

REGENERATION OF PINUS PINASTER FORESTS AFTER WILDFIRE

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Abstract

Wildfires are of extreme importance in *Pinus pinaster* forests of central and northern Portugal. Reforestation plans after wildfire are generally made without consideration for the possibility of natural regeneration. This paper addresses the question of the factors responsible for the occurrence of natural regeneration and concludes that litter accumulation, rock outcrops, slope, aspect, harvest, fire characteristics, and stand age are well related to the regeneration observed. Limitations of the model proposed are discussed.

Introduction

Pinus pinaster is the most abundant tree species in Portugal, representing about 30 percent of the total forest cover. These forests are extremely susceptible to fire, representing about 50 percent of the total area burnt annually. In Portugal wildfires are a very important problem due to the extreme susceptibility of the monospecific extensive plantations of fast-growing trees (pines and eucalyptus).

Establishment of *Pinus pinaster* after wildfire is quite variable, depending on various factors that are not well understood. The importance of studying the fac-

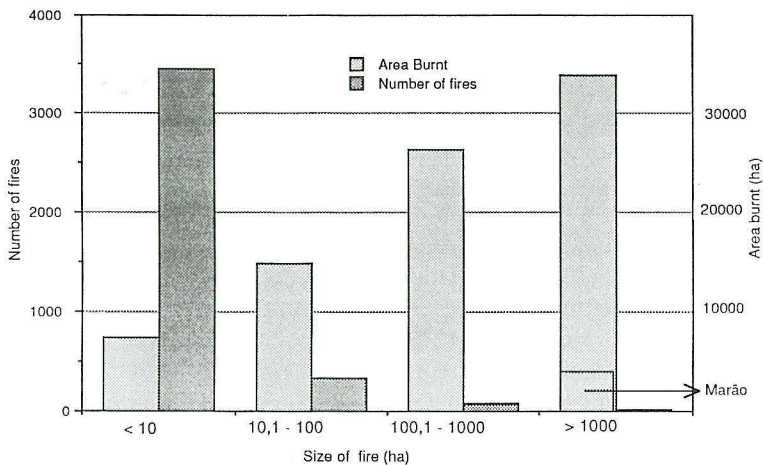
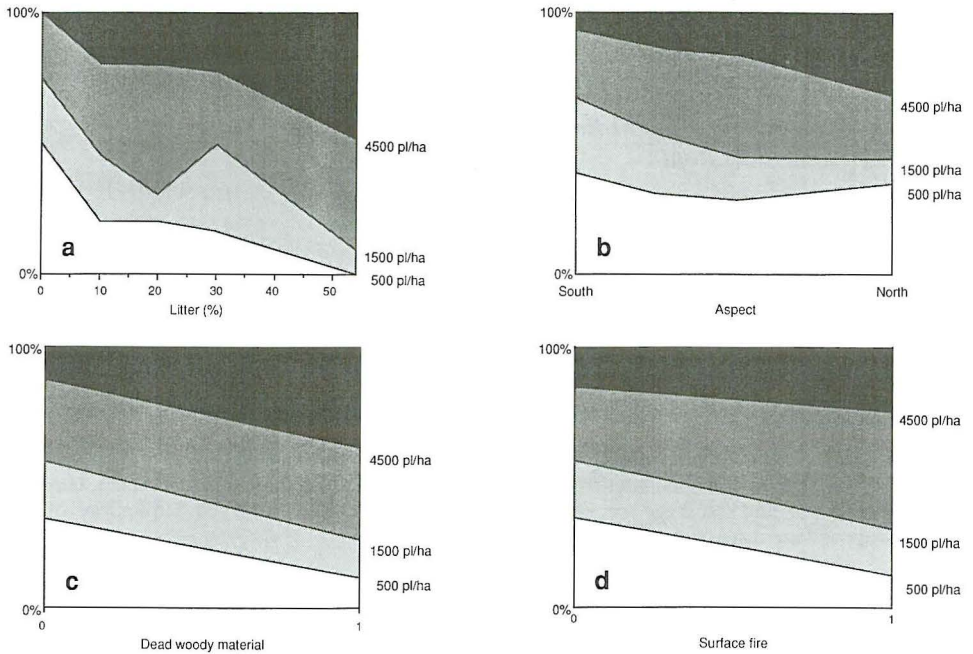


Fig. 1. Distribution of number of fires and areas burnt in Portugal (1985) by classes of fire size. The fire of Marão is indicated.



tors involved is in the substantial funds spent on artificial replanting. On the other hand, in the perspective of production, potential benefits of changing species or varieties are lost when natural regeneration occurs. Therefore, there is a need to be able to predict if natural regeneration after a wildfire will occur to evaluate that alternative when planning the future of a burnt forest.

The same problem was recognized in other situations by various authors who suggested the importance of different factors in determining the establishment of trees following wildfires. First, a significant seed input to the ground surface is the major requirement for a successful regeneration. Distance to the closest surviving trees is considered an important factor to study (Achear *et al.* 1984; Trabaud *et al.* 1985), as well as the age of the stand (Shearer and Schmidt 1971) and its seed production the year of the fire (Ahlgren 1976; Braysham 1965; Wellner 1970). Secondly, losses of seeds to extreme temperatures, predation, or seed movements through erosion can be related to the existence of a significant cover protection of the soil surface (Fiedler *et al.* 1985), aspect (Alexander 1984), and slope (Stein 1986; Velez 1985). Thirdly, germination and successful establishment must occur. These are dependent upon favorable weather conditions after fire (Wellner 1970). Precipitation, aspect, slope and rock outcrops can affect regeneration (Velez 1985). Finally, after seedlings are established, they can be damaged by grazing (Zimmerman and Neuenschwander 1984), or by the logging operations (Schubert 1970; Velez 1985).

The understanding of the main factors involved in regeneration of *Pinus pinaster* after wildfire is the objective of this paper.

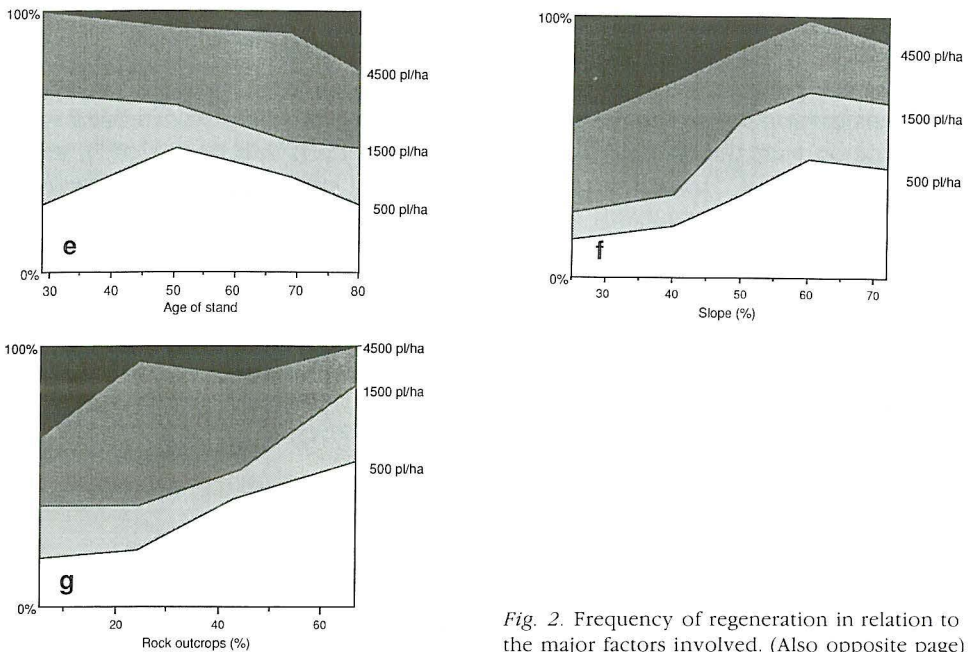


Fig. 2. Frequency of regeneration in relation to the major factors involved. (Also opposite page)

Study area and methods

In September of 1985 a very large wildfire (Fig. 1) swept through about 3000 ha of communal forests in a mountain range of northern Portugal (Serra do Marão). This mountain is characterized by an average annual precipitation of around 1500 mm and a mean annual temperature of about 13 °C. Soils are generally shallow, derived from schists. The importance of that particular fire, and the need to obtain information on the postfire regeneration of the pines, created the opportunity for this study.

Within the study area, 265 circular plots (2 m radius) were systematically located 150 m apart, in 5 contour lines (elevations 600, 700, 800, 900 and 1000 m). Pine seedlings were counted within the plots and 6 density classes were established:

Class 1 – Value 0.0	Density < 500 pl./ha
Class 2 – Value 0.2	500 < Density < 1500
Class 3 – Value 0.4	1500 < Density < 2500
Class 4 – Value 0.6	2500 < Density < 3500
Class 5 – Value 0.8	3500 < Density < 4500
Class 6 – Value 1.0	4500 < Density

Elevation, slope, aspect, soil, stand and fire characteristics, vegetation, logging practices, grazing, were some of the 30 variables estimated in each plot.

Simple correlations between regeneration values and those variables were computed. A stepwise regression approach was then used to build an equation to predict regeneration values (REG).

Results and discussion

Significant correlation was found between percent of soil covered with litter (LIT) and regeneration values ($r = 0.508^{**}$). Other variables positively correlated with regeneration were the presence of dead woody material (MAT, $r = 0.276^{**}$), stand age (AGE, $r = 0.214^{**}$), northern aspects (ASPN, $r = 0.195^{**}$), and surface fires (F2, $r = 0.155^*$). Variables negatively correlated with regeneration were percent of the surface with rock outcrops (ROC, $r = -0.409^{**}$), slope (SLO, $r = -0.325^{**}$), and distance to closest tree (DIS, $r = -0.180^*$). Variation of regeneration with some of those factors can be seen in Fig. 2.

Results of the stepwise regression essentially confirm those findings. The final predictive model was:

$$\text{REG} = .296 + .062\text{LIT} + .033\text{AGE} - .045\text{SLO} + .059\text{ASPN} + .162\text{MAT} \\ + .118\text{F2} - .018\text{ROC}$$

with $R = .635$

Conclusions

The variables selected by the 'stepwise' procedure were those suggested by other authors. Litter seems to have a major influence in the final outcome, possibly because of the fact of the protection against predation, erosion, extreme temperatures and water stress. Also, destruction of pine seeds was probably less on sites where litter was not completely consumed by fire. The other factors also explain part of the total variation observed.

Finally, it must be stressed that the natural complexity of the regeneration process caused more than half of the variation observed to remain unexplained. Nevertheless the equation proposed can be used as a first contribution to the understanding of the process, as an indicator to help in the future planning of burnt areas, but essentially as the basis for future research.

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