Bio-Protection
Bioprotection science for New Zealand

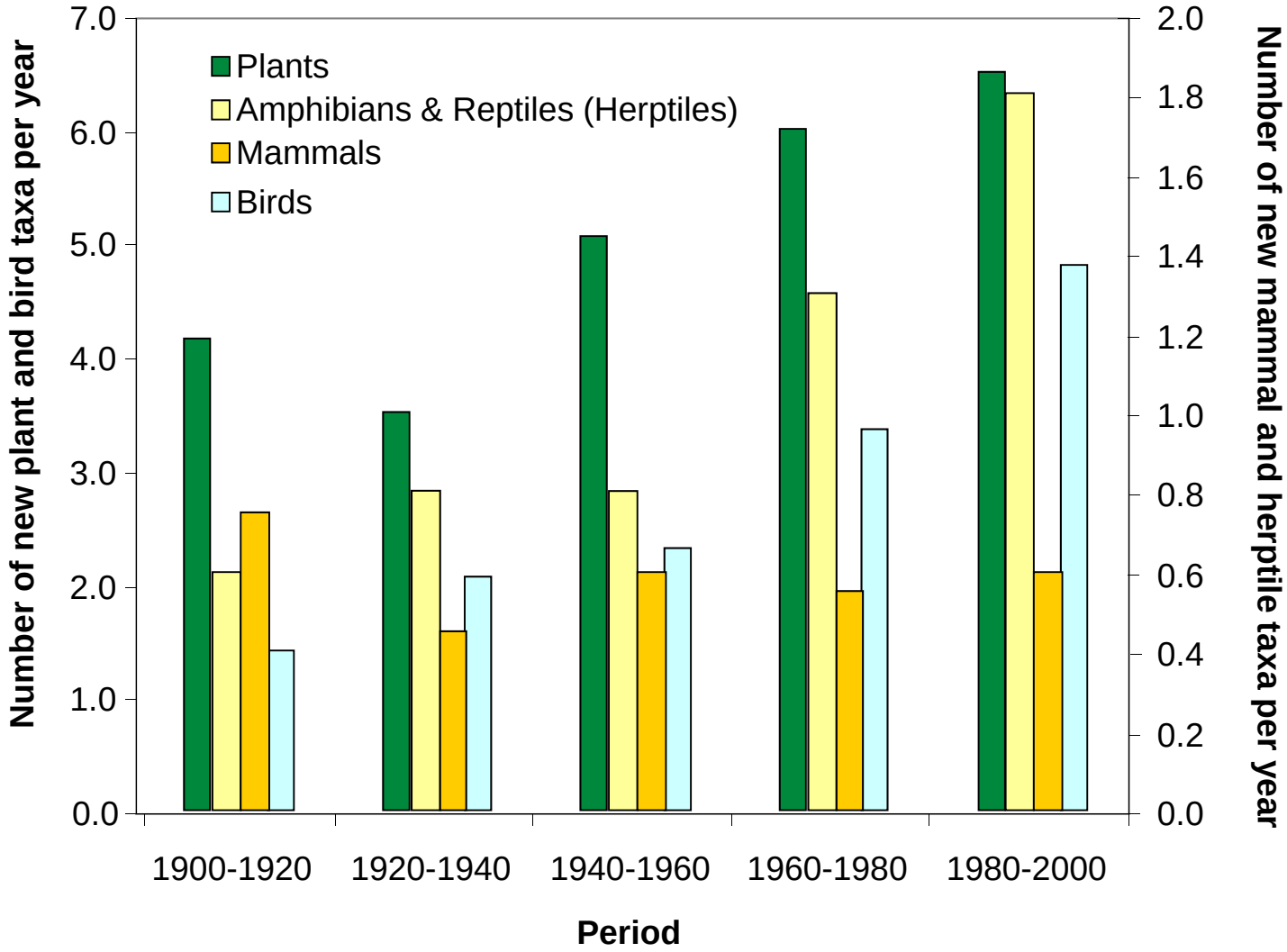
Invasive species risks: can we predict the environmental consequences of biological invasions?

Philip Hulme

CHALLENGING BOUNDARIES IN RISK ASSESSMENT SHARING EXPERIENCES

7-8 November 2012

Increasing pressure from alien species in EU



Hulme PE *et al.* (2009) *Science* **324**, 40-41.

Invasive alien impacts in Europe

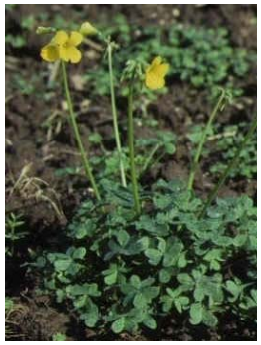
		IMPACTS	
Taxonomic group	*Species*	*Ecological (%)*	*Economic (%)*
Terrestrial plants	5789	326 (5.6)	315 (5.4)
Terrestrial invertebrates	2481	342 (13.8)	601 (24.2)
Marine flora and fauna	1071	172 (16.1)	176 (16.4)
Freshwater flora and fauna	481	145 (30.1)	117 (24.3)
Terrestrial vertebrates	358	109 (30.4)	138 (38.5)

Vilà M *et al.* (2010) *Frontiers in Ecology and the Environment* **8**, 135-144.

Alien impacts: non-native flora

Campylopus introflexus
Limits heathland regeneration

Rhododendron ponticum
Reduces species richness



Oxalis pes caprae
Economic damage

Hyacinthoides hispanica
Hybridization with natives

Fallopia japonica
Ecosystem change

Ambrosia trifida
Health risk

Hulme PE (2007). *Issues in Environmental Science and Technology*, **25**, 56-80.

Alien impacts: non-native fauna

Sciurus carolinensis
Wildlife disease

Branta canadensis
Social and economic pest

Arthurdendyus triangulatus
Earthworm predator

Cervus nippon
Hybridization with natives

Neovison vison
Wildfowl predator

Arion lusitanicus
Economic damage

Hulme PE (2007). *Issues in Environmental Science and Technology*, **25**, 56-80.

Invasion risk assessment criteria

Key elements of an invasive species risk assessment protocol:

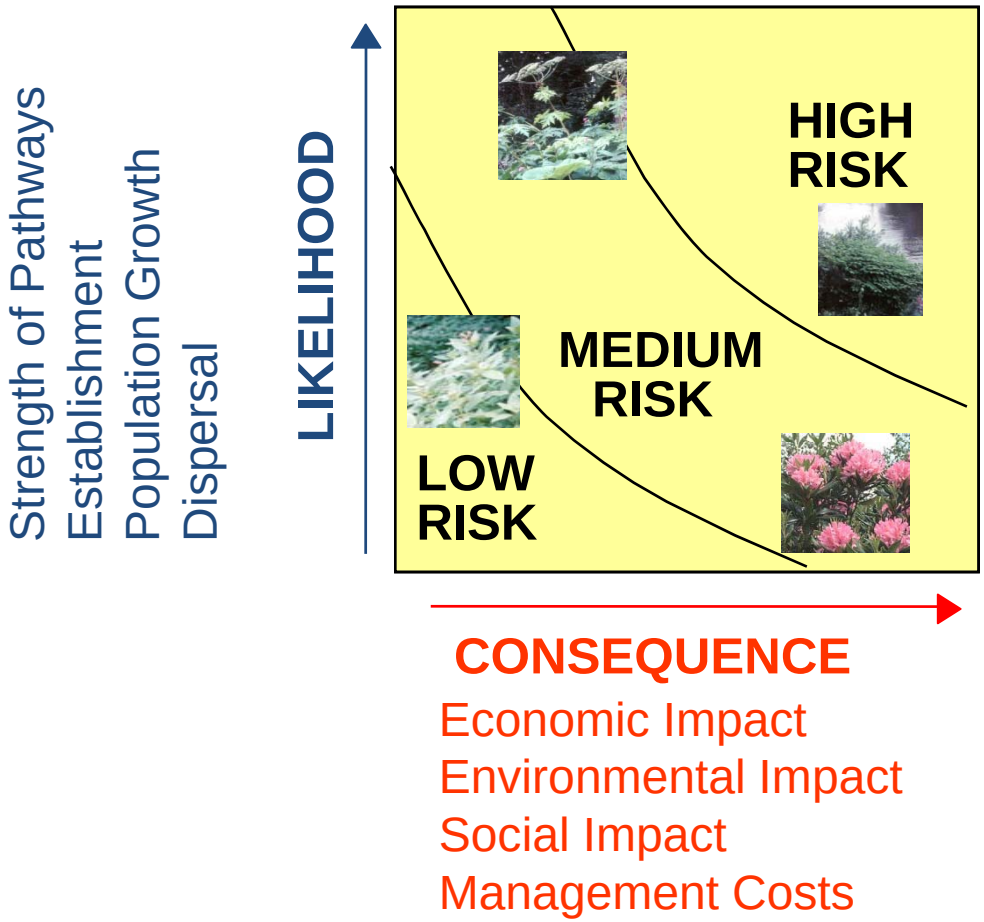
1. Species Identity
2. Description of Risk Area (Provence, France, EU)
3. Likelihood of Introduction (origin, sources and pathway strength)
4. Likelihood of Establishment (climate and habitat matching)
5. Likelihood of Population Spread (demography, dispersal)
6. Consequences of impact on environment (receptor risk)
7. Consequences upon economic sectors
8. Feasibility and costs of management



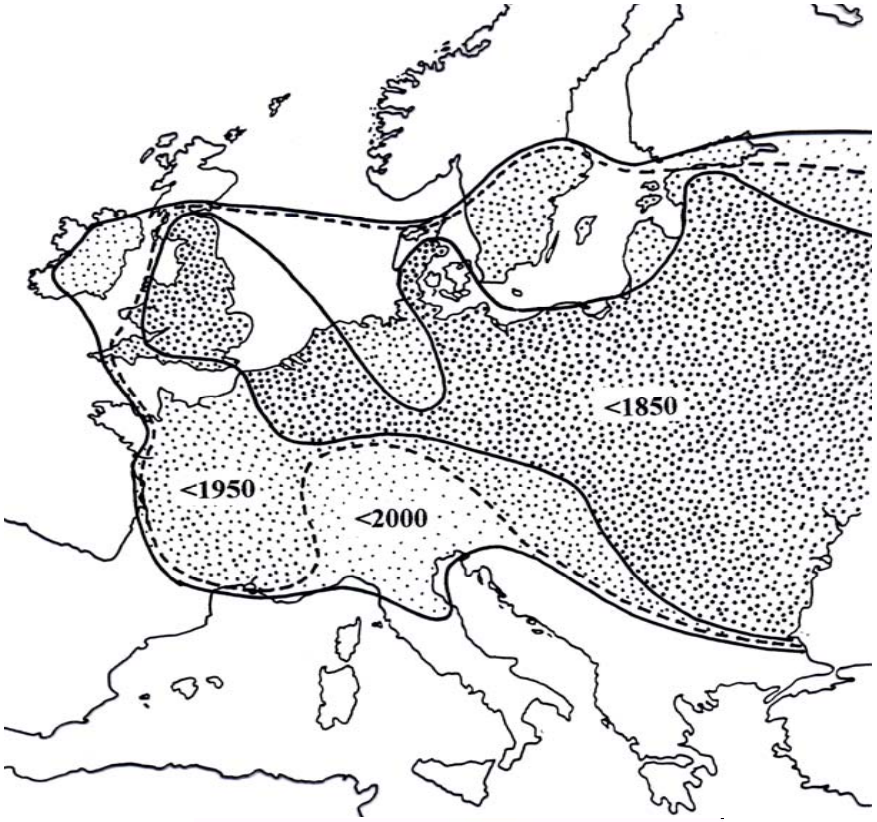

Hulme PE (2011) In: *Fifty Years of Invasion Ecology – The Legacy of Charles Elton* pp. 301-314, DM Richardson (Ed.) Blackwells.

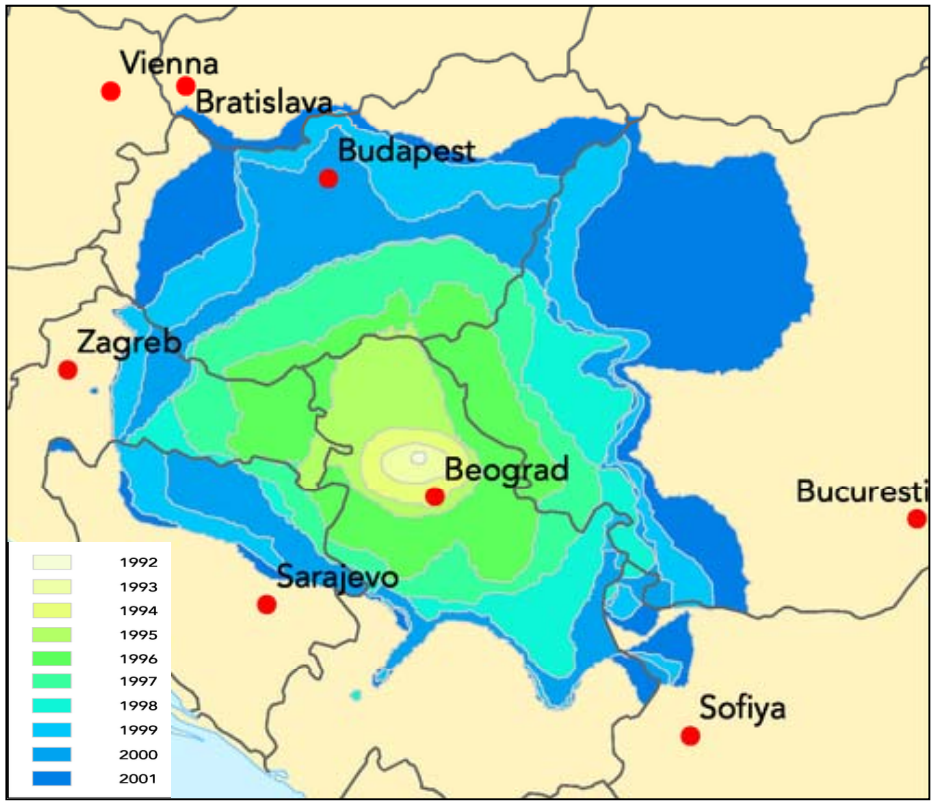
Risk = likelihood x consequence

Risk assessment is a scientifically based process to identify hazards, characterize their adverse impacts, evaluate the level of exposure of a target to those hazards and estimate the risk

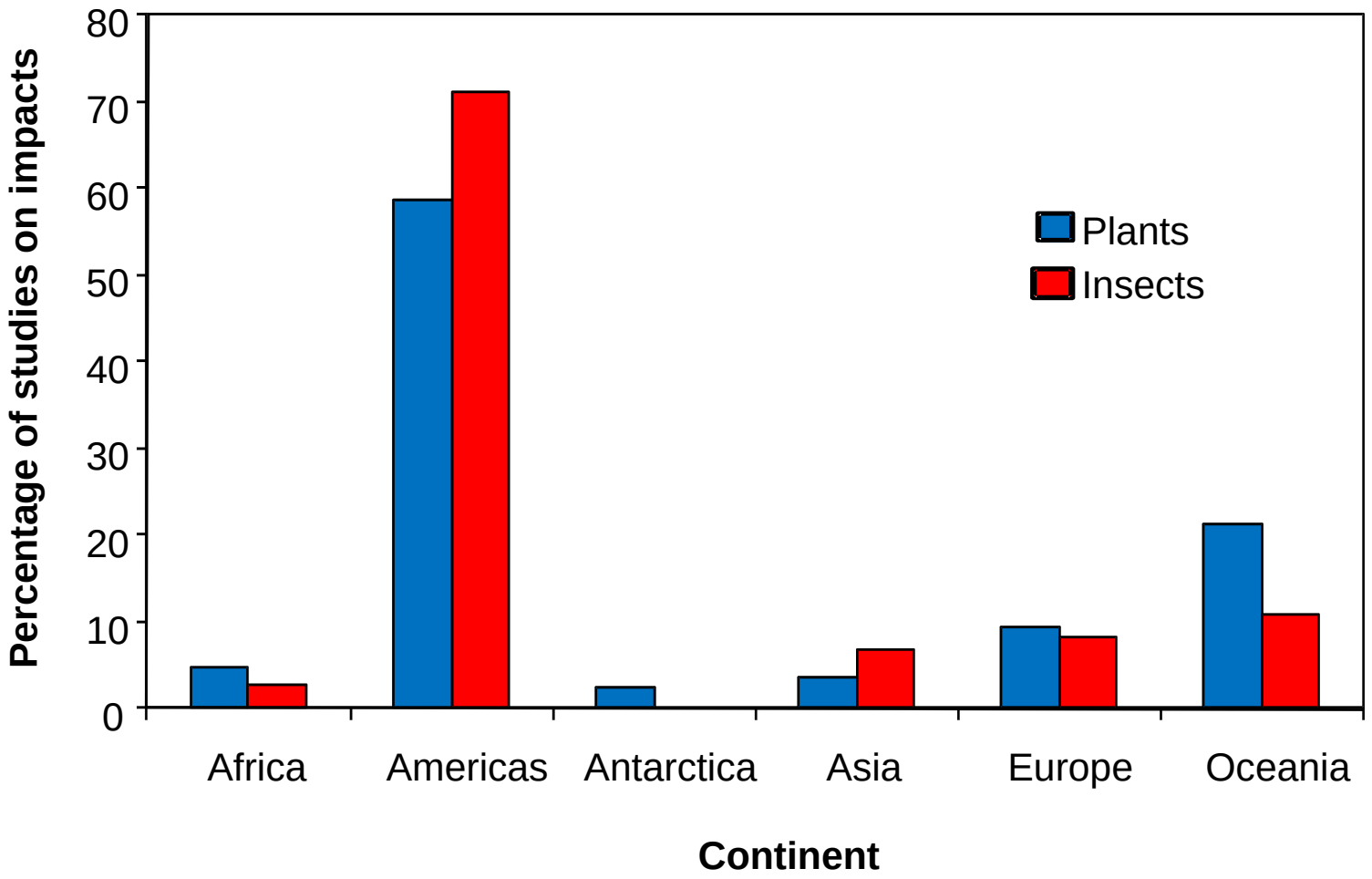


Establishment, distribution & spread





Knowledge of alien impacts worldwide

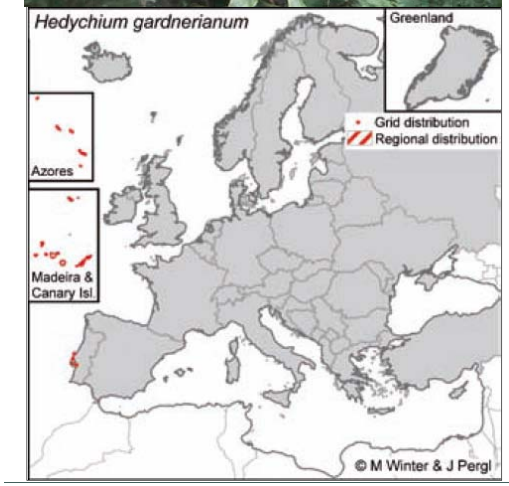


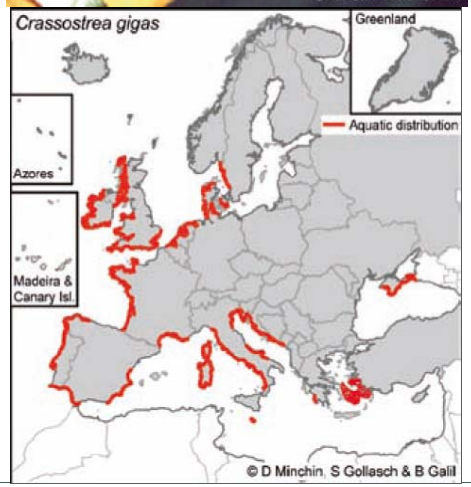
Distribution and impacts in Europe

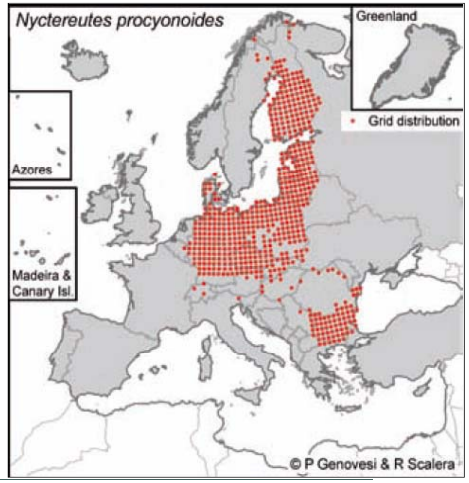
Common approach is to use distribution as a proxy for impact:

1. Number of regions present
2. Abundance or cover

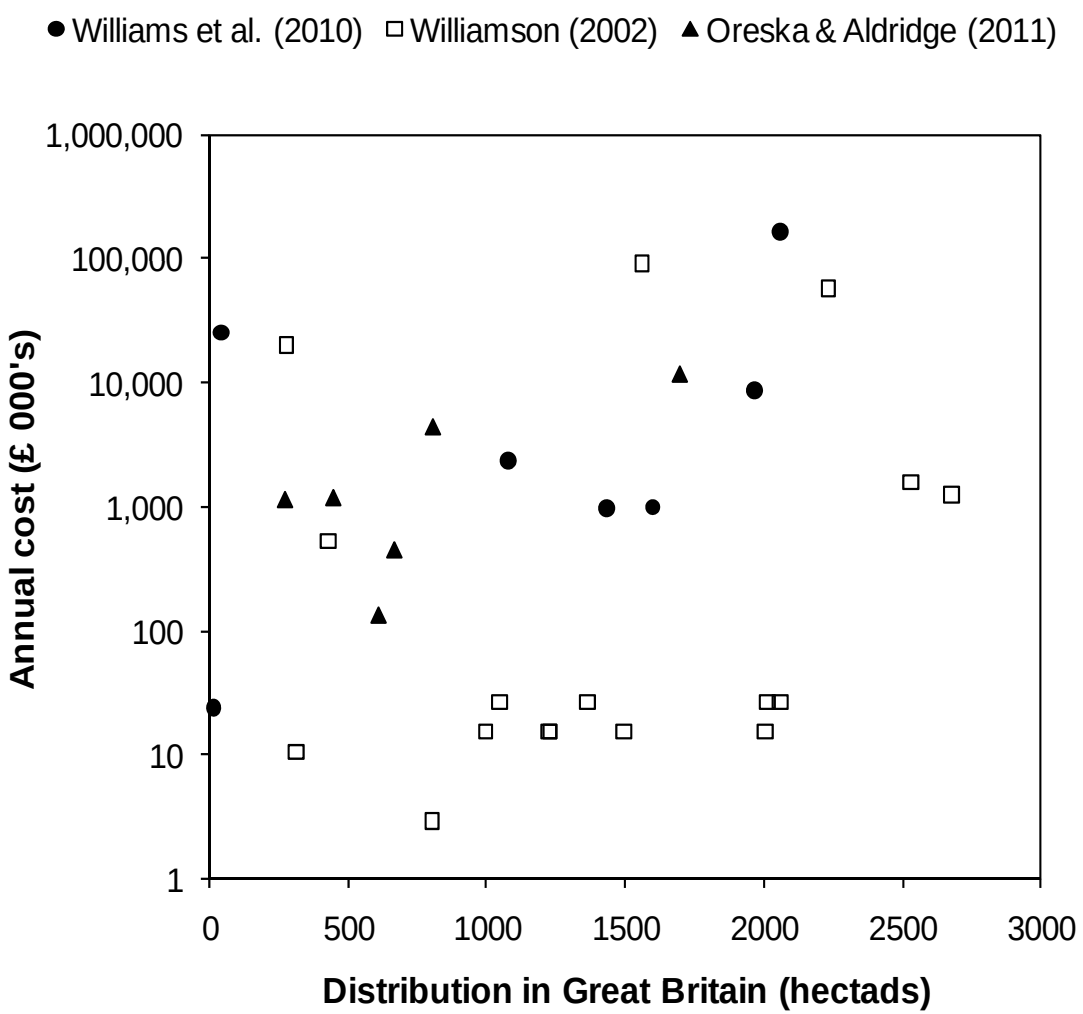
Problem of different units & spatial scales







Estimating potential impact

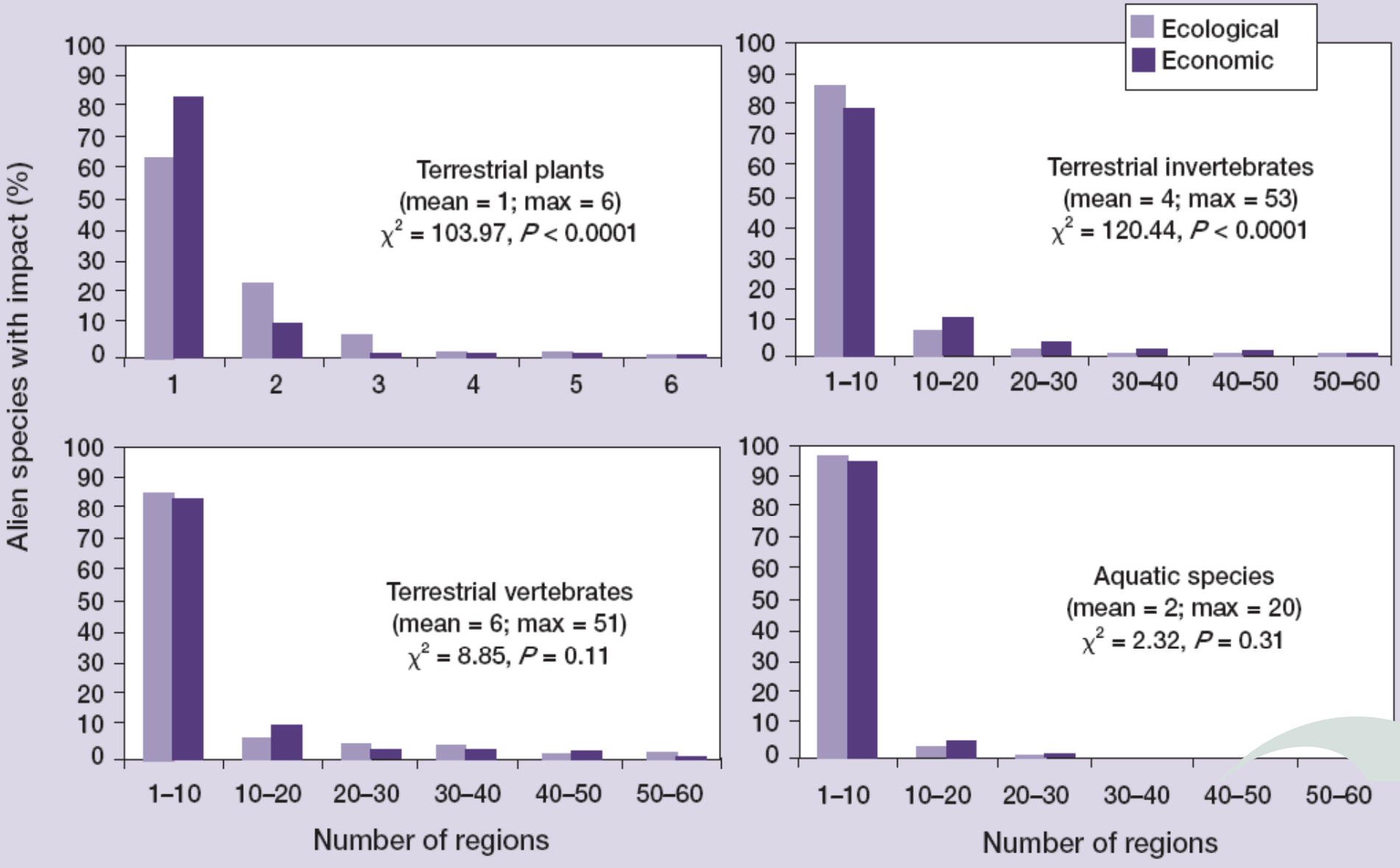


In the absence of reproducible measure of impact, distribution range is often used as a proxy for economic impact.

But these variables may not be related.

Hulme PE (2012) *Journal of Applied Ecology,* **49**, 10-19

National impact not regional problem



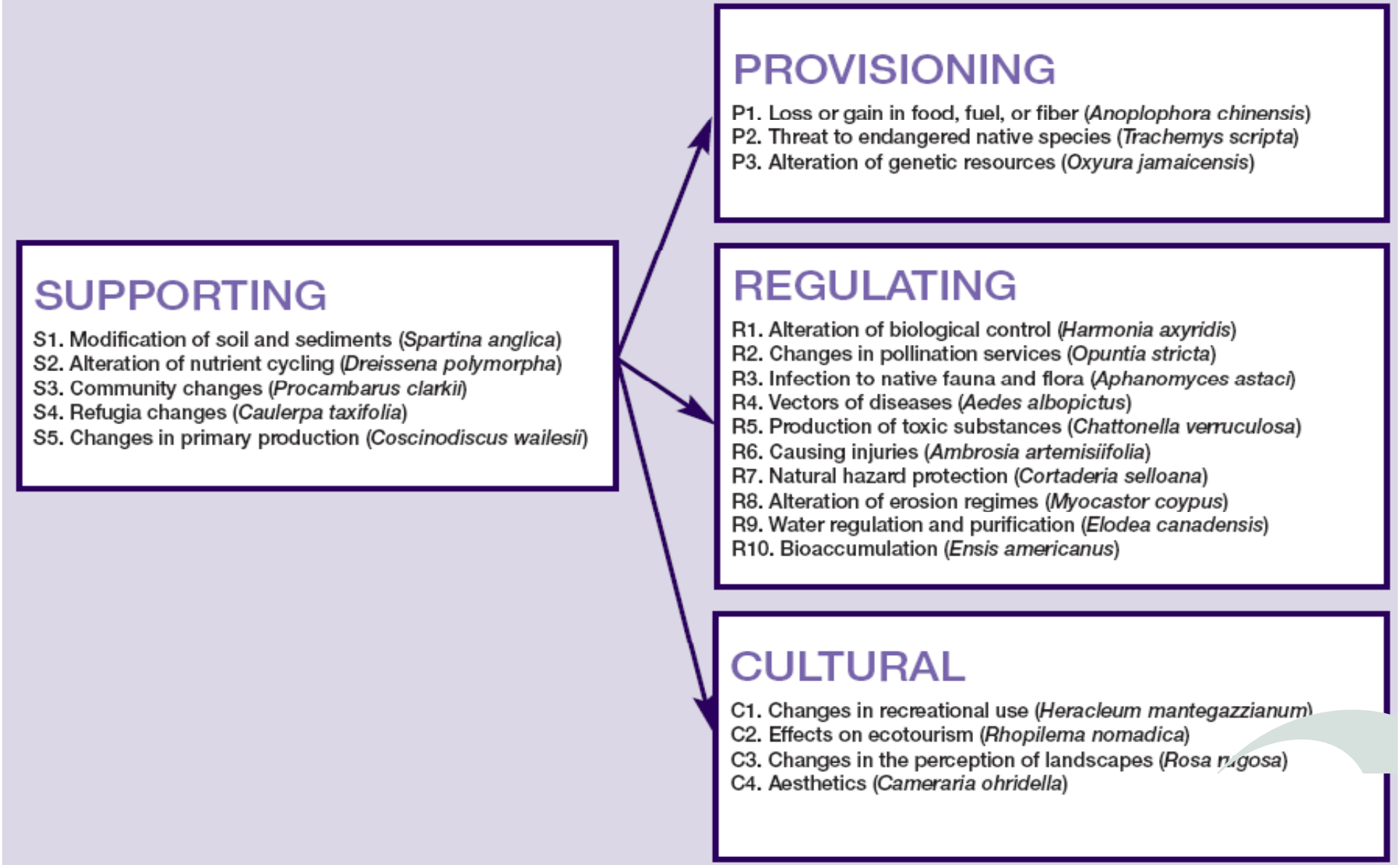
Vilà M *et al.* (2010) *Frontiers in Ecology and the Environment* **8**, 135-144.

Diversity of impacts on ecosystems

Environmental impacts could include:

1. Reduction, displacement or elimination of:
    - Keystone species or major components of ecosystems
    - Endangered, threatended, endemic or listed species
    - Other native species;
2. Effects on community structure
    - Species richness, diversity, evenness
    - Community connectance
3. Significant change in ecological processes
    - Hydrology, geomorphology
    - Nutrient and mineral cycling
4. Significant change in the structure and/or stability of an ecosystem
5. Significant effects on designated environmentally sensitive areas

Translate impact to ecosystem service



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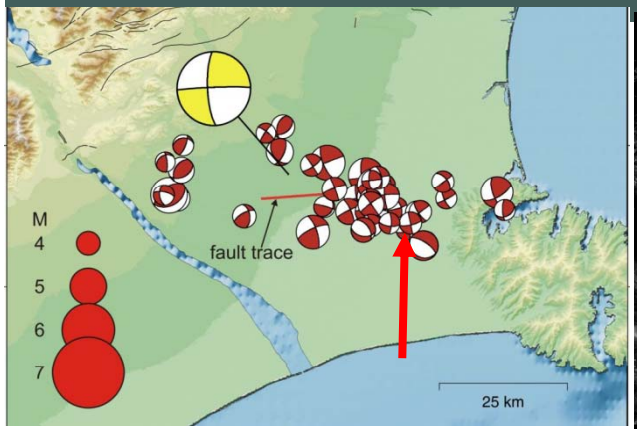
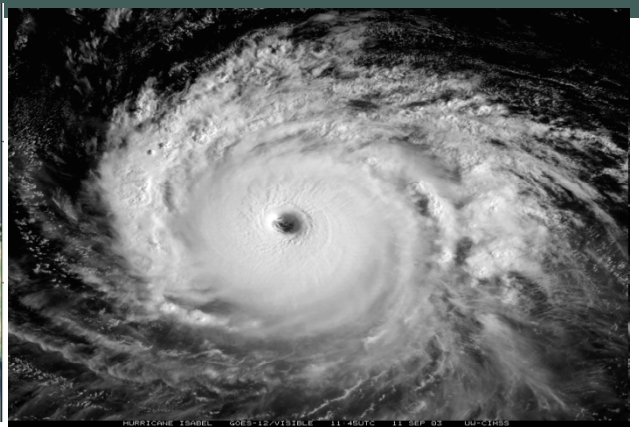
Consequence: quantifying impacts



Richter scale



Saffir–Simpson scale

Fujita scale

Measure requires needs to account for the following impact attributes:

1. target system (genotype, population, community, ecosystem)
2. severity (including whether to offset any beneficial effects)
3. spatial extent
4. duration
5. cumulativeness (impact accumulates over time until effects evident)
6. latency (reflecting the delay between cause and effect)
7. Irreversibility
8. Integrate over different impact currencies

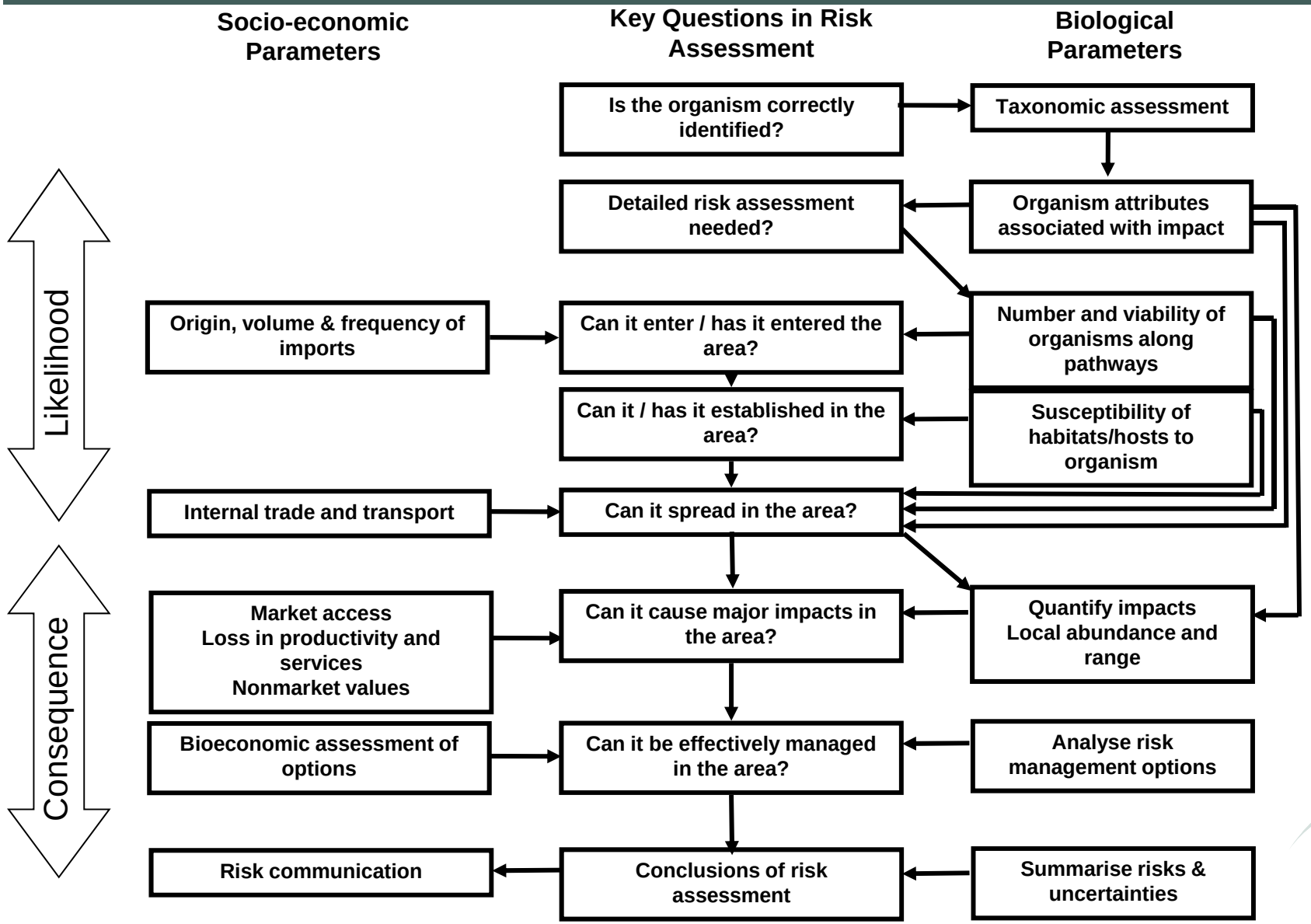
Risk assessment best practice

Key requirements of a risk assessment protocol:

1. Standard, robust and objective
2. Comparatively simple:
   - Relatively few, unambiguous data entries
   - Information can be provided relatively quickly
3. Flexibility in dealing with new information
4. Account for uncertainty in information
5. Weigh different elements of the assessment appropriately
6. Tested and validated
7. Should enable prioritisation and classification of risks

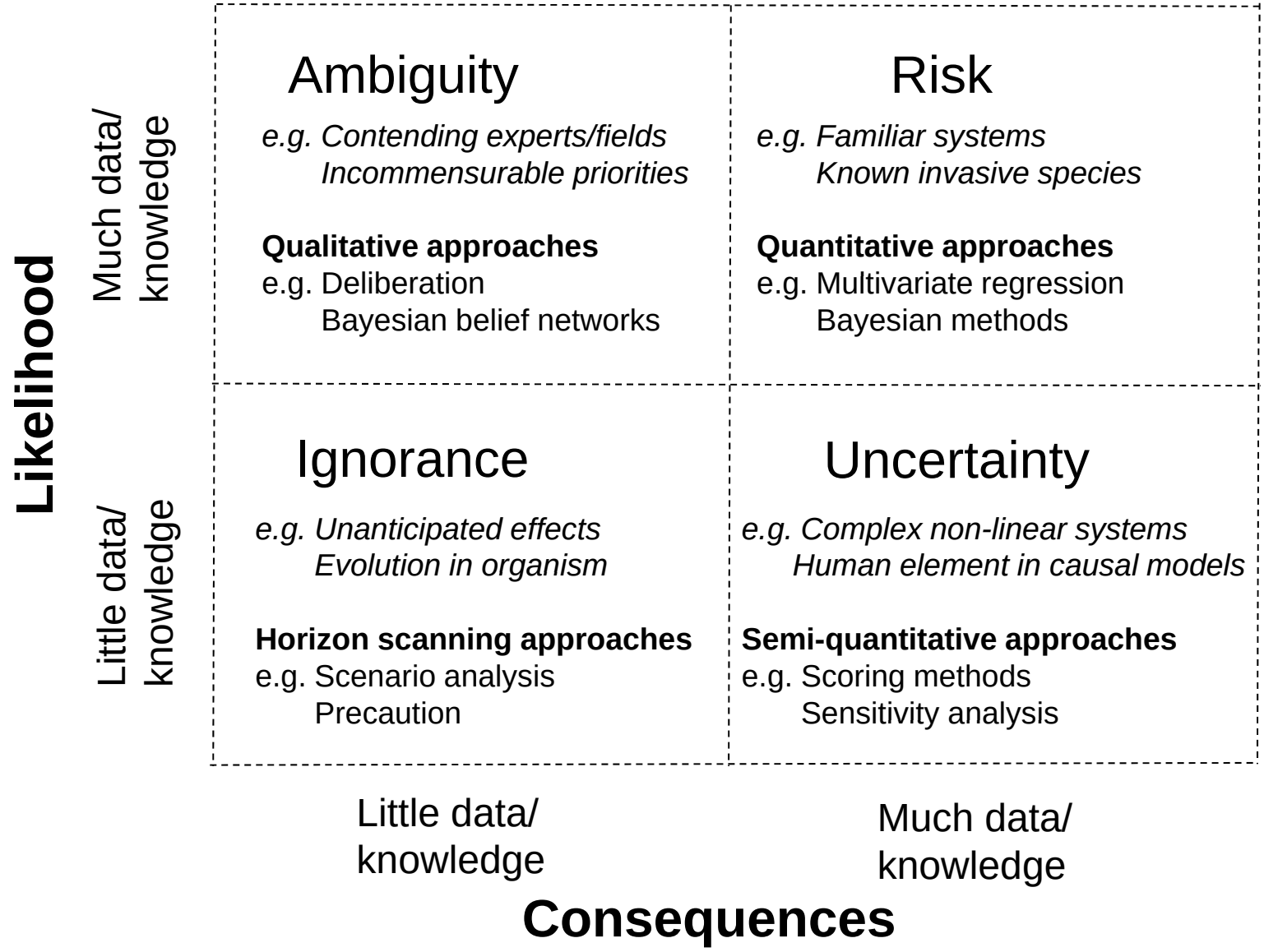



Complexity in invasion risk assessment



Hulme PE (2011) In: *Fifty Years of Invasion Ecology – The Legacy of Charles Elton* pp. 301-314, DM Richardson (Ed.) Blackwells.

Dealing with uncertainty



Hulme PE (2011) In: *Fifty Years of Invasion Ecology – The Legacy of Charles Elton* pp. 301-314, DM Richardson (Ed.) Blackwells.

Alien impacts: cognitive biases

Do we have biases in our perception of impacts?
Which species would you suspect of having the highest impact?

The answer may be surprising?

Conclusions

Ecosystem impacts of invasive species are an increasing threat:

1. Current quantitative knowledge of impacts is poor
2. There is an absence of objective measures of the hazards
3. Need to integrate impacts into ecosystem service perspectives
4. Derive standardised and repeatable measures of impacts
5. Use different approaches to risk assessment
6. Prediction may be poor thus invest in mitigation and response

Thank you

Hulme PE (2007) Biological Invasions in Europe: Drivers, Pressures, States, Impacts and Responses. In *Biodiversity Under Threat* (eds Hester R. & Harrison RM) pp. 56-80, Issues in Environmental Science and Technology, 2007, 25, Royal Society of Chemistry, Cambridge

Hulme PE, Pyšek P, Nentwig W & Vilà M. (2009) Will threat of biological invasions unite the European Union? *Science* **324**, 40-41.

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