How to manage windthrows in Central Europe to prevent bark beetle outbreaks?

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ABSTRACT

Bark beetle ( Ips typographus) epidemics in Europe are typically triggered by excessive availability of freshly dead trees and trees with compromised defense, which often occur after windstorms or droughts. Subsequently, enlarged beetle populations migrate to the surrounding forests, which were not affected by the primary disturbance. Removal of windfelled trees (salvage or sanitation logging) is therefore a frequent management response to prevent the build-up of bark beetle populations. Yet, the effectiveness of the removal remains poorly understood, particularly when the outbreaks are amplified by faster beetle development cycles and reduced tree defense under climate change conditions.

Moreover, diverse ownership, management objectives and limited resources often restrict salvaging operations, and the final effect on bark beetle populations is thus even less clear. To better understand the interplay between climate, management, bark beetle populations, and host trees, we use the process-based forest landscape and disturbance model iLand. We studied differences between the removal of windfelled trees applied evenly over the landscape, focused on the vicinity of roads (scenario of limited logging resources) and concentrated in a contiguous block (scenario of spatially diversified management objected to) on a 16.050 ha forest landscape in Central Europe. We found that the removal of >80% of all windfelled trees is required to substantially reduce bark beetle disturbances. Focusing on the vicinity of roads created a "fire break effect" on bark beetle spread, and was moderately efficient in reducing landscape-scale bark beetle disturbance. Block treatments substantially reduced outbreaks in treated areas. Leaving parts of the landscape untreated (e.g., conservation areas) had no significant amplifying effect on outbreaks in managed areas. Our research suggests that the management of interacting disturbances from wind and bark beetles requires much more complex considerations than are currently practiced.

MODEL AND STUDY AREA

Process-based ecosystem model: iLand
- simulates forest landscape dynamics at the level of individual trees
- large-scale mortality events are simulated by spatially explicit models of disturbance agent (wind, bark beetles, wildfires)
- combines approaches from physiological, gap and landscape models

Location: Central Western Carpathians, Slovakia (Central Europe)
Area: 16,000 ha, 70% forest cover
Species composition: Spruce 75% — European larch 10% — Scots pine 9% — Silver fir 3% — European beech 2%

Environment: 620-1,550 m a.s.l.; Cambisols, Podzols and Rendzinas. Growing season air temperatures: 12-15°C. Growing season precipitation: 380-510 mm

Management: Timber production oriented management; rotation period 100 years; regeneration system in mixed stands is uniform shelterwood; a small-scale clearcutting system with 3 harvest cycles is applied in spruce monocultures with a maximum closed-cut area of 3 ha.

Disturbances: regular wind damage followed by bark beetle outbreaks; intensifying disturbance rate and a high proportion of salvage and sanitary felling in the recent two decades

When treatment applied in the entire landscape:
- Volume affected annually by bark beetles decreased nonlinearly with increasing salvage logging intensity
- Removal of 60 and 95% of windfelled trees caused 34 and 67% decrease in beetle killed volume under reference climate
- Under climate change, efficiency decreased to 17 and 47%, respectively

Windthrow treatments:
- without treatment
- salvage logging in a block or a buffer around forest roads
- salvage logging across the whole forest area

-Removal of 80 and 95% of windfelled trees caused 34 and 67% decrease in bark beetle outbreaks

Photos were taken by Roman Modlinger.

REFERENCE


How can different levels and spatial patterns of salvage logging prevent bark beetle outbreaks?