

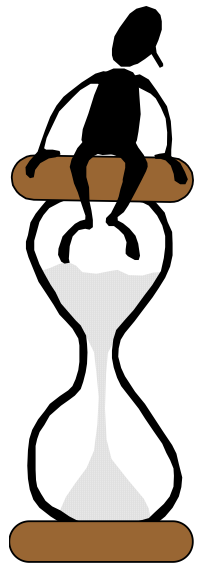
Social network analysis in One Health epidemiology 2019

Risk assessment in Veterinary Epidemiology

Prof. Dr. Marcus Doherr

To get started ...

- Introductions
- Some thoughts about risk
- Small group exercise 1
- Large group discussion
- Risk assessment in veterinary epidemiology
 - Objectives
 - Definitions, Terminology
 - Approaches
- Small group exercise 2
- Large group discussion
- Some issues about numbers
- Final discussion & summary



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- VetMed 1983-1989 & Dissertation in Vet. Parasitology 1990 in Hannover (DE)
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Inst. Veterinary Epidemiology & Biostatistics

<http://www.vetmed.fu-berlin.de/einrichtungen/institute/we16/index.html>



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Institut für Veterinär-Epidemiologie und Biometrie

Zentrum für Veterinary Public Health

Willkommen auf der Homepage des Instituts für Veterinär-Epidemiologie und Biometrie. Unser Gebäude finden Sie auf dem Campus Döppel als Haus 21 ([Lageplan](#)).

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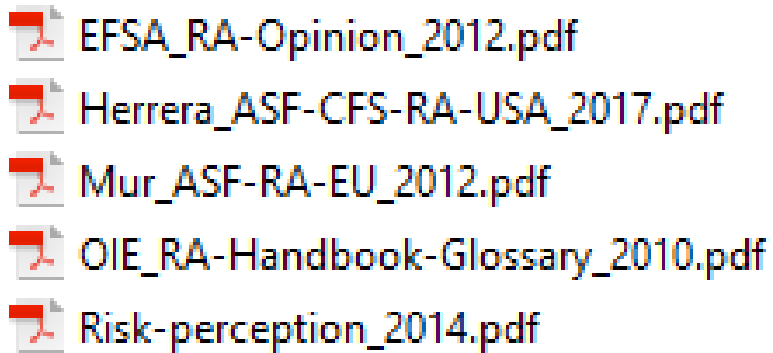
[PraeRi – Eine Prävalenzstudie zum Thema Tiergesundheit, Hygiene und Biosicherheit in deutschen Milchkuhbetrieben](#)

12.10.2016

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Documents provided

- Lecture slides (PDF)
- Exercise instructions (printout)
- Background documents (PDF)



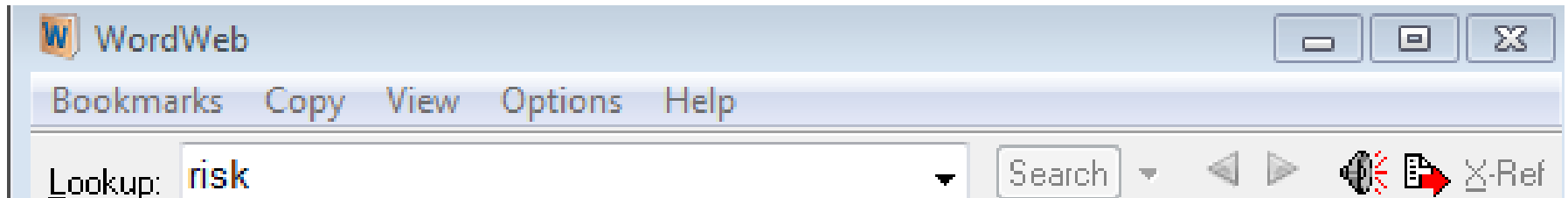
Our perception of risk ...

- Risk perception is a highly personal process of decision making, based on an individual's frame of reference developed over a lifetime ...
... when it come to making decisions about health and safety, we don't always worry the most about the most pressing risks.
- ... this risk perception gap ... is a natural extension of our hard-wired ability to quickly size up threats, ... an extraordinarily sophisticated form of intelligence ... born out of millennia of quickly assessing high risks."

-> Evolutionary trait

Environmental Health Perspectives Vol 122 | number 10 | October 2014

Definition of risk



Noun: risk 🎵 [UK] 🎵 [US] risk

1. A source of danger; a possibility of incurring loss or misfortune
"drinking alcohol is a health risk"
2. A venture undertaken without regard to possible loss or injury
"he saw the rewards but not the risks of crime"
3. The probability of becoming infected given that exposure to an infectious agent has occurred
4. The probability of being exposed to an infectious agent

Speaking about models ...

Box, G. E. P. (1976), "Science and statistics" (PDF), Journal of the American Statistical Association, 71: 791–799, doi:10.1080/01621459.1976.10480949.

2.3 Parsimony

Since all models are wrong the scientist cannot obtain a "correct" one by excessive elaboration. On the contrary ... he should seek an economical description of natural phenomena.

2.4 Worrying Selectively

Since all models are wrong the scientist must be alert to what is importantly wrong. It is inappropriate to be concerned about mice when there are tigers abroad.

“All models are wrong ... but some are useful”

Types of models ...



<https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUK EwjTjvX3tYnhAhVGsqQKHRmLBmwQjRx6BAgBEAU&url=https%3A%2F%2Fwww.produktsHOT.de%2Fmodel.html&psig=AOvVaw07IBe2pg3aHJJZ926h5Vc6s&ust=1552920448690911>

Conceptual model:

a representation of a system using general rules and concepts

Physical model or plastic model:

a physical representation in three dimensions of an object, such as a globe or model airplane

Scale model:

a representation of an object which maintains general relationships between its constituent aspects

Scientific model:

a simplified and idealized understanding of physical systems

Several modelling domains

**Risk
factor
analysis
models**

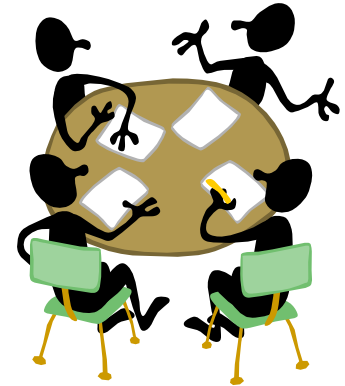
**Network
analysis
models**

**Infectious
disease
("SIR")
models**

**Risk
analysis
models**

Small Group Exercise 1

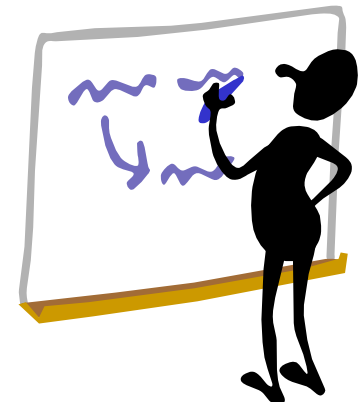
- Grouping into 4 groups
- Group assignment:



In your group, identify the key parameters of the assigned model type and summarize them on a flipchart for presentation

Also, quickly think about the key parameters for the other models in order to contribute to final group presentations

-> Handout exercise 1



Key characteristics to address in group discussion

Graphical representation on the model (simple example)

Main objectives of the model

Most relevant information (data) needed

Typical modelling environment / software used

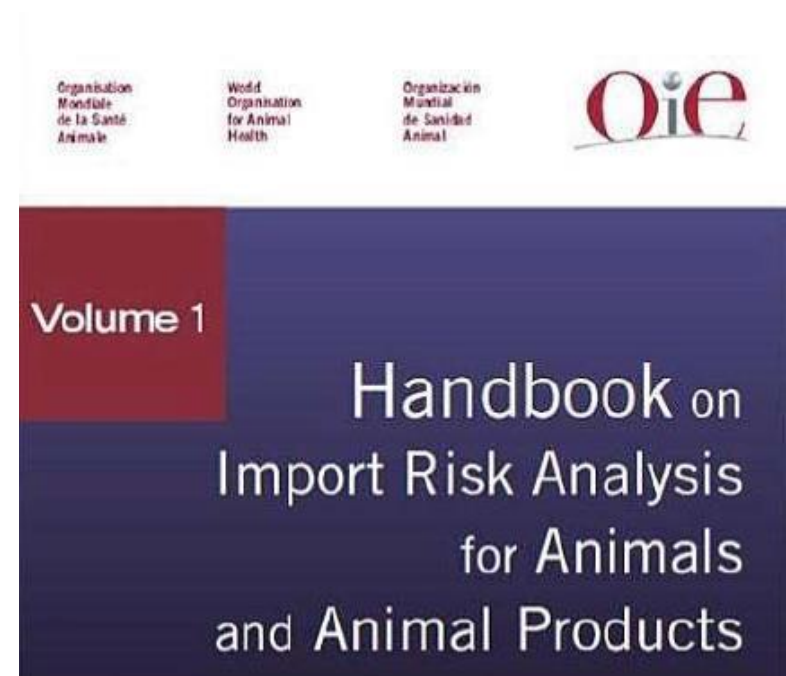
Risk assessment in the “one health” domain

- Risk:

The likelihood of the occurrence and the likely magnitude of the biological and economic consequences of an **adverse event or effect to animal or human health.**

- Risk

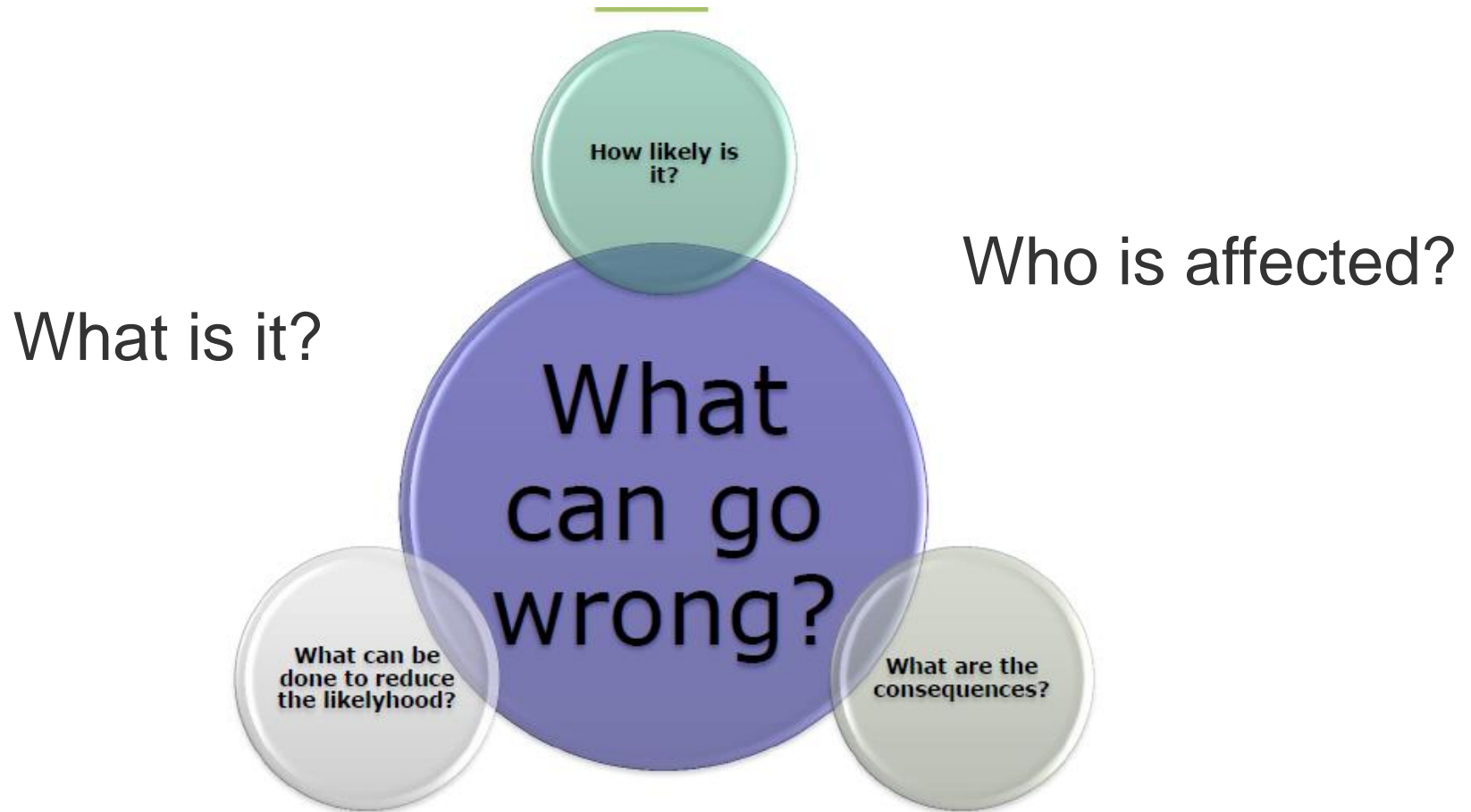
≈ probability × impact



Key players in health & animal health risk assessments

- World Health Organisation (www.who.int)
- World Organisation for Animal Health (www.oie.int)
- European Food Safety Authority (<http://www.efsa.europa.eu>)
- UN Food and Agricultural Organization (<http://www.fao.org>)
- Respective national institutions / authorities

Most relevant questions ...



Some definitions

- Good summary provided in EFSA Scientific Opinion on Risk Assessment Terminology (EFSA Journal 2012;10(5):2664)
 - > PDF document in your background file collection

Mandate

The European Food Safety Authority (EFSA) asked its Scientific Committee to develop an opinion on the use of risk assessment terminology and how increased harmonisation across its Scientific Committee and Panels could reduce ambiguity and improve the consistency and clarity of its technical risk assessments to risk managers, consumers and the wider scientific and stakeholder community.

Slightly different approaches in different areas

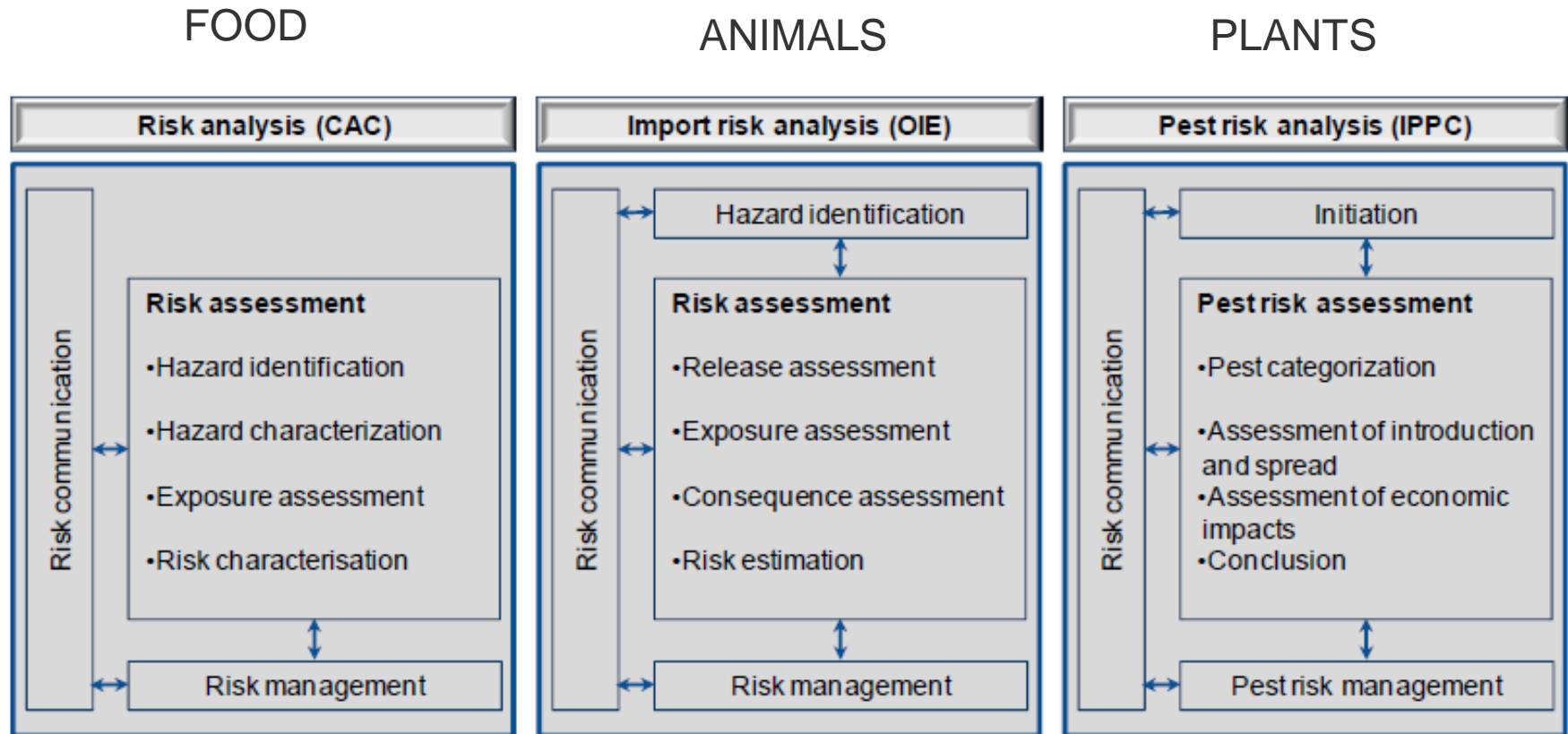


Figure 1: Comparison of risk assessment structures within the risk analysis frameworks of CAC, IPPC and OIE (modified from Maijala 2006).

EFSA Journal 2012;10(5):2664

Onother possibility to present the components of RA

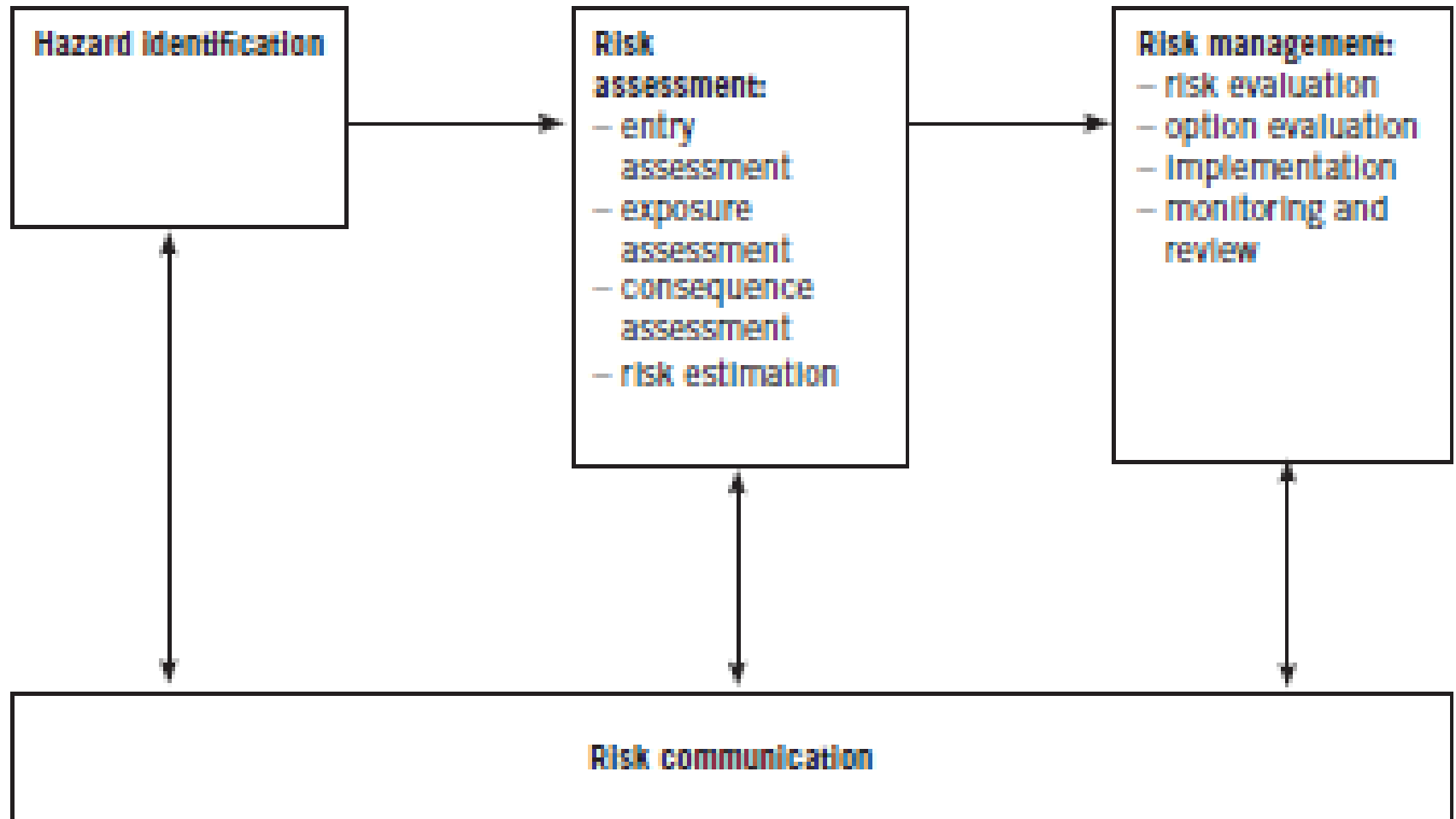
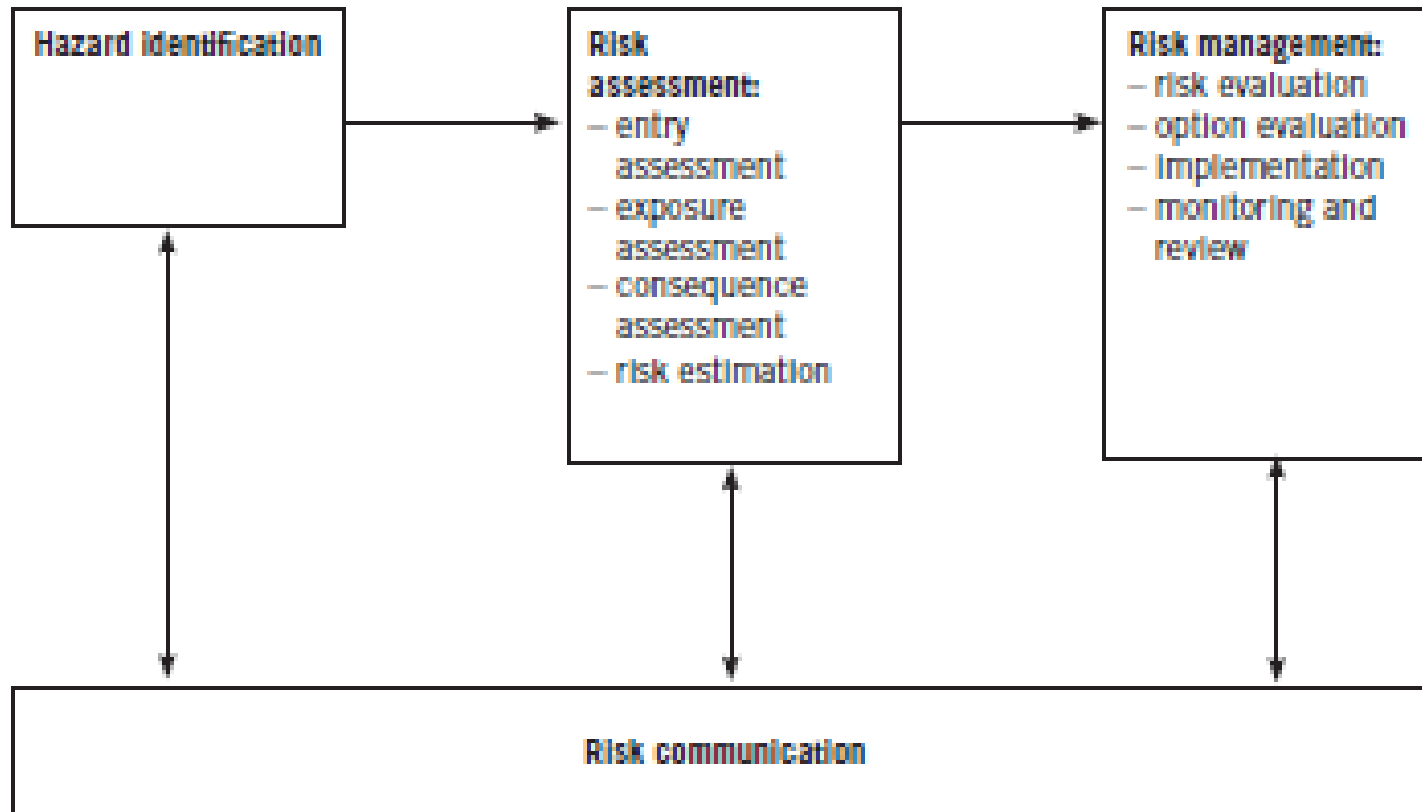
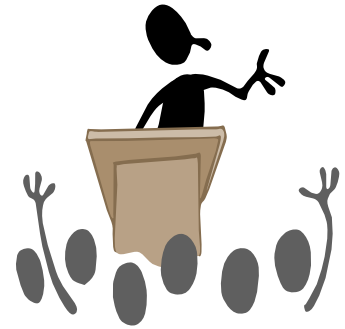


Figure 1 The structure of the OIE risk analysis process

Who does what?

Risk manager

Risk assessor



Hazard / Pest and Risk (Table 1)

Term	Organisation	Definition/explanations
Hazard/pest	CAC	a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect (CAC, 2011) A biological, chemical or physical agent in, or condition of, a good with the potential to cause an adverse health effect (FAO/WHO, 2008)
	OIE	Biological, chemical or physical agent in, or a condition of, an animal or animal product with the potential to cause an adverse health effect (OIE, 2011)
	IPPC	'Hazard' not specified; Pest is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (IPPC, 2011b) Contaminating pest is a pest that is carried by a commodity and, in the case of plants and plant products, does not infest those plants or plant products (IPPC, 2011b)
Risk/pest risk	CAC	A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food (CAC, 2011)
	OIE	Likelihood of the occurrence and the likely magnitude of the biological and economic consequences of an adverse event or effect to animal or human health. (OIE, 2011)
	IPPC	Pest risk (for quarantine pests): The probability of introduction and spread of a pest and the magnitude of the associated potential economic consequences (IPPC, 2011b) Pest risk (for regulated non-quarantine pests): The probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (IPPC, 2011b)

EFSA Journal 2012;10(5):2664

Hazard / Pest and Risk (Table 1 cont.)

Risk analysis	CAC	A process consisting of three components: risk assessment, risk management and risk communication. (CAC, 2011)
	OIE	The process composed of hazard identification, risk assessment, risk management and risk communication. (OIE, 2011)
	IPPC	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (IPPC, 2011b)
Risk assessment	CAC	<p>A scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterization, (iii) exposure assessment, and (iv) risk characterization. (CAC, 2011)</p> <p>Qualitative Risk Assessment: A risk assessment based on data which, while forming an inadequate basis for numerical risk estimations, nonetheless, when conditioned by prior expert knowledge and identification of attendant uncertainties permits risk ranking or separation into descriptive categories of risk. (FAO/WHO, 2008)</p> <p>Quantitative Risk Assessment: A risk assessment that provides numerical expressions of risk and indication of the attendant uncertainties (FAO/WHO, 2008)</p>
	OIE	Evaluation of the likelihood and the biological and economic consequences of entry, establishment and spread of a hazard within the territory of an importing country (OIE, 2011)

EFSA Journal 2012;10(5):2664

Qualitative and quantitative approach

Qualitative risk assessment:

An assessment where the outputs on the likelihood of the outcome or the magnitude of the consequences are expressed in qualitative terms such as “high”, “medium”, “low” or “negligible”.

Quantitative risk assessment:

An assessment where the outputs of the risk assessment are expressed numerically such as “0.01% probability” or “5 infections / 100'000 individuals and year”

- “The qualitative approach is suitable for the majority of import risk analyses, and is currently the most common type of assessment undertaken to support routine import decision making.
- However, in some circumstances it may be desirable to undertake a quantitative risk analysis. Quantification involves developing a mathematical model to link the steps of the risk pathway, which are expressed numerically.”

Source: [Handbook on Import Risk Analysis for Animals and Animal Products Part 1 \(OIE, 2010\)](#)

General recommendations (rules) in RA

Rule 1:

be as consistent as possible, use accepted standards for approaches, risk classification and terminology

Rule 2:

reach agreement on question / scope and available time & resources between all stakeholders involved EARLY in the process

- Glossar extracted from OIE Handbook on Import Risk Analysis for Animals and Animal Products, Volume 1, 2nd Edition, 2010 (ISBN: 978-92-9044-626-2)
- EFSA Scientific Opinion on Risk Assessment Terminology; EFSA Journal 2012;10(5):2664

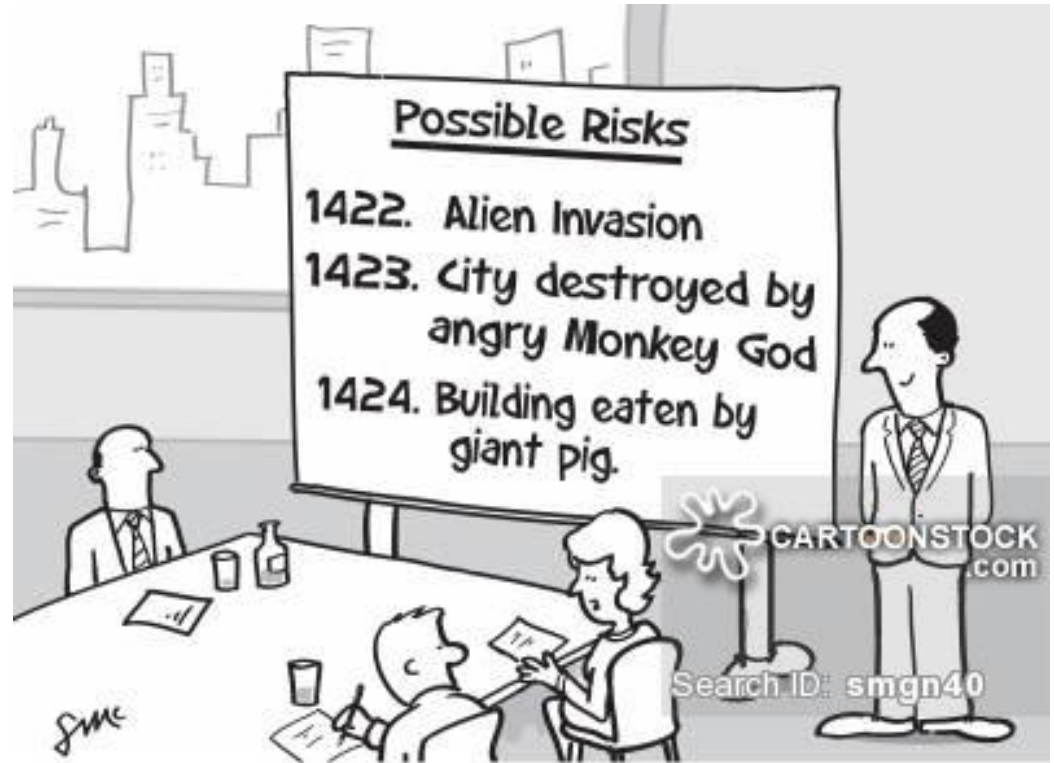
(Import) Risk Assessment

Scopes of (Import) RA

- Hazards & Commodities
- Involved pathways
- Affected populations
- Expected consequences

Communication strategies

- during RA
- for result of RA
- other



"Well he certainly does a very thorough risk analysis."

Measures vs. Measurements (1)

Measures relate to Risk Management:

- Risk management
The process of identifying, selecting and implementing measures that can be applied to reduce the level of risk.
- Sanitary measure
A measure ... destined to protect animal or human health or life ... from risks arising from the entry, establishment and/or spread of a hazard.

Measures vs. Measurements (2)

Measurements relate to actual values

- Parameter: a characteristic of the target population
- Estimate: our “best guess” of a population parameter [value] based on a sample

Uncertainty: The lack of precision in [input] values which is due to lack of information or measurement error (bias) ...

- Variability: real-world complexity in which the value of an input [value] is not the same for each case due to natural diversity in a given population

Steps of actual import risk assessment (1)

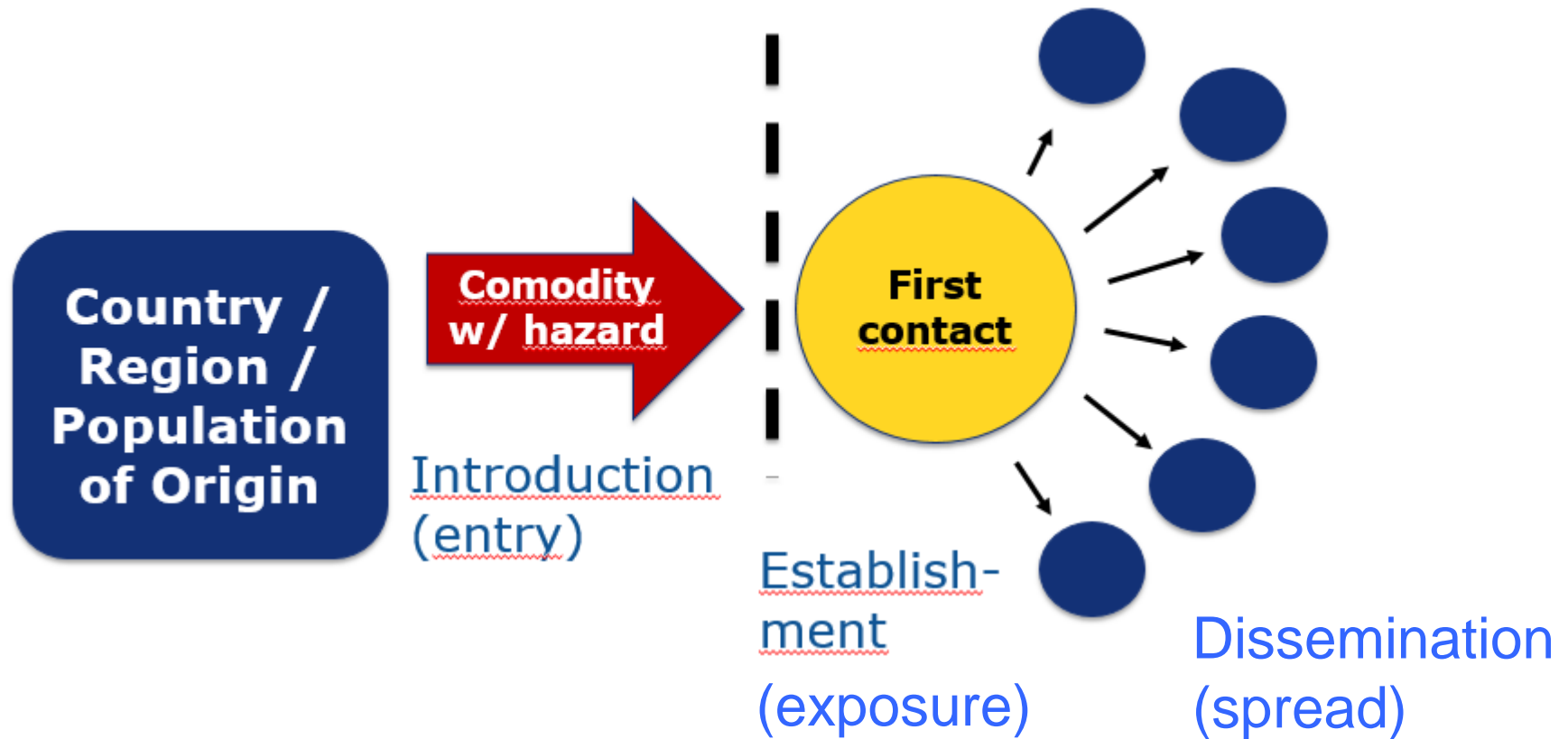
Draw scenario tree on risk pathway(s) for hazard to enter country

- Visualization of problem
- Clarification of risk question
- Identification of information needs

Sources of information

- OIE, EU / EFSA data & reports
- Inspection reports (FVO etc)
- Systematic literature review
- Internet, gray literature
- Expert consultation / opinion

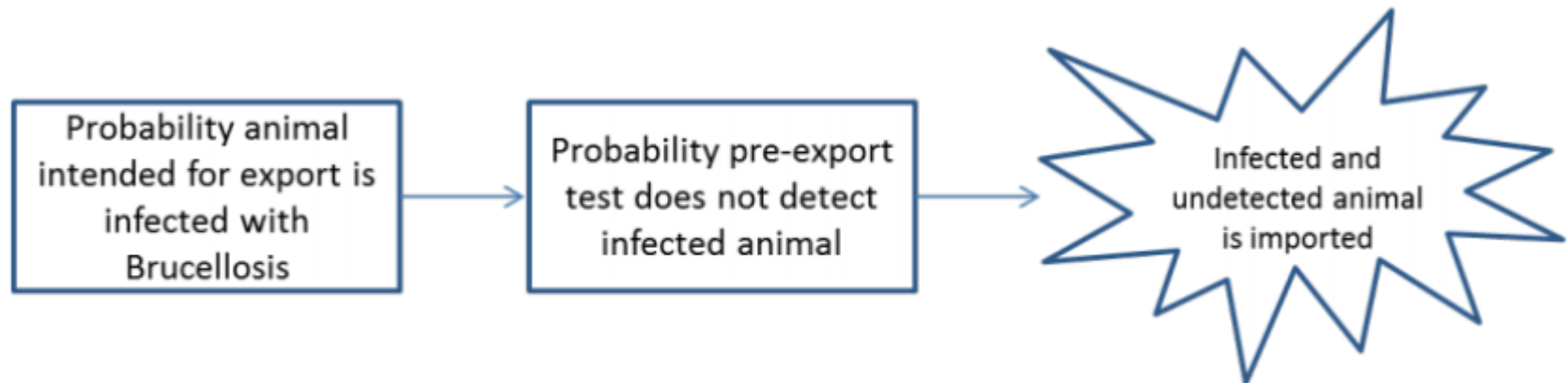
Steps in IRA (2)



Steps in IRA (3)

Entry Assessment

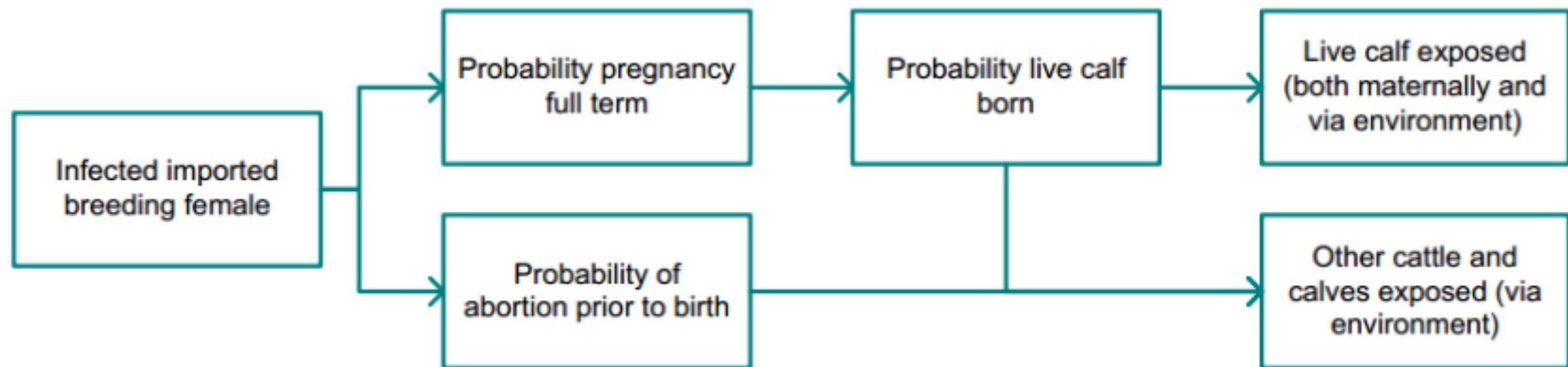
“What is the annual risk of importing Brucellosis into Country X via breeding cattle from Country Y?”



Steps in IRA (4)

Exposure assessment

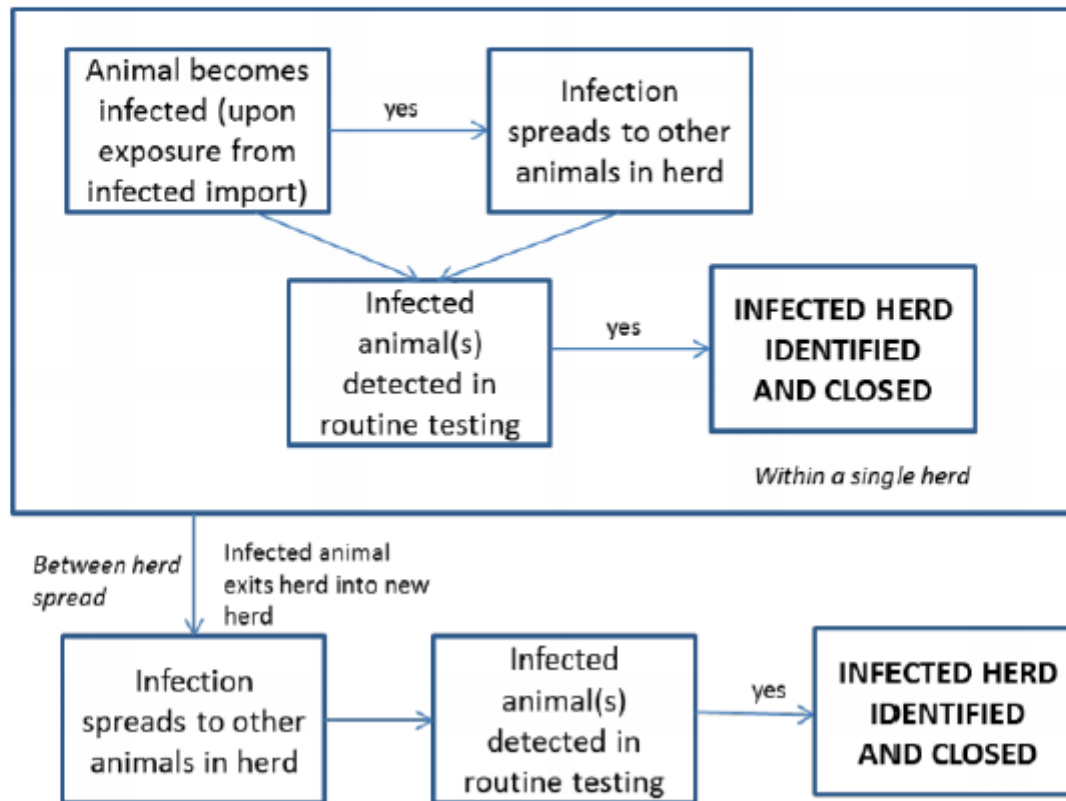
“What is the risk of indigenous cattle being exposed to Brucellosis from the importation of infected breeding animals?”



Steps in IRA (5)

Consequence Assessment

“What is the rate of spread of the disease and the time until detection under a variety of testing regimes?”



Steps in IRA (6)

Risk estimation:

The process of integrating the results from the **entry assessment**, **exposure assessment**, and **consequence assessment** to produce overall measures of risks associated with the hazards identified at the outset.



Qualitative

Semi-quantitative

Quantitative

Steps of IRA (6)

- Examine risk mitigation (sanitary) options
- Scenarios & sensitivity analysis in risk assessment

Explore ranges of input values at different steps as well as for different mitigation options

- > relative comparison of outcomes
- -> influence of certain values / assumptions on outcomes
- Peer-review process of IRA before (costly) management options are taken
- Communication of results to Risk Management

Qualitative scales in RA (1)

34

Qualitative risk characterization in risk assessment

Table 3.4a Qualitative measures of likelihood.

Level	Descriptor	Example description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Source: <http://www.fao.org/docrep/012/i1134e/i1134e03.pdf>

Qualitative scales in RA (2)

Table 4. Example of a harmonised list of probability terms, used by the Intergovernmental Panel on Climate Change (IPCC) to express the likelihood of an outcome occurring. Note that although expressed differently, the 2005 and 2010 definitions are equivalent and, in both cases, the probability ranges for different terms overlap (e.g. likely and very likely).

Term	IPCC (2005)	IPCC (2010)
Virtually certain	> 99% probability	99-100% probability
Very likely	> 90% probability	90-100% probability
Likely	> 66% probability	66-100% probability
About as likely as not	33 to 66% probability	33 to 66% probability
Unlikely	< 33% probability	0-33% probability
Very unlikely	< 10% probability	0-10% probability
Exceptionally unlikely	< 1% probability	0-1% probability

⁶ Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives (OJ L 354, 31.12.2008)

Qualitative scales in RA (3)

Qualitative scales; EU / EFSA GBR 2007

Table 1: Level of external challenge in a given 5-year period resulting from import of live cattle or MBM from UK or other BSE-risk countries

Level of external challenge	Risk units resulting from imported live cattle and MBM using weighting factors
Extremely high	$\geq 10,000$
Very high	1,000 - < 10,000
High	100 - < 1,000
Moderate	20 - < 100
Low	10 - < 20
Very low	5 - < 10
Negligible	0 - < 5

Source: *The EFSA Journal* (2007) 463, 1-35

Opinion of the Scientific Panel on Biological Hazards on the revision of the Geographical BSE risk assessment (GBR) methodology

Qualitative scale in RA (4)

Hypothetical example	Probability or Number of Comodity being imported						
Probability of Comodity being infected with agent (hazard)	Extremely high	Very high	High	Moderate	Low	Very low	Negligible
Extremely high							
Very high							
High							
Moderate							
Low							
Very low							
Negligible							

Requires expert discussion

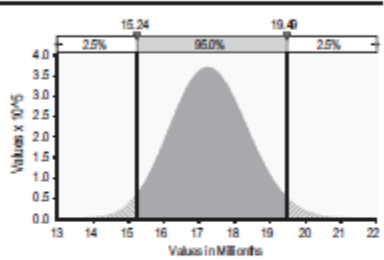
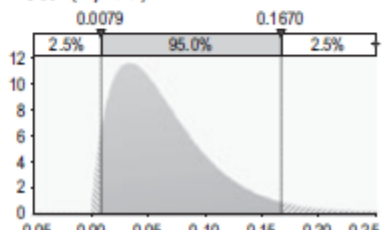
Often initial quantification

Uncertainty not considered

Quantitative approaches

- Deterministic (fixed) probabilities along pathways with scenarios
 - Fixed values as result from each pathway & scenario
- Stochastic simulation (input parameter distributions)
 - Outcome (result) probability distribution

Table 1. Description and parameterization of model inputs

Notation	Definition	Source	Parametrization	Data values for Russian Federation (September)
P_1	Probability of selecting an ASF-infected pig from country o in month m before detection of ASFV infection	$NI = Po \times Ou \times To \times HpNo = \text{pig population}$	Beta (α_1, α_2) $\alpha_1 = NI + 1$ $\alpha_2 = No - (NI + 1)$	 <p>A Beta distribution plot for P_1. The x-axis is labeled 'Values in Millions' and ranges from 13 to 22. The y-axis is labeled 'Values x 10^5' and ranges from 0.0 to 4.0. The distribution is centered around 17.5. Vertical lines mark the 2.5% quantile at 15.24 and the 97.5% quantile at 19.40. The area between these lines is shaded, representing the 95.0% central interval.</p>
Po	Probability of infection in country of origin	OIE (2011a), OIE (2011c) Where: X : number of outbreaks by month; M : number of months considered	Beta (α_1, α_2) $\alpha_1 = X + 1$ $\alpha_2 = M - (X + 1)$	 <p>A Beta distribution plot for Po. The x-axis ranges from -0.05 to 0.25. The y-axis ranges from 0 to 12. The distribution is skewed to the right, peaking around 0.02. Vertical lines mark the 2.5% quantile at 0.0079 and the 97.5% quantile at 0.1670. The area between these lines is shaded, representing the 95.0% central interval.</p>

Mur et al., Transboundary and Emerging Diseases. 59 (2012) 134–144

Example 1 - ASF

Transboundary and Emerging Diseases

Transboundary and Emerging Diseases

ORIGINAL ARTICLE

Quantitative Risk Assessment for the Introduction of African Swine Fever Virus into the European Union by Legal Import of Live Pigs

L. Mur¹, B. Martínez-López¹, M. Martínez-Avilés^{1,2}, S. Costard³, B. Wieland³, D. U. Pfeiffer³ and J. M. Sánchez-Vizcaíno¹

¹ VISA-VET Center and Animal Health Department, Veterinary School, Complutense University of Madrid, Madrid, Spain

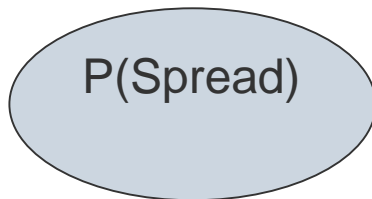
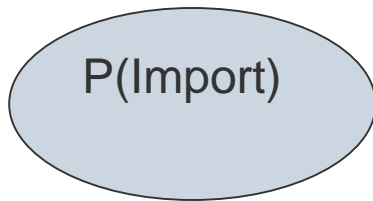
² Research Centre in Animal Health, CISA-VINIA, Madrid, Spain

³ Veterinary Epidemiology & Public Health Group, Royal Veterinary College, Hatfield, Hertfordshire, UK

Mur et al., Transboundary and Emerging Diseases. 59 (2012) 134–144

Risk pathway and calculation

ASF-infected animal



The probability of having at least one outbreak of ASF in Europe, namely the probability of introduction (PI), in one of the 27 EU countries because of import of an ASF-infected (but non-detected) pig during the HRP was estimated per country of origin of imported pigs ($o = 5$ countries), per month ($m = 12$ months) and by country of destination ($d = 27$ countries), assuming a binomial process (OIE, 2010b) of the form:

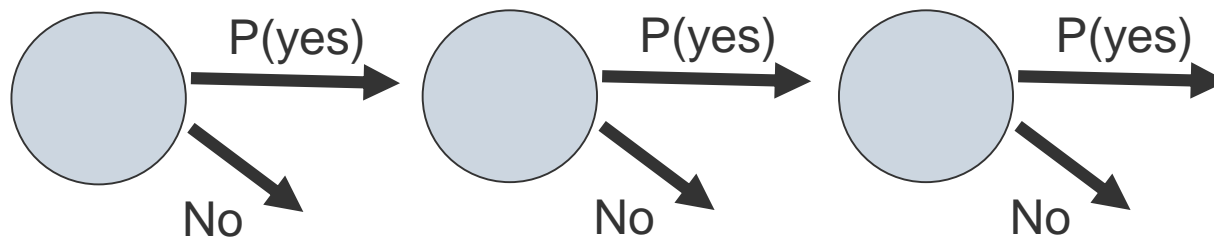
$$PI = \sum 1 - (1 - p_{odm})^{n_{odm}}$$

Mur et al., Transboundary and Emerging Diseases. 59 (2012) 134–144

Exercise 2

- Grouping
- Draw a scenario / risk pathway for ASF introduction with domestic pigs at an individual animal level that includes at least the following events
 - Infection at country of origin
 - Detection at country of origin
 - Survival at country of origin
 - Detection at country of origin
 - Transmission at country of origin

Discuss
possible
data sources



Discussion & summary (1)