Conversions of coppices to a coppice-with-standards in Urban Forests of Moravský Krumlov

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ABSTRACT: Conversions of oak coppices were many times carried out only by renaming to false high forests. The paper presents a method of the conversion of overmature coppices to a coppice-with-standards implementation of which was started in urban forests of Moravský Krumlov. The method is inspired by Nanquett's method and conversions by J. Wiehl. The objective is to manage according to selection principles in a coppice-with-standards. In experimental plots established in 1999, the increment of standards and the development of natural regeneration of sessile oak were monitored in particular.

Keywords: conversion; coppice; coppice-with-standards; sessile oak

In frequent discussions and considerations on close-to-nature management or on management using selection principles, one of possibilities is neglected how the principles can be fulfilled in oak forests, viz. to create and manage a coppice-with-standards. This type of a forest can include both diversity of tree species and age and thus also of storeys and origin (generative or vegetative). In addition to the high forest where trees are of seed origin and the low forest or more accurately coppice forest where trees originate by the sprouting capacity of stumps or roots the coppice-with-standard represents the combination of a coppice forest forming the lower storey and uppermost storeys created from standards primarily of seed origin, i.e. the high forest in various stages of maturity. Height increment of standards is smaller, however, diameter increment is more marked as compared with closed stands of the high forest. Research into volume production of the coppice-with-standard forest is limited (DOLEŽAL et al. 1969). This type of the forest is considerably extended particularly in France and Greece. Sufficiency of trees of the seed origin is a precondition for growing the coppice-with-standards. In the Czech Republic, with respect to the small area of the forest (in 1930 some 2.3% forest land) it is included either into the low forest or in case of the higher number of standards into the high forest (POLENO 1999).

Coppice-with-standards is a type of the forest suitable for growing oak stands. In addition to standards of seed origin we need part of a main storey from trees of good sprouting capacity, above all oak, hornbeam and linden. The storey forms lateral shading for growing quality standards and serves as a store for the selection of future standards. The coppice-with-standards forest shows many advantages, viz. small costs for regeneration and relatively high production (even from the aspect of value). Its usually high species diversity contributes to humus decomposition, preservation of soil fertility and also static and ecological stability. Because clear felling does not occur there the forest used to be favourably assessed from the viewpoint of landscape ecology, nature protection and aesthetics. However, management in the forest is difficult and laborious. It requires frequent silvicultural measures, viz. cleanings in the lower storey and thinnings in the main and standard storeys and ensuring the adequate opening up for preserving the oak advance growth and growing quality trees of seed origin, i.e. future standards.

The main problem of urban forests of Moravský Krumlov is incomplete conversion of hardwood coppices to the high forest mostly carried out by clear-felling and planting Scots pine or by the preservation of a coppice to the false high forest. However, the method is only renaming the problem. Forests of the coppice origin show a predetermined development given by its physiological character which cannot change due to reservation but only grows older. We can aid to delay disintegration of the stands by tending measures, however, we cannot prevent gradual increase of rots in the most valuable part of a stem, dieback of particular trees, decrease in fertility and sprouting capacity. However, postponing the conversion has caused that the forest property is overmature from the forest-management point of view and provides sufficient felling possibilities and thus also higher yield for the next

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30 years when the major extent of operations connected with the conversion will be carried out.

To verify suitability and possibilities of the proposed method of conversion and regeneration experimental plots have been established in the forest management unit where the increment and development of sessile oak standards and oak regeneration limiting the successfulness of the conversion are monitored.

Conversions

Conversions, according to a definition changes in the silvicultural system, were most often understood and implemented as changes in the silvicultural system from less productive systems to systems providing higher production, i.e. mostly from coppices to high forests or coppice-with-standards. At present, however, changes in cutting under systems involving coupes in monocultures to the selection system (ŠACH 1996) are the more frequently published type of conversions.

According to the method of implementation forest terminology distinguishes three types of conversions:

Direct conversion – a new stand is established after the complete removal of an original stand – clear felling with the following artificial regeneration.

Indirect conversion – uses for establishing a new stand natural regeneration and at the same time the protective effect of the original stand under the longer time of conversion or a new forest is formed using and preserving some components of original stands.

Conversion through a coppice-with-standards – a coppice is transformed to a coppice-with -standards with the higher proportion of the storey of standards which makes possible a transformation to the high forest. If standards are selected from individuals of sprout origin and regeneration of seed origin is supported in the lower story we speak about inverse (false) coppice-with-standards (JURČA 1988).

Very elaborated method of conversions of oak coppices is Nanquett's method which originated in France in 1858 to 1860 (SIGOTSKÝ 1953; VYSKOT 1958). It is based on a French method being the combination of the direct and indirect conversion. Its use was maintained till the mid-20th century. It was developed particularly with respect to the biology of oak. In order to prevent intensive development of sprouts hindering relatively slowly growing oaks of seed origin oak coppices are converted only at an age of 60 years when their sprouting capacity decreases. If it is possible to use natural regeneration, the best oak trees in the coppice are liberated as future standards. The conversion is carried out gradually and the conversion period is related to the future stand rotation. The procedure is carried out in four stages. In the first, preparatory stage, the future conversion is prepared by searching and liberating seed trees. Then the conversion proper can be initiated. In the second stage, preparatory measures are carried out and in the third and fourth stages existing management continues with a difference that suitable standards are carefully searched and liberated.

In Czech lands, works of Julius Wiehl, director general of Liechtenstein forests are the most frequently assessed method of conversions and obviously the most extensive described conversion of broadleaved coppices (VYSKOT 1957, 1958, 1961; TRUHLÁŘ 1969). J. WIEHL (1847–1917) consistently accepted the shelterwood system of small-scale management. It is a procedure which adumbrates scientific conception of a permanently productive forest (TRUHLÁŘ 1996). In addition to successive multi-stage strip shelterwood felling he also occasionally used, usually for special purposes (introduction of coniferous species particularly of larch, control of poorly stocked areas and stands of low-class quality, conversions of coppice forests) small- area clear felling either with standards or without them. In the conversion of coppice forests he elaborated a specific method originality of which consisted in the integration of oak standards and larch as a fast-growing species into the process of conversion for the purpose of compensation of production losses in the course of the conversion period.

Wiehl put great emphasis on careful tending measures (above all crown thinnings) which were to be carried out 2 to 3-times within the original 40-year-old coppice rotation period simultaneously with assessing sprout clumps and examining soil-improving woody species. Management is aimed at three objectives:

1. light increment,
2. larch,
3. oak stand (SIGOTSKÝ 1953).

Use of selection principles

Some principles of the selection system can be even fulfilled in uplands and lowlands with sessile oak as a principal species. Remnants of two-storied stands where oak standards can provide valuable assortments and the second storey makes possible to select final-crop trees as standards for a future period offer the possibility. Main principles of a permanently productive forest (so called "Dauerwald") expressed by MÖLLER (in JURČA 1988) are as follows:

– to preserve the forest on the whole area;
– to use natural regeneration, to support and provoke it;
– to mark the whole annual cut by the selection of particular trees;
– to achieve the highest increment percentage for the highest growing stock.

According to the classification of THOMASIUS (1992), based on the requirements of a predominating species for light the proposed conception of the coppice-with-standards forest is classified to the type of "a permanently productive forest from light-demanding species" which is formed by groups of certain developmental stages of trees arranged predominantly side by side (horizontally) or in case of the very sparse shelter of an old stand vertically forming together the mosaic of a young, medium-aged and old stand approaching the ecological balance only when assessing larger areas.

Research area – forest management unit (FMU) Urban Forests of Moravský Krumlov

The FMU area is 498 ha. As for species composition, sessile oak predominates (46% stand area) and broadleaves in total amount to 89% stand area. A predominating silvicultural system is coppice forest (292.5 ha). The forest management plan distinguishes also coppice-with-standards (104.29 ha) although it refers to remnants from the past which were not certainly intentionally managed. High forest represents only 94.36 ha.

The FMU is situated in foothills of the Bohemian-Moravian Upland natural forest region. It is predominantly located in the second (beech/oak) forest vegetation zone with sporadic transitions to the first (oak) and third (oak/beech) zones. As for forest type groups (FTG), groups in the nutrient-rich series (H) are abundant, then groups in the acid series (C, K). The occurrence of transition groups (S) is considerable and particularly in peripheral parts, exposed and extreme sites overlap (J, Z, X).

In the historical urban forest, forest type group (FTG) 2H – loamy beech/oak community is dominant in the northern part and FTG 2S – fresh beech/oak community in the southern part.

Altitudes in the FMU range from 220 to 380 m. As for herbaceous vegetation, thermophilous species and communities occur frequently. Forest communities are of considerable diversity including a number of species belonging rather to the Pannonian region. As for main commercial species, beech does not occur at all and spruce occurs only as a remnant of conversions carried out at the turn of the 19th and 20th centuries in the former demesne; its natural occurrence has not been noticed. Original species composition was as follows: sessile oak in particular (*Quercus petraea* Liebl.), on slopes pubescent oak (*Q. pubescens* Willd), occasionally *Q. cerris* L., autochthonous species of oak communities such as hornbeam (*Carpinus betulus* L.), small-leaved linden (*Tilia cordata* Mill.), European aspen (*Populus tremula* L.), European birch (*Betula verrucosa* Ehrh.), wild service tree (*Sorbus torminalis* [L.] Crantz), hawthorn (*Crataegus oxyacantha* L.), on moist localities black alder (*Alnus glutinosa* [L.] Gaertn.), European ash (*Fraxinus excelsior* L.), willows (genus *Salix*) and on dry rocky localities probably Scots pine (*Pinus sylvestris* L.). Since the mid-19th century, locust (*Robinia pseudoacacia* L.) of inferior production potential coming mostly from former pastures was introduced into some localities.

PROPOSED METHOD OF CONVERSION

The conversion of oak coppices in Urban Forests of Moravský Krumlov has been proposed and in some stands already started using a procedure described below. It is necessary to emphasize that in contrast to conversions described in literature (Vyskot 1958; Truhlář 1969; Sigotský 1953) we begin to convert stands of mostly coppice origin (coppices – false high forests) at an age of 70–90 years, some of them originally grown as coppice-with-standards but with missing quality main storeys where it would be possible to select sufficient amounts of oaks of seed origin as future standards at an age of 40 to 60 years. In principle, we try to return to the original method of management in these forests after 50 years.

Crucial moments of the conversion are as follows:
– preservation and development of advance growth of sessile oak in particular;
– the development of often insufficient crowns;
– limiting the formation of epicormic shoots in liberating standards;
– wood quality of standards limited by the progress of fungal parasites (rots) in the butt part deteriorating the most valuable part of a stem.

1st phase – regeneration with the preservation of standards

This stage will probably take (according to Nanquett's method) the original oak coppice rotation of ca. 40 years (Sigotský 1953; Vyskot 1958). Its duration can be modified according to the condition of converted stands. If it is successfully implemented it will lay the foundation for the formation of a multi-storeyed coppice-with-standards.

A. Preparatory stage

It represents sanitation felling. In case of the conversion of stands normally tended the preparatory stage is unnecessary.

B. 1st stage of shelterwood felling

Within two or three years after acorn fall when germinating seedlings can be suppressed in shadow it is necessary to carry out the first measure (felling) which is aimed at removing subdominant and intermediate trees of poor quality. As for the general level of upper canopy we remove low-quality trees with undeveloped crowns using light positive selection in order to assist to the development of crowns of future-crop trees showing straight stems and adequate crowns. If mature standards of d.b.h. over 50 cm occur in the stand we can fell those which show drying crowns weakened by *Loranthus europaeus* L. In total, we mark about 1/3 of trees and fell about 25% growing stock. The measure should not result in the radical disturbance of the stand environment. The objective consists in the gradual levelling of diameters and heights of the main stand. After the measure, stand density ranges between 7 and 8.

Nanquett's method (Sigotský 1953; Vyskot 1958) starts the conversion at an age of 60 years of the coppice which better corresponds to our activities as compared with Wiehl's method. However, it does not take into account preservation of any part of the original stand.

C. 2nd stage of shelterwood felling

The second stage of shelterwood felling starts in a period when the released stand nearly restored canopy and seedlings begin again to suffer due to shade. It is mostly after 3 to 6 years. If larch and pine regenerated in the stand we have to pay maximum possible attention to them particularly individual protection from browsing damage. Introduction of pine during conversions supports also PROCHODA (1931). We remove remaining inferior-quality subdominant, intermediate and suppressed trees of coppice origin and at the same time (but some exceptions) we complete felling of mature standards if fall of their acorns is not already necessary. The stand is divided by the network of extraction tracks which can later serve for the stand division to parts where young growth tending will be carried out. Also in the future, they will serve for skidding operations. Division of stands is also emphasized by DOLEŽAL (1957). A last step in the course of the second stage of shelterwood regeneration is removing undesirable woody species, cleaning and reduction of sprouts.

D. 3rd stage of shelterwood felling

The third and last stage of the shelterwood regeneration at the beginning of the coppice-with-standards formation occurs in the course of 10 to 15 years from the initiation of the conversion. J. Wiehl proposed an age of 6–8 years (SIGOTSKÝ 1953; WIEHL 1912). The stage consists in felling last mature standards and preserving only the storey of standards preferably of seed origin. If the trees do not occur in the stand we choose standards from quality trees of coppice origin. We try the approximate amount of standards per ha ranged from 80 to 120 trees in order it would be possible to say that it is a case of a coppice-with-standards with an average number of standards (POLENO 1999). In the experimental plots, the number of standards ranges from 83 to 166 per ha which corresponds to the number mentioned above.

Following operations in the two-storied stand consist in the care of standards and removing epicormic shoots by pruning. A main objective is to create a promising pole stand or even a stand approaching maturity from advance growth with the sufficient proportion of oaks of seed origin preserving oak and also hornbeam trees of coppice origin and/or other species of various origin.

2nd phase – formation of a fully valuable coppice-with-standards

We can speak about starting the second phase if a two-storied stand was created with the upper storey of standards (in this case mostly of trees of coppice origin) and main storey consisting of trees of seed and coppice origin which already provides timber to the top of 7 cm d.o.b (‘Derbholz’), trees of coppice origin reached their usual rotation period and shaded oak regeneration begin to occur in the stand. Thus, a probable age of the main storey is 40 years. It corresponds to the start of the 2nd stage according to Nanquett’s method (SIGOTSKÝ 1953). At this age, not to commit the mistake of State Forests, we have to start radically to open a main storey, to liberate it. We proceed in such a way that above all we fell low-quality trees of coppice origin as well as suppressed trees of seed origin. We harvest also mature standards established in the first stage. This should be made gradually because standards will create the backbone of economics of the forest property. Also J. Wiehl (SIGOTSKÝ 1953) aimed felling of standards at the period representing a certain yield vacuum. Through the felling of standards carried out particularly in seed years after acorn fall the stand is heavily opened. The aim of the stage is to create a three-storied stand.

3rd phase – management in the coppice-with-standards

The period should proceed according to the principles of a group selection system. The conception of management is connected there with principles of the selection system, permanently productive forest – “Dauerwald” (JURČA 1988; KRUTZSCH 1956). We suppose observing Möller’s principles of the “Dauerwald”:

– the forest will be preserved on the whole area;
– we will use natural regeneration, viz. vegetative and above all generative;
– felling will be marked through the selection of individual trees;
– through the growing of standards we achieve as high as possible increment percentage relating the highest attainable growing stock (departure from Möller’s conception).

Thus, we obtain an upper storey created by roughly 80-year-old oaks predominantly of seed origin which can be felled according to their maturity and other conditions at an age of 100–160 years. Felling in the most valuable storey will be naturally preferentially aimed at standards of coppice origin. The main storey created by the sufficient number of trees of seed origin together with other trees of coppice origin at an age of 40–80 years is maintained in open canopy in such a way groups of oak regeneration (of seed origin) to be able to live and gradually grow in the lower storey.

The coppice-with-standards silvicultural system is kept as a final system for it biodiversity as well as due to production reasons formulated by TRUHLÁŘ (1969) as compared with production of a coppice forest and high forest on sites poor in nutrients. Coppice-with-standards provides a possibility of the sustainable yield of well-marketable logs.

Establishment of experimental plots

For the purpose of the study, six stand parts were selected. Their general common characteristics was age 60–80 years, silvicultural system being false high forest up to coppice-with-standards or at least its remnants, sessile oak being a main species. The occurrence of trees of seed origin at an age of the main stand is minimum. On the other hand, the majority of "mature" standards is very probably of seed origin. Four selected stand parts are situated on nutrient-poor sites, forest type group 2S – fresh beech/oak community, two are on nutrient-rich sites, forest type group 2H – loamy beech/oak community.

Three types of measures were assessed (A – removal of 30% growing stock, B – removal of all trees with the exception of standards, C – control) and each of the types was repeated five times in the given stand part. In total, 15 plots were placed into each of the stand parts, the total study included 90 plots. In stand parts, areas belonging to particular types of a measure were randomly situated. In this way, representative samples were placed in each of the stand groups.

After surveying and stabilization of research plots in each of the stands, standards were found out and permanently marked by numbers as a basis and the main objective of the study. In the course of the measurement, evaluation of the following parameters was carried out in all trees of the given plot:

I. Tree type
II. Tree species
III. Diameter at breast height (d.b.h.)
IV. Tree height
V. Crown height
VI. Crown diameter
VII. Social position according to the tree height
VIII. Stem quality from the aspect of shape
IX. Crown quality from the aspect of shape
X. Regeneration cover
XI. Regeneration origin

All sets (particular experimental plots according to the type of measure – A1, B1, C1, A2 etc.) in six stands under study were separately processed in tables. For every character, the number of trees was determined in the studied set (plots A1 – A5 – set **A**, plots B1 – B5 – set **B** etc.) and arithmetic mean and median were calculated. To determine the rate of variability of studied sets, standard deviation s_x and coefficient of variation s_x% were calculated.

For every type of measures in the stand (data from 5 plots – 0.157 ha), stand basal area was calculated in m^2 per ha, growing stock in m^3 per ha and the number of trees per ha both for all trees and separately for "filtered" standards (1999), in 2001 only for standards. In periodically performed measurements, comparisons can be also carried out of increments and other changes in target trees, i.e. standards. Regeneration or its cover and development are recorded in tables evaluating both total cover (degree of coverage) of species regeneration in stands according to the type of measure and separately the cover of generative regeneration of the main species, i.e. of sessile oak. The following statistical characteristics were determined for the evaluation: arithmetic mean, median, standard deviation and coefficient of variation.

Data sets obtained are relatively extensive. In each of the trees a number of parameters was determined. For the measured standards the following parameters were analysed: *stem form, crown form and basal area in the type of a measure* in standards.

To determine the effect of various intensity of measures on the development of measured quantities multivariate analysis of variance was used (MANOVA). The analysis was used because of the fact that in each of the trees more parameters were measured simultaneously.

One-way analysis of variance (ANOVA) was used to determine relationships in a set created of all standards between the stem form and the forest type group (FTG), the crown form and FTG and basal area and FTG. The same parameters were tested in relation to the type of a measure.

Final tests in standards were carried out to determine the dependence of the three parameters on the standard origin, i.e. vegetative or generative.

In studying the degree of coverage of sessile oak regeneration relationships were tested using ANOVA between regeneration and FTG and degree of coverage and type of the measure.

RESULTS

Data in the paper include only 2 measurements in the 2-year interval. Therefore, for assessing the increment and development of standards it is not possible to deduce fundamental conclusions. Basic statistic characteristics of all 6 stands under investigation in 1999 and 2001, both of the set of all trees in 1999 and above all of all marked standards in 1999 and 2001are available in the author of the paper. The growing stock of standards ranges from 40 m^3/ha (in stand 2C06 on a site poor in nutrients) to 167 m^3/ha (in stand 616B08 on a site rich in nutrients). Numbers of standards per ha range from 83 to 166 which, but one exception, corresponds to a coppice-with-standards with an average number of standards (POLENO 1999).

Interesting results are given by a percentage comparison of the current increment of a basal area in particular stands according to the type of a measure depicted in Fig. 1. The values are referred to all measured standards. Although

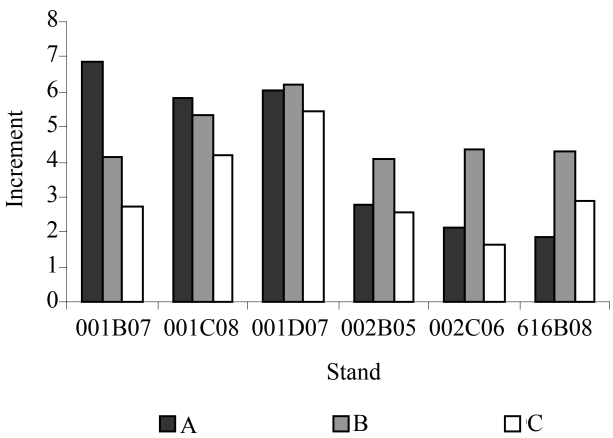

Fig. 1. Basal area increment of a standard in 1999–2001 in % according to the type of a measure

Table 1. MANOVA test results 1999 according to stand parts

Stand	Wilk's lambda	F	DF effect	DF error	p
616B08	0.922161	0.6892	6	100	0.658816
2C06	0.916003	0.7474	6	100	0.612863
2B05	0.975192	0.1727	6	82	0.983447
1D07	0.932917	0.7184	6	122	0.635522
1C08	0.906646	1.0547	6	126	0.393499
1B07	0.925233	0.7660	6	116	0.598138

Table 2. MANOVA test results 2001 according to stand parts

Stand	Wilk's labmda	F	DF effect	DF error	p
616B08	0.848900	1.4226	6	100	0.213410
2C06	0.869591	1.2061	6	100	0.309476
2B05	0.762663	1.9827	6	82	0.077477
1D07	0.841817	1.8282	6	122	0.098998
1C08	0.836452	1.9614	6	126	0.076037
1B07	0.892917	1.1265	6	116	0.351331

results of measurements for such a short period cannot serve for expressing conclusions, it is evident that in four stands of six the highest b.a. increment occurred in plots **B,** i.e. the most opened plots where only standards were preserved and all other trees were removed.

In two stand parts, the increment was highest in plots **A,** i.e. less opened plots, in plots **C** the values were lowest in five stands. The results support a hypothesis on the stimulation of a height increment of overmature coppices (false high forests) through opening up of a stand.

To determine a relationship between the type of measure and parameters such as stem form, crown form and basal area these values were tested in particular years of measurements using multivariate analysis of variance (MANOVA). It refers to a relation of several variables possible relationships of which can affect other economic or silvicultural decisions. All tests were carried out for α = 0.05 significance level.

If the parameters are tested in relation to the type of a measure, preliminary results do not speak about any dependence, zero hypothesis is not refused, p values are always higher than α = 0.05 (see Tables 1 and 2). Only in 2001 after carrying out measures in stands 2B05 and 1C08, p values approach the value of 0.05, i.e. refusing the zero hypothesis. However, based on the results obtained as yet it is not possible to make any conclusions.

To determine the statistical significance of differences between values of the tested parameters not differentiating stand parts a set was made of all standards and an analysis was carried out of a relationship to forest type groups (FTG). The test demonstrated that standards in FTG 2S differed from standards in FTG 2H in all three parameters (see Table 3).

The conclusion confirms the importance of a site for the quantity and quality of production.

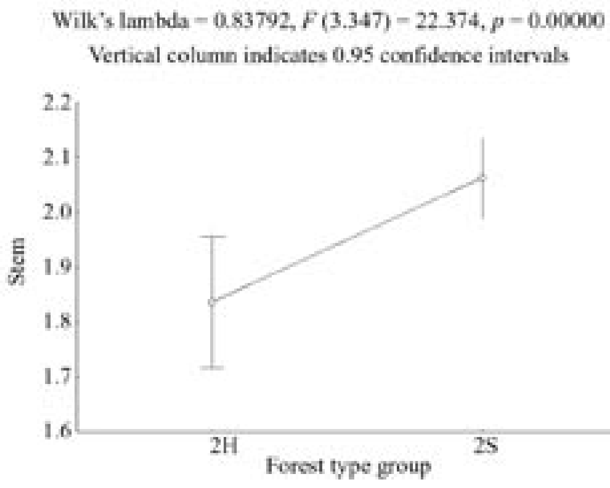

Fig. 2. Forest type group (FTG) – stem form of standards

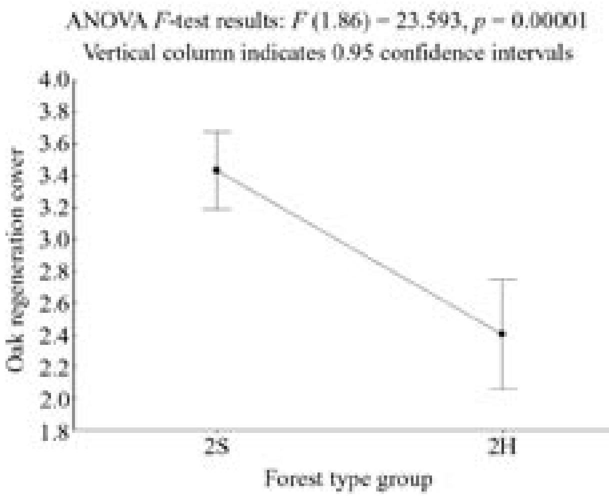

Fig. 3. Forest type group – oak regeneration cover

Table 3. MANOVA test results of all standards according to FTG

	Test	Value	F	Effect	Error	p
Absolute term	Wilk's	0.038191	2,912.969	3	347	0.000000
FTG	Wilk's	0.837919	22.374	3	347	0.000000
Measure	Wilk's	0.959521	2.415	6	694	0.025671

In evaluating relationships between an independent variable (FTG or the type of a measure) and a dependent variable ANOVA analysis was carried out. Statistically significant differences were found in tests of the stem form in relation to the forest type group (FTG). Thus, an assumption has been confirmed that in a richer FTG 2H the stem quality is better as compared with a poorer FTG 2S. Fig. 2 documents results of the test. Vertical confidence intervals do not overlap.

The stem form of all standards was tested using ANOVA analysis in relation to the type of a measure. It was demonstrated that differences between values were not statistically significant. The conclusion has confirmed an assumption that stands were statistically comparable in the course of the establishment of experimental plots and during two years it is not possible to suppose marked changes in the stem form caused by the type of a measure, i.e. various opening up. Both for the present and supposed future production, the most ascertainable parameter is basal area (b.a.). Testing the significance of differences between b.a. of standards in FTG 2S and FTG 2H has proved a logical assumption that b.a. of standards in a richer FTG 2H is markedly higher than in a poorer FTG 2S.

On the hand, the test did not demonstrate the statistical significance of differences between the type of a measure and b.a. of standards. It is caused by the methodology of sampling the standards at the establishment of experiments. The plots were placed into stand parts in such a way to be comparable and to present a representative sample.

In testing the cover of regeneration of all stands according to FTG it was found that there was a statistical difference between cover values in FTG 2S and FTG 2H. Regeneration in a poorer FTG 2S shows higher cover than in a richer 2H (Fig. 3). In testing the significance of differences between regeneration cover in plats according to the type of a measure in all stands no significant statistical differences were found. It corresponds to a previous commentary on the establishment of relatively homogeneous experimental plots and the short period of monitoring.

DISCUSSION

In verifying the basic condition of successfulness of the proposed method of conversion, i.e. if the selection of standards at an age of about 80 years is of any sense and the standards are also accrue in the future we study an increment particularly a diameter increment and basal area increment derived from it. ŠEBÍK (1985) mentions a gradual decrease in the increment and culmination values according to the degree of tinning intensity up to an age of 86–144 years. However, these data can be hardly used in stands of a coppice origin. The same problem of assessing the production was studied by TRUHLÁŘ (1969) comparing the coppice production with a 40-year rotation and the high forest production with a 120-year rotation. His conclusion that the lower production of coppices is often caused by a poorer site was confirmed by testing the dissimilarity of standards in FTG 2S (poorer) and FTG 2H (richer). TRUHLÁŘ (1969) also comments unsuitability of using yield tables not corresponding to growth conditions of the environment. In assessing the production, he insisted mainly on the mean height of a stand but ŠEBÍK (1985) mentioned that the mean height was suitable for the classification of even-aged stands. In all-aged stands, it losses, however, its meaning. For the present, presented results indicate that in standards under investigation current increment occurred after two years. The increment expressed by the b.a. increment was not negligible but two measurements only could not determine a cause and relationship to the type of a measure or FTG. In other two studied parameters, significant changes in the statistical evaluation due to the type of a measure did not occur in such a short period. A significant difference was confirmed between standards of seed origin and standards of coppice origin in favour of standards of seed origin.

In evaluating the cover of regeneration the significance of differences was corroborated between regeneration in FTG 2S – "fresh" beech/oak community (higher cover) and FTG 2H – "loamy" beech/oak community.

The significance of differences between particular types of measures, i.e. degree of opening up has not been proved yet. For the success of the gradual conversion it is important that oak seedlings can survive under conditions of light shade for a number of years (VYSKOT 1978).

SUMMARY

Conversions of oak coppice forests similarly as problems of growing coppice-with-standards forests are on the periphery of interest in our forestry. Not even legal norms relating to forest management do not take into consideration implementation and peculiarities of the conversions.

In Urban Forests of Moravský Krumlov, mostly oak forests of coppice origin, a number of remnants of coppice-with-standards has been preserved. However, these forests were not grown as coppice-with-standards in the past. There is a lack of final-crop trees of seed origin – future standards – in the stands. If a conversion was carried out there during past 50 years it was a conversion through direct clear felling and artificial regeneration using mainly Scots pine. Conversions carried down by reservation, i.e.

in the way of indefinite postponement were also realized. The conversion system presented in this paper was chosen for the conversion currently required and being started. It was inspired by indirect conversion through coppice-with-standards planned and realized by J. Wiehl at the turn of the 19th and 20th centuries and by Nanquett's method.

The coppice conversion to coppice-with-standards is split into three periods. The first two of them follow the Nanquett and J. Wiehl methods as for duration of coppice rotation while the third period is not limited.

I. Regeneration and standards preserved
To create a two-storied forest from standards and advance growth particularly of oak of seed origin using natural regeneration by successive shelterwood felling in three stages at a 3 to 5-year interval.

II. Creation of coppice-with-standards
To create the main storey from advance growth, to open it in the form of groups and to support new natural regeneration through opening up. To preserve at least part of standards of seed origin in the upper storey. To manage according to "Dauerwald" principles of the permanently producing forest.

III. Coppice-with-standards management
To continue creation of a group-arranged forest rich in structure and species.

To verify the rightness of preserving standards from overmature coppices – false high forests – experimental plots were established in six stand parts where the standards and natural regeneration development are tested.

As the tests were carried out in 1999 and 2001 only the results are rather limited. So far diameter increment of these standards has been proved. There are significant differences between standards of seed origin and those of coppice origin. There are also significant differences between standards growing on rich and poor sites. As for assessing natural regeneration significant differences were proved between regeneration on a poor site (FTG 2S) where its cover was higher than that on a rich site (FTG 2H). So far, significant differences in standards or regeneration in plots with various intensity of opening up have not been proved.

The work gives an assumption of creating a structurally rich forest, the close-to-nature forest of autochthonous species grown much more often as coppice-with-standards in the past.

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Převody pařezin na střední les v městských lesích Moravský Krumlov

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ABSTRAKT: Převody dubových pařezin byly častokrát realizovány pouze přejmenováním na nepravé kmenoviny. Článek představuje metodu převodu přestárlých pařezin na střední les, jejíž realizace byla zahájena v Městských lesích Moravský Krumlov. Metoda je inspirována Nanquettovou metodou a převody J. Wiehla. Cílem je hospodaření výběrnými principy ve středním lese. Na pokusných plochách založených v roce 1999 je sledován zejména přírůst výstavků a vývoj přirozeného zmlazení dubu zimního.

Klíčová slova: převody; pařeziny; střední les; dub zimní

Převody dubových pařezin – stejně jako problematika pěstování středního lesa – se nacházejí na okraji zájmu našeho lesnictví. Na jejich realizaci a zvláštnosti s nimi spojené nepamatují ani právní normy upravující hospodaření v lesích.

V lesích města Moravského Krumlova, většinou v doubravách výmladného původu, se dochovala řada pozůstatků středního lesa. Tyto porosty však nebyly v minulosti pěstovány jako střední les, nenachází se zde dostatek nadějných stromů semenného původu jako budoucích výstavků. Pokud zde byl v uplynulých 50 letech prováděn převod, šlo o převod přímý holosečí a umělou obnovou především borovice. Realizoval se i převod předržením, tj. odložením převodu na neurčito. Pro v současnosti nutnou a již zahájenou obnovu těchto porostů byl zvolen způsob převodu předložený v příspěvku. Je inspirován nepřímým převodem přes střední les, navrženým a prováděným na přelomu 19. a 20. století J. Wiehlem a Nanquettovou metodou.

Převod pařezin na střední les je rozvržen do tří etap; první dvě mají podle Nanquettovy metody i podle J. Wiehla délku původního obmýtí pařeziny, třetí je neohraničená:

I. Obnova s ponecháním výstavků
S využitím přirozeného zmlazení postupnou clonnou sečí na tři zásahy v intervalech 3–5 let vytvořit dvouetážový les z výstavků a nárostu především dubu semenného původu.

II. Tvorba plně hodnotného středního lesa
Vytvořit z nárostu hlavní etáž a tu hloučkovitě až skupinovitě rozvolňovat a prosvětlováním podporovat nové zmlazení, budoucí nárost. V nadúrovni udržet alespoň část výstavků semenného původu. Hospodařit podle zásad trvale tvořivého lesa – Dauerwaldu.

III. Hospodaření ve středním lese
Pokračovat ve vytváření hloučkovitě až skupinovitě uspořádaného, strukturálně i druhově bohatého lesa.

Pro ověření oprávněnosti ponechávání výstavků z přestárlých pařezin – nepravých kmenovin – byly v šesti porostních skupinách založeny pokusné plochy, kde probíhá vyhodnocování ponechaných výstavků a vývoje přirozeného zmlazení. Protože hodnocení proběhlo jen v letech 1999 a 2001, jsou výsledky skromné. Zatím se prokázalo, že u výstavků dochází k tloušťkovému přírůstu, že existují významné rozdíly mezi výstavky semenného a výmladného původu a významné rozdíly ve výstavcích podle stanoviště. Pokud jde o hodnocení zmlazení, prokázaly se významné rozdíly mezi zmlazením na chudším stanovišti (SLT 2S) – zde je jeho pokryvnost větší než na stanovišti bohatším, hlinitém (SLT 2H). Zatím nebyly prokázány významné rozdíly ve výstavcích ani ve zmlazení na plochách s různou intenzitou prosvětlení.

Započaté práce zakládají předpoklad k vytvoření strukturálně bohatého lesa, lesa přírodě blízkého z původních dřevin, pěstovaného v minulosti v mnohem častějším tvaru lesa středního.

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