Alien Alert *project*

Working package 3 : review of impact assessment methods

A review of methods that assess the **biodiversity & socio-economic impacts** of invasive alien species

I. Stiers, B. D'hondt, L. Triest and E. Branquart

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Report autorship :

Iris Stiers[1], Bram D'hondt[2,3] (coordinator), Ludwig Triest[1], Etienne Branquart[4]

1 - Vrije Universiteit Brussel, Plant Biology and Nature Management, Brussels

2 - Belgian Biodiversity Platform, Belgian Science Policy Office, Brussels

3 - Royal Belgian Institute of Natural Sciences, Brussels

4 - Service Public de Wallonie, Département d'Étude du Milieu Naturel et Agricole, Gembloux

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Inhoud

Introduction

This document reviews published methods for assessing the biodiversity & socio-economic impacts of (potentially) invasive alien species. As such, its results should feed into the development of a renewed risk assessment protocol within the framework of the *Alien Alert* project (working package 4).

Since a similar review was recently undertaken by Leung et al. (2011), we used their list as a basis and went in further detail, providing (i) a summary for each study, (ii) an overview of the biodiversity and economy impacts considered, and (iii) an overview of their formats.

> Leung B., Roura-Pascual N., Bacher S., Heikkilä J., Brotons L., Burgman M.A., Dehnen-Schmutz K., Essl F., Hulme P.E., Richardson D.M., Sol D., Vilà M. (2012) TEASIng apart alien risk assessments: a framework for best practices. Ecology Letters 15: 1475-1493.

Overview & general summaries

A1. Ahmed et al. (1988)

> Ahmed S., Linden A. & Cech Jr J. (1988) A rating system and annotated bibliography for the selection of appropriate, indigenous fish species for mosquito and weed control. Bulletin of the Society of Vector Ecologists, 13, 1-59.

Could not access the reference.

A2. Bomford (2006)

> Bomford M. (2006) Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models. A report produced for the Department of the Environment and Heritage, Commonwealth of Australia.

Summary :

Bomford M (2006) presents updated versions of the risk assessment models (Bomford, 2003; Bomford and Glover, 2004; Bomford 2005) recalibrated for use with the new version of CLIMATE. Models were developed for assessing the risk that exotic vertebrates could establish in Australia for mammals, birds, freshwater finfish, reptiles and amphibians. An integral part of these models is climate matching between each species' overseas geographic range and Australia. The risk assessment models for mammals, birds and freshwater finfish were developed from analyses of successful and failed introductions of exotic mammals, birds and finfish to Australia. It was not possible to compare the climate match scores of successful and failed introductions of exotic reptiles and amphibians introduced to Australia because too few exotic species in these taxa have been introduced. Instead, climate match scores were calculated for exotic reptiles and amphibians introduced to Britain, Florida and California.

Note: Interpretation of the risk assessment into the different parts was difficult for me and parts in the assessment were confusing and unclear (regarding to impact).

Biodiversity impacts considered :

- detrimental effects on prey abundance and/or habitat degradation (mammals) (C1)
- agricultural damage (birds and mammals)→ not sure if this is plant health or biodiversity (C1)
- hybridization (birds) (C1)
- competition with native fauna for tree hollows (birds) (C4)
- to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world (C5)

Economy impacts considered :

- Harm to property (species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material. Estimate the total annual dollar value of such damage) (C10)

A3. Branquart (2007)

> Branquart E. (2007) Guidelines for environmental impact assessment and list classification of non-native organisms in Belgium. ISEIA Guidelines, Harmonia information system (version 2.5), 1-4.

Summary :

Invasive alien species in Belgium are allocated to different list categories based on a simplified environmental impact assessment protocol (ISEIA) and geographic distribution in Belgium (species invasion stage). The assessment consists of four sections: dispersion potential (1), colonization of high conservation value habitats (2), adverse impacts on native species (3) and ecosystems (4).

Biodiversity impacts considered :

- Impact on native species (predation/herbivory, interference competition, transmission of diseases, genetic effects).
- Impact on ecosystems (modifications of nutrient cycling or resources pools, physical habitat modifications, modifications of natural successions, food web disruptions).

Economy impacts considered :

not included

A4. Brunel et al. (2010)

> Brunel S., Branquart E., Fried G., Van Valkenburg J., Brundu G., Starfinger U., Buholzer S., Uludag A., Joseffson M. & Baker R. (2010) The EPPO prioritization process for invasive alien plants. EPPO Bulletin, 40, 407-422.

Summary :

Prioritization process for invasive alien plants to produce a list of invasive plants that are established or could establish in the EPPO region (Part A) and to determine the highest priority species for an EPPO pest risk analysis (Part B).

Biodiversity impacts considered :

- Impact on native species, habitats and ecosystems (disruption of natural processes, modification of habitat structure)
- Impact on agriculture, horticulture and forestry → maybe also plant health

Economy impacts considered :

Not considered per se but they speak in their objectives about economic impacts and in the decision tree about 'additional' impacts.

- Impact on infrastructure and recreational activities (in the question about additional impacts)
- Impact on agriculture, horticulture or forestry (ask whether there are economic losses)

A5. Caley & Kuhnert (2006)

> Caley P. & Kuhnert P.M. (2006) Application and evaluation of classification trees for screening unwanted plants. Austral Ecology, 31, 647-655.

Summary :

Classification and regression tree models as an alternative to the current Australian Weed Risk Assessment system. Four attributes of introduced plants examined, namely: (i) intentional human dispersal of propagules; (ii) evidence of naturalization beyond native range; (iii) evidence of being a weed elsewhere; and (iv) a high level of domestication. The authors adapted the AWRA risk assessment system for the use of TREE models and removed the questions about impacts. According

to Leung et al 2012, there is one question about impact, I assume they mean ‘evidence of being a weed’. There is no clear mentioning of impacts so the RA was not considered for review.

A6. Champion & Clayton (2000)

> Champion P.D. & Clayton J.S. (2000) Border control for potential aquatic weeds. Department of Conservation Wellington (New Zealand).

Summary :

The existing MAF Weed Assessment Model (developed by P.A. Williams based on Pheloung 1996), as with other general weed evaluation models, fails to adequately separate aquatic plants with different levels of impact. Many of the attributes scored by this model are not relevant to the assessment of aquatic plants. Champion and Clayton developed a new weed risk assessment model. It provides a useful basis to compare the success of one aquatic species with another. This model is based on adaptations of the systems used in Esler et al. (1993) and Champion (1995). Attributes of the plants. ecology, biology and weediness are assessed based on observations of their behaviour in New Zealand, and/or information from other countries.

Biodiversity impacts considered :

- competitive ability within and between growth forms
- damage to natural areas (reduce biodiversity, reduce water quality, negatively affect physical processes)

Economy impacts considered :

- obstruction (water use – recreation, access, water flow-power generation, irrigation-flood control, aesthetic)

A7. Cook & Proctor (2007)

> Cook D. & Proctor W. (2007) Assessing the threat of exotic plant pests. Ecological Economics, 63, 594-604.

Summary :

In this paper, a deliberative multi-criteria evaluation technique is applied to a case study in which a jury is asked to prioritise a set of plant pests and diseases in Western Australia. Biological, ecological and economic information was conveyed to jurors before they were asked to rank each species in order of perceived significance to the State's biosecurity system using a Deliberative Multi-criteria Evaluation process. In the study they mention environmental (e.g flora and fauna), economical (e.g. production costs) and socio-cultural (e.g. human health) criteria but they don’t explain the kind of impact under each criteria.

Biodiversity impacts considered :

- flora and fauna
- ecological linkages
- extinctions and irreversibilities

Economy impacts considered :

- yield loss
- production costs
- local economies
- cultural loss

A8. Copp et al. (2005)

> Copp G.H., Garthwaite R. & Gozlan R. (2005) Risk identification and assessment of non-native freshwater fishes: concepts and perspectives on protocols for the UK. Technical Report no. 129. Cefas, Lowestoft (UK).

Summary :

A conceptual risk assessment approach for freshwater fish species that addresses the first two elements (hazard identification, hazard assessment) of the UK environmental risk strategy. Implementation of the Hazard Identification (FISK = Fish Invasiveness Screening Kit) and Hazard Assessment (IFRA = Invasive Fish Risk Assessment) phases is a staged process, initiated by an initial screening tool (FISK) to identify which species are potentially invasive. For species considered potentially invasive, a second phase, a more detailed risk assessment (IFRA), is undertaken to determine the probability of introduction and to provide a detailed analysis of the risks of establishment or impact, neither of which is provided for in the Hazard Identification phase. FISK adapted from WRA, IFRA adapted from EPPO.

Biodiversity impacts considered :

FISK

- impacts to wild stocks of angling or commercial species → can also be economical impact
- impacts to aquacultural, aquarium or ornamental species
- impacts to rivers, lakes or amenity values? → can be ecosystem functioning but also economical impact
- competition with native species
- Feeding or other behaviours reduce habitat quality for native species
- Hybridizes naturally with native species
- Does species prey on a native species (e.g. previously subjected to low or no predation)

IFRA

- history of environmental impact (organism modifies or damages vulnerable habitats, has significant impacts on native wildlife)
- severity of environmental impact (Impacts may include predation, competition, reduced habitat quality, genetic effects such as hybridization or introgression, introduction of parasites or pathogens , changes in disturbance regimes, resource pools and supply rates)
- vulnerable groups in the recipient country potentially placed at risk by the establishment of this organism (threatened species, habitats or ecosystem types; species that may be exposed to significantly increased levels of predation or competition (for food or habitat), or are they any closely related taxa or species with a similar ecology/morphology that may be particularly susceptible)
- environmental damage in the recipient area → not clear if they mean physical damage or habitat degradation

Economy impacts considered :

FISK

/ → but see my comment on the biodiversity impacts

IFRA

- history of economic loss (include loss of earnings due to reduced productivity, costs of mitigation, remediation and eradication, research costs, reduced earnings, impacts to export markets, banning of sale of commercially popular species
- severity of economic loss (commercial, recreational and traditional fisheries, aquaria/ornamental fish trade, human and animal health)
- economic risk
- likelihood of economical impact
- history and severity of social impact (social impacts includes effects to human and animal health, cultural values, quality of life)

A9. Cowie et al. (2009)

> Cowie R.H., Dillon Jr R.T., Robinson D.G. & Smith J.W. (2009) Alien non-marine snails and slugs of priority quarantine importance in the United States: A preliminary risk assessment. American Malacological Bulletin, 27, 113-132.

Summary : Preliminary risk assessment of non-marine snails and slugs. Species are ranked according to 12 attributes—seven biological variables and five aspects of human interaction—based on thorough review of the detailed literature.

Biodiversity impacts considered :

Biodiversity impacts are not clearly separately mentioned:

- Major pest elsewhere (environmental damage, human disease)
- “multi-pest” if an organism causes problems in more than one field of agriculture (including livestock health), environment, human health, and commerce, regardless of degree.

Economy impacts considered :

- Economic potential (major economic loss in the United States, including costs of control or eradication). This attribute overlaps with the attribute of being a major pest elsewhere, but is explicitly focused on economic cost.

A10. Cunningham et al. (2004)

> Cunningham D.C., Barry S.C., Woldendorp G. & Burgess M.B. (2004) A Framework for Prioritizing Sleeper Weeds for Eradication 1. Weed Technology, 18, 1189-1193.

Could not access the reference.

A11. Daehler & Carino (2000)

> Daehler C.C & Carino D.A. (2000) Predicting invasive plants: prospects for a general screening system based on current regional models. Biological Invasions, 2, 93-102.

Summary :

In this paper the authors evaluated existing screening systems outside the regions for which they were developed. Screening systems for predicting invasive plants have been independently developed for the non-indigenous floras of North America, the South African fynbos, and Australia. The authors tested tested them for the non-indigenous flora of the Hawaiian Islands. Only minor modifications were made to the three screening systems before their application to the Hawaiian flora. There is no clear mentioning of questions on impacts so the RA was not considered for review. Moreover, it is rather an application of existing weed risk-assessments than a new development.

A12. Daehler et al. (2004)

> Daehler C.C., Denslow J.S., Ansari S. & Kuo H.-C. (2004) A risk assessment system for screening out invasive pest plants from Hawaii and other Pacific islands. Conservation Biology, 18, 360-368.

Summary :

the authors tested the ability of a modified version of the Australian and New Zealand weed risk-assessment system to identify plant pests in Hawaii and other Pacific islands. This is rather an application of existing weed risk-assessments than a new development. They modified only 4 out of the 49 questions in the Australian and New Zealand system (Pheloung et al., 1999). They refer to this modified Australian and New Zealand WRA system as the Hawaii WRA system (H-WRA). None of the questions on impact were modified so this system was not reviewed as a RA.

A13. Skurka et al. (2011)

> Skurka Darin G.M., Schoenig S., Barney J.N., Panetta F.D. & DiTomaso J.M. (2011) WHIPPET: A novel tool for prioritizing invasive plant populations for regional eradication. Journal of Environmental Management, 92, 131-139.

Summary :

the authors developed a novel science-based, transparent, analytical ranking tool to prioritize weed populations, instead of species, for eradication and tested it on a group of noxious weeds in California. They named the tool WHIPPET (Weed Heuristics: Invasive Population Prioritization for Eradication Tool). They took into account both species and population characteristics.

Biodiversity impacts considered :

- Impact to wildlands

takes into account: 1) impact on abiotic ecosystem processes; 2) impact on plant community composition, structure, and interactions; 3) impact on higher trophic levels; and 4) impact on genetic integrity.

Economy impacts considered :

- Impact to agriculture. Costs to agricultural production are viewed in terms of both reduced yield and the control costs incurred to maintain yield.

- Impact to regional site value

Estimate risk of a noxious weed population affecting the region surrounding the infestation site which included: 1) agricultural commodities at risk; 2) rarity occurrences (concentrations of rare species finds recorded in the California Natural Diversity Database); 3) important recreation areas; and 4) protected land with limited control options.

A14. Department of Primary Industries (2008)

> Department of Primary Industries (2008) Victorian Weed Risk Assessment (WRA) method. In: (ed. Department of Primary Industries SoV) Victoria, Australia.

Summary : The Weed Risk Assessment (WRA) developed by the Biosciences Research Division of the Department of Primary Industries, Victoria, is a prioritisation process or risk assessment, based on the analytic hierarchy process (AHP), which ranks weeds by:

1) Assessing the plant's invasiveness.

2) Comparing the plant's present and potential distribution; and

3) Determining the impacts of the plant on social, economic, and environmental values.

The WRA is therefore expressed as a hierarchy, the components of which are weighted (using AHP) to allow the determination of a weed risk score for individual species.

Biodiversity impacts considered :

- Impact on natural rescources

Impact on water quality (ie. dissolved 02, water temperature)

Reduce the biomass of the community (nb. biomass acting as a carbon sink)

Change the frequency or intensity of fires

- Impact on flora and fauna

Impact on the vegetation composition

Structure of a vegetation community

Threatened flora spp.

Threatened fauna spp.

Non-threatened fauna spp.

Benefits or facilitates the establishment of indigenous fauna

Toxic, its burrs or spines affect indigenous fauna

Pest Animals (Provide a food source to assist in success of pest animals; Provide important habitat or harbour for serious pests)

Economy impacts considered :

- Impact on Tourism

Restrict human access

Reduce the 'tourism / aesthetics/ recreational use of the land'

- Cultural Damage to indigenous or European cultural sites

- Impact on natural resources

Impact on water flow within watercourses or water bodies

Increase soil erosion → biodiversity or economical?

A15. EPPO (2011)

> EPPO (2011) Guidelines on Pest Risk Analysis: Decision support scheme for quarantine pests. European and Mediterranean Plant Protection Organization Europe.

Summary :

the EPPO decision-support scheme for quarantine pests is intended to be used to assess the potential importance of a particular pest for a clearly defined area (the PRA area). The scheme provides detailed instructions for the following stages of pest risk analysis: initiation, pest categorization, probability of introduction, potential economic consequences and pest risk management. The assessment in section A is in the form of a binary decision tree, constructed from a sequence of questions based largely on decision points with two alternative options. If the scheme leads to the conclusion that an organism has the necessary characteristics of a quarantine pest, the pest is then evaluated in greater detail, in section B. From this evaluation, it should be possible to arrive at a conclusion concerning the level of 'pest risk' presented by the pest.

Biodiversity impacts considered :

- Negative impact on native biodiversity

To what extent does the pest cause a decline in native species

To what extent does the pest cause changes in the composition and structure of native species communities

To what extent does the pest hybridize with native species

- Alteration of ecosystem processes and patterns

To what extent does the pest cause physical modifications of habitats

To what extent does the pest cause changes in nutrient cycling and availability

To what extent does the pest cause modifications of natural successions

To what extent does the pest disrupt trophic and mutualistic interactions

- Conservation impacts

To what extent does the pest occur in habitats of high conservation value

To what extent does the pest cause harm to rare or vulnerable species

Economy impacts considered :

Social effects are impacts on human well-being, other than economic impacts. The main social effects are:

• Landscape effects. To assess the impacts on the landscape two elements need to be involved:

o Land use function (agriculture, living area)

o Contribution to wellbeing (aesthetic value, (cultural-) historic value)

• Loss of employment

• Products and services such as water quality, animal grazing, hunting and fishing (in addition to effects on plant health).

A16. Essl et al. (2011)

> Essl F., Nehring S., Klingenstein F., Milasowszky N., Nowack C. & Rabitsch W. (2011) Review of risk assessment systems of IAS in Europe and introducing the German-Austrian Black List Information System (GABLIS). Journal for Nature Conservation, 19, 339-350.

Summary :

The authors give a mini-review of existing European risk assessment procedures and present a newly developed and tested risk assessment tool for invasive alien species (IAS) in Germany and Austria, the “German–Austrian Black List Information System” (GABLIS). GABLIS has been developed as a trans-national and taxonomically universal risk assessment system, which takes into account solely the detrimental effects of alien species on biodiversity.

Biodiversity impacts considered :

- Interspecific competition

- Predation and herbivory

- Hybridistation

- Transfer of pathogens and organisms

- Negative effects on ecosystem functioning

Change of vegetation structures

Change of water balance

Reduction of insolation

Effects on sedimentation

Effects on erosion

Effects on nutrient dynamics and soil chemistry

Effects on soil formation

Change of trophic relations

Effects on vegetation dynamics

Change of succession processes

Decoupling of host-parasite or mutualist relations

Economy impacts considered :

not included

A17. European Technology Platform for Global Animal Health (2006)

> European Technology Platform for Global Animal Health. (2006) Strategic Research Agenda. Belgium.

Not considered relevant here as biodiversity impacts are not included.

A18. Fejzic et al. (2008)

> Fejzic N., Haracic S.S., Dargatz D.A., McCluskey B.J., Cornwell S.M., Salman M. & Mumford E.L. (2008) Development of an animal health surveillance infrastructure in Bosnia and Herzegovina-case report. Slovenian Veterinary Research 45, 43-48.

Not considered relevant here as biodiversity impacts are not included.

A19. Garry Oak Ecosystems Recovery Team (2007)

> Garry Oak Ecosystems Recovery Team (2007) General decision process for managing invasive plant species in Garry Oak and associated ecosystems (GOEs).

Summary :

The decision support tool is intentionally short and concise. It is driven by a series of questions to help users decide whether, and how, to manage invasive plant species in any GOE. It assumes that users are sufficiently knowledgeable about GOEs and invasive, native and rare species to understand the questions and to know where to look for help in answering them if needed.

Biodiversity impacts considered :

- Impact on native plant communities

outcompeting and crowding them out

reduction in overall biodiversity

Economy impacts considered :

- landscape aesthetics

visual blight

- natural environments

increased erosion or restricted water flow in aquatic or riparian areas

- recreation

obstacle to travel

A20. GB Non-native species Secretariat (2011)

> GB Non-native species Secretariat. (2011) Great Britain Non-native species Rapid Risk Assessment (NRRA). GB Non-native species Secretariat. York, United Kingdom.

Already consulted in light of *Alien Alert*; see elsewhere (B. D'hondt).

A21. Gederaas et al. (2007)

> Gederaas L., Salvesen I. & Viken A. (2007). Norsk svarteliste 2007: økologiske risikovurderinger av fremmede arter. Artsdatabanken.

Summary :

The 2007 Norwegian Black List is the first official overview of ecological risk analyses for a selection of alien species that have been recorded in Norway. Ecological risk means that the species may have negative impacts on ecosystems, indigenous species and genotypes, or be a vector for other species (parasites and diseases) which may be harmful to indigenous biological diversity. Economic or health effects are not assessed. The risk analysis consists of two phases. Phase 1 is a simplified risk analysis where species that have been documented as being problem-free are categorized as having low risk. For most of the species, there is no documentation that they are problem-free and a risk analysis must then be performed in Phase 2.

Biodiversity impacts considered :

- Can the species negatively affect natural habitats or ecosystems?

negative impact on ecosystems, environments, habitats or species diversity

- Can the species negatively affect indigenous species?

negative impact on Red list species, negative impact on indigenous species that are not red list species.

- Can the species negatively affect the genetic diversity?

Genetic information can be transferred to natural populations

Negative impact on locally adapted genotypes

Economy impacts considered :

not included

A22. Hayes & Sliwa (2003)

> Hayes K.R. & Sliwa C. (2003) Identifying potential marine pests - a deductive approach applied to Australia. Marine Pollution Bulletin, 46, 91-98.

Summary :

the study outlines a deductive hazard assessment technique to identify potential marine pests that may arrive via ballast water and/or hull fouling.

Biodiversity impacts considered :

- detrimental habitat modification

- alters trophic interactions or food webs

- dominates/out competes and limits the resources of native spp.

- predator of native spp.

- alters bio-geochemical cycles

- induces novel behavioural or eco-physiological responses in native spp.

- genetic impacts such as hybridisation and introgression

- herbivory

Economy impacts considered :

- water abstraction/nuisance fouling

- loss of aquaculture/commercial/recreational harvest

- loss of public/tourist amenity

- damage to marine structures/archaeology

A23. Hiebert & Stubbendieck (1993)

> Hiebert R.D. & Stubbendieck J.L. (1993) Handbook for ranking exotic plants for management and control. US Department of the Interior, National Park Service, Natural Resources Publication Office.

Summary :

in this study the authors developed the Exotic Species Ranking System for resource managers to sort exotic plants within a park according to the species level of impact and its innate ability to become a pest. This information can then be weighed against the perceived feasibility or ease of control.

Biodiversity impacts considered :

- significance of threat to park resources

- level of visual impact on the landscape

- competitive ability

- level of impact in natural areas

Economy impacts considered :

not included

A24. ISPM-11 (2004)

> ISPM-11 (2004) Pest Risk Analysis for Quarantine Pests Including Analysis of Environmental Risks and Living Modified Organisms. IPPC/FAO Rome.

Summary :

the standard provides details for the conduct of pest risk analysis (PRA) to determine if pests are quarantine pests. It describes the integrated processes to be used for risk assessment as well as the selection of risk management options. This document only gives guidelines but there are no real questions on impact as such it was not considered for review.

A25. Jefferson et al. (2004)

Jefferson L., Havens K. & Ault J. (2004) Implementing invasive screening procedures: The Chicago Botanic Garden model. Weed Technology, 18, 1434-1440.

No access to the reference.

A26. Johnson (2009)

> Johnson, S. (2009) NSW Weed Risk Management System. Industry and Investment NSW. Orange, New South Wales, Australia.

Summary :

the NSW Weed Risk Management (WRM) system aims to provide a standard, nationally accepted and transparent process to help make decisions about the introduction, prioritisation and declaration of potential weed or weed species.

Biodiversity impacts considered :

- Does the weed reduce the establishment of desired plants?

- Does the weed reduce the yield or amount of desired vegetation?

- Does the weed reduce the quality of products, diversity or services available from the land use?

- Does the weed have major positive or negative effects on environmental health?

food shelter, fire regime, altered nutrient levels, soil salinity, soil stability, soil water table

Economy impacts considered :

- What is the weed's potential to restrict the physical movement of people, animals, vehicles, machinery and/or water?

A27. Koop et al. (2012)

> Koop A.L., Fowler L., Newton L.P. & Caton B.P. (2012) Development and validation of a weed screening tool for the United States. Biological Invasions, 14, 273-294.

Summary :

in this study, the authors develop a new weed risk assessment model for the entire United States that increases non-invader accuracy. The new screening tool uses two elements of risk, establishment/spread potential and impact potential, in a logistic regression model to evaluate the invasive/weedy potential of a species.

Biodiversity impacts considered :

Allelopathic

Change ecosystem processes and parameters that affect other species?

Change community structure?

Change community composition?

Likely to affect any federal Threatened and Endangered plant species?

Likely to affect any globally outstanding ecoregions?

Outcompetes, replaces or otherwise affects desirable plants and vegetation?

Economy impacts considered :

- Impacts human property, processes, civilization, or safety?

- Changes or limits recreational use of an area?

- Reduces the quality or availability of irrigation, or strongly competes with plants for water? → maybe both biodiversity and economical impact?

- Lowers commodity value?

- Is it likely to impact trade? → considered as economical impact?

A28. McKenzie et al. (2007)

> McKenzie J., Simpson H. & Langstaff I. (2007) Development of methodology to prioritise wildlife pathogens for surveillance. Preventive Veterinary Medicine, 81, 194-210.

Not considered relevant here as biodiversity impacts are not included.

A29. Miller et al. (2010)

> Miller T.K., Allen C.R., Landis W.G. & Merchant J.W. (2010) Risk assessment: Simultaneously prioritizing the control of invasive plant species and the conservation of rare plant species. Biological Conservation, 143, 2070-2079.

Summary :

the authors adapted the Relative Risk Model to assess combinations of rare species, invasive species, and regions. It also can be applied to different taxonomic groups and at different spatial scales. This flexibility makes it a promising tool for invasive species risk assessment. They used the Relative Risk Model to quantify risks posed to endangered plant species by non-indigenous invasive plant species in Nebraska.

I could not find the questions on impact. The Relative Risk Model was originally developed by Landis (2004) so I used this reference.

29b. Landis W.G (2004). Ecological Risk Assessment Conceptual Model Formulation for Nonindigenous Species

Summary : This article addresses the application of ecological risk assessment at the regional scale to the prediction of impacts due to invasive or nonindigenous species (NIS). The first section describes risk assessment, the decision-making process, and introduces regional risk assessment. A general conceptual model for the risk assessment of NIS is then presented based upon the regional risk assessment approach.

Unfortunately I could not find the type of questions, ranking etc.

Biodiversity impacts considered :

- Replacement of economically, culturally,or socially important species

- Decrease in available habitat for significant species

- Decrease in biodiversity

- Transformation of habitat type

- Change in population dynamics

Economy impacts considered :

- Alterations of landscape structure

A30. Minnesota Interagency Exotic Species Task Force (1991)

> Minnesota Interagency Exotic Species Task Force. (1991) Report and recommendations of the Minnesota Interagency Exotic Species Task Force. Minnesota Department of Natural Resources. Minnesota, USA.

Summary :

The Interagency Exotic Task Force focused on the negative environmental and ecological impacts of exotic species.

Biodiversity impacts considered :

- effect on natural processes/character

- threat to resources

- competitive ability

Economy impacts considered :

not included

A31. More et al. (2010)

> More S.J., McKenzie K., O'Flaherty J., Doherty M.L., Cromie A.R. & Magan M.J. (2010) Setting priorities for non-regulatory animal health in Ireland: results from an expert Policy Delphi study and a farmer priority identification survey. Preventive Veterinary Medicine, 95, 198-207.

Not considered relevant here as biodiversity impacts are not included.

A32. Morse et al. (2004)

> Morse L.E., Randall J.M., Benton N., Hiebert R. & Lu S. (2004). An invasive species assessment protocol: Evaluating non-native plants for their impact on biodiversity, Version 1. US Government Documents (Utah Regional Depository), 537.

Summary :

The protocol is used to assess species (or infraspecific taxa, as appropriate) individually for a specified "region of interest" and to assign each species an Invasive Species Impact Rank (IRank) of High, Medium, Low, or Insignificant to categorize its negative impact on natural biodiversity within that region. The protocol includes 20 questions and contains four sections: Ecological Impact, Current Distribution and Abundance, Trend in Distribution and Abundance, and Management Difficulty.

Biodiversity impacts considered :

- Impact on Ecosystem Processes and System-Wide Parameters

fire occurrence, frequency, and intensity

geomorphological changes (e.g., erosion and sedimentation rates)

hydrological regimes (including soil water table)

nutrient and mineral dynamics

system-wide reductions in light availability (e.g., an aquatic invader covering an entire water

body which would otherwise be open)

changes in salinity, alkalinity, or pH

- Impact on Ecological Community Structure

- Impact on Ecological Community Composition

- Impact on Individual Native Plant or Animal Species

Strongly outcompetes a particular native species

Hybridizes with a particular native species

Parasitizes a particular native species

Poisons a particular native species

Hosts a non-native disease which damages a particular native species

Distracts pollinators from a particular native species

- Conservation Significance of the Communities and Native Species Threatened

Economy impacts considered :

not included

A33. Nentwig et al. (2010)

> Nentwig W., Kühnel E. & Bacher S. (2010) A generic impact scoring system applied to alien mammals in Europe. Conservation Biology, 24, 302-311.

Summary :

The authors present a generic scoring system that compares the impact of alien species among members of large taxonomic groups. Impact was classified as either environmental or economic.

Biodiversity impacts considered :

- hybridization

- herbivory

- predation

- competition

Economy impacts considered :

- forestry (Impact through herbivory, effect on forest growth, impact on seed dispersal, browsing on young trees, damage to plantations, gnawing of bark, damage by causing floods, damage to mature forest through seed consumption, bark stripping or antler rubbing, death of trees by felling or flooding)

- infrastructure (damage to fences and/or plantations, gnawing electricity cables etc., causing road accidents, damage through burrowing or nesting in buildings, impact through pollution, damage to flood defence systems, danger to human safety)

A34. OiE (2011a)

> OiE (World Organization for Animal Health). (2011a) Terrestrial Animal Health Code. OIE (World Organization for Animal Health) Paris, France. OIE (World Organization for Animal Health). (2011b). Aquatic Animal Health Code. OIE (World Organization for Animal Health) Paris, France.

Not considered relevant here as biodiversity impacts are not included.

A35. Olenin et al. (2007)

> Olenin S., Minchin D. & Daunys D. (2007) Assessment of biopollution in aquatic ecosystems. Marine Pollution Bulletin, 55, 379-394.

Summary :

Using basic information on abundance and distribution of alien species, the authors developed an index that classifies AS impacts on native species, communities, habitats and ecosystem functioning in marine environments. This method can be used to evaluate impact at five different levels of biopollution, fitting within the existing schemes for water quality assessment.

Biodiversity impacts considered :

- Impact on native species and communities

change(s) in species ranking, shift(s) in community dominant species, displacement of native species, loss of type-specific community, and loss of keystone species

- Impact on habitats

habitat alteration, habitat fragmentation and habitat loss

- Impact on ecosystem functioning

changes in food web and functional groups

Economy impacts considered :

not included

A36. Ou et al. (2008)

> Ou J., Lu C. & O'Toole D.K. (2008). A risk assessment system for alien plant bio-invasion in Xiamen, China. Journal of Environmental Sciences, 20, 989-997.

Summary :

A risk assessment system for alien plant invasion has been designed using a ranking system and an analytic hierarchy process. The system consists of 17 secondary indices, grouped into 6 primary indices reflecting the different stages in the bio-invasion process: introduction, establishment, dispersion, current range, infestation, and artificial control. Biogeographical, ecological, and experience-linked aspects of the species as well as artificial disturbance were taken into account in the index selection and criterion development.

Biodiversity impacts considered :

- Impact on ecosystem processes and system-wide parameters

Increase in fire occurrence, frequency, and intensity in local area;

geomorphological changes caused by erosion and sedimentation;

hydrological regime changes and reduced available aquatic habitats caused by rapid transpiration;

impact on availability of nutrients and minerals, e.g. the species is a nitrogen fixer and causes a

change of soil nitrogen;

cause system-wide reduction in light availability;

change in salinity, minerals, alkalinity,or pH;

others

- Impact on native plant or animal species

Strongly out-competes a particular native species;

produces spines, thorns, burrs, or is toxic to animals;

produces chemical substance to inhibit the germination or growth of other plants;

climbing or smothering growth habit;

hybridizes with a particular native species (especially with precious species);

hosts a disease or pest which causes damage;

other

Economy impacts considered :

- Impact on economy and other aspects

Local agriculture, forestry or fishing;

ecological community structure, causes alteration of original ecological function;

availability of soil, wetland, or other resources;

destruction of original landscape and causes damage to sites of importance to tourism;

impacts human health;

others

A37. Parker et al. (2007)

> Parker C., Caton B.P. & Fowler L. (2007) Ranking nonindigenous weed species by their potential to invade the United States. Weed Science, 55, 386-397.

Could not access the reference

A38. Pheloung et al. (1999) and Pheloung (2001)

> Pheloung P., Williams P. & Halloy S. (1999) and Pheloung P. (2001) A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. Journal of Environmental Management, 57, 239-251.

Summary :

A model designed specifically for the Australian quarantine authority: theWeed Risk Assessment model (WRA). A weed risk assessment system is described that uses information on a taxon's current weed status in other parts of the world, climate and environmental preferences, and biological attributes. The system is designed to be operated by quarantine personnel via a user-friendly computer interface.

Biodiversity impacts considered :

Biodiversity questions are not clearly listed. in my opinion the following questions are related to biodiversity impacts.

- allelopathic

- parasitic

- produces spines, thorns or burrs

- toxic to animals

- creates a fire hazard in natural ecosystems

- climbing or smothering growth habit

- forms dense thickets

Economy impacts considered :

not included

A39. Reichard & Hamilton (1997)

> Reichard S.H. & Hamilton C.W. (1997) Predicting invasions of woody plants introduced into North America. Conservation Biology, 11, 193-203.

Not considered relevant here as biodiversity impacts are not included.

A40. Risk Assessment and Management Committee (1996)

> Risk Assessment and Management Committee. (1996) Generic nonindigenous aquatic organisms risk analysis review process (for estimating risk associated with the introduction of nonindigenous aquatic organisms and how to manage for that risk). A report.

Summary :

The goal is to provide a standardized process for evaluating the risk of introducing nonindigenous aquatic organisms and, if needed, determining the correct risk management steps needed to mitigate that risk.

Biodiversity impacts considered :

- ecosystem destabilization

- reduction in biodiversity

- reduction or elimination of keystone species

- reduction or elimination of endangered/threatened species

Economy impacts considered :

- aesthetic damage

A41. Sæther et al. (2010)

> Sæther BE, Holmern T, Tufto J & Engen S. (2010) Forslag til et kvantitativt klassifiseringssystem for risikovurdering av fremmede arter. Senter för bevaringsbiologi. Trondheim, p. 144.

reference is only available in the Norwegian language

A42. Smallwood & Salmon (1992)

> Smallwood K.S. & Salmon T.P. (1992) A rating system for potential exotic bird and mammal pests. Biological Conservation, 62, 149-159.

Summary :

A rating system was developed to prioritize research and control efforts for preventing birds and mammal species invasions and eradicating established exotic pests. Four rating criteria were the species potential (1) to be introduced; (2) to establish; (3) to cause damage; and (4) to be controlled.

Biodiversity impacts considered :

The authors have a section ‘damage potential’ in their assessment but they fail to say what the content is of the damage potential.

They mention:

- damage in introduced range → no mentioning of what kind of damage is considered

- damage to agriculture → idem

- damage to natural resources

Endangered species

Wildlife-impact on species similar to local species

Wildlife habitat destruction

Economy impacts considered :

- damage to natural resources

Erosion/water flow

A43. SZEID (2006)

> SZEID. (2006) Documentation for prototype AHW prioritisation decision support tool. Version 1.1. p. 14.

Summary :

A prototype decision support tool to prioritise animal health issues. Key criteria that determine the relative importance of each issue considered in the Decision Support Tool have been identified and defined in the context of their influence, on the impact of the issue being considered, on each of the four reasons for government intervention under the GB Animal Health and Welfare Strategy and the epidemiology of the disease or issue, and risk of a detrimental change.

Biodiversity impacts considered :

- Impact on wider society

Impact on global environment (effect on ecosystem and ecosystem services)

Impact on local environment (including landscape, water, soil and air quality and biodiversity)

Economy impacts considered :

- Impact on wider society

Economic & social impact on the wider rural economy (including shops, community, tourism,shows, sports events, riding schools etc). Excludes direct impact on agricultural economy.

A44. Tucker & Richardson (1995)

> Tucker K.C. & Richardson D.M. (1995) An expert-system for screening potentially invasive alien plants in South-African fynbos. Journal of Environmental Management, 44, 309-338.

Summary :

The development and application of an expert system is described for screening alien woody plants for their invasive potential in South African fynbos. The system is proposed for use by potential introducers to demonstrate low invasive risk before importing woody alien species for cultivation.

Not considered relevant here as biodiversity impacts are not included.

A45. Ward et al. (2008)

> Ward D., Stanley M., Toft R., Forgie S. & Harris R. (2008) Assessing the risk of invasive ants: a simple and flexible scorecard approach. Insectes Sociaux, 55, 360-363.

Summary :

An assessment system which is simple, can be tailored for specific-user and regional requirements, and has the potential to integrate a variety of additional information. Target species are invasive ants in New Zealand.

Biodiversity impacts considered :

- Impact on native environment

Competitive advantage over other ants

Detrimental impacts on native invertebrates

Detrimental impacts on vertebrates

Harms indigenous flora

Economy impacts considered :

- Likely pest status to humans

Damages structures

A46. Warner et al. (2003)

> Warner P., Bossard C., Brooks M., DiTomaso J., Hall J., Howald A., Johnson D., Randall J., Roye C. & Ryan M. (2003) Criteria for categorizing invasive non-native plants that threaten wildlands. California Exotic Pest Plant Council and Southwest Vegetation Management Association.

The reference is a book → no access

A47. Weber & Gut (2004)

Weber E. & Gut D. (2004) Assessing the risk of potentially invasive plant species in central Europe. Journal for Nature Conservation, 12, 171-179.

Summary :

A risk assessment system was developed to assess the invasion potential of new environmental weeds in central Europe. A pre-evaluation step excludes species that are officially controlled, widespread, or intended for use in protected cultures only.

There is no clear mentioning of questions on biodiversity impact so the Ra was not considered for review.

A48. Weber & Gut (2005)

Weber E. & Gut D. (2005) A survey of weeds that are increasingly spreading in Europe. Agronomy for Sustainable Development 25, 109-121.

Summary :

A Europe-wide survey was conducted by sending questionnaires to weed scientists in order to evaluate currently troublesome weeds and those which may cause problems in the future. Recipients were asked to list species that are spreading and cause problems in agroecosystems, and to rate these according to three scores (degree of weediness, degree of spread potential, and degree of control success), with three levels for each score (low, medium and high).

There is no clear mentioning of questions on biodiversity impact so the Ra was not considered for review.

Format of the risk assessments

Reference	Stages considered before impact	Nr questions on impact	Point scales, aggregation and weighting	Uncertainty and validation	Output
2. Bomford (2006)	establishment	C = Risk of becoming a pest following establishment (C1 –C11) according to Leung et al 2012 there are 10 questions on impact but Bomford uses all questions in the C stage for calculating the pest risk score. In my opinion, not all these questions have to do with impact.	Most of the questions in the C stage or categorical (multiple choice) but with differences in the amount of categories (going from 0-2 to 0-5). The question about economic impact is given a monetary value and then converted to a score. All questions are treated equally. The pest risk score is calculated on stage C of the risk assessment. A species' Pest Risk Score = C = the sum of its scores for C1–C11.	Uncertainty is rated for some of the questions by using 'unknown' as one of the possible answers. 'Unknown' always gets the highest possible score.	A species' Pest Risk Score is converted to a Pest Risk Rank (Low, Moderate, Serious or Extreme)
3. Branquart (2007)	dispersal colonization	4 questions in total, 2 on biodiversity impact	Answers can be given on a 3-point scale (low = 1, medium = 2, high risk = 3). Each question is assigned the same weight. The global score is the sum of risk rating scores (between 4 and 12)	includes an assessment of uncertainty (unlikely = 1, likely = 2, deficient data = no score)	Species are assigned to a list based on their total score: black list (high environmental risk), watch list (moderate environmental risk), and alert list for potential risk species which are not yet present in Belgium
4. Brunel et al. (2010)	establishment spread	11 questions in total. 3 questions on impact. One question on impact on native species, habitats and ecosystems, 1 on impact on agriculture, horticulture or forestry and 1 on additional impacts (covering plant and human health, impact on infrastructure and recreational activities)	6 yes/no questions; 5 questions with a 3-point scale (low, medium, high). Questions on biodiversity impacts and additional impacts are on a 3-point scale with an option 'no information available'. Each question is assigned the same weight	includes an assessment of uncertainty rated as low, medium, high. An overall uncertainty for Part A should be summarized. When no information is available the process does not allow any conclusion	Species are assigned to a list based on a matrix that includes spread potential and impact (Part A). High spread and high impact = list of (potential) invasive plants; medium spread or impacts = observation list; high impact = observation list; all other species = minor concern. When no information is available, the process does not allow any conclusion. Part B: no, low or high priority for PRA
6. Champion & Clayton (2000)	entry dispersal establishment	36 questions in total, 5 on biodiversity impact, 5 on economic impact	Multiple choice questions. The attributes of greatest importance are ranked on a scale of 0-10, of intermediate importance 0-5 and 0-3 and of minor importance 0-1. Weighting is built in the scoring	No	The score is the sum of the individual questions and is only used as a ranking

7. Cook & Proctor (2007)	arrival	10 questions in total, 3 on biodiversity impact, 4 on economical impact	type of questions? All questions on a 10 point scale, 1 is low impact, 10 is high impact. An initial score was allocated for each pest under each criterion by the workshop conveners, and then discussed and modified until overall agreement was reached on each individual score. Total score is the weighted sum of all subcategories	Formed a "risk index" based on variability of scores by panel members	Ranking of the scores
8. Copp et al (2005)	introduction dispersal spread	FISK: 49 questions in total, 7 on biodiversity impact, 2? on economical impact IFRA: 36 questions in total, 4 on biodiversity impact, 4 on economical impact, 4 on social impact	FISK: yes/no questions adapted from WRA, answers converted to weighted scores then sum of the scores IFRA: 3- point scale adapted from the EPPO (2000) pest risk analysis standard. L = low, M = moderate, H = high. Unless otherwise stated, scores are: L = 1, M = 2, H = 3. No weighting, sum of the sums for each category.	FISK: no IFRA: To deal with uncertainty (precautionary approach), an 'unknown' response is by default equated with a 'yes' response, as appropriate to the question	FISK: accept, evaluate (=need further evaluation), reject taxon for IFRA IFRA: ranking
9. Cowie et al (2009)	introduction	12 questions in total, 2 on biodiversity impact, 1 on economical impact	Species and species groups were scored by giving them a '1' if the data suggested that an attribute would enhance their pest potential and a '0' if the data suggested it would not do so. If an attribute was mixed or would enhance pest potential only somewhat, it was scored as '0.5', and if the data were insufficient, there was no score. The scores were summed and then divided by the total number of attributes scored	No	ranking from 0 to 1, least to greatest concern

13. Skurka Darin et al (2011)	dispersal	1 question on biodiversity impact, 1 on economical value	Each criterion was scored as very high (10 points), high (6 points), medium (3 points), low (1 point), or very low (0 points) priority. Each score multiplied by the corresponding weight for that criterion and added the weighted criteria scores. The final score is the sum of all criteria priority point scores weighted by their percent contribution to the overall decision to eradicate	In the case of an unknown, an expert's best estimate was used to assign a middle score (6 or 3) so as not to bias the population towards very high or very low priority.	ranking according to the overall priority score
14. Department of Primary Industries (2008)	import vectors establishment dispersal	13 questions on biodiversity, 5 on socio-economics	Intensity rating of questions H=1, MH=0.75, M=0.5, ML=0.25, L=0. Weight multiplied by score and the scores then summed up	Each question scored for uncertainty	Ranking towards priority
15. EPPO (2011)	entry establishment spread	9 questions on biodiversity impact, 1 on social impact	Impacts on biodiversity are scored on 3 point scale (low, medium, high). Social impact on a 5 point scale (minimal, minor, moderate, major, massive). No explanation on the final score	Level of uncertainty is included (low, medium, high)	No ranking
16. Essl et al (2011)	introduction import vectors dispersal establishment	5 questions on biodiversity impact	Each criterion is assigned a "yes" or "no" ("yes" being the confirmation of negative impacts) if the data allow a scientifically sound answer. If the evidence is contradictory or less clear, but the data suggest that the species might fulfil this criterion, the assessment "evidence-based assumption" is given. If data are missing or highly incomplete, the criterion is assessed as "unknown".	If data are missing or highly incomplete, the criterion is assessed as "unknown".	High (=Black List), intermediate (=Grey List), low risk (=White List)
19. Garry Oak	import vectors	2 questions on biodiversity impact, 3 on socio-economical impacts	Yes/no questions with weighting included	No	Overall score

Ecosystems Recovery Team. (2007)	establishment				
21. Gederaas L., Salvesen I. & Viken A. (2007)	establishment	3 questions on biodiversity impacts in phase 2	Multiple choice questions	Option 'don't know' in the answers	Phase 1 identifies species as not requiring further assessment Phase 2 classifies species in 3 risk categories (low, high, unknown risk)
22. Hayes K.R. & Sliwa C. (2003)	transport vectors	8 questions on biodiversity impact, 4 questions on socio-economic impact	Impact yes or no	If there is uncertainty in one of the criteria than the species is excluded	Only identification as possible pests
23. Hiebert R.D. & Stubbendieck J.L. (1993)	establishment dispersal	4 questions in biodiversity impacts	The Exotic Species Ranking System uses numerical ratings, is written in outline format, and is divided into two main sections: I. Significance of Impact and II. Feasibility of Control or Management. Each section is based on a scale of 100 points	No	Ranking, plot of impact and feasibility of control
26. Johnson, S. (2009)	establishment	9 questions on biodiversity impact, 1 on socio-economical impact	Multiple-choice questions using different scales	uncertainty score is determined by calculating the percentage of 'do not know' answers that have been recorded in the **Invasiveness**, **Impacts** and **Potential distribution** sections	The score for weed risk is calculated by adjusting the Invasiveness, Impacts and Potential distribution scores to range from 0 to 10, and then multiplying these. Weed risk will have a maximum of 1000 and a minimum of 0. **Comparative Weed Risk = Invasiveness × Impacts × Potential distribution**
27. Koop A.L., Fowler L., Newton L.P. & Caton B.P. (2012)	establishment spread	7 questions on biodiversity impact, 5? questions on socio-economical impact	Binary questions yes/no. Equally-weighted sum of answered questions	Scoring as unknown possible	Low risk, high risk, evaluate further

30. Minnesota Interagency Exotic Species Task Force. (1991)	dispersal	3 questions on biodiversity impacts	Multiple choice questions with different scales, weighting inbuilt in the scoring	No	Environmental threat (minimal, moderate, severe, unknown)
32. Morse L.E., Randall J.M., Benton N., Hiebert R. & Lu S. (2004)	establishment dispersal	5 questions on biodiversity impacts	four scaled responses (A-D, plus U = unknown), weighting inbuilt in the scoring	Unknown category included	Invasive Species Impact Rank (IRank) of High, Medium, Low, or Insignificant
33. Nentwig W., Kühnel E. & Bacher S. (2010)	None	4 questions on biodiversity impact, 2 questions on socio-economics	All answers are scored on a 5-point scale, weighted sum of scores multiplied by the percentage of area occupied by the respective species in Europe	If hard data for a given impact category are lacking, the scoring system allows use of values based on expert opinion	Impact ranking
35. Olenin S., Minchin D. & Daunys D. (2007)	None	3 questions on biodiversity impacts	Impact questions scored on a 5-point scale, no weighting.	No	Matrix combining three levels of impact with abundance and distribution ranges of species. Biopollution Level on a scale 0-4 (weak, moderate, strong, massive)
36. Ou J., Lu C. & O'Toole D.K. (2008)	establishment	2 questions on biodiversity impacts, 1 question on socio-economics	weight of primary indices and secondary indices in the scoring system was defined using the AHP approach. Each of the primary indices was allocated with a weight on a percentage basis, and a certain portion of the	No	Invasion risk ranking

			weight under each primary index was allocated to the subdivided secondary indices. The sum by adding up all the values was 100.		
38. Pheloung P., Williams P. & Halloy S. (1999) and Pheloung P. (2001)	establishment	7 questions on biodiversity impacts	Yes/no questions, sometimes option low, intermediate, high. Equal weight to nearly all questions	Option 'don't know'	total score ranging from 14 (benign taxa) to 29 (maximum weediness). The total scores are converted to one of the three possible recommendations by two critical score settings. The lower critical score, 0, separates acceptable taxa from those requiring evaluation, and the higher critical score, 6, separates taxa requiring evaluation from those that should be rejected.
40. Risk Assessment and Management Committee. (1996)	dispersal	1 question on biodiversity impact and 1 on socio-economical impact	? Combination of environmental, economic and perceived impact rated as low medium high. If one of the categories is rated as high than the overall impact is high.	Each question scored for uncertainty	Low = organism of little concern Medium = organism of moderate concern High = organism of major concern
42. Smallwood K.S. & Salmon T.P. (1992)	transport establishment	3 questions on biodiversity impacts, 1 on socio-economic impacts	Combination of yes/no and multiple choice questions. weighting of criteria according to their relative importance	a correction value of 0.05 to category ratings with questionable information, and 0.10 to ratings with poor or non-documented information	Total score between 9 and 27

SZEID. (2006)	transport establishment dispersal	2 questions on biodiversity impacts, 1 on socio -economic impact	Multiple choice questions with proposed scores. Different weights are given to different questions unrelated to the different sections	No	score based on the categorical option chosen for each criterion considered, multiplied by the weighting for that criterion
45. Ward D., Stanley M., Toft R., Forgie S. & Harris R. (2008)	transport establishment	4 questions on biodiversity impacts, 1 question on socio-economic impact	All answers scored on a 3-point scale (0, 0.5, 1)	No	High, medium, low risk


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