

## **Resistance to Invasion and Resilience to Fire in Desert Shrublands of North America**

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## Fire and Invasive Plants Special Feature

# Resistance to Invasion and Resilience to Fire in Desert Shrublands of North America

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### Abstract

Settlement by Anglo-Americans in the desert shrublands of North America resulted in the introduction and subsequent invasion of multiple nonnative grass species. These invasions have altered presettlement fire regimes, resulted in conversion of native perennial shrublands to nonnative annual grasslands, and placed many native desert species at risk. Effective management of these ecosystems requires an understanding of their ecological resistance to invasion and resilience to fire. Resistance and resilience differ among the cold and hot desert shrublands of the Great Basin, Mojave, Sonoran, and Chihuahuan deserts in North America. These differences are largely determined by spatial and temporal patterns of productivity but also are affected by ecological memory, severity and frequency of disturbance, and feedbacks among invasive species and disturbance regimes. Strategies for preventing or managing invasive plant/fire regimes cycles in desert shrublands include: 1) conducting periodic resource assessments to evaluate the probability of establishment of an altered fire regime; 2) developing an understanding of ecological thresholds associate within invasion resistance and fire resilience that characterize transitions from desirable to undesirable fire regimes; and 3) prioritizing management activities based on resistance of areas to invasion and resilience to fire.

### Resumen

Los asentamientos de Anglo-Americanos en los desiertos de matorrales de Norteamérica resultaron en la introducción y subsecuente invasión de varias especies de pastos no nativos. Estas invasiones, han alterado el régimen de fuego preestablecido, convirtiendo los matorrales de especies nativas en pastizales de gramíneas anuales inducidas y poniendo en riesgo varias especies desérticas nativas. El manejo efectivo de estos ecosistemas requiere de un entendimiento de la resistencia ecológica a la invasión y la resiliencia al fuego. La resistencia y resiliencia difieren entre los desiertos de matorral fríos y cálidos de Norteamérica tales como Great Basin, Mojave, Sonorense, y Chihuahuense. Estas diferencias son determinadas en gran medida por patrones espaciales y temporales de productividad pero también es afectado por la memoria ecológica, la severidad y frecuencia del disturbio y la retroalimentación entre las especies invasoras y el régimen de disturbio. Las estrategias para prevenir o manejar plantas invasoras/ciclos de régimen de fuego en los desiertos de matorral incluyen: 1) realizar evaluaciones periódicas de los recursos para evaluar la probabilidad de que se establezca un régimen de fuego alterado; 2) desarrollar un entendimiento de los umbrales ecológicos asociados entre la resistencia a la invasión y la resiliencia al fuego que caracteriza la transición entre regímenes de fuego deseables e indeseables; y 3) priorizar las actividades de manejo basadas en la resistencia de las áreas a la invasión y la resiliencia al fuego.

**Key Words:** Chihuahuan Desert, ecological resilience, ecological resistance, Great Basin Desert, Mojave Desert, Sonoran Desert

## INTRODUCTION

Plant invasions and their interactions with fire regimes are recognized as threats to biodiversity and other natural resources worldwide (Brooks et al. 2004). In the desert regions of North America, invasive plants have altered fire regimes, which, in many cases, have resulted in large-scale conversions of native plant communities to invasive plant dominance (D'Antonio and Vitousek 1992; Brooks et al. 2004). These

changes are affecting ecological processes including water cycles (Wilcox and Thurow 2006), nutrient dynamics (Evans et al. 2001), carbon budgets (Bradley et al. 2006), and regional albedos (Millennium Ecosystem Assessment 2005). Many of the native species associated with these desert ecosystems are at risk, and several are either listed or are being considered for listing under the Endangered Species Act (1973). Examples include the desert tortoise (*Gopherus agassizii*) and the sage grouse (*Centrocercus* spp.).

The concepts of ecological resistance and resilience are used increasingly to develop approaches for sustainable ecosystem management (Walker et al. 2004; Briske et al. 2008) and can provide useful insights into the factors influencing plant invasions and fire both within and among North American desert ecosystems. These concepts allow comparisons over a variety of spatial scales, and can be used to develop management approaches that are appropriate at scales ranging from landscapes (Walker et al. 2004) to ecological sites (Briske et al. 2008). In this paper, we discuss the concepts of resistance

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