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Gene pool conservation programme of Norway spruce *Picea abies* (L.) Karst. in the Beskid Mts

Abstract: The paper describes the measures adopted by the Czech State Forests for the conservation and reproduction of the Norway spruce gene pool in the Moravian-Silesian Beskid Mts. In addition to the assurance of natural regeneration in genetically valuable stands and the use of high-quality autochthonous stands as seed sources for artificial regeneration, the measures include selection of plus-trees, establishment of seed orchards, seed stands and clone archives, and identification of gene pools. Seeds of the most valuable regional populations are deposited in a seed bank.

Additional key words: seed orchard, seed stand, clone archive, artificial regeneration

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Introduction

Originally, Norway spruce *Picea abies* (L.) Karst. was only found at the highest elevations of the Beskid Mts. Apparently, its historical representation was as low as 5%. In the course of time, the distribution of tree species in the natural forests has been altered and currently Norway spruce represents 75% of the tree population in the Beskids. Considering such an enormous increase it is unlikely that only local genetic sources were used. It has been proved that spruce seeds purchased from abroad (mainly from the Austrian Alps) were used in the region of Tesin county and Archbishopal Forests in the Ostravice region. For this reason we cannot consider the current Beskid spruce population to be of native origin.

In spite of the predominance of foreign spruce in the Beskids, the economic output of the forest is higher than in other regions of the Czech Republic. This is due to favourable natural conditions, conducive to the spruce introduced here in the past.

Currently, import of spruce seed into the Beskids from other forest regions of the Czech Republic is prohibited, while export of the Beskid spruce to other

parts of the country is permitted when it is moved to a similar elevational ecozone.

The Czech State Forests have pursued a genetic conservation programme for Norway spruce in the Beskid region as a part of the “Conception for the Preservation and Reproduction of the Genetic Resources of Forest Trees Species” (Novotný et al. 1994) which is progressing at two main levels: operational and strategic.

Conception for the Preservation and Reproduction of the Genetic Resources of Forest Tree Species

Operational level

This management level is concerned with genetic conservation applied within small management units. Stress is mainly placed on:

- preferential use of natural regeneration where there are parent stands of high quality and where a shelterwood system could be used,

- regular management of genetic resources in forest stands, emphasising maintenance of stands of high genetic quality, approved for seed harvesting,
- responsible utilisation of local high-quality stands for artificial regeneration of other low-quality areas.

Strategic level

The strategic management level consists of a series of programmes which guide and support management at the operational level. A regional geneticist is responsible for coordinating these programmes and regional units also participate. The main programmes within the strategic level are:

- demarcation of particular autochthonous populations of Beskid spruce,
- demarcation of stands of high genetic quality for conservation (genetic reserves),
- optimisation of approved seed stands used for seed harvesting,
- planning and coordination of seed harvesting,
- researching and approving of trees of high genetic quality,
- establishing seed orchards and clone archives,
- establishing seed stands,
- filing valuable spruce seeds into the regional tree species bank.

Particular autochthonous populations of Beskid spruce

As mentioned above, the native spruce stands were present only in the highest regions of the Beskid Mts (1000 m a.s.l.) and this is where a number of isolated spruce stands aged from 170 to 270 years have been preserved: Lysá hora, Smrk, Kněhyně, Travný, Velký Polom. The native origin of these trees has been verified and they are regarded as the most valuable part of the forest ecosystems in the Beskids. Considering the small area in which they grow (about 100 ha), their old age and the significant threat from biotic and abiotic factors, we consider them to be critically threatened populations. For their preservation and reproduction, a full complex of measures have been designed, as mentioned hereafter.

Genetic reserves

Genetic reserves are large complexes of autochthonous forest stands or wood complexes with a notable proportion of genetically valuable trees in an area, which is sufficient for the preservation of the genetic variability of the population. When using an appropriate management method, they are capable of self-reproduction. The main forestry objectives in genetic reserves are the preservation and reproduction of the genetic resources of those tree species for which the genetic reserves have been set aside. The basic method of reproduction in genetic reserves is natural regeneration. If artificial regeneration is nec-

essary, it is usually used only for the tree species for which the genetic reserve was designed.

For Norway spruce, nine genetic reserves have been approved in the Beskid Mts. They occupy an area of about 3205 ha. From them three genetic reserves of the autochthonous mountainous ecotype of Beskid spruce have been approved on top hills (Kněhyně, Smrk, Lysá hora) as a part of the Natural Reserve System. In genetic reserves, a shelterwood system is preferred and a rotation period and a regeneration period have been adopted. Both are as a rule 10–20 years longer than the periods usually used in the commercial forest. The three genetic reserves within the Natural Reserve System use a continuous rotation period. The quality of management in each genetic reserve is subject to periodic reviews by the Czech State Forests.

Stands approved for seed harvesting

Forest stands used for seed harvesting within the Czech Republic fall into two categories, depending on their commercial value. Category “A” comprises original forest stands of very high commercial value. This category may also include non-native forests of excellent productivity, quality and good health. Forest stands of category “B” also achieve very high productivity, but they do not reach the standards for category “A”. The whole area of approved spruce stands of category “A” in the Beskids is 887 ha, of which 332 ha (top elite forest stands) are genetic reserves. Approved forest stands of category “B” cover an area of 3015 ha, of which 367 ha are genetic reserves.

For artificial regeneration of Norway spruce in the Beskid Mts, reproductive material from approved stands of category “A” or from individual plus-trees is used. The current proportion of artificial regeneration from this high-quality genetic material is 80%. This shift to higher genetic quality by using artificially regenerated stands has become possible thanks to using specialised seed-collecting firms. From 1992 to 1996, these firms successfully collected seed in the majority of autochthonous stands of high-elevation spruce where cone collection had not been carried out in the past. It is interesting that the quality of seed from original stands aged over 200 years exceeds all quality indexes of seed from younger stands of lower elevations.

Because priorities have changed during the organization phase of seed collection and the needs for spruce seeds have lowered due to the increased natural regeneration, the necessary land area of approved seed stands in the Beskid region had to be reevaluated. As a result, the forest management strategy has been changed to continually reducing the area of forest stands of category “B” and using natural regeneration and the general principles of a shelter woodsystem in forest stands of category “A”. In the past, the latter stands were left till old age and were often clear cut without leaving a new generation.

Plus-trees

Plus-trees represent individuals of extraordinary value from the point of view of production, quality and resistance. They serve mainly for the collection of grafts and the establishment of seed orchards and clone archives. Research on plus-trees in the Beskid Mts was initiated by Prof. Kantor from the Mendel University of Agriculture and Forestry in Brno in the 1970s in connection with the establishment of the first seed orchards in the Czech Republic. As a result of this initiative, three seed orchards of Beskid spruce in the region of central Moravia (Forest Enterprise Litovel) have been established. In the course of the last ten years, in accordance with the establishment of clone archives by the Czech State Forests, 570 plus-trees have been researched and established, of which 400 were reproduced and established in the seed orchard and the clone archive in the Frydek and Ostravice Management Units during the period 1994–2002. From these plus-trees, seed has been collected in cone years.

Seed orchards and clone archives

As mentioned above, till today, four seed orchards and one clone archive of spruce have been established for the Beskid region of the Czech Republic. The oldest seed orchard covers 2 ha and dates back to 1982. It is of a very good quality, but has not produced cones till now. Another two orchards, established during 1968–1988 in the region of Litovel, were heavily damaged by a flood in 1997 and they may need to be clear felled. The seed orchard established in 1996 in the Management Unit Ostravice has 1.40 ha and 140 clones, and its health quality is very good. The clone archive in the Forest Management Unit Frydek in Lískovec (1.5 ha) represents a collection of 390 clones of autochthonous Beskid spruce. From them sufficient genetic sources for future seed orchards and cultivation of forest trees have been established. The significance of this lies in the preservation of unique trees, many of which are continuously disappearing and some of which no longer exist, for future generations.

Based on our experience with the oldest spruce seed orchards, we can expect full fructification of seed orchards at 25 years of age, and with this long-time

perspective in mind we should plan their establishment. During the harvest of 1992, 1200 kg cones per ha were collected in the 27-year-old seed orchard of the Jeseniky spruce, situated in the Forest Management Unit of Sternberk. The qualitative parameters of this seed were comparable with seed from forest stands.

Seed stands

Seed stands represent the progeny of approved forest stands of category “A” and they are the next element in the conservation of the genetic resources of particular Norway spruce populations in the Beskids. Especially valuable are seed stands established *in situ* by natural regeneration, and this process of seed stand establishment is preferred by the Czech State Forests. For the future, establishment of seed stands through artificial regeneration *ex situ* is being considered using mainly Beskid spruce populations. The current area of such established spruce seed stands in the Beskids reaches 120 ha.

Seed bank of regional forest tree populations

A seed bank of regional forest tree populations has been established at the Seed Enterprise of the Czech State Forests in Tyniste nad Orlici for the purpose of conserving valuable forest tree populations whose seed could be long-term stored. Filling the bank is performed on the basis of a long-term programme aimed to conserve the genetic resources of valuable forest tree populations for the period of 30–40 years. To date, 110 kg of seed from eight particular autochthonous populations of Beskid spruce have been stored and we will be continually supplementing the bank.

References

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