The Economics of Biosecurity: Risk, Border Quarantine, Local Surveillance and Eradication Measures

Tom Kompas

Crawford School of Economics and Government
Australian National University

Nhu Che*

Australian Bureau of Agricultural and Resource Economics

**The views presented are those of the authors and do not represent the official view of ABARE.*

The Problem

Close proximity between countries and international trade and tourism increases the probability of an incursion and the spread of exotic diseases and pests; ones that can do great harm, and in some cases be potentially devastating to local industry, animal and human health, and the environment.

Traditional Measures

- Pre-border measures and border quarantine (i.e., preventing a potential incursion at the border).
  - Limits on imports
  - Airport inspections, and inspections of shipping containers and contents
- Local surveillance programs (preventing spread in the local environment).
  - Surveillance traps
  - Blood screening and visual inspection
- Containment and eradication programs.

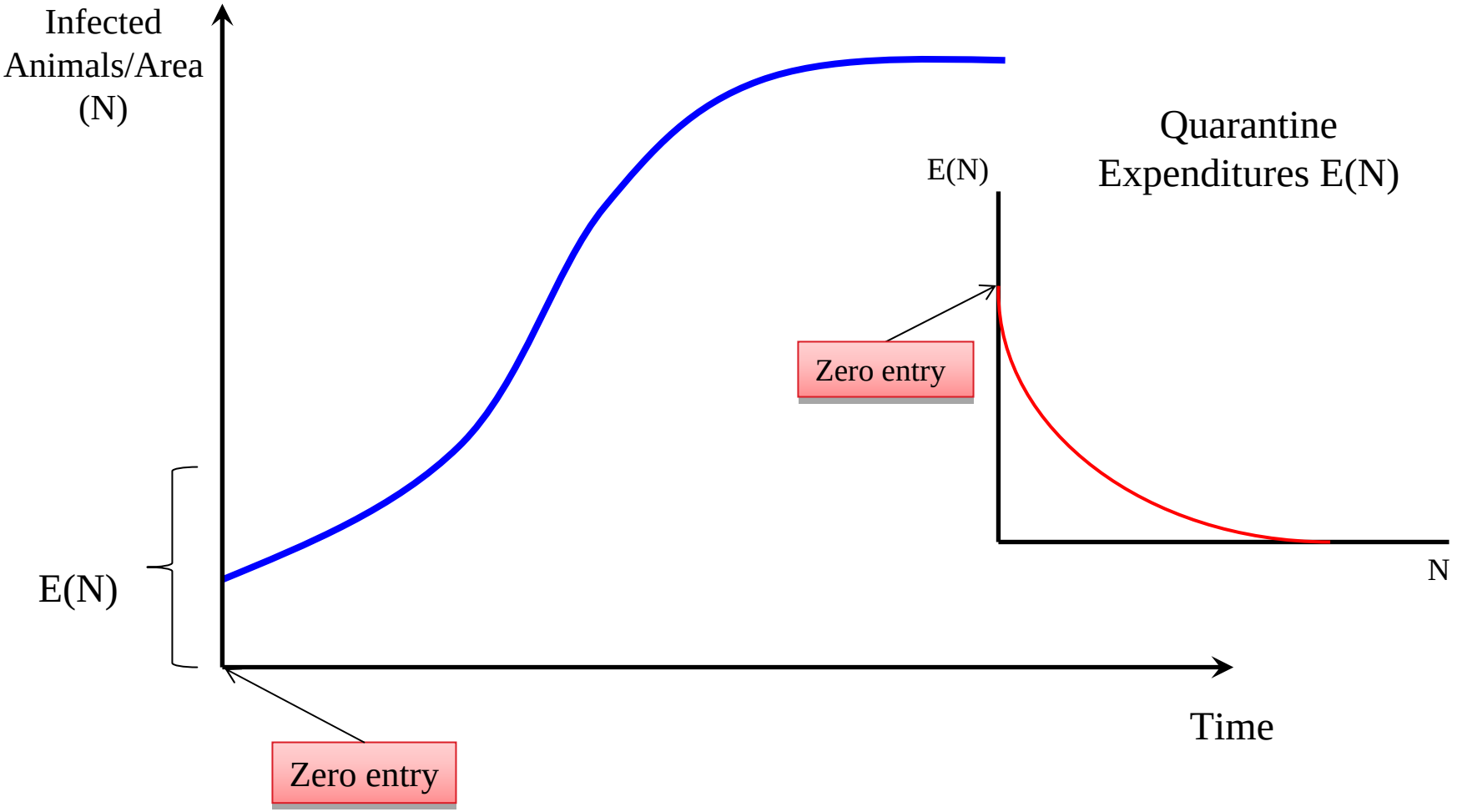
The Puzzle

How much should be spent, or what costs should be incurred, for pre-border measures and border quarantine, surveillance and eradication activities to protect plant and animal health and the environment? How to allocate resources across various threats?

- Ban imports and close airports?
- Spend $0 on quarantine and surveillance?
- Spend all of GDP on quarantine and surveillance?
- Eradicate? Contain? Neither?
- How to allocate resources across various threats?

Border Quarantine

Border Quarantine Measures



Optimal Quarantine Expenditures

- Optimal Border Quarantine
  - Benefit: Less initial entry gives smaller damages (or more benefits) over time, prior to full saturation.
  - Trade-off: The smaller is initial entry the more expensive is the border quarantine program
  - Objective: Minimize all expenditures: damages (e.g., losses in plant and animal health, damage to the environment, trade restrictions, containment and eradication costs) plus the cost of the quarantine program itself.

    (Equivalent to equating the marginal benefits of having less damages to the marginal costs of quarantine expenditures.)
- **Conditional on**:
  - Probability of entry
  - Spatial and density spread, and E(N) function
  - Prices and costs that may vary over time, discount rate

Case study: Risk of OJD in WA

- Quarantine measure against OJD in imported sheep in WA: blood tests, screening, and general surveillance

Possible quarantine measures	Risk of infected rams entering *(no/month)*
• Free entry or no quarantine activity	18.5
• Australian Sheep Johne's Disease Market Assurance Program	0.5
• Movement Restrictions Program	Less than 0.5 (depends on level of restriction)
• National OJD Management Program	Close to 0
•	

Source: *Agriculture Protection Program (APP) 2000b.*

- Papers:
  - Tom Kompas and Nhu Che, *A Practical Optimal Quarantine Measure*, ANU, 2003
  - Tom Kompas, Nhu Che and Pham Van Ha, "An Optimal Quarantine Measure", ANU, 2009.
- Method: Stochastic Bioeconomic Model with a Jump-Diffusion Process.

OJD in WA: Key Parameters

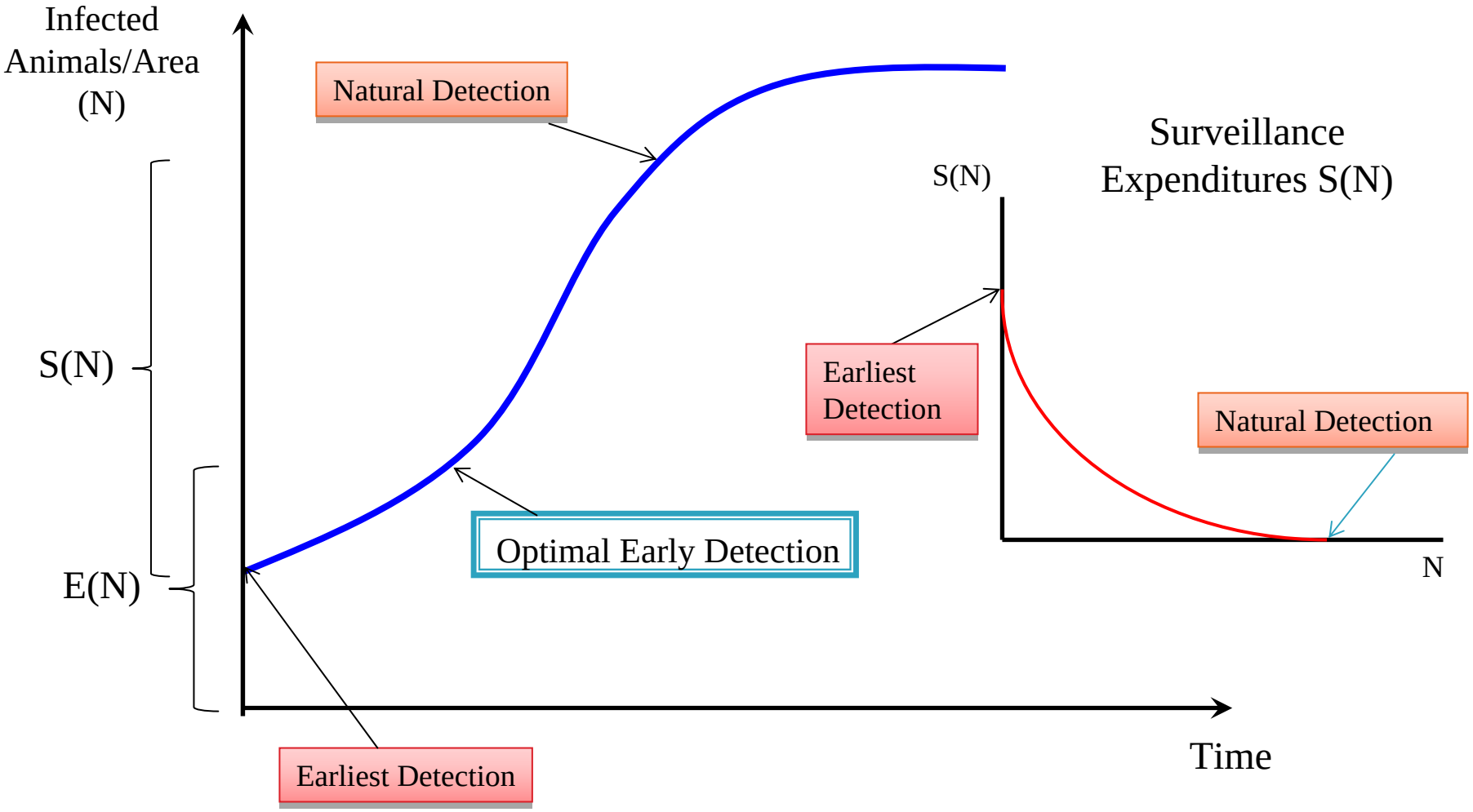
			Mean value and standard error
1. Total production loss			
• Number of sheep in the state		*(number)*	N(26 000 000, 500 000)
• Maximum infection level		*(% of total sheep)*	N(26, 5)
• Growth rate of OJD	transmission	*(%/month)*	N(1.4, 0.5)
• Maximum average costs of OJD		*($/head)*	N(14, 1.4)
• Discount rate *(%/year)*			5
2. Quarantine expenditures			
• Max quarantine expenditures *($/month)*			$300 000
• Risk of infected rams entering under 'Free Entry' *(no/month)*			N(18.5, 1.85)
• Current quarantine expenditures		*($/month)*	$40 000
• Current risk of infected rams entering *(no/month)*			N(1.84, 0.18)
3. Welfare losses from trade restrictions			
• Volume of rams imported		*(no/month)*	550
• Difference of domestic price and imported price *($/ram)*			$1 000
• Conformance cost for ram exported *($/ram)*			$75/ram

OJD in WA

Results: **The optimal quarantine measure gives a potential entry of 0.116 infected sheep per year, or one potentially infected sheep every nine years.** At this potential entry the value of time horizon T, or the time when the present value of the cost of the disease becomes zero, is 130 years . The minimum total cost of 67 million over 130 years roughly decomposes into 33.8 million in quarantine costs, 16 million in trade losses and 17.2 million in direct losses.

Local Surveillance Measures

Local Surveillance Measures



Optimal Surveillance Expenditures

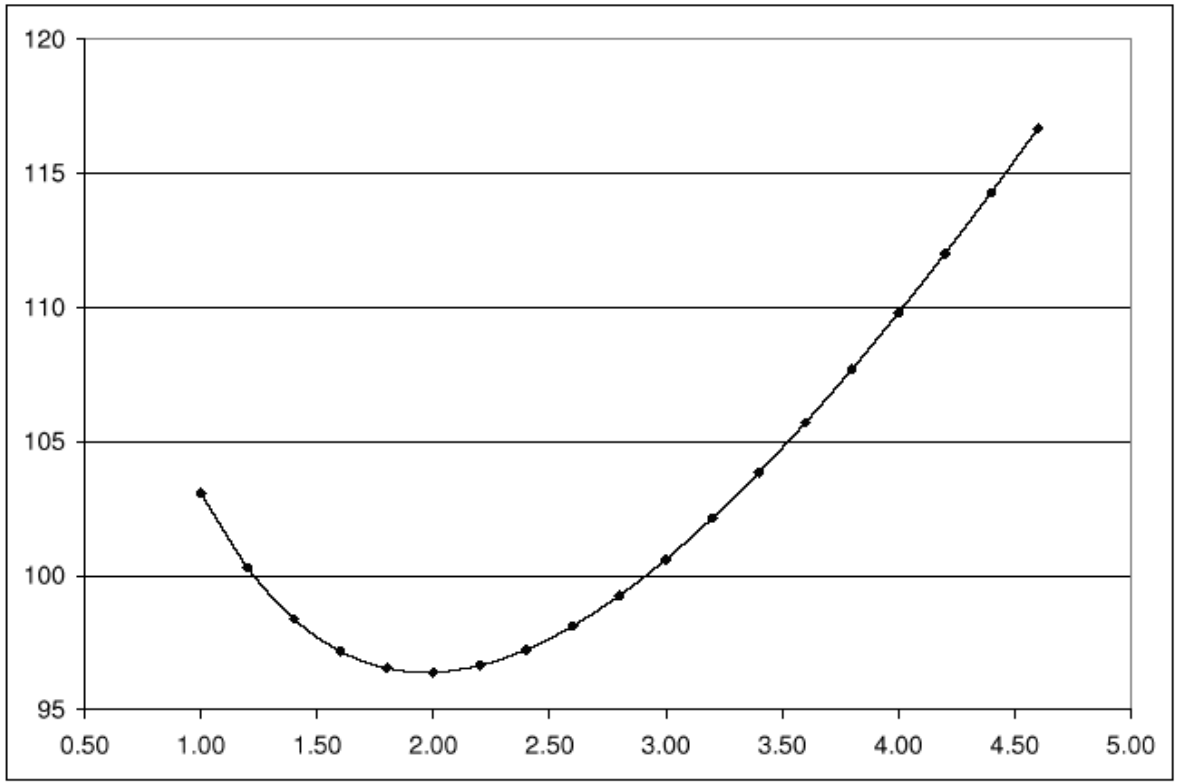
- Optimal Surveillance
  - Benefit: Earlier detection and consequent action gives smaller damages over time (or more benefits)
  - Trade-off: The earlier is detection the more expensive is the local surveillance program
  - Objective: Given a border quarantine measure, minimize all expenditures: damages (e.g., losses in plant and animal health, damage to the environment, trade restrictions, containment and eradication costs) plus the cost of the surveillance program itself.

    (Equivalent to equating the marginal benefits of having less damages to the marginal costs of surveillance expenditures.)
- **Conditional on**:
  - Natural detection point (can be altered)
  - Spatial and density spread, and S(N) function
  - Prices and costs that may vary over time, discount rate

Case study: PFF in Australia

- PPF attacks fruit and habitat, and in early stages is difficult to detect by inspection (boarder quarantine is limited and ineffective).
- Largest risk of entry: via the Torres Strait Islands and at ports of entry.
- Current surveillance grid: 1 trap for every 6,200 km^2, 1,878 traps in total, Current Expenditures = $1,380,000 (including the program's fixed costs).
- 1995 outbreak in QLD: $43m in eradication and management costs over a 13 month period.
- Papers:
  - Tom Kompas, Nhu Che, L. Cao and Nico Klijn, *A Practical Optimal Surveillance Measure: Papaya Fruit Fly in Australia*, ABARE Report to DAFF, Chief Plant Protection Officer, 2003
  - Tom Kompas, Nhu Che and Pham Van Ha, "An Optimal Surveillance Measure Against Papaya Fruit Fly in Australia", ANU, 2009.
- Method: Stochastic Bioeconomic Model with a Jump-Diffusion Process.

Optimal Surveillance Grid and Expenditures



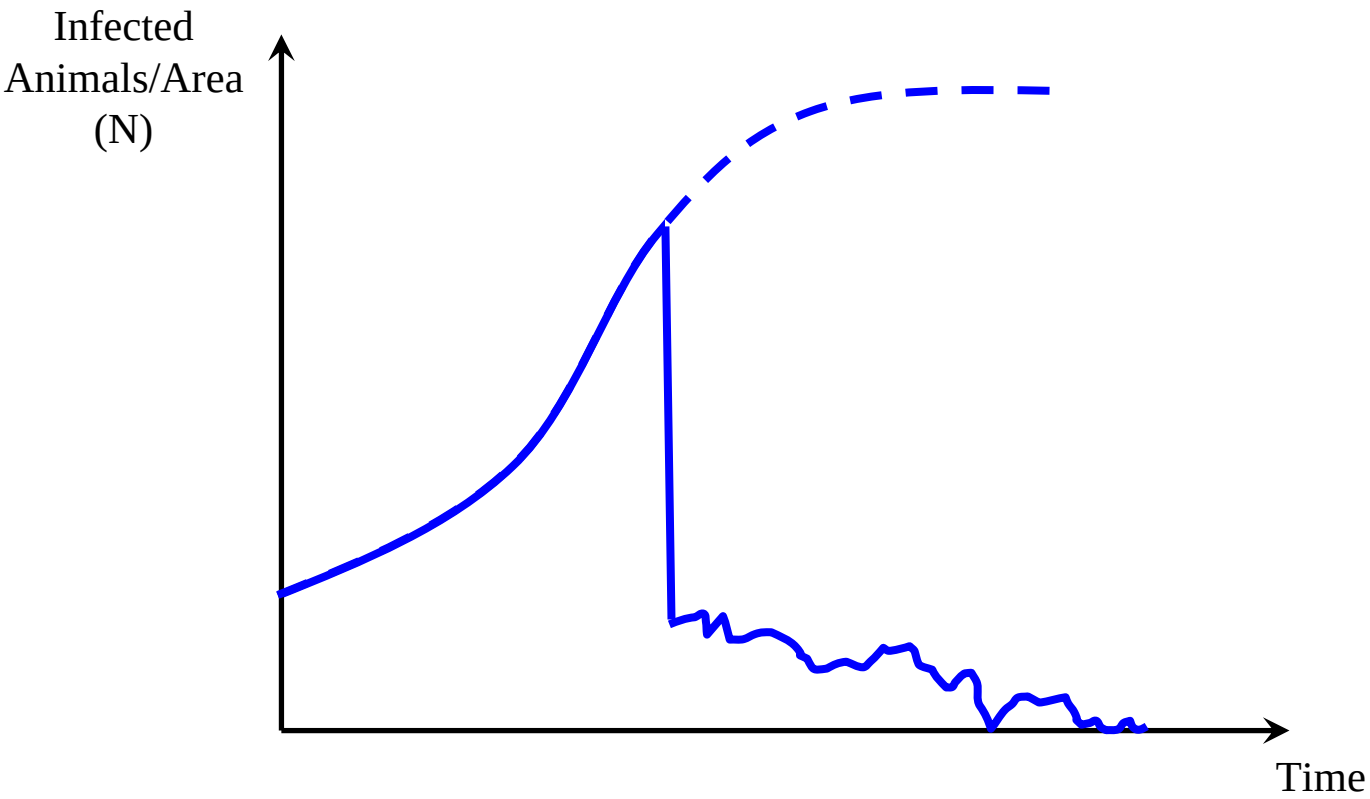
Optimal: one trap per 2,000 km^2 and $E^*(c)$ = \$3m (AUS)

Current: \$1.38m: Current surveillance grid: 6,200 km^2

Eradication and Containment

Containment and Eradication

(The role of cost-benefit analysis (CBA) after an incursion, or for a potential incursion.)



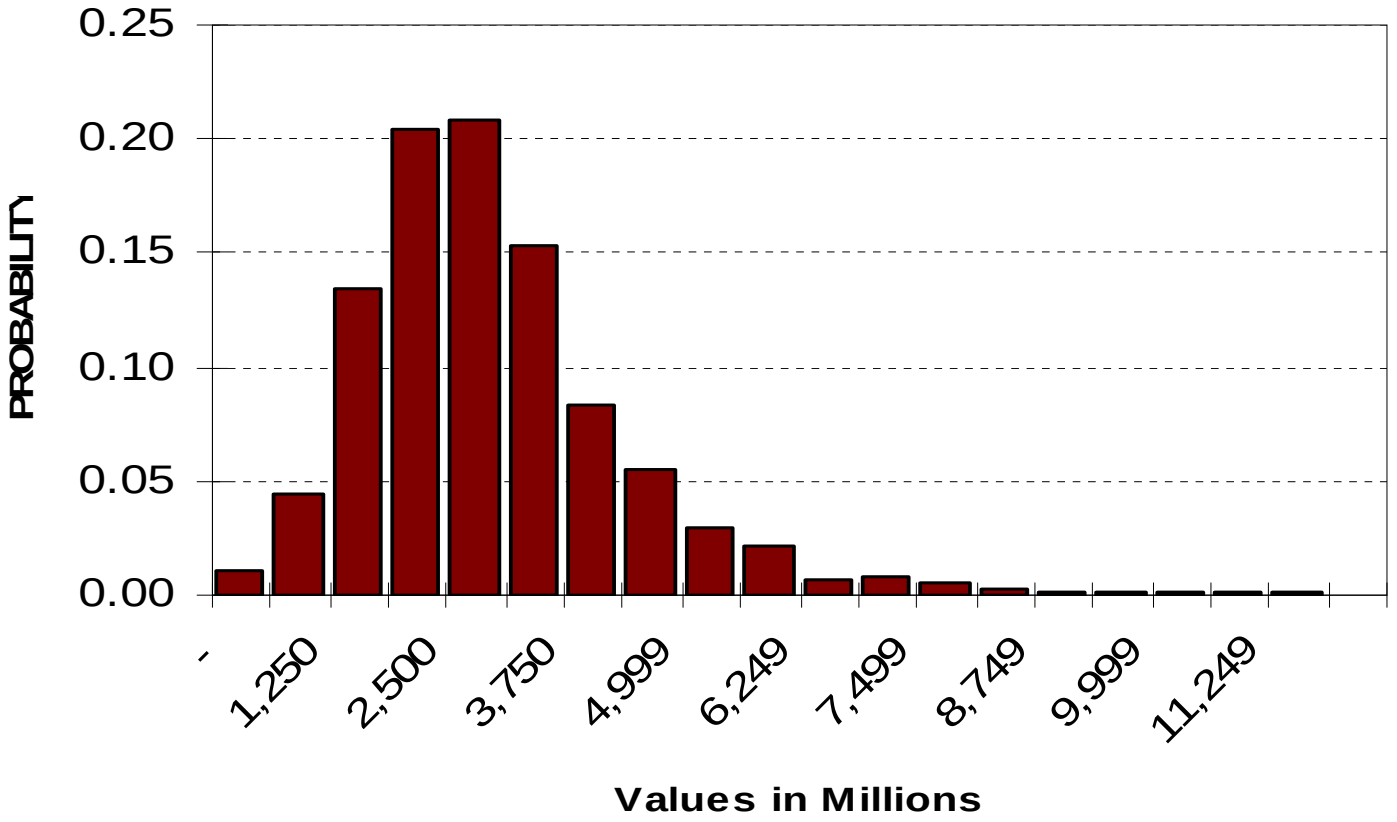
Note: The potential size of benefits depend on size of initial entry and the choice of early detection, for given eradication/containment exercise.

CBA: RIFA

Cost components	Values *(average/year)*	Net Present Values *(average/year)*
Property value losses	$150,517,000	$47,224,000
Property repair and treatment	$70,139,000	$22,311,000
Household medical treatment	$7,246,000	$2,702,000
School costs	$5,367,000	$1,635,000
Electrical equipment	$11,973,000	$3,647,000
Golf courses	$17,913,000	$5,434,000
Cattle industry	$33,266,000	$10,214,000
Opportunity cost of labour	$937,000	$351,000
Total average/year	$296,420,000	$93,267,000
Total potential cost of RIFA	$8,893,000,000	$2,798,000,000
Total cost for eradication		$109,661,000
Preliminary Benefit-Cost Ratio (BCR)		**25:1**

Source: Tom Kompas and Nhu Che, *An Economic Assessment of the Potential Costs of Red Imported Fire Ants,* ABARE report, Canberra, 2001.

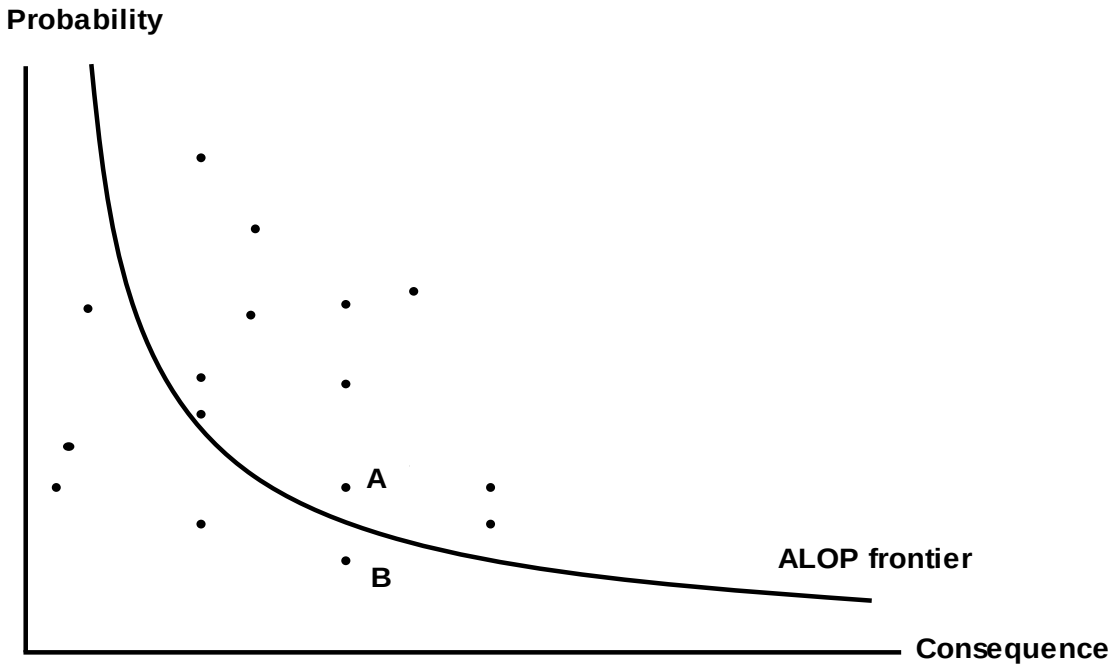
Probability Frequency on NPV of the costs of RIFA:



Pre-Border CBA

Pre-Border CBA

- Measures of ‘Import Risk Analysis’ and ‘Appropriate Level of Protection’



Thanks for your comments and questions!

Tom Kompas

tom.kompas@anu.edu.au

http://www.crawford.anu.edu.au/staff/tkompas.php

THE AUSTRALIAN NATIONAL UNIVERSITY