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People's attitudes towards deadwood in forest: evidence from the Ukrainian Carpathians

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Abstract: People's attitudes towards forest stand characteristics including deadwood are becoming increasingly relevant in sustainable forest management. The aim of this study is to investigate people's attitudes towards deadwood in forest. The study was carried out in the Rakhiv region (Ukraine) characterized by high importance of forest resources for the local community and economy. People's opinions were collected through the face-to-face administration of a questionnaire to 308 respondents. The survey investigated three aspects: importance of deadwood in forest; people's perceptions of positive and negative effects of deadwood in forest; effects of presence and amount of deadwood in different types of forest on people's aesthetical preferences. The results show that the majority of respondents consider deadwood as an important component of the forest, but generally they prefer intensively managed forests without deadwood. According to the respondents' opinions, the most important positive effect of deadwood is a contribution to stand dynamics, while the most important negative effect is an increasing risk of insects and diseases.

Keywords: sustainable forest management; standing dead trees; lying deadwood; people's perceptions and preferences; questionnaire survey; Rakhiv region (Ukraine)

In the Global Forest Resources Assessment 2020 (FAO 2018) deadwood encompasses all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. According to this definition, deadwood includes wood lying on the surface, standing dead trees, dead roots, and stumps of not less than 2.5 cm in size, while wood fragments below this threshold are to be considered litter (Paletto, Tosi 2010).

Until recently, deadwood in forest ecosystems was perceived negatively in the traditional forest management. The presence of deadwood in forest was associated with the frequent occurrence of forest fires (Travaglini et al. 2007), insects and diseases (Radu 2006), as an obstacle to recreational activities (Pelyukh, Zahvoyska 2018) and forest management practices (Travaglini et al. 2007).

As time has gone by, many studies have shown several positive functions of deadwood in a forest ecosystem (Paletto et al. 2012). Particularly, deadwood plays a key role for biodiversity conservation providing habitats for vertebrates, cavity-nesting birds, saproxylic insects, bryophytes and lichens (Müller, Bütler 2010), carbon, nitrogen and phosphorus cycles (Holub et al. 2001), natural regeneration of natural and semi-natural forests (Merganičová et al. 2012), forest productivity (Debeljak 2006), soil erosion and hydrological processes (Kraigher et al. 2002), to prevent the occurrence of avalanches (Kupferschmidt et al. 2003), stabilizing steep slopes and stream channels (Densmore et al. 2004).

In recent decades, deadwood has become an indicator of Sustainable Forest Management (SFM)

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under the criterion "Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems" identified by the 3rd Ministerial Conference on the Protection of Forests in Europe (MCPFE 1998). In addition, deadwood was included in the five-point carbon pools (above-ground and below-ground biomass, deadwood, litter, soil) provided by Intergovernmental Panel on Climate Change-Good Practice Guidance for Land Use, Land-Use Change and Forestry.

Such recognition of the role of deadwood contributed to the increased amount of this forest component in most of European regions over the past 20 years. In Europe, the average volume of deadwood, both standing dead trees and lying deadwood, ranges between 8 $m^3 \cdot ha^{-1}$ in the northern part of Europe and 20 $m^3 \cdot ha^{-1}$ in the central and western part of Europe. In Ukraine, the average volume of total deadwood was 6 $m^3 \cdot ha^{-1}$ (3.7 $m^3 \cdot ha^{-1}$ of standing dead trees and 2.3 $m^3 \cdot ha^{-1}$ of lying deadwood) in 2015 (Forest Europe 2015). In the European beech (*Fagus sylvatica* L.) virgin forest of the Ukrainian Carpathians the volume of deadwood is a bit higher than across the country – from 30 to 50 $m^3 \cdot ha^{-1}$ in the middle of the optimum stage and 200–300 $m^3 \cdot ha^{-1}$ at the end of the decomposition stage (Commarmot et al. 2005).

In the literature, many authors investigated the individual perceptions and preferences for the aesthetic aspects of forests related to forest management, such as tree species composition, horizontal and vertical stand structure, recreation infrastructures (Nielsen et al. 2007; Edwards et al. 2012; Paletto et al. 2013; De Meo et al. 2015). However, there are few studies about people's perceptions and preferences towards the amount of deadwood in a forest ecosystem (Tyrväinen et al. 2003; Nielsen et al. 2007; Golivets 2011; Hauru et al. 2014; Jankovska et al. 2014; Pastorella et al. 2016a, b; Paletto et al. 2017). Integration of information about people's perception of forest stand characteristics – such as deadwood amount – into forest management planning may enhance the visibility and recreational attractiveness of forest areas (De Meo et al. 2015).

In the Ukrainian Carpathians, investigations about people's perceptions and preferences towards deadwood in forest ecosystems are scarce. Our previous study shows that residents prefer closed mixed forests, but they negatively perceive deadwood in forest (Pelyukh, Zahvoyska 2018). Despite these studies, there is still a paucity of information on people's preferences regarding the visible aspects of forest management, with special regard to deadwood.

Starting from these considerations, the main objective of the present study is to investigate the people's perceptions and preferences towards the presence of deadwood in Ukrainian forests to support forest managers in increasing forest recreational attractiveness. The research questions are thus to understand the positive and negative effects of deadwood in forest considering the people's opinions; to determine the effects of deadwood presence and amount in broadleaved, conifer, and mixed forests on people's aesthetical preferences.

MATERIAL AND METHODS

Study area

The study area is Rakhiv region (48°3'24.72"N; 24°11'48.35"E) in the Ukrainian Carpathians (Fig. 1). The region has a surface of 1,892 km^2 and a population of 93,053 inhabitants divided into 28 villages, three urban-type settlements and one city.

The forests cover a surface area of 1,258 km^2 comprising 66.5% of the Rakhiv region territory with the average growing stock of 370 $m^3 \cdot ha^{-1}$. The main tree species are Norway spruce (*Picea abies* /L./ Karst.), European beech (*Fagus sylvatica* L.), Silver fir (*Abies alba* Mill.), Sycamore maple (*Acer pseudoplatanus* L.), Elm (*Ulmus glabra* Huds.), European ash (*Fraxinus excelsior* L.). According to the data of the Ukrainian governmental forest inventory association "Ukrderzhlisproekt", spruce is the main damaged tree species in the Rakhiv region. The dead spruce trees amount to a volume of 2,220 m^3; 1,440 m^3 damaged by a windstorm and 8,490 m^3 by insects.

The population of the Rakhiv region mostly lives in a rural area (57.8% of the total) and is characterized by a high economic and socio-cultural dependence on forest resources.

Questionnaire survey

The residents of the Rakhiv region were involved in the survey using a semi-structured questionnaire consisting of 15 closed-ended questions divided

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Fig. 1. The geographical location of the study area, Rakhiv region, Ukraine

into three thematic sections. The survey focused on the residents in order to understand the opinions and points of views of local mountain people which are closely related to forest resources.

The first thematic section focuses on the personal information of respondents such as gender, age, level of education, place of work, and place of residence.

The second thematic section considers people's perceptions of three forest stand characteristics: tree species composition, forest stand structure, and canopy openness. In addition, this thematic section investigates people's preferences for recreational infrastructures located in forest and goods and services provided by forest.

The third thematic section focuses on the personal perception of effects generated by deadwood in forest. This thematic section consists of three questions where the respondents assessed the level of deadwood importance in forest, and importance of four negative (i.e. increasing risk of forest fire and insect damage, loss of aesthetic value; obstacle to recreational activities) and ten positive effects of deadwood in forest (i.e. biodiversity conservation; promotion of soil and slope stability by reducing the rate of runoff and erosion; stabilizing stream channels; carbon storage; regulation of nitrogen and phosphorus cycle; contribution to stand dynamics increasing soil fertility; contribution to the new regeneration of natural forest and semi-natural forest; bioenergy production). A 10-point Likert scale format (from 1 = very low to 10 = very high value) was used in order to rate the importance of each effect of deadwood in forest (Likert 1932).

The last question of this thematic section investigates people's aesthetical preferences towards the presence and amount of deadwood in broadleaved, conifer, and mixed forests. For each type of forest, images have been developed where different amounts of deadwood are presented (Fig. 2): (a) all standing dead trees and lying deadwood were removed from forest; (b) forest managed in order to leave less than 15% of medium-sized standing dead trees (smaller than 40 cm) and lying deadwood; (c) forest managed in order to leave more than 15% of large-sized standing dead trees (larger than 40 cm) and lying deadwood. The aim of this last question was to identify the people's opinions on preferred amount and size of deadwood in forests from the aesthetical point of view. The stem diameter of 40 cm was chosen as a diameter class which leads to an increase of species diversity (Dittrich et al. 2014) and it was used as a threshold for standing dead trees to consider the "habitat trees" in the study. According to Bütler et al. (2013) "habitats trees" are defined as standing dead trees providing ecological niches (microhabitats) such as cavities, bark pockets, large dead branches, epiphytes, cracks, sap runs, or trunk rot.

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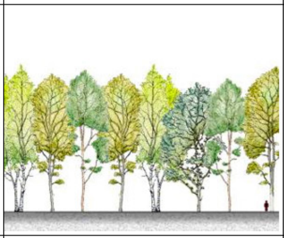
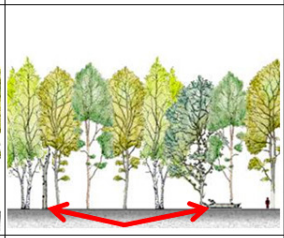
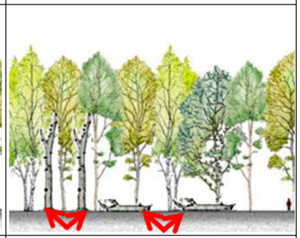
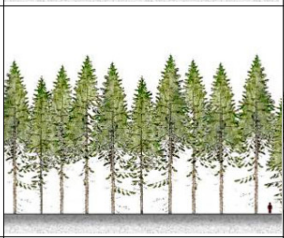
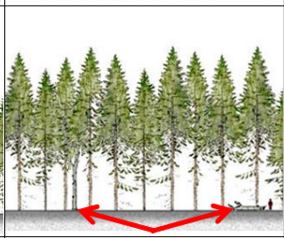
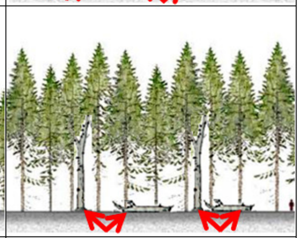
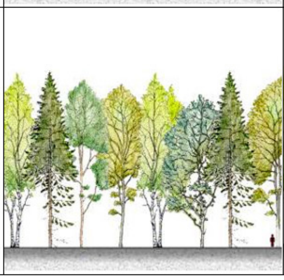
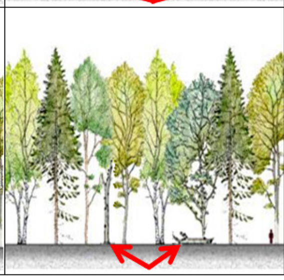
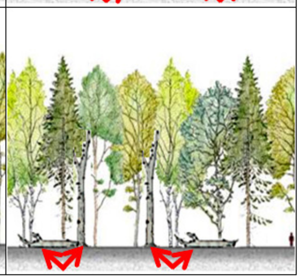
No.	No deadwood in forest	Presence of less than 15% of medium sized standing dead trees (smaller than 40 cm in diameter) or lying deadwood	Presence of more than 15% of large sized standing dead trees (larger than 40 cm in diameter) or lying deadwood
1.			
2.			
3.			

Fig. 2. Images of different amount of deadwood in three types of forest [images were developed by Fitalew Taye, Anna Filuyskhina, Thomas Lundhede, Niels Strange, Jette Bredahl Jacobsen (University of Copenhagen) and Marek Giergiczny (University of Warsaw)]

The survey was conducted in the period from 16 to 30 April 2018 (two weeks) in different villages and cities in the Rakhiv region. The survey was conducted on a sample of 308 persons representing the socio-demographic characteristics of the Rakhiv region. The questionnaire was administered face-to-face that lasted from 15 to 25 minutes each by a single interviewer. The face-to-face administration system was chosen in order to increase response rate, quality of data acquired and a better opportunity to explain the questions unclear to respondents (Goyder 1985).

The sample of respondents was sized considering the main socio-demographic characteristics of local population in the Rakhiv region such as gender, age, level of education, residence and place of work. In the sample, 48% of the respondents are men and 52% are women (Fig. 3). The majority of the respondents are aged between 35 and 55 years of age (40%). Regarding the level of education, the distribution of the sample of respondents is synthesized as follows: 7.1% of respondents have an elementary school degree; 39.9% of respondents have a high school degree; 52.3% of respondents have a university degree, while the remaining 0.7% have not finished an elementary education, or they have not even started.

The majority of the respondents live in a rural area (60.4%), whereas 39.6% in an urban area. Concerning the place of work, the sample of respondents is mainly composed of private sector employees (38.3% of total respondents) followed by pensioners (25.3%), public sector employees (19.5%), students (6.5%), housewives (6.5%) and unemployed people (3.9%).

Data analysis

In this paper, the results of the third thematic section are presented.

The overall respondents' perception of deadwood in forest was evaluated considering the scores assigned to each positive and negative effect provid-

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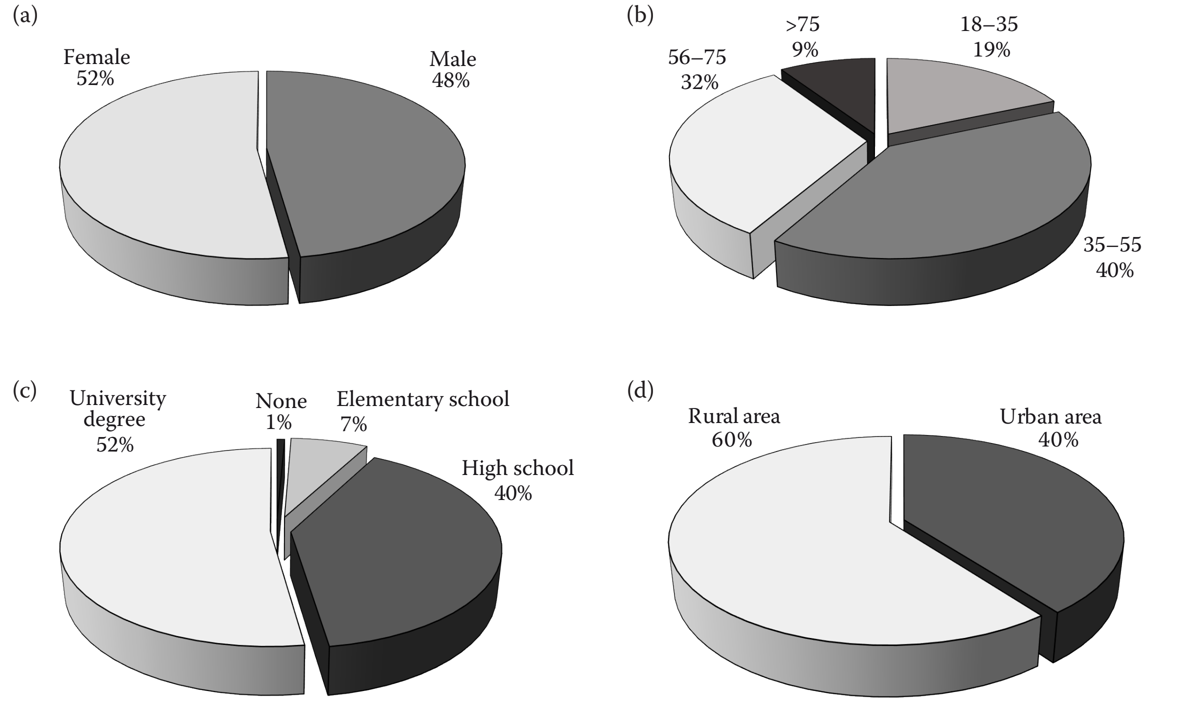

Fig. 3. Socio-demographic characteristics of the respondents: a) Gender, b) Age structure, c) Level of education, d) Residence

ed by deadwood. For each respondent, the overall perception (P_i) was calculated using the following equation (Eq. 1):

$$P_i = \frac{\sum_{y=10}^{1} F_{iy}}{10} - \frac{\sum_{j=4}^{1} F_{ij}}{4} \quad (1)$$

where:

P_i – overall perception of respondent i ($P_i \in [-9 : 9]$)

F_{iy} – positive effect y played by deadwood according to respondent's i perception ($F_{iy} \in [1 : 10]$)

y – index of positive effect s provided by deadwood (y = 10)

F_{ij} – negative effect j played by deadwood according to respondent's i perception ($F_{ij} \in [1 : 4]$)

j – index of negative effect caused by deadwood (j = 4).

The overall perception of each respondent has been used to aggregate the total respondents in five groups: (1) people who perceive deadwood in a very positive way (P_i greater than +1.50); (2) people who perceive deadwood in a positive way (P_i between +1.49 and +0.50); (3) people who perceive deadwood in a neutral way (P_i between +0.49 and –0.49); (4) people who perceive deadwood in a negative way (P_i between –0.50 and –1.49); and (5) people who perceive deadwood in a very negative way (P_i less than –1.50).

In addition, the collected data were analysed considering the socio-demographic characteristics of respondents. The χ^2 test was used to test significance of differences between the groups of respondents. The non-parametric Kruskal-Wallis test and Mann-Whitney U-test were used to highlight the impact of socio-demographic characteristics of the respondents on the answers collected using the Likert scale response format. The non-parametric Kruskal-Wallis test was used to test the statistical differences for age and level of education, while the non-parametric Mann-Whitney U-test was used for testing gender and location impacts.

The main descriptive statistics have been developed for all questions: mean, standard deviation for the data collected using the Likert scale response format, frequency distribution (%) for all other questions.

Spearman's rank correlation coefficient was used to analyse correlations between preferred types of forest (mixed, conifer, broadleaved forests) indicated in the second thematic section of the questionnaire and the images with presence and different amount of deadwood shown in the third thematic section of the questionnaire.

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RESULTS

Positive and negative effects of deadwood

The results of the third part of the questionnaire show that the majority of the respondents (51.0%) consider deadwood as an important component of the forest ecosystem, while 19.8% of respondents consider this component unimportant. The respondents with a high level of education assign a higher importance to deadwood than respondents with a lower level of education. However, the χ^2 test showed no statistically significant differences between groups of respondents with different levels of education. The highest importance of deadwood in forest was estimated by rural inhabitants (60% of rural respondents). The χ^2 test confirms statistically significant differences between perceptions of persons who live in urban and rural areas (χ^2 test: $P = 0.011$, $\alpha = 0.05$).

The results of overall respondents' perceptions of the effects provided by deadwood (Fig. 4) show that 41.9% of respondents consider deadwood a positive component of forest ecosystem, while 28.9% of respondents consider deadwood a negative component of forest ecosystem. Besides, 29.2% of respondents consider the positive and negative effects provided by deadwood on the same level of importance. The overall perception of 308 respondents is in a range between $P_i = -5.54$ and $P_i = 5.95$ with a mean value of 0.28.

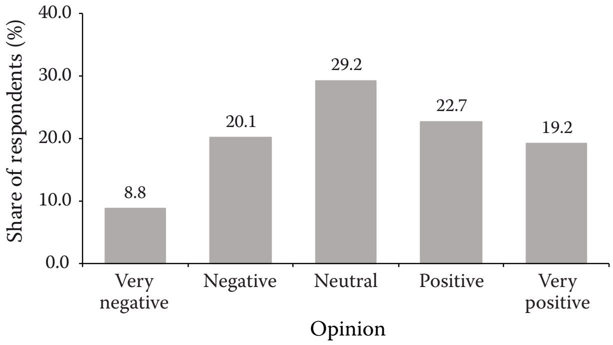

Fig. 4. Distribution of overall respondents' perception (Pi) regarding positive and negative effects of deadwood in forest

The results show that the most important positive effects of deadwood according to respondents' perceptions (Fig. 5) are the contribution to stand dynamics (mean = 7.93), followed by contributions to natural forest regeneration (7.82), and biodiversity conservation (7.66).

Observing the results by socio-demographic characteristics of respondents, a statistically significant difference was found in answers of groups

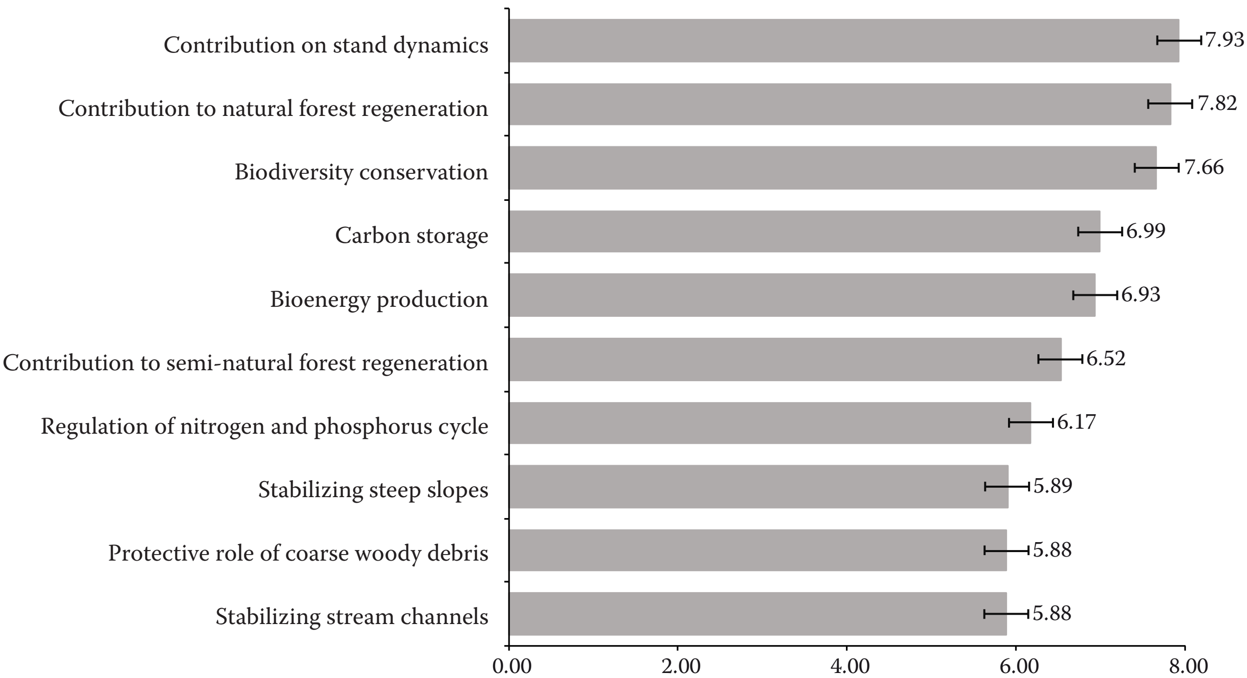

Fig. 5. Perceived importance of the positive effect of deadwood in forest. Mean value from all respondents on a 10-point scale (from 1 = very low to 10 = very high value)

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of respondents with different level of education and age. The non-parametric Kruskal-Wallis test (α = 0.05) shows statistically significant differences related to the level of education only for the deadwood contribution to semi-natural forest regeneration (P = 0.041). The persons with a higher educational level assign a greater importance to this effect of deadwood than the persons with an elementary school degree. Concerning the age, the non-parametric Kruskal-Wallis test shows statically significant differences for many positive effects of deadwood: stabilizing steep slope (P = 0.011) and stream channels (P = 0.004), carbon storage (P < 0.0001), contribution to stand dynamics (P < 0.0001), contribution to the new regeneration of natural and semi-natural forest (both P < 0.0001), and bioenergy production (P < 0.0001): elderly people assign a greater importance to all above-mentioned positive effects provided by deadwood than younger people.

The non-parametric Mann-Whitney U-test (α = 0.01) shows a statistically significant difference for gender: women rated higher the effect on biodiversity conservation (P = 0.002). In terms of geographical location, a significant difference was found with regard to biodiversity conservation (P = 0.002), stabilizing steep slopes (P < 0.0001), stabilizing stream channels (P ≤ 0.001), carbon storage (P ≤ 0.001), regulation of nitrogen and phosphorus cycle (P < 0.0001), contribution to stand dynamics (P ≤ 0.001), contribution to natural forest regeneration (P ≤ 0.001) and semi-natural forest regeneration (P ≤ 0.001). All these positive effects of deadwood in forest rural inhabitants rated higher than urban ones.

According to respondents' estimations, an increasing risk of insect damage is the most important negative aspect related to the presence of deadwood in forest (mean = 7.94, Fig. 6). The least important negative effect is an increasing risk of forest fire (4.34).

Respondents estimated the negative effects of deadwood from the aesthetic point of view and obstacles to recreational activities on average at 6.94 and 6.72 points, respectively.

The non-parametric Kruskal-Wallis test evidences statistically significant differences for the following negative aspects related to the age of respondents: increasing risk of insect damage (P = 0.030), loss of aesthetic value (P = 0.001), and obstacles to recreational activities (P = 0.006). In this case, younger people assign a greater importance to all negative effects provided by deadwood than elderly people.

The non-parametric Mann-Whitney U-test shows statistically significant differences between females and males, and between urban and rural population. Females assigned a higher importance to "Increase the risk of forest fire" (P ≤ 0.001), while males to "Increase the risk of insect damage" (P ≤ 0.003). Respondents from rural areas rated higher "Increase the risk of insect damage" than people who live in urban areas (P ≤ 0.001).

Presence and amount of deadwood

The results (Fig. 7) show that for the respondents the most popular images of the mixed (37.3% of the respondents) and coniferous (21.8%) forests with less than 15% of medium-sized standing dead trees (diameter smaller than 40 cm) and lying deadwood were followed by the images of the same types of forests but without deadwood (12.7% each).

Spearman's rank correlation coefficient shows a positive correlation between the preferred types of forest (second thematic section of the question-

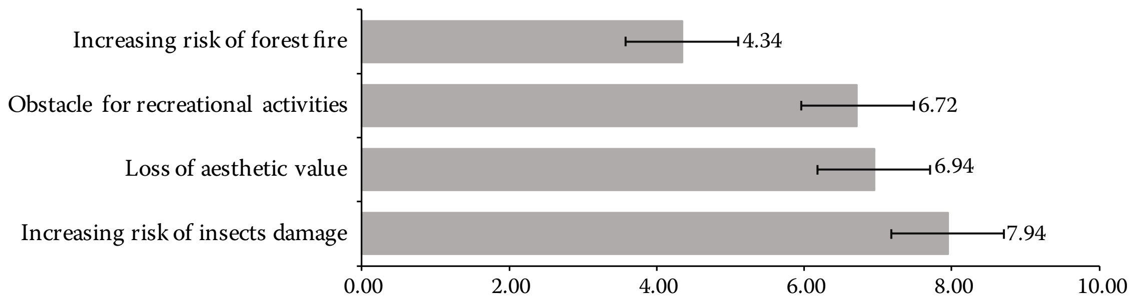

Fig. 6. Perceived importance of the negative effect of deadwood in forest. Mean value from all respondents on a 10-point scale (from 1 = very low to 10 = very high value)

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Fig. 7. Top four preferred types of forest with different amount of deadwood

naire) and the images of different types of forest characterized by different amount of deadwood ($\sigma = 0.69$, $\alpha = 0.05$).

When observing the results by groups of respondents interesting differences are highlighted. The order of preferences is the same for all groups of respondents, but elderly people and people with a low level of education prefer intensive management for each type of forests in which deadwood is removed during the silvicultural treatments.

DISCUSSION

In the present study, all respondents highlighted the relevant contribution of deadwood to stand dynamics. This finding is consistent with the international literature where some authors showed a positive correlation between the presence of deadwood in forest ecosystems and stand productivity (Debeljak 2006).

The respondents of this study consider deadwood as a key element of biodiversity in forest ecosystems. All respondents highly estimated this effect of deadwood in forest ecosystems. An increasing amount of deadwood in forests is considered as one of the potential management options for enhancing biodiversity in most of Europe's forest types (Forest Europe 2015) which could increase the species richness (Müller, Bütler 2010). Many studies emphasized the importance of deadwood for biodiversity conservation. Norden et al. (2004) found that deadwood is important for diversity of wood-inhabiting fungi in boreal forests. Pastorelli et al. (2018) found that the decay class of deadwood is closely related with the abundance of fungal and bacterial communities in Mediterranean forests.

Several authors have emphasized how coarse woody debris contributes to soil surface stability (Merganičová et al. 2012), slows down soil erosion and surface water runoff (Kraigher et al. 2002), prevents an occurrence of avalanches (Kupferschmidt et al. 2003), stabilizes steep slopes and stream channels (Densmore et al. 2004). However, the results of the present study show a low score assigned by respondents to all these functions of deadwood compared with others. Probably, the low degree of importance assigned to these effects of deadwood in forest is due to the complexity of the issues and respondents' ignorance of them.

The results of this study are not consistent with other studies (Radu 2006; Travaglini et al. 2007; Paletto et al. 2012) which indicate that the presence of a large amount of deadwood in forest is seen as a threat of the spread of forest fires. Respondents estimated this negative effect of deadwood the lowest among all others. This result may be explained by the fact that forest fires are not widespread in the Ukrainian Carpathians. Probably, a survey conducted in a Mediterranean country would have given rise to different results.

At the same time, respondents highly estimated the risk of insect damage in forests related to the presence of deadwood. Other studies (Radu 2006) highlighted an increased risk of insect damage in the unmanaged ancient forests as well. The report of MCFPE (Forest Europe 2015) notified that

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the accumulated fresh dying deadwood can create a risk of insect outbreaks. Other possible explanations of such a high estimation are obviously also related to the current massive drying of secondary spruce forests in the Rakhiv region. Spruce through a shallow root system is susceptible to uprooting (Merganičovà et al. 2012) and invasion of the bark beetle (Krynytskyy, Chernyavskyy 2014).

Respondents highly rated a negative impact of deadwood on recreational activities in forest and on aesthetic forest views. These results are consistent with studies (Tyrväinen et al. 2003; Edwards et al. 2012; Jankovska et al. 2014; Pelyukh, Zahvoyska 2018) that showed that people prefer managed forests where deadwood was removed. For example, Jankovska et al. (2014) showed that the respondents preferred managed forests where dead branches and deadwood were removed from urban Scots pine (*Pinus sylvestris* L.) forests of Riga, Latvia. Tyrväinen et al. 2003 indicated that tourists and visitors dislike standing dead trees in Helsinki City forests.

Conversely, Pastorella et al. (2016a) show that more than 60% of respondents prefer unmanaged forests and close-to-nature managed forests, 40% of respondents prefer intensively managed forests in which deadwood is removed during the forest operations in two study areas (Genova valley in the Trentino-Alto Adige region in Italy and Sarajevo Canton in Bosnia-Herzegovina). The relationship between recreational attractiveness of a site and deadwood is strictly related to the forest management practices. Many authors highlighted that an amount of deadwood is inversely correlated with the intensity of forest management (Paletto et al. 2014) and with the degree of accessibility to forest (Behjou et al. 2018). Therefore, forest managers should consider all these variables to increase recreational attractiveness of a specific forest site.

The results of Spearman's rank correlation coefficient are in accordance with the results of a recent study by Pelyukh, Zahvoyska (2018) who indicated that the residents of the Lviv region (Ukrainian Carpathians) prefer mixed forests, then conifer and broadleaved forests. According to these data, we can infer that respondents consider the tree species composition, as well as age structure, as an important component of the recreational value of forests followed by the presence and amount of deadwood.

Deadwood has become an important indicator which determines the level of forest naturalness as highlighted in several studies (Laarmann et al. 2009; Moravčík et al. 2010; Winter et al. 2010; Merganič et al. 2012). Bakhtiari et al. (2014) showed that the concept of "naturalness" in ecosystems through a low level of intervention is very important to common citizens. The forest stand characteristics such as "unspoiled nature" and "naturalness" were estimated by respondents quite high. Nevertheless, the results of current research show that the respondents much more prefer the managed forest in which deadwood was removed although the stated preferences can depend on the geographical location and type of forest.

One of the questions often discussed is how much deadwood should be left in forest (Commarmot et al. 2005; Merganičovà et al. 2012) and how the society perceives different amounts and size of deadwood in forest (Tyrväinen et al. 2003; Nielsen et al. 2007; Golivets 2011; Jankovska et al. 2014; Pastorella et al. 2016a, b; Paletto et al. 2017). According to investigations of Golivets (2011) deadwood is one of the most important factors which contributes to creating a negative attitude to the forests in Sweden. The present study confirms this assumption and it was found that residents of the Rakhiv region prefer forests where up to 15% of deadwood is left or all deadwood is taken away from the forest site after silvicultural treatments. These results are in line with those of previous studies conducted in the Lviv region (Ukrainian Carpathians) where the authors found the respondents' negative attitude to visits to forest with more than 15% of deadwood (Pelyukh, Zahvoyska 2018).

However, several studies show positive perceptions of the presence of deadwood in forest by residents and visitors (Nielsen et al. 2007; Hauru et al. 2014; Pastorella et al. 2016a). Pastorella et al. (2016) showed that a high percentage of visitors in a case study (peri-urban forest of Sarajevo city in Bosnia-Herzegovina) positively perceived standing dead trees and lying deadwood in forest ecosystems. In a case study from Finland (Helsinki city), Hauru et al. (2014) demonstrated that urban forests with lying deadwood are considered more aesthetically appealing than forests with old or no logs. The results of those studies match those observed in the earlier study of Nielsen et al. (2007) where it was detected that leaving a "few" standing or fallen dead trees for natural decay instead of none provoked a positive willingness to pay.

People's attitude to deadwood in forest is closely connected with the background characteristics of

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respondents: age, level of education, recreational activity (Tyrväinen et al. 2003), gender and geographical/cultural context (Pastorella et al. 2016a). In the present study, gender and geographical location are the socio-demographic characteristics that influence the perception of positive and negative effects of deadwood to the greatest extent.

The results of this study come along with the research results of Tyrväinen et al. (2003) highlighting that elderly people with a low level of education prefer forests without deadwood (intensively managed forests). In addition, the results of this study are in line with the results by Paletto et al. (2012), emphasizing that the rural inhabitants assign a greater importance to all forest ecosystem services rather than the urban ones.

CONCLUSIONS

The strengths of the survey method applied in this study are the simplicity in collecting and processing data derived from a semi-structured questionnaire and the possibility of using this information in an SFM decision-support system. Conversely, the main weakness of the survey method is due to the fact that in most cases collected information is site-specific.

The present study evidences that the population of the Rakhiv region believes that deadwood is an important component of a forest ecosystem. At the same time, all respondents highly evaluate the increased risk of insect damage related with the presence of deadwood. Such results can be explained by the widespread processes of drying of secondary spruce forests in the Rakhiv region, which have a negative impact on the recreational value in accordance with the respondents' opinions. This feature of the region forestry should be considered during extrapolating the obtained results at the country's level and in development of forest policy.

One of the more significant findings that emerge from this study is that the population of the Rakhiv region prefers mixed forest with less than 15% of deadwood. These findings are in accordance with other results evidencing the need of secondary Norway spruce stands conversion into mixed uneven-aged forest according to the close-to-nature forest management paradigm (Krynytskyy, Chernyavskyy 2014; Pelyukh et al. 2018).

The results of this study should be integrated into forest decision-making for expanding the recreational use of forests and formation of recreationally attractive forest landscapes. Besides, these findings prove the flow of benefits generated by the conversion of even-aged secondary Norway spruce stands into mixed uneven-aged woodlands (Zahvoyska 2014; Zahvoyska et al. 2017).

Finally, the results of this study can be an important starting point for future studies aimed at highlighting the social perception of deadwood in different forest conditions. The results of studies about people's opinions and preferences towards deadwood can provide useful information to communicate to citizens the role of deadwood in forest ecosystems and to support decision makers in the definition of forest management strategies at a local level.

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