DETERMINATION OF *PINUS SYLVESTRIS* L. TRUNK DIAMETER BASED ON STUMP DIAMETER IN DIFFERENT BOREAL CONIFEROUS FOREST CONDITIONS OF PERMSKII KRAI (RUSSIA)

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ABSTRACT

Sometimes there are situations when it is necessary to determine the size of cut logs in the logging area in its absence. Mostly such situations arise in the detection of illegal logging. They can also occur in the case legal harvesting, when the tenant of a forest plot does not receive the scheduled volumes of timber for which he paid the money. In this case, the diameters of the felled trees are determined by the tree stumps. Recalculation of diameters is carried out on special tables developed in the early 20th century. Studies conducted in Krasnoyarsk, Khabarovsk, Bryansk (Russia), Gomel (Belarus), showed the need to refine the data of scaling tables for local conditions. Large discrepancies between actual and tabular trees appear with the increasing diameter of the tree. Studies of the relation of the formation of the butt log of pine (*Pinus sylvestris* L.) in the Perm region was carried out in 2015-2016. Forest plots were selected in different forest types of the middle taiga (Nirobskii forestry) and southern taiga (Perm urban forestry). Measurement of trees was carried out in pure pine stands at the age of 75-130 years. The stand density of the plantings was of 0.6-0.8. In each forest type the replication of studies was threefold. Studies have shown that trunks of pines formed a fuller bole in the Perm region, than the established scaling tables. For trees 40cm in diameter, recalculation leads to underestimation of the pine tree trunk diameter by 1-2 diameter class. That is understating the actual volume of felled tree by (16-20 %). There were no significant differences in the formation of the pine bole between the forest zones or by the corresponding types of forest. Also, there were no significant differences between forest types, which allows using a single conversion scale for the taiga part of the Perm Territory. Due to the fact that the relative completeness of the comparative stands were close, the influence of the distance between the trees on the development of the butt of pine trunks was not detected.

Key words: *illegal logging, diameter of pine stump, forest type, middle taiga, southern taiga, boreal coniferous forest.*

INTRODUCTION

Forests are about 45 % of the territory of Russian Federation. The logging and the wood processing are traditional field of activities in our country. The large forest territory and the lowering of forest control after late forestry reforms are causes of the illegal logging incident increase. The wood volume of illegal logging is 10-35 % of the harvesting volume in Russia. In some regions the illegal logging or the dubious wood origin are 50 % (Golovan 2015). According to unpublication date of Ministry of native recourses and forestry of Permskii krai the illegal logging is 8295 incidents from 2008 to 2015. The volume of this wood is 463000 ^{3} and the loss is more 3 billions rubles. The clearing of crime of illegal logging is increase. If culprits of illegal logging were revealed 39 % of incidents in 2008, that this index was 75 % in 2015. But imperfect proof base lengthen court investigations. The investigation of illegal logging has four stages. The first is establishment of the placement and the measure of the logging plot. At this stage an expert uses geodetic tools. The second is the wood volume measurement by the stumps. An expert measures stump diameter and determines wood volume by specific tables (Vice 2011.). The third is the clarification of the logging time. Used dendrochronogical method enables to determine year of the logging. Also scientists look for another methods of the time identification. The fourth is the tool and mechanism recognizing by leave traces. The information about these researches are absent in publications. The object of research is a correlation between pine (*Pinus sylvestris* L.) trunk and butt diameters for the successive determination of wood volume. Used standard tables are not correct for different regions of Russia(Golovan 2015, Klennikova 2012 Vice 2011.). The big difference are displaying for mature and overmature forest.

MATERIAL AND METHODS

Researches were fulfilled in 2015-2016 in pine stands of Permskii krai (subzones middle and southern taiga) in Russian Federation. Trunk and butt diameters of pines were measured on plots with different forest type. They are lichen pine forest, cowberry pine forest, green-moss pine forest, sorrel pine forest, bilberry pine forest and polytric pine forest. The age of pine forests are about 90-130 years. Diameters were measured at heights 10, 20 and 130 cm above soil surface (Kishenkov 2009). The length to near-by trees was measured for the study of their influence. The stand density of the plantings was of 0.6-0.8. Researches pine-trees had diameters 20, 40 and 60 cm at height 1.3 m.

RESULTS AND DISCUSSION

Facts of table 1 show a small difference between forest types in taiga subzone and between subzones. But pines growing in optimal soil conditions have a less pronounced butts then pines growing in dry and wet soils. Pines growing in Middle taiga have a less pronounced butts then pines growing in similar conditions of Southern taiga. These inconspicuous differences enable to use one computational table for diameter trunk determination. Any way the real correlation between pine

trunk diameter and stump diameter is big then facts of standard table. The larger the pine trunk, the tighter the difference! Other authors write about this problem too (Kishenkov 2009).

Facts of table 2 show the divergence of damage account if we use different tables for pine diameter trunk determination. The expert measures same stumps and computes their diameters to trunk diameters using standard table. He gets low diameter class then it is real. The industrial wood yield declines. The cost of the felled tree declines about 33 %. The account of a cost of felled pine tree was done according to the rates of the charge for unit of wood and coefficients for a rates of the charge used in Russia [5, 6].

Table 1. Correlation $D_{1,3}/D_{0,2}$ for pines growing in different forest type of southern and middle taiga

Forest type	Diameters of pine trunk ($D_{1.3}$)		
	20 cm	40 cm	60 cm
Southern taiga			
(　　) cowberry pine forest	0.847±0.010	0.868±0.012	0.928±0.008
(　　) green-moss pine forest	0.882±0.006	0.939±0.009	0.956±0.004
(　　) sorrel pine forest	0.903±0.007	0.916±0.006	0.954±0.007
(　　) bilberry pine forest	0.852±0.011	0.877±0.007	0.924±0.006
(　　) polytric pine forest	0.875±0.017	0.898±0.007	0.936±0.004
Middle taiga			
(　　) lichen pine forest	0.890±0.010	0.870±0.010	0.920±0.010
(　　) cowberry pine forest	0.850±0.004	0.900±0,004	0.950±0.004
(　　) bilberry pine forest	0.850±0.010	0.890±0.010	0.940±0.010
(　　) polytric pine forest	0.860±0.010	0.890±0.010	These trees are absent
Standard table for European part of Russia	**0.800**	**0.820**	**0.830**

Table 2. Difference of damage accounted by standard and new tables

Index	Own value			Standard table		
	Small stump	Middle stump	Large stump	Small stump	Middle stump	Large stump
Diameter of real stump ($D_{0.2}$), cm	24	44	63	24	44	63
Diameter of trunk after computation ($D_{1.3}$), cm	20	40	60	19,1	35,9	51,9
Diameter class, cm	20	40	60	20	36	52
Trunk volume, m^3	0.249	1.221	2.876	0.249	0.969	2.137
Volume of large timber, m^3	0	0.899	2.447	0	0.582	1.825
Volume of middle timber, m^3	0.154	0.158	0.032	0.154	0.248	0.038
Volume of small wood, m^3	0.057	0.020	0	0.057	0.022	0
Volume of fireplace wood, m^3	0.005	0.012	0.063	0.005	0.010	0.034
Cost of one felled pine tree for 2017 (27/06/2017), euro	0.43	3.39	8.22	0.43	2.55	6.16

The declining of wood volume is the problem of state forestry. The first the damage of the illegal logging is low then it is real. The second the wood volume examined by the expert on logging plot is lower then it is describe in the mensurational description for that plot. These situations took place when the leaseholder felled the bought forest, account the timber volume and sow its discrepancy to bought wood volume. According to expert facts the state forestry put up the overstated wood volume to the leaseholder.

CONCLUSIONS
The determining of wood volume by stumps needs the differentiated approach in each region of Russia.
There were no significant differences in the formation of the pine bole between the forest zones or by the corresponding types of forest in Perm region. Also, there were no significant differences between forest types, which allows using a single conversion scale for the taiga part of the Perm Territory.
The mistakes of trunk diameter determine is cause of the reducing of actual wood volume (at 1.15-1.26 once). The damage of illegal logging is reduced at 33 %.

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O koeffitsientakh k stavkam platy za edinitsu ob"ema lesnykh resursov i stavkam platy za edinitsu ploshchadi lesnogo uchastka, nakhodyashchegosya v federal'noi sobstvennosti (Postanovlenie Pravitel'stva RF ot 17 sentyabrya 2014 947). About coefficients for a rates of the charge for unit of forest source volume and the rates of the charge for the unit of a forest plot square is in federal property. Decree of the Government of the Russian Federation No 947 of 17 September 2014

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