Experiences with Quarantine Risk Assessment

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Overview

- Definition of Risk
- Consequence as a component of RA
- Examples
  - Bananas (which contains some very good work by BA)
  - Branched Broomrape
- Limitations
  - Methodology
  - Data
- Ways forward
- Is there a better way?

Definition of Risk

- Risk = Likelihood × Consequence
- Expected loss
- $\Sigma \text{likelihood}_i \times \text{consequence}_i$
- Good place to start is with the consequence

Consequences

- Asset to be protected
- Often much easier to quantify than likelihoods
  - Economic
  - Environmental (pesticides in global environment)
  - Social
  - *On a $$ scale??*
- Consequence can drive the risk assessment
- Competing risks with same consequences
  - Components of risk assessment not independent

Some experiences from banana Import Risk Assessment

- Multiplicity of threats
- Definition of unit
  - Ton, bunch, cluster, finger
- Likelihood scales
- Use of expert opinion
  - Biases
  - Need to get credible results
- Lack of good data

Multiplicity of threats

- Viruses, bacteria, fungi, weeds, insects etc.
  - Range of expertise required
  - Biometrician is there the whole time!
- Competing risks
  - Risks need to be combined
  - Approximately additive when small
- Problem not addressed in Australian IRAs
  - Only maximum risk is considered
  - Should combine risk from different threats

Definition of unit

- Different units considered in bananas
  - Growing unit (disease incidence)
  - Prob (Disease in bunch)
  - Tonne of bananas
  - Carton, Cluster…
  - Problem with current system
- No allowance for number of diseased bananas in a bunch in framework
- Alternative approach
  - Expected number of disease units should be followed

Pathway analysis

- Currently many pathways explored
  - Perhaps 20 for banana imports
  - Likelihoods of pathways are combined
- Can we dismiss some quickly?
  - Fit for purpose approximation
  - Simpler analysis
- Are we missing any important ones?
  - Often important in risk analysis
  - What theory is available to check this?

Scales of Likelihood (1)

Level	Definition	Mid Range	Range	Max/Min
High	>0.7	0.85	0.3	1.176471
Moderate	0.3 - 0.7	0.5	0.4	2.333333
Low	0.05 - 0.3	0.175	0.25	6
Very low	0.05 -0.001	0.0255	0.049	20
Extremely low	0.001 - 0.0	0.0005	0.000999	1000
Negligible	<0.000001	0.0000005	0.000001	infinite

Actual range decreases with low likelihood classes

Relative range increases dramatically

Important decisions often based on low classes

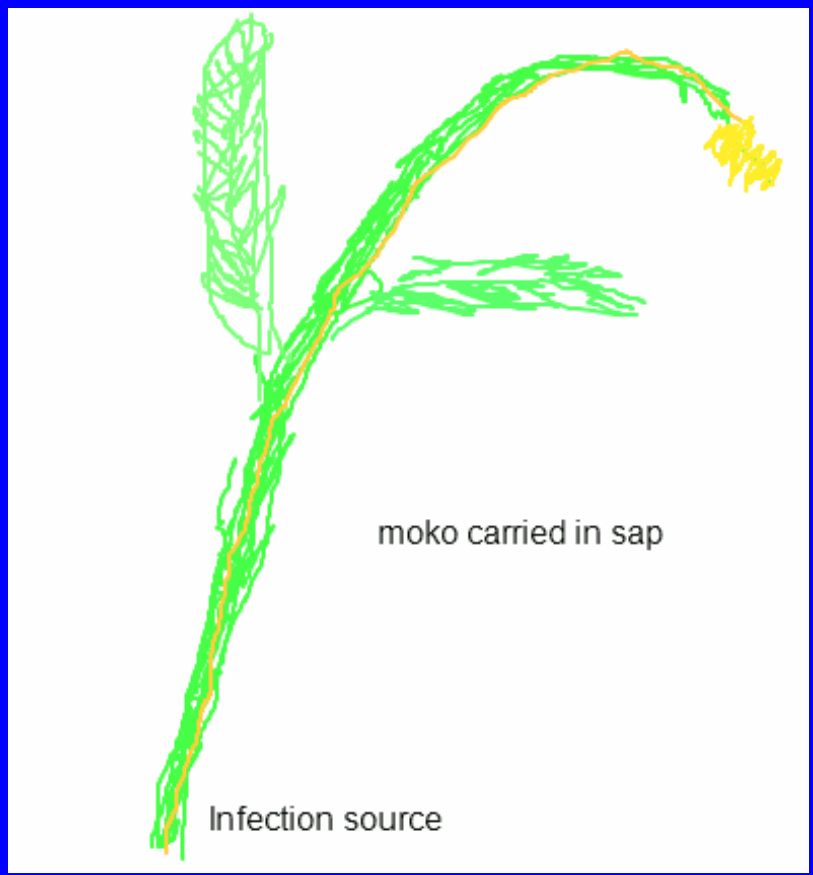
Likelihood scales (2)

- Need likelihood scale to be evenly spaced on log scale
  - Sensitivity analysis homes in on large relative range
- Consequence scale also needs to be on same on same scale
  - Otherwise ‘low risk’ definition changes
- Basic theory but referenced

Expert opinion

- Can't rely on frequentist probabilities
  - No luxury of adequate data
- Expert opinion is required
- Opinions typically biased to what is expected
- Seek ways of getting more accurate data
- Examples over

Moko in bananas



- Early infection causes obvious wilting
- Late infection won't have reached bunch
- Some infections reach bunch and cause symptomless infections

Early → Late

P(moko in tonne bananas)

- Estimate of disease frequency plausible
- Require probability of infected symptomless bananas
- Small window of infection time available
- Some data available on this
- Prob = Window width/production time
  - Soon expanded to P(moko in tonne)
- Focus expert opinion on window width
  - More in experts experience
  - Result more precise

Prob(fruitfly in tonne bananas) (Hard green)

- Denoted negligible in RA (<1/1,000,000)
- Initially accepted by expert
- Possible for eggs to be laid if banana damaged and damage not detected
- Implications of 'negligible' are
  - Occurs < 1 time per year in all Philippines
  - P < 1/5,000,000,000 per banana finger
- Expert then upgraded P to extremely low

Note: this would affect risk estimate by factor of 1000

Obtaining data

- Extreme financial and political pressure on scientists
  - How do you monitor a chlorine bath?
- Difficult to obtain independent data
  - E.g. incidence of moko
  - Remote sensing?
- Useful data on insects from NZ which imports Philippino bananas
- Room for further research in sampling theory

Import risk assessment is complicated by politics and commerce

Branched broomrape

- Parasitic weed in SA mallee near Murray Bridge
- Germinates and attaches to host in autumn
- Stores reserves underground
- Emerges as spike of flowers in spring
- Sets up to to 50,000 seeds

Definition of Risk for Branched Broomrape

- Weed in quarantine near Murray Bridge, SA
- Risk = Probability × Consequence
  - Consequence is >> $200 M
  - GRDC estimate
  - Depends on location of infestation
- Probability of escape from quarantine area

Estimation of likelihood of escape

- Viable seed in paddock
- Germination
- Attaching to host
- Plant maturing
- No plants being detected
- Seeds moving from paddock
- Transport out of quarantine area
- Establishing a new infestation

- Very hard to prove absence
- Depends on many factors
- Host availability
- Herbicides?
- Depends on plant density
- Timing and mechanism
- Destination
- Location and number of seeds

How effective is visual sampling?

Low chance of seeing single plant!

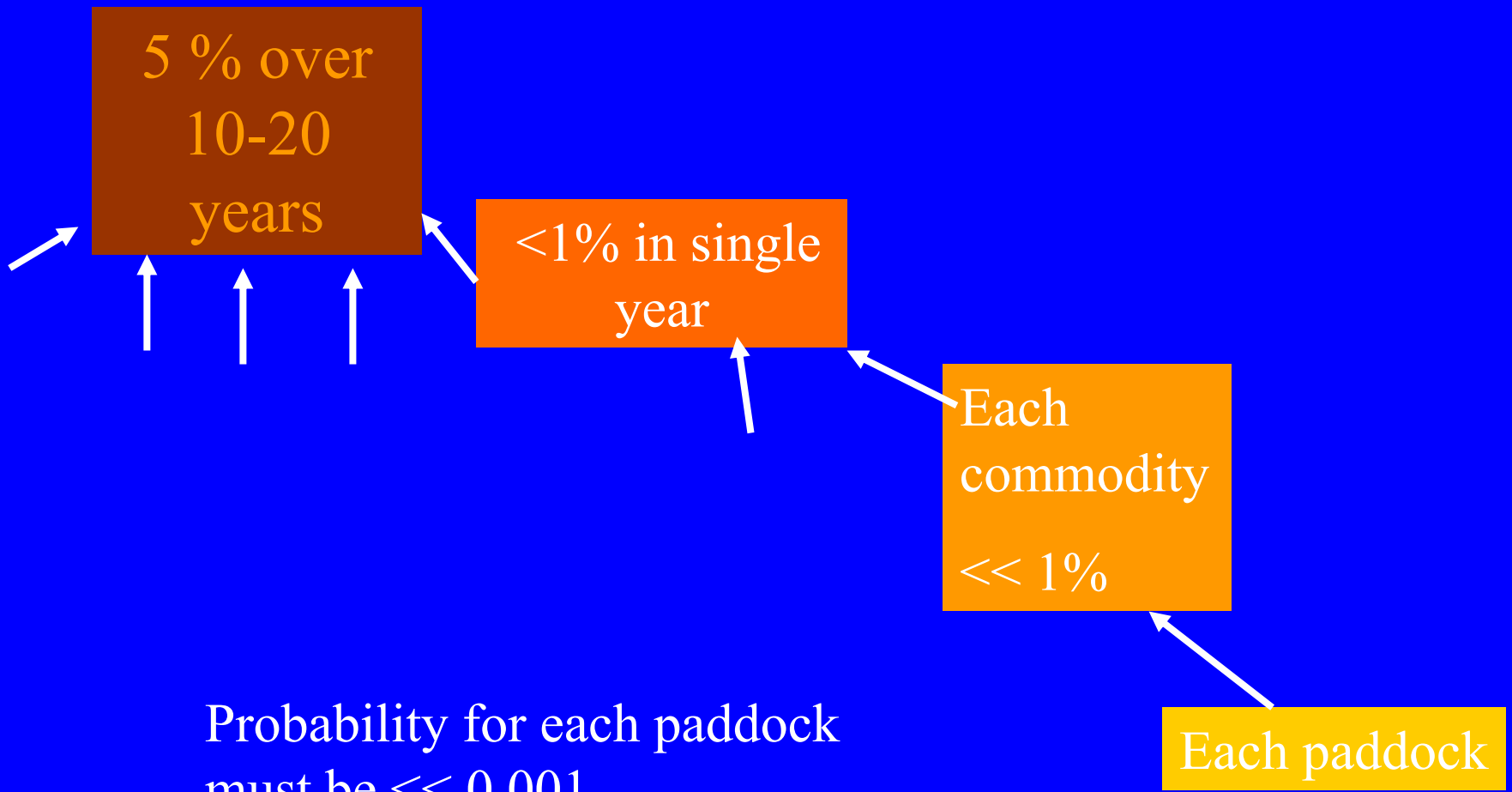
Sighting distance	1.2	3	5	10	20
Area (ha)					
2	16%	40%	66%		
5	10%	25%	42%	84%	
10	7%	18%	30%	59%	
20	5%	13%	21%	42%	84%
50	3%	8%	13%	26%	53%
100	2%	6%	9%	19%	37%

Note 1. 1.2 m is median reported sighting distance

Note 2. Assumes ‘ideal’ observer

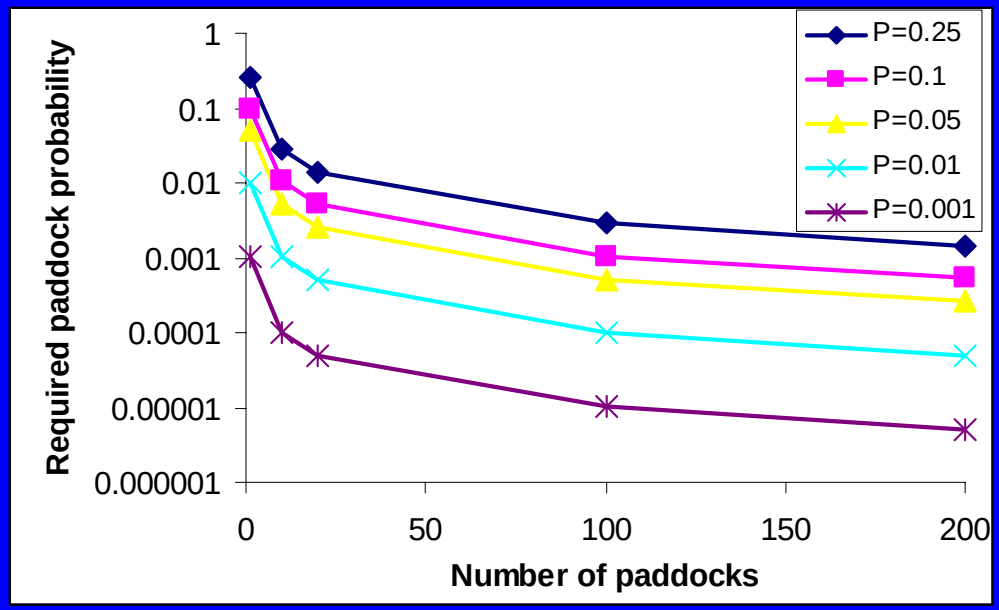
Note 3. Assumes plant is flowering at time of survey

What probability is required



Probability for each paddock must be << 0.001

Effect of number of paddocks on final probability

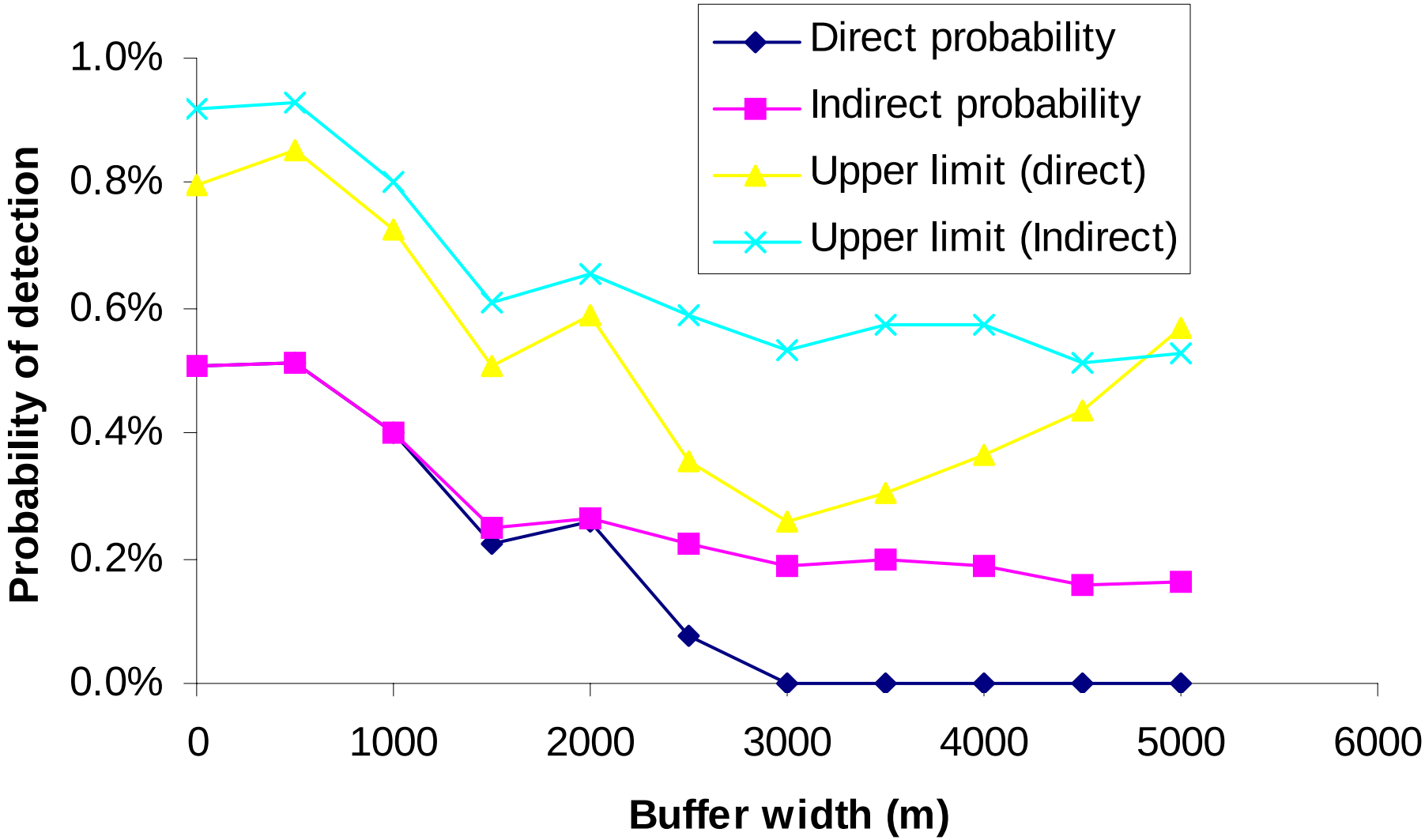


- For peas, if required probability for all pea paddocks 0.1%, and 100 paddocks of peas, probability for each paddock is < 0.001%.

Probability of seed in paddock

- Greater than probability of detection
- Probability of detection
  - Depends on history
  - Width of buffers

Effect of buffer width



Method of estimation of probability for grain

Component	Provisional probability
•Prob (paddock has flowering plant)	0.01
•Prob (ripe seeds when harvest) ×	0.01
•Prob (header height) ×	0.01
•Prob (staying on screen) ×	0.1
•Prob (not being blown) ×	0.1
•Prob (starting new infestation)	1
Overall	**0.00000001**

Require expert opinion in estimating probability components – input on above welcome

How many seeds for new infestation?

- If steady state
  - P(success) = 1/seeds per plant
  - Useful first approximation
- ID50 = dose required for 50% infection
  - Some literature on this
  - What curve for ID00.1 etc?
  - What factors affect ID50?
  - How do you obtain data?

Is there a better way to estimate quarantine risk?

- Current position
  - Extensive and good quality work is carried out be Biosecurity Australia
  - Semi-quantitative
  - Extensive review process
  - Very costly
- Need to explore
  - Qualitative
  - More quantitative (can we afford this?)

Confidence intervals

- Nominally produced by Monte Carlo simulations
- Are they realistic given we are having trouble with estimate of probability?
- Currently median probability used by Biosecurity Australia
- Confidence interval may be to wide for practical purposes

Suggested research directions

- Robust consequence quantification
- Combining multiple threats
  - Over what time period?
- Correlation structure (which unit)
- New theory for enumeration of pathways
- How can we get best value for $
- Theory on pathway enumeration
- Likelihood/consequence scales
- ID50 etc research
- Risk communication