REFRAMING RISK: AN UPDATED APPROACH TO PRIORITIZATION

TRANG T. VO
Plant Epidemiology and Risk Analysis Laboratory
Plant Protection and Quarantine
Animal and Plant Health Inspection Service
U.S. Department of Agriculture

Memphis, TN
October 29, 2015
Questions Asked of Us

• What are the benefits of APHIS’ actions?

• Are our actions producing the intended results?
Objectives

- Measure damages mitigated or avoided per dollar spent

- Why is such a measure needed?
  - Show progress
  - Affect change
  - Prioritization
Risk has been traditionally viewed as the likelihood of pest introduction.

Lack of common framework for measuring risk (expected impacts) along the safeguarding continuum.
Risk Definition

Economic perspective on risk:

Risk implies future uncertainty about deviation from expected outcome.

Risk (or expected impact) = Likelihood x Consequences
Biological and Economic Impacts

Pest behavior

Direct (physical) impacts:
- yield
- timber
- environ. resources

Indirect impacts:
- downstream markets
- trade

Economic Value of Impacts
Money used as a common unit of measurement to sum and compare disparate impacts and outcomes.
Safeguarding Flowchart

Regulatory Policy
- e.g., Q-37, Q-56; treatment protocols

Pre-entry (offshore) mitigations
- preclearance; pre-departure; systems approach; monitoring & surveillance; exclusion

Border mitigations
- inspection (cargo, baggage, vessels, mail)

Post-entry mitigations
- detection/survey; containment; management

Probability of entry

Prob. of establishment

Risk-based Analysis
- Expected losses without risk mitigations \( \geq \) losses with mitigations?

YES
- Regulatory Solution

NO
- Non-regulatory Solutions

Pr1

Pr2

Pr3
Our Goals

1. Prioritize pests
2. Evaluate what actions to take
3. Prioritize across pest programs
What exotic pests should we be concerned about?

Ex-ante analysis: Evaluation of Potential Impacts

Pests not introduced

Estimate consequences and probability of introduction (entry & establishment),

Newly introduced

Should we do something?

Estimate spread and expected impacts with and without mitigations

Established/‘limited distribution’

Should we continue?

Ex-post analysis: Evaluation of Observed Impacts

Evaluate program effectiveness based on observed impacts
New Model for Evaluating Impacts

- Multiple choice yes/no questions (criteria) predictive of impact
- Selected factors considered in evaluating impacts:
  - unmitigated damage
  - frequency/severity of outbreaks
  - current production practices
  - private cost of control
  - research
<table>
<thead>
<tr>
<th></th>
<th>select one</th>
<th>Uncert.</th>
<th>Score</th>
<th>Comments/Evidence</th>
<th>Reviewers: please put your initials before any comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Is the organism capable of dispersing naturally more than 1 km/year?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[YES]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[NO]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[?] unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b</td>
<td>Does the organism typically disperse naturally more than 1 km/year?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[YES]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[NO]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[?] unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For this question, consider all non-human mediated dispersal mechanisms including water, wind, flight, and phoresy. As specifically as possible, identify the main mechanisms of dispersal in &quot;comments/evidence.&quot; If you can't find information on the species, you may (and are encouraged to) use information on closely related species, but raise your uncertainty level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Reproduction is:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[a] sexual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[b] parthenogenic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[c] both</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[?] unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information from closely related species may be used as long as the reproductive strategy is the same for all members of the taxonomic group. If you use this type of information, raise your uncertainty level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Does the organism typically have more than one generation per year?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[YES] The organism typically has more than one generation per year or the number of generations per year varies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[NO] The organism typically has only one generation (or less) per year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[?] The number of generations per year is unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do NOT use information from closely related species to answer this question.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Oviposition:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[a] eggs are placed by themselves a relative distance from any</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Identified over 100 non-native arthropods and 80 pathogens that have become established in the United States

• Team of entomologists/pathologists & economists classified each pest/pathogen in terms of its observed impacts in the United States
• Each pest/pathogen was analyzed \textit{as if it were not present in the U.S.} using the potential questions
• Statistician compared results to observed impacts
• Each question were tested as to how well it predicted actual impact; non-predictive questions were removed
• Weighted each question by its predictive power
Acceptable Level of Risk

- Determine whether a pest poses a risk that is greater than an established threshold for acceptable level of risk.

- Apply the same criteria for evaluating pest impacts across exclusion & detection programs.
Can the pest cause economically and/or environmentally significant damages to U.S. agriculture or natural resources? *

Can the pest spread and cause damage to other states or affected entities?

Is containment or management of the pest technically feasible?

Can the cost of a program be justified by the expected losses to affected parties?

Besides economic, are there other overriding considerations (e.g., statutory or judicial directives, political concerns) that call for Federal action?

Pest is not a candidate for Federal response

Pest is a candidate for Federal response

* Economic significance is based on established thresholds for acceptable level of risk.
Economic Commodity Models

• Partial equilibrium models of major agricultural commodities
• Linkages between fresh and processed sectors in producing and non-producing regions
• International and domestic trade
Commodity Models – cont’d

Consideration of *market prices* enables estimation of impacts on all affected entities in society, including:

- Producers in affected areas
- Producers in unaffected areas
- Consumers
- Trade

Stakeholders
Commodity Models – cont’d

- Small grains – wheat, soybean, corn, sorghum, barley, oats, rice, forage
- Nursery stock
- Seed (grains)
- Non-citrus tree fruits – pear, apple, peach, plum, sweet cherry, tart cherry
- Citrus fruits – orange, grapefruit, tangerine, lemon
- Potato
Limitations of Past Analyses

• Did not account for temporal spread;
• Use of total value of production overstated impacts;
• Only affected producers considered;
• Impacts limited to costs or financial impacts;
• Options not always evaluated;
• Inconsistent linkages between pest control operations and outcome.
BioEconomic Framework

Pest Spread Model
- Pest Introduction
- Pest Spread
- Affected Resource Outputs

Economic Model
- Market Shock(s)
- Market Reaction
- Welfare Impacts
Economic Criteria for Prioritizing

**EFFECTIVENESS** (are objectives achieved?)

Benefits = losses with a program – losses without a program < 0

**EFFICIENCY** (objectives achieved at the lowest average cost?)

Net benefits = benefits – program costs
Non-economic Criteria for Prioritizing

• Types of damages where Federal role is justifiable (e.g., environmental versus commercial pests, or multi-host versus single-commodity pests);
• Availability of control tools;
• Availability of funding from non-APHIS sources;
• Inability of industry/stakeholders to organize;
• Statutory directives.
### Example: Results of Analysis of the Emerald Ash Borer Program

<table>
<thead>
<tr>
<th>Present values in million dollars /1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With Program (40.6 km)</strong></td>
</tr>
<tr>
<td>44 years until colonization</td>
</tr>
<tr>
<td>Damages from newly infested area until colonization</td>
</tr>
<tr>
<td>Avoid Losses (Without program - With program)</td>
</tr>
<tr>
<td>Program Cost until colonization</td>
</tr>
<tr>
<td>Net Benefit (Avoided losses - Program Cost)</td>
</tr>
<tr>
<td>Benefit-cost ratio (Avoided losses/Program Cost)</td>
</tr>
</tbody>
</table>

1/Present values discounted at a rate of 3.9%.
How Measures are Used for Prioritizing

![Graph showing B/C ratio vs. Program expenditures ($ millions) for programs A to I. Programs D and H are highlighted with larger markers.](image)
Questions?

Trang T. Vo
Agricultural Economist
(301) 851-2249