

SIMULATING THE INTERACTIONS OF FOREST STRUCTURE, FIRE REGIME, AND PLANT INVASION IN THE SOUTHERN APPALACHIANS USING LANDIS

Weimin Xi¹, Szu-Hung Chen¹, Andrew G. Birt¹,
John D. Waldron², Charles W. Lafon³, David M. Cairns³,
Maria D. Tchakerian¹, Kier D. Klepzig⁴, and Robert N. Coulson¹

¹Texas A&M University, Knowledge Engineering Laboratory,
Department of Entomology, College Station, TX 77843

²University of West Florida, Department of Environmental Studies,
Ft. Walton Beach, FL 32547

³Texas A&M University, Department of Geography,
College Station, TX 77843

⁴U.S. Forest Service, Southern Research Station,
Asheville, NC 28804

ABSTRACT

Southern Appalachian forests face multiple environmental threats, including periodic fires, insect outbreaks, and more recently, exotic invasive plants. Past studies suggest these multiple disturbances interact to shape species-rich forest landscape, and they hypothesize that changes in fire regimes and increasing landscape fragmentation may influence invasive processes. However, long-term impacts of these multiple factors, landscape-scale processes that drive invasion, and forest management practices required to reduce damage from invasive plants are still unclear. We have developed a modeling approach to investigate the synergistic effects of wildfires and landscape fragmentation on the spread of two major exotic invasive plants, princess-tree (*Paulownia tomentosa*) and tree-of-heaven (*Ailanthus altissima*). LANDIS-II, a spatially explicit forest succession model, was used to simulate forest dynamics and plant invasion in a xeric pine-oak landscape, the predominant vegetation in the southern Appalachian Mountains. We parameterized a pool of the 36 dominant tree species including three major invasive tree species, and using a variety of forest fragmentation and fire scenarios, simulated changes in the abundance of the two invasive plants over a 200-year period. Species establishment coefficients were derived through rescaled spatial

constancy data from the Carolina Vegetation Survey. We found that intermediate levels of fire frequency promoted spread of the invasive species, but that low and high extremes of fire frequency limited their invasions. Increased fire frequency promoted the growth of yellow pine species (pitch pine, Table Mountain pine, and shortleaf pine), while reducing less fire tolerant white pine. We also found that under the same level of fragmentation, a higher proportion of initial forested patches resulted in an increase in abundance of the invasive species in the landscapes because of greater seed availability. These results suggest that the synergistic effects of wildfires and landscape fragmentation are complex, and increasing fire frequency (or re-introducing fires) could maintain xeric pines, but it also may promote plant invasion. Under increasing fragmentation, a tradeoff between lower fire frequencies to minimize plant invasion and higher frequencies to promote pines in the southern Appalachian landscape may be required for integrated forest vegetation management. More generally, the modeling framework we have developed will allow us to investigate the factors that promote the spread of other invasive species, and in return, help foresters manage the invasive plant problems.