USDA
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Animal and Plant Health Inspection Service,
Plant Protection and Quarantine

Quantitative Uncertainty Analysis For A Weed Risk Assessment Model

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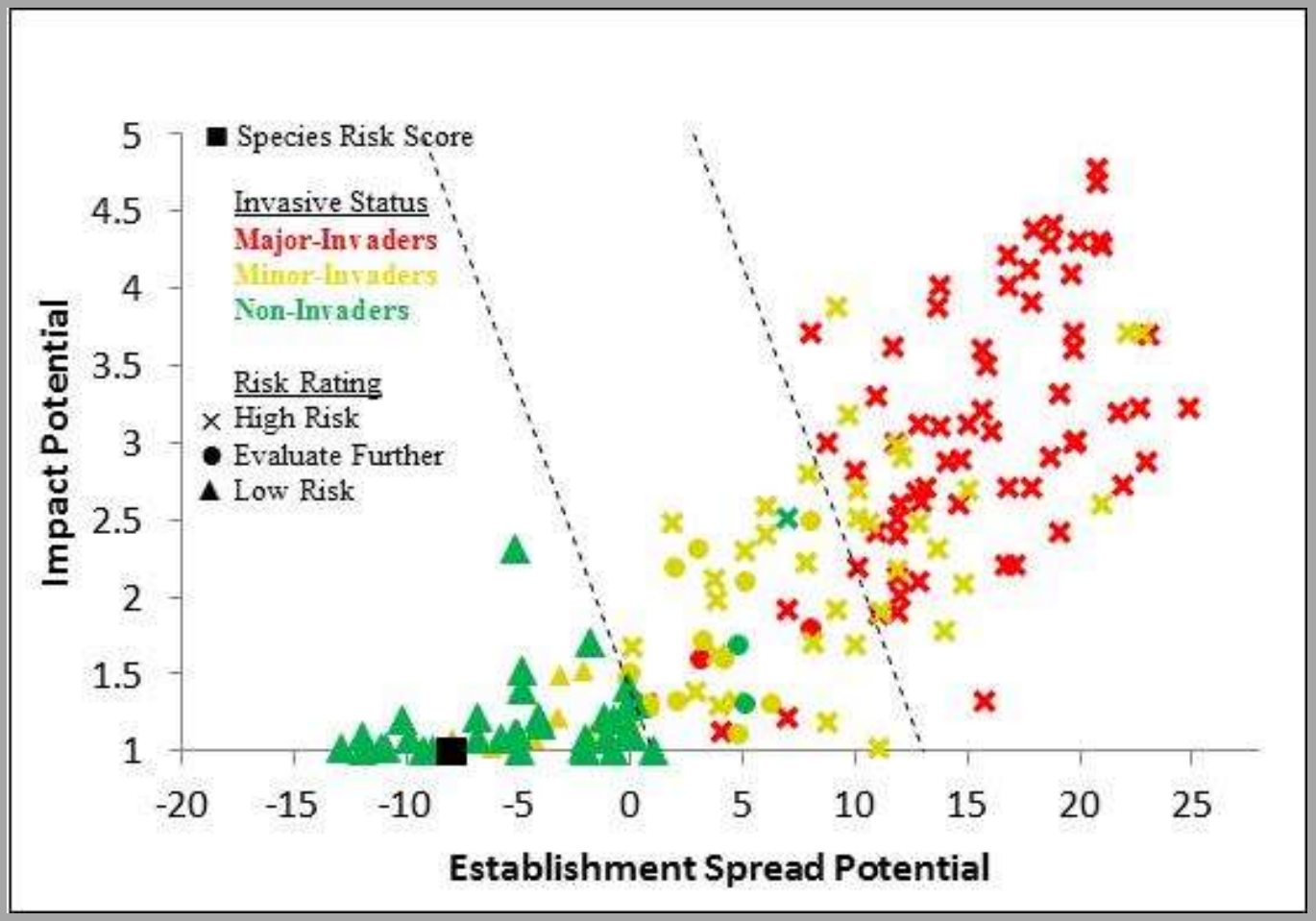
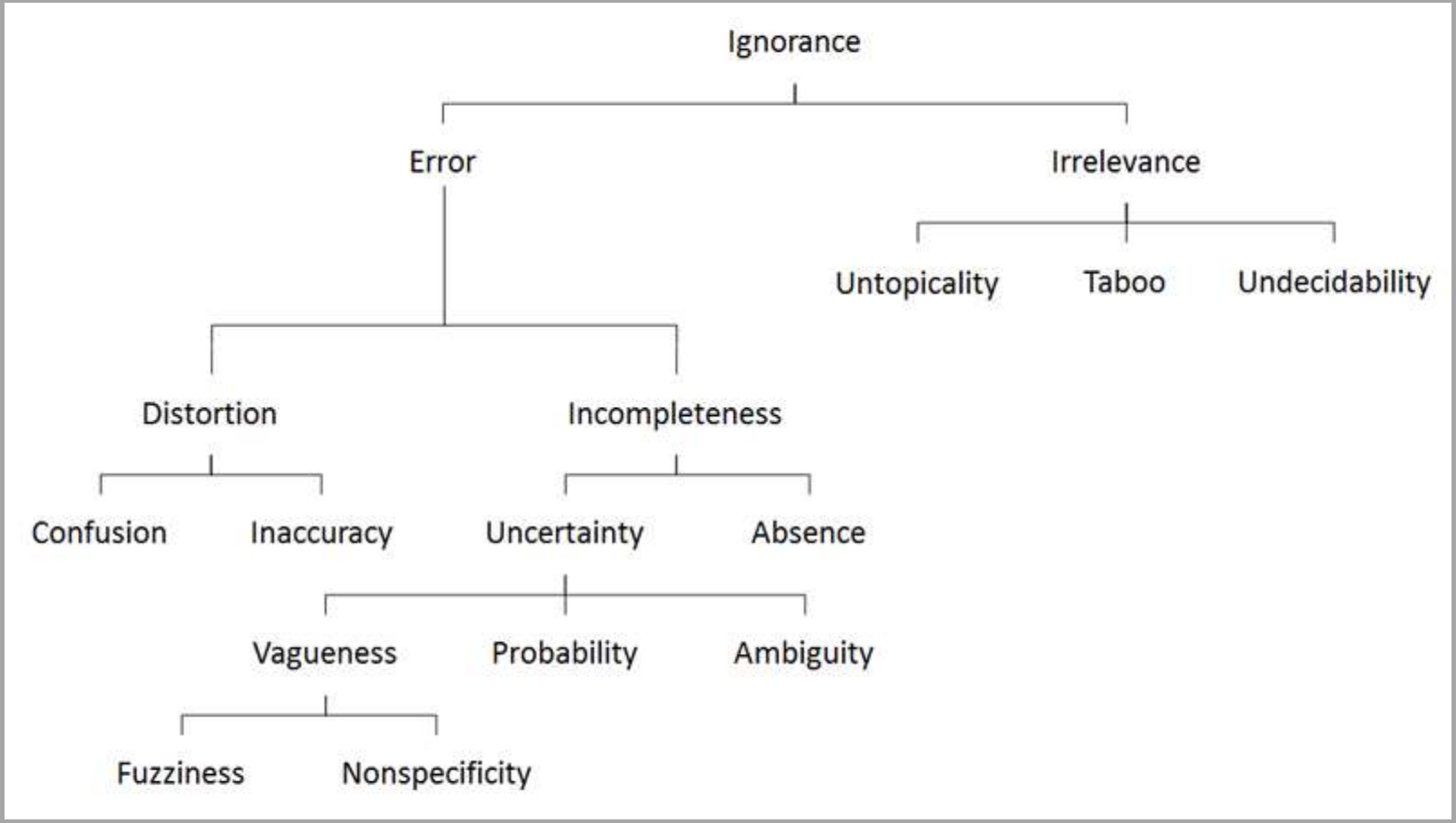
PPQ Weed Risk Assessment Model



Koop et al., 2012. Biological Invasions

Uncertainty



Smithson (1989) “Ignorance and Uncertainty”

Uncertainty Ratings

- Fundamental to risk analysis
- Rarely applied in WRA systems

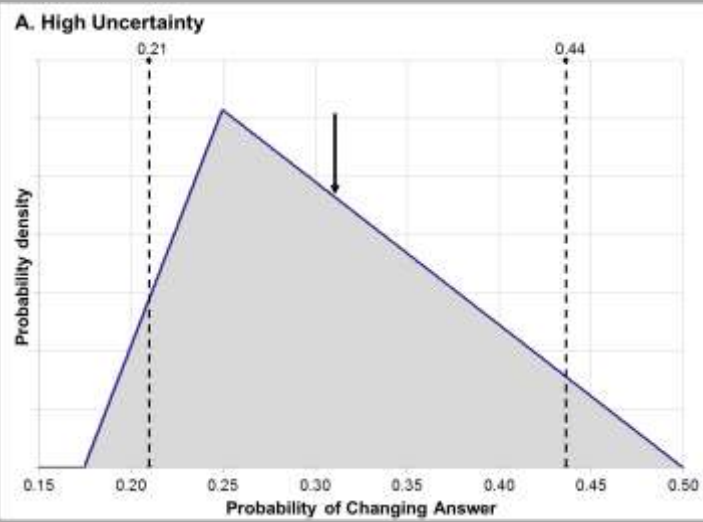
- In the PPQ WRA model:
  - Negligible = multiple, excellent sources
  - Low = single, decent source
  - Medium = conflicting/indirect evidence, poor source(s)
  - High = very weak or completely conflicted evidence

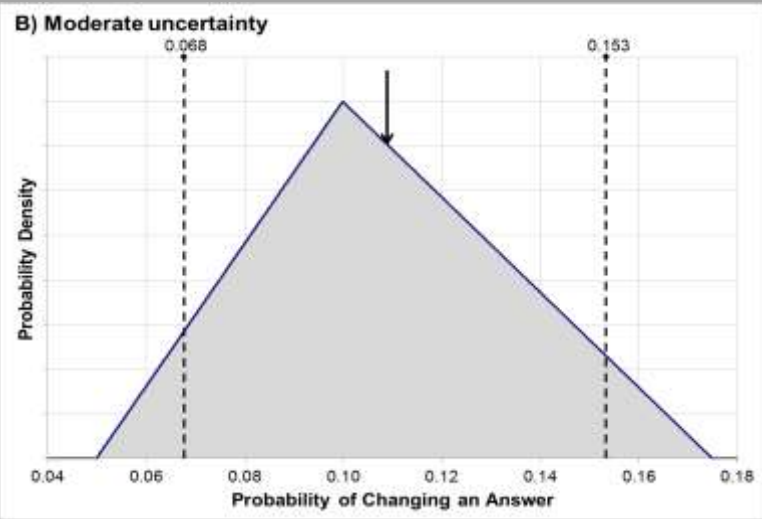
Modeling Objective

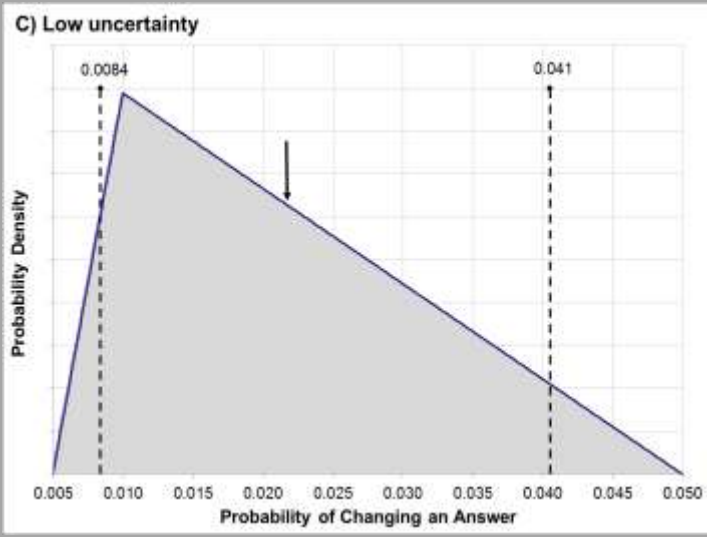
- Use uncertainty ratings quantitatively

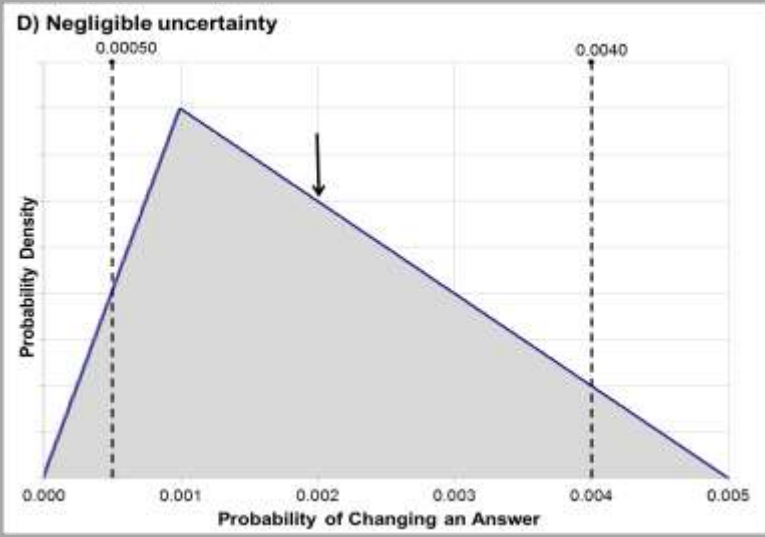
- Key idea: Ratings inform likelihood of an answer changing
- Two uses
  - Stochastically simulate answer changes and calculate new scores
  - Static estimate (U_0) for finished WRA (mean = 0.17)

Likelihoods of Answer Changing

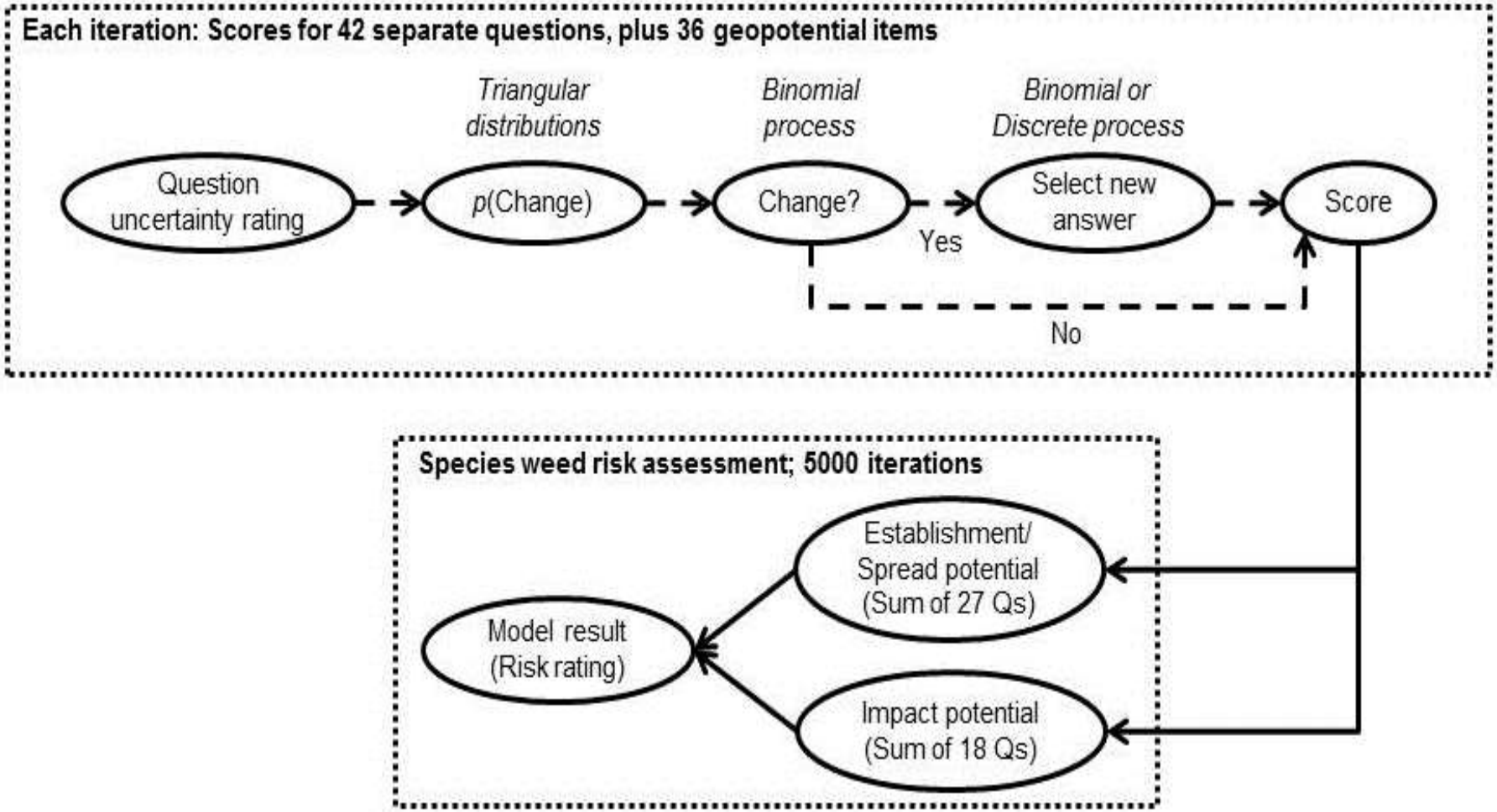








Simulation Model



Results Presented

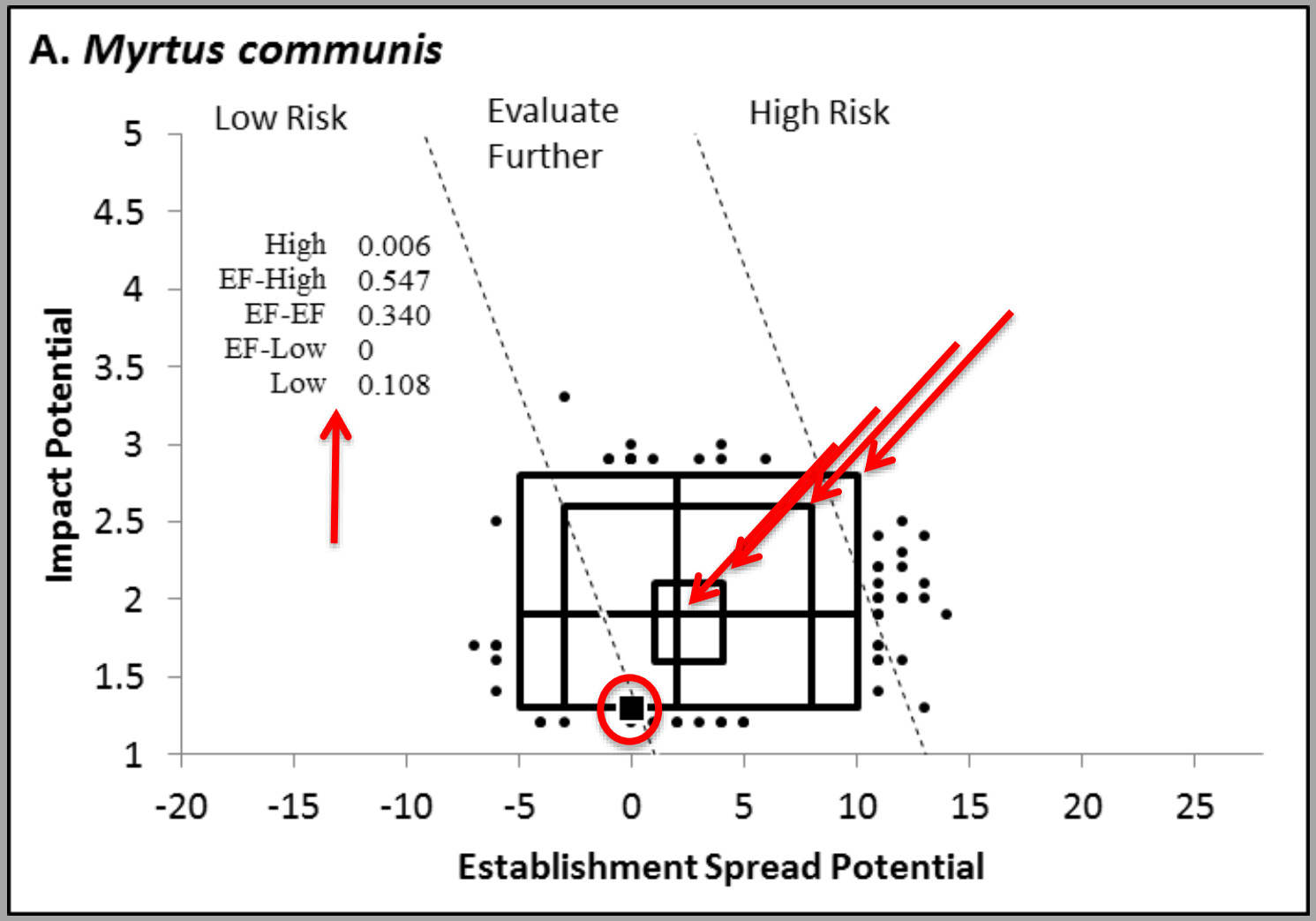
- 1. Reasonable variation in scores?
- 2. Analysis results consistent with original model ratings?

- **Key question**: Helpful addition to WRA?

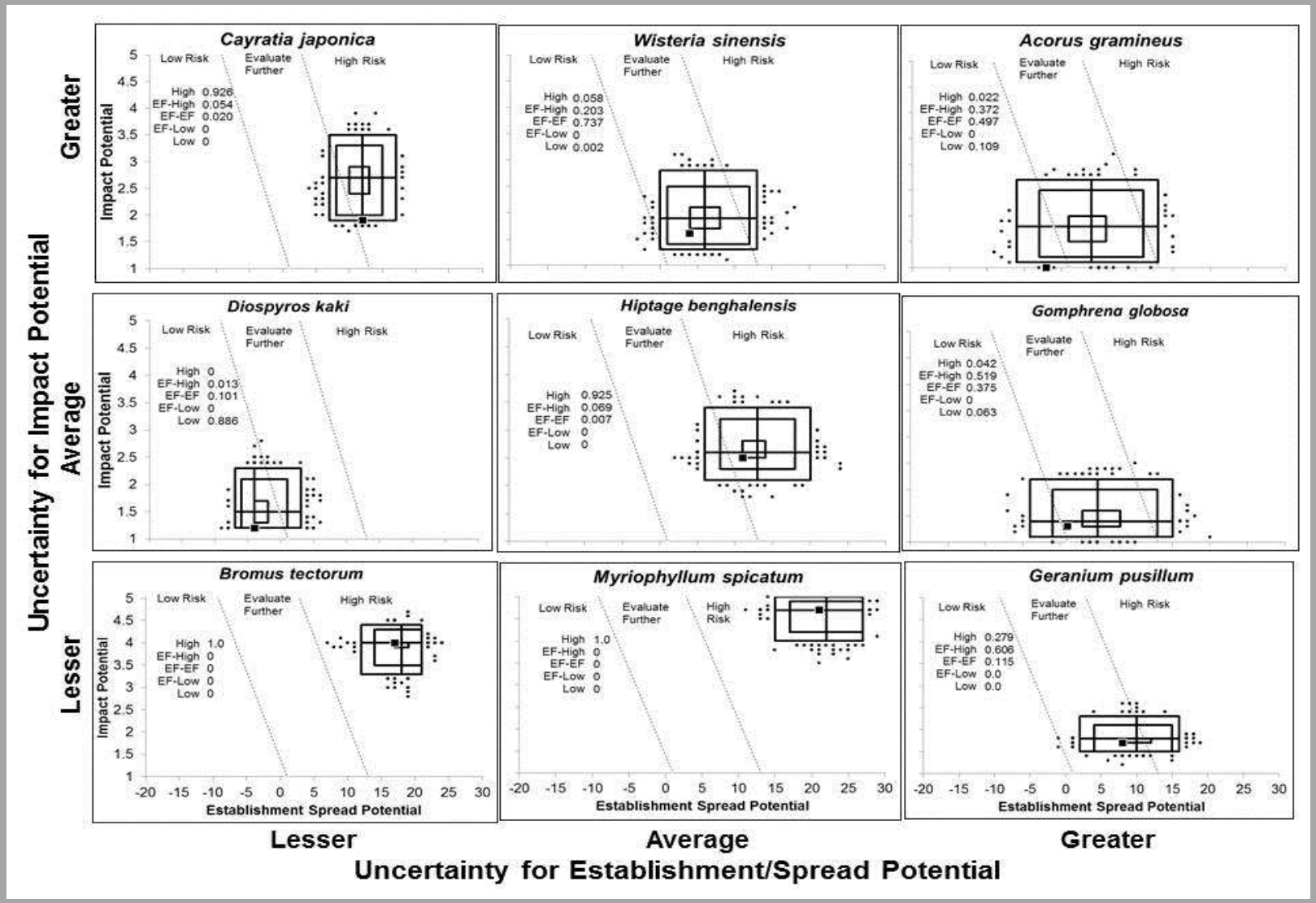
Methods

- Evaluate uncertainty simulation results for the 204 test species from model development/validation
- Q_{Rmax} = Rating with greatest proportion of outcomes in 5000 iterations
  - $Q_{High} = 0.25$, $Q_{EF} = 0.4$, $Q_{Low} = 0.35$
  - $Q_{Rmax} = Q_{EF}$

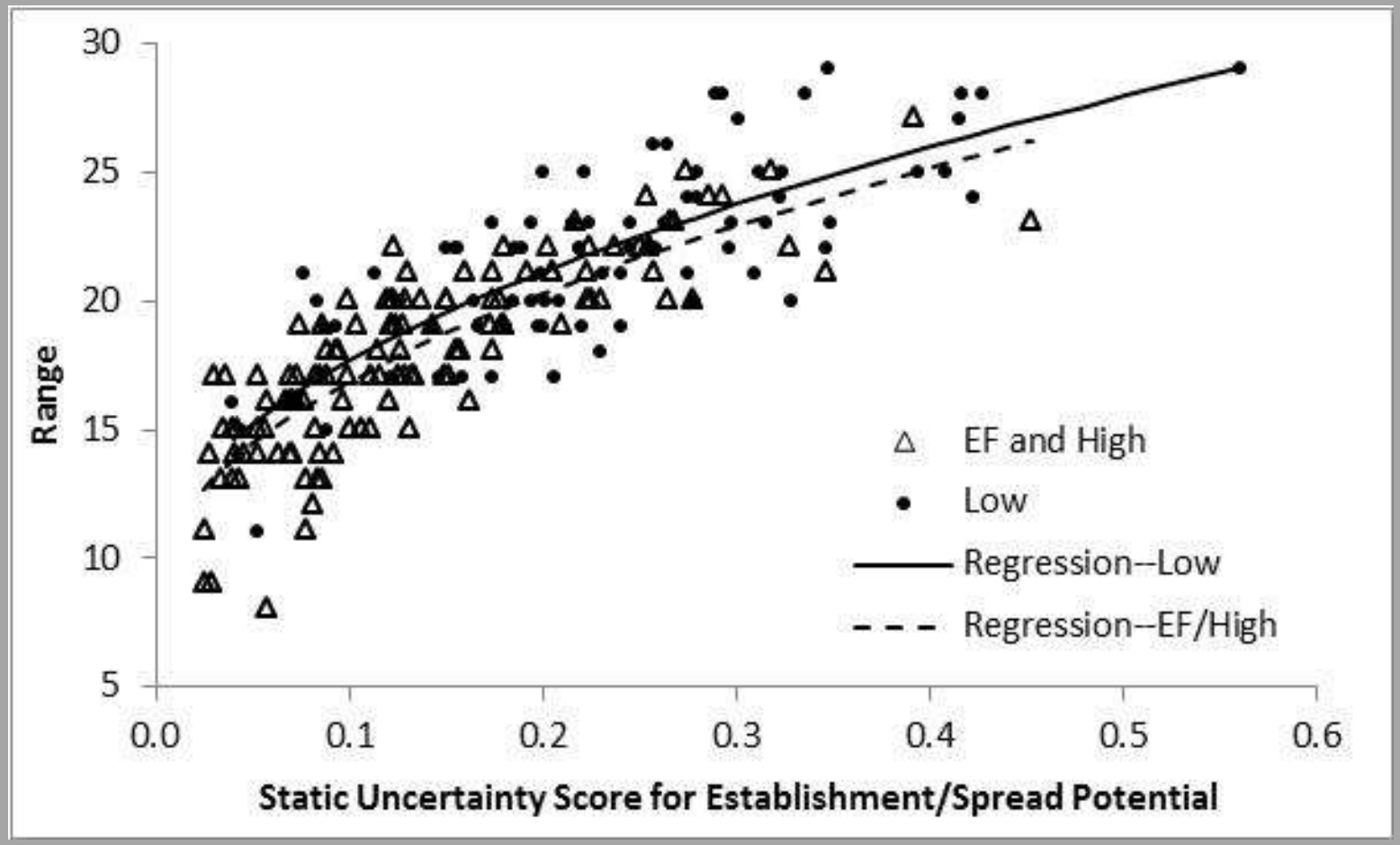
Reporting Charts



Variability Results 1



Variability Results 2



Similar result for Impact Potential, but depended on risk rating

Variability Conclusions

- Variability around simulated scores seemed reasonable
  - Simulated ratings could include all three outcomes
  - Tendency for median scores to increase
- Simulated scores/ranges reflected static uncertainty estimate
- Independent of baseline scores

Consistency Results

- Original rating matched Q_{Rmax} = 178/204 (87%)
  - For High Risk spp. (103), Q_{Rmax} was always High (Low risk outcomes *did* occur, though)

- 26 spp. = non-match between original rating and Q_{Rmax}
  - 19 Low risk spp. with Q_{Rmax} = Evaluate Further
  - 2 Low risk spp. with Q_{Rmax} = High
  - 5 Evaluate Further spp. with Q_{Rmax} = High

  - Note: observed no *lower* Q_{Rmax} here, but theoretically possible

Non-matching WRA characteristics

- Low risk species
  - Scores near threshold
  - Static uncertainty values (U_0) > average [Especially for two with Q_{Rmax} = High risk]

- Evaluate Further species
  - Either greater Estab./Spread Potential scores (3) or greater U_0 (2)

Change original risk rating to Q_{Rmax}?

- 26 outcomes
  - 1 = increase Major Invader accuracy
  - 3 = false positives (Non-Invader to High risk)
  - 15 = reduce Non-Invader accuracy
  - 7 = no effect (Minor Invaders)

- Conclusions
  - Q_{Rmax} seems to give conservative estimate
  - Don’t recommend adopting it as final rating

Conclusions

- Improved and insightful evaluation of the uncertainty associated with each WRA
- Holistic, bottom-up approach builds on question-level uncertainty ratings
- Species-specific uncertainties rather than model-specific uncertainties
- Provides decision makers with much more information about the assessment and rating