

Climate change and fire regimes in the Sierra de Manantlán, México

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Abstract

Fire has been attributed as one of the most influential factors in vegetation community and succession in the Sierra de Manantlán Biosphere Reserve in Jalisco and Colima, México. A mosaic of low, mixed and high severity fire regimes characterizes the landscape with ecosystems ranging from mesophyllous mountain forest to higher elevation pine and oak forest. Research needs to be done to ascertain the fire regime(s) and historical range of variability in the biosphere reserve in order to facilitate scientifically informed land and fire management plans.

Additional keywords: Fire regimes, historical range of variability, pine, oak,

Introduction

Since 1987, the Sierra de Manantlán in Jalisco and Colima, México, has been a UNESCO MAB Biosphere Reserve. Located in the northwestern region of the Sierra Madre del Sur (Fig. 1) and running along the Pacific Coast, the reserve contains the largest area of protected tropical dry forest in México and the largest protected area of mesophyllous mountain forest (cloud forest) on México's Pacific slope (Cuevas-Guzmán *et al.* 1994). Vegetation within its 139,600 hectares ranges from tropical dry and subdeciduous forest to oak, pine, fir and mixed forest types and supports one of the highest levels of biodiversity in the world with 3,460 plant and animal species (Jardel *et al.* 2003). *Zea diploperennis*, a rare wild maize of significant cultural and scientific importance, grows in the reserve and requires a frequent, low-severity fire regime to maintain open pine-oak stands (Jardel *et al.* 2004). *Selasphorus rufus* (rufus hummingbird), an important migratory bird to México, the United States and Canada, also relies on these open areas of the reserve for its wintering ground. However, many species, such as the threatened jaguar, rely on the dense cloud forest that is susceptible to complete destruction in high-severity fires (Jardel, *et al.* 2004). Fire is common in the biosphere reserve and has been attributed as one of the most influential factors in vegetation communities and succession. Ignitions are primarily from agricultural burning and other anthropogenic sources, although lightning is responsible for a small percentage. Preliminary studies put the mean fire return interval between 5 and 14 years, and the fire regimes over the landscape range from frequent (<25 years) low severity surface fires to infrequent (50-100 years) stand replacing fires (Jardel *et al.* 2003).



Fig. 1. Location of the Sierra de Manantlán biosphere reserve. From Jardel *et al.* (2003).

Climate change has the potential to have a severe effect on the ecosystem's function by decreasing soil and foliar moisture, increasing fuels and flammability and increasing mortality of flora and fauna by fire. Results may be loss of habitat and biodiversity, additional releases of carbon into the atmosphere and reduced absorption of greenhouse gases. In addition, the reserve protects the upper portions of three watersheds that provide critical water supplies to over 400,000 people (Jardel *et al.* 2004). Within the reserve are several thousand indigenous inhabitants who participate in decisions about management related to their communal and ejido lands and are directly impacted by wildfire and ecosystem alterations. Fire regimes in México and the reserve are not well understood, and research is needed before scientifically informed management plans can be designed to adaptively protect the area in the face of climate change while providing quality of life for a historically marginalized community. While ecological effects of fire regimes have been studied in the reserve, there has been no research to establish the historical range of variability of fire regimes, the impact of climate change on the historical range of variability or to examine adaptive management plans.

Objectives

To determine the historical range of variability (HRV) in the Sierra de Manantlán, to ascertain the effects of climate change on fire regimes and to propose strategies to return the landscape to a trajectory compatible for purposes of ecological conservation, protection of biodiversity and preservation of cultural integrity.

Hypotheses

1. The historical range of variation of fire regime prior to 1987 was statistically different from the present range of variation of fire regime.
2. The main contributing factors to changes in fire regime in the Sierra de Manantlán biosphere reserve, México, are climate, fire suppression (fuels accumulation) and timing of anthropogenic burning.
3. Dendrochronological records will show that increases in wildfire occurrence and severity correspond with years of higher temperature and lower precipitation.

Methods

We collected 120 cores during the first field season and the process of mounting, sanding and analyzing those samples to create a master chronology for crossdating tree rings is underway. We also GPS-located fire-scarred trees, snags and stumps. In the second field season we will sample live and dead trees with fire scars in order to crossdate years with fire. We will conduct a rigorous forest inventory of vegetation, fuels and age-structure using the standards in the U.S. Forest Service's Fuels Characteristics Classification System (FCCS) Field Sampling Guide. This will allow accurate prediction of fire behavior and the ability to use the Forest Service's FCCS software to design potential silvicultural treatments to reduce fire hazard. We will analyze climate data using superposed epoch analysis to determine whether the master chronology patterns are correlated with climate, and if so, we will be able to project future fire behavior based on existing climate projections using statistical time-to-event analysis. We will collaborate with research scientists and students from the University of Guadalajara, the reserve managers, and members of the ejidos and indigenous communities to author proposed restoration and land-use management plans.

Reconstruction of the historical range of variability of fire regimes will be the basis for developing the land and fire management plans. This will include recommendations for fire management on a landscape scale with reintroduction of fire by the use of prescribed fire in some areas, fire exclusion in others, silvicultural treatments (thinning, pruning, scattering and removal of fuels) to accelerate a return to a resilient forest with a fire regime within the historical range of variability.

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