



Factors affecting woody plant species diversity of fragmented seasonally dry oak forests in the Mixteca Alta, Oaxaca, Mexico

Factores que afectan la diversidad de especies leñosas en fragmentos de bosque de encino estacionalmente seco en la Mixteca alta oaxaqueña, México

Remedios Aguilar-Santelises✉ and Rafael F. del Castillo

Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Oaxaca (CIIDIR-Oaxaca). Instituto Politécnico Nacional. Calle Hornos 1003, Col. Nochebuena, 71230 Santa Cruz Xoxocotlán, Oaxaca, México.

✉ mraguilars@ipn.mx

Abstract. We explored the relationship between fragment area, topographic heterogeneity, and disturbance intensity with tree and shrub species diversity in seasonally dry oak forest remnants in the Mixteca Alta, Oaxaca, Mexico. The fragments are distributed in a matrix of eroded lands and crop fields, have a complex topography, and are disturbed by plant extraction and trail opening. Sampling was conducted in 12 fragments from 12-3 211 ha. Topographic heterogeneity was estimated by the fragment's standard deviation in slope-aspect, slope, and altitude. The density of stumps and roads were used as estimators of disturbance intensity. Fisher's α diversity ranked from 0.95 to 4.55 for the tree layer; and 2.99 to 8.51, for the shrub layer. A structural equation model showed that the diversity of woody plants increases with topographic heterogeneity and disturbance in the remnants. When these 2 variables were considered, diversity tended to decrease with fragment size probably because smaller fragments have a greater perimeter-to-area ratio and therefore proportionally offer more opportunities for pioneer species colonization. Indeed, the tree-to shrub-layer diversity ratio increased with fragment size. Conservation strategies in fragmented forests must consider the fragment's environmental heterogeneity, the disturbance type and intensity, and the species to be preserved.

Key words: fragmentation, seasonally dry oak forest, human disturbance, species-area relationship, topographic heterogeneity, structural equation modeling.

Resumen. Exploramos la relación entre el área, la heterogeneidad topográfica y el disturbio en remanentes de bosque de encino estacionales en la Mixteca Alta, Oaxaca, México. Una matriz de suelo erosionado y cultivos rodea los fragmentos, que están afectados por extracción vegetal y caminos y presentan topografía compleja. Muestreamos la vegetación en doce fragmentos de 12 a 3 211 ha. Estimamos la heterogeneidad ambiental con las desviaciones estándar en pendiente, orientación y altitud del fragmento, y la intensidad de disturbio, por la densidad de tocones y el área afectada por caminos. La diversidad α de Fisher varió entre 0.95 y 4.55 para el estrato arbóreo y 2.99 y 8.51 para el arbustivo. Un modelo de ecuaciones estructurales lineales mostró que la diversidad aumenta con la heterogeneidad topográfica y la perturbación humana. Al considerar estas dos variables, la diversidad disminuyó con el tamaño del fragmento probablemente porque proporcionalmente los fragmentos pequeños tienen mayor perímetro que los grandes y favorecen a las pioneras. La razón entre la diversidad del estrato arbóreo y el arbustivo aumentó con el tamaño del fragmento. Las estrategias de conservación en bosques fragmentados deben considerar la heterogeneidad ambiental, el disturbio y las especies que deben ser conservadas.

Palabras clave: fragmentación, bosques de encino estacionalmente secos, disturbio, relación especies-área, heterogeneidad ambiental, modelaje de ecuaciones estructurales.

Introduction

Fragmentation processes involve habitat losses and the splitting of the remaining habitat into pieces of various sizes and degrees of isolation (Laurance, 2008). Currently, a large part of the land surface is being affected

by human activities, causing ecosystem fragmentation and jeopardizing biodiversity through habitat reduction, increased isolation, and alterations in biotic and abiotic factors in the remaining fragments (Saunders et al., 1991; Fahrig, 2003; Wade et al., 2003; Otálora et al., 2011). Several factors have been associated with biodiversity in fragmented landscapes. These include fragment size *per se*, based on the species-area theory (Arrhenius, 1921;