

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

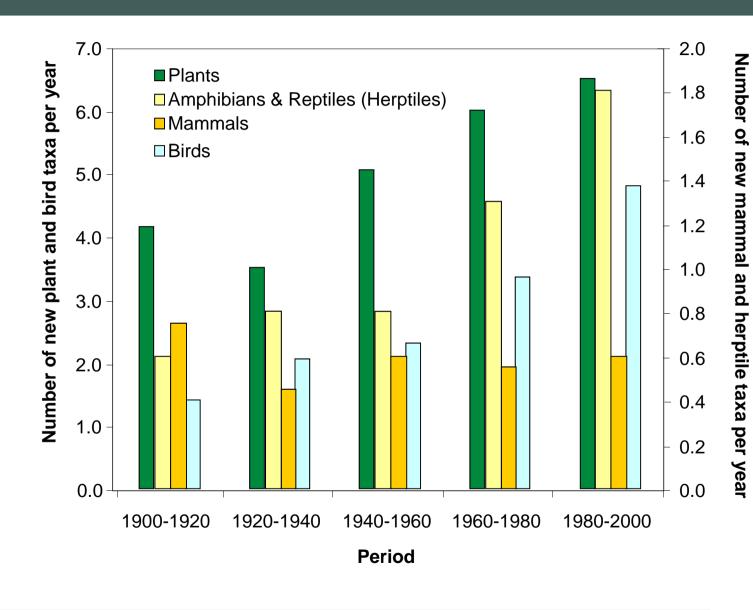
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CHALLENGING BOUNDARIES IN RISK ASSESSMENT SHARING EXPERIENCES

7-8 November 2012



Increasing pressure from alien species in EU



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)







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



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

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









Risk = likelihood x consequence

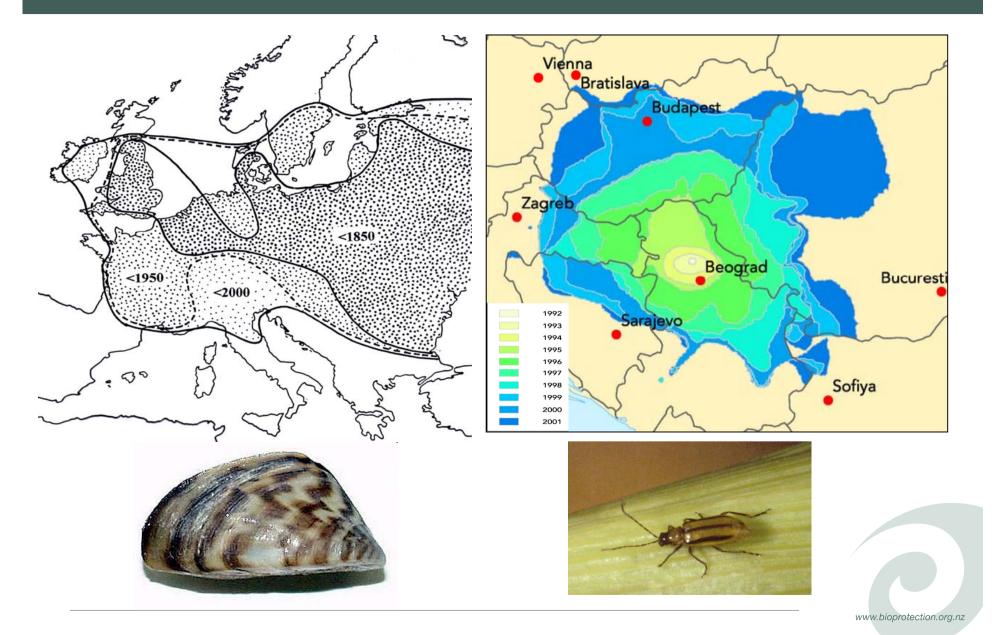
Risk assessment is a scientifically based process to identify hazards, characterize their adverse impacts, evaluate the level of exposure of a target to those hazards and estimate the risk

Strength of Pathways HIGH LIKELIHOOD **RISK Establishment** Population (Dispersal **MEDIUM RISK** LOW RISK CONSEQUENCE **Economic Impact Environmental Impact Social Impact**

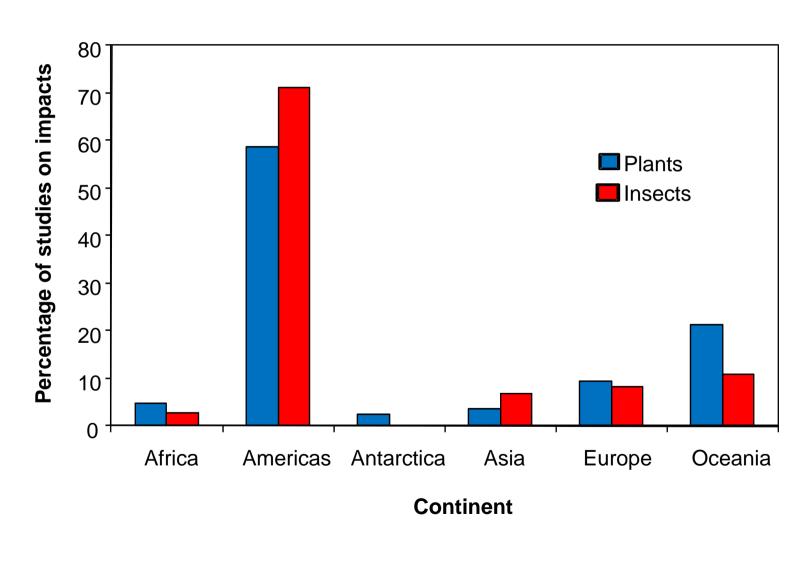
Management Costs



Establishment, distribution & spread



Knowledge of alien impacts worldwide



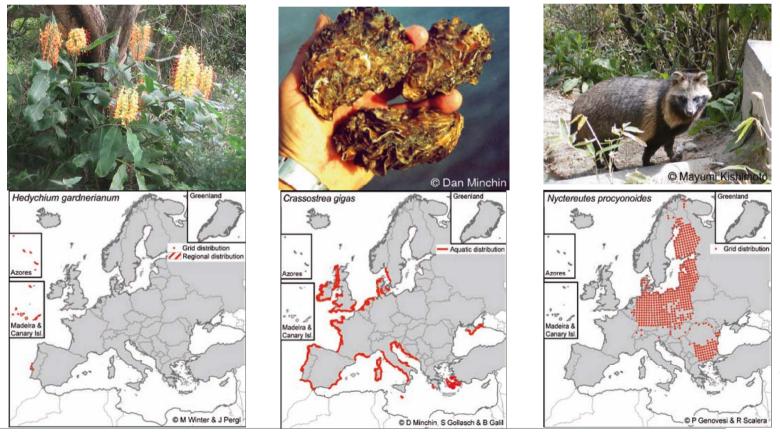


Distribution and impacts in Europe

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

- 1. Number of regions present
- 2. Abundance or cover

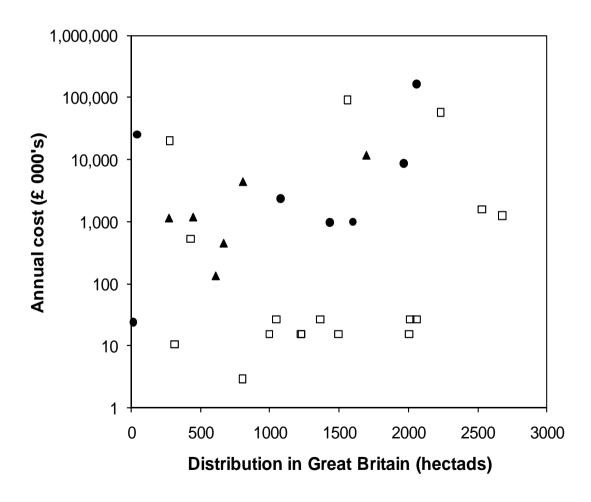
Problem of different units & spatial scales





Estimating potential impact

Williams et al. (2010)
 □ Williamson (2002)
 ▲ Oreska & Aldridge (2011)

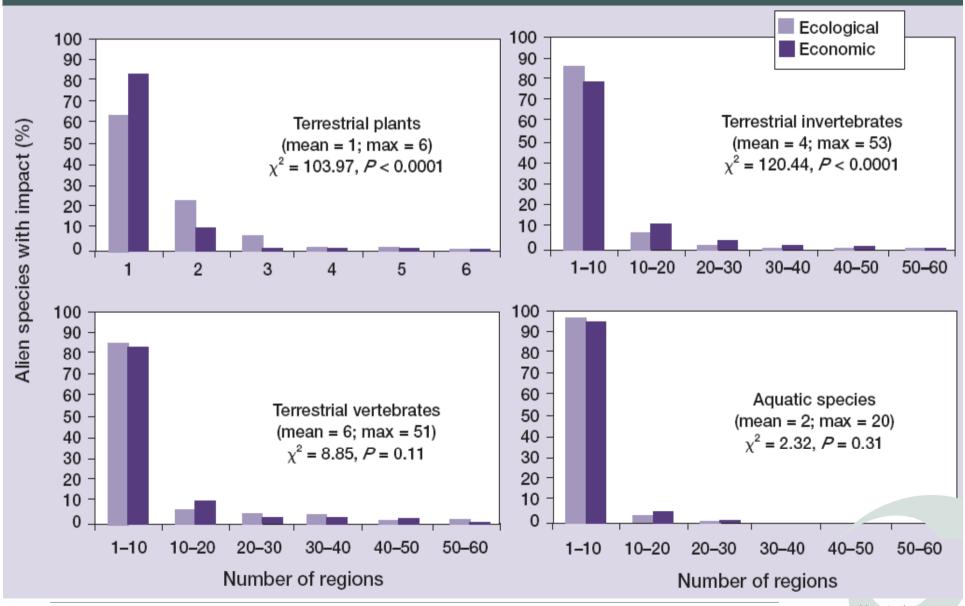


In the absence of reproducible measure of impact, distribution range is often used as a proxy for economic impact.

But these variables may not be related.



National impact not regional problem



Increasing spatial scale

Diversity of impacts on ecosystems

Environmental impacts could include:

- 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
- 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

SUPPORTING

- S1. Modification of soil and sediments (Spartina anglica)
- S2. Alteration of nutrient cycling (Dreissena polymorpha)
- S3. Community changes (Procambarus clarkii)
- S4. Refugia changes (Caulerpa taxifolia)
- S5. Changes in primary production (Coscinodiscus wailesii)

PROVISIONING

- P1. Loss or gain in food, fuel, or fiber (Anoplophora chinensis)
- P2. Threat to endangered native species (Trachemys scripta)
- P3. Alteration of genetic resources (Oxyura jamaicensis)

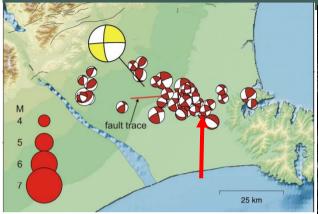
REGULATING

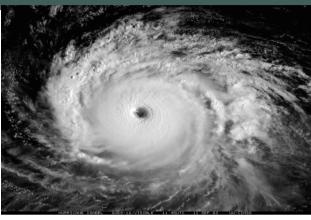
- R1. Alteration of biological control (Harmonia axyridis)
- R2. Changes in pollination services (Opuntia stricta)
- R3. Infection to native fauna and flora (Aphanomyces astaci)
- R4. Vectors of diseases (Aedes albopictus)
- R5. Production of toxic substances (Chattonella verruculosa)
- R6. Causing injuries (Ambrosia artemisiifolia)
- R7. Natural hazard protection (Cortaderia selloana)
- R8. Alteration of erosion regimes (Myocastor covpus)
- R9. Water regulation and purification (Elodea canadensis)
- R10. Bioaccumulation (Ensis americanus)

CULTURAL

- C1. Changes in recreational use (Heracleum mantegazzianum)
- C2. Effects on ecotourism (Rhopilema nomadica)
- C3. Changes in the perception of landscapes (Rosa ragosa)
- C4. Aesthetics (Cameraria ohridella)

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
- 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

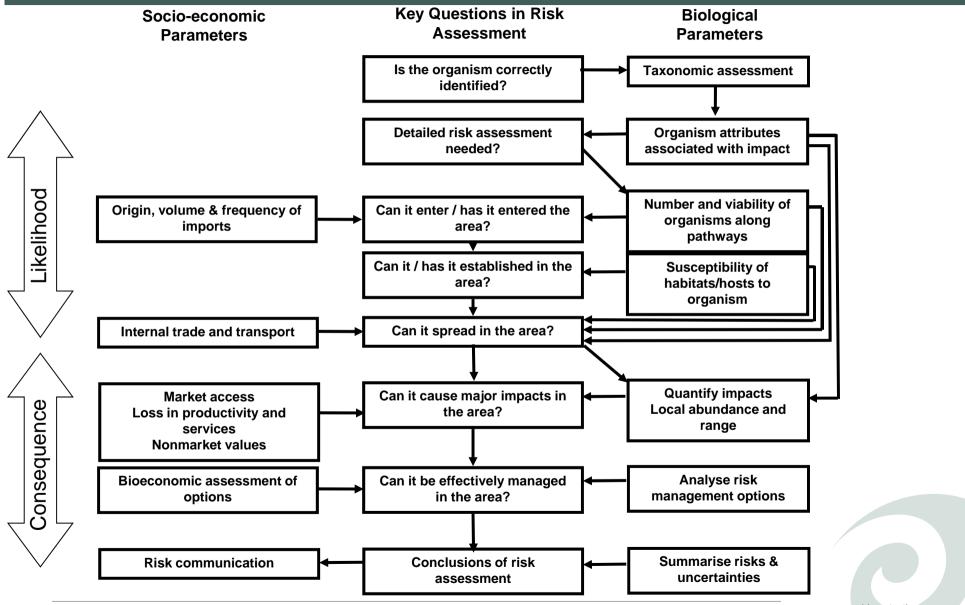








Complexity in invasion risk assessment



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

Dealing with uncertainty

Much data/ knowledge

-ikelihood

Little data/ knowledge

Ambiguity

e.g. Contending experts/fields Incommensurable priorities

Qualitative approaches

e.g. Deliberation

Bayesian belief networks

Ignorance

e.g. Unanticipated effects Evolution in organism

Horizon scanning approaches

e.g. Scenario analysis
Precaution

Risk

e.g. Familiar systems
Known invasive species

Quantitative approaches

e.g. Multivariate regression Bayesian methods

Uncertainty

e.g. Complex non-linear systems

Human element in causal models

Semi-quantitative approaches

e.g. Scoring methods Sensitivity analysis

Little data/ knowledge Much data/ knowledge

Consequences

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

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