RISK PRIORITISATION SCHEMES OF INVASIVE PATHOGENS, PESTS AND WEEDS

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Outline – Scoring frameworks

- Review
- Practices
- Strengths
- Weaknesses

Prioritisation / ranking / scoring

- Can prioritise / rank for instance
  - Farms or regions (surveillance)
  - Persons (vaccination)
  - Transport media (surveillance)
  - Control methods
  - Pests and diseases
- A structured system that places biological hazards into a ranking order by asking the evaluator a series of questions
- Spreading the resources according to the risk
  - Assess species suggested for introduction
  - Assess species likely to enter
  - Assess established species
- Not just academic play
  - Infectious diseases in Canada (+ UK)
  - Import of plants in Australia: >2800 species: ca. 50% accepted, ca. 25% rejected
  - Aspirations towards this regarding animal diseases and plant pests in the EU
    - EU invasive species strategy? Finnish?

Invasive species (animal diseases) N = 70 (+ 250)

Invasive species, animal diseases, human diseases, food safety N = 78

ECOLOGY LETTERS

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REVIEWS AND SYNTHESIS

TEASIng apart alien species risk assessments: a framework for best practices

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Abstract

Some alien species cause substantial impacts, yet most are innocuous. Given limited resources, forecasting risks from alien species will help prioritise management. Given that risk assessment (RA) approaches vary widely, a synthesis is timely to highlight best practices. We reviewed quantitative and scoring RAs, integrating > 300 publications into arguably the most rigorous quantitative RA framework currently existing, and mapping each study onto our framework, which combines Transport, Establishment, Abundance, Spread and Impact (TEASI). Quantitative models generally measured single risk components (78% of studies), often focusing on Establishment alone (79%). Although dominant in academia, quantitative RAs are underused in policy, and should be made more accessible. Accommodating heterogeneous limited data, combining across risk components, and developing generalised RAs across species, space and time *without* requiring new models for each species may increase attractiveness for policy applications. Comparatively, scoring approaches covered more risk components (50% examined > 3 components), with Impact being the most common component (87%), and have been widely applied in policy (> 57%), but primarily employed expert opinion. Our framework provides guidance for questions asked, combining scores and other improvements. Our risk framework need not be completely parameterised to be informative, but instead identifies opportunities for improvement in alien species RA.

Keywords

Colonisation, exotic, habitat suitability, life history trait, non-indigenous, propagule pressure, policy, risk analysis, species distribution, uncertainty.

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A review of risk prioritisation schemes of pathogens, pests and weeds: principles and practices

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Society's resources are scarce, and biosecurity actions need to be targeted and prioritised. Various models have been developed that prioritise and rank pests and diseases according to the risks they represent. A prioritisation model allows utilisation of scientific, ecological and economic information in decision-making related to biological hazards. This study discusses such models and the properties associated with them based on a review of 78 prioritisation studies. The scope of the models includes all aspects of biosecurity (human, animal and plant diseases, and invasive alien species), but with an emphasis on plant health. The geographical locations of the studies are primarily North America, Europe, Australia and New Zealand. Half of the studies were conducted during the past five years. The review finds that there generally seems to be several prioritisation models, especially in the case of invasive plants, but only a select few models are used extensively. Impacts are often accounted for in the model, but the extent and economic sophistication of their inclusion varies. Treatment of uncertainty and feasibility of control was lacking from many studies.

Key-words: biosecurity, pest, pathogen, weed, prioritisation, model, review

1) to review and compare existing risk approaches and to assess the current state of the literature;

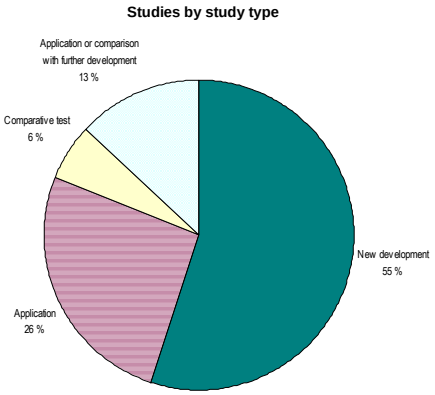
2) to integrate individual RA models reviewed and the major concepts in invasion biology into a coherent full RA model, both verbally and mathematically.

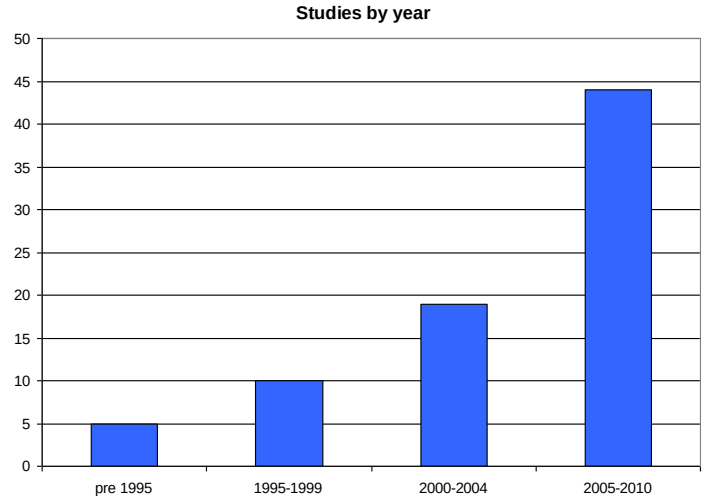
The aim of this study is to gain an overview of the types of studies conducted, to assess the strengths and weaknesses of prioritisation, and to note good practices for conducting such studies.

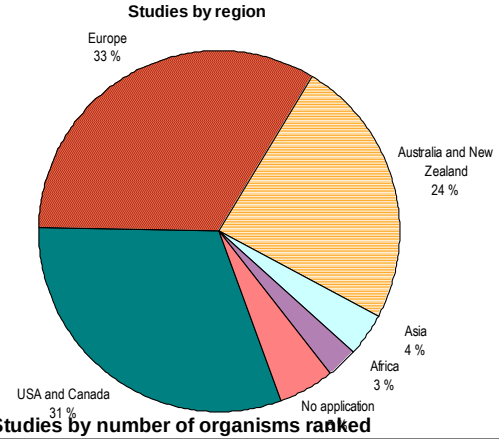
Literature review

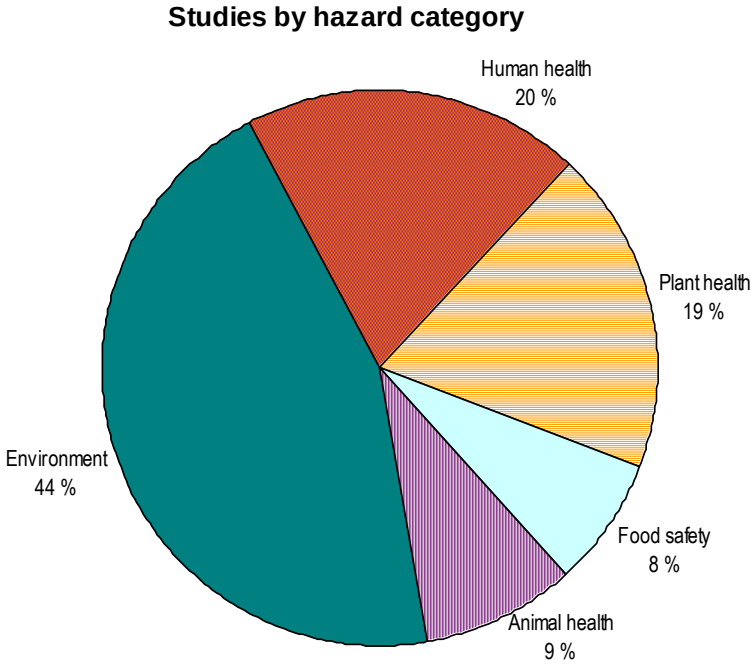
Heikkilä 2011

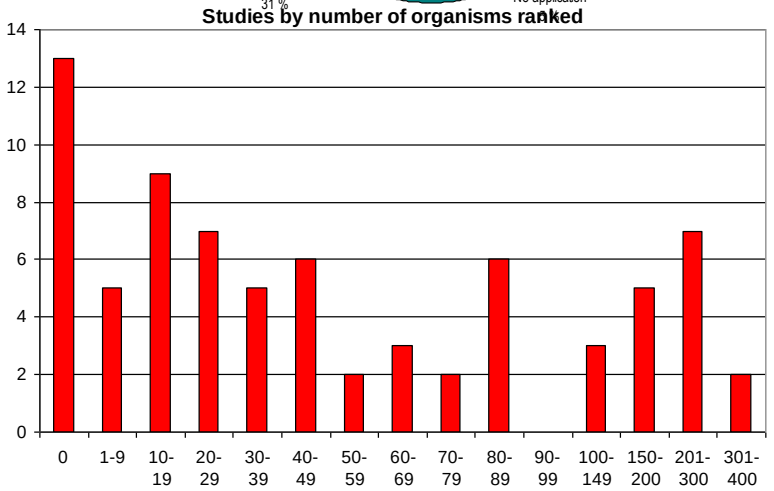
- Geographical location
- Topic of study
- Year of publication
- Number of organisms
- Originality of models







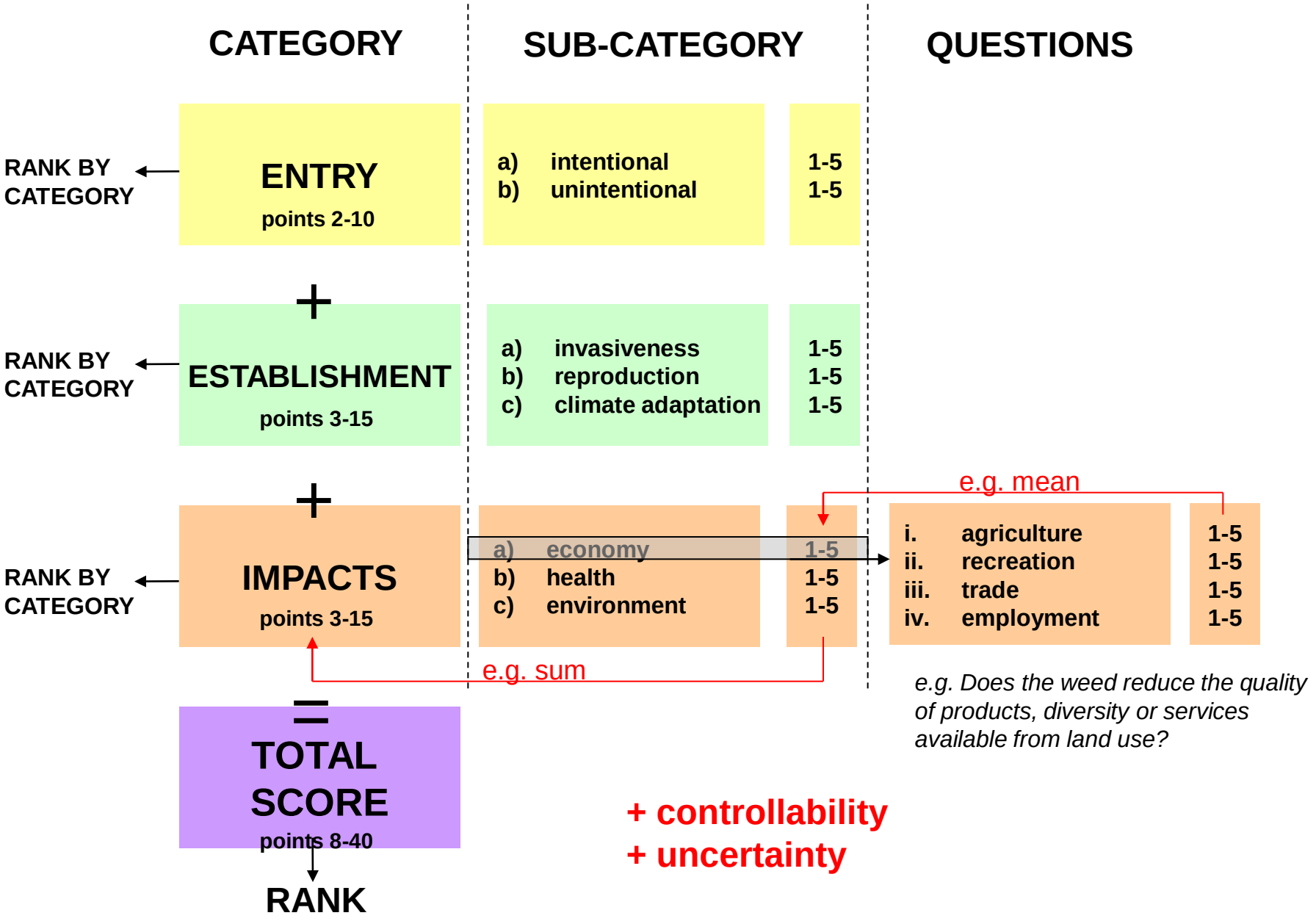




Model applications

Australian Weed Risk Assessment (WRA)	Weeds in Australia (Pheloung 1995)	Weeds in • Australia (Cunningham et al 2004) • Australia and New Zealand (Pheloung et al. 1999) • Hawaii (Daehler et al. 2004; Buddenhagen et al. 2009) • Florida (Gordon et al. 2008b) • Chicago (Jefferson et al. 2004) • Spain (Gassó et al. 2010; Andreu and Vilà 2010) • Italy (Crosti et al. 2010) • Czech Republic (Křivánek and Pyšek 2006) • Japan (Nishida et al. 2009; Kato et al. 2006) • Tanzania (Dawson et al. 2009) Fish in • UK (Copp et al. 2005; Copp et al. 2009; Tricarico et al. 2010)
Reichard-Hamilton decision tree	Weeds in North America (Reichard and Hamilton 1997)	Plant health in • Hawaii (Daehler and Carino 2000) • Chicago (Jefferson et al. 2004) • Iowa (Wirdlechner et al. 2004) • Czech Republic (Křivánek and Pyšek 2006)
Weber and Gut model	Weeds in Central Europe (Weber and Gut 2004)	Weeds in • Spain (Andrey and Vilà 2010)

Basic structure

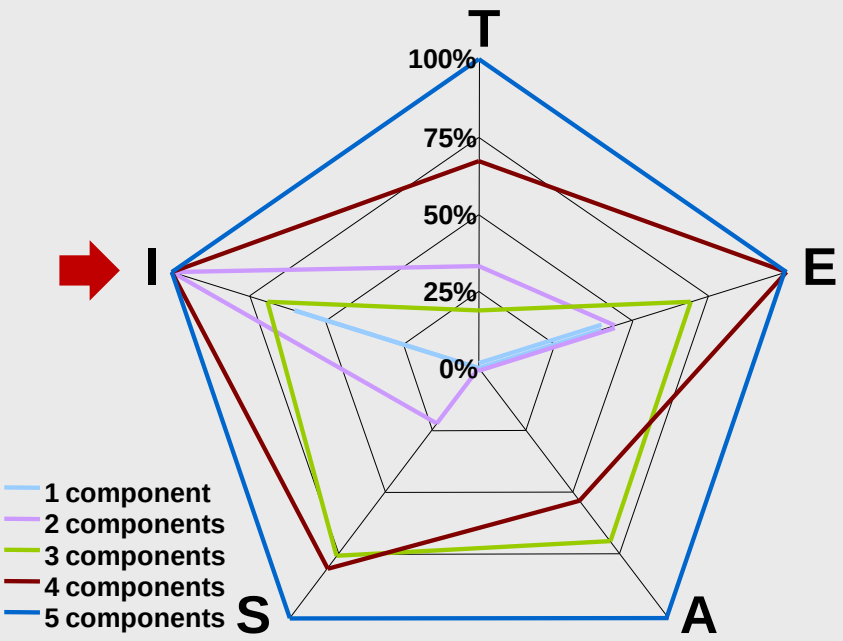


Model structure

- Categories included in models
  - Heikkilä 2011:
    - Entry 27%;
    - Establishment 71%;
    - Impacts 90%
  - Leung et al:
    - Transport 47%;
    - Establishment 76%;
    - Abundance 53%;
    - Spread 65%;
    - Impact 87%

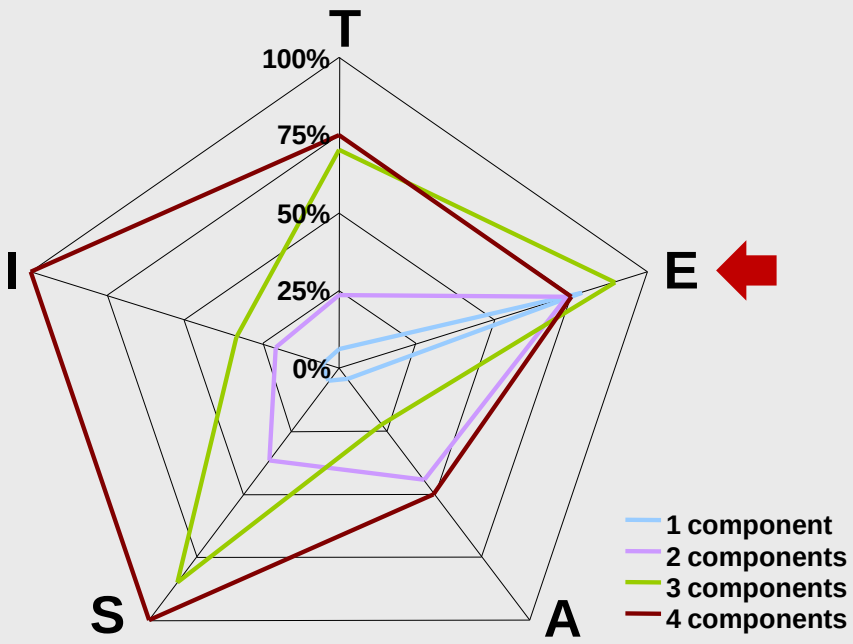
  - Reflects that many were used for assessing intentional imports
  - Extensiveness and sophistication of impacts varied widely

SCORING APPROACHES



- Broad coverage of TEASI components (50% of reviewed RAs include at least 3 components and 18% include all 5).

QUANTITATIVE APPROACHES

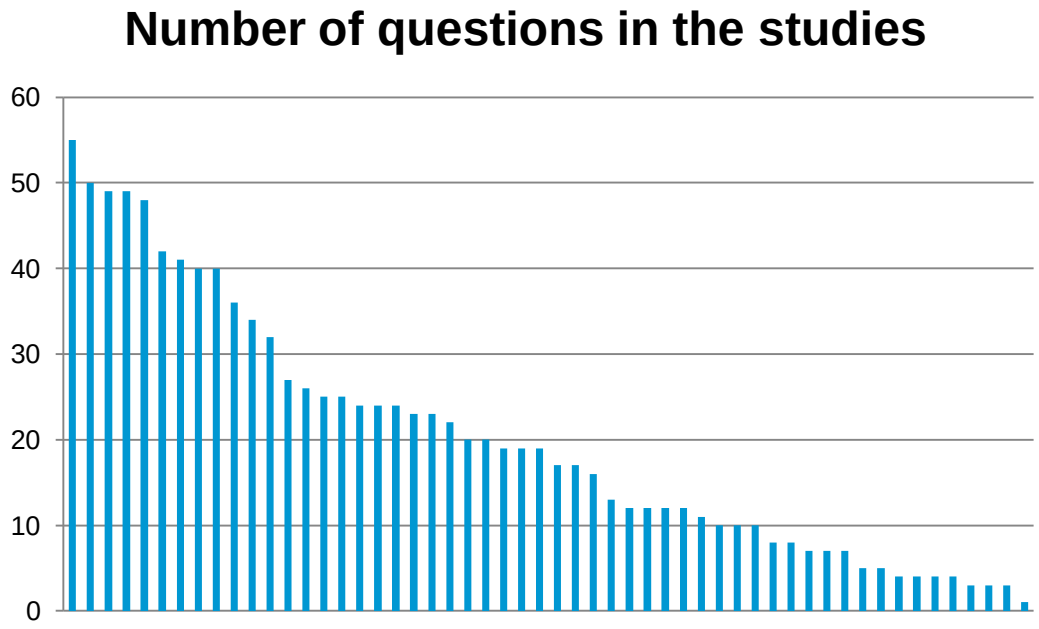


- Most RAs examine a single TEASI component (78%).

- Establishment is the most commonly estimated component (79% of all models).

Carrying out the assessment

- The number of questions
  - Mean 22 (20); Median 17 (18)
  - Specificity and sensitivity



- Point scales
  - 5% numerical scale with binary yes/no questions
  - Otherwise semi-quantitative

Point scales

[0, 3, 5]

[A-D]

[0, 1, 3, 5]

[0, 3]

[1-3]

[0, 1, 3, 6, 10]

[1-5]

[1-10]

[0-5]

[0-2]

[0, 5]

[0-4]

[1, 2, 4]

[-10, 1, 2, 5, 10]

[2, 4]

[-3-5]

[-1, 0, 1]

[0-10]

[0, 1]

[0-6]

[0, 1, 2, 4]

[0, 10]

[1-4]

[0, 0.5, 1]

[1-9]

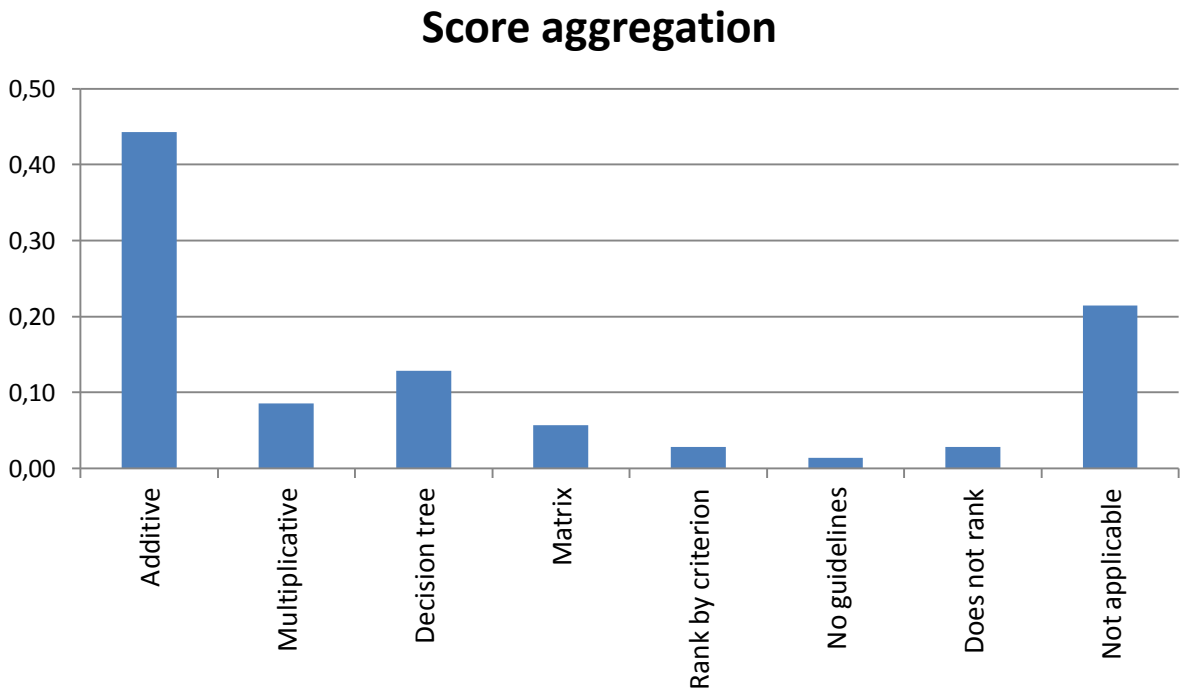
[0, 1, 3, 5, 10]

[0, 5, 10]

[0, 3, 5, 7, 10, 15]

Aggregation and weighting

- Score aggregation
  - Multiplicative: if any component approaches zero, so does the total score
  - Aggregation by criteria

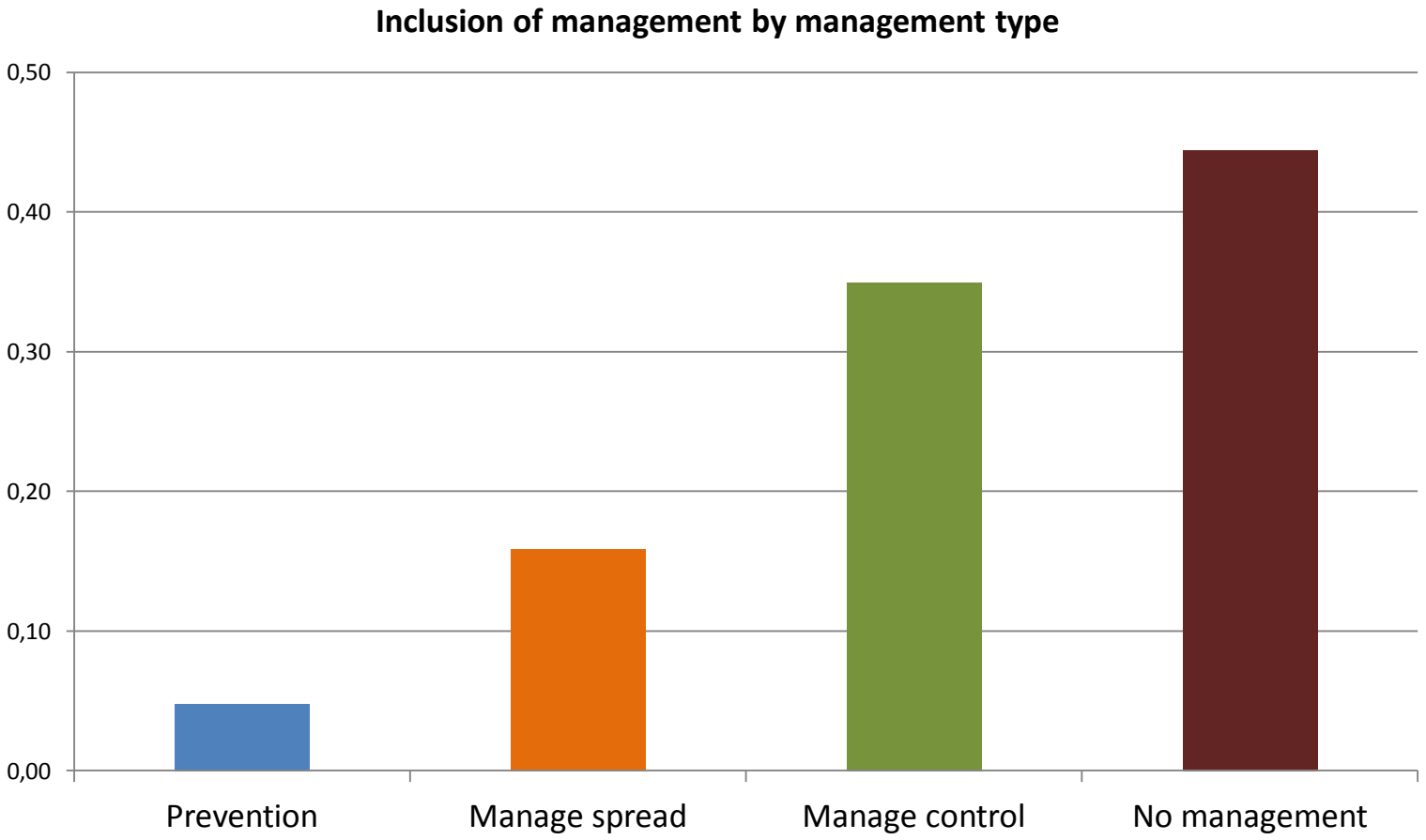


- Weighting
  - 59% include some kind of weighting
    - determined by researchers, subjected to evaluation panel or determined with statistical analysis
    - Different point scales; number of questions in sub-criteria; multiplicative weights

Management

Feasibility of control

- excluding human actions likely to produce sub-optimal outcome
- preventability; controllability
- 36%-44% did not include any measure; even when included, mostly based on one or few questions



Uncertainty

- Input uncertainty: quality and existence of information and panellists' knowledge
  - 47% did not include any measures for input uncertainty
- Output uncertainty: how reliable the outcome of the model is
  - 36% did not include any validation + 12% had no application

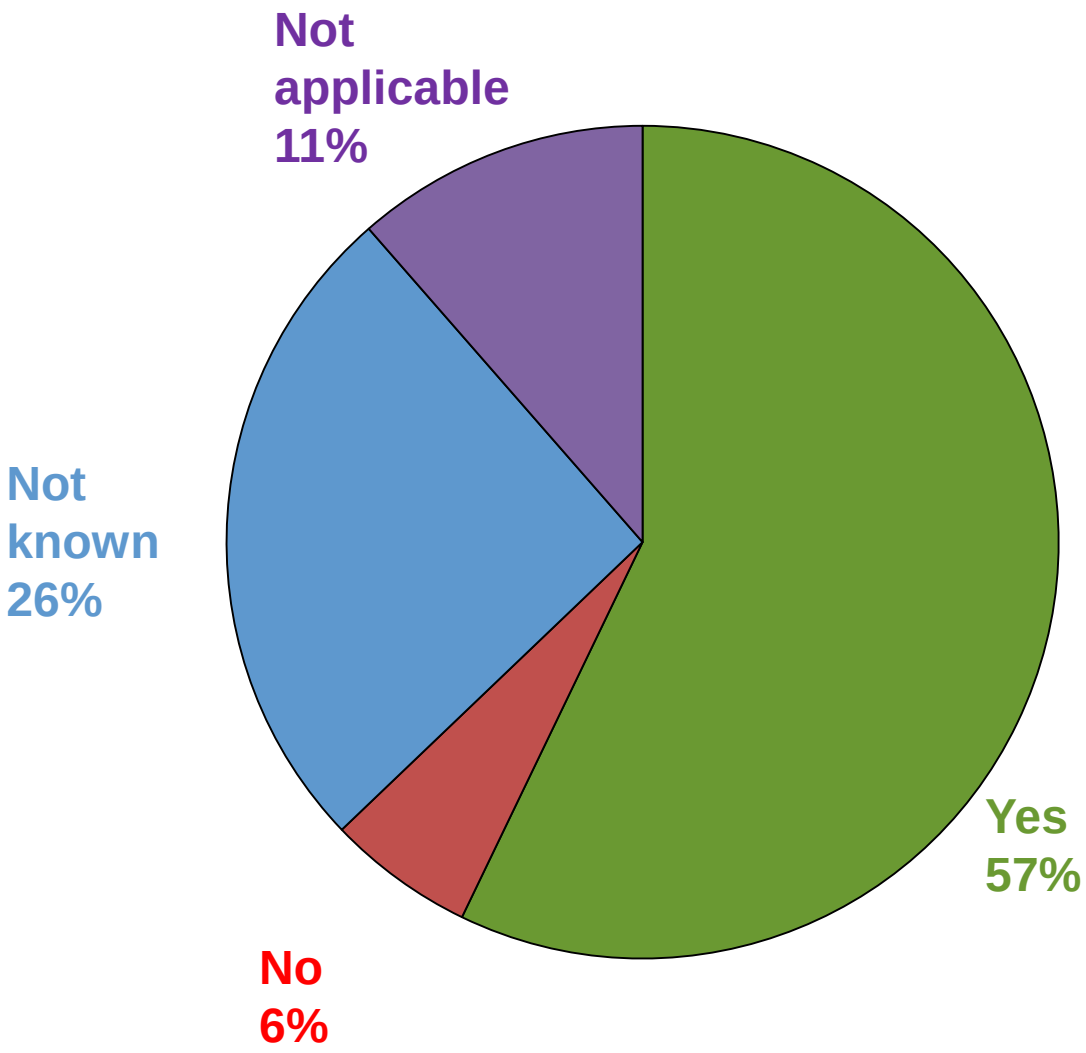
INPUT UNCERTAINTY

- Provide a score for uncertainty related to each answer or for the reliability of information used in answering the question (e.g. journal, observation, anecdotal)
- It is not necessary to answer all the questions or can answer "do not know"
- Can answer multiple choices (a scale of answers) instead of a single choice
- Use more than one evaluator
- Specifically ask about uncertainty related to the species
- Do not include the species if there is uncertainty

OUTPUT UNCERTAINTY

- Second round of panel evaluation, where results of the first round are fed back to the panel (or other experts)
- Model sensitivity tested by changing the input values by a given percentage and calculating the impact on the final results
- Species with moderate risk scores are assigned to an "evaluate further" category and a second round of evaluation
- Results are given as a distribution instead of simple point scores
- Results are validated by comparing some of them against known species, by subjecting them to expert evaluations or by comparing against results of other models

Used for policy support?



Strengths

1. Allows comparison of species and hence more efficient resource allocation: allocate resources according to risk
2. Provides a transparent base for decision-making
3. Assists in conceptualising the problem
4. Offers a (semi-)quantitative aid to multi-criteria decision-making
5. Allows assessment of many species in a relatively short time
6. Assists in involving scientists in the decision-making process
7. Helps in detecting species that are surprisingly high or surprisingly low in the list

Weaknesses (challenges?)

Matter of design

1. Assesses only natural characteristics, not societal response
   - i.e. assumes nothing is done about the species
   - controllability is too often not included
2. If there is correlation among the criteria, the results are biased towards the correlated criteria
3. Uncertainty is too often not accounted for
   - What to do with the missing information?

Matter of application

4. Grouping of the organisms may be challenging
   - evaluate “influenza” or “H5N1” and common inluenza separately
   - Evaluate “sexually transmitted diseases” or “HIV/AIDS”
5. The outcome is time and space specific
6. Does not take into account the current level of investment
7. Does badly when actions target multiple hazard
   - not an action-prioritisation tool

Matter of trust?

8. Semi-quantitative scores are arbitrary, and not fully transparent
9. Scoring and score aggregation are non-linear
   - 4 is not twice as harmful as 2, change from 1 to 2 is not same as change from 4 to 5
   - 2 in economic impacts is not necessarily the same as 2 in environmental impact

Finally…

- Generally a fair amount of frameworks, especially for plants, but only few used extensively
- Studies primarily conducted in the past five years
- Impacts often accounted for, but level of inclusion varies
  - social and trade impacts generally lacking
  - exclusion of sub-components when they do not increase prediction?
- Treatment of uncertainty still inadequate
  - identification of when uncertainty matters?
- Management still inadequately incorporated
- Relatively commonly applied in policy, unlike fully quantitative risk assessments
- Structured, holistic and transparent mechanism

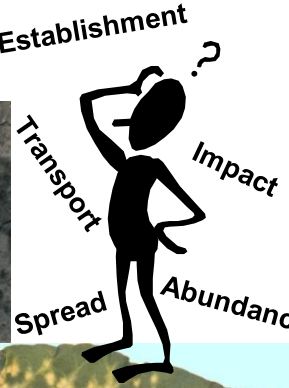
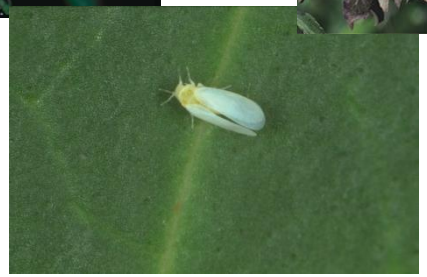
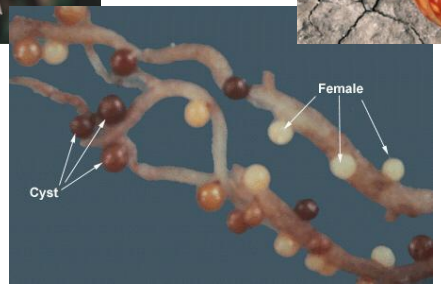





Female
Cyst

Thank you





Establishment
?
Impact
Abundance
Spread
Transport


Female
Cyst