Evaluation of the Viability of the Butternut Resource

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Introduction

Butternut (*Juglans cinerea* L.) is a widespread, but rare tree. Its natural range extends from New Brunswick south to North Carolina, then west to Minnesota and south to Missouri. Additionally, small pockets of butternut occur in Arkansas, Mississippi, Alabama, Georgia, and South Carolina (Rink 1990) (Fig. 1). Butternut is valued for its wood, flavorful nuts, wildlife mast, and contribution to forest diversity. Its wood is used for furniture, paneling, specialty products, and carving.

Figure 1. Range of butternut (*Juglans cinerea* L.).

Butternuts were first reported dying from a canker disease in 1967. Since then, butternuts of all ages have been dying throughout their range in North America (Ostry 1998b). The fungus *Sirococcus clavigignenti-juglandacearum* is the cause of the lethal stem disease that may be threatening the viability of butternut as a species (Ostry et al. 1994, Ostry 1998a, Nair 1998). This fungus was probably introduced into North America (Furnier et al. 1999) and is possibly spread by insects (Katovich and Ostry 1998).

Objectives

1. *To determine the frequency of occurrence of butternut using updated FIA data by ecoregions, states, counties, or other units.*
2. *To determine the site or stand factors in which butternut occurs to determine information for restoration and/or preservation.*
3. *To determine the change in butternut frequency over time due to incidence of butternut canker disease.*

Abstract

Butternut (*Juglans cinerea* L.), a widespread but rare tree, is being affected by a lethal canker disease caused by the *Sirococcus clavigignenti-juglandacearum* fungus. The fungus was probably introduced from outside North America and is possibly spread by insects. The first butternut deaths were reported in 1967 and butternuts of all ages are dying throughout the range of butternut in North America. We evaluated the distribution of butternut in the eastern United States using U.S. Forest Service Forest Inventory and Analysis (FIA) plot data. Butternut occurrence was then classified by ecoregion province and section levels. Significant differences in butternut occurrence existed at both levels. Kriging was used to initially derive a probability map of butternut occurrence across the eastern United States. This map was then overlaid by forest density data, resulting in an adjusted probability map of butternut occurrence in eastern forests. Candidate areas for butternut reintroduction have been identified by this analysis. In addition, field plots evaluating the progression of butternut canker in natural and planted seedlings in young stands were established.

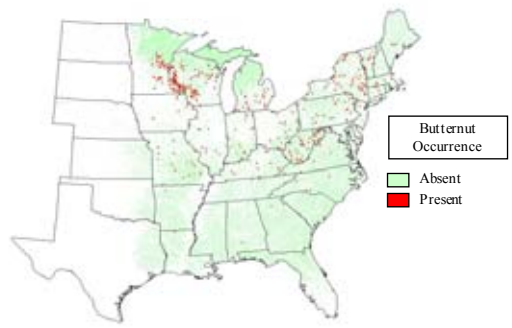

Figure 6. Presence or absence of butternut trees on FIA plots in the eastern United States. (Symbols for plots with butternut present are enlarged to aid viewing.)

Table 1. Butternut occurrence by ecoregion province.

Province	# of FIA Plots with Butternut	Total # of FIA Plots	% of Plots w/ Butternut
222	215	13871	1.55
M221	68	5630	1.21
221	72	6332	1.14
M212	21	2953	0.71
212	114	24354	0.47
251	17	4156	0.41
231	8	14138	0.06
232	2	13830	0.01
234	0	1267	0.00
255	0	615	0.00
331	0	158	0.00
332	0	462	0.00
411	0	52	0.00
M222	0	474	0.00
M231	0	753	0.00

Table 2. Butternut occurrence by ecoregion section for the 20 sections with the most butternut.

Section	# of FIA Plots with Butternut	Total # of FIA Plots	% of Plots with Butternut
222L	95	1211	7.84
212E	13	221	5.88
221B	14	343	4.08
222M	35	1344	2.60
222I	14	564	2.48
222J	24	1006	2.39
212K	30	1429	2.10
222H	10	515	1.94
M221B	17	920	1.85
212F	23	1330	1.73
M212C	8	487	1.64
M221A	37	2392	1.55
221F	7	487	1.44
M221C	8	560	1.43
221D	3	211	1.42
251B	3	226	1.33
251D	7	558	1.25
221E	31	2523	1.23
M212B	5	420	1.19
221A	11	953	1.15

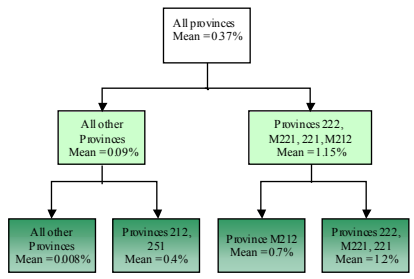

Figure 7. A CART analysis of province-level proportion of plots with butternut produced four significantly different groups.

Methods

Objective 1

FIA plot data were classified according to butternut occurrence. This analysis was done using the most recent FIA data from each state in the eastwide database. The classified plots were further classified using a hierarchical ecological classification system of ecoregion provinces and sections (Bailey 1995, Fig. 2). A nonparametric data classification technique (CART) was used to look for differences in butternut occurrence between provinces and sections.

Indicator kriging was repeated separately for each ecoregion section in the East to estimate the probability of a cell having butternut present. The results were put together into a mosaic. These probability estimates were then adjusted for forest density using a land cover (proportion forest) map generated from Multi-Resolution Land Characteristics Consortium (MRLC) data. Each 30-m pixel was classified as either forest or non-forest and then pixels were aggregated into 1-km percent forest pixels. The forest density map values were then multiplied by the butternut probability map values to create an adjusted kriged butternut canker susceptibility map.

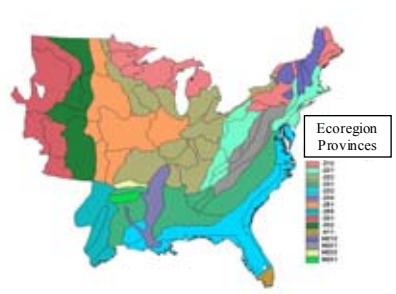

Figure 2. Ecoregion map of provinces (colored areas) and sections within provinces (black lines).

Objective 2

FIA plots with and without butternut will be used for a nonparametric data classification technique (Classification and Regression Trees, or CART) analysis that finds natural divisions in site and stand variables to distinguish site characteristics that favor butternut. This will be done in the second year.

Objective 3

Two approaches are being used to accomplish this objective:

1. Establishment of permanent plots on the Monongahela, Allegheny, and Nicolet National Forests in stands with a significant butternut component to follow changes over time. In 2001, 33 plots were established on the Nicolet National Forest on 160 acres. Treatments included uncut controls (Fig. 3); 30 and 60 ft^2/acre residual BA level shelterwood cuts; and 1-, 2-, and 5-acre clearcuts (Fig. 4). Butternuts were reserved using guidelines and butternut seedlings were planted (Fig. 5).

2. Analysis of FIA remeasured plot data from multiple surveys will be used to detect changes in butternut occurrence or mortality over the last 20 to 30 years. This will be done in the third year.

Figure 3. Healthy butternut reserve tree in an uncut control plot.

Figure 4. View of a clearcut plot from the buffer area.

Figure 5. Planted butternut seedling in a clearcut plot.

Results

Objective 1

We first made a map of all FIA plots showing where any butternut tree was measured (Fig. 6). There is a strong correlation between the range map and butternut occurrence on FIA plots. We then grouped the FIA plots by province and section within the eastern United States and calculated the percentage of the FIA plots that had at least one butternut tree present. Seven of the 15 provinces contained no butternut. Butternut occurrence ranged from 0.01 to 1.55% of the FIA plots in the other 8 provinces (Table 1).

A Classification and Regression Trees (CART) analysis showed that the 15 eastern U.S. ecoregion provinces analyzed were classified into four significantly different groups based on the percentage of FIA plots containing butternut (Fig. 7). Of the 82 sections within the 15 provinces analyzed, 40 had no butternut sampled. Of the 42 sections that had butternut, the percentage of FIA plots containing butternut ranged from 0.03 to 7.8%. Section 222L, the North Central U.S. Driftless and Escarpment, contained a significantly higher proportion of butternut (7.8%) than all other sections (Table 2).

Kriging produced a probability surface where the probability of butternut occurrence varied from 0 to 74.6 percent (Fig. 8). One problem with these kriged surfaces is that non-forested land is included in the surface. Using the forest density map (Fig. 9) as a filter, we could then adjust the probabilities to values that are more representative of actual forest occurrence. The resulting probability surface is reduced both in area (non-forest areas dropped) and in probability with the range now varying from 0 to 71.5 percent (Fig. 10).

Objective 3

Results for the Nicolet National Forest butternut regeneration study include: (1) Reserve trees exposed in clearcuts were in poorer health than elsewhere, (2) there were few stump sprouts, (3) butternut regeneration was not uniform across the site, (4) 60% of the butternut regeneration was cankered, (5) there was poor survival of planted butternut stock, (6) new seedlings continued to be recruited, and (7) previously tagged "resistant" trees were still healthy.

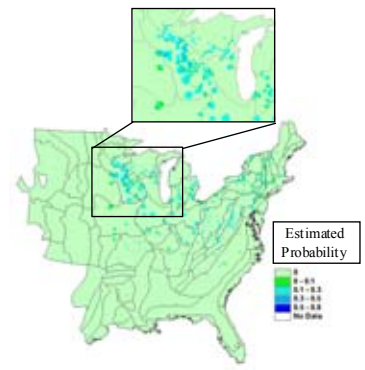

Figure 8. Kriged map of butternut occurrence probabilities based on FIA plots for each ecoregion section.

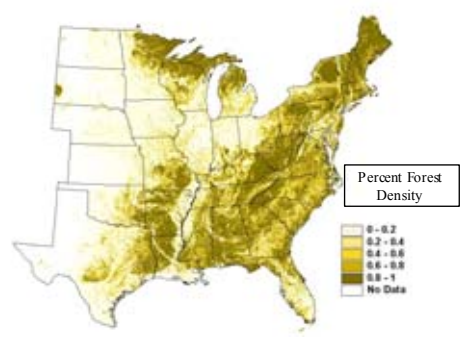

Figure 9. Percent forest density map based on MRLC data.

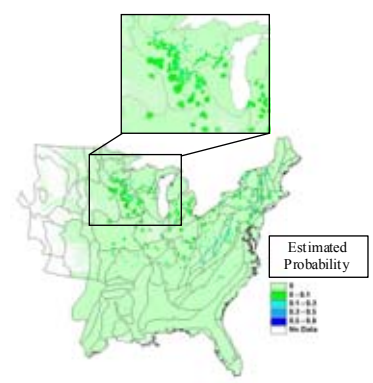

Figure 10. Kriged map of butternut occurrence probabilities adjusted for forest density.

Conclusions

- Several provinces and several sections within provinces have significantly greater occurrence of butternut than others.
- Butternut occurrence, while rare, has a definite ecological relationship that can be used to identify areas for butternut reintroduction or preservation.
- Butternut regeneration will not be successful without resistant planting stock.
- Resistance appears to be persisting in some trees.
- Further analysis will look for site characteristics and mortality trends over time.

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