Tree Species Composition and Structure near Road Borders in the Laurel Forest of Anaga (Tenerife – Islas Canarias)

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Abstract

Urbanization is one of the main causes of species extinction. Closely linked to urbanization are road systems, which are a source of biotic and abiotic effects on the surrounding landscape. The continued existence of these corridors results in enormous human activity (Forman & Alexander, 1998). In particular, roads sharply define and fragment forest ecosystems leading to changes in plant species composition and vegetation structure from road border to the surrounding interior.

This paper assesses border effects on tree species richness and composition in the laurel forest of Anaga, Tenerife, Spain. Effects of anthropogenic corridors on vegetation differed among the study sites. Multivariate analysis revealed that species composition is more related to the sampling site than to the effect of the corridor, while for density, significant differences were found between the road border and forest interior but not as a regular pattern. This suggests that main corridor disturbances regarding tree basal area is limited to the immediate road edge in the laurel forest, while for species composition, no significant differences were found.

Keywords: *DBH, DCA, disturbances, edge effect, tree density*

INTRODUCTION

Road systems have an impact on the forest plant community, defining sharp borders that delimit the forest matrix, and change species composition and structure from road edges to the surrounding interior (Ranney *et al.*, 1981). Not only is species composition affected, but so are ecological processes by the presence of these human infrastructures (Matlack, 1994). A complete understanding of forest dynamics requires the study of these edge areas, where ecological processes differ from those occurring within the forest (Ranney *et al.*, 1981).

Islands are fragile ecosystems prone to human direct or indirect alterations and are particularly susceptible to the introduction of alien species (Whittaker, 1998). Habitat fragmentation is also known to negatively affect native biotas through

the invasion of exotic species (Suarez *et al.*, 1998). Considering that Tenerife has increased its road surface by 400 % in the last 80 years (Pulido and Utrilla, 1984, García *et al.*, 1989), the island's native ecosystems may have suffered great alterations derived from area reduction and edge effects.

Our aim was to analyze the influence of road corridors in one of the most emblematic ecosystems of the Canary Islands: the laurel forest. We attempted to evaluate road edge effects on tree species composition and structure (density and basal area) in order to determine the extent of the effect of the road disturbance.

MATERIAL AND METHODS

The study was conducted in the Anaga Rural Park in the NE corner of Tenerife, Canary Islands (28° 19' N, 16° 34' W). The park encompasses a 7

to 8 million year- old basaltic massif (Ancochea *et al.*, 1990) covering about 130 km². The park represents 7 % of Tenerife's total area. Today, only 10% of the forest remains, which has been formally protected since 1988, currently experiencing fewer human disturbances and no area reduction.

The annual precipitation of the park reaches 900 mm, but can be twice this amount considering fog drip (Kämmer, 1974). The mean annual temperature is close to 15°C with minimal annual and daily fluctuations. There are no frost events. Two seasons can be differentiated, winter and summer, but in most years, differences between the two most extreme months are not large (Ceballos and Ortuño 1976).

We selected the main paved road at El Moquinal, located at the centre of the Anaga Rural Park, which carries the most intense road traffic in the park. Four perpendiculars were randomly selected to the road beginning from the canopy of the last tree next to the road. Each plot was 30 x 15 m, and was divided into three transects of 10 x 15 m, and each transect was subdivided into three subplots 10 x 5m, resulting in three subplots at 0, 5 and 10 m distance from the road border.

Within each subplot, all tree species were identified (>2.5 cm diameter breast high; DBH) and noted DBH for the calculation of basal area and density. We looked for differences between these

variables in the three subplots using as a factor the distance to the road border, using ANOVA.

Data normality was checked with the Shapiro-Wilk test and the homocedasticity of the data with a multiple F test. The post-hoc Tukey test was used to detect significant differences among groups for the different variables. Basic statistical methods followed Zar (1984) and were implemented using the SPSS statistical package (Anon, 1986).

Ordination techniques help to explain community variation (Gauch, 1982), and they can be used to evaluate trends over time as well as space. We used Detrended Correspondence Analysis (DCA; Hill and Gauch 1980, using CANOCO; ter Braak & Šmilauer 1998) to examine how species composition changed over space and whether different classes could be identified from the analyses. Analyses were based on species basal area.

RESULTS AND DISCUSSION

Roads and trails are abrupt discontinuities, contrasting with the wider and more diffuse edges common to many natural areas (Delgado *et al.*, 2001). These road effects can penetrate long distances into the forest and may alter the forest matrix in different ways (Forman & Alexander, 1998) depending on the species.

In the case of basal area (Fig. 1), our results revealed non-significant differences between the border and the forest interior.

Fig. 1. Mean values and standard deviations for basal area at each site and border distance. Identical letters above the bars indicate non-significant differences ($p < 0.05$): A ($F_{2,6} = 3.080$; $p > 0.05$) B ($F_{2,6} = 1.859$; $p > 0.05$), C ($F_{2,6} = 1.801$; $p > 0.05$), D ($F_{2,6} = 0.516$; $p > 0.05$)

Fig. 2. Mean values and standard deviations for density at each site and border distance. Identical letters above the bars indicate non-significant differences ($p < 0.05$): A ($F_{2,6}=10,948$; $p < 0.05$) B ($F_{2,6}=1,765$; $p > 0.05$), C ($F_{2,6}=1,926$; $p > 0.05$), D ($F_{2,6}=4,572$; $p > 0.05$)

The impact on trees is less relevant, this can be due to the previous presence of the trees to the building of the roads (in the case of the road analysed, it was built and paved around 70 years ago). In this case, more time will be necessary in order to find differences. Furthermore, the pattern of response to the road is different at the different sites, revealing non-consistent patterns in this case.

With respect to tree density, a more consistent pattern was found, with more individuals at plots near to the border than in the interior. Although these differences were only significant at one of the sites, they suggest a higher density at the border in relation to tree regeneration and different environmental characteristics of these plots due to the road: higher insolation, more nutrients, etc. (Arévalo *et al.*, 2008).

In the case of tree species composition, the lack of differences is also evident, as there is no discrimination between the plots in the DCA analysis (Fig. 3).

The only notable information is that the polygon that enclosed the plots at 10 m distance is larger, indicating a more diverse species composition. However, as indicated before, there was practically no discrimination between plots based on distance indicating no differences in species composition.

Fig. 3. Plot and species scores in the space defined by axis I and axis II of the DCA. Polygons enclose plots at the tree distances to the border (Polygon of dashed lines for 5m distance to the border, dotted lines for 10 and solid line for 15 m). Eigenvalues of axes I and II were 0.552 and 0.343 and the cumulative percentage of variance of both axes was 51.6%). Abbreviations for species are: *Apollonias barbuja* (AB), *Erica platycodon* (EP), *Ilex canariensis* (IC), *Ilex perado* (IP), *Laurus novocanariensis* (LN), *Morella faya* (MF), *Ocotea foetens* (OF), *Persea indica* (PI), *Picconia excelsa* (PE), *Prunus lusitanica* (PL), *Rhamnus glandulosa* (RG), *Visnea mocanera* (VM), *Viburnum rigidum* (VR)

Roads in the Canary Island laurel forest permit visitor contact with relatively remote areas and allow local inhabitants to move across the territory. However, a deeper understanding of the effects of these anthropogenic corridors is required to ensure the value of these unique laurel forest remains (Kuiken, 1988).

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CONCLUSION

Roads in the Canary Island laurel forest permit visitor contact with relatively remote areas and allow local inhabitants to move across the territory. However, a deeper understanding of the effects of these anthropogenic corridors is required to ensure the value of these unique laurel forest remains (Kuiken, 1988).

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