Considering the Impact of Classification Uncertainty in Weed Risk Assessment

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Koop et al 2012 WRA (Weed Risk Assessment) Model

- Developmental and validation data sets of 34 major invaders, minor invaders, non-invaders (204 taxa).

- $Log(Odds(major\ invader)) = b_{01} + b_{11}ES + b_{21}Imp$

- $Log(Odds(non\text{-}invader)) = b_{02} + b_{12}ES + b_{22}Imp$
  - ES = Composite Establishment and Spread Score
  - Imp = Composite Impact Score

- Cut-off values determined by ROC analysis giving equal weight to false positive and false negatives.

- In validation, model accurately identified 94.1% of major-invaders and 97.1% of non-invaders, no false positives or false negatives

Koop et al 2012 WRA (Weed Risk Assessment) Model
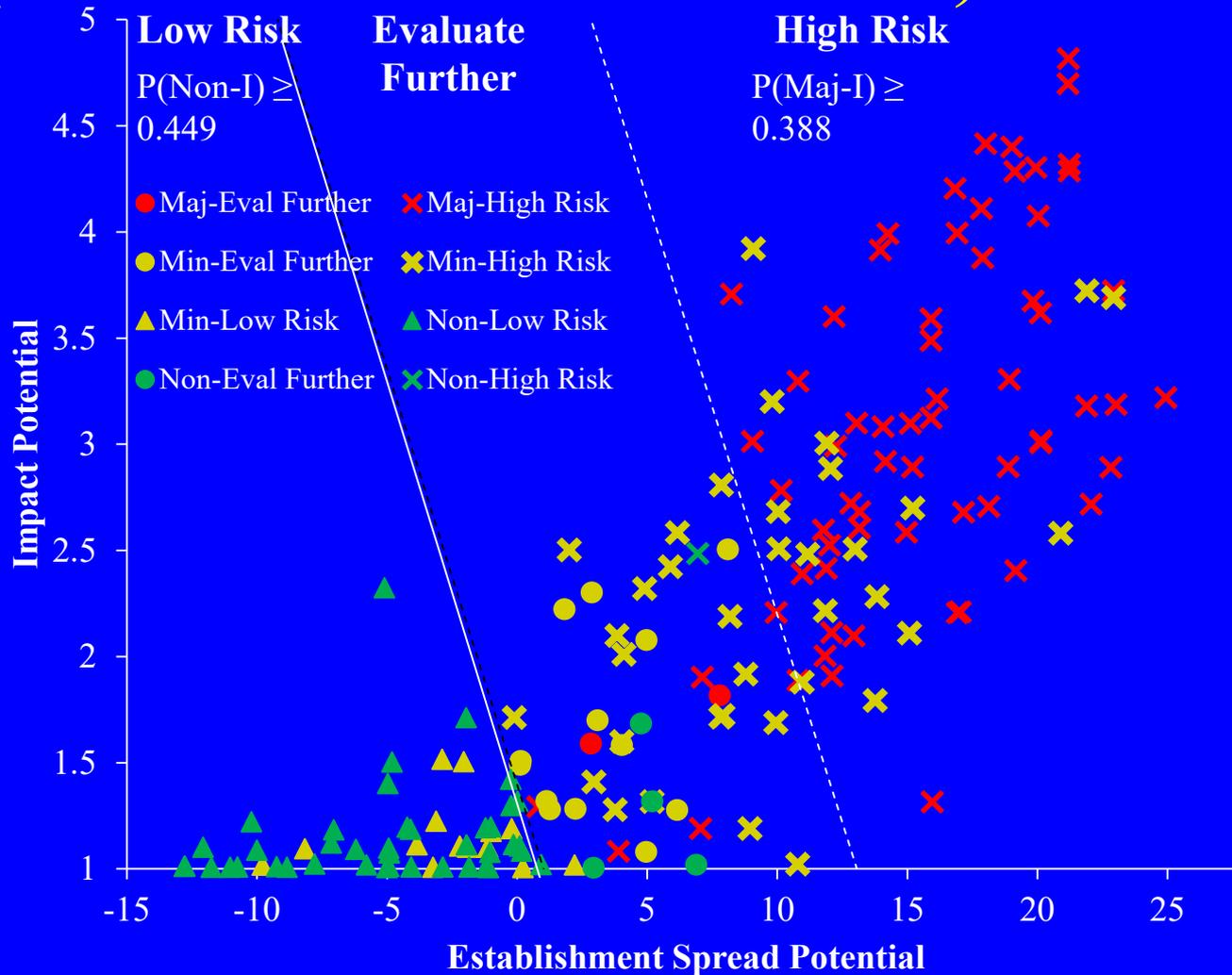
Stress Test

- Robustness of Koop et al (2012) WRA model to random *a priori* classification error

- Uncertainty scenario: p(one category misclassification error) = 0.1
  - For "major invader," p(minor invader) = 0.1
  - For "minor invader," p(major invader) = p(non-invader) = 0.05
  - For a "non-invader," p(minor invader) = 0.1.

- Results: No statistically significant difference in the parameter estimates derived with and without the assumed classification error, and the confidence intervals about the generalized R^2 and percent discordant pairs generated assuming classification error contained the values calculated assuming no classification error

- Is the "stress test" stressful enough?

- Only considers *random* classification error analogous to measurement error on the dependent variable

Weed Risk Assessment

- Hulme 2012 Weed risk assessment: a way forward or a waste of time?

- Problems with objective measure of hazard, predicting complex hierarchical and nonlinear systems, quantifying uncertainty and variability, biases in expert judgment, low base rate, etc.

- Recommends adaptive management over prediction-based prevention
  - Assumes effective early detection, mitigation, management
  - "Assume a can opener"

Weed Risk Assessment

- Smith et al 2015 Predicting Biofuel Invasiveness: A Relative Comparison to Crops and Weeds. Both the Australian and US weed risk assessment models fail to parse weeds from crops

- Of the 40 species assessed, the A-WRA and US-WRA ranked 34 and 28 species, respectively, as high risk, including the major crops alfalfa, rice, canola, and barley*

- *Gordon et al 2016 Rebuttal – Smith et al combined data from sub-specific taxa.

Weed Risk Assessment

- Classification model with omitted variables
- Variance in dependent variable (weed status) unexplained by the model may be related to omitted variables
- For example, beneficial impacts of crop plants

What is a weed?

- Perrins et al 1992. A survey of differing views of weed classification: implications for regulation of introductions

- Disagreement among agriculturalists, ecologists, taxonomists, conservationists and gardeners as to the weed status of forty-nine annual species

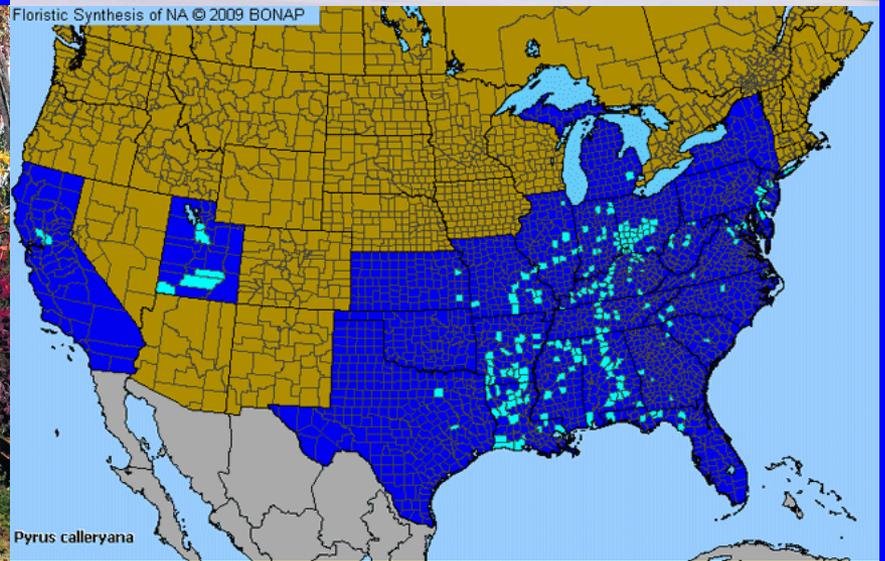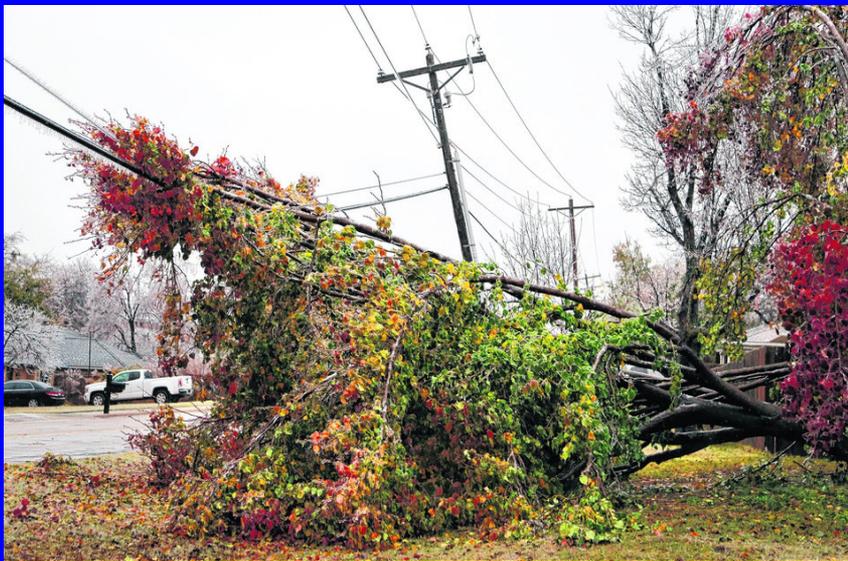- Weediness vs invasiveness
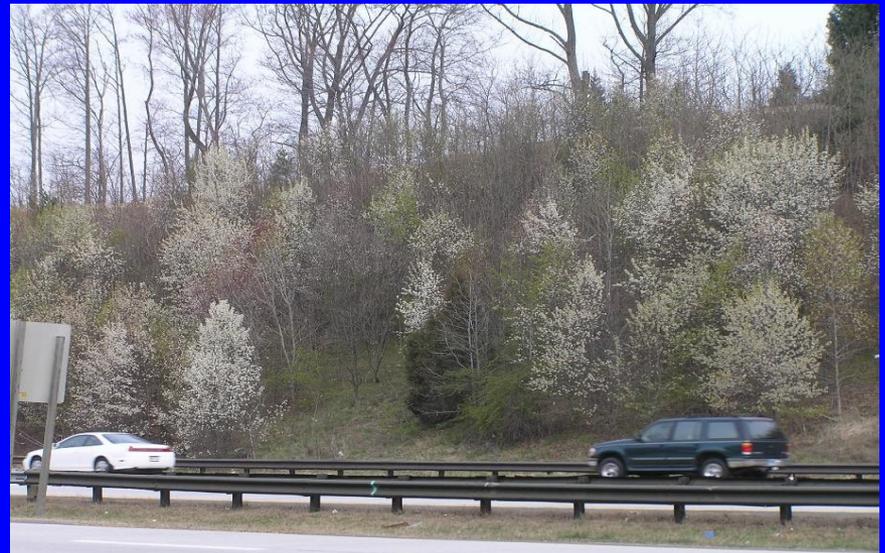
Corn in a Cornfield

Volunteer Corn in Soybean Field

Bradford Pear
Prized
Ornamental

Callery Pear

Bradford Pear Invasive Weed

Floristic Synthesis of NA © 2009 BONAP

Pyrus calleryana

Weed Classification Decisions

- WRA models as model for identifying determinants of classification decision are limited by an omitted variables problem

- WRA models consider potential negative impacts (risks) but not potential beneficial impacts that may have been considered in recorded classification decisions (i.e., the observed dependent variable).

Consideration of Omitted Variables

- WRA models are simple models of complex process

- In practice, data and resources constrain model inputs

- In principle, when information is available, no reason why omitted variables, such as potential benefits, can't be considered at some point in the decision-making process other than application of the WRA as a weed risk screening tool

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Kentucky Bluegrass

- APHIS. 2011. Review of Petition to Add Genetically Engineered Glyphosate-tolerant Kentucky Bluegrass to the Federal Noxious Weed Regulations.

"The WRA found that Kentucky bluegrass has *demonstrated value* in some natural areas, however. For example, it can be an important part of the diet of wildlife (e.g., elk, bighorn sheep), and Kentucky bluegrass is one of the most important forage species for cattle and sheep summering in mountain meadows in eastern Oregon. The WRA also notes that Kentucky bluegrass is a recommended pasture grass in some eastern and western states, and is widely grown as a turfgrass species in all 50 United States" (emphasis added).

Creeping Bentgrass

- APHIS. 2015. APHIS' petition response regarding glyphosate-resistant creeping bentgrass

"In the WRA we also found that creeping bentgrass has *demonstrated value* in some production systems. For example, creeping bentgrass is a useful forage species for both livestock and wildlife because it stays green during summer and it can be grown for hay. We also note that creeping bentgrass is widely grown as a turf grass species in all 50 United States, although its use is usually limited to golf courses because it is very management-intensive" (emphasis added).

Weed Classification Decisions

- Variance unexplained by WRA models is unsurprising – many omitted variables have potential explanatory value

- Classification of a plant as a weed is a benefit-cost balancing decision, but we as risk analysts tend to frame it as a purely risk-based decision

- WRA not a waste time, just not sole determinant of decisions

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