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Induction thinnings of mountain spruce forests

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ABSTRACT: The paper presents models of decennial thinning percents of spruce in mountain locations. They were derived by regression fitting from empirical material with 108 measurements on 93 research plots. Models were derived for untended and partially tended stands. They were compared with the models of thinning percents of spruce at mountain locations from yield tables, induction thinning percents of spruce at lower locations and planned decennial thinnings according to forest management plan. Type of thinnings was analysed by means of thinning indexes and thinning intervals were proposed.

Keywords: spruce; induction thinnings; thinning percent; type of thinning; thinning interval; thinning index

Issues of thinning have been studied from many aspects for a long time. First of all the type, intensity and interval of thinnings have been studied. Thinnings are studied in stands of all commercially important tree species with the aim of increasing their production, yield as well as stability and health condition. In Slovakia HALAJ (1975) and HALAJ et al. (1986) dealt with thinnings as a complex, but mainly from the production aspect. The results of the research were indicators of the type, intensity and interval of thinnings for 5 main tree species, namely spruce, fir, pine, oak and beech. In the case of spruce only the stands at lower locations were involved. It means that for spruce stands of mountain locations, i.e. mountain spruce stands of the 7th altitudinal spruce zone, no thinning research has been carried out. Its lower boundary in Slovakia corresponds to the altitude of approximately 1,300 m.

Thinning intensity is the most important indicator from the operational and management aspects. It can be given in absolute or relative units. Type of thinning can be given by means of quantitative indicators, volume (I_v), diameter (I_d) and height (I_h) thinning index (HALAJ 1975). JOHNSTON et al. (1967) determined volume index I_v for different types and levels of thinnings.

Thinning interval is the most important time indicator of thinning. It incorporates the beginning of thinning and its duration within rotation. According to SANIGA (1985) the first thinning should be carried out immediately at the beginning of pole stage forest, at the latest with average diameter of stand 10 cm or at the stand age of 25 years. ABETZ (1975) constructed directive curves for performing thinnings in spruce stands. RÉH (1993) recommended to start with thinning in mountain forests early as they are the most effective within 40–50 years from the aspect of forest function fulfilment in protective forests. In Scandinavia, only 2–3 thinnings for the whole rotation are reckoned with (KORPEĽ et al. 1991). In French yield tables for the pine *Pinus pinaster* (DÉCOURT, LEMOINE 1969) differentiated thinning interval of 4, 6 and 8 years is used. At present, especially in the stands of spruce growth type, heavy thinnings with low frequency (4–5 per rotation) and with intervals longer than 10 years are applied (KORPEĽ et al. 1991). In accordance with Work Procedures for Forest Management in Slovakia (1995) in forest practice, thinning is a treatment in the stand in which average diameter is minimally 10 cm.

The aim of the paper is to derive decennial thinning percents, type and interval of thinnings in spruce stands in mountain locations of Slovakia from empirical data on marked thinnings on thinning research plots.

MATERIALS AND METHODS

Background data were obtained by own measurements on 83 single thinning research plots that were established by the authors in 1999–2002, and on 10 pilot research plots established by Lesoprojekt Zvolen (Institute for Forest Management) with the aim of construction of yield tables already in 1970–1980 and preserved up to now. Single thinning research plots were established proportionally in relation to the spruce distribution in mountain regions of Slovakia. A majority of the plots, 47, were established in the Low Tatras Mts. and 25 plots in the High Tatras Mts. The remaining plots are in the Slovenské Rudohorie Mts. and the Poľana Mts. On 10 pilot research plots 15 repeated measurements from the past years were carried out and they were re-measured again. 108 measurements were done on all 93 research plots. Research plots were established in closed spruce stands at mountain locations of the 7th altitudinal spruce vegetation zone. The area of plots ranged from 0.08 to 0.36 ha and it was marked in a way to include minimally 200–250 trees. On average there were 248 trees per plot.

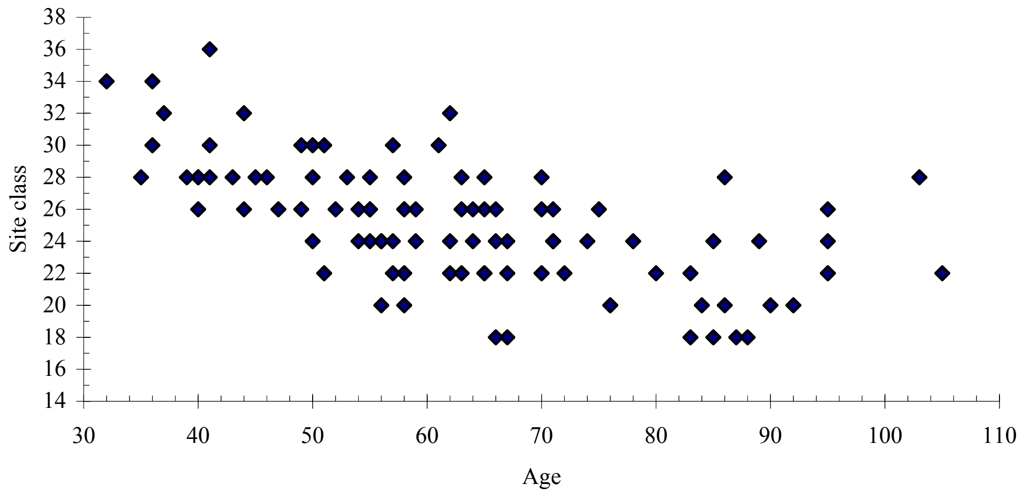

Fig. 1. Distribution of measurements on research plots according to age and site class of stands

The aim of thinning was to increase stand resistance to injurious agents, improve health condition and stand environment as well as to modify stand density. Marked thinning corresponded to the momentary state of the stand, age, site class, standing volume and its distribution in the stand, quality of trees and their health condition, stand tending used until then, stand resistance, degree of threat and site conditions. Basic silvicultural characteristics of marked thinnings were as follows:

1. Type of thinning: low thinning with removal of tree classes 5, 4, part of 3 and 2b.
2. Selection: negative, removing undesirable parts of stand.
3. Thinning intensity: moderate adapted to the main aim of thinning.
4. Interval: 10 years.

Age and yield class composition of research plots is illustrated in Fig. 1. Based on it the age of stands is 30 to 105 years and absolute height site class according to mean height at the age 100 years is within the range 18–36. Density of stands is calculated according to stocking from yield tables HALAJ et al. (1987) with the highest stock level 3.0 within the range 0.52–1.40. There are eight forest types represented on these plots.

Based on the measured characteristics of trees on research plots average and per-hectare values were calculated for total stand, main stand and secondary stand. They were used for the derivation of some other values as thinning percent and thinning indexes. Thinning percent as the value of relative thinning intensity is given by the ratio of timber volume from thinning (standing volume of secondary stand) to standing volume of main stand after thinning in percent according to the formula:

$$V_{3t}\% = \frac{V_{3t}}{V_{2t}} 100 \qquad (1)$$

where: $V_{3t}\%$ – thinning percent at the age t,
V_{3t} – standing volume of secondary stand at the age t,
V_{2t} – standing volume of main stand at the age t.

Volume (I_v), diameter (I_d) and height (I_h) thinning index was calculated according to the formulas:

$$I_v = \frac{v_3}{v_1} \qquad (2)$$

$$I_d = \frac{d_3}{d_1} \qquad (3)$$

$$I_h = \frac{h_3}{h_1} \qquad (4)$$

where: v_3, d_3, h_3 – volume, diameter and height of the mean stem of thinning,
v_1, d_1, h_1 – the same values of stand before thinning.

Based on the calculated values, regression models of empirical thinning percent of spruce in mountain locations were derived according to formulas (1)–(4). Derived model values were compared with the models of spruce stands at lower locations as given by HALAJ et al. (1986). At the same time regression models of thinning indexes were derived and thinning intervals were proposed for the stands of mountain spruce stands.

RESULTS

Thinnings that were marked on research plots followed from the state and needs of concrete stand tending of mountain spruce stands. They were induction thinnings that followed from a certain state of stands. Their intensity changes according to repeated treatments. Within these treatments they become closer to development thinning percents gradually. After the establishment of plots and marking of thinnings it was found that the stand structure was very imbalanced. It was particularly of very different quality, health condition but mainly damage to trees first of all by abiotic injurious agents. There occurred stands that had been only under natural effects during the whole life, very dense stands with accumulated large number of trees of secondary stand as well as not so dense stands and partially tended stands.

Empirical material of thinnings was verified consistently before the own assessment. Suitability of determined treatments was evaluated according to biometric criteria (volume thinning index, thinning percent) and existing descriptive data on research plots. Decennial thinning percents were calculated according to formula (1) in volume units, stem volume outside bark and volume of wood exceeding 7 cm diameter inside bark. With regard to the very high density and stock level of stands in mountain spruce forests more accurate stocking was calculated according to the data from yield tables of HALAJ et al. (1987) with stock level 3.0. After general evaluation of the whole empirical material, especially its variability, it was divided into two sets, namely one set for:

1. Untended stands which represent the first treatments on research plots being established in stands not tended until then or in stands with absolutely neglected tending.
2. Partially tended stands represented by stands with evidently performed tending treatments in a previous period. In any case this is not a purposeful (systematic) and long-term tending of these stands.

Model decennial thinning percents were derived for both sets according to a mathematical model (HALAJ et al. 1986) where thinning intensity depends on the age t and stocking ρ of the stand:

$$V_3\% = \frac{1}{\dfrac{1}{b_1 + b_2 \,.\, \rho} + \dfrac{1}{b_3 + b_4 \,.\, \rho} \,.\, t} \qquad (5)$$

Models were derived by non-linear least-squares methods. Table 1 presents mathematical and statistical characteristics and parameters of both models. Correlation index is a rate of closeness. It has the value 0.678 for partially tended stands and 0.770 for untended stands. Variability of measured thinning percents around the values fitted by a mathematical model is given by absolute and relative mean error of regression equation. This gives standard deviation (or coefficient of variation) of empirical thinning percents round to equalled. Absolute error has the value ±3.44% and relative almost 33.3% with partially tended stands and ±3.5%, 21.7% for untended stands. The values of mean error are relatively high but appropriate to the considerable variability of thinning percents in empirical material.

Derived models of decennial thinning percents for untended and partially tended stands with stocking 1.0–0.9–0.8–0.7 are illustrated in Fig. 2. There are systematic

Table 1. Mathematical and statistical characteristics and parameters of function (5) of decennial thinning percents of main stand in volume unit wood with dbh under bark

Stands	Number of measurements	Correlation index	Mean error or regression equation		Parameter b_1 b_2 b_3 b_4
			absolute (%)	relative (%)	
Untended	49	0.770	3.50	21.7	2.392524 E + 01 1.566086 E + 01 –1.113870 E + 03 2.968814 E + 03
Partially tended	43	0.678	3.44	33.3	7.947123 E + 01 –4.632662 E + 01 –1.344775 E + 03 2.419578 E + 03

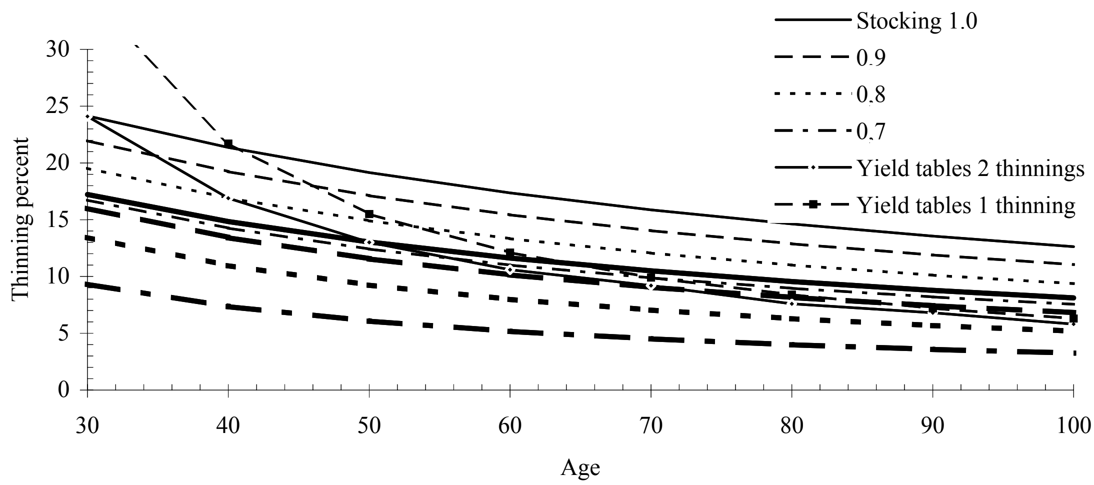

Fig. 2. Spruce mountain sites. Decennial thinning percents of main stand of untended (thin line) and partially tended stands (thick line) derived from research plots in dependence on age and stocking

differences between the models of both groups. Untended stands have higher values by about 4–7% than partially tended stands. This difference decreases with higher age. Relatively small differentiation of derived models is conditioned by the fact that the groups of partially tended stands are represented by research plots displaying frequently only some indications of thinning. It means their systematic tending is not going on.

We can state on the basis of derived models that inductive thinning percents are influenced more significantly only by two factors, namely age and stocking. Dependence on age slightly decreases in hyperbola. Stocking effect is slightly more significant. With lower stocking thinning percent also decreases more intensively. In addition to the factors that are direct variables in the mathematical model, it is necessary to consider especially stand tending until now. As to the experimental material this tending of stands was registered only on the basis of evident presence of old and older stumps after tree felling. The intensity and type of thinning were decisive but stand structure, quality and health condition of stems and whole trees, their damage by injurious agents and others were also important. There were lots of dead trees in the stands of mountain spruce forests and they were difficult to include or not in decennial thinning. A subjective view and approach of the person marking thinning cannot be neglected either. The experience of a concrete person who is able not only to appraise the actual state of the stand but also to estimate the intensity of thinning appropriately for an in-advance chosen 10-year thinning interval is important.

Type of thinnings

We evaluated the type of marked thinnings in spruce stands of mountain locations by means of qualitative and quantitative indicators. Though qualitative indicators for the evaluation of thinnings are very broad and uncertain, they are very popular in forestry practice. Based on these indicators we distinguished 3 degrees of low thinnings on research plots:

1. The proper low thinning including sporadic intervention into the crown layer.
2. Low thinning with moderate intervention into the crown layer.
3. Low thinning with frequent intervention into the crown layer.

In our empirical material the 2nd degree, it means low thinning with moderate intervention into the crown layer, occurs the most frequently (54.4%). The two remaining degrees have the same proportion (22.8%). Low thinning is reasonable for spruce as it is the tree species with naturally balanced quality of stems. Cases of more frequent treatments in the crown layer occurred mainly in stands heavily damaged by snow or rime (sanitary selection) and during adjustment of spacing in very dense groups of trees.

Quantitative indicators of the type of thinning, for example thinning indexes I_v, I_d, I_h, have the advantage that

Table 2. Mathematical and statistical characteristics of thinning indexes I_v, I_d, I_h of untended and partially tended stands according to degrees of low thinnings 1, 2, 3

Stands	Thinning degree	Number of measurements	Volume thinning index I_v				Diameter thinning index I_d				Height thinning index I_h			
			Arithmetical mean	Variation range	s_x	s_x (%)	Arithmetical mean	Variation range	s_x	s_x (%)	Arithmetical mean	Variation range	s_x	s_x (%)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Untended	1	6	0.35	0.25–0.39	0.05	13.2	0.65	0.57–0.69	0.04	6.2	0.75	0.69–0.80	0.04	4.8
	2	25	0.46	0.40–0.55	0.04	9.3	0.72	0.69–0.79	0.03	3.9	0.82	0.76–0.88	0.03	3.3
	3	18	0.59	0.55–0.72	0.04	6.9	0.79	0.77–0.87	0.02	3.1	0.89	0.85–0.93	0.02	2.3
	Total	**49**	**0.49**	**0.25–0.72**	**0.09**	**18.5**	**0.74**	**0.57–0.87**	**0.06**	**7.5**	**0.84**	**0.69–0.93**	**0.05**	**6.1**
Partially tended	1	15	0.34	0.19–0.40	0.05	15.9	0.64	0.54–0.69	0.04	6.0	0.76	0.61–0.81	0.05	6.5
	2	25	0.46	0.41–0.54	0.03	8.1	0.72	0.69–0.77	0.02	3.3	0.83	0.80–0.87	0.02	2.5
	3	3	0.59	0.53–0.62	0.04	6.8	0.79	0.75–0.82	0.03	3.8	0.88	0.87–0.90	0.01	1.1
	Total	**43**	**0.43**	**0.19–0.62**	**0.08**	**19.1**	**0.70**	**0.54–0.82**	**0.05**	**7.5**	**0.81**	**0.61–0.90**	**0.05**	**6.6**
Total	1	21	0.35	0.19–0.40	0.05	14.9	0.65	0.54–0.69	0.04	6.0	0.75	0.61–0.81	0.05	6.1
	2	50	0.46	0.40–0.55	0.04	8.8	0.72	0.69–0.79	0.03	3.6	0.83	0.76–0.88	0.02	3.0
	3	21	0.59	0.53–0.72	0.04	6.9	0.79	0.75–0.87	0.02	3.1	0.89	0.85–0.93	0.02	2.2
	Total	**92**	**0.46**	**0.19–0.72**	**0.09**	**20.0**	**0.72**	**0.54–0.87**	**0.06**	**8.0**	**0.82**	**0.61–0.93**	**0.05**	**6.5**

Table 3. Mathematical and statistical characteristics of the dependence of volume thinning index I_v of untended and partially tended stands on age

Stands	Number of measurements	Correlation index	Mean error		Regression coefficients	
			absolute ± s_x	relative ± s_x (%)	a_1	a_2
Untended	49	0.138	0.092	18.76	0.4437938	2.985935
Partially tended	43	0.464	0.075	17.33	0.2812874	8.853119

Table 4. Average data on thinnings in mountain spruce stands

Thinning	Number of stands		Average age	Stocking	Site class	Area (ha)	Standing volume (m³/ha)	Thinning percent	Slenderness coefficient
	n	(%)							
Unplanned	536	64	65.5	0.73	23.0	3,386	214	–	0.71
Planned	300	36	48.9	0.81	25.5	1,729	166	11.2	0.75
Total	836	100	59.9	0.76	23.8	5,115	198	–	0.72

they specify qualitative (verbal) definitions of different types of thinning simply numerically and logically. On research plots thinning indexes were calculated according to formula (2), (3) and (4). Types of thinning given qualitatively 1, 2, 3 were quantified by means of thinning indexes I_v, I_d, I_h. Their mathematical and statistical characteristics for untended and partially tended stands are given in Table 2. Based on arithmetical means of all types of indexes we can state that thinnings of the 3rd degree have the highest values. Similarly, the regularity between height, diameter and volume index with the relation $I_h > I_d > I_v$ was confirmed. The analysis of thinning indexes also confirmed the results by HALAJ (1975), who considered volume index I_v the most suitable because its values are the most differentiated for different types of thinning. Diameter index I_d can be used with advantage especially for marking the chosen type of thinning in the stand as well as for sorting timber from thinnings.

Besides the basic statistical characteristics of thinning indexes their dependences on the age of stand were also derived. To fit volume index I_v hyperbola of the following form was used:

$$y = a_1 + \frac{a_2}{x} \quad (6)$$

Mathematical and statistical characteristics of fitting are shown in Table 3. The values of absolute mean error 0.092 (relative mean error 18.76%) and correlation index 0.138 of untended stands show high variability of I_v index and its small dependence on age. According to regression discount they are influenced by the age of stand only in about 2% of dependence. Correlation index of partially tended stands is higher with regression discount 22%. Dependence of I_v on age is smaller for untended than for partially tended stands. The unfitted and fitted course of volume thinning index I_v of untended and partially tended stands in dependence on age is illustrated in Fig. 3.

Derived volume thinning indexes I_v can be used for determining the mean stem of thinning from the mean stem of total stand of spruce stands in mountain locations.

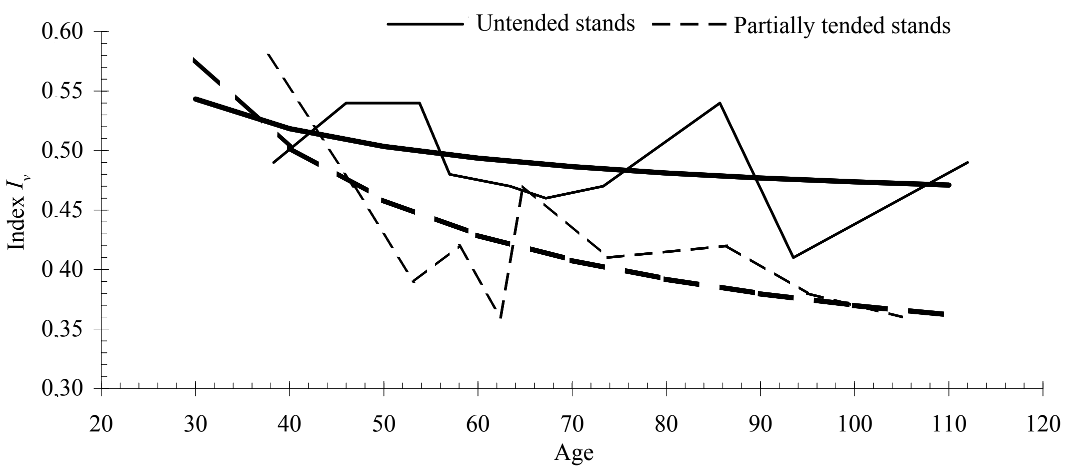

Fig. 3. Fitted and unfitted course if volume thinning index I_v in untended and partially tended stands in dependence on age

Thinning interval

Thinning interval defines the periodicity of thinning treatments. It is expressed most frequently by the number of years between two treatments following each other, when thinning is performed. For the collection of experimental material for research on thinning intensity a 10-year thinning interval was determined according to the methodology. This interval is based especially on literature knowledge published until now, and the same planning period in forest management plans is also an important argument for the 10-year thinning interval.

In planning, the beginning and end of thinning, it means its duration in rotation (life of stand) is inseparable time characteristics. Determination of these time characteristics was based on the age when constant mean diameters of the stand are reached, e.g. 6, 19 and 25 cm in dependence on the yield class. These diameters characterize growth phases of stands:

– 6 cm lower limit of the growth phase of pole stage, which is considered in silviculture as the beginning of thinnings;
– 19 cm upper limit of the growth phase of pole stage;
– 25 cm upper limit which is considered in silviculture as the end of thinnings.

Mountain spruce stands of site class 32–16 reach the given diameters at the age of 20–35 years. In accordance with Work Procedures of Forest Management the age for first thinnings is 30–55 years, when stands should reach the mean diameter of 12 cm. These spruce stands should reach mean the diameter of 25 cm at the age 60–110 years.

After generalization of all aspects of planning and performing thinnings in mountain spruce stands we recommend the following thinning intervals according to site classes:

– site classes 28–32: 40-year thinning period. To perform 5 thinning treatments at the stand age of 20–60 years. 1st and 2nd thinning with 10-year thinning interval, 3rd–5th thinning with 15-year interval;
– site classes 22–26: 55-year thinning period. To perform 4 thinning treatments at the stand age of 25–80 years; 1st and 2nd thinning with 15-year thinning interval, 3rd–4th thinning with 20-year interval;
– site classes 16–20: 70-year thinning period. To carry out 3 thinning treatments at the stand age of 35 to 105 years. 1st and 2nd thinning with 20-year thinning interval; 3rd thinning with 30-year interval.

Thinning is not considered in the stands of the lowest site class, it means 10–l4. Proposed thinning intervals should be understood as general recommendations. In practice the thinning interval should be determined in a concrete stand only on the basis of actual state and needs of the stand.

DISCUSSION

Models of induction thinnings in mountain spruce stands represent decennial thinning percents derived from marked thinning treatments on research plots. These models were compared with the models of thinning percents of spruce stands in lower locations (HALAJ et al. 1986). The comparison is illustrated in Fig. 4, on the basis of which we can assume that thinning percents of mountain spruce stands reach only 60% in comparison with spruce stands in lower locations.

We made a similar comparison also with currently planned decennial thinnings in forest management plans. We sorted out spruce stands of the 7th altitudinal spruce zone with the age 30–100 years, stocking 0.7–1.0 and spruce proportion 90–100% from valid plans. The stands where thinning was planned and those where it was not planned were sorted out separately. As Table 4 shows, in most of these stands (64%) thinning is not planned in forest practice.

Fig. 5 presents a comparison of model thinning percents of partially tended stands with planned percents in forest management plans. As we can see, the model percents are higher by about 30–40% than they are planned in forest management plans.

Though all comparisons demonstrate that thinning model percents have higher values than those applied until now, they cannot be recommended as average values, only

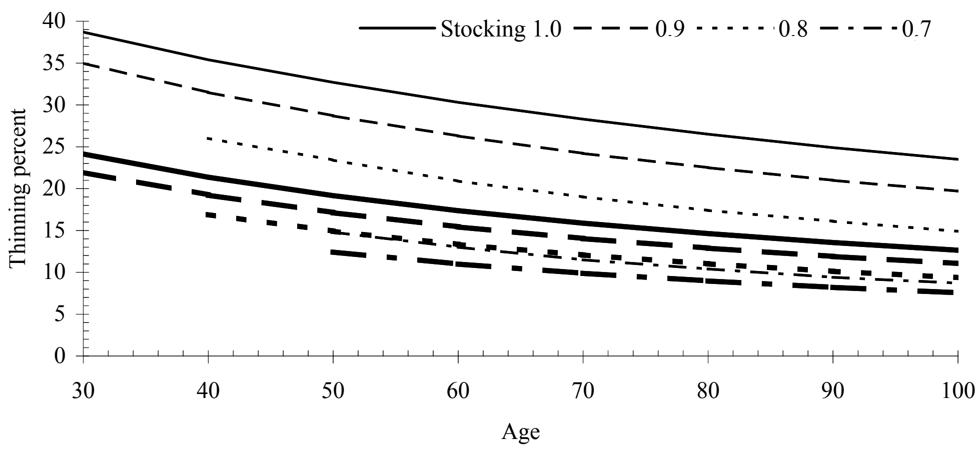

Fig. 4. Comparison of decennial thinning percents of untended stands in lower locations (HALAJ 1986 – thin line) and mountain locations (thick line). Thinning percents from main stands in volume unit wood with dbh under bark

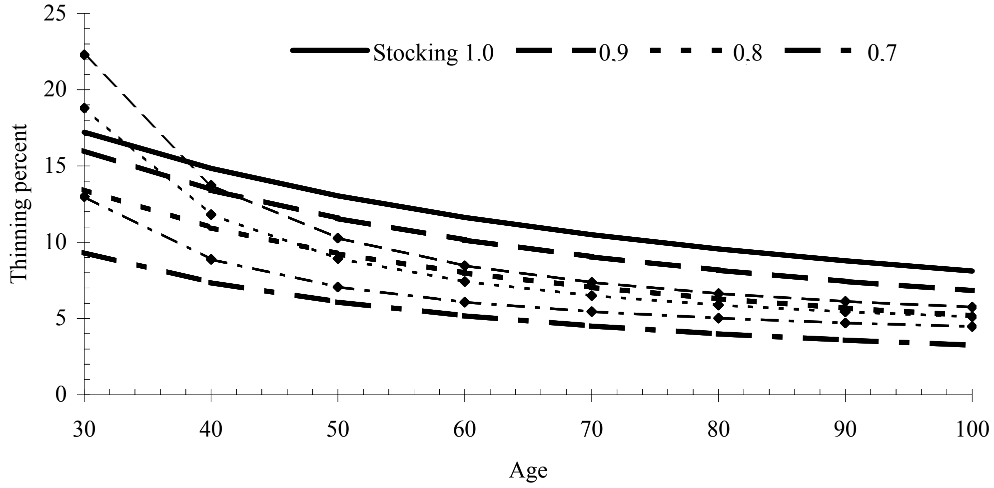

Fig. 5. Development of planned (thin line with dots) and model decennial thinning percents for partially tended stands (thick line) in dependence on age and stocking

as minimal values. The currently applied thinning intensity of 5–7% in older stands and about 10% in younger stands is insufficient as it only copies natural dieback and loss of trees in stands.

The fitted course of volume thinning index I_v does not correspond to generally valid literature knowledge. In accordance with the knowledge I_v should grow with age during life-time tending of stands, with mean diameter, height and decreasing number of trees (DELVAUX 1968). In accordance with HALAJ (1975) the reason for this discrepancy is that thinnings in experimental material were only the first treatments in stands, not the tendency of their lifetime development and tending. Some other authors studying the type of thinnings on short-term experimental plots (CARBONNIER 1971) also drew the same conclusions.

Under current conditions of the management of mountain spruce stands with insufficient accessibility of these stands the issue of their rationalization is very actual. It is based on a possibility of accumulating several time-close thinnings into a smaller number of thinnings with longer interval.

Though the role of mountain forests in the 7th altitudinal spruce zone is mostly the fulfilment of non-production functions, their production function and tending must not be neglected, either. Despite of the relatively good natural conditions their static stability is disturbed due to long-term absence of their tending. The stands cumulate a large amount of biomass from dead trees and they enter the stage of decline very early. The considerably unfavourable state of mountain spruce stands is also caused by their bad accessibility. Lasting non-uniform opinions regarding the need of their more systematic tending also contribute to this unfavourable state as well as inconsistent implementation of planned tending treatments. Their management would be optimal if the requirement for increasing non-production functions is met. In justified cases, mainly in homogeneous and even-aged spruce stands with better site classes that were established after large disasters on large areas, the use of production function could also be considered optimal. From this aspect the tending of forest stands by thinnings can be an optimal or at least sufficient way of their management.

References

ABETZ P., 1975. Eine Entscheidungshilfe für die Durchforstung von Fichtenbeständen. Allg. Forstz., *30*: 666–667.

CARBONNIER CH., 1971. Bokens produktion i södra Sverige. Stud. For. Suecica, *91*: 89.

DÉCOURT N., LEMOINE B., 1969. Le Pine maritine dans le sud-ouest de la France. Tables de production provisoires. Ann. Sci. For., *26*: 3–44.

DELVAUX J., 1968. L`éclaircie. Définitions et points de vue. Station de Recherches des Eaux et Forêts. Groenendaal-Hoeilaart: 16.

HALAJ J., 1975. Prebierky smrekových porastov SSR. Bratislava, Príroda, Lesn. Štúd., *22*: 126.

HALAJ J., PETRÁŠ R., SEQUENS J., 1986. Percentá prebierok pre hlavné dreviny. Bratislava, Príroda, Lesn. Štúd., *40*: 99.

HALAJ J., GRÉK J., PÁNEK F., PETRÁŠ R., ŘEHÁK J., 1987. Rastové tabuľky hlavných drevín ČSSR. Bratislava, Príroda: 362.

JOHNSTON D.R., GRAYSON A.J., BRADLEY R.T., 1967. Forest Planning. London, Faber: 541.

KORPEĽ Š. et al., 1991. Pestovanie lesa. Bratislava, Príroda: 472.

RÉH J., 1993. Hospodárenie v účelových lesoch. Zvolen, Edičné stredisko TU: 213.

SANIGA M., 1985. Časový účinok prebierkových metód na stabilitu smrekových porastov proti vetru. Lesnícky časopis – Forestry Journal, *31*: 335–346.

Pracovné postupy hospodárskej úpravy lesov, 1995. Zvolen, Lesoprojekt: 594.

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Induktívne prebierky horských smrečín

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ABSTRAKT: Obsahom článku sú modely decenálnych prebierkových percent smreka horských polôh. Odvodili sa regresným vyrovnávaním z empirického materiálu so 108 meraniami na 93 výskumných plochách. Modely sa odvodili pre nevychovávané a čiastočne vychovávané porasty. Porovnali sa s modelmi prebierkových percent smreka horských polôh z rastových tabuliek, induktívnych prebierkových percent smreka nižších polôh a plánovanými decenálnymi prebierkami podľa lesného hospodárskeho plánu. Pomocou prebierkových indexov sa analyzoval aj druh prebierok a navrhli sa prebierkové intervaly.

Kľúčové slová: smrek; induktívne prebierky; prebierkové percentá; druh prebierky; interval prebierky; prebierkový index

Cieľom práce je odvodenie decenálnych prebierkových percent, druhu a intervalu prebierok smrekových porastov horských polôh Slovenska z empirických údajov vyznačených prebierok na prebierkových výskumných plochách.

Podkladové údaje sa získali meraním na 83 jednorázových prebierkových výskumných plochách a 10 poloprevádzkových výskumných plochách. Najviac – 47 plôch – sa založilo v Nízkych Tatrách, 25 plôch vo Vysokých Tatrách a zvyšných 11 je v Slovenskom Rudohorí a na Poľane. Na 10 poloprevádzkových výskumných plochách sa ešte prevzalo 15 opakovaných meraní z minulých rokov. Celkový empirický materiál tak tvorí 108 meraní. Vekové a bonitné zastúpenie výskumných plôch je znázornené na obr. 1.

Účelom vyznačenej prebierky bolo nielen zvýšiť odolnosť porastu proti škodlivým činiteľom, zlepšiť zdravotný stav a porastové prostredie, ale aj upraviť hustotu porastu. Základné pestovateľské charakteristiky vyznačovaných prebierok boli: druh prebierky – podúrovňová, výber – negatívny, sila zásahu – mierna a interval prebierky – 10-ročný.

Z nameraných veličín na výskumných plochách sa vypočítali priemerné a hektárové veličiny združeného, hlavného a podružného porastu. Z týchto údajov sa odvodili prebierkové percentá a prebierkové indexy. Prebierkové percento sa počítalo podľa vzorca (1). Objemový (I_v), hrúbkový (I_d) a výškový (I_h) prebierkový index sa vypočítali podľa vzorcov (2)–(4). Po zhodnotení celého empirického materiálu – najmä jeho variability – sa tento rozdelil do dvoch súborov:

1. Nevychovávané porasty, ktoré reprezentujú prvé zásahy na výskumných plochách založených v doteraz vôbec nevychovávaných alebo výchovne úplne zanedbaných porastoch.
2. Čiastočne vychovávané porasty, ktoré reprezentujú porasty s evidentne uskutočnenými výchovnými zásahmi v predchádzajúcom období.

Modelové decenálne prebierkové percentá sa odvodili v závislosti od veku a zakmenenia porastu pre obidva súbory podľa matematického modelu (5). V tab. 1 sú matematicko-štatistické charakteristiky a parametre oboch modelov. Odvodené modely decenálnych prebierkových percent pre nevychovávané a čiastočne vychovávané porasty zakmenenia 1,0–0,9–0,8–0,7 sú znázornené na obr. 2. Okrem faktorov, ktoré sú priame premenné v matematickom modeli, je potrebné významne zvažovať najmä doterajšiu výchovu porastov. V porastoch horských smrečín bolo často aj veľké množstvo suchárov, ktoré bolo problematické zaraďovať alebo nezaraďovať do decenálneho prebierkového zásahu.

Druh vyznačovaných prebierok v smrekových porastoch horských polôh sa hodnotil pomocou kvalitatívnych a kvantitatívnych ukazovateľov. Na výskumných plochách sa rozlišovali tri stupne podúrovňových prebierok:

1. podúrovňová prebierka čistá (vrátane ojedinelého zásahu do úrovne);
2. podúrovňová prebierka s miernym (pomiestnym) zásahom do úrovne;
3. podúrovňová prebierka s častým zásahom do úrovne.

V zhodnocovanom empirickom materiáli sa vyskytuje najčastejšie (54,4 %) 2. stupeň, t.j. podúrovňová prebierka s miernym zásahom do úrovne. Ostatné dva stupne majú rovnaké, t.j. 22,8% zastúpenie. Podúrovňový charakter zásahov je pri smreku opodstatnený. Prípady častejších zásahov do úrovne sa vyskytli hlavne v silne poškodených porastoch snehom alebo námrazou (zdravotný výber) a pri úprave rozstupu v prehustlých skupinách stromov.

Kvalitatívne vyjadrené druhy prebierok 1, 2, 3 sa pomocou prebierkových indexov I_v, I_d, I_h pretransformovali na kvantitatívne. Ich matematicko-štatistické charakteristiky pre nevychovávané a čiastočne vychovávané porasty uvádza tab. 2. Analýza prebierkových indexov potvrdila všeobecne platnú zákonitosť vzťahu $I_h > I_d > I_v$. Pre diferencovanie druhu prebierok je aj tu najvhodnejší objemový index I_v. Hrúbkový index I_d možno s výhodou použiť najmä na vyznačenie zvoleného druhu prebierky v poraste ako aj pri sortimentácii zásoby prebierok. Na vyrovnanie objemového indexu I_v v závislosti od veku sa použila hyperbola. Matematicko-štatistické charakteristiky vyrovnania sú uvedené v tab. 3. Vyrovnaný priebeh indexu I_v nezodpovedá všeobecne platným literárnym poznatkom (obr. 3). Príčina tejto nezhody je v tom, že prebierky v pokusnom materiáli reprezentujú len prvé zásahy v porastoch a nie tendenciu ich celoživotného vývoja a výchovy.

Prebierkový interval definuje periodicitu opakovania prebierkových zásahov. Pre zber pokusného materiálu na výskum sily prebierok sa stanovil 10-ročný prebierkový interval. Po zovšeobecnení všetkých aspektov plánovania a realizácie prebierok horských smrečín navrhujeme podľa boním tieto prebierkové intervaly:

– bonity 28–32: 40-ročné prebierkové obdobie. Vo veku porastov 20–60 rokov vykonať päť prebierkových zásahov. Prvú a druhú prebierku s 10-ročným prebierkovým intervalom, 3.–5. prebierku s 15-ročným intervalom;
– bonity 22–26: 55-ročné prebierkové obdobie. Vo veku porastov 25–80 rokov vykonať štyri prebierkové zásahy. Prvú a druhú prebierku s 15-ročným prebierkovým intervalom, 3.–4. prebierku s 20-ročným intervalom;
– bonity 16–20: 70-ročné prebierkové obdobie. Vo veku porastov 35–105 rokov vykonať tri prebierkové zásahy. Prvú a druhú prebierku s 20-ročným prebierkovým intervalom, 3. prebierku s 30-ročným intervalom. V porastoch najhorších boní, t.j. 10–14, sa s prebierkovými zásahmi neuvažuje.

Uvedené modely induktívnych prebierok sa na obr. 4 porovnali s modelmi prebierkových percent smrekových porastov nižších polôh (HALAJ et al. 1986). Porovnanie je znázornené na obr. 4. Prebierkové percentá horských smrečín dosahujú z percent smrečín nižších polôh približne len 60% podiely.

Vykonalo sa aj porovnanie so súčasne plánovanými decenálnymi prebierkami v lesnom hospodárskom pláne. Z platných lesných hospodárskych plánov sme vytriedili smrekové porasty 7. smrekového vegetačného stupňa s vekovým rozpätím 30–100 rokov, zakmenením 0,7–1,0 a zastúpením smreka 90–100 %. Osobitne sa sledovali porasty, v ktorých sa plánovali a neplánovali prebierky. Podľa tab. 4 vo väčšine z týchto porastov (64 %) sa v praxi lesného hospodárstva prebierky neplánujú. Na obr. 5 sa porovnávajú modelové prebierkové percentá čiastočne vychovávaných porastov s plánovanými percentami v lesných hospodárskych plánoch. Modelové percentá sú približne o 30–40 % vyššie, ako sa plánujú. Všetky porovnania ukázali, že modelové prebierkové percentá majú vyššie hodnoty ako v praxi aplikované priemerné prebierkové zásahy. V praxi aplikovaná sila prebierok vo výške 5–7 % v starších a približne 10 % v mladších porastoch je nedostatočná.

Aj keď význam horských lesov 7. smrekového lesného vegetačného stupňa je hlavne v plnení mimoprodukčných funkcií, nie je možné podceňovať aj ich produkčný význam. Napriek ich relatívne dobrým prírodným podmienkam je dlhodobým zanedbávaním výchovy ich statická stabilita narušená. Porasty kumulujú veľké množstvo odumretých stromov a predčasne sa dostávajú do štádia rozpadu. Značne nepriaznivý stav horských smrečín je do určitej miery spôsobený aj ich neprístupnosťou. Podiel na tomto stave má aj pretrvávajúca nejednotnosť názorov na potrebu ich systematickejšej výchovy ako aj nedôsledná realizácia naplánovaných výchovných zásahov. Za optimálne by bolo možné považovať také obhospodarovanie, aby sa naplnila požiadavka zvyšovania neprodukčných funkcií, ale v odôvodnených prípadoch – predovšetkým v rovnorodých a rovnovekých smrekových porastoch lepších boní – aj využitie produkčnej schopnosti. Z tohto pohľadu môže byť výchova lesných porastov prebierkami optimálny, alebo aspoň dostatočný spôsob ich obhospodarovania.

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