Inventory of dead wood in the Kněhyně-Čertův mlýn National Nature Reserve, the Moravian-Silesian Beskids

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ABSTRACT: In four permanent experimental plots, dead wood was inventory under conditions of mountain forest ecosystems of the Kněhyně-Čertův mlýn National Nature Reserve, the Moravian-Silesian Beskids. Down woody material, standing dead trees as well as living trees were recorded. Data obtained were used to determine partial and summarized volumes of dead wood and its proportion in a living stand. Each of the surveyed areas was described not only from the viewpoint of mensuration but also with respect to subsequently carried out studies of biodiversity of wood mycoflora, succession of decomposition processes, natural regeneration on the dead wood etc. Mean volume of dead wood and a share in the total standing volume reaches 132 m^3/ha (40%), of this 86 m^3/ha is down woody material and 46 m^3/ha volume of standing dead trees. Mean total standing volume per ha amounted to 332 m^3/ha in the region of the Kněhyně-Čertův mlýn NNR.

Keywords: dead wood; inventory; Field Map system; the Moravian-Silesian Beskids; the Kněhyně-Čertův mlýn National Nature Reserve

The amount of dead wood, particularly as fallen dead wood and standing dead trees is attracting attention from forest managers as part of their interest in increasing biodiversity within forests managed for timber. Existing levels of dead wood in managed and unmanaged forests were assessed to provide a basis for what might be considered high or low amounts of dead wood under present conditions.

The occurrence of dead wood is a characteristic feature of forest ecosystems. Thus, it markedly differentiates the forest form other types of terrestrial ecosystems. A favourable effect of the dead wood shows in the element cycling, retention function of the forest, dead wood is important from the viewpoint of biodiversity, forest regeneration particularly in mountain regions etc. The proportion of dead wood and plant remainders kept in the forest is a result of the exploitation and management of the forest significantly differing from the condition in the natural forest.

While virgin and natural forests contain 50–200 m^3 dead wood per ha, as against only 1–5 m^3/ha in conventionally managed forest. The amount of dead wood can serve as an indicator of the naturalness and maturity of forest stands, but its ecological value is also determined by its composition and condition. Dead wood forms a habitat for many species, e.g. 1,500 species of higher fungi and some 1,300 species of beetles (Albrecht 1991).

The Kněhyně-Čertův mlýn National Nature Reserve (NNR) represents an important remainder of the virgin-type forest of a total area of 196 ha in the Moravian-Silesian Beskids being situated on the top and adjacent slopes of Mt. Kněhyně (1,257 m alt.) and Mt. Čertův mlýn (1,206 m alt.). It includes flat top ridges with levelled surface and erosion-denudation valley slopes of all aspects in the range from 1,000 to 1,257 m alt., where rock slides and slope debris or even stone fields occur. In the region of the Moravian Western Carpathians, the area of the Kněhyně-Čertův mlýn NNR is the best-preserved complex of relatively natural forest ecosystems at the contact of a spruce/fir and spruce vegetation zone.

The aim of the paper is to record the present condition of wood decomposition in the studied region, to characterize its volume and dispersion of dead wood under conditions of mountain forests of the Beskids. From a long-term aspect, the objective of the paper consisted in establishing the basis to record the dynamics of wood decomposition processes and its importance for biodiversity and regeneration of the forest.

MATERIAL AND METHODS

Establishment and surveying permanent experimental plots

Permanent experimental plots (PEP) were established in 2001 simultaneously with surveying using the method

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Table 1. Basic characteristics of particular PEP in the Kněhyně-Čertův mlýn NNR

Permanent experimental plot (PEP)	Čertův mlýn I	Čertův mlýn II	Kněhyně I	Kněhyně II
Abbreviation of the PEP	CM-I	CM-II	KN-I	KN-II
Co-ordinates	49°29´15´´N 18°18´07´´E	49°29´14´´N 18°18´06´´E	49°29´45´´N 18°18´47´´E	49°29´49´´N 18°18´49´´E
Altitude (m)	1,150–1,180	1,120–1,150	1,220–1,240	1,230–1,245
Slope (°)	36	33	11	12
Aspect	W	W	SE	E
Stand age	160	160	170	170
Species composition (%)	beech 85, sycamore maple 13, spruce 2	beech 55, spruce 43, sycamore maple 2	spruce 100	spruce 99, beech 1
STG	*Fagi-acereta superiora* (6C3)	*Abieti-fageta piceae typica* (6B3)	*Sorbi-piceeta* (7 A-AB 3)	*Sorbi-piceeta* (7 A-AB 3)

of Field Map (Russ 2001). The PEP are of a standard size 50 × 50 m, area 0.25 ha. Boundaries of PEP were stabilized in corner points and in centres of particular sides by wooden pegs which were painted by a reflective paint for the purpose of visualization. Pegs also marked reference points inside the area, which are inevitable in case of additional measurements. The number of reference points is directly related to the visibility of terrain.

The following parameters were studied in the plots: the volume of dead wood, the number of dead stems, species composition, the structure of dead wood.

Characteristics of particular plots from the viewpoint of their development

The permanent experimental plots were situated in stands of the same age amounting to 160 years in Mt. Čertův mlýn and 170 years in Mt. Kněhyně.

The species composition of stands in PEP is diametrically different between Čertův mlýn (PEP CM-I, CM-II) and Kněhyně (KN-I, KN-II). While forest stands of Mt. Čertův mlýn are characteristic by the occurrence of *Fagus sylvatica* L., *Acer pseudoplatanus* L. and *Picea abies* (L.) P. Karst, in Mt. Kněhyně, there are climax spruce stands with sporadically interspersed beech and mountain ash.

In all PEP, stands occur in the stage of disaggregation. In PEP KN-II only, where a fragment has been preserved from the parent stand (which is replaced by relatively vital natural regeneration), we can speak on the stage of regeneration.

Surveying the forest detail with the inventory of dead wood

In PEP, all living trees and dead standing trees were numbered. Fallen dead trees were marked separately. In case of fallen dead beech trees, often branched or with multiple stems, the stem was divided into sections.

The situation was recorded in the Field Map system and further modified and visualized using the ArcView (GIS) program. A final output consists in position plans of particular PEP with the precise positional mapping of surveyed objects.

In living trees, the following parameters were measured: diameter at breast height (dbh), height, deviation from the vertical axis, crown height (both of living and dead crowns) and crown projection in some plots. In mapping the forest detail, stress was mainly laid on the inventory of dead wood. In standing dead trees, height and dbh were measured and in fallen dead trees, diameter at top end, butt end and at points of fracture.

Trees with a diameter < 4 cm were recorded in the form of polygons and in maps they occur as the layer of regeneration including both natural seeding and advance growth. Planting in advance (if occurred) was recorded in the form of points.

In conclusion of the inventory, 1 to 2 transects were designed at right angles to the contour showing the course of terrain in particular PEP.

Volume calculation, processing and evaluation of data

The volume of living trees and standing dead trees was calculated by means of tables based on respective heights and dbh. In standing dead trees but also in living trees with broken off crown where the accuracy of calculation according to volume tables would not be fulfilled, the calculation was carried out using Smalian's formula for calculation of the lying stem volume which calculates with the area of butt end (S0) and top end (S1) of the section of a respective length (h) $[(S0 + S1)/2 \times h]$. Similarly, the volume of fallen dead stems is calculated by the Field Map programme. A laser telemeter is not able to determine the stem diameter and, therefore, diameter in the point of breaking off and at the tree base had to

Table 2. The number and volume of living trees and standing and fallen dead trees per ha

PEP	Species	Living trees		Standing dead trees		Fallen dead trees	
		number trees/ha	volume (m^3/ha)	number trees/ha	volume (m^3/ha)	number trees/ha	volume (m^3/ha)
CM-I	*Fagus sylvatica*	296	180.52	40	14.56	200	39.80
	Acer pseudoplatanus	44	58.16	0	0.00	0	0.00
	Picea abies	8	11.64	0	0.00	16	10.08
	Total	**348**	**250.32**	**40**	**14.56**	**216**	**49.88**
CM-II	*Fagus sylvatica*	124	83.04	32	10.56	132	24.24
	Acer pseudoplatanus	4	2.64	0	0.00	0	0.00
	Picea abies	96	204.16	48	47.96	120	44.76
	Total	**224**	**289.84**	**80**	**58.52**	**252**	**69.00**
KN-I	*Picea abies*	220	178.76	140	61.32	220	66.96
	Total	**220**	**178.76**	**140**	**61.32**	**220**	**66.96**
KN-II	*Picea abies*	280	84.12	112	48.96	280	156.64
	Fagus sylvatica	20	0.48	0	0.00	0	0.00
	Sorbus aucuparia	4	0.04	0	0.00	0	0.00
	Total	**304**	**84.64**	**112**	**48.96**	**280**	**156.64**

be converted by means of stem taper. The taper was calculated for each of the plots separately for living trees with undamaged crown tops. Tree overbark volume was converted to tree underbark volume using a coefficient $k = 0.90909$.

RESULTS

Total volume of living and dead wood per ha

The total wood supply determined by the Field Map method amounted to 315, 418, 307 and 290 m^3/ha in PEP CM-I (Table 2), CM-II, KN-I and KN-II , respectively. The average wood supply per ha was 332 m^3/ha. Thus, the sum of total wood supplies in four PEP (4 × 0.25 ha) representing an area of 1 ha amounted to 309 m^3/ha.

The living stand volume (growing stock) and its share in the total wood supply amounts to 250 (80%), 290 (69%), 179 (58%) and 84 (29%) m^3/ha in CM-I, CM-II, KN-I and KN-II, respectively. Mean volume of the living stand amounts to 193 m^3/ha.

The volume of dead trees (both standing and fallen) and their proportion in the total wood supply is 64 (20%), 128 (31%), 128 (42%) and 206 m^3/ha (71%) in CM-I, CM-II, KN-I and KN-II, respectively. Mean volume of dead trees amounts to 132 m^3/ha.

The volume of standing dead trees and their share in the total volume of dead trees amounts to 14 (23%), 58 (46%), 61 (48%) and 49 m^3/ha (24%) in CM-I, CM-II, KN-I and KN-II, respectively. Mean volume of standing dead trees amounts to 46 m^3/ha.

The volume of down woody material and its share in the total volume of dead trees amounts to 50 (77%), 70 (54%), 67 (52%) and 157 m^3/ha (76%) in CM-I, CM-II, KN-I and KN-II, respectively. Mean volume of fallen dead trees amounts to 86 m^3/ha.

Mean proportion of dead wood in the total standing volume amounted to 40% (Table 3). The lowest proportion

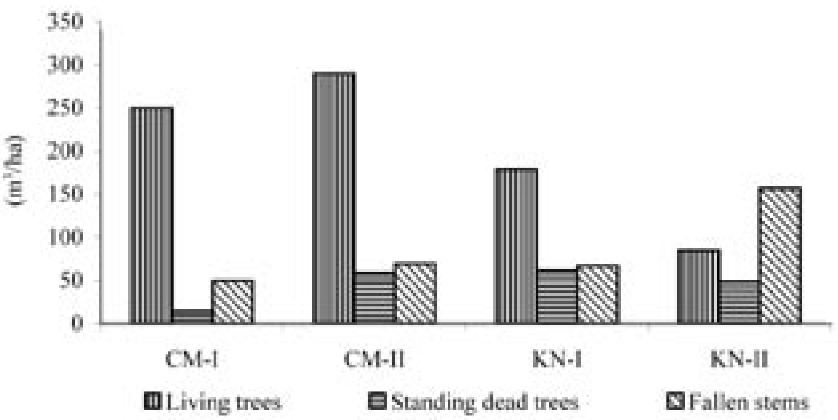

Fig. 1. Total wood supply per ha according to particular plots

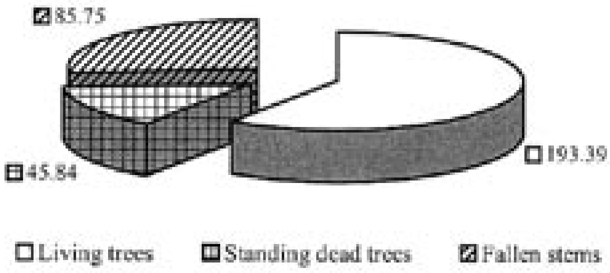

Fig. 2. Average wood supply per ha in the Kněhyně-Čertův mlýn NNR

was in CM-I (20.47%) and CM-II (30.64%). It is necessary to consider the high proportion of dead wood in KN-II (70.84%) as the result of unnatural disaggregation of the stand. As for stress factors, particularly air pollution and *Ips typographus* (L.) occurred at the end of the 80s and at the beginning of the 90s of the 20th century.

From the viewpoint of species composition, it is necessary to mention the situation in CM-I where at an age of 160 years it is possible to state that a number of beech trees lives to a physiological age under given conditions and windfalls of the trees occur owing to the development of stem rots (*Ustulina deusta* [Fr.] Petrak, *Fomes fomentarius* [L.: Fr.] Kickx, *Ganoderma applanatum* [Pers.] Pat. etc.). While in beech it is possible to state that the proportion of dead wood is about 30% of the volume of living trees, in *Acer pseudoplatanus* L. no dead stem was recorded in the stage of development. Similar situation occurs also in PEP CM-II where the proportion of beech dead wood was about 40%. The situation is also similar from the aspect of the number of dead stems when their number approaches

Table 3. Total wood supply per ha and the proportion of living trees and standing and fallen dead trees

PEP	Living trees		Dead trees: standing dead trees		Dead trees: fallen stems		Dead trees: coarse woody material		Living trees + dead trees
	(m^3/ha)	(%)	(m^3/ha)	(%)	(m^3/ha)	(%)	(m^3/ha)	(%)	(m^3/ha)
CM-I	250.32	*79.53*	14.56	*4.62*	49.88	*15.85*	64.44	*20.47*	314.76
CM-II	289.84	*69.36*	58.52	*14.01*	69.50	*16.63*	128.02	*30.64*	417.86
KN-I	178.76	*58.22*	61.32	*19.97*	66.96	*21.81*	128.28	*41.78*	307.04
KN-II	84.64	*26.16*	48.96	*16.87*	156.64	*53.97*	205.60	*70.84*	290.24
∑ PEP	200.89	*60.42*	45.84	*11.53*	85.75	*25.79*	131.59	*39.58*	332.48

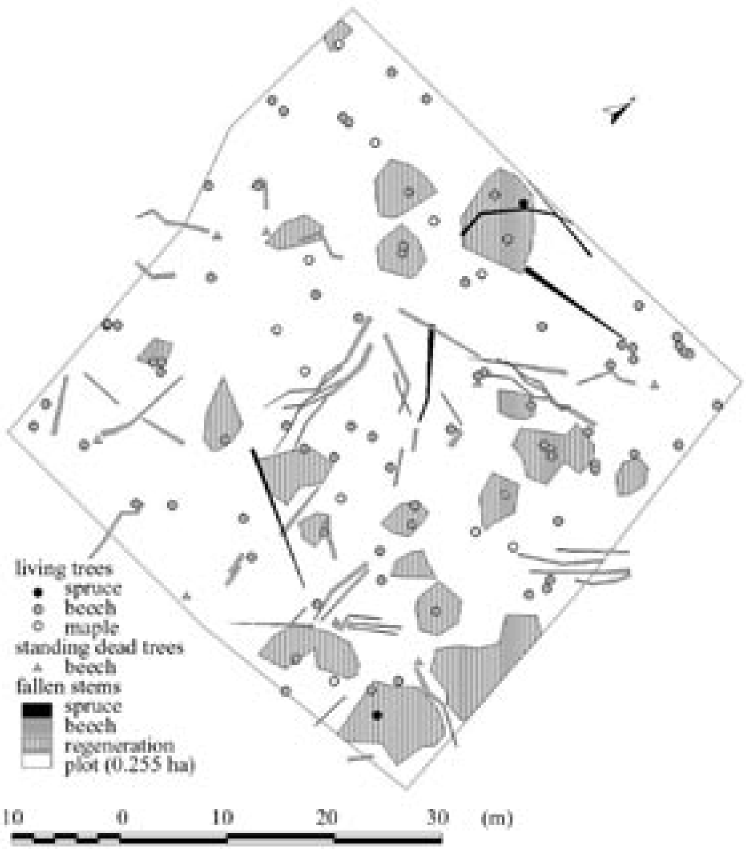

Fig. 3. Situation in plot Čertův mlýn I (CM-I)

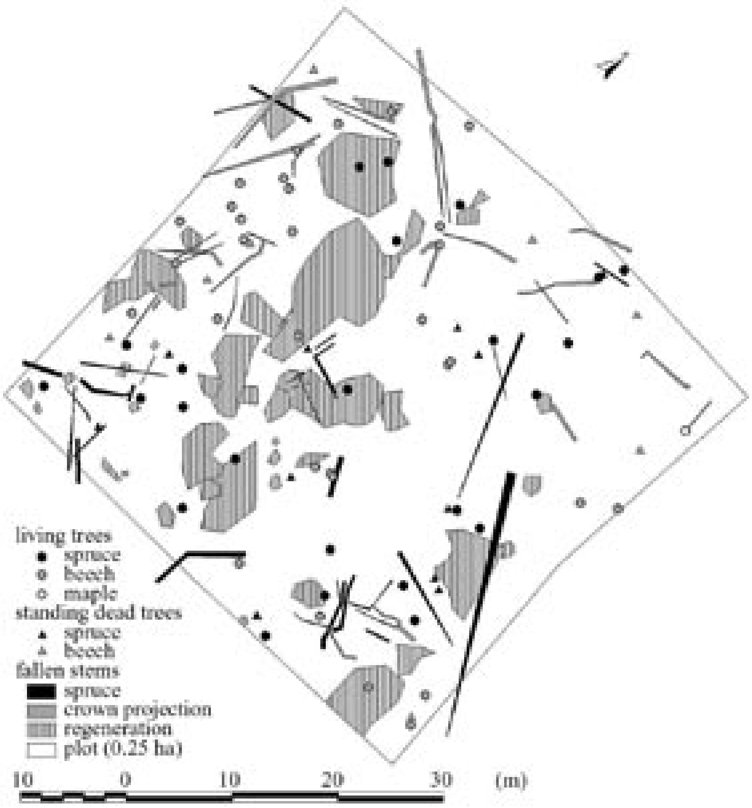

Fig. 4. Situation in plot Čertův mlýn II (CM-II)

or exceeds the number of living stems. The condition reflects dynamics of stands when wood decomposition is under given conditions a long-term process. Plots KN-I and KN-II in Mt. Kněhyně are more or less homogeneous stands dominated by spruce. The volume of dead wood is dominant there. The condition is, however, the result of other stressors than the result of a natural development of stands which is particularly evident in plot KN-II where the dominance of dead wood as against the wood of living trees is quite distinct. It is necessary to mention the proportion of living beech trees although dead wood of the species has not been noticed.

Fig. 5. Situation in plot Kněhyně I (KN-I)

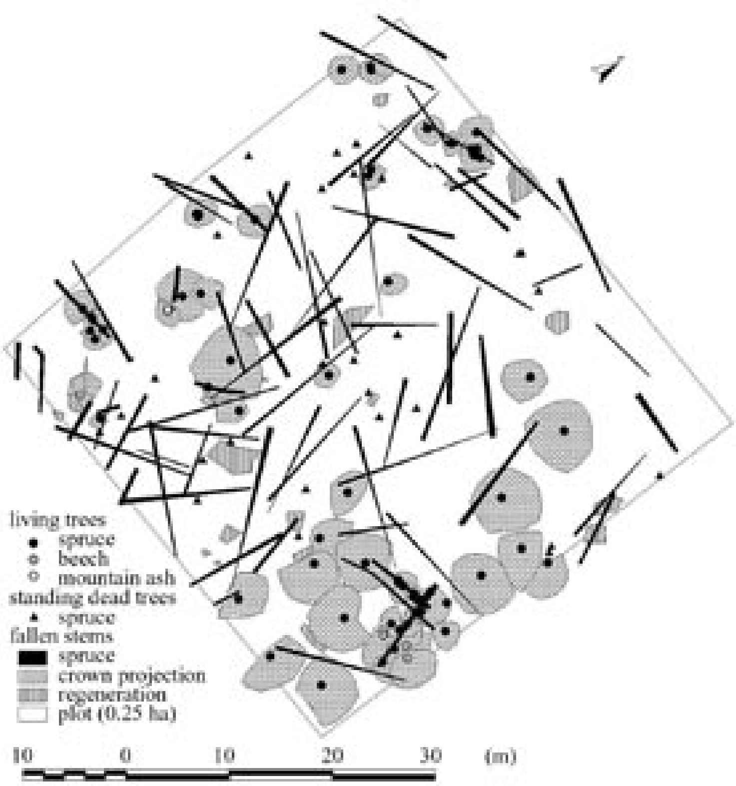

Fig. 6. Situation in plot Kněhyně II (KN-II)

Table 4. The proportion of dead wood, viz. actual (measured) and model minimal (20%) and optimal (30%) of the example of investigated plots

Permanent experimental plots	Actual volume		Model volume			
			minimal		optimal	
	(m^3/ha)	(%)	(m^3/ha)	(%)	(m^3/ha)	(%)
CM-I	64	20	64	20	94	30
CM-II	128	31	84	20	125	30
KN-I	128	42	61	20	92	30
KN-II	206	71	58	20	87	30
Mean	**132**	**40**	**66**	**20**	100	30

DISCUSSION

The volume of dead wood in central European forests is being estimated to range between 50 to 200 m^3 per hectare (ALBRECHT 1991). However, the volume of decaying wood greatly depends on the forest type, stand age, relief, etc. Studying the situation in Czech nature reserves HORT and VRŠKA (1999) mention the share of dead trees in total stock ranging from 8.6–47% of total standing volume. Expressed in absolute terms, the volume of decaying wood in these reserves ranged between 50 to 220 m^3 per hectare. KORPEĽ (1988, 1997) recorded as much as 85–400 m^3 decaying wood per hectare in the Carpathian spruce virgin forests. The amount and structure of dead wood vary depending on geographical location, stand age, forest type etc. The proportion in the standing volume fluctuates with the developmental stage of the forest.

While in Scandinavia, the standing volume is about 50–150 m^3/ha in relation to locality (ROUVINEN, KOUKI 2002), in the region of Karelia in Russian, the volume of coarse woody debris amounts to 69.5 m^3/ha ranging from 22.2 to 158.7 m^3/ha (KARJALAINEN et al. 2002).

A nationwide inventory for estimating the amount, structure, and dynamics of dead wood has been conducted in Sweden already. Based on data from 1994–1996, the average volume of dead wood on managed productive forestland in Sweden was estimated to be 6.1 m^3/ha. The highest average volumes were found in spruce (*Picea abies*) forests in northern Sweden (12.8 m^3/ha). The average annual production of dead wood was estimated to be 0.18 m^3/ha (FRIDMAN, WALHEIM 2000). In Britain, KIRBY et al. (1998) mention 60–140 m^3/ha of dead wood from unmanaged forests and less than 20 m^3/ha from managed forests.

The highest biomass of dead wood was observed in the Slovak virgin forest of Badín in the disaggregation phase with 455.36 m^3/ha and with 439.16 m^3/ha in Dobroč for the same stand development stage. The relation between dead wood and living biomass in the aggregation phase (juvenile growing phase) was 1:2 in Badín forest and between 1:2 and 1:3 in the Dobroč forest, while a maximum was reached in the optimal phase with a variation between 1:5 and 1:6. In the disaggregation phase, the variation was between 1:2 and 1:2.5 (SANIGA, SCHÜTZ 2001a). A similar situation can be noticed also in other virgin forests of Slovakia (SANIGA, SCHÜTZ 2001b, 2002).

The stronger differences were revealed among the various developmental phases in the Bialowieza Primeval Forest in Poland. The volume of coarse woody debris ranged from 147 m^3/ha in degradation phase to 630 m^3/ha in biostatic-optimal phase. Difference in rate of stand development was responsible for the variability of tree volume within 338 m^3/ha in early succession stand versus 634 m^3/ha in close-to-climax stand. Coarse woody debris contributed about one-quarter of the total above ground wood biomass in Bialowieza ecosystems, ranging from 87 to 160 m^3/ha (BOBIEC 2002).

High standing volume and the occurrence of dead wood is mentioned by DEBELJAK (1999) on the example of the Pecka fir/beech (*Abieti-Fagetum dinaricum*) Slovenian virgin forest. For beech, he gives the volume of dead wood 109.29 m^3/ha and growing stock 529.65 m^3/ha. For silver fir, it is 521.19 m^3/ha of dead wood and 166.12 m^3/ha growing stock.

According to studies conducted in the period 1987 to 1991, the proportion of dead wood in present commercial forests of the Czech Republic ranges about 7% of the total biomass (KRAUS 1999). In natural forests, the volume of dead wood is, however, substantially higher. Based on studies of natural conditions in nature reserves of the CR, the volume of dead wood in relation to the total standing volume ranges from 9 to 50% (HORT, VRŠKA 1999; VRŠKA et al. 2000a,b, 2001a,b,c, 2002). In mountain climax spruce communities in the Krkonoše Mts., the proportion of dead wood reaches up to 35% of the total standing volume. The average volume of coarse woody debris amounts there 162 m^3/ha (u.b.), of this 115 m^3 are standing dead trees and 46 m^3 down woody material (JANKOVSKÝ et al. 2002).

The average volume of dead wood determined by measurements in the Kněhyně-Čertův mlýn National Nature Reserve (NNR) was 132 m^3/ha, i.e. 40% of the total wood volume. Of this, 86 m^3/ha amounts to wood of down woody material and 46 m^3/ha standing dead trees. The determined standing volume of a living stand as an average for all plots amounts to 193 m^3/ha. If we do not take into account PEP Kněhyně II where the stand was affected by a bark beetle disaster the growing stock amounts to on average 240 m^3/ha. These data roughly correspond to the lower limit of volumes from 1976 (VACEK et al. 1994) at the Labský důl locality, the Krkonoše Mts. which ranged from 157 to 916 m^3/ha. The highest growing stock occurs in PEP Čertův mlýn II, viz. about 290 m^3/ha and, on the contrary, the lowest one in PEP Kněhyně II where it reaches 84 m^3/ha only.

Also in the Milešický prales Nature Reserve, the Šumava Mts. which approaches by its altitude of 1,100 m to conditions of PEP in the Beskids, 138 m^3/ha of standing dead trees were recorded, thus nearly the same volume (HORT, VRŠKA 1999). The average proportion of dead wood in relation to the living stand amounts to 68% (without PEP Kněhyně II 45%). Very similar values were found in the Razula NNR (715–815 m alt.), viz. 47%. The lowest volume of standing or fallen dead trees occurs in PEP Čertův mlýn I amounting to 14 or 50 m^3/ha, respectively. The highest volume of standing dead trees occurs in PEP Kněhyně I, viz. 61 m^3/ha and that of fallen dead trees in PEP Kněhyně II, viz. 157 m^3/ha.

In total, the average proportion of dead wood in studied PEP amounts to about 40% of the total average standing volume which is 332 m^3/ha. The value considerably approaches to 35% found in PEP in the Krkonoše Mts. (JANKOVSKÝ et al. 2002).

From the viewpoint of forest ecosystem management, it is not possible to determine universally either a minimum or maximum proportion of dead wood particularly with respect to the forest dynamics. Similarly, the high proportion of dead wood is not a symptom of stability or of the autochthonous character of an actual stand particularly as for the consequence of a premature disintegration of a forest ecosystem. Even in mature stages, the amount of dead wood does not exceed 60–70% of the standing volume. Thus, a higher proportion can be the result of a premature disintegration and disturbance of an ecosystem. About 20% of a growing stock can be considered to be the minimum amount of dead wood. The limit was observed in all plots under investigation. A condition in plots Čertův mlýn I and II can be considered to be the natural condition of a sycamore maple or silver fir/beech community at the beginning of the stand disintegration. Differences in the proportion of dead wood between the plots are minimum ranging from 20 to 30%. However, as for an absolute difference, it is possible to find as much as double difference in the volume of dead wood in both plots resulting from differences in the growing stock. In other two plots Kněhyně I and Kněhyně II, there is a higher proportion in dead wood as a result of damage to the stand by air pollution and bark beetles in previous years. Under given conditions of the nature reserve and stand age, about 30% of the standing volume is considered to be the optimum proportion of dead wood (Table 4). However, it is necessary to emphasize a fact that the mentioned values of the minimum and optimum volumes of dead wood are intended for mature stands situated in the 6th spruce/fir/beech to the 7th spruce forest vegetation zone and classified in the category of protection or special-purpose forests. A situation on the Mt. Kněhyně top can be considered to be a quite unnatural condition. In 1992, a bark beetle disaster occurred there and barked and debranched wood was left on the plot. Stems are decomposed to a minimum extent by the fungus *Gloeophyllum abietinum* (Bull.: Fr.) P. Karst. Other species of wood-destroying fungi occur on such debarked stems only exceptionally.

To a certain extent, the findings obtained can be also applied in a commercial forest where the share of dead wood is given from 1 to 6%. For example in Germany, it is from 1–3 m^3/ha to 5–10 m^3/ha, i.e. 1–2% of the growing stock (AMMER 1991). In the Czech Republic, the proportion approaches 7% which amounts to about 15–20 m^3 unprocessed wood per ha (KRAUS 1999). The values consider the above-ground part of a stem only while the woody biomass of roots and stumps is not included in the calculations. Generally, the woody biomass of underground parts is estimated to be 30 to 60% of the standing volume. The character of decomposition of woody biomass placed in soil and that of the above-ground part is diametrically different as well as the decomposition of smallwood (below 7 cm d.o.b.) and wood of stems. From the viewpoint of forest management planning, it is possible to consider about 15 to 30 m^3/ha to be a minimum amount of left above-ground biomass. The structure, quality and dispersion of left woody biomass is a marked and so far unstudied factor. In the majority of commercial forests, the only suitable substrate for decomposition processes is logging debris, stumps and root systems which are usually not processed. Particularly stems of larger dimensions are absent.

CONCLUSION

In 2000–2002, in 4 permanent experimental plots of an area of 50 × 50 m situated in the zone of climax spruce, sycamore maple/beech and rowan/spruce communities in the Beskids, a general inventory was carried out of living and dead wood with an accurate survey of particular plots.

An average total timber supply per ha in the region of the Kněhyně-Čertův mlýn NNR amounted to 332 m^3/ha. The average volume of coarse woody debris and a proportion in the total standing timber reaches 132 m^3/ha (40%) of which down woody material amounts to 86 m^3/ha and standing dead trees represent 46 m^3/ha.

About 20–30% of the growing stock can be considered to be the optimum amount of dead wood. Under given conditions, it is 60–120 m^3/ha. However, the structure and quality of wood in a stand as well as frequency distribution of dead wood in particular stages of decomposition or age are a question. The found out volume of dead wood cannot be generalized for commercial forests where other priorities are determined than in case of protected regions. Nevertheless, also there it is acceptable even from the economic point of view to leave standing dead trees and down woody material without any processing. In case of phyto-sanitary hazard only, it is necessary to consider sanitation measures. The most important risk factor in spruce is cambioxylophagous insect particularly in case of unmixed spruce stands.

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Inventarizace tlejícího dřeva v NPR Kněhyně-Čertův mlýn (Moravskoslezské Beskydy)

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ABSTRAKT: Na čtyřech trvalých výzkumných plochách v podmínkách horských lesních ekosystémů NPR Kněhyně-Čertův mlýn (Moravskoslezské Beskydy) bylo inventarizováno tlející dřevo. Byly zachyceny tlející kmeny, stojící souše a živé stromy. Získaná data byla využita ke stanovení dílčích a sumarizovaných objemů tlejícího dřeva a jeho podílu na živém porostu. Každý zaměřený objekt byl popsán nejen z pohledu dendrometrického, ale i s ohledem na následně probíhající výzkumy biodiverzity dřevní mykoflóry, sukcese dekompozičních procesů, přirozené obnovy na tlejícím dřevě aj. Průměrná celková hektarová zásoba dřeva byla v oblasti NPR Kněhyně-Čertův mlýn 332 m^3/ha. Průměrný objem tlejícího dřeva a podíl na celkové zásobě dřeva dosahuje 132 m^3/ha (40 %), z toho 86 m^3/ha činí hmota ležících souší a 46 m^3/ha hmota stojících souší.

Klíčová slova: tlející dřevo; inventarizace; Field Map; Moravskoslezské Beskydy; NPR Kněhyně-Čertův mlýn

Přítomnost tlejícího dřeva je charakteristickým rysem lesních ekosystémů. Výrazně tak determinuje les od jiných typů terestrických společenstev. Příznivý efekt tlejícího dřeva se projevuje v koloběhu prvků, v retenční funkci lesa, tlející dřevo je významné z hlediska biodiverzity, podpory mykorhiz apod. Je významným fenoménem obnovy lesa zvláště v horských oblastech. Cílem práce je inventarizace tlejícího dřeva v podmínkách NPR Kněhyně-Čertův mlýn.

Na čtyřech trvalých výzkumných plochách (dále TVP) označených jako Kněhyně I a II (dále KN-I, KN-II) a Čertův mlýn I a II (dále CM-I, CM-II) byla provedena inventarizace tlející dřevní hmoty. Na TVP jsou očíslovány veškeré živé stromy a stojící souše. Ležící souše jsou označeny samostatně. Situace byla zachycena v systému Field Map a dále upravována a vizualizována v programu ArcView (GIS). Finálním výstupem jsou poziční plány jednotlivých TVP s přesným pozičním vykreslením zaměřených objektů.

U živých stromů byl změřen průměr ve výčetní výšce, výška, případný odklon od svislé osy, nasazení živé a odumřelé části koruny a na některých plochách korunová projekce. Při mapování lesního detailu byl důraz kladen především na inventarizaci tlejícího dřeva. U stojících souší byla měřena pouze výška, tloušťka ve výčetní výšce a u ležících souší průměr na čele, čepu a v místech zlomu.

Celková zásoba dřeva zaměřená metodou Field Map činí u TVP CM-I 315 m^3/ha (tab. 2), u CM-II 418 m^3/ha, u KN-I 307 m^3/ha a u KN-II 290 m^3/ha. Průměrná hektarová zásoba dřeva je 332 m^3/ha. Součet celkových zásob dřeva na čtyřech TVP (4 × 0,25 ha), které mají dohromady rozlohu 1 ha, dosahuje 309 m^3/ha.

Objem živého porostu a jeho podíl na celkové zásobě dřeva dosahuje u CM-I 250 m^3/ha (80 %), u CM-II 290 m^3/ha (69 %), u KN-I 179 m^3/ha (58 %) a u KN-II 84 m^3/ha (29 %). Průměrný objem živého porostu činí 193 m^3/ha.

Objem souší (stojících i ležících) a jejich podíl na celkové zásobě dřeva je u CM-I 64 m^3/ha (20 %), u CM-II 128 m^3/ha (31 %), u KN-I 128 m^3/ha (42 %) a u KN-II 206 m^3/ha (71 %). Průměrný objem souší dosahuje 132 m^3/ha.

Objem stojících souší a jejich podíl na celkovém objemu souší činí u CM-I 14 m^3/ha (23 %), u CM-II 58 m^3/ha (46 %), u KN-I 61 m^3/ha (48 %) a u KN-II 49 m^3/ha (24 %). Průměrný objem stojících souší dosahuje 46 m^3/ha.

Objem ležících souší a jejich podíl na celkovém objemu souší činí u CM-I 50 m^3/ha (77 %), u CM-II 70 m^3/ha (54 %), u KN-I 67 m^3/ha (52 %) a u KN-II 157 m^3/ha (76 %). Průměrný objem ležících souší je 86 m^3/ha.

Průměrný podíl tlejícího dřeva z celkové porostní zásoby byl 40 % (tab. 3). Nejnižší podíl byl u plochy CM-I (20,47 %) a CM-II (30,64 %). Vysoký podíl tlejícího dřeva na ploše KN-II (70,84 %) je nutné považovat za důsledek nepřirozeného rozkladu porostu. Ze stresových faktorů se zde koncem osmdesátých a počátkem devadesátých let 20. století uplatnily především imise a lýkožrout smrkový *Ips typographus* L.

Z hlediska druhového složení je třeba se zmínit o situaci na ploše CM-I, kdy ve věku stromů 160 let je možné konstatovat, že řada buků se zde dožívá fyziologického věku v daných podmínkách a dochází k vyvracení buků v důsledku rozvoje hnilob ve kmenech (*Ustulina deusta* [Fr.] Petrak, *Fomes fomentarius* [L.: Fr.] Kickx, *Ganoderma applanatum* [Pers.] Pat. aj.). Zatímco u buku je možné konstatovat, že podíl tlejícího dřeva je asi 30 % objemu dřeva živých stromů, u *Acer pseudoplatanus* L. nebyl zaznamenán v této fázi rozpadu žádný tlející kmen. Obdobná situace je i u TVP CM-II, kde podíl tlejícího dřeva buku byl asi 40 %. Podobná situace je i z hlediska počtu tlejících kmenů, kdy se jejich počet blíží počtu nebo překračuje počet kmenů živých. Tento stav reflektuje dynamiku porostů, kdy rozklad dřeva je v daných podmínkách dlouhodobým procesem. Plochy na Kněhyni KN-I a KN-II jsou víceméně homogenní porosty s dominancí smrku. Objem tlejícího dřeva je zde dominantní. Tento stav je však spíš důsledkem působení jiných stresorů než výsledkem přirozeného rozvoje porostů, což je zřejmé zvláště na ploše KN-II, kde je jednoznačná převaha tlejícího dřeva nad dřevem živých stromů. Zde je třeba upozornit na zastoupení živých buků, přestože tlející dřevo této dřeviny nebylo zaznamenáno.

Za optimální množství tlející dřevní hmoty je možné v těchto podmínkách považovat asi 20–30 % porostní zásoby; v daných podmínkách je to 60–120 m^3/ha. Otázkou je však struktura a kvalita dřevní hmoty v porostu a rozložení četnosti tlejícího dřeva ve stupních rozkladu, resp. jejího stáří. Zjištěné množství tlejícího dřeva není možné generalizovat pro lesy hospodářské, kde jsou vytyčeny jiné priority než v případě chráněných území; přesto i zde je také z ekonomického hlediska přijatelným řešením ponechání stojících a ležících souší bez jakéhokoli zpracování. Jen v případě hrozby fytosanitárních rizik je nutné uvažovat o sanačním zásahu. Nejvýznamnějším rizikovým faktorem je v případě smrku podkorní hmyz, zvláště pokud jde o nesmíšené smrkové porosty.

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