

The Influence of Forest Management Histories on Dead Wood and Habitat Trees in the Old Growth Forest in Northern Iran

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Abstract—Dead wood and habitat tree such as fallen logs, snags, stumps and cracks and loose bark etc. are regarded as an important ecological component of forests on which many forest dwelling species depend on presence of them within forest ecosystems. Meanwhile its relation to management history in Caspian forest has gone unreported. The aim of research was to compare the amounts of dead wood and habitat trees in the forests with historically different intensities of management, including: forests with the long term implication of management (PS), the short term implication of management (NS) which were compared with semi virgin forest (GS). The number of 405 individual dead and habitat trees were recorded and measured at 109 sampling locations. ANOVA revealed volume of dead tree in the form and decay classes significantly differ within sites and dead volume in the semi virgin forest significantly higher than managed sites. Comparing the amount of dead and habitat tree in three sites showed that, dead tree volume related with management history and significantly differ in three study sites. Meanwhile, frequency of habitat trees was significantly different within sites. The highest amount of habitat trees including cavities, cracks and loose bark and fork split trees was recorded in virgin site and lowest recorded in the sites with the long term implication of management. It can be concluded that forest management cause reduction of the amount of dead and habitat tree specially in a large size, thus managing this forest according to ecological sustainable principles require a commitment to maintaining stand structure that allow, continued generation of dead trees in a full range of size.

Keywords—Cracks trees, forest biodiversity, fork split trees, nature conservation, sustainable management.

I. INTRODUCTION

THE importance of dead and habitat trees to the ecological integrity of forested ecosystems has been understood for several decades [1], [2], and it is only within the last decade that researchers and land conservation specialists have teamed up to develop the best strategies for woody debris management with regards to volume, composition, and spatial distribution to achieve targets for specific conservation goals. There is not a one-size-fits-all solution for dead and habitat trees management; instead, solutions appear to be ecosystem- and conservation-goal specific. For example, as conservation managers work to reduce the risk of extinction of wood-living invertebrates and cryptogams in boreal forests managed for timber production in Scandinavia, they find it is necessary to

increase artificially the volume and number of dead and habitat trees by felling trees and cutting high stumps, thus forming additional habitat for these at-risk species [3]. Fallen dead tree (logs) and stumps provide nurse logs for regeneration in temperate, boreal and sub mountain-subalpine forest types [4]. All type of dead tree play different role in the forest ecosystems. Dead tree is increasingly regarded as a major component of forest structure, and a useful indicator of biodiversity in forests [5]-[8]. For this reason, it was adopted as an indicator for sustainable forest management by the Ministerial Conference on the protection of forests in Europe [9]. The nature of the dead tree resource and the implications of this for nature conservation are well-established issues and concerns.

Caspian forests with an area around 2,000,000 ha are located on the northern slopes of Alborz Mountain between 20 and 2,200 m a.s.l. in the north of Iran (south of the Caspian Sea). Pure and mixed beech stands belong to the most important, rich and beautiful stands appearing at the middle and upper elevation on the northern slopes. The natural dense stands are found at 1,000–2,100 m and the high stocking volume stands at 900–1,500 m a.s.l. [10]. Beech (*Fagus orientalis* Lipsky) is the most valuable wood-producing species in the Caspian forests covering 17.6% of the area and representing 30% of the standing volume; it can grow taller than 40 m and exceeds diameter at breast height larger than 1.5 m [11]. Late frost, early heavy snow and direct sunlight damage its seedlings. As a sapling, *F. orientalis* is much more resistant to frost, sunscald and drought stress than the European beech (*Fagus sylvatica* Lipsky) [12]. This forest was managed by a close-to-nature silvicultural method such as tree selection method.

To date, no comprehensive studies have dealt with the amount of habitat tree in the area with different management history in the Caspian beech forests of northern Iran. Forests in the north of Iran managed based on ecological concepts and in close to the nature way, so the recognition of the importance of management of the dead wood and habitat tree is vital if its nature conservation objectives and obligations are to be met. Thus, the goal of this study was to quantify the effect of management on the amount and quality of dead and habitat trees in an area of deciduous forests in Hyrcanian forests, and to assess to what extent historically different intensities of management have affected this relationship and the dead tree resource.

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II. MATERIALS AND METHODS

A. Study Area

The study was conducted within the Gorazbon, Patom and Namkhenh section of the Kheyroud Experimental Forest in northern Iran, which is owned and managed by the University of Tehran for education, research, and conservation (Fig. 1). The forest covers a total area of 8,000 ha and ranges in latitude from 36°27'N to 36°40'N and in longitude from 51°32'E to 51°43'E [13]. The climate is sub-Mediterranean with a mean annual temperature of 9°C and total annual precipitation of 1380 mm. Selected forest communities occupy plateaus or moderately inclined slopes which are dominated by moderately acidic to alkaline brown forest soils with deep, organic A-horizons, limestone bedrock, and a surface largely free of rocks [14]. Most stands have an uneven age structure where new seedling establishment occurs within canopy gaps [15]. The undisturbed mature beech stands were classified as a climax forest and it represent a regional example of old-growth forests with no historical cutting or harvesting of trees [16]. The elevations of this area range between 1,000 – 2,000 m and Oriental beech forests dominate. Oriental beech and European hornbeam are the major species with Persian maple (*Acer velutinum*), Cappadocian maple (*Acer cappadocicum*), largeleaf linden (*Tilia platyphyllos*), smooth leaved elm

(*Ulmus minor*), Wych elm (*Ulmus glabra*), sweet cherry (*Cerasus avium*), common yew (*Taxus baccata*), and wild service tree (*Sorbus torminalis*) as less common, but still important part of the forest composition [10].

TABLE I
DESCRIPTION OF STUDY SITE INDICATING MANAGEMENT HISTORY AND
OTHER STRUCTURAL CHARACTERISTICS

Study Area	Site code	Area (ha)	Management history	Elevation (m)
Patom	PS	59	60 yr<	480-630
Namkhaneh	NS	39	20 yr<	950-1110
Gorazbon	GS	75	Unmanaged	850-1220

B. Dead and Habitat Tree Selection and Description

Dead tree comes in many forms [16], [17], but above ground two tend to predominate dead trees on the forest floor (logs), and standing dead trees (snags) and these are the two on which the present study focuses. All of dead trees including: fallen logs and snags had measured within the study sites using the full callipering method. For each piece of coarse woody debris, we recorded species, total length, form (log, snag or stump), diameter at both ends, diameter at the midpoint, and decay class. Lengths and diameters were taken at the edge of the plot boundary if the log extended outside of the plot.

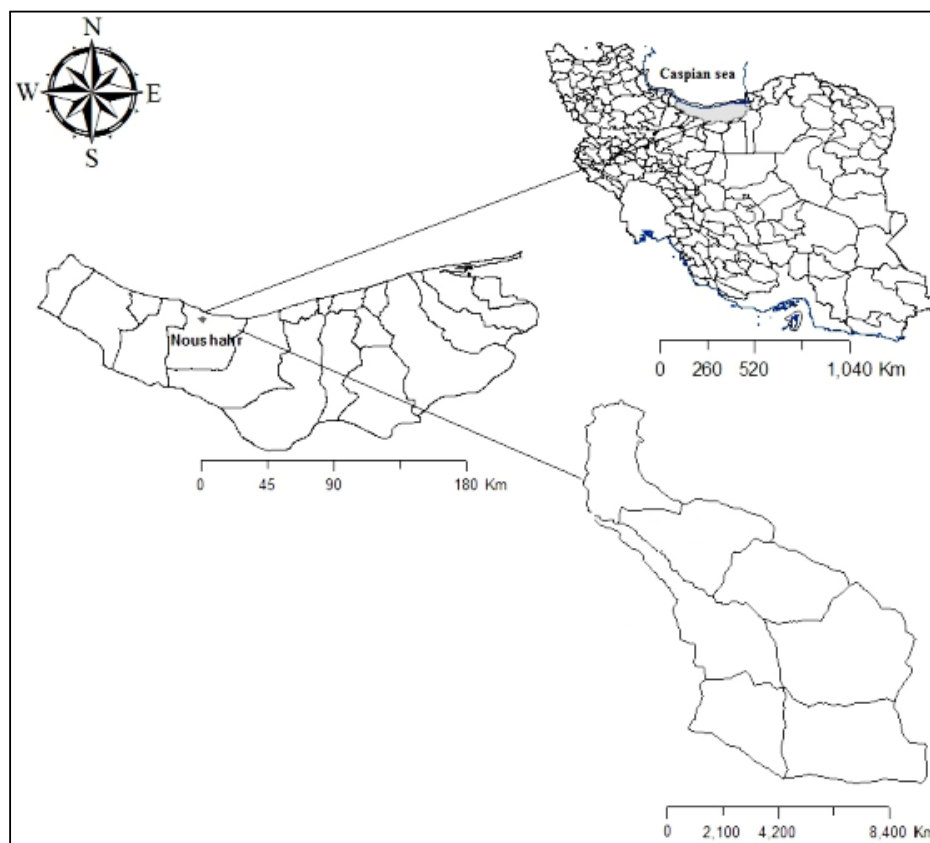


Fig. 1 The Study area in the North of Iran

Diameters of logs and snags were measured using calipers; however, for taller snags, top diameters were estimated visually. For snags taller than 4 m, height was measured with a clinometer. Dead trees standing at an angle of less than 45° from the vertical were classified as snags and those at a greater than 45° from the vertical were classified as logs. Decay classes were defined according to Albrecht [18] as Class 1 (recently dead), Class 2 (bark loose with some decay in the sapwood), Class 3 (decay obvious throughout the secondary xylem) and Class 4 (woody debris mixing with soil, little structural integrity).

Most dead trees displayed a mixture of different decay stages along their total length; therefore, the dominant decay stage class was used during the analysis. Diameter at breast height was measured on dead trees in the early stages of decay. In order to investigate the species composition around large dead trees, according to [19] the 0.1 ha circle plots established around dead trees having diameter larger than 50 centimeters. We also record the number and type of habitat trees including A. Non-woodpecker cavity, B. Canopy dead wood; v C. Fruit bodies of saproxylic fungi; D. Cavities with mould; E. Root-buttress cavity; F. Cracks and G. Fork split (Fig. 2).

C. Data Analysis

To calculate the volume of dead trees, Newton's formula was used [20] for snag and log volume:

$$V = \frac{L(A_b + 4A_m + A_t)}{6},$$

where, V = volume in m³, L = length, and A_b, A_m and A_t = the cross-sectional area at the base, middle, and top, respectively. The volume for stumps was calculated by:

$$V = A_m \times L,$$

where, V = volume in m³, A_m = cross-sectional area at the middle of the stump, and L = length.

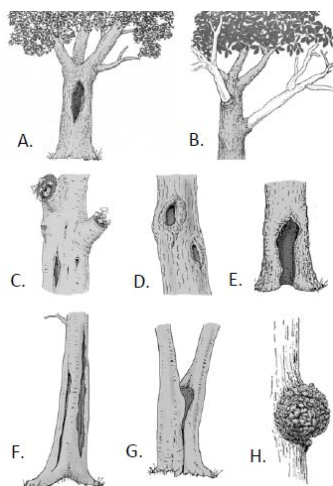


Fig. 2 Different microhabitat types [2]

To determine whether the number of habitat trees and volume of CWD of different types, decay classes and size classes differed among these three forests, different management histories was considered as a fixed factor and volume of CWD was analyzed as a response variable using one-way analysis of variance (ANOVA). If there was a significant effect of different management histories, the least squares mean separation with Turkey's correction was used to test for differences among sites. Normality and homogeneity of variance of the residuals were tested and data were log-transformed if the homogeneity of variance was not met. All statistical tests were considered significant at the $p < 0.05$ level [21].

III. RESULTS

Totally 215 individual dead trees were recorded and measured at 79 sampling locations. GS as a semi virgin forest generally contained greater volume of dead tree. The results showed that the stocking volume of alive and dead trees was 352m³ ha⁻¹ and 3.2 m³ ha⁻¹ in PS and 531m³ ha⁻¹ and 5.17 m³ ha⁻¹ in NS, respectively.

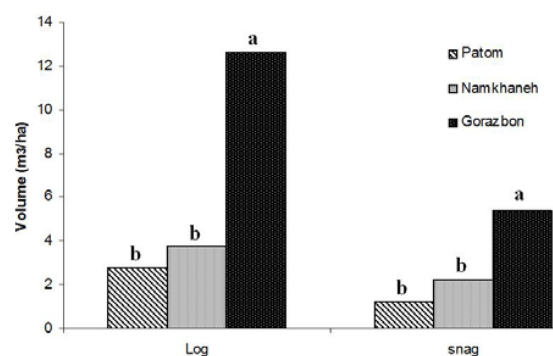


Fig. 3 Dead tree volume in different study sites

The 32% of all dead trees in PS were snag and 68% belonged to log forms. This amount in NS calculated 36 and 64 %, respectively (Fig. 3). We found the same results in the GS. In this site, 70% of dead tree was logs. Stocking volume also calculated 685 m³ ha⁻¹ in the GS. High amount of logs in contrast snags showed rapidly decomposing of material in these forests. Results of ANOVA indicate significantly different among three study sites. Volume of dead tree significantly higher in unmanaged forests (GS) in comparing with two other sites ($F = 14.25$; $P < 0.001$).

In order to investigate the species composition around large dead trees, the dead trees with diameter higher than 50 centimeters were considered being the fixed area sampling plots (0.1 ha). The results showed beech constitute the highest amount of live trees in PS, whereas the most of dead trees in the given site was hornbeam. The same results obtained in the other sites. *F. orientalis* is the dominant tree species in the study area and showing the greatest standing volume. In the PS 57, 31.4 and 11.8 % of live trees that allocated around large dead trees were *F. orientalis*, *C. betulus* and other species, respectively. In the NS, this amount calculated 49.5,

30 and 19.5 %, respectively (Table II). Moreover, according to the full callipering inventory of dead trees in study sites, the highest amount of dead volume recorded in the GS as un-managed sites and the lowest was in the PS with the long term of management implication.

TABLE II
TOTAL VOLUME OF LIVING TREE VOLUME OF ORIENTAL BEECH FORESTS AT STAND LEVEL

Species Tree	Live trees(m ³ ha ⁻¹)		
	PS	NS	GS
<i>Fagus orientalis</i>	156.3	278.4	397
<i>Carpinus betulus</i>	131.5	165.5	75
<i>Parrotia persica</i>	15.68	-	-
Other species	49.57	9.02	213
Total	352.33	531.3	685

TABLE III
TOTAL DEAD TREE VOLUME OF ORIENTAL BEECH FORESTS AT STAND LEVEL

Species Tree	Dead trees (m ³ ha ⁻¹)		
	PS	NS	GS
<i>Fagus orientalis</i>	0.99	2.30	15.91
<i>Carpinus betulus</i>	1.81	22.2	1.62
<i>Parrotia persica</i>	0.28	-	-
Other species	0.08	0.73	1.30
Total	3.16	5.1	18.85

We count the number of 135 habitat trees within study sites. The most frequent of habitat tree was the fruit bodies of saproxylic fungi that approximately constitute 18% of all type of habitat trees. According to the results had shown in Fig. 4 and 5 the unmanaged study site (GS) encompasses high frequency of habitat trees. In addition, results revealed the number of different kind of habitat trees significantly varies among sites with different management histories. In addition, the numbers of habitat trees including cavities, Cracks, loose bark, and Fork split trees significantly vary among sites. The number of habitat trees reaches to the highest amount in the virgin site and their lowest in the site with the long-term implication of management.

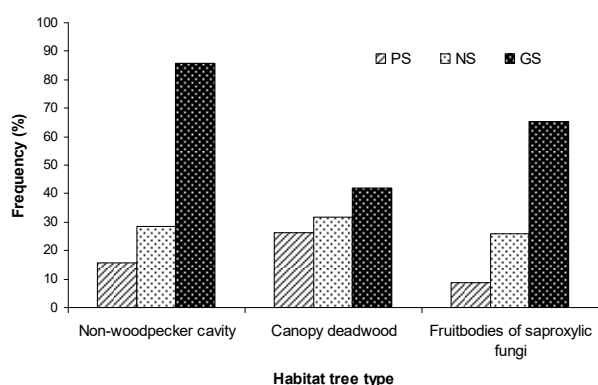


Fig. 4 The frequency of different type of habitat in different study sites

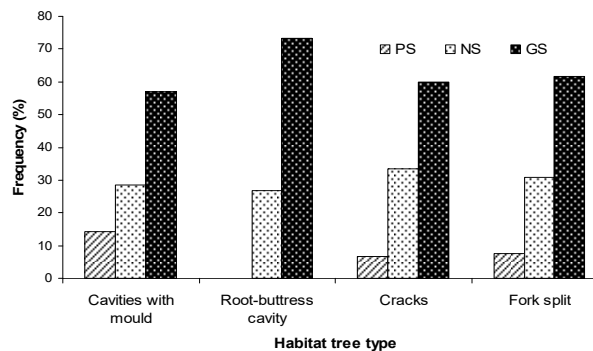


Fig. 5 The frequency of Cavities, root-buttress, cracks and fork split trees in different study sites

IV. CONCLUSION

A tightly controlled selection silviculture system using reduced-impact logging techniques to remove just a few highly valued timbers would impinge on dead and habitat tree volumes or size-distributions to a far lower extent than more extensive and more poorly controlled systems. Nevertheless, any system whose long-term effect is to reduce the proportion of basal area contributed by larger-diameter trees, even if the aim is to maintain a “reverse J” shaped distribution of size-classes in the equilibrium state [16] risks ultimately reducing overall dead tree volumes in general, and volumes in the larger size-classes in particular. Given the known dependence of many organisms on this resource in temperate forests, ample consideration should be given to the dead tree and stand structure when formulating policies, silvicultural systems and criteria and indicators for ecologically sustainable forest management.

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