Imperial College London

Consistent frameworks for evolving biosecurity decisions

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Criteria for ISM economic frameworks

- Relevant
  - Long-term, risk focus
  - Planning resource use for a range of acceptable objectives – not just optimising
- Efficient
  - For the range of stakeholders
- Practical
  - For all users: from policy to applications
- Consistent
  - Invasive species management decisions are made repeatedly
  - Affects distribution of benefits and costs
  - Useful for regulatory compliance

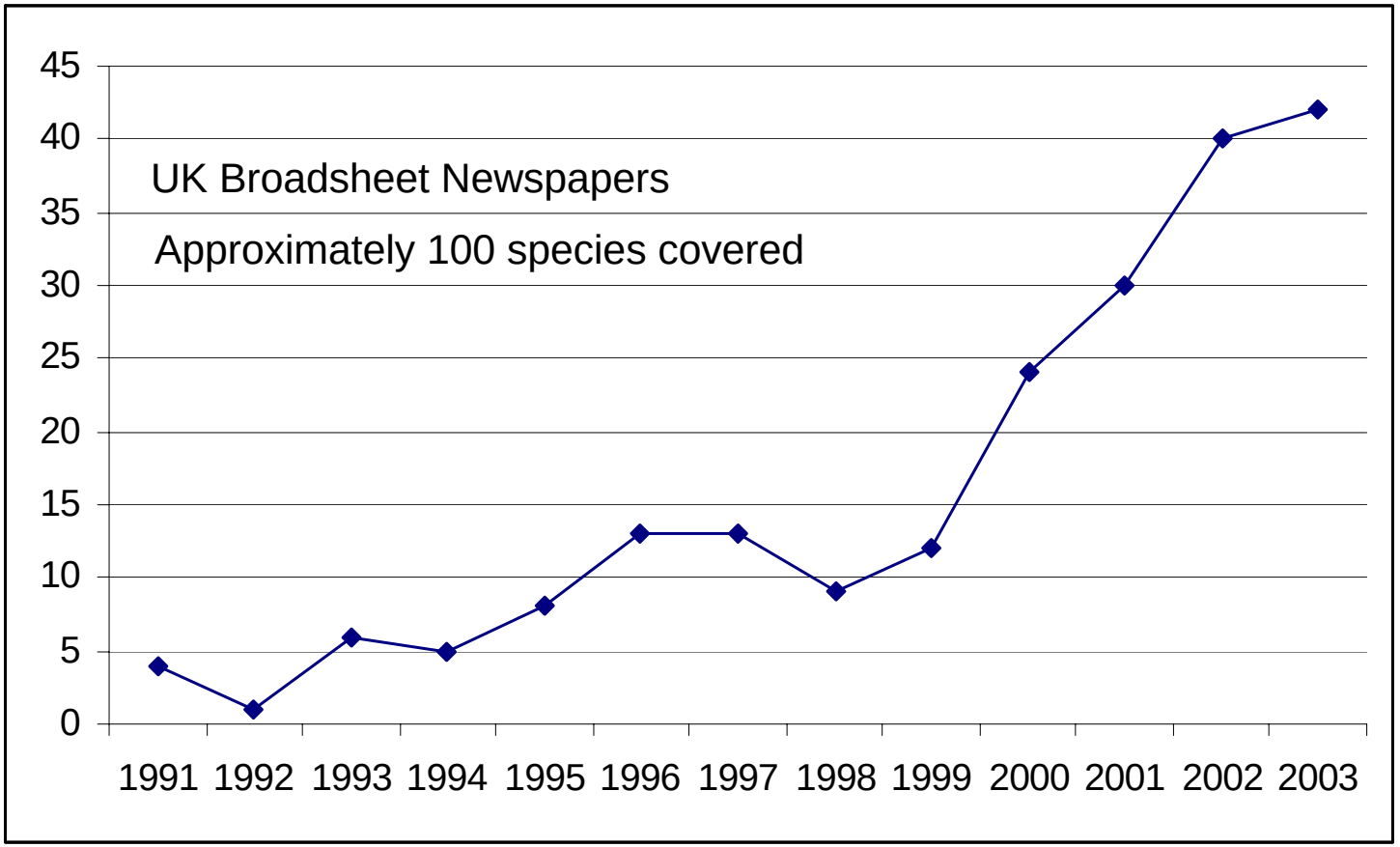
Predictive projects: conceptual to practical

- UK DEFRA Future of Biosecurity
  - 30 year horizon scan looking at drivers for biosecurity
- ERMA NZ New Organism Release Assessment
  - Judicial review process for beneficial introductions
- UK DEFRA Non-native Organism Risk Assessment Scheme
  - First European effort on a common cross-taxa risk assessment scheme for intentional and accidental introductions

A new agenda for biosecurity

- **Phase 1**
  - **Predict the nature, diversity, rate and pathways for key biological threats**
  - **Develop an approach to predict the ecological and economic impacts of new biosecurity threats**
  - **Assess the nature and magnitude of biological risks to the UK economy over the next 30 years**
- **Phase 2**
  - **Examine the value of current and proposed measures to prevent and manage biosecurity risks**
  - **Propose approaches to reduce future risks and identify technology or policy which this may require**

British media stories on invasive species



FMD and the Countryside Lobby

- Britain’s biggest peace-time disaster
- Dissolution of MAFF, creation of DEFRA
- Perceived marginalisation by rural interest groups
- Foxes and the imposition of urban values

A long past has led to the present

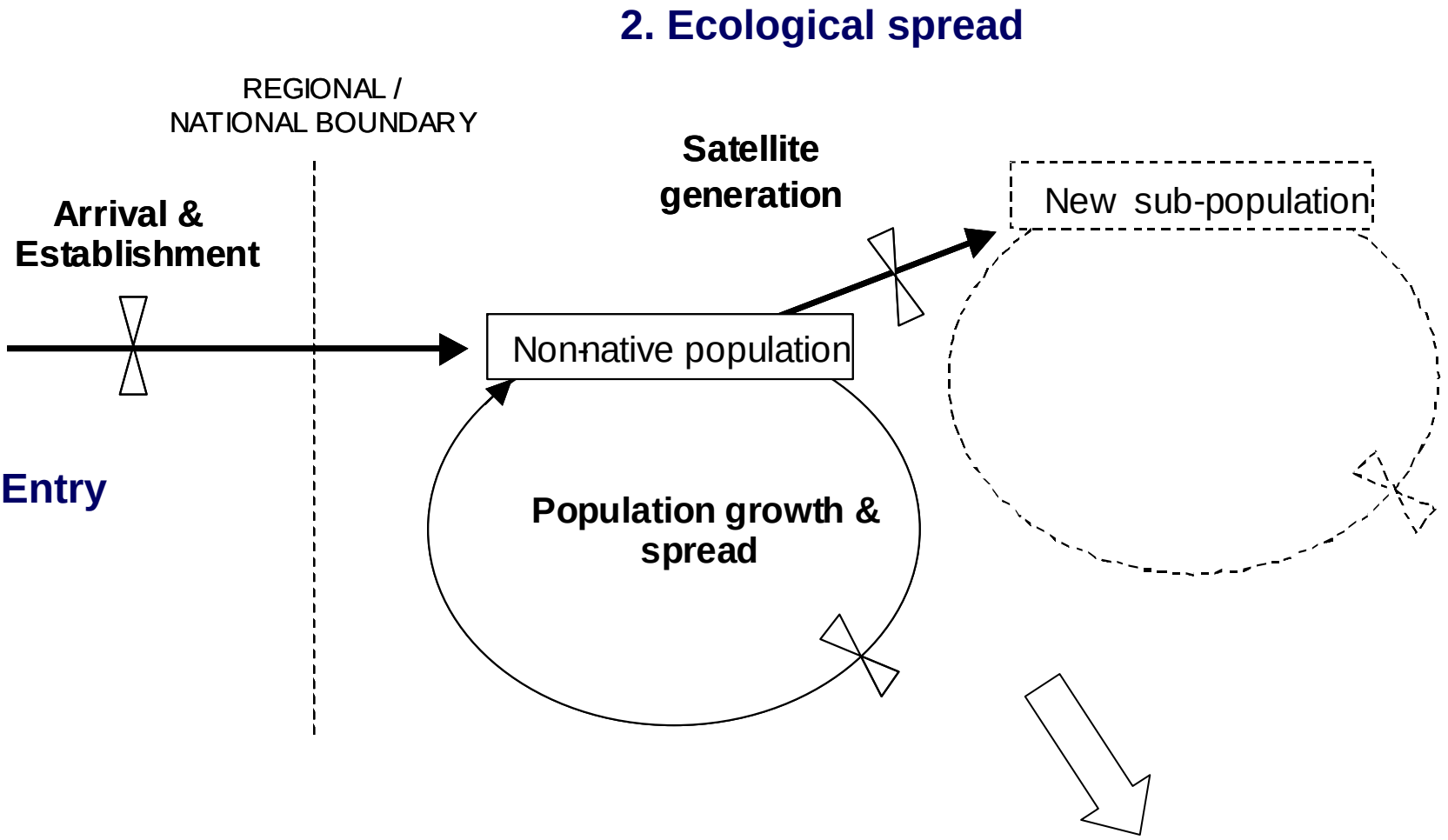
- No unified national quarantine service
- Distinct agencies, inspectors and control responsibilities
- Unbalanced priorities and placements
- Influence of fee collection and limited stakeholders
- Business plans based on operations rather than risk-reducing outcomes

Three tasks

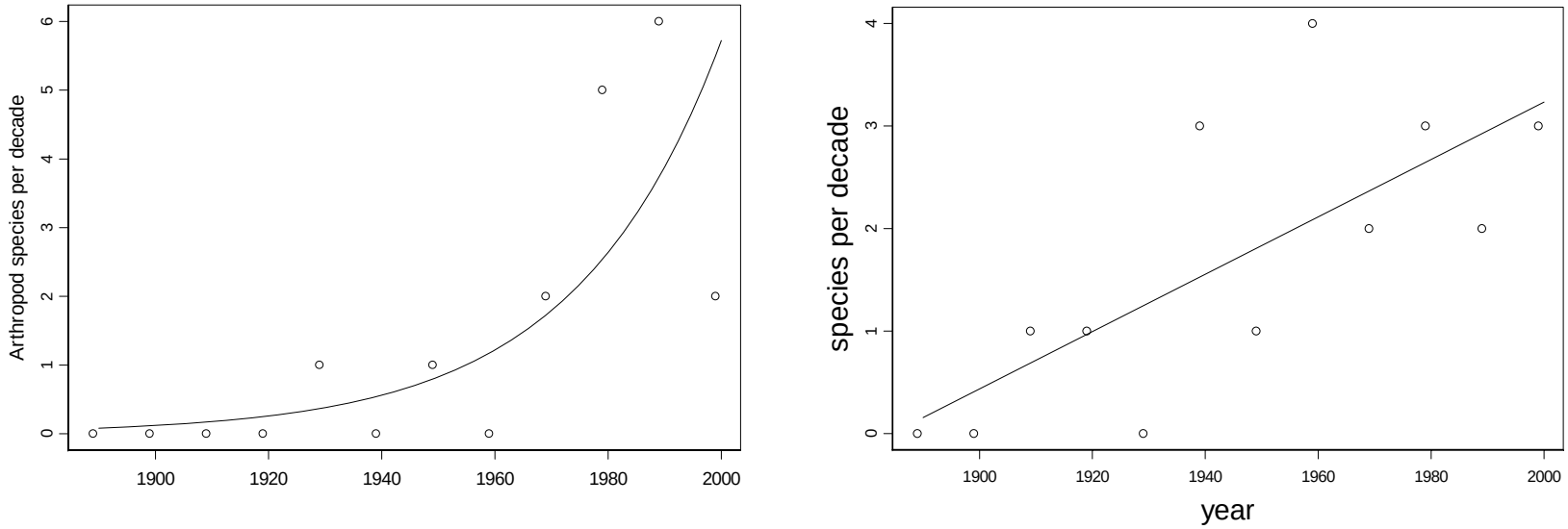
- Integrated ecological/economic model
- *State of the Art* reviews by DEFRA Agencies
- *Environmental values* review with NGOs

- Parallel project on integrated PRA approach

Conceptual model: DEFRA Future of Biosecurity

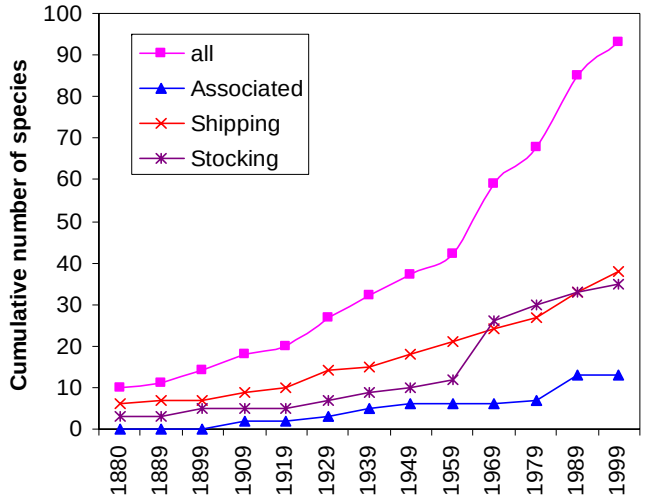


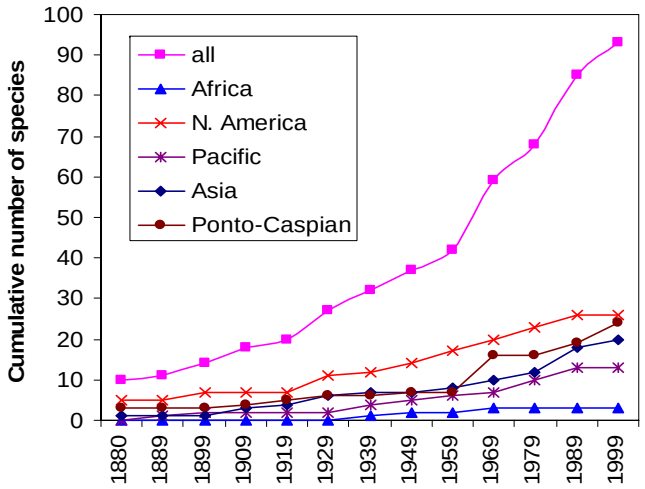
Data and hypothesis surveys – entry

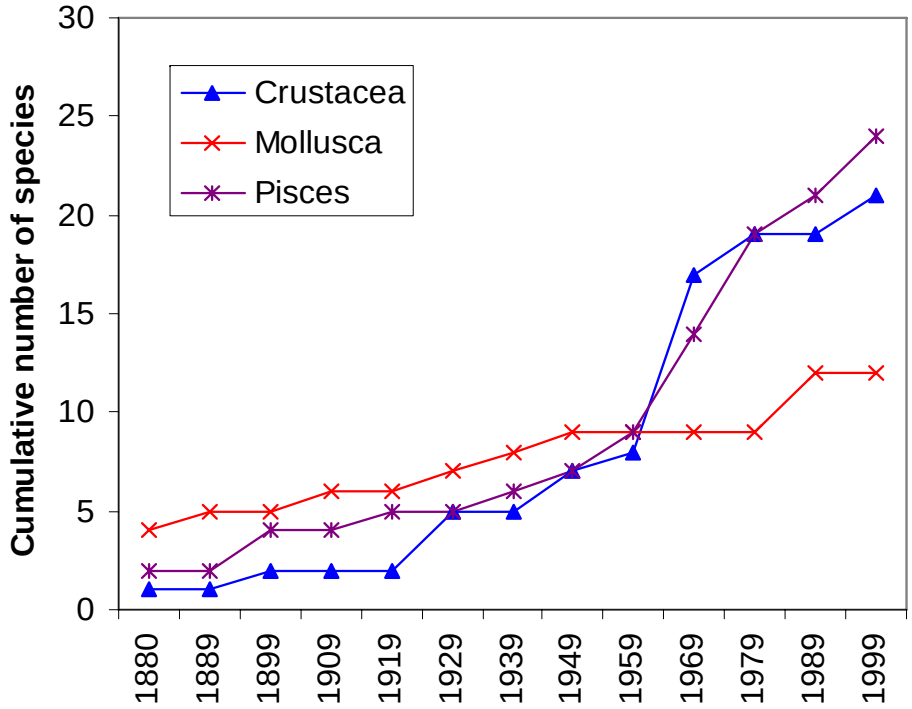


First records of new arthropods (left) and plant diseases (right) in Europe by decade 1890-2000. Smith, 1997

Data and hypothesis surveys - entry

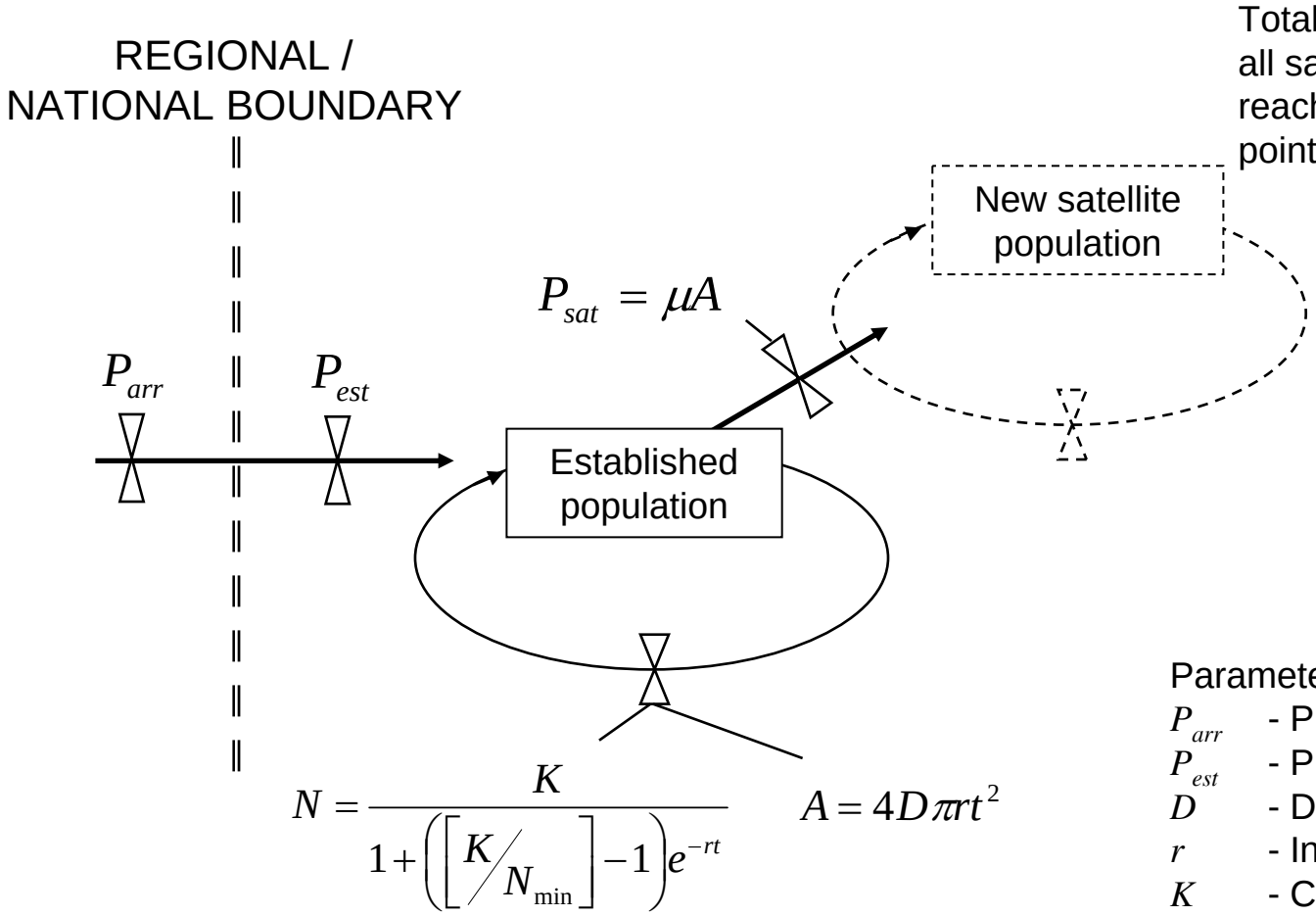






Olenin 2003, Klaipeda University, Lithuania

Ecological spread model

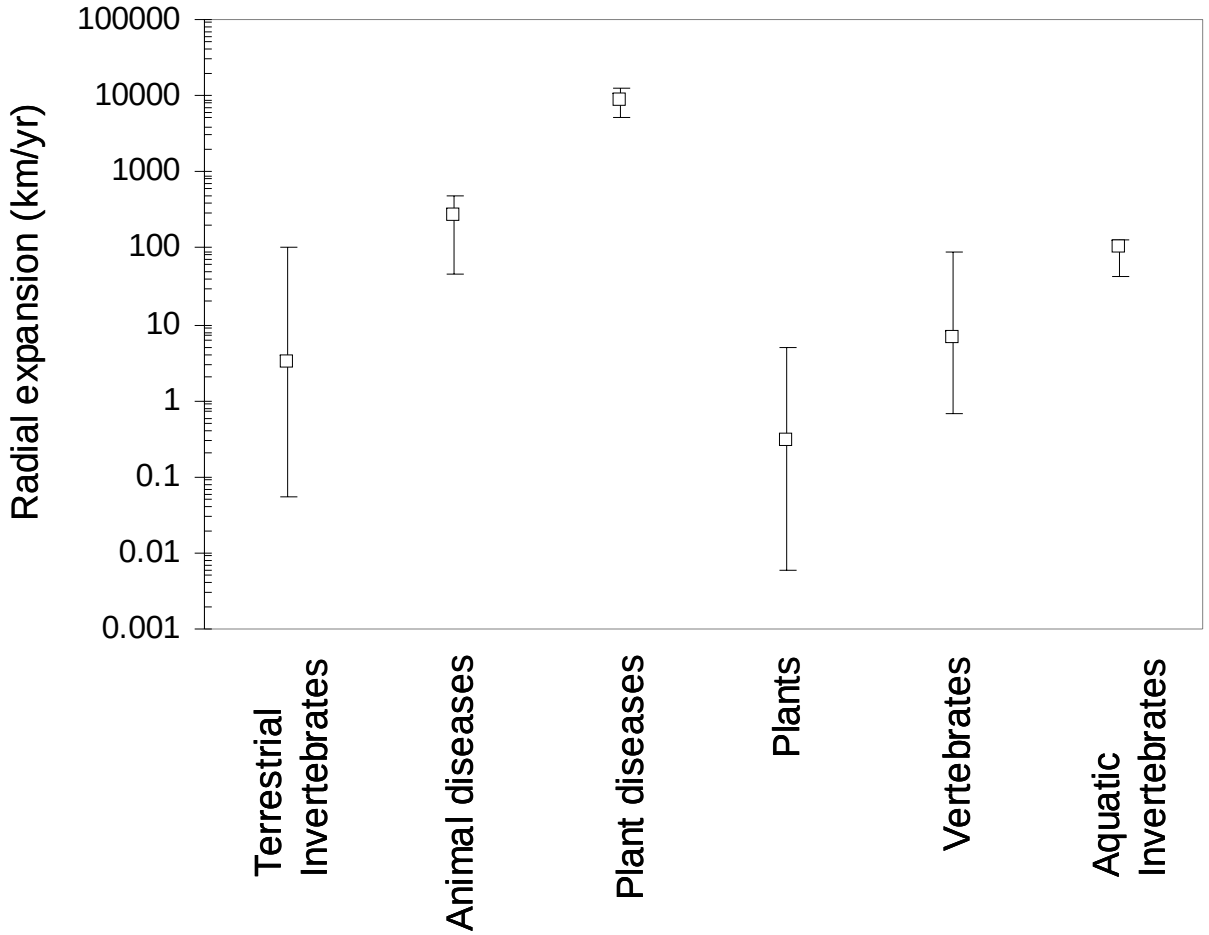


Total area summed across all satellites increases until reaching $A_{max,}$ at which point it remains constant

Parameters:

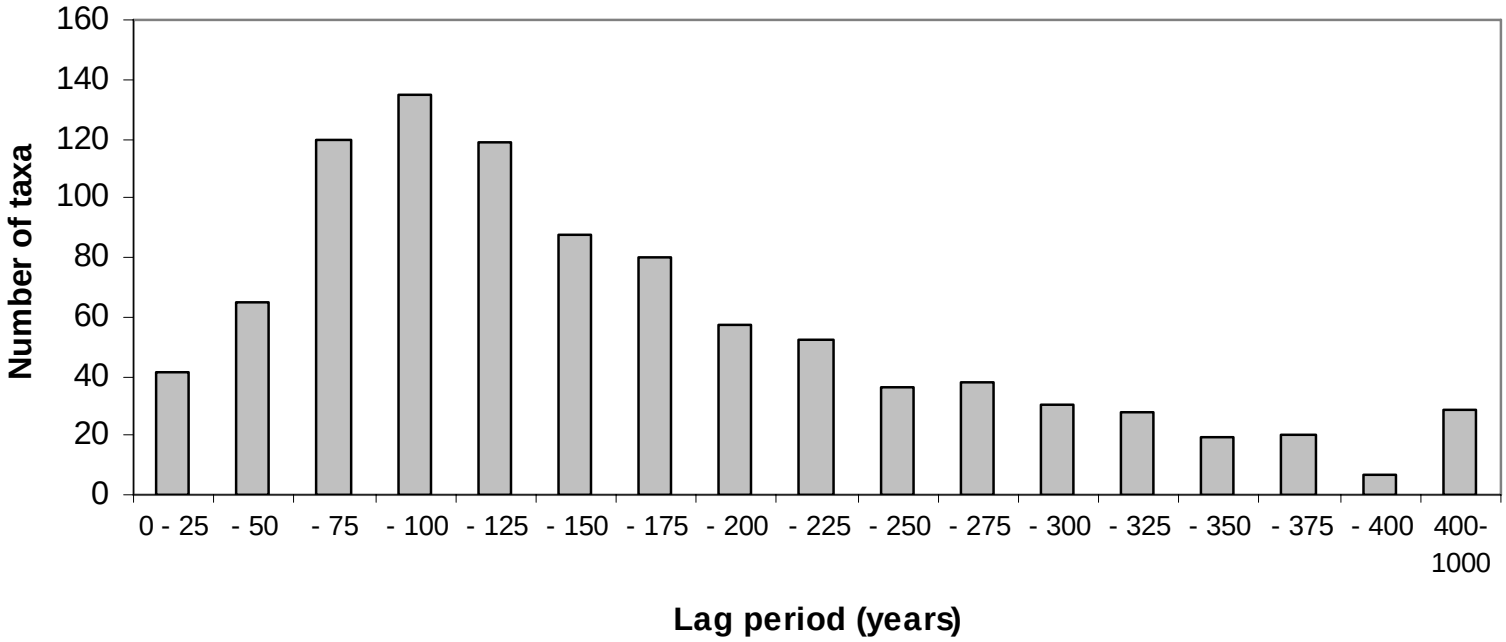
P_{arr}	- Probability of arrival
P_{est}	- Probability of establishment
D	- Diffusion coefficient
r	- Intrinsic rate of increase
K	- Carrying capacity
N	- Local population density
μ	- Rate of new satellite generation

Data and hypothesis surveys - spread



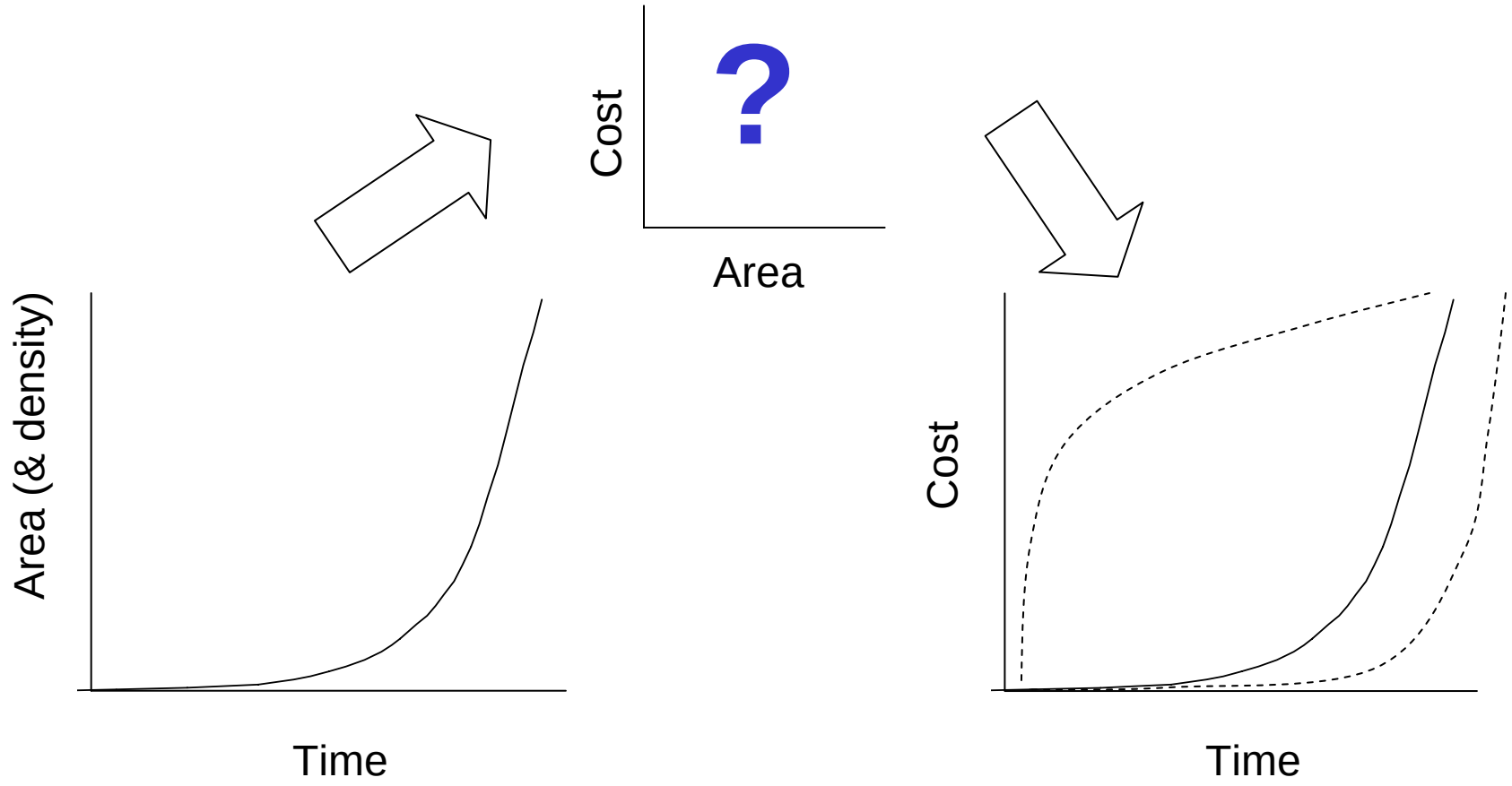
Median annual radial spread rates in Europe for taxa included in this study

Data and hypothesis surveys - spread



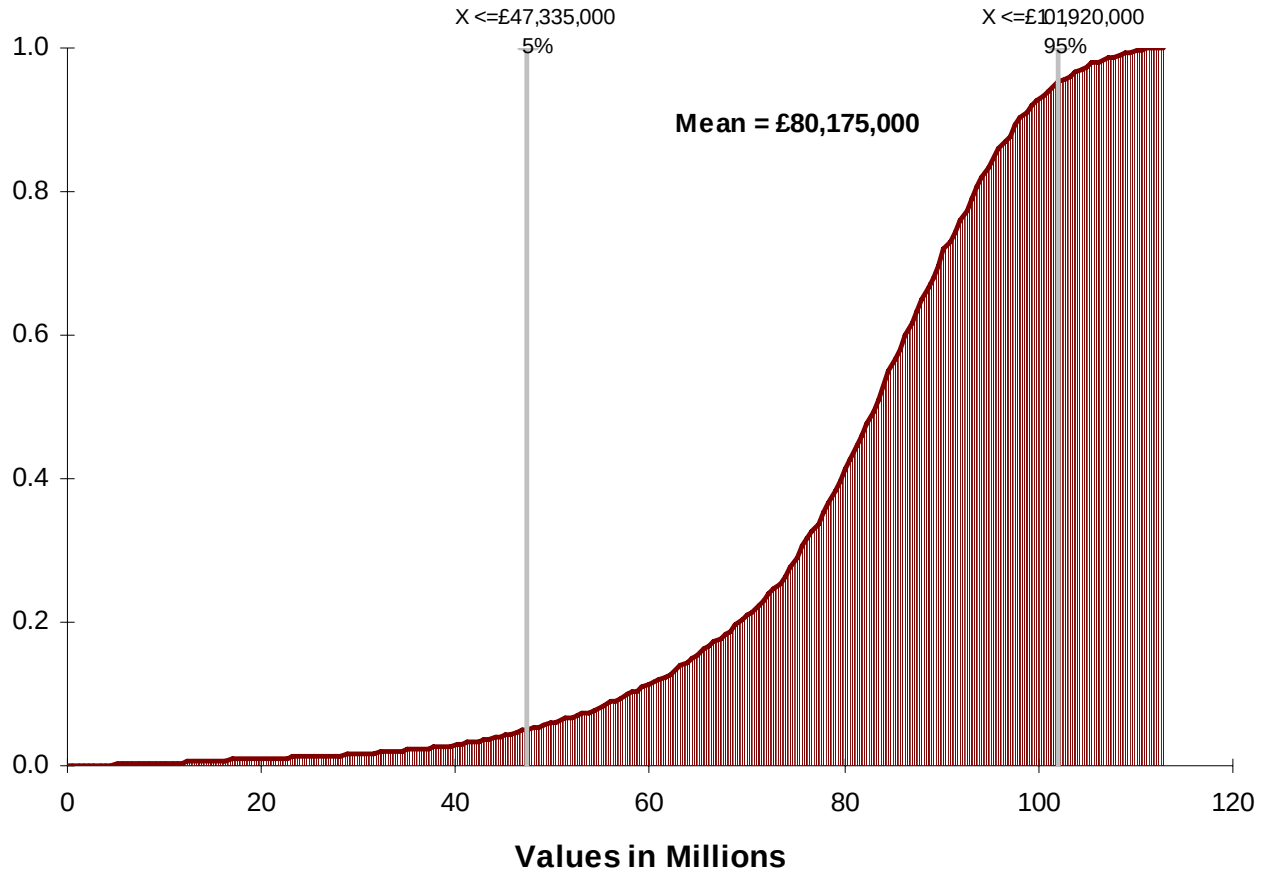
Lag from first introduction to first record in the wild for new plant species in the British Isles. Preston *et al*., 2002

Linking ecology with economics



Newcastle Disease

Average annual expected damage £

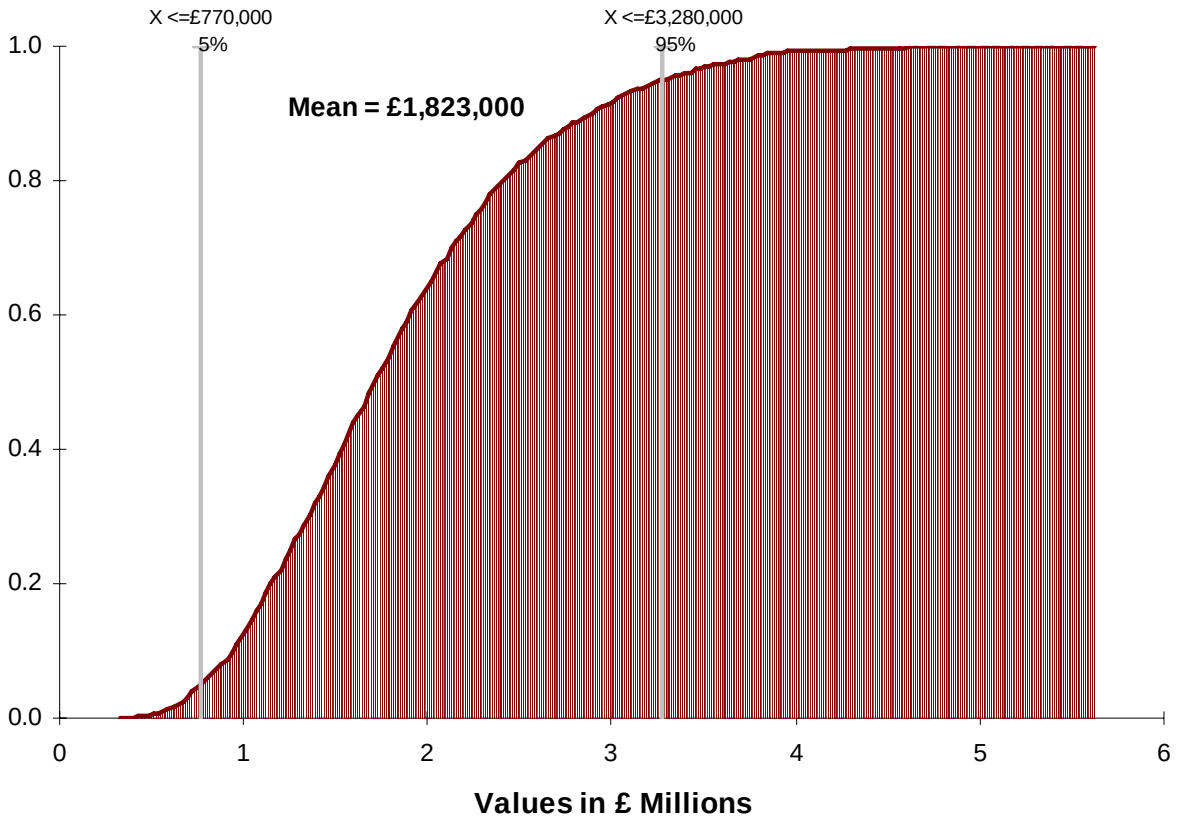


Sensitivity analysis – Newcastle Disease

Parameters (-/+ 50%)	Resultant change (% of value)
P(entry)	**-24.5/+16.4**
P(establishment)	**-23.5/+17.7**
Average total cost – vaccination	-5.4/+4.0
Average total revenue loss – yield	-0.1/+0.2
Average total revenue loss – export	**-44.2/+45.5**
Animals infected at introduction (Amin)	-0.9/+1.0
Max animals infected (Amax)	-3.6/+4.1
Intrinsic rate of spread (r)	-4.1/+4.1
Density at introduction	-2.0/+1.5
Maximum density (K)	-1.0/+0.9
Max satellite infections (Smax)	-0.9/+1.6
Intrinsic rate of new satellites (μ)	-11.5/+9.3
Infection diffusion coefficient (D)	-1.4/+0.7

Wild Boar

Average annual expected damage



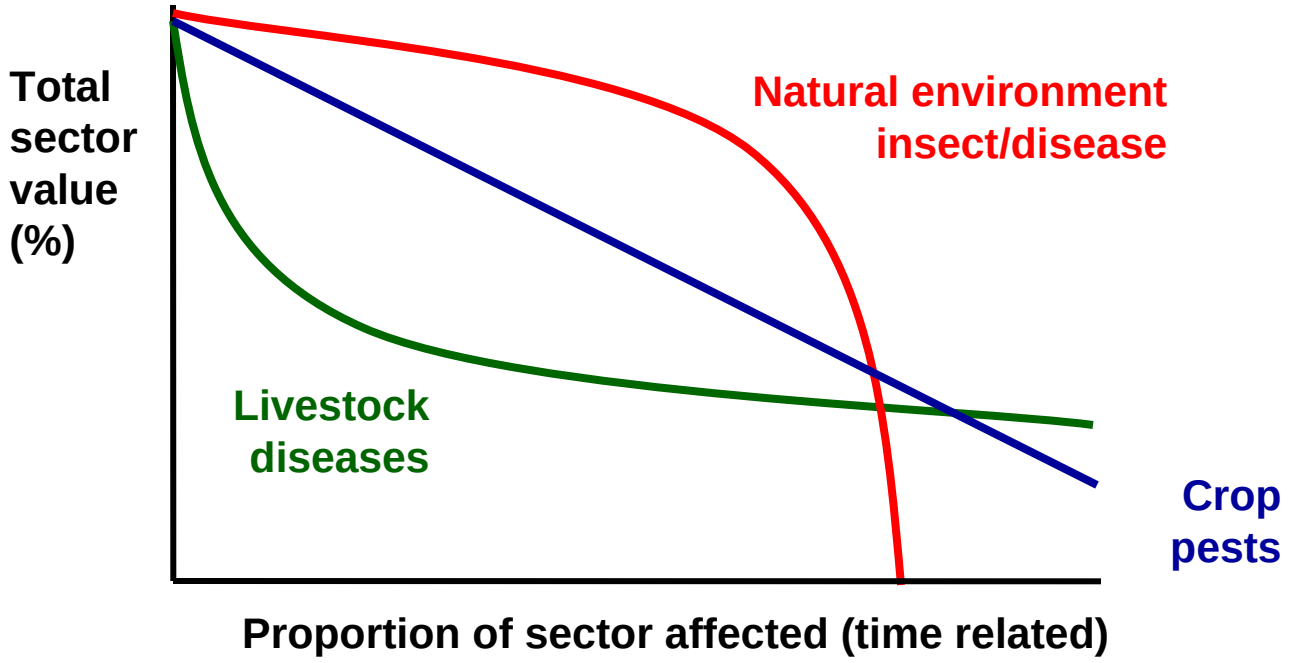
Sensitivity analysis – Wild Boar

Parameters (-/+ 50%)	Resultant change (% of value)
P(entry)	na
P(establishment)	na
Average total cost – vaccination	-5.5/+5.2
Average total revenue loss – yield	**-44.6/+43.3**
Average total revenue loss – export	na
Animals infected at introduction (Amin)	-5.1/+4.4
Max animals infected (Amax)	**-87.7/+29.4**
Intrinsic rate of spread (r)	**-44.5/+44.1**
Density at introduction	-0.3/+0.6
Maximum density (K)	-8.4/+4.8
Max satellite infections (Smax)	-0.7/+1.2
Intrinsic rate of new satellites (μ)	-0.2/+0.2
Infection diffusion coefficient (D)	-22.7/+22.6

Annual modelled impact over 20 years

Species	Average Impact (£)	Environmental Effect
Colorado Beetle	135,000	Nil
Wild Boar	1,823,000	Low
Newcastle Disease	80,175,000	Moderate
FMD	1,030,000,000	Moderate
Gyrodactylus salaris	20,522,000	High
Creeping Thistle	30,350,200	Very Low

Three general forms of invasion impact



Changing external dimensions of biosecurity

- Trade, travel and markets
  - More and different sources
  - New emphasis on rising pathways
- Climate
  - Greater over winter survival, more establishment
- Values
- Technology

Values – public vs private

- Current “key risks” reflect limited stakeholders
  - DEFRA sees Colorado potato beetle as a key pest; three of the six key plant pests are on potato
  - Public concern over Japanese knotweed, exotic crabs, oak galls and Sudden Oak Death
- Current controls reflect technical focus
  - DEFRA plan for FMD culling
  - Public revulsion of cattle culling and rejection of rural closure for “special interest” of agriculture

Values - private dynamics

- Public attitudes are variable, inconsistent, and variously informed
  - There is no clear public concept of biosecurity
  - Some potential stakeholders object to the concepts of “alien”, “invasion”, “eradication”
  - A widely travelled public likes many non-native species
  - Public expects a managed, not a “natural”, environment
  - The public does not trust scientific interpretation of perceived problems and solutions

State of the Art reviews

- CEFAS on aquatic environments
- CSL on plant health, bee health, mammals, birds and related diseases
- IAH on exotic viral pathogens
- VLA on animal diseases and veterinary public health

- Parallel integrated PRA design project led by CSL involves the same groups, plus others

SoA Conclusions

- **Technology**
  - Better databases needed to determine background risk
  - Integrated PRA assessment models
  - Tracing using electronic tags on containers, packaging
  - Better biochemical detection and identification technology
  - GIS use in eradication management
  - Economic models for dynamic benefit/cost analysis
  - Vaccination as standard preventative for livestock disease
- **Legislation**
  - Harmonised EU layer to reduce internal EU transfer (one third of UK plant health cases from Netherlands)

Prevention versus eradication

- *SoA* supports prevention
  - General prevention is worthwhile against a wide range of unspecifiable risks
  - Specific detection methods can not be justified against many unknown agents/pathways
  - Essential in low economic value cases which do not support rapid detection technology
- *Future of Biosecurity* keeps options open
  - Better tracing, control technology reveals threats/pathways, can make detection/eradication a more efficient option
  - Current actions are eradication, not prevention, focussed

Conclusions - Future of Biosecurity

- Biosecurity problems are increasing in Britain
- Models must compare risks across taxa
- Export impacts have most immediate effect; environmental risks have long time horizons
- Environmental impact is growing due to changing public attitudes
- Prevention is not *a priori* better than eradication; objective analysis is needed because technology is improving both options

ERMA NZ Beneficial Organism Introductions

- Hazardous Substances and New Organisms Act 1996
- Environmental Risk Management Agency is the regulatory agency
- New Organisms for Release (NOR) and for Release with Control (NORC)
- Process intended for “beneficial” introductions
- ERMA provides guidelines to applicants

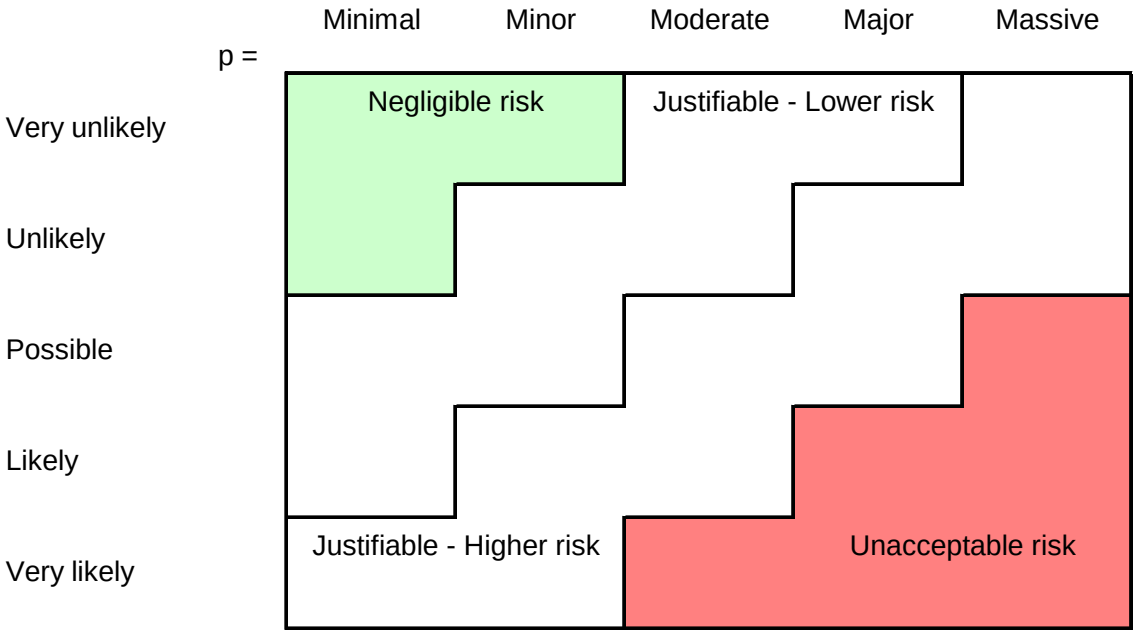
ERMA NZ Beneficial Organism Introductions

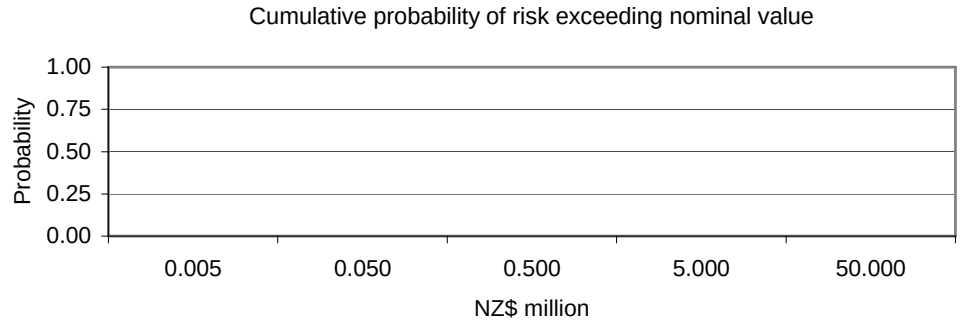
Score	Description	Monetary loss and response costs	Health impact	Environmental impact	Social impact
1	**Minimal**	Up to $10k /yr	Local, mild, short-term, reversible effects to individuals	Local, short-term population loss, no significant ecosystem effect	No social disruption
2	**Minor**	$10k-$100k /yr	Mild short-term reversible effects to identifiable groups, localised	Some ecosystem impact, reversible changes, localised	Significant concern expressed at local level
3	**Moderate**	$100k-$1m /yr	Minor irreversible effects and/or larger numbers covered by reversible effects, localised	Measurable long-term damage to populations and ecosystem, but little spread, no extinction	Temporary changes to normal activities at local level
4	**Major**	$1m-$10m /yr	Significant irreversible effects locally or reversible effects over large area	Long-term irreversible ecosystem change, spreading beyond local area	Some permanent change of activity locally, concern expressed over wider area
5	**Massive**	$10m + /yr	Widespread, severe, long-term, irreversible health effects	Widespread, long-term population loss or extinction, affecting several species with serious ecosystem effects	Long-term social change, significant loss of employment, migration from affected area

ERMA NZ Beneficial Organism Introductions

Score	Description	Definition	Frequency definition
1	Very unlikely	This sort of event is theoretically possible, but is never known to have occurred and is not expected to occur	1 in 10,000 years
2	Unlikely	This sort of event has not occurred anywhere in living memory	1 in 1,000 years
3	Possible	This sort of event has occurred somewhere at least once in recent years, but not locally	1 in 100 years
4	Likely	This sort of event has happened on several occasions elsewhere, or on at least one occasion locally in recent years	1 in 10 years
5	Very likely	This sort of event happens continually and would be expected to occur	Once a year

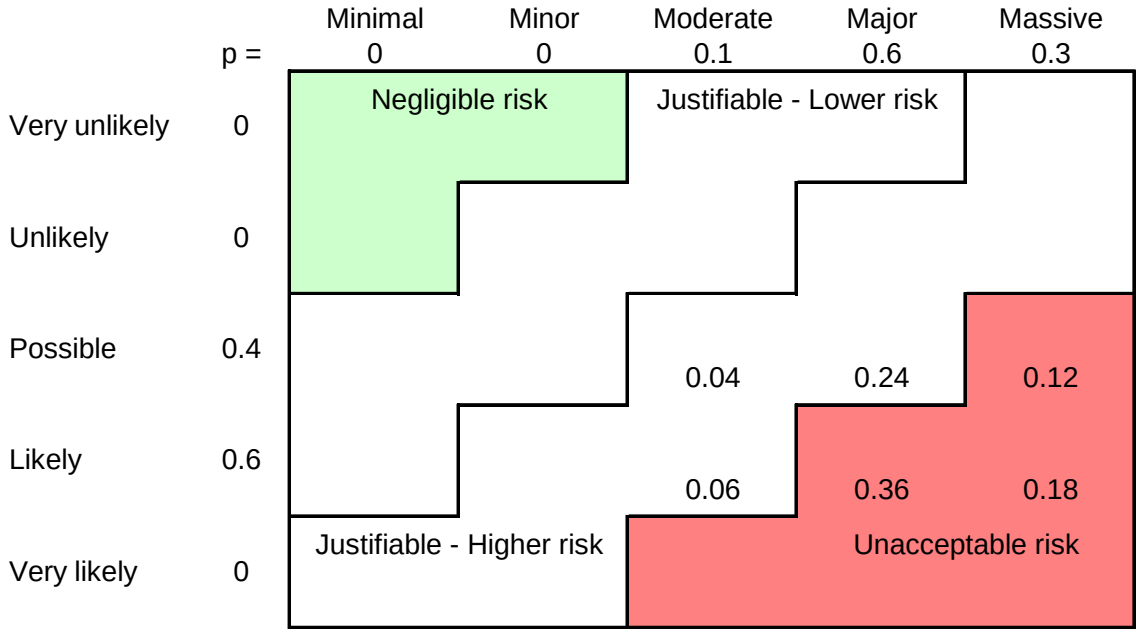
ERMA NZ Beneficial Organism Introductions



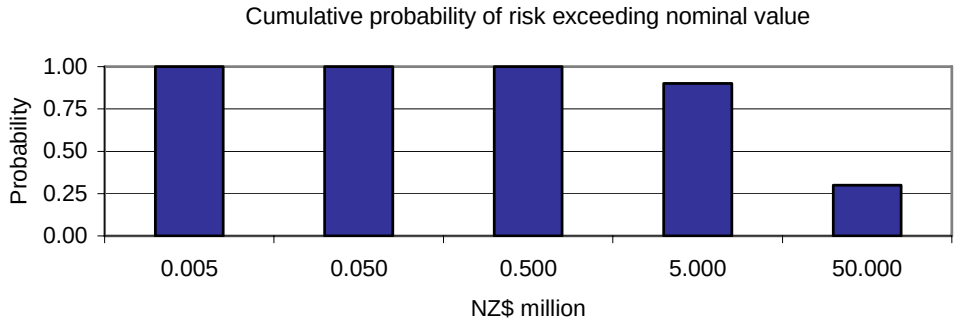


Modal value (NZ$ mn)	0.000	Mean value (NZ$ mn)	0.000

ERMA NZ Beneficial Organism Introductions

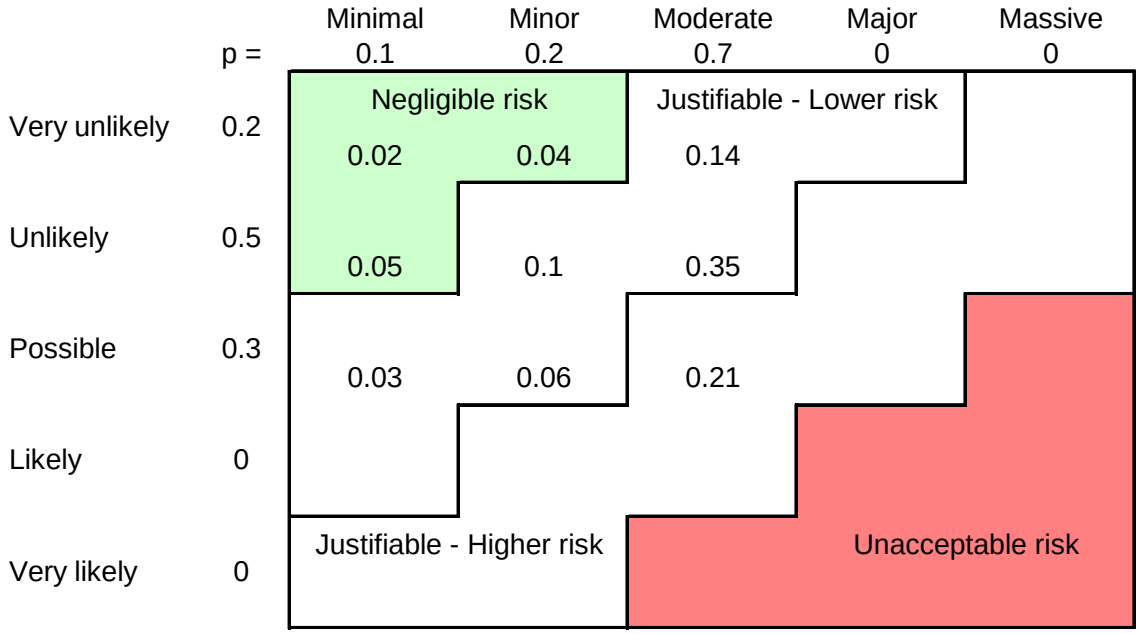


Unacceptable for release

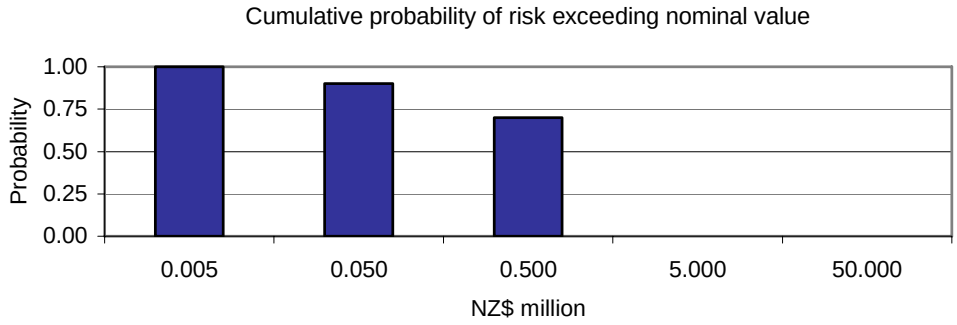


Modal value (NZ$ mn)	1.800	Mean value (NZ$ mn)	18.050

ERMA NZ Beneficial Organism Introductions

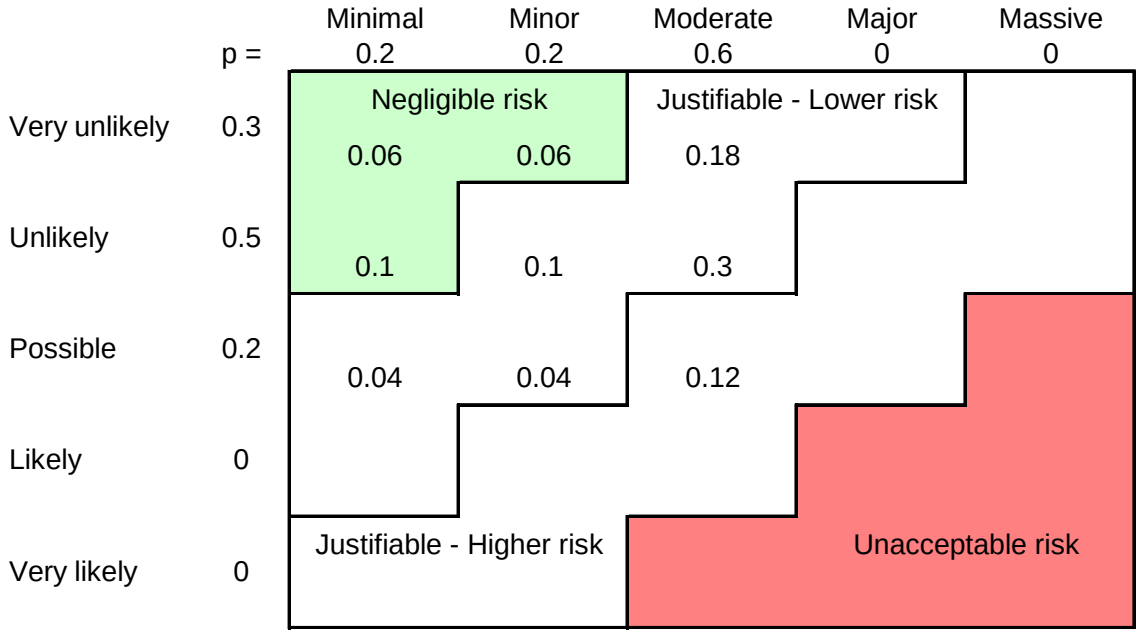


Acceptable for release

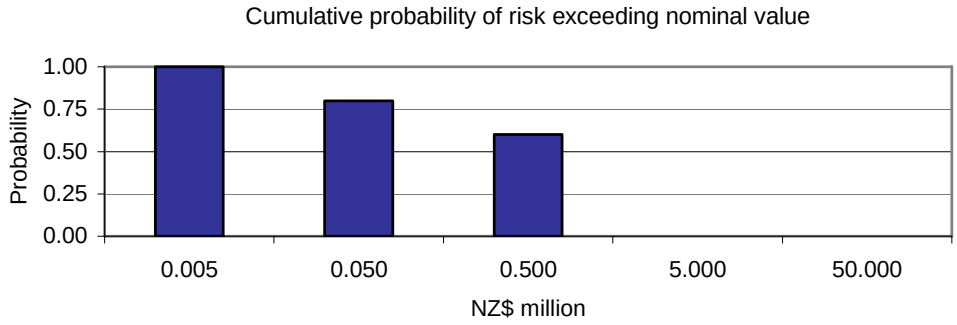


Modal value (NZ$ mn)	0.175	Mean value (NZ$ mn)	0.361

ERMA NZ Beneficial Organism Introductions

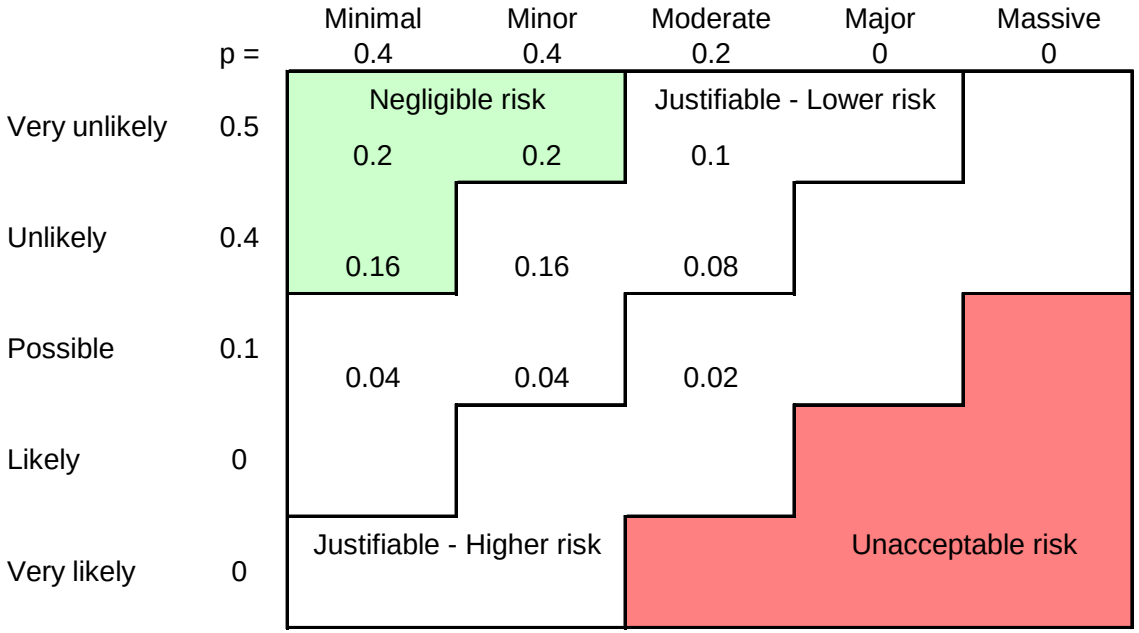


Monitoring reduces risk in controlled release

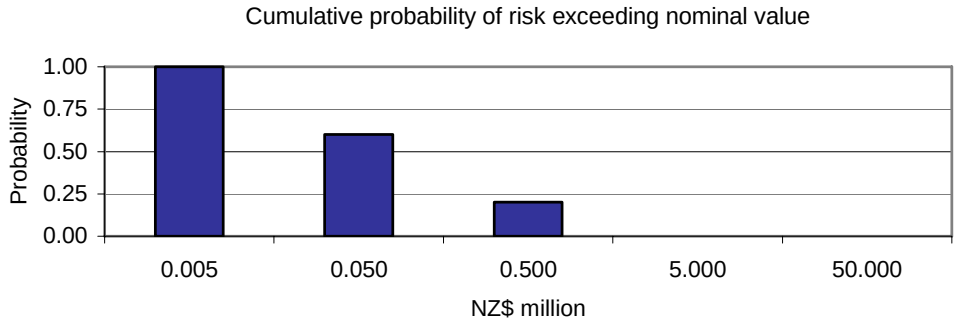


Modal value (NZ$ mn)	0.150	Mean value (NZ$ mn)	0.311

ERMA NZ Beneficial Organism Introductions



Monitoring plus spread prevention reduces risk more under controlled release



Modal value (NZ$ mn)	0.010	Mean value (NZ$ mn)	0.122

The value of risk reduction?

- Uncontrolled release
  - Some justifiable risk is acceptable
  - No further questions asked?

- Controlled release
  - What level of risk is to be attained?
  - How many options to consider?
  - Least cost, least risk, max net benefit?

UK Non-native Organisms Assessment

Breakdown by major categories.

The assessments were divided into four main categories :

- Entry 17 questions
- Establishment 14
- Spread 4
- Impact 16

- Entry and establishment essentially define how likely it is that an organism will invade.

- Impact and spread on the other hand define the magnitude of the effect should it do so.

DEFRA UK Non-native Organism Assessment

Definitions of scale values

	Scale point				
Type	**0**	**1**	**2**	**3**	**4**
likelihood	**very unlikely**	**unlikely**	**moderately likely**	**likely**	**very likely**
number	**very few**	**few**	**moderate number**	**many**	**very many**
extent	**very rare**	**rare**	**occasional**	**frequent**	**widespread**
frequency	**very rarely**	**rarely**	**occasionally**	**often**	**very often**
speed	**very slow**	**slow**	**intermediate**	**rapid**	**very rapid**
controllability	**very easily**	**easily**	**with some difficulty**	**difficult**	**very difficult**
importance	**minimal**	**minor**	**moderate**	**major**	**massive**
effect	**minimal**	**minor**	**moderate**	**major**	**massive**

Conclusions

- Level?
  - National level across taxa
  - Common international approach helps establish precedents
  - Trade-offs: specific case detail vs common application
- Specification?
  - Templates for data
  - Training in concepts and data presentation
  - Electronic tools for easy, transparent processing
- Sequence for design?
  - How much to invest before wide agreement on specifications
- Technical or political?
  - Is consistency merely technical or are there political dimensions?