INVASIBILITY OF MAJOR FOREST TYPES BY NON-NATIVE CHINESE TALLOW IN EAST TEXAS

Zhaofei Fan[1]

Abstract--Non-native invasive Chinese tallow trees [*Triadica sebifera* (L.) Small*,*formerly *Sapium sebiferum* (L.) Roxb.] are rapidly spreading into natural ecosystems such as forests in the southeastern United States. Using the 2001-2010 USDA Forest Service's Forest Inventory and Analysis (FIA) data and forest land cover data, we estimated the regional invasibility of major forest types (groups), loblolly/shortleaf pine forests and oak/gum/cypress forests, by using Geographic Information Systems (GIS) and geostatistical tools. We defined the regional invasibility of a forest ecosystem as its susceptibility to the colonization and establishment of Chinese tallow, measured by a function of tallow presence and cover percent. The invasibility of these two major forest types to tallow has been estimated and potential management applications discussed.

INTRODUCTION

The rapid spread of Chinese tallow [*Triadica sebifera* (L.) Small*,*formerly *Sapium sebiferum* (L.) Roxb.] is a significant concern in the southeastern United States, for it displaces native species, changes natural soil conditions, and creates a transformation of community structure from grassland to woodland (Battaglia and others 2009, Bruce and others 1995). Wang and others (2011) utilized Forest Inventory and Analysis (FIA) data from the USDA Forest Service to simulate the expansion of Chinese tallow (hereafter referred to as tallow) in Texas and Louisiana. They estimated that over 1.5 million ha of forest lands could be occupied by tallow by the year 2023. Further, their study estimated that tallow could migrate over 300 km into areas as far north as 34 °N latitude within the next 115 years (100 years if temperatures increase by 2 °C).

For invasive species research and management, it is a challenge to understand the invasion process and associated driving factors and to design effective methods for controlling the spread of tallow and reducing ecological and economic loss. The objective of this study is to quantify the invasibility of major forest communities by tallow. The information will be useful to control and mitigate the spread of tallow trees in southern forested lands.

METHODS

The study area is confined to east Texas where tallow has a relatively longer invasion history and is more prevalent in the target forests (fig. 1). From 2001 to 2008, a total of 2,426 FIA plots were measured in east Texas among which 454 plots were found to be infested by tallow with an overall probability of presence of 19 percent. Of the 2,426 FIA plots, there were 2,224 that were measured in both consecutive cycles (1999-2004 and 2005-2008), and 190 of the plots were found to be newly infested by tallow in the 2005-2008 period. This represented an overall annual probability of spread of 1.8 percent. Classification and regression tree (CART) was used to classify the study region into a set of homogenous, stationary sub-regions of similar spread patterns of tallow. Within each homogeneous sub-region, both the newly infested and all infested FIA plots were extracted, separately by forest type group and the spread rate (change of presence probability). The cover change of tallow in different forest types/communities was calculated from this information. To assess the invasibility of a forest community, we calculated the means of presence probability and cover percent by CART-identified sub-region. A simple linear regression was used to analyze the relationship between cover percent (response variable) and presence probability (independent variable). The slope (increase of cover percent per unit of change of presence probability) of the regression was used to measure the "relative invasibility" of a forest community.

[1]Associate Professor, Mississippi State University, College of Forest Resources, Department of Forestry, Mississippi State, MS 39762.
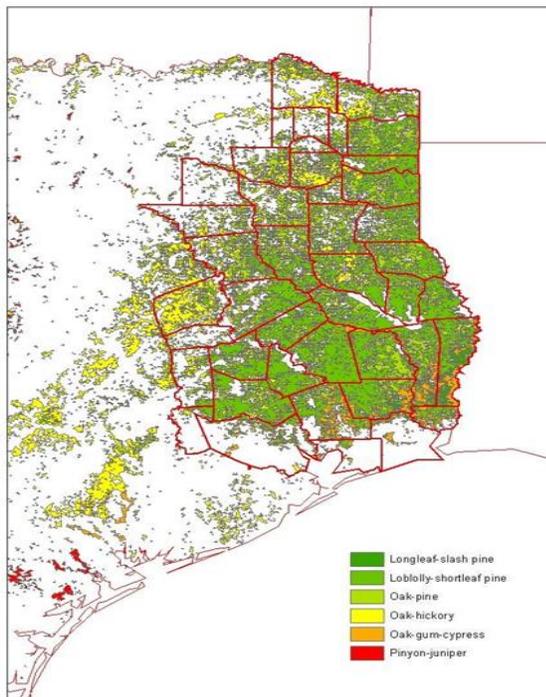
Figure 1--Distribution of forest covers/communities in east Texas

RESULTS AND DISCUSSION

As reported by Fan and others (2012), east Texas was classified into four relatively homogeneous spread regions: (1) region I, latitude ≤ 30.4˚ and longitude ≤ -94.9˚ (most prevalent); (2) region II, latitude ≤ 30.4˚ and longitude > -94.9˚ (highly prevalent); (3) region III, latitude > 30.4˚ and longitude > -94.9˚ (moderately prevalent); and (4) region IV, latitude > 30.4˚ and longitude ≤ -94.9˚ (less prevalent). This spread pattern was attributed to climate (e.g., low temperature), site slope, distance to roads and infested plots, forest type, stocking, physiographic condition, human activity, and natural disturbances such as wind and fire. However, the impact of these factors varied spatially. Among the identified contributing factors, forest type proved to affect tallow spread regionally (Fan and others 2013). Within the two dominant forest type (groups), the oak/gum/cypress forest (annual infestation probability = 3.5 percent) was more sensitive to invasion than the loblolly/shortleaf pine forest (annual infestation probability = 1.8 percent). Due to many confounding factors, the cover change of tallow *per se* is not appropriate to quantify the invasibility of different forest communities (types). Instead, the slope of the

regression model of tallow's cover change against its presence probability change from each homogeneous spread region was used. The slope of the regression model for the oak/gum/cypress forests was nine times larger than that of the loblolly/shortleaf pine forest, indicating the former was highly susceptible to tallow compared to the latter (fig. 2). The slope coefficient considered both the invasion (introduction and spread) and growth (colonization and establishment) processes and balanced the potential confounding factors in the regression model. Therefore, it is more reliable to evaluate the general invasibility of a forest community, and useful comparisons of invasibility (or susceptibility) among different forest communities and environments can be made.

CONCLUSION

The invasibility (susceptibility) of major forest types/groups to invasive species varies by a number of contributing factors that affect the invasion and growth process. But the average invasibility can be estimated by a relative measure, the slope coefficient of the regression lines of cover (dominance) change versus presence (abundance) data. By the slope coefficient, the oak/gum/cypress forest is more invasive or susceptible to tallow than the loblolly/shortleaf pine forest.

LITERATURE CITED

Battaglia, L.L.; Denslow, J.S.; Inczauskis, J.R.; Baer, S.G. 2009. Effects of native vegetation on invasion success of Chinese tallow in a floating marsh ecosystem. Journal of Ecology. 97(2): 239-246.

Bruce, K.A.; Cameron, G.N.; Harcombe, P.A. 1995. Initiation of a new woodland type on the Texas coastal prairie by the Chinese tallow tree [*Sapium sebiferum* (L.) *Roxb*.]. Bulletin of the Torrey Botanical Club. 122: 215-225.

Fan, Z.; Tan, T.; Crosby, M.K. 2012. Factors associated with the spread of Chinese tallow in east Texas forestlands. Open Journal of Ecology. 2(3): 121-130.

Fan, Z.; Moser, W.K.; Hansen, M.H.; Nelson, M.D. 2013. Regional patterns of major non-native invasive plants and associated factors in upper midwest. Forest Science. 59 (1): 38-49.

Wang, H.H.; Grant, W.E.; Swannack, T.M. [and others]. 2011. Predicted range expansion of Chinese tallow tree (*Triadica sebifera*) in forestlands of the southern United States. Diversity and Distributions. 17: 552-565.
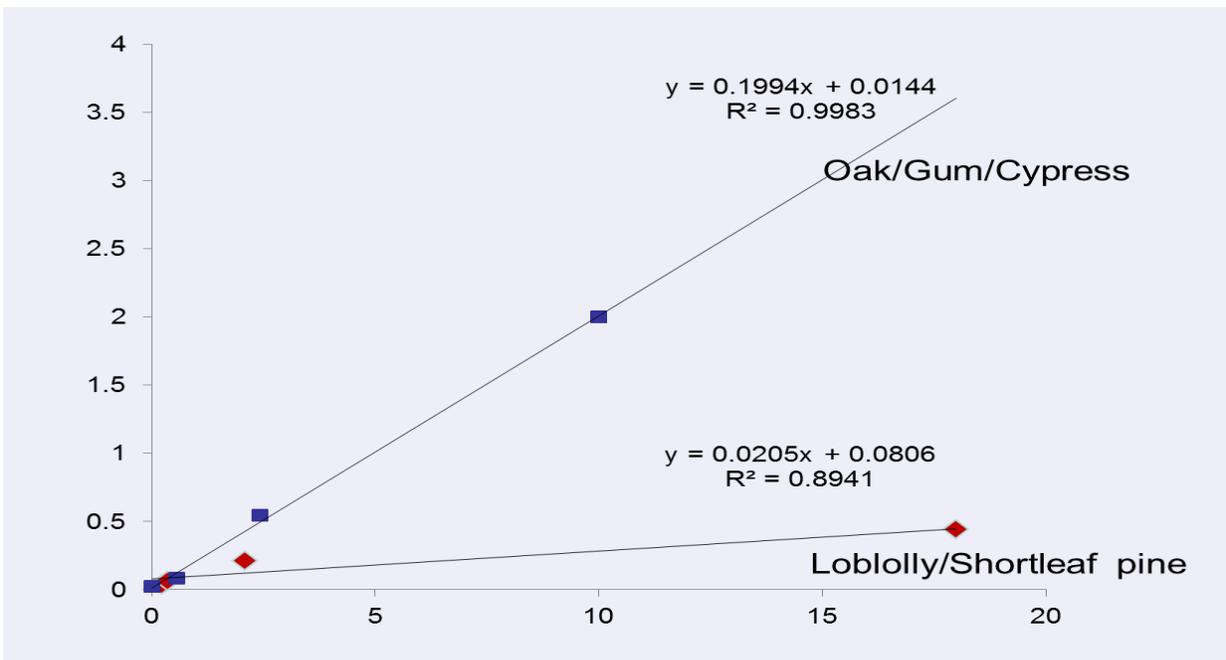
Figure 2--Regression lines of annual increase of cover (%, Y-axis) vs. presence probability (%, X-axis) of tallow by forest type (group).