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Stand Dynamics in the Virgin Forest "Neuwald"

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Abstract

The virgin forest "Neuwald", 20 ha in size, is one of the last remnants of virgin forest left in Austria. Based on an initiative of the owner in 1830, the stock has remained untouched without any further silvicultural interventions. Since 100 years, however, high deer densities have led to disturbed population dynamics. In 1986, a systematic grid of sample plots was established to study the stand structure of the dominant spruce-fir-beech-forest. On 34 permanent sample plots, each 1000 m² in size, data on stand structure were collected. Since then, surveys were made at an interval of 10 years. Tree mortality was recorded every 5 years. Although the virgin character of the forest is being gradually lost, the value of this stand is still high, particularly from a scientific point of view. Concerning the resilience of the overstorey, the lack of ingrowth has led to an inadvertent experiment.

The dominant tree species Norway spruce, silver fir and European beech show significant differences in the frequency distribution with respect to their dbh (diameter at breast height). Thus, beech is the most frequent tree species below 50 cm dbh, while silver fir is the most frequent tree species over 70 cm dbh. As to dbh- distribution, shifts in the composition of the tree species are expected. When comparing the observation years of 1986 and 2006, it became obvious that many trees died due to windthrow but also due to other diseases. On the other hand no considerable tree ingrowth into the sample plots could be identified. The number of trees has decreased significantly. Contrary to expectations, the stock volume in the same period remained at the same level. The virgin forest ecosystem is thus resilient enough to buffer the chronic lack of ingrowth by expansion of overstorey.

Keywords

Resilience, stand dynamics, mortality, deadwood, carbon sink, forest reserves

Introduction

The virgin forest "Neuwald" with a size of 20 hectares is one of the last remnants of virgin forests left in the Eastern Alps (ZUKRIGL et al. 1963; KRAL & MAYER 1968), (Fig. 1). On the personal initiative of the owner Count Hoyos a harvesting ban was imposed during the exploitation of the region in the early 19th century which has been observed until today (MAYER et al. 1972). However, with the establishment of wildlife feeding at the end of the 19th century followed a continued period of sustained high deer density (ZUKRIGL et al. 1963; FRANK & MAYER 1988). Until today, more than 100 years later, browsing has led to a permanent reduction of regeneration. Despite the sometimes very thin canopy neither regeneration nor ingrowth into the overstorey has taken place. The virtually complete absence of regeneration for over 100 years thus leads to an unintended experiment, an experiment with reluctance.

The main questions of this study are: (1) How does the lack of natural regeneration and ingrowth, at simultaneous tree mortality, affect the inventory parameters: stem number, basal area, volume, tree species composition and diameter distribution? (2) Is the ecosystem sufficiently resilient and able to compensate the long-lasting lack of ingrowth and dying trees with an increase of increment of the remaining stand?

Figure 1: The virgin forest "Urwald Neuwald". © Steiner

Methodology

The forest "Neuwald" is composed of a spruce-fir-beech forest, and, in small areas, also of spruce and spruce-fir forest (ZUKRIGL et al. 1963; MAYER et al. 1972). The present study is limited to a dominant spruce-fir-beech forest which can be assigned in equal parts to the Adenostylo glabrae-Fagetum Moor 1970 and the Cardamino trifoliae-Fagetum Oberdorfer 1987 (WILLNER & GRABHERR 2007).

A sampling grid was used which was originally established for the purpose of the recording and documentation of damaged trees ("forest dieback") (FRANK & MAYER 1988). The sampling grid established in 1986 consists of 34 sample plots à 1000 m², arranged in a 60 x 60 m grid. By limiting this study to spruce-fir-beech forest communities, 26 sample plots remained for analysis where - using a minimum dbh of 10 cm - all trees were recorded, coordinated, measured and assessed according to different criteria. The first survey in 1986 was followed by a study carried out at a five year interval on the survival of individual trees to capture the mortality rates. In 1986, 1996 and 2006 the dbh of all individual trees was measured. For the present study, the re-inventory of 2006 was compared to the results of the first inventory in 1986.

A methodological weakness of the survey design is the lack of identification of standing and lying deadwood in the first inventory in 1986 because other issues ("forest dieback") were more important at this time. While the absolute deadwood can be specified only vaguely, we can identify exactly the dieback rates at five 5-year periods since 1986.

As since 1986 a number of height measurements have been made, height functions (height model) could be adjusted for the dominant tree species, spruce, fir and beech. The volumes were then calculated for all tree species using form number functions (POLLANSCHÜTZ 1974) for all individual trees. By means of periodic repeat inventories both the dieback of trees (mortality) and the increment in merchantable timber volume of the remaining standing trees could be accurately determined, and conclusions drawn on the development and resilience of the stock.

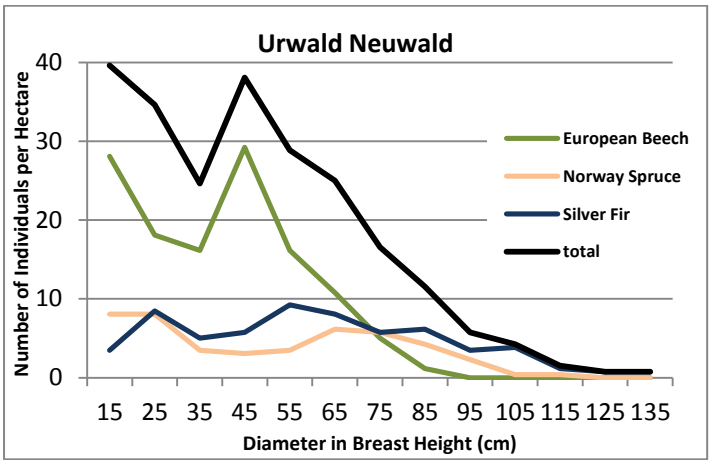

Figure 2: Diameter distribution of main tree species in the virgin forest "Urwald Neuwald".

Results

In the spruce-fir-beech forest area the overstorey of the forest "Neuwald" is composed almost exclusively of the three main tree species´. The dbh-distribution shows large differences (Fig. 2). Fir and spruce between 20 and 90 cm dbh have relatively constant stem numbers. In the diameter classes above this size spruce decreases rapidly. Fir, however, is found regularly in higher diameter classes reaching a dbh of up to 138 cm. Totally different is the dbh range of beech; in the range up to 60 cm dbh stem numbers twice to 3 times as high as conifer species were found. Above this size, it decreases rapidly reaching comparatively modest maxima of just over 80 cm. In the range below 50 cm dbh an unbalanced individuals density becomes evident.

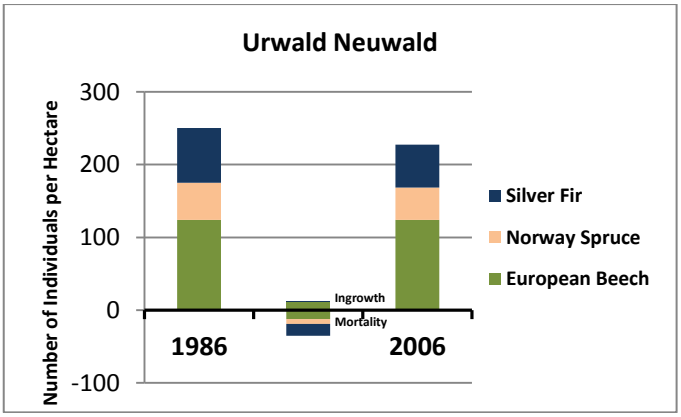

Figure 3: Comparison of 1986 survey with 2006; number of stems of main tree species per ha, ingrowth and mortality.

When comparing the 1986 survey with 2006, in the individuals over 10 cm dbh, a decrease of 250 n / ha to 227 n / ha can be noticed for a period of 20 years (Fig. 3). While in beech mortality and ingrowth were balanced at 12 n / ha, there is no ingrowth for 7 dead spruce trees / ha and 1 ingrowth for 17 fir / ha. Regarding the merchantable timber volume, there was a slight increase in volume over the course of 20 years of 715 m³ / ha to 741 m³ / ha (Fig. 4). Beech and fir show the best growth performance. The excellent growth performance observed especially in older fir trees results in considerable increment of the whole stand – despite the lack of ingrowth.

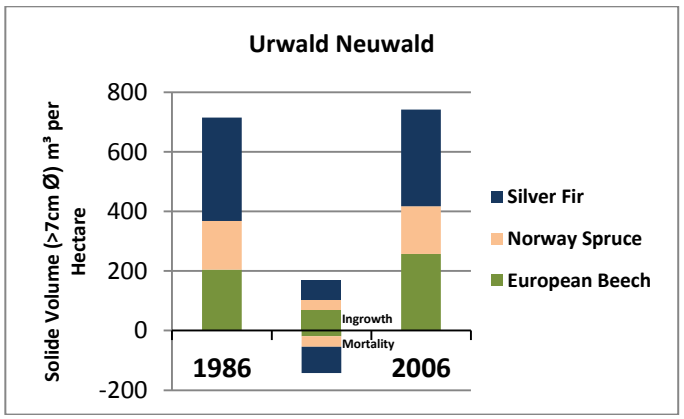

Figure 4: Comparison of solid volume of 1986 survey with 2006; total solid volume (>7cm Ø) m³ per ha, growth and mortality.

Discussion

Massive browsing on regeneration by red deer for decades has led to a permanent disturbance of the natural stand development in the virgin forest „Neuwald“. Studies in spruce-fir-beech forests in south-eastern Europe suggest a similar trend to increasing beech dominance at the expense of fir in comparable forest types (VRŠKA et al. 2009; DIACI et al. 2011). However, in the virgin forest „Neuwald“ not only a change of tree species can be observed, but a decrease of all three main tree species spruce, fir and beech. A total dieback of fir projected in 1988 (FRANK & MAYER 1988) from the perspective of air pollution induced „Waldsterben“ (forest dieback) cannot be confirmed from today's point of view. All the more surprising is the long lasting capacity of the forest ecosystem to compensate the age-related mortality and the complete lack of regeneration by overstorey growth. Under the current view of climate change and the discussion concerning the status of unmanaged forests as carbon sinks these findings could be important because they demonstrate the ability of these forests for carbon storage over many decades.

Conclusions

Although for more than 100 years virtually no considerable ingrowth has occurred from regeneration, the merchantable timber volume has not decreased in the investigation period 1986 - 2006. To the contrary, the case of the forest "Neuwald" shows that such forest ecosystems are able to compensate age-related mortality over decades through increased increment of the remaining stand. In the study period of 1986-2006 increment and mortality are balanced despite the lack of ingrowth from regeneration, there is even a small stock accumulation.

Future

In the time scale, the present comparison of two observations is not more than a flash in the evolution of this „virgin forest“. Nevertheless, first conclusions on the stand dynamics can be drawn from repeated surveys of stand structure. With each periodic survey of both the standing and the dead wood stocks, the value of the virgin forest remnant will increase as the reference stock of the development of a forest without direct human influence.

To get a better insight into the stock dynamics in terms of organic and necromass, but also of carbon storage, the differentiated identification of dead wood, regeneration and humus status in future studies will be sought.

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