

промислових забруднень, показниками органічних промислових забруднень, біологічними та бактеріологічними показниками. Спостереження за якістю поверхневих вод проводиться на основних річках Карпат.

Серед багатьох екологічних проблем однією з основних є забезпечення раціонального використання водних ресурсів, охорони їх від виснаження і забруднення. Забезпеченість водою місцевого стоку на одну людину по Україні припадає 0,96 тис. м³. Поряд з тим в окремі періоди року в деяких районах існує напруження з водозабезпеченням. Водні ресурси використовуються вкрай нераціонально, неекономно і крім того, відбувається значне їх забруднення як промисловими, так і сільськогосподарськими стоками та відходами. Одними з найбільших забруднювачів поверхневих та підземних вод є населені пункти, а також тваринницькі ферми і комплекси, оскільки на них, як правило, відсутні очисні споруди, каналізація. Гранично допустимі концентрації деяких забруднюючих речовин у водоймах нерідко перевищуються в десятки разів.

Отже, розвиток виробництва і господарська діяльність, в ході яких людина почала використовувати дедалі більшу кількість природних ресурсів, зумовили порушення рівноваги в навколишньому середовищі, що, в свою чергу, призвело до порушення економічної ситуації. Це загострює увагу до економічних проблем і, перш за все, до зменшення запасів невідновних сировинних та енергетичних ресурсів, до забруднення довкілля і втрат чистих вод, родючих земель, багатьох видів рослин і тварин, до збереження необхідної якості природного середовища, а головне, в кінцевому результаті, до впливу всіх негативних екологічних факторів на здоров'я людини.

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DAMAGE ON FOREST STANDS IN THE ORE MTS. AFTER USE OF THE LOGGING MACHINERY

More and more progressive technologies for logging and hauling are most of all constantly used from ecological and economical point of view. These technologies can also operate in regions with environmentally sensitive forest management. The area of the Ore Mts. is a sample, due to its historical stress caused by the regional industrial production – pollution. Impacts of the up-to-date logging systems on the forests during pre-commercial thinning has been analysed there (Harvester Timberjack 1070 and Forwarder Timberjack 810B). Results are talking in favour of the further usage of this technology. Damaged area of the injured trees range according to age classes between 1,50-2,38 %.

Keywords: harvester technology, damages on the forest stand

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Пошкодження дерев в лісових масивах ORE MTS. після використання лісозаготівельних машин

Дедалі більш прогресивні технології з екологічної та економічної точок зору використовуються для лісозаготівельних робіт і транспортування лісу. Ці технології також можуть застосовуватися і в регіонах з відчутно вразливим до лісозаготівельної діяльності довкіллям. Так територія ORE MTS є прикладом забрудненої площі через діяльність місцевого промислового виробництва. Проаналізовано вплив на довкілля лісових машин – харвестера TIMBERJACK 1070 і форвардера TIMBERJACK 810B в умовах рубань догляду. Зроблено висновок щодо доцільності подальшого використання цих машин.

Ключові слова: харвестерна технологія, пошкодження дерев.

Introduction

The product costs are constantly growing entries of the logging and hauling activities ranged to the analytical priorities. This is a reason why a new search for new technologies or up-to-dating of those actually used ones have ever been taking place in order to decreasing costs. This is by definition the only issue seen by many foresters as a main care of logging. But a lot of them do not realize another issue, namely that more expensive one which may be caused by the logging and hauling operations for the futurity. Not only the possibilities of tree injuries with a danger of threading the trees by fungous-infections and that of spreading them in relation to their size and positioning of injury at the concrete tree species but also influence of increase size are concerned.

Consequences of the injuries arisen on the forest species and the tree injuries have been normally a doorway for infecting the damaged trees by wood-destroying funguses. Therefore the rot of standing trees becomes a normal concomitant circumstance of cut and of concentration in vegetation (Fanta 1958) and the wood quality declines. The trees with damaged roots and buttresses have been attacked by ligniperdous funguses mostly because of being wasted with the most of injuries (Douda 1986). The fungous-infection spreads trough the root rubs more slowly than through the root buttresses, probably thanks a different root and stem anatomy (Fanta 1958). A different impact is to be presumed also among the injuries of buttresses or roots and on the stem. At the damages of lower sections, the fungous-infection spreads in "one" stream only but on contrary, at the stem damage, the infection may be spread trough the stem in "two" streams and the damage of valuable stem section could be nearly doubled at the same interval.

Not too effective decontamination results are a cause why the damages have to be minimized because the tissue structure and physiological functions of the fungous parasite are very closed to host. This is a cause why many chemical substances do not destroy a parasite and its germs (spores and spawn) but are victimizing at the same time also the treated tree (Černý 1976). The biggest and most dangerous tree injuries are those in down-to-earth section up to 60 cm made on the thin barked species (spruce), especially then on those with a superficial distribution of root anatomy, when concentrating wood (Ulrich 2001), whereby the danger of infection, most frequently with *Stereum sanguinolentum* increases.

Thereupon an increase decrease of injured trees also occurs, and thereby their removal of production process and the decrease of production and non-production capacity of forest occur (Douda 1986). The spruce is mostly suffering with rot and

damaging and therefore the biggest danger may threaten just in homogenous, extensive and to bad hauling access exposed growths, which have been included just in the region of the Ore Mountains, where the research to this report is realized.

Goal

The goal is to run the scattering analysis on the forest management plant Kraslice in the frame of a research intention "The Renewal of Ecosystem of the Ore Mountains", where the harvester technology – a Timberjack 1070 and an Timberjack 810B forwarder are used (see the parameters on the Table 1). The analysis of damage volume on the species in the forest growths where the technology is used, in relation on the age classes in consideration of individual sections of trees damaged by logging and hauling, i.e. by felling, handling the felled tree, shortened stems, by stocking the assortments onto hauling lines of their loading and last but not least influence of own forestry mechanization which is used on the area used at the hauling and logging activities. Even the analysis of damage occurrence of various area sizes is not left out of the consideration.

Table 1. Enginery parameters

Chosen parameters	Timberjack 1070	Timberjack 810B
Weight [kg]	13800	1900
Length [mm]	6600	7960
Width [mm]	2780	2520
Height [mm]	3620	3720
Clearance [mm]	575	595
Power [kW]	123 kW/2200 ot./min.	80,5/2400 ot./min.
Front tyre	700 × 22,5	600 × 22,5
Rear tyre	600 × 30,5	600 × 22,5
Speed [km.h ⁻¹]	0 -25	0 – 25

Demonstration of a not too big damage rate of the harvester technologies on the species is in fine. Ratio of these technologies on loggings is ever increasing regarding to the tendency of reducing the growth of production costs, respectively o their partial items, especially then those of wages. A long developing trend of the harvester technologies, as it is shown by independent researches, when competently used, could give upon the decreasing of post-cutting impacts against the forest ecosystems, it means no exposure to the destabilization of growths with spreading of wood-destroying funguses. Hereby the quality of wood which falls down into the inferior classes after have been infected with rot, would eroded minimally.

Methodology

The used methodology presents an experimental acquisition and assessment of the damages on the whole area of forest growths, using a following-up mathematic-statistic analysis of all of these negative issues. It is possible to assume that the most rate of damages on the species have been risen just by moving the engines (the harvester and the forwarder) along the hauling lines. Therefore the assessed damages are measured and recorded alongside the whole lengths of the hauling lines and all of other damages on the operating area are recorded at the same time. All injuries on the trees are divided by tree sections (roots, buttress, stem), integrated in area intervals (0–10 cm², 11–50 cm², 51–200 cm², 201–500 cm² a 501–1000 cm²). A registra-

tion of other natural, technical and technological conditions and factors for detailed analyses based on the number code elaborated in the cooperation with the MZLU in Brno is an integral part of the realized experimental examination.

Results and discussion

The presented results are possible to be divided into two groups:

- The number of damages on the species (both separated according the specie section and according the area intervals).
- The number of damaged trees (Table 2).

Table 2. Quotients and Numbers of Damages on the Forest Stands

Interval	Tree section						Numbers of damages	Share of damages
	Root		Buttress		Trunk			
Age vlase – 3								
[cm ²]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]
0–10	0,5	1,9	0,1	0,4	0,5	1,9	1,1	4,2
11-50	2,3	8,8	1,6	6,1	0,9	3,4	4,8	18,3
51-200	4,4	16,8	5,0	19,1	1,1	4,2	10,5	40,1
201-500	1,6	6,1	4,1	15,6	0,3	1,1	6,0	22,9
501-1000	0,3	1,1	3,2	12,2	0,3	1,1	3,8	14,5
Number of damages	9,1	34,7	14,0	53,4	3,0	11,8	26,2	100
Numbers of damages				Share of injured trees				
[ks/ha]				[%]				
19,3				1.50				
Age vlase – 4								
[cm ²]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]
0–10	0	0	0,2	0,6	0,3	1,0	0,5	1,6
11-50	2,8	9,0	2,7	8,7	1,0	3,2	6,5	20,8
51-200	5,4	17,3	7,4	23,7	1,0	3,2	13,8	44,2
201-500	1,3	4,2	5,6	17,9	0,6	1,9	7,5	24,0
501-1000	0,1	0,3	2,4	7,7	0,4	1,3	2,9	9,3
Number of damages	9,6	30,8	18,3	58,7	3,3	10,6	31,2	100
Numbers of damages				Share of injured trees				
[ks/ha]				[%]				
23,7				2,38				
Age vlase – 5								
[cm ²]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]	[ks/ha]	[%]
0–10	0	0	0,1	0,6	0,2	1,2	0,3	1,8
11-50	0,5	3,1	1,2	7,4	1,5	9,2	3,2	19,9
51-200	1,1	6,7	4,2	25,8	1,8	11,0	7,1	43,6
201-500	0,8	4,9	2,7	16,6	0,5	3,1	4,0	24,5
501-1000	0,1	0,6	1,3	8,0	0,3	1,8	1,7	10,4
Number of damages	2,5	15,3	9,5	58,3	4,3	26,4	16,3	100
Numbers of damages				Share of injured trees				
[ks/ha]				[%]				
13,0				2,25				

The measuring of rubs has been realized for the age classes 3, 4 and 5 after have put on the above mentioned harvester assembly. Even though, regarding an insufficient number of measurements (44 growths), it was not possible to refute the zero hypothesis to difference of number of damages or injured trees in individual age classes (Table 3), let us look on the individual differences. A harvester technologies using Timberjack 1070 and Timberjack 810B enginery have damaged in odd age classes from 1,50 % to 2,38/ left standing trees in the growths (Figure 1). In a lower age class, 1,50 % of left standing trees have been damaged, it means that 19,3 trees/ha of forest growths are injured. In the age class IV, the share of injured trees is increasing by 0,83 percent points up to 2,38 % (23,7 trees.ha⁻¹) and in the 5th age class, there is 2,25 % injured trees (13,0 pieces. ha⁻¹) from the total amount on the area. The lowest share of injured trees in the 3rd class is given by not too much developed butters which are in the higher class 4th more damaged by a draught mechanism of forest technology when travelling along the hauling lines, and also by moving trees upon the soil surface at the clearance eventually by unsuitable putting of log to the trees or among the trees at the lines and by following damaging of buttresses with a hydraulic jib of a forwarder. In the lowest age class, a damage volume on the trunks is going decreased thanks to deeper branching, and therefore thanks to preventing to contact with a standing tree in the case of a non-guided fall-down. The damage ratio in the 5th age class, compared with that of 4th age class, decreases due to larger spacing of trees and a thicker bark.

The number of total damages is higher than that of own injured trees. The ratio of injured trees to the total number of rubbings makes respectively 75,6 %, 81 % and 85,4 % in accordance to the individual age classes 3, 4 and 5. Hereby a representation of two or more injuries on one tree (Figure 2) is possible to be approved in accordance with the individual classes. The multiplicity of injuries is given by the growth coverage. With an impact on the more injured specie, the risk of its infecting with rot decreases, and that eventuates in secondary commercial losses.

The damages have been recorded in accordance to their distribution on the tree sections:

- Root to the 1m distance from the tree,
- Buttress
- Trunk with no regarding height of the rubbing position.

Table 3. Scattering Analysis of the Damaged Trees and Rubbing of Bark on 1 ha without Concern to the Forest Age Classe

Source	Sum of squares	Degrese of freedom	Mean square	F-ratio	p-value
Scattering analysis of the damaged trees					
Age class	159,38	2	79,69	0,1685	0,8455
Within groups	19391,3	41	472,96		
Total	19550,7	43	-	-	-
Scattering analysis of the damages					
Age class	631,94	2	315,97	0,3635	0,6978
Within groups	35632,0	41	869,22		
Total	36269,9	43	-	-	-

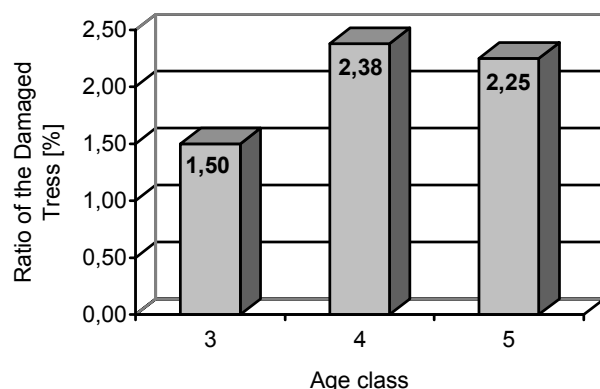


Figure 1. Ratio of the Damaged Tress

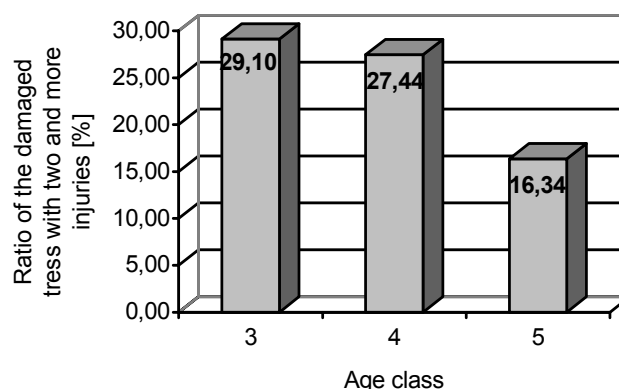


Figure 2. Ratio of damaged trees with two and more injuries

The tree sections are not possible to be specified with single valued specific units because their metrical span is changing with the age, natural conditions and with the specie type. The damage is always on the tree and its context with the tree section has been assessed specifically to each of injured specie.

The distribution of damages on the tree sections is not possible to be included into the characteristics of quantitative damages. A different risk of infecting and following-up spreading velocity of rot trough the specie is possible to be taken into consideration in accordance with positioning on the root, buttress or tree stem. This is given first of all by wood volume mass, the spreading of fungous infection with varied velocity is to be considered with the volume mass variability.

Table 4. Scattering Analysis of Damages Aminy Different Tree Parts

Source	Sum of squares	Degrees of freedom	Mean square	F-ratio	p-value
Tree section	4060,42	2	2030,21	11,82	0,00002
Within groups	22162,94	129	171,81		
Total	26223,36	131	-	-	-

Considerable differences among the damage numbers on odd tree sections are evident from the Figure 3. This is approved also by scattering analysis – a hypothesis of mean value equality is overruled with high reliability (Table 4). A detailed assessment of the odd sections has been realized by the Scheffe's method for multiple comparing (Table 5). Differences between the roots and butters and between stems and butters appear as statistically confident (on the confidence level 0,05). On the contrary, the difference between the roots and stems has not been approved.

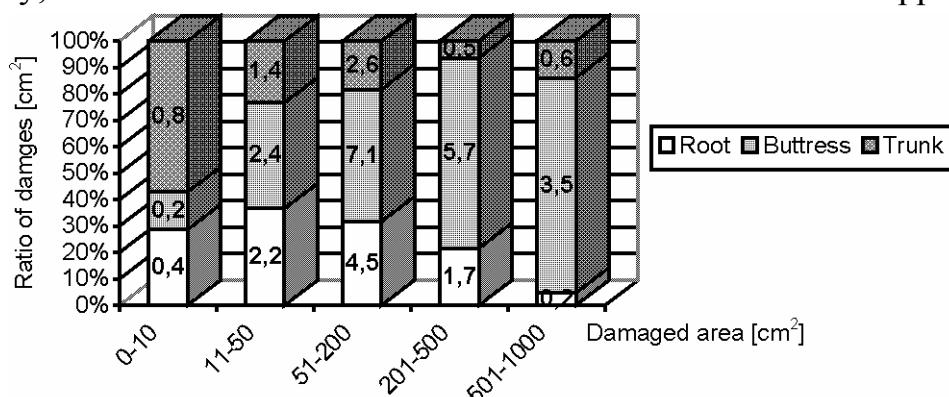


Figure 3. Ratio of damages on tree parts according to the size of bark rubbing

The root butters are most damaged onto 18,9 damages/ ha⁻¹, namely without having regarded the age class, the root system includes 9,0 damages.ha⁻¹. The minimal number of injuries is declared on the stems by value 5,8 piece.ha⁻¹. A minimum damages on stems is given by the minimization of interaction engineery – tree, namely always, if the skidding lines are traced by the width 3,5–4 m and led trough the growth in places with a minimal share of obstacles which are increasing the risk of skewing the machine and damaging of stem by uprights, cabs or other components. Another danger for stem injury is a non-guided way of downfall in a case of lack of operator's experiences or of cutting the overgrown trees, which are not possible to be transferred by a logging head.

Table 5. Multiple Comparing of Damages on Tree Parts

Section	Count	Mean	Homogeneous group
Trunk	44	5,91	X
Root		8,95	X
Buttress		18,89	X

The last analysis is realized among the selection of five intervals specifying the area damage on odd tree sections (0-10 cm², 11-50 cm², 51-200 cm², 201-500 cm² a 501-1000 cm²). The hypotheses of equality of mean values of the number of damages on partial area intervals (Table 6) have been overruled in frame of sections among the selections. Then the differences between all interval pairs have been assessed with the Scheffée's method for multiple comparing (Table 7) on the significance level 0,05.

Table 6. Scattering Analysis of the Damages According to Size within the Tree Part

Source	Sum of squares	Degree of freedom	Mean square	F-ratio	p-value
Scattering analysis of root damages					
Area interval	541,32	4	135,33	13,30	0
Within groups	2187,35	215	10,17		
Total	2728,67	219	-	-	-
Scattering analysis of butter damages					
Area interval	1316,64	4	329,15	13,11	0
Within groups	5399,67	215	25,11		
Total	6716,31	219	-	-	-
Scattering analysis of trunk damages					
Area interval	136,55	4	34,13	6,22	0,0001
Within groups	1180,52	215	5,49		
Total	1317,07	219	-	-	-

The smallest numbers of damages appeared on the **root sections** in the area injury intervals 501-1000 cm², 0-10 cm², 201-500 cm², and 11-50 cm². The odd intervals in the frame of this group are statistically indistinguishable (they make a so called homogenous group). The interval of area injury 51-200 cm² of this group differentiates statistically from all of the intervals by a significant way - the damage rate here is higher.

The smallest damage number on the **sections of buttress** appear at the interval group 0-10 cm² and 11-50 cm², the biggest damage number at the interval 201-500 cm² and 51-200 cm². The smallest damage number on the **stem sections** appear at the interval group 201-500 cm², 501-1000 cm², 0-10 cm² and 11- 50 cm², the biggest damage number at the interval 11-50 cm² and 51-200 cm².

Table 7. Multiple Comparing of Damages of Size Damages

S.	Interval	Count	Mean	Homogeneous group
Root	501-1000 cm ²	44	0,19	X
	0-10 cm ²		0,38	X
	201-500 cm ²		1,65	X
	11-50 cm ²		2,18	X
	51-200 cm ²		4,54	X
Buttress	0-10 cm ²	44	0,16	X
	11-50 cm ²		2,42	XX
	501-1000 cm ²		3,50	X
	201-500 cm ²		5,68	XX
	51-200 cm ²		7,13	X
Trunk	201-500 cm ²	44	0,53	X
	501-1000 cm ²		0,55	X
	0-10 cm ²		0,80	X
	11-50 cm ²		1,40	XX
	51-200 cm ²		2,62	X

The damage ratio on the tree sections in the interval in accordance to the rubbing size is elaborated clearly in the Figure 3. The smallest rubs up to 10 cm² have the lowest occurrence – by the tree sections. Their number here is 1,4 piece.ha⁻¹. This is given by a quick rolled down injuries as well as by a minimum of probability of condition for the rise of these injuries on the species with thicker bark, where it occurs to its superficial damage only without having infringed the wood fibre, which is not registered as damage. A mean damage number 6,0 piece.ha⁻¹ (without having regarded the age class) is at the size 11-50 cm². But a risk of infecting by rot is growing here up to 12-44 % (Grammel 1988). A biggest occurrence of damages is in the interval 51-200 cm² – 14,2 damage.ha⁻¹. The highest significance is approved at the damages of this interval. In addition, from this interval up to the higher ones, the probability of infecting the specie with rot is already 100 %. The interval 201-500 cm² includes 7,9 rubs on ha. The damage in the mentioned interval and in the following interval (501-1000 cm², i.e. 4,3 damage.ha⁻¹) may be caused with an intensive overtravell on a skidding line and with a multiple overtravell over the same buttress or root, which is not protected with slashing cover. The damages of these intervals are not exceptional neither at the exits from the analysed growths or on the truck landing border and growth where the damages are caused most times by a hydraulic jib or by handling with cut-outs.

Conclusion

It exists a lot of series of logging and hauling technologies and their modifications for operational cutting. But none of them is possible to be regarded as such a perfect one that no damages stay in the forest growths when realizing that. By the same way, we can choose neither such ones where the damage volume is the smallest one because they may not be usable under concrete conditions because of disproportional high production costs or a deficient technical company background (vehicle fleet etc.). In spite of that the future perspective for the harvester technologies remains because the lower damages, based on the research, have been approved when this assortment method compared with the trunk methods – MP, horse, LKT – 22 % (Ulrich) – and it is possible to regard these technologies as thrifty ones.

An analysis of possible technologies with goal-directed optimising its logging and technological parameters or optimising technical parameters of engaged enginery can be of remarkable signification for minimization of damages.

Getting a minimum of damages in the forest growths at the production process does not consist only in selection of the enginery and logging technologies but it is also necessary to follow with responsibility the every times repeated fundamentals related to engaging the TDS in the production process, i.e.:

- Consistent section of the growths;
- Marking the trees for cutting;
- Following of production techniques.

The economical production has been often trumping the ecological point of view. But some few appreciate that both direct labour costs on decontamination and first of all losses for the future because a danger of contamination of the trees with fungous infections rises with escalating of damages, and therefore rises damaging and depreciation of wood material and decreasing of growth.

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MOUNTAIN TOURISM PLANNING WITH THE PARTICIPATION OF LOCAL PEOPLE IN THE UKRAINIAN CARPATHIANS

The Ukrainian Carpathians located in southwestern Ukraine attract many tourists not only from inside Ukraine but from abroad by providing them with an opportunity of skiing and other outdoor activities. A canvass survey was conducted in Rozhanka village on the

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