

# Spatial Patterns of First Spruce Bark Beetle (*Ips typographus* L.) Infestation of Standing Norway Spruce (*Picea abies* [L.] Karst.) After Heavy Storm Damage in Switzerland

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## Abstract

On December 26, 1999, Switzerland was struck by the most severe storm in the country's history. An extensive dataset from the Canton Berne allowed us to test the hypothesis that in regions where windthrown wood was cleared a) the intensity of the first *Ips typographus*-infestation on standing trees after the storm depends on the distance from windthrow areas and b) the intensity of the first infestation depends on the temperature differential at different altitudes. Both hypotheses have been verified, however our results suggest that the first infestation of standing trees after the storm is not caused by the emigration of bark beetles from adjacent windthrow areas.

## Material and Methods

Windthrow areas (>0.5 ha) were digitized from orthophotos. Additionally, the forest managers recorded the center-coordinate of scattered windthrow groups with the corresponding amount of wood. The clearing of windthrow areas and the removal of scattered windthrow trees was completed approximately one year after the storm. Furthermore, the forest managers recorded the infestation spots on standing trees with the corresponding amount of spruce. The trees were harvested in the same year. For horizontal analysis we classified the data in different distance rings around the windthrow areas. For vertical analysis we classified the data in different altitudinal belts. For each distance class and altitudinal belt we calculated the forest area, the volume of infested standing spruces, and the volume of scattered windthrown wood. For the altitudinal belts, we calculated also the total standing volume of Norway spruce from data of the Swiss National Forest Inventory.

## Results and Discussion

We found a dramatic decrease in the proportion of beetle-infested spruce trees per forest area with increasing distance from windthrow areas (Fig. 1). This was also found by Wichmann and Raven (2001). These authors concluded that the spatial pattern of bark beetle infestation of standing spruce after heavy storm damage reflects the spread of *I. typographus* emigrating from the windthrow areas. Our study indicates, however, that the first infestation of standing trees after heavy storm damages may not reflect the spread of *I. typographus*. We found a strong positive relationship between the

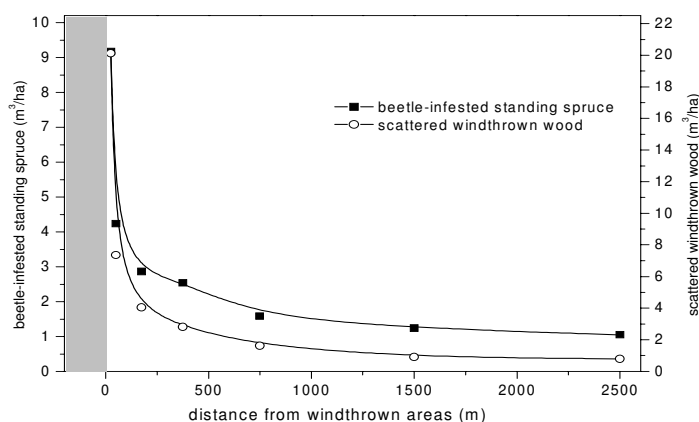


Figure 1.—Densities of beetle-infested standing spruce (■) and scattered windthrown wood (○) in relation to the distance from windthrow areas.

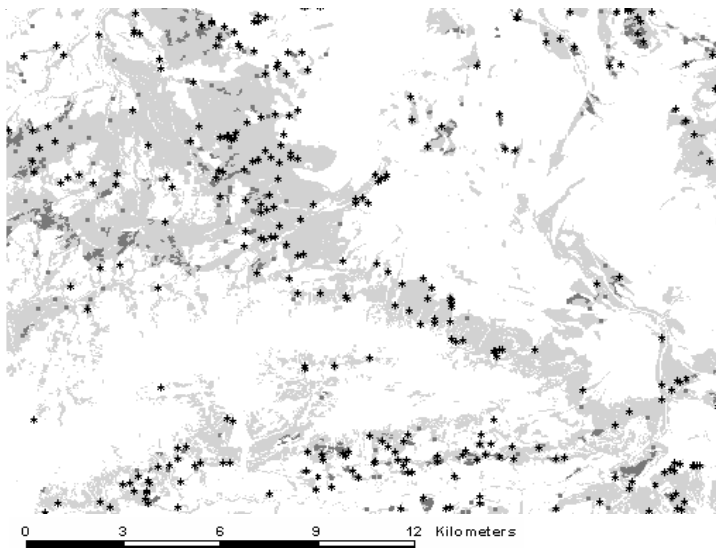


Figure 2.—Representative part of the Canton Berne with forest area (light grey), windthrow areas (dark grey), scattered windthrow groups (●) and spots of infestation (★) for the year 2001.

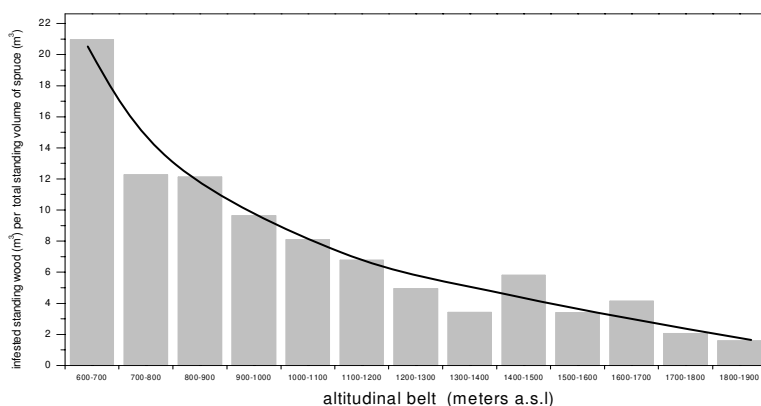


Figure 3.—Beetle-infested spruce per total standing volume of spruce in relation to altitudinal belts (meters above sea level).

volume of scattered windthrown trees and the volume of bark beetle infested spruce ( $r^2 = 0.996$ ,  $p < 0.0001$ , c.f. Fig. 1). Considerable infestation was found also at greater distances ( $> 500$  m) from the windthrow areas (Fig. 2). We hypothesize that the volume of scattered windthrown wood might be an indicator of reduced host-tree resistance of the residual stands after heavy storm damage. This means that the first infestation of standing spruce occurred mainly in weakened trees.

In Switzerland, an altitudinal increase of 100 m corresponds to an average temperature decrease of  $0.65^\circ\text{C}$ . Therefore, the gradual decrease in beetle-infested spruce from the lower elevations up to higher altitudes (Fig. 3) stresses the importance of temperature on the velocity of spruce bark beetle development; this was reported also by Wermelinger and Seifert (1998) but under laboratory conditions.

## References Cited

- Wermelinger, B. and M. Seifert. 1998.** Analysis of the temperature dependent development of spruce bark beetle *Ips typographus* (L.) (Col., Scolytidae). J. Appl. Ent. 122: 185-191.
- Wichmann, L. and H.P. Raven. 2001.** The spread of *Ips typographus* (L.) (Coleoptera, Scolytidae) attacks following heavy windthrow in Denmark, analysed using GIS. For. Ecol. Manag. 148: 31-39.