Discussion Group 1

Methodologies in pest risk assessment:

qualitative *vs.* quantitative approaches in the assessment of introduction potential

Scope of DG1

In the IPPC Glossary: Introduction is "*the entry of a pest resulting in its establishment*"

Therefore DG1 is limited to the first two of the four stages of Pest Risk Assessment:

- Entry

- Establishment

- Spread

- Impacts

A great diversity of approaches for assessing entry and establisment potentials

- **Qualitative approaches**

Require risk assessors to choose from categorical ratings *e.g* very low, low, moderate, high, very high.

- **Quantitative approaches**

Can be used by risk assessors to obtain numerical probabilities.

Qualitative approaches

- risk rating methods (e.g. EPPO scheme);

- linking risk ratings to quantities/probabilities;

- summarising risk ratings and communicating uncertainty.

USDA Guidelines for Pest Risk Assessments

Sub-elements	Ratings
Quantity imported annually	Low, Med., High 1, 2, 3
Survive post harvest treatment	Low, Med., High 1, 2, 3
Survive shipment	Low, Med., High 1, 2, 3
Not detected at port or entry	Low, Med., High 1, 2, 3
Moved to suitable habitat	Low, Med., High 1, 2, 3
Contact with host material	Low, Med., High 1, 2, 3

Problems related to qualitative approaches

- Ratings not always clearly defined.

- No consensus on method for combining ratings.

Clear definitions of ratings must be provided to risk assessors and stakeholders !

Examples of definitions of ratings

Quantity of commodity imported annually
Low (1 point): < 10 containers/year
Medium (2 points): 10 - 100 containers/year
High (3points): > 100 containers/year

from USDA Guidelines

Examples of definitions of ratings

- Negligible = 0 (no potential to survive)

- Low = 1 (potential to survive on a third or less of the range of hosts in the PRA area)

- Medium = 2 (potential to survive on a third to two thirds of the range of hosts in the PRA area)

- High = 3 (potential to survive throughout most or all of the range of hosts in the PRA area)

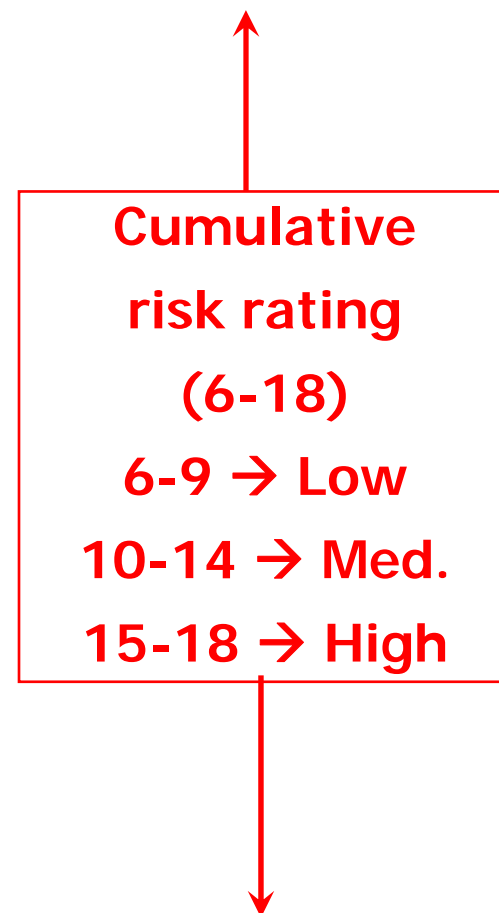**from Canadian Food Inspection Agency: establishment potential rating guidelines (2002)**

necessarily represent the final conclusions

Difficult to make generic definitions

Appropriate definitions may depend on pests and areas

No consensus on methods for combining scores

USDA Guidelines for Pest Risk Assessments

Sub-element	Ratings
Quantity imported annually	Low, Med., High 1, 2, 3
Survive post harvest treatment	Low, Med., High 1, 2, 3
Survive shipment	Low, Med., High 1, 2, 3
Not detected at port or entry	Low, Med., High 1, 2, 3
Moved to suitable habitat	Low, Med., High 1, 2, 3
Contact with host material	Low, Med., High 1, 2, 3

Cumulative risk rating (6-18)

6-9 → Low

10-14 → Med.

15-18 → High

Table 8.4   Matrix of rules for combining descriptive likelihoods — Biosecurity Australia

	Likelihood 2					
Likelihood 1	**High**	**Moderate**	**Low**	**Very (V) low**	**Extremely (E) low**	**Negligible**
High	High	Moderate	Low	V low	E low	Negligible
Moderate	Moderate	Low	Low	V low	E low	Negligible
Low	Low	Low	V low	V low	E low	Negligible
Very low	V low	V low	V low	E low	E low	Negligible
E. low	E low	E low	E low	E low	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

These slides were presented in the plenary session
and followed by discussion and may not
necessarily represent the final conclusions

What is the best method for combining scores?

from Hennen (2007)

Combining scores	Simple	Programming effort	Robust	Objective	Dealing with uncertainty	Relevant (for EPPO)	Sensitive / match knowledge	Complete	Laborious	Reliable	Maintenance	Flexible	Required expert knowledge	Weighted overall score
1 Sum of scores | 2 Arithmetic mean	+	+	+	+	-	o/+	--	-	+	-	+	-	+	5.3
3 Weighted average/sum	+	+	+	o	-	+	o	o	o	+	o	o	-	7.0
4 Maximum	+	+	+	+	-	--	-	-	+	--	+	--	+	3.5
5 Cross the Threshold	+	+	o	+	-	--	o	-	+	-	+	o	o	4.7
6a Mandatory	+	+	o	+	-	--	-	-	+	-	+	--	o	3.5
6b Optional	+	+	+	o	-	-	-	-	+	-	+	-	o	4.5
7 Differentiated scores (Imagine)	--	-	-	-	-	+	++	+	-	o	-	+	--	5.5
8 Fuzzy combinations	-/o	--	o	o	+	+	+	+	-	+	o	+	-	6.4
9 Rule-based Experts Systems	-	--	-	--	+	o	+	o	--	o	--	+	--	3.6
10 Holt (Bayesian)	-/o	o	-/+	o	-	++	-	-	+	-	+	-	+	5.6

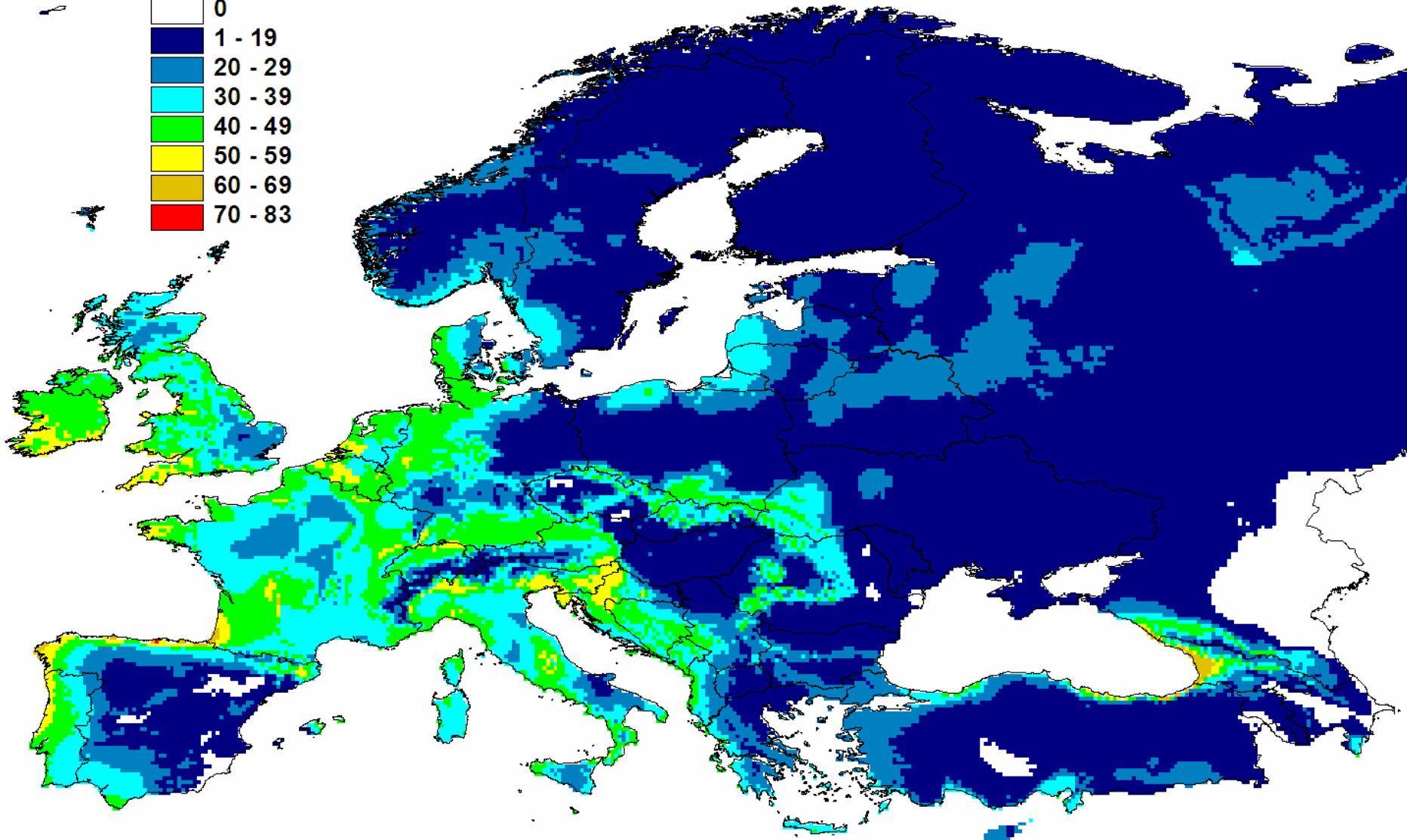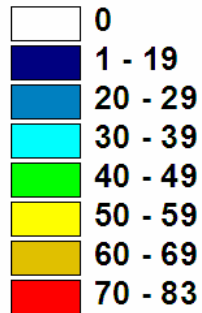necessarily represent the final conclusions

Quantitative approaches

- available models;

- parameter estimation;

- assessing and communicating model accuracy.

A great diversity of models.

- Climate-based systems (NAPPFAST, CLIMEX).

- Statistical models (Poisson, binomial, logistic…)
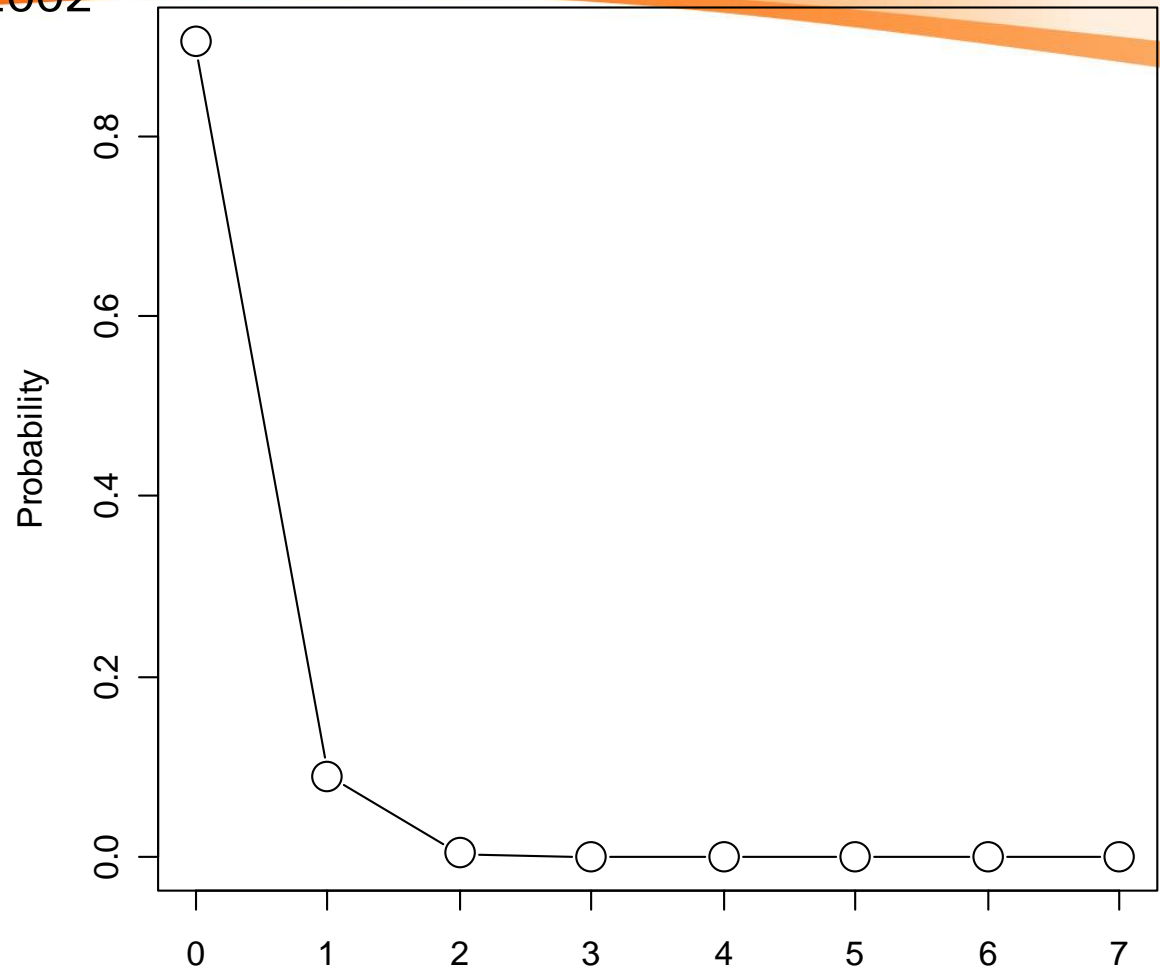
- Population ecology model (Leslie matrix…)

CLIMEX index of establishment suitability for *Phytophthora ramorum*

Legend:
- 0
- 1 - 19
- 20 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 - 83

necessarily represent the final conclusions

Estimation of probability of entry

from Stansbury et al., 2002
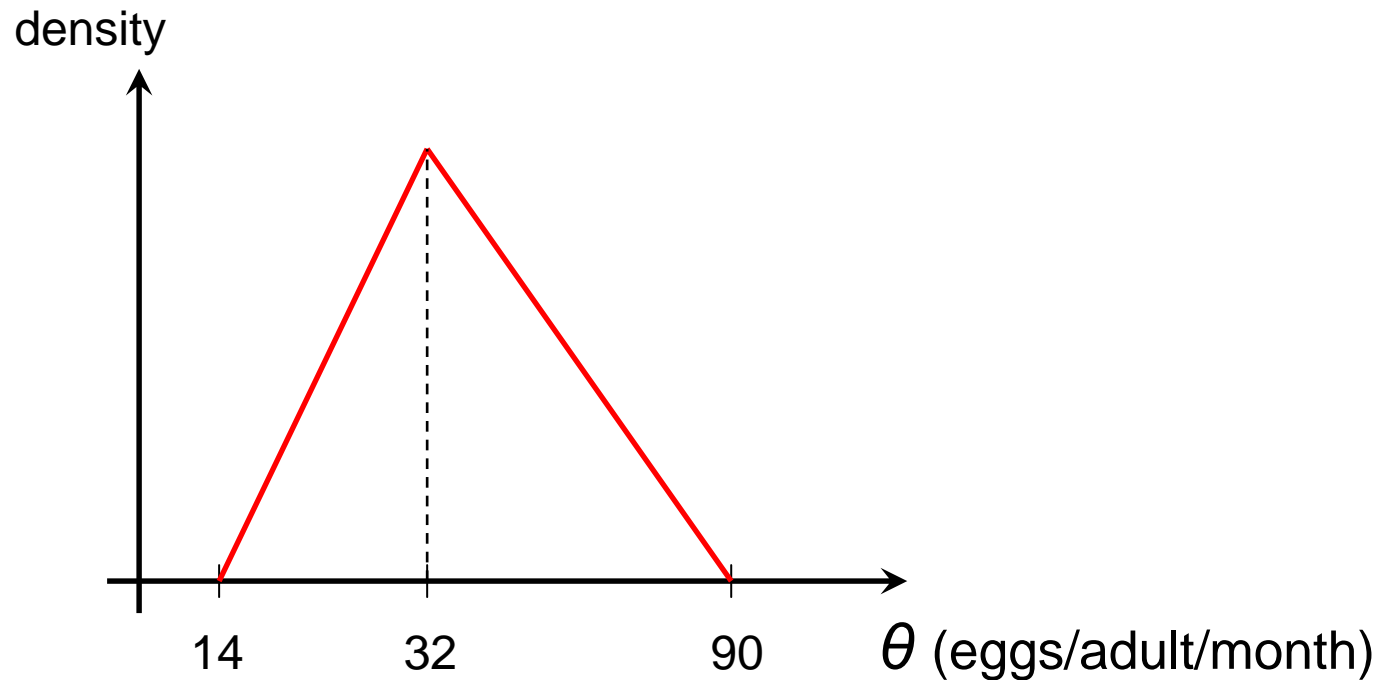

Number of successful entry of *Tilletia indica* in Australia

Population ecology model for estimating the probability of establishment of the Asian longhorned beetle (*Anoplophora glabripennis*)

$$f_4$$

| Eggs n_1 | $\xrightarrow{s_1}$ | Larvae n_2 | $\xrightarrow{s_2}$ | Pupae n_3 | $\xrightarrow{s_3}$ | Adults n_4 |

from Bartell & Nair (2003).
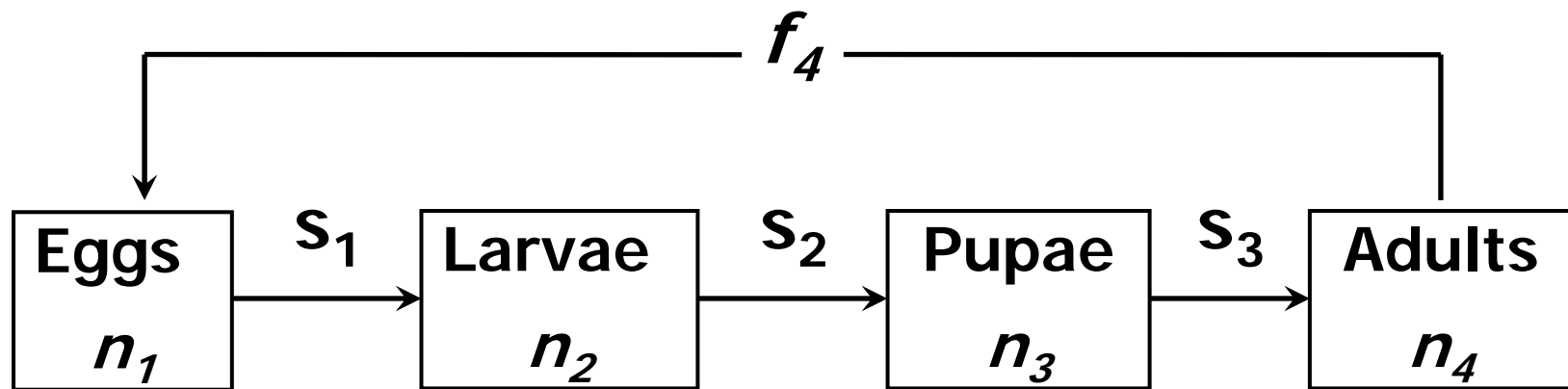
Parameter estimation is a major problem

Estimation of fecundity rate

density

14   32   90 θ (eggs/adult/month)

from Bartell & Nair (2003).

How to choose?

- Advantages and disadvantages of each approach for the assessor, decision makers and stakeholders.

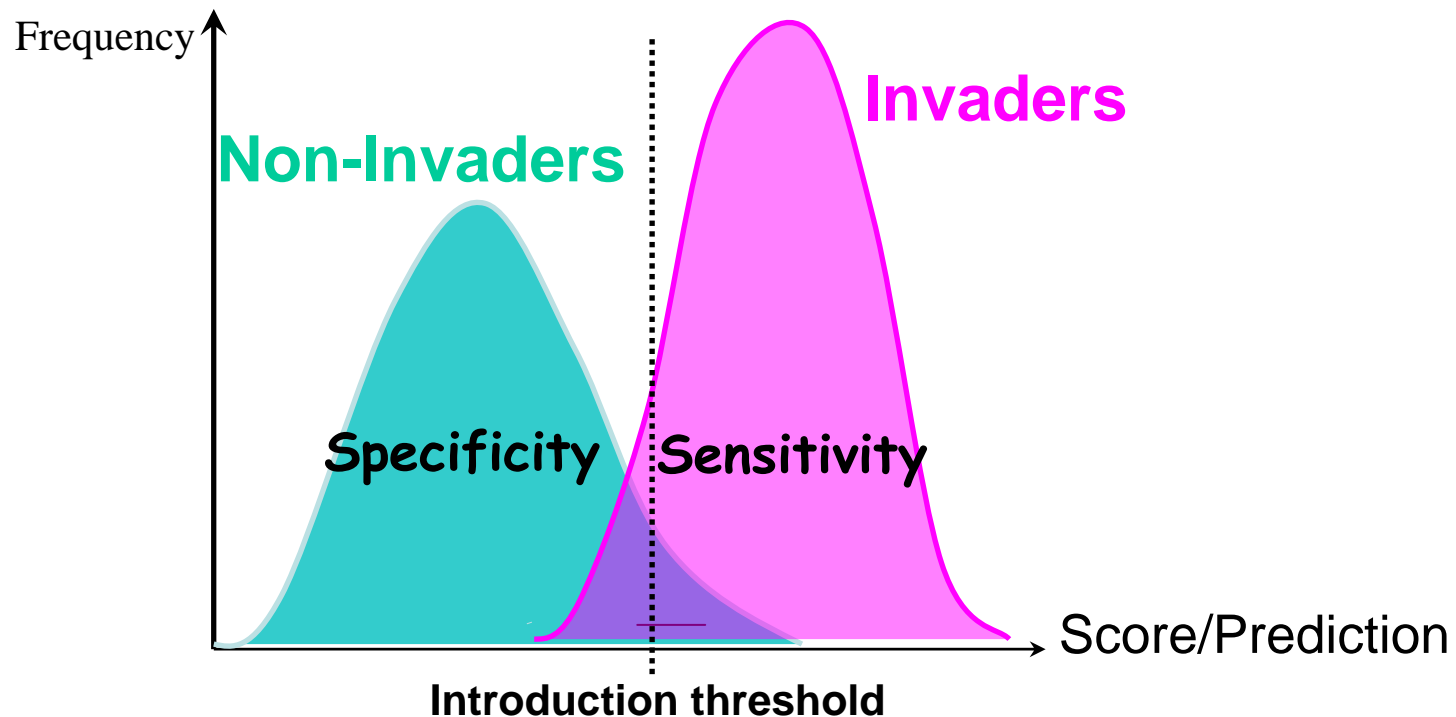- How to assess the accuracy of different pest risk assessment methods.

Qualitative approaches

- Easy to understand.

- A qualitative PRA can be done quickly.

- Problems of consistency due to
  - inaccurate definitions of ratings,
  - methods used for combining scores.

- Explicit definitions needed.

- Training workshops could be organized to improve the consistency of the assessments made by experts.

- Another option: provide evidences only (no ranking).

Quantitative approaches

- Time and resources can be problematic.

- Data not sufficient. Expert knowledge often required for estimating parameters.

- Uncertainty can be taken into account using probability distributions.

- Models can be used to combine probability of entry and probability of establishment.

- Models can be used to identify important knowledge gaps.

Toward a comparison of the accuracies of different approaches?

Frequency

Non-Invaders

Invaders

Specificity Sensitivity

Score/Prediction

Introduction threshold