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STAND RENEWAL OF STORM-DAMAGED BEECH FORESTS UNDER THE INFLUENCE OF COMPETING VEGETATION

Christoph Angst
Swiss Federal Research Institute WSL, CH-8903 Birmensdorf, e-mail: christoph.angst@wsl.ch

Abstract

What is the appropriate and the most economic way to restore large windthrow areas? Under what conditions can restoration partly or fully be left to the processes of natural regeneration? Can it even be advisable not to harvest the fallen timber? How will young trees be affected by competing vegetation (e.g. *Rubus fruticosus* L. agg.)? Many questions like these were open after storm "Lothar" in December 1999 destroyed forests in Central Europe in a hitherto unknown extent. Therefore, the Swiss Federal Research Institute WSL established five research sites in windthrown beech forests to study natural regeneration processes. These sites were set up as pairs of exploited and unexploited windthrow areas. Data on natural regeneration and competing vegetation has been recorded each year since 2001 on 296 sample plots. On nearly every site *Rubus fruticosus* agg. has already covered considerable parts of the windthrow area, especially where the fallen timber had not been harvested. The influence of *Rubus fruticosus* agg. on beech regeneration is rarely described in the literature. Beech saplings are more vulnerable to damage by *Rubus fruticosus* agg. than saplings of other tree species on those three sites where sufficient beech was present. Yet, *Rubus fruticosus* agg. cover and beech sapling density were uncorrelated. The presence of *Rubus* sp. can also be of advantage to young trees, for example by preventing ungulates from browsing them.

Keywords: *Rubus fruticosus* L. agg., beech, maple, natural vegetation, windthrow, competition, Switzerland

Introduction

Environmental awareness in our society and an increasingly difficult economic situation for our forestry are forcing forest managers to make use of natural processes to a much higher extent than before. The heavy storms that hit Western and Central Europe during the last decade contributed to the acceleration of this trend. Restoring large windthrow areas in a traditional way would mean economic ruin for many forest owners. Therefore, natural regeneration has become a common practice today, even though it can lengthen forest restoration processes considerably (Michiels 1993; Bücking et al 1998).
Especially on large open areas, competing vegetation very often slows down the regeneration processes (von Lüpke 1987). Different vegetation types like grasses or shrubs can have this effect, but at least in regions with Atlantic climate, blackberry (*Rubus fruticosus* L. agg.) and bracken fern (*Pteridium aquilinum* L.) seem to compete against young trees the most effectively (Barten 1997). A survey in Germany suggests that the problems with *Rubus fruti-*

cosus agg. in forests have become worse (Barten 1997). One of the most frequently mentioned reasons for the increase in *Rubus fruticosus* agg. cover in our forests is the eutrophication of the soils by atmospheric nitrogen deposition (Kuhn et al 1987; Schreiner 2000).
Rubus fruticosus agg. is controlled mechanically or by herbicides (Huss 1982; Barten 1997; Barten and John 1998). The most common method to control *Rubus fruticosus* agg. effectively is to mow it periodically. This is very costly, not always successful, and also is accompanied with negative side effects for the young trees (Huss 1978). The necessity and success of control measures are also dependent upon the species of *Rubus fruticosus* agg. The term *Rubus fruticosus* agg. is used for a group of various species and subspecies that differ in habit, ecological behavior, and geographic distribution (Weber 1995; Barten 1997; Schreiner 2000).
The vulnerability to *Rubus* cover depends on the tree species. Norway spruce (*Picea abies*), sycamore maple (*Acer pleudoplatanus*), and ash (*Fraxinus excelsior*) can cope reasonably well with adjacent *Rubus fruticosus* agg. Beech saplings (*Fagus sylvatica*), in contrast, seem to be especially endangered by mechanical effects of overgrowing *Rubus* cover (Schreiner and Grunert 1998). Under dense *Rubus* cover, beech seedlings usually die of light shortage (Wehrlen 1985). In addition *Rubus* cover often hides large mice populations that can cause mortality in beech regeneration (von Lüpke 1987; Schreiner et al 2000).
Several investigations into the effect of competing vegetation on different tree species have been published (Mayer 1963; Huss 1978; von Lüpke 1987; Barten 1997; Schreiner 2000). However, there are only a few publications dealing with the influence of *Rubus fruticosus* agg. on beech regeneration (e.g. Wehrlen 1985), even though, according to the already mentioned survey in Germany, *Rubus fruticosus* agg. seems to be a considerable problem in beech forests as well (Schreiner and Grunert 1998). Since the silvicultural importance of *Rubus fruticosus* agg. depends on the *Rubus* species and on the region, generalizations are difficult (Bartl 1997; Schreiner 2000). Therefore, the field of research in this topic is still extensive and of current interest.
After the storm "Lothar" destroyed many beech stands in Switzerland on 26th December 1999, the Swiss Federal Research Institute WSL started to observe the natural regeneration in former beech forest stands. In this paper we present some results of the first two years of observation concerning the influence of *Rubus fruticosus* L. agg. on beech and sycamore maple regeneration.

Materials and Methods

The presented five study sites are windthrow areas of 2 to 30 ha situated in the Swiss lowlands (Fig. 1). All of them were totally destroyed by storm "Lothar" and belong to the "Eu-Fagion" suballiance (Ellenberg and Klötzli 1972). These beech habitats occur on rich and deep brown soils, in oceanic climate with an annual precipitation of about 1.000 to 1.200 mm. Their altitude ranges from 450 to 550 m a.s.l. Slope varies between 0 and 20 %. In Messen and Habsburg the pre-storm stands were nearly pure Norway spruce and various conifer species stands, respectively about 35 and 100 years old. The pre-storm stands in Müntschemier, Wohlen and Sarmenstorf were dominated by beech trees and between 80 and 100 years of age.

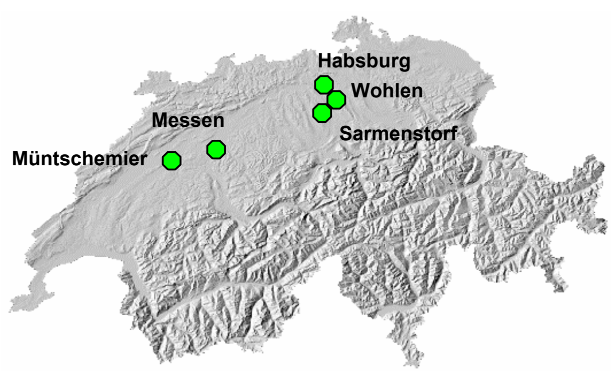

Fig.1: Studied windthrow areas.

Each study site was divided into two experimental units. In one unit, the timber was harvested, in the other all fallen trees remained untouched. No further measures such as tree planting or weed mowing have been carried out on either of the two units. Saplings and competing vegetation were surveyed in each unit on 20 to 25 circular sample plots of 20 m^2, set up in a rectangular 20 x 20 m grid, covering 5 % of the investigated surface. Plot centers were marked permanently. In 2001 and 2002, surveys were conducted during summer. For each sapling (trees between 20 and 300 cm of height) the following parameters were recorded: polar co-ordinates (azimuth, distance from plot center), species, height of the sapling in cm before bud break in spring, estimated year of germination, vegetation close to the sapling, signs of browsing by roe deer. For each plot, the cover of the following surface types was estimated: branches, timber touching the ground, timber above the ground, pit, mound, eroded surface, other surface without specific structure, and the cover of competing vegetation types.

Results

Sapling density varied greatly among the study sites (Table 1). Three sites showed a greater sapling density in the cleared than in the uncleared condition, while on the other two sites the relation is opposite. The highest sapling density was found in Müntschemier, Sarmenstorf and Wohlen, where the former stands were clearly dominated by beech trees. In these sites beech saplings contributed significantly to the high sapling density (Table 2). Because of the small number of beech saplings in the other sites, our further analysis will focus on the sites Müntschemier, Sarmenstorf and Wohlen.

As in most of our study sites, *Rubus fruticosus* agg. was the competing species with the highest cover in Müntschemier, Sarmenstorf and Wohlen (Table 3). Only in the uncleared unit of Müntschemier, was *Rubus idaeus*, with 57%, more frequent than *R. fruticosus* agg. In the uncleared unit of Wohlen 80 % of the area were covered with *Rubus fruticosus* agg. in the third year after storm Lothar. *Pteridium aquilinum* is lacking in these three study sites, but occurred in Habsburg.

Table 1: Sapling density (mean [n ha^{-1}] ± standard deviation [% of mean]) in 2002. Saplings are 20 to 300 cm tall.

Condition	Habsburg	Messen	Müntschemier	Sarmenstorf	Wohlen
Uncleared	920±10.7	725±6.2	13520±6.9	6840±2.8	17273±3.9
Cleared	4000±6.6	7333±4.8	2958±6.5	4375±5.9	37750±3.3

Table 2: Beech sapling density (mean [n ha^{-1}] ± standard deviation [% of mean]) 2002. Saplings are 20 to 300 cm tall.

Condition	Habsburg	Messen	Müntschemier/ Brüttelen	Sarmenstorf	Wohlen
Uncleared	100±24	0	12120±7.8	4620±3.2	8659±5.3
Cleared	1900±9.7	63±23.3	1979±7.6	3400±7.3	26650±4

Table 3: Mean cover of competing vegetation in each portion of three study sites in 2002.

Study site	**Condition**	***Rubus fruticosus*** agg.	***Rubus idaeus***	***Pteridium aquilinum***	***Juncus*** **sp.**
Müntschemier/Brüttelen	uncleared	35	57	0	0
	cleared	23	23	0	8
Sarmenstorf	uncleared	61	33	0	0
	cleared	76	9	0	5
Wohlen	uncleared	80	3	0	0
	cleared	44	5	0	1

The cover of *Rubus fruticosus* agg. increased considerably from 2001 to 2002 (Fig. 2). As an effect of the harvesting operations, in the cleared units the cover of competing vegetation was lower there at the beginning. This was especially evident in Müntschemier where timber was harvested only in March 2001. These differences do not seem to last for a long time: in each of the cleared units the increase in cover was higher than in the uncleared units. As the first survey in Wohlen was conducted in 2002, values for 2001 are lacking here.

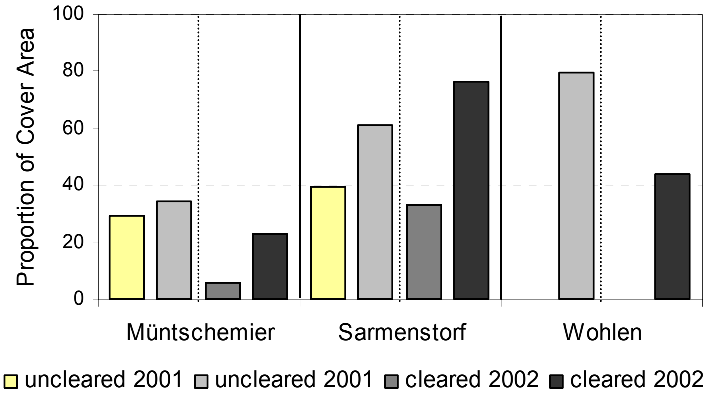

Fig. 2: Proportion of area covered by Rubus fruticosus agg. in 2001 and 2002 in the cleared and uncleared portions of three study areas. The data for Wohlen for 2001 are missing since the first data collection only took place in 2002.

The considerable increase of *Rubus fruticosus* agg. is also shown in the proportion of saplings in company with *Rubus fruticosus* agg. (Fig. 3). While a vast majority of the saplings and shrubs were not yet in contact with *Rubus fruticosus* agg. in 2001, this changed dramatically in 2002. The exception to this was in Müntschemier where the number of saplings and shrubs touched by *Rubus fruticosus* agg. Increased only slightly. number of saplings and shrubs touching *Rubus fruticosus* agg. increased only in the uncleared unit of Müntschemier, and there only slightly.

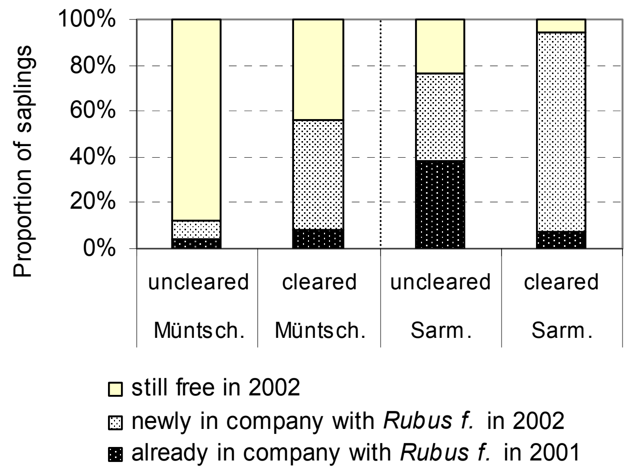

Fig. 3: Proportion of saplings in two study areas immediately adjacent to *Rubus fruticosus* agg. in 2001 and 2002. All of the saplings are 20 to 300 cm tall.

On the plot level, sapling density and cover of *Rubus fruticosus* agg. were uncorrelated (Fig. 4). No effect of *Rubus* cover upon the density of beech saplings was evident, even though only those saplings (with 20 to 129 cm of height) were considered which we can assume were potentially under the influence of *Rubus fruticosus* agg.

However, this lack of correlation between density of beech saplings and cover of *Rubus fruticosus* agg. does not mean that the beech saplings were unaffected by *Rubus*. On an individual level, 76 % of them exhibited a slanted stand because of *Rubus fruticosus* agg. or could not break through the *Rubus* cover and were thus damaged by competing *Rubus fruticosus* agg. (Fig. 5). This was clearly more than for the sycamore maple and ash the only other species for which the database was at least 100 individuals.

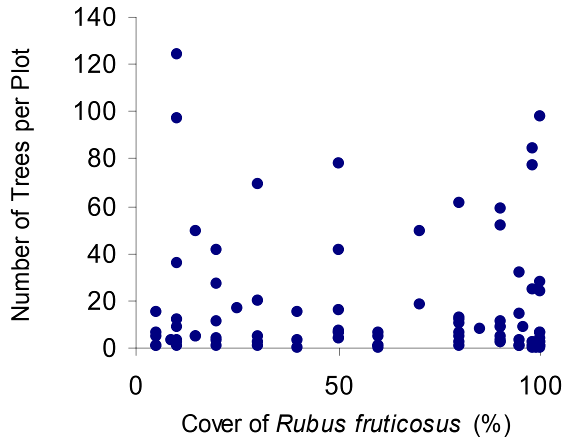

Fig. 4: Correlation between the percentage of plot area covered by Rubus fruticosus agg. and the number of beech saplings in the plot. Saplings are 20 to 129 cm tall.

The impact of *Rubus fruticosus* agg. on the risk of saplings getting browsed by roe deer is shown in figure 6. The height of *Rubus fruticosus* agg. surrounding maple saplings was strongly correlated (r^2 = 0.62) with the percentage of browsed saplings. Saplings in high *Rubus* cover were less browsed by roe deer than those in neighborhood of *Rubus fruticosus* agg. growing close to the ground.

Discussion

Rubus fruticosus agg. has enlarged its geographic range and become even more competitive in many regions of Central Europe (Neite and Pahlke 1991; Barten 1997; Schreiner and Grunert 1998; Schreiner 2000). Our study sites fit well into this general picture. After storm “Lothar”, *Rubus fruticosus* agg. captured the terrain to a distinctly higher extent than other

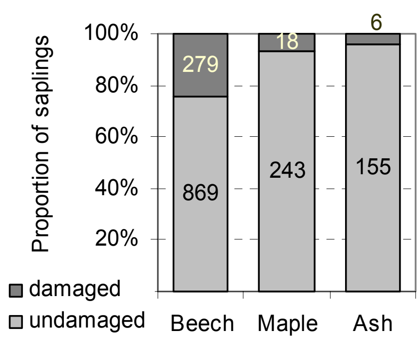

Fig. 5: Percentage of damage to saplings (species with more than 100 individuals) caused by competing vegetation, mainly by Rubus fruticosus agg. Saplings from all three research areas have been compiled. Saplings are 20 to 129 cm tall. The figures in the bars indicate the number of saplings undamaged or damaged by competing vegetation.

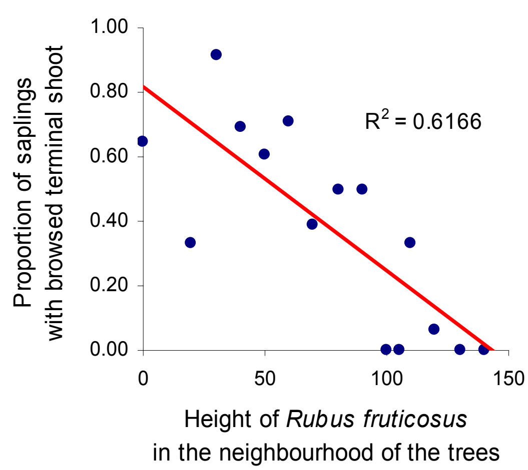

Fig. 6: Impact of maximum height of adjacent Rubus fruticosus agg. to the risk for a sycamore maple to be browsed by roe deer. The data consists of 386 saplings between 20 and 130 cm of height.

competing vegetation types, e.g. *Rubus idaeus*, *Pteridium aquilinum*, *Carex brizoides* or *Juncus* sp., which also occur in the windthrow areas investigated.

Compared with other economically important tree species in Central Europe, beech is known to react especially sensitively to competing vegetation (von Lüpke 1987; Binder 1992). Beech saplings suffer mainly under mechanical suppression (Schreiner and Grunert 1998). As seedlings they also often die of light shortage under dense *Rubus* cover despite their relatively high shade tolerance (Wehrlen 1985). In addition to the competing vegetation, the extreme climate of large windthrow areas is another aspect with which beech saplings do not cope very well (von Lüpke 1987).

The differences in the sensitivity of different tree species towards competing vegetation, as shown in figure 5, has not been statistically tested. A chi-square analysis is not suitable because the data are not really independent. Beech saplings in particular often stand in dense groups, so that if one sapling is affected by competing vegetation, its neighbor most probably will be affected, too. Figure 5 only describes the often-observed high vulnerability of beech saplings.

Our sapling density data do not support the hypothesis that *Rubus fruticosus* agg. negatively affects the density of saplings. This result can be explained in different ways:

- The influence of competing vegetation might be overshadowed by side effects of the harvesting operations. In the cleared units, the removal of the blown trees surely reduced the density of advanced regeneration, including beech seedlings that had just germinated after the mast year 1999. Likewise, *Rubus fruticosus* agg. was negatively affected by the harvest activities. Therefore, spots where saplings survived the clearing measures may also exhibit a greater *Rubus* cover.
- In May 2000, a quite exceptional drought occurred that caused many beech seedlings to die (SMA 2000). Seedlings occurring under a still low and not yet dense *Rubus fruticosus* agg. cover might have had a higher survival chance than those on bare soil. This might counteract a competitive effect between beech saplings and *Rubus fruticosus* agg.
- Tree regeneration and the spread of *Rubus fruticosus* agg. started simultaneously after windthrow. Many of the freshly germinated beech seedlings reached more than 30 cm of height during the first vegetation period in 2000. During the first two years, only a minority of the saplings was in touch with *Rubus fruticosus* agg. (Fig. 3). This initial advantage in height might be the reason why many of the beech saplings are still alive even though meanwhile they might be surrounded or even overgrown by a dense *Rubus* cover (Schreiner and Grunert 1998). The lead of beech saplings may even be sufficient to outperform *Rubus fruticosus* agg. in the long-term.

It is beyond the scope of this study to verify which explanation is the most likely. However, we will make an effort to determine the *Rubus fruticosus* agg. species occurring on our study sites. This differentiation can be essential (Barten 1997).

In some cases the companionship of *Rubus fruticosus* agg. can also be to a sapling's advantage. Sycamore maple, for example, is a favorite browsing tree for roe deer. Our results suggest that high *Rubus fruticosus* agg. cover reduces the probability of browsing damage for maple saplings. This may be explained firstly by the fact that high *Rubus fruticosus* agg. cover is an effective obstacle to roe deer. Secondly, in some situations roe deer may prefer *Rubus fruticosus* agg. leafs to maple twigs (Wehrlen 1985).

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References

Barten, R., 1997: Brombeere (Rubus fructicosus) - ein Problem im Forst?, Forst und Holz, Vol. 52, No. 7, pp. 190-192.

Barten, R., John, H., 1998: Ein Kommentar zu: Brombeeren in den Wäldern Baden-Württembergs, AFZ/Der Wald, Vol. 53, No. 11, pp. 604-605.

Bartl, M., 1997: Ist das Ausgrasen von Brombeere Geldverschwendung?, AFZ/Der Wald, Vol. 52, No. 18, pp. 979.

Binder, F., 1992: Aufforstung in Waldschadensgebieten - Untersuchungen zur künstlichen Verjüngung von Beständen im Frankenwald, Fichtelgebirge und in den Bayerischen Kalkalpen, Forstliche Forschungsberichte, München, Vol. 119, pp. 224

Bücking, W., Schüler, G., Beck, M., Stolz, T., 1998: Flächige Dokumentation der Struktur, Bodenvegetation und Verjüngung der Sturmwurfflächen. In: A. Fischer (ed.): Die Entwicklung von Wald-Biozönosen nach Sturmwurf, ecomed, pp. 75-93

Ellenberg, H., Klötzli, F., 1972: Waldgesellschaften und Waldstandorte der Schweiz, Mitteilungen Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL), Vol. 48, No. 4, pp. 589-930.

Huss, J., 1978: Die Wirkung von Unkrautbekämpfungen auf die Entwicklung von Waldverjüngungen, Allgemeine Forstzeitung, Vol. 84, No. pp. 120-125.

Huss, J., 1982: Die Bekämpfung der Konkurrenzvegetation von Waldverjüngungen in der forstlichen Praxis, AFZ, Vol. 37, No. 14, pp. 398-400.

Kuhn, N., Amiet, R., Hufschmid, N., 1987: Veränderungen in der Waldvegetation der Schweiz infolge Nährstoffanreicherungen aus der Atmosphäre, Allgemeine Forst- und Jagdzeitung, Vol. 158, No. 5/6, pp. 77-84.

Mayer, H., 1963: Bodendecke und Naturverjüngung, Centralblatt für das gesamte Forstwesen, Vol. 80, No. 1, pp. 1-20.

Michiels, H.-G., 1993: Die Stellung einiger Baum- und Straucharten in der Struktur der Vegetation im Bereich der hochmontanen und subalpinen Waldstufe der Bayerischen Kalkalpen, Forstwissenschaftliche Fakultät der Universität München und Bayer. Forstliche Versuchs- und Forschungsanstalt, Forstliche Forschungsberichte München, München, Vol. 135, pp. 361

Neite, H., Pahlke, U., 1991: Immissionsbedingte Veränderungen der Bodenvegetation in Eichen-Hainbuchenwäldern der Westfälischen Bucht in den letzten 30 Jahren, Forst und Holz, Vol. 46, No. 10, pp. 286-289.

Schreiner, M., 2000: Vorkommen und Ausbreitung von Brombeeren sowie ihre Bedeutung für die Naturverjüngung von Tannen-Fichten-Wäldern - dargestellt am Beispiel der Region "Oberer Neckar", Forstwissenschaftliche Fakultät der Albert-Ludwigs-Universität, Dissertation, Freiburg i. Brsg., Vol. 199

Schreiner, M., Grunert, U., 1998: Brombeeren in den Wäldern Baden-Württembergs, AFZ/Der Wald, Vol. 53, No. 5, pp. 223-227.

Schreiner, M., Bauer, E.-M., Kollmann, J., 2000: Reducing predation of conifer seeds by clear-cutting Rubus *fruticosus* agg. in two montane forest stands, Forest Ecology and Management, Vol. 126, No. 3, pp. 281-290.

SMA. 2000: Witterungsbericht vom Mai 2000, Schweizerische Zeitschrift für Forstwesen, Vol. 151, No. 9, pp. 349.

von Lüpke, B., 1987: Einflüsse von Altholzüberschirmung und Bodenvegetation auf das Wachstum junger Buchen und Traubeneichen, Forstarchiv, Vol. 58, No. pp. 18-24.

Weber, H.E., 1995: Rubus L. In: G. Hegi (ed.): Illustrierte Flora von Mitteleuropa, Vol. IV/2A, 3 ed, Blackwell Wissenschafts-Verlag, Berlin, pp. 284-595

Wehrlen, L., 1985: La ronce (Rubus *fruticosus* agg. L. agg.) en forêt, Revue forestière française, Vol. 37, No. 4, pp. 288-304.