

# Vegetation Changes in the Pine Forests of the Nature Park Tervete, Latvia

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**Abstract:** - The article focuses on analysis of vegetation changes in the pine forests in the period 1957-2007 in the Nature Park „Tervete”, Latvia. The pine forest vegetation is formed by character species of summer-green broad-leaved forest class *Querco-Fagetea* and western taiga forest class *Vaccinio-Piceetea*. In order to estimate changes of vegetation during the 50 years, constancy of all species and average ecological values were calculated, and life forms and plant strategies were compared. The estimated Jaccard's coefficient ( $C = 0.36$ ) is indicator of significant changes in species composition. In 1957 the total number of species was 195, 112 of which were not registered in 2007. In total, 121 species were registered in 2007, 38 of them were new, but 83 species had survived since 1957. In 1957 *Pinus sylvestris* L. was prevailing in the tree layer but in 2007 the tree layer contains pine along with *Quercus robur* L., *Acer platanoides* L. and *Tilia cordata* Mill. The ecological indicators of light decreased, but soil reaction and nitrogen content indicators increased. The indicators of continentality, temperature and moisture have not changed significantly. Comparing the plant strategy groups in 1957 and 2007, the number of competing and stress tolerant plants increased, but the number of ruderal plants decreased, which indicates the stabilisation of environmental conditions in the Nature Park „Tervete”. Comparing the representation of life forms, there was an increase in the phanerophyte, nanophanerophyte and geophyte group species and cover. The number of terophytes and hamephytes decreased, but the hemicriptophyte species typical of meadows and pastures have been replaced by the species typical of forests. As the result of climate changes the former broad-leaved - spruce and broad-leaved forest vegetation which was characteristic for this territory is renewing.

**Key-Words:** - Forest vegetation, *Querco-Fagetea*, *Vaccinio-Piceetea*, Nature Park Tervete

## 1 Introduction

In many places of temperate climate regions in Europe and also in Latvia over the last decade an intensive transformation of forest stands has been observed [10,11] and changes in vegetation in general. Different scenarios of climate changes differ only in the rapidness of processes, but on a global scale the main tendencies are similar. Observations and forecasts indicate that climate changes will have a significant impact on both – ecosystems, species and their communities. According to the forecasts – with the increase in temperature the potential areal of many European species could move several hundred kilometres to the north and north-east, moreover – several European species will be threatened and they could start disappearing [12]. This tendency is also expected with regard to tree species. As a result of this, the proportion of broad-leaved trees (beech, lime tree, oak) is likely to increase in the forests of the Baltic Sea region and it will also affect the distribution area of other related species.

In order to understand the reaction of the forest stands to such relatively rapid changes and find ways to help the forests adapt, it is very important to investigate the current situation. The structure and composition of the species of plant communities reflect the condition of the environment and the main anthropogenic factors which affect it, therefore the analysis of vegetation is very significant. Taking into consideration the fact that pine stands react most dynamically to changes [11], pine forest communities were chosen as the object of research. In Latvia's Nature Park „Tervete” there is a unique forest landscape complex, where the rarely encountered forest biogenecenosis - *Pinetum corylosum* prevails. The dominant species in the stand is Scots pine *Pinus sylvestris* L., but on the second layer there are usually deciduous trees – English oak *Quercus robur* L., Norway maple *Acer platanoides* L., small-leaved lime *Tilia cordata* Mill. and European ash *Fraxinus excelsior* L. [19]. Most of pine stands are highly productive. It is supposed that historically pure pine stands with broad-leaved trees on the second layer

were formed in place of the destroyed spruce and oak forests [5, 20].

The vegetation in the Nature Park „Tervete” has been described on different levels and its analysis has also been made [3, 20, 21]. At the beginning of the 80s in the 20th century a detailed classification of vegetation was worked out for the Nature Park „Tervete”. In total 12 different plant community groups were distinguished, from which 8 correspond to forest plant communities. Three of them are pine forest communities: with Norway spruce *Picea abies* (L.) H. Karst. on the second layer and admixture of some oaks; with spruces and broad-leaved trees admixture on the second storey; with silver birch *Betula pendula* Roth and grey alder *Alnus incana* (L.) Moench. on the second layer. In the course of time the landscape changes, and it is important to clarify what changes have taken place, what factors have influenced that and what development tendencies could be expected in the future.

The aim of the research is to describe, analyse and evaluate the plant communities of the pine forests in the Nature Park „Tervete”, by comparing the results obtained in the years 1957 and 2007.

In order to reach the aim, the following tasks have been set:

- 1) to research the vegetation of pine forests in the Nature Park „Tervete”;
- 2) to determine and compare the ecological indicators of plant communities – moisture, light, continentality, nitrogen content, soil reaction and temperature in the years 1957 and 2007;
- 3) to explain the correlations between the species structure of plant communities and their occurrence, using the analysis of plant life forms and strategy types.

## 2 Problem formulation

### 2.1. Description of the territory

The Nature Park „Tervete” has been a specially protected nature territory since 1957. In this area turf carbonate soils have been formed on the carbonatic parent rocks [14]. Analysing the present-day data on the distribution of soils, it has been stated that the forest stands in the vicinity of Tervete grow on the former cultivated agricultural soils [17]. The highest number of sunny days in Latvia has been stated in this territory. The territory is characterised by a sizable total of active temperatures (about 2000°C), that is very important for plants which prefer warm weather. There spring arrives very early, however, the early awakening of nature is

accompanied by very late spring frosts which can be observed on the plain in still June. In the territory of the nature park the annual average amount of precipitation is low - 560 mm, but during the warm period more than two thirds of rain falls there. The snow cover in winter is thin - up to 20 cm. The depth of the soil frost on average does not exceed 40 cm [8]. The central part of the park is crossed by the river Tervete, which together with side glens create sectioned relief [17]. The Nature Park „Tervete” is characterised by a large diversity of flora and mosaic of vegetation. The largest part of the territory is occupied by forests. In the 80s of the 20th century 594 species of vascular plants belonging to 335 genera and 94 families were registered in the park. 560 species form the local flora, but 40 - 50 species (9 %) are adventive [20]. The presence of adventive species shows that the process of forest vegetation change has started, which is more intensive in forests on dry sites. The changes mainly pertain to the herb and shrub layers [16]. In the nature park the prevailing forest growth condition types are those of dry site (Hylocomiosa - 82 %, Myrtillosa – 9 %, Vacciniosa – 1 % and Aegopodiosa – 5 %), while other types can be found in small areas [17].

### 2.2. Comparison of vegetation research methods

The first research of the Nature Park „Tervete” was carried out in 1957. The Drude scale was used to describe the plant communities [3]. A repeated recording and inventory of vegetation in 8 sample plots (the area of each plot - 400 m<sup>2</sup>) was carried out in 2007, using the Braun-Blanquet method [2, 15].

The comparison of the Drude and Braun-Blanquet scales' values was made [4, 6, 13]. The total projective coverage of tree layer (E3), shrub layer (E2), herb layer (E1) and moss layer (E0) as well as the coverage canopy closure of each separate species in the composition of trees, shrubs and herbs has been evaluated in the sample plots in percentage.

### 2.3. Data processing methods

The descriptions of vegetation are summarised in the data base of Excel software programme. The occurrence of plant species is characterised by the consistency index which is calculated by referring the number of those sample plots where the species has been identified to the number of the whole group of sample plots. The average values of ecological indicators in 1957 and 2007 were determined using Ellenberg's tables of ecological values [6]. In order to explain the correlations between the species composition of the

plant communities and their occurrence, the life forms (the ability to adapt to unsuitable climatic conditions) and strategy types (the characterisation of the plant competition ability) were analysed. Such division of plants expresses their attitude to stress and disturbances [7].

For comparison of the flora Jaccard's similarity coefficient was calculated. If the calculated Jaccard's coefficient  $C=1$ , the communities are equal, but if  $C=0$ , these are different communities [12]:

$$C_j = \frac{j}{(a+b+j)}$$

$j$  = total number of species for both communities (in 1957 and in 2007),

$a$  = number of plants found only in the 1st community (in 1957),

$b$  = number of species found only in the 2nd community (in 2007).

For the credibility evaluation statistical methods were used: the verification of the hypotheses on the parameters of two general clusters [1].

### 3. Problem solution

The vegetation of the Nature Park „Tervete” is formed by summer-green broad-leaved forest class *Querco-Fagetea* and western taiga forest class *Vaccinio-Piceetea* character species. The territory of the Nature Park „Tervete” is located on the border of the former broad-leaved - spruce and broad-leaved forest zone. The broad-leaved forests have suffered most from economic activities. The territory of Tervete in Zemgale plain is an ancient culture historical agricultural area, where broad-leaved tree species growing in fertile soil were almost fully cut down already back in the 18th and 19th centuries. There is a lack of evidence concerning the most widespread tree species in Tervete in that period. The evaluation of the growing areas indicates that it could have been English oak. There are separate oak groups or stands left there. From the beginning of the 19th century, as a result of decrease in grain prices and the increase in the value of wood, a partly reforestation of agricultural lands took place [18]. Although the broad-leaved forest territories in Latvia in the course of time were mostly replaced by spruce, however, the Scots pine has a high level of adaptability to different soils with different moisture content in them [16]. At the end of the 19th century in Zemgale 90 % of the all artificially grown forests were pine. This tendency was also promoted by the gentry, which considered spruce and birch to be „weed” species. In

the 20s–30s of the 20th century the percentage of forest cover in Zemgale reached 27.03% [18].

The total number of species in 8 sample plots in 1957 was 195, from which 112 were not identified in 2007. In 2007, 121 species were identified, from which 83 species were common to those registered in 1957, but 38 species were new. The comparison of the number of species by layers is shown in Figure 1. Jaccard's similarity coefficient ( $C=0.36$ ) calculated for the comparison of flora indicates about considerable changes in the structure of species. In the tree layer in 1957 the prevailing species was pine, but in 2007 together with pine the layer of the trees was also made by *Quercus robur*, *Acer platanoides* and *Tilia cordata*. Over the period from 1957 to 2007 the coverage of tree layers had increased. In the layer of shrubs and advanced growth the occurrence of *Betula pendula*, *Juniperus communis* L., *Populus tremula* L., *Quercus robur* is more seldom, but – *Padus avium* Mill., *Corylus avellana* L., *Ribes spicatum* (C. Hartm.) Hedl. and *Lonicera xylosteum* L. is more often.

In the course of time the representation of *Sorbus aucuparia* L. in sample plots has not changed. In the herb layer the number of mezofyte meadow and pasture class *Molinio-Arrhenatheretea* character plants has diminished considerably since 1957 [13]. In the herb layer the grasses and other meadow species have diminished or disappeared. Now the herbaceous plants typical of broad-leaved forests - *Actaea spicata* L., *Anemone nemorosa* L., *Carex digitata* L., *Maianthemum bifolium* (L.) F.W. Schmidt, *Mycelis muralis* (L.) Dumort., *Oxalis acetosella* L., *Paris quadrifolia* L. and sprouts of broad-leaved trees and shrubs are found. The moss layer has become considerably thinner, the characteristic species of western taiga forests - *Hylocomium splendens* (Hedw.) B., S. et G. and *Pleurozium schreberi* (Brid.) Mitt. have been replaced by the moss species typical of more fertile forests e.g. *Eurhynchium angustirete* (Broth.) T. Kop. etc.

In each sample plot indicators for the following factors were calculated for each species of the sample plot: light, moisture, soil reaction, nitrogen, temperature and continentality [6]. Analysing and comparing the ecological indicators it should be concluded that in the course of time between 1957 to 2007 the soil in the Nature Park „Tervete” had been enriched, a thicker undergrowth had formed and the canopy closure had been observed in the second layer of the tree stand. The increase in the amount of nitrogen on average by 1.1 indicates eutrophication. A slight increase has been observed in the values of moisture and soil reaction,

but the indicators of continentality and temperature were similar both in 1957 and in 2007 (Figure 2).

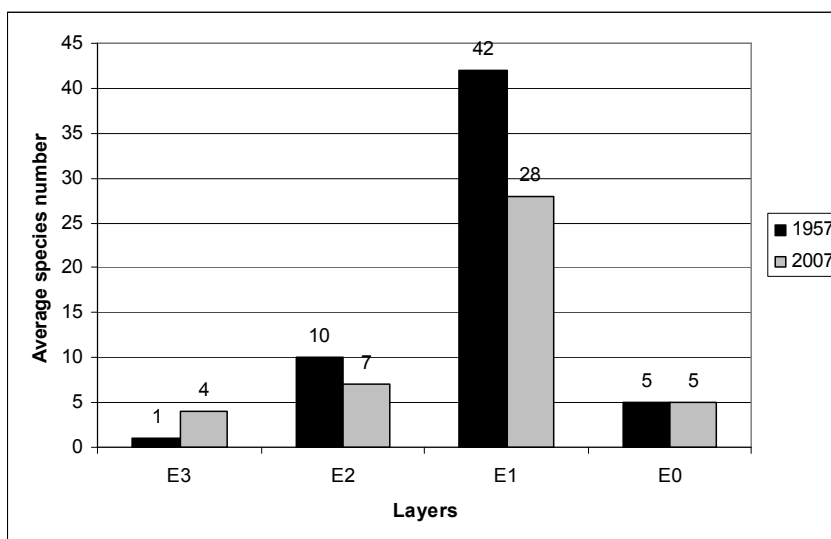


Fig. 1. The comparison of species' number in 1957 and 2007

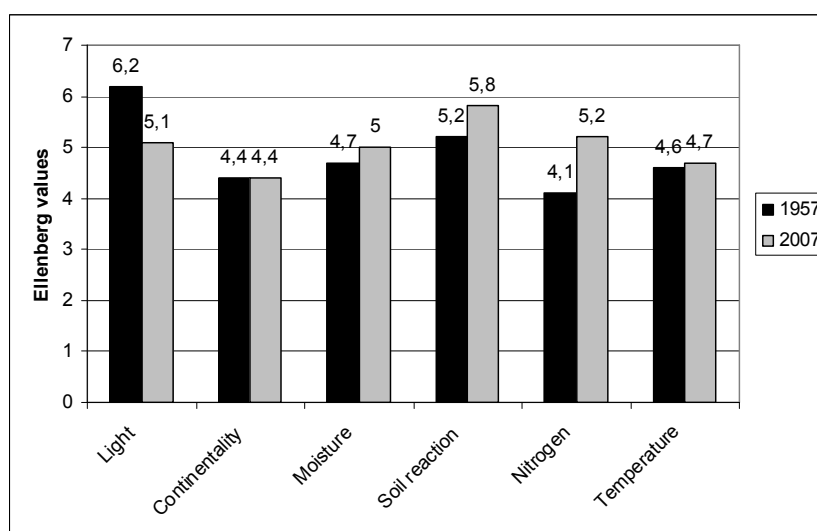


Fig. 2. Comparison of ecological indicators of 1957 and 2007

Analysing the results of 1957 and 2007 changes were observed also in the structure of plants with regard to survival strategy: the proportion of competing strategy type of plant species increased from 36.8% in 1957 to 45.2% in 2007, new species had established themselves – *Amelanchier spicata* (Lam.) K.Koch, *Angelica sylvestris* L., *Euonymus europaea* L., *Ribes alpinum* L., *Sambucus nigra* L., *Ulmus laevis* Pall., *Ulmus glabra* Huds. No ruderal species had been identified. The proportion of plants of mixed or transitional type strategic group had decreased – no more *Antennaria dioica* (L.) Gaertn., *Anthoxanthum odoratum* L., *Campanula patula* L., *Campanula rotundifolia* L., *Geranium sanguineum* L. etc. had been identified. It shows that the

environmental conditions in the Nature Park „Tervete” have become stable, and no large scale disturbances have occurred. At the same time the presence of stress tolerant species show that the species have adapted to different environmental conditions.

Comparing the results of 1957 and 2007 concerning the life form representation, the increase in the projective coverage of phanerophytes or woody plants was observed. Geophytes' cover also increased: new species were found in the sample plots in 2007, for example, *Paris quadrifolia*, *Polygonatum odoratum* (Mill.) Druce which can be explained by the adaptation of plants use of seasonal conditions. As a result of soil eutrophication, the cover of

nanophanerofytes or plant cover of shrubs has increased - in 2007 new species were found: *Euonymus europaea* L., *Ribes alpinum* L., *Ribes spicatum* E. Robson, *Sambucus nigra* L. With the increase of tree and shrub layer cover, growing conditions in the herb layer have changed. The hemicriptophytes - typical meadow and pasture species have been replaced by the species typical of forests - *Angelica sylvestris* L., *Mycelis muralis* (L.) Dum., *Sanicula europea* L., *Astrantia major* L., *Ranunculus lanuginosus* L. Terophyte group plant cover has decreased - only *Impatiens parviflora* DC. and *Stellaria media* (L.) Vill. are found. The same pertains to the hamephyte group plant cover – in 2007 no such species as *Arctostaphylos uva-ursi* (L.) Spreng., *Vaccinium vitis-idaea* L. and *Thymus serpyllum* L. were found.

The results of the dispersion analysis show that the period of 50 years has been significant for the changes in vegetation in the sample plots of Nature park „Tervete” (with 95 % credibility level). As the result of climate changes the former broad-leaved - spruce and broad-leaved forest vegetation which was characteristic for this territory is renewing.

#### 4 Conclusions

1. The vegetation of Nature Park „Tervete” is formed by the characteristic species of summer-green forest class Querco-Fagetea and western taiga forest class Vaccinio-Piceetea.

2. The total number of species in 1957 was 195, from which 112 species were no longer found in 2007. In the year 2007, 121 species were registered from which 38 were new species and 83 species were common with 1957.

3. Comparing the ecological indicators of 1957 and 2007, the indicators of light, soil reaction and nitrogen content were different. The indicators of light decreased, but soil reaction and nitrogen content indicators increased. The indicators of continentality, temperature and moisture have changed slightly.

4. Comparing the plant strategy groups in 1957 and 2007, the number of competing and stress tolerant plants increased, but the number of ruderal plants decreased, which indicates the stabilisation of environmental conditions in the Nature Park „Tervete”.

5. Comparing the representation of life forms, there was an increase in the phanerophyte, nanophanerophyte and geophyte group species and cover. The number of terophytes and hamephytes decreased, but the hemicriptophyte species typical of meadows and pastures have been replaced by the species typical of forests.

6. In the period from 1957 to 2007 the changes of pine forest community in the Nature Park „Tervete” have been significant. As the result of climate changes the former broad-leaved - spruce and broad-leaved forest vegetation which was characteristic for this territory is renewing.

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