

# Canopy Openness and Lai Estimates in Mixed Pine-oak Forest with Different Management System in Northeast Mexico Using Hemispherical Photography



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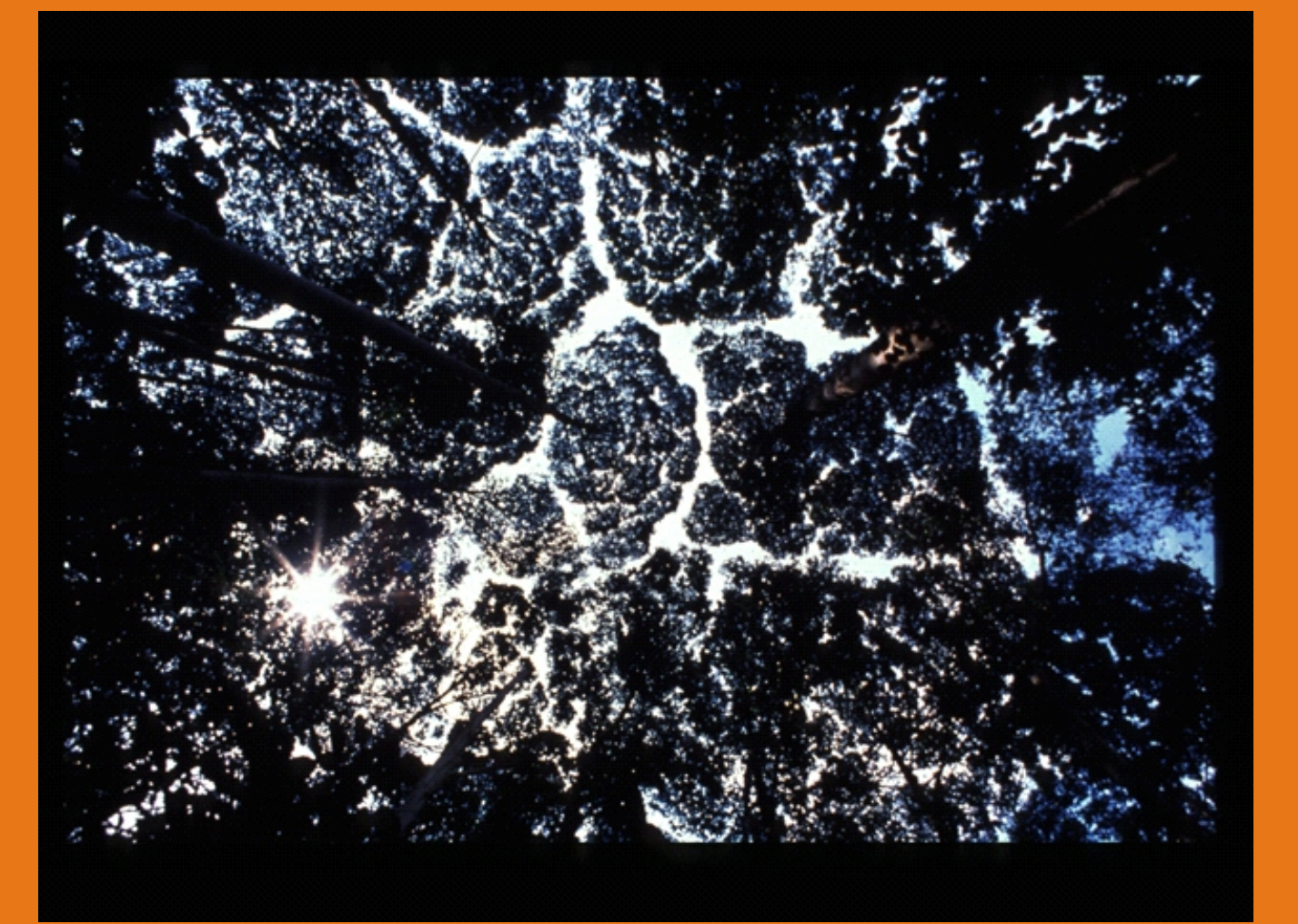
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## INTRODUCTION

Natural regeneration of production forest is a viable option for sustainable forest management in Mexico and has drawn major attention to natural regeneration processes. Inancial profitability, better plant establishment, native regeneration material and high seedling densities are main advantages of naturally regenerated forestst. However, Structural variation in mixed pine oak forest canopies influences light availability and distribution. In temperate mixed forest, natural and man-made small scale disturbances produce canopy openings that are an important source of heterogeneity in forest understory light regimes, and play a critical role in determining patterns of tree regeneration.

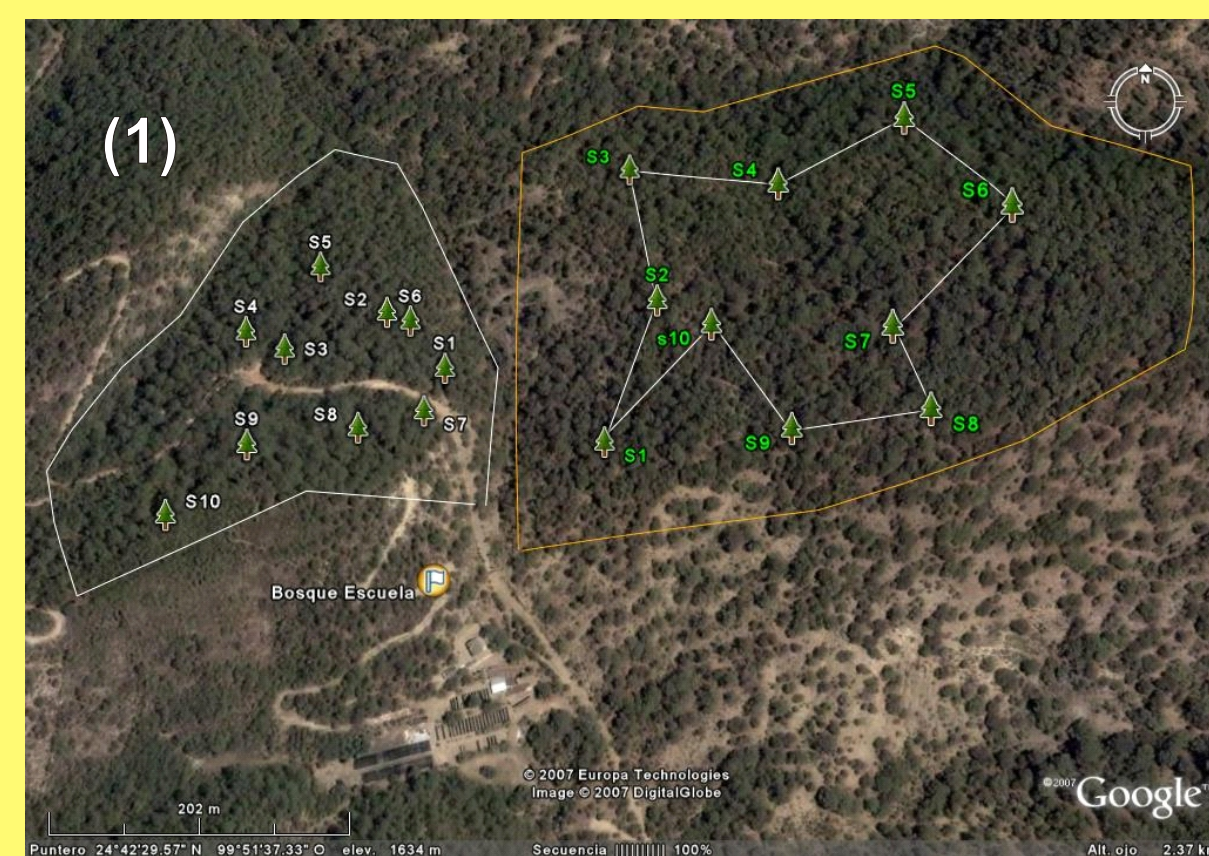
## OBJECTIVE

The objective of the study was to determine how canopy openness (CO) is affected by selection cutting, and how the CO influences the woody regeneration.



## MATERIALS AND METHODS

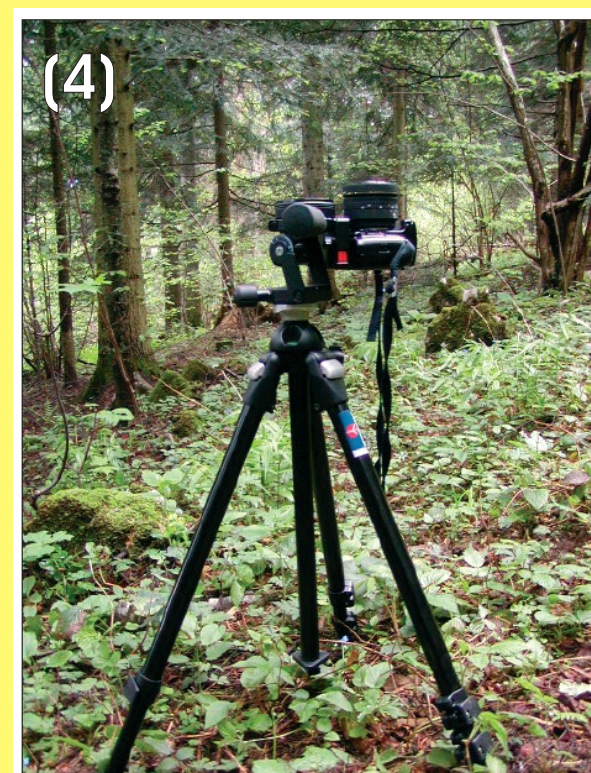
The study area is located in north eastern Mexico, in the Sierra Madre Oriental. The investigation was carried out in two forest stands. One forest situated in the Bosque Escuela, which is the research and education forest of the University of Nuevo Leon. The another studied forest stand is located in close vecinity of the BE (Fig. 1).



### Forest stands and plot selection

Two forest stands with a different land use according to the general use of the study were selected:

1. Natural forest with low human impact, situated insede the Bosque Escuela (With out management -UFS, Fig. 2).
2. Forest, that is grazaed by livestock of the nearby village Santa Rosa, located outside the Bosque Escuela (grazed forest stand - GFS, Fig. 3).



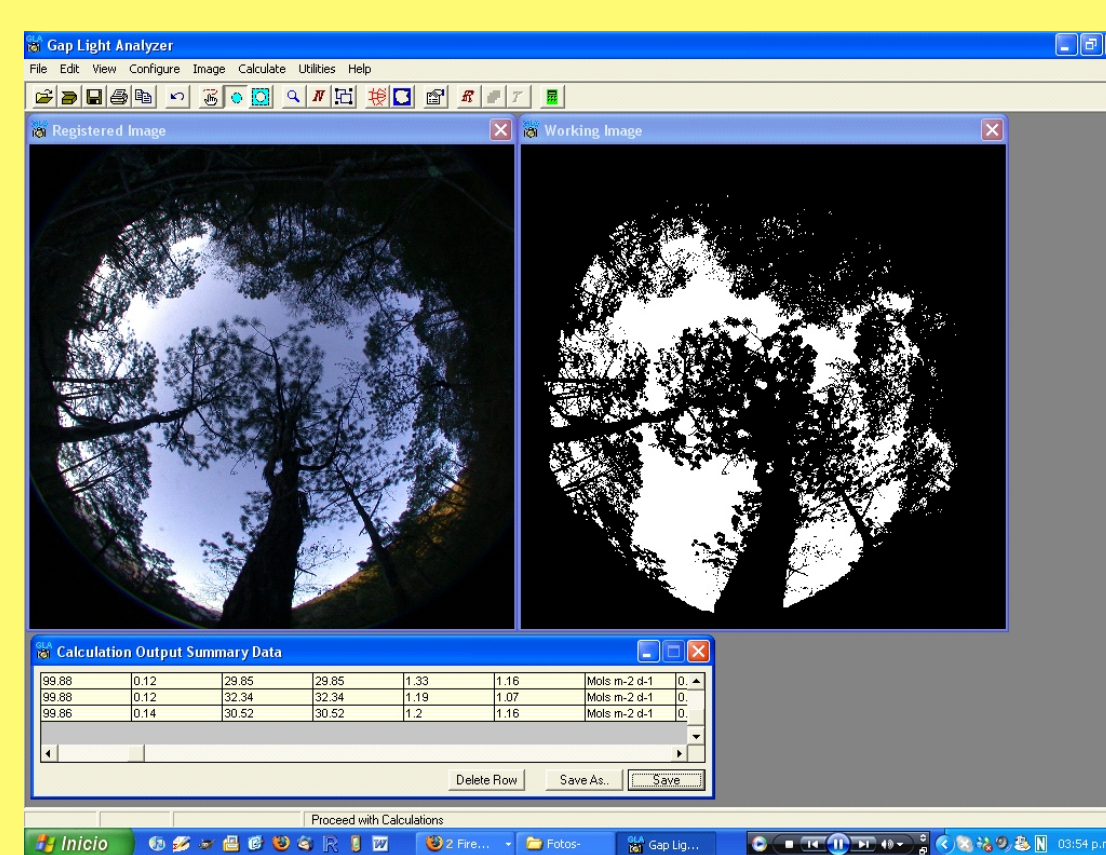
## DATA COLLECTION

### Stand inventory

Forest structure was measured in three compartments (A) 500m<sup>2</sup> for tree species 10 cm, (B) 100m<sup>2</sup> for individuals with dbh 10 cm and dbh 3 cm and (C) for all woody species dbh 3 cm.

### Hemispherical photography

All field work was carried out during February 2007. The parameters used to characterise the forest canopy were the Canopy Openness (CO) and the Leaf area index (LAI). We took nine hemispherical photography per plot, at 1.3m above-ground with a Cannin 7.5 mm fish-eye lens (Figure 4). Images were analyzed for canopy openness and LAI with Gap Light Analyzer (GLA, ver. 2.0).



## RESULTS AND DISCUSSION

### Light parameters

In general, the light availability in the understory is highly variable. The canopy openness (CO) ranges from 18.8 to 47.4 %, mean value is 29.9%. For the UFS the mean CO ranges from 18.8 to 36.6 % and the GFS ranges from 22.3 to 47.5. The Leaf area index (LAI) for the GFS ranges from 0.67 to 1.81 (mol/m<sup>2</sup>/d) and for the UFS from 0.96 to 1.66 (mol/m<sup>2</sup>/d). The two stands differ significantly among each other in canopy openness (P=0.003) and LAI (P=0.19, Fig. 5).

Values of all examined light characteristics are closely related; there is a negative significant linear regression between Canopy openness and LAI (P = 0.001 in both cases).

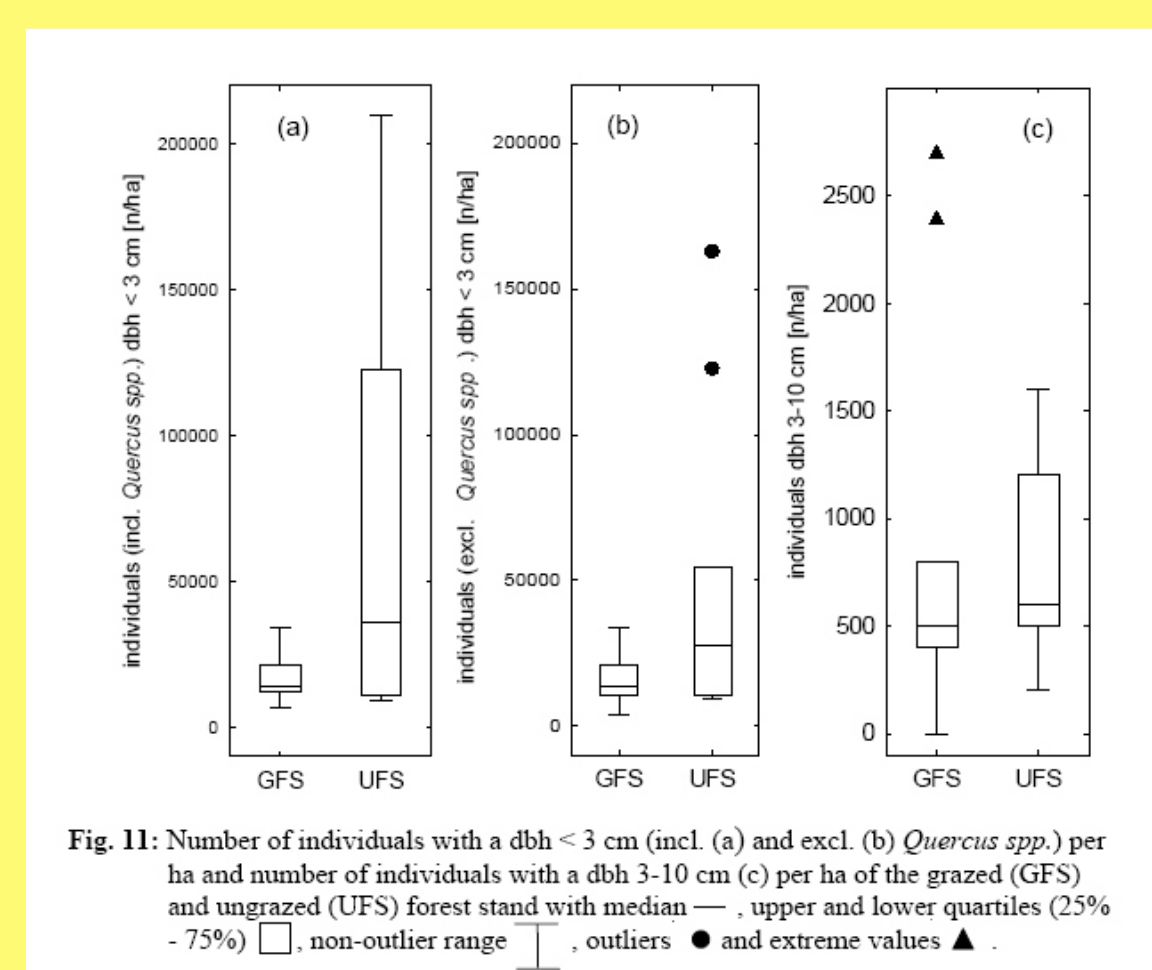
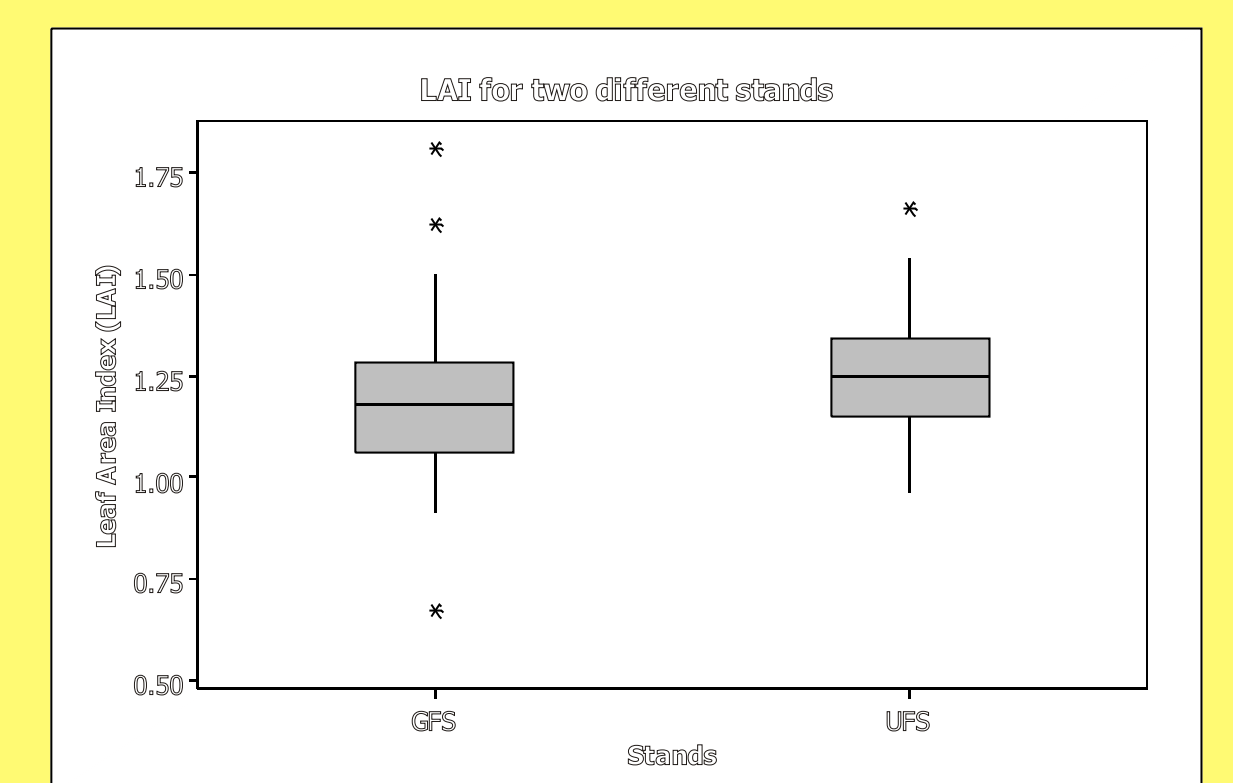
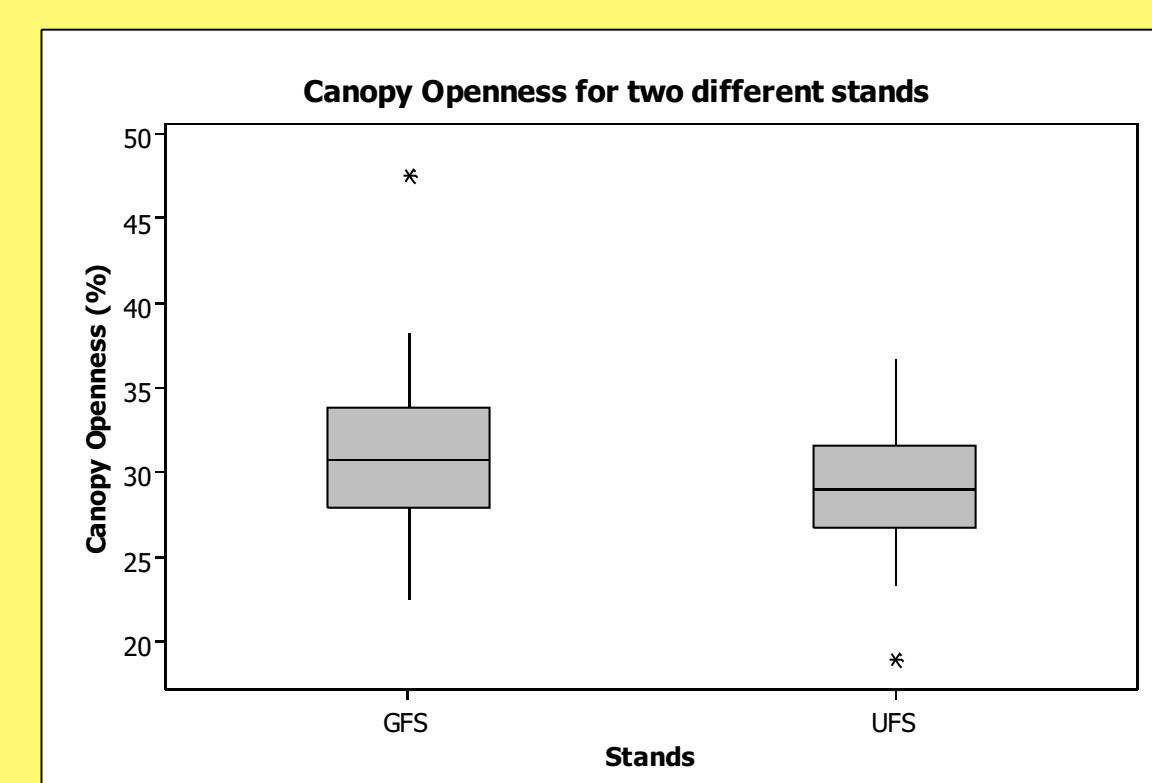


Fig. 11: Number of individuals with a dbh < 3 cm (incl. (a) and excl. (b) *Quercus* spp.) per ha and number of individuals with a dbh 3-10 cm (c) per ha of the grazed (GFS) and ungrazed (UFS) forest stand with median —, upper and lower quartiles (25% - 75%) □, non-outlier range ▭, outliers ● and extreme values ▲.

*Nature regeneration patterns* The amount of individuals with a dbh < 3 was significantly lower (P<0.05) in the grazed forest stand than in the ungrazed forest stand. The mean for the GFS (17080 individuals per ha) and was lower in contrast with the ungrazed forest stand (73160).

During this study a total number of 18 different tree/ woody plant species were found on all 20 study plots. 17 different species in the dbh-class < 3 cm and ten different species in the dbh-class 3-10 cm. In the dbh-class > 10 cm only seven different species were found. Alpha Diversity of woody plants with a abh < 3 cm (Fig. 13 a) was significantly (p < 0.05) higher on the ungrazed forest stand. Alpha Diversity of woody plants with a

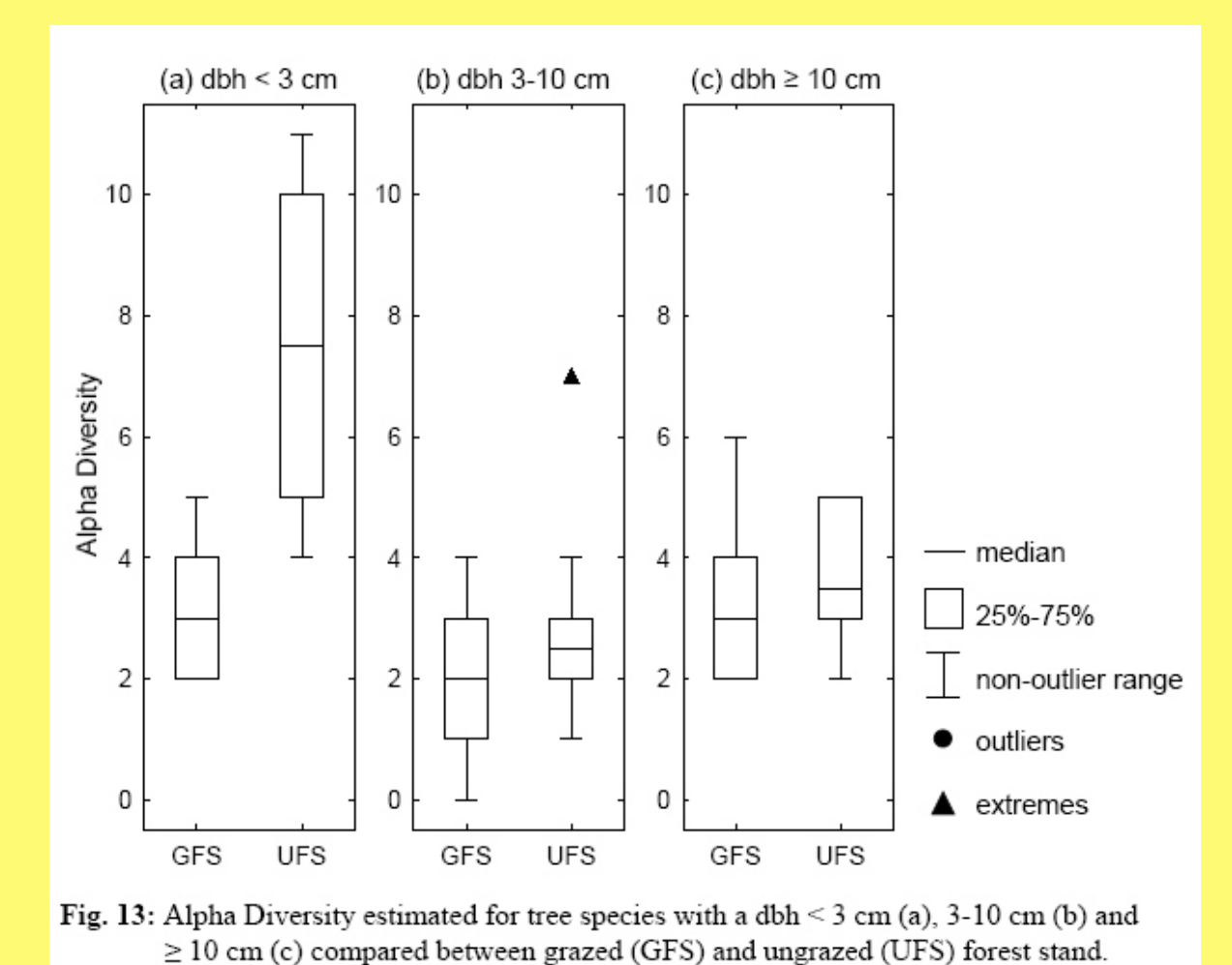


Fig. 13: Alpha Diversity estimated for tree species with a dbh < 3 cm (a), 3-10 cm (b) and ≥ 10 cm (c) compared between grazed (GFS) and ungrazed (UFS) forest stand.

## CONCLUSION

This study has revealed the influence of different management system on natural regeneration community patterns and development. Knowledge of processes and factors influencing nature regeneration is essential for its successful application.

## REFERENCES

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