The mixed forest s of Greece

ZAGAS T., TSITSONI T. & HATZISTATHIS A.
Aristotle University of Thessaloniki, Department of Forestry and Natural Environment, Laboratory of Silviculture, P.O. Box 262-University Campus 54 006 - Thessaloniki

Abstract

Greece is a mountainous Mediterranean country characterised by a variety of microenvironments. As a result, a great number of mixed forest types is appeared.
These stands are natural 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, Unevenage stands, Mixed stands.*

Introduction

Greece is a mountainous Mediterranean country characterised by a variety of climates, bedrock, soil types, topographic characteristics and microenvironments. As a result, a great number of natural forest types appears, 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 (Burkhart 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 (Dafis1989).
Since the late of the 18th century, silviculturalists 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, Burkhart 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 the wind and snow, but the resistance against

fire and ice 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 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 the valuable services.
So we will present to you 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).

Mixed stands of evergreen broadleaves zone (Quercetulia ilicis)

- Shrubberies and stands of evergreen - broadleaves

These stands are consisted 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 stands as well as their protective, hydrological and generally social role.
The forests are threatened by the wildfires, the clearings and the overgrazing. 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

The *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 and in their position to prevail 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 were protecting these forests with their continuous appearance. 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 impressive aesthetically and more resistant against the 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 mountains of Crete, where under the limited conditions of the environment, the 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 the *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.*

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 which are today middle stands.
These woods have a long history of management: woodcutting, woodpasture and cutting for leaf fodder. They vary vastly 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 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 from the thirteen existing totally 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, appeared rarely and occupy a small relatively area. Also oak stands which are adjacent to conifer stands (Black pine, Scotch pine, fir) create mixed stands with these species.
In the following we will study approximately the above types of mixed stands.

-Mixed stands of deciduous broadleaves (Tilio - Acerion)

These stands appear at the small valleys with special favourable soil and water condition. They consist of many broadleaves species as *Tilia* sp., *Acer*. sp., *Ostrya carpinifolia, Quercus* sp. etc.

This type of stands appear in a restricted scaleat Olympus, Pindos and Rhodopi mountains. 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 year but especially in autumn.

-Mixed stands of oak - Black pine

In cases where the oak stands are adjacent to the 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 low oak stands in high ones 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 the Pindos, Olympus and Rhodopi mountains.

-Mixed stands of oak - Scotch pine

The Scotch pine has the same behaviour as the Black pine and it occupies every available space in the coppice oak stands as a pioneer species.
Characteristically in Rhodopi the Scotch pine has been settled very quickly in large areas of coppice oak stands. After the clearcutting of the oak stands the Scotch pine (which is conserved without damages) strengthens its position increasing its participation. This phenomenon has a particular ecological importance because it contributes greatly to the rehabilitation and conversion of coppice oak stands of our country.

-Mixed stands of oak - fir

The fir as a shade - tolerant species has the ability to regenerate easily under the canopy of oak. So, at the mountainous oak stands and the areas where the grazing is restricted or forbidden, these all have been transformed into two or three storey stands. This happens because the fir has been established in large areas to the middlestorey and understorey.
Typical examples of the fir establishment into oak stands we can meet at Olympus in stands of *Quercus dalechampi* and the Pindos in stands of *Quercus cerris.* In the future it is up to qualified forester to decide on the rate of both species in the stand, according to the ecological condition and the kind of forest management.

Mixed stands of the beech zone (Fagetalia)

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

-Mixed stands of beech - fir

The 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, Pindos and Grammos mountains. They comprise biotopes of valuable species of our fauna.

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

These stands appearat the same area where the both species create pure stands. The Black pine as a pioneer species occupies areas where the beech stands are being destroyed by illegal human activities and there are only the remnant of such stands today.
After the settlement of *P. nigra* the beech follows in a few years (nursing effect) and it consists stands of Black pine - beech or Black pine - beech- fir. The rate of these species changes because of the dynamic of these stands. The beech takes over the role of secondary stand and it can dominate in the area after the final felling of the Black pine. *P. nigra* will dominate only to the extreme sites, shallow dry or very wet soils, where the beech has competitively reducing ability. Stands of this category we can meet at the Pindos, Olympus and Grammos mountains. These stands at the Pindos and Grammos and the pure stands of beech comprise the important biotope of the brown bear.

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

The Scotch pine has a similar behaviour with the Black pine and it is settled in the bare areas in Rhodopi mountain.
In a few years the beech appears on the best sites of the Scotch pine, as an understorey and it tends to replace the Scotch pine. In this case the beech is for some time the secondary stand because we want to exploit the productivity of Scotch pine stand.

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

These stands are occurred at the area of Rhodopi. They form mature ecosystems in relation to the previous ones and they are closer to the stage “climax”. They are unevenaged stands with all kinds of mixture which depend on the site quality and the local conditions generally.
They are characterised by the good organisation from the ecological point of view and the relatively high biodiversity.

-Mixed stands of Scotch Pine - beech - Norway spruce

These stands are occurred at Rhodopi like the three previous categories. Those stands have common characteristics with the three last above mentioned stand types. With the first and second type, which are coming from the Scotch pine pioneer stands and with the third type, that this will be the form of stands when the Scotch pine will vanish. These are two or three storey stands depending on the age of the upper storey and as it is getting older - and consequently the thinning out of the canopy - the presence of shade - tolerant species on all storeys is confirmed.

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

These stands can be met at the virgin forest in Paranesti and they are the most mature ecosystems in Europe which are in the stage “climax”. It's about a forest with a variety of composition and structure and high biodiversity and landscape diversity.
These stands are the biotope of many rare species in European level. The most important species of fauna are the following: *Ursus arctos, Rupicarpa rupicarpa, Tetrao urogalus* and possibly *Lynxs lynxs.*

Mixed stands of the Vaccinio-picetalia zone

Mixed stands of Scotch pine - Norway spruce

The stands of this category were created in the same way with the above mentioned stands. The Norway spruce is regenerated under the Scotch pine stands immediately after their first thinning. Sometimes, however, it is settled at the same time with the Scotch Pine and forms 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, the Scotch pine will disappear (Zagas 1994a,b).

Conclusions

From the above we can conclude that the most important types of mixed stands of Europe are met also in Greece.
It is worth-while to point out that these stands are natural and they develop potentially with or without human influence. For this reason they comprise important laboratories of the studying of nature with scientific interest.
The European scientists who work at the research of the mixed stands will find answers to many of their questions by having only a visit at 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, so as that the most representative, to be given harmless to the future generations.

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