Overview

Presented at
National Plant Board Meeting
Mystic, Connecticut
July 23-26, 2012

Who am I?

• Special Projects Coordinator for the PERAL Weed Team
  Plant Protection and Quarantine
  Center for Plant Health Science and Technology
  Plant Epidemiology and Risk Analysis Laboratory
  Raleigh, NC

• Risk analyst – Plant population biology

Our Mission

• Prepare weed risk assessments (WRA) in response to concerns about weed risk from customers
• Provide technical and resource support to colleagues and customers on weed and invasive plant issues
• Support PPQ’s mission of plant protection by proactively identifying and assessing noxious weeds and pest plants of concern

What is Weed Risk Assessment?

WRA: An evaluation of the probability of the introduction and spread of a plant, and of the potential consequences, helping us to make informed management decisions that will reduce the economic and ecological harm caused by weedy and invasive plants

Our WRA process

Receive WRA request
Add to queue and determine priority/target date
Scientific review
Editorial review
Asst. Director review
WRA development
Revision requested
WRA finalized and submitted to customers

Style of the assessment

• Mostly Yes/No questions; a few multiple choice
• Record uncertainty: neglig, low, mod, high, max
• Evidence and supporting documents recorded for each
Risk Elements in the WRA

- Establishment / Spread Potential (23)
- Impact Potential (18)
- Geographic Potential (3/36)
- Entry Potential (14)

The Predictive Model

- Calculates Prob (invasiveness) using a logistic regression model

\[
P(\text{Non-I}) + P(\text{Min-I}) + P(\text{Maj-I}) = 1
\]

- Developed & validated with 204 U.S. species

Risk Space

Model Performance

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>Maj- Invaders (True +)</td>
</tr>
<tr>
<td>US - PPQ WRA</td>
<td>0.941</td>
</tr>
<tr>
<td>US - Aus WRA</td>
<td>0.971</td>
</tr>
<tr>
<td>Mean (8 other AUS tests)</td>
<td>0.936</td>
</tr>
</tbody>
</table>

- Overall accuracy is higher than the Australian WRA
- Non-invader and major-invader performance similar

Risk & Uncertainty

Uncertainty is a component of risk
A good PRA always documents uncertainty
Documenting uncertainty in the PPQ WRA

- Negl: 0.1%
- Low: 1%
- Mod: 10%
- High: 25%
- Max: All answers equally likely

Uncertainty describes our confidence in our answers. Expresses our belief that some other answer is correct.

Evaluate the sensitivity of a species’ risk scores to uncertainty

What would the final risk score be if we chose a different set of answers?

<table>
<thead>
<tr>
<th>Item</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negl</td>
<td>0.1%</td>
</tr>
<tr>
<td>Low</td>
<td>1%</td>
</tr>
<tr>
<td>Mod</td>
<td>10%</td>
</tr>
<tr>
<td>High</td>
<td>25%</td>
</tr>
<tr>
<td>Max</td>
<td>All answers equally likely</td>
</tr>
</tbody>
</table>

Monte Carlo Simulation (@Risk)

- Randomly change answers based on the uncertainty level
- Calculate the new risk scores
- Determine the new result, and run secondary screening if necessary
- Repeat this 5000 times
- Plot and evaluate simulated risk scores

Example – Rumex sagittatus

Benefits
- Dig deeper?
- Is result robust?
- Suggests possible decision for Evaluate Further

Climate – Geographic Potential

- Influences the success of colonizing species
- Climatic suitability in WRAs
  - Species adapted to climatic conditions receive higher risk scores

Climate

- Predictive WRA model does not include climatic suitability
  - The U.S. is very diverse
  - Climate suitability is evaluated separately using a simple climate matching tool
Geographic Potential

- Each WRA includes a predictive map
  - Joint the overlap of the 3 climatic variables
    - Cold hardiness, Annual precipitation, Köppen-Geiger climate class
- Calculate & report the percentage of the U.S. suitable for establishment
- Report the climatic profile

Entry Potential

- Entry – Movement of a pest into an area
  - 14 questions (y/n, mult. choice)
    - Intentional
    - Unintentional
- Not necessary most of the time
- Useful for contaminants

The Final Product

- Word/PDF document
  - 12-15 page summary of results from Excel file
    - Always submitted to customers
- Excel file
  - Kept separate, but available upon request

Completed WRAs

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpinia modesta</td>
<td>Low Risk</td>
</tr>
<tr>
<td>Artemisia austriaca</td>
<td>High Risk</td>
</tr>
<tr>
<td>Artemisia japonica</td>
<td>High Risk</td>
</tr>
<tr>
<td>Astragalus macrocarpum</td>
<td>High Risk</td>
</tr>
<tr>
<td>Batrachium crenatum</td>
<td>High Risk</td>
</tr>
<tr>
<td>Chamaesyce emoryi</td>
<td>High Risk</td>
</tr>
<tr>
<td>Chamaesyce vitellina</td>
<td>High Risk</td>
</tr>
<tr>
<td>Eupatorium bicoloratum</td>
<td>High Risk</td>
</tr>
<tr>
<td>Falcaria vulgaris</td>
<td>High Risk</td>
</tr>
<tr>
<td>Hippophae rhamnoides (Elaeagnaceae)</td>
<td>High Risk</td>
</tr>
<tr>
<td>Huita hbalstonii</td>
<td>High Risk</td>
</tr>
<tr>
<td>Hippophae rhamnoides (Elaeagnaceae)</td>
<td>High Risk</td>
</tr>
<tr>
<td>Huita hypbline</td>
<td>Evaluate Further</td>
</tr>
<tr>
<td>Huita hypbline</td>
<td>Evaluate Further</td>
</tr>
<tr>
<td>Huita hypbline</td>
<td>Evaluate Further</td>
</tr>
</tbody>
</table>

The Final Product

- Background: Initiation, distribution, US status
- Narrative summary of risk elements
- Map of potential US distribution
- Results & conclusions
  - Risk score in relation to the 204 species
  - Graphical results of the uncertainty simulation
- Discussion
- Literature Cited
- Appendix: excerpt of the Excel assessment

Hippophae rhamnoides (Elaeagnaceae)

- Cultivated in the U.S., naturalized in 2 WY counties
- Become very invasive in Canadian prairies
- Forms dense thickets, N-fixer, alters natural habitats

Completed=36; Development=5; Queue=47
Opportunities & Challenges in WRA

- Weeds won’t wait
- Lots of plants out there
  - Plants that are here
  - Plants that are coming
- Limited Resources

Working Together

- What we can do for you
  - Do WRAs for some of your weeds
  - Inform you when we have completed WRAs
  - Train & mentor you to do your own WRAs
  - Provide literature information to support your efforts
- What you can do for us
  - Tell us about new and emerging weed threats
  - Identify weeds not yet in the U.S. that could be problematic
  - Collaborate on WRA projects (evidence, experts, review)

For more information or to submit requests for WRA

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Our Vision

To be globally recognized as a credible authority in weed risk assessment

Our Customers

- APHIS headquarters (e.g., Noxious Weed Program, Plants for Planting staff)
- Other Federal agencies (e.g., Forest Service, Fish & Wildlife Service, National Park Service)
- State and local governments
- Non-governmental organizations
- Any individual, group, or other “legal entity”
Our history with WRA

• 2005: PERAL started doing WRA using a narrative process
• 2008: Formed a team
  – began redesigning our WRA procedure
• 2010:
  – Completed development
  – Assessing weeds and invasive plants
• 2011: Published a paper
• Sept 2011: First WRA-101 training

Our history with WRA (cont.)

• January 2012-present:
  – Doing WRAs
  – Getting organized
  – Identifying team mission/vision/goals
  – Developing project management process
  – Launching team SharePoint site
• May 2012: ISO certification
• June 2012: second WRA 101 training

Platform: Microsoft Excel Workbook

The screening tool
Question-specific guidance
Model results
Printable data entry page
Paste GIS maps of potential US distribution here

GENERAL GUIDANCE

ES-Imp graph
Simulation graph
Values for the 204 sp

Description of changes in file

Paste GBIF output here

General guidance
Platform for uncertainty analysis using @Risk

Weed Risk Assessment

Pre-border Screening Tools
• Goal: Assess invasive and weedy potential (prediction)
• Traits: Behavior elsewhere, congeners, climatic compatibility, inherent species traits (invasiveness & impact)

Post-border Charac. & Prioritization Tools
• Goal: Characterize current invasions to help prioritization
• Traits: Impacts, potential distribution, and feasibility of control

Sample Questions

• Establishment/Spread
  – Climbing or smothering growth habit?
  – Self-compatible or apomictic?
  – Propagules bird dispersed?

• Impact
  – Change community composition?
  – Change or limits recreational use of an area?
  – Reduce crop/product yield?

Summarizing uncertainty for each risk element

0
Uncertainty Index
1

• Uncertainty level
  • (negl, low, mod, high, max)

<table>
<thead>
<tr>
<th>Species</th>
<th>E/S</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>B</td>
<td>0.20</td>
<td>0.03</td>
</tr>
<tr>
<td>C</td>
<td>0.17</td>
<td>0.10</td>
</tr>
<tr>
<td>D</td>
<td>0.22</td>
<td>0.36</td>
</tr>
</tbody>
</table>

From our model validation (N=204) mean uncertainty = 0.17
Predictive pest risk mapping

In ArcGIS overlay

Primary Climate layers:
- Plant hardiness zones
- Annual precipitation
- Köppen-Geiger climate classes

Secondary Screening Tool

Secondary Score =
1. prolific reproduction
2. minimum generation time
3. shade adapted
4. commodity contaminant
5. No. nat. dispersal vectors
6. forms dense thickets

Geographic Potential

<table>
<thead>
<tr>
<th>Cold Hardiness Zones</th>
<th>Köppen-Geiger Climate Classes</th>
<th>10-inch Precip Bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 (-50F or below)</td>
<td>Tropical rainforest</td>
<td>0-10 inches (0-25 cm)</td>
</tr>
<tr>
<td>Zone 2 (-50 to -40F)</td>
<td>Tropical savanna</td>
<td>10-20 inches (25-51 cm)</td>
</tr>
<tr>
<td>Zone 3 (-40F to -30F)</td>
<td>Steppe</td>
<td>20-30 inches (51-76 cm)</td>
</tr>
<tr>
<td>Zone 4 (-30F to -20F)</td>
<td>Desert</td>
<td>30-40 inches (76-102 cm)</td>
</tr>
<tr>
<td>Zone 5 (-20F to -10F)</td>
<td>Mediterranean</td>
<td>40-50 inches (102-127 cm)</td>
</tr>
<tr>
<td>Zone 6 (-10F to 0F)</td>
<td>Humid subtropical</td>
<td>50-60 inches (127-152 cm)</td>
</tr>
<tr>
<td>Zone 7 (0F to 10F)</td>
<td>Marine west coast</td>
<td>60-70 inches (152-178 cm)</td>
</tr>
<tr>
<td>Zone 8 (10 to 20F)</td>
<td>Humid continental cool summers</td>
<td>70-80 inches (178-203 cm)</td>
</tr>
<tr>
<td>Zone 9 (20F to 30F)</td>
<td>Humid continental warm summers</td>
<td>80-90 inches (203-229 cm)</td>
</tr>
<tr>
<td>Zone 10 (30F to 40F)</td>
<td>Subarctic</td>
<td>90-100 inches (229-254 cm)</td>
</tr>
<tr>
<td>Zone 11 (40F to 50F)</td>
<td>Tundra</td>
<td>100+ inches (254+ cm)</td>
</tr>
<tr>
<td>Zone 12 (50F to 60F)</td>
<td>Icecap</td>
<td></td>
</tr>
<tr>
<td>Zone 13 (above 60F)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other Potential Risk Elements / Modules

- Feasibility of control
- Extent of current and potential range
- Extent of cultivation
- Biofuels
- GMOs & LMOs

Species Information

Initiation

Foreign distribution

U.S. distribution and status
## 1. Analysis Results

### Establishment/Spread Potential

<table>
<thead>
<tr>
<th>Text summary</th>
<th>Risk score</th>
<th>Impact Potential</th>
<th>Uncertainty index</th>
</tr>
</thead>
</table>

We found a number of literature that has identified several factors that may influence the establishment and spread of the species. These factors include:

- Habitat suitability
- Availability of hosts
- Climate suitability

### Geographic Potential

**Text summary**

And U.S. map (Figure 1)

**Entry Potential**

### Geographic Potential

**Text summary**

**Entry Potential**

### Geographic Potential

**Text summary**

**Entry Potential**

## 2. Results and Conclusion

Model probabilities for Major, Minor, and Non-Invader Risk score (High Risk, Evaluate Further, or Low Risk)

Secondary Screening result (if applicable)

Figure 2: Risk score (red) relative to species used to develop the model

Figure 3: Shows effect of uncertainty on the risk score

## 3. Discussion

Summary and discussion of overall results of assessment

- Includes effect of uncertainty on final conclusion
- May include additional information that may be useful for risk managers

## 4. Literature Cited

Appendix A

Excerpt of the Excel risk assessment

For each question, provides:

- answer and uncertainty rating
- risk score
- evidence