

Estimation of Presence Probability of Multiflora Rose and the Driving Factors in the Upper Midwest

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Introduction

Non-Native invasive plants (NNIP) cause billions of dollar losses each year. It is a challenge for setting management policy since the management of NNIP depends on the stages of invasion. There are four of these stages: introduction, colonization, establishment and spread. In general, it is prohibitive to get rid of the NNIP from the invaded region when the invaded plant is well established. Efforts to control invasive plants should focus on the establishment stage (Webster et al. 2006). Thus, identify the invasion stages by investigating the presence probability is critical to developing an effective management strategy.

Objectives

- Investigate the distribution of Multiflora Rose (MR)
- Estimate the presence probability at the county level
- Identify the invasion stages of MR and the severely invaded region (or the called “hot area”)
- Identify the driving factors that affect MR establishment

Data

- In total, 8,863 FIA data measured in 2005 and 2006 across the seven Upper Midwest states were included.
- Potential driving factors including county forest percentage, road density, forest type, ecoregion, forest fragmentation, latitude, and longitude, were calculated based on the FIA and USGS database.

Methodology

- The presence probability for each county is estimated by:

$$p_i = \frac{\sum_{j \in \eta_i} s_j}{\sum_{j \in \eta_i} n_j}$$

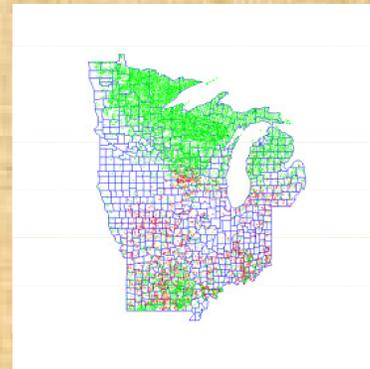


Figure 1. FIA plots with (red) and without (green) MR in the Upper Midwest.

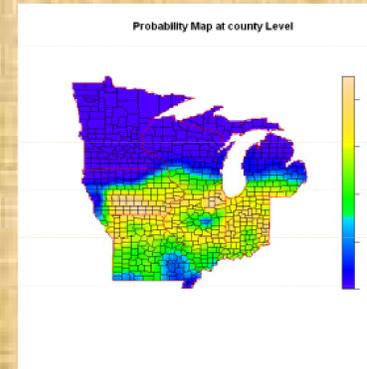


Figure 2. The smoothed presence probability of MR (bandwidth = 0.25)

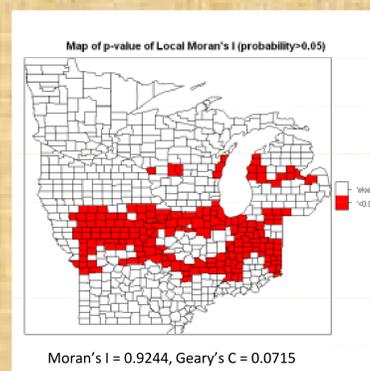


Figure 3. The “hot spots” of MR based on the local Moran’s I test .

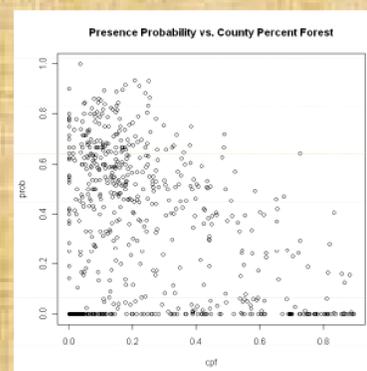


Figure 4. Relationship between MR presence probability and county forest percentage.

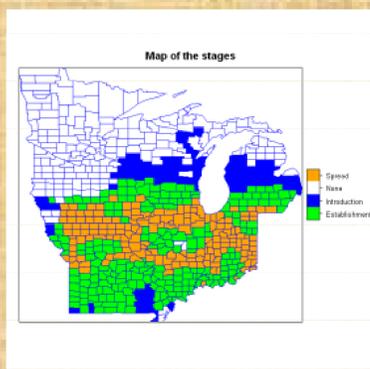


Figure 5. The invasion stages of MR based on the estimated presence probability: introduction (0, 0.2), establishment [0.2,0.6), and spread= [0.6,1).

where: s_j is the number of presence plots in the county j , n_j is the total plots in the county j , η_i is the set of neighbor for the county i , including the county i .

- Gaussian kernel smoothing was conducted to estimate the presence probability of MR across the study area.
- Moran’s I test was used to identify local clusters (or “hot spots”) with the p-value of local Moran’s I less than 0.05.
- The spatial autoregressive (SAR) model was used to identify the driving factors.

Preliminary Result

- The estimated probability map shows that MR spreads mainly toward east, west and south. Temperature is possibly a limiting factor for MR to spread toward north (Minnesota, Michigan and Wisconsin) (Fig. 2).
- The Moran’s I and Geary’s C Tests show that the distribution of MR is highly spatially correlated. The “hot spots” are mainly clustered in Iowa, Illinois, Indiana and northern Missouri(Fig. 3).
- The SAR model shows that county forest percentage is the only significant driving factor and is negatively related to the presence probability of MR (Fig. 4).
- Based on the probabilistic analysis of the estimated county-level presence probability of MR, four invasion stages: non-infestation (white), introduction (blue), establishment (green) and spread (maroon) were delineated (Fig. 5).

Literature Cited

- Moser, W.K., Hansen, M.H., and Nelson M.D., The extent of selected non-native invasive plants on Missouri forestland, *Proceedings of the 16th Central Hardwoods Forest Conference*.
- Webster Cr, Jenkins MA, Jose S. 2006, Woody invaders and the challenges they pose to forest ecosystems in the eastern United States, *J Forestry*, 104(7): 366-374