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Risk-return in biosecurity

Professor Mark Burgman

Centre of Excellence for Biosecurity Risk Analysis

Ministry for Primary Industries
Manatū Ahu Matua

Australian Government
Department of Agriculture

THE UNIVERSITY OF MELBOURNE
Australia

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Regulator's Conundrum

Biosecurity Regulator

Protect us from Pests:

- Agriculture / Industry
- Human Health
- Environment

but

Facilitate Trade

- Don't Cost too Much
- Don't Take too Long
- Don't Impede Trade

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Tough decisions

Australian 2012-2013 Annual Biosecurity Report

- 16 200 000 Air passengers
- 186 580 000 Mail Articles
- 16 300 First-port visits
- 645 000 Air Freight Consignments (< $1000)

…and

- 2 500+ Non-native plant species
- 10 000's Pests …

Multiple objectives

- Find as much as possible
- Learn as quickly as possible
- Deter (border surveillance)
- Decide (post-border: eradicate, contain, manage)

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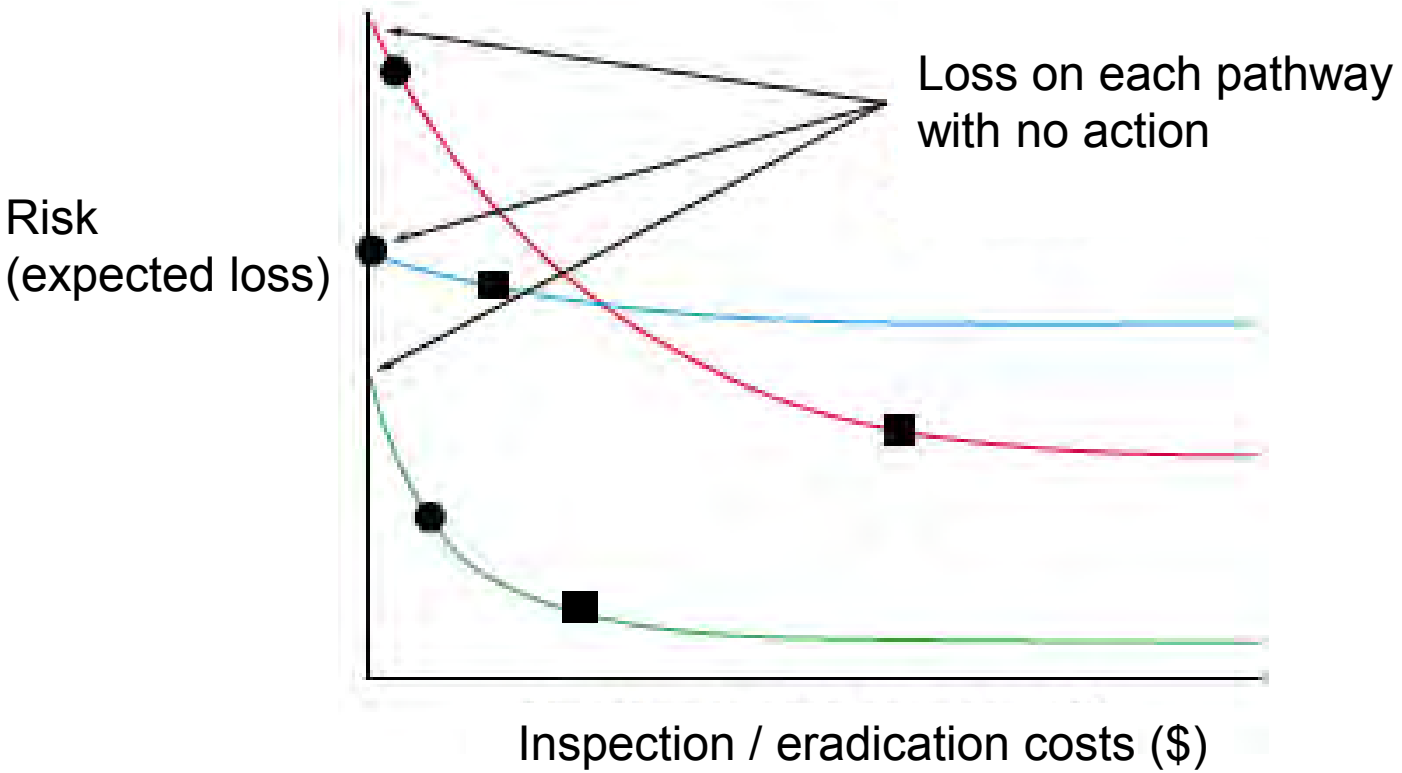
Risk-return: the underlying principle

- Maximise the return on investments
- Maximise risk-reduction per $ spent



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Implementing risk-return strategies

1. Surveillance effort
   - Compliance Based Inspection Scheme (CBIS)
2. Process control, feedback and pattern detection
   - Inference and data mining
3. Intelligence gathering
   - International Biosecurity Intelligence System (IBIS)
4. Post-border priorities: decision making
   - Knapsack problem

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1. Surveillance effort

Ecological Applications, 21(4), 2011, pp. 1410–1417

Allocating surveillance resources to reduce ecological invasions: maximizing detections and information about the threat

ANDREW ROBINSON,[1,4] MARK A. BURGMAN,[2] AND ROB CANNON[3]

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[2]*Australian Centre of Excellence for Risk Analysis, School of Botany, University of Melbourne, Parkville, Victoria 3010 Australia*
[3]*Biosecurity Services Group, Department of Agriculture, Fisheries, and Forestry, Canberra, Australian Capital Territory 2601 Australia*

Abstract. Allocating resources to detect invasive pests, diseases, and pathogens on exposure pathways requires a trade-off between the need to detect as many contaminated items as possible and the need to acquire knowledge about contamination rates. We develop a model and an algorithm that provide guidance for the allocation of inspection resources across multiple dynamic pathways in cases where not every item can be inspected. The model uses a null hypothesis that the contamination rate of a pathway is above a specified level: a risk cutoff. Pathways with a risk above the cutoff are fully inspected, and those with a risk below the cutoff level are monitored at a rate that would detect a change of the risk to being above the cutoff level with high probability. We base our decision on the 95% upper confidence limit for the contamination rate. We demonstrate via simulations and a data set that focusing inspection resources on specific pathways can result in substantially more effective intervention, and that the reduction in overall effectiveness of monitoring low-risk pathways need not be substantial. Use of the model demands the selection of the risk cutoff, and this limit can be set according to projected consequences.

Inspection systems to

- Intercept
- Learn
- Deter

Robinson et al.
Ecol. Applic. (2011), 21, 1040-1047.

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Risk-Based Inspections

CSP-1: Pathway is in one of two modes: census, or sample.

1. In census mode, inspect all items. Switch to sample after *c* consecutive passes.
2. In sample mode, inspect *f* % of the items, randomly selected. Switch to census upon any fail.

Start in census mode.

CBIS: Compliance Based Inspection System

rewards importers who demonstrate consistent compliance with biosecurity requirements with a reduction in the number of inspections at the border.

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Future challenges

- Combining reduced inspections with compliance arrangements to target commodities that have a range of high and low compliance
- Technical and IT improvements to target or exclude countries and other variables on a pathway
- Identifying inspection regimes (combinations of compliance and failure) that influence importer behaviour the most
- Improving communication with stakeholders to influence uptake and compliance
- Improving data collection and analysis to increase the number of commodities eligible for CBIS.

To learn more, see:
http://www.agriculture.gov.au/import/plant-products/risk-return

2. Process control, feedback and pattern detection

This section provides a statistical overview of the data. The full dataset comprises 1661 consignments with record creation dates ranging from October 2005 to April 2011, and comprises entries from 17 countries and 157 suppliers.

A smoothed plot of the quarantine failure rate against time is presented in Figure 3.1. The figure shows a failure rate descending smoothly from just under 1% to less than 0.3%. The failure rate for the entire period was 0.54%, and for the analysis period (everything after June 2008) was 0.44%.

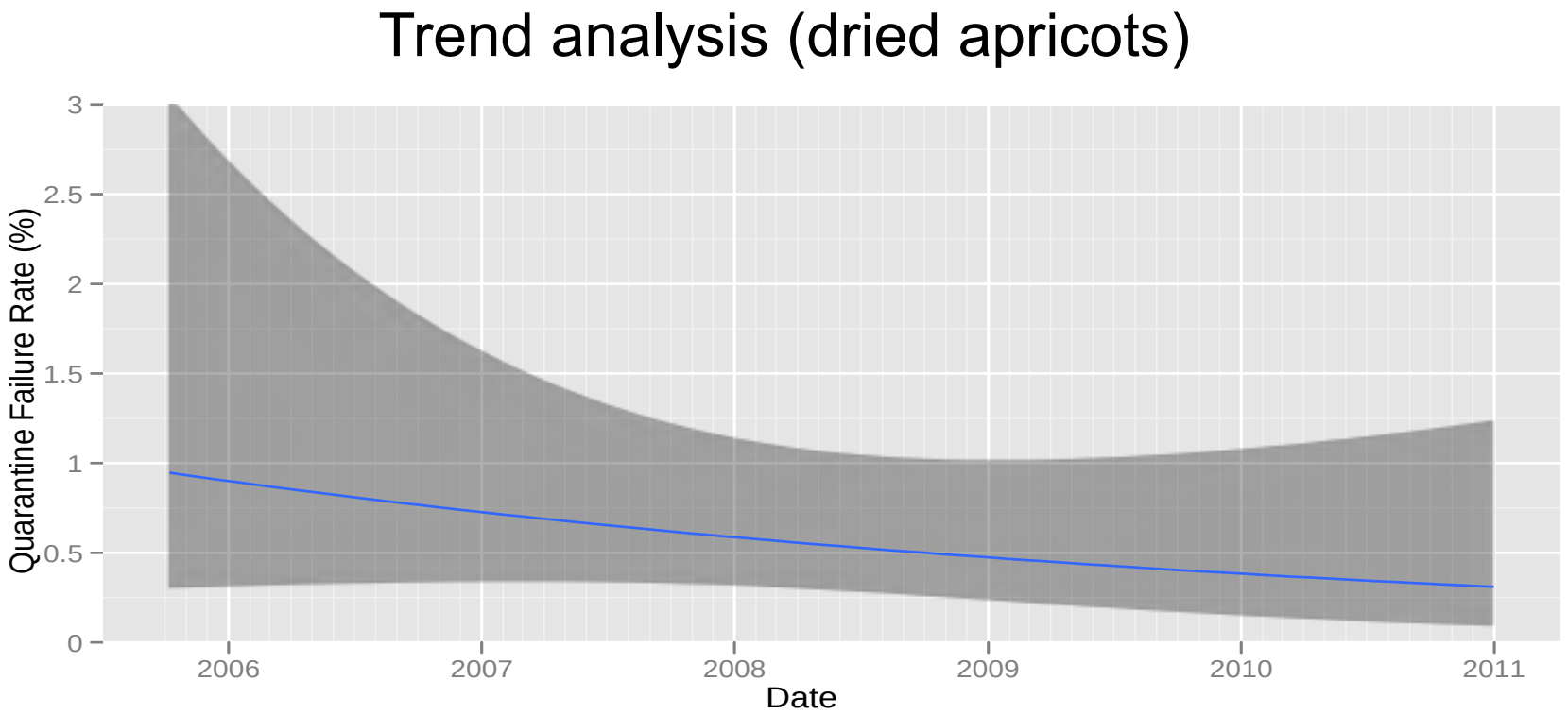

Figure 3.1: Quarantine failure rates (%) smoothed by date, with a 68% confidence interval (shaded region) added. The width of the shaded region indicates the uncertainty of the line, which becomes narrower as the sample size increases.

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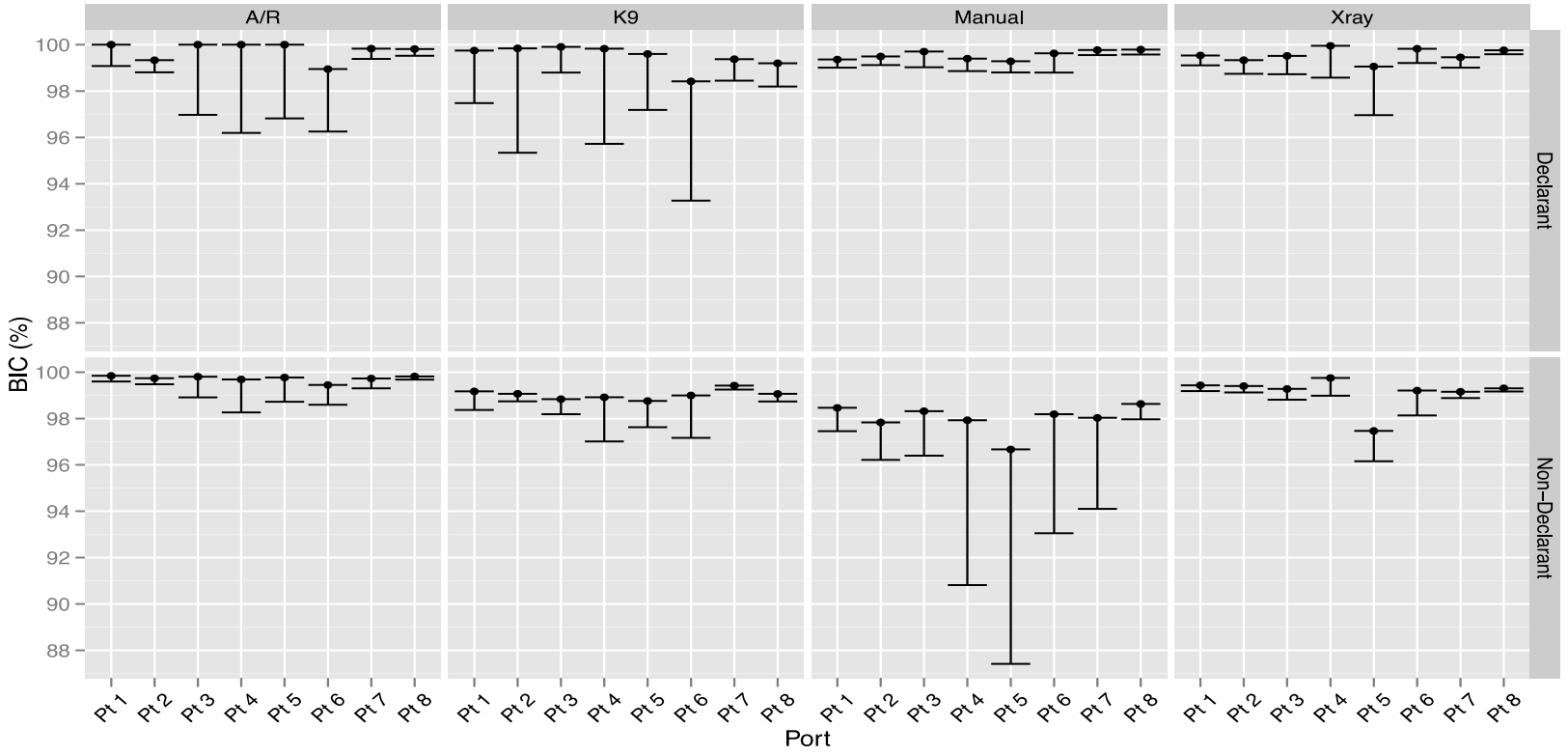
Monitoring and Reporting:

Failure rate by Port, Channel, and Declaration



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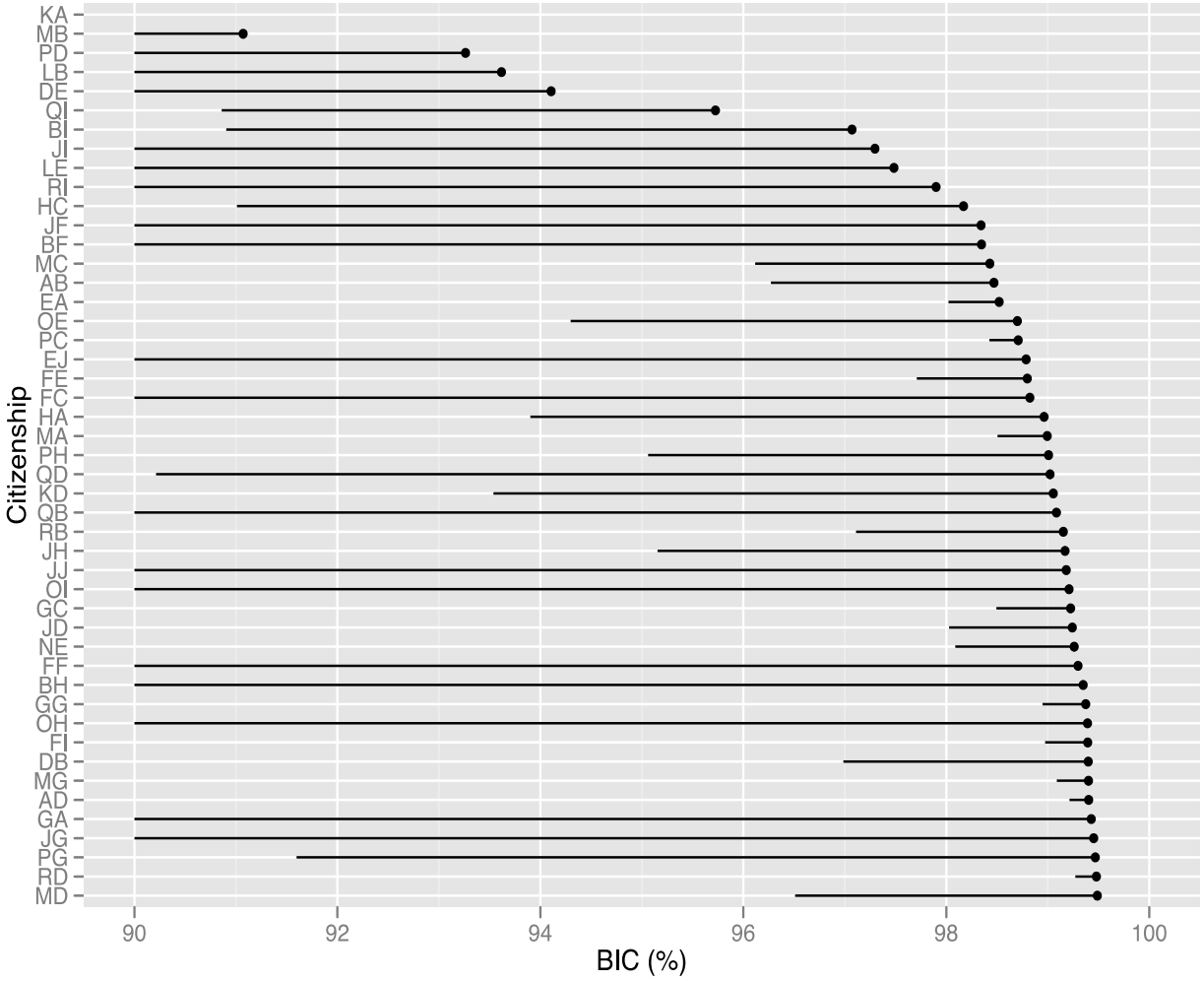
Data mining: e.g., profiling / compliance



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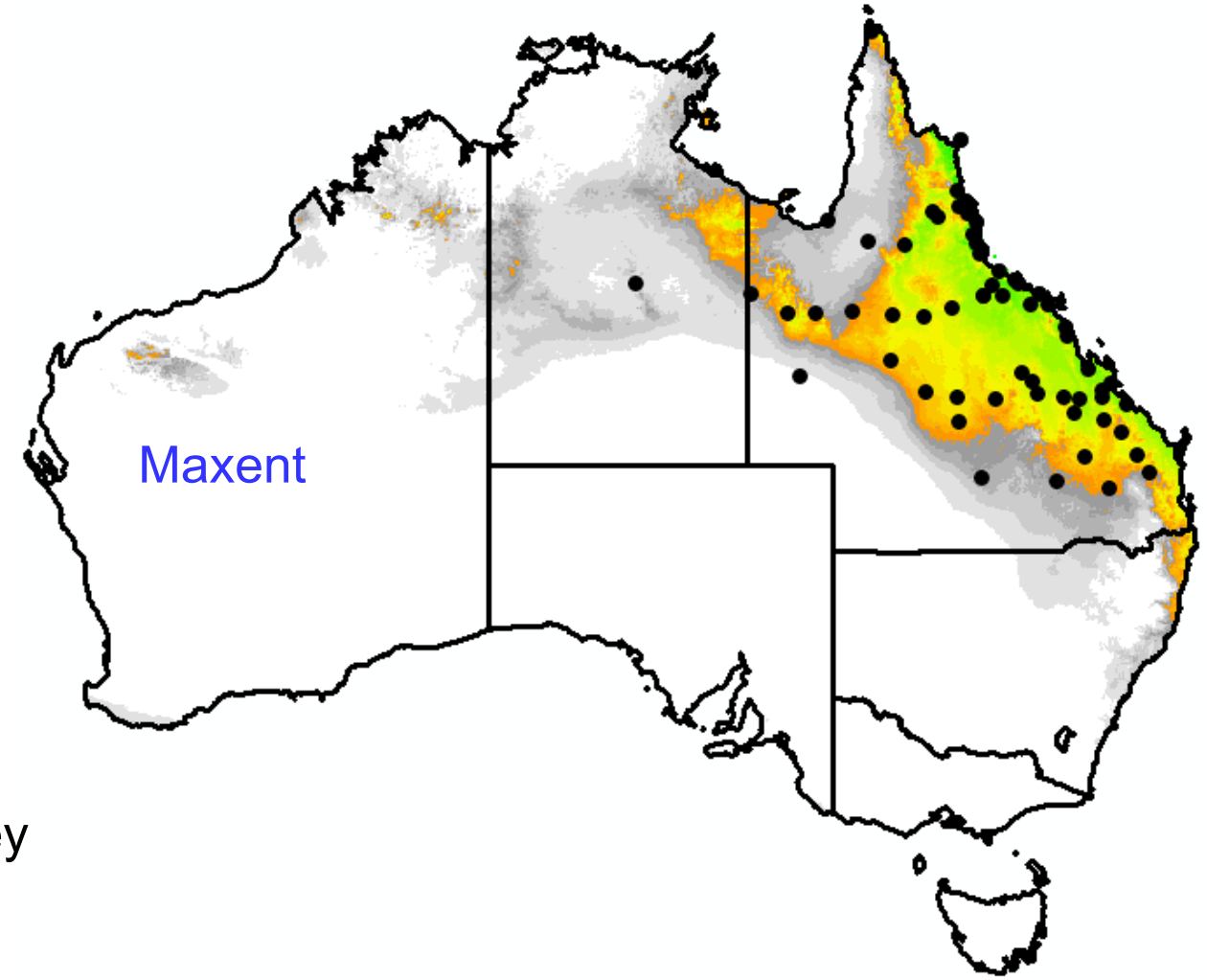
Data mining
e.g. species distribution modelling



Jane Elith
Michael Kearney
John Leathwick

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3. Intelligence gathering: IBIS

ProMED

GPHIN

WDIN

BioCaster

EpiSPIDER

HealthMap

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ORIGINAL ARTICLE

Comparison of Web-Based Biosecurity Intelligence Systems: BioCaster, EpiSPIDER and HealthMap

A. Lyon[1,2], M. Nunn[3], G. Grossel[3] and M. Burgman[1]

[1] Australian Centre of Excellence for Risk Analysis, University of Melbourne, Melbourne, Vic., Australia
[2] University of Maryland, College Park, MD, USA
[3] Department of Agriculture, Fisheries and Forestry, Canberra, ACT, Australia

Keywords:
BioCaster; EpiSPIDER; HealthMap; automated biosecurity intelligence; open-source information

Summary

Three web-based biosecurity intelligence systems – BioCaster, EpiSPIDER and HealthMap – are compared with respect to their ability to gather and analyse information relevant to public health. Reports from each system for the period

Lyon et al. (2011) Transboundary and Emerging Diseases 59, 223-232

Diversity and Distributions, (Diversity Distrib.) (2013) 19, 640–650

Using internet intelligence to manage biosecurity risks: a case study for aquatic animal health

Aidan Lyon[1]*, Geoff Grossel[2], Mark Burgman[3] and Mike Nunn[2]

Principles

- IBIS gathers open-source intelligence on aquatic animal, terrestrial animal and plant health issues
- Articles are validated by the user community
- Open community, anyone can join
- Users can suggest their own subjects and search terms
- Users are also able to review ‘raw’ articles and make decisions about whether or not to 'publish' them
- Simple alert function to get a ‘daily digest’ email of promoted articles of interest

Welcome to IBIS! The latest 20 articles are displayed. To customise the home page results to match your preferences, log in or sign up.

Join the network

IBIS is an intelligence network for plant and animal (aquatic and terrestrial) biosecurity. The network and database is growing daily with members devoted to collecting and organising information used for tracking and forecasting diseases and following emerging disease trends.

By joining the network, you will gain access to more features and be able to contribute back to the network --- e.g., by adding your own topics to search for. To join the network, use the registration form, and an administrator will respond as soon as possible.

User login

Username *

Password *

Create new account
Request new password

Log in

Issues

October 2015 - Trending Issue: Turtles

Vp goes global - a one health issue

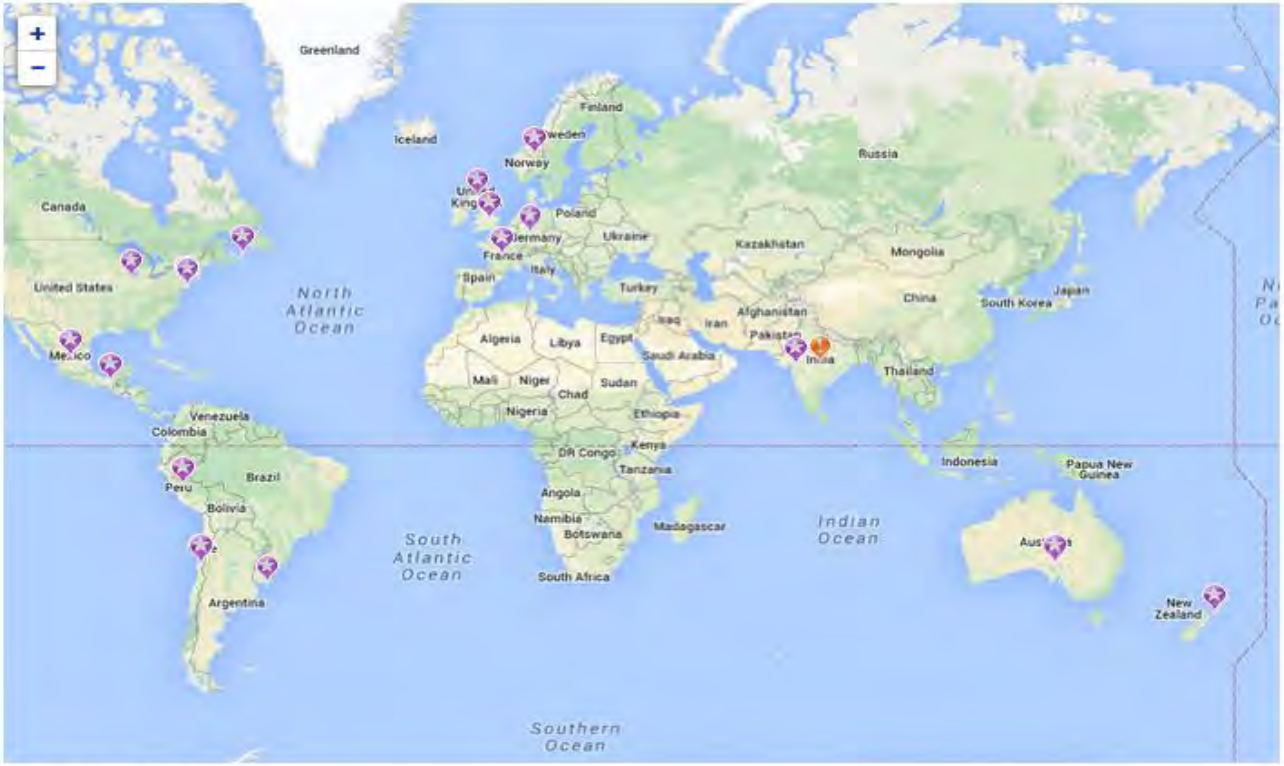
China - Pushing the Envelope

International trade in ornamental fish. What are the disease risks?

Streptococcus agalactiae & Vibrio - food security & food safety 2013-15

View all

Latest articles



Articles listed by publish date.

- 2015-02-01 Mysterious whale deaths along SA coast baffle scientists
- 2015-01-30 French state oysters spread sex disease | The Times
- 2015-01-30 Sea lice infestation risks too great to enable salmon farm renewal - PlanningResource (subscription)
- 2015-01-30 New weapons in the battle against salmon lice | ScienceNordic
- 2015-01-30 Senckenberg Nature Research Society | crayfish plague: The Killer heels - Fast and reliable detection of the pathogen in water samples | Press Release | Press Release
- 2015-01-30 Disappearing shellfish on B.C.'s coast confounding experts - Globalnews.ca

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Issues

Scrapie and sporadic Creutzfeldt-Jakob disease (sCJD) - mouse model relationship

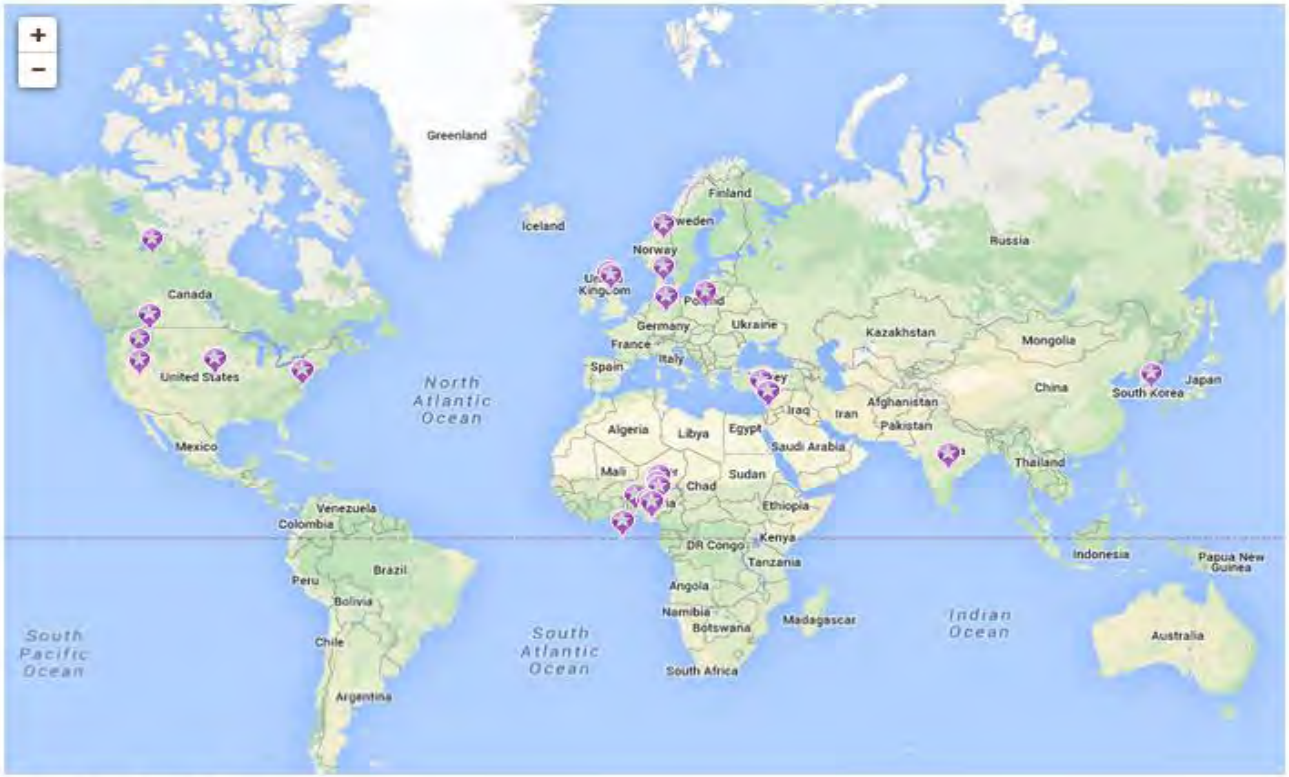
LUMPY SKIN - Emerging Issue CYPRUS Dec 2104

Foot and mouth disease in South Korea

Equine Herpes Virus spreading?

View all

Latest articles



Articles listed by publish date.

- 2015-02-01 LSD vaccines against diseases will be provided
- 2015-01-31 Study models FMD vaccine strategies - American Veterinary Medical Association
- 2015-01-31 canada says husband of woman diagnosed with avian flu also infected
- 2015-01-31 Nevada confirms avian flu case - Reno Gazette Journal
- 2015-01-30 FEATURE-Road-kill deer get mulched as US states turn to composting - Reuters
- 2015-01-29 Danish Pig Industry Adapting to New Challenges - ThePigSite.com

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Username *

markab@unimelb.

Password *

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Issues

Brown Marmorated Stink Bug in the USA

The Drosophila suzukii threat to grapes in Europe

Northern Australia - Cucumber mosaic virus outbreak 2014-15

Africa - Cassava brown streak disease getting

Latest articles

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2015-02-01 Comments to "Xylella fastidiosa:" Next week declared a state of calamity "

2015-01-31 Early detection device developed for catastrophic citrus tree greening disease - Daily Mail

2015-01-31 Citrus quarantine in Fresno County - The Packer

2015-01-30 NT teams work to wipe out virus crippling banana industry - 9news.com.au

Plant Health

IBIS | Aquatic Animal Health | Terrestrial Animal Health

Home Articles Issues Manual Contact Log in Register

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By joining the
to more featu
back to the n
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network, use
administrator
possible.

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markab@unimelb.

Password *
••••••••

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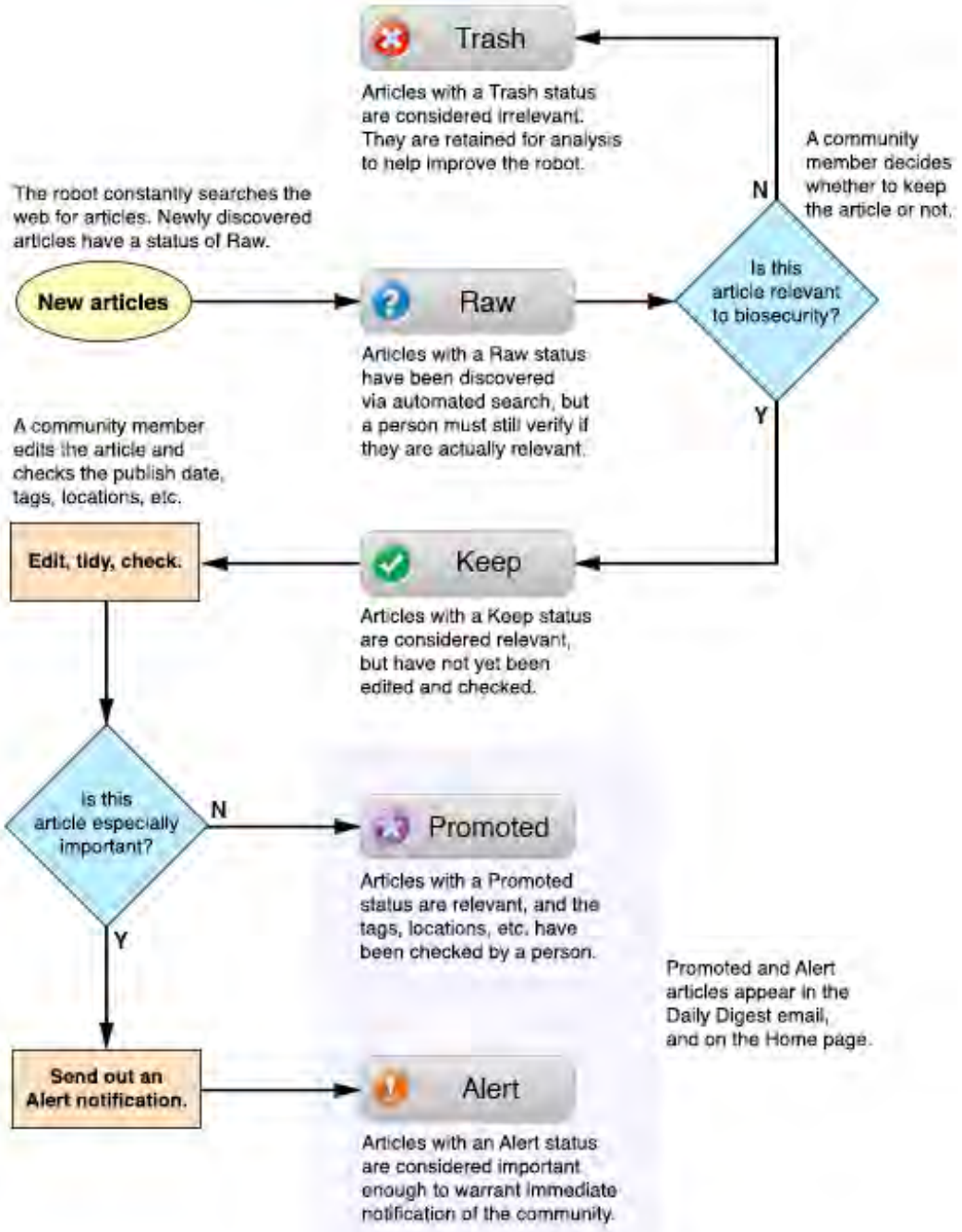
Workflow



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Some of the search sources

- Google: news, blogs, web, scholar
- Microsoft academic
- News sources: CIDRAP
- Journals: e.g. Emerging infectious diseases
- OIE alerts, ProMED, UC Davis FMD news
- Social media: Twitter

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Challenges for the future

- Developing and maintaining an engaged user community
- Dealing with inaccurate material
  - Current approach: promote comment and discussion
- Social media: can we find the relevant information?
  - Do people 'tweet' relevant biosecurity information?
- Search engine optimisation
- Site performance
- Turning intelligence into action

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4. Post-border priorities: Making decisions

Decisions involve tradeoffs

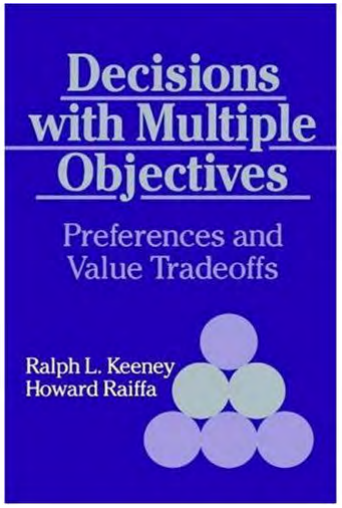
Tradeoffs involve weights

Weights are a function of two things:

i. How important the attribute (the criterion) is to the decision-maker

ii. The range of the attributes

Von Neumann and Morgenstern



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Whose weights?

- Benefit Cost Analysis: render values in $ (willingness-to-pay, contingent valuation, hedonistic pricing…)
  - Surveys
- Utility Cost Analysis: render values in utility (e.g., DALYs)
  - Samples / Measurement
- Cost Effectiveness Analysis: value per unit resource
  - Samples / Measurement
- Multi-criteria Analysis: retain units, examine scenarios
  - Face to face meetings, ‘representatives’, negotiation
- Deliberative decision-making: citizen juries, science cafes

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Biosecurity priorities

If we can render *Severity* on a single, commensurate axis;

$$Efficiency = \frac{Risk \acute{} Pr(Success)}{Cost}$$

$$= \frac{(\Pr(EES) \acute{} Severity \acute{} Extent) \acute{} Pr(Success)}{Cost}$$

Solution = ‘knapsack problem’

Joseph et al 2009, Aaron Dodd 2015

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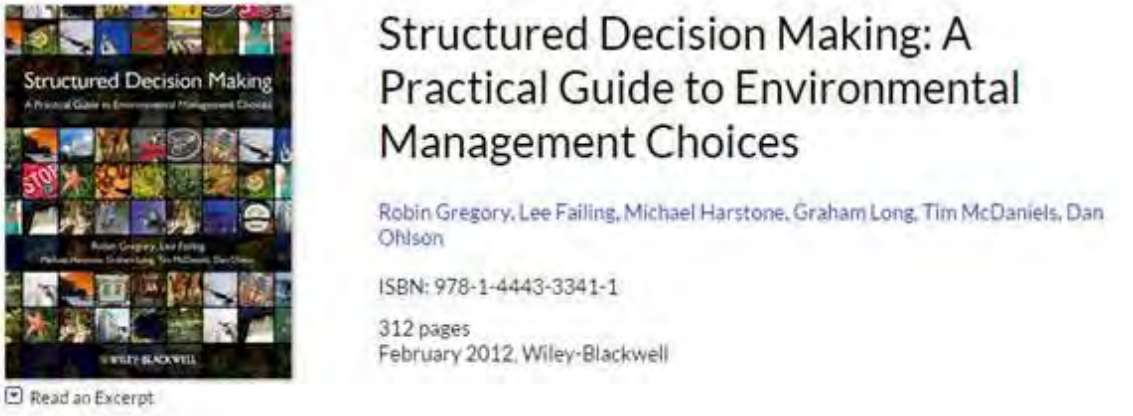
Biosecurity priorities

If we can't render *Severity* on a single, commensurate axis, perform the analysis for each criterion separately (economy, environment, human health)

Structured decision making (Keeney, Raiffa, Gregory)



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Questions?

Thanks to

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- Aidan Lyon
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- Tom Kompas
- Sam Hamilton
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- Simone Tolson
- Andrew Cupit
- Andrew Robinson
- Shaun Moss
- Josh Lee
- Justin Trefry
- And many others…