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Use of selected allowable cut indicators in near-natural forest management

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ABSTRACT: The objective of this paper is to evaluate the possibilities of using selected allowable cut indicators in near-natural forest management by supplementing two indicators to present allowable cut indicators. Namely it is 1/30 of forest stand growing stock of the last three age classes and higher and 1/40 of forest stand growing stock of the last four age classes and higher. These indicators are compared with the allowable cut indicator 1/20 of forest stand growing stock of the last two age classes and higher which in relation to the forest law can be used in the present control of cuttings. The evaluations were carried out at selected five forest user's units where near-natural forest management is applied. The results confirmed that it is not possible to use the indicator 1/20 in environmentally sound silvicultural systems. The results demonstrated the continuity of cuttings if the indicator 1/30 was used.

Keywords: cutting control; allowable cut indicator; forest user's unit

PROBLEM ANALYSIS AND AIM OF THE STUDY

One of the most important parts of forest management is cutting control. The problems of determining a suitable felling volume on the basis of analysis of productive and felling possibilities of forest stands that belong to particular forest user's units are solved by cutting control. It is necessary to use allowable cut indicators for objective determination of felling volume.

We can characterize allowable cut indicators as data derived from reviews of mensurational data on basic spatial arrangement units for cutting control. These reviews inform us about felling possibilities in these units. The basic units for cutting control have changed during the development of forest management.

The basic units were management groups and later working circles in the past. Forest user's units have become the basic unit for cutting control at the present time. In comparison with previous units the character of forest user's units is different. Forest user's units (FUU) were created according to the renewal of owner's and user's relations to forests.

According to public notice No. 5/1995 Coll. on forest management, four basic allowable cut indicators can be used in the present practical forest management: final mean increment, 1/20 of forest stand growing stock of the last two age classes and higher, felling volume calculated from theoretical clearing area and mean standing volume of mature forest stands, felling volume calculated from the percentage of growing stock removal in age classes.

These allowable cut indicators have some negative and positive characters for their application. It is evident in FUU with irregular or extreme age structure. It is caused by the fact that they are created for large forest parts of an area within the range of 5,000–10,000 ha. An area of present FUU is within the range of 50–5,000 ha. A quantitative group ranging from 250 to 550 ha is the most common. Only a few FUU have an area larger than 5,000 ha. It is important to take into consideration several age classes for felling volume calculation in order to ensure the continuity of fellings during several decades. Gradual balance of age structure is also ensured in this way.

There are some differences between the particular allowable cut indicators and approved felling volume. Therefore, derived allowable cut indicators do not mean approved felling volume.

Application of allowable cut indicators during cutting control development has changed. The analyses made by several authors GREGUŠ (1976), HERICH and HLADÍK (1993), HERICH (1994), ŽÍHLAVNÍK (1993, 1996, 1997, 1998, 2000) showed that each allowable cut indicator has some advantages and disadvantages. Similar allowable cut indicators for clear-cutting and also for the shelterwood system are used at the present practical forest management. The current knowledge of allowable cut indicators has confirmed that it is suitable to use a combination of more allowable cut indicators for cutting control. It is main-

ly important if the allowable cut indicators taking into consideration near-natural forest management are used. That is why suitable felling volume in particular FUU can be determined on the basis of their analysis and mutual comparison. When using this method it is possible to apply more environmentally sound silvicultural systems (POZNAŃSKI 2001; MIŚ 2001). Problems of forest stand development after an environmentally sound silvicultural system was applied were solved by BARNA (2000a,b).

That is why the aim of this paper is to evaluate possibilities of selected allowable cut indicators by supplementing other two indicators to the present allowable cut indicators. Namely it is 1/30 of forest stand growing stock of the last three age classes and higher and 1/40 of forest stand growing stock of the last four age classes and higher.

The allowable cut indicator 1/20 of forest stand growing stock of the last two age classes and higher is typical of a clear-cutting system because 50% of standing volume is cut if this indicator is used. This indicator does not allow to use longer regeneration periods that are necessary in near-natural forest management. Therefore, we try to show by its evaluation in comparison with the other two indicators that it is not possible to use it in environmentally sound silvicultural systems. It will be necessary to determine this indicator only for the clear-cutting system under new forestry legislation. It would be suitable that the other allowable cut indicators will be embodied into new forestry legislation as they are not used at the present time.

Growing stock forecasting and evaluation of the continuity of allowable cut indicators during three decades (by 2013) on the basis of solved methods (MARUŠÁK 1998, 1999) are also the aim of this paper. The mentioned problems were solved within the scientific Grant project VEGA 1/7052/20.

MATERIAL AND METHODS

For the evaluation of selected allowable cut indicators the forest user's units of the management unit of a School Forest Enterprise of Technical University in Zvolen were used. Five FUU were chosen out of several ones because of their similar irregular age structure. In the paper they are designated by numbers 1–5. In each FUU near-natural forest management is applied. FUU No. 1–4 are managed by non-state owners and FUU No. 5 is managed by a state enterprise. All forest stands are commercial forests. Rotation period in the particular FUU is from 100 to 120 years and regeneration period is 30 years. The data of forest management plan, which is in force from 1993 to 2002, were used for the evaluation.

The age structure of evaluated forest user's units is characterized by indices and statistical characteristics (MARUŠÁK 2001a,b). Average value of differences between real and normal area of particular age classes ($\overline{dif}$), standard deviation of differences (s_{dif}) and coefficient of variation of differences ($s_{dif\%}$) are used. Further characteristics of age structure are as follows: coincidence index of the age classes, coincidence index of the mature age classes, index of the mature age classes and index of the overmature age classes. Coincidence index of the age classes (I_{ZH}) characterizes an approach of the composition of real classes to normal ones. Coincidence index of the mature age classes (I_{ZHr}) expresses the coincidence of distribution of real mature age classes with normal ones. Index of the mature age classes (I_{RP}) refers to the lack or surplus of the mature age classes. Index of the overmature age classes (I_{PS}) informs about the representation of overmature age classes. All calculated indices of particular FUU are shown in Table 1.

Table 1. Review of statistical characteristics and indices of the age structure of evaluated forest user's units

FUU	$\overline{dif}$	s_{dif}	$s_{dif\%}$	I_{ZH}	I_{ZHr}	I_{RP}	I_{PS}
1	6.87	5.39	78.5	0.622	0.538	1.880	0.000
2	6.46	5.75	89.1	0.717	0.652	1.207	0.000
3	8.09	7.73	95.6	0.672	0.632	1.991	0.003
4	30.22	21.73	71.9	0.571	0.553	1.436	0.089
5	10.94	9.02	82.5	0.810	0.692	1.890	0.023

Forest user's unit No. 1 (FUU 1) with forest area of 145.31 ha is characterized by irregular age structure (Table 1). Age classes 1st–2nd, 9th–11th are superfluous. Forest stands older than 111 years and 6th age class are missing. The area of 3rd–5th and 7th, 8th age classes is smaller than the normal one (Fig. 1A). Rotation period is 100 years. Standing volume structure is in relation with age structure (Fig. 2A). The proportion of conifers is higher than that of broadleaves.

Forest user's unit No. 2 (FUU 2) has the forest area of 182.91 ha. Age structure is irregular without 7th, 8th, 12th, 14th–15th age classes. The area of 1st, 2nd, 4th–6th, 10th age classes is larger than normal. The other age classes are under normal (Fig. 1B). Rotation period is 120 years. Standing volume of age classes of this FUU is shown in Fig. 2B. The proportion of broadleaves standing volume is higher than that of conifers. It is evident especially in the 10th age class.

Forest user's unit No. 3 (FUU 3) with forest area of 197.11 ha is also irregular (Table 1). The area of 1st, 2nd, 10th–12th age classes is larger than normal. One overmature age class (15th) is also represented. Other age classes are smaller than normal (Fig. 1C). Rotation period is 100 years. Standing volume of age classes is shown in Fig. 2C. The proportion of conifer standing volume is higher than that of broadleaves.

Forest user's unit No. 4 (FUU 4) has the largest area (563.34 ha). Age structure is very irregular (Table 1). Overmature age classes (14th, 15th) are represented. The area of 1st, 2nd, 9th and 10th age classes is larger than normal. The area of the other age classes is much smaller than normal (Fig. 1D). Rotation period is 110 years. Standing volume structure (Fig. 2D) is also in relation with age structure. The proportion of broadleaves standing volume is higher in mature age classes and especially in overmature age classes.

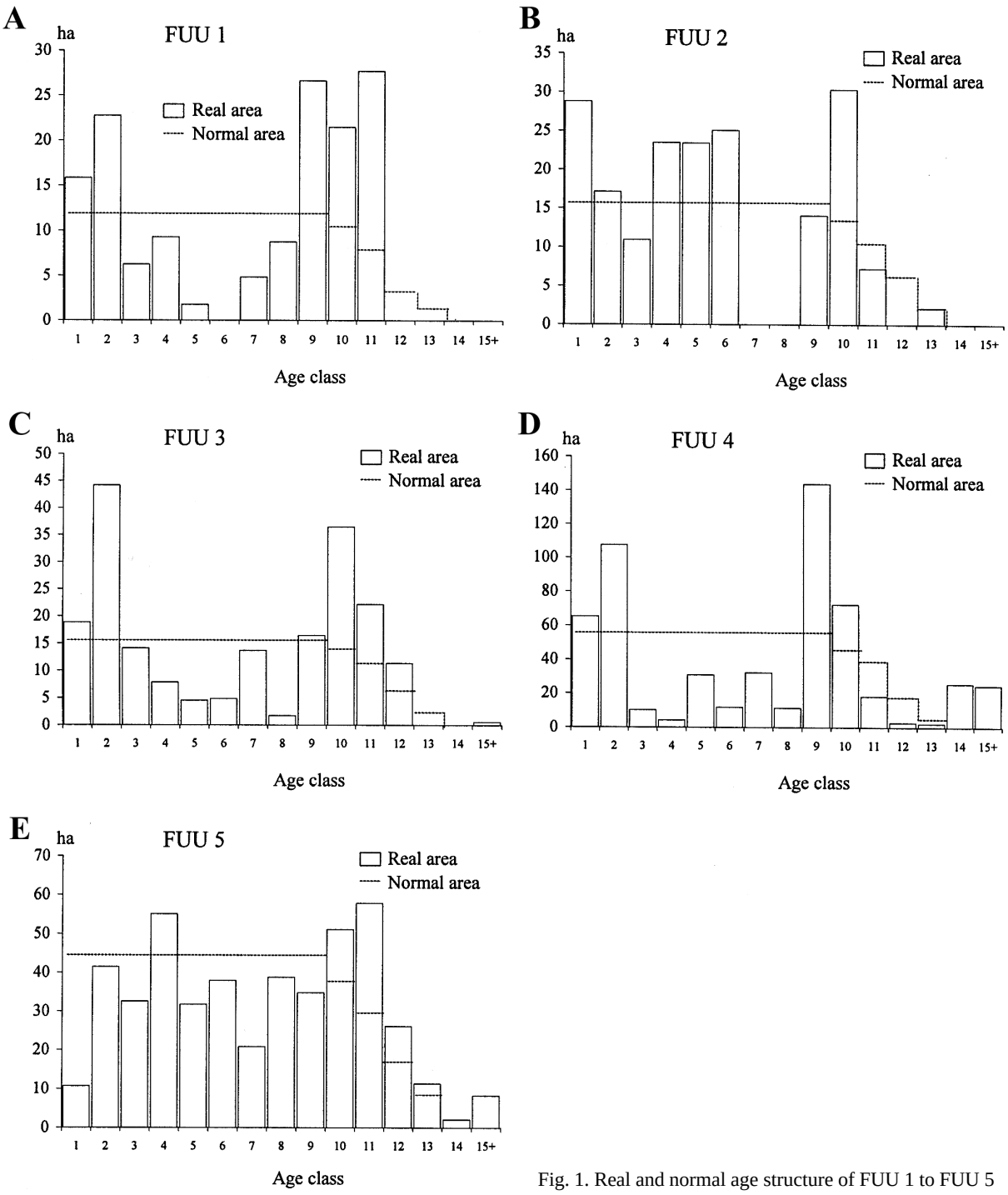

Fig. 1. Real and normal age structure of FUU 1 to FUU 5

Forest user's unit No. 5 (FUU 5) with forest area of 461.02 ha is managed by the state. Age structure is also irregular but in comparison with previous FUU it is more suitable (Table 1). Overmature age classes (14th, 15th) are also represented. Mainly mature age classes have a larger area than those in normal state (Fig. 1E). Rotation period is 110 years. Standing volume structure is shown in Fig. 2E. Broadleaves are in the highest proportion in mature age classes.

The above-mentioned FUU, when considering their age structure, partly characterize a high number of the present FUU in the Slovak Republic.

Within the evaluation, three allowable cut indicators were used. The continuity of their values during three decades was evaluated. Expected growing stock in the 2nd and 3rd decade was forecasted. Standing volumes of conifers and broadleaves of particular age classes were used. After finished calculation, the state of standing volume of mature age classes in 2013 was evaluated.

Expected growing stock is calculated by help of increment coefficients (MARUŠÁK 1999):

$$V2_i = [(V1_i \cdot k_{p1,i}) - (IF_i + MF_i)] \cdot k_{p2,i} \quad (1)$$

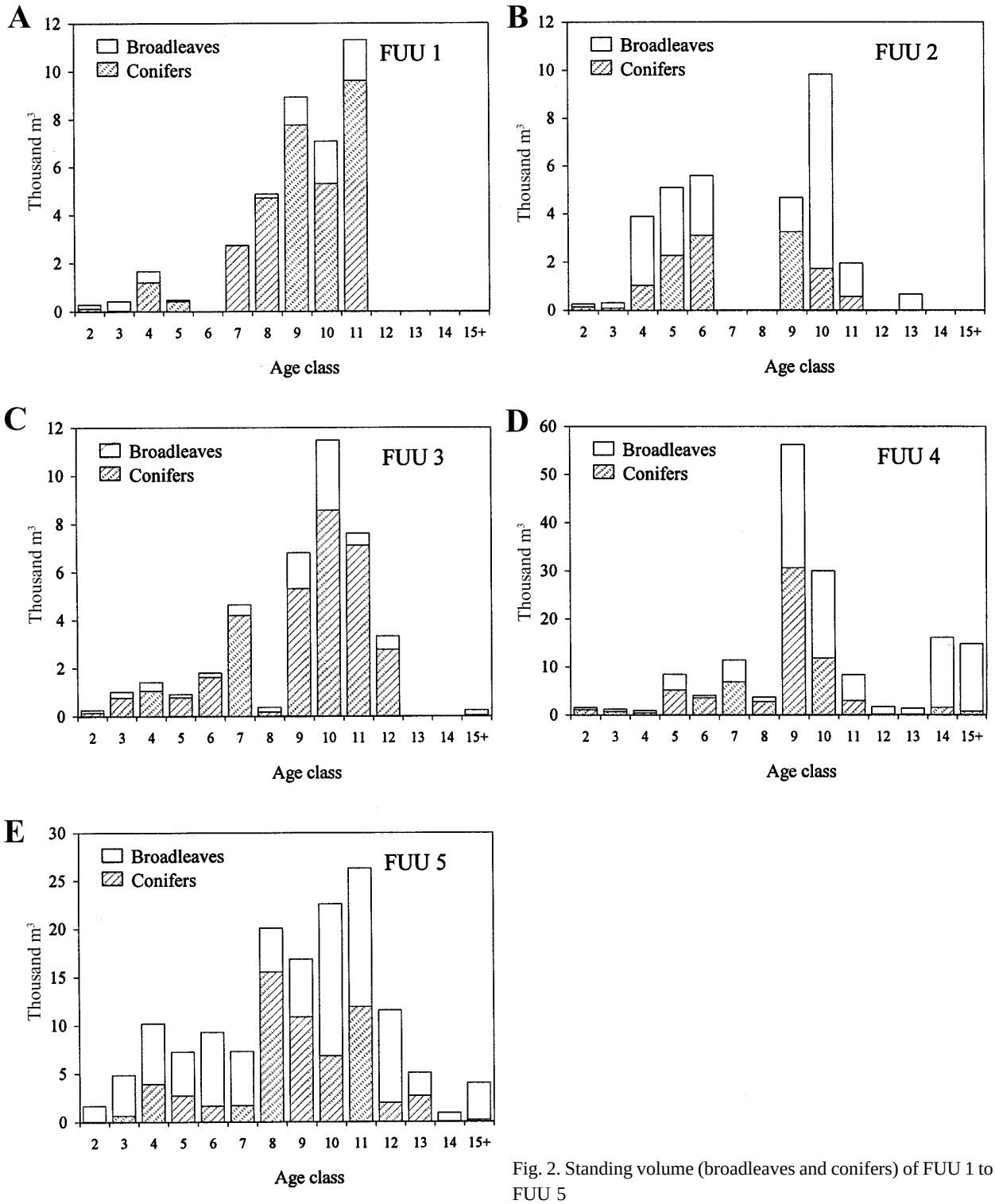

Fig. 2. Standing volume (broadleaves and conifers) of FUU 1 to FUU 5

where: $V1$ – growing stock in the 1st decade,
$V2$ – expected growing stock in 2nd decade,
IF – intermediate felling,
MF– main felling,
$k_{p1,i}$, $k_{p2,i}$ – increment coefficients,
i – age class.

Expected growing stock in the 3rd decade is calculated in a similar way like the expected growing stock in the 2nd decade. Other conditions of original formula were not included in this calculation.

The values of allowable cut indicators 1/20 of forest stand growing stock of the last two age classes and higher (1/20), 1/30 of forest stand growing stock of the last three age classes and higher (1/30) and 1/40 of forest stand growing stock of the last four age classes and higher (1/40) were calculated by the formulas:

$$1/20 = \frac{\sum_{i=p-1}^{n} V_i}{2} \qquad (2)$$

Table 2. The values of calculated allowable cut indicators and their statistical characteristics of particular FUU

FUU	Year	Allowable cut indicator								
		1/20			1/30			1/40		
		Conifers	Broadleaved	Total	Conifer	Broadleaved	Total	Conifer	Broadleaved	Total
FUU 1	1993	11,337	2,329	13,666	9,128	1,608	10,736	7,529	1,210	8,739
	2003	9,847	1,570	11,417	8,506	1,311	9,816	6,800	1,091	7, 890
	2013	7,331	980	8,311	6,775	1,041	7,816	6,221	999	7,220
	$\bar{x}$	9,505	1,626	11,131	8, 136	1,320	9,456	6,850	1,100	7,950
	$s_x\pm$	2,025	676	2,689	1,219	284	1,493	655	106	761
	$s_x\%$	21.3	41.6	24.2	15.0	21.5	15.8	9.6	9.6	9.6
FUU 2	1993	280	1,034	1,314	764	3,390	4,153	1,385	2,898	4,283
	2003	1,157	5,269	6,425	1,870	3,231	5,101	1,234	2,554	3,788
	2013	2,867	4,112	6,979	1,463	2,512	3,975	1,429	2,943	4,372
	$\bar{x}$	1,435	3,471	4,906	1,366	3,044	4,410	1,349	2,798	4,148
	$s_x\pm$	1,316	2,189	3,123	560	468	605	102	213	315
	$s_x\%$	91.7	63.1	63.7	41.0	15.4	13.7	7.6	7.6	7.6
FUU 3	1993	11,891	2,848	14,738	7,986	1,966	9,952	7,040	1,584	8,624
	2003	7,382	1,902	9,284	8,114	1,773	9,887	6,898	1,491	8,389
	2013	7,730	1,514	9,243	7,439	1,515	8,954	6,573	1,407	7,980
	$\bar{x}$	9,001	2,088	11,088	7,846	1,751	9,597	6,837	1,494	8,331
	$s_x\pm$	2,509	686	3,161	359	226	559	240	88	326
	$s_x\%$	27.9	32.9	28.5	4.6	12.9	5.8	3.5	5.9	3.9
FUU 4	1993	8,644	27,466	36,110	15,959	26,852	42,811	12,657	20,372	33,029
	2003	23,826	31,929	55,756	14,368	21,892	36,260	13,913	19,562	33,475
	2013	17,035	20,371	37,406	15,310	19,829	35,139	14,277	17,551	31,829
	$\bar{x}$	16,502	26,589	43,090	15,212	22,858	38,070	13,616	19,162	32,777
	$s_x\pm$	7,605	5,829	10,988	800	3,610	4,144	850	1,452	851
	$s_x\%$	46.1	21.9	25.5	5.3	15.8	10.9	6.2	7.6	2.6
FUU 5	1993	11,778	23,448	35,226	11,466	17,641	29,107	12,486	14,367	26,853
	2003	13,740	17,986	31,726	15,706	15,913	31,619	12,022	14,650	26,672
	2013	20,102	14,440	34,542	12,545	15,662	28,207	11,556	16,544	28,100
	$\bar{x}$	15,207	18,624	33,831	13,239	16,405	29,644	63,260	10,093	27,208
	$s_x\pm$	4,352	4,538	1,855	2,203	1,077	1,768	465	1,184	778
	$s_x\%$	28.6	24.4	5.5	16.6	6.6	6.0	0.7	1.2	2.9

$$1/30 = \frac{\sum_{i=p-2}^{n} V_i}{3} \quad (3)$$

$$1/40 = \frac{\sum_{i=p-3}^{n} V_i}{4} \quad (4)$$

under following conditions:

$$p = \frac{u}{10} \quad (5)$$

where: V – growing stock,
i – age class,
n – the oldest age class,
p – last age class in relation to rotation period,
u – rotation period.

Total volume of allowable cut indicator is determined in this way. For forecasting it is necessary to divide this volume into age classes.

Theses statistical characteristics were used for evaluation: arithmetic mean (x), standard deviation (s_x) and coefficient of variation ($s_{x\%}$). These values were calculated for the particular FUU and allowable cut indicators.

RESULTS AND DISCUSSION

The obtained results show that in general 1/40 has the most balanced and 1/20 has the most unbalanced course of values. It was confirmed in this way that 1/20 is not

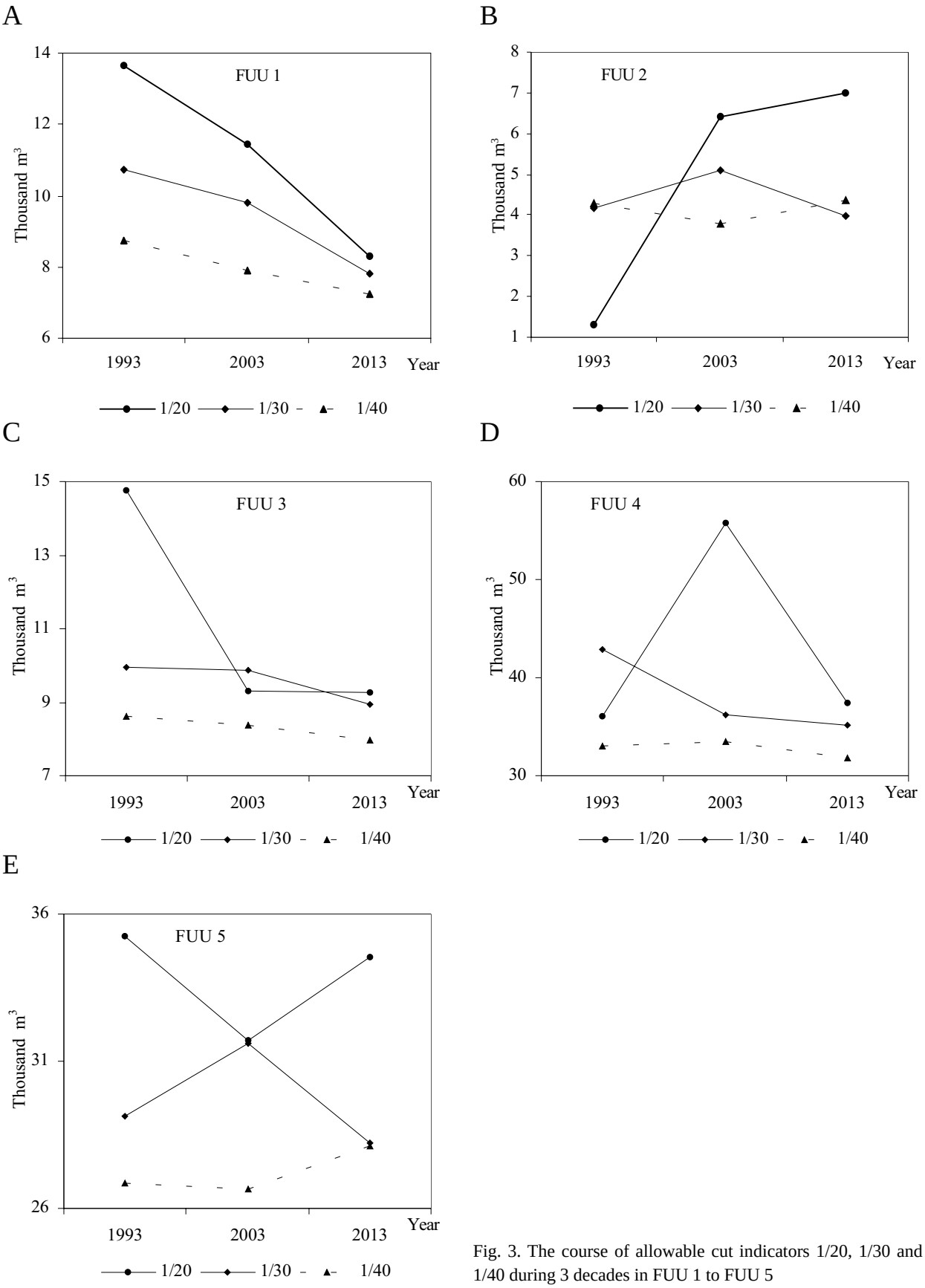

Fig. 3. The course of allowable cut indicators 1/20, 1/30 and 1/40 during 3 decades in FUU 1 to FUU 5

suitable and cannot be used in near-natural forest management. The values of particular allowable cut indicators in particular decades are shown in Table 2. The values of conifers and broadleaves and the values of conifers and broadleaves in total were calculated.

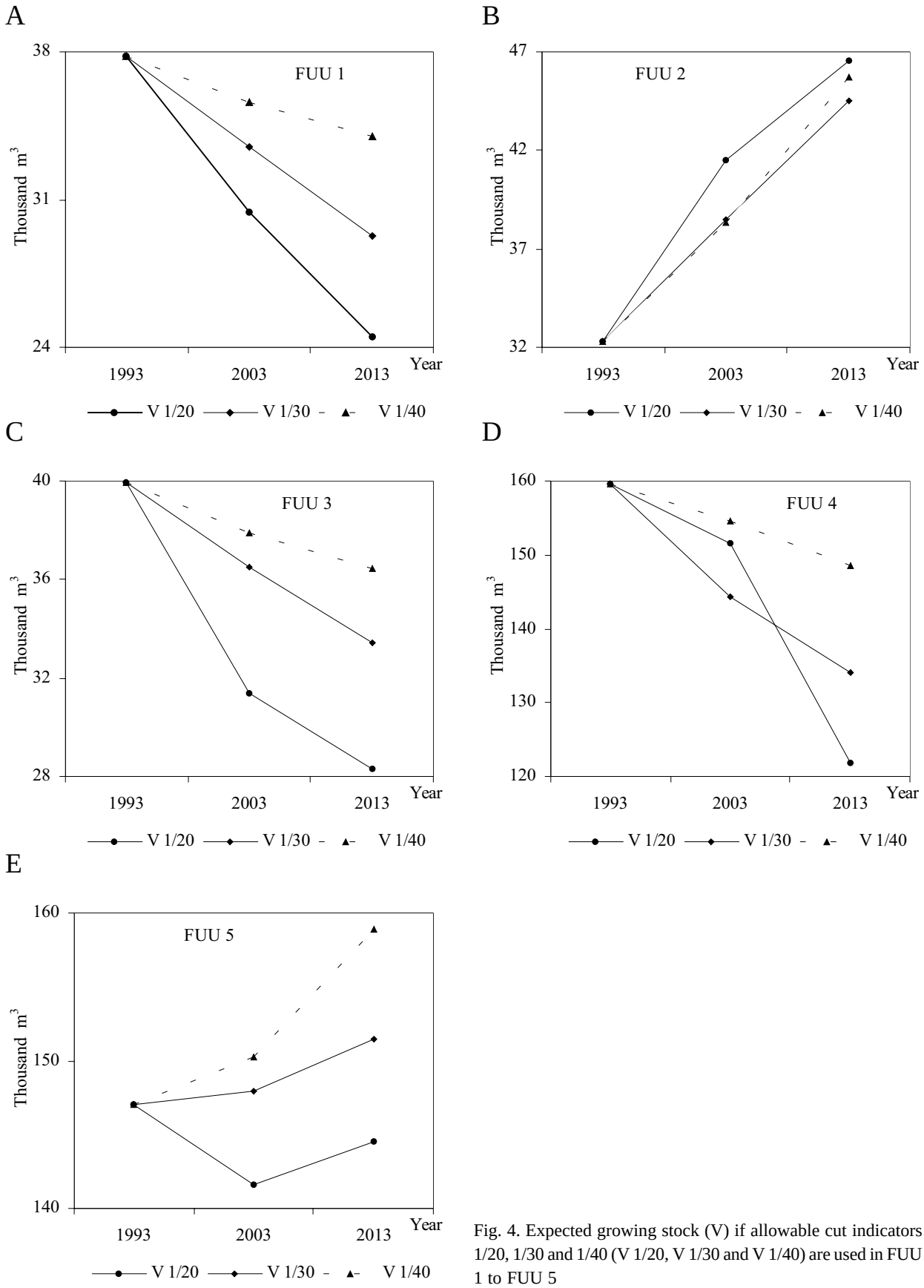

Fig. 4. Expected growing stock (V) if allowable cut indicators 1/20, 1/30 and 1/40 (V 1/20, V 1/30 and V 1/40) are used in FUU 1 to FUU 5

In FUU 1 it is possible to see a more balanced course of the values of indicator 1/30 and indicator 1/40. All allowable cut indicators show a decreasing tendency (Fig. 3A). It is influenced by age structure where the area of age classes that are included into calculation in the 2nd and 3rd decade is small. The average value of indicator 1/20 is

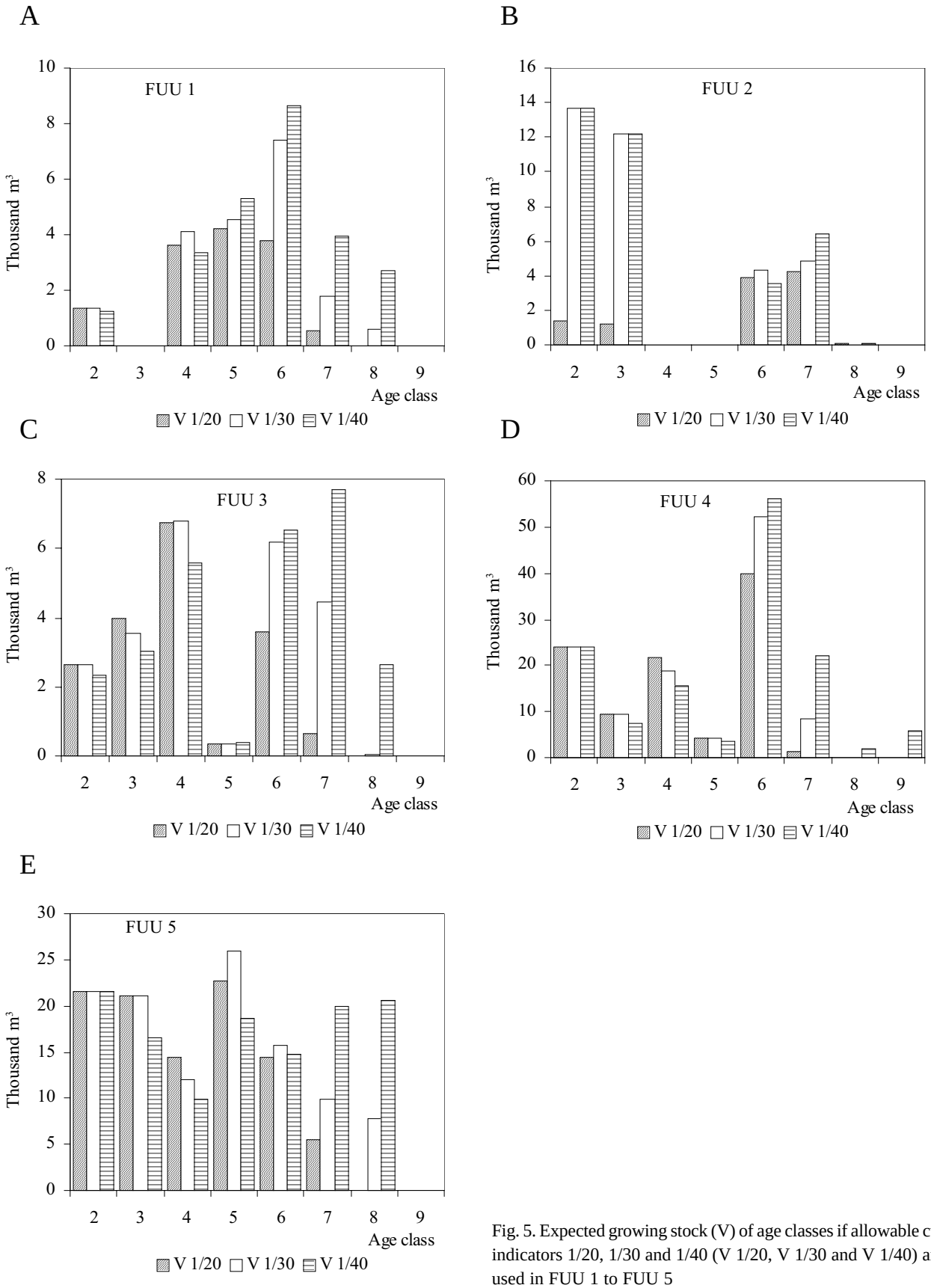

Fig. 5. Expected growing stock (V) of age classes if allowable cut indicators 1/20, 1/30 and 1/40 (V 1/20, V 1/30 and V 1/40) are used in FUU 1 to FUU 5

11,131 m³ with standard deviation s_x = 2,689 m³ and coefficient of variation $s_{x\%}$ = 24.2%. These values are much higher in comparison with indicator 1/30 and mainly with indicator 1/40. A more fluent course of indicator 1/40 is characterized by the value of coefficient of variation $s_{x\%}$ = 9.6%. The course of calculated allowable cut indica-

tors of conifers and broadleaves is also the most balanced if 1/40 is used. In spite of the fact that 1/40 has lower values in comparison with 1/20 and 1/30, by its application overmature forest stands and age classes are created in the future. If 1/40 is used, the expected standing volume distribution in age classes is also different in comparison with the expected standing volume distribution if 1/20 and 1/30 are used. The expected growing stock in 2013 if particular allowable cut indicators in 1993 and 2003 were used is illustrated in Fig. 5A. Allowable cut indicator 1/20 reduced standing volume to a larger extent than other allowable cut indicators. This fact is also confirmed by Fig. 4A. It shows the expected growing stock in 2003 and 2013 for the particular allowable cut indicators.

As concerns the age structure and structure of standing volume of FUU 2, the values of indicator 1/20 are not so high in this unit. In spite of this, the course of indicator 1/20 is very irregular ($s_{x\%}$ = 63.7%). Significant irregularity was determined for conifers and broadleaves. The course of the values of indicator 1/30 ($s_{x\%}$ = 13.7%) and indicator 1/40 ($s_{x\%}$ = 7.6%) in this unit is also more balanced. Therefore an increase in the expected growing stock in the next decades is more balanced than if 1/20 is used (Fig. 4B). In relation to the given age structure and structure of standing volume of this FUU the expected growing stock distribution is not so irregular in 2013 if 1/40 is used (Fig. 5B).

Like in FUU 1 the values of allowable cut indicators in FUU 3 decrease in particular decades. The most significant decrease and the most unbalanced course is determined if 1/20 is used. The values of these allowable cut indicators between the 1st and 2nd decade significantly decreased according to the age structure. Differences between the coefficients of variation of particular allowable cut indicators are significant (1/20 – 28.5%, 1/30 – 5.8%, 1/40 – 3.9%). The given course of allowable cut indicators influences the expected growing stock in 2003 and 2013 that will decrease (Fig. 3C). This decrease is connected with unbalanced age structure. If 1/30 and 1/40 are used, the course of expected growing stock is much more balanced than if allowable cut indicator 1/20 is used. If 1/40 is used, the structure of standing volume of age classes in 2013 is significantly different from the other allowable cut indicators. It is especially evident in the 13th and 14th age class (Fig. 5C).

The unbalanced age structure of FUU 4 is especially evident if 1/20 is used. The value of the coefficient of variation is the highest again (25.5%) if 1/20 is used. The course of allowable cut indicators 1/30 ($s_{x\%}$ = 10.9%) and 1/40 ($s_{x\%}$ = 2.6%) is more balanced. The course of these indicators is shown in Fig. 3D. Alike, the course of these indicators of conifers and broadleaves is more continuous than the course of indicator 1/20. The values of these indicators also significantly influence the course of the expected growing stock (Fig. 4D). This course is the most balanced if indicator 1/40 is used. Like in the previous FUU, if 1/40 is used, the standing volume of the oldest age classes is created. In this case the mentioned age classes are 12th–15th (Fig. 5D).

In FUU 5 the differences between particular allowable cut indicators are not so significant with respect to the more balanced age structure (Fig. 3E). In spite of this fact, the most balanced course of the values is obtained if 1/40 is used. If this allowable cut indicator is used, the expected growing stock is also higher (Fig. 4E). On the other hand, if this indicator is used, the standing volume is cumulated in the oldest age classes. It is standing volume of the 13th and 14th age class (Fig. 5E).

We can state from the evaluation of particular FUU, which also represent the other FUU in the Slovak Republic to a large extent, that it is partly possible to generalize the above-mentioned results with respect to their irregular age structure.

Allowable cut indicator 1/20, as mentioned in the introduction, removes 50% of the growing stock as follows from its description. After its evaluation a very unbalanced course was pointed out. It is another reason not to use it in near-natural forest management. It is due to the fact that the course of values in each decade is very much influenced by the area of age class taken into consideration for calculation after a shift of age classes has occurred. It follows from the principle of this indicator because only the last two age classes and higher are taken into consideration for calculation. Because the age structure is irregular with extreme representation of mature age classes, with respect to a short period that is taken into account, this indicator does not have a balanced characteristic. Its coefficients of variation for the age structure were in the range of 5.5–63.7%. That is why its application is possible first of all only in forest stands where the conditions of using of clear-cutting system and its forms are satisfied.

The application of indicator 1/40 confirmed its original balanced characteristic of the felling course during a longer period. It is indicated by the calculated values of coefficients of variation in the range of 2.6–9.6%. It follows from a higher number of age classes used for calculation. It is not always possible to use this indicator in FUU where stand tending was neglected. Age classes are shifted to mature age classes in such FUU where regeneration does not require intensive cuttings with respect to their state. Considering younger age classes for the calculation of allowable cut indicator and if determined fellings are not realized in these age classes, large differences in the continuity of felling development will arise during a longer period. If this indicator is used, moderate cuttings in mature age classes are presumed. The standing volume will be cumulated in the oldest age classes.

The best results of ensuring the continuity of the values were obtained if indicator 1/30 is used. The values of its coefficients of variation are in the range of 5.8–15.8%. The course of indicator values is balanced and a little different from indicator 1/40. That means its positives are more significant because it does not take into consideration younger age classes. The calculated felling volume can be realized after considering all criteria and conditions of particular FUU. On the basis of evaluation we can use this allowable cut indicator in near-natural forest management.

In comparison with some authors who dealt with the influence of regeneration cutting on the forest stand structure (BARNA 2000a; SANIGA 2001) and authors who dealt with cutting control (GREGUŠ 1976; MARUŠÁK 2001c; MIŚ 2001; POZNAŃSKI 2001; ŽÍHLAVNÍK 2001) the obtained results confirmed that it is possible to use them in practical forest management and in new forestry legislation.

CONCLUSION

The possibilities of using allowable cut indicators in near-natural forest management are solved in the paper. Other two allowable cut indicators are supplemented to the present indicators. Namely it is 1/30 of forest stand growing stock of the last three age classes and higher and 1/40 of forest stand growing stock of the last four age classes and higher. These indicators are compared with allowable cut indicator 1/20 of forest stand growing stock of the last two age classes and higher which in relation to the forestry law can be used for the present cutting control.

We can state from the evaluation of particular FUU that, concerning their irregular age structure that also represents the other FUU in the Slovak Republic to a large extent, it is partly possible to generalize the above-mentioned results.

Allowable cut indicator 1/20, as mentioned in the introduction, removes 50% of the growing stock as follows from its description. After its evaluation a very unbalanced course was pointed out. It is another reason not to use it in near-natural forest management.

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The best results to ensure the continuity of the values are obtained if indicator 1/30 is used. The values of its coefficients of variation are in the range of 5.8–15.8%. The course of the indicator values is balanced and a little different from indicator 1/40. That means its positives are more significant because it does not take into consideration younger age classes. The calculated felling volume can be realized after considering all criteria and conditions of particular FUU. On the basis of evaluation we can use these allowable cut indicators in near-natural forest management.

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Použitie vybraných ťažbových ukazovateľov v prírode blízkom obhospodarovaní lesa

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ABSTRAKT: V príspevku sa zhodnotila možnosť použitia vybraných ťažbových ukazovateľov v prírode blízkom obhospodarovaní lesa. Ide o ťažbové ukazovatele 1/30 zásob porastov posledných troch vekových stupňov a starších a 1/40 zásob porastov posledných štyroch vekových stupňov a starších. Tieto ťažbové ukazovatele sú porovnávané s ťažbovým ukazovateľom 1/20 zásob porastov posledných dvoch vekových stupňov a starších, ktorý je podľa súčasných právnych predpisov používaný v ťažbovej úprave lesa. Hodnotenia sa vykonali v piatich vybraných lesných užívateľských celkoch s uplatňovaným prírode blízkym hospodárením. Dosiahnuté výsledky potvrdili, že ťažbový ukazovateľ 1/20 nie je možné používať pri jemnejších spôsoboch hospodárenia. Výsledky potvrdili plynulosť priebehu ťažieb počas dlhšieho obdobia použitím ťažbových ukazovateľov 1/30 a 1/40.

Kľúčové slová: ťažbová úprava lesa; ťažbový ukazovateľ; lesný užívateľský celok

Cieľom príspevku je zhodnotiť možnosť použitia vybratých ťažbových ukazovateľov, a to doplnením terajších ukazovateľov o ďalšie dva ťažbové ukazovatele, a to 1/30 zásob porastov posledných troch vekových stupňov a starších a 1/40 zásob porastov posledných štyroch vekových stupňov a starších. Ťažbový ukazovateľ 1/20 zásob porastov posledných dvoch vekových stupňov a starších je typický ukazovateľ pre holorubný hospodársky spôsob. Preto jeho zhodnotením v porovnaní s ďalšími dvoma chceme dokázať to, že nie je možné ho používať v jemnejších hospodárskych spôsoboch. V novej právnej úprave ho odporúčame stanoviť len pre holorubný hospodársky spôsob. Ďalšie dva ťažbové ukazovatele by bolo vhodné doplniť do novej právnej úpravy. Ďalej cieľom príspevku je prognózovať vývoj a plynulosť ťažbových ukazovateľov v priebehu troch desaťročí do roku 2013 na základe doteraz vyriešených metód.

K zhodnoteniu vybraných ťažbových ukazovateľov boli použité lesné užívateľské celky (LUC) vytvorené z lesného hospodárskeho celku Školský lesný podnik Technickej univerzity vo Zvolene. Vzhľadom na rozsah príspevku bolo vybraných 5 LUC s podobnou nepravidelnou štruktúrou. V práci sú tieto LUC vzhľadom na nezneužitie údajov treťou osobou označené číslami 1–5. LUC 1–4 sú obhospodarované neštátnymi subjektami a LUC 5 spravuje štát. Všetky porasty patria do kategórie lesov hospodárskych s rubnou dobou 100–120 rokov a obnovnou dobou 30 rokov. K hodnoteniu boli použité údaje lesného hospodárskeho plánu s dobou platnosti 1993–2002.

Z dosiahnutých výsledkov vyplynulo, že vo všeobecnosti vo všetkých lesných užívateľských celkoch má najvyrovnanejší priebeh ťažbový ukazovateľ 1/40 a najnevyrovnanejší ťažbový ukazovateľ 1/20. Týmto sa potvrdilo, že ťažbový ukazovateľ 1/20 sa nemôže používať v prírode blízkom obhospodarovaní lesa. Hodnoty ťažbových ukazovateľov 1/20, 1/30, 1/40 sú uvedené po jednotlivých desaťročiach v tab. 1. Zvlášť sú uvedené hodnoty pre ihličnaté a listnaté dreviny a spolu.

Zhodnotením jednotlivých LUC môžeme konštatovať, že vzhľadom na ich nepravidelnú vekovú štruktúru, ktorá vo veľkej miere reprezentuje aj ostatné LUC vyskytujúce sa v rámci Slovenska, je možné uvedené výsledky zovšeobecniť čiastočne už teraz.

Ťažbový ukazovateľ 1/20 tak, ako bolo v úvode konštatované, čerpá až 50 % zásob, čo vyplýva z jeho charakteru. Po zhodnotení jeho priebehu sa ukázalo, že má veľmi nevyrovnaný priebeh, čo je ďalší dôvod na jeho nepoužívanie v prírode blízkom obhospodarovaní lesa. Uvedené je zapríčinené tým, že v každom desaťročí je priebeh tohto ťažbového ukazovateľa silne ovplyvnený veľkosťou vekového stupňa, ktorý po posune prichádza do výpočtu, keďže sa používajú len posledné dva vekové stupne a staršie. Tým, že väčšinou veková štruktúra LUC je nepravidelná s extrémnym zastúpením rubných vekových stupňov, sa pri ťažbovom ukazovateli nedá uvažovať s jeho vyrovnávacou schopnosťou. Jeho variačné koeficienty v jednotlivých hodnotených LUC sa pohybovali v rozpätí 5,5–63,7 %. Uvedené rozpätie vyplynulo z vekovej štruktúry LUC. Preto jeho použitie je možné predovšetkým len v porastoch, ktoré spĺňajú kritériá pre použitie holorubného hospodárskeho spôsobu a jeho foriem vzhľadom na ich stav a zabezpečenie ich obnovy.

Použitie ťažbového ukazovateľa 1/40 potvrdilo jeho pôvodný vyrovnávací charakter priebehu ťažieb za dlhšie obdobie. Svedčia o tom vypočítané hodnoty variačných koeficientov tohto ukazovateľa v rozpätí 2,6–9,6 %. Vyplýva to z väčšieho počtu vekových stupňov použitých pri výpočte.

Vzhľadom na stav LUC z hľadiska ich výchovy nie je možné použiť tento ukazovateľ v LUC, ktorých výchova bola zanedbaná. To spôsobuje, že do rubných vekových stupňov sa presúvajú vekové stupne, v ktorých násled-

ná obnova vyžaduje veľmi mierne zásahy vzhľadom na ich stav. Uvažovanie mladších vekových stupňov vo výpočte ťažbových ukazovateľov a následné nerealizovanie stanovenej výšky ťažby podľa tohto ukazovateľa spôsobuje veľké odchýlky v plynulosti vo vývoji ťažieb počas dlhšieho obdobia.

Jeho použitím sa predpokladá mierny zásah do rubných vekových stupňov, čo sa následne prejavuje vznikom prestárlych porastov.

Najlepšie výsledky v zabezpečení plynulosti priebehu hodnôt sa dosiahli pri použití ťažbového ukazovateľa 1/30. Jeho hodnoty variačných koeficientov sa pohybujú od 5,8 % do 15,8 %. Priebeh tohto ťažbového ukazovateľa je vyrovnaný a málo odlišný od ťažbového ukazovateľa 1/40. Znamená to, že jeho klady použitia sú významnejšie, keďže nezasahuje aj do mladších vekových stupňov. Jeho vypočítaná hodnota sa zároveň môže realizovať vo forme ťažieb po zvážení všetkých kritérií a charakteristík príslušného LUC. Tento ukazovateľ na základe jeho hodnotenia je možné použiť v prírode blízkom obhospodarovaní lesa.

Pri porovnaní s niektorými autormi, ktorí sa zaoberali vplyvom obnovných zásahov na štruktúru porastu (BARNA 2000; SANIGA 2001) a autormi, ktorí sa zaoberali ťažbovou úpravou lesa (GREGUŠ 1976; POZNAŃSKI 2001; MIŚ 2001; MARUŠÁK 2001; ŽÍHLAVNÍK 2001), výsledky dokazujú, že je ich možné aplikovať v praktickej HÚL a v novej právnej úprave.

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