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Kristen Kordecki
Chicago Botanic Garden

Mark P. Widrlechner
United States Department of Agriculture, isumw@iastate.edu

Peter Bristol
Chicago Botanic Garden

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Predicting the Risk of Naturalization for Non-native Woody Plants in the Chicago Region

Kristen Kordecki[1], Mark Widrlechner[2], and Peter Bristol[1]

[1]Chicago Botanic Garden, Glencoe, IL; [2]USDA-ARS, North Central Regional Plant Introduction Station, Ames IA

Abstract

We investigated 135 non-native woody plants commonly cultivated in the Chicago region to determine if we can use models developed in Iowa to predict whether non-native woody plants will become naturalized (and thus, potentially invasive) based on climate data, native range data and life characteristics. At present, the data collected and preliminary results hold out promise that this approach will produce predictive models useful in the Chicago region.

Introduction

Non-native, invasive plant species have become a significant ecological and economic issue, as global species diversity decreases and the cost of management increases. Invasive plants constitute a threat to global biodiversity second only in impact to the direct destruction of habitat (Coblentz, 1990; Mack et al., 2000). Although relatively few cultivated woody plants have become problematic in non-cultivated areas (Reichard & Hamilton, 1997), their numbers are increasing. For example, the asian bittersweet, *Celastrus orbiculatus* (Fig. 1), is now posing serious threats to forest ecosystems in the Eastern and Central US.

As they become more sophisticated, risk assessment protocols are proving useful in predicting the likelihood that a species will become naturalized or invasive. Modeling with life-history characteristics, native-range data and climatic analogs can provide researchers, land managers and horticulturists with a powerful new tool to predict the risk of naturalization (Widrlechner et al., 2004).

Fig. 1 *Celastrus orbiculatus* (Photo credit: The Nature Conservancy)

Methods

Swink and Wilhelm (1994) included 22 counties from WI, IL, IN, and MI in the Chicago region. For this study, we expanded the region by adding three counties in IN and three in MI (Fig. 2). We divided the region into two study areas, of approximately equal size: Part A in WI and IL, and Part B in IN and MI. Each of the study areas is relatively homogenous for climate and soils. Calcareous clay and loam soils are common in Part A and sand and muck soils widespread in Part B.
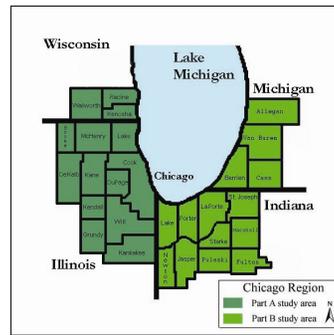

Fig. 2 Chicago region study areas

We collected life-characteristic (Table 1) and native-range data for 135 non-native tree, shrub and vine species widely cultivated in the Chicago region. Of the 135, we determined that 38 species (28%) can be considered as naturalized in Part A of the study area. Local floras, Manual of Woody Landscape Plants (Dirr, 1998), Internet resources and experts were consulted to obtain life-characteristic information. Native-ranges were gathered primarily from the GRIN database, supplemented by the Floras of North America, China, Japan and Taiwan.

Preliminary Results

We have been able to prepare a world map displaying the proportion of a region's native woody plants cultivated in Part A of the Chicago region that have naturalized there. This helps identify parts of the world that have particularly low or high risks of naturalization. In Figure 3, yellow and orange regions have below-average risk, but red and purple regions have woody floras that are more prone to naturalize in the Chicago region. Such maps should be useful for evaluating future explorations and new foreign introductions.

Fig. 3 Proportion of naturalizing taxa (N ≥ 10)

Widrlechner et al. (2004) published geographic-risk factors for 100 species based on their native ranges. We independently calculated such factors for 135 species. A linear regression (Table 2) between Iowa values and those for Part A of the Chicago region resulted in a high correlation with a slope of ~ 1 and intercept ~ 0. These data strongly suggest that the geographic component of models developed for Iowa will be transferable to the Chicago region.

Table 2 Comparison of geographic-risk values for Iowa and the Chicago region
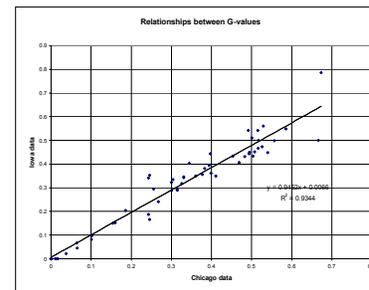
Next Steps

Our next steps include subjecting the life-history characteristics for all 135 species to a decision tree designed by Reichard and Hamilton (1997) and to three models developed from Iowa data (Widrlechner et al., 2004). All these models categorize species into three classes: "accept for introduction," "reject," or "further analysis." We can determine the power and accuracy of the various models based on how well they assign species to these classes. If none of these models has acceptable levels of power and accuracy, we will employ classification and regression trees (CART) (Fig. 4) to extract the most significant combinations of life-history characteristics and geographic-risk values and develop a new model for Part A of the Chicago region. We also plan to test our models on Part B to help determine the role that local edaphic and climatic variation plays in influencing the power and accuracy of models.
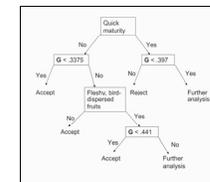

Fig. 4 Sample CART model (Widrlechner et al., 2004)

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Table 1 Sample life-characteristics spreadsheet

Scientific Name	Invades Outside NA	Group is Invasive in NA	NA Native	Naturalized in Chicago region (Part A)	Quick Vegetative Spread	Sterile Hybrid	Quick Maturity	Requires Germ Pre-treatment	Fleshy Fruits Dispersed by Birds	Evergreen
Aronia arbutifolia (L.) Pers.	0	1	1	0		0		1	1	0
Berberis thunbergii DC.	1	0	0	1	0		0	0	1	0
Calycanthus floridus L.	0	0	1	0	0		0	1	0	0
Campsis radicans (L.) Seem. ex Bureau	1	0	1	1	1		0	1	0	0