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MANAGEMENT of Natura 2000 habitats
* (Sub-) Mediterranean pine forests with endemic black pines
9530

Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

EUROPEAN COMMISSION

environment

The European Commission (DG ENV B2) commissioned the Management of Natura 2000 habitats. 9530 *(Sub)-Mediterranean pine forests with endemic black pines

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Alpine *Pinus nigra* forest in Friuli Venezia Giulia (Italy). Photo: P. Susmel

95 Mediterranean and Macaronesian mountainous coniferous forests

EUNIS Classification:

G3.5 - *Pinus nigra* woodland

* Priority habitat

Summary

These forests, often thick and dominated by various subspecies of *Pinus nigra*, are found at montane-Mediterranean level on dolomitic substrate (EC 2007). This habitat type occurs at a few sites in the EU and has a fragmented distribution area. Mature *Pinus nigra* forests can develop a high and closed arboreal canopy, and have several age classes and trees well over 30 metres high, as well as a shaded understory. These black pine forests both protect against erosion and torrential floods and act as a carbon sink practically all year round.

The main threats to *Pinus nigra* forests include unsustainable cutting for production purposes (particularly timber), the spread of exotic species, defoliation by insect pests (especially *Thaumetopoea pityocampa)*, overgrazing, fires and genetic pollution.

Management of pine forest containing endemic black pines should involve adequate representation of associated species and formation of irregular structures, containing trees of various ages, including very old specimens in order to secure genetic variability and an appropriate amount of dead wood. The importance of maintaining a certain volume of dead wood to assure biodiversity conservation and forest functionality has been acknowledged at international level.

Control of *Thaumetopoea pityocampa* and *T.wilkinsonii* infestations can be dealt with directly by, for example, aerial and ground spray treatments and by indirect measures such as thinning, cleaning, pruning and weeding, plus the use of pine tree species resistant to caterpillar attack.

Extensive and controlled grazing is advisable inside pine forest in an effort to balance the positive and negative effects (fire prevention and disappearance of species associated with the habitat, respectively).

To reduce the risk of genetic pollution, it is important to avoid planting black pines of unknown origin in the proximity of autochthonous pinewoods as intraspecific hybridisation can easily occur among different subspecies of black pine.

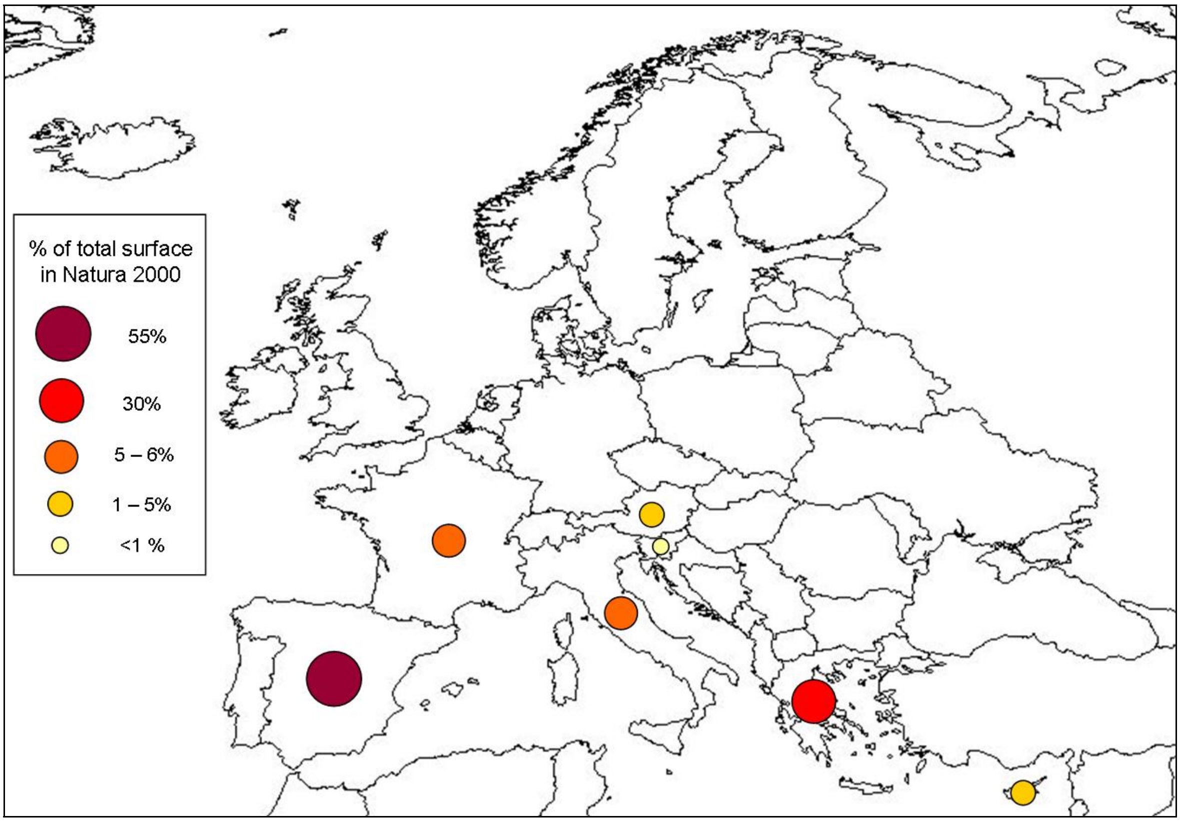
The management of the black pine forests should also take into consideration the requirements of the associated fauna of conservation value such as the biggest European raptor, the *Aegypius monachus* (cinereous vulture), which nests on flat-topped *Pinus nigra* trees in a large part of its distribution area, and a small passerine bird, the *Sitta whiteheadi* (Corsican nuthatch), endemic to Corsica, which feeds on insects and pine seeds, and nests in holes in old trees. In particular, old and mature trees should be favoured for their survival and the period of the year for carrying out the silvicultural interventions should be accurately planned, as the human activity can compromise the success of their breeding

1. Description of habitat and related species

This habitat type comprises forests of the montane-Mediterranean level, on dolomitic substrate (high tolerance to magnesium), dominated by pines of the *Pinus nigra* group, often with a dense structure (EC 2007).

Distribution

(Sub)-Mediterranean pine forests with endemic black pines occur at limited number of sites in southern EU countries, over a fragmented distribution area. Spain hosts more than half the EU total of 169 sites.



Percentage distribution of the total surface of (Sub)-Mediterranean pine forests with endemic black pines in Natura 2000

(Sub)-Mediterranean pine forests with endemic black pines in Natura 2000 sites

The following data have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover indicated for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Biogeographical region	Nº of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Mediterranean	143	252,166	93.87
Alpine	20	15,943	5.94
Continental	3	505	0.19
Countries	Nº of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Spain	69	146,458	54.52
Greece	35	80,432	29.94
France	16	15,688	5.84
Italy	37	11,480	4.28
Austria	5	10,241	3.81
Cyprus	2	3,523	1.31
Slovenia	2	792	0.30
TOTAL	**166**	**268,614**	**100**

Note: (Sub)-Mediterranean pine forests with endemic black pine are also present in Bulgaria and Romania, according to the national lists of habitats in the 92/43/CE EU Directive (Habitats Directive).

Main habitat features, ecology and variability

Pinus nigra forests, comprising a variety of subspecies, generally occupy medium and high mountain zones, often on substrates rich in magnesium (dolomites, in the case of the Western subspecies, and dolomites and serpentines in the case of the Eastern subspecies) (Regato *et al.* 1991). Some sub-types are present on deep soils, but in most cases the soil is superficial and not mature (Sánchez 2005).

The climate in the distribution area is sub-Mediterranean-continental. Winters are cold, frost common and summer droughts compensated at times by frequent storms.

Mature *Pinus nigra* forests can develop a high and closed arboreal canopy, with several classes of ages and individuals far above 30 m high, and shady undergrowth. *Pinus nigra* can occur with other coniferous species, mainly *Juniperus* sp., in areas where pine forest is less thick and there is only a thin intermediate layer with non-evergreen tree and shrub species (MMAMRM in prep.).

Pinus nigra is a long-lived frugal species able to adapt ecologically and physiologically to very different environmental conditions; it colonizes various ecological niches and plays a leading role in different stages within forest succession (MMAMRM in prep.).

Main subtypes identified

This habitat comprises a few forest subtypes, with variation chiefly associated with the characteristic *Pinus nigra* subspecies. The main typologies are listed below.

<u>Alpine-Apennine *Pinus nigra* forests:</u>

Pinus nigra ssp. forests of the eastern Italian, Austrian and Slovenian Alps and of the Apennines (EC 2007).
In the Alps, this type occurs on deep soil at poor dolomite and limestone sites at low to moderate altitudes (200-1,200 m) in continental climates with some summer rainfall (Earle 2007). A particular kind of *Pinus nigra* forests, with intermediate features between Alpine-Apennine *Pinus nigra* forests and Calabrian laricio pine forests, is represented by the *Pinus nigra* ssp. *italica* stands (Blasi *et al.* 2005), which are restricted to relict sites mainly in the Appennines of the Abruzzo region (Costa Camosciara, Villetta Barrea) on rocky limestone-dolomite terrain between 1,000-1,300 m; with low woodland not exceeding 15 m (EEA 2006b).

Characteristic species: *Fagus sylvatica, Fraxinus ornus, Ostrya carpinifolia, Picea abies, Pinus sylvestris, Quercus pubescens, Sorbus aria* (Ellmauer 2005).

Western Balkanic *Pinus nigra* forests

Pinus nigra ssp. *nigra* of the southern slopes of the Dinarides, the Pelagonides; *Pinus dalmatica* forests of the Dalmatian coastal areas (EC 2007).

Pinus salzmannii forests

This habitat is present in the Pyrenees, northern Iberian Range, Gredos Mountains, Serrania de Cuenca range, Maestrazgo, the Cazorla, Segura and Alcaraz ranges, Sierra Nevada and the Causses (EC 2007). According to the Spanish habitat interpretation manual (Bartolomé *et al.* 2005), the subspecies *Pinus nigra salzmannii* (Spanish black pine) is endemic to the western part of the *Pinus nigra* distribution area, its habitat occurring on calcareous substrate between 900 and 2,200 m and annual precipitation ranges between 700-1,600 mm (MMAMRM in prep.).

In France, this habitat is present at an altitude of 300-900 m in areas with high precipitation, but dry in summer and a minimum winter temperature of between +2° and -3°C on dolomite or siliceous substrates (Bensettiti *et al.* 2001).

Characteristic species: the high altitude forests (1,600-2,200 m) consist of open formations with a shrub layer that includes species such as *Juniperus sabina*, *J. communis*, *Erinacea anthyllis*, *Astragalus granatensis* and *Vella spinosa* (Bartolomé *et al.* 2005). The low altitude forests (900-1,500 m) are thick formations with species such as *Juniperus communis, Acer monspessulanum, Ameliancher ovalis, Sorbus aria, Buxus sempervirens, Helleborus foetidus, Geum sylvaticum, Hepatica nobilis, Thalictrum tuberosum* (Bartolomé *et al.* 2005). Low mountain forests (300-900 m) comprise *Pinus sylvestris, Juniperus oxycedrus, J. phoenicea, Quercus petraia, Calluna vulgaris* and *Cistus laurifolius* (Bensettiti *et al.* 2001)

Corsican laricio pine forests

According to Bensettiti *et al.* (2001), the *Pinus nigra* ssp. *laricio* forests of the mountains of Corsica (800 to 1,800 m) occur on granitic substrates in areas with abundant precipitation, but dry summers, a mean annual temperature between 6° and 12°C. These forests occur mainly on south-facing slopes, while on less sunny and cooler northern slopes, they combine with beech, silver fir, common yew and holly tree forest.

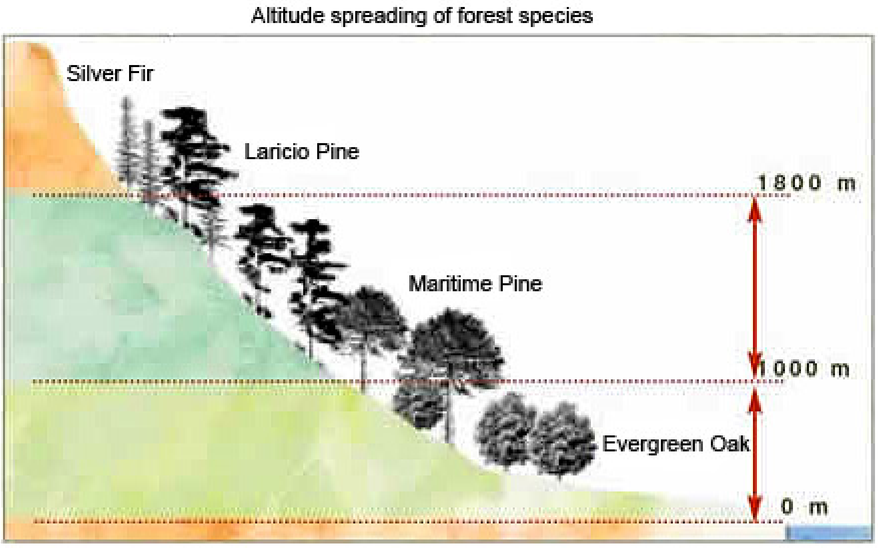


Figure 1. Altitude spreading of forest species. Source: LIFE Nature project LIFE00NAT/F/007273

Corsican pine forests are the keystone of a complex ecosystem. They guarantee the survival of many animals and plants, including the endemic bird *Sitta whiteheadi* (Corsican nuthatch) (ONF 2005).

Characteristic species: *Pinus pinaster, Juniperus communis, Erica arborea, E. scoparia, Quercus ilex.*

Calabrian laricio pine forests

Pinus laricio ssp. *calabrica* forests occur in southern Italy on the Sila massif, Aspromonte and Etna (EC 2007). They are found mainly on siliceous and poorly developed soils, with sparse rock outcrops, between 1,200 and 1,800 m (Minelli 2007). Pinewoods are characterised by a well-developed tree layer, often containing old specimens (up to 50 m and 90 cm in diameter in Sila). In contrast, the understory has very few species. As pedogenesis proceeds, mature-site native forest species (beech, downy oak) colonise microenvironments with a more developed soil profile (EEA 2006b).

A recent, not yet published study, based on molecular analyses, shows that the Calabrian pine derives from the Spanish black pine and not from the Austrian pine as believed until now (Verta, pers. comm.).

Characteristic species: *Fagus sylvatica, Cytisus scoparius, Erica arborea, Hypochoeris levigata* (Minelli 2007).

Pallas's pine forests

Montane forests of *Pinus nigra* ssp. *pallasiana* (Pallas's pine) in Greece and the Balkan Peninsula (EC 2007), southern Carpathians, Cyprus and Anatolia (EEA 2006b). This habitat presents adaptations similar to Salzmann pine forests to cold continental winters and dry summers, and is mostly found on limestone dolomite substrates.

Some authors distinguish between subspecies *pallasiana*, which in Cyprus is present between 1,200 and 1,900 m of altitude, and subspecies *caramanica*, which is present only in Greece, Turkey and Cyprus at 800-2,000 m in strictly Mediterranean climates with no summer rainfall (USAID 2006).

Characteristic species: *Abies borisii regis, Taxus baccata, Fagus sylvatica, Ostrya carpinifolia, Fraxinus ornus* and in the shrub layer *Q. coccifera* and *Juniperus oxicedrus* (EEA 2006b).

Species that depend on the habitat

Birds

Sitta whiteheadi (Corsican nuthatch) is endemic to Corsica (BirdLife International 2004), being closely associated with mature pines in Corsican pine forests (EEA 2006b). It feeds on insects and pine seeds, and nests in holes in old trees, which it usually excavates itself. There is an average of 1.58 pairs/10 hectares of forest, with a clear preference for the pure stands (ONF 2005). Their optimal habitat consists of old stands of Corsican pine with abundant dead and rotting trunks for nest sites, at altitude between 1,000 and 1,500 m (Thibault and Bonaccorsi 1999).

Local distribution and population numbers are limited by forest burning and the shortage of nest sites as a result of the felling of older, dead or rotten trees (BirdLife International 2004).

The dependency of *Sitta whiteheadi* on the Corsican pine means the former's requirements need to be taken into account in forest management and makes it an optimal bioindicator of forest conservation, particularly open coppices (ONF 2005).

Aegypius monachus. Very rare in Europe, *Aegypius monachus* (cinereous vulture) is protected under the 79/409 ("Birds") Directive. Breeding requires slopes covered with forest in open valleys and low sierras (Heredia *et al*. 1996), or in open pine forest of *Pinus brutia* (Turkish pine) and *P. nigra* with dense undergrowth of oak brushwood, such as in Greece (Katsadorakis *et al*. 1993). The cinereous vulture breeds in loose colonies or solitarily. It builds a large nest on top of a tree (*Pinus, Quercus, Juniperus*, etc.) where it lays one egg (Heredia *et al*. 1996).

A study carried out in 2001-2002, on the Turkey's largest colony, in the Türkmenbaba Mountains, shows that the black pine forests are the preferred breeding habitat for the vultures, at least in part of its distribution area. Nest tree (height, diameter at breast height or dbh, species, crown shape) and site (altitude, aspect, slope, distance to road, clearing or human activity) characteristics were recorded for 24-28 pairs. Preferences for site properties were statistically tested against randomly selected sites. The species invariably nests on flat-topped *Pinus nigra* trees with a height of about 10.7 and dbh of about 133 cm. Roads were recorded as close as 20 m to an active nest. Statistical tests revealed a significant preference for slightly steeper slopes (33% vs. 21%) in the middle third of valley sides, and for a relatively narrow belt of altitude (1,286±99 m), but not for aspect or distance to clearings, human presence or roads (Erdogdu *et al.* 2003).

Habitat loss (Birdlife International 2006) and the alteration of the breeding habitat are the main causes of the decline of the cinereous vulture population (Heredia *et al*. 1996). According to the European action plan, the alteration is usually related to forestry operations, including afforestation with exotic species, tree-felling during the breeding season, undergrowth clearing, opening up of fire breaks, etc. Apart from the direct effect on the habitat, these activities cause disturbance to the breeding pairs and facilitate access to otherwise inaccessible areas. Also forest fires play a role (Heredia *et al*. 1996); for instance, one fire in 1992 in Andalucía destroyed eight nests containing young, as well as 21 empty breeding platforms (Andalus 1993).

Bats

Some woodland bats that prefer old-growth forest as they need hollow trees for roosting and/or hibernation, e.g. *Barbatella barbastellus* (barbastelle), *Nyctalus lasiopterus* (giant noctule) and *N. leisleri* (Lesser noctule), are present in black pine forests (ONF 2005). Threats to these species are poorly understood, but their low population density and slow population growth make them vulnerable to the loss and fragmentation of ancient deciduous woodland habitat.

Invertebtrates

Graellsia isabellae has been identified in Spain as a species that shows a high affinity to the (sub)-Mediterranean pine forests with endemic black pines (MMAMRM in prep.).

Related habitats

9110 *Luzulo-Fagetum* beech forests

In the supra-Mediterranean zone, the black pine, in competition with beech (*Fagus sylvatica*), occupies the less productive soils, while in cooler and wetter settings (i.e. inner or northern slopes) the *Pinus nigra* forests are displaced by beech forest vegetation with *Abies alba* (silver fir) (9110 habitat).

9340 *Quercus ilex* and *Quercus rotundifolia* forests

As a pioneer of plant communities, black pine also grows at lower altitudes on the degraded soils of other species, e.g. oak forest. Here, 9530 (sub-) Mediterranean pine forest with endemic black pines habitat is often present in transition or in mosaic with forests where *Quercus ilex* or *Q. rotundifolia* (Bensettiti *et al.* 2001, Gamisans *et al.* 1991) predominate according to elevation, exposure and substrate.

9540 Mediterranean pine forests with endemic Mesogean pines

- *Pinus dalmatica* forests of the Dalmatian coastal areas (Western Balkanic *Pinus nigra* forests - subtype of the 9540 habitat) occurs in stands above the Aleppo pine forests (CSG 1998), one of the subtypes of the 9540 habitat. Aleppo pine forests consist of *Pinus halepensis* (Aleppo pine), which commonly colonises thermo- and calcicolous meso-Mediterranean scrub (EC 2007).

- Within the supra-Mediterranean levels of Corsica, mostly on granitic substrates, *Pinus pinaster*-dominated forests (*Corsican mesogean pine forests* - subtype of the 9540 habitat) occur locally on adrets (sunny, south-facing side of a mountain or mountain valley) and at lower altitudes, as facies of Corsican laricio pine forests (EC 2007).

- In the Aegean islands, *Pinus pallasiana* occurs in mixed stands with *Pinus brutia* at higher areas of the broad *Pinus brutia* belt of Thasos, up to about 400 to 500 metres (*Aegean pine forests of Thasos* - subtype of the 9540 habitat) (EC 2007).

91R0 Dinaric dolomite Scots pine forests (*Genisto januensis-Pinetum*)

The 91R0 habitat consists of *Pinus sylvestris* woods of dolomitic soils of the Dinarides. These forests often occupy somewhat higher elevations than the similar dolomite *Pinus nigra* woods of the subtype *Western Balkanic* Pinus nigra *forests* (EC 2007).

Ecological services and benefits of the habitat

Carbon storage

CO_2 emissions increased from a pre-industrial concentration of ca 280 ppm to 368 ppm in the year 2000 (Keeling and Whorf 1994). Predictions of future climate change as a consequence of increasing atmospheric carbon dioxide vary widely. Forest ecosystems are capable of storing large quantities of carbon in living biomass, necromass, soil organic matter. Remarkable variations among carbon accumulates do occur, while little information on carbon stored by Mediterranean formations is available (Costa and La Mantia 2005). Two recent studies carried out on the Sila massif, one of the most important areas for Calabrian pine *(laricio)* forests, show that this kind of forest acts as a carbon sink virtually all-year round. The carbon stored in the ecosystem ranges from 1,130 g C m^{-2} to 1,230 g C m^{-2} (Marino *et al.* 2005) and that stored in dead wood is of 3.3 Mg C ha^{-1} (La Fauci *et al.* 2006).

Protection against erosion

Black pine forests play a protective role against erosion and torrential floods as demonstrated by a multi-annual project financed by the Croatian Ministry for Science, Education and Sport. They reduce soil erosion due to rain flow by a factor of up to 107 in comparison with bare terrain (Topić *et al.* 2001, Topić *et al.* 2005).

In the Tarvisio state reserve (Italy), the black pine forests are classified as “protective forest against soil erosion” and managed with this aim (Perlicher pers. comm.).

Recreation

They are used for various recreational activities such as hiking (Promoth 2007).

Trends

During the Tertiary Era, oro-Mediterranean pinewoods constituted a well defined and large vegetation belt, localised along warm and dry mountainsides. The most important regression occurred during the postglacial age, when the beech woods expanded and the pinewoods migrated to mountain ridges all around the Mediterranean basin (Minelli 2007).

Since Roman times, the black pines forests in Austria and Slovenia have been conserved and maintained for resin harvesting. During the first half of 20th century, harversting was systematic, with each worker making about 1,000 incisions per year and producing up to 1,200 kg/y of resin. After petroleum by-products became widespread from the 1950s and 1960s, resin production ceased, and the forests were subject to both natural and artificial transformations (Ellmauer 2005, Zorman 2003).

In France, where two subtypes of (sub)-Mediterranean pine forests with endemic black pines occur, there are two different trends: *Pinus salzmannii* forests are receding fast due to fires and hybridisation with black pines of unknown origin, while the spread of Corsican pine *(laricio)* forest was propitiated by ancient forestry practices such as the Genoese exploitation of oak trees and fir woods and, since 1768 (Corsica annexed to the French Republic), important economic interests have given Corsican pine *(laricio)* trees a boost in relation to other species. The expansion of Corsican forests is also due to re-colonisation of abandoned pasture land (Bensettiti *et al.* 2001).

Throughout the Mediterranean region, black pinewoods were managed for production purposes, particularly timber (Van Haverbeke 1990). In Spain, forest management has been practised in a more or less generalized, systematic manner since the end of the 19th century. As interpreted through changes in stock (the quantity of forest biomass, basically wood, accumulated in forests) and forest potential (an *a priori* estimate of how much wood ought to (or could) be removed annually), over the last century, management of these forests has yielded very positive results. This is especially true where forestry has been more intensive, such as the "Los Palancares y Agregados" forest in Cuenca. Over the last 100 years it has been felled to achieve uniform thinning in a cycle of 120 years and regeneration period of 20 years. Incomplete natural regeneration has been assisted by means of small scarification, and movements of earth have facilitated the establishment and subsequent development of the regenerated material (Montero and Cañellas 1999).

Threats

Forestry management incompatible with nature conservation

Pine forest structure was affected by timber exploitation in the 19th century in that either its structure was simplified or regular and semi-regular structures dominated by one age class or irregular structures with no old specimens were created. In some cases this type of forest management led to soil degradation and encouraged the appearance in the undergrowth of more heliophilous scrubs and grasses. In other cases, short turns of cuttings – taking into account species longevity – resulted in forest fragmentation (MMAMRM in prep.). Forest fragmentation and, in particular, isolation of the clusters prevents the necessary genetic interchange between different populations as the propagules do not spread and the species colonization processes characteristic of these forests that might allow natural recovery of the relict formations do not come into play. One example of this isolation is the reduced genetic diversity of the relict population of the Betic Range (Spain) in comparison with other populations of this species (Climent *et al.* 2006).

Unsuitable forestry management, including unsustainable cutting and total removal of dead trees, results in the decrease of biodiversity, risking the rarefaction of fauna and flora that is important in conservation terms (Bensettiti *et al.* 2001), while the abandonment of forestry practices can lead to an increase in biomass and the attendant increased risk of fire (Generalitat Valenciana 2007).

Pinus nigra plays an important role in soil development on substrates that are difficult for plants to colonize, as in the case of dolomites. Under the environmental conditions in which these forests grow, soil processes are very slow. The presence of good soil conditions is crucial to ensuring sound forest regeneration and development. Some forestry treatments, such as clear cutting in steep slopes, can result in the loss or degradation of forest land, leading to regressive sequential stages and significantly reducing the pines’ potential` for growth and their regeneration capacity (MMAMRM in prep.).

Invasive alien species

Pinewoods in Spain are being invaded by two exotic species: Chinese *Ailanthus altissima* (tree of heaven) and the North American *Robinia pseudoacacia* (black locust) (Generalitat Valenciana 2007).

Pests

Harmful insects include *Rhyacionia buoliana* (European black pine shoot moth), *Sphaeropsis sapinea* (tip blight) and *Dothistroma septospora* (a needle blight known as the ‘red band disease’) (Isajev *et al.* 2004). But the pine processionary caterpillars of the genus *Thaumetopoea*, in particular *T. pityocampa* and *T. wilkinsonii*, are the most important insect pests of pine forest in the European Mediterranean countries. Defoliation caused by these insects weakens and reduces the growth of pines, and the hairs of the larvae can cause severe irritation to humans and animals (UNDP 2007). Outbreaks pose a considerable threat to young trees, which may be completely defoliated. For trees weakened by defoliation, death may be direct or more often indirect, following a secondary infestation by bark beetles. The damage is extremely serious (Ciesta and Gulensoy 2003). As an example, *Thaumetopea* spp. has affected about 16% of the pine forest in Albania, and in 1994 this pest spread to about 70.000 ha, with intensities of attack ranging from 5 to 95% (Dida *et al.* 2002).

Overgrazing

This poses a threat particularly in Corsica. Although grazing, especially by pigs, does not impact directly on the regeneration of *Pinus nigra* plants, it does have a serious impact on grasses and other species typical of the habitat (Bensettiti *et al.* 2001), such as *Juniperus* spp. (ONF 2005). In addition, in some areas in Spain there is a high pressure of ungulates, which could jeopardize the regeneration (Del Río pers. comm.).

Illegal fires

The Mediterranean region is particularly prone to illegal fires. Each year more than 50,000 fires burn an average of 600,000 and 800,000 hectares, which account for 1.3-1.7% of the entire surface area of Mediterranean forest (Petrella *et al.* 2005). *Pinus nigra* disperses its seeds in winter, but they remain viable only for a short period of time. Thus, the recruitment of this species depends on year-to-year seed production. During large fires, all seedlings and saplings are burned and tree survival is usually very low (Ordóñez 2004). In France, catastrophic fires lead to the destruction of half the surface area of *Pinus nigra* forests (Bensettiti *et al.* 2001) and in Catalonia (Spain) about 30% was destroyed between 1994 and 1998 (Ordóñez 2004). Moreover, when these forests are mixed with *P. pinaster* (maritime pine), the latter tends to replace *P. nigra,* which takes longer to regenerate after a fire (Bensettiti *et al.* 2001, MMAMRM in prep.).

Genetic pollution

Intraspecific hybridisation can easily occur among all black pine subspecies. Extensive plantations were made across Europe over the last two hundred years with material from unknown and/or very distant sources for which no historical traces exist. This has probably resulted in extensive mixing of local and imported gene pools all over the pine's distribution area (Isajev *et al.* 2004, Generalitat Valenciana 2007, Bensettiti *et al.* 2001).

Fragmentation and edge effect

Natural black pine forests must be large enough and their patches should be interconnected to maintain the species without suffering a long-term genetic loss. Fragmentation of *Pinus nigra* forests is particularly dramatic in the relict black pine populations in Spain (Sistema Central, Sistema Ibérico and the Betic mountains) where the forest structure is often lost and just some clumps of scattered trees with scant regeneration remain (MMAMRM in prep.).

Climate change effects

Climate changes compounded with the exodus from the countryside are likely to diminish Mediterranean forest cover, which would be replaced by fire-prone shrub communities. This could be aggravated by outbreaks of pathogens, fires and other large-scale disturbances (Resco de Dios *et al.* 2007). For instance, rising temperatures are encouraging the upward spread of *Thaumetopoea pityocampa* (Hódar *et al.* 2003). Its distribution area is rapidly changing in accordance with climate change because caterpillars develop during the winter and are sensitive to higher temperatures at that stage (Robinet 2007).

In a recent study in Greece, experts from the Aegean University used a forest gap dynamics model, developed and parameterised for the climatic conditions and forest species of the eastern part of the Mediterranean basin (GREFOS), to identify potential impacts of climate change on the structure of forest communities in the transition zone between Mediterranean and temperate climate. The results indicate that *Pinus nigra* forests tend to colonise areas at higher altitudes, disappearing from the lower ones only when fire frequency increases. At 900 m altitude the normal successional pathway is from *P. nigra* to *Quercus frainetto* (Italian oak) vegetation, and no significant change in the abundance and dynamics of these two species is forecast due to climate change without an increase in fire frequency, as both species are quite drought-tolerant. But when climatic change is followed by an increase in fire frequency, *Q. frainetto* seems to perform better as a result of its resprouting ability and greater heat requirements. At 1,300 m altitude, the number of *P. nigra*, normally replaced by *Abies borisii-regis* (Bulgarian fir) rises due to climate changes, in particular when there is also an increase in fires (Fyllas and Troumbis 2005).

2. Conservation management

General recommendations

The management of the Mediterranean forests should aim at the improvement of the ecosystem functions through the conservation of biological and of functional diversity (de Dios 2006). The high variability of the (sub)-Mediterranean pine forests with endemic black pines and the diverse ecological conditions in which it occurs determine differences in productivity and regeneration capacity that should be taken into account in their management. Also species richness is an important parameter to be considered (Alejano and Martínez 2003).

The black pine forests often occur on steep slopes and/or on shallow soil, where only moderate interventions are suggested in order to avoid soil erosion (de Dios 2006) or, as in the case of the Tarvisio forest (Italy), where no interventions are admitted because this habitat represents a permanent plant community (paraclimax), which the environmental conditions (instable soil, climate, etc.) do not allow the evolution to the successive stadium (Perlicher pers. comm.).

Pinus nigra is dominant in these forests. Therefore, the following characteristics of the species should be taken into account when planning interventions because of the potential to jeopardize successful outcomes.

- *Pinus nigra* is adapted to many soil types and topographic conditions. It is a long-lived species, with medium to fast growth. Pines mature at about 80 years old, commonly developing a flat, round, or spreading crown (Van Haverbeke 1990).
- *Pinus nigra* seed viability is very short on the ground. In addition, seed predators further decrease its low survival capacity. In winter, at the beginning of dispersal period, rodents are the main seed predators, while in spring it is ants (Ordóñez 2004). Moreover, pine seedlings up to about 2 months of age are subject to predation by rodents, while older seedlings apparently become unpalatable (Van Haverbeke 1990). This high predation rate makes the probability of *P. nigra* seeds germinating in autumn almost zero (Ordóñez 2004).
- In certain conditions, such as after a fire, few seedlings become established in natural conditions and over a wide range of degrees of cover. In general, the behaviour of young *P. nigra* plants is more similar to that of shade-tolerant species, such as oaks, than to low-altitude Mediterranean pines, because the establishment of *P. nigra* seedlings is improved under high cover conditions. As these conditions are usually lacking in recently burnt areas, regeneration of this species is strongly limited after fire (Franco *et al.* 2004). On the contrary, older saplings of European black pine are intolerant to shade and require full sunlight (Vogel 1981).

Finally, the management of these forests should take into consideration the presence and density of accompanying species, and should be aimed at improving their coexistence with *P. nigra*, in order to increase the ecosystem stability (de Dios 2006).

Active management

Silviculture

Some black pine forests are or were managed for timber production, which usually results in quite homogeneous stands in terms of age and size of the trees. Some of these exploited forests are very far from the typical structure of a mature forest. Considering that *Pinus nigra* is a very long-lived species which can attain over thousand years, with individuals of up to 2 m diameter and over 30 m height, current stands are usually well below their natural longevity, being managed with a rotation age that does not exceed 150 years, where no large trees can be normally found. It is recommended to find a balance between production objectives and conservation needs and try to reach in some areas a similar status to that found in non-intervened forests, whose dynamics depends mainly on natural perturbations (MMAMRM in prep.).

Proper management of (sub)-Mediterranean pine forests with endemic black pines should try to maintain irregular structures with trees of different ages (MATT 2004), including very old specimens, in order to secure the kind of broad genetic variability that allows the forest to survive the various natural disturbances and environmental stresses of the continental sub-Mediterranean climate (MMAMRM in prep.). Good coverage of associated species should also be encouraged.

Suitable management should also promote a closed structure with a well developed canopy, which offer suitable microclimatic conditions (shade and humidity) for regeneration. It is also recommended to maintain a number of old trees as well as an appropriate amount of dead wood, which play an important role in the conservation of biodiversity (MMAMRM in prep.).

Some particular recommendations that may be applied under certain conditions are presented below.

Fostering regeneration. In general regeneration of forests composed by long-lived species can be reached with clear cuttings, which mimic the natural disturbances to the ecosystem (e.g. fires) (Università di Udine 2002, de Dios 2006).

In the state forests of Cyprus, for instance, the Ministry of Agriculture, Natural Resources and Environment encourages the natural regeneration of uneven-aged stands by the repeated removal at relatively short intervals (felling cycle of 10-15 years) of the oldest and largest *P. nigra* subsp. *pallasiana* trees, either as single, scattered individuals or in small groups, with the aim of preserving the naturalness of the forest. Rules for marking the plants of *P. nigra* to be removed have been created. When no natural regeneration occurs in the stand within an acceptable time frame or when regeneration is unsatisfactory, creating poor and under-stocked stands, planting and direct seeding are carried out to hasten natural regeneration (Forest Department 2006).

In Corsica, to favour regeneration by seeds for *Pinus nigra* subsp. *laricio* var. *Corsicana*, when forest productivity is higher than 5-6 m^3/ha per year and the forest has accesses (tracks or cable), cuttings can be applied on trees 150 - 200 years old and rather large (70 cm on average in the best stations, 55 cm in the worst). When productivity is low, cuttings with an interval of 30-40 years can be made to encourage natural regeneration of *P. nigra*. This technique is the best option to manage small homogeneous areas (Bensettiti *et al.* 2001).

According to the results of the LIFE Nature project 03NAT/E/000059 "Habitats management in the Noroeste region, Murcia (Spain)", clearing of competitive species (mainly *Pinus halepensis*) and pruning of trees can favour the regeneration of the *P. nigra* subsp. *salzmannii* forest. When natural regeneration continues to be poor, *P. nigra* can be planted after clearing of suitable areas, preparing holes and installing protective devices. Planting of black pines can be carried out with a density of 900-1,200 plants/ha. Accompanying species should also be planted in order to increase biodiversity (Murcia Region 2007).

In Italy, the National Forestry Corp manages a seed bank of Italian autochthonous trees, among which the different subspecies of *P. nigra* and *P. laricio* are included. The seeds, of known origin, are used for the production of saplings utilised for planting programs (Verta pers. comm.).

Promoting an irregular structure. In public properties of southern Italy, strip and patch clear cuttings were applied in the past in order to obtain stands with an even-aged structure over vast areas. In private properties, instead, Calabrian pine stands have a complex structure that is the result of a particular form of selection cutting based on traditional local knowledge. Cuts of marked trees are repeated approximately every 20 years on the same section of the forest. Results show that stand structure consists of very small clusters (60-100 m^2) of trees in four distinct age classes which are the result of the natural regeneration occurring in the gaps opened by the periodic removal of the biggest trees in the stand. The volume of harvested trees is slightly less than the volume increment for the average cutting cycle (Ciancio *et al*. 2006).

(Sub)-Mediterranean pine forests with endemic black pines in good conditions have around 10-20% coverage of associated species. To conserve some of these species, e.g. fir trees, which live less than *Pinus nigra*, the following forestry technique has proven reliable: each turn of cutting pine should be matched by two turns of the other species until they are deemed to be regenerating (Bensettiti *et al.* 2001).

Fostering the presence of old trees. Selective cuttings and the prolongation of the utilization cycles can be used to favor the creation of multi-stratified structures and to increase the number of old and large trees (La Fauci *et al*. 2006).

The Giganti della Sila and the Gallopane biogenetic state reserves (Italy) have the specific objective of conserving black pine forests and veteran trees of *Pinus laricio* subsp. *calabrica*. The reserves include uneven-aged high forests with individuals up to 200-250 years old and 50 veteran trees (six of which left on the ground as dead wood). The latter are over 350 years old, have diameters (at 1.30 m height) between 71 and 187 cm, height between 35 and 43 m, with a volume of wood of 30-62 m^3. The forests are left to natural evolution as the local conditions favour the permanence of *P. laricio*, which ages and regenerates abundantly without human interventions (Verta pers. comm.).

Encouraging the presence of dead wood. The importance of maintaining a certain volume of dead wood to ensure conservation of forest biodiversity and functionality has already been recognized at international level and in particular in the European Union forest policy. Up to a third of European forest species depend on the presence of dead wood (Dudley and Vallauri 2004). According to Ammer (1991) and Vallauri *et al.* (2003), the terms of reference for the amount of dead wood in pine forests in Germany and France range from 5-10 to 15 m^3/ha. It includes both standing dead trees and coarse woody debris. It is usually sufficient to leave decaying trees to natural evolution, but in certain cases it might be necessary to increase the volume of dead and decaying wood. The techniques that can be used differ greatly one from another (for an overview, consult Cavalli and Mason 2003).

Managing alien species. The introduction of alien species should be avoided. Where they have already colonised forest land, plants should be removed gradually or be used to create dead wood (Cavalli and Mason 2003).

Maintaining relict areas. Within the relict populations of *Pinus nigra* in Spain (Gredos, Guadarrama, Tejeda and Almijara), some active measures have been proposed in order to promote regeneration, genetic exchange among different populations and local ecotypes maintenance (MMAMRM in prep.). In a similar case in the Tarvisio forest in Italy, about 27 ha of black pine forest is integrally protected and left to natural evolution, as the local conditions favor the permanence of the *P. nigra*, which constitutes a paraclimax community (Perlicher pers. comm.)

Pest control

Control of infestations by *Thaumetopoea pityocampa* and *T. wilkinsonii* can be carried out through direct and indirect measures.

Direct control measures used to deal with extensive infestation in recent years include aerial and ground spray treatments using biological and chemical controls, and the mechanical collection and destruction of larval nests (used only in limited areas), the last one being in winter (Regione Emilia-Romagna 2006). For instance, the Cypriot forestry authorities have active programmes to control outbreaks. The current approach is a biological control method through the aerial application of *Bacillus thuringiensis* (MOA 2007), which produces toxins specific to Lepidoptera. Thousands of hectares of forest are sprayed each year in the EU. The treatment has to be carried out at the end of summer. Applications in autumn or winter usually produce no measurable impacts (Promoth 2007). Doses of 100-150 g of product in 100 litres of water yielded good results with the caterpillars of first and second age. Higher doses (up to 300-350 g/hl of water) are necessary for older caterpillars. The product should be administered during the evening (Regione Emilia-Romagna 2006).

Traps using sexual pheromones to capture adult males represent another measure of biological control. The traps should be placed in a medium-high position on the south-western side of the plants, every 100 m along the perimeter and the access roads to the wood. The traps should be installed before they emerge from the cocoons, starting from mid-June (Regione Emilia-Romagna 2006).

Indirect control methods aim to strengthen trees so they can stand a higher degree of infestation - these include practices such as thinning, cleaning, pruning and weeding, plus the use of pine tree species resistant to caterpillar attack (UNDP 2007).

Monitoring programmes should accompany the control measures in order to evaluate the effectiveness of the measures used and eventually to re-balance the interventions to be carried out in the following years (MATT 2004).

An outbreak of pine processionary caterpillar has been underway in Cyprus for several years. Systematic monitoring is carried out using pheromone traps and counting the number of males caught to reveal patterns of adult appearance, flight period and an indication of adult population level. This is complemented by field observations and sampling (MOA 2007).

"Control of the pine processionary caterpillar threat to forest lands" (extract from UNDP 2007)

Thaumetopoea wilkinsonii is the major defoliator of pine trees in Cyprus. A project, supported by the Bi-communal Development Programme of the United Nations, aimed to develop a more effective integrated pest management programme for this harmful insect. It focused on population monitoring including identification of areas requiring treatment based on counts of egg masses and larval colonies, post-treatment assessments based on counts of surviving larval colonies and aerial and ground surveys designed to estimate the surface and severity of defoliation. It also analysed current practices and alternative prevention techniques, and made recommendations for changes to forest policy. It focused on procurement of equipment for future efforts and on training activities including integrated pest management, health and safety training and arranging of a conference on the pine processionary caterpillar. A study of egg masses and larval colonies was conducted atsample plantations where tree height was less than 2 metres between October and December 2002. In March the following year, a survey was carried out to assess the intensity of foliage damage in each of the 30 sample plantations and to determine the relationship between egg masses and subsequent damage. The prediction/decision support model developed as a result of this work can be used to identify young pine plantations in need of direct control of pine processionary caterpillar infestations.

Rational grazing

Extensive and controlled grazing activity should be carried out inside pine forests in order to balance its positive (fire prevention) and negative effects (disappearance of species associated with the habitat and loss of regeneration). The sustainable grazing load should be calculated for each area, a grazing plan drafted and agreements signed with breeders in order to guarantee sound implementation of the plan (ONF 2005)

Habitat restoration

Practices in extensive reforestation programmes involving *P. nigra* may differ widely in terms of their ultimate success, economic cost and undesired ecological impact. A recent study has analysed different types of vegetation clearing (mechanical, controlled burning or grazing), soil preparation (ripping or planting holes) and reforestation methods (broadcast seeding, spot seeding and planting) to restore *P. nigra* forests. These practices have been compared in terms of seedling establishment, economic costs and ecological impact. Seedling establishment after sowing, was very poor and not influenced by vegetation clearance. In plantations, seedling survival was higher for ripper treatment than for planting holes, in all vegetation clearance treatments, except the control. However, the higher economic cost of the hole-planting treatment and the negative impact of mechanical clearing and burning on small mammals equalised the effect of the two techniques. The best option was planting in uncleared or lightly grazed areas, with soil prepared by ripping (Espelta *et al.* 2003).

Mechanical cultivation can be applied on deep, fertile soils where there is a suitable slope gradient. Native trees of sound provenance and grown within polyurethane containers are usually used. On steeper slopes, terracing, mini *gratoni* and pit planting are also applied. In shallow soils, seeding is inevitable (Department of Forest 2006).

Within the LIFE project 03NAT/E/000059 "Habitats management in the Noroeste region, Murcia (Spain)" a *Pinus nigra* ecological restoration on 403.48 ha was carried out during 2007 through some key actions:

1) clearing of competitive species (mainly *Pinus halepensis*) and pruning of trees on 197 ha and
2) seeds collection and planting to increase *Pinus nigra* density (on about 27 ha).

The remaining surface of black pine forest interested by the project was left untouched (Murcia Region 2007).

Other relevant measures

Fire prevention

The adoption of an integrated approach to forest fire management is crucial, and starts with landscape and forestry planning (EEA 2006a, MATT 2004), including accompanying measures such as auxiliary areas to break up the horizontal continuity of the vegetation in strategic zones, public awareness to prevent accidental fires and strict regulations regarding risk activities such as recreational use or the use of forest tracks by motor vehicles, etc. (MMAMRM in prep.). It is far less expensive to prevent fire than to extinguish it (Ioannou and Papageorgiou 2007).

Surveillance. It should be carried out using observation points that cover large areas so as to minimize the costs. They should focus on the most sensitive areas and where fire risk is greatest. Satellite-based systems permit early warning of fire ignition over large areas, but systems based on surveys from planes are more common to cover specific areas in critical periods.

Forestry practices. To increase forest resilience against fires, it is advisable to create appropriate microclimatic conditions and vertical separation between tree foliage and the lower layers, as well as to carry out management measures that accelerate the succession processes, decrease the presence of pyrophitic species (fire loving), and reduce colonisation time by formations containing much heliophilous (which need full sunlight) scrub (MMAMRM in prep.). Moderate interventions of removing dead branches, removal of the excess of combustible material, cutting of pyrophitic species and felling of trees are recommended (de Dios 2006).

During large-scale fires, *Pinus nigra* survival is usually very low. Cone production is higher and more frequent in large trees and also in "green islands" of vegetation, particularly the small ones. Their higher survival and higher and regular seed production rates make them the main post-fire seed sources. Therefore, to improve the post-fire regeneration of this species, it is important to keep the largest trees and the "green islands" as possible seed dispersal sources (Ordóñez 2004, Ordóñez 2005).

Preventing genetic pollution

The prime principle in reducing the risk of genetic pollution is to avoid planting black pines of unknown origin in the vicinity of native pinewoods, as intraspecific hybridisation is easy among different subspecies of black pines. This is particularly true for localized and fragmented subspecies, such as *P. nigra laricio*, and for subspecies that are particularly threatened, such as *P. nigra salzmanii* in France (Isajev *et al.* 2004).

Reduction of genetic pollution should be addressed as follows (Bensettiti *et al.* 2001):

- progressively eliminate all introduced black pines
- decide on native plants from which to obtain the propagation material
- use this material to reconstitute habitat

The effects of creating gaps inside artificial stands of pine forest in order to encourage renaturalisation through colonisation by native species have been studied by Gugliotta *et al.* (2006), in the Southern Apennines. *Pinus nigra* seedling establishment was studied in small (380 m^2), medium (855 m^2) and large (1,520 m^2) gaps created in artificial Calabrian pine (*Pinus laricio*) stands (mean height 22 m). After three growing seasons, the initial results highlight that:

a) Calabrian pine seedling density was higher in large gaps than in medium and small ones; silver fir seedlings appear after the second growing season in small and medium gaps; and
b) seedling mortality of Calabrian pine was relevant in small and medium gaps.

According to this study, it appears that the creation of small and medium gaps can encourage renaturalisation of artificial pine stands.

Monitoring

Monitoring programmes are particularly important to assess the conditions, conservation status and effects of activities or interventions carried out on pine forests.

The main attributes to be monitored are:
- Habitat extent
- Vegetation structure: cover of characteristic and associated species, including bryophytes and lichens
- Vegetation composition: frequency of characteristic and associated species
- Presence and amount of dead wood

The collection and demarcation of habitat type can take place in the context of a site inspection on a scale of 1:10,000. As the basis for mapping, the use of aerial photographs taken no more than 5 years previously is recommended. Dissolution accuracy should be at least 0.1 ha (Ellmauer 2005). Habitat monitoring can be carried out using the Braun-Blanquet phytosociological methods in sampling areas of 400 m^2 (AN.KA 2003).

Table 2. Monitoring parameters, processes and methods. Extracted from Pallas's pine forest management plan for Elatakos at the Natura 2000 site of Lake Tavropos (AN.KA 2003)

Parameter	Process - Method	Frequency	Analysis, evaluation and presentation of elements and information
Climate • Temperature • Precipitations	Min - Max	Monthly	Tables and ombrothermic diagrams
Ground • General Description • Natural attributes • Chemical attributes	Weight, Humidity, Structure Determination C, N, P and pH	Annually	Tables
Vegetation • Trees • Bushy • Grass • Mushrooms	Complete recording (Braun Blanquet) and photographing Taxonomic	April - May and July - August September - November and May - June	Comparative presentation, tables, Photographs
Fauna • Vertebrates • Invertebrates	Complete recording	Annually	Tables taxonomic
Damage • Biotic • Abiotic	Complete recording	Annually	Evaluation of size of damage
Total evaluation of Ecosystem Estimate of Dynamics	Recording, Estimate of succession	Annually	Presentation of characteristic parameters that is changed

Creation of reserves networks

Several sub-Mediterranean pine forests with endemic black pines are protected within nature reserves and are not subject to exploitation in the EU. The genetic diversity of *Pinus nigra* and the size, location and connectivity between the sites to protect should be considered when creating reserves for this habitat type with the aim of setting up a functional network. Also some active management measures can improve the status of these protected forests, e.g. fostering regeneration.

The creation of a reserves network of mature forests with no human intervention within the *Pinus nigra* distribution has been proposed in Spain. The sites should have a minimum surface of 100 ha, being preferable a few number of large areas than many little clumps. Moreover, ecological connectivity between the sites must be maintained (MMAMRM in prep.).

In Southern Italy, the National Forestry Corp manages several black pine forests reserves where access is possible through the payment of a ticket (with a symbolic price) only for guided tours (Verta pers. comm.).

Special requirements driven by relevant species

Sitta whiteheadi and bats

Sitta whiteheadi habitat mainly consists of old stands of Corsican pine with abundant dead and rotting trunks for nest sites. Also, several bat species use the same habitat. Therefore, forest management should encompass protection of standing dead trees and "habitat trees" consisting of old *Pinus nigra* sp. *laricio* trees left to grow naturally. According to the results of LIFE Nature Project LIFE00 NAT/F/007273 "For conservatory management of the *laricio* pine habitats", 1-2 decaying trees per hectare represent a suitable ecological niche both for *Sitta whiteheadi* and for bats (ONF 2005).

Aegypius monachus

The preservation of old, mature trees is essential for the survival of the cinereous vulture and should be incorporated into management plans (Erdogdu *et al.* 2003). In particular, the requirements of the raptor should be taken into consideration in planning the period of the year during which the silvicultural interventions are carried out, as human disturbance can compromise the breeding success of (Heredia *et al.* 1996).

According to Katsadorakis *et al*. (1993) the following measures are recommended to conserve suitable forests for the breeding of the cinereous vulture in the Evros Prefecture (Greece), which includes the black pine forest of Dadia, where the only reproducing colony in Greece and the Balkan States lives:

1. Definition of areas with particular ecological value for nesting, in which strict protection measures should be enforced.
2. Management for the creation of uneven-aged forest areas while preserving mature stands at all times.
3. Special management of evergreen broad-leaved stands with large isolated pine trees: these trees must be safeguarded as nest-sites.

Cost estimates and potential sources of EU financing

Maintaining dead wood. The service provided through promoting decaying wood in France was calculated for mature trees maintained for at least 30 extra years. Immobilizing the asset has a cost based on the market value of the tree and the set-aside of the land. Taking into consideration an updating rate and a certain number of trees per hectare, a complex mathematical formula was established to calculate the income foregone. Some parameters will depend on location, but averages of €75 for an oak and €89 for a beech were calculated (Thauront *et al.* 2003). Incentive aids are also foreseen in Wallonnia for private foresters and the measures favouring biodiversity are mandatory in public forests (Branquart 2005). In Nordrhein-Westfalen, compensation payments for economic losses are planned with regard to maintenance of well-defined levels of decaying trees and deadwood (EC 2003).

Habitat restoration. Within the LIFE project 03NAT/E/000059 "Habitats management in the Noroeste region, Murcia (Spain)" the cost of clearing of competitive *Pinus* species, pruning of trees on 197 ha and planting of *Pinus nigra* on about 27.28 ha was of €597,170.56 (Murcia Region 2007).

Relations with potential sources of EU funds

The cost issue has to be seen in the light of Article 17 of the Charter of Fundamental Rights of the European Union, which sets the principle of compensation for income foregone, as well as rules concerning concurrency.

Management measures for Natura 2000 were defined in the annexes of the Communication from the Commission on Financing Natura 2000 (COM 2004-0431 and its working documents). Four categories were defined with several types of activities for each of them. The first two concern the establishment of the Natura 2000 network and management planning, administration and maintenance of network-related infrastructure. They will not be considered within these guidelines. The latter two are more appropriate to this exercise with a focus on active management. The monitoring items and the action focusing on facilities to encourage visitor access or the action relating to land purchase are not of concern here. This means that only conservation management measures, management schemes and agreements, provisions of services and infrastructure costs will be considered.

Concerning potential sources of EU financing, a Guidance Handbook (Torkler 2007) presents the EU funding options for Natura 2000 sites for the period 2007-2013, which are, in principle, available at national and regional levels. Furthermore, an IT tool is available on the EC web site (http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm).

For the period 2007-2013, several EU funds are available (EARDF, EFF, ERDF, and Cohesion Fund), which are implemented in accordance with national/regional programmes based on EU and national strategic guidelines. Furthermore, several project funds, whether interconnected or not with Structural Funds, can be used as Interreg, LIFE+, the 7th Research Framework Program (FP7) or Leader+. However, some types of actions are not allowed for certain financial schemes, e.g. within LIFE+ recurring management is not eligible. Each Member State has identified the issues that are of most concern locally, and has prioritized EU funds in order to address these issues. The integrated use of these resources will allow financing various management actions for areas with habitats listed in the Habitats Directive and included in the Natura 2000 network.

Among the diversity of sources for EU funding, the following funds might primarily be of interest for the management models on (sub)-Mediterranean pine forests with endemic black pines:

- The European Regional Development Fund (ERDF) and the Cohesion Fund. These funds might be relevant in single cases although activities related to Natura 2000 sites mostly need to be integrated into a broader development context. However, the Interreg approach is more flexible, but needs a European objective and partnership. Different geographical levels were defined, and all of them have their specific rules, eligibility criteria and objectives.

- The Financial Instrument for the Environment (LIFE+). The 'Nature' component of LIFE+ supports best practice and demonstration projects contributing to the implementation of the Birds and Habitats Directives, but only exceptionally outside Natura 2000 sites. The 'Biodiversity' component is for demonstration and innovation projects contributing to the objectives of the Commission Communication 'Halting the loss of biodiversity by 2010 – and beyond'. Both the 'Nature' and 'Biodiversity' components focus on non-recurring management actions (at least 25 % of the budget). Recurring management is not eligible under LIFE+. The "Information" component offers the possibility of financing actions aimed at training forestry personnel in fire prevention.

- The European Rural Development Fund (EARDF). This programme has potential to cover several management activities that might be relevant although the measures have to be covered in the National Strategy and Rural Development plans (RDPs) in order to be eligible on a national basis. Furthermore, Leader+ projects have to be analysed on a national basis. EARDF (Council Regulation N° 1698/2005) foresees financial schemes for forests and wooded areas owned by private owners or by their associations or by municipalities or their associations. These schemes are mentioned in Article 46 (Natura 2000 payments to compensate restrictions on the use of forests) and Article 47 (forest-environment payments for voluntary commitments going beyond the relevant mandatory requirements). Both of them cover additional costs and income foregone as a result of the commitment made. So far the success rate of these measures within rural development appears to be quite low.

Furthermore, support for non-productive investments is dealt with by Article 49 for all kinds of forests when investments are linked to:

- achieving commitments undertaken pursuant to the forest-environment payments (Article 47)
- achieving commitments undertaken pursuant to other environmental objectives (including Natura 2000)
- enhancing the public amenity value of the forest concerned

Furthermore, support for non-productive investments is foreseen under Article 49 for all kinds of forest when the investments are linked:

- to the achievement of commitments undertaken pursuant to the forest-environment payments (Article 47)
- to the fulfilment of commitments undertaken pursuant to other environmental objectives (including Natura 2000)
- to enhance the public amenity value of forest

The second abovementioned item was used in France to co-finance the forest Natura 2000 agreements. Furthermore, all forests are eligible for this scheme. Thanks to the high resilience of forest habitats, irregular one-off non-productive investments can be used to improve the conservation status of the habitat.

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