Bark Beetle Management After a Mass Attack — Some Swiss Experiences

B. Forster, F. Meier and R. Gall

Forest Insect and Disease Survey FIDS, Swiss Federal Research Institute WSL CH-8903 Birmensdorf

Abstract

In 1990 and 1999, heavy storms accompanied by the worst gales ever recorded in Switzerland, struck Europe and left millions of cubic metres of windthrown Norway spruce trees; this provided breeding material for the eight-toothed spruce bark beetle (*Ips typographus* L.) and led to mass attacks in subsequent years which resulted in the additional loss of millions of cubic meters of standing spruce trees. In addition to the ecological concerns, many forest owners were faced with a difficult financial situation, resulting in a change in strategy that left some storm and bark beetle damaged areas uncleared. Also, logistical issues made it sometimes impossible to remove all of the timber before a new generation of beetles emerged. This situation forced forest services and land-owners to set priorities. To address questions related to developing a new risk assessment, we initiated observation projects about scolytid behaviour occurring in variously threatened storm areas and regions.

Keywords: storm damage, bark beetles, Scolytidae, *Ips typographus*, forest protection

Mass attacks of bark beetles following storm damage

In the last decade, two heavy storms struck Western and Central Europe; they were the worst gales ever recorded in Switzerland. In 1990 storm "Vivian" caused a loss of 5 million cubic meters of wood, representing a one-year regular cut in Switzerland. Norway spruce stands (*Picea abies* (L.) Karst.) in the central and eastern Alps and Prealps were the most severely damaged. A total of about four million cubic meters of spruce timber was blown down. In the following six years, the eight toothed spruce bark beetle (*Ips typographus* L.) caused mass attacks which resulted in the death of another 2 million cubic meters of standing spruce trees (Fig. 1). This phenomenon was also a record for Swiss forests.

In 1999 storm "Lothar" produced 13 million cubic meters of windthrown wood, which included 8 million cubic metres of spruce. The worst storm damage occurred in the western and central Plateau regions and in the Prealps. In addition to spruce, windthrows occurred also in many mixed and broadleaf stands. The amount of subsequent bark beetle attacks that will follow this storm is not yet known, but will certainly exceed the level of timber infested after "Vivian" (Meier et al. 2002). During a period of 200 years prior to storm "Vivian," no other Swiss bark beetle gradation produced more than 500,000 cubic meters of timber loss.

Experiences from mass attacks abroad have demonstrated that spruce bark beetles are one of the most effective natural factors that can quickly influence forest dynamics by killing large stands of conifers (Nationalparkverwaltung Bayerischer Wald 1996, Wittwer et al. 1998). Bark beetle gradations follow frequently after storm damage or when warm and dry periods occur during the growing season (Weslien and Schröter 1996).

Outbreaks of bark beetles should be contained in order to maintain both forest sustainability and protection against natural hazards. In Switzerland this is accomplished mainly through mechanical forest practices especially by preventive clearing of devastated areas and by evacuating or debarking freshly infested spruces. After the two big storms, the forest services realized that it was impossible to clear all damaged stands in a timely manner and that there would be a high risk of bark beetle outbreaks. Reasons and conditions were analyzed that enforce clearing practices in storm-damaged areas and bark beetle infestation spots, as well as decisions to leave damaged areas uncleared. Priorities had been established and new strategies in bark beetle management and risk assessment were developed.

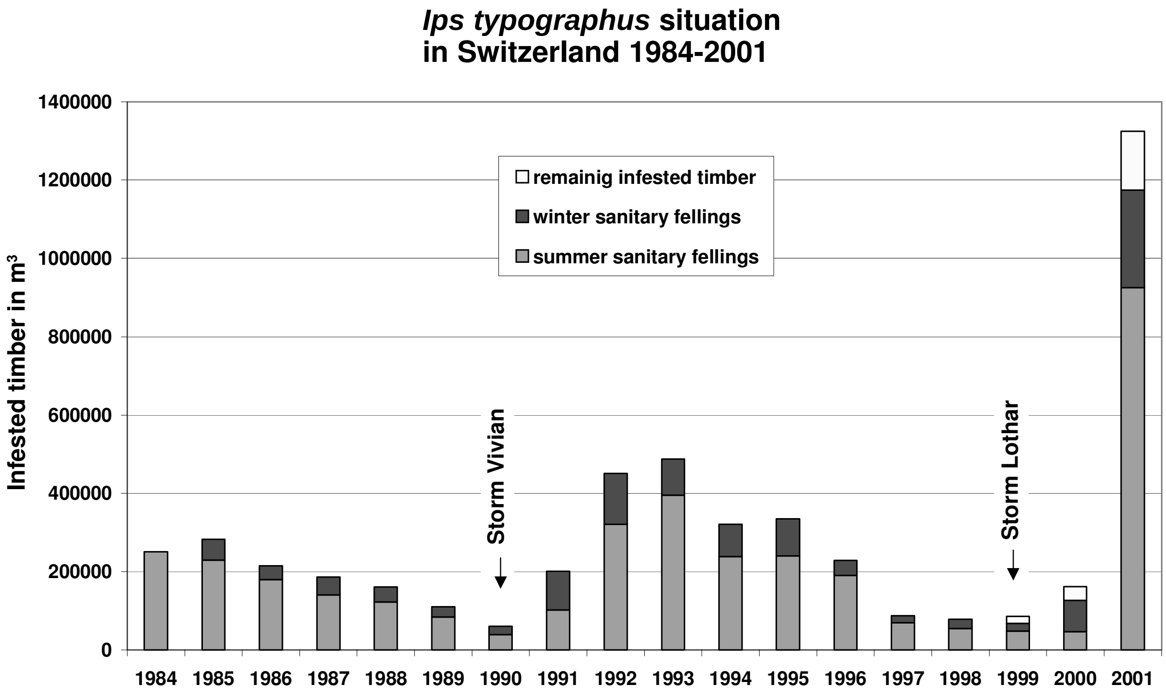

Figure 1.—Yearly infestation and sanitary felling of *Ips typographus* attacked spruce in Switzerland

Knowledge about *Ips typographus*

Ips typographus is the best known forest insect in Central Europe. During the last 200 years, numerous publications have dealt with its biology, epidemiology and management. *Ips typographus* has a strong predilection for mass attacks, consequently after storm events, beetle populations build up rapidly in wind thrown spruce stems and there is a high risk for subsequent attacks in neighbouring spruce forests. There is a strong relationship between storm intensity and subsequent bark beetle attacks (Fig. 2 and Fig. 3). In the first vegetation period after a storm, beetle populations are able to multiply by a factor of more than 10 in only one generation (Wermelinger et al. 1999). In later years, natural enemies help to control excessive propagation, but under favourable weather conditions and if there are still plenty of susceptible host trees, mass attacks will often continue for several years. Emerging bark beetles have dual strategy which allows a portion of the population to stay in suitable infestation spots <u>and</u> allows other to spread to new areas (Duelli et al. 1997). Flight distances can vary considerably. Active flight normally takes place within the first 500 metres however some can get caught by updrafts and then transported over distances of several kilometres. In mountain areas with steep slopes, passive wind transport of beetles seems to be more frequent because the area of turbulence that occurs above tree crowns can easily be reached by horizontal flight.

At lower elevations, two generations of *Ips typographus* can normally be observed per year; above ca 1300 metres asl., only one generation is common. This is one of the reasons why mass attacks peak normally earlier in the Plateau than in the Alps. In 2000, immediately after the storm “Lothar”, breeding conditions for *I. typographus* were very favourable. An abundance of damaged spruce timber was available as suitable breeding material, and very favourable weather conditions occurred, resulting in an explosion of beetle populations (Fig. 1). In warmer areas, two and a half or even three generations of beetles were observed and a second generation was recorded in areas up to about 1600 metres asl.

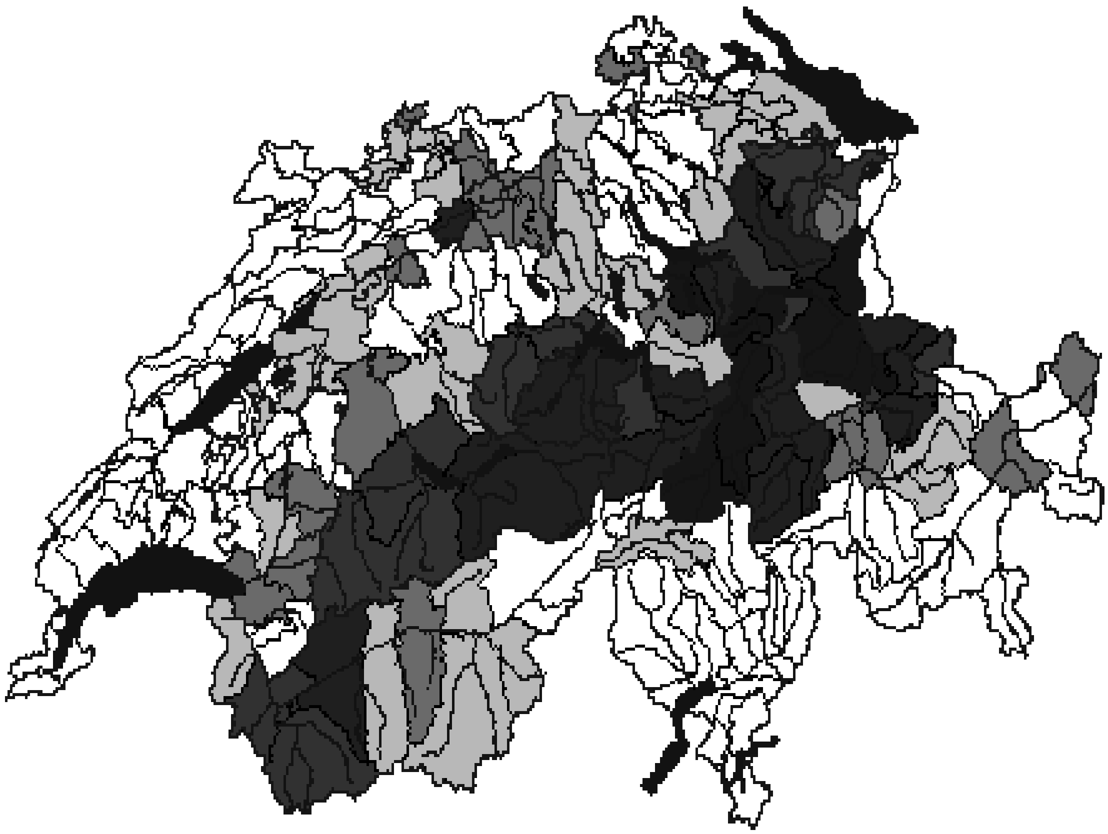

Figure 2.—Density of storm damage by forest district, caused by "Vivian" 1990
(dark colours indicate heavy windthrows)

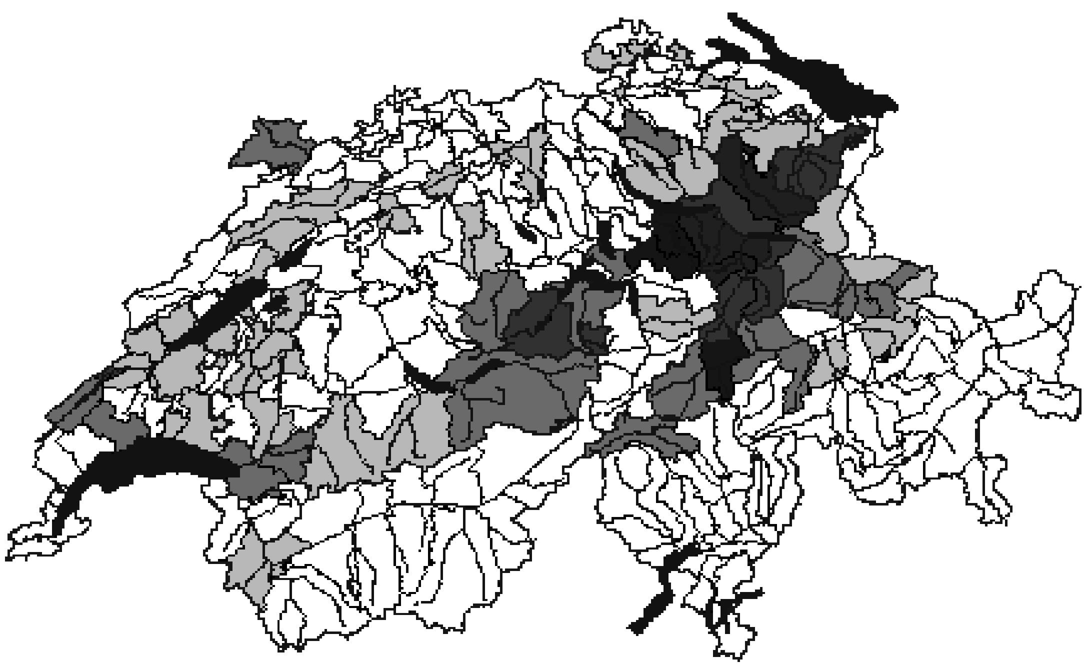

Figure 3.—Density of bark beetle attack by forest district 1992-1996 (dark colours indicate heavy attacks by *Ips typographus*)

Field experiences and new challenges

During the 1990s and after storm "Vivian", there were only a few storm-damaged areas and neighbouring spruce stands where bark beetle control activities were not implemented. In these regions, secondary beetle attack on storm-damaged timber often exceeded 60% on average. In the worst case, new spot infestations spread until almost the entire stand was killed (Forster 2001b); similar phenomena have also been described in Germany (Niemeyer et al. 1995). Within some regions where severe storm damage occurred and where adequate control measures could not be taken in time, the percentage of secondary timber lost due to beetles approached 100%. Examples of this are described from the Toggenburg Valley in the canton St. Gall (Schmidtke and Scherrer 1997) and from the Schwanden region in the canton Glarus (Kantonsforstamt Glarus 1995). Conversely, good experiences with efforts to remove storm damaged timber occurred in the severely devastated eastern Bernese Oberland or in the canton Schwyz, where secondary beetle attacks were recorded on only 20 to 40% of windthrown trees. The removal of damaged trees from storm areas affected by "Vivian" and reduction of subsequent bark beetle attacks was also observed in the canton Wallis (Metral 1995). These examples indicate that, even in a disastrous situation, forest protection measures are effective in lowering subsequent bark beetle damage to about 50% of that which would have occurred without intervention.

Today, the demands of forest owners and the public are changing considerably and more storm and bark beetle damaged areas will remain uncleared. In addition to ecological concerns, the difficult financial situation experienced by many forest owners has caused them to consider changing strategies and leaving some damaged areas uncleared. Many mountain forest owners are unable to cover their harvesting costs because of the decline in timber revenue. Logistical reasons (accessibility) made it sometimes impossible to remove all timber before it was infested and before a new generation of beetles emerged. These facts forced forest services and timber land owners to establish priorities (Forster 1998). To address questions related to assessment of risk, the WSL initiated observation projects of scolytid behavior in different threatened storm areas and regions (Forster 2001a).

As a result of these projects, we propose the following recommendations: an overview of a storm disaster must be established and the regional forest functions must be known. The necessity for clearing damaged stands to satisfy a given forest function needs to be assessed. Then the means (harvest specialists, machinery, time) must be evaluated along with the financial situation and the feasibility of hiring additional manpower. If the means are not insufficient to clear all areas in time, or other objections against clearing exist, <u>priorities</u> must be established. Due to the mobility of the beetles, a common strategy must be considered for entire valleys or landscape compartments encompassing several square kilometres.

In order to reduce infestation levels in strict protection forests, disaster areas should normally be cleared. In some cases, the stems can be debarked and then used in place as paravalanche construction. If such compartments of at least two square kilometres can be cleared to prevent potential attacks or to destroy infected breeding material in time, this will help to lower the risk of secondary bark beetle attack on standing trees. In areas with appropriate forest protection measures, mass attacks peak earlier than in other locations but fewer standing trees will be infested.

If all wind thrown trees cannot be removed or debarked in time, or in less important protection forests, adapted management strategies should be used. The stated goal is to limit secondary damage by bark beetles to such a degree that sustainable forest management can be realized. Because not all windthrown trees on totally damaged areas will be infested before they dry out, we propose to first clear the areas with a high proportion of <u>thrown</u> trees before clearing areas with mainly <u>broken</u> stems. Fallen trees that still have some root contact with the soil and/or that are lying in the shade of standing trees remain suitable for bark beetle colonization for a longer period of time. Therefore, this will reduce the availability of potential breeding material in subsequent years. Despite new recommendations about establishing priorities, a mixture of different management strategies are observed quite often in damaged stands, especially within private forests. This is a result of differences among owners, their means (manpower, finances, machinery) and their individual interpretation of priorities and opportunities. Management conflicts arise along the borders of different ownerships, especially if stands containing storm damage and bark beetle infestations border on managed stands where control practices are being implemented. In these cases buffer zones of some 100 to 1500 metres in width should be established (Niemeyer et al. 1995 and Heurich et al. 2001). However, frequently there is not enough space available for buffer zones and consequently the edges of managed stands will be re-infested. It is almost impossible to determine to what degree infestations in unmanaged stands contribute to new infestations that occur in neighbouring stands.

The actual "state of the art" on what is known about bark beetle behaviour and the effectiveness of control measures was compiled and published a few years after the storm "Vivian" (Jansen and Duelli 1993). Later the Swiss Forest Agency and the WSL compiled a key on windthrow clearing based on our initial experiences with "Vivian" (BUWAL 2000). Recommendations were again published after the storm "Lothar" (Forster et al. 2000, Forster 2001c) and communicated further through training courses and through the internet (www.pbmd.ch).

Conclusions

• There is a strong relationship between the intensity of storms and subsequent bark beetle attacks.

• In cases of disastrous storm damage in Norway spruce stands, subsequent bark beetle outbreaks can not be avoided and secondary damage on standing trees must be accepted.

• If newly attacked standing trees can be detected and processed efficiently, the gradation will generally subside sooner than in stands where the level of intervention is inadequate. Our experiences indicate that even in a disastrous situation, the application of forest protection measures will effectively lower subsequent bark beetle damage to about 50% of that which would occur without intervention measures.

• By establishing priorities, the course of the gradation can be influenced regionally. It is very important that resources should not be spent inefficiently or for punctiform control measures; resources must be committed to the regions most at risk. The same management strategy must be used within landscape compartments, throughout the affected region regardless of ownership.

• In Swiss mountain forests, the annual growth of timber has not been harvested for many years. This practice has provided high stocks of timber which will be more at risk of storm and bark beetle damage in future years. Additionally, bark beetles are likely to play an even more significant role in forest dynamics if projections on climate change will lead to warmer vegetation periods.

References Cited

BUWAL (ed.), 2000. Entscheidungshilfe bei Sturmschäden im Wald. Schriftenreihe Vollzug Umwelt. Bundesamt für Umwelt, Wald Landschaft (BUWAL), Bern. 100 p.

Duelli, P., P. Zaradnik, M. Knizek and B. Kalinova. 1997. Migration in spruce bark beetles (*Ips typographus* L.) and the efficiency of pheromone traps. J. Appl. Ent. 121, 297-303.

Forster, B. 1998. Storm damages and bark beetle management: how to set priorities. In: Methodology of Forest Insect and Disease Survey in Central Europe, Proceedings of the first Workshop of the IUFRO WP 7.03.10 - Ustron-Jaszowiec, Poland, April 1998. Edited by Grodzki, W. et al., IBL Forest Research Institute, Warszawa: 161-165.

Forster, B. 2001a. Bark beetle survey: Can monitoring of *Ips typographus* help to minimise control measures? In: Knizek, M. et al. (eds.), 2001: Methodology of Forest Insect and Disease Survey in

Central Europe. Proceedings of the IUFRO WP 7.03.10 Workshop, Sept. 24-28 2000, Busteni, Romania. Brasov, Forest Research and Management Institute (ICAS), Section of Brasov, 22-25.

Forster, B. 2001b. Chronologie der Borkenkäferentwicklung im Raum Schwanden 1990 bis 1997. In: Sophie und Karl Binding Stiftung (ed.) 2001: Binding Preis für vorbildliche Waldpflege 2001. Vivian als Chance. Gemeinde Schwanden GL. Basel, 115 p. 41-42.

Forster, B. 2001c. Käferholz erkennen und richtig handeln. Wald Holz 82, 8: 72-74.

Forster, B., B. Wermelinger and F. Meier. 2000. Sturmschäden und Borkenkäfer. Die Situation nach "Lothar". Wald Holz 81, 2: 40-42.

Heurich, M., A. Reinelt and L. Fahse. 2001. Die Buchdruckermassenvermehrung im Nationalpark Bayerischer Wald. In: Waldentwicklung im Bergwald nach Windwurf und Borkenkäferbefall. Bayer. Staatsforstverwaltung Wiss. Reihe, Grafenau, Vol. 14, 9-48.

Jansen, E. and P. Duelli. 1993. Borkenkäfer: Was wissen wir, was vermuten wir, was sollten wir wissen? Schweiz. Wald 129,7-8:31-33.

Kantonsforstamt Glarus (ed.) 1995. Sturmschäden im Glarner Wald vom 27./28.2.1990. Schlussbericht. Glarus. 52 p.

Meier, F., R. Engesser, B. Forster and O. Odermatt. 2002. Forstschutz-Überblick 2001. Birmensdorf, Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft. 18 p.

Metral, R. 1995. Bekämpfung des Borkenkäfers im Unterwallis. Der Aufwand hat sich gelohnt. Wald Holz 76,6:20-21.

Nationalparkverwaltung Bayerischer Wald (ed.). 1996. Totholz im Nationalpark Bayerischer Wald, Entwicklung des Anteils abgestorbener Fichten. Grafenau, 36 p.

Niemeyer, H., J. Ackermann and G. Watzek. 1995. Eine ungestörte Massenvermehrung des Buchdruckers (*Ips typographus*) im Hochharz. Forst Holz 50,8:239-243.

Schmidtke, H. and H.-U. Scherrer. 1997. Sturmschäden im Wald. Schlussbericht NFP 31. Zürich, vdf Hochschulverlag. 38 p.

Wermelinger, B., M.K. Obrist, P. Duelli and B. Forster. 1999. Development of the bark beetle (Scolytidae) fauna in windthrow areas in Switzerland. Mitt. Schweiz. Entomol. Ges. 72, 3-4: 209-220.

Weslien, J. and H. Schröter. 1996. Natürliche Dynamik des Borkenkäferbefalls nach Windwurf. Allg. Forst Z./Der Wald 51,19:1052-1055.

Wittwer, D., K. Matthews, K. Zogas, L. Trummer, E. Holsten, B. Schulz, P. Hennon, M. Schultz, J. Riggs and R. Burnside. 1998. Forest Insect and Disease Conditions in Alsaka – 1998. Gen. Tech. Rep. USDA For. Serv. R10-TP-74. 57 p.