Conference Volume	6th Symposium for Research in Protected Areas 2 to 3 November 2017, Salzburg	pages 739 - 740

Natural forest dynamics following bark beetle outbreaks in the Berchtesgaden National Park – Forest structure and biodiversity during disturbance and succession

Maria-Barbara Winter, Roland Baier, Jörg Müller, Christian Ammer

Keywords

Natural disturbances, Natural regeneration, Alpha diversity, Beta diversity, Vascular plants, Arthropods, Wood-inhabiting fungi, Northern Limestone Alps

Summary

Disturbances are an integral part of forest ecosystems. Irrespective of scale, i. e. from single-tree dynamics to large-scale disturbances such as windthrows, fire or insect calamities, disturbances influence natural species composition and regeneration processes of forests. High shares of pure secondary coniferous stands and changing climatic conditions have increased the impact of large-scale disturbances over the last century and it is likely that they will further increase in the future due to the ongoing climate change. Knowledge about the impact of these disturbances on species composition and natural forest succession is essential for a sustainable forest management aiming to mimic natural processes for ecological and economic reasons. Due to steady interventions namely salvage-logging, planting and thinning activities, natural dynamics can hardly be studied in managed forests. However, large strictly protected areas enable such investigations of forest stand dynamics.

Therefore, natural forest succession following bark beetle-induced spruce dieback and the related changes in stand structure and biodiversity were studied in the Berchtesgaden National Park (Germany) in the Northern Limestone Alps. Centuries of intensive timber extraction, mainly due to salt mining, and intentionally high ungulate populations had heavily altered the structures and species composition of the forests in the Berchtesgaden National Park. Stands had shifted from structured natural mixed mountain forests dominated by European beech (*Fagus sylvatica* L.), silver fir (*Abies alba* Mill.) and Norway spruce (*Picea abies* (L.) H. Karst) towards homogenous stands consisting purely or predominantly of Norway spruce. Following the establishment of the national park in 1978, severe bark beetle infestations occurred especially after the winter storms 'Vivian/Wiebcke' in 1990 and 'Kyrill' in 2007. Evaluations of aerial photographs revealed a scattered and rather small-scale development of the bark beetle infestations. Mean gap sizes comprised 0.07 ha (1990-1997) and 0.29 ha (2007-2012) and total infestation areas covered 30 ha (1990-1997) and 260 ha (2007-2012). Applying a chronosequence of 96 study plots of undisturbed secondary spruce stands (**mature stage**), stands affected by bark beetles within the last five years (**initial early-seral stage**) and stands infested in the 1990s (**advanced early-seral stage**) forest succession was surveyed in montane to subalpine altitudinal zones, on south- and north-facing slopes.

The bark beetle-induced dieback of the mature spruce stands significantly reduced stand volumes and crown cover, and led to a strong increase in the amount of standing deadwood. Large shares of standing deadwood broke down due to decomposition during the first two decades of succession. Humus degradation and significant changes in mesoclimatic conditions were not found. The significantly increased shares of radiation at the forest floor induced by the spruce dieback, increased cover and height of the ground vegetation.

Even though tree seedlings had to compete with the vital ground vegetation, the gaps got regenerated rather fast. Around 5.000 seedlings and saplings (> 50 cm height) could be found on average per hectare in the montane zone two decades after the bark beetle infestation. This development was slightly protracted in high montane zones. There the importance of deadwood as substrate for seedlings establishment increased with altitude and decay stage. Natural regeneration was dominated by Norway spruce, sycamore maple (*Acer pseudoplatanus* L.) and rowan (*Sorbus aucuparia* L.). European beech and silver fir which would naturally dominate the mixed mountain forests, were found in very little shares. As a result of only few seed trees due to historical forest management seedlings of these species were rare in this study. The changes in forest structure due to disturbance and the scattered patterns of the post-disturbance regeneration initiated an increase of structural heterogeneity on stand and landscape level. The importance of advance regeneration for the regeneration success was almost negligible. Contrary to the expectations, more than 90 % of the seedlings did germinate after the disturbance events. This indicates a high resilience of the mountain forests after medium-scale disturbance, if ungulate densities enable the survival of the natural regeneration.

Epigaic species showed either no changes (Coleoptera, Arachnida, Mollusca) or decreasing species densities (Collembola) due to missing litter supply after the disturbance. Contrary, the light, nutrient and dead wood dependent species (vascular plants, Heteroptera, Aculeata, pollinating Coleoptera) did profit from the temporary gap conditions and revealed a significant increase in species densities during succession. The findings suggest that in unmanaged forests after bark beetle attack, a structurally complex phase prior to tree canopy closure can last several decades. Moreover, the still increasing species densities in the advanced early-seral stage indicate that some stand structures, driving the species diversity only fully develop given this extended time period. The mosaic of the different small-scale successional stages revealed a high gamma diversity, especially for wood-inhabiting fungi and saproxylic beetles. The species compositions of vascular plants did not vary significantly among the successional stages on landscape scale. Instead, differences among the stages were found in shifts in species dominance.

Management approaches aiming at sustaining biodiversity of mountain forest, should tolerate extended early-seral stages to support the full range of organisms and functions associated with canopy-opening disturbances. Under comparable post-disturbance conditions, the high resilience of the mountain forests is expected to lead to fair natural regeneration densities, if ungulates are managed accordingly.

References

WINTER, M.-B. 2016. Natürliche Waldentwicklung unter dem Einfluss des Borkenkäfers im Nationalpark Berchtesgaden. Bestandesstruktur und Biodiversität im Verlauf von Störung und Sukzession. Doktorarbeit an der Georg-August-Universität Göttingen. Available online: http://ediss.uni-goettingen.de/handle/11858/00-1735-0000-0028-8796-2

Contact

Maria-Barbara Winter
Maria-barbara.winter@forst.bwl.de
Forest Research Institute of Baden-Württemberg (FVA)
Wonnhaldestraße 4
79100 Freiburg
Germany

Roland Baier
roland.baier@npv-bgd.bayern.de
Berchtesgaden National Park Administration
Doktorberg 6
83471 Berchtesgaden
Germany

Jörg Müller
Joerg.mueller@npv-bw.bayern.de
Bavarian Forest National Park Administration
Freyunger Straße 2
94481 Grafenau
Germany
OR
University of Würzburg
Field Station Fabrikschleichach
Glashüttenstr. 5
96181 Rauhenebrach
Germany

Christian Ammer
christian.ammer@forst.uni-goettingen.de
Georg-August-Universität Göttingen
Silviculture and Forest Ecology of the Temperate Zones
Büsgenweg 1
37077 Göttingen
Germany