

The mixed forests of Greece

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Abstract

Greece is a mountainous Mediterranean country characterised by a variety of microenvironments. As a result, a great number of mixed forest types appear.

These stands are natural by unevenaged stands with a lot of ecological and social advantages (as resistance against biotic and abiotic factors) high biodiversity and aesthetical beauty.

For this reason, these forests must be protected and managed in a sustainable way, in order to fulfil their valuable services.

This paper is dealing with the most important and representative mixed-species stands of Greece beginning from those existing in the lower elevations (zone of evergreen broadleaves) and continuing to the higher ones (zone of boreal conifers).

Keywords: *Natural forests, Unevenaged stands, Mixed stands.*

1. Introduction

Greece is a mountainous Mediterranean country characterised by a variety of climates, bedrocks, soil types, topographic characteristics and microenvironments. As a result, a great number of natural forest types appear, as well as, a mixture of different forest species, conifers and broadleaves (Zagas 1990, Tsitsoni 1991, Ganatsas 1993, Zagas et al.1999).

Although mixed-species stands are common, there is no universally accepted definition of "mixed forest". Usually, the mixed stand is defined as a stand of trees with two or three species comprising the usable volume.

The proportion of the stand composed of the minor species, varies from country to country. For instance, in Sweden and Norway the composition limit for the minor species is 30% of the basal area. In Central Europe the limit is usually 10% of either basal area or volume (Burkhardt and Tham 1992).

In Greece, we accept the limit of Central Europe and additionally the minor species must influence the ecological conditions of the stand (Dafis 1989).

Since the late of the 18th century, silviculturists started to characterise the species composition of the forest stands (Thomasius 1973). After the middle of the 19th century a reaction against man - made monocultures and a move back to natural mixed forest took place in Central Europe (Heyer 1854, Burkhardt and Tham 1992).

The natural mixed-species forest with unevenaged stands is the most desirable from protective and ecological point of view (Hatzistathis and Ispikoudis 1995). This forest is very resistant to biological pests and damages from wind and snow, but the resistance against fire and frost depends on the characteristics of the individual trees or stands and the particular site of the conditions involved (Smith 1986).

The mixed-species stands are the most attractive from aesthetical point of view, the most stable and functional from ecological point of view and the richest from the point of biodiversity.

For Greece the mixed forests consist of a great capital, which is the most valuable heritage for the future generations.

For this reason these forests must be protected and managed in a sustainable way, in order to fulfil their valuable services.

So we will present the most important and representative forest mixed stands of Greece beginning from those existing in the lower elevations (zone of evergreen broadleaves) and continuing to the higher ones (zone of boreal conifers).

2. Mixed stands of evergreen broadleaves zone (*Quercetalia ilicis*)

- Shrubberies and stands of evergreen broadleaves

These stands consist of the species *Quercus ilex*, *Q. coccifera*, *Arbutus unedo*, *A. adrachne* etc. They are stands with great richness of species, fauna and flora, and consequently with great ecological stability but with a relatively low productivity.

Today we must give up the production of wood and its products. We have to appreciate the ecological and aesthetic value of these stands as well as their protective, hydrological and generally social role.

The wildfires, the clearings and the overgrazing threaten the forests. The measures of protection consist of the fire prevention, the stoppage of grazing and especially the protection of soil.

- Mixed stands of Aleppo pine and Aegean pine with evergreen broadleaves

P. halepensis, *P. brutia* and *Cupressus sempervirens* are three frugal conifers which can create stands in these extremely xerothermic environments (Tsitsoni and Karagiannakidou 2000). After continuous wildfires these tree species can be gradually replaced by the evergreen shrubs of the previous category. In the past, these stands had a particular financial interest due to their exploitation of the resin production. The resin collectors were handling appropriately the understorey and they protected these forests. After the abundance of the resin production, the accumulated biomass was increased and these stands are in danger of wildfires (Tsitsoni 1997). They are in need of the treatment of the understorey for the diminution of the wildfire dangers. In addition these stands are in danger by clearings and overgrazing especially after wildfires (Tsitsoni et al. 1997).

- Mixed stands of Aleppo pine-cypress and Aegean pine-cypress

Although *P.halepensis* and *P. brutia* normally create pure stands with or without understorey of evergreen broadleaves, they create mixed stands under special conditions with *Cupressus sempervirens* var. *pyramidalis* and *C. sempervirens* var. *horizontalis*.

These mixed stands present advantages against the pure ones, because they exploit the soil better, they are aesthetically impressive and more resistant against wildfires. These advantages are used in the artificial creation of stands especially of urban forests in which the social purpose comes first (Hatzistathis and Dafis 1989).

More impressive are the stands of the above species when they are mixed with *Olea oleaster* in its cultivated or wild form.

Two characteristic examples of these two categories are:

a) Mixed stands *P. brutia* - *C. sempervirens* at the White Mountain chain of Crete (Fig 1), where under the limited conditions of the environment, *C. sempervirens* tends to grow on bare rock, while *P. brutia* on soil and fine scree (Rackham 1992).

b) Mixed stands *P. halepensis* - *C. sempervirens* at the Ionian Islands where *C. sempervirens* comes first at the extremely poor soils and creates mixed-species stands with evergreen broadleaves and *Olea oleaster* and naturally with *P. halepensis*.

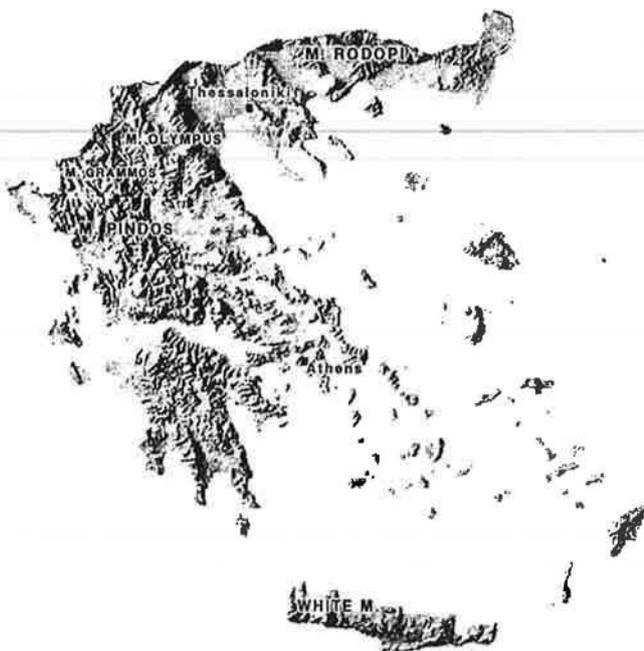


Figure 1. Geophysical map of Greece.

3. Mixed stands of the *Quercetalia pubescentis* zone

The oak stands in Greece cover an area of more than the 1/3 of its total surface. These stands are coppices and only a few stands are in the procedure of conversion to high forest. These woods have a long history of management: woodcutting, wood pasture and cutting for leaf fodder. They vastly vary in structure, often forming a mosaic with steppe, and displaying many different combinations of coppicing, browsing and pollarding. For the most part they are composed of oak with no other tree species except sometimes an understory of *Juniperus oxycedrus*, *Carpinus orientalis*, *Crataegus* sp. and rare individuals of *Sorbus torminalis* (Dafis 1966, Rackham 1992).

These woods are usually an intimate mixture of at least two or three species of oak from the thirteen existing in Greece. This kind of mixture should disquiet those ecologists who measure the diversity of vegetation by counting the number of species regardless of how diverse those species are (Rackham 1992).

In this zone of oak stands, sometimes mixed stands of various broadleaves are created having a special ecological interest.

These stands belong to the ecotope *Tilio-Acerion*, which appeared rarely and occupies a relatively small area. Also oak stands that are adjacent to conifer stands (Black pine, Scotch pine, fir) create mixed stands with these species.

The above types of mixed stands are below shortly discussed.

- Mixed stands of deciduous broadleaves (*Tilio-Acerion*)

These stands appear in small valleys with special favourable soil and water condition. They consist of many broadleaved species as *Tilia* sp., *Acer* sp., *Ostrya carpinifolia*, *Quercus* sp. etc. This type of stands appears in a restricted scale at Olympus Mountain and Pindos and Rhodopi Mountain chain. They have a special ecological interest because of their rareness and variety of species, which participate in these stands.

They are stands with great aesthetic value during the whole year but especially in autumn.

- Mixed stands of oak - Black pine

In cases where oak stands are adjacent to Black pine stands, we notice an appearance of Black pine in the oak stands which always starts from openings and eroded soils. This situation turns into action the theory about the conversion of coppice oak stands into standard forest types changing the forest species (Tsitsoni and Zagas 1994). For this reason these stands seem to be of a great practical and scientific interest.

Typical stands of this category are met at Olympus Mountain and Pindos and Rhodopi Mountain chain (Fig 1).

- Mixed stands of oak - Scotch pine

Scotch pine has the same behaviour as Black pine and it occupies every available space in the coppice oak stands as a pioneer species.

Characteristically in Rhodopi Scotch pine has settled very quickly in large areas of coppice oak stands. After clearcutting of the oak stands Scotch pine (which is conserved without damages) strengthens its position. This phenomenon has a particular ecological importance because it contributes significantly to the rehabilitation and conversion of coppice oak stands of the country.

- Mixed stands of oak - fir

Fir as a shade - tolerant species has the ability to regenerate easily under the canopy of oak. So, at mountainous oak stands and in areas where grazing is restricted or forbidden, they all have been transformed into two or three storied stands. This happened because fir established in large areas in the middlestorey and understorey.

Typical examples of the fir establishment into oak stands can be met at Olympus Mountain in stands of *Quercus dalechampi* and at Pindos mountain chain in stands of *Quercus cerris*. In the future it is up to qualified foresters to decide on the rate of both species in the stand, according to the ecological condition and the kind of forest management.

4. Mixed stands of the beech zone (Fagetalia)

The beech usually creates mixed stands with the fir but it can naturally and easily settle under the canopy of the pioneer stands of Black pine, Scotch pine and Norway spruce.

- Mixed stands of beech - fir

Beech and fir are two species with similar silvicultural and biological attributes. For this reason their natural mixture is easy and continuous. These species comprise valuable ecosystems from any aspect because they have a high biodiversity, high productivity, ecological stability and a great aesthetic value during the year.

We can meet stands of this category on Olympus Mountain, and Grammos Mountain on Pindos Mountain chain. They comprise biotopes of valuable species of our fauna.

- Mixed stands of beech - Black pine and Black pine - beech

These stands appear at the same area where both species create pure stands. Black pine, as a pioneer species, occupies areas where beech stands have been destroyed by illegal human activities. Today there are only remnants of such stands.

After the settlement of *P. nigra* the beech follows in a few years (nursing effect) and forms stands of Black pine - beech or Black pine - beech - fir. The rate of these species changes because of the dynamics of these stands. The beech takes over the role of secondary stand and can dominate on areas after the final felling of the Black pine. *P. nigra* will only dominate to extreme sites, shallow dry or very wet soils, where the beech has a reduced competitive ability. Stands of this category can be met at the Olympus Mountain, and Grammos Mountain on Pindos mountain chain. These stands at Pindos (Grammos Mountain) as well as the pure stands of beech comprise the important biotope of the brown bear.

- Mixed stands of beech - Scotch pine and Scotch pine - beech

Scotch pine has a similar behaviour as Black pine and is settled in the bare areas in Rhodopi Mountain chain.

In a few years beech appears as an understorey on best sites of Scotch pine, and tends to replace Scotch pine. In this case beech is for some time the secondary stand because people exploits the productivity of Scotch pine.

- Mixed stands of Norway spruce - beech or beech - Norway spruce

These stands occur at the Rhodopi area. They form mature ecosystems in relation to the previous ones and are closer to the "climax" stage. They are unevenaged stands with all kinds of mixture, depending on the site quality and the local conditions. They are characterised by a relatively high biodiversity.

- Mixed stands of Scotch pine - beech - Norway spruce

These stands also occur at Rhodopi area like the three previous categories. They have common characteristics with the above-mentioned three last stand types: with the first and second types, which develop from the Scotch pine pioneer stands and with the third type, as Scotch pine will vanish sometime. They are multi-storey stands depending on the age of the upper storey. By getting older - and consequently by the opening out of the canopy - the presence of shade - tolerant species in all storeys is confirmed.

- Mixed stands of beech - fir - Norway spruce - Scotch pine

These stands can be met at the virgin forest in Rodopi area and they are the most mature ecosystems in Europe in the "climax" stage. The forest has a various composition and structure and shows high biodiversity and landscape diversity.

These stands are the biotope of many rare species on European level. The most important fauna species are: *Ursus arctos*, *Rupicapra rupicapra*, *Tetrao urogalus* and possibly *Lynx lynx*.

5. Mixed stands of the Vaccinio-picetalia zone

- Mixed stands of Scotch pine - Norway spruce

These stands were created in the same way as the above-mentioned stands. Norway spruce regenerates under Scotch pine immediately after the first thinning. Sometimes, however, it is settled at the same time as Scotch pine and forms immediately mixed stands from the beginning. This happens at northern slopes with steep inclination. The Norway spruce presents high competitiveness on those sites and if the stands are left to their natural development, Scotch pine will disappear (Zagas 1994a,b).

6. Conclusions

We can conclude that the most important types of mixed stands of Europe are also met in Greece.

It is worthwhile to point out that these stands are natural and that they develop high potencies with or without human influence. For this reason they are important laboratories for scientific study of nature. European scientists, dealing with research of mixed stands will find answers to many of their questions by visiting the mixed stands of Greece.

Because of the above-mentioned reasons many of these forests are protected and others are going to be part of international conventions of protection to be given harmless to the future generations.

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