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EFFECTS OF HARVESTING ACTIVITIES ON LITTER DECOMPOSITION RATES OF SCOTS PINE, TROJAN FIR, AND SWEET CHESTNUT

UTJECAJ AKTIVNOSTI PRIDOBIVANJA DRVA NA STUPANJ RASPADANJA LISTINCA ŠKOTSKOG BORA, TROJANSKE JELE I PITOMOG KESTENA

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Summary

This study aims to investigate the possible effects of harvesting activities on litter decomposition in micro ecologic areas belonging to 3 different species (Trojan fir (*Abies nordmanniana subsp. Equi-trojani* (Aschers & Sint. ex. Boiss) Coode & Cullen), scots pine (*Pinus sylvestris* L.) and sweet chestnut (*Castanea sativa* Miller)). To this end, litter decomposition experiments were carried out on these three species. The litter decomposition specimens were placed on their own stands where there were harvesting activities in previous years and in neighboring stands where there were no harvesting activities for control purposes. Theses micro ecologic areas are nonharvesting activity areas (control) (C), intra-forest skidding roads (Skidding road) (SR), under logging residues (Logging residue) (LR) and areas with a 20% slope and top-soil damaged during harvesting activities and scalped mineral soil (SMS). The decomposition processes were observed for 18 months, mass change values were calculated every six months and their mass loss and decomposition values were calculated. At the end of eighteen months, it was seen that the effects of intra-forest activities on litter decomposition showed differences among micro ecologic areas. According to the study results, forest harvesting activities (C, SR, LR and SMS) affect litter decomposition in various micro ecologic areas that occur in the remaining stand in great extent. As well as this, it is seen that the effect of forest harvesting activities on the litter decomposition is not in the same direction for every species. This study revealed that on micro ecologic areas decomposition sorting in ascending order was LR > C > SMS > SR for scots pine needles, LR = SR > C > SMS for Trojan fir needles, and C > SR > LR > SMS for sweet chestnut leaves. It has been concluded that forest harvesting activities influenced litter decomposition rates significantly.

KLJUČNE RIJEČI: litter mass loss, logging, skidding road, scalping, logging residue.

INTRODUCTION
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In forest ecosystems, the litter decomposition is a nutrient resource, rich in nutritional elements required for trees to grow. It also plays an important role in the pedogenesis mechanism (Sariyildiz and Anderson, 2005) and as an energy resource for soil micro- and macro-organisms that live in the environment (Heal et al., 1997). The litter breaks down and decomposes and creates a humus layer. The litter decomposition and nutrient release play a critical role in the biochemical cycle of forests as well (Aerts, 1997). Considering the carbon released into the environment, it is also important for the carbon cycle (Indermühle et al., 2000). This

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makes the litter decomposition an important part of the global carbon budget (Liski et al., 2003).

There has been several studies on the importance of litter decomposition (such as Prescott, 1997; Sariyildiz, 2002; Girisha et al., 2003; Sariyildiz and Küçük, 2008; Sariyildiz et al., 2008; Çakıroğlu 2011). In these studies, it was revealed that there were three main factors influencing the litter decomposition and nutritional element release. These are (1) the climatic characteristics (especially temperature and precipitation) of the environment in which the litter decomposition occurs, (2) number, type and activity of micro-organisms and edaphones that perform the litter decomposition, and (3) the chemical components of the litter (especially total carbon, nitrogen, hemicellulose, lignin and nutritional element concentrations and their ratios such as C:N or lignin: N). In general, while climatic characteristics are effective on the litter decomposition in different geographic regions, the chemical composition of the litter is particularly effective in more limited, local areas (Sam et al. 2004).

The relationship between the quality of decomposing material and decomposition rate was emphasized in numerous studies and it was reported that there could be another dominant factor in addition to the two main factors that influences the course of micro-organism activities (climatic characteristics and chemical composition of the litter) (Sariyildiz, 2002). In these studies, the effects of forest stands and organic matters in the area on the litter decomposition in different wood raw material production regimes (Prescott, 1997) and the effects of soil erosion and compaction that occur as a result of activities carried out in forest ecosystem during wood raw material production on the biological characteristics of the soil were investigated (Startsev et al., 1997). There have also been studies that were conducted in order to determine the efficiency of sustainable forestry activities and interventions that were made in order to meet forests' silvicultural requirements, especially after clear-cutting (Bird and Chatarpaul, 1988). Although there have been studies in the literature on the differences between litter decomposition mechanisms on different micro-ecological areas formed after harvestingactivities in the remaining stand (Kranabetter and Chapman, 1999; Bird and Chatarpaul, 1988; Jordon et al., 2003), there are no studies on the effects of different methods used in wood raw material production on the litter decomposition.

Therefore, this study aims to investigate the possible effects of harvesting activities on stands belonging to 3 different species (Trojan fir (*Abies nordmanniana subsp. Equi-trojani* (Aschers & Sint. ex. Boiss) Coode & Cullen), scots pine (*Pinus sylvestris L.*) and sweet chestnut (*Castanea sativa* Miller)) and logging residues in the stand as a result of these activities on the litter decomposition. To this end, litter decomposition experiments were carried out on these three species. The litter decomposition specimens were placed on (1) nonharvesting activity areas (control) (C), (2) intra-forest skidding roads (Skidding road) (SR), (3) under logging residues (Logging residue) (LR) and areas with a 20 % slope and top-soil damaged during harvesting activities and (4) scalped mineral soil (SMS) micro ecologic areas. The decomposition processes were observed for 18 months and mass change values were calculated every 6 months.

STUDY AREA
PODRUČJE ISTRAŽIVANJA

This study was conducted in Kastamonu (41° 22' N, 33° 47' E) located in the western Blacksea region of Turkey (Fig. 1). Fifty percent of the forests in Kastamonuis made up of coniferous trees (such as larch, scots pine, Trojan fir, calabrian pine), 28 % broad-leaved trees (beech, oak, sweet chestnut, alder, aspen, hornbeam, etc.), and 22 % mixed stands (OGM, 2006). Although the industrial wood harvesting in Kastamonu varies between years, the annual average production is approximately 1 Million m^3. In the areas where the study was carried out, the annual production average is 2,500 m^3 in coniferous forests and 500 m^3 in broad-leaved forests. The mechanization level of the study area in harvesting activities is motor-manual level. Chainsaws are used in tree felling and limbing, and tractors or manpower is used in skidding. The harvesting method is cut to length.

Scots pine and Trojan fir stands were selected in Handüzü Forest Sub-district Directorate forests. Harvesting activities in this area were completed previous year. Trojan fir stands were selected on northeast facing slope with an altitude of 1,630 m, and Scots pine stands on north facing slope with an altitude of 1,530 m. The Trojan fir trees were 120-130 years old and 30–32 m tall, and the Scots pine trees were 100–110 years old and 18–21 m tall on average. The annual average temperature was 9.8°C, the average high temperature was 16.2°C, the highest temperature was 38.9°C, the lowest temperature was –26.9° C, the average rainfall was 449.7 mm and the average relative humidity was 70 % (Climate Data collected from 1975–2011).

The study area for sweet chestnut was selected among sections that were within the boundaries of Gemiciler Forest Sub-district Directorate and the harvesting activities on these sections were completed a year ago as well. The area faced north and had an altitude of 300 m. The trees in the sweet chestnut stand were 160–170 years old and 22–29 m tall on average. Examining the climate values, the annual average temperature was 13°C, the highest temperature was 26.5°C, the lowest average temperature was 2.3°C, the average rainfall was 1027.7 mm and the average relative humidity was 75.4%. The climate values of the study areas were determined by interpolating the data of the nearest Kastamonu Central Meteorological Station (791 m, facing north) to altitudes of 1,530 m, 1,620 m and 300 m.

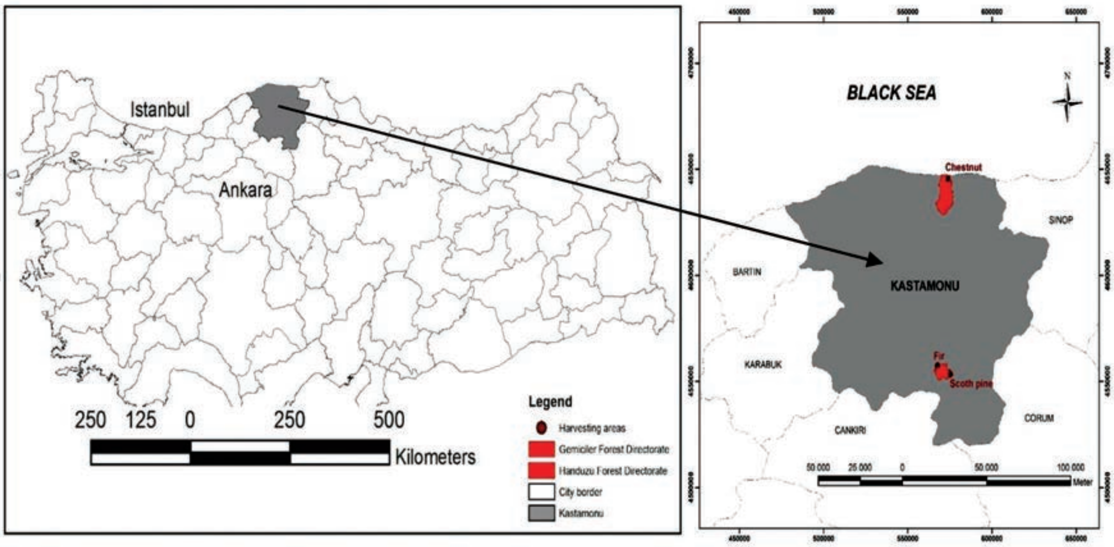

Figure 1. Locations of Scots pine,Trojan fir, and Sweet chestnut harvesting sites
Slika 1. Mjesta eksploatacije škotskog bora, trojanske jele i pitomog kestena

MATERIALS AND METHODS
MATERIJALI I METODE RADA

Trojan fir and scots pine needles and sweet chestnut leaves that fell on the ground in the study areas where the harvesting activities were completed a year ago were manually collected in October-November 2010, put into nylon bags, labeled and brought to the laboratory. Cleaned and air-dried samples were then put into decomposition bags with a mesh width of 1 mm and a size of 20x20 cm. In order to determine the amount of moisture in the air-dried samples before taking them to the decomposition areas, a batch from each sample was weighed on a precision digital scale and oven-dried at 85 °C for 24 hours and the amount of moisture in the samples was calculated using the weight difference between air-dried samples and oven-dried samples.

In order to determine the effects of three different environments formed on stands as a result of harvesting activities (SR, LR, SMS) on litter decomposition, the decomposition bags were placed on these areas and on control areas, where no harvesting activity was performed. The number of decomposition bags placed on areas to carry out the experiment, which was planned to take eighteen months, was 360 in total for scots pine and trojan fir [2 species (scots pine and trojan fir) x 4 factors (C, SR, LR and SMS) x 3 sampling times (6th 12th and 18th months) x 3 study areas x 5 repetitions = 360]. Since the sweet chestnut harvesting area was rather small, the study was carried out on a single area and a total of 60 decomposition bags were prepared for sweet chestnut samples [4 factors X 3 sampling times X 5 repetitions = 60].

After determining the wet weights of the decomposition bags, and the needles and leaves air-dried samples in the laboratory and then oven-dried at 85°C for 24 hours (Sariyildiz et al., 2008; Sariyildiz et al., 2004; Sariyildiz, 2003). The amount of moisture in the needles and leaves was calculated using the difference between wet weights and oven-dried weights. Then the mass loss compared the initial weight was found. The decomposition constant (k) was calculated based on the $Wt=W0.e^{-kt}$ formula, which was used in Olson's (1963) decomposition model and is still widely used today. Here, Wt= t refers to the remaining mass at time t and W0 refers to the initial mass. The time required for 50% mass loss was calculated based on the $T50 = 1/k$ formula and the time required for 95% mass loss was calculated based on $T95 = 3/k$ formula, which were also used by Olson.

STATISTICAL ANALYSIS
STATISTIČKA ANALIZA

One-way analysis of variance was used in order to determine the effects of harvesting activities on the decomposition progress for each species using the SPSS program (Version 20 for Windows). To be able to use the analysis of variance, the data must have the minimum interval scale and show normal distribution. The fact that the obtained data was quantitative meets the first assumption. One sample Kolmogorov-Smirnov (K-S) test was performed to determine whether the data conformed to normal distribution and it was found that it showed a normal distribution at $\alpha = 0.05$ level of significance ($p>0.05$). Tukey's honestly significant difference (HSD) test, which is one of the multiple comparison tests, was used in order to demonstrate the differences resulting from harvesting activities ($p<0.05$).

RESULTS
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Table 1 shows the remaining mass values of scots pine, Trojan fir, and sweet chestnut that belong to litter decomposition rating after forest harvesting activities that are composed on the remaining stand in varied micro ecologic areas (C, SR, LR and SMS). All ANOWA's were significant at P<0,05. Tukey's method of multiple pairwise comparison at $\alpha = 0.05$ was used to determine significantly means. Means with the same letter are not significantly different by columns.

At 6th month, it was seen that the difference between decomposition rates of SR and LR needles which were found in scots pine harvesting area were not statistically significant compared with the needles in C(p>0.05). Likewise, the difference between the decomposition rates in SR and SMS and the rates of C was not statistically significant (p>0.05). However, the difference between the decomposition rates of LR and SMS was statistically significant (p<0.05) (Fig. 2). The maximum decomposition rate was in LR (33 %) and the minimum decomposition rate was in SMS (29.4 %) (Table 1). This situation showed that the decomposition was happening slower in the sloppy parts where the top soil was removed than the other parts. Local heat was increasing in the micro ecologic areas in LR and so this increases soil creatures' activities. This situation made the decomposition increase. However, when it's looked upon the harvesting areas of Trojan fir, and sweet chestnut, the statistical differences between the decomposition rates of needles and leaves in C, SR, LR, and SMS was not found statistically significant (P>0.05) (Table 1). As there was no statistically significant difference, the maximum decomposition in Trojan fir needles was C (30.5 %) and the minimum decomposition was LR (29.1%). The maximum decomposition rate in sweet chestnut was SR (38.6 %) and the minimum decomposition rate was SMS (33.6 %) micro ecologic area (Fig. 2).

Table 1. The remaining mass values of scots pine, trojan fir, and sweet chestnut (C-Control, SR-Skidding road, LR-Logging residue, SMS-Scalped mineral soil

Tablica 1. Preostala masena vrijednost škotskog bora, trojanske jele i pitomog kestena (C-kontrola, SR-traktorski put, LR-drvni ostatak, SMS-ogoljelo mineralno tlo

Species *Vrste*	Treatment *Obrada*	6. month (%) *6. mjesec (%)*	12. month (%) *12. mjesec (%)*	18. month (%) *18. mjesec (%)*
Scots pine *Škotski bor*	C	68,3^{ab}±2,73	55,6^{b}±1,56	46,5^{a}±5,03
	SR	68,3^{ab}±4,13	58,5^{b}±4,94	50,4^{a}±6,79
	LR	67,0^{a}±3,80	51,0^{a}±4,18	43,2^{a}±5,31
	SMS	70,6^{b}±2,87	64,4^{c}±3,71	49,1^{a}±11,4
Trojan fir *Trojanska jela*	C	69,5^{a}±3,23	59,7^{a}±4,15	53,1^{a}±5,31
	SR	70,2^{a}±3,35	61,2^{a}±2,13	51,9^{a}±6,74
	LR	70,9^{a}±2,87	59,6^{a}±2,33	51,8^{a}±5,78
	SMS	70,2^{a}±1,75	62,3^{a}±3,44	56,0^{a}±4,61
Sweet chestnut *Pitomi kesten*	C	64,1^{a}±4,01	47,9^{a}±3,29	39,6^{a}±3,44
	SR	61,4^{a}±2,81	56,0^{b}±6,24	46,1^{ab}±6,24
	LR	65,7^{a}±2,57	57,9^{b}±3,87	50,6^{bc}±3,67
	SMS	66,4^{a}±4,40	62,0^{b}±1,38	56,4^{c}±0,83

At 12th months, the difference between C and SR decomposition rates in scots pine harvesting area was not statistically significant (p>0.05). As well as this, the differences between decomposition rates of LR, SMS and C and SR are statistically significant (P<0.05). However, the difference of decomposition rates of needles that occupy in the remaining stand of Trojan fir harvesting area in varied micro ecologic areas were not statically significant from one another and C (P>0.05). There was no statistical difference (P>0.05) among the decomposition rates of SR, LR and SMS in micro ecologic areas in the remaining stand of harvesting area in sweet chestnut section. Decomposition rates between C and the other micro ecological areas did differ significantly (P<0.05). However, as there was no statistically significant difference, the maximum decomposition rate of Trojan fir needles was LR (40.4%) and the minimum decomposition rate was SMS (37.7%) (Fig. 3, Table 1).

At 18th month, the decomposition rates between the scots pine and Trojan fir harvesting areas in the varied micro ecological areas were not statistically significant. This was the same with the control groups. However, the maximum de-

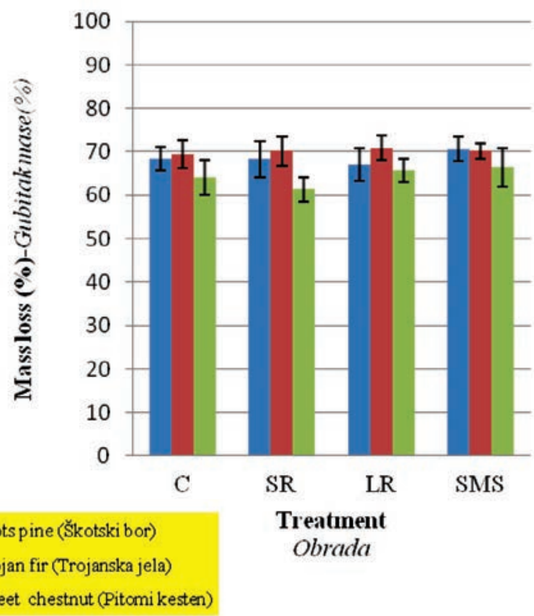

Figure 2.Decomposition progress (%) in the remaining stand after six months later at the end of harvesting activities for various species in C (Control), SR (Skidding road), LR (Logging residue) and SMS (Scalped mineral soil areas)

Slika 2. Napredak procesa raspadanja (%) u sastojinama nakon šest mjeseci na kraju aktivnosti eksploatacije za različite vrste u područjima C (kontrola), SR (traktorski put), LR (drvni ostatak) i SMS(ogoljelo mineralno tlo)

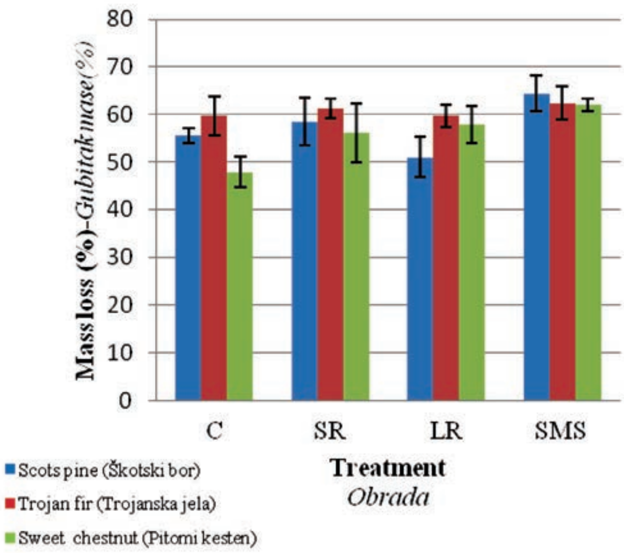

Figure 3. Decomposition progress (%) in the remaining stand after 12 months at the end of harvesting activities for various species in C (Control), SR (Skidding road), LR (Logging residue) and SMS (Scalped mineral soil areas)

Slika 3. Napredak procesa raspadanja (%) u sastojinama nakon 12 mjeseci na kraju aktivnosti eksploatacije za različite vrste u područjima C (kontrola), SR (traktorski put), LR (drvni ostatak) i SMS(ogoljelo mineralno tlo)

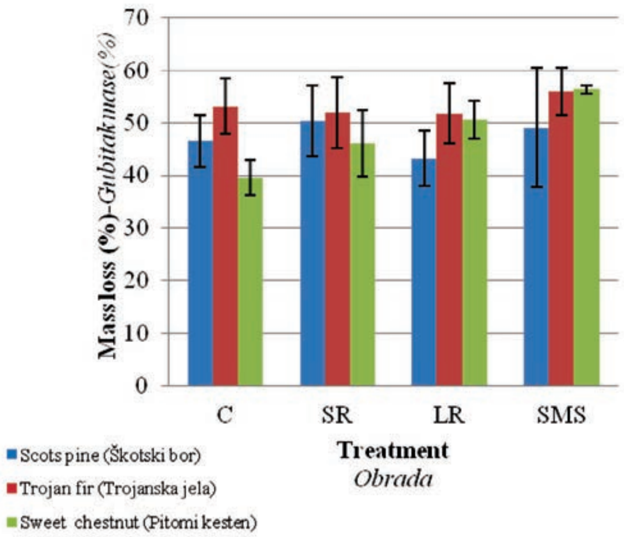

Figure 4. Decomposition progress (%) in the remaining stand after 18 months at the end of harvesting activities for various species in C (Control), SR (Skidding road), LR (Logging residue) and SMS (Scalped mineral soil areas)

Slika 4. Napredak procesa raspadanja (%) u sastojinama nakon 18 mjeseci na kraju aktivnosti eksploatacije za različite vrste u područjima C (kontrola), SR (traktorski put), LR (drvni ostatak) i SMS(ogoljelo mineralno tlo)

composition rate of needles in scots pines was LR (56.8 %) and the minimum decomposition rate was SR (49.6 %). Maximum decomposition rate of Trojan fir needles was LR (48.2 %) and the minimum decomposition rate was found in SMS (44 %). On the other hand, in the sweet chestnut harvesting area, the difference between LR, SMS and C was statistically significant ($P<0.05$). The decomposition rate between SR and SMS was also statistically significant ($P<0.05$). At the end of the decomposition progress, the maximum decomposition rate for the scots pine needles was found on LR followed by C, SMS, SR, and LR = SR > C > SMS for the Trojan fir needles; and; C > SR > LR > SMS for the sweet chestnut leaves (Fig. 4, Table 1).

Table 2 showed that forest harvesting activities effected litter decomposition in great extent in varied micro ecologic areas that was appearing in remaining stand. The average time (year) for mass to lessen of its 50 % and 95 % was 2.33 and 7.00 for scots pines needles in the C micro ecological area. However, in SR (2.59 and 2.78) and in SMS the time was increased (2.40 and 7.20). The time was decreased in the areas where LR appeared (2.12 and 6.37). Likewise, when the Trojan fir needles are compared with the C as it is in scots pines needles; it is seen that the decomposition time was increased on the SMS micro ecological area. However, the time was decreased in the micro ecological areas where LR appeared (Table 2). Different from the scots pine needles, in the Trojan fir needles that are put on the SR the decomposition time was lessened. For the species of sweet chestnut; the harvesting activities decreased decomposition rates of the leaves of the species in great extent and it caused the average time that was needed for its mass to minimize by 95% in C micro ecological area (year), to increase from 5.82 to 6.90 in SR, and in the micro ecological areas where there was LR to 7.89 and on the SMS to 9.41 (Table 2).

Table 2. Litter decomposition constancy of scots pine, trojan fir, and sweet chestnut (k) which decompose in various parts of harvesting area and the estimated time (year) that is needed the decomposed material to lose its 50% and 95% of being

Tablica 2. Konstanta raspadanja listinca škotskog bora, trojanske jele i pitomog kestena (k) koji se raspadaju u različitim dijelovima područja eksploatacije te procijenjeno vrijeme (godina) koje je potrebno da materijal koji se raspada izgubi 50 % i 95 % mase

Species *Vrste*	Treatment *Obrada*	k±sd	T_{50} (year)	T_{95} (year)
Scots pine *Škotski bor*	C	0,4285±0,066	2,33	7,00
	SR	0,3858±0,076	2,59	7,78
	LR	0,4710±0,070	2,12	6,37
	SMS	0,4164±0,185	2,40	7,20
Trojan fir *Trojanska jela*	C	0,3505±0,059	2,85	8,56
	SR	0,3683±0,075	2,71	8,14
	LR	0,3683±0,064	2,72	8,15
	SMS	0,3237±0,045	3,09	9,27
Sweet chestnut *Pitomi kesten*	C	0,5158±0,048	1,94	5,82
	SR	0,4347±0,078	2,30	6,90
	LR	0,3802±0,039	2,63	7,89
	SMS	0,3187±0,008	3,14	9,41

DISCUSSION
RASPRAVA

According to the study results, forest harvesting activities (C, SR, LR and SMS) affect litter decomposition in various micro ecologic areas that occur in the remaining stand in great extent. As well as this, it is seen that the effect of forest harvesting activities on the litter decomposition is not in the same direction for every species.

Decomposition rates did not significantly change for the Trojan fir and sweet chesnut at 6th month. Only for the scots pines species, decomposition rates between SMS and LR micro ecological areas did differ significantly. The decomposition rate was much more in LR as the local heat was increased in LR and so it increased the soil microorganisms' activities. However, the decomposition in SMS was detected to be happening rather slowly than the other micro ecological areas as the top surface of the soil was eroded.

At 12th month, there were statistically differences in the decomposition rates of scots pines and sweet chestnut species occurred in the remaining stand on micro ecologic areas. However, at the end of the 18th month, only in the species of sweet chestnut, there was a statistical difference on the areas under the SMS and LR. It is thought that these differences were caused by the microorganisms in the soil. Decomposition rates in LR and C were higher than in SR and SMS due to probable high temperature that affect the number and activities of microorganisms.

In general, at the 18th month, the decomposition rates of scots pines and Trojan fir needles were close to each other. On the other hand, the leaves of sweet chestnut were decomposed faster than the other two species. It was found that there were differences on the decomposition rates of needles and leaves in micro ecologic area that occurred at the end of harvesting activities. Also, there was no significant difference between the decomposition rates of sweet chestnut in the C and in SR. Moreover, there was no significant difference between the LR and SMS.

The effects of chemical differences in leaves of various species on the decomposition rate in various geographical and climate conditions are defined (Swift et al., 1979; Berg and Ekbohm, 1983; McClaugherty and Berg, 1987; Taylor et al., 1989; Sariyildiz, 2002; Sariyildiz et al., 2004; Sariyildiz et al., 2008). In this study, the field experiments for each tree species were carried out under the same climatic and geographic conditions.

The decomposition rates showed different speed order among the species. Bird and Chatarpaul (1988) found that the decomposition rate was ordered from ascending to descending as; complete tree method > uncut area > random harvesting. Decomposition of leaves in litter bags was significantly greater ($P<0.05$) on harvested plots than on the uncut plot (U), and was greater on the whole tree harvest plot (W) than on the conventionally harvested plot (C). In the same study, maple tree *k* values were ordered according to the harvesting images after 2 years later: the order was shown as ascending to descending from whole tree harvest, conventional harvest and uncut forest. However, in this study, the decomposition rates at 18th was given as; for the scots pines needles the decomposition order: LR > C > SMS > SR from ascending to descending; for the Trojan fir needles order was LR=SR>C>SMS. Also for the sweet chestnut leaves the order was given as: C > SR > LR > SMS.

Since the chemical composition of the fir and pine needles was constant, differences in k rates likely resulted from changes in microclimate or soil organisms (Kranabetter, J. M. and Chapman, B. K. 1999). In the study that is done by Cakıroglu (2011) it was found that decomposition rate constant (k) was 0.254 for the Trojan fir. The needed time for the needles to decompose by 95 % was 11.8 years for the Trojan fir. The mass loss in Trojan fir needles was defined as 36.1 %. This study also has similar results with the study that was done by Cakiroglu (2011) (Table 2).

Sarıyıldız and Kucuk (2008) found that k values for the north slope groups, the time which was needed for the decomposition of top, hill and slope of north slopes by 95 % is 8.1, 7.6 and 7.1 (year), respectively. These values for the scots pines were found as 7.8, 6.9 and 6.4 (year). The same values in south slopes showed that decomposition by 95 % for the Trojan fir was 9.6, 9.0 and 7.6 year and for the scots pines the time that was needed for the decomposition was found as 8.3, 8.0 and 7.4 years. In this study, similar findings exist. Moreover, year differences were seen in various harvesting activities areas, such as minimum year was 7.2 and the maximum year was 5.3 in scots pines. Also, in Trojan fir the minimum year difference was 0.7 year and the maximum year was 5.9 years. In the sweet chestnut it was 0.3 year in minimum values and 9.6 years for the maximum values (Table 2). Sarıyıldız (2002) pointed out that the changes that can occur in the soil conditions in time would affect the chemical structure of the leaves and by this way; it would also affect their decomposition rates. This situation clearly showed that in our study, forestry harvesting activities changed the top soil surface structure and this change would had a bare effect on the decomposition.

Consequently, the wood harvesting activities in the forest, which forms the whole of the ecosystem, can be defined as the human intervention. This is a must for the supply of the endless human needs. In this study, it was examined that the differences occurred on the needle and leaves decomposition rates in micro ecologic areas where human intervention is especially seen on the forests. Accordingly, it was found that harvesting activities affect litter decomposition in micro ecologic areas in remaining stand in great extent. To present this effect more clearly, studies should be done which would detect both chemicals in the leaves and the soil minerals.

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Sažetak

Cilj istraživanja je ispitati moguće učinke pridobivanja drva na raspadanje ostataka u mikroekološkim područjima koja pripadaju trima različitim vrstama drveća (trojanska jela (*Abies nordmanniana subsp. Equitrojani* (Aschers & Sint. ex. Boiss) Coode & Cullen), bijeli bor (*Pinus sylvestris L.*) te pitomi kesten (*Castanea sativa* Miller)). U tu svrhu provedeni su eksperimenti njihova raspadanja ostataka nakon radova sječe i izrade. Uzorci ostataka za razgradnju stavljeni su u vlastite sastojine gdje su prethodnih godina obavljeni radovi pridobivanja drva, te u susjednim sastojinama gdje tih radova nij bilo (kontrola). Izabrana mikroekološka područja bila su područja bez aktivnosti pridobivanja drva (kontrolna) (C), unutaršumski traktorski putovi (traktorski put) (SR), šumski ostaci (Šumski ostaci) (LR) i područja s nagibom od 20 % i gornjim slojem tla oštećenim tijekom aktivnosti pridobivanja drva, te mineralno tlo s erodiranim tjemenom (SMS). Proces razgradnje pratio se 18 mjeseci. Vrijednosti promjene mase mijerile su se svakih šest mjeseci. Izračunate su njihove vrijednosti gubitka mase uzrokovane razgradnjom. Nakon osamnaest mjeseci, uočeno je da su učinci unutaršumskih aktivnosti na raspadanje ostataka pokazali razlike između mikroekoloških područja. Prema dobivenim rezultatima, aktivnosti pridobivanja drva (C, SR, LR te SMS) utječu na raspadanje ostataka u različitim mikroekološkim područjima koja se javljaju u preostalim sastojinama u velikoj mjeri. Uz to, uočeno je da učinak aktivnosti pridobivanja drva na raspadanje ostataka nije jednak za svaku vrstu. Ovo istraživanje ukazuje kako je na mikroekološkim područjima redoslijed raspadanja u uzlaznom trendu bilo LR > C > SMS > SR za iglice bijelog bora, LR = SR > C > SMS za iglice trojanske jele, te C > SR > LR > SMS za lišće pitomog kestena. Zaključeno je da su aktivnosti pridobivanja drva znatno utjecale na stupanj raspadanja ostataka.

KLJUČNE RIJEČI: gubitak mase, sječa, traktorski put, erodiranje tjemena, šumski ostatak