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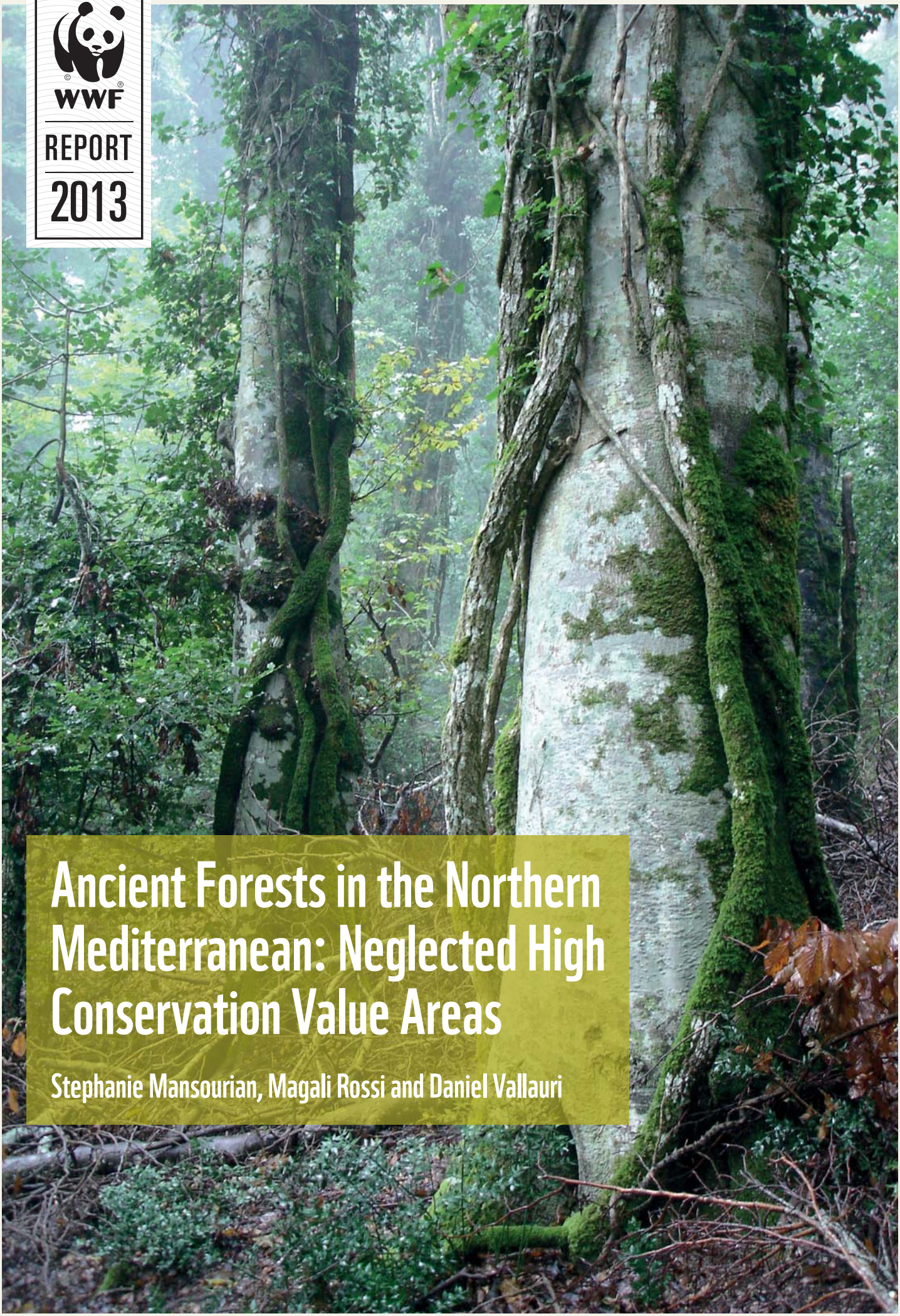

Ancient Forests in the Northern Mediterranean: Neglected High Conservation Value Areas

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TABLE OF CONTENTS

ACRONYMS LIST

A-HCVF	Ancient High Conservation Value Forest
AMF	Adriatic Model Forest
BP	Before Present
CEFE	Centre d'Ecologie Fonctionnelle et Evolutive
CEPF	Critical Ecosystem Partnership Fund
CNRS	Centre National de la Recherche Scientifique
COST	European Cooperation in Science and Technology
CREAF	Centre de Recerca Ecològica i Aplicacions Forestals
Dbh	Diameter at breast height
EEA	European Environment Agency
ENGREF	Ecole Nationale du Génie Rural des Eaux et des Forêts
EPHE	Ecole Pratique des Hautes Etudes
EU	European Union
FAHVC	Forêt Ancienne à Haute Valeur de Conservation
FAO	Food and Agriculture Organization of the United Nations
FHVC	Forêt à Haute Valeur de Conservation
FSC	Forest Stewardship Council
FYROM	Former Yugoslav Republic of Macedonia
GIS	Geographic Information System
GPF	Global Programme Framework
GPFP	Groupe des vieilles forêts Pyrénéennes
HCV	High Conservation Value
HCVA	High Conservation Value Area
HCVF	High Conservation Value Forest
INR	Integral Nature Reserve
IPA	Important Plant Area
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MAB	Man and Biosphere Reserve
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MMFN	Mediterranean Model Forest Network
NP	National Park
NTFP	Non-Timber Forest Product
PA	Protected Area
PA4LP	Protected Areas for a Living Planet
PES	Payment for Ecosystem Service
PSEDA-ILIRIA	Protection and Social and Environmental Development Association (Albania)
SAC	Special Area of Conservation
SPA	Special Protection Area
SNV	Netherlands Development Organisation
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFS	United States Forest Service
WHS	World Heritage Site
ZNIEFF	Zones d'Intérêts Écologiques, Floristiques et Faunistiques

EXECUTIVE SUMMARY

The Mediterranean ecoregion is one of the world's biodiversity hotspots. It owes its ecological uniqueness essentially to the combination of two factors: on the one hand, it has evolved over millennia, containing some important refugia from the last ice age and on the other, the region has also been shaped by the great ancient civilisations of the Mediterranean basin.

Ancient forests have not been widely researched or prioritised in most countries of the Mediterranean. Today they amount to probably less than 1% of the total area of the ecoregion. Yet they do exist and they hold a wealth of biodiversity and important information, notably on resilience and adaptation to threats such as climate change or forest fires.

There are various reasons why ancient Mediterranean forests deserve our attention, not least because there are few left. They can also inform sustainable management, conservation strategies and restoration; they provide important habitats and microhabitats for wildlife and other biodiversity; they hold key information on how forest biodiversity has resisted to threats and on its resilience to climate change in particular; they have specific economic and cultural values; they are part of our natural heritage and are a source of inspiration.

Several initiatives or policies exist that although not explicitly about ancient forests and the Mediterranean are of relevance, such as World Heritage Sites, Man and Biosphere Reserves (MAB), high conservation value forests (HCVF - a concept developed and promoted notably by the Forest Stewardship Council and WWF), IUCN protection categories Ia and Ib, PAN Parks, Re-Wilding Europe and Natura 2000.

In the framework of its programme on "Ancient high conservation value forest (A-HCVF)" WWF France commissioned this report in order to better understand the state of play concerning ancient Mediterranean forests and to help it, together with partners, define future priorities for work. Interviews, questionnaires and a literature review were used to obtain a better preliminary picture of ancient Mediterranean forests across 15 countries in the region (Albania, Bosnia-Herzegovina, Croatia, Cyprus, France, Greece, Italy, Former Yugoslav Republic of Macedonia, Malta, Montenegro, Portugal, Serbia, Slovenia, Spain and Turkey). One hundred and one questionnaires were sent out (via the online application: 'Survey Monkey') and 12 phone (or Skype) interviews were held. An extensive literature review also complemented this work.

The questionnaire and interviews considered:
- *Definitions of ancient forests* – a jungle of words emerged when reviewing which specific terms were used to define ancient forests in each language of the Mediterranean.
- *Relevant characteristics in the Mediterranean* – maturity, ancientness, amount of deadwood, nativeness, structure and lack of human intervention were considered 'very important' characteristics (out of 12 proposed characteristics) by the majority of respondents.
- *Sites* – a total of over 80 potential sites in 15 countries emerged from this assessment (see map on page 7); many more remain to be discovered and researched.
- *Projects* – the report notes only a small number of projects that were, in most cases, only indirectly related to ancient forests.
- *Tools to identify, map, protect and monitor ancient forests* – the three most important tools used in the Mediterranean are: measurements of trees and stands, and of the amount of deadwood, and aerial photography.
- *Gaps in knowledge* – important gaps in knowledge that should be urgently addressed include surveys of species, mapping of ancient forests, land use history, monitoring, valuing ancient forests, improving awareness and understanding, integrating ancient forests into relevant policies and applying improved understanding of these relict forests to protection, management and restoration of Mediterranean forests.

ANCIENT FORESTS ARE PART OF THE MEDITERRANEAN CULTURAL AND NATURAL HERITAGE

• *Cultural features* – today, the cultural role of ancient forests seems underestimated by our panel (scientists, NGOs and managers).
• *Threats* – of the 15 threats provided in the questionnaire, the main threats (with over 50% of respondents considering them to be either 'important' or 'major') identified were: anthropogenic fires, tourism/recreational development, infrastructure and tourism, mismanagement, timber and NTFP extraction, urbanisation and housing, climate change, biomass and fuelwood and biodiversity loss.
• *Area of forest 'undisturbed by man' in each country* – in most countries, respondents disagreed with the figures officially reported for "forests undisturbed by man" under the 'Forest Europe' process.

As a result of this research, a common desire to further the conservation of A-HCVF emerged, as well as differences of perception between countries.

Major gaps concerning ancient Mediterranean forests that emerged through this assessment can be divided into four categories: knowledge; protection; values and threats; and policies and management practices. They lead to the following ten recommendations for short to medium term (2-5 years) work:
- **Recommendation 1:** Establish a network of interested parties on ancient forests in the Mediterranean.
- **Recommendation 2:** Define a common method for assessing and identifying ancient forests, and their associated values.
- **Recommendation 3:** Use this assessment and the sites already protected as references and to fully inventory and map ancient forests in priority landscapes.
- **Recommendation 4:** Promote the key role of ancient forests to stimulate innovative protection, management and restoration of forest biodiversity and set up pilot demonstration activities in priority landscapes.
- **Recommendation 5:** Explicitly link ancient forests to relevant policies and lobby for their integration into relevant biodiversity strategies and programmes.
- **Recommendation 6:** Assess threats and promote the urgent protection of the Mediterranean's remaining ancient forests.
- **Recommendation 7:** Apply effective monitoring systems in ancient forests so that they can serve as a reference ecosystem to evaluate the conservation status of Mediterranean forest habitats more broadly, and specifically those in Natura 2000 sites.
- **Recommendation 8:** Analyse features of resilience of ancient forests over time and use them to develop innovative strategies for climate change adaptation and/or ecological restoration.
- **Recommendation 9:** Launch a communications campaign so that ancient forests can be better valued as part of both the cultural and natural heritage of the Mediterranean.
- **Recommendation 10:** Broaden the exercise undertaken in this study to the south eastern and southern Mediterranean countries.

Ancient forests are part of the Mediterranean natural and cultural heritage, yet they are not suitably valued; and time is running out to secure their survival and recovery.

RÉSUMÉ EXÉCUTIF

L'écorégion Méditerranée est l'un des hauts lieux de la biodiversité mondiale. Elle tient son originalité écologique essentiellement de la combinaison de deux facteurs : d'une part, son histoire évolutive à l'échelle des millénaires fait qu'elle présente des refuges importants de la dernière période glaciaire ; d'autre part la région a été modelée par les grandes civilisations anciennes du bassin méditerranéen.

Les forêts anciennes n'ont pas fait l'objet de recherches ou d'une priorité dans la majorité des pays de la Méditerranée. Aujourd'hui, elles comptent sans doute pour moins de 1% de la surface totale de l'écorégion. Toutefois, elles existent bien et possèdent une grande biodiversité et des données importantes, particulièrement sur la résilience et l'adaptation aux pressions comme les changements climatiques ou les incendies.

Les raisons pour lesquelles les forêts anciennes de Méditerranée méritent notre attention sont variées, notamment du fait de leur rareté. Elles peuvent être source d'information pour la gestion durable, les stratégies de conservation et de restauration ; elles fournissent des habitats et micro-habitats importants pour la faune et les autres espèces ; elles détiennent des informations clés sur la façon dont la biodiversité des forêts a résisté aux menaces, et sur sa résilience aux changements climatiques en particulier ; elles ont une valeur économique et culturelle spécifique ; elles font partie de notre patrimoine naturel et sont une source d'inspiration.

Plusieurs initiatives et politiques existent qui, même si elles ne portent pas spécifiquement sur les forêts anciennes et la Méditerranée sont pertinentes pour celles-ci. Par exemple, les sites du Patrimoine mondial, les réserves de l'Homme et de la Biosphère (MAB), les forêts à haute valeur de conservation (FHVC – un concept développé et promu particulièrement par le Forest Stewardship Council et WWF), les catégories de protection UICN Ia et Ib, PAN Parks, Rewilding Europe et Natura 2000.

Dans le cadre de son programme sur les forêts anciennes à haute valeur de conservation (FAHVC), le WWF-France commandita ce rapport dans le but de mieux comprendre l'état des lieux relatif aux forêts anciennes de Méditerranée et d'aider à définir, avec des partenaires, les priorités de travail à venir. Des interviews, un questionnaire et une revue de la littérature ont été utilisés pour obtenir une première image des forêts anciennes dans 15 pays de la Méditerranée (Albanie, Bosnie-Herzégovine, Croatie, Chypre, France, Grèce, Italie, ex-République yougoslave de Macédoine, Malte, Monténégro, Portugal, Serbie, Slovénie, Espagne et Turquie). Cent un questionnaires ont été envoyé (via une application en ligne : 'Survey Monkey') et 12 interviews par téléphone (ou Skype) ont eu lieu. Une revue étendue de la littérature a complété ce travail.

Le questionnaire et les interviews ont portés sur les thèmes qui suivent :
- *Définitions des forêts anciennes* – une forêt de mots est révélée par la revue des termes utilisés dans chaque langue pour définir les forêts anciennes en Méditerranée.
- *Caractéristiques clé en Méditerranée* - maturité, ancienneté, quantité de bois mort, indigénat, structure et absence d'intervention humaine (parmi les 12 proposées) sont considérées comme des caractéristiques 'très importantes' par la majorité des répondants.
- *Sites* – un total de plus de 80 sites potentiels dans les 15 pays ressort de cette étude (voir carte page 7) ; bien d'autres restent à rechercher et découvrir.
- *Projets* – le rapport note seulement un petit nombre de projets en lien avec les forêts anciennes, qui dans la majorité des cas le sont indirectement.
- *Outils pour identifier, cartographier, protéger et suivre les forêts anciennes* – les trois outils les plus utilisés en Méditerranée sont : mesure des arbres et des peuplements, de la quantité de bois mort, et les photographies aériennes.
- *Lacunes de connaissances* – les plus importantes lacunes qui doivent être comblées en priorité incluent l'inventaire des espèces associées, la cartographie des forêts anciennes,

l'histoire des usages du sol, le suivi, l'appréciation des valeurs des forêts anciennes, l'amélioration de la prise de conscience, l'intégration des forêts anciennes dans les politiques clé et l'utilisation des enseignements de ces forêts reliques pour la protection, gestion et restauration des forêts méditerranéennes.

- *Aspect culturel* – aujourd'hui, la valeur culturelle des forêts anciennes de Méditerranée semble sous-estimée par notre panel (scientifiques, ONG, gestionnaires).
- *Menaces* – parmi les 15 menaces proposées dans le questionnaire, les principales (avec plus de 50% de réponses considérant qu'elles sont soit 'importantes' soit 'majeures') apparaissent être : les incendies d'origine humaines, le développement touristique ou récréatif, les infrastructures et le tourisme, la mauvaise gestion, l'exploitation du bois et des produits forestiers non ligneux, l'urbanisation, les changements climatiques, le développement du bois énergie et la perte de biodiversité.
- *Surface forestière* 'non perturbée par l'homme' dans chaque pays – dans la majorité des pays, les répondants marquent leur désaccord avec les chiffres officiel rapporté comme 'forêt non perturbés par l'homme' dans le cadre du processus 'Forest Europe'.

LES FORÊTS ANCIENNES FONT PARTIE DU PATRIMOINE NATUREL ET CULTUREL DE LA MÉDITERRANÉE, BIEN QUE NON ENCORE APPRÉCIÉES À LEUR JUSTE VALEUR

Les résultats de cette recherche font apparaître un désir commun de conservation des FAHVC, de même que des différences de perceptions entre les pays.

Les principales lacunes concernant les forêts anciennes de Méditerranée qui apparaissent dans cette enquête peuvent être divisées en quatre catégories : connaissances, protection, valeurs et menaces, politiques et pratiques de gestion. Elles conduisent aux dix recommandations suivantes pour un travail à court à moyen terme (2-5 ans) :

- **Recommandation 1 :** Etablir un réseau de partenaires intéressés sur les forêts anciennes de la Méditerranée.
- **Recommandation 2 :** Définir une méthode commune pour identifier et évaluer les forêts anciennes et les valeurs qui leurs sont associées.
- **Recommandation 3 :** Utiliser cette évaluation et les sites déjà protégés comme des références et inventorier et cartographier de façon complète les forêts anciennes des paysages prioritaires.
- **Recommandation 4 :** Promouvoir le rôle clé des forêts anciennes pour stimuler des innovations pour la protection, gestion et restauration de la biodiversité forestière et mettre en œuvre des activités pilotes dans les paysages prioritaires.
- **Recommandation 5 :** Lier de façon explicite les forêts anciennes aux politiques pertinentes et faire pression pour une intégration dans les stratégies et programmes sur la biodiversité.
- **Recommandation 6 :** Evaluer les menaces et promouvoir la protection urgente des forêts anciennes restant en Méditerranée.
- **Recommandation 7 :** Mettre en œuvre un système de suivi dans les forêts anciennes, de façon à ce qu'elles puissent servir d'écosystème de référence pour évaluer le bon état de conservation des forêts méditerranéennes plus largement, et celles inclues dans le réseau Natura 2000 en particulier.
- **Recommandation 8 :** Analyser les paramètres de la résilience des forêts anciennes dans le temps et les utiliser pour développer des stratégies novatrices pour l'adaptation aux changements climatiques et/ou la restauration écologique.
- **Recommandation 9 :** Lancer une campagne de communication de façon à ce que les forêts anciennes soient mieux appréciées comme faisant partie du patrimoine à la fois naturel et culturel de la Méditerranée.
- **Recommandation 10 :** Elargir l'exercice entrepris dans cette étude aux pays du Sud-Est et du Sud de la Méditerranée.

Les forêts anciennes font partie du patrimoine naturel et culturel de la Méditerranée, bien que non encore appréciées à leur juste valeur ; il est urgent de garantir leur survie ou restauration.

Map of some of the quoted potential sites. This study highlighted over 80 sites in 15 Euro-Mediterranean countries with potential interest. Many more remain to be discovered and researched.

Carte de quelques sites potentiels cités. L'étude met en avant plus de 80 sites avec un intérêt potentiel dans les 15 pays euro-méditerranéen. Bien d'autres restent à découvrir et à étudier.

INTRODUCTION

Mediterranean forest landscapes have evolved over millennia alongside the great civilisations of the region. Despite the fact that forests and indeed the environment more broadly have been significantly modified by humans in most countries, the region qualifies as a global biodiversity hotspot with a large number of unique and endemic species. In fact the Mediterranean is considered the third richest biodiversity hotspot in the world in terms of plant diversity (Mittermeier *et al.*, 2004, cited in CEPF, 2010). Of the approximately 25,000 known plant species, over 13,000 are endemic to the region (CEPF, 2010). The ecoregion is also unique for its fauna due to its long evolutionary history (Blondel *et al.*, 2010).

Mediterranean forest biodiversity: A natural and cultural heritage

To explain the biodiversity of the ecoregion's terrestrial ecosystems and forests today, two factors must be considered:

a. The evolutionary trajectory since the Plio-Pleistocene (Pignatti, 1978; Quézel and Médail, 2003; Blondel *et al.*, 2010). While much of southern Europe's vegetation shifted during the last ice age, important refugia remained in the four main peninsulas, i.e. Iberia, Italy, the Balkans and Anatolia, as well as most Mediterranean islands. These relicts have considerably influenced the development of a unique post-ice age vegetation (Quézel and Médail, 2003). Studies demonstrate that two categories of vegetation can be distinguished in the Mediterranean: that which remains from before the Plio-Pleistocene[1] and that which redeveloped from these refuges, later transformed through human influence.

b. Human influence. Millennia of human influence have shaped the forests and landscapes of this ecoregion leaving a distinct natural heritage that is intertwined with the cultural heritage (Thirgood, 1981; Blondel, 2006; Blondel *et al.*, 2010). Ancient texts describe the extent of forests and the reliance of ancient Mediterranean civilisations on timber (for fuel, charcoal, ship-building, construction etc.) (Thirgood, 1981; Hughes and Thirgood, 1982). Guilaine (2001) sums up the long natural and human history of the Mediterranean basin as a progressive process of neolithisation, starting around 9,000 BP in the eastern part of the basin but occurring only 4,000 years later in central France or Spain. Paleoecology and genetics also reconstruct the progressive recolonisation of Mediterranean vegetation after the last glaciation and the progressive transformation by newly established populations and agriculture (Reille *et al.*, 1996). More recently, nineteenth century geographical maps, scientific reports and paintings bear witness to a gradual loss in forest cover in southern Europe. Indeed the pattern of forest cover in the northern Mediterranean is one of gradual decline with a trough reached in the late nineteenth and early twentieth centuries depending on the countries, followed by a gradual increase in the latter part of the twentieth century associated with rural abandonment (approximately 2% of forests recover per year). This forest transition (according to the concept developed by Mather (1992)) is key to understanding current forest landscape structure, ecological values and conservation problems, and to defining conservation strategies. In France, and many other northern Mediterranean countries, the impacts of this forest transition have been well studied (Debussche *et al.*, 1996; Mather *et al.*, 1999; Vallauri *et al.*, 2012).

Remnants of ancient forests are (or were) very often tiny patches in cultivated, grazed, over-grazed or eroded Mediterranean landscapes. This reality, still present in many places – especially in the North African and Middle Eastern countries – is sometimes hidden now in large newly forested landscapes in northern countries

[1] The geological period that ended 12,000 years ago.

Mediterranean forests today: A global priority

Forests of the Mediterranean zone are typically composed of broadleaved species, particularly oaks, both evergreen and deciduous, such as *Quercus ilex, Q. suber, Q. coccifera, Q. pubescens, Q. cerris, Q. pyrenaica, Q. toza, Q. calliprinos, Q. ithaburensis* and others, or conifers such as *Pinus halepensis, P. brutia, P. pinea, P. pinaster* and *Juniperus* spp. (Scarascia-Mugnozza *et al.*, 2000) or the Atlas cedar (*Cedrus atlantica*) and the Lebanese cedar (*Cedrus libani*). A unique, scrub-like, vegetation - maquis and garrigue – also characterises the Mediterranean climatic zone. A typical feature of Mediterranean forests is that they include both deciduous and evergreen trees. In addition, many forests are mixtures of broad-leaved and coniferous forests. Ten areas serve as centres of plant diversity for the Mediterranean basin: the High and Middle Atlas Mountains in North Africa; the Rif-Betique range in southern Spain and two coastal strips of Morocco and Algeria; Maritime and Ligurian Alps of the French-Italian border; Tyrrhenian Islands; southern and central Greece; Crete; southern Turkey including Cyprus; Israel and Lebanon; Cyrenaica in Libya and the Macaronesian islands (Médail and Quézel, 1997). According to Plantlife, Important Plant Areas (IPAs)[1] can be found in Croatia, Italy, Former Yugoslav Republic of Macedonia (FYROM), Montenegro, Slovenia, Turkey and parts of Spain (Plantlife website).

IF TODAY'S MEDITERRANEAN FORESTS ARE TO BE CONSERVED, SUSTAINABLY MANAGED AND RESTORED, IT IS ESSENTIAL TO UNDERSTAND THE KEY DETERMINANTS OF FOREST BIODIVERSITY

Within the region, patterns of deforestation and secondary forest succession differ in the north and the south of the Mediterranean. Indeed along the southern shore of the Mediterranean, deforestation remains on the rise, and has been coupled with desertification and land degradation, while in the north Mediterranean the recent decades have seen a rise in forest cover stemming from a combination of rural land abandonment and plantations.

Today Mediterranean forests continue to face serious threats (large fires, urbanisation, unsustainable use, climate change…) putting biodiversity under pressure. In some cases, severe wildfires are a key threat spreading through large newly reforested landscapes (pioneer forest stands), and particularly in abandoned rural areas where shrub encroachment leads to an increased amount of vegetation on the ground that contributes to fuelling fires. Severe wildfires may also impact rare high conservation value forests. Climate change is already affecting the region, and scenarios forecast increased temperatures and aridity in the Mediterranean basin (Regato, 2008). Poor land use practices (notably mono-culture plantations of introduced species, over-grazing) and extensive human pressure (urbanisation) already exacerbate the impacts of climate change.

If today's Mediterranean forests are to be conserved, sustainably managed and restored, it is essential to understand the key determinants of forest biodiversity – from an ecological perspective but also in space and time.

Aim of the report

In the framework of its programme on "Ancient Forests as key high conservation value areas (HCVA) of the Mediterranean" WWF France commissioned this report in order to better understand the current status and knowledge concerning ancient Mediterranean forests and to enable it, together with its partners, to define future priorities for work.
The purpose of this report is to set a common base across the Mediterranean for future work on relict, ancient, mature, old-growth forests and wilderness areas by ensuring a common collective understanding of the terminology, facts and figures, ongoing activities and relevance in the northern part of the Mediterranean region (Albania, Bosnia-

[1] Identified based on threatened species, botanical richness and threatened habitats.

Herzegovina, Croatia, Cyprus, France, Greece, Italy, Former Yugoslav Republic of Macedonia (FYROM), Malta, Montenegro, Portugal, Slovenia, Serbia, Spain and Turkey, see Figure 1). At this stage, the report focuses exclusively on the European part of the Mediterranean region. In a next phase, work will be extended to the eastern and southern parts of the basin.

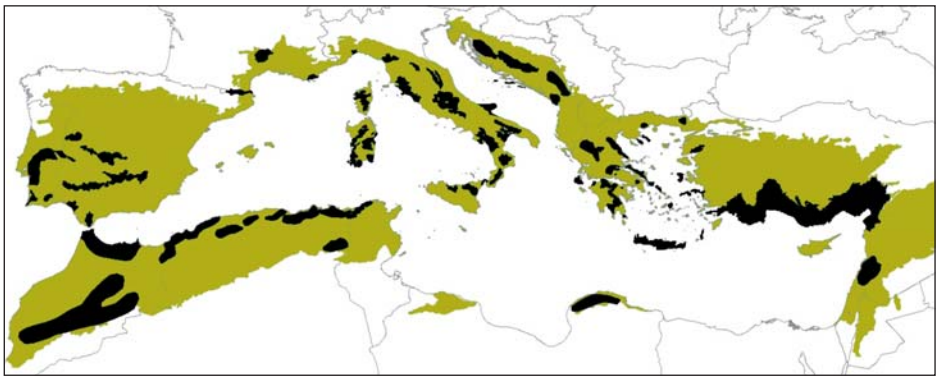

Figure 1.
Geographic scope of WWF's Mediterranean forest strategy (green) and priority landscapes (black)

Why are ancient forests important in the Mediterranean?

Ancient Mediterranean forests are living laboratories. Despite their generally small size, there are many arguments for researching and conserving ancient Mediterranean forests:

a. Sustainable management. Understanding the ecology of ancient forests in the Mediterranean contributes to improving management practices and ensuring that they are locally-adapted. Currently, in many parts of the Mediterranean, silvicultural practices have been borrowed from northern Europe, and are frequently not suited to local conditions.

b. Conservation strategies. Ancient forests form an important core zone that helps to define priorities for protection. Indeed, under the EU COST Action E27 it emerged that ancientness was one determining criterion for the selection of 40% of the protected areas analysed (Frank *et al.*, 2007).

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Large liana and lichen (*Lobaria pulmonaria*) two indicator taxa that can be found in old tree stands

c. Restoration. While restoration cannot re-create exactly ancient forest systems, the process of restoration will in most instances seek to mimic, inasmuch as feasible, these processes (see for example Mansourian *et al.*, 2005). Progress in the study of the natural dynamics of ancient forests in the Mediterranean would contribute to improve the processes of restoration or recovery of damaged or destroyed forest systems, and to increase knowledge for easy identification of reference ecosystems.

d. Biodiversity. Ancient forests provide important habitats for wildlife, particularly vulnerable or range-restricted species that cannot colonise new areas. They contain multiple microhabitats (deadwood, cavities etc.) and as such are home to a diverse range of species, notably saproxylic species, fungi, small mammals and birds.

e. Threats. As the Mediterranean region continues to face significant anthropogenic and natural threats, it is useful to understand how ancient forests have adapted to past threats and how they evolved; particularly, as they are supposed to be more resistant and resilient to anthropogenic disturbances than younger forests. Such information can provide key insights in order to better design conservation strategies for facing current and future threats.

f. Resilience to climate change. Given climate change scenarios for the Mediterranean, it is important to understand the processes that enabled ancient forests to survive through time and through different climatic regimes and other stressors, in order to inform the conservation, management and restoration of Mediterranean forests. A study by Bakkenes *et al.* (2002) interviewed forest managers, and concluded that in southern Europe, 60–80% of the flora present in 1990 in any given grid cell of the map they used would go extinct by 2050 as opposed to 20–40% further north (cited in Petit *et al.*, 2005). An understanding of past mortality rates in forests, and also of the relationship of each species to other key criteria (beyond climate) helps to understand changes that can be attributed to climate change and to define possible mitigation measures (Nagel *et al.*, 2012). A more detailed study would serve to guide managers based on a better understanding of how species could adapt or move under changing climatic conditions.

GIVEN CLIMATE CHANGE SCENARIOS, AN UNDERSTANDING OF THE PROCESSES THAT ENABLED ANCIENT FORESTS TO BE RESILIENT THROUGH TIME WILL HELP TO SHAPE FUTURE ADAPTATION STRATEGIES

g. Economic value. Ancient forests in the Mediterranean can provide income to local communities notably through valuable non-timber forest products (including medicinal plants, mushrooms and cork) which can be collected sustainably, through the knowledge associated with their genetic materials and through forms of sustainable ecotourism. Inspired by protected ancient forests, close-to-nature silviculture could improve current silvicultural methods and yield greater economic benefits.

h. Knowledge. Ancient forests are living laboratories where our understanding of the evolution of landscapes can be studied. They provide clues to diverse complex natural processes which are particularly valuable given the 'hotspot' nature of the Mediterranean.

i. Natural heritage. Ancient woods are by their very nature, irreplaceable. The presence of relict species and ecosystems within ancient forests signifies that unless these are protected, and further researched, we may lose forever large parts of this natural heritage.

j. Cultural values. Cultural values related to mythology, religion, recreation and customs are associated with ancient forests. Maintaining and restoring them is therefore also important for these reasons. The cultural dimension must be considered in a region where nature and people have interacted for millennia. In many countries, royalty and the church were among the first protectors and managers of forests; communities have also protected ancient forests associated with ancient mythologies.

k. Inspiration. Last but not least, ancient forests in all their diversity and history serve as an important tool to inspire people - from naturalists to poets, sports people, children or decision-makers - and to promote conservation of the delicate and vulnerable Mediterranean ecosystems.

For all these reasons, ancient forests are an important component of the Mediterranean with extremely high conservation value. Yet, overall in the northern Mediterranean region, while some countries, such as France, Italy and Slovenia, have been working on ancient forests, many have only given limited or indirect, if any, consideration to these forests. Furthermore, at the regional level, there are significant differences in understanding and defining ancient forests and their associated qualities.

Mythology and forests in southern Europe

Ancient forests are strongly associated with mythology and religion in southern Europe. For example in Greece, Mount Olympus (where ancient and/or old Bosnian pine —*Pinus heldreichii*– and beech forests can be found) is a UNESCO Man and Biosphere Reserve (MAB) because of its importance from a cultural as well as a natural standpoint; it was believed to be the home of the gods in ancient Greece.

Pan was the ancient Greek god associated with forests and nature, and many Greek forests have a sacred value (Trakolis *et al.*, 2005), such as:
- The holy wood of ancient Athens 'Heroon';
- The holy wood of Argos;
- The holy wood of Artemis in Skylounta;
- The holy wood of Despoina in Arkadia;
- Dodoni's holy wood;
- Eumenides's holy wood in Kolonos;
- Jupiter's holy wood in Olympia, created by Hercules.

Forests are referenced in various ancient texts by philosophers such as Aristotle and Plato. They were also important in Ancient Rome and were believed to be the homes of various deities.

The rich mythology of south eastern Europe is also closely associated with forests. For example, in the Southern Slavic countries (including Bosnia-Herzegovina, Croatia, Montenegro and FYROM) the female nymph-like spirits called "vile" were believed to live in the forest and possess both positive and negative powers. In some legends they were portrayed as beautiful dancers. In the Janj region of Bosnia-Herzegovina vile were believed to protect shepherds (Conrad, 2000).

Olympus Mountain, the home of ancient gods… and forests

OVERVIEW OF ANCIENT FORESTS

A typical forest ecosystem can be described using a number of characteristics. Research in the last three decades on natural forest ecosystems indicates that a number of key ecological qualities are important (Dudley, 2011; Vallauri, 2007; Vallauri *et al.*, 2010).

These include:

a. Diversity of trees, species and habitats. Assemblages of tree species that evolved together form ecological communities. A diversity of tree species in turn provides a range of different habitats and therefore, also supports a vast range of fungi, vertebrate and invertebrate species (biodiversity as a whole).

b. Nativeness. By definition, forests that have not been planted or otherwise brought in by humans, will be composed of native species.

c. Forest stand structure. Forest stands naturally exhibit a range and complexity of structural factors, including irregularity of forest floor, different-sized forest gaps, diverse tree ages or diameters and vertical structure.

d. Micro-habitats of the living trees. Various micro-habitats (notably in tree cavities, in the tree canopy, in the undergrowth etc.) that provide for numerous specialist species can be found in forests with complex structures.

e. Maturity of living trees and diversity of age classes. Without human intervention, trees are able to reach their maturity and as trees die and others regenerate, diverse ages can be found in a forest. Longevity of most dominant tree species is superior to 300 years, sometimes more than a millennium.

f. Presence of deadwood. Deadwood occurs naturally in forests as a result of the ageing process but also as a result of natural disturbance events such as storms, lightning strikes etc. The uprooting of dead trees creates natural holes that are often full of water, providing habitats for many insects and breeding amphibians. Older forests will have more deadwood, as will forests that have not been managed (Dudley and Vallauri, 2004; Vallauri *et al.*, 2005).

Cavities and deadwood: two key characteristics of ancient forests that are generally absent in new or managed forests

Importance of deadwood

It is only recently that the importance of deadwood has been recognised, with a study indicating that 80% of articles on deadwood were published after 2000 (with the majority focusing on boreal forests) (Bouget, 2009). Because of the important risk of fire, deadwood has traditionally been removed in Mediterranean forests.

Although an indicator on the volume of deadwood has been included in the Forest Europe process (indicator 4.5.), for the Mediterranean region only Croatia, Italy and Slovenia had provided data for this indicator in 2010 according to the publically available UNECE statistics (see: http://w3.unece.org/pxweb/).

Generally-speaking, Mediterranean research is still lagging behind on the topic of deadwood although notable research programmes have been started, for example in Italy. In 2004, WWF called on European governments to restore 20-30 cubic metres of deadwood per hectare by 2030 (Dudley and Vallauri, 2004).

g. **Forest dynamics (range of successional stages and phases).** Complex forests exhibit gap dynamics including different successional phases, as well as evidence of natural regeneration.
h. **Continuity in time of forest cover (the strict scientific interpretation of ancientness).** Long term continuous forest cover does not necessarily mean the same quality of forest cover but is an indicator that the forest has been established for a long time. It has strong implications on soil processes and the occurrence of species with low dispersion rates.
i. **Continuity in space, connectivity and large scales.** Large scales enable movement of species and genes, provide more flexibility for adaptation and recovery from threats (resilience). Large scale conservation and maintaining or restoring connectivity in landscapes is fundamental for the survival of many endangered species.

Although essentially covering the same topics, Winter *et al.*, (2011) re-grouped these essential features of forests as follows: 1) forest categories, 2) forest age, 3) forest structure, 4) dead wood, 5) regeneration, 6) ground vegetation and 7) naturalness.

STRICTLY SPEAKING, THE SCIENTIFIC TERM 'ANCIENTNESS' REFERS TO THE NUMBER OF' YEARS FOREST COVER HAS BEEN CONTINUOUSLY PRESENT. HOWEVER, AN ANCIENT FOREST IS COMMONLY RELATED TO SOME OTHER CHARACTERISTICS, OLD TREES, STRUCTURE, DEADWOOD...

Brustel and Savoie (2011) note the following key characteristics of 'ancient' forest ecosystems in the Pyrenees : 1) the oldest trees reach their natural maturity; 2) stratified structure; 3) diversity of species; 4) high standing volume of 600-1000 m^3/ha; 5) large amounts of deadwood (between 10 and 200 m^3/ha versus 2 m^3/ha in managed forests) in various stages of decomposition; 6) several standing dead trunks; 7) several microhabitats (cavities, etc.) for a diversity of animal species.

None of the above qualities are exclusive, compulsory or binary. In different forest types, different characteristics may dominate. For example, old beech (*Fagus sylvatica*) forests could occur almost as mono-specific stands in humid conditions ; therefore, holding very low woody species diversity.

Also, for each characteristic, more specific thresholds can be set for different forest types and climatic conditions (see e.g.: Peterken, 1996). For example, today the average density of deadwood (both standing and on the ground) in south eastern Europe is estimated to be 15 m^3/ha with data suggesting that the amount of deadwood, particularly standing deadwood, has been slightly increasing in most of Europe's regions over the past 20 years (Forest Europe *et al.*, 2011). However, the current data are quite heterogeneous on such questions (different diameter thresholds and inventory methodologies). The amount and quality of deadwood varies considerably mostly (but not only) depending on forest types as these will affect the rates of decay.

What are ancient forests?

Strictly and scientifically speaking, the term 'ancientness' refers to the number of years forest cover has been continuously present. This definition is directly related to the long term processes in forest soils that determine forest biodiversity and functioning (versus ploughed, deforested and eroded agricultural lands) (Hermy *et al.*, 1999; Dupouey *et al.*, 2002). In the UK, areas that have been under continuous forest cover since 1600 are called 'ancient woodlands'; the term is clearly defined and is inserted in forest policy and classification. The date of 1600 is applied because of historical data suggesting that tree planting was unlikely to have happened before that date, so any trees existing from then were probably very old (Rotherham, 2011). In other countries the timeline could be different, for example 1830 is applied in northern France as a cut off to define ancient forests (Vallauri *et al.*, 2012).

The specific attributes of ancient forests and their respective importance, will be very much region-specific. Thus, for example, values and features of importance in boreal or North American forests will not have the same importance in the Mediterranean context. Even within this vast ecoregion, different sub-regions exhibit different ecological characteristics. For example the eastern and western extremes of the Mediterranean ecoregion have different ecological, geological as well as human histories, which have shaped and continue to shape, their forest ecosystems.

Today the debate on ancient forest research and conservation takes place alongside other considerations, for three main reasons:

- First, ancientness is only one among several forest ecological qualities, and may be one of the last documented by science, and currently least well understood in conservation circles;
- Secondly, in some contexts, for example in the temperate or boreal zone where the debate on forest conservation was initiated, ancientness was obvious and other qualities were felt as being more important. For example in the United States the term 'old growth' is used and these forests are defined as having old trees and several of the following attributes: "*1. large trees for the species and site, 2. wide variation in tree sizes and spacing, 3.accumulations of large-sized dead standing and fallen trees that are high relative to earlier stages; 4. decadence in the form of broken or deformed tops or boles and root decay, 5. multiple canopy layers, and 6. canopy gaps and understory patchiness. Old-growth is not necessarily 'virgin' or 'primeval'. Old-growth could develop following human disturbances* (USFS, 1989 in FAO, 2002)."
- Finally, the concept of naturalness – that includes the dimensions quoted here – as it relates to forests is complex, still poorly understood by science and lacks a universally-accepted definition.

Several terms frequently used include: mature forests, relict forests, wilderness areas, wild forests, old forests, frontier forests, natural forests, native forests, climax forests, primary forests, virgin forest, pristine forest, primeval forest, forest undisturbed by man, intact forest landscapes or authentic forests (see for e.g. Rouvinen and Kouki, 2007; Dudley and Stolton, 2003; Dudley, 2011). While these terms overlap in the broad sense, they do not always refer precisely to the same thing, with for example 'old forests' not always being composed only of native species, therefore, not necessarily being equivalent to 'native forests'. In 2002, the FAO hosted a workshop on forest definitions and for the term 'old growth' as many as 98 definitions were collected from different sources (FAO, 2002)! It can be concluded that the topic is relevant but understood differently from one context to another, and in different scientific circles.

THE SPECIFIC ATTRIBUTES OF ANCIENT FORESTS AND THEIR RESPECTIVE IMPORTANCE, WILL BE VERY MUCH REGION-SPECIFIC

For the purposes of this report we use the following terms:

- '**Ancientness**' applied in the strict scientific sense (i.e: number of years of continuous forest cover),
- '**Naturalness**' as the prevalence of natural processes and the occurrence of features shaped by them (Peterken, 1996),
- '**Ancient forests**' as a general, relatively loose term to signify those forests that exhibit a number of fundamental forest ecological qualities, including ancientness but also complex structures, presence of deadwood, diversity of species and habitats, evidence of disturbance etc.

Importantly, there are two distinctions to be made between the ecologist's understanding of ancientness as it relates to forests, and that of the policy-maker. National (and regional) definitions of ancient forests are directly linked to policies (as seen in Rotherham, 2011). Once ancient forests are defined, political decisions may lead to their pro-

tection from any human intervention, or at least logging or deforestation. Equally, once ancient forests are defined, they may attract significant funding, research or tourism interest. Therefore, the ecological definition leads to a direct policy consequence. And in some cases it is precisely because of the potentially negative policy impact that strict definitions are difficult to reach.

Scientific research

THERE ARE AN ESTIMATED 117,000 HA OF 'NATURAL FOREST' IN THE WEST EURO-MEDITERRANEAN AND 1,528,000 HA IN THE EAST EURO-MEDITERRANEAN

European research programmes (such as COST E4 and COST E27) have dedicated funding to research on forest reserves and protected areas which are of relevance to ancient forests. COST is a framework for scientific and technical co-operation, promoting the co-ordination of national programmes at a European level. COST E4 was implemented between 1995 and 2000 and dedicated to research on 'natural' forests and "to create a European network of forest reserves, to collect ongoing research, to standardise research methodology and to create an accessible central data bank" (Parviainen *et al.*, 2000). COST E27 was launched in 2002 and focused on better understanding categories of protected forest areas (Frank *et al.*, 2007). These two programmes have provided significant insight into the state of forests in the Mediterranean and have served to improve understanding and knowledge about specific forest areas in the region. They have also helped to establish links among networks of researchers across Europe.

Several universities (for example the forest faculties of the Universities of Ljubljana and Belgrade) have programmes studying specific aspects of ancient (or 'virgin' or 'old-growth') forests, generally at a national level.

Relevant conservation policies

It is useful to consider the overlap and/or relevance of ancient forests to other current initiatives and processes in the EU Mediterranean region as it can help to identify where and how to position (particularly from a political point of view) ancient forest work in the region.

The process begun under the Ministerial Conference on the Protection of Forests in Europe (MCPFE) – now "Forest Europe" – sought to quantify the importance of 'natural forests' based on the extent of human intervention. According to the most recent (2011) 'State of Europe's Forests' there are 117,000 ha of 'natural forest' ('undisturbed by man') in the south west Mediterranean and 1,528,000 ha in the east Euro-Mediterranean (Forest Europe *et al.*, 2011). The same assessment concludes that in all of Europe excluding the Russian Federation, undisturbed forests cover 4% (8 million hectares) of the continent.

A number of related initiatives and programmes such as Natura 2000, High Conservation Value Forests (HCVF), Man and Biosphere Reserves, World Heritage Sites, and IUCN's protected area categories Ia and Ib on strict nature reserves and wilderness areas respectively are widespread in the Mediterranean. These relate to ancient forests as shown in Table 1 below.

The above demonstrates the existence of a diversity of potential 'entry points' for the conservation of ancient forests. In particular, there may be a distinction between the ecologist's definition, that of the forester and that of the policy-maker. For each stakeholder there are different consequences in identifying and labelling a forest as 'ancient' which adds to the complexity of the task. Yet, given their conservation importance and

Table 1. Initiatives that relate to ancient forests

RELATED CONCEPT/INITIATIVE	LINK TO ANCIENT FORESTS	KEY CHARACTERISTICS
IUCN category Ia Nature Reserves – "strictly protected areas set aside to protect biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values." (Dudley, 2008)	**"Conservation value" of ancient forests**	Full dynamics, no/minimal human footprint
IUCN Category Ib Wilderness areas – "usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition." (Dudley, 2008)	**Ancient forests can qualify as areas that are both; "unmodified" and in "natural condition"**	Full dynamics, no/ minimal human footprint, 'leave no trace' recreation
Natura 2000 network – "The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) which they designate under the 1979 Birds Directive." (EU website)	**"Most valuable species and habitats" potentially found in ancient forests**	Diversity of species and habitats
Man and Biosphere reserves – "places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature." (UNESCO website).	**Opportunity to reconcile both the conservation and social values of ancient forests (eg: Mt. Olympus in Greece)**	Diversity, zonation and balancing human footprint with nature
World Heritage Natural sites – "natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty." **UNESCO** is at the moment exploring the feasibility of a broader **World Heritage beech forest** site with the aim to build a European beech forest conservation network (http://whc.unesco.org/en/news/906). Some of the beech forest sites noted below (Section 4) could be included in this network (UNESCO website).	**"Outstanding" habitats can be ancient forests. Ancient forests can also be areas valued in terms of science and conservation. (e.g. Virgin beech forest of Ukraine and Slovakia)**	Nativeness, structure, maturity of living trees (old-growthness), deadwood, dynamics
High Conservation Value Forests – Under Principle 9 for FSC certification, forest managers are required to identify any High Conservation Values (HCVs) that occur within their individual forest management units, to manage them in order to maintain or enhance the values identified, and to monitor the success of this management. Nine high conservation values are recognised under the HCVF concept (biodiversity values (e.g. endemism, endangered species, refugia); large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance; rare, threatened or endangered ecosystems; areas providing basic ecosystem services in critical situations (e.g. watershed protection, erosion control); areas fundamental to meeting basic needs of local communities (e.g. subsistence, health); Areas critical to local communities' traditional cultural identity) (FSC website).	**Diverse biodiversity values of ancient forests** **Cultural values of ancient forests**	Diversity, nativeness, old-growthness, deadwood
Re-wilding Europe – aims to rewild one million hectares of land by 2020, creating 10 magnificent wildlife and wilderness areas of international quality (Rewilding Europe website).	**Ancient forests provide an important reference point for a "re-wilding" programme.**	Dynamics, large scale, reduced human footprint
PAN parks – aim to safeguard European wilderness, the continent's most undisturbed areas of nature for future generations (PAN Parks website).	**Ancient forests are among the continent's most undisturbed areas**	Diversity, old-growth, nativeness, dynamics, large scale

the high degree of threats facing remaining ancient forests in the Mediterranean region, a clear understanding of the reality of these forests, their identification and subsequent management or conservation, are critical.

Relationship to WWF Priorities

Global Programme Framework

The Mediterranean ecoregion is one of the 35 priority places identified by WWF in its Global Programme Framework (GPF) in 2008, and within the Mediterranean region lies one of WWF's 36 priority species, namely cork oak.

The multiple facets of a priority species: Cork oak


© Daniel Vallauri

The cork oak (*Quercus suber*) can only be found in the western Mediterranean Basin countries of Algeria, France, Italy, Morocco, Portugal, Spain and Tunisia. Covering approximately 2.7 million hectares, cork oak landscapes are home to endangered species such as the Iberian lynx (*Lynx pardinus*), Spanish Imperial eagles (*Aquila adalberti*) and Black vulture (*Aegypius monachus*). In Spain and Portugal the cork agro-silvo-pastoral landscapes are called dehesas and montados respectively and are particularly important for migratory birds. At the same time they are at the core of a significant and sustainable economic activity: cork production (WWF, 2006). Portugal alone accounts for about 50% of the global cork industry and with a total annual turnover of about EUR 850 million (www.eco-innovation.eu/), the cork industry provides an estimated 16% of Portugal's total foreign income (www.cork.pt). *Quercus suber* trees live on average between 100 and 300 years. Cork harvesting modifies the stand structure and composition but can retain old trees and their crucial microhabitats (cavities for example) for wildlife.

WWF Mediterranean forest strategy

Within the WWF Mediterranean programme, a specific forest strategy was defined in 2011. The vision for WWF's Mediterranean forest programme is: "*The Mediterranean forest landscapes, with their cultural values, unique biodiversity and ecological functions are maintained, restored, secured and accounted for providing ecosystem services for present and future generations*". Ancient forests are one of the six biodiversity targets selected for WWF's priority work within this regional forest strategy (in addition to special natural forest types (with relevant conservation value); cork oak forests; medicinal and aromatic plants; semi-natural forests (widespread exploited forests); large and medium-sized vertebrates).

WWF's Mediterranean forest strategy identified the following threats as impacting on ancient forests: fire, effects of climate change, bad forest management, land use change and over-exploitation. An explicit and ambitious goal and two objectives have been agreed for WWF's work in the region, namely:

• **Goal**: By 2020, the most ancient forests of the Mediterranean region, and their endangered dwelling species, are widely acknowledged by forest stakeholders, scientifically defined with relevant criteria adapted to the Mediterranean realities, mapped and included in the network of protected areas.

• **Objective 1**: By 2016, 50% of the Mediterranean's ancient forests are under protection.

• **Objective 2**: By 2020, the value of ancient forests is widely recognised by administrators, forest managers and local communities.

WWF has been present in a number of areas in terrestrial conservation in the Mediterranean region (both north and south of the sea) (see Figure 2).

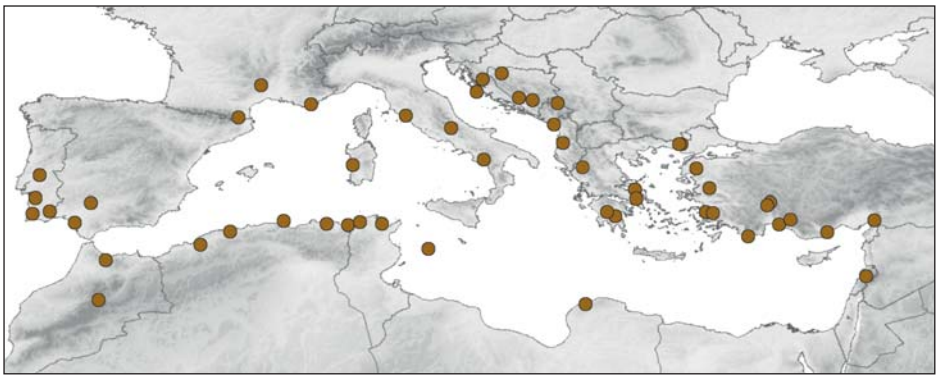


Figure 2.
Areas where the WWF Network has been engaged in developing terrestrial conservation projects in the last decade (source: WWF, 2010).

WWF France's forest programme

WWF France has developed a significant programme on ancient Mediterranean forests in recent years, attempting to fill an important gap in this category of HCVF in the Mediterranean part of France. Through this programme it has been engaging with other key Mediterranean actors and has acquired relevant experience and promoted this conservation topic, both by raising awareness and fuelling the debate about ancient forests at a national level and by creating tools to assess, survey and map them in the field. Figure 3 shows the broad framework of WWF France's programme.

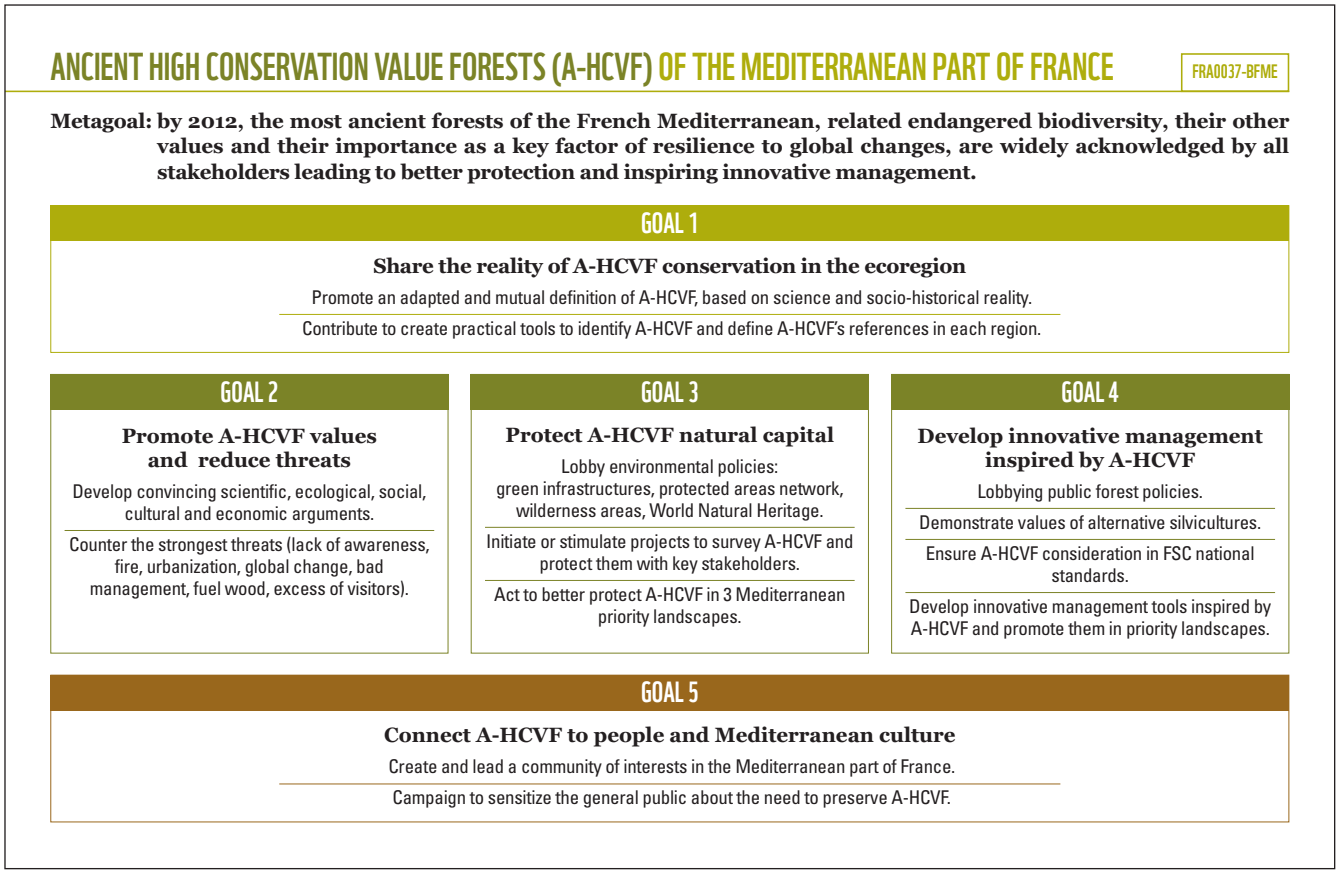


Figure 3. WWF France's ancient forest programme framework 2009-2012

POSITIONING ANCIENT FORESTS

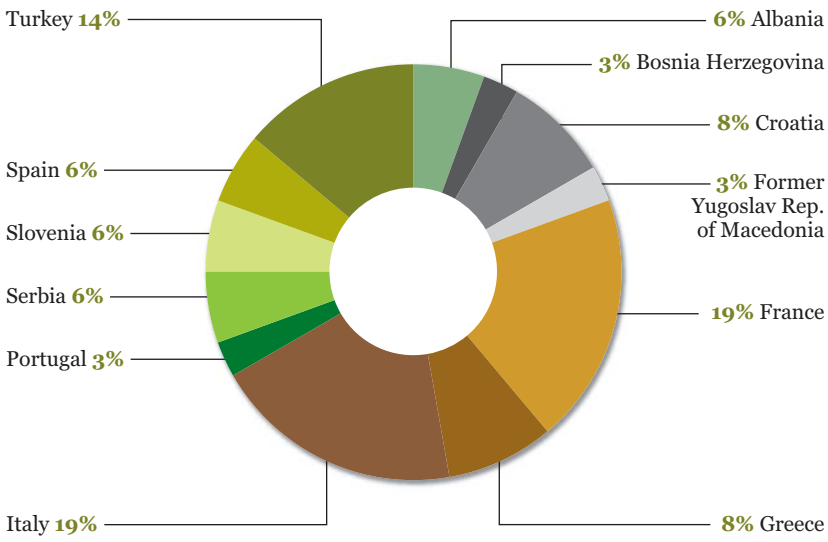
Through this report, the aim is to begin to better understand the state of play concerning ancient Mediterranean forests across the countries of the northern part of the Mediterranean basin (in a first phase[1]) and to define future priorities for joint work. More specifically, the purpose is to set a common baseline across the Mediterranean related to terminology, facts and figures, ongoing activities and relevance of ancient forests.

Methodology

This assessment started in summer 2012 with, in a first phase, a questionnaire (using the online tool 'Survey Monkey') being sent out to 101 researchers and practitioners from the northern and eastern Mediterranean region from the following 14 countries: Albania, Bosnia-Herzegovina, Croatia, Cyprus, Former Yugoslav Republic of Macedonia (FYROM), France, Greece, Italy, Montenegro, Portugal, Serbia, Slovenia, Spain and Turkey. Contacts were established with Malta further into the process and e-mail exchanges served to provide relevant data for this island state.

The simple questionnaire covered the following topics: 1) definitions, 2) relevant characteristics in the Mediterranean, 3) sites and projects, 4) tools to identify, map, protect and monitor 'ancient forests', 5) gaps in knowledge, 6) cultural features, 7) threats and 8) area of forest 'undisturbed by man' in each country. Questionnaire recipients were selected based on their prior involvement in Mediterranean-wide forest-related research programmes. All the WWF national offices were contacted, as was WWF's regional Mediterranean office. The questionnaire covered definitions and characteristics specifically relevant for 'ancient forests in the Mediterranean'; threats affecting them, and sought to identify major sites, projects and actors. A total of 36 responses (see Figure 4 for breakdown of respondents' nationalities) were received to the questionnaire out of 101

Figure 4. Origin of the 36 questionnaire responses



[1] In a second phase, the southern and southeastern part of the Mediterranean basin will be examined

sent (a response rate of 36%) of which 27 were fully complete. Respondents were from academia, governments and NGOs. Some worked directly on relevant projects, while others were involved in the forest sector more broadly.

This survey phase was complemented by 12 telephone or Skype interviews. They were held with representatives from 10 countries (Albania, Bosnia-Herzegovina, Croatia, Greece, Italy, Portugal, Serbia, Spain, Slovenia and Turkey). Also, an extensive literature search was conducted (see reference list).

In order to gather information we purposefully refrained from providing interviewees and respondents with strict definitions for the term 'ancient forests' and used it as a loose term to allow participants to offer their own understanding, definitions and perceived relevance to Mediterranean forests.

In all, the sample size and the responses represent a cross-section of the Mediterranean community involved in forests. Results shown in this section should be seen as an illustration or a snapshot of the situation as perceived by this relatively small sample. However, they are representative of major countries and entities involved in forest conservation, and as such, serve to provide a solid basis for defining priorities and key topics for future work.

Key terms

One of the aims of this assessment was to determine how ancient forests were defined and understood in the different countries of the region.

Indeed, within the Mediterranean region the terminology 'ancient forests' has variable meaning, even within a country a number of words and definitions may be used. The diversity of languages in the region adds to the complexity of reaching a common definition for 'ancient forests' at the regional level.

A JUNGLE OF WORDS IS USED TO REFER TO ANCIENT FORESTS, EVEN WITHIN THE SAME COUNTRY

Figure 5 is based on questionnaire responses received during this research. A total of 36 respondents (100% of respondents) answered the following question: "*What words are commonly used to refer to 'ancient forests' in your country (do not hesitate to use your own language)?*" Respondents provided an English translation and, in many cases, the terminology in their own language. The purpose of this 'disorganised' table (Figure 5) is to demonstrate the diversity of terms and the challenge in harmonising the terminology at a regional level.

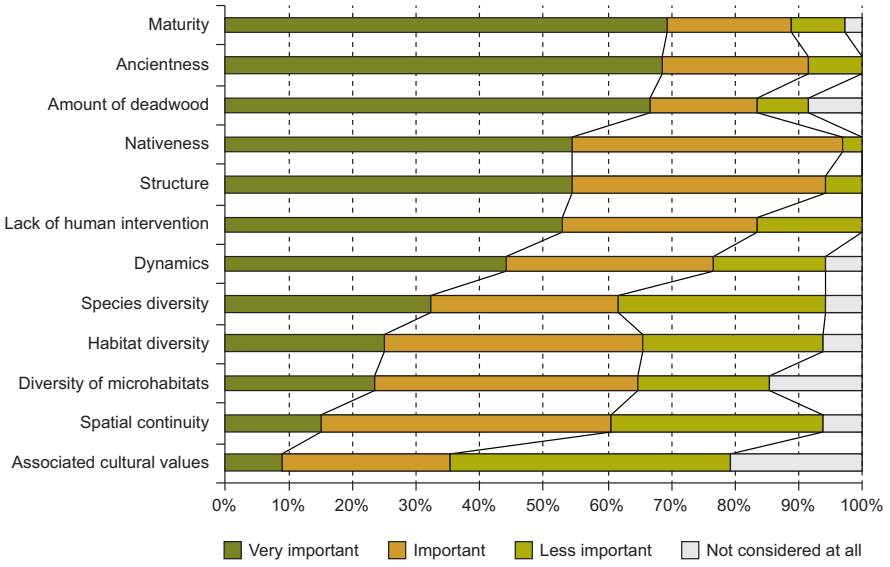
From this table, the key traits that emerge associated with ancient forests are related to: age, extent of human interventions and conservation value.

Figure 5. A jungle of words

Key qualities associated with ancient forests in the Mediterranean

For this report, twelve characteristics of forests were proposed in the questionnaire and respondents had to rate each as either 'very important', 'important', 'less important' or 'not considered at all'. The question posed was: "*In your country (or the Mediterranean part of your country, for those with several biogeographical zones), which forest qualities are considered to identify 'ancient forests' (please tick as many as appropriate)?*" Responses can be seen in Figure 6 below.

Figure 6.
Characteristics of ancient forests in the Mediterranean



A total of 36 responses were received for this question. Figure 6 shows that the majority of respondents identified the age of trees present as 'very important', followed closely by long term continuity of forest cover (ancientness) and the amount of deadwood. Nativeness and structure were considered both important and very important by over 90% of respondents (96.9% and 94.3% respectively). The only one quality that was considered as both important and very important by less than 50% of respondents was "associated cultural values" (35.3%). Interestingly, species diversity was considered as less important by nearly a third (32.4%) of respondents.

Threats

The question that was posed relating to threats was: "*What are the main threats to 'ancient forests' in your country?*"

Respondents to the questionnaire were provided with a list of threats which they had to rate. Twenty-eight responses were received to this question. Figure 7 below provides an overview of responses.

Anthropogenic fires were seen as the predominant threat by over half of respondents and if one considers both major and important threats, 85% of respondents considered fire as important. Taking both major and important threats combined, mismanagement

appeared as the main threat according to close to 90% of respondents (88.9%) followed by anthropogenic fires (85.4%) and climate change (84.6%). Plantations and agricultural expansion were seen as a minor threat by a significant majority of respondents (87.5% and 64% respectively). Tourism and recreational development, and urbanisation were unclear with approximately equal proportions (1/3 each) of respondents considering them minor, important and major threats.

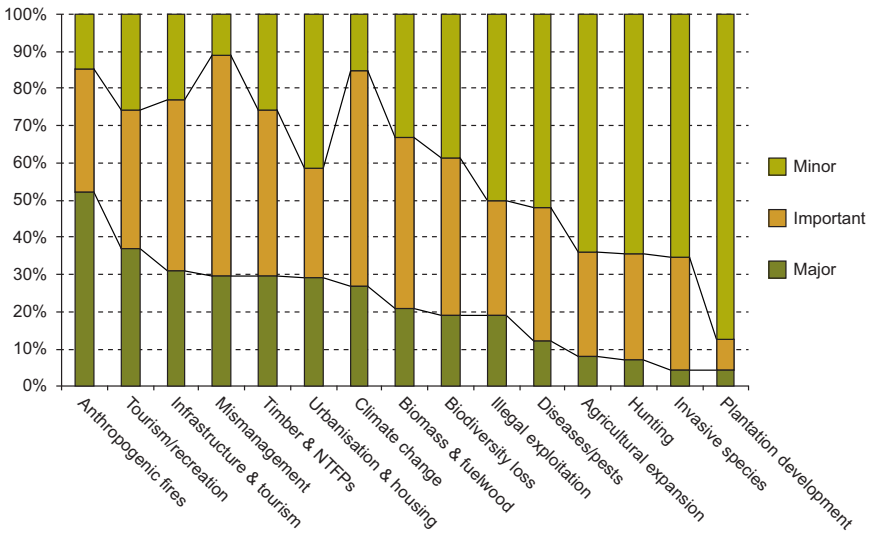
Additional threats that were highlighted by respondents were:

- Land ownership (forests that were on private land),
- Agricultural expansion particularly in riverine ecosystems,
- Overgrazing
- Limited knowledge
- Poor recognition of the intrinsic value of ancient forests, including within institutions
- Lack of protection.

While some threats are relatively widespread across the entire region (for example, urbanisation), others are more specific to a country or sub-region (for example, plantation development). A more detailed threats analysis would serve to better identify major threats in individual countries.

Figure 7.
Threats to ancient forests

(NB: Timber and non-timber forest products (NTFPs) excludes biomass and fuelwood which are considered separately)



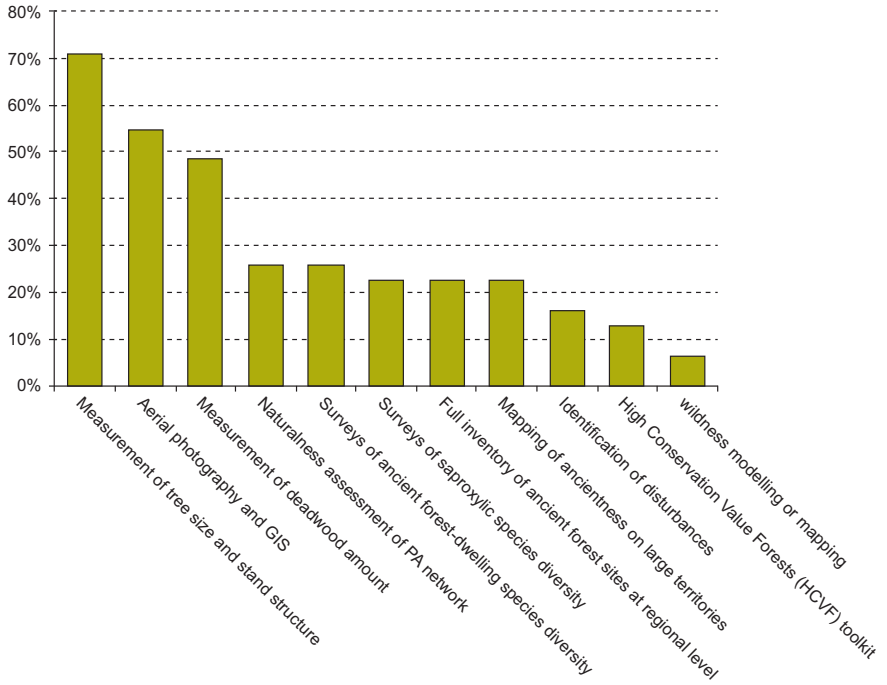
Tools used to measure ancient forests in the Mediterranean

A range of tools may be used to identify, monitor and measure forests. These include surveys, satellite images, age of trees, presence and type of deadwood, presence of natural and unnatural disturbance regimes, tree health surveys (see e.g.: Dudley *et al.*, 2007). Importantly, their presence or absence on old maps and in old texts is an important surrogate that helps to identify the duration of forest cover (Vallauri *et al.*, 2012; Rotherham, 2011). For example the use of a 1749-1790 map of France (the Cassini map) together with maps from the 19th century, provides a reference point for France's forest cover (Vallauri *et al.*, 2012).

Questionnaire respondents were presented with 11 tools to measure ancient forests and were asked which ones were used in their country. The question posed was "*What tools are used/available in your country to identify, map, protect and monitor 'ancient forests'*?"

Thirty-one responses were received as depicted in Figure 8.

Figure 8.
Tools used to survey, monitor or map ancient forests in the Mediterranean countries



COUNTRIES THAT HAVE RESEARCHED ANCIENT FORESTS MORE, ARE MORE LIKELY TO USE A WIDER RANGE OF DIFFERENT TOOLS TO RECOGNISE AND MONITOR THEM

By far the three most important tools used are the measurement of tree size and stand structure, aerial photography and GIS to analyse landscape structure, and measurement of deadwood.

From the analysis, it stands out that countries that have researched ancient forests more (such as France, Italy and Slovenia) are more likely to use a wider range of different tools to recognise and monitor ancient forests.

Most countries use tree measurements as a tool in line with the fact that this is a widespread European forestry activity. Deadwood appears to be used as an important means of identifying ancient forests in Bosnia-Herzegovina, France, Italy, Serbia and Slovenia. Aerial photography and GIS are used across most countries, as per our sample. Surveys of saproxylic species only seem to be undertaken, according to our respondents, in France, Italy and Slovenia. France and the Balkans are the ones surveying ancient forest-dwelling species. Mapping ancientness over large territories is essentially done in France which is attributed to the existence of old territorial maps with forest cover (see: Vallauri *et al.*, 2012). The connection to high conservation values forests (HCVF) is less widespread than expected. In the HCVF toolkit (developed with the assistance of WWF) the process generally includes an identification of relict and old-growth forests and related topics.

Extent of forests undisturbed by man

The "State of Europe's Forests" reports on the area of forest 'undisturbed by man' using data from Forest Europe (previously the 'Ministerial Conference on the Protection of Forests in Europe' (MCPFE)). Questionnaire respondents were asked to comment on these figures.

Specifically, the question posed in the questionnaire was: "*According to the Ministerial Conference on the Protection of Forests in Europe (MCPFE), the total area of forest 'undisturbed by man' (in 2010) in the Euro-Mediterranean countries is as per the figures below (in 1000s of ha). Can you please comment on this figure for your country? (Albania: 84.8, Bosnia-Herzegovina: 2, Croatia: 7, Cyprus: 13.2, France: 30, Greece: 0, Italy: 93, Malta: 0, Montenegro: NA, Portugal: 24.1, Slovenia: 109, Spain: 0, The Former Yugoslav Republic of Macedonia: 0, Turkey: 973).*"

A total of 28 responses were received to this question, as shown in Table 2.

THERE REMAINS SOME WORK TO HOMOGENISE THE CONCEPT OF FORESTS 'UNDISTURBED BY MAN' IN EUROPE IN ORDER TO ENSURE THAT REAL AND MEANINGFUL COMPARISONS CAN BE MADE

Two points stand out from the responses received for this question: on the one hand the figures are quasi-systematically questioned and on the other, the lack of clarity in definitions is raised. It can be concluded that there remains some work to homogenise the concept of forests 'undisturbed by man' in Europe in order to ensure that real and meaningful comparisons can be made and to keep track of these areas. It can be noted that this challenge also holds true for important characteristics such as deadwood or forest stand age, although there is an ongoing process of homogenisation of data in forest inventories through Forest Europe.

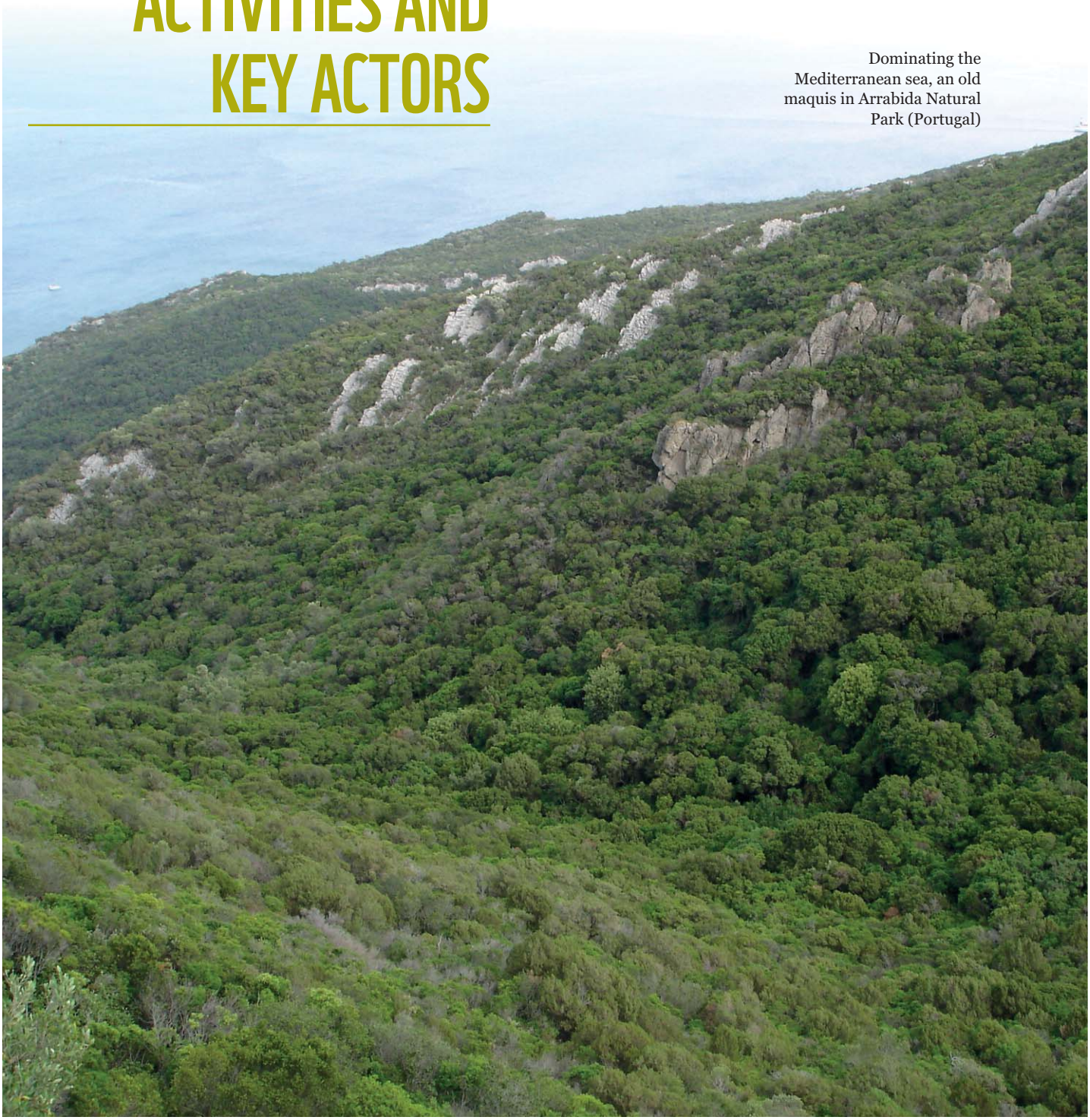
Table 2. Area of forest 'undisturbed by man' in ha
(Source: UNECE online statistical database, http://w3.unece.org/pxweb/?lang=1)

COUNTRY	AREA OF FOREST 'UNDISTURBED BY MAN' IN HA*	QUESTIONNAIRE RESPONSES
Albania	84,800	The figure is not realistic. No study has been carried out recently.
Bosnia-Herzegovina	2,000	0.07% of the total forest area (2,004 ha)
Croatia	7,000	Seems reliable
Cyprus	13,200	
France	30,000	The number seems correct Unreliable figure at national level (data based only on 2-3 criteria.) Using the strict definition of 'undisturbed by man' then the figures for Cyprus, France and Portugal are not realistic.
Greece	0	This is not true - there are several undisturbed forests in Greece. The number for Greece is not correct. It is around 239 ha (including National parks, aesthetic forest, wetlands). I agree since officially there is a small area of "ancient semi-natural forests" of 22,143 ha
Italy	93,000	I don't know if those figures are realistic. This number seems to me very high (it represents 10% of total forest area in Italy). 93,000 ha is a very high area I think the surface is overestimated. In comparison to other countries it may be plausible – the key is the definitions used for 'forest' and for 'undisturbed'
Malta	0	
Montenegro	NA	
Portugal	24,100	It depends on how the concept of 'ancient forest' is defined. It is probably an over-estimation.
Serbia	1,000	1,200 ha According to the National Forest Inventory in Serbia: 1,200 ha
Slovenia	109,000	Data is over-estimated (under 2,000 ha) According to my knowledge in Slovenia there are 172 forest reserves totalling 9,782 ha and 14 strict forest reserves with a surface of 540 ha.
Spain	0	There is no accurate information in Spain
FYR Macedonia	0	
Turkey	973,000	It may be less than this amount. I am not sure on what basis this figure was estimated It is a logical figure.

* Data for 2010.

OVERVIEW BY COUNTRY OF MAIN FORESTS, ONGOING ACTIVITIES AND KEY ACTORS

In this section, for each of the 15 countries reviewed in the northern Mediterranean, a brief overview of forests, potentially important sites from a point of view of ancient forests and a selection of existing projects that are of relevance is provided (except for Cyprus, Malta and Montenegro where a shorter description is provided because of a lack of data). It is based on interviews, questionnaires and an extensive literature review. This section is intended to provide a snapshot and is certainly not meant to be exhaustive.



Dominating the Mediterranean sea, an old maquis in Arrabida Natural Park (Portugal)

ALBANIA

Forests

Essentially a Mediterranean country, Albania can be divided into broad ecological zones, from a coastal zone to an alpine zone reaching up to 2,700 metres above sea level. Five vegetation types have been defined for Albania: a) Mediterranean maquis; b) oak forests; c) beech forests; d) fir forests; e) Bosnian and Balkan pine forests (Haska, 2010). The most common tree species are: beech (*Fagus sylvatica*), spruce (*Picea abies*), pines (*Pinus nigra, P. peuce, P sylvestris, P. leucodermis* and *P. heldreichii*), silver fir (*Abies alba*) and Bulgarian fir (*A. borisii-regis*), poplar (*Populus tremula*), sycamore maple (*Acer pseudoplatanus*), hop hornbeam (*Ostrya carpinifolia*) and rowan (*Sorbus aucuparia*) (Metaj, 2009). Over half of the high beech forests found in Albania are about 100 years old (Haska, 2010).

ALBANIA HAS 2,313 HA DESIGNATED AS 'INTEGRAL NATURE RESERVES' ACROSS 27 UNITS

Some potential sites

The country currently has 802 protected areas covering 12.57 % of its total land surface (EEA database online).

The term 'Integral Nature Reserves' (INR) is used in Albania to define important core areas of high conservation value (HCV) and ancient forests. A total of 2,313 ha have been designated as INRs in 27 units (see Table 3 below from Haska, 2010 and Figure 9). Under a quarter of these INRs fall within IUCN category II and the remainder in IUCN category IV. The maturity of those forests is limited (from 90 to 200 years old). A naturalness analysis of the forests could be further detailed through discussions with managers.

Figure 9.
Map of some ancient forests in Albania

→ **National Park of Thethi** (2,630 ha), in the Albanian Alps, combines mixed forest stands and pure beech stands. Within the park, in a 50 ha forest, trees have been estimated to reach up to 150 years of age.

→ **National Park Mali I Dajtit** includes Mediterranean shrubs (*Arbutus unedo*), oaks and at high altitudes pure beech forest and some mixed forest of beech and conifers.

→ **National Park Lura** has many pure and mixed stands of beech with Bosnian and Balkan conifers. Trees inside a 300 ha INR are between 100 and 180 years of age.

→ **National Park Lugina e Valbones**, in the Albanian Alps, has some virgin forests with pure beech and mixed stands where beech occurs with other species such as Norway spruce (*Picea abies*).

Table 3.
European Beech Nature Reserves in Albania (Haska, 2010)

NR.	DISTRICT	FOREST	Surface (ha)	PARCEL	Altitude (m a.s.l.)	Age (years)
I	**Berat**	Tomorr (National Park)	30	9a	870-1,050	110
II	**Bulqize**	Liqeni i Zi	54	4a-22b	1,300-1,725	80-120
III	**Devoll**	Perparimaj	81	85, 86, 87, 88	1,300-1,650	70-110
IV	**Diber**	Lure (National Park) Zhuri i Pllahut	300 34	1-32 32a	850-1,750	100-180
V	**Has**	Tej Drinini Bardhe	80	140, 141	1,110-1,340	110-115
VI	**Kolonje**	Orgocke	50	60, 69	1,500	160
VII	**Librazhd**	Qarrishte Rrajce Dardhe-Xhyre Lepush Stravaj	124 77 112 25 42	96-112 64a, 65a 28a, 29b 69ab, 70a 20, 21a	1,150-1,750 1,600-1,650 1,350-1,450 1,150-1,670 1,210-1,543	90-180 120-155 80-135 180-190 200
VIII	**Mat**	Qaf Shtame-Kete Isuf Emin Piloci	86 20	24, 34-35 23, 24	900-1,700 1,400-1,600	125-170 90-160
IX	**M.Madhe**	Lugina e Vermoshit Fusher Zeze Thethi (National Park)	74 20 50	53a, 53b 39b 4	1,250-1,700 1,500-1,650 1,518	170 160-170 150
X	**Pogradec**	Bishnice Guri i Nikes	43 72	17a 8, 9	1,604-1,854 1,050-1,220	190 100-110
XI	**Puke**	Iballe	48	35, 36a	754	80
XII	**Shkoder**	Cukal	500	1-20	1,350-1,735	135-180
XIII	**Tirane**	Dajt (National Park) Bize	74 47	36, 37 95, 96, 97, 98	1,400 1,277-1,490	130 140-170
XIV	**Tropoje**	Curraj i Eperm Nikaj Mertur Lumi i Gashit Çerem - Dragobi	40 75 30 122	97a 10, 11a 89b 87, 88, 89	900-1,160 800-1,400 1,600 1,350-1,950	130 105 130 90-120
Total			**2,313**			

→ **National Park Zall Gjocaj** has some virgin forests including a mix of beech, black pine, fir, Bosnian pine, ash, maple etc.

→ **National Park Bredhi i Drenoves** is composed of mixed forests including *Abies borisii-regis* mixed with maple, ash, black pine and some beech.

→ **National Park Llogara** contains some beech forest at particularly high altitudes (Haska, 2010).

→ **National Park Mali i Tomorrit** is composed of beech and Bosnian pine forest, and others forest species, in pure or mixed stands.

→ **Lumi i Gashit strict nature reserve** (IUCN category Ia) covers an area of 14,500 ha (EEA website) within which a 30 ha INR is estimated to be 130 years of age.

→ The transboundary **Prespa National Park** that is shared with Greece and FYROM, is important for its oaks and beech.

Projects

Questionnaire respondents for Albania did not indicate projects other than current management of national parks, as pertaining to ancient forests.

BOSNIA-HERZEGOVINA

Forests

Bosnia and Herzegovina can be divided into five geographical sub-regions: a) the Illyric region (western humid region), b) the Moesiac region (eastern arid region), c) the central European region (northern part of Bosnia), d) the EU-Mediterranean region (evergreen region) and e) the Mediterranean mountain region (Pintaric, 1999). The altitudinal range is from sea level to just over 2,300m. The most significant forests (Table 4) are composed of beech (*Fagus sylvatica*), oak, mixed forests of beech, Norway spruce (*Picea abies*) and silver fir (*Abies alba*), and mixed forests of black pine (*Pinus nigra*) and Scots pines (*Pinus sylvestris*). After WWII afforestation was undertaken essentially with Norway spruce, Scots pine and Black pine.

Beech forests are common – covering an estimated 1,225,000 ha, of which 93% are natural or semi-natural (Ballian, 2010) – and can be found in associations with sessile oaks (*Quercus petraea*) in the lowest forest zones while at higher elevations beech can be found in pure stands.

Table 4. Main forest types in Bosnia-Herzegovina (Pintaric, 1999)

FOREST TYPE	AREA	PERCENT
Mixed forests of beech Norway spruce and silver fir	630,000 ha	50%
Beech forests	389,000 ha	30%
Oak forests	115,000 ha	9%
Scots and Black pine	96,000 ha	8%
Other high forests	36,000 ha	3%
High forests (total)	**1,266,000 ha**	**100%**

ONE WELL STUDIED OLD-GROWTH FOREST IS THE LOM FOREST IN THE DINARIC MOUNTAINS, A 295 HA STRICT RESERVE ESTABLISHED IN 1956

Some potential sites

→ **Lom forest.** One well-known old-growth forest is the Lom forest in the Dinaric mountains (see Figure 10). This 295 ha reserve was established in 1956 (although it has no official IUCN category) as a way of protecting the old-growth character of the forest (Bottero *et al.*, 2011). It is located at an altitude of between 1,200 and 1,500 metres. A buffer zone surrounds the strict reserve. Three-quarters of the reserve is composed of mixed beech and fir (*Piceo-Abieti-Fagetum Illyricum*). Large old trees can be found in the reserve, as well as a diverse vertical and horizontal structure and abundant coarse woody debris. Bottero *et al.* (2011) found that the mean diameter at breast height (dbh) of standing dead wood was 56.1 cm for Norway spruce, 69.2 cm for silver fir and 41.8 cm for beech.

→ **Janj forest** covers a 195 ha area, found at between 1,000 and 1,400 metres, and is composed of a mix of beech, spruce and fir with some maple (*Acer* spp.), elm (*Ulmus* spp.) together with other species of broad-leaved trees (Pintaric, 1999).

→ **Perućica strict forest reserve** is composed of spruce, fir and beech and covers an area of 1434 ha inside the National Park of Sutjeska (17,250 ha). It contains a range of different forest associations (Pintaric, 1999).

Figure 10.
Map of some ancient forests in Bosnia-Herzegovina

Projects

A research project is underway within the three best-preserved old forests (Lom, Janj and Perucica), entitled "Conservation and management of Bosnian old-growth forests". The main objectives are:

a. to study the structure, dynamics, and developmental stages of these forests, and to establish a network of permanent plots in the three sites;

b. to analyse the disturbance history at the stand (field research) and at the landscape (field research and remote sensing) levels;

c. to reconstruct past and present climate-growth relationships and to develop hypotheses regarding future dynamics according to the different IPCC (Inter-governmental Panel on Climate Change) scenarios;

d. to establish collaboration among universities and research institutes from Italy, Slovenia and Bosnia-Herzegovina (Department of Forestry and Renewable Forest Resources, University of Banja Luka, Faculty of Forestry).

Another research project focuses on the structure and development dynamics of the virgin forests of 'Ravna Vala' in Bjelašnica mountain. It aims to determine the floristic structure, amount of dead wood, structure of trees based on species, height and diameter, and the development dynamics of vascular plants.

CROATIA

Forests

Forests in Croatia can be found in three distinct zones: 1. the lowlands, 2. the Mediterranean and sub-Mediterranean zone and 3. the hills and mountains (Matic, 1999). In terms of tree species, forests are divided as per Table 5.

Table 5. Main tree species in Croatia (Matic, 1999)

DOMINANT TREE SPECIES	PROPORTION
Beech	36%
Other hard broadleaves	18%
Pedunculate oak (*Quercus robur*)	16%
European fir	12%
Sessile oak (*Quercus petraea*)	9%
Other conifers	5%
Other soft broadleaves	4%
	100%

Mixed forest (spruce, fir, beech) in Plitvice Lakes National Park

Less than a fifth (18%) of forests are privately owned. The specific Mediterranean zone is composed in part of holm oak and Aleppo pine and also pubescent oak and black pine (Matic, 1999). The largest old-growth forests consist of beech.

Some potential sites

→ **Motovunska šuma** (Motovun forest, 281 ha, IUCN category Ib) is the largest floodplain forest in the Croatian Mediterranean (see Figure 11). It is located in the floodplain of the Mirna river and represents the last forest remnants of ancient common oak (*Quercus robur* L.) and narrow-leaved ash (*Fraxinus angustifolia* L.) (Sladonja *et al.*, 2012).

→ **Čorak basin.** The Dinaric range contains the best virgin forests of beech and fir (*Abieti Fagetum illyricum*) (Matic, 1999). Čorkova uvala (Čorak basin, IUCN category Ib) is a special forestry reserve of 75 ha closed to visitors and found inside the Plitvice Lakes National Park (29,482 ha, World Heritage Site). It contains virgin forests of beech and fir with trees reaching over 50m in height and diameters of over 1.5 metres (Mužinić and Filipović, 2006). Here the analysis of some of the beech forest identified trees close to 150 years old (Novotny *et al.*, 2010). Both wolves and bears can be found in these forests (Mužinić and Filipović, 2006).

→ **Prasnik special reserve.** In the lowlands, pedunculate oak (*Quercus robur*) and common hornbeam (*Carpinus betulus*), and associations of pedunculate oak can be found in Prašnik (Matic, 1999). Some of the oaks in Prasnik special reserve (IUCN category Ib) are between 250 and 300 years old, with diameters (dbh) of 70 to 200 cm, and heights of up to 36 metres (Matic, 1999).

→ **Muški Bunar** is a 59 ha reserve (IUCN category Ib). It is an example of a 300-year-old virgin forest composed of beech, and beech and sessile oak associations. The beech trees reach 40m in height, with diameters at breast height of up to 200 cm (Matic, 1999).

→ **Dundo** is a 106 ha forest reserve (IUCN category Ib) on the Island of Rabu which is one of the few preserved forests of holm oak (*Quercus ilex*) in the Mediterranean (Matic, 1999).

Figure 11.
Map of some ancient forests in Croatia

Projects

The MAVA-funded WWF programme "Protected Areas for a Living Planet" (PA4LP) aims to establish a network of connected protected areas along the Dinaric Arc. The main project objectives are increasing awareness on the value of local biodiversity and estimating the potential for establishing trans-boundary protected areas. The current phase of the project (2009-2012) is being implemented by IUCN, SNV and WWF. Under the project there are six cross-border areas in five countries of which Plitvicka Jezera in Croatia.

THE DINARIC RANGE CONTAINS THE BEST VIRGIN FORESTS OF BEECH AND FIR, LIKE ČORKOVA UVALA IN PLITVICE LAKES NATIONAL PARK

The Adriatic Model Forest (AMF) was recently launched under the "Instrument of Pre-accession Assistance" Adriatic programme and within the Mediterranean Model Forest Network (MMFN). The Croatian Forest Research Institute is the lead partner in Croatia. The project objectives are to promote and support the Model Forest[1] concept and to innovate for sustainable forest management.

[1] Model Forests are managed in a sustainable manner, reflecting environmental and socio-economic issues from the perspective of local needs and global concerns; they must be in a large landscape, include broad partnerships and a commitment to sustainability.

CYPRUS

THE CYPRESS TREE OF AGIOS NIKOLAOS IS ESTIMATED TO BE OVER 700 YEARS OLD AND IS ASSOCIATED WITH VARIOUS LEGENDS

Ancient texts and fossils bear witness to the fact that Cyprus was once densely forested (Thirgood, 1981). Fossils indicate that Troodos Range was once covered with pine forests (Cyprus Forest department website). Today however, only 18% of the island counts as forest and these are essentially found on higher ground in the Troodos and Pentadactylos mountain ranges. The island can be divided into three zones: the plains, the hills and the mountains. Most of the forests remain in the highlands where olive, carob, hermes oak, lentisc and terebinth can be found, as well as Calabrian pine (*Pinus brutia*) found at altitudes up to 1,200m (Cyprus Forest department website), Italian cypress (*Cupressus sempervirens*) which can be found up to 1,200m in the Pentadactylos mountains and Phoenician juniper (*Juniperus phoenicia*) (Kyriacou, 2005). Troodos Pine can be found in the central Troodos area from 1,200m up to 1,950m. The endemic Cyprus cedar (*Cedrus brevifolia*) can be found only in the Paphos forest around Tripylos peak from 800 to 1,400m. Juniper (*Juniperus foetidissima*) can also be found in mixed stands with *Pinus nigra* ssp. *pallasiana*, from 1,500m up to 1,950m (Cyprus Forest department website). The following broadleaved trees can also be found: plane tree (*Platanus orientalis*) along riverbanks, often found in mixed stands with alder (*Alnus orientalis*), at altitudes of up to 1,500 m. Small scattered groups of oaks (*Quercus infectoria* ssp. *veneris*) can be found, including some very old, isolated trees such as the oriental plane tree of Agia Mavri which is estimated to be around 800 years old (Cyprus Forest department website).

Cedrus in Troodos National Park

Protected forests fall under two categories: national forest parks and nature reserves. Essentially two criteria have been used for the creation of protected reserves: the presence of threatened habitats (although this is done without using any national or international standards) and the presence of red-listed species (based on the criteria used by the IUCN).

The Department of Forestry within the Ministry of Agriculture, Natural Resources and the Environment has a project to protect trees that are nature monuments. These are old trees, frequently just a single tree which, in many cases, is associated with a legend. For example, the cypress tree of Agios Nikolaos is estimated to be over 700 years old and is associated with various legends.

FRANCE

Forests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France has four biogeographical regions: the Atlantic, continental, Alpine (Alps and Pyrenees) and Mediterranean regions. In the latter region, broadleaved species, like holm oak (*Quercus ilex*) and downy oak (*Q. pubescens*) are common, together with maquis. Conifer and beech forests can be found in the mountains (mostly *Abies alba* with *Picea abies*, *Pinus* spp. and *Larix decidua*). Beech can be found in the mountainous zones of the Mediterranean, such as Corsica, the Luberon, Ventoux, Lure, Verdon, etc.) and, notable exception, very close to the sea (La Massane, La Sainte Baume) or at low elevation (Cagnes sur Mer, Valbonne) (Ducousso, 2010).

France defines 'natural forests' as "*high forests of native species, always present, free of human activity for at least 50 years*". It has been estimated that only 0.2% of forests qualify as ancient forest across the entire French territory (30,000 ha), and of these, only half are protected (Brustel and Savoie, 2011). French forests are mainly young (nationally, 79% of the area are no more than 100 years old). There has been a steep rise in forest cover after WWII, from 11.5 million ha to 15 million ha (Despert *et al.*, 2005), following rural abandonment. The minimum forest cover was reached during the XIXth century in France, although later in the Mediterranean than in other parts of the country.

Different categories of protection exist (Vallauri, 2003), both at the central level and at the regional levels, with a diversity of ownership and management responsibility. The main categories of interest here (in total there are more than 20 different statuses for forest protection in the country) are: national parks, strict biological reserves, managed biological reserves, national nature reserves, regional nature reserves and Corsican nature reserves, strictly protected forests within nature reserves and regional parks. Continuity of forest cover over time is not a feature that is considered in the main categories of forested protected areas. However, old-growthness, vertical structure and age are considered in the creation of strict biological reserves and strict forest reserves within national nature reserves (Despert *et al.*, 2005). There are six national parks in mainland France (10 across all of France's territories) four of which are situated in the Mediterranean (Port-Cros NP) or surrounding mountain zone (Mercantour NP, Cévennes NP and Ecrins NP).

Some potential sites

More or less similar to the HCVF methodology, France established zones called "*zones d'intérêts écologiques, floristiques et faunistiques* (ZNIEFF)" in 1982 (Vallauri *et al.*, 2012). A relatively high proportion of these ZNIEFFs are characterised by ancientness (34%), while ancientness represents only 11% of forests inside national parks (IUCN category II) (Vallauri *et al.*, 2012).

WWF France assessed 31 potential hotspots in 2011-2012 with the aim to identify and document their values for each criterion of naturalness. Some important and well-known sites (Figure 12) containing ancient forests in France's Mediterranean and surrounding mountain zone include (from Lorber and Vallauri, 2007 and http://www.foretsanciennes.fr/):

On the continent

→ **La Réserve du bois du Chapître** is a 552 ha old beech and fir forest, some parts of which have been unmanaged for 50 years.

→ **La Réserve de La Sainte-Baume** is a 138 ha beech forest, some parts of which have been unmanaged for 50 years.

SOME IMPORTANT AND WELL-KNOWN ANCIENT FORESTS OF THE REGION ARE BEING STUDIED

→ **La Réserve de la Chartreuse de la Verne** is a holm oak forest, some parts of which have been unmanaged for 50 years.

→ **Nature reserve of Py** is a private beech, fir and pine forest, some parts of which have been unmanaged since 1945.

→ **Réserve de la Pinata** is a mature beech and pine forest, some parts have been unmanaged for 50 years.

→ **Réserve des Gorges de la Frau** is a beech forest, some parts have been unmanaged since 1886.

→ **La Chartreuse de Valbonne** is an oak and beech forest, in which some tiny parts have been unmanaged for 50 years.

→ **Aiguines** is a mature beech forest, unmanaged since at least 50 years.

→ **Le Bois noir de Breil** is situated in the core zone of the Mercantour National Park and is made up of mature fir, larch and pine trees. The upper part has been unmanaged for over 50 years.

→ **Le Mont Ventoux strict reserve** is a mix of mature beech and fir, unmanaged since 1945.

→ **Le Vallon de Saint-Daumas, les Jaudelières** is a mature cork oak forest.

→ **Le Bois de Païolive** is an 11,000 ha forest mostly ancient and famous for hosting many rare and indicator species of ancient forests (www.foretsanciennes.fr). It is made up of relatively 'mature' downy oaks, considering the surroundings, and has experienced low levels of harvesting since over 50 years. It is a WWF pilot site in the priority landscape of Cévennes. Trees found here reach low heights of <15m and diameters of over 30cm and can be up to 200 years old – with a mean age of around 110 years (Boissier and Givors, 2010).

Island of Corsica

→ **Forêt territoriale du Fango** lies in north western Corsica extending from sea level up to 2,500m above sea level and is well-known for its outstanding old stands of holm oak (*Quercus ilex*). The overall forest covers an area of 4,318 ha (Richard *et al.*, 2004; Panaïotis, 1994), with small patches of old holm oak. Trees date back to the mid-nineteenth century reaching average heights of 15 metres (Panaiotis *et al.*, 1997). Panaiotis *et al.* (1997) estimate mortality age for holm oak in the Fango valley to be 170 +/– 46 years. It is also a Man and Biosphere Reserve.

→ **Other Corsican pine forests** – The **Forêt territoriale du Tavignano** covers 1,015 ha and is made up essentially of laricio pines, interspersed with beech and alder. It is an integral biological reserve because of the biodiversity value of its unmanaged forests. Other Corsican pine forests are ancient, with trees probably older than 1,000 years, but detailed studies are missing.

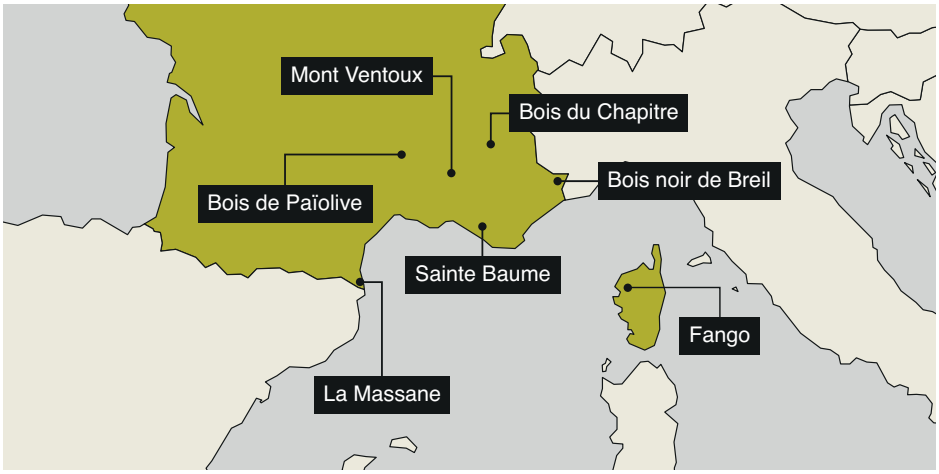


Figure 12.
Map of some ancient forests in France

The Massane forest


© RN de la Massane

The old beech forest of 'La Massane' is a unique living laboratory and conservation hotspot in the Mediterranean region. It is a 336 ha beech (*Fagus sylvatica*) forest classified as a national natural reserve ("Réserve Naturelle Nationale") in 1973 and considered a relict forest. Wood has not been harvested here for over one century (since 1880). It lies within the Albères range northwest of the Pyrenees and 5km from the Mediterranean coast. The altitudinal range is between 600 and 1,100m (Danneyrolles, 2012).

The Massane is the subject of extensive research. In total 6,367 species have been identified so far in this forest (Garrigue and Magdalou, 2011), with over 1,400 species of beetle alone, of which seven are endemic to the Massane (Travé and Garrigue, 1996 in Defaut, 2000). For example the rare hermit beetle (*Osmoderma eremita*) is common in La Massane, living in cavities in large oaks or beech trees of over 300 years of age. One quarter (26%) of mammals and 17% of birds have been found to live in cavities in the Massane (Travé, 2003).

Findings from evolutionary ecology, using genetic screening (microsatellites), show that beech trees of the region belong to a different genetic clade than those found elsewhere in Europe. 'La Massane' forest has a high degree of beech genetic diversity, suggesting that the region has been a refugia where beech survived the last glaciations. Other species may have done so, since we find also Tertiary relict lineages (e.g. the rare beetle (Coleoptera) *Anthaxia midas* ssp. *Oberthüri*).

The exhaustive mapping and survey over the last 14 years on a permanent plot (of 28.8 ha and 50,000 trees), and local weather station, has helped to accurately monitor forest dynamics. For example, the impact of the drought and heat wave of 2003 has been quantified, with beech being highly vulnerable to these weather events. However, the method Syrph the Net (StN), based on the use of hoverflies (Diptera: Syrphidae) as indicator species (130 species in 'La Massane'), indicates a good conservation status (ecological integrity= 92 %).

Digs have also revealed the cultural importance of this zone.

Projects

Ancient forests are a key component of WWF France's current forest strategy and of WWF International's Mediterranean forest strategy. Specifically, since 2010, WWF France's Programme on Ancient Forests seeks to develop assessment tools, inventories, mapping, and the application of these to forest management (including a network of retention islands – "îlots de vieux bois") and conservation (new protected areas). WWF is collaborating with several partners including park management authorities such as in the Luberon regional park and the Mercantour National Park. In the Païolive forest WWF is supporting biodiversity studies.

The "Groupe des vieilles forêts Pyrénéennes"(GVFP) is an informal multi-disciplinary group of researchers from the regions of Aquitaine, Midi-Pyrénées and Languedoc-Roussillon studying the forests of the Pyrenees mountains. Their focus is on the naturalness and biological diversity of the fragments of unmanaged forests remaining in this zone, including the Catalan Pyrenees which is in the Mediterranean ecoregion.

THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA (FYROM)

Forests

The Former Yugoslav Republic of Macedonia (FYROM) can be divided into the following climatic zones: 1. a sub-Mediterranean region covering 40% of the territory, characterised by the presence of common tree species such as hornbeam (*Ostria carpinifolia* and *Carpinus orientalis*), and extending up to 600m above sea level; 2) a sub-continental region covering 37% of the territory and extending between 600 and 1,200m above sea level that is dominated by deciduous oak forests; 3) a sub-humid region covering 22% of the country and composed of a lower beech forest area between 900 and 1,250m above sea level and a higher belt with mountainous beech forest (*Fagetum montanum*) and mixed beech and fir forest up to 1,700m; 4) a sub-Alpine region which represents only 1% of FYROM and is located above 2,200m (Chemonics International Inc., 2001). The forest types in FYROM are presented in Table 6.

Forests cover 37% of the land area - 950,594 ha - of which less than 30% represent high forests (Karadelev, 2005). A total of 319 tree and shrub species, with more than 80 subspecies and varieties can be found in FYROM (Chemonics International Inc., 2001).

Table 6.
Forest types in FYROM (Karadelev, 2005)

FOREST TYPES	AREA
Pure deciduous forest (beech, oak-all kinds, other hard deciduous trees, poplar, other soft deciduous trees)	541,730 ha
Mixed deciduous forest (beech, oak-other deciduous, beech-other deciduous, oak-other deciduous, other deciduous)	277,146ha
Pure conifer forest (juniper, fir, black pine, white pine, and other conifers)	81,673 ha
Mixed forest – deciduous / coniferous (beech-juniper tree-fir, black pine, white pine, other deciduous trees and conifers)	57,445 ha
Mixed conifer forest (juniper tree-fir, black and white pine, other conifers)	7,656 ha

The country's protected areas are divided into: strict nature reserves, national parks, natural monuments, landscapes with special natural features, localities with specific plant and animal species outside nature reserves.

The majority (85%) of forests remain under public ownership (Karadelev, 2005).

Some potential sites

Potential sites have not been identified in FYROM, in part because of gaps in knowledge and information on biodiversity.

Projects

The project “Strengthening the Ecological, Institutional and Financial Sustainability of Macedonia's National Protected Areas System”, financed by UNDP had as its main objectives: 1) designating a representative national protected area system, 2) improving systemic and institutional capacity to provide an enabling framework for establishing and managing a representative protected area network, 3) establishing, field testing and replicating protected areas and planning processes. It was implemented by the Macedonian Ecological Society and Ministry of Environment and Physical Planning of FYROM.

GREECE

Forests

Greeck fir forest in Parnitha NP

In 1992 half of Greece was covered in forests and maquis, of which half was for commercial purposes (Trakolis *et al.*, 2005). The main forest types identified are presented in Table 7 (Trakolis *et al.*, 2005).

The bio-geographical zones of Greece are: a) Thermo-Mediterranean (altitude: 0-600m): EU-Mediterranean matorral and thermophilous conifer zone (coastal, hilly, sub-mountainous); b) meso-Mediterranean (altitude: 600-1,000m): sub-Mediterranean shrub and forest (hilly, sub-mountainous) c) supra-Mediterranean (altitude: 1,000-1,500m): *Fagus* and *Abies* forest zone (including sub-Mediterranean conifers); d) mountain Mediterranean (1,500-2,000m): Boreal conifer (e.g. *Picea*) zone; e) oro-Mediterranean/Alpine (2,000-3,000m): No forests (Georghiou and Delipetrou, 2010).

The country hosts an estimated six thousand plant species, of which about 800 are endemic (Trakolis *et al.*, 2005).

Table 7.
Forests of Greece (Trakolis *et al.*, 2005)

FOREST TYPE	AREA	% OF TOTAL FORESTS
Mediterranean broad leaved sclerophyllous forests and shrub	3,153,882 ha	48.42%
Mediterranean and sub-Mediterranean mixed oak forest	1,471,839 ha	22.60%
Montane beech and mixed beech fir spruce forest	884,139 ha	13.58%
Mediterranean coniferous forests and woodlands	883,548 ha	13.57%
Mediterranean riverine woodlands and gallery forests	86,579 ha	1.33%
Chestnut coppice	33,081 ha	0.50%

OF THE 51 PROTECTED NATURAL MONUMENTS DECLARED BETWEEN 1975 AND 1985, 12 ARE ANCIENT FORESTS

In 2012 WWF, in collaboration with the Laboratory of Forest Management and Remote-Sensing of the Forestry Faculty of the Aristotle University of Thessaloniki, completed a land cover mapping of the country. The result showed that approximately half of the country's land cover in 2007 was under some form of forest (forests: 16%, maquis: 16% and sparsely forested areas: 21%) with the remainder as agricultural areas, bare lands and artificial surfaces (Liarikos *et al.*, 2012). Figure 13 highlights forest cover change over a twenty-year period.

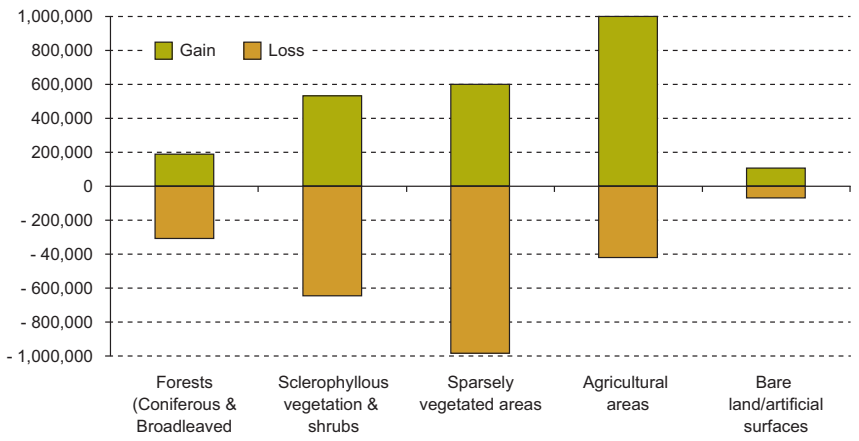
Forests were significantly reduced over centuries in Greece as they were used for shipbuilding and fuelwood. Those in the interior and in the mountains were partially spared. During the Byzantine era (14th century) and right up to the end of the 19th century, Peloponnesus produced oak and pine wood for shipbuilding (Trakolis *et al.*, 2005).

Under Greek law, protection categories are: national parks, aesthetic forests and protected natural monuments and wildlife refuges. Protected natural monuments are mainly isolated old trees associated with a legend (e.g. the plane tree of *Pausanias* in Aigio), but

may also harbour virgin or ancient forests. Of the 51 protected natural monuments declared between 1975 and 1985, 12 are ancient forests or forest stands totalling 1,092 ha (Goulandris Natural History Museum website).

Seventy-two percent of forests belong to the state (Trakolis *et al.*, 2005).

Figure 13.
Greek land cover changes (ha) over a 20-year period (1987-2007) (Liarikos *et al.*, 2012)



Some potential sites

Figure 14.
Map of Fraktos and Olympus forests

→ **Fraktos** is a virgin forest in the western Rhodope Mountains straddling Greece and Bulgaria (see Figure 14) located at between 1,000 and 1,900m. Because of the Cold War and its situation at the border between Greece and Bulgaria, this forest was spared from logging. The vegetation includes conifers (*Pinus sylvestris, P. heldreichii, Picea abies* and *Abies alba*) and beech. In lower areas, the forest is dominated by *Fagus sylvatica, Quercus petraea, Q. pubescens, Q. frainetto, Q. cerris* and *Q. coccifera* (Petrov *et al.*, 2006). The forest service and managing authority of the protected area collaborate to protect species and habitats, and to further research and education.

→ **Paranesti forest** is a virgin forest of 500 ha also in the Rhodope Mountains. This forest consists of mixed stands of beech, fir, Norway spruce and Scots pine (Zagas *et al.*, 2001).

Old *Pinus heldreichii* forests in Olympus National Park

→ **Olympus National Park** is Greece's oldest national park (created in 1938) and was considered the residence of the twelve gods of Ancient Greek mythology. The core area contains forests of *Pinus heldreichii, P.nigra* and *Fagus sylvatica* which have remained untouched for many decades. The strong cultural dimension may have played an important role in protecting this forest.

→ **Valia-Kalda.** The core area of Pindos National Park (also known as Valia-Kalda, IUCN category II) totals 3,360 ha (while the national park covers 6,927 ha). The lower altitudes (1,000-1,600m) are made up of dense forests of European black pine (*Pinus nigra*) and common beech (*Fagus sylvatica*) with some trees being as old as 700 years (protectedplanet.net). At higher altitudes (1,600 to 1,900m), Bosnian pine (*Pinus heldreichii*) is the dominant species. The Pindus mountains are considered to have been a refugia during the Pleistocene (Médail and Diadema, 2009).

→ **Crete.** The mountainous island of Crete exhibits a high degree of endemism. Here one of the only two indigenous European palm tree species can be found, the Cretan date palm (*Phoenix theophrasti*) which is classified under the Habitats directive and of which the largest area can be found in the Vai grove in eastern Crete (EEA website). The monastery of Toplou is an active partner in protecting 13.4 ha (Silva *et al.*, 2010). In particular, the **Samaria gorge National Park** holds also an old cypress (*Cupressus sempervirens*) forest which could be of interest.

Projects

Relevant research projects in Greece are:

- "The mapping of The Virgin Forest Frakto Dramas", using aerial photographs, financed by the Greek Ministry of Agriculture. Duration: 1992 - 1993.
- "Establishment and evaluation of Ornithological Biotopes for incorporation in the European Network of the Instruction 79/409/E.E.C.: Mountain Mavrovouni, Thessali, Biotope Pinovo-Tzena, Biotope Kaimaktzalan". Duration: 1994 – 1995.
- "Improvement of the management and the conditions of conservation of the national Parks of Greece. Management Plan for the National Park of Pindos and the National Park of Samaria" Duration: 1995 - 1996.
- "Conservation and Management actions in SPAs in Greece". Duration: 1998 - 2001.

ITALY

Forests

Italy can be sub-divided into three main regions: 1) the Alpine region (the Alps and other high mountain areas), 2) the continental region (the Po Valley *sensu lato*, including the Adriatic slopes of the Apennines up to the border with the Marche region), and 3) the Mediterranean region (the remaining part of Italy, including the Tyrrhenian slopes, the southern Apennines and marine islands).

Forests and other wooded areas cover 10,467,533 ha in Italy according to the second and most recent forest census (Gasparini and Tabacchi, 2011). An estimated 100 tree species can be found in Italian forests. The main forest types are mixed or pure high forest stands of spruce (*Picea abies*), silver fir (*Abies alba*), larch (*Larix decidua*) and mountain pines (*Pinus sylvestris, P. nigra, P.cembra, P. mugo*) found in the Alpine region. Beech (*Fagus sylvatica*), deciduous oaks (*Quercus petraea, Q. robur,* and *Q. cerris*) and other hardwood species can be found at lower elevations. Pure forests of silver fir (*Abies alba*), Sicilian fir (*Abies nebrodensis*), Bosnian pine (*Pinus leucodermis*) can be found on remote sites in the Southern Apennine range. Riparian forest stands of alder (*Alnus* spp.), ash (*Fraxinus* spp.), poplar (*Populus* spp.), willow (*Salix* spp.) and elm (*Ulmus* spp.) can also be found, as well as sclerophyllous Mediterranean forests of holm oak (*Quercus ilex*), cork oak (*Quercus suber*), juniper (*Juniperus* spp.) and Mediterranean dwarf palm (*Chamaerops humilis*) (Cullotta *et al.*, 2005).

The upper sections of the Apennines are dominated by pure beech (*Fagus sylvatica*) or mixed beech/silver fir forests, mountain pines (*Pinus nigra* ssp. *laricio*) and chestnut (*Castanea sativa*). Small remnants of ancient alluvial and mixed oaks (*Querco-Carpineta*) forests can be found in the Po valley. In the Mediterranean region, associations of pine (*Pinus halepensis, P. pinea, P. pinaster*) and oak (*Quercus cerris, Q. pubescens*) are dominant. Evergreen oaks (*Quercus ilex* and *Q. suber*), often mixed with other sclerophyllous species, can be found in the Mediterranean maquis (Cullotta *et al.*, 2005). Thirty-four percent of forests are publically owned.

In Italy there are 871 protected areas according to 2010 statistics (Italian Ministry of Environment website). Terrestrial protected areas cover 2,911,851.85 ha. Categories of protected areas in Italy are national parks, regional natural parks, state or regional natural reserves, other nature protected areas, special conservation zones and sites of community importance (Natura 2000).

The term 'foreste vetuste' was introduced in Italy in the scientific literature in 1994 (Piovesan, 1994). Today, ancient forests form part of Italy's biodiversity strategy. A definition for 'foreste vetuste' describes the heterogeneity of the forest as key (Blasi *et al.*, 2010). The proposed definition for Italian ancient forests states that the forest should have no or negligible human influence, demonstrate all the phases of dynamics, including individual trees of different sizes and ages, presence of deadwood, flora in line with the biogeographical context including presence of highly specialised species benefiting from low disturbance and presence of microhabitats (Blasi *et al.*, 2010).

ANCIENT FORESTS FORM PART OF ITALY'S BIODIVERSITY STRATEGY

Because deadwood is generally collected in Italian commercial forests, these show low rates of deadwood, with an average of 8.8 m^3/ha estimated by the last National Forest Inventory (INFC, 2005).

Some potential sites

→ **Gennargentu and Orosei Gulf National Park.** In Sardinia, human intervention, particularly in the rugged interior, has been of low intensity and forest fragments can be found. In the Gennargentu and Orosei Gulf National Park remains of an old holm-oak forest with Juniper bushes can be found. Some important communities of European yew (*Taxus baccata*) have been found and listed under the EU Habitats Directive (Panizza and de Waele, 2012). From a sample of 147 individual yew trees in six populations on the island, Farris and Filigheddu (2008, cited in Farris *et al.*, 2012) reported an average age of 250 years. The Gennargentu National Park hosts relict trees of the following species: *Quercus pubescens* Willd., *Taxus baccata* L., *Ilex aquifolium* L., *Populus tremula* L., *Ribes sandalioticum* Arrig., *Helleborus argutifolius* Viv., *Paeonia mascula* (L.), *Rhamnus alpina* L., *Digitalis purpurea* L., *Gentiana lutea* L., *Daphne oleoides* Schreber, *Scrophularia umbrosa* Dumort., *Ranunculus platanifolius* L. (Arrigoni, 1968; 1988, cited in Citterio *et al.*, 2007).

→ **Faggeta di Fonte Novello, Faggeta di Achiero and Frassineto di Valle Vaccaro forests.** The Gran Sasso National Park holds a number of ancient stands, including Faggeta di Fonte Novello, Faggeta di Achiero and Frassineto di Valle Vaccaro. The tiny Fonte Novello forest was last harvested over 300 years ago. Paradoxically one of the reasons why this forest remained untouched appears to be because of legal wranglings over the delimitation of the border between Pietracamela and Fano Adriano Municipalities (Lombardi *et al.*, 2010). The amount of deadwood is approximately 80 m^3/ha, and the largest trees have diameters (dbh) of over 160 cm.

→ **The National Park of Abruzzo** located in the Lazio and Molise regions of Central Italy contains several remnants of ancient forest. The park is important for a range of wildlife including wolves, bears, chamois, white-backed woodpecker, golden eagle and the rare orchid 'lady's slipper'. One of the most famous ancient forest in the Abruzzo National Park is the Valle Cervara (see Box below and Figure 15).

Valle Cervara (from Piovesan *et al.*, 2005)

© Daniel Vallauri

The Valle Cervara is situated within the Abruzzo National Park (IUCN category II) in Central Italy. It is part of the strict reserve in the core zone of the national park. Here exceptional old beech forest stands can be found at altitudes of 1,200-1,850m where slopes reach 70%. The four patches identified as old growth total about 25 ha. These are essentially mono-specific stands of *Fagus sylvatica* with a mean age of 314 years (± 105). The maximum age identified in these forests was close to 600 years, which is far beyond the longevity known for beech in Europe. Basal area has a mean value of 41 m^2/ha and the density of individual trees with dbh of over 75 cm is 11.7 stems per ha. The carbon stored in live above-ground biomass in the forest is estimated at approximately 164 t C/ha. The forest appears resilient to the tough winter conditions witnessed at these altitudes. Piovesan *et al.* (2005) counted 19 snags/ha of which 92% of snag volume comes from stems with diameters at breast height greater than or equal to 50 cm. The mean value for dead material (snags plus coarse woody debris) in Valle Cervara is 65 m^3/ha, equivalent to 12% of the total volume.

Figure 15.
Map of some ancient forests in Italy

68 FORESTS FORM A RESEARCH NETWORK OF ANCIENT FORESTS IN ITALY

Projects

The Ministry of the Environment has promoted and funded the development of a network of ancient forests across national parks. The first research phase of the project, coordinated by the "Centro di Ricerca Interuniversitario Biodiversità, Fitosociologia ed Ecologia del Paesaggio" (University of Rome La Sapienza), is finished. As a result, 68 forests were selected to form part of this network (Blasi *et al.*, 2010). Under this project, ancient forests occurring within national parks were mapped (Blasi *et al.*, 2010).

An EU LIFE project (LIFE99 NAT/IT/006245) in the Bosco Fontana focused on urgent conservation actions to conserve the last remaining floodplain forest in the Po basin and in particular its stocks of dead wood, aging trees and the saproxylic fauna which depends on them. The project was run by the Corpo Forestale dello Stato (Centro Nazionale per la Biodiversità Forestale).

A project by the Universities of Molise, Calabria, Florence and Tuscia focused on the identification, characterisation and management of old-growth forests in the Mediterranean environment. The objective of this research project was to analyse, using innovative methods, the structure and dynamics of old-growth forests in the Mediterranean environment with the aim of defining management guidelines (Chirici and Nocentini, 2010).

The project "Monitoring the old-growth forests network of the Cilento and Vallo di Diano National Park" involved a group of researchers with a range of expertise – including botanists, forest scientists, entomologists and mycologists – and took an ecosystem approach to define a comprehensive monitoring plan, in which structural and biological indicators were proposed (Calamini *et al.*, 2011).

A project entitled "Climate change and forests – Dendroecological and ecophysiological responses, productivity and carbon balance on the Italian network of old-growth beech forests" was led by the University of Tuscia with the aim to characterise and describe the ecology, structure, auxology and ecophysiology of Italian old-growth beech forests from the Alps to the Appenines. It also aimed to define the maximum carbon stock per unit of surface and the global carbon balance of beech forests (Ziaco *et al.*, 2012).

MALTA

Malta is largely deforested with very few remnants of what was once a forested landscape. Today, only four small woodland remnants of holm oak and Aleppo pine can be found in Malta: Ballut tal-Wardija, L-Imgiebah, il-Bosk and Ta'Baldu (Borelli and Varela, 2001; Environment Ministry website: www.mepa.org.mt). Coastal wood remnants can also be found, dominated by tamarisk trees (*Tamarix* spp.) and chaste trees (*Vitex agnus-castus*) and some riparian woodland relicts also exist, dominated by white poplar (*Populus alba*) and different elm trees (*Ulmus* spp.) (Malta Environment Ministry website: www.mepa.org.mt). Pollen analyses suggest that once dense pistacia woodlands or scrubs dominated the north western Maltese landscapes (Djamali *et al.*, 2012).

The only native oak in Malta is the holm oak (although other species do occur) of which only small fragments remain on the main Maltese island (Borelli and Varela, 2001). Some of these trees are estimated to be between 500 and 900 years old and have circumferences of between four and six metres (Borelli and Varela, 2001). Under the "Antiquities Act" (1925) all trees over 200 years of age are protected in Malta (Borelli and Varela, 2001). Further, in 2001 all holm oak populations were declared nature reserves (Bozzano and Turok, 2003).

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MONTENEGRO

Montenegro can be divided into three zones: the Adriatic coast and lowlands in the south west, a central lowland plain and an inland mountain region in the west. The country is predominantly mountainous with over 60% of the territory being above 1,000 metres (Srdjevic, 2005).

→ **Biogradska Gora National Park** is situated between the Tara and Lim rivers in the Bjelasica mountains, and was first protected in 1878 when it was donated to the ruler of Montenegro: Duke Nikola Petrovic (Husak, 2011). Ever since, it remained under some form of protection, and in 1952 it was officially declared a national park. It contains two main zones: a strict protection zone of 1,600 ha which is a virgin forest reserve with clear limitations, and a zone with a more lax form of protection covering a further 3,850 ha (Čurović *et al.*, 2011). In this reserve, the forest is mainly composed of beech and fir. Some trees have been estimated to be over 400 years old with heights of 40m (Dubak, 2009 cited in Husak, 2011). Deadwood is estimated at 100 m^3/ha (Sabovljevic *et al.*, 2010). Twenty-six plant communities can be found, with about 2,000 flowering species and about 90 tree species. Current (incomplete) surveys show that the reserve is also home to an estimated 200 bird species, 80 butterfly species, 350 insect species as well as a number of mammals including large carnivores such as wolves, bears and foxes.

PORTUGAL

Forests

In the north and centre of Portugal, forests are influenced by the Atlantic with a cooler, wetter climate, while in the south, forests fall under the Mediterranean climatic influence characterised by hot, dry summers and cool, wet winters (Almeida, 2005). The breakdown in predominant forest tree species can be found in Table 8. Pines (*Pinus pinaster*) and Eucalyptus (*Eucalyptus globulus*) plantations are predominant in the north and central part of the country, while cork oak (*Quercus suber*) and holm oak (*Q. rotundifolia*) either as single species stands or mixed with other species (e.g. *Pinus pinea*) dominate in the south (Almeida, 2005).

Table 8.
Portugal's forests for 2005-2006 (National Forest Inventory, ICNF website)

SPECIES	AREA	% OF TOTAL FORESTS
Maritime pine (*Pinus maritimus*)	885,000 ha	27.87%
Eucalyptus (*Eucalyptus globulus*)	740,000 ha	23.31%
Cork oak (*Quercus suber*)	716,000 ha	22.55%
Holm oak (*Quercus ilex*)	413,000 ha	13.01%
Portuguese oak (*Quercus faginea*)	150,000 ha	4.72%
Umbrella pine (*Pinus pinea*)	130,000 ha	4.09%
Chestnut (*Castanea sativa*)	30,000 ha	0.94%
Other broadleaves	86,000 ha	2.71%
Other conifers	25,000 ha	0.79%
Total	**3,175,000 ha**	**100%**

NATIVE OAK WOODLANDS IN PORTUGAL WERE FOUND TO HAVE NEARLY TWICE AS MANY FOREST PLANT SPECIES AS EUCALYPTUS PLANTATIONS

A recent forest study sought to determine the diversity of forest plant species in different forest types in the northwest of the country (Alto Minho - forest patches of between 0.22 ha and 36.52 ha). The results showed 52 forest plant species in oak woodlands, 33 in pine plantations and 28 in Eucalyptus plantations (Proença *et al.*, 2010). This study confirms a higher plant diversity in native oak woodlands as compared to commercial forest plantations.

Close to 90% of forests are privately-owned (Almeida, 2005).

The categories of protection in Portugal are as follows: national parks, nature parks, nature reserves, protected landscapes, natural monuments and private protected areas (ICNF website).

Some potential sites

As a result of Portugal's history, there are very few remaining stands of old and natural forests in the country. After centuries of harvesting for shipbuilding and fuelwood, Portugal experienced a long history of forest management and of commercial plantations of introduced species (especially Eucalyptus).

→ **Mata Nacional do Buçaco** may be one of Portugal's oldest forest stands. Located near a monastery and castle, it is a 105 ha arboretum-like forest gathering several hundred tree species introduced from the New World, soon after its discovery by Portugese sailors. This stand, designated as a Natura 2000 site, is dominated by non-native species. Nevertheless, it bears a high tree diversity, a relatively high maturity and is an area with high historic and recreation interests. It also illustrates how complex it is to evaluate natural heritage in the Mediterranean.

However, Portugal may host also some interesting ancient forests.

→ **Mata do Solitario reserve**, within the natural park of Arrábida (IUCN category V) in southern Portugal (see Figure 16), may qualify as one of the rare old maquis formations of evergreen Mediterranean shrubs. It is a strict reserve. The umbrella pine (*Pinus pinea*) in the São Luís hills, may have been present in Arrábida for 4,500 years (ICNF website). Other species found here include the Portuguese oak (*Quercus faginea*), and the cork oak (*Quercus suber*).

→ **Mata da Albergaria**, a 600 ha oak woodland in the north of the country (outside of the country's strict Mediterranean zone) within the National Park of Peneda Geres (category II, 70,200 ha) may qualify as ancient forest. The park also forms part of the 'PAN Parks' network (panparks.org) and hosts large slopes newly colonised by forest after rural abandonment.

→ **'Montados'** ('dehesas' in Spain) are agro-silvo-pastoral systems of evergreen oak (cork oak and holm oak) intertwined with maquis and other human-modified habitats. Because of their habitat heterogeneity generated by human use (Bugalho *et al.*, 2011) they represent centres of high biodiversity in the western Mediterranean sub-region. Inside these areas, in southern Portugal, old oak stands can be found that are among the oldest native forest stands in the country. Old cork oak are especially interesting as they are able to accommodate many microhabitats for biodiversity (like in old-growth forest), even if the cork is harvested.

Figure 16.
Map of Mata do Solitario

Mata do solitario in Arrábida Natural Park is one of the last remnants of old maquis

Projects

Portugal's forest sector is quite unique for two reasons, on the one hand most forests are privately-owned, and in most cases in relatively small stands (under 100 ha). On the other hand, the country has invested tremendously over the years in developing a plantation industry that has mainly claimed agricultural marginal lands and in some cases replaced native forests. Furthermore, in an average year, Portugal suffers more from forest fires than any other country in the Mediterranean, particularly in areas that have fallen to rural abandonment and where shrub encroachment has occurred. With this in mind, the main areas of work related to forests concern promoting good forest management and the potential for sustainable forestry and for creating socio-economic incentives for the conservation of high conservation value areas. WWF work in Portugal has focused very much on promoting FSC certification and identifying high conservation value forests under this process (Branco *et al.*, 2010). Also, WWF is working intensively on cork oak restoration and management, and payment for ecosystem services (PES). Recently a "water and biodiversity PES scheme" between an association of cork oak producers and the Coca-Cola company in Portugal was mediated by WWF.

THERE IS LIMITED DATA ON FOREST STRUCTURE, DYNAMICS AND MORE GENERALLY, ON NATURAL FORESTS IN PORTUGAL

Much of the literature encountered on forests in Portugal relates to fire management although data exists on forest inventories. There is however, limited data on forest structure, dynamics and more generally, on natural forests in the country.

SERBIA

Forests

Ancient forests are associated with a lack of human intervention in Serbia. The country has some small areas of ancient forests, essentially beech (*Fagus* spp.) forests. Three beech species can be found here: European beech (*Fagus sylvatica* L.), oriental beech (*Fagus orientalis* Lipsky) and a species of Balkan beech (*Fagus moesiaca*), although the extent to which the latter is a distinct species is yet unclear (Šijačić-Nikolić *et al.*, 2011). Balkan beech is deciduous and can reach up to 30-45 m in height with a diameter of 2m, and a lifespan of up to 300 years (Šijačić-Nikolić *et al.*, 2011).

SERBIA HAS ABOUT 43 SMALL BEECH FORESTS THAT ARE CONSIDERED ANCIENT

Serbia's total forest area amounts to 2.1 million ha. Forests can be found throughout the country, although larger areas can be found in the eastern and southern parts of the country (Srjdevic, 2005). There are 518,051 ha of forests under protection (in 463 protected areas) covering 5.86% of the country's overall territory (Serbian State forest enterprise website).

A total of 205 indigenous species of trees and shrubs (170 broadleaf and 35 coniferous) are present in Serbia and there are several primary gene centres for endemic and endemic-relict species (e.g. *Pinus peuce, Pinus heldreichii, Fraxinus pallisae, Forsythia europaea, Corylus colurna*) (Srjdevic, 2005). Beech forests represent over 50% of the country's forests (by volume - Šijačić-Nikolić *et al.*, 2011).

The following protected area categories exist in Serbia: national parks, nature parks, landscapes with exquisite characteristics and beauty, nature reservations and nature monuments (Srjdevic, 2005).

Fifty-six percent of forests are state-owned, however, even privately-owned forests are administered by the Directorate of Forests, under the Ministry of Agriculture, Forestry and Water Resources.

Some potential sites

There are about 43 small beech forests that are considered ancient. Six strict nature reserves of pure beech virgin forests (Ostojic *et al.*, 2008) are listed below:

→ **Danilova Kosa** (6.7 ha) is a strict nature reserve in western Serbia at an altitude of between 680 and 750m with steep slopes. Here trees can be up to 200 years old.

→ **Feljeshana** (15.28 ha) is a strict nature reserve (IUCN category Ia) in eastern Serbia (see Figure 17) at an altitude of 420 to 550m. The forest is composed of montane beech (*Fagetum montanum asperuslosum typicum*), with trees aged up to 300 years. Some trees reach heights of more than 40m, with very high wood volume.

→ **Kukavica** (75.76 ha), in south eastern Serbia, lies at an altitude ranging from 700 to 1,200 m. Here beech trees are aged about 140 years.

→ **Vinatovača** (37.43 ha) is a strict nature reserve (IUCN category Ib) in eastern Serbia at an altitude of between 630 and 870m. It is made up of old beech forests with trees about 200 years old and reaching up to 46m in height and one metre in diameter at breast height.

→ **Golema Reka** (34.6 ha) lies inside the nature park of Stara Planina at an altitude of 1,250-1,350m.

→ **Busovata** (14.6 ha) is a strict nature reserve in east Serbia.

Figure 17.
Map of some ancient forests in Serbia

Projects

The Faculty of Forestry in Belgrade is working on a project on regeneration of pure beech old-growth forests in Serbia funded by the Ministry of Agriculture, Forestry and Water Management. The objectives are: 1) stand state and spontaneous regeneration in pure beech old-growth forests in Serbia, 2) to compare structure and dynamics between unmanaged and managed beech forests; to determine state and overall potential of beech old-growth forest reserves. The project is funded by the Ministry of Agriculture, Forestry and Water Management and conducted by the Faculty of Forestry.

SLOVENIA

Forests

OLD-GROWTH FORESTS ARE WELL STUDIED IN SLOVENIA: FOURTEEN FOREST SITES HAVE BEEN IDENTIFIED

Slovenia is a highly forested country, with 57% forest cover for a total of 1,149,633 ha (SFS Report 2003 cited in Boncina, 2011). Overall, the degree of naturalness of Slovenian forests is high. Altitudinal range varies from sea level to 2,864 metres above sea level. The country is divided into six different regions: the alpine, prealpine, dinaric, sub-Mediterranean, pre-dinaric and sub-pannonian regions. With a diversity of climatic zones and habitats, Slovenia's forests are also very diverse, composed of mixed oak/hornbeam (8%), montane beech and mixed beech-fir-spruce (41 %), lowland and submontane beech (30%), mixed spruce and fir (7%) and other forest types (5%). Slovenia is considered to have been an important glacial refuge for beech in Europe (Magri *et al.*, 2006).

Protected forests in Slovenia are sub-divided into large areas (national parks) and 'small protected areas' categorised as natural monuments, strict nature reserves and nature reserves.

Only a quarter of forests are state-owned.

Some potential sites

Fourteen virgin forest sites have been identified (see Table 9 and Figure 18 below).

Table 9. Names, sizes and dominant tree species of Slovenia's 14 virgin forests (Nagel *et al.*, 2012)

OLD-GROWTH RESERVE	SIZE (ha)*	DOMINIANTE TREE SPECIES	ALTITUDE (m a.s.l.)
Bukov vrh	8	*Fagus sylvatica*	*1,250-1,314*
Zdrocle	157	*F. sylvatica, Picea abies*	*1,300-1,477*
Krokar	75	*F. sylvatica, Abies alba*	*750-1,190*
Strmec	16	*A. alba, F. sylvatica*	*820-940*
Prelesnikova kolisevka	3	*P. abies*	*425-475*
Kopa	13	*F. sylvatica*	*980-1,080*
Rajhenavski Rog	51	*A. alba, F. sylvatica*	*800-920*
Pecka	60	*A. alba, F. sylvatica*	*795-910*
Gorjanci-Trdinov vrh	23	*F. sylvatica*	*990-1,150*
Ravna gora	16	*F. sylvatica*	*890*
Krakovo	40	*Quercus robur*	*152-153*
Donacka gora	28	*F. sylvatica*	*600-800*
Belinovec	4	*F. sylvatica*	*600-700*
Sumik	20	*F. sylvatica, A. alba, P. abies*	*800-1,150*
Total area	514		

*Approximate size of the old-growth area. The actual sizes of the reserves that contain the old-growth areas are often larger than the values reported here because they include buffer zones

Figure 18.
Map of some virgin forests in Slovenia

In total, these forests amount to 514 ha, with the largest area being Zdrocle situated high in the Dinaric range and totalling 157 ha. Not all of this area has been untouched however, as there is evidence of management in some parts of the zone.

→ **Krokar forest** is a 75 ha virgin forest remnant located on a plateau in the Dinaric mountain range in Southwest Slovenia, and ranges from 750 to 1,190m in elevation. It is dominated by beech (96%) with some silver fir and the occasional mountain maple (*Acer pseudoplatanus*), common ash (*Fraxinus excelsior*) and mountain elm (*Ulmus glabra*). The basal area is 44m²/ha and the average canopy height is approximately 35 m while average gap sizes are of 137 m² (Zeibig *et al.*, 2005).

→ **Pečka forest** is a strict forest reserve of approximately 60 ha at an altitude of 795 to 910 metres. It is a mix of silver fir and beech (*Omphalodo-Fagetum* association) typical of the Dinaric region. Trees reach a height of over 35 m and their diameter at breast height can be over one metre (Marincek and Marinsek, 2004).

→ **Krakovo**. The Krakovo remnant is a lowland flooplain forest dominated by *Quercus robur* in south eastern Slovenia (Nagel *et al.*, 2012).

→ **Rajhenavski Rog** is a 51 ha forest of silver fir and beech. It contains a high proportion of deadwood, estimated at 300 m³/ha (Odor *et al.*, 2005). Another striking characteristic of this forest is its old trees, frequently reaching 500 years of age, reaching up to 50m with diameters (dbh) of over 1.5 metre. These massive trees can have up to 50 tonnes of timber matter each (Hartmann, 1999).

The beech-fir strict reserve Rajhenavski Rog

Projects

The country has a long tradition in monitoring strict reserves, with the first full inventory of old growth forests (for areas up to 100 ha) taking place between 1953 and 1954. Every 10 years a full inventory is repeated. Some reserves have data sets going back over 100 years (Boncina, 2011). For example, it is known that in 1892 some virgin forests were protected as 'special purpose forests' in the Kocevje region (Boncina, 2011).

A project to assess the forest reserve network, establish new research plots and apply research findings to forest management is being implemented by the Biotechnical Faculty of Ljubljana.

SPAIN

Forests

Old *Abies pinsapo* stands in Sierra de las Nieves, Andalusia

In 2011, Spain reported total forest cover of 18,173,000 ha (Forest Europe *et al.*, 2011). In the National Forestry Inventory, Spanish forests are divided into three categories: (i) *forestal arbolado* (wooded land with tree cover over 20 %), (ii) *forestal arbolado ralo* (sparse tree cover of 5-20 %), and (iii) *forestal desarbolado* (non-wooded forest areas) (Montiel-Molina *et al.*, 2005). Of all European countries, Spain has the largest proportion (27%) of unclassified forest (Forest Europe *et al.*, 2011).

Spain's forests consist mainly of mixed stands, including mixed conifers, mixed broadleaves and mixtures of conifers and broadleaves. Main forest types are Mediterranean and sub-Mediterranean mixed oak forest, Mediterranean broad-leaved sclerophyllous forests and shrub, and Mediterranean and Macaronesian (Canary Islands) coniferous forests (Montiel-Molina *et al.*, 2005).

Spain hosts over 8,000 species of vascular plants of which 1,500 are endemic (Montiel-Molina *et al.*, 2005). Through pollen records it has been possible to model the progress of tree cover in different regions of Spain over 10,000 years (Riera Mora, 2006).

The country has a long tradition of protected areas which were established as far back as the 15th century by royalty (reales sitios) in order to secure their sites of leisure (Montiel-Molina *et al.*, 2005). There are 47 different protection categories (five at the national level and 42 at the regional level). Spain's protected forest surface - including both protected national areas and public utility forests - amounts to 6,679,958 ha (Montiel-Molina *et al.*, 2005). Approximately 47% of Iberian-Balearic forests and 87% of the Canary Islands forests are included in Natura 2000; although the majority still lacks management plans. Currently, only 12.7% of the Spanish forest area has management plans, even though they are required by Spanish forest law (Hernández and Romero, 2011).

Two thirds of forests are privately owned in Spain.

Some potential sites

→ **Parc Natural de Poblet** is a 400ha wilderness area within the natural park of el Poblet in Catalunya (IUCN category V) that consists of coastal holm oak (*Quercus ilex*), Pyrenean oak (*Quercus pyrenaica*) – the only such forest in Catalonia – Scots pine (*Pinus sylvestris*), stone pine (*P. pinea*), Aleppo pine (*P. halepensis*) and black pine (*P. nigra* ssp. *salzmannii*). This zone was managed by Cistercian monks from the twelfth century until 1835 (Torcal and Mallarach, 2008). It was then quasi-deforested until a new law protecting it in 1901 (Generalitat de Catalunya website).

→ **Moncayo forest.** The Moncayo beech forest (1,000-1,900m) is situated within the Dehesa de Moncayo Nature Park (IUCN category V) in Aragon province south of the Pyrenees.

→ **Teixedal de Casaio**, in the province of Galicia (northern Spain), harbours 300 centenary individuals of the European yew (*Taxus baccata*) with some estimated to be 400 years old (Tabarés, 2005).

→ In the **Sierra de las Nieves National Park** (Andalusia) relict pinsapo fir (*Abies pinsapo*) can be found. This is one of the three southernmost European populations of these firs (the other two being the Reales de Sierra Bermeja Natural Area and the Sierra de Grazalema Natural Park) (Fernández-Cancio *et al.*, 2007). Large trees with dbh of 40cm amount to less than 5% of individuals (Linares *et al.*, 2009). While above 1,100m pinsapo firs form a homogenous forest, below 1,100m they coexist with maritime pine (*Pinus pinaster*), cork oak (*Quercus suber*), *Q. faginea* Lam. and holm oak (*Q. ilex*) (Fernández-Cancio *et al.*, 2007).

→ **Garajonay National Park** (Canary island - La Gomera - 3,984 ha) is home to a heath-laurel relict cloud forest.

→ **The Reserva Integral de Muniellos** is an integral biological reserve and a biosphere reserve in the Asturias province of Spain. It covers 5,488 ha and is dominated by oaks. Timber extraction ceased in the 1970s. The reserve is home to brown bears and capercaillies, and there is also a population of the rare Kerry slug (protectedplanet.net). Figure 19 maps out some of these potential sites.

Figure 19.
Map of some potential ancient forests in continental Spain

IN CATALONIA A DETAILED FOREST INVENTORY OF THE MOST UNIQUE (AGED/DIVERSE) FORESTS HAS BEEN RECENTLY UNDERTAKEN

Projects

In Catalonia a detailed forest inventory to identify, map and value the most unique (aged/diverse) forests in terms of productivity, social/aesthetic/recreational and biodiversity values has been undertaken by the CREAF (*Centre de Recerca Ecològica i Aplicacions Forestals*) and the Generalitat de Catalunya (Regional Administration).

Also in Catalonia, the Programme Sèlvans (see: www.selvans.cat) from the Diputació de Girona (department of Girona in the State of Catalonia) is seeking to establish a network of virgin and mature forests across Catalonia, Spain and Europe in a first pilot phase, later to be deployed internationally. The project intends to use payments for ecosystem services to establish a network of 70 sites.

Overall, there is limited monitoring of natural forests in Spain although one programme started in 1995 in Garajonay National Park (Parviainen, 2000).

Recently, the Fundación Félix Rodríguez de la Fuente and the Council of Valencia presented the project 'Great Trees for Life', funded by LIFE +. The aim of the project is to preserve the unique trees and ancient forests of the Spanish Natura 2000 sites, since in the last century more than 80% of old Spain's old trees have disappeared.

TURKEY


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Forests

In Turkey, forests cover 21,537,091 ha of which 16,662,379 ha are high forest and 4,874,712 are coppice forest. The forest is composed of 13,158,774 ha of coniferous trees and 8,378,317 ha of broadleaved trees (Republic of Turkey, 2010 and see Table 10). Statistics from 2012 identified a total of 5,152,561 ha of oak forest of which 2,105,937 ha is productive forest and 877,618 ha is productive high forest.

Situated at the intersection between three continents, Turkey straddles the Euro-Siberian, Mediterranean and Irano-Turanian geographical zones. As such, Turkey is a major centre of endemism and of utmost biological importance. There are approximately 9,000 species of vascular plants in Turkey, of which about 3,000 are endemic to Turkey (Colak and Rotherham, 2006). In the Euro-Siberian region which covers most of north Anatolia and a narrow strip along the Black Sea coast of European Turkey, temperate forest can be found. The Mediterranean region is composed of dry forest of coniferous trees and maquis with some exceptions especially in the Amanos Mountains. Biodiversity is abundant particularly along the zone from the Amanos Mountains in the south to the Kaçkar Mountains in the northeast (Çağlar, 2003). In the Mediterranean zone, maquis vegetation can be found below 1,000-1,200 metres, while conifers dominate above this altitude (Colak and Rotherham, 2006).

Table 10. Importance of Turkey's forest types and dominant tree species, estimated through forest cover (Colak and Rotherham, 2006).

FOREST SPECIES	% OF FOREST COVER
Pinus spp.	30%
Quercus spp.	22.7%
Mixed broad-leaved forests	18.5%
Maquis	8.4%
Mixed coniferous forests	5.5%
Juniperus spp.	4.6%
Mixed coniferous and broadleaved forests	4.5%
Fagus orientalis	3.3%
Abies spp.	0.9%
Picea orientalis	0.7%
Cedrus libani	0.5%
Alnus spp.	0.2%
Castanea sativa	0.1%
Other broad-leaved species	0.1%

The forest law of 1956 (Law 6831) identifies four main functions for the country's forest estate: water protection (16%), erosion control (11%), production (47%) and nature conservation (19%), with the remainder being for cultural, defence and other purposes (Kuvan *et al.*, 2011).

Figure 20.
Map of some potential ancient forests in Turkey

Some potential sites

→ **Çığlıkara Strict Nature Reserve.** There are valuable Lebanese cedar forests (*Cedrus libani*) in the western Taurus Mountain range, notably in Elmalı (Antalya) where Çığlıkara Strict Nature Reserve (IUCN category Ia) of 15,889 ha of pure cedar of Lebanon (*Cedrus libani*) was established within the higher altitudes of the mountain range (see Figure 20).

→ **Babadağ.** Babadağ (home to the endemic *Acer undulatum*) near Fethiye in Muğla province, has a rich forest ecosystem composed of cedar, Cilicica fir (*Abies cilicica*), Turkish pine (*Pinus brutia*) and junipers, and maquis along the coastline which is naturally protected due to its steepness (Özhatay *et al.*, 2005). Babadağ is both an Important Plant Area (IPA) and a WWF forest hotspot.

1,580 PLANT TAXA CAN BE FOUND IN THE AMANOS MOUNTAIN RANGE, OF WHICH 251 ARE ENDEMIC

→ **Kazdağı National Park and Gürgendağ (Turkish Fir) Strict Nature Reserve.** Kazdağı Mountain is the home of the endemic Turkish fir and is protected under various categories. The forests inside Kazdağı National Park and Gürgendağ Strict Nature Reserve are notable for their restricted zone of Turkish fir (*Abies nordmanniana* ssp. *equi-trojani*) as well as for being mentioned in Homer's Iliad (Uysal, 2010). Here, above 1,000m fir trees can be found, while at lower altitudes the forest is mainly composed of pines and oriental beech. Altogether, there are about 800 plant taxa in the National Park, 68 of which are endemic to Turkey and 31 of which are endemic to the park (Sevgili *et al.*, 2011; Uysal, 2010; Anonymous, 2000).

→ The **Amanos Mountain range**, situated between the Black Sea and the Mediterranean Sea, is an Important Plant Area according to Plantlife with 1,580 taxa, of which 251 are endemic to Turkey (Düzenli *et al.*, 2009) and a WWF forest hotspot. In the western, more humid part of the mountains, the most southern relict populations of Euxinian (from the Black Sea) and Euro-Siberian flora can be found, such as oriental beech (*Fagus orientalis*), oriental hornbeam (*Carpinus orientalis*), Turkey oak (*Quercus cerris*), European yew (*Taxus baccata*), lime (*Tilia argentea*) and common boxwood (*Buxus sempervirens*) (Düzenli *et al.*, 2009).

→ **Datça Peninsula** is a forest hotspot defined by WWF in 1999 in the western part of Turkey and an Important Plant Area due to its rich flora, fauna and high maquis ecosystem. It contains forest stands of relict endemic tree species of Datça palm (*Phoenix theophrastii*). The area is also important because of the ancient port and city of Knidos of the Caria civilization (Avcıoğlu *et al.*, 2006; Avcıoğlu and Lise, 2005).

→ **Dibek Forest** is a strict nature reserve (IUCN category Ia) in the western Taurus Mountains dominated by cedar trees with many monumental trees. It totals 550 ha including the historical ruins of Lycians (Anonymous, 2000).

→ **Lake Kartal Strict Nature Reserve** is an area of 550 ha protected under IUCN Ia category. Around the steep slopes of the glacial valley of Lake Kartal there are Anatolian black pine (*Pinus nigra* ssp. *pallasiana*) old growth forests with monumental trees estimated to be 800-1,200 years old (Anonymous, 2000).

→ **Aladağlar** is an Important Plant Area home to the highest peak of the Taurus Mountain range. Here forest ecosystems of Lebanese cedar, Turkish pine and Anatolian black pine (*Pinus nigra* ssp. *pallasiana*) and maquis can be found.

→ **Kaş** maquis. Along the remote coastline of the western Taurus Mountains there are maquis ecosystems hosting a wealth of biodiversity and protected from human access. Dilek Peninsula – Büyük Menderes Delta National Park – was home to the last Anatolian leopard (*Panthera pardus tuliana*). It is known as Mycale Mountains of the ancient Ionia Region. The Peninsula (an Important Plant Area) has a well preserved maquis ecosystem, protected from human activity (Özhatay *et al.*, 2005).

Projects

Questionnaire respondents for Turkey did not indicate the existence of any specific project on ancient forests.

MAJOR GAPS AND PRIORITIES

This section highlights major gaps related to ancient Mediterranean forests that were identified during this assessment. They are divided into four categories: knowledge; protecting natural capital; values and threats; and inspiring policies and management practices.

1. Knowledge

Reaching a practical definition for ancient forests relevant to the Mediterranean region

The lack of a common **definition** and understanding of ecological, social and economic qualities associated with naturalness, old-growth and ancient forests in the Mediterranean region hampers potential collaboration across countries. As such, the time is right to build on existing networks and efforts being undertaken in some countries (e.g. France, Italy and Slovenia), to attempt to frame these terms for wider application across the Mediterranean region. This definition must be practical, adapted to the Mediterranean realities, its specific history and diversity. A solution to avoid the common pitfall of defining something so diverse, complex and context-dependant is – using WWF France's experience – to evaluate the multiple dimensions of forest qualities (diversity, maturity, structure…), rather than looking for a sole threshold for all the Mediterranean ecoregion above which forest qualifies as being ancient. Thus, the aim becomes to identify the location of Mediterranean forests, and how they can retain or recover the more relevant characteristics in a given context.

Ancient forest-dwelling biodiversity

KNOWLEDGE ABOUT THE DIVERSITY OF INVERTEBRATE SPECIES FOUND IN THE DIFFERENT MICRO-HABITATS PRESENT IN ANCIENT FORESTS IS LIMITED

Further studies are needed on specific **parameters** such as gaps in forest continuity, microhabitats, deadwood occurrence and decay, but also monitoring of fauna, fungi, vertebrate, invertebrate and saproxylic species and indicator plant species, to improve understanding of the typical traits of ancient Mediterranean forests.

Full inventories of **species** are missing in most cases. For example, knowledge about the diversity of invertebrate species found in the different micro-habitats present in ancient forests is limited. Yet, much of their ecological value lies precisely in this diversity of habitats and of species. Specific inventories of saproxylic or cavity-dwelling species (insects, birds, small mammals), mosses, fungi and lichens, but also plant genetics, plant associations etc. are needed.

Key ecological characteristics

Specific research is needed to understand the **minimal viable size** of ancient forests depending on species, location, altitude etc. This knowledge will contribute to secure optimal conservation measures.

Specific **tools** to support improved identification and knowledge of these forests are not widespread among the Mediterranean forest and conservation communities. For example, data on several indicators, such as volume of deadwood under the 'Forest Europe' process, in the available UNECE statistics (see: http://w3.unece.org/pxweb/) of southern European countries, are not reported by many Mediterranean countries, suggesting that for many countries the collection of this data remains a challenge.

In general, **knowledge** about ancient forests in the Mediterranean, as concerns their evolution and characteristics (including associated biodiversity) in particular, remains limited. There is a need to better understand their structure and long term dynamics, as well as past disturbance regimes, in all forest types, especially in the meso and supra-Mediter-

ranean levels where data is scarce. In many countries in the region there is a lack of data related to their specific age, biomass, naturalness, conservation status, genetics etc. Coordinated research and participatory inventories of ancient forests in the Mediterranean would help to place these forests on the political and cultural maps.

Historical dimension of ancient forest in the Mediterranean

IN MOST COUNTRIES, SPATIAL AND DESCRIPTIVE INFORMATION IS MISSING (OR IS OUTDATED)

The **history of land-use** within target areas and related conservation values is currently misunderstood in the Mediterranean. A clear understanding is important in order to define appropriate conservation and management actions, and to design relevant restoration actions. For example, "*Will a lack of management increase or decrease diversity? Does naturalness and lack of management increase the risk of severe wildfires? Will ancient forest stands be more resilient to wildfires? Will they be more resilient to climate change?*"

2. Protecting a natural capital

Surveying a natural heritage

A major gap that is related to the first point is the limited availability of inventories, **maps and descriptions** of the region's ancient forests. Without a clear understanding of how to identify these forests it is impossible to map them. Yet without clear inventories and maps of the areas in question, conservation actions can only be limited. In most countries, spatial and descriptive information is missing (or is outdated). An encyclopaedia for ex -Yugoslavia exists for example which identifies old-growth forests. However, it is over 30 years old and major changes have taken place since.

Monitoring

There is a need for a common approach to the **collection of information** and to monitoring ancient forests in the region. Long term monitoring of these forests is necessary to better understand their evolution.

Identification of common **indicators** for ancient forests in the Mediterranean, where these can be harmonised (for example based on WWF France's methodology) would be important. Furthermore, adaptation, range of variation of each criterion and thresholds for different forest types and species remain to be defined for the region.

Long term **monitoring** would also help to determine the time it would take for the development of old-growth conditions to appear in previously-managed stands. It could also inspire management practices that do not reduce drastically ancient forest ecological qualities.

3. Values and threats

Understanding and integrating cultural and social values

Gaps also exist with respect to **social and cultural features and values** of ancient forests. It is essential to understand the positive and negative perceptions linked to ancient forests. For example, while high forest and large trees are positively perceived by the general public, large amounts of deadwood are still not associated with healthy or well managed forests in the Mediterranean region. Such socio-cultural analyses are important both to develop an efficient communication or education programme on ancient forests, and to anticipate negative reactions from stakeholders or the general public. Furthermore, the information, knowledge and research that do exist in this area

tend to be disconnected from research into the ecology of these forests and consequently potential synergies in defining, funding and implementing conservation strategies that are locally-relevant are lost. A better understanding of these factors can serve to improve their long term protection.

Economic considerations

The opportunity cost potentially involved in conserving ancient forests, particularly when these are on private land, needs to be recognised and adequately compensated. **Payments for ecosystem** services (PES) could be used as an approach for this, but this is an area with little data and more research would be needed to better understand the economic implications in specific settings. Experiences in some areas, for example related to **high conservation value forests**, could be documented and lessons learnt and best practices extracted for wider application (e.g. Branco *et al.*, 2010).

Education and awareness-raising

IT IS CRUCIAL TO LOOK FOR NOVEL WAYS OF VALUING BIODIVERSITY AND ECOSYSTEM SERVICES OF ANCIENT FORESTS

There is a general **lack of awareness and understanding** by Mediterranean civil society about the presence and importance of ancient forests.

The divide between foresters and ecologists is very apparent when it comes to ancient forests, with the former seeing an urgent need to regenerate them and the latter eager to conserve them forever ancient. While for ecologists the scientific and biological value of ancient forests is undisputed, for foresters, the presence of vast amounts of deadwood, and reduced annual increments make them less interesting. It is crucial to reconcile these, sometimes opposite views and to look for novel ways of valuing biodiversity and ecosystem services. In a Mediterranean context with limited remnants of ancient forests, it would seem conceivable to focus on their biological values, including in terms of better understanding long term ecological processes. Ancient forests are very often in zones (elevation, slope, soil productivity) with low harvesting interest, a key reason for which they have remained 'untouched'.

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Monitoring ancient forests is important, for example coring giant pines (aged over 1,000 years old) in Corsica as shown in this photograph

INFORMATION ON ANCIENT FOREST ECOSYSTEMS IS OF CRITICAL VALUE TO DEFINE REFERENCE ECOSYSTEMS FOR RESTORATION

4. Inspiring policies and management practices

Integration into relevant policies

While ancient forests may be found within other **categories of land management** (such as protected areas) or different land use projects and policies (for example HCVF and Corine), they are not a distinct political or even programmatic category in most countries. That does not signify necessarily that another layer or category should be created. However, a clear link to these highly valuable forests would need to be made within relevant land management categories, projects and policies.

Application to conservation, forest management and restoration

Knowledge obtained on the processes that have helped to shape ancient forests and to enable them to evolve as they did, will have direct application in **conservation, sustainable forest management and restoration**. Ancient forests in some cases already form core areas of protected areas. The relationships between different species and their impact on productivity, or the optimal size of gaps for different forest types, can inspire forest managers and contribute to improving forest management practices. It includes discussion about the amount of deadwood to retain, the way to establish a network of retention islands, stand structure, age of harvest and altogether the best Mediterranean-adapted close-to-nature silviculture practices. Equally, information on ancient forest ecosystems is of critical value to define reference ecosystems for restoration, another important topic in the Mediterranean ecoregion.

Landscape-level integration

Ancient forests within landscapes serve as a genetic resource base, a seed source, a biodiversity source, an important area for connectivity, a haven for wildlife, to cite but a few. However, their role is not well explored in landscape conservation work. Further investigation is necessary to better understand this role and to incorporate ancient forests in practical landscape-level policies and land use decisions.

CONCLUSIONS AND RECOMMENDATIONS

Ancient forests are present in the Mediterranean albeit covering probably less than 1% of the ecoregion. In this region, which is unique and tremendously rich from a biological perspective, ancient forests contribute to the natural and cultural heritage. These forests are living laboratories holding a wealth of information, for example on adaptation to climate change, on species as yet unknown to science, on important ecological and silvicultural parameters... Yet they are relatively poorly understood and researched, and many are highly threatened.

Within its global forest programme, and specifically within its Mediterranean forest programme, WWF has prioritised ancient forests. Several other research teams, governmental agencies and NGOs, scattered around the Mediterranean also try to do so. The time is now right to consolidate these efforts and to create a broader Mediterranean-wide programme on ancient forests that would address a specific gap in high conservation value forests and conservation policies. Through this review a total of 80 potential sites were identified in 15 countries.

THROUGH THIS REVIEW A TOTAL OF 80 POTENTIAL SITES WERE IDENTIFIED IN 15 COUNTRIES

Work related to ancient forests needs to be understood and undertaken at different levels: on the one hand further **research** is needed (in order to better understand ancient forests and to define the relevant qualities in the Mediterranean, threats impacting on them, means of valuing them etc.) and on the other, **political measures** need to be developed to suit and support the protection, management and restoration of ancient forests.

We highlight ten recommendations for short to medium term (2-5 years) work.

→ RECOMMENDATION 1: Establish a network of interested parties on ancient forests in the Mediterranean

Building on research networks such as those supported by the European Commission (COST) and others, it would be valuable to establish a network of interested parties that would promote further action on ancient forests in the Mediterranean region. This group or network would lead research and conservation action on ancient forests in the region. WWF could act as coordinator of such a network of stakeholders at the regional level.

→ RECOMMENDATION 2: Define a common method for assessing and identifying ancient forests, and their associated values

While the diversity of languages in the Mediterranean is not conducive to agreement on one single and simple definition, it should be possible to define broad parameters applicable to all countries in the region and to ensure that these translate into the different Mediterranean languages. These parameters would serve to improve understanding across the region of this conservation target, and to help comparison and analysis across the region.

→ RECOMMENDATION 3: Use this assessment and the sites already protected as references and to fully inventory and map ancient forests in priority landscapes

Maps and field inventories of ancient forests across the region are necessary in order to better understand these forests and to be able to protect them accordingly. The sites identified through this assessment provide a start, a reference point, but a comprehensive identification and mapping of ancient forests throughout the region would be necessary as a matter of urgency in order to protect them as a network.

→ RECOMMENDATION 4: **Promote the key role of ancient forests to stimulate innovative protection, management and restoration of forest biodiversity and set up pilot demonstration activities in priority landscapes**

Three specific areas of work that need to be better understood by a range of stakeholders are the contribution of or interface between ancient forests and protection, management and restoration of forested landscapes. Pilot activities in priority landscapes can serve to highlight the importance and role of ancient forests in these three approaches within landscape conservation. WWF could take the lead (in close collaboration with a range of partners) in sites and landscapes where it is already active.

→ RECOMMENDATION 5: **Explicitly link ancient forests to relevant policies and lobby for their integration into relevant biodiversity strategies and programmes**

While ancient forests have not been the focus of significant research or conservation effort in most of the Mediterranean, they relate to a number of other programmes and initiatives, such as World Heritage Sites and Man and Biosphere Reserves (UNESCO), high conservation value forests, IUCN protection categories Ia and Ib, PAN Parks, Re-Wilding Europe and Natura 2000. It is useful to make these links explicit and to better integrate priorities related to ancient forests within these programmes or initiatives.

→ RECOMMENDATION 6: **Assess threats and promote the urgent protection of the Mediterranean's remaining ancient forests**

Ancient forest sites covering less than 1% of the Mediterranean region contribute, to a large extent, to what makes the Mediterranean a biodiversity hotspot. However, these forests are under continued pressure and only a share of them is protected. Given WWF's strong presence in the region and its expertise on protected areas, this would be an area for the organisation to focus in the immediate future with a view to securing the remaining fragments of ancient forests in the region.

ANCIENT FOREST SITES COVERING LESS THAN 1% OF THE MEDITERRANEAN REGION CONTRIBUTE TO MAKING THE MEDITERRANEAN A FOREST BIODIVERSITY HOTSPOT

→ RECOMMENDATION 7: **Apply effective monitoring systems in ancient forests so that they can serve as a reference ecosystem to evaluate the conservation status of Mediterranean forest habitats more broadly, and specifically those in Natura 2000 sites**

Effective and practical monitoring of Mediterranean ancient forests, at the level of their dynamics, evolution and the entire ecosystem, is essential for a better understanding of these forests and the species they host. In turn, such monitoring serves to provide a reliable reference base to measure various dimensions and the conservation status of other forest ecosystems in the region.

→ RECOMMENDATION 8: **Analyse features of resilience of ancient forests over time and use them to develop innovative strategies for climate change adaptation and/or ecological restoration**

Ancient forests in the Mediterranean harbour important information on the resilience of forest ecosystems (trees, the ecosystem and biodiversity as a whole) to climate change and other threats. These features need to be better understood and incorporated into wider conservation strategies.

→ RECOMMENDATION 9: **Launch a communications campaign so that ancient forests can be better valued as part of both the cultural and natural heritage of the Mediterranean**

Wild nature is no longer an integral part of Mediterranean cultures (except maybe in the Balkans). However, because of religious or hunting purposes, some forests that we qualify today as ancient are anchored in Mediterranean culture. But with industrialisation, the loss of connection to our natural heritage has taken its toll in the Mediterranean region, surprisingly at a time when rural abandonment creates opportunities for larger areas of new forests. Improving understanding and awareness of the cultural, religious, and social importance of ancient forests is necessary to renew their cultural value and to ensure that the remnants of these relict ancient forests are preserved.

→ RECOMMENDATION 10: **Broaden the exercise undertaken in this study to the south eastern and southern Mediterranean countries**

While this assessment focused on the European part of the Mediterranean, important forests remain in parts of North Africa and the Middle East (e.g. *Cedrus libani, C. atlantica,* cork oak…). Their conservation status is often problematic, due to overgrazing, repeated large fires, resource collection, etc. This assessment should be expanded to include these forests in order to develop a comprehensive overview and programme for ancient forests at the regional scale. First steps in the southern and south eastern part of the Mediterranean region would include identifying partners, sites and looking also at definitional issues, forest historical contexts and protection priorities.

IMPORTANT ANCIENT FORESTS OF NORTH AFRICA AND THE MIDDLE EAST SHOULD ALSO BE ASSESSED

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ANNEX 1: Overview of all potential sites identified in this report

This annex summarises the list of potential sites emerging specifically from this assessment. It is to be noted that the sites listed here are far from representing an exhaustive list of ancient forests for the Mediterranean. Instead, they represent a sample of potential sites that emerged from this specific research and that are highlighted in this report. In many cases ancient forests may represent a small part of a larger forest or reserve.

COUNTRY	KNOWN POTENTIAL SITES
Portugal	Mata do Solitario reserve, within the Natural Park of Arrábida
Portugal	Mata da Albergaria
Spain	Parc Natural de Poblet
Spain	Moncayo forest
Spain	Teixedal de Casaio
Spain	Sierra de las Nieves
Spain	Garajonay National Park (Canary island – La Gomera)
Spain	Reserva Integral de Muniellos
France	Réserve du bois du Chapître
France	Réserve de la Sainte-Baume
France	Chartreuse de la Verne
France	Réserve de Py
France	Réserve de la Pinata
France	Réserve des Gorges de la Frau
France	Chartreuse de Valbonne
France	Aiguines
France	Bois noir de Breil
France	Réserve du Mont Ventoux
France	Vallon de Saint-Daumas
France	Bois de Païolive
France	Réserve de la Massane
France (Corsica)	Forêt territoriale du Fango
France (Corsica)	Forêt territoriale du Tavignano
Italy	Gennargentu and Orosei Gulf National Park
Italy	Valle Cervara (Abruzzo NP)
Italy	Faggeta di Fonte Novello in the Gran Sasso National Park
Italy	Faggeta di Achiero in the Gran Sasso National Park
Italy	Frassineto di Valle Vaccaro forests in the Gran Sasso National Park
Italy	Further sites in Abruzzo National Park

COUNTRY	KNOWN POTENTIAL SITES
Slovenia	Bukov vrh
Slovenia	Zdrocle
Slovenia	Krokar
Slovenia	Strmec
Slovenia	Prelesnikova kolisevka
Slovenia	Kopa
Slovenia	Rajhenavski Rog
Slovenia	Pecka
Slovenia	Gorjanci-Trdinov vrh
Slovenia	Ravna Gora
Slovenia	Krakovo
Slovenia	Donacka gora
Slovenia	Belinovec
Slovenia	Sumik
Croatia	Motovunska šuma
Croatia	Čorak basin
Croatia	Prasnik special reserve
Croatia	Muški Bunar
Croatia	Dundo
Bosnia-Herzegovina	Lom forest
Bosnia-Herzegovina	Janj forest
Bosnia-Herzegovina	Perućica strict forest reserve
Montenegro	To be identified - Possible isolated patches in Biogradska Gora National Park
Serbia	Danilova Kosa
Serbia	Feljeshana
Serbia	Kukavica
Serbia	Vinatovača
Serbia	Golema Reka
Serbia	Busovata
Albania	National Park of Thethi
Albania	National Park Mali I Dajtit
Albania	National Park Lura
Albania	National Park Lugina e Valbones
Albania	National Park Zall Gjocaj
Albania	National Park Bredhi i Drenoves
Albania	National Park Llogara
Albania	National Park Mali i Tomorrit
Albania	Lumi i Gashit strict nature reserve
Albania	Prespa National Park

COUNTRY	KNOWN POTENTIAL SITES
Greece	Fraktos forest (western Rhodope mountains)
Greece	Paranesti forest
Greece	Olympus National Park
Greece	Valia-Kalda
Turkey	Çığlıkara Strict Nature Reserve
Turkey	Babadağ
Turkey	Kazdağı National Park
Turkey	Gürgendağ Strict Nature Reserve
Turkey	Datça Peninsula
Turkey	Dibek Strict Nature Reserve
Turkey	Lake Kartal Strict Nature Reserve
Turkey	Aladağlar
Turkey	Kaş maquis
Turkey	Dilek Peninsula- Büyük Menderes Delta National Park
Turkey	Further sites in the Amanos range
Turkey	Further sites in the Taurus Mountain range and coastal mountains – to be identified.
Cyprus	To be identified – Possible isolated patches in the Troodos and Pentadactylos mountain ranges

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IN SHORT

100% RECYCLED

1,200

Number of years of the oldest known trees in ancient forests of the Mediterranean

1%

Maybe less, the area of ancient forests left in the Mediterranean

10

Recommendations to tackle challenges for the conservation of the Mediterranean's ancient forests

>80

Potential sites highlighted, as a first attempt to gather information in 15 countries

6,367

The number of species hosted by a single small ancient forest (La Massane, France)

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