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CHANGES IN FOREST HEALTH IN ESTONIA IN 1985—93

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Abstract. The health of Estonian forests is not good. From 1985 to 1992 the total area of heavily damaged forests increased more than three times.

Within the international joint programme "Assessment and Monitoring of Air Pollution Effects on Forest" a survey of the Estonian forest condition was carried out in 1989—93. Over 1400 Scots pines (*Pinus sylvestris* L.) and 600 Norway spruces (*Picea abies* (L.) Karst.) were monitored on 16×16 km forest monitoring sample plots.

During the last five-year period 49—63% of the spruce sample trees and only 22—35% of the pine trees had practically no defoliation (needle loss 0—10%). In different years 25—35% of the pines were either moderately or severely defoliated (needle loss >25%). The average defoliation rate of spruce crowns was lower. Less than 20% of the spruces showed defoliation with needle loss over 25%.

Key words: forest condition, forest decline, defoliation.

INTRODUCTION

Estonia is quite rich in forests. According to the latest data (1 January 1993), the total area of the forest land makes up about 48% of the total land area of the Republic of Estonia. Unfortunately, up to 1985 Estonia lacked an operative and reliable source of data on the state of the health of the forests.

Changes that had taken place in the vitality of forests in Central Europe already in the 1970s resulted in a need for regional estimation of forest condition based on standardized international methods of monitoring and research. At the beginning of the 1980s an extensive national survey into the state of health of the forests was started in some Central European countries (Brechtel et al., 1991). Similar work was started in the Scandinavian countries in 1984 (Andersson, 1988). Since 1985 Finland has participated in the UN—ECE programme on forest damage survey (Salemaa et al., 1991). Estonia and Lithuania were the first countries in the former Soviet Union that initiated the forest monitoring in 1988.

The Estonian Research Institute of Forestry and Nature Conservation (ERIFNC) is responsible for the forest monitoring in Estonia. Since 1 January 1991 the Estonian Service of Forest Protection has been working as an independent state institution. This institution has the most operative database about the more damaged stands in Estonia.

The forest survey was carried out in the state-owned forests of Estonia in cooperation with researchers from the ERIFNC and the forest pathologists of the Service of Forest Protection. The field work was mainly done by the forest pathologists of this service. The researchers of the ERIFNC direct and control the work and compile annual reports on the national surveys of forest damage.

MATERIAL AND METHODS

A network of systematically distributed permanent sample plots (93) was established in 1988. The sampling units are in a 16×16 km grid. On each plot, 24 dominant, codominant and dominated trees, most of them pines (*Pinus sylvestris* L.) and spruces (*Picea abies* (L.) Karst.), were assessed in accordance with an ECE quide (Manual . . . , 1986). The total number of conifers on the sample plots is over 2000. For example, in 1993 the vitality of 1455 Scots pines and 620 Norway spruces was assessed. The main methods used for the determination of the vitality of trees were defoliation and discolouration estimations. Three main groups of characteristics were estimated:

— Crown vitality (defoliation %, discolouration % of needles, frequency of dead branches in the crown, the age of the oldest needles (of which at least 80% of the total initial number has remained on the branches);
— Severity of the abiotic and biotic damages (occurrence of pest insects and fungal diseases, game damages, mechanically caused injuries, damages due to wind, snow or frost, and fire);
— The coverage and vitality of lichen species on the tree stems.

The defoliation of the trees was the main characteristic of the vitality of trees. It was estimated annually (from September to November) in five needle-loss classes:

Class	Degree of defoliation	% of needle loss
0	not defoliated	0—10
1	slightly defoliated	11—25
2	moderately defoliated	26—60
3	severely defoliated	>60
4	dead	

In this work a short survey of the defoliation of tree crowns on forest monitoring sample plots during the last five years (from 1989 to 1993) is presented. For the characterization of the changes in forest condition the data from 1985 to 1992 on the total area of the heavily damaged stands (hotbeds of damages) in the state-owned forests were also used. This database is being annually compiled by the forest pathologists of the Estonian Service of Forest Protection.

RESULTS AND DISCUSSION

The total area of heavily damaged forests is growing in Estonia. This has been particularly noticeable in recent years. These forests are being inventoried as hotbeds of damages. A characteristic feature of the hotbeds is that throughout a year more than 5% of the total number of trees die out. As a rule, not only suppressed trees but also dominant and codominant ones die. From 1989 to 1992, the total area of damaged stands of this kind more than doubled (Fig. 1) and amounted to 6775 ha. These are stands of various species and they grow on different site types.

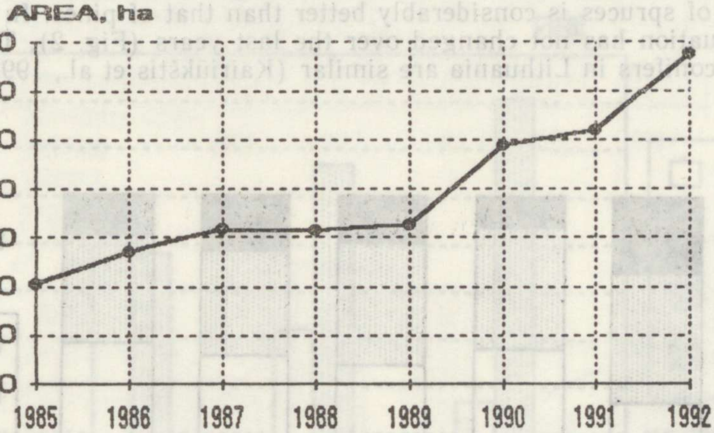


Fig. 1. Total area of hotbeds of damages.

The symptoms of injury in heavily damaged forests may be very different. The most frequent damaging agent for spruce and pine was root rot (*Heterobasidion annosum*, *Armillaria* spp.). In 1992 about 44% of the hotbed areas was damaged by root rot. Particularly big areas of root rot damages in pine forests can be found in the southeastern part of Estonia.

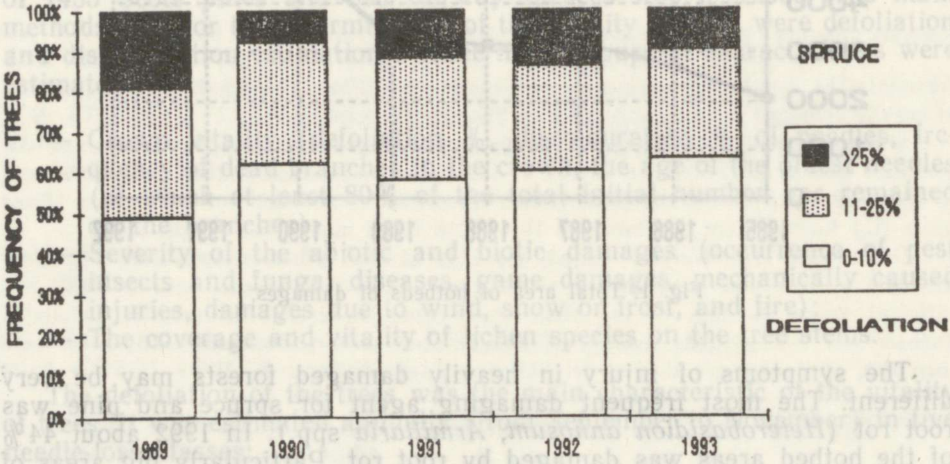
Other important biotic agents causing the increase in hotbed areas are insects (*Tomicus* spp., *Ips* spp.) and mammals. Among mammals the beaver (*Castor fiber*) is often threatening our forests. This animal causes clogs of the drainage systems and forests of the flooded areas suffer heavily from excessive water. Note that the data in Fig. 1 do not include the area of forests damaged by the moose (*Alces alces*). Moose damages have been an especially serious problem in Estonia during the last decades. The areas of moose damages are inventoried in every three years. The summary of the latest data (from 1991) shows that about 15 000 ha is seriously damaged in the Estonian state-owned forests by the moose.

As to the abiotic agents, the most common forest damages are caused by the wind, especially in these areas where root rot has already harmed the tree roots.

The condition of conifers is very often not good on the forest monitoring sample plots either. In the autumn of 1993 out of all the conifer sample trees estimated ($n=2065$), 41.2% were not defoliated (needle loss up to 10%). Slight defoliation was observed in case of 37.8% of the trees and 21.0% were defoliated over 25% (classes 2—4). It should be mentioned that on the basis of the Nordic classification of crown thinning, the result would be different. According to the Nordic classification, a needle loss of 10—20% has only minor importance, and it is primarily the result of the variation in needle biomass caused by the genetical make-up of the tree population and environmental factors (Jukola-Sulonen et al., 1987). On the basis of this classification the total percentage of conifers considered to be practically without defoliation would be 65.6%. There is no doubt that the Estonian forests and their growth conditions are more similar to the forests of Nordic countries than to many of the other European countries.

In comparison with 1992 the state of tree crowns has improved to some extent. In 1992 the proportion of conifers of over 25% defoliation was 29.5%.

In accordance with the defoliation degree of trees the state of the health of spruces is considerably better than that of pines. In this respect the situation has not changed over the last years (Fig. 2). The damages of the conifers in Lithuania are similar (Kairiūkštis et al., 1992).



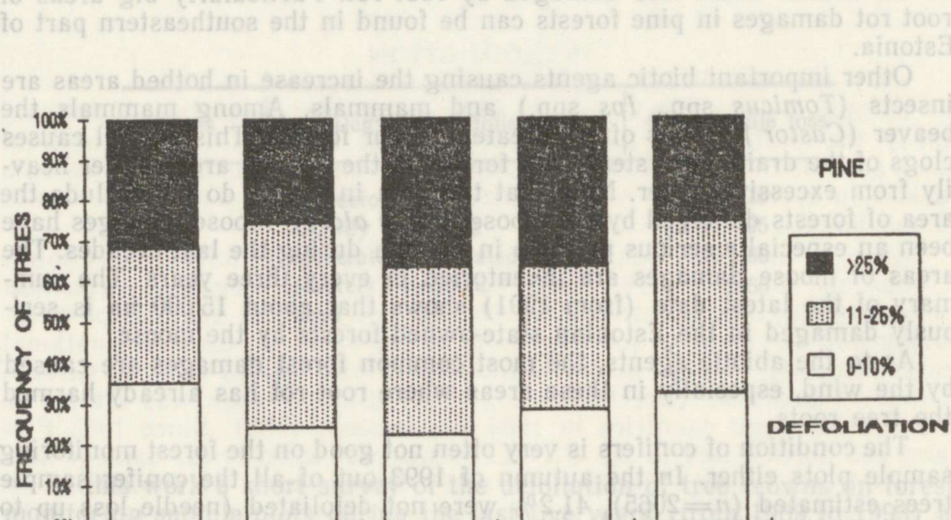


Fig. 2. Defoliation frequency distribution of conifers (classes 0, 1, and 2 + 3 + 4) from 1989 to 1993).

On many sample plots pines have only one-year-old needles on the branches. In 1993 such a situation of pines was observed on 12 sample plots. The majority of these plots were found in northeastern and south-eastern Estonia. The most common needle age class for the upper crown of the pines was not more than two years (Fig. 3), although it has been declared that in Estonia the pine needles survive normally at least three years in the tree crowns. Actually the percentage of pine sample trees of the needle age class over two years was very low, only 1—2%. The problem is not so serious in spruce forests. Most of the spruces had five- to eight-year-old needles in the upper part of the crown.

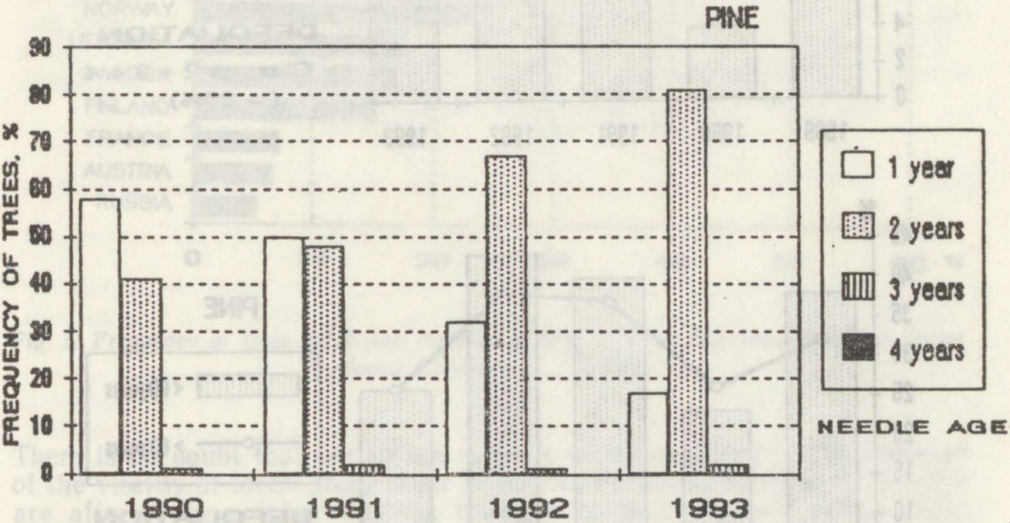


Fig. 3. Frequency of pine sample trees of different needle age classes.

Some fungal diseases as well as pest insects have played an important role in the heavy defoliation of pines. In 1993 the most frequent damages on pine sample trees were caused by pine canker (*Ascocālyx abietina*), pine beetle (*Tomicus* spp.), and bark beetle (*Ips* spp.). In 1992 and 1993 the pine looper (*Bupalus piniarius*) devastations affected the pine forest condition on big areas in the southeast of Estonia.

The defoliation of conifer sample trees is not the same in different regions of the country. The percentage of more heavily defoliated pines (classes 2—4, needle loss >25%) is the highest in the northwest of Estonia (in 1993, 83% from $n=195$). The percentage is also comparatively high (41.6% from $n=356$) in western Estonia including the big islands in the Baltic Sea. The defoliation of the spruce sample trees is the highest in the northwest of Estonia (56% from $n=45$).

Conifer sample trees of different ages did not show big differences in the defoliation degree. Mostly the percentage of more heavily defoliated pines was slightly higher among the older trees. For spruce the reverse tendency became evident. The frequency of the more heavily defoliated pines and spruces (classes 2—4) among younger than 60 and older than 60 in 1989—93 is presented in Fig. 4. The distribution of trees between these two age classes was as follows: 46% of the pines and 55% of the spruces were below 60 years old and respectively 54% and 45% were over 60. The corresponding numbers of trees were 671 and 774 for pine and 338 and 282 for spruce in 1993.

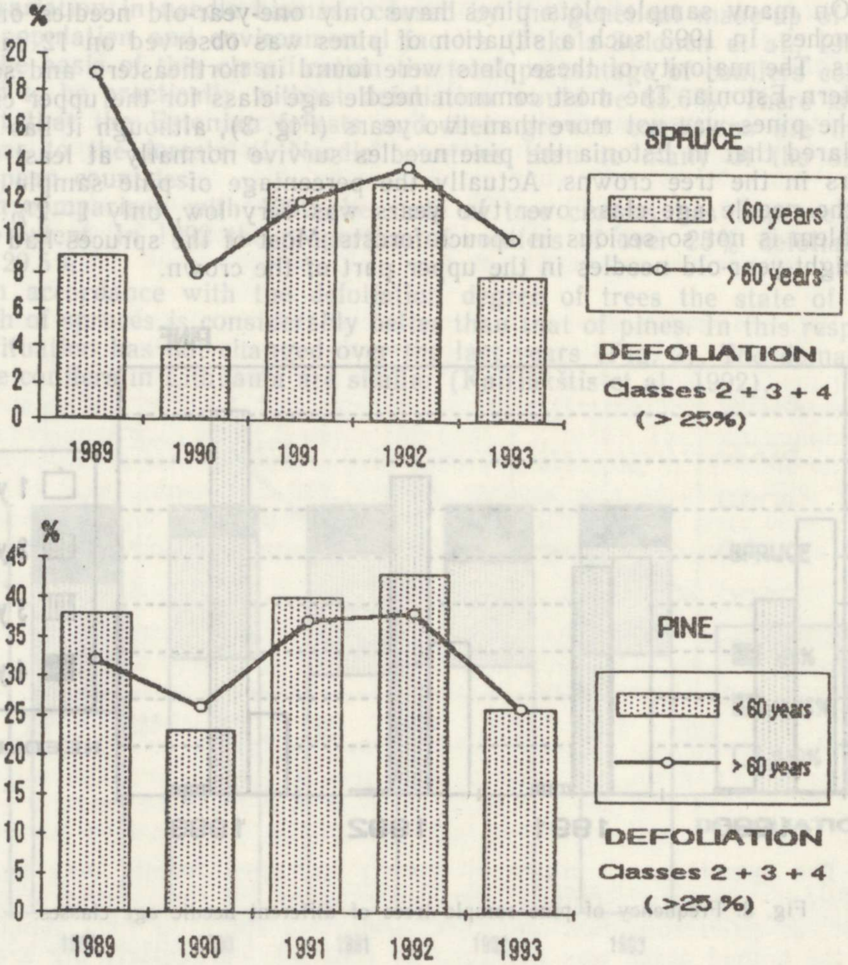


Fig. 4. Frequency of conifers of different age defoliated more than 25%.

It is obvious that a comparison of the data on the defoliation rate of forest trees in Estonia and in other countries (Fig. 5) is not suitable for serious conclusions. The data from 1992 on the forest condition in European countries (Forest Condition ..., 1993) suggest that the situation in Estonia is approximately the same as in Denmark or in Germany. However, it is not very reasonable to compare Estonia and these two countries because of the differences in their climatic conditions, tree species composition, silvicultural practices, and pollution load. The subjectivity of visual observations in forest surveys is also a problem. Still, it may be noted that the defoliation of conifers in Estonia is higher than in Finland and lower than in another neighbouring country—Latvia.

A five-year period is too short to make any firm conclusions about the condition and the changes of the state of the health in Estonian forests. The assessment of crown defoliation provides little information on its cause and effect. For a better understanding of the cause—effect relationship more information on soil and needle chemistry, air quality and deposition, climate etc. is required. The ERIFNC has started complex investigations of this kind on special sample plots of forest monitoring level II. It is most likely that the poor condition of the trees on the forest monitoring sample plots is expressed as a multistress symptom.

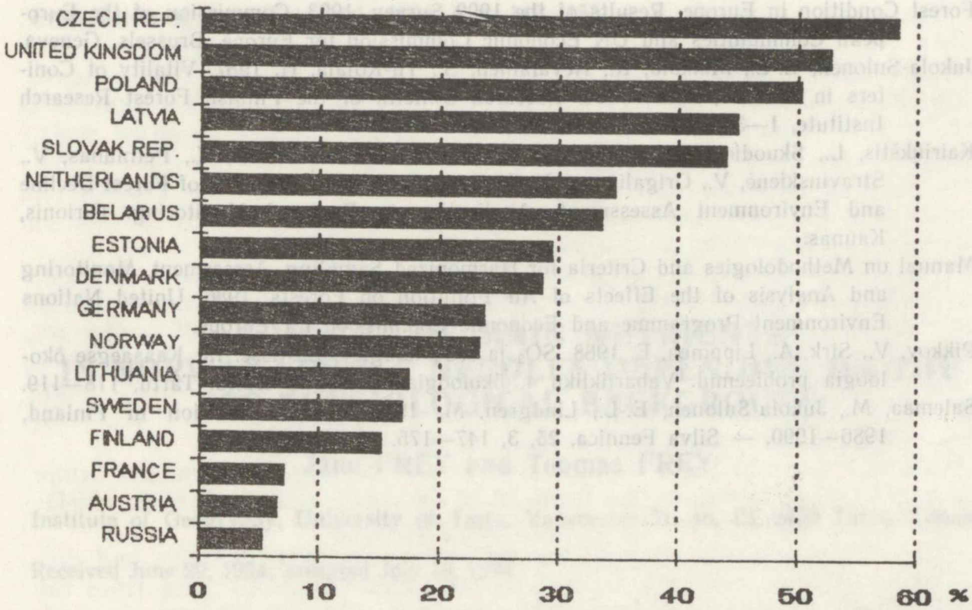


Fig. 5. Frequency of trees defoliated more than 25% in some European countries (after Forest Condition . . ., 1993).

There is no doubt that one of the reasons which can lead to the decrease of the vitality of forest trees is air pollution. Forest ecosystems in Estonia are affected by sulphur dioxide, nitrogen compounds, acid precipitation (though not very often), as well as alkaline precipitation (quite common in Northeast Estonia). Pollutants reach the atmosphere from our local pollution sources and also by wind from other countries. Long-range pollution events of western and eastern origin are known to be evident in Estonia (Pikkov et al., 1988). However, at present it is very difficult to distinguish the effects of air pollution on trees from those of climatic and biotic factors. In Finland the forest condition and all the factors affecting the defoliation in forests have been investigated very thoroughly. Nevertheless, the researchers of the Finnish Forest Research Institute have mentioned that no clear connections were found on the national level between the regional distribution of forest defoliation and the pollution load (Salemaa et al., 1991). The relationship in Estonia is more evident in forests around local pollution sources. Still, the defoliation of the tree crowns in various forests must be taken as an early symptom of forest decline phenomena.

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