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Species conversion of spruce stands in the Wisła Forest District

Abstract: The paper provides some guidelines on the choice of the target species compositions for plantations that would replace monocultural spruce stands growing on the sites of the Silesian Beskid Mts. Part of the guidelines relates to the rules governing the sequence in which the monocultures will be converted into mixed stands. It is suggested that those rules should be combined with the principles of the establishment of progeny plantations. The seed stands of the Istebna spruce are experimentally divided into four categories according to their ability to perform the function of a seed stand. The following features of the stands are analysed: vitality, density, stage of regeneration, protective and cultural functions. The paper contains also an outline of the methods of species conversion and the relevant references.

Additional key words: *Picea abies*, Istebna spruce, seed stand

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Introduction

In the natural forest district of the Silesian and Little Beskid Mts the largest area of forests is currently occupied by spruce *Picea abies* (L.) Karst. – 73.6%, and a small part by beech *Fagus sylvatica* L. – 17.2%, and fir *Abies alba* Mill. – 3.5%. The dominant site type is mountain forest (52.6%) and mixed mountain forest (34%), while mixed mountain coniferous forest accounts only for 5.1% (Trampler et al. 1990). The Wisła Forest District has 94% of spruce, 4% of beech and 2% of fir stands growing predominantly on the sites of mixed mountain forest (73.6%) and mixed mountain coniferous forest (21.5%), and occasionally on the site of mountain forest (4%) (Szozda 2001). The figures presented indicate clearly that the proportion of spruce is too high in the region in question.

Based on historical data, Twaróg (1971) determined the following average species composition of natural stands growing in the lower forest zone of the southern Beskid Żywiecki Mts: fir 58% (from 40 to 90%), spruce 28% (from 10 to 60%) and beech 14% (from 0 to 40%). For the reserve Oszast (Beskid Żywiecki Mts: altitude about 1000 m; mixed mountain forest site type; cambiosols developed from the sandstones of Carpathian flysch), Jaworski et al. (2001), using historical data, recommend the silvicultural type of stand comprising 20% of beech, 30% of fir, 40–50% of spruce and an admixture of sycamore (*Acer pseudoplatanus* L.) The difference between the present species compositions and those of the past results from the mass replacement of mixed stands by pure spruce stands in the 19 th century (Boratyński et al. 1998, Szozda 2001).

It is well known that spruce monocultures have a degrading effect on the soil (Sikorska 1987, Maciaszek 1996) and are susceptible to diseases (Capecki 1994, 1996, Skrzyszewski 2002), therefore it is necessary to combine their utilization with conversion into mixed stands. In the Wisła Forest Dis-

trict, however, due to the specific soil and climatic conditions of this area (Rieger 1968, Baran 1996) and the vitality and high productivity of its spruce stands (Rieger 1968), the proportion of spruce in the newly established plantations should be increased on the mountain forest site, and especially on the mixed mountain forest site.

Rules governing the selection of stands to be convert

When the management stands requiring conversion have a large area, it is necessary to make a preliminary classification in order to determine the urgency of that conversion. The classification is based on the following criteria: the degree of exposure to biotic and abiotic factors, age, productivity and quality of monocultures, and the specificity of site conditions (Leibundgut 1967). In the Wisła Forest District most spruce stands are stable and part of stands are labile. Because of the high quality of stands and their considerable volume growth 8 $m^3 \cdot ha^{-1} \cdot year^{-1}$, as compared with 5 $m^3 \cdot ha^{-1} \cdot year^{-1}$ in the Promotional Forest Complex "The Silesian Beskid Forests" (Anonymous 1995) the conversion can as a rule be started when the cutting age is attained.

In the case of seed stands one should bear in mind that they are mainly spruce monocultures of advanced age. Part of them still perform their function but others are unable to fulfil it due to old age, diminished vitality and decreased canopy density, which is why their potential period of regeneration dangerously shortens. When the conversion is postponed, it would be impossible to maintain the adequate regeneration periods of fir and beech, and as a consequence the newly established stands would, as before, have an impoverished species composition. In addition, it would be the second consecutive generation of spruce monoculture.

It seems purposeful to revise, especially in the light of silvicultural risk distribution, the principle which assumes that progeny plantations are single-species and accepts all features, even weaknesses, of monocultures (Bernadzki 1993). Taking into account the forest site types occurring in the Wisła Forest District (mixed mountain forest and mountain forest), on the one hand, and a stability and good vitality of spruce monocultures in this area, on the other, it is proposed in the present study that the species compositions of the new plantations comprise a high proportion, about 50–75%, of spruce, 20–40% of fir and beech and 5–10% of larch (*Larix decidua* Mill.), pine (*Pinus sylvestris* L.), sycamore, ash (*Fraxinus excelsior* L.) and mountain elm (*Ulmus glabra* Huds.). In stands where the light conditions or the stage of spruce regeneration do not allow the introduction of shade-tolerant species it is suggested that progeny plantations are supplemented with an admixture of the broadleaved species mentioned and the light-demanding species, according to the local microsites and altitude.

Silvicultural management classes of permanent seed stands

Class I

Stands are dense, of high vitality, still able to play a role of permanent seed stands. In the units included in this class (Skrzyszewski 1995) the number of trees per hectare ranges from 129 to 441 (mean 234), and only in three cases it exceeds the recommended 300 (Kocięcki 1988). The units, however, have a varied density, and the above figures are only average. In the units where the number of trees per hectare is smaller than recommended it is suggested that neighbouring stands are joined together or parts having greater density are adopted as seed stands. The operations in the Class I stands will currently be limited to sanitation cutting, and, when necessary, gentle tending cutting (in overcongested groups) in the form of ground thinning, only occasionally and very slightly entering in the upper storey in order to maintain long crowns and prepare for more intensive cutting in the future. The stands in question should in the future be replaced by progeny plantations whose species composition would be in the range mentioned earlier. Since it is possible to keep long regeneration periods, valuable regenerations of fir can be obtained.

Class II

Stands have a discontinuous canopy (the area of gaps is frequently large, over 1 ha) but in parts are dense. These stands show signs of weakness (defoliation) whose intensity suggests that stand stability may be destroyed in the nearest 20–30 years (Skrzyszewski 1995). It is thus proposed that they are removed from the register of permanent seed stands (change of category) and that their conversion (regeneration) is started. The group in question includes also stands in which a higher proportion of fir and beech (30–40%) in the regeneration is desired.

With gaps larger than 0.5 ha in area the introduction of larch should be considered in the part the most exposed to direct insolation (i.e. the central and northern part of a gap). This concerns particularly slopes of southern exposure.

Class III

Stands are similar in character to Class II. The whole area of such units is covered by spruce regeneration having the following features:

– registered origin,

– considerable canopy density (frequently differing between storeys),
– good quality,
– still advantageous magnitude of height increment as compared to lateral shoot increment,
– the height at which felling and skidding damage is moderate.

Stopping the opening-up and removal cuts in those stands will result in a loss of the silvicultural value of regenerations.

In most cases it will be impossible to enrich the species composition of stands with a valuable admixture of fir and beech because of the advancement and coverage degree of spruce regenerations.

It is suggested that the silvicultural practices relevant to Class III should be modified in the case of spruce regeneration which remained too long under the canopy shelter, is overly slender with shortened crowns, and because of that has a low silvicultural value and runs the risk of considerable damage from felling and skidding work. The following measures should be adopted: removing the defective upgrowth (one may leave the best specimens) and, in the seed year, cultivating the soil to prepare it for sowing in order to produce spruce regeneration once again.

The progeny plantations obtained after regenerating the Class III stands will contain a high proportion of spruce – about 75% (the upper value of the range mentioned earlier).

Class IV

The stands exhibit the following features:
– advanced age,
– occurrence of trees having large dimensions,
– varied species composition or structure,
– historical connection with the Istebna spruce (cultural value),
– high natural value,
– ability to perform non-production functions.

A special type of silvicultural management is suggested which involves an individual approach to each stand; the Swiss irregular shelterwood system in its unordered form is also allowed. The stand (or stands) which has (have) not been included in the harvest plan, eg. 149h, should also be classified under that category.

A detailed description of the units considered is to be found in an earlier work (Skrzyszewski 1995).

The conception presented in this study does not fully comply with the general rules of conduct in seed stands; the difference lies in proposing final cuttings in selected units, diversifying the species composition of progeny plantations, etc. It is worth mentioning that this conception provides for a long-term procedure to be followed over many decades.

The management plan proposed for seed stands does not envisage redefining their priority function which still remains the preservation of genetic value and not the production of timber. It is necessary, however, to prepare for the time when those stands cease fulfilling their basic task. Then they will require replacement by progeny plantations in which spruce and other species should be sheltered at young age.

In the Wisła Forest District, seed stands should represent different forest ranges, altitudes and sites. It is also important to ensure that the process of harvesting of the stands of oldest age classes is started in advance (to avoid forced harvest), which will make it possible to obtain regeneration of registered origin (progeny plantations). When adopting the resolution to take a stand off the register of permanent seed stands, one should (if needed) choose new units of the same type.

Species conversion methods

The methods used for the species conversion of spruce stands depend on the silvicultural stand type and on other determinants of the long-term objective of silvicultural management (Table).

Suitable methods for the seed stands of the Wisła Forest District are the modified shelterwood systems and the narrow-strip and group system. The rules for their species conversion according to the methods suggested and for a further procedure are to be find in the relevant literature (Fabijanowski and Oleksy 1959, Jaworski 1986, 1988, 1990, 1995, Jaworski and Poznański 2000).

Table 1. Species conversion methods of spruce stands

Silvicultural stand type	Conversion method (cutting system)	Comments	Class
Spruce	modified border and strip shelterwood system (with lowest width of cutting area)	partial conversion, 20–30% of fir and beech	II, III
Fir-beech-spruce Beech-fir-spruce	narrow-strip and group system	partial conversion, about 40% of fir and beech	I, II, IV
Spruce-beech-fir	Swiss irregular shelterwood system	total conversion	IV
Fir	spacially disordered underplanting	when all the gaps and places with most reduced density have been underplanted, one of the methods specified in column 2 is used	all classes

During conversion it is necessary to give special attention to the following:
- appropriate choice of the species composition; separation of single-species parts by mixed stands,
- maintenance of sufficiently long partial regeneration periods, especially for fir,
- establishment of a proper planting spacing for a given species,
- maintenance of the small-group form of stand mixture and a uniform distribution, especially for species that represent a small share of the species composition (the form of stand mixture, however, should ensure that the industrial wood assortments are obtained),
- application of tending methods that enhance the resistance of spruce to abiotic damage (Fabijanowski and Jaworski 1996, Burschel and Huss 1997),
- likelihood that the health state and stability of stands whose density is severely reduced during conversion may decrease,
- necessity to prevent animal damage,
- use of adequate measures to increase biodiversity (Bernadzki 1993) and conserve landscape as well as maintain the cultural role of the stands.

While choosing the planting stock, one should take into account the results of provenance experiments (Sabor 1990) and other researches on the variability of introduced species (Skrzyszewski 2001), and the characteristics of the seed base (Bałut et al. 1987).

The stands considered in this study are characterised in more detail in an earlier publication (Skrzyszewski 1995, Skrzyszewski and Skrzyszewska 1996).

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