

F. LOMBARDI ^{1*}, G. CHIRICI ¹, M. MARCHETTI ¹, R. TOGNETTI ¹, B. LASSERRE ¹, P. CORONA ², A. BARBATI ², B. FERRARI ², S. DI PAOLO ², D. GIULIARELLI ², F. MASON ³, F. IOVINO ⁴, A. NICOLACI ⁴, L. BIANCHI ⁵, A. MALTONI ⁵, D. TRAVAGLINI ⁵

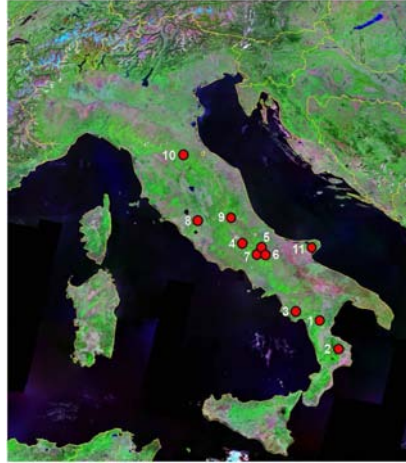
¹ Dipartimento di Scienze e Tecnologie per l'Ambiente ed il Territorio, Università degli Studi del Molise, Pesche (IS), Italy; ² Dipartimento di Scienze dell'Ambiente Forestale e delle sue Risorse, Università degli Studi della Tuscia, Viterbo, Italy; ³ Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale "Bosco della Fontana" - CFS - Marmirolo (MN), Italy; ⁴ Dipartimento di Difesa del Suolo Vincenzo Marone, Università della Calabria, Arcavacata di Rende (CS), Italy; ⁵ Dipartimento di Economia, Ingegneria, Scienze e Tecnologie Agrarie e Forestali, Università Degli Studi Di Firenze, Italy.

* Corresponding author: fabio.lombardi@unimol.it

Keywords: deadwood occurrence, unharvested Mediterranean forests, sustainable forest management, forest inventory, Italy.

Background

The presence of large amounts of dead wood is a typical criterion to identify old-growth conditions: standing and downed dead wood and woody detritus are indirect evidence of canopy mortality and gap phase dynamics. In North America and in Europe, many studies were conducted on old growth forests, focusing on their structural dynamics, stand age structure, natural regeneration and on deadwood as indicator of old-growth conditions. In Southern Europe, particularly in the Mediterranean forests, such studies have been much more scarce. In this area, forests have been heavily exploited since ancient times. So, old-growth forests are very rare and usually are found only inside strict forest reserves or in remote and impervious mountain areas. In order to characterize the level of naturalness and the role of deadwood for identifying old-growthness under Mediterranean conditions, eleven study sites located in undisturbed forest stands were selected across the Italian peninsula and records of deadwood and stand structure were carried out.



ID Area	Site	Location	Main species	Altitude (m. a.s.l.)	Mean annual T (°C)	Mean annual P (mm)	Years since unmanaged
1	Cozzo Ferriero	Pollino National Park, Basilicata District	<i>F. sylvatica</i> L.	1700	7.3	1350	80
2	Fosso Cecita	Sila National Park, Calabria District	<i>P. Iaricio</i> P.	1170	9.9	1180	110
3	Monte Sacro	Cilento e Vallo di Diano National Park, Campania District	<i>F. sylvatica</i> L.	1420	7.1	1600	60
4	Val Cervara	Abruzzo, Lazio and Molise National Park, Abruzzo District	<i>F. sylvatica</i> L.	1780	7.2	1211	no references
5	Abeti Soprani	EU Natura 2000 Network site, Molise District	<i>A. alba</i> Mill.	1300	8.4	1124	30
6	Collemeluccio	MaB Unesco Reserve, Molise District	<i>A. alba</i> Mill.	950	9.2	960	50
7	Monte di Mezzo	MaB Unesco Reserve, Molise District	<i>F. sylvatica</i> L.	1100	8.6	1022	55
8	Cimini mountains	Lazio District	<i>F. sylvatica</i> L.	1000	14.3	1300	61
9	Fonte Novello	Gran Sasso e Monti della Laga National Park	<i>F. sylvatica</i> L.	1340	10.0	1071	310
10	Sasso Fratino	Foreste Casentinesi National Park	<i>F. sylvatica</i> L.	1000	9.0	1689	51
11	Area Pavari	Gargano National Park, Puglia District	<i>F. sylvatica</i> L.	760	11.6	1041	56



Figure 1 and Table 1 - Location and basic characteristics of the study areas.

Methods

1-ha size plot was fully surveyed at the study sites. All live trees, dead standing trees, dead downed trees, snags, stumps, and lying coarse woody debris were registered (diameter $\geq 5\text{cm}$). For each individual, the exact location within the plot, tree species, dbh, height or length, crown structure and height, and decay level (Hunter classification scheme) were recorded.

Results

The amounts of deadwood indicate a large variability among the investigated forests: the total volume ranged between 2 and 143 m^3ha^{-1} , with an average of 60 m^3ha^{-1} . Lying deadwood is the most abundant component, due to the natural mortality occurring in the stands in relation to the processes established in the last decades. On the contrary, stumps are the less represented type of deadwood in almost all the study areas. All the decay classes are present in each study site.

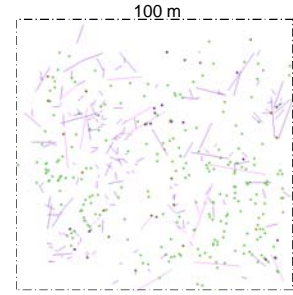


Figure 2. An example of the census carried out in each study site.

Area	Volume (m^3/ha)							Living volume
	Standing dead wood	Snag	Dead downed trees	Coarse woody debris	Stumps (natural origin)	Stumps (from cutting)	Deadwood total volume	
Abeti Soprani	63.0	14.0	3.5	4.7	6.1	4.2	95.6	569.8
Monti Cimini	0.1	3.6	12.2	15.7	0.7		32.3	783.8
Collemeluccio	9.4	1.2	3.0	2.9	0.9		17.4	557.8
Cozzo Ferriero	31.3	1.2		37.6	1.3		71.3	1383.3
Fonte Novello	18.4	19.6	29.7	18.6	2.4	0.2	88.9	1030.3
Fosso Cecita	0.8	0.3	0.5		0.3		1.8	583.9
Montedimezzo	2.7	4.0	15.2	3.6	0.7	0.2	26.5	702.5
Monte Sacro	12.4	3.6	22.3	30.8	1.5		70.7	469.3
Sasso Fratino		15.6		49.0	0.7		65.3	1189.1
Val Cervara	1.6	16.6	32.4	88.5	3.9		143.0	363.6
Gargano Pavari		26.7	45.1	20.1	3.6		95.5	666.3

Table 2 - Deadwood amounts across components and living volume in each study area

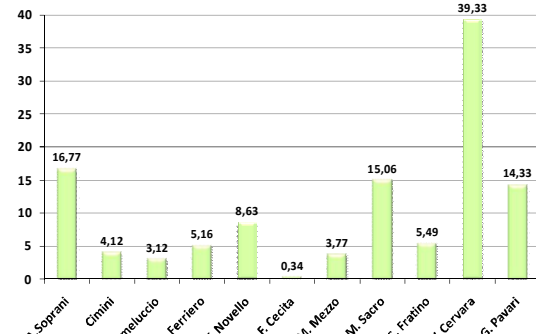


Table 3 - Ratio of dead to living wood in the studied sites

Discussion and Conclusions

The amount of deadwood recorded, even if lower than that reported for old growth forests, could have a different meaning due to the faster decay occurring in Mediterranean forests. Old-growth features and the characteristics of each indicator should be framed and referred to well-defined climatic and biogeographic contexts. In this study, three main deadwood features prove to characterize forest stands close to old-growthness: a ratio of dead to living wood not lower than 10%; lying deadwood much abundant than the standing one and large range of deadwood size and decay classes across all the deadwood components.

One of the questions still open is how long does it takes the development of old-growth conditions from managed stands and, in addition, how long they could be in relation to forest types, climate and orographic traits.

Study areas	Standing dead wood					Snag					Dead downed trees					Coarse woody debris					Stumps (natural origin)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Abeti Soprani	5	7				4	1				3	1				2	1	2			1			2	4
Monti Cimini							11				38					48					2				
Collemeluccio	47	7				6					15	2				5	9	2	1	1		4	1		
Cozzo Ferriero		32	12					2						3	22									1	2
Fonte Novello			9	6	5		2	6	5		8	17	3	5		4	2	6						3	
Fosso Cecita		32	7				6	9				12	13				7	2				3	2		
Monte di Mezzo	7	3				11	3				4	26	2			1	4	8	2			3	1		
Monte Sacro		15	2				4	1			16	5	8	3		11	12	8	12	2	1			1	2
Sasso Fratino							16	4	4			13	16	3	16										1
Val Cervara							6	6				16	5	1		1	3	22	8			2	1		
Gargano Pavari						1	5	22	1		1	5	38	4		2	2	7			1	3	1		

Table 4 - Decay class (according to Hunter, 1990) distribution across deadwood components. Values are reported as percentages with respect to the overall deadwood volume (m^3ha^{-1}) in each study site