Natural disturbances in Central-European mountain spruce forests: a basis for forest restoration

Magda Edwards-Jonášová, Martin Čermák

Global Change Research Centre of the AS CR, Na Sádkách 7, CZ - 370 05 České Budějovice, Czech Republic
edwards.m@czechglobe.cz

Introduction

Risk of natural disturbances is a frequently discussed topic in the context of mountain spruce forests and global climate change. Natural disturbances such as bark beetle outbreaks and windfalls are a natural part of the dynamics of spruce forests, but at present their frequency and intensity in Central Europe is growing. This raised doubts about the possibility of restoration of affected spruce forests and led to the enforcement of salvage logging even in some protected areas. Although small-scale disturbances are common and considered natural in Central Europe, for landscape-scale disturbances there is no information on natural development from the past, because in such cases affected areas were artificially afforested.

The aim of this study was to evaluate the development of natural regeneration in disturbed areas and to propose the best method for restoration of disturbed forests. Study plots represent two main types of natural disturbances in Central European forests, bark beetle outbreak and windfall. In both cases, the impact of the original natural disturbance, as well as the impact of artificial disturbance in the form of salvage logging were investigated.

Study area 1: Bark beetle outbreak in the Šumava National Park (Czech Republic)

A large complex of mountain spruce forests (*Calamagrostio villosae-Piceetum*) situated in the central part of the Šumava National Park was affected by a bark beetle outbreak in the 1990s. A non-intervention approach was used in some core zones of the national park, while salvage logging was applied in all the other parts of the Šumava Mts. Natural regeneration and vegetation composition were evaluated between 1998 – 2012 in non-intervention plots (dead canopy), clearcut plots and partly surviving waterlogged forest.

Study area 2: Windstorm in the Tatra National Park (Slovakia)

A catastrophic windstorm occurred in the Tatra National Park in 2004 and destroyed an extensive area of subalpine larch-spruce forests (*Lariceto-Piceetum*). Part of the windfall area was left uncleared for natural development, but most of the area was cleared. Long-term monitoring of cleared and uncleared windfall and reference forest started in 2007.

Results

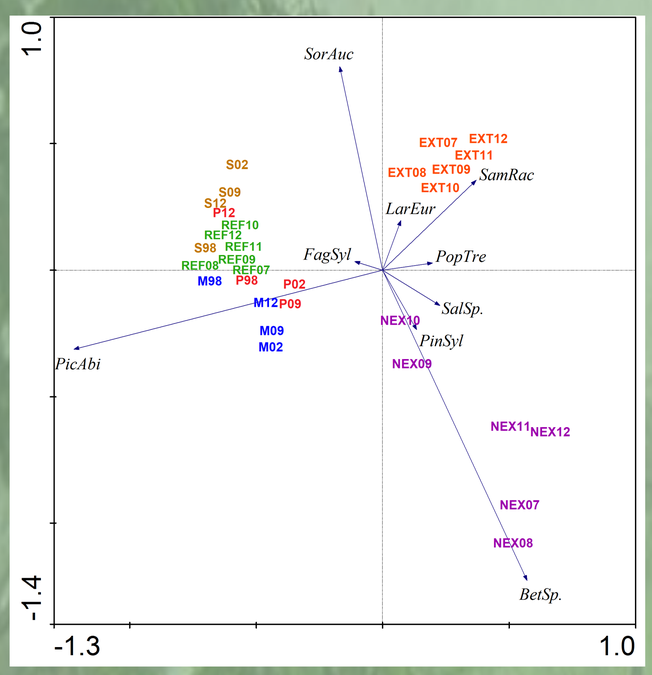
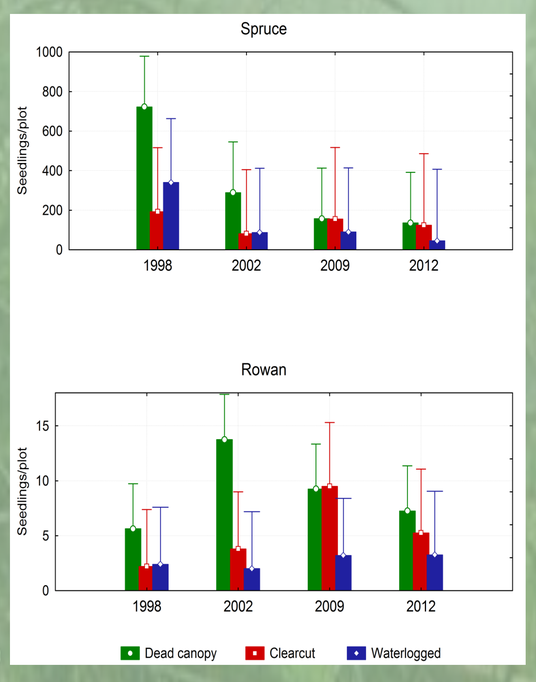


Fig. 1. PCA ordination (standardized by samples) - projection of tree species (seedlings and saplings) and passively projected centroids for type of plot in each year.

Bark beetle plots: S – dead canopy, P – clearcut, M – waterlogged plots.

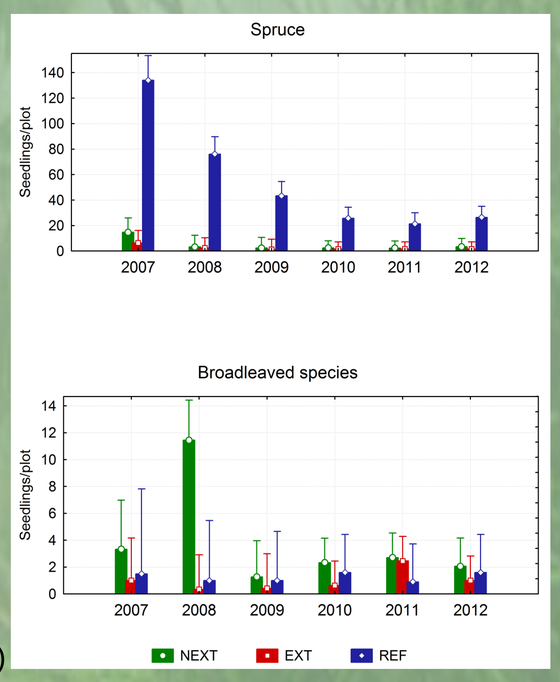
Windfall plots: NEXT – uncleared, EXT – cleared, REF – reference forest.

Bark beetle (Study area 1)



(a)

Windfall (Study area 2)



(b)

Fig. 2. Mean numbers of spruce (*Picea abies* (L.) and rowan (Sorbus aucuparia (L.) seedlings in bark beetle plots (400 m^2), in 2009 and 2012 including plantings (a), and spruce and broadleaved species in windfall plots (20 m^2) (b).

Windfall disturbance (unlike bark beetle) caused change of species composition in favor of pioneer broadleaved species (Fig. 1).
Natural disturbances increased diversity of microhabitats and structures of previously managed forests towards natural ones.
In both cases salvage logging significantly reduced quantity (Fig. 2), age and height structure of natural regeneration compared to natural disturbance.

Conclusions

Based on long-term monitoring of natural regeneration and vegetation composition we concluded that non-intervention in mountain spruce forests affected by bark beetle or wind disturbance is a much better option for the restoration of these forests than any forestry measures. The disturbance caused by salvage logging had a significant negative effect on vegetation and natural regeneration of indigenous species of mountain spruce forests, which led to the need for artificial reforestation. The non-intervention approach achieved similar numbers of spruce and rowan as with artificial reforestation, but at no cost. The age and height structure of the future forest and the condition of original vegetation is more prosperous under dead canopy and windfall areas. Moreover, the non-intervention approach allows for natural selection, which can be expected to lead to the formation of substantially resistant stands.

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