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Contribution to the assessment of the conservation status of spruce forests in Greece

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This paper provides a conservation assessment of the habitat type "Acidophilous Forests (Vaccinio-Piceetea)" within the Natura 2000 sites "Elatia-Pyramis Koutra" (GR1140003), a managed forest and "Partheno Dasos Kentrikis Rodopis" (GR1140001), an unmanaged forest located in the prefecture of Drama (NE Greece). These sites are the only Natura 2000 sites in Greece with this habitat type. Thirty-eight sample plots of 500 m^2 each were selected randomly in these two sites. Three parameters and ten criteria were used to assess conservation status. The main results show that Elatia forest comprises various developmental stages, with a relatively low percentage of dead wood (5.7% of the stand), of which only 50% was of large size (DBH > 30 cm) and 30% standing. Only one biotope tree and no ancient trees were recorded in Elatia forest. Most of the sample plots showed signs of man-made gaps or clearings (habitat fragmentation). The overall conservation status assessment of the managed Elatia forest is "inadequate" (B) while that of the unmanaged forest is "favourable" (A). We conclude that there is much room for improvement in the current forest management practices of the Elatia forest.

Key words: assessment, conservation status, forest, habitat, spruce.

INTRODUCTION

The EEC "Habitat Directive" (Directive 92/43, 21 May 1992) and the ones that followed (European Commission, 1992, 1997, 2006), aimed at the preservation of biodiversity through the conservation of natural habitats and wild fauna and flora within the territory of the Member States of the European Union. They provide the framework for the development of a network of Sites of Community Interest (SCI), called NATURA 2000 network. Main target of this network was to ensure the conservation and the restoration of various types of natural habitats and habitats of species within the natural boundaries of member States (Schnitter *et al*., 2006).

According to Dimopoulos *et al.* (2005), Greece harbours 85 Annex I habitat types and 30 additional types selected from a national perspective. There are 359 NATURA 2000 sites, of which 78 (21.7%) have been included in the area of responsibility of management institutions, containing 92 habitat types.

One important habitat type is the "Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea)", (NATURA 2000 Code: 9410). The southernmost limits of its European distribution extend to this area of Northern Greece. In spite of their ecological importance and the small area they cover, spruce forests in Greece are classified first among the country's most productive forests. Furthermore, the spruce forests in Greece represent a very important habitat type for management as well as for protection and conservation (Eleftheriadou, 1992).

There have been attempts to classify biodiversity conservation through the classification of threats and actions developed by the Conservation Measures Partnership (CMP, 2005) and the World Conservation

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Union IUCN Species Survival Commission (IUCN, 2005). Dimopoulos *et al.* (2005) suggested three criteria for the assessment of the conservation status of habitat types: intactness of habitat-specific structure, completeness of habitat-specific species and impacts. Spanos & Feest (2007) in their review on the assessment of biodiversity in forest ecosystems, suggested that the determination of forest biodiversity should be based upon three main components of the forest ecosystems: structure, composition and function. Salafsky *et al*. (2008) combined the best elements of the CMP and IUCN (2005) classifications, tested them with actual project data and produced a unified classification for threats and actions. Balmford *et al.* (2009) examined Salafsky's system and proposed an alternative one where threats are explicitly classified both by their prevailing mechanism and by their source. In Spain, Velázquez *et al.* (2010) and Hernando *et al.* (2010) proposed methodologies which integrate the conservation of biodiversity into the management of NATURA 2000 sites using environmental diagnosis criteria and defining quantitatively the conservation status of forest habitats for improving forest management and enhancing biodiversity.

The aim of this study is to examine and assess the conservation status of habitat type 9410, in two NATURA 2000 sites that differ in their management: a protected but conventionally managed forest and the strictly protected, unmanaged (virgin) forest of Central Rhodope. Our goal is to test the German pattern modified according to the European Guidelines for conservation assessment in order to use it as a model for the assessment and monitoring of other habitat types.

MATERIALS AND METHODS

Study area

The study areas are the NATURA 2000 network sites known as "Elatia-Pyramis Koutra" site (GR1140003) and "Partheno Dasos Kentrikis Rodopis" site (GR1140001). They occupy about 8010 ha and extend from the northern part of the Forest Villages of Elatia and of Virgin Forest in Central Rhodope to the Greek-Bulgarian border (Dimopoulos *et al*., 2005). Geographically they are located between 41°28′40″ – 41°34′25″N, 24°13′44′ – 24°24′43″E and 41°31′13″ – 41°33′16″N, 24°27′59″ – 24°30′44″, respectively (Fig. 1). In this particular area of Greece (the Rhodope mountains), the above-mentioned habitat type reaches its southernmost limit of distribution in Europe and it is unique for Greece. The unmanaged forest expresses important natural values due to undisturbed forest ecosystem (Schmidt-Vogt, 1987, 1991; Chris-

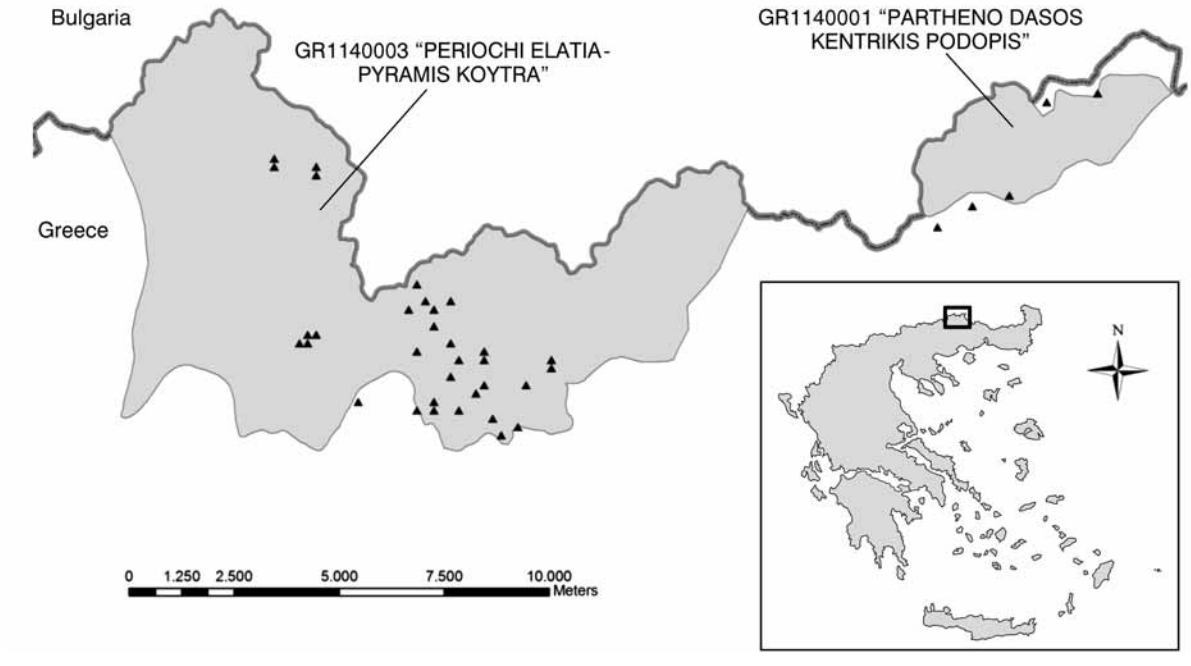

FIG. 1. Map of the study areas ("Elatia-Pyramis Koutra site" GR1140003, "Partheno Dasos Kentrikis Rodopis site" GR1140001) showing the distribution of the 38 sample plots within the spruce forests.

tensen, 1997). According to the official Standard Data Form spruce forests cover 3738 ha, being the habitat type with the highest coverage within the two protected sites. It represents 44% of the whole Greek spruce forests.

Field studies were conducted in spring and summer of 2007 and 2008. Based on a grid of cell size 200 × 200 m over imposed on the habitat type, 38 sample plots were randomly sampled. In each selected sample plot we established a circular area with radius r = 12.6 m (area 500 m^2) using a GPS (Garmin eTrex Vista Cx) and a tree height measuring device (Hagloef VertexIII). Thirty three of the samples were placed in Elatia (managed) forest and 5 in Fraxto (unmanaged) forest. In most sample plots the dominant tree was spruce (*Picea abies* Karst.) either forming pure stands or mixed with other species like scots pine (*Pinus sylvestris* L.), fir (*Abies borisii-regis* Mattf.) and beech (*Fagus sylvatica* L.). In a few plots the dominant species was scots pine or beech but other stand characteristics were typical of Habitat Type 9410. In each sample plot and for all trees with breast height diameter greater than 10 cm the following forest biometric and ecological parameters were recorded: site characteristics (exposition, inclination, altitude, relief), species, diameter at breast height (DBH), standing dead wood, lying dead wood for trees with diameter greater than 10 cm at the low end, biotope trees/ancient trees according to Bavarian forest service protocols for biotope trees, after slight modification (Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF), 2004), forest canopy discontinuation (anthropogenic or natural), damages on trees from harvesting, shrubs layer, ground flora, rejuvenation.

Identification of the Habitat Type 9410 was based on the descriptions given in the "Interpretation Manual of European Union Habitats" (European Commission – DG Environment, 2007). We consider as Habitat Type 9410, habitats with dominating spruce and low presence of related tree species as well as the presence of the typical species in the herb layer.

Assessment of the conservation status of the 9410 habitat

The assessment was based on the regulations and procedures given in "Assessment, monitoring and reporting under Article 17 of the Habitats Directive" (European Commission, 2006). More specifically, we based our assessment on three different parameters: i) the stand structure, ii) typical species coverage, iii) threats and damages (Table 1). For each parameter, we used a number of criteria with specific weights.

TABLE 1. Parameters and criteria for the conservation status assessment of Habitat Type 9410

Stand Structure	Weight	A (favourable)	B (inadequate)	C (unfavourable)
1. Number of development stages	40%	≥ 2	2	1
2. Overall volume of dead trees	15%	> 20% (> 75 m^3 ha^{-1})	> 2-20% (7.5-75 m^3 ha^{-1})	up to 2% (7.5 m^3 ha^{-1})
3. Coarse dead trees (D > 30 cm)	15%	Sufficient (≥ 3)	Few (1-2)	Absent
4. Number of Biotope and ancient trees	30%	≥ 2	1	0
Typical Species Coverage		**A (presence)**	**B (sufficient)**	**C (absent/Partly absent)**
1. Tree layer	50%	> 90%	between 33% and 90%	< 33%
2. Herb layer	50%	> 90%	between 66% and 90%	< 66%
Damage/Threats*		**A (without)**	**B (few)**	**C (many)**
1. Invasive species	10%	No	< 2% of the plot	≥ 2% of the plot
2. Fragmentation (anthropogenic gaps)	45%	Without gap	Gap in the neighbouring area (> 1r** & < 2r)	Gap within the plot (< 1r)
3. Anthropogenic damages (Forest exploitation)	45%	Without	At few trees only (1-2)	At more than 2 trees

If only one criterion is C the entire parameter (damage) is treated as C (see Schnitter *et al*., 2006).
**1r = radius of the plot.

For example, the parameter "stand structure" comprises four different criteria: number of developmental stages, overall dead wood, coarse dead wood and biotope/ancient trees with weighting factors 40, 15, 15 and 30%, respectively. Using the criteria and the weights presented in Table 1 for each parameter, each sample plot was classified into one of three classes: A (favourable conservation status), B (inadequate conservation status) and C (unfavourable conservation status).

For the differentiation of the developmental stages, we adopted the classification of the Greek Forest Service that is based on the diameter classes of the trees as presented in Table 2.

The overall dead wood refers to the total standing and lying dead wood volume appeared in the plots (Speight, 1989; Derleth *et al.*, 2000; Holeksa, 2001). The coarse dead wood refers to the snags and lying dead stems with diameters more than 30 cm. The biotope trees refer to the trees with visual appearance of holes or signs of animal nests, necrosis that would enable colonisation by beetles, fungi, etc. The ancient are defined as trees with a DBH more than 80 cm for spruce and 40 cm for scots pine. These trees are considered characteristic for the benefit of nature protection. The parameter typical species comprises two different criteria: tree layer and herb layer. The tree layer criterion refers to the coverage of typical tree species of the habitat (Table 3). The species list is based on silvicultural/phytosociological studies (Eleftheriadou, 1992; Eleftheriadou *et al*., 2000), as well as on data from the present research.

The parameter threads and damages comprise three different criteria: invasive species, forest canopy discontinuations and anthropogenic damages. Forest canopy discontinuations are considered the gaps or clearings that lie within the forest and disturb its continuation, e.g. harvesting operations. This small scale stand fragmentation was recorded within the sample plot (1r) or in the adjacent area (>1r & <2r). The following canopy discontinuation categories were assigned: A: without gaps, B: gap(s) adjacent to plot's boundary and C: gap(s) within the plot. Anthropogenic damages are considered to be all the damages caused by harvesting activity, wood extraction, skidding roads construction, etc. (European Commission, 1997). Natural damages like windfall or insect attacks were not used for the assessment of this criterion.

After the separate assessment of each parameter for every sample plot using the algorithm: criterion 1 × weighting factor 1 (%) + criterion 2 × weighting factor 2 (%) +...+ criterion n × weighting factor n (%), a general value of A or B or C was assigned. The overall assessment of the sample plot was then calcu-

TABLE 2. Development stages according to the guidelines of the Greek Forest Service

Developmental stages	Brief description
Stage 1	Rejuvenation stage (coverage of rejuvenation more than or equal to 10%)
Stage 2	Pole stage (DBH from 10-21 cm and 15 or more stems)
Stage 3	Timber stage (DBH 22-35 cm and 10 or more stems)
Stage 4	Sawlog stage (DBH 36-48 cm and 5 or more stems)
Stage 5	Maturity stage (DBH over 50 cm and 10 or less stems)

TABLE 3. Typical species for the forest assessing conservation status of the spruce habitat type

Typical species of
Tree layer: *Abies alba, Fagus sylvatica, Picea abies*
Herb layer: *Ajuga reptans, Aremonia agrimonoides, Athyrium filix-femina, Calamagrostis arundinacea, Corallorhiza trifida, Deschampsia flexuosa, Dryopteris filix-mas, Euphorbia amygdaloides, Fragaria vesca, Luzula luzulina, L. luzuloides, L. sylvatica, Melampyrum sylvaticum, Mycelis muralis, Myosotis sylvatica, Orthilia secunda, Oxalis acetosella, Poa nemoralis, Pteridium aquilinum, Pulmonaria rubra, Pyrola chlorantha, Rubus idaeus, Soldanella rhodopaea, Vaccinium myrtillus, V. vitis-idaea, Veronica chamaedrys, V. officinalis*

TABLE 4. Algorithm for overall status assessment

Structure*	A	A	A	A	A	B	B
Typical species	B	A	B	C	A	B	C
Anthropogenic Damages	C	B	B	C	C	C	C
OVERALL ASSESSMENT	B	A	B	C	B	B	C

* The sequence is not relevant

lated according to the algorithm shown in Table 4 (Lana (Bund/Länder-Arbeitsgemeinschaft Naturschutz, Landschaftspflege und Erholung Ed.), 2001), where each parameter had an equal weighting (1/3).

RESULTS

Structure of the habitat type-Development stages

The major difference between the two studied forests concerning the distribution of developmental stages (Fig. 2) is that the dominant stage in Elatia is the first (rejuvenation) occurring in the 32.6% of the sample plots while in the virgin forest the saw log stage dominates (33.3% of the sample plots). In Elatia forest, 17 (51.5%) sample plots had more than two developmental stages and assigned the value A ("favourable"), 15 (45.5%) had exactly two developmental stages and were assigned the value B ("inadequate") and only one plot (3%) had just one development stage and was characterised "unfavourable" (C). The virgin forest 80% of the plots exhibited more than two development stages and the rest (20%) were characterized as "inadequate".

Overall volume of dead wood

In the 33 sample plots of the studied habitat in Elatia forest a total of 133 dead trees were found (81 spruce, 51 scots pine and one beech). Dead wood was found in all sample plots except two. Its percentage varied from 0.2-55.4% of the whole timber volume within the sample plot. In absolute numbers the quantity of dead wood varied from 0.023-5.212 m^3 or 0.46-104.24 m^3 ha^{-1} (average 60.839 m^3 ha^{-1}). Dead trees were spruce only in 13 plots, scots pine in 18 plots and both spruce and pine in 10 plots. The proportion of dead spruce reached two thirds (66.2%) of the entire dead wood volume, and that of scots pine reached one third (33.6%). For beech the proportion was negligible (0.2%). In the virgin forest the values of the overall deadwood ranged from 52.8 to 226.1 m^3 ha^{-1}. Per plot, the distribution of the overall deadwood of spruce ranged from 4.61 to 100% and of scots pine from 14.91 to 95.39%.

Coarse dead wood (DBH >30 cm)

In Elatia forest, eleven sample plots (1/3 of the sample) had coarse dead trees (DBH >30 cm) with overall timber volume that ranged from 2.5-51.6%. Taking into consideration all sample plots, the volume of coarse dead wood is 34805 m^3 ha^{-1}, which is over 50% of all the dead wood. Among the 21 coarse dead trees observed, 12 were spruce and 9 scots pines. Trees with large diameter (max. diameter 57 cm) were predominately spruce, while those with small diameter

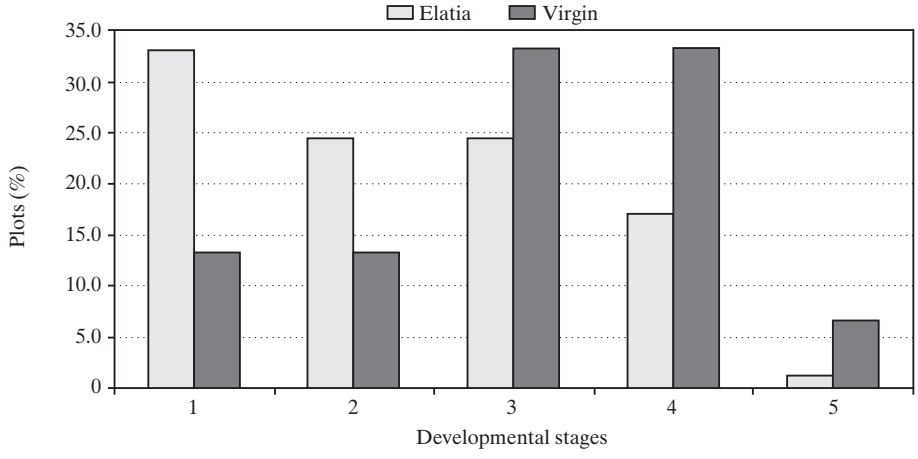

FIG. 2. Distribution of developmental stages in the spruce forests (Habitat Type 9410) in Elatia and Virgin forest, Drama.

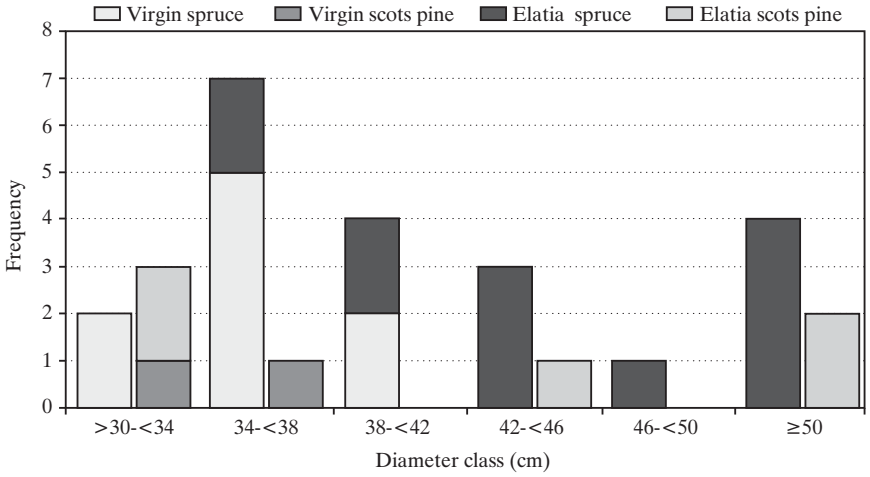

FIG. 3. Distribution of diameters of coarse dead trees (DBH > 30 cm) of spruce and scots pine in Elatia and Virgin forest, Drama.

TABLE 5. Distribution of coarse dead trees (DBH > 30 cm) based on tree condition and position in Elatia site

	Tree species								
	Spruce			Scots Pine			Overall		
Condition	No.	Vol. (m^3)	%	No.	Vol. (m^3)	%	No.	Vol. (m^3)	%
Recently dead	2	2.713	20.7	1	0.537	8.9	3	3.250	17.0
Early decomposition	6	6.053	46.2	6	4.188	69.2	12	10.241	53.5
Advanced decomposition	1	0.403	3.1	1	0.925	15.3	2	1.328	6.9
Rotten	3	3.924	30.0	1	0.400	6.6	4	4.324	22.6
Overall	12	13.093	100.0	9	6.050	100.0	21	19.143	100.0
Position									
Lying	9	9.169	70.0	3	2.447	40.4	12	11.616	60.7
Standing	3	3.924	30.0	5	3.203	52.9	8	7.127	37.2
Bend	–	–	–	1	0.400	6.6	1	0.400	2.1
Overall	12	13.093	100.0	9	6.050	100.0	21	19.143	100.0

were scots pines (max. diameter 41 cm) (Fig. 3).

The distribution of coarse dead tree shows two height classes: the first with heights of 14-16 m and the second with heights of 18-26 m. More than half of the coarse dead trees (both spruce and pine) were recently dead or in early decomposition stage; 70% of the dead spruce was found lying on the ground while 52.9% of the dead scots pine was found in standing position. Nearly two thirds of the coarse dead trees were found lying on the ground and one third was standing (Table 5).

Biotope and ancient trees

In the 33 sample plots of the managed forest of Elatia, only one biotope tree (Fig. 4) and no ancient trees were found. Based on this criterion, the conservation status of the studied habitat type in Elatia forest is characterised as C. In the virgin forest, there were more than two biotope trees per plot, and thus the assessment was A.

Typical species of the tree layer

In Elatia forest, 8 plots (24.2%) were assigned the value B (33-90% of typical species) because mixed forests of spruce and scots pine tend to evolve into pure spruce. Twelve plots (36.4%) were assigned the value C (less than 33% of typical species) and 13 plots (39.4%) were assigned the value A (more than 90% of typical species). In the virgin forest, 20% were assigned the value A and the rest the value B.

FIG. 4. The biotope tree (spruce) found within the Habitat Type 9410 in Elatia forest.

Typical species of the ground layer

In Elatia, 18 plots (54.5%) were classified as B, 12 plots (36.4%) as C and 3 plots (9.1%) as A. In the virgin forest all plots were assigned the value A (more than 90% of ground layer species were typical).

Damages and threats

Alien or invasive species
Alien or invasive species of Habitat Type 9410 are considered to be all those species that are not indigenous to the natural vegetation e.g. *Robinia pseudacacia* and may suppress indigenous species. No invasive species were found in any of our sample plots.

Forest canopy discontinuation

Disturbances like forest canopy discontinuation were rather intensive in Elatia (managed) forest due to harvesting and other operations. Eleven plots (33.3%) were exhibited no canopy discontinuations and were assigned the value A, 11 (33.3%) showed some signs of disturbance in the adjacent to plot's boundary and were assigned the value B and 3 plots (9.1%) were disturbed and were assigned the value C. This was not the case in the virgin forest because harvesting operations are not allowed due to the strict protection regime, thus the virgin forest was classified as A regarding the canopy discontinuation criterion. Overall, in the managed forest, 21.2% of the forest gaps observed are associated with the natural forest succession process, while the remaining is attributed to the forest harvesting operations.

Damage (utilisation of the forest)

In Elatia forest, almost half the plots (48.5%) were assigned the value A since no anthropogenic tree damage was observed, nine plots (27.3%) have had damages at one to two trees and were assigned the value B and eight plots (24.2%) have had damages at more than two trees and were assigned the value C. Better conditions were found in virgin forest since 80% of the plots were classified as A and 20% as B.

Assessment of the conservation status of the habitat type 9410

In Table 6 we summarize the conservation status assessment for Habitat Type 9410. The majority of sample plots from Elatia forest were assigned to class B (volume of death wood, typical ground species and number of disturbances) or C (number of coarse death trees and number of biotope trees). Considering the number of developmental stages and the number of tree damages most plots were assigned the value A. In the virgin forest most sample plots were assigned the value A for all criteria with the exception of the number of coarse death trees and the typical tree species (Table 6).

Per parameter used the assessment is as follows: On the basis of the habitat type structure, the Elatia forest plots were classified as A (30%), B (69.7%) and C (27.3%). The virgin forest plots were classified as A (80%) and B (20%). Regarding the typical species the Elatia forest was classified as A (33.3%), B (36.4%) and C (30.3%). The virgin forest was classified as A (40%) and B (60%). Regarding damages and threads, Elatia forest was classified as A (48.5%), and C (51.7%). The unmanaged forest was classified as A (100%).

The overall assessment for all parameters and criteria based on the algorithm in Table 2, is as follows: In Elatia forest, three sample plots (9.1%) are within category A, 22 sample plots (66.7%) within category B and 8 (24.2%) within category C. The overall assessment of Habitat Type 9410 in Elatia is B. In the unmanaged forest four plots (80%) are within cate-

TABLE 6. Assessment of the conservation status of Habitat Type 9410 in Elatia and Virgin forest

	Elatia forest Number of plots in Class			Virgin Forest Number of plots in Class		
Criterion*	A	B	C	A	B	C
Number of developm. stages	17 (51.5%)	15 (45.5%)	1 (3.0%)	4 (80.0%)	1 (20.0%)	0 (0.0%)
Overall volume of dead wood	2 (6.0%)	20 (61.0%)	11 (33.0%)	3 (60.0%)	2 (40.0%)	0 (0.0%)
Number of coarse dead trees	3 (9.0%)	8 (24.0%)	22 (67.0%)	1 (20.0%)	3 (60.0%)	1 (20.0%)
Number of biotope trees	0 (0.0%)	1 (3.0%)	32 (97.0%)	5 (100.0%)	0 (0.0%)	0 (0.0%)
Typical species in the tree layer	13 (39.4%)	8 (24.2%)	12 (36.4%)	2 (40.0%)	3 (60.0%)	0 (0.0%)
Typical species in the ground layer	3 (9.1%)	18 (54.5%)	12 (36.4%)	5 (100.0%)	0 (0.0%)	0 (0.0%)
Number of forest disturbances	11 (33.3%)	19 (57.6%)	3 (9.1%)	5 (100.0%)	0 (0.0%)	0 (0.0%)
Number of tree damages	16 (48.5%)	9 (27.3%)	8 (24.2%)	4 (80.0%)	1 (20.0%)	0 (0.0%)

* The symbols A, B, C are defined in Table 1 for each criterion used

gory A, and one plot in category B (overall assessment is A).

DISCUSSION

European legislation (European Commission, 2006) and various researchers (Burkhardt *et al*., 2004; Spanos & Feest, 2007; Hernando *et al*., 2010; Velázquez *et al*., 2010) state that for a reliable assessment of the conservation status of habitat types and species of the Directive 92/43/EEC, appropriate biotic parameters and criteria have to be selected. For this purpose, we selected three parameters (forest structure, typical species and damages/threats) and ten criteria in a manner that it can be easily applied by Forest Service managers or management authorities. The classification into three simple values (A, B, C) helps to avoid any possible intermediate values and make the classification more subjective (Hernando *et al.*, 2010).

The developmental stages observed in the spruce forest of Elatia are the result of two main factors: first, the origin of the forest, which derived through the succession of former pastures by natural regeneration, and second, the applied forest management regime (i.e. shelter-wood system in small areas). These factors have favoured uneven aged stands with vertical structures contributing to the better stand stability, amenity values and providing shelter for some rare species like capercaillie (*Tetrao urogallus* L.). However, this form of management requires full forestry, silvicultural training and high financial input (Schmidt-Vogt, 1991). Furthermore, it is known that spruce may contribute in different developmental stages as an intermediate species or builds up the final plant community in pure stands or mixed with beech and fir (Schmidt-Vogt, 1987).

The overall amount of dead wood in Elatia (managed) forest shows a wide range of numbers (0.46-104.24 m^3 ha^{-1}). This is due to the great variation in forest utilization, structure, productivity, etc., which plays an important role for the potential of dead wood quantities. Similar results are reported by Hahn & Christensen (2004). A mean absolute value of deadwood of 60.84 m^3 ha^{-1} (or 5.7% of the stand), where approximately half of it has large diameter (i.e. DBH $>$ 30 cm), corresponds to values of managed forests of western European countries. Similar results are reported in Greek beech forests where the amount of dead wood was 66.46 m^3 ha^{-1} (Daskalakou *et al*., 2008). This amount of dead wood falls within the threshold values (20-70 m^3 ha^{-1}) of dead wood reported by Müller & Bütler (2010) for mixed-montane forests. In contrast, the values of dead wood for protected forests or forests without management are three to four times higher (Derleth *et al*., 2000; Holeksa, 2001; Colak *et al*., 2009). The overall amount of dead wood in the virgin forest of Rhodope is much higher than in Elatia (52.8-226.1 m^3 ha^{-1}), which represents 10.1 to 24.1% of the standing wood volume. These results are in accordance with the reported dead wood in European mountain natural forests (Bretz Guby & Dobbertin, 1996; Debeljak, 2006). The main reason for this difference of dead wood in the two forests is the thinning applied in Elatia forest due to management operations that reduce natural mortality by timber logging. The high percentage (33.6%) of scots pine deadwood and the very small (0.2%) of beech deadwood as well as the mixture or de-mixture of species in the studied habitat type, indicates the successional development of vegetation in the area.

It is known that the location and condition of decomposing dead trees influences the habitat type and a number of protected forest species (e.g. saprophytes, non-vertebrates, mosses, lichens, mammals, birds) making the dead wood a key ecological factor in forest ecosystems. Stokland *et al*. (2004) reported that, in Scandinavia, it has been estimated that 6000-7000 species depend upon dead wood. For this reason the ratio of fallen and standing dead wood observed (60:40) could initially be considered as satisfactory, but a slight increase of the percentage of standing deadwood (10-20%) is desirable to improve the status of the habitat type. Colak *et al.* (2009) in their study, stress that, in order to effectively conserve the biodiversity associated with the coarse dead wood in forests, it is important to achieve a balance between the coarse dead wood of fallen (logs) and those of standing trees (snags). It is worth mentioning that the dead scots pine trees did not exceed 41 cm in diameter. This shows its low competitiveness compared to spruce trees, and determines the rotation time of scots pine at 60 years. Due to our limited sample plots, it is not possible to draw definite conclusions concerning the location of the dead trees within the structure of the stand (understorey, overstorey) or the reasons for their mortality (natural or anthropogenic).

An important indication of habitat quality is the existence of biotope or ancient trees. The absence of such trees in Elatia forest is exclusively the result of recent forest utilization. In the initial management period, in sixties, one main silvicultural target was the forest improvement by sanitation cutting. Thus, almost all the malformed and aged trees progressively removed from the forest resulting in the scarce presence of biotope or ancient trees (Fig. 4). The modern adaptive management of protected forests (NATURA 2000) impose the change of the old-fashioned (timber orientated) management practices into new multipurpose management system. The new forest management plans should incorporate actions for retaining at least 30-50 biotope or ancient trees per ha, contributing to biodiversity enhancement. Humphrey *et al.* (2004) recommend the retention of 30-40 large and over 100 years old ancient/veteran trees per ha, even in spruce plantations, to enhance deadwood habitat.

The present-day picture of the mixed Elatia forest can be explained by the historical development of the studied area. Elatia forest derived from former mount forest pasturelands after the progressive abandonment of the local population in the previous century. Thus, as far as the species succession is concerned, the forest still has an irregular structure and it is relatively young (Eleftheriadou, 1992; Eleftheriadou *et al.*, 2000).

The selection of typical species in the herb layer was based on the fact that they are representative species of the Habitat Type 9410 and can be determined easily by foresters, environmental scientists, etc. Therefore we excluded from this study ephemeral species and those which are difficult to determine i.e. *Hieracium* spp. The non-typical species of the herb layer are mainly those that indicate former grazing and/or vegetation of non-wooded areas. Non typical aggressive neophytes were not observed within the study area and have not been observed by other researchers (Eleftheriadou, 1992).

The forest of Elatia, is a natural forest that is being managed by the Greek Forest Service under a regular management plan that is revised every 10 years. The formation of canopy discontinuations (gaps) within the forest is considered natural if it occurs during the natural development of the forest (natural mortality). However, in Elatia, harvesting operations, damage trees and disrupt canopy continuity and change the structure of the forest. According to the IUCN-CMP classification (IUCN, 2005) logging and temporary recreation are activities that may cause habitat fragmentation. These damages could be minimized by more detailed planning of harvesting techniques and better training of the loggers.

Based on the overall conservation status assessment of the spruce forest and forest utilization in Elatia which assigned as “inadequate”, we conclude that there are many options available for the improvement of the forest’s conservation status by changing old fashioned management techniques. This improvement would benefit nature protection without necessarily increasing enormously the cost of additional management measures. Finally, the neighbouring virgin forest can be used as a pattern for studying the dynamic evolution and protecting important natural values.

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