Risk Mapping for Forest Pests

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White Oak, *Quercus alba*
The Native Range of White Oak

(Burns & Honkala 1990)
The Native Range of Northern Red Oak

(Burns & Honkala 1990)
Chestnut oak, *Quercus prinus*

(Liebhold et al. 1997)
The Native Range of Chestnut Oak

(Burns & Honkala 1990)
The Native Range of Black Oak

(Burns & Honkala 1990)
Northern Red Oak, *Quercus rubra*

(Liebhold et al. 1997)
Total Basal Area of Preferred Species

ft² / acre

- 0 - 0.33
- 0.33 - 3.6
- 3.6 - 10.6
- 10.6 - 18.3
- 18.3 - 70.1
- no data
Percent Land Area Above 20% in Preferred Basal Area

Legend:
- Blue: 0.0 to 0.5
- Green: 0.5 to 2.0
- Yellow: 2.0 to 5.0
- Red: 5.0 to 10.0
- Pink: 10.0 to 100.0
- No Data
Percent Land Area Above 80% in Preferred Basal Area
Second Effort….

- In round two, S&PF was interested in making a national forest pest risk map.
- Sandy and I were approached about revising our gypsy moth effort.
- For this effort, we started with the FIA AVHRR forest type map.
- GM rate of spread was added into this effort as well.
FIA forest type group map

Subset for forest type groups that contain susceptible forest types (Oak-pine, Oak-hickory, Oak-gum-cypress, Elm-ash-cottonwood, and Aspen-birch):

Susceptible types
… excluded any counties where less than 10% of land area was covered by forests that have > 20% BA preferred species…

(from: Liebhold et al. J. Forestry 95: 20-24)
Susceptible forest types
Third effort…

- Sandy had been introduced to geostatistics, so the availability of actual GPSed plot locations allowed us to use kriging as a new approach.
1989 Pennsylvania FIA data % basal area: Preferred by gypsy moth

% BA in Preferred Species

<table>
<thead>
<tr>
<th>% BA</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10.5</td>
<td>#</td>
</tr>
<tr>
<td>10.5 - 27.6</td>
<td>#</td>
</tr>
<tr>
<td>27.6 - 47.7</td>
<td>#</td>
</tr>
<tr>
<td>47.7 - 70.8</td>
<td>#</td>
</tr>
<tr>
<td>70.8 - 100</td>
<td>#</td>
</tr>
</tbody>
</table>
% BA Preferred by the Gypsy Moth
Kriged from 1989 PA FIA Plot Data
Final kriged map for east

% BA in Species Preferred by Gypsy Moth

% Preferred BA
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
STDP Proposal for Risk Mapping Technology

- Armed with actual plot locations and our new geostatistical tools, we got funded to develop this technology along with rate of spread into a prototype for the National Pest Risk Map
RESULTS – Beech bark disease
RESULTS – Beech bark disease
RESULTS – Hemlock Woolly Adelgid

Hemlock basal area (m²/ha)
- 0
- 0 - 3
- 3 - 6
- 6 - 9
- 9 - 12
- 12 - 15
- No Data

Hemlock basal area (m²/ha) adjusted for forest density
- 0
- 0 - 3
- 3 - 6
- 6 - 9
- 9 - 12
- 12 - 15
- No Data

% forest cover
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- No Data
RESULTS – Hemlock Woolly Adelgid
RESULTS – Gypsy Moth

Basal area (m²/ha) of species preferred by gypsy moth

- 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 28
- No Data

Basal area (m²/ha) of species preferred by gypsy moth adjusted for forest density

- 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 28
- No Data

% forest cover

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- No Data
RESULTS – Gypsy Moth

Proportion of years with gypsy moth infestation through 2025:
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- No Data

Gypsy moth risk through 2025:
- 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 23
- No Data
About this time, Sudden Oak Death hit the scene

- I heard a talk by David Rizzo on his tests of northern red oak and black oak
- I decided to use this approach to determine the risk to the East from SOD
- Our risk map went on to be used as the basis of the national SOD risk map
- We then added in the NE shrub data as an additional risk factor
Kriged map of the estimated percent forest basal area for the red and live oak groups adjusted for forest density.
Kriged probability of overstory hosts of *Phytophthora ramorum*
Kriged probability of understory hosts of *Phytophthora ramorum*
Probability of presence of overstory and understory hosts of *Phytophthora ramorum*
Forest Health Monitoring, Evaluation Monitoring Proposal on Butternut

- Butternut canker has been devastating butternut
- However, Mike Ostry has some putative resistant genotypes
- If true resistance exists, then knowledge on where to restore butternut is needed
- We mapped the occurrence of all butternut (live and dead) and also analyzed by ecoregions and found out some interesting things
Butternut Presence/Absence

Absent

Present
Estimated probability of occurrence of butternut
Butternut occurrence by ecoregion province.

<table>
<thead>
<tr>
<th>Province</th>
<th># of FIA Plots with Butternut</th>
<th>Total # of FIA Plots</th>
<th>% of Plots w/ Butternut</th>
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<tbody>
<tr>
<td>222</td>
<td>290</td>
<td>13862</td>
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<tr>
<td>221</td>
<td>88</td>
<td>6318</td>
<td>1.39</td>
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<tr>
<td>M221</td>
<td>74</td>
<td>5614</td>
<td>1.32</td>
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<tr>
<td>M212</td>
<td>28</td>
<td>2915</td>
<td>0.96</td>
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<tr>
<td>251</td>
<td>26</td>
<td>4156</td>
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<td>212</td>
<td>142</td>
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<td>231</td>
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<tr>
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<td>753</td>
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</table>
A CART analysis of province-level proportion of plots with butternut produced four significantly different groups.
Butternut occurrence by ecoregion section.

<table>
<thead>
<tr>
<th>Section</th>
<th># of FIA Plots with Butternut</th>
<th>Total # of FIA Plots</th>
<th>% of Plots w/ Butternut</th>
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<tr>
<td>222L</td>
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<td>212E</td>
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<td>221B</td>
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<td>M221A</td>
<td>40</td>
<td>2387</td>
<td>1.68</td>
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</table>
State & Private wanted an Emerald Ash Borer Risk Map

- Based on our success creating the SOD risk map, an EAB risk map was requested.
- We did two different host layers for this map – an upland ash layer based primarily on FIA plots and a lowland ash layer based on FIA plots and other factors.
Risk to Emerald Ash Borer based on Forests

Ash basal area/acre adjusted for forest density

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 10
- 10 - 28
- No Data

North

Miles

600

0

600

1200
Riparian ash host risk to EAB
Summary

- Over time, we have increased our ability to create realistic estimates of species occurrences that allows us to estimate invasive pest risk.
- Given the host species range, we can produce a host risk map for almost any forest pest.
- We have used only periodic FIA data so far – the challenge ahead is to figure out how to incorporate annual FIA data into this system.