Is Japanese Barberry the Next Multiflora Rose? – Exploring Current and Future Suitable Habitat in Wisconsin

NIELS JORGENSEN AND MARK RENZ
Source: climate.nasa.gov
HOW IS WISCONSIN’S AVERAGE ANNUAL TEMPERATURE CHANGING?

1. Investigate observed and projected temperature change by selecting a decade on the left side.
2. Select a decade on the right side and compare maps using the temperature color scale.
3. Roll over maps to compare temperatures for communities throughout Wisconsin.
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SELECT DECADE

2000

47.9°F

SELECT DECADE

2070

55.4°F

vs.
How is Wisconsin's Average Annual Temperature Changing?

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Invasive Plants and Climate Change

Invasive plants have been shown to better respond to changes in the environment

- Earlier season green-up (Miller-Rushing et al. 2006)
- Utilize CO₂ more effectively (Free Air Carbon Dioxide Enhancement studies)
- Track climate space better than natives (Beckage et al. 2008)
**Berberis thunbergii**

Shrub native to Japanese highlands

Introduced to the US in 1875 as ornamental

Regulated species in the state of Wisconsin
  - Restricted status
  - Not all cultivars are regulated

Leaves out early in spring and persists well into fall
  - Beginning to see an increase in reports in our natural areas

Major issue in parts of New England, where it has been shown to produce thick stands that provide ideal habitat for ticks that carry Lyme disease
Question and Objectives

What is the extent of Japanese barberry suitable habitat in WI currently, and does that change in the future?

Determine drivers of suitable habitat for Japanese barberry under current climatic conditions in WI

Predict potential suitable habitat under future climate change scenarios

Explore most at risk areas and land cover types
Habitat Suitability Modeling

- Species occurrence records
- Extensive database

- Precipitation
- Temperature
- Soils attributes
- Distance to dispersal corridors
- Topographic attributes
- Vegetation indices
- Generally accepted predictors from literature

\[ \text{Probability of suitable habitat} \]

\[ \text{Species occurrence records} + \text{Extensive database} = \text{Probability of suitable habitat} \]
Approach

Developed habitat models using 5 commonly accepted approaches

- 30-m spatial resolution; Wisconsin as spatial extent
- Probability maps were converted to binary (suitable pixels vs. not-suitable)
- Assessed common drivers of suitable habitat

Applied 12 different future climate change scenarios keeping other variables constant

- Ranged from conservative to extreme estimates
- Predictions were to mid-century and end-century

Summarized climate change results

- Change maps
- Impact assessment of Ecoregions and land cover classes
Results
Model Evaluation

All models performed well based on AUC and other metrics

◦ Great: 0.8-0.9
◦ Excellent: >0.9

Any overfitting of the models was performed prior to development of the climate change models

Field validation data

◦ 84% of new occurrences were correctly classified by models
◦ Data gathered by citizen scientists

<table>
<thead>
<tr>
<th>Model</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boosted regression trees</td>
<td>0.94</td>
</tr>
<tr>
<td>Generalized linear models</td>
<td>0.84</td>
</tr>
<tr>
<td>Multivariate adaptive regression splines</td>
<td>0.89</td>
</tr>
<tr>
<td>MaxEnt</td>
<td>0.91</td>
</tr>
<tr>
<td>Random forests</td>
<td>0.93</td>
</tr>
</tbody>
</table>
Predictor Importance

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Tree Cover</td>
<td>31.91%</td>
</tr>
<tr>
<td>Winter Minimum Temperatures</td>
<td>27.37%</td>
</tr>
<tr>
<td>Summer Precipitation</td>
<td>10.33%</td>
</tr>
<tr>
<td>Summer Maximum Temperatures</td>
<td>4.85%</td>
</tr>
<tr>
<td>Fall Precipitation</td>
<td>4.20%</td>
</tr>
<tr>
<td>Distance to Water</td>
<td>4.10%</td>
</tr>
<tr>
<td>Distance to Roads</td>
<td>3.40%</td>
</tr>
<tr>
<td>Winter Precipitation</td>
<td>2.94%</td>
</tr>
<tr>
<td>Slope</td>
<td>2.92%</td>
</tr>
<tr>
<td>Spring Precipitation</td>
<td>2.46%</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>2.35%</td>
</tr>
<tr>
<td>EVI</td>
<td>1.41%</td>
</tr>
<tr>
<td>% Clay</td>
<td>1.38%</td>
</tr>
<tr>
<td>Aspect</td>
<td>0.38%</td>
</tr>
</tbody>
</table>

- **Percent tree canopy cover**
  - Prefers more dense canopies

- **Winter minimum temperatures**
  - Prefers warmer winter temperatures

- **Summer precipitation**
  - Prefers less precip
Model Results and Change Maps
Current Habitat Model
Current and Future Habitat Model Predictions

Current

2050s

2080s

Change

Model Agreement

0 Models
1 Model
2 Models
3 Models
4 Models
5 Models

Model Agreement

0 Models
1 Model
2 Models
3 Models
4 Models
5 Models

Model Agreement

0 Models
1 Model
2 Models
3 Models
4 Models
5 Models

Change in Model Agreement

Decrease
No Change
Increase

Maps showing the predicted habitat changes for Wisconsin from current conditions to the 2050s and 2080s, highlighting areas of change.
Future Impact Areas
<table>
<thead>
<tr>
<th>Ecoregion Level III</th>
<th>Current Suitability</th>
<th>Percent Change from Current Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2050s</td>
</tr>
<tr>
<td>Central Corn Belt Plains</td>
<td>24.71%</td>
<td>177.79%</td>
</tr>
<tr>
<td>Driftless Area</td>
<td>46.83%</td>
<td>3.40%</td>
</tr>
<tr>
<td>North Central Hardwood Forests</td>
<td>26.89%</td>
<td>50.51%</td>
</tr>
<tr>
<td>Northern Lakes and Forests</td>
<td>25.61%</td>
<td>31.36%</td>
</tr>
<tr>
<td>Southeastern Wisconsin Till Plains</td>
<td>41.06%</td>
<td>4.32%</td>
</tr>
<tr>
<td>Western Corn Belt Plains</td>
<td>17.96%</td>
<td>36.24%</td>
</tr>
</tbody>
</table>

Greatest potential impacted area:
- >1 million hectares in North Central Hardwood Forests
- >2 million hectares in Northern Lakes and Forests
<table>
<thead>
<tr>
<th>Land Cover Type</th>
<th>Current Suitability</th>
<th>Percent Change from Current Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2050s</td>
</tr>
<tr>
<td>Urban/Developed</td>
<td>37.70%</td>
<td>7.31%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>19.86%</td>
<td>-9.92%</td>
</tr>
<tr>
<td>Grassland</td>
<td>16.12%</td>
<td>34.76%</td>
</tr>
<tr>
<td>Forest</td>
<td>38.86%</td>
<td>56.93%</td>
</tr>
<tr>
<td>Wetland</td>
<td>29.84%</td>
<td>22.01%</td>
</tr>
<tr>
<td>Barren</td>
<td>22.43%</td>
<td>-18.13%</td>
</tr>
<tr>
<td>Shrubland</td>
<td>14.26%</td>
<td>88.20%</td>
</tr>
</tbody>
</table>

Greatest potential impacted area:
- >2.5 million hectares of *current* forests
- >500,000 hectares of *current* wetlands
Overall Conclusions

Japanese barberry suitable habitat is largely driven by canopy cover and constrained by climatic drivers.

Future scenarios suggest barberry will generally shift north and to the east.

Areas of increasing suitable habitat:
- Generally speaking all areas will see likely increases in suitability to Japanese barberry.
- Northern Lakes and Forests and Central Hardwoods.

Forests will be increasingly more susceptible to Japanese barberry in the future.
- That comes with the increased potential for tick populations to spread Lyme and other diseases.
Parting question: Will we be able to prevent Japanese barberry from becoming so widespread and abundant that it feels like a lost cause? Can we prevent it from becoming another multiflora rose-level invasion?
Questions?

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Japanese barberry (*Berberis thunbergii*)

Legend:
- No Data
- Species Reported

Map created: 10/4/2018

[Map of Japanese barberry distribution across the United States]
multiflora rose (Rosa multiflora)