EFFECT OF TWO SUCCESSIVE WILDFIRES IN PINUS HALEPENSIS MILLER STANDS IN CENTRAL GREECE

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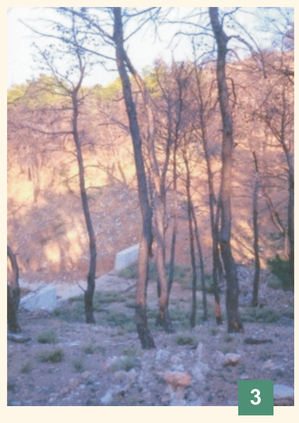
AIM & INTRODUCTION

Postfire regeneration has been extensively studied throughout the world. Especially, in the Mediterranean region the postfire recovery process of the burned ecosystems has been clearly identified through many studies, and the adaptation mechanisms have been well established (Trabaud, 1994; Tsitsoni, 1997). However, the recovery process depends on how long the time interval between fires is and the type of ecosystem (Polakow and Dunne, 1999; Eugenio and Lloret, 2006; Goudelis et.al. 2007); in the case of *Pinus halepensis* forests, it is estimated that full recovery requires more than 30 years (Arianoutsou and Ne'eman, 2000).

Photo 1. *A view of the study area*

The aim of this study was the estimation of differences, 5 years after the last wildfire, in soil and vegetation composition between *P. halepensis* dominated communities that were once burnt (1998) and communities that were twice burnt in a short time interval (1995 and 1998), in the area of Penteli, central Greece. The parameters monitored were the physical and chemical attributes of soil surface horizons and the vegetation composition, density, and growth, while the overall goal was the estimation of differences in the recovery process in once and twice burnt areas.



Photos 2, 3 & 4.
Burnt stands of *Pinus halepensis* in the study area.

MATERIALS & METHODS

The study was carried out in Penteli, 30km from the city of Athens. The region consists of part of the Mount Penteli whose altitude ranges from 100 to 1107m. The parent rock materials are mainly limestone and schists and a small part is covered by sedimentary formations. The slope gradient was 15% - 30%. The vegetation of the area belongs to *Quercetalia ilicis* and particularly to the association *Oleo-lentiscetum*. The climate is characterized as Mediterranean type (Csa). The annual amount of rainfall is 413mm and the dry period has an average duration of 56 months, lasting from April to September. The ecosystem studied was pre-fire dominated by *P. halepensis* with a shrub storey of maquis species. The area was burned in July 1995 and a large part of the area was burnt again in August in 1998. The age of *P. halepensis*s trees ranged from 30 to 40 years as shown by tree ring analyses. 16 permanent plots of 100m^2 were established just after the second fire (August 1998) in the burnt areas in different locations; 5 in areas burnt once (B_1), 11 in areas burnt twice (B_2), in 1998. The choice of burnt areas was based on maps. Within each plot, 5 subplots of 1m^2 were selected; 4, 2m from each corner, and 1 in the centre. In each subplot, all woody plant species were recorded, as well as their density and height. The monitoring took place 5, 10, 15, and 60 months after fire. Site characteristics were also recorded; altitude, aspect, topography. Soil sampling was carried out 5 years after the fire and included one soil sample from each plot. The sample was taken from the upper 20cm. Statistical analysis was performed using the SPSS package. The differences in total stem density, species density and growth between B_1 and B_2 were assessed using *t*-tests (P<0.05).

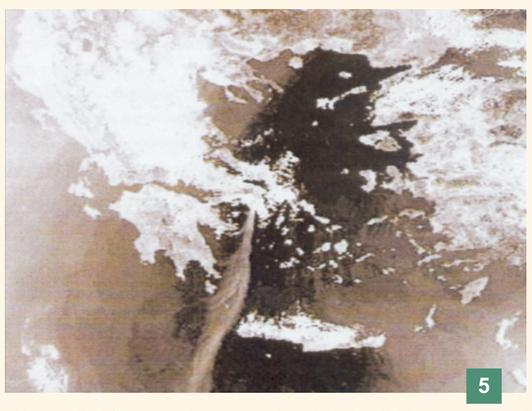


Photo 5. *The smoke from the 1998 wildfire extended from north to south of Greece (beyond Crete island).*

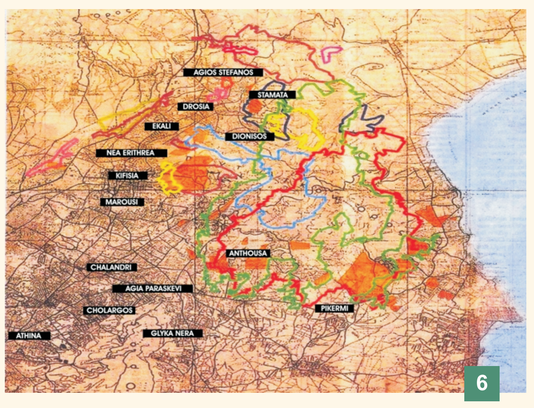


Photo 6. *Map showing the burned areas. The red line marks the 1995 wildfire and the green marks the one in 1998.*

RESULTS & DISCUSSION

The results showed that 5 years after the wildfire soil pH did not differ between twice and once burnt areas, while organic matter was found higher in the once burnt areas (Table 1). The vegetation composition was similar in the two areas while the dominant species were those, which existed before the fire, while vegetation density was considerably lower in twice burnt areas (Table 2). The growth of woody species oscillated in the same levels in the two areas. The vegetation composition consisted mainly of sprout-regenerated species, *Quercus coccifera*, *Pistacia lentiscus*, *Phillyrea latifolia* and less from seed-regenerated species, *P. halepensis, Cistus monspeliensis*, and *C. creticus*. As is shown in Figure 1, the pattern of postfire colonization vegetation density is similar in both cases.

Five years after the fire, the ecosystems were dominated by the maquis species that existed in the prefire period, with a small presence of the tree species *P. halepensis* and a relatively high proportion of *Cistus spp.* (obligate seeders).

The plant community was mainly composed of evergreen broadleaf shrubs: *Q. coccifera*, *P. lentiscus*, *P. latifolia*, *Erica arborea*, *Arbutus unedo*, *A. andrachne* and some seasonal dimorphic sub-shrubs e.g. *C. creticus*, *C. monspeliensis* and *Callicotome villosa*. Postfire natural regeneration of the prefire dominant tree species *P. halepensis,* was low in terms of stem density; seedling growth was also low.

Table 1. *Soil pH and organic matter 5 years after the wildfire.*

Land Category	Soil Depth	pH	Organic matter
Burnt once	0 – 5 cm	6.78	4.54
	5 – 20 cm	6.71	3.55
Burnt twice	0 – 5 cm	6.71	4.21
	5 – 20 cm	6.68	3.05

The values are the medians and where N = 17, ns = non significant differences, P<0.05, t-test.

Concerning the vegetation density change a high percentage of stems of several species died back during the postfire summer due to drought stress (Goudelis et al. 2007). However, vegetation density was further reduced during the next years due to mainly to competition between the individuals and less to drought stress. Although resprouter species were more abundant in twice-burnt areas and the opposite was found for seeder species, no statistically significant differences were observed in the relative abundances of regenerative groups.

Based on the findings of the study, it is suggested that the repetition of wildfire in a short time affected negatively the ecosystem, and this could add to the risk of area degradation.

Photo 7. Resprout of *Quercus coccifera*

Photo 8. Resprout of *Quercus coccifera.*
Photo 9. Resprout of *Cotinus coggygria* and *Arbutus unedo.*

Table 2. *Postfire density and growth of woody species, in B_1 and B_2, 5 years after the wildfire.*

	B_1 areas		B_2 areas	
Species	Density (stems/m^2)	Mean height (cm)	Density (stems/m^2)	Mean height (cm)
Resprouters	**10,40a**		**5,40b**	
Quercus coccifera	6,65a	47,43ns	3,56b	52,74ns
Pistacia lentiscus	0,00	0,00	1,04*	65,77*
Phillyrea latifolia	0,16*	181,25a	0,07*	25,83b
Arbutus unedo	0,20ns	31,67a	0,21ns	110,71b
Nerium oleander	0,00	0,00	0,16*	136,14*
Erica arborea	1,50*	28,80*	0,06*	47,50*
Cotinus coggygria	1,45*	39,17*	0,00	0,00
Dittrichia viscose	0,00	0,00	0,18*	59,92*
Pistacia terebinthus	0,16ns	146,50a	0,12ns	51,75b
Olea europaea	0,28*	107,14*	0,00	0,00
Seeders	**1,96ns**		**1,77ns**	
Pinus halepensis	0,33ns	71,38ns	0,38ns	73,64ns
Cistus monspeliensis	1,10ns	38,02ns	1,39ns	42,81ns
Cistus creticus	0,25*	34,60*	0,00	0,00
Phlomis fruticosa	0,28*	112,00*	0,00	0,00
Total	**12,36a**		**7,17b**	

*Values of the same species for the same parameter followed by different letters are significantly different, ns = non significant differences, * insufficient data for the test.*

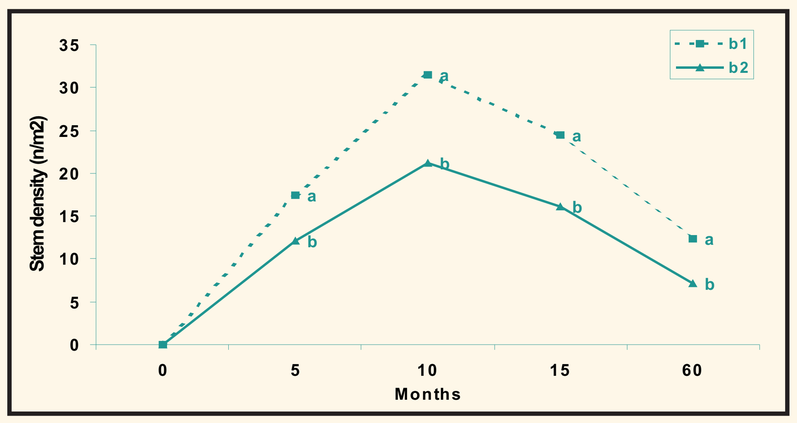


Figure 1. *Postfire vegetation density change in 5 years after the fire*

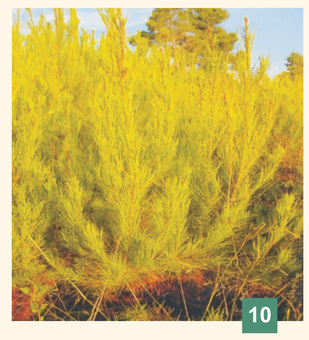


Photo 10. Natural regeneration of *Pinus halepensis*

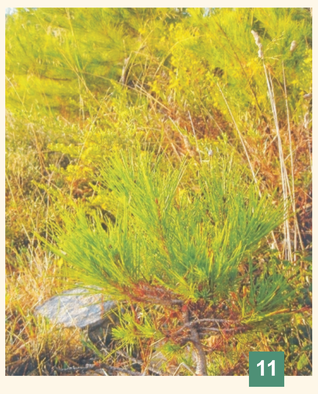


Photo 11 & 12. Seedlings of *Pinus halepensis.*
Photo 13. Regeneration of *Cistus monspeliensis*

References

Arianoutsou, M., & Ne'eman, G., (2000). Post-fire regeneration of natural *Pinus halepensis* forests in the East Mediterranean basin. *In* G Ne'eman and L Trabaud (eds), Ecology, Biogeography and Management of *Pinus halepensis* and *P. brutia* Forest Ecosystems in the Mediterranean Basin, pp. 269-289. Backhuys Publishers, Leiden, The Netherlands.

Eugenio, M. & Lloret, F., (2006). Effects of repeated burning on Mediterranean communities of the northestern Iberian Peninsula. J. Veg. Sci. 17:755-764

Goudelis, G., Ganatsas, P.P, Spanos, I., & Karpi, A., (2007). Effect of repeated fire on plant community recovery in Penteli, cental Greece. *In* Stokes et al. (eds), Eco- and Ground Bio-Engineering: The Use of Vegetation to Improve slope Stability, 337-343. Springer.

Polakow, D.A., & Dunne, T.T., (1999). Modeling fire-return interval T: stochasticity and censoring in the two-parameter Weibull model. Ecol. Model. 121, 79-102.

Trabaud, L., (1994). Postfire plant community dynamics in the Mediterranean Basin. *In* JM Moreno and WC Oechel (eds) The Role of Fire in Mediterranean Type Ecosystems. Ecological Studies, vol. 107, pp. 115. Springer-Verlag, New York.

Tsitsoni, T., (1997). Conditions determining natural regeneration after wildfires in the *Pinus halepensis* (Miller, 1768) forests of Kassandra Peninsula (North Greece). For. Ecol. Manage. 92, 199-208.