactions between browsing and climate change as the latter will affect species’ ability to regenerate and may facilitate the establishment of invasive and non-endemic species

References and Acknowledgements


Photo credits: Schweizerische Gebirgswaldpflegegruppe (Swiss Mountain Sylvicultural Group)

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